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РД-9Б TURBO-JET ENGINE

OPERATING INSTRUCTIONS

SECRET

PREFACE

This publication should be regarded as the main guide to be followed when operating the РД-9Б turbo-jet engine.

The book is based on the materials of the manufacturing plant as well as on experience gained during operation of the engine.

Instructions on operation and maintenance of the РД-9Б engine, presented in this publication, apply to the engines of the fourth series.

Operation of the fifth series engines equipped with afterburners incorporating precombustion ignition, as well as of the sixth series engines furnished with push-button control of the maximum and augmented ratings and with НР-11ВА pump incorporating afterburner control unit does not differ to any considerable degree from operation of the fourth series engines. All peculiarities as to operation of these engines are referred to in Chapters XII and XIII.

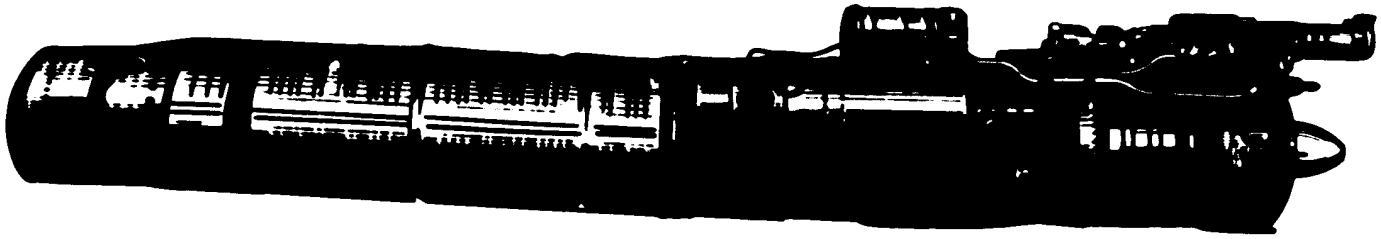

Fig.1. PA-9B Engine with Afterburner

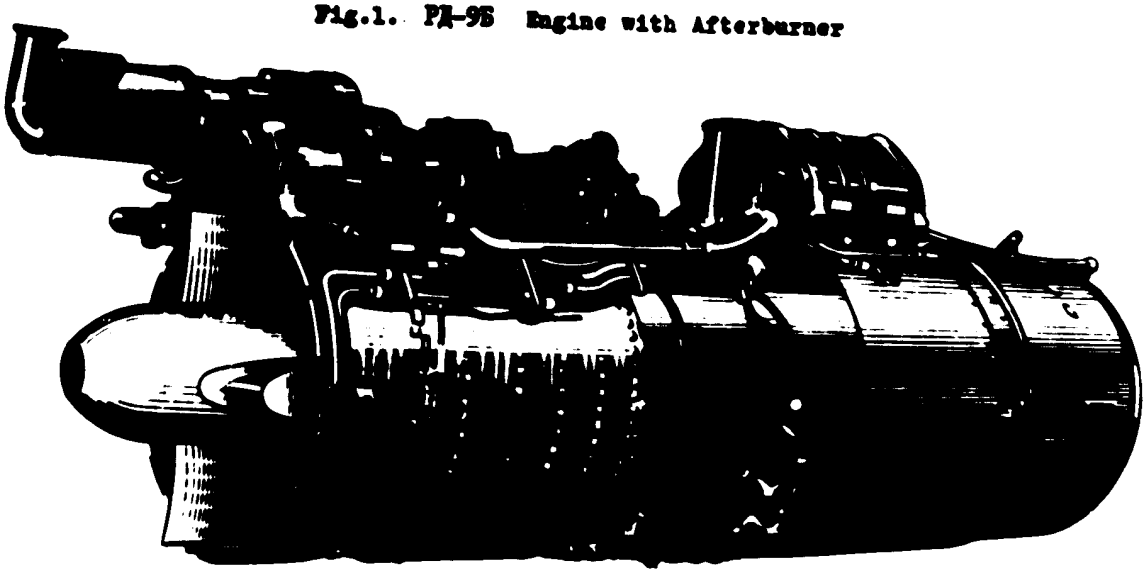

Fig.2. PA-9B Engine without Afterburner Tube and Jet Nozzle. Right-Hand View

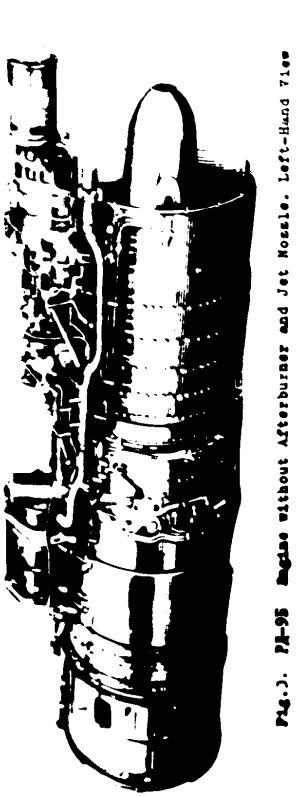

Fig.3. РД-9Б Engine without Afterburner and Jet Nozzle. Left-Hand View

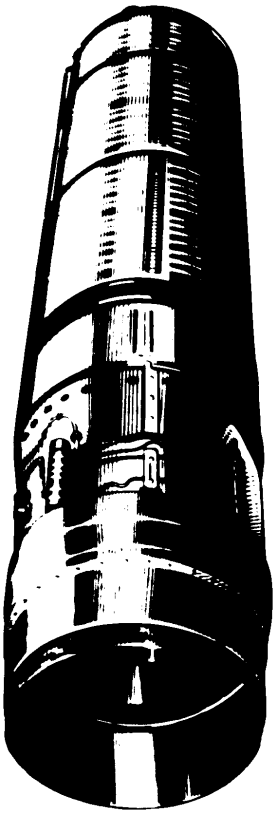

Fig.4. Afterburner Tube with Jet Nozzle

Chapter I

РД-9Б TURBO-JET ENGINE (FOURTH SERIES) [illegible]

(Figs 1, 2, 3, and 4)

General Data

1. Designation	РД-9Б
2. Engine type	turbo-jet engine with afterburner
3. Compressor	
type	axial-flow nine-stage [illegible] automatic control of [illegible] blow-off from 5th stage
corrected upper speed limit at stand tests	not over 8700 r.p.m.
4. Combustion chambers	
type	straight-flow, individual, arranged in common housing
number	10
arrangement	along circumference
combustion chamber numbering (if viewed from adjustable jet nozzle end)	beginning with upper left-hand chamber, counter-clockwise
5. Turbine (type, number of stages)	axial, two-stage
6. Direction of rotation of engine rotor	counter-clockwise (as viewed from adjustable jet nozzle end)

7. Jet nozzle
   type ..... adjustable (three positions)
   diameter of jet nozzle
   exhaust area (with after-
   burner turned on, at start-
   ing, and within speed range
   from idling to 4500-6500 r.p.m. minimum 495 mm; maximum diameter is limited by minimum overlapping of shutters (4 mm)
   at maximum rating 435-452mm
   at other ratings ..... 458-475 mm

Fuel System

8. Fuel booster pump
   type ..... ЦН-9, centrifugal, with constant-pressure valve
   direction of rotation ..... left-hand
   gear ratio 1.25

   Notes: 1. Direction of rotation of the units referred to under "general data" are given if viewed from the shank end.
   2. Gear ratios for the units are calculated by the following formula:

$$i = \frac{\text{n of engine}}{\text{n of unit}}$$

   where i is gear ratio
   n - r.p.m.

9. Main fuel regulating pump
   type ..... HP-10A, plunger, with automatic devices ensuring metering of fuel, fed into main combustion chambers at all ratings

   engine speed is regulated
   automatically ..... beginning from 8200 ±100 r.p.m.
   direction of rotation (if
   viewed from drive end) ..... right-hand
   gear ratio 3.125
10. Starting fuel pump (one per two engines)
   type ..... ПНР-10-9М, gear, driven by electric motor МУ-102А
   gear ratio to electric motor.. 1.0
   direction of rotation
   (looking at pump flange) ..... left-hand
   fuel pressure regulator
   (incorporated in pump) ..... spring loaded reducing valve
   pump output with engine
   operating on ground at
   counter-pressure of
   2 kg/sq.cm., voltage across
   motor terminals amounting to
   24 V and current of 5 A ..... 40 h.p.
11. Afterburner fuel regulating pump
   type ..... HP-11A, plunger, with automatic devices ensuring metering of fuel and its delivery into afterburner with engine operating at augmented rating
   direction of rotation
   (looking from drive end) ..... right-hand
   gear ratio 3.125
12. Main burner
   type ..... centrifugal, double-duct with filter in every duct

number 10

13. Starting atomizer
type ..... centrifugal
number 4
14. Afterburner fuel nozzle
type ..... centrifugal
number 17
15. Low-pressure fuel filter ..... gauze, disc type, installed on fuel-oil unit 317A
16. Starting fuel pressure (during engine starting) ..... 1.0-1.75 kg/sq.cm.
17. Amount of fuel consumed during one starting of engine..... not over 0.5 kg
18. Fuel pressure before main and afterburner high-pressure fuel pumps ..... 1.6-2.6 kg/sq.cm. For short periods - up to 2.8 kg/sq.cm.
19. Fuel pressure before main burners ..... not over 80 kg/sq.cm.
20. Fuel pressure before afterburner fuel nozzles ..... not over 90 kg/sq.cm.
21. Engine acceleration ability(period during which engine gains maximum speed with control lever shifted within 1.5-2 sec.) from beginning of automatic regulation (8200 ± ±100 r.p.m.) to normal rating ..... 9-12 sec.

from idling rating to normal rating ..... 9-12 sec.
from idling rating to maximum rating ..... 9-13 sec.
from idling rating to augmented rating ..... not over 15 sec.

22. Gas temperature rise after turbine, during acceleration check ..... not over 750°C
23. Speed increase when checking acceleration ability and after turning on and off afterburner (for short period of 3 to 5 sec.) ..... not over 11,600 r.p.m.
24. Time period during which engine speed increases from maximum to augmented (as indicated by increase in afterburner fuel pressure)... not over 6 sec.

Oil System

25. Lubricating system ..... closed-circuit, self-sustained pressure lubrication
26. Oil pumps
(a) pressure oil pump
type ..... gear, single stage
number 1
direction of rotation ..... left-hand
gear ratio 4.0
output at normal rating with counter-pressure amounting to 3-4 kg/sq.cm. and oil temperature of 60-65°C..... 25 lit/min.
(b) scavenge oil pump
type ..... gear, three-stage
number 1

direction of rotation ..... left-hand
gear ratio 2.55
output at normal rating with counter-pressure amounting to 1.0 kg/sq.cm. and oil temperature of 70-75°C: stage scavenging oil from compressor inlet housing ..... 50 lit/min.
stage scavenging oil from centre bearing housing ..... 22 lit/min.
stage scavenging oil from rear bearing housing ..... 22 lit/min.

27. Pressure of oil in pressure line at idling rating ..... not less than 1 kg/sq.cm.
at maximum r.p.m. ..... $4.5_{-0.5}$ kg/sq.cm.

Note: Indicated oil pressure values are referred to stand test conditions. When operating the aircraft oil pressure is checked by the pilot lamp connected to oil pressure warning mechanism 2СДУ5-1.3-2.2 (See Table 1 "Engine ratings").

28. Oil consumption ..... not over 0.5 kg/hr[x/]
29. Temperature of oil at engine inlet at all ratings ..... not below -40° and not above +85°C
30. Fuel-oil unit
type ..... 317A. Incorporates oil tank, fuel-oil cooler, and low-pressure fuel filter
temperature of fuel at fuel-oil cooler inlet ..... not over 40°C

x/ Oil consumption for engines numbered up to No. Г534227 should not exceed 1.5 kg/hr.

amount of oil in oil tank
maximum ..... 10.5-11 lit.
minimum (after flight) ..... not less than 7 lit.

Starting System

31. System type ..... electric, self-sustained, automatic, with changing of voltage from 24 to 48 V (use of 24 V system is allowed). Engine is started by starter-generator operating as starter through automatic starting system energized from storage batteries. Storage batteries are boost charged by starter-generator functioning as generator. Starting may be accomplished by use of ground supply source with voltage across terminals amounting to 24-30 V (with no load)
32. Starter-generator ..... ГСР-СТ-6000А. At engine starting it is used as starter; during engine operation it functions as D.C. generator
direction of rotation ..... left-hand
gear ratio
at starting 0.356
when functioning as generator 1.25
power developed at starting (at voltage of 21 V and current of 200A ..... 3.5 h.p.

generator power (at voltage ... V) ..... 6000 W
period of operation during starting when 24 V system is used ..... 44.3 ±0.5 sec.
when 24-48 V system is used 31.5 ±0.5 sec.
permissible number of successive switchings at starting .....5 (followed by 30 min. cooling period)

33. Starting equipment (installed on aircraft) starting box
24 V system ПКС-6000Е
24-48 V system ПКС-6000М
battery switch box (24-48 V system) КПА-2
battery change-over relay (24-48 V system) РПА-200М
starting timing device 24 V
24 V system АВП-1ВЕ
24-48 V system АВ-5А
relay (for 24-48 V system) ...two relays РП-2, three relays РП-3 and one relay РД-20Г

34. Time of engine acceleration to idling rating or to speed 100 r.p.m. lower than idling rating
24 V system ..... not over 80 sec.
24-48 V system ..... not over 60 sec.

35. Permissible short-time (up to 10 sec.) gas temperature rise after turbine when starting engine on ground ... not over 850°C

36. Number of engine startings without boost charging storage batteries: if 24-48 V system is employed - from two storage batteries 12САМ-12 or with 24 V system - from one storage battery 12САМ-28 ..... not less than 3

Ignition, Electric Equipment, and Control Systems

37. Type of ignition (engine and afterburner) ..... spark, vibrating
38. Engine booster coil
type КП-21Б1М
number 1
39. Afterburner booster coil
type КПМ-1А
number 1
40. Engine spark plugs
type ..... СД-96, shielded
number 4
41. Afterburner spark plug
type СП-02
number 1
42. Generator control equipment (installed on aircraft)
carbon-pile voltage regulator Р-25А
differential-minimum relay... ДМР-400
stabilizing transformer Т-1Г
ballast resistor БС-6000
43. Afterburner control unit (installed on aircraft)
24 V system КАФ-2
24-48 V system КАФ-2А
44. Compressor air blow-off band control mechanism
type ..... hydraulic, piston type, with centrifugal and magnetic valves

pressure of fuel in air blow-off hand control system ..... not over 85 kg/sq.cm.
engine speed at which hand uncovers air blow-off ports (with engine control lever shifted towards speed decrease) ..... 9700-100 r.p.m.

5. Adjustable jet nozzle shutter control mechanism
type ..... hydraulic, piston type
number of actuating cylinders 4
hydraulic fluid ..... AMГ-10 oil
pressure of hydraulic fluid in control system ..... 90-140 kg/sq.cm.
temperature of hydraulic fluid ..... from -40 to +60°C
6. Switches of jet nozzle shutter control mechanism (installed on aircraft)
type ..... ГА-21 two-position magnetic valves
number (per 1 engine) 2
7. Control panel ..... ПУ-3, (a) switches on and off maximum and augmented ratings;
(b) shifts jet nozzle shutters to augmented or normal position at engine speed of 4500-6500 r.p.m. when engine control lever is moved to "Cut-Off" (СТОП) or NORMAL (НОМИНАЛ) stops respectively;
(c) switches over stages of oil pressure warning mechanism 2СДУ5-1.3-2.2;
(d) makes possible cold cranking of engine with control lever set at "CUT-OFF" (СТОП) stop;
(e) switches over electric system serving for corrosion-preventive treatment of engine

48. Warning and interlocking devices
(a) minimum fuel pressure warning mechanism (in aircraft booster pump line) ..... СД-3, membrane type, automatically switches off augmented or maximum rating when fuel pressure in aircraft fuel booster system drops below 0.3 kg/sq.cm.
(b) minimum fuel pressure warning mechanism (in afterburner manifolds) ..... ДСД-2, membrane type,
(a) prevents opening of jet nozzle shutters when afterburner is turned on in case excessive fuel pressure in afterburner manifolds drops below 0.2 kg/sq.cm. as compared to total pressure of gases in afterburner;
(b) prevents jet nozzle shutters from being closed when afterburner

	is turned off in case excessive fuel pressure in afterburner manifolds exceeds 0.2 kg/sq.cm. as compared to total pressure of gases in afterburner
(c) Hydraulic switch controlling fuel delivery by pump НР-11 (installed on aircraft)	УТ-34/1, automatically turns off afterburner when there is no hydraulic pressure in intermediate chambers of cylinders controlling adjustable jet nozzle shutters
(d) limit switch of НР-10А pump hydraulic decelerator...	prevents cutting-in of maximum or augmented rating when engine speed is below 10,400 ±200 r.p.m. with engine control lever smoothly shifted to respective stop
(e) limit switch Л (in control panel)	(a) prevents jet nozzle shutters from being opened to augmented position at altitudes, where engine speed at low throttle exceeds 9700_{-100} r.p.m.; (b) makes it impossible to cut in augmented or maximum rating, if engine speed is below 9700_{-100} r.p.m. with control lever shifted within 1.5-2 sec.

