

11. Should the engine fail to start, the entire procedure must be repeated. Bad starting is often caused by excessive fuel quantity injected by the starting injection pump. In such a case the throttle must be fully opened, the propeller must be turned by hand 3 to 4 revolutions against the direction of the engine rotation with the ignition switched off. After 3 to 4 unsuccessful attempts the engine starting must be discontinued. The cause of the defect must be determined and remedied. Prior to each starting, during which the injection pump is used, the propeller must be turned 3 to 4 times.

11.2 Warming up and testing the engine

1. Within 1 minute after starting the engine its speed must be set to 700 to 900 r.p.m. and it must be left to warm up until the temperature of the inlet oil starts to rise. Then the speed is to be increased to 1100 — 1200 r.p.m. and gradually increased to 1800 — 2000 r.p.m.
2. During warming-up the engine equipped with cowling louvres in winter the louvres and the blower of the oil cooler must be kept closed until the temperature of the cylinder heads reaches 120 °C and that of the inlet oil 40 °C.
In case of a rapid increase of temperature open the louvres and the flap of the oil cooler somewhat sooner than the above mentioned temperatures are attained.
3. The engine is warmed up when the temperature of the cylinder heads has attained 120 °C and the oil temperature at the inlet to the engine is min. 40 °C. Then the engine test can be carried out.
4. Check the engine run at the take-off speed for 15 to 20 sec.
The instruments must read the following data:
 - a) Speed 2450 r.p.m.
 - b) Oil pressure 4 to 6 kg per sq. cm
 - c) Fuel pressure 0.2 to 0.5 kg per sq. cm
5. Check the operation of magnetos and spark plugs. Adjust the throttle lever at 1900 r.p.m., subsequently switch off each magneto for max. 30 sec. Between switching over keep both magnetos switched on for 20 to 30 sec., in order to warm up the spark plugs. With the engine running on a single magneto the speed must not drop by more than 65 r.p.m.
6. Check the function of the speed regulator and the propeller — see handbook "The V 520 Propeller — Technical Description and Operation Instructions".
7. Check the engine run at the rated speed. The instruments must read the following data:
 - a) Speed 2200 r.p.m.
 - b) Oil pressure 4 to 6 kg per sq. cm
 - c) Fuel pressure 0.2 to 0.5 kg per sq. cmIn order to prevent the engine from overheating owing to insufficient blowing long operation at rated speed is not permitted.
8. Check the acceleration of the engine. In order to secure the normal acceleration the temperature of the cylinder heads should not be below 100 °C and the temperature of inlet oil min. 40 °C. It should carefully be kept in mind that any speed

(acceleration) change transitions of the engine has to be carried out gradually, i.e. by sufficiently smooth and never violent shifting the gas control lever and the speed preselector control lever.

9. Check the engine run at idling and low propeller pitch — the control lever in the "Take-off" position. The instruments should read the following data:

- a) Speed min. 550 r.p.m.
- b) Oil pressure min. 1.0 kg per sq. cm
- c) Fuel pressure min. 0.2 kg per sq. cm

Note: During warming-up and the ground engine test the temperature of the cylinder heads must not exceed +230 °C and the temperature of inlet oil +75 °C.

12 ATTENDANCE TO ENGINE DURING FLIGHT

12.1 Take-off and climbing

Prior to taking off the reading of the instruments indicating the engine run must be checked once more. The lever of the front louvres and of the oil collar flap must be set to a position safe-guarding the recommended thermal conditions of the engine. Check the engine for being warmed up, check the engine acceleration and the speed value of the take-off and rated performance in relation to the specified values. The take-off can be commenced at normal engine speed, the throttle lever being continuously set to the position corresponding to full throttle. It is permitted to use the take-off speed for 5 minutes of continuous run.

The climbing can be carried out at rated or cruising (0.75 of rated value) power. During climbing the temperature conditions of the engine must be incessantly followed. The maximum temperatures permitted for max. 5 minutes of continuous run are as follows:

- a) Temperature of the cylinder heads +240 °C
- b) Temperature of inlet oil +85 °C

If the temperature conditions of the engine exceed the maximum permitted values, the climbing must be interrupted and the engine cooled, the aircraft must be brought to horizontal flight and the output of the engine must be reduced by partly closing the throttle and decreasing the engine speed. Upon adjustment of the thermal conditions the climbing can continue.