Aircraft Accessory Units

49. Hydraulic pump (installed by Manufacturer on accessory drive gearbox)
    - type ..... unit 623, gear, constant displacement, or 435BM, variable displacement plunger type
    - number 1
    - direction of rotation ..... right-hand
    - gear ratio 4.5

Measuring Instruments

50. Tachometer (installed by Manufacturer)
    - type ..... 2ТЭ-15 with generator ДТ-3
    - direction of rotation of tachometer generator ..... left-hand
    - gear ratio to generator 4.0
51. Thermometer for measuring temperature of gases aft of turbine (installed by Manufacturer)
    - type ТВГ-11
    - number of thermo-couples .... 4, connected in series
52. Oil pressure warning mechanism ..... 2СДУ5-1.3-2.2, membrane type, closes pilot lamp circuit (pilot lamp lights up) when oil pressure in oil pressure line drops below 1.3 kg/sq.cm. at engine speeds below 9700_{-100} r.p.m., or when oil pressure drops below

2.2 kg/sq.cm. at engine speeds of over 9700_{-100} r.p.m.

Overall Dimensions of Engine

Length of engine with afterburner .... 5555 mm
Engine diameter on combustion chamber section .... 665 mm
Afterburner diameter .... 645 mm
Maximum height of engine complete with accessories ...... 938 mm

Engine Weight

Dry weight of engine complete with fuel-oil unit 317A .... $695^{+2 \text{ per cent}}$ kg

Engine Service Life

Engine service life up to first overhaul .... 100 hours

Table 1

Engine Ratings

Rating	R.P.M.	Temperature of gases aft of turbine, C° (not over)		Oil pressure at engine inlet	Period of continuous operation, min. (not over)		Total operation time during service life, hours
		on ground	in flight		up to 6000 m.	at 6000 m. and higher	
1	2	3	4	5	6	7	8
Augmented	11,150±50	650[x] 680[xx]	Within 620-680[xxx]	Pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not light up	6	10	5

x At the ambient air temperatures below +15°C.

xx At the ambient air temperatures of +15°C and higher.

xxx When climbing with the afterburner turned on (at altitudes of over 10,000 m.) temperature of gases aft of the turbine may increase for a short period to 700°C.

If РД-9Б engines of the fourth or fifth series are used with 40 mm wide (instead of [illegible] mm wide) plate of the afterburner diffuser flame arrestor, temperature of gases aft of the turbine may rise to 700°C for not more than 30 sec., when climbing with the afterburner turned on.

1	2	3	4	5	6	7	8
Maximum	11,150 ±50	650	680	Pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not light up	6	10	[illegible]
Normal	11,150 ±50	550		Same	Unlimited		40
0.8 normal	10,400 ±50			Same	Unlimited		
Idling	4100^{+200}	650		Same	10^{xxx}		

xxxx Continuous operation of the engine on the ground at speeds below 9700_{-100} r.p.m. should not exceed 5 min. (with the aircraft fuselage jointed).

Chapter II
FUEL AND LUBRICANT
1. Fuel

The engine uses T-1 or TC-1 fuel grades. In winter it is allowed to use the above fuels with addition of 0.3 per cent liquid "И" (by weight).

The recommended grades of fuel should possess the following physico-chemical properties:

Nos	Physico-chemical properties	Fuel grade	
		T-1	TC-1
1	2	3	4
1	Density ρ_4^{20}	0.80-0.85	0.775
2	Distillation characteristic		
	(a) distillation point °C, not over	150	150
	(b) 10 per cent distilled at temperature of °C, not over	175	165
	(c) 50 per cent distilled at temperature of °C, not over	225	195
	(d) 90 per cent distilled at temperature of °C, not over	270	230
	(e) 98 per cent distilled at temperature of °C, not over	280	250

1	2	3	4
	(f) residue and losses, per cent, not over	2	2
3	Kinematic viscosity, c.s. (a) at temperature of 20°C, not less than	1.5	1.25
	(b) at temperature of 0°C, not over	4	2.5
	(c) at temperature of -40°C, not over	16	8
	(d) at temperature of -50°C, not over	25	
4	Acidity, mg KOH per 100 ml of fuel, not over	1.0	1.0
5	Flash point in closed cup, °C, not less than	30	28
6	Crystallizing point, °C, not over	-60	-60
7	Cloud point, °C, not over	-50	-50
8	Iodine number gr of iodine per 100 gr of fuel, not over	2	3.5
9	Aromatic hydrocarbons content, per cent, not over	25	22
10	Actual gum content, mg per 100 ml of fuel		
	(a) at manufacturing plant, not over	8	7
	(b) at place of consumption, not over	11	10
11	Total sulphur, per cent, not over	0.1	0.25
	including mercaptan sulphur, not over	-	0.01
12	Water-soluble acids and alkalies	None	

1	2	3	4
13	Low heating value, cal/kg not less than	10,250	10,250
14	Copper-strip test	-	As specified
15	Ash content, per cent, not over	0.005	0.005
16	Mechanical impurities and water	None	

For starting purposes clean aviation gasoline (unleaded) is utilized.

2. Lubricant

For lubricating the rubbing parts of the engine in summer and in winter time aviation oil MK-8 or its substitute (transformer oil) is used.

Note: Transformer oil may be used at ambient air temperatures of not below -30°C.

At lower ambient air temperatures oil MK-8 should be utilized.

Aviation oil MK-8 should possess the following physico-chemical properties:

Nos	Physico-chemical properties	Numerical values
1	2	3
1	Kinematic viscosity, c.s. (a) at 50°C, not less than	8.30
	(b) at 20°C, not over	30.0
2	Kinematic viscosity at -20°C to kinematic viscosity at +50°C ratio, c.s., not over	60
3	Acid number, mg KOH per 1 gr of oil, not over	0.04

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1	2	3
4	Stability	
	(a) oxidation deposit, per cent, not over	0.1
	(b) acid number after oxidation, mg KOH per 1 gr of oil, not over	0.35
5	Ash content, per cent, not over	0.005
6	Sulphur content, per cent, not over	0.14
7	Water-soluble acids and alkalies	None
8	Mechanical impurities	None
9	Water	None
10	Flash point in closed cup, °C, not over ...	135
11	Pour point, °C, not over	-55
12	Sodium test with acidification, units, not over	2
13	Aniline point, °C, not less than	79
14	Density ρ_4^{20}, not over	0.885

Notes: 1. For oils extracted from Dossor petroleum kinematic viscosity at -20°C to kinematic viscosity at +50°C ratio should not exceed 75 c.s., while acid number after oxidation must not exceed 0.5 mg KOH per 1 gr of oil.

2. Oil should be stored and shipped in drums and cans.

3. Oil check samples should be equal to 1.5 lit.

Transformer oil should possess the following physico-chemical properties:

Nos	Physico-chemical properties	Numerical values	
		Transformer oil	Transformer oil with additive BTM-1
1	2	3	4
1	Kinematic viscosity, c.s.		
	(a) at 20°C, not over	30	30

1	2	3	4
	(b) at 50°C, not over	9.6	9.6
2.	Acid number, mg KOH per 1 gr of oil, not over	0.05	0.03
3	Stability:		
	(a) oxidation deposit, per cent, not over	0.10	0.05
	(b) acid number after oxidation, mg KOH per 1 gr of oil, not over	0.35	0.20
4	Ash content, per cent, not over..	0.005	0.005
5	Water-soluble acids and alkalies	None	
6	Mechanical impurities	None	
7	Flash point in closed cup, °C, not less than	135	135
8	Pour point, °C, not over	-45	-45
9	Sodium test with acidification, units, not over	2	2
10	Formation of water-soluble acids at beginning of ageing:		
	(a) non-volatile water-soluble acids, mg KOH per 1 gr of oil, not over	0.005	0.005
	(b) volatile water-soluble acids, mg KOH per 1 gr of oil, not over	0.005	0.005
11	Transparence at +5°C	Transparent	
12	Dielectric losses angle tangent:		
	(a) at 20°C, per cent, not over..	0.3	0.3
	(b) at 70°C, per cent, not over..	2.5	2.5
13	Additive BTM-1 content, per cent, within	-	0.009-0.015

Notes: 1. Oil check sample should be equal to 2 lit.

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2. For transformer oil extracted from Emba petroleum, acid number after oxidation should not exceed 0.5 mg of KOH per 1 gr of oil.
3. An oil sample is passed through two paper filters, with subsequent determination of dielectric losses angle tangent.

If the test result does not comply with the specified value, the oil sample should be desiccated in a thermostat at a temperature of 105 to 110°C during 3 hours, then it should be cooled in the thermostat or in a hermetically sealed vessel (a desiccator without desiccant) to the testing temperature, after which dielectric losses angle tangent should be determined anew; if the test result complies with the specified value the oil should be considered fit for use.

To determine dielectric losses angle tangent, copper, brass, or stainless steel electrodes with chrome or nickel plated operating surfaces should be used, the procedure being carried out at electric field intensity amounting to 1 $kV_{r.m.s.}/mm$.

Chapter III

PREPARATION OF ENGINE FOR OPERATION

1. Filling of Fuel, Oil and Hydraulic Systems

1. Check to see that the main and starting fuel tanks are properly filled; if necessary, fill them with fuel as laid down in Aircraft Operating Instructions.

When filling fuel into the tank, use a filter of capron fabric, installed on the fuel servicing truck, and a filter of gauze No.200/30 to No.250/100 provided on the fuel dispensing gun.

2. Check the oil tank of the fuel-oil unit 317A, and fill it with oil, should it be necessary.

With the oil tank filled to capacity the tank should hold 10.5-11 lit. of oil (Provided the engine oil system is filled fully). When checking the oil level in the tank, use an oil-depth gauge (dip stick) with two edges marked "ЛЕВ." (LEFT-HAND) and "ПРАВ." (RIGHT-HAND), for the left-hand and right-hand engines respectively.

The aircraft is allowed to fly only with the engine oil tank filled to capacity. Minimum amount of oil remaining in the oil tank after flight should not be less than 7 lit.

Note: In case of emergency, the aircraft may be flown with the oil tank not filled to the full mark; after flight not less than 7 lit. of oil must remain in the tank.

If for some reason or other oil has been discharged from the engine oil system, fill the oil tank as set forth in the respective instructions, after which crank the cold

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engine two to three times to allow the engine oil system to be filled. The engine oil system capacity (without the oil tank) amounts to about 2.5 lit. After cranking the engine start it, accelerate to 10,000 r.p.m., then stop it. Check amount of oil in the oil tank, and add oil to the required level.

This done, check to see that the oil tank filler plug is securely tightened.

CAUTION: Do not add oil into the tank during engine operation, to avoid oil throw.

3. Check, and if necessary fill the aircraft hydraulic system reservoir with operating fluid (AMT-10 oil), as prescribed in Aircraft Operating Instructions.

When filling the tanks with fuel, oil, and operating fluid (AMT-10 oil) observe the following:

(a) do not fill the tanks of aircraft which are exposed to gases discharged by taxiing aircraft, or when some aircraft with operating engines are positioned at leeward;

(b) when carrying out the filling procedure direct special attention to cleanliness of the dispensing gun and the hose of the servicing truck; make sure the funnels and filters used during the filling procedure, as well as the tank fillers and their caps are clean;

(c) use care to prevent dirt, sand, water, dust, or other foreign matter from getting into the tank filler;

(d) prior to filling the aircraft tanks, drain 1 to 2 lit. of oil and fuel into clean containers from the servicing tank sump, allow it to settle and check the oil and fuel for mechanical impurities and water;

(e) fuel and oil delivered into the aircraft tanks should be provided with a Certificate signed by the respective officials and containing fuel and oil analysis data. The analysis data should comply with the requirements of the respective State Standard.

Notes: 1. If the corrosion-preventive compound has not been removed from the engine, perform the procedure as instructed in Chapter X, after filling the fuel and oil tanks.

2. When installing a new engine on the aircraft, proceed as recommended in Chapter IX.
3. If the aircraft has been parked for a prolonged period of time, oil should be added into the tank to 10.5-11 lit. level after starting and operating the engine on the ground at a speed of 10,400-11,150 r.p.m. for 1 min. to avoid overfilling the oil system and to prevent oil from being thrown out of the breather.

2. Preparation of Engine for Starting

1. Prior to starting the engine the ground near the aircraft should be thoroughly swept. All foreign objects in front of and behind the aircraft should be removed. During engine starting and operation the maintenance personnel should keep at a distance of not less than 5 m. from the air intake duct and off the exhaust gas stream.

Make sure the dust raised by the exhaust gases of an engine in operation does not settle on other aircraft.

2. Perform the pre-flight inspection of the engine.

3. Remove plugs from the aircraft air intake duct and from the afterburner.

4. Manipulate the band to open the ports for air blow-off from the compressor (in case they are closed) for which purpose remove wrench 240K-12.

5. Open the fuel shut-off cock (in case it is closed).

6. Check to see that:

(a) the aircraft storage battery 12CAM-28 is properly charged;

(b) the aircraft and ground fire-fighting facilities are in proper condition;

(c) the chocks are fitted under the aircraft wheels.

CAUTION! When dismantling the pipe-lines and the units of the fuel system and also in case air locks are

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likely to occur, prime the fuel system as recommended in Section 7 of Chapter IX.

3. Starting of Engine

The engine may be started or cranked by using both the aircraft and ground sources of D.C., with voltage across the terminals amounting to 24-30 V (with no load applied).

The ground power supply is the main source utilized for starting and cold cranking of the engine; it provides for automatic starting of the engine as well as for starting with manual control of fuel delivery to the engine.

In any case the temperature of the gases after the turbine should not exceed 800°C (during the entire starting cycle).

Turn on the switches and circuit breakers providing for starting and operation of the engine in accordance with the requirements set forth in the respective Aircraft Operating Instructions.

To check the engine for proper starting during flight it is necessary to check the operation of switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) by closing it for 2-3 sec. prior to starting the engine on the ground. This should cause lamp "IGNITION" (ЗАЖИГАНИЕ) to light up, which is an evidence of normal operation of the flight starting system.

If, after checking engine starting there is a suspicion that starting fuel continues to burn in the engine, crank the engine as laid down in Section 7 of Chapter IX.

Automatic Starting of Engine

The engine is started automatically on the ground only. Automatic starting of the engine is accomplished as follows:

1. After closing the respective switches and circuit breakers, set the engine control lever at the idling rating retainer, taking care not to shift the control lever beyond the retainer, to prevent appearance of flame from the jet

nozzle during engine starting, which is accompanied by a sharp rise in temperature of gases after the turbine.

2. Not later than 10 sec. after the engine control lever has been set at the idling rating retainer (to avoid appearance of flame at the exhaust during engine starting), press button "STARTING" (ЗАПУСК) and keep it pressed for 1 to 2 sec.

This should cause the engine to smoothly, without lagging and popping, accelerate to the idling speed. Engine acceleration to the idling speed or to a speed lower than the idling by 100 r.p.m., when engine start is accomplished with the help of ground power source АПА-7, or with the help of one aircraft storage battery 12САМ-28, should take not more than 80 sec.

On aircraft provided with automatic switching of voltage from 24 to 48 V, engine acceleration to the idling speed or to a speed lower than the idling by 100 r.p.m. should take not more than 60 sec. When starting the engine, watch the instruments recording the engine operation.

Instantaneous (up to 10 sec.) rise in temperature of gases after the turbine should not exceed 850°C.

If some trouble becomes evident during starting or some of the engine characteristics happen not to comply with the above values, it is necessary to immediately discontinue the engine starting by shifting the engine control lever to the "CUT-OFF" (СТОП) stop, simultaneously disconnecting switch "STARTING UNITS" (АГРЕГАТЫ ЗАПУСКА). If engine starting is interrupted before pilot lamp "IGNITION" (ЗАЖИГАНИЕ) goes out, it is necessary to close switch "STARTING UNITS" (АГРЕГАТЫ ЗАПУСКА) after complete stoppage of the engine, to run the starting equipment through the complete cycle of operation. Do not restart the engine until the cause of trouble is detected and eliminated. When restarting the engine, it is allowed to control the procedure by manipulating the engine control lever to prevent rise of gas temperature after the turbine.

If engine starting does not comply with the above requirements, adjust it as instructed under Section 5 of Chapter VI.

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Engine Starting with Manual Control of Fuel Delivery

Starting of the engine with manual control of fuel delivery is allowed only on the ground, in case automatic starting is made difficult or impossible.

Engine starting with manual control of fuel delivery should be performed as follows:

1. After closing the respective switches and circuit breakers, check the position of the engine control lever; the lever should be set at the "CUT-OFF" (СТОП) stop.

2. Press button "STARTING" (ЗАПУСК) and keep it pressed for 1 to 2 sec.; 1 to 2 seconds later, start delivering main fuel into the engine by slowly and smoothly shifting the engine control lever.

3. Slowly move the engine control lever to the idling rating retainer, taking care not to allow the temperature of gases aft of the turbine to increase over the permissible limits.

If the engine is hunting during starting, which is evidenced by characteristic "rumbling" and sharp rise of gas temperature after the turbine, the engine control lever should be first slightly moved back until "rumbling" ceases up, and 1 to 2 sec. later again shifted to the idling rating retainer; while proceeding in this manner, check engine operation (by listening) and temperature of gases aft of the turbine.

The temperature of gases after the turbine during engine starting with manual control of fuel delivery into the engine, should be the same as when starting the engine automatically. If troubles develop during engine starting, proceed as when starting the engine automatically.

On aircraft powered by two engines, the second engine is started independently from the starter-generator of the first engine running at idling speed, starting being controlled by the engine automatic starting units. When starting the first engine, the control lever of the second engine should be set in the "CUT-OFF" (СТОП) position. Otherwise fuel

will accumulate in the second engine, which may result in burning of nozzle vanes and turbine blades at starting.

Note: When the second engine is being started, the first, running, engine has its air blow-off ports closed by the band. As a result of this, power is delivered through band limit switch Л and the pair of contacts in the second stage of oil pressure warning mechanism 2СДУ5-1.3-2.2 to the pilot lamp which gives false indications of a pressure drop below 1.3 kg/sq.cm. up to the moment when the starting cycle of the second engine is over.

If, when starting the second engine (with the first engine running), the pointer of the 2ТЭ-15 tachometer indicator does not record any increase in the engine speed within 10 sec. after pressing button "STARTING" (ЗАПУСК), the running engine should be immediately stopped by shifting the engine control lever to the "CUT-OFF" (СТОП) position. The second engine control lever should also be set in the "CUT-OFF" (СТОП) position.

Restarting of this engine is allowed only after eliminating the trouble and cranking the engine. If these requirements are not complied with, the running engine may drive flame into the compressor of the other engine, which will result in its failure.

When starting the engine observe the following:

1. Do not start the engine from discharged storage batteries, for this will result in rising of gas temperature aft of the turbine in excess of the permissible limits, and the engine will not be able to reach the idling speed.

2. Do not start the engine, if the measuring instruments are defective.

3. If no fuel ignition occurred during engine starting, crank the engine prior to restarting, as laid down in Section 7 of Chapter IX.

4. Do not restart the engine unless the turbine has come to a complete stop, to avoid breaking the ratchet gear of the starter-generator two-speed drive.

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5. Do not restart the engine unless the cause of failure at the previous starting has been duly detected and eliminated.

6. After five successive startings of the engine, or after cranking the cold engine 4 times in succession, it is necessary to make an interval for 30 min. to cool down the starter-generator before starting or cranking the engine anew.

7. After five unsuccessful startings or four cold successive crankings, check oil level in the oil tank of fuel-oil unit 317A. If more than 2 lit. of oil have been consumed, drain oil from the front case of the engine, after which add the same amount of fresh oil into the oil tank of fuel-oil unit 317A.

8. Start the other engine only with the first engine running at the idling speed. Otherwise, closing of the air blow-off ports of the engine running at a speed exceeding the idling r.p.m., will lead to engine hunting and undesirable increase of gas temperature aft of the turbine.

9. When starting the engine for the first time after removal of corrosion-preventive compound the temperature of gases after the turbine may rise slightly in excess of the permissible limits. If this is the case, interrupt the starting procedure, and then restart the engine without adjusting the automatic starting device.

10. Prior to starting the second engine (with the first engine running for more than 5 min.) it is necessary to crank the engine for removal of fuel leaking through the clearances in the throttle cock of the HP-10A pump.

11. If some scheduled maintenance operations have been carried out on the engine, or in the engine compartment, starting should be performed with the access panels open, to facilitate the engine inspection.

CAUTION. Do not close switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) when starting the engine on the ground, or use it for starting the engine.

4. Warming and Checking of Engine

After the starting cycle is over and the engine has gained stable speed with the engine control lever at the idling rating retainer, run the engine at this speed for 1 min., checking the measuring instruments for proper functioning.

Increase engine speed to 10,400 r.p.m. and maintain this speed for 0.5 to 1 min., to warm up the engine.

This done, check the engine operation at all ratings.

1. Smoothly shift the engine control lever to the idling rating retainer, and check the following points with the engine running at idling speed:

(a) engine speed, which should be within the limits indicated in Table 2 and in Fig.5;

(b) temperature of gases aft of the turbine, which should not exceed 650°C;

(c) oil pressure; the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not burn.

Continuous operation of the engine on the ground at the idling speed as well as at speeds lower than 9700_{-100} r.p.m. (with the fuselage tail section attached) should not exceed 5 min.

Note: If a 5 min. period is not sufficient for carrying out engine adjustment (when running on the ground at the idling speed or at speeds below 9700_{-100} r.p.m., with the fuselage tail section attached, increase engine speed to 9800-10,000 r.p.m. and maintain it at this level for 1 min. or shut down the engine in case the engine speed cannot be increased, and proceed with the interrupted operations, restarting the engine, if necessary.

2. Apply brakes to the aircraft wheels, and smoothly move the engine control lever to the "NORMAL" (НОМИНАЛ) stop.

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When increasing engine speed check the r.p.m. value at which adjustable jet nozzle shutters are shifted from the position, corresponding to the augmented rating, to the position corresponding to the normal rating. The shutters of the adjustable jet nozzle should change their position at a speed of 4500 to 6500 r.p.m. Check the shifting of the adjustable jet nozzle shutters by the pressure gauge indicating pressure of operating fluid (AMT-10 oil) in the aircraft hydraulic system. With the shutters changing their position, the pressure gauge pointer slightly deflects to the left, indicating pressure drop, after which it quickly returns to the initial position. Shifting of the jet nozzle shutters can be checked visually. The observer should place himself in such a position so as to be clear of the stream of exhaust gases discharged from the engine jet nozzle.

With the engine running at the normal rating, check the following points by the indications of the instruments:

(a) engine speed, which should be within 11,150 ±50 r.p.m.;

(b) temperature of gases aft of the turbine, which should not exceed 550°C;

(c) pressure of oil. The pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not burn.

3. In case engine characteristics at the normal rating do not comply with the above values, move the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop.

With the engine running at the maximum speed check the following points by the indications of the instruments:

(a) engine speed, which should be within 11,150 ±50 r.p.m.;

(b) temperature of gases aft of the turbine, which should not exceed 650°C;

(c) pressure of oil. The pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not burn.

Note: If engine speed at the maximum rating differs considerably from engine speed at the normal rating (by more than 100 r.p.m.) it is necessary to adjust maximum speed as instructed under Section 2 of Chapter VI.

4. Keep the engine control lever at the "MAXIMUM" (МАКСИМАЛ) stop for not less than 3 sec., with the engine running at a speed of 11,150 ±50 r.p.m., then shift the engine control lever to the "AFTERBURNING" (ФОРСАЖ) stop. Turning on of the afterburner is accompanied by lighting up of the respective pilot lamp and also by certain changes in the temperature of gases aft of the turbine.

When the afterburner is turned on, the temperature of gases after the turbine may remain at the previous level, corresponding to the sustained maximum speed; it may increase by not more than 5°C or drop by not more than 20°C, with subsequent increase to the level not exceeding the permissible limit for augmented rating. If turning on of the afterburner causes the engine to run at a speed providing for stable temperature of gases (for 4 to 5 sec.) aft of the turbine, amounting to less than 450-500°C, which testifies to the fact that the afterburner is inoperative, shift the engine control lever to the "MAXIMUM" (МАКСИМАЛ) or "NORMAL" (НОМИНАЛ) stop, after which turn on the afterburner again.

With the engine operating at the augmented rating, check the following points by the indications of the instruments:

(a) engine speed, which should amount to 11,150 ±50 r.p.m.;

(b) temperature of gases aft of the turbine. With the ambient air temperature below +15°C, the temperature of gases after the turbine should not exceed 650°C; with the ambient air temperature being +15°C, and over the temperature of gases aft of the turbine should not exceed 680°C;

(c) pressure of oil. The pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should not burn;

(d) the pilot lamp indicating afterburner operation should burn.

When turning the afterburner on and off, a short-time (3 to 5 sec.) abrupt increase of engine speed to 11,600 r.p.m. is allowed. Maximum engine speed of 11,150 ± 50 r.p.m. should be regained within 3 to 5 sec. after the abrupt increase has occurred.

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If turning on of the afterburner is accompanied by surge or by increase of gas temperature aft of the turbine in excess of the permissible limits, turn off the afterburner by shifting the engine control lever to the "MAXIMUM" (МАКСИМАЛ) or "NORMAL" (НОМИНАЛ) stop. Subsequent turning on of the afterburner should be accomplished only after the cause of trouble has been detected and eliminated.

To preserve engine life, checking of the engine at augmented as well at maximum speed should not continue for more than 10 sec., due to the fact that the actuating cylinders of the jet nozzle are inadequately blown by air on the ground. In case it becomes necessary to adjust the maximum and augmented ratings, the engine may be operated continuously at these ratings for not more than 6 min., with the aircraft fuselage tail section detached and the afterburner mounted on a special frame.

5. Smoothly shift the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop and make sure the afterburner has been turned off (the respective pilot lamp should go out).

If shifting of the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop does not cut off the afterburner, do it by manipulating "AFTERBURNER EMERGENCY CUT-OFF SWITCH" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА). (Each engine is provided with one switch).

6. By smoothly shifting the engine control lever to the idling rating retainer, reduce engine speed to idling and check engine operation at intermediate ratings; check engine speed at which the air blow-off ports are open. Opening of the ports for air blow-off from the compressor should occur at a speed of 9700_{-100} r.p.m. As soon as the band uncovers the air blow-off ports, the engine changes its sound, and a jet of air is discharged from the engine compartment.

Engine speed may vary at the intermediate ratings within the following limits:

(a) at 8200 $\pm$100 r.p.m. to 9700_{-100} r.p.m., not over $\pm$45 r.p.m.;

(b) at 9700_{-100} r.p.m. to 11,150 $\pm$50 r.p.m., not over $\pm$20 r.p.m.

At sustained and intermediate ratings the engine should run smoothly, with no flame discharged from the jet nozzle.

7. Make sure the engine can be properly controlled within the range of automatic regulation (8100-11,150 r.p.m.), that is within the range of speeds at which fuel delivery is controlled automatically by the centrifugal governor of the HP-10A fuel pump, as well as from idling speed to the speed at which the centrifugal governor starts to function.

With the engine control lever smoothly shifted towards increasing or a reducing speed within 15 sec. in the range of 8100-11,150 r.p.m., and within 10 sec. in the range of 4100-8100 r.p.m., engine speed should change strictly in step with the engine control lever travel.

8. Having checked the engine for proper operation at sustained and intermediate speeds, check it for acceleration ability.

Acceleration ability of the engine should be checked with the engine compartment access panels closed, proceeding as follows:

(a) manipulating the engine control lever set the engine to run at 8200 $\pm$100 r.p.m., and smoothly (within 1.5-2 sec.) move the engine control lever as far as "NORMAL" (НОМИНАЛ) stop. Normal speed should be reached within 9 to 12 sec. (acceleration time);

(b) set the engine control lever to the idling rating retainer and then smoothly move it to the "NORMAL" (НОМИНАЛ) stop (within 1.5-2 sec.). Normal speed should be gained within 9 to 12 sec. (acceleration time).

When checking engine acceleration from idling to normal speed, determine the time period required for the engine to pass from idling speed to 9500 r.p.m., which should be within the range indicated in Table 3 and in Fig.10;

(c) set the engine control lever to the idling rating retainer and smoothly (within 1.5 to 2 sec.) move it to the "MAXIMUM" (МАКСИМАЛ) stop. In this case engine should gain maximum speed within 9-13 sec. (acceleration time);

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(d) set the engine control lever to the idling rating retainer and smoothly (within 1.5 to 2 sec.) move it to the "AFTERBURNING" (ФОРСАЖ) stop. In this case engine should gain augmented rating within 10 to 15 sec. (acceleration time).

After checking acceleration ability and running the engine at a corresponding speed for 8 to 10 sec., quickly reduce engine speed to the idling r.p.m. Speed reduction should be accomplished by smoothly shifting the engine control lever (within 1.5 to 2 sec.) from the respective stop to the idling rating retainer. This should cause the engine to smoothly slow down its speed to the idling r.p.m.

When checking acceleration ability the engine should pick up speed without any surge or rise of gas temperature after the turbine over 750°C. When carrying out the procedure, an instantaneous increase of engine maximum speed to 11,600 r.p.m. is allowed (for not more than 3 to 5 sec.). The engine should slow down to 11,150 ±50 r.p.m. within 3 to 5 sec. after the speed increase has occurred. When the engine is checked for proper acceleration from the idling speed to the maximum speed, a delay in rate of acceleration is likely to occur at the moment of passing from manual to automatic control (the hydraulic decelerator of the HP-10A pump starts to exert a more strong influence on engine acceleration) that is within the range of 10,000 to 11,000 r.p.m.

In case the engine becomes "hot-logy" i.e. fails to accelerate to the required r.p.m., with the temperature of gases aft of the turbine increasing in excess of the permissible level, or is hunting, or if the engine becomes "cold-logy" i.e. does not respond to shifting of the control lever with the gas temperature after the turbine being constant, discontinue the acceleration check by shifting the engine control lever to the "CUT-OFF" (СТОП) stop, and adjust engine acceleration as instructed under Section 4 of Chapter VI.

If, when checking engine acceleration from the idling speed to the augmented rating, the afterburner pilot lamp lights up before the engine gains a speed of 9700_{-100} r.p.m.

(after the engine control lever has been set in the "AFTERBURNING" (ФОРСАЖ) position), immediately interrupt the procedure and check the electric system for proper operation. When acceleration ability of the engine is being checked, the afterburner pilot lamp should not light up unless the engine reaches a speed of 9700_{-100} r.p.m.

Note: If engine acceleration ability is checked immediately after the corrosion-preventive compound has been removed or the HP-10A fuel pump replaced, repeatedly (4 to 5 times) race the engine to a speed of 10,000-10,400 r.p.m. (prior to checking engine acceleration ability), to remove corrosion-preventive compound from the acceleration control unit of the HP-10A pump.

In case the aircraft is powered by two engines, acceleration ability should be checked with the engine compartment inspection panels closed, using the following procedure:

(a) start the second engine, warm and check it as recommended above;

(b) accelerate one of the engines to a speed of 8000 r.p.m. and check the other engine for proper acceleration from the idling speed to the nominal speed, first by slowly (within 3 to 4 sec.) and then by quickly (within 1.5 to 2 sec.) shifting the engine control lever from the idling rating retainer to the "NORMAL" (НОМИНАЛ) stop. In both cases the engine should accelerate its speed without being "logy"; no sharp rise of gas temperature aft of the turbine in excess of 750°C should be observed.