12.2 Horizontal flight

The engine performance is chosen in relation to the required speed and altitude of the flight according to the table of preferable cruising conditions determined during the flight tests of the aircraft. The readings of instruments at normal engine speed corresponding to cruising performance should be as follows:

a) Temperature of inlet oil:	min. max. recommended	+40 °C +75 °C +50 to +65 °C
b) Temperature of cylinder heads:	min. max. recommended	+140 °C +230 °C +160 to 210 °C
c) Fuel pressure	min. max.	0.2 kg per sq. cm 0.5 kg per sq. cm
d) Oil pressure	min. max.	4 kg per sq. cm 6 kg per sq. cm

During the flight at aircraft equipped with cowling louvres, the temperature of the cylinder heads and of the oil is regulated by opening the front louvres and the oil cooler flap to varying degree. The quality of the mixture prepared by the carburetter depends upon the altitude of the flight. For the purpose of regulating the mixture quality during the flight in various altitudes the carburetter is fitted with an automatic altitude corrector.

13 STOPPING THE ENGINE RUN AND MAINTENANCE OF ENGINE

13.1 Stopping the engine run

1. Prior to being stopped the engine must be cooled down as follows:
 - a) At aircraft equipped with cowling louvres open fully the louvres and the oil cooler flap.
 - b) Adjust the propeller to minimum pitch, reduce speed to 700 — 800 r.p.m. and keep the engine running under these conditions, until the temperature of the cylinder heads attains 140 °C.
 - c) Prior to stopping, increase speed to 1900 — 2000 r.p.m. for 1 to 2 sec. Reduce speed to 600 — 700 r.p.m., switch off the ignition and slowly open fully the throttle.
2. At aircraft equipped with cowling louvres it is forbidden to shut the louvres and to apply the hood to the engine at a temperature of the cylinder heads exceeding +140 °C. The igniting cables could get damaged.
3. Stop the fire extinguishing valve of the fuel installation.
4. After each flight the respective entry in the engine log must be made stating the readings of the instruments, any irregularities in the engine operation and the operation hours of the engine. The same applies to the propeller log and the log sheet of the speed regulator.

13.2 Maintenance of engine

The basic of servicing the engine is the after-flight maintenance carried out immediately after finishing the flight and its aim is to prepare the engine for further operation.

- a) Lift the cowling and check by hand, whether all cylinders were in operation. If some of them are found to be cold (insufficiently warmed) or overheated, detect the cause of the defect and remove it at once.
- b) If oil is not diluted with fuel in winter, drain off oil completely from the tank, the cooler, the pipe-line and the slurry trap.
- c) Inspect the engine thoroughly, clean the engine itself as well as its ancillaries from impurities and oil.
- d) Inspect and treat the propeller and the speed regulator according to the handbook "The V 520 Propeller — Technical Description and Operating Instructions".
- e) Check the fuel, oil and air piping, their fastening, tightness at joints and eventual seeping of oil and fuel through hoses.
- f) Check the cocks in the fuel and oil lines and the drain plugs.
- g) Inspect the exhaust manifold and its fastening and make sure that the manifold shows no traces of overheating and that the exhaust gases do not leak at the joints.
- h) Check the screening of the ignition cables, their end sleeves and fastening of the cables.
- i) Check the fastening in the engine-mount and the state of the vibration dampers. Inspect the engine mount, particularly for cracks, deformations of the main ring, struts and nodes. Check the fastening bolts.
- j) Inspect all rubber couplings and the reliability of fastening. Check the correct function of the leverage, pull-rods and cables of the engine and equipment control. Any undesired clearance must be taken up.
- k) Drain condensate from the AK 50 M air compressor duct. Blow the duct in cold weather.
- l) Check the remaining fuel and oil in the respective tanks and determine the consumption.
- m) Check the operation of the cowling louvres and the flap in the oil cooler blower.
- n) Check the compression in the cylinders and tightness of valves by slowly cranking the engine.
- o) Check the tightness of joint between the cylinder head and the cylinder.
- p) Check the condition and tightness of the inlet manifold.
- r) Check the condition of the cowling.
- s) If an interruption in the engine operation lasting more than 10 days is anticipated a partial preservation according to chapter 16 of this handbook must be carried out.
- t) Having completed the inspection and the respective maintenance work, cover the engine with the respective hoods in order to prevent access of dust, sand and humidity.