In both cases the engine should accelerate from idling r.p.m. to 9500 r.p.m. within the same time period (the difference not to exceed 1.5 sec.) indicated in Table 3 and in Fig.10;

(c) check acceleration ability of the first engine in a similar manner, with the second engine set to run at a speed of 8000r.p.m.;

(d) check both engines simultaneously for proper acceleration from the idling to normal speed.

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If both engines attain the speed of 9500 r.p.m. within to 10 sec., acceleration check may be stopped by setting the engine control levers at the idling rating retainers.

When acceleration check is carried out on both engines simultaneously, any difference between the engine speeds is allowed; the pointer of the tachometer indicator of the right-hand engine relative to the tachometer indicator of the left-hand engine, and vice versa, may lag behind to any value, but any interruption in engine acceleration or increase of gas temperature aft of the turbine in excess of 750°C, in both engines, should be excluded.

5. Engine Stopping

After checking the engine, its normal stoppage at any speed should be accomplished as follows:

1. Bring engine speed to 10,000 r.p.m. by smoothly shifting the engine control lever, and run the engine at this speed for 1-2 min. to allow the engine parts to cool down, after which shift the engine control lever to the "CUT-OFF" (СТОП) stop.

2. While stopping the engine, check the turbine and compressor rotors for smooth rotation by listening, to make sure no abnormal noises are heard.

Stoppage of engine should be accompanied by a rattling noise produced by the cams of the starter-generator two-speed drive. If, during engine stoppage, some noises are heard which question the engine soundness, it is necessary to check the engine aurally while turning it repeatedly with the help of the starter-generator. Do not start the engine unless the causes of trouble are detected and eliminated.

When stopping the engine after performing one or two flights, check the turbine and compressor rotors for easy rotation by determining the time period which is necessary for the rotors to come to a complete stop after being slowed down to the idling speed. The above time period should not be less than 1 min., and it should remain approximately constant throughout the entire service life of the engine.

3. After the turbine and compressor rotors have come to a complete stop, disengage the fuel booster pumps. If one of the engines is still running, do not cut off the booster pumps.

4. After the turbine and compressor rotors have come to a complete stop, plug the engine air intake duct. Plug the jet nozzle 30 to 50 min. after engine stopping (depending on the ambient air temperature).

Should it become necessary to immediately stop the engine, push the control lever abruptly to the "CUT-OFF" (СТОП) stop.

The engine should be stopped immediately under the following circumstances:

(a) when the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 lights up;

(b) when leakage of fuel, oil, or operating fluid (АМТ-10 oil) is detected in the engine system or in the aircraft supply pipe-lines, which creates fire hazard;

(c) when a sharp rise in gas temperature aft of the turbine occurs;

(d) when abnormal sparking is observed in the afterburner;

(e) when foreign noises appear during engine operation;

(f) if the engine starts to vibrate.

Note: Stopping of engine may be accompanied by smoke issuing from the jet nozzle. To eliminate smoking, crank the cold engine repeatedly.

If this is of no avail, check to see that:

(a) the lever of the НР-10А pump closely fits to the stop and there is a clearance of 1-2 mm between the engine control lever and the stop provided in the cockpit, when the engine control lever is set in the "CUT-OFF" (СТОП) position;

(b) the drain cock is in proper condition, and no leakage of fuel and oil into the afterburner is observed.

Chapter IV

OPERATION OF ENGINE DURING FLIGHT

1. Take-Off and Climb

Prior to flight the engine should be warmed up and checked at the ratings enumerated in the pilot's Instructions. Instrument readings should comply with the data presented under Section 4 of Chapter III.

Position the aircraft in the take-off direction and apply brakes to the landing gear wheels. Smoothly shift the engine control lever to bring engine speed to a maximum value which can be tolerated by the brakes. Then check the following points by the readings of the instruments;

(a) engine speed,

(b) temperature of gases aft of the turbine,

(c) oil pressure by the indications of the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2.

Having ascertained that the instruments and the engine function normally, release the brakes and start a take-off run. At take-off the instruments controlling engine operation should give the same readings as when checked on the ground. Take-off may be performed with the engine operating at normal, maximum or augmented rating. When climbing to an altitude of 6000 m., continuous operation of the engine at maximum or augmented rating should not exceed 6 min.; when climbing to an altitude of over 6000 m. continuous operation should not exceed 10 min.

Repeated operation of the engine at maximum or augmented ratings is allowed only after the engine has run for not less than 1 min. at normal or lower speed. Within the established period of continuous operation of the engine at maximum and augmented ratings any number of interruptions is allowed between switchings of these ratings.

When climbing with the engine running at maximum or augmented rating, do not allow gas temperature aft of the turbine to exceed 680°C. When climbing at augmented rating at altitudes of over 10,000 m., temperature of gases aft of the turbine is allowed to rise to 700°C for a short period of time.

If the aircraft is powered with engines РД-3Б of the fourth or fifth series, with 40 mm wide (instead of 28 mm wide) plate of the afterburner diffuser flame arrester, temperature of gases aft of the turbine may rise to 700°C for not more than 30 sec., when climbing with the afterburner turned on.

In case temperature of gases after the turbine exceeds the permissible limits at maximum and augmented ratings, it is necessary to reduce engine speed and continue climbing.

2. Level Flight

Level flight may be performed at any of the engine ratings. The duration of flight at normal, cruising (0.8 of normal rating) and intermediate ratings is unlimited.

At maximum and augmented ratings continuous operation of the engine at altitudes of up to 6000 m. should not exceed 6 min., whereas at altitudes above 6000 m. continuous operation should not exceed 10 min.

After the engine has been running for 6 or 10 min. (with respect to altitude) at maximum or augmented rating, the engine control lever should be shifted to the position providing for normal or lower speed which, however, should not be less than 9700^{-100} r.p.m. Repeated operation of the engine at maximum or augmented rating is allowed only after it has been running for 1 min. at normal or lower speed. Within the permissible time period of continuous engine operation at maximum and augmented ratings, any number of interruptions is allowed.

During flight the following instruments should be kept under periodical observation:

(a) tachometer indicator;

(b) turbine outlet gas temperature indicator;

(c) pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-22;

(d) afterburner pilot lamp.

Instrument indications should correspond to established engine rating (See Table 1).

If instrument indications at maximum and augmented ratings exceed the specified values, move the engine control lever to the "NORMAL" (НОМИНАЛ) stop or reduce engine speed and continue flight.

If turning on of the afterburner is accompanied by engine hunting or a rise in gas temperature aft of the turbine in excess of the permissible limits, turn off the afterburner by shifting the engine control lever to the maximum or normal rating stop and continue the flight at these ratings. In case the engine still hunts or elevated gas temperature aft of the turbine persists, shift the engine control lever to the "CUT-OFF" (СТОП) position, and then start the engine as instructed in Section 3 of this Chapter. Do not run the engine at augmented rating unless the trouble is detected and eliminated.

In case the afterburner turns on spontaneously, with temperature of gases aft of the turbine dropping suddenly, immediately turn off the afterburner by shifting the engine control lever to the maximum or normal rating position, to prevent the engine from picking up speed. If shifting of the engine control lever to the maximum or normal rating stop does not turn off the afterburner, the procedure should be performed by means of switch АЗС-5 "AFTERBURNER EMERGENCY CUT-OFF" switch (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА).

When resorting to augmented rating at altitudes of over 11,000 m., the following should be taken in consideration:

1. The higher the speed of the aircraft the more [illegible] is operation of the afterburner at a given altitude.

2. The higher the speed of the aircraft the higher is the altitude at which the afterburner may be reliably turned on.

When performing flight with the afterburner turned on, at altitudes of over 17,000 m., a considerable drop or increase of gas temperature after the turbine may be experienced for a short period of time (10 to 15 sec.). Therefore, the temperature of gases aft of the turbine should be kept under close observation, especially when climbing, for if the temperature drops below 620°C, the afterburner may cut off spontaneously, while temperature increase over 680°C (or over 700°C when climbing) may result in engine overheating.

The most favourable ratings of the engine at level flight depending on the load, speed, and altitude are given for each type of aircraft in special instructions dealing with computation of flight range and duration.

Engine ratings, at which the compressor air flow-off ports are open, are not economical, for in this case specific fuel consumption is considerably increased.

During flight at engine speed, at which the air blow-off band operates, the band may open and close the air blow-off ports intermittently, as a result of which the engine speed will vary within ±100 r.p.m., and the pilot may experience some "pops". Therefore it is necessary, if possible, to avoid operating the engine at speeds at which opening and closing of the air blow-off ports occur.

The engine control lever may be quickly shifted during flight towards speed increase from any position, except from that which is lower than the idling speed retainer. Shifting of the engine control lever should be accomplished within not less than 1.5 to 2 sec.

CAUTION. Quick shifting of the engine control lever towards speed increase, to the respective stops, with the engine still running at unstable speed, is prohibited.

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In this case engine characteristics should be the same, as when checking engine acceleration ability on the ground (See Section 4 of Chapter III).

If engine acceleration during flight is accompanied by hunting or an increase of temperature of gases aft of the turbine in excess of the permissible level, immediately shift the engine control lever to the idling rating retainer and bring engine speed to the required r.p.m. without resorting to acceleration.

If this is of no avail, immediately shift the engine control lever to the "CUT-OFF" (СТОП) position, after which start the engine as instructed under Section 3 of this Chapter.

After the flight is over, check engine acceleration on the ground, detect and eliminate the cause of trouble.

3. Starting Engine in Air

In case the engine stops during flight immediately shift the engine control lever to the "CUT-OFF" (СТОП) position, without disengaging the booster pump of the fuel tank.

To start the engine during flight proceed as follows:

1. Descend to an altitude of 9000 m. and reduce the aircraft speed to ensure engine autorotation within 2000–3000 r.p.m.

2. To provide for normal operation of the engine during flight, at starting and at other ratings, check to see that the switches and circuit breakers, ensuring proper starting and operation of the engine in air are closed.

3. Set the engine control lever to the idling rating retainer and 2 to 3 sec. later operate switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ). This should cause pilot lamp "IGNITION" (ЗАЖИГАНИЕ) to light up; after switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) is open, pilot lamp "IGNITION" (ЗАЖИГАНИЕ) should go out.

4. Up to the moment when the engine gains idling speed, check temperature of gases aft of the turbine never allowing it to rise in excess of 750°C; check the engine speed.

5. As soon as the engine starts, open switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) and 0.5 to 1 min. after the engine has gained idling speed, smoothly shift the engine control lever to the required stop.

Maximum speed should be reached not earlier than 1 min. after the engine has been brought to idling r.p.m.

It takes up to 45 sec. to start the engine in air after switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) has been closed. In case the engine has not started in 45 to 50 sec., shift the engine control lever to the "CUT-OFF" (СТОП) stop and open switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ); restart the engine 30 to 40 sec. after the engine control lever has been shifted to the "CUT-OFF" (СТОП) stop.

If temperature of gases after the turbine during starting exceeds 750°C, shift the engine control lever beyond the idling rating retainer towards the "CUT-OFF" (СТОП) stop and bring the engine to idling speed, by manipulating the engine control lever for manual regulation of fuel delivery. If engine starting with manual regulation of fuel delivery is accompanied by a rise in temperature of gases aft of the turbine in excess of the permissible level, move the engine control lever to the "CUT-OFF" (СТОП) stop and after scavenging the engine for 30 to 40 sec., restart it taking care to move the engine control lever to the idling speed retainer more smoothly and slowly. After two unsuccessful attempts to start the engine, it is recommended to descend by 1000–2000 m. prior to starting the engine again. The engine should be restarted not earlier than 30 to 40 sec. after the engine control lever has been shifted to the "CUT-OFF" (СТОП) stop. This time period between successive startings is necessary for fuel to be removed from the combustion chambers of the engine.

4. Stopping Engine in Air

For normal stopping of the engine during flight it is necessary to smoothly shift the engine control lever to the "CUT-OFF" (СТОП) stop.

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Emergency stopping of the engine during flight should be resorted to under the following circumstances:

(a) when excessive vibration (flutter) sets up;

(b) when the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.3 lights up;

(c) in case of fire in the engine compartment.

In case of fire, set the engine control lever in the "CUT-OFF" (СТОП) stop, close the fuel shut-off cock and make use of the fire-fighting system as recommended in the pilot's Instructions; do not restart the engine.

Do not close the fuel shut-off cock when stopping the engine during flight in any other case.

In case of excessive increase in temperature of gases after the turbine, reduce engine speed to a r.p.m. at which temperature of gases aft of the turbine will be within the permissible limits. In this case the engine may not be stopped.

CAUTION. The parts of the HP-10A and HP-11A fuel pumps are lubricated and cooled by fuel utilized by the engine, therefore when the engine is stopped by manipulating the fuel shut-off cock, the HP-10A and HP-11A pumps should be replaced by new ones or by sound pumps which have already been in operation; when replacing the pumps proceed as laid down under Sections 1 and 2 of Chapter VII.

In case the engine stops spontaneously during flight, immediately shift the engine control lever to the "CUT-OFF" (СТОП) stop, and after scavenging the engine for 30 to 40 sec. restart it using the standard procedure.

5. Piloting, Gliding, Landing, and Taxiing

Aircraft powered by the РД-9Б engines are capable of inverted flight for not more than 15 sec.

When flying under zero or near zero negative "g" conditions, oil pressure drop in the oil pressure line of the engine should not exceed 15 sec. (the pilot lamp of the oil pressure

warning unit lights up). In case the pilot lamp of the oil pressure warning unit burns for more than 15 sec., stop performing the mission, stop the engine, descend to the required altitude and restart the engine in air as recommended in Section 3 of this Chapter.

If, after the engine has been started, oil pressure reaches the normal value (the pilot lamp of the oil pressure warning unit does not burn), the flight may be continued. In case the pilot lamp of the oil pressure warning unit goes on burning after the engine is started, stop the engine and go in for landing.

After landing and taxiing the aircraft to the parking area, stop the engine as instructed in Section 5 of Chapter III.

Taxiing may be performed at any of the engine speeds, starting from idling speed. Instrument indications, when taxiing, should be within the limits set for the respective ratings. Special attention should be directed to indications of gas temperature aft of the turbine, when the engine control lever is being shifted from the idling speed retainer towards the "NORMAL" (НОМИНАЛ) stop; do not allow gas temperature to exceed the permissible level.

When taxiing, see that no dust or other hard particles, raised by the gases ejected from the engine, get into the air intake ducts of other aircraft. If several aircraft are taxiing one after another an interval of not less than 50 m. should be maintained between them to prevent hard particles from getting into the air intake duct of the next aircraft.

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Chapter V

ENGINE MAINTENANCE

1. General

Normal, trouble-free operation of the engine and of its individual units throughout the specified service life can be guaranteed only if operating instructions contained in this publication are fully complied with, and also if all kinds of inspections and routine maintenance operations are done with due care and at specified intervals. All defects detected during inspections and routine maintenance operations should be immediately corrected. After eliminating any leakage of fuel, oil or operating fluid (AMT-10, oil), it is necessary to start the engine and check it for leakage while it is in operation.

If access to the places to be inspected is difficult or impossible, the aircraft should be disjointed or the engine should be removed. When disjointing the aircraft, care should be taken to comply with the instructions as to mounting the afterburner on a frame (See Section 5 of Chapter IX).

Prior to carrying out mounting or routine maintenance operations on the engine, it is necessary to manipulate the band by means of wrench 240Ж-12 to close the air blow-off ports in the compressor housing as soon as the respective access panels are open, to prevent penetration of any foreign matter into the compressor.

When removing units, assemblies and parts from the engine the exposed portions of the joints should be closed by special plugs or by plugs made of vinyl polimer fabric.

Removal of units, assemblies and parts from and their installation on the engine should be accomplished in accordance with the procedure detailed in Chapter VII.

Prior to removing the units, assemblies and parts of the fuel system, close the fuel shut-off cock or drain fuel from the system.

Before removing the units, assemblies and parts of the oil system, drain oil from fuel-oil unit 317A and from the sump of the engine inlet housing.

After installation of the units, assemblies and parts of the fuel system, prime the system as recommended in Section 7 of Chapter IX. After the units, assemblies and parts of the oil system have been installed in position, crank the cold engine to fill the oil system with oil.

When performing any mounting or other operations on the engine use only those tools which are contained in the aircraft engine tool kit. When carrying out some operation on a jointed fuselage, fasten the tools to prevent them from dropping into the fuselage.

After the engine compartment is duly checked and inspected and prior to closing the inspection panels, open the compressor air blow-off ports by removing wrench 240Ж-12.

If the engine is being started with the access panels open, manipulate the band to open the air blow-off ports directly before starting the engine.

When performing any operations on the aircraft or on the engine, do not rest against the parts and the pipe-lines of the engine, for this may cause deformation or failure of or undesirable stresses in the engine parts and assemblies.

When carrying out maintenance work on the aircraft, do not place any bolts, nuts, cotter pins, safety wire, or other parts onto the engine. The work over, check to see that no small parts or foreign objects have been left on the engine or in the engine compartment. The engine compartment should also be thoroughly cleaned of dust, dirt and oil.

Checking of the engine and electric equipment instruments, as well as routine maintenance of the instruments and electric equipment should be performed in compliance with the instuctions contained in the respective Service Logs; checks should

also be done in case soundness of some of the instruments is questioned.

All routine maintenance operation as well as all procedures pertaining to elimination of troubles in engine operation should be duly registered in the Engine Service Log.

2. Preflight Inspection of Engine

Preflight inspection of the engine should be accomplished through the inspection holes, air intake duct and the afterburner, for which purpose remove the access panels and take the plugs out of the air intake duct and the jet nozzle.

1. Check oil level in the oil tank of fuel-oil unit 317A. If necessary, replenish oil as laid down in Section 1 of Chapter III.

See that the plug of the oil tank is securely tightened.

2. Check the tanks of the main fuel system, starting fuel system and of the hydraulic system for proper filling as recommended in the Instructions on Aircraft Operation.

3. Inspect the aircraft air intake duct.

When carrying out the inspection, see that the air intake duct is free of any foreign objects. Make sure the riveted joints in the air intake duct are intact. Use a portable lamp or a headlight when performing the above inspection.

In winter time, remove snow and ice from the air intake duct surface with the help of hot air supplied from the ground sources.

4. Inspect the engine compartment. When performing the above inspection, see that the engine compartment is free of any foreign objects and that no leakage of fuel, oil or hydraulic fluid (AMT-10 oil) shows up.

If fuel, oil, or hydraulic fluid (AMT-10 oil) is detected in the engine compartment, trace the leakage to its source and eliminate it, after which check the systems for leakage on the operating engine.

In case foreign objects are found in the engine compartment, perform a more thorough inspection with all the access panels of the engine compartment removed.

5. Check to see that the joints of the system controlling the lever of the НР-10А pump and the lever of the ПУ-3 control panel are intact and properly locked.

6. Inspect the inner surface of the afterburner and the jet nozzle shutters by using a portable lamp or a headlight.

Make sure the afterburner is free of warping, cracks and aluminum film.

7. See that the aircraft storage battery is normally charged.

Note: When performing engine pretake-off inspection, comply with the Aircraft Operating Instructions.

3. Postflight Inspection of Engine

Postflight inspection of the engine is the main inspection procedure, therefore its quality effects readiness of the aircraft and the engine for subsequent flights.

After the engine has stopped and cooled down, remove the access panels and inspect (if possible) the following assemblies of the engine:

1. Inspect the air intake duct and the blades of the compressor first stages by using a portable lamp or a headlight. Dirt or mechanical damage is not allowed.

2. Use the portable lamp or the headlight to inspect the inner surface of the afterburner and the shutters of the jet nozzle. See that they are free of cracks, burnt ports, and warping; make sure there is no aluminum film on the inner surface of the afterburner.

3. Make sure there is a clearance between the afterburner ejector and the aircraft fuselage skin; the clearance should be uniform on the entire circumference. The clearance value is indicated in the Aircraft Operating Instructions.

4. Inspect and check the engine units and pipe-lines for proper fastening and locking.

5. Ascertain that the supply wires, external wiring of the instruments and the thermocouple wires are intact and securely fastened.

6. Inspect the filler of the oil tank and the fuel filter of fuel-oil unit 317A, as well as the unloading ports of the flame igniters and the drain cocks through the main inspection holes and the access hatches; see that there is no leakage in the fuel, oil and hydraulic pipe-lines.

When performing the check for leakage, direct special attention to the following places: the flanges of the units and the flame igniters, the union nuts of the burners, the pipe-line-to-manifold joints, and the housing joints.

7. Use wrench 240Ж-12 to check the compressor air blow-off band for smooth travel. The band should be capable of free movement under the force of the spring.

8. Make sure the aircraft control link is securely connected to the lever of the ПУ-3 control panel; see that the link running from the lever of the НР-10А pump is securely connected to the lever of the ПУ-3 control panel.

9. Check the fuel and oil tanks for proper filling; if necessary, replenish fuel and oil to the required level as recommended under Section 1 of Chapter III.

Note: If, due to some reasons, fuel has been completely drained from the fuel system of the engine, the fuel system and the system controlling the compressor air blow-off band operation should be subjected to corrosion-preventive treatment not later than 24 hours after fuel has been drained.

If the aircraft is parked for a prolonged period of time, with the fuel system filled up, the engine should be inspected and started at regular intervals (every 5 to 7 days), as instructed in Section 2 of Chapter X.

After the engine has been inspected, eliminate the troubles detected, close the inspection holes and fit the plugs into the air intake duct and into the jet nozzle.

After each flight, fill in the engine Service Log, registering the time period and the ratings of engine operation, the readings of the instruments, controlling the engine operation, and elimination of troubles detected during operation.

4. Routine Maintenance

Routine Maintenance after First 5±1 Hours of Engine Operation

After first 5±1 hours of engine operation perform all procedures pertaining to postflight inspection and also detach the oil unit breather pipe from the pipe union of the oil unit and from the breather pipe of the oil tank of fuel-oil unit 317A. Turn off the nuts securing the oil filter cap, remove the washers and the cap complete with the filter from the studs. Remove the spring and the gauze installed at the oil inlet to the reducing valve, from the oil unit housing. Replace the cover of the oil unit housing by cap 788П-7. Inspect the oil unit filter and the oil inlet gauze and wash them in clean gasoline, if necessary.

To wash the filters of the oil unit, proceed as follows:

1. Without removing the oil unit filter from the cover, rinse it in a bath with clean gasoline, having fitted rubber plug 532П-100 into the cover hole communicating with the burn valve beforehand, and after turning cap 717П-7-10 onto the cover pipe union, to guard the inner cavity of the cover against dirt.

2. Wash the gauze installed at the oil inlet to the reducing valve in a bath with clean gasoline.

3. Dry the filters without blowing them with compressed air.

After the filters have been washed, remove the cap from the oil unit housing and install the gauze and the spring in place.

Remove the plugs from the filter cap and install the cap complete with the filter onto the oil unit housing, having

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fitted a new gasket under the cap. Secure the cap with nuts after installing plain and spring washers.

Connect the oil unit breather pipe to the pipe union of the oil unit and to the breather pipe of the oil tank of fuel-oil unit 317A; be sure to fit new packing rings in the joints.

Routine Maintenance after 10 ±2 Hours of Engine Operation

When dealing with engines of up to No.Г534276, which have not been subjected to repairs, every 10±2 hours of operation check the bolt, securing the nose bullet fairing for proper tightening. To this end check the bolt for proper tightening and locking by using wrench A $\frac{\text{ОНЖ-1}}{114}$, without removing the engine from the aircraft. If the bolt is loose (the bolt can be easily turned in either direction), proceed as follows:

1. Carefully unbend the tabs of the locking washer.
2. Turn out the bolt with the help of wrench A $\frac{\text{ОНЖ-1}}{114}$, and remove spherical and locking washers from the bolt. Inspect the bolt thread.
3. Remove the fairing and employing a portable lamp inspect the threads of the bush receiving the bolt and installed in the cover of the inlet housing nose portion (turn the entire threaded portion of the bolt by hand into the nose portion cover, checking the bush for stripped threads, then turn out the bolt).
4. Fit the fairing in position.
5. Put a new locking washer (part 3124511) taken from the individual set of spare parts, and the spherical washer onto the bolt. Turn in the bolt by hand until the supporting surface of the bolt head rests against the surface of the locking washer. Then use wrench A $\frac{\text{ОНЖ-1}}{114}$ to turn the bolt head through one flat to press the locking washer. Slacken the bolt, backing it out 1.5 to 2 turns.

6. Turn in the bolt by hand until the bolt head contacts the locking washer, after which accomplish final tightening of the bolt by turning it through 1.5 to 2 flats of the head with the help of wrench A $\frac{\text{ОНЖ-1}}{114}$.

7. Lock the bolt by bending the tabs of the locking washer over the bolt head flats.

Routine Maintenance after 25±5 Hours of Engine Operation

After every 25 ±5 hours of engine operation perform the procedures pertaining to the postflight inspection, besides:

1. Check the system controlling the lever of the HP-10A pump; see that there is no scuffing or play in the control system; check the lever of the HP-10A pump for proper fastening and locking; check the lever for proper connection to the control links. Treat the control link joints with gun grease (State Standard ГОСТ 3005-51).
2. Check the position of the HP-10A pump lever when shifting the engine control lever to the idling speed retainer. With the engine control lever set at the idling speed retainer, the notch on the lever of the HP-10A pump should be located between the notches marking the idling rating sector on the dial of the HP-10A pump.
3. Inspect the ring and the shutters of the jet nozzle for cracks, warping, and scores.
4. Remove the fuel filter of fuel-oil unit 317A, wash the filtering element in clean gasoline without stripping it, and check the filtering discs for damaged gauze. If signs of gauze damage are detected, replace the filtering element by a new one, proceeding as recommended under Section 6 of Chapter VII.

When reinstalling the old filtering element, or installing a new one, replace the packing rings of the fuel filter cap by new ones.

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Note: Proceed as described above when dealing with fuel-oil units 317A, delivered by the Manufacturer before the 1st of May, 1958 (See date of manufacture in the unit Certificate); the fuel filters of these units are provided with filtering discs having bronze gauzes.

5. Inspect attachment fittings of the engine and the afterburners.

Routine Maintenance after 50±5 Hours of Engine Operation

Perform maintenance work as recommended after 25 hours of engine operation, besides:

1. Remove the filter complete with the cap from the oil unit, as instructed in Section "Routine maintenance after first 5 ±1 hours of engine operation".

Inspect the gauze discs (filtering elements) for dirt and mechanical damage. No torn gauze discs should be allowed. If necessary, perform thorough cleaning of the oil filter as follows:

(a) wash the filter on the outside with clean gasoline, as recommended in Section "Routine maintenance after first 5 ±1 hours of engine operation";

(b) unlock and turn off the nut securing the gauze discs; take the thrust cap and the gauze discs off the filter frame;

(c) close the inner (central) hole of the gauze discs with rubber plug 533П-100 and clean the surfaces of the gauze discs with brush 119-546, soaked in clean gasoline.

When cleaning the gauze discs see that no dust, dirt or other foreign matter gets into the inner cavities of the gauze discs;

(d) dry the gauze discs without blowing them with compressed air;

(e) wash the filter cap complete with the frame, the thrust cap, nut, gauze installed at the fuel inlet into the

reducing valve as well as the spring in clean gasoline and dry them up without using compressed air.

Prior to washing the filter cap fit rubber plug 532П-100 into its hole communicating with the return valve and turn cap 717П-7-10 onto the cap pipe union. When washing the filter cap, see that no dirt or other foreign matter gets into the inner cavity of the cap through the hole provided in the filter frame.

After cleaning, install the gauze discs and the thrust cap onto the filter frame, then turn the nut onto the coupling bolt, having fitted a new locking washer under the nut. Lock the nut.

Install the gauze at the oil inlet to the reducing valve, mount the spring and the filter complete with the cap as instructed in Section "Routine maintenance after first 5 ±1 hours of engine operation".

2. When dealing with engines provided with fuel-oil units 317A manufactured before the 1st of May 1958 (See date of manufacture in the unit Certificate) replace the fuel filter by a new one, as set forth in Section 6 of Chapter VII (the filtering discs of these fuel filters are provided with bronze gauzes).

Note: When handling fuel-oil units 317A, manufactured after the 1st of May 1958, whose fuel filters are provided with filtering discs having nickel gauzes, do not inspect the filtering discs every 25 ±5 hours of engine operation, and do not replace the fuel filter after 50 ±5 hours of operation.

3. Use a feeler gauge to measure the radial clearance between the upper edges of the turbine second stage blades and the plates of the second stage nozzle ring vanes.

Determine the radial clearance proceeding as follows:

(a) fit the feeler gauge between the upper edge of the turbine second stage blade and the plate of the second stage nozzle ring vane (in any point);

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(b) turn the turbine relative to the feeler gauge and note the longest blade, that is the blade, having the least clearance to the respective vane plate. Mark this blade with a red crayon;

(c) determine the minimum clearance between the longest blade and the second stage nozzle ring. The minimum permissible clearance between the upper edge of the turbine second stage blade and the plates of the second stage nozzle ring vanes should not be less than 1.6 mm. If the clearance is less than 1.6 mm the engine is not to be operated. With the clearance equal to or exceeding 1.6 mm, inspect the turbine blades visually for dents, cracks and signs of overheating; make sure there are no signs of blades brushing against the plates of the second stage nozzle ring vanes.

Dents on the leading and trailing edges of the blades, as well as cracks, and signs of overheating or brushing are to be excluded.

4. Check to see that the afterburner is securely fastened to the engine; make sure there are no dents on the afterburner shrouds. Correct defective shrouds.

5. With the engine being at standstill, check the shutters of the jet nozzle for proper shifting, using the following procedure:

(a) detach the plug connector of the limit switch of the HP-10A pump hydraulic decelerator and mount device (plug connector) 754П-7 on the respective component part of the wire harness;

(b) detach the component part from the plug connector of fuel pressure warning unit ДСД-2 (controlling fuel pressure in the afterburner manifolds);

(c) connect the ground hydraulic installation to the aircraft hydraulic system, and build up a pressure of 80 to 140 kg/sq.cm.;

(d) connect the ground power supply source to the aircraft mains and close the following switches: the electric system master switch "STORAGE BATTERY" (АККУМУЛЯТОР), АЗС-5 "AFTERBURNER EMERGENCY CUT-OFF SWITCH (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА), and АЗС-5 "CUT-OFF COCK, OIL" (ПЕРЕКРЫВНОЙ КРАН, МАСЛО);

(e) shift the engine control lever to the idling speed retainer. The shutters of the jet nozzle should be in a position corresponding to augmented rating. With the engine control lever moved towards "NORMAL" (НОМИНАЛ) stop, the shutters should shift to the position corresponding to normal rating. Time period required for the shutters to shift from the augmented to the normal position is not limited.

Repeat the checking procedure 2 to 3 times;

(f) use wrench 240Ж-12 to close the compressor air blow-off ports with the help of the band;

(g) shift the engine control lever to the maximum speed stop and keep it in this position for 8 to 10 sec.; repeat the procedure 2 to 3 times with an interval between two successive shiftings of not less than 30 sec. When shifting the engine control lever to the maximum speed position, see that the shutters of the jet nozzle function normally; check the time period required for the shutters to shift from the normal speed position to the maximum speed position; the shutters should shift to the required position within 2,5-5.0 sec.;

(h) shift the engine control lever to the "AFTERBURNING" (ФОРСАЖ) stop, after which mount device 834П-7 for 1-2 sec. on the component part of the plug connector of fuel pressure warning mechanism ДСД-2. When turning on the afterburner check the time period required for the shutters of the jet nozzle to shift from the maximum speed position to the augmented speed position. The shutters should open to the required position within 1.2-2.5 sec. Repeat the procedure 2 to 3 times;

(i) open the compressor air blow-off ports by removing wrench 240Ж-12.

Remove device 754П-7 from the component part of the plug connector of the HP-10A pump hydraulic decelerator limit switch.