13.3 Inspection of engine after every 10 and 25 hours of operation

- a) After every 10 hours of operation inspect and wash the fuel filter of carburettor and the fuel filter on the fireproof wall.
- b) After every 25 hours of operation the insertion pieces of the LUN 7611 cleaner fitted to the fireproof wall should be removed, washed out and re-mounted.

13.4 Inspection of engine after 50 hours of operation

The above mentioned after-flight maintenance must be further supplemented by the following procedure:

- a) Check the compression in all cylinders by screwing the coupling of hose connected to a pressure gauge into the hole for the forward spark plug. If the propeller is now turned, the pressure gauge must read a value of 3.5 to 5 kg per sq. cm at the instant of completion of the compression stroke. The compression must be checked at a temperature of the cylinder heads ranging from 40 to 60 °C.
- b) Check the valve clearance between the valve shanks and the rocker arms. The clearance should be 0.3 to 0.4 mm. In case of a difference it must be adjusted to the above mentioned values.
- c) Remove the spark plugs and clean their electrodes. Check the rigidity and deposit on the central electrode. Check the spark gap of the spark plugs. Unsuitable spark plugs must be replaced by new ones. Check the condition of the spark plugs by visual inspection of the contact space of the spark plug (blackened, oiled).
- d) Dismount all oil filters, inspect and wash them and remount.
- e) Inspect and wash the air filter in the carburettor suction branch as well as the fuel filter.
- f) Wash and lubricate the control leverage and pull-rods, including the speed regulator control.
- g) Renew the oil filling.

Note: When changing the oil in engine it is recommended to scavenge the oil circuit and the cavities in the propeller. Dismount the locking valve from the propeller (see handbook "The V 520 Propeller — Technical Description and Operation Instructions"), and move the propeller blades by hand at least twice from the low to the high pitch and back. After scavenging (the locking valve is closed again) the propeller must be air-vented by several pitch adjustments (max. 5 times) with the engine running within the range of the controllable speed.

13.5 Inspection of the engine after 100 hours of operation

Carry out all measures specified for maintenance after the flight and after 50 hours of operation and in addition:

- a) Dismount the propeller and check the tightening of the nut of the reducer. If necessary, the M 462-4020 nut should be tightened by blows of a 400 g hammer on the wrench handle. Then remount the propeller (see page 42).
- b) Dismount the distributors from the magnetos. Inspect and clean the distributor and contact breaker contacts and adjust the contact clearance to 0.25 — 0.35 mm.
- c) Wash the oil tank and the oil piping of the oil system.
- d) Wash the container, valves and the filter of the pressure air system.
- e) Check the position of the regulating needle of the carburettor altitude correction, adjust according to thermobarogram, as required. This must be carried out with extreme care.

- f) Attend to the propeller in accordance with the handbook "The V 520 Propeller — Technical Description and Operation Instructions".
- g) The maintenance work finished, start and test the engine, check the reliability of all piping joints and couplings of the engine control pull-rods.

14 PREPARATION AND PERFORMANCE OF ENGINE AT LOW TEMPERATURES

In order to ensure normal operation of the engine in winter, the preparatory work must be carried out in time.