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Connect the plug connector of the limit switch of the HP-10A pump hydraulic decelerator to the plug connector of fuel pressure warning mechanism ДСД-2. Lock the plug connectors with brass wire.

Detach the ground hydraulic installation. Open all the switches.

Note: If the time period required for the shutters of the jet nozzle to shift from one position to another does not comply with the above limits, adjust the shutters as laid down in Section 20 of Chapter VII.

6. When checking the engine after completing the routine maintenance operations, inspect and check all joints of the fuel, oil, and hydraulic pipe-lines for leakage, with the engine running and the aircraft fuselage disjointed. Tighten the nuts of the pipe-line joints should any leakage be detected. The nuts of the fuel and oil pipe-line joints, provided with rubber seals should not be turned through more than two flats. If a nut can be turned by more than two flats, replace the rubber sealing by a new one as instructed in Chapter VII.

Checking Engine after Completing Routine Maintenance Operations

After completing the routine maintenance operation and eliminating the troubles detected, check the engine on the ground, with the aircraft fuselage disjointed, as laid down in Section 4 of Chapter III.

Prior to starting the engine proceed as follows:

1. Inspect the aircraft air intake duct and the afterburner for foreign objects.
2. Bleed air from the fuel system as instructed in Section 7 of Chapter IX.
3. Crank the cold engine to fill the oil system with oil, as recommended in Section 7 of Chapter IX.

Chapter VI
ADJUSTMENT OF ENGINE UNITS

In the course of engine operation it is allowed to carry out adjustment of:

(1) idling speed;
(2) maximum speed;
(3) speed at which the compressor air blow-off band control mechanism operates;
(4) engine acceleration;
(5) automatic starting;
(6) speed at which the limit switch of the HP-10A pump hydraulic decelerator operates;
(7) speed at which the jet nozzle shutters shift from one position to another;
(8) oil pressure at the engine inlet;
(9) time of jet nozzle shutters operation;
(10) control panel ПУ-3;
(11) temperature of gases aft of the turbine at augmented rating.

Adjustment should be performed by qualified personnel under the supervision of respective officers.

Proceed to adjusting the units only if absolutely sure of the respective instrument reading accuracy.

When carrying out the adjustment procedure it is necessary to pay due attention to the position of the adjusting details of the units, registered in their Service Logs.

Adjustment over, record the position of the adjusting detail in the respective Service Log; put down the adjustment procedure carried out in the engine Service Log.

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1. Adjustment of Idling Speed

Idling speed of the engine changes depending on the ambient air temperature, and should be maintained within the limits indicated in Table 2 and Fig.5.

Prior to checking idling speed it is necessary to warm up the engine by running it for 2 min. at 10,000 r.p.m.

Before adjusting idling speed make sure that when the engine control lever is shifted to the idling rating retainer, the indicator of the HP-10A fuel pump lever is positioned between the notches marking the idling rating sector on the dial of the HP-10A pump. By shifting the engine control lever to either direction between the notches provided on the dial of the HP-10A pump, ascertain that idling speed changes properly. Shifting of the engine control lever should not cause engine speed to change by more than 100 r.p.m. If engine speed changes by more than 100 r.p.m., the fuel pump should be replaced.

Idling Speed r.p.m. with Ambient Air Temperature

Ambient air temperature, °C	Idling speed, r.p.m.	
	lower limit	upper limit
+30	4200	4300
+15	4175	4275
0	4150	4250
-15	4125	4225
-30	4100	4200

Notes: 1. If the ambient air temperature rises in excess of +30°C or drops below -30°C, the engine speed graph (See Fig.5) should be continued in a straight line to either direction.

2. With the ambient air temperature below -30°C, the lower speed limit of the engine should not be less than 4100 r.p.m.

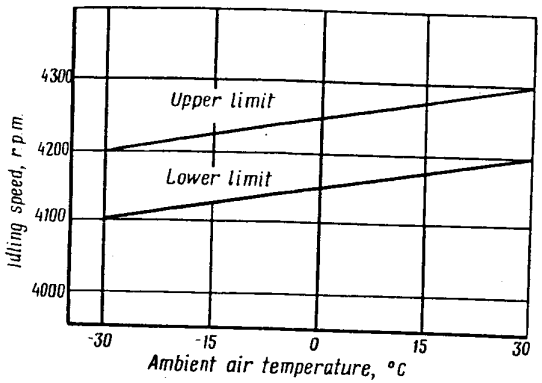

Fig.5. Graph Showing Dependence of Idling Speed on Ambient Air Temperature

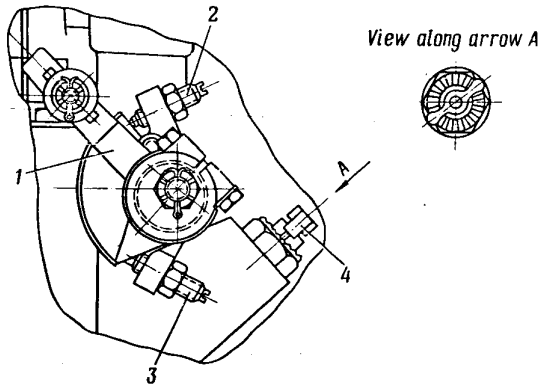

Fig.6. Adjustment of Idling Speed
1 - HP-10 pump lever; 2 - maximum speed stop screw; 3 - STOP (СТОП) position screw; 4 - thumb-piece.

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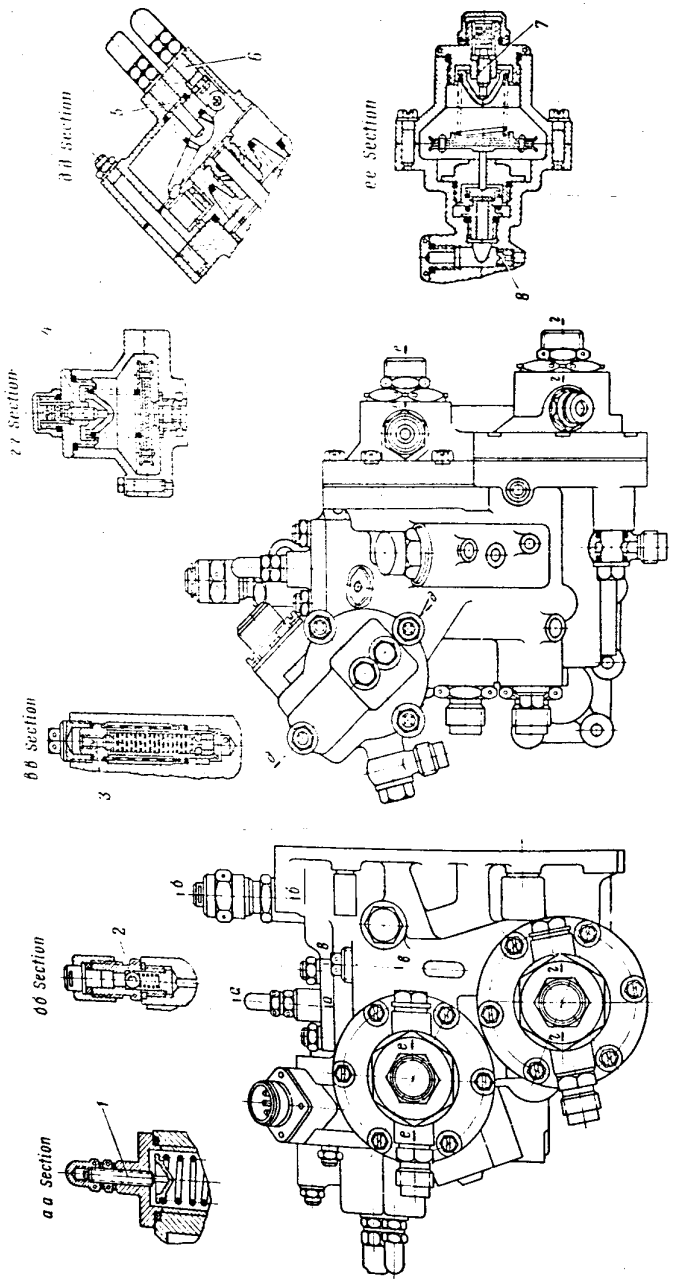

Fig.7. HP-10A Fuel Pump

1 - adjusting screw of distributing valve; 2 - air bleeder valve; 3 - throttling unit of pump hydraulic decelerator; 4 - acceleration control unit spring adjusting screw; 5 - maximum speed adjusting screw; 6 - hydraulic decelerator limit switch operation adjusting screw; 7 - starter control unit spring adjusting screw; 8 - starter control unit fuel jet.

Adjustment of idling speed should be carried out as follows:

1. Unlock the thumb-piece of the HP-10A fuel pump (Fig.6).

2. Turn the thumb-piece to adjust idling speed within the limits indicated in Table 2 and in Fig.5. When the thumb-piece is turned in the clockwise direction, engine speed is increased, while turning of the thumb-piece in the counter-clockwise direction causes engine speed to decrease. Turning of the thumb-piece by one click (in either direction) causes engine speed to change by approximately 15-25 r.p.m.

3. Lockwire the thumb-piece taking care not to disturb adjustment.

4. After performing adjustment of idling speed, check engine acceleration ability as instructed in Section 4 of Chapter III.

2. Adjustment of Maximum Speed

Checking of engine maximum speed will be accomplished prior to each flight, with the engine warmed up. Maximum speed should amount to 11,150 ±50 r.p.m.

When carrying out the check, run the engine at maximum speed for not less than 10 to 20 sec.

If engine maximum speed differs from the specified value, check it by using a reference tachometer with a measuring accuracy of ±20 r.p.m. within 10,000-12,000 r.p.m. range. When checking engine speed take into consideration the tachometer indicator error. If engine speed, when checked by the reference tachometer, happens to be in excess of or lower than 11,150 ±50 r.p.m., carry out adjustment of engine maximum speed.

Perform adjustment of engine maximum speed, with the jet nozzle shutters in the normal rating position, proceeding as follows:

1. Unlock and turn off the safety cap enclosing the screw of the HP-10A pump hydraulic decelerator (Fig.7, Д-Д Section).

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2. Back off the locknut of the HP-10A pump hydraulic booster screw and turn the screw out through two revolutions.

3. By manipulating the screw of the HP-10A pump lever stop, adjust engine speed to $11,250^{}_{-50}$ r.p.m. The engine should not be allowed to operate at a speed of 11,250 r.p.m. for more than 10 sec.; operation of the engine at a speed exceeding 11,250 r.p.m. is not allowed.

4. Making use of the hydraulic decelerator screw, adjust maximum speed to 11,150 ±50 r.p.m. When the hydraulic decelerator screw is turned out maximum speed is increased; when the screw is turned in engine speed is decreased. With the hydraulic decelerator screw turned through one complete revolution, maximum speed is changed by 500 to 700 r.p.m.

5. To check the engine for stable operation at maximum speed, shift the engine control lever to the "NORMAL" (НОМИНАЛ) stop four times. When shifting the engine control lever for the first and third times, move it slowly; at other times the control lever should be shifted in the same manner as when checking acceleration ability. The engine should be run at maximum speed for 30 to 40 sec.

6. Having adjusted maximum speed, tighten up the locking nut of the hydraulic decelerator screw taking care not to turn the adjusting screw; turn the cap onto the hydraulic decelerator screw and lockwire the cap.

Note: If during adjustment of maximum speed, correction of the HP-10A pump lever stop has been performed, check the engine controls and adjust them, if necessary, as instructed in Section 1 of Chapter VII and Section 5 of Chapter IX.

Adjustment of Maximum Speed when r.p.m. at Normal Rating Differs Greately from r.p.m. at Maximum Rating

If engine maximum speed, adjusted at normal rating within 11,150 ±50 r.p.m. differs from the specified value by more than 100 r.p.m. when the engine control lever is shifted

to the maximum speed position, the throttling unit of the HP-10A fuel pump servo-mechanism may be replaced by a throttling unit of greater capacity (over 200 cu.cm/min.) or the jet of the HP-10A pump minimum fuel pressure valve may be replaced by a jet having a larger diameter orifice (within 0.8-1.0 mm).

Replacement of the throttling unit and the jet of the minimum pressure valve is carried out by a representative of the Manufacturing plant.

3. Adjustment of Speed at which Compressor Air Blow-Off Band Control Mechanism Operates

Engine speed at which the band opens the compressor air blow-off ports should be checked prior to each flight on a warmed-up engine. The respective engine speed should be checked by smoothly shifting the engine control lever from the 10,000 r.p.m. position to the 9000 r.p.m. position.

The band should open the compressor air blow-off ports at a speed of $9700^{}_{-100}$ r.p.m. The moment the ports are open the engine noise changes and air pressure in the aircraft engine compartment is increased. If engine speed happens to be in excess of or less than $9700^{}_{-100}$ r.p.m., the band control mechanism should be adjusted as follows:

1. Unlock and slacken the locking nut of the centrifugal valve adjusting screw (Fig.8).

2. Manipulate the screw to adjust the speed to the required value ($9700^{}_{-100}$ r.p.m.). When the screw is turned in the speed increases; when the screw is turned out speed decreases. With the centrifugal valve adjusting screw turned through one complete revolution the engine speed changes by 300-400 r.p.m.

3. Adjustment over, tighten the locking nut taking care not to turn the adjusting screw; lockwire the nut.

Notes: 1. If the total change in the engine speed at which the air blow-off ports are opened, exceeds 150-200 r.p.m., replace the centrifugal valve.

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2. Engine speed, at which the compressor air blow-off ports are closed by the band should not exceed the speed at which the ports are opened by more than 150 r.p.m.

4. Adjustment of Engine Acceleration

The engine leaves the Manufacturing plant with the HP-10A fuel pump acceleration control unit being properly adjusted.

Adjustment of the acceleration control unit in the course of engine operation is allowed only in case the HP-10A pump is replaced, and also if some engine acceleration characteristics happen to differ from the values presented in Section 4 of Chapter III.

To ensure normal engine acceleration and to prevent engine speed from dropping carry out adjustment of engine acceleration as follows:

1. Start the engine, check and adjust idling speed as recommended in Section 1 of this Chapter.

2. Remove the cap from the HP-10A pump pipe union serving to check fuel pressure in the auxiliary pipe-line. Fit the pipe union with a special pipe provided with a damper and a pressure gauge having a measuring range of 0 to 25 kg/sq.cm., with a division value not exceeding 1 kg/sq.cm. When connecting the pressure gauge, fill the pipe with fuel by delivering it through the pipe union with the throttle cock open. This done, tighten up the nut.

3. Unlock the screw of the HP-10A pump distributing valve spring (See Fig.7, a–a Section) and the screw of the acceleration control unit spring (See Fig.7, r–r Section); unlock the air bleed jet located on the pipe serving for air delivery to the acceleration control unit (Fig.9).

Note: Unlock the screw of the distributing valve spring only in case it is necessary to change fuel pressure in the auxiliary pipe-line at idling speed.

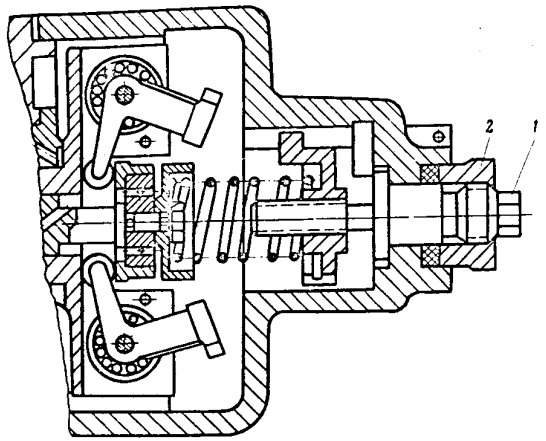

Fig.8. Centrifugal Valve
1 – adjusting screw; 2 – locking nut.

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2. Engine speed, at which the compressor air blow-off ports are closed by the band should not exceed the speed at which the ports are opened by more than 150 r.p.m.

4. Adjustment of Engine Acceleration

The engine leaves the Manufacturing plant with the HP-10A fuel pump acceleration control unit being properly adjusted.

Adjustment of the acceleration control unit in the course of engine operation is allowed only in case the HP-10A pump is replaced, and also if some engine acceleration characteristics happen to differ from the values presented in Section 4 of Chapter III.