The maintenance work specified for the respective number of flight hours is to be carried out, but the minimum scope of this work should correspond to the maintenance work after 50 flight hours, and in addition the following measures are to be taken;

- a) Provide the oil cooler with a thermally insulating jacket to protect the oil in the cooler against congealing.
- b) Check the system of oil diluting with fuel.
- c) Check the function of the air heating system at the entry to the carburetter.
- d) Should the engine be preheated by high temperature developing heaters, the ignition cables and the rubber couplings of protective sleeves of tappets at the cylinders No. 4, 5, 6 and 7 must be wound with asbestos ropes.
- e) Scavenge the oil tank, the filters and the piping of the oil system with paraffin.
- f) Check the mounting of flexible hoses of the oil system. The tubes must not sag in order to prevent the formation of pockets in which oil could accumulate and congeal.
- g) Wash and blow the fuel filter. Check all fuel piping, remove every sagging, where fuel sediments could gather and freeze up.
- h) Wash and dry the compressed-air container and the duct of the pressure air system. Check the duct for possible sagging, in which humidity could get condensed and frozen.
- i) Check and/or repair the thermo-insulating jacket of the engine. Slip the jacket over the engine and make it tightly embrace the cowling.

Further the following instructions must be observed:

Prior to starting at a temperature of $+5^{\circ}\text{C}$ or lower the engine must be heated by a preheating device. During heating the engine must be protected by a warm cover. The air temperature at the outlet from the preheater is to be preset to max. 110 to 120°C . It is forbidden to turn the propeller of a cold engine. Should the oil be drained off from the tank, oil warmed to $75 - 80^{\circ}\text{C}$ must be filled in the engine without removing the cover. This must be carried out immediately before starting the engine. If oil was not drained after the flight from the oil system and not diluted with fuel, oil in the tank must be also heated to $15 - 20^{\circ}\text{C}$ during the engine heating. The heating finished, deflect the hot air for 2 to 3 minutes in the direction of the oil cooler in order to warm up the congealed oil in its honeycombs.

14.1 Preparation of cold starting

(Refers to engines equipped with dilution of oil with fuel.) The viscosity of oil diluted with fuel is lower and it is, therefore, possible to dispense with draining the oil from the engine and with its heating prior to starting the engine. The engine can be started without heating the oil at ambient air temperature of down to -20°C . At lower temperatures oil must be drained and heated prior to starting the engine.

For the purpose of oil dilution with fuel a proportioning nozzle is incorporated in the screen of the oil sump of the engine, by means of which fuel is injected into the drawn off oil. The fuel supply system is provided with a branch pipe at the fuel inlet to the carburetter. This pipe is connected to a mechanically controlled valve, which after opening releases fuel to the oil circuit. The valve is controlled from the cockpit.

The required quantity of fuel for oil dilution amounts to $13 \pm 2\%$ by volume of the total quantity of oil in the oil installation. The quantity of fuel contained in oil from the previous dilution must be, however, also taken into account as long as the next dilution takes place within 45 to 50 min. of engine operation. Fuel contained in oil evaporates almost completely during this period. The oil level in the tank must also be checked and this state must be taken into consideration when diluting the oil, or it must be refilled to specified level.

The dilution is to be carried out always after finishing the aircraft operation, when it is anticipated that the aircraft will be out of operation for several hours (i.e. when oil in the engine and the tank gets cold). The engine thus prepared for the 13% cold starting is capable of operation at full throttle already at a temperature of inlet oil of $+5^{\circ}\text{C}$.

The dilution is to be carried out after the flight, as soon as the temperature of inlet oil has attained $20 \pm 5^{\circ}\text{C}$, the procedure being as follows:

Start the engine, let it run at 1600 r.p.m., open the valve and reclose after the specified period (according to Table in para. 14.2).

The engine is kept running for 6 more minutes in order to blend the fuel with oil. Then 3 transitions up to 2150 r.p.m. and back to idle run are carried out and the engine is stopped. During the engine run take care that the temperature of inlet oil does not exceed $+35^{\circ}\text{C}$.

Note: After the first ten operation hours since the beginning of the cold start performance inspect and clean the oil filter, since a considerable quantity of sediments is washed out from the engine by the diluted oil.

14.2 Table of dilution of MS-20 oil.

Extension of engine run since last dilution (minutes)	Quantity of oil in tank (lit.)					
	12		8		6	
	Period of opening of the dilution valve in min.-sec. according to the fuel content in oil of $13\% \pm 2\%$ by volume					
	min.-sec.		min.-sec.		min.-sec.	
10	—	57	—	53	—	50
20	1	20	1	10	1	06
30	1	25	1	18	1	12
Undiluted oil	2	20	1	40	1	30

14.3 Engine performance in winter

The temperature of air entering the carburetter must be kept within the range of $+12 \div 25$ °C in order to ensure good engine run under any performance on ground and in flight.

Thus the formation of ice accretion in the diffuser and the jet of the carburetter will be prevented. The ice accretion is formed most often during fog, snowing or rain, when the air humidity is increased and the ambient temperature is low.

15 COCKPIT TOOLS FOR SERVICING THE M 462 — RF ENGINE

	Drawing No.	Name of tool	Application
1.	700002	Double-ended box spanner, 9×11 mm	Tightening of nuts of the valve tappet guides, bolts for fastening deflectors of the cylinder heads, nuts of deflectors struts and nuts for fastening the rear air breathing of the compressor case
2.	700016	Hammer	
3.	700880-2	Flat spanner 7×9 mm	Tightening of nuts of air distributor, the speedometer drive housing and sleeves of air pipes
4.	700880-7	Flat spanner 19×22 mm	For fastening of union nuts of the removable conductors of the cable ramp and spark plugs elbows
5.	UB-24-05	Pressure lubricator	For preserving and depreserving the engine
6.	UB-24-07	Flat spanner 17×19 mm	For mounting and dismounting the nut and cap of the pressure reduction valve of the oil pump, filter of oil piping to the speed regulator, nut of pipe extension for the compressor valve, nuts fastening the generator, nuts for clamping the fuel piping and tightening of nuts of angle irons and shielding pipes of ignition cables
7.	UB-24-16	Side spanner 14 mm	For carburetter fastening
8.	UB -24-53	Handle	For spanner of the inlet tube nut and for spanner for tightening cylinder nuts
9.	UB-24-76	Flat spanner 27 mm	For fastening pull-rod covers
10.	10-24-72	Indicator of dead centre of pistons	Checking of timing adjustment setting of magnetos and pressure air distributor

	Drawing No.	Name of tool	Application
11.	10-32-07	Spanner for adjustment of valve	For adjustment of clearance between the push-rod and rocker arm roller. For mounting and dismounting lids of the rocker arm mechanism casing
12.	10-32-12	Spanner for the suction-manifold nut.	For mounting and dismounting suction manifold
13.	14-24-533	Handle	For spark plug spanner and for spanner of the oil sump filter
14.	14-24-538	Spanner of cylinder fastening nut	For tightening the cylinder bolts
15.	14-24-542	Side spanner 11 mm	For tightening of deflectors and nuts of pipe extensions of oil supply and outlet
16.	14-24-571	Spanner of suction manifold nut	For mounting and dismounting suction manifold
17.	14-24-620	Box spanner 36 mm	For mounting and dismounting the oil sump filter and oil pump
18.	14-24-630	Spark plug spanner 22 mm	For mounting and dismounting spark plugs
19.	14-24-640	Box spanner 9 mm	For nuts of forward and rear air breathing
20.	14-24-660	Spanner for lock nuts of the rocker arm regulating bolt	Securing of rocker arm regulating bolt
21.	14-324-101	Universal spanner with exchangeable heads	For hexagonal nuts of dimensions 9, 11 and 14 mm
22.	14-324-06	Spanner head 11 mm	For universal spanner 14-324-101
23.	14-324-07	Spanner head 14 mm	For universal spanner 14-324-101
24.	14-324-08	Spanner head 9 mm	For universal spanner 14-324-101
25.	14-324-09	Handle of universal spanner	For universal spanner 14-324-101
26.	14-324-10	Extension of universal spanner	For universal spanner 14-324-101