To ensure normal engine acceleration and to prevent engine speed from dropping carry out adjustment of engine acceleration as follows:

1. Start the engine, check and adjust idling speed as recommended in Section 1 of this Chapter.

2. Remove the cap from the HP-10A pump pipe union serving to check fuel pressure in the auxiliary pipe-line. Fit the pipe union with a special pipe provided with a damper and a pressure gauge having a measuring range of 0 to 25 kg/sq.cm., with a division value not exceeding 1 kg/sq.cm. When connecting the pressure gauge, fill the pipe with fuel by delivering it through the pipe union with the throttle cock open. This done, tighten up the nut.

3. Unlock the screw of the HP-10A pump distributing valve spring (See Fig.7, a–a Section) and the screw of the acceleration control unit spring (See Fig.7, r–r Section); unlock the air bleed jet located on the pipe serving for air delivery to the acceleration control unit (Fig.9).

Note: Unlock the screw of the distributing valve spring only in case it is necessary to change fuel pressure in the auxiliary pipe-line at idling speed.

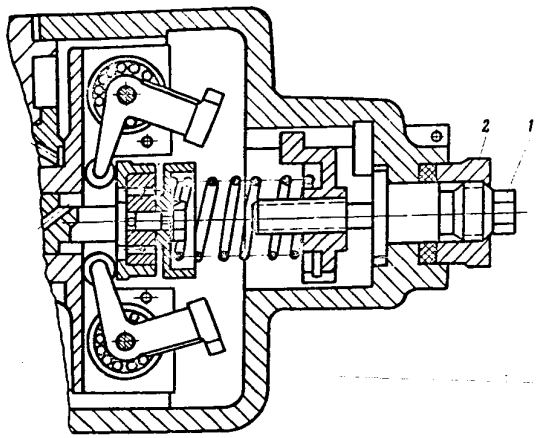

Fig.8. Centrifugal Valve
1 – adjusting screw; 2 – locking nut.

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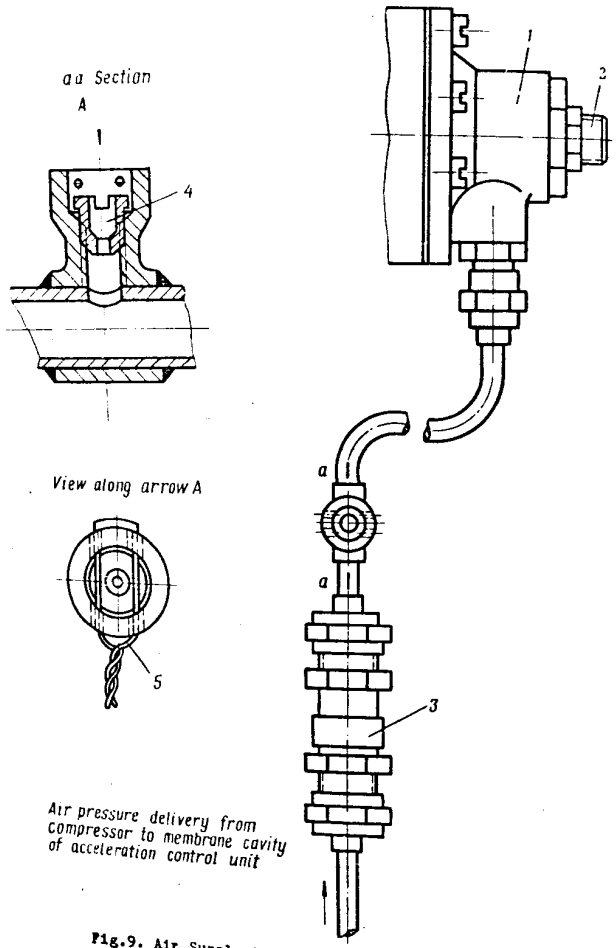

Fig.9. Air Supply to Acceleration Control Unit of HP-10A Pump

1 - acceleration control unit; 2 - cap enclosing acceleration control unit spring adjusting screw; 3 - air cleaner; 4 - acceleration control unit air bleed jet; 5 - lockwire.

4. Check fuel pressure in the auxiliary pipe-line at idling speed and adjust it to within 10-13 kg/sq.cm. by manipulating the screw of the distributing valve spring (See Fig.7, a-a Section). When the screw is turned in fuel pressure increases and vice versa.

5. Turn the air bleed jet from the pipe serving for air delivery to the acceleration control unit.

6. Check fuel pressure in the auxiliary pipe-line at engine speed corresponding to a fully open throttle cock, with the air bleed jet turned out. Fuel pressure in the auxiliary pipe-line at this speed should exceed fuel pressure, adjusted at idling speed by 1 to 4 kg/sq.cm. and should be within 11-16 kg/sq.cm. If the difference between the pressures of fuel in the auxiliary pipe-line at a speed, corresponding to fully open throttle cock (with the air bleed jet turned out), and at idling speed is less than or exceeds 1 to 4 kg/sq.cm., adjust it by manipulating the screw of the acceleration valve spring (See Fig.7, Г-Г Section). When the screw of the acceleration control unit spring is turned in, fuel pressure increases, when the screw is turned out fuel pressure decreases.

Turning of the acceleration control unit spring screw by 0.5 turn in either direction causes the difference between fuel pressures in the auxiliary pipe-line at a speed corresponding to a fully open throttle cock (with the air bleed jet turned out), and idling speed to change by 1 kg/sq.cm.

CAUTION. Do not turn out the screw of the acceleration control unit beyond the pipe union face.

7. Turn the air bleed jet into the pipe serving for air delivery to the acceleration control unit (See Fig.9). Remove the pipe with the pressure gauge and blank off the pipe union of the HP-10A pump.

8. Check engine acceleration as recommended in Section 4 of Chapter III. Engine acceleration time from idling speed to 9500 r.p.m., depending on the ambient air temperature, should be within the limits set in Table 3 and in Fig.10.

Table 3

Engine Acceleration Time from Idling Speed to 9500 r.p.m., with Ambient Air Temperature

Ambient air temperature, °C	Acceleration time, sec.	
	lower limit	upper limit
+30	8	10
+15	7.5	9.5
0	7	9
-15	6.5	8.5
-30	6	8

Note: Total engine acceleration time should be within the following limits:

(a) from idling speed to normal rating - 9-12 sec.;

(b) from idling speed to maximum rating - 9 - 13 sec.;

(c) from idling speed to augmented rating - 10-15 sec.

In case acceleration time does not comply with the specified values, replace the jet serving for bleeding air from the acceleration control unit.

To decrease acceleration time, install an air bleed jet with less diameter orifice, and vice versa. Use air bleed jets with 2 to 3.5 mm diameter orifices. Start adjustment procedure by installing an air bleed jet with 2.7 to 3 mm diameter orifice.

If acceleration time cannot be adjusted by selecting a proper air bleed jet, additional adjustment may be carried out by manipulating the screw of the acceleration control unit spring (See Fig.7, r-r Section) as well as the screw of the HP-10A pump distributing valve spring (See Fig.7, a-a Section). If the screw of the acceleration valve spring turns by not more than ±0.5 turn from the position it has been set in during adjustment of fuel pressure differential in the auxiliary pipe-line (See Point 6), fuel pressure differential may not be checked. In case the screw of the acceleration valve spring turns by more than ±0.5 turn, be sure to check and, if necessary, adjust difference between fuel pressures in the auxiliary pipe-line at a speed corresponding to a fully open throttle cock (with the air bleed jet turned out) and at idling speed, as instructed under Point 6.

9. Check and adjust engine acceleration from 8200 ±100 r.p.m. to the normal, maximum and augmented ratings by choosing proper throttling unit of the HP-10A pump hydraulic decelerator.

Acceleration time from 8200 ±100 r.p.m. to the normal rating should amount to 9-12 sec.; to maximum rating - 9-13 sec.; to augmented rating - 10-15 sec.

When a throttling unit of less capacity is installed acceleration time increases, and vice versa.

Note: The throttling unit of the HP-10A pump hydraulic decelerator is replaced by a representative of the respective Manufacturing plant.

10. Adjustment over, lockwire all adjustment elements, close the aircraft engine compartment access panels and check engine acceleration from idling speed to the normal rating as instructed in Section 4 of Chapter III.

11. When performing adjustment of acceleration on a newly installed engine, or after replacement of the HP-10A pump, check engine acceleration from 3800 r.p.m. to the normal rating, which should not be accompanied by engine hunting or a rise in temperature of gases aft of the turbine in excess of the specified value. In this case engine acceleration time is not limited.

12. Check the engine for proper control as laid down in Section 4 of Chapter III.

13. If the above adjustment of acceleration has called for manipulation of the screw controlling the spring of the HP-10A pump distributing valve, the screw of the starter

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control unit spring should be backed off by 2-3 turns prior to restarting the engine.

Carry out the final adjustment of starting after fully adjusting engine acceleration.

14. Adjustment of engine acceleration over, enter the value of fuel pressure in the additional pipe-line at idling speed in the engine Service Log; make sure to register the orifice diameter of the jet serving for bleeding air from the engine acceleration control unit.

Notes: 1. If, in the course of engine operation adjustment of acceleration is to be carried out due to some reasons, it should be accomplished by replacing the jet for bleeding air from the acceleration unit of the HP-10A pump.

Use of the screw of the distributing valve spring is allowed provided fuel pressure differential in the auxiliary pipe-line is checked afterwards as laid down in Point 6.

The screw may be turned within ±0.5 turn from the position it has been set in during previous adjustment of fuel pressure differential in the auxiliary pipe-line; a further check on fuel pressure differential is not required.

2. Engine acceleration time is subject to change due to clogging of the fuel filter of fuel-oil unit 317A, and also due to air getting into the engine fuel system. Therefore, if no stable acceleration time can be obtained, check the fuel filter of fuel-oil unit 317A for cleanliness and flush the engine fuel system. Besides, engine acceleration time may be changed during adjustment of idling speed, therefore after performing adjustment of idling speed, check engine acceleration.

5. Adjustment of Automatic Starting

Adjustment of automatic starting will be accomplished in case starting does not comply with the requirements referred to in Chapter III.

Adjustment of automatic starting is done by changing pressure on the membrane of the HP-10A fuel pump starter control unit, which is accomplished by manipulating the screw of the spring (See Fig.7, e-e Section) and the jet serving to bleed air from the respective chamber of the starter control unit (Fig.11).

When the spring screw is turned in, pressure on the membrane increases, while engine acceleration time decreases, causing an increase in the temperature of gases aft of the turbine. Backing out of the spring screw exerts opposite influence.

An increase in the diameter of the orifice of the air bleed jet causes the pressure on the membrane to drop; in this case engine acceleration time increases, while temperature of gases aft of the turbine decreases. Decreasing diameter of the air bleed jet exerts a reverse influence.

When performing adjustment of starting it should be taken into consideration, that the spring screw exerts a greater influence on engine acceleration ability within the speed range of up to 2000 r.p.m., while the air bleed jet exerts a greater action within the final phase of engine acceleration.

For normally adjusted automatic starting an air bleed jet with 1.4 to 2.7 mm diameter orifice should be used.

Adjustment of automatic starting should be performed as follows:

1. Unlock the screw of the starter control unit spring and the jet for bleeding air from the starter control unit.

2. By manipulating the spring screw and the air bleed jet, adjust starting so that the temperature of gases aft of the turbine should not exceed 800°C. All the other characteristics at starting should comply with the values presented in Chapter I of the present Instructions.

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Note: If necessary, a representative of the Manufacturing plant may replace the spring of the starter control unit on the HP-10A pumps of early production models.

3. After carrying out adjustment of automatic starting during which the screw of the starter control unit spring has been turned out, it is necessary to check the reserve of the starter control unit spring tension, with the engine at standstill, proceeding as follows:

(a) detach the pipe, serving for fuel delivery to the return valve, from the elbow piece of the HP-10A pump;

(b) check the screw of the starter control unit spring for proper position (the screw should not project beyond the pipe union face);

(c) back out the screw of the starter control unit spring by half turn and cut in the aircraft fuel booster pump;

(d) check fuel leakage into the elbow through the closed stop-cock of the HP-10A pump; leakage should not exceed 20 cu.cm/min.

If fuel leakage into the elbow does not exceed 20 cu.cm/min., return the spring screw to the initial position, that is turn it in by half turn; then connect the pipe for fuel delivery to the return valve to the pump elbow. This done, starting may be considered properly adjusted.

In case fuel leakage through the elbow of the HP-10A pump exceeds 20 cu.cm/min., replace the spring of the starter control unit by a less rigid one, or replace the HP-10A pump.

4. After carrying out adjustment of the automatic starting, lockwire the air bleed jet and the cap of the starter control unit spring screw.

6. Adjustment of Speed at which Limit Switch of HP-10A Pump Hydraulic Decelerator Operates

The limit switch of the HP-10A pump hydraulic decelerator should operate at a speed of 10,400 ±200 r.p.m., when the

engine control lever is smoothly shifted from 10,000 r.p.m. to the "NORMAL" (НОМИНАЛ) stop.

Operation of the HP-10A pump hydraulic decelerator limit switch is checked by the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2, with the help of adapter 833П-7. To check operation of the limit switch of the HP-10A pump hydraulic decelerator, detach the component parts of the plug connectors from the limit switch of the HP-10A pump hydraulic decelerator and from oil pressure warning unit 2СДУ5-1.3-2.2, after which use adapter 833П-7 to join the connector of the limit switch with the plug of the wire harness running to oil pressure warning mechanism 2СДУ5-1.3-2.2. While shifting the engine control lever, watch the pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 to check the speed at which the limit switch of the HP-10A pump hydraulic decelerator operates. The pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 should light up at a speed of 10,400 ±200 r.p.m., with the engine control lever slowly shifted from the 10,000 r.p.m. position to the "NORMAL" (НОМИНАЛ) stop.

If engine speed at which the limit switch of the HP-10A pump hydraulic decelerator operates, differs from the specified values, perform adjustment using the following procedure:

1. Unlock and turn off the cap enclosing the screw of the limit switch of the HP-10A pump hydraulic decelerator (See Fig.7, Д-Д Section).

2. Slacken the locking nut and by turning the screw of the limit switch adjust the speed at which the limit switch operates to 10,400 ±200 r.p.m., with the engine control lever slowly shifted from the 10,000 r.p.m. position to the "NORMAL" (НОМИНАЛ) stop. When the screw is being turned out the speed at which the limit switch operates increases, and vice versa.

3. Check the engine speed, at which the pilot lamp of the oil pressure warning unit lights up with the engine accelerated from idling speed to the normal rating. The pilot lamp should light up at a speed of not less than $^{9700}_{-100}$ r.p.m. If the pilot lamp of oil pressure warning

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mechanism 2СДУ5-1.3-2.2 lights up at a speed lower than 9700^{-100} r.p.m., check the aircraft electric system.

4. Turn on the locking nut, keeping the limit switch screw against rotation; turn the cap on the limit switch screw and lock it with wire.

5. Remove adapter 833П-7 and fit in the plugs of oil pressure warning mechanism 2СДУ5-1.3-2.2 and of the НР-10А pump.

7. Adjustment of Speed at which Jet Nozzle Shutters Shift from One Position to Another

When the engine is being started, the shutters of the jet nozzle are in the position corresponding to the augmented rating (the minimum diameter of jet nozzle opening is equal to 495 mm; the maximum diameter is limited by minimum overlapping of the shutters equal to 4 mm).

When the engine control lever is moved further towards the "NORMAL" (НОМИНАЛ) stop, the shutters of the jet nozzle should shift to the position corresponding to the normal rating, when engine speed reaches 4500–6500 r.p.m. (diameter of jet nozzle opening should be within 458–475 mm).