	Drawing No.	Name of tool	Application
27.	14-324-12	Flat spanner 11 × 14 mm	For bolts of the engine frame, speed regulator, oil pump, oil pump filter, fuel pump and nut of slewing elbow
28.	14-324-13	Single-ended flat spanner	For nuts of carburetter fastening
29.	14-324-100	Spanner 7 mm	For deflector nuts
30.	14-32-21	Flat spanner 36 × 41 mm	For nuts of cable ramp, oil sump filter
31.	14-232-03	Box spanner 14 × 17 mm	Tightening of the generator, carburetter, speed regulator and bolts of engine suspensions
32.	26-26-28	Peg	Spare for spanner 10-32-21
33.		Combination pliers 150 GOST 5547-52	For securing bolts and nuts
34.		Thickness gauges 100 mm long, GOST 632-41	For checking clearance between push-rod and rocker arm roller
35.	700345	Screwdriver A 150 × 0.5, GOST 5423-54	Tightening of sleeves of ignition conductors and starting air tubes
36.	700346	Screwdriver A 200 × 1 GOST 5423-54	Regulation of pressure reduction valve of oil pump, fastening of pull-rod cover, fuel pipes and magneto lids
37.	700880-8	Double-ended flat spanner 24 × 27 mm	For nut of pressure reduction valve of oil pump and for fastening pull-rod protecting sleeves
38.	14-324-17	Flat spanner 30 mm	For housing of pressure reduction valve of oil pump
39.	M 462-904	Box spanner 11 mm	For compressor nuts
40.	M 462-906	Spanner of propeller shaft nut.	For tightening propeller shaft nut
41.	M 462-923	Spanner for magnetos	For fastening of magnetos
42.	M 462-930	"Konekta" pressure gauge 2.5 to 8.5 atm. g., with tube	To determine compression values when turning by the propeller
43.	M 462-931	Spanner of oil filter	For dismounting of LUN 7611 oil filter

The tools are delivered in the case together with the engine.

16 PRESERVATION OF ENGINE

The engine preservation is the basic method of protection of the component parts against corrosion, it ensures that the engine remains undamaged during storage and ensures regular operation of the engine in use.

The following preserving materials are recommended:

1. Preservation of internal surfaces of the engine:
 - a) Storage of engine up to one year — oil MS 20+yellow ceresin according to GOST 1013-49 and CSN 65 7111.
 - b) Storage of engine up to 3 months — oil MS 20+yellow ceresin.
 - c) Engines put out of operation for a period of up to 2 months without being dismantled from the aircraft as well as engines sent for repairs — oil MS 20.
2. For preserving the external surfaces of the engine oil MS 20+yellow ceresin are also used.
3. Should the above mentioned materials not be available for preserving the external surfaces for a period of 2 months, the use of OK 1 preserving oil is permitted.

16.1 Preserving engine if put out of operation without being dismantled from aircraft

Prior to preserving the engine maintenance work corresponding to the number of flight hours performed before its being put out of operation must be carried out. The extent of maintenance work, however, must correspond at least to that performed after 50 flight hours of the engine.

The engine is to be prepared for preserving as follows:

1. Fill each fuel tank with 20 lit. of fuel.
2. Drain off oil from the oil tank and oil cooler and fill the tank with 8 — 10 lit. of fresh oil (in winter the oil must be heated to 75 — 80 °C prior to filling).
3. Start the engine and keep it running at 1100 to 1200 r.p.m. for 10 to 15 min.
4. Drain oil from tank and cooler.
5. At the cylinder head temperature of 40 to 70 °C unscrew the forward spark plugs and turn the propeller 8 to 10 times in order to remove the combustion products from the cylinders. Turn the propeller with the magnetos switched off and the throttle opened.
6. For preservation of propeller — see handbook "The V 520 Propeller — Technical description and Operation Instructions".

16.2 Preserving engine when putting it out of operation for 15 days

1. Inject 150 to 200 c. cm. of pure aircraft oil free of moisture, e.g. MS 20 heated to 40 — 50 °C, into each cylinder with the piston in BDC. Having injected oil into all cylinders turn the propeller through 4 or 5 revolutions with the ignition off and the fuel supply shut off.
2. Clean all accessible parts lacking surface protection as well as all friction surfaces and coat them with a thin layer of technical vaseline.