Checking of engine speed, at which the shutters of the jet nozzle shift from the position corresponding to augmented rating to the position corresponding to normal rating, should be carried out on a warmed-up engine by smoothly shifting the engine control lever. If the jet nozzle shutters change their position at a speed lower than 4500 r.p.m. or exceeding 6500 r.p.m., adjust shifting of the shutters as follows:

1. Unlock and turn out the four bolts holding the upper cover of control panel ПУ-3, then remove the cover (Fig.12).

2. Unlock screw 11 serving for adjustment of control panel limit switch 3 operation.

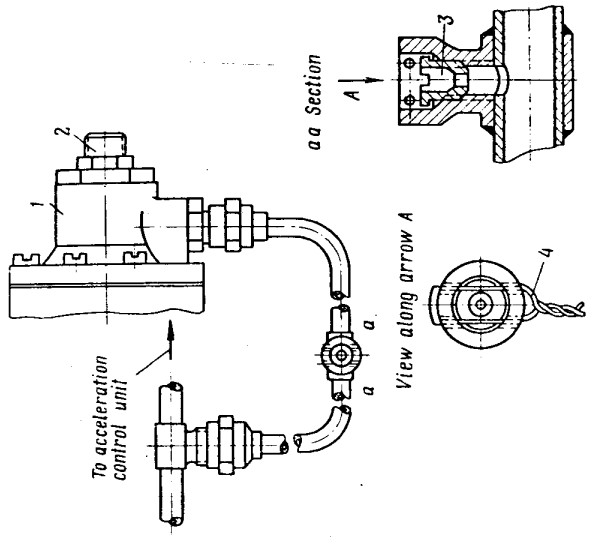

Fig.11. Air Supply to Starter Control Unit of НР-10А Pump

1 – starter control unit; 2 – cap enclosing starter control unit spring adjusting screw; 3 – starter control unit air bleed jet; 4 – lock-wire

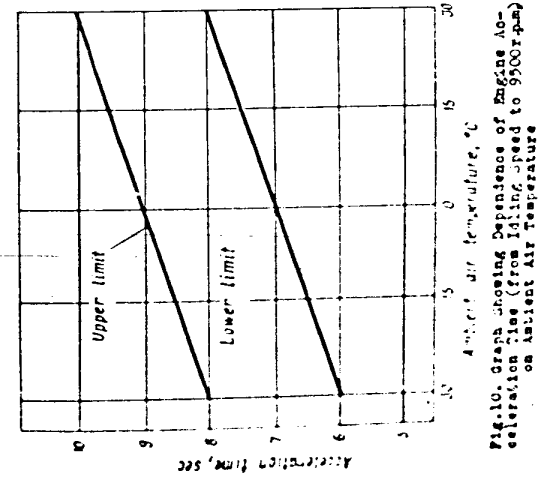

Fig.10. Graph showing Dependence of Engine Acceleration Time (from Idling Speed to 6900 r.p.m.) on Ambient Air Temperature

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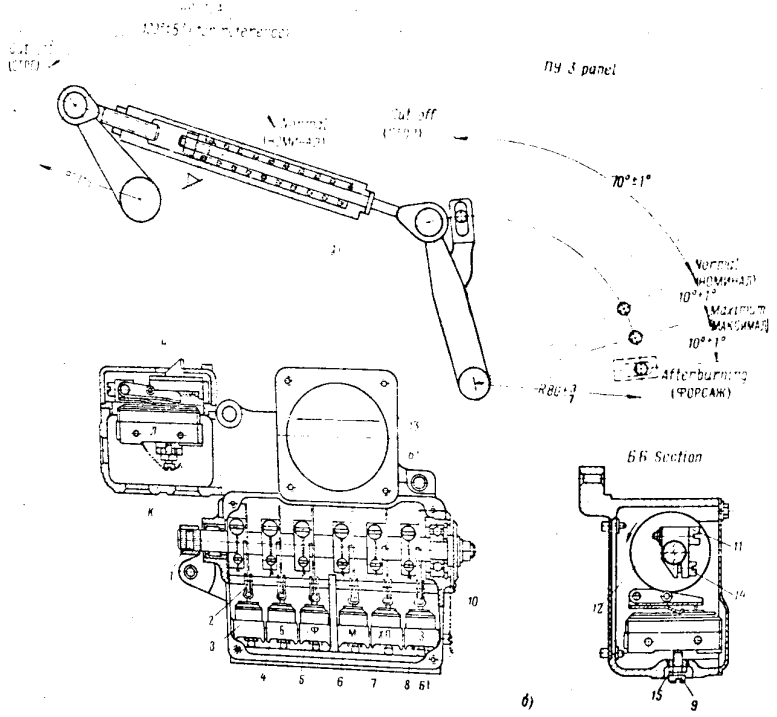

Fig.12. ПУ-3 Control Panel

а - kinematic diagram of engine control; б - control panel.

1 - lever; 2 - guide; 3 - limit switch (spare); 4 - limit switch Б (interlocking); 5 - limit switch Ф (for turning on afterburner); 6 - limit switch М (for setting engine at maximum rating); 7 - limit switch ХП (cold cranking); 8 - limit switch 3 (for shifting jet nozzle shutters to augmented position at starting); 9 - limit switch adjusting screw; 10 - dial; 11 - cam adjusting screw; 12 - profiled cam; 13 - housing; 14 - coupling screw; 15 - locking nut.

3. Release and loosen screw 14 locked along with screw 11.

4. Turn screw 11 to adjust the jet nozzle shutters so that they should change their position at the required engine speed.

When screw 11 is turned in the jet nozzle shutters change their position at a lower engine speed, and vice versa. One complete turn of screw 11 causes the jet nozzle shutters to change their position at an engine speed differing by 1000-1200 r.p.m.

5. Turn in screw 14 and lockwire it together with screw 11.

6. Install in position the upper cover of control panel ПУ-3, turn in the four bolts and lock them by new locking washers.

8. Adjustment of Oil Pressure

Adjustment of oil pressure is carried out after replacement of the oil unit or in case oil pressure does not comply with the specified limits.

Prior to carrying out the adjustment, measure oil pressure in the engine pressure pipe-line, for which purpose remove the cap from the pipe union provided on the pipe serving for oil delivery to oil pressure warning mechanism 2СДУ5-1.3-2.2 and connect a pressure gauge to the pipe union.

Oil pressure in the pressure line at normal rating after the engine has been properly warmed up should amount to $4.5_{-0.5}$ kg/sq.cm.

If oil pressure does not fall within the specified limits, the reducing valve of the oil unit should be adjusted as follows:

1. Unlock the shank of the reducing valve spring adjusting screw (Fig.13).

2. Release and turn off the screw locking nut, keeping the valve body against rotation with the help of a wrench.

3. Turn the screw to adjust oil pressure so that at normal rating oil pressure in the pressure line is within $4.5_{-0.5}$ kg/sq.cm. limit.

When the screw is being turned in oil pressure increases, and vice versa. One complete turn of the screw causes oil pressure to change by 3 to 4 kg/sq.cm.

4. Tighten the locking nut without allowing the screw to rotate.

5. Lockwire the screw shank and the locking nut.

After adjustment of oil pressure is completed, detach the pressure gauge, fit the cap onto the pipe union and lockwire it.

9. Adjustment of Control Panel ПУ-3

Adjustment of control panel ПУ-3 is carried out in case some defects have become evident during engine operation, which are associated with operation of control panel ПУ-3.

Prior to subjecting control panel ПУ-3 to adjustment, check it for proper operation.

Checking Control Panel ПУ-3 for Proper Operation

Trouble-free operation of control panel ПУ-3 is largely dependent on proper connection of engine controls to the lever of the control panel.

Prior to checking operation of the control panel, check the system of engine control as instructed in Section 5 of Chapter IX.

Check the control panel for proper operation by using a special device, and proceeding as follows:

1. Detach the component part from the main plug connector of the engine and connect the plug of the special device to the main plug connector (according to the Diagram presented in Fig.14).

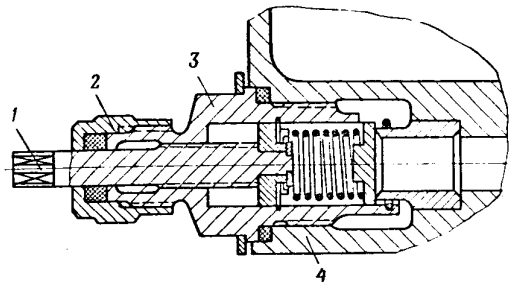

Fig.13. Oil Unit Reducing Valve

1 – reducing valve spring adjusting screw; 2 – locking nut; 3 – reducing valve housing; 4 – oil unit housing.

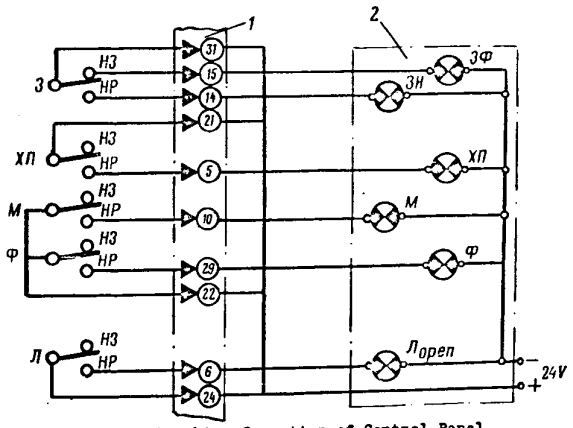

Fig.14. Checking Operation of Control Panel ПУ-3. Diagram

1 – main plug connector ШР55П35НШ3 ; 2 – device for checking operation of control panel limit switches.

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With the device energized and the engine control lever in the CUT-OFF (СТОП) position, lamps ЗФ and Л of the device should burn (when the compressor air blow-off ports are open, See Fig.14). If the compressor air blow-off ports are closed, lamp Л of the device should not burn.

2. Smoothly move the engine control lever from the "CUT-OFF" (СТОП) position to the "AFTERBURNING" (ФОРСАЖ) position, and check the limit switches of the control panel for proper operation by watching the pilot lamps of the device. The pilot lamps should light up in the following sequence:

(a) when the lever of the control panel is shifted to an angle of 4°_{-1} (on the dial of the control panel) lamp ХП should light up;

(b) shifting of the control panel lever to an angle of $23 \pm 1^{\circ}$ (on the control panel dial) should cause lamp ЗН to light up and lamp ЗФ to go out;

(c) when the engine control lever is set at the "MAXIMUM" (МАКСИМАЛ) stop, lamp М should light up;

(d) with the engine control lever shifted to the "AFTERBURNING" (ФОРСАЖ) stop, lamp Ф should light up.

When the engine control lever is moved backward, that is from the "AFTERBURNING" (ФОРСАЖ) stop to the "CUT-OFF" (СТОП) position, the pilot lamps of the device should go out and light up in the reverse sequence.

To ascertain that the limit switches of the control panel function properly, perform the above check 2 to 3 times.

3. Check operation of limit switch Л of the control panel by lamp Л of the device while manipulating the compressor air blow-off band to open the air blow-off ports 3 times.

If one or more limit switches of the control panel are not capable of stable operation, subject them to thorough adjustment as recommended below.

Note: The pilot lamps of the device respond to operation of the following limit switches of control panel ПУ-3:

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(a) lamp Л - to limit switch Л of compressor air blow-off band;

(b) lamp ЗФ (jet nozzle shutters in position corresponding to augmented rating) - to limit switch 3;

(c) lamp ЗН (jet nozzle shutters in position corresponding to normal rating) - to limit switch 3;

(d) lamp М - to limit switch М of maximum rating;

(e) lamp Ф - to limit switch Ф of augmented rating;

(f) lamp ХП - to ignition limit switch ХП

Adjustment of Control Panel Limit Switches

Before adjusting the limit switches of the control panel, detach the engine control link from the lever of the control panel.

Proceed to adjusting the limit switches of the control panel by using the special device, and working as follows:

1. Unlock and turn out the four bolts securing the upper cover of the control panel.

2. Unlock screws 11 and 14 (See Fig.12).

3. Unlock screws 9 and locking nuts 15.

4. Shift the lever of the control panel to an angle of 90 $\pm 2^{\circ}$ from the "CUT-OFF" (СТОП) position (on the control panel dial); all guides 2 should be at the lobes of cams 12.

With the lever in the "CUT-OFF" (СТОП) position the notch on the control panel housing should be in line with the notch on the lever, while the dial zero should be positioned against the notch provided on the control panel housing. If the dial zero does not line up with the notch, slacken the nut of dial 10 and turn the latter so that the zero is in line with the notch, provided on the control panel housing.

5. By manipulating adjusting screws 9, ensure normal operation of limit switches ХП, З, М, and Ф, for which

purpose carry out the following operations on each of the limit switches:

(a) back out screw 9 until the respective lamp of the device goes out;

(b) by carefully turning in screw 9, determine the moment when the lamp lights up;

(c) for creating an effort when the rod is pressed, turn screw 9 in additionally by 0.5 turn.

When carrying out adjustment of the control panel limit switches, it should be borne in mind that the moment lamp ЗН of the device lights up, lamp ЗФ should go out, and vice versa.

Operation of the control panel limit switches should be checked in both extreme positions of the cam shaft with elimination of axial play.

6. By pressing guides 2 with a feeler, check the rods of the limit switches for reserve travel, which should be not less than 0.1 mm. If no reserve travel can be obtained, turn out screw 9 to ensure the specified reserve travel, taking care not to back out screw 9 by more than 0.25 turn.

In case turning out of screw 9 through 0.25 turn is not sufficient for ensuring the specified reserve travel of the limit switch, replace the control panel.

7. Back out screws 14 by 2 to 3 turns. By manipulating screws 11 adjust operation of the limit switches according to angles of turn of the control panel lever (on the control panel dial) using the following procedure:

(a) set the control panel lever at an angle of 4_{-1}°, and by turning screw 11 ensure proper operation of the control panel limit switch, which is evidenced by lighting up of lamp ХП;

(b) in a similar way, adjust operation of the following limit switches:

- limit switch 3, with the control panel lever set at an angle of $23 \pm 1^{\circ}$;

- limit switch М, with the control panel lever set at an angle of 75_{-1}°;

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- limit switch Ф, with the control panel lever set at an angle of 85°_{-1};

When the control panel lever is moved backward, that is to the "CUT-OFF" (СТОП) position, the limit switches should operate at the same angles of turn of the control panel lever, but in the reverse order.

As soon as operation of each of the limit switches has been properly adjusted, lock cams 12 and tighten screws 14.

8. Adjustment of the control panel over, lockwire screws 9, 11, and 14. Install the upper cover on the control panel, and secure it with bolts fitted with new locking washers. Lock the bolts by bending the locking washer tabs over the flats of the bolt heads.

9. Connect the engine control link to the control panel lever.

10. After completing all adjustment operations, check control panel ПУ-3 for proper operation.

Adjustment of Limit Switch Л Controlling Operation of Compressor Air Blow-Off Band

Prior to adjusting limit switch Л of the compressor air blow-off band, check the limit switch for proper operation by shifting stop H (See Fig.12) thereby opening and closing the compressor ports with the help of the air blow-off band.

Before opening the compressor ports, check to see that there is a clearance between stop H and the adjusting screw of limit switch Л drive.

When the compressor ports are open, limit switch Л should operate (a sharp click should be heard) if stop H is shifted to a distance of 2-4 mm. From the position corresponding to fully closed compressor ports to the position corresponding to fully open compressor ports (the driven sector is set at the stop), stop H acted upon by the adjusting screw of the limit switch Л drive should travel a distance of 5-7 mm. Additional travel of stop H from position "DRIVEN SECTOR AT STOP" (ВЕДОМЫЙ СЕКТОР НА УПОРЕ) should be not less than 1.5 mm.

When the compressor ports are closed, limit switch Л should operate in the same position as when opening the ports, that is stop H should be 2 to 4 mm short of the position, corresponding to fully closed compressor ports (a click should be distinctly audible).

Check operation of limit switch Л by opening and closing the compressor air blow-off ports three times.

In case stop H moves with some difficulty or its travel, with the compressor ports fully open, is less than 5-7 mm, or if limit switch Л does not operate at all (no click is heard), remove the drive of limit switch Л and check it for proper operation. The slide should move along the rod smoothly, without binding, and under the force of spring it should shift to the stop, while the adjusting screw and the drive body should have no bends. Replace the drive of limit switch Л if any defects have been detected.

If the drive of limit switch Л functions normally, while limit switch Л does not operate or operates irregularly when the compressor ports are being opened or closed, subject limit switch Л to adjustment, proceeding as follows:

1. Detach the free moving rod, connecting the control panel lever to the lever of the НР-10А fuel pump, from the lever of ПУ-3 control panel.

2. Disconnect the plug connector of the oil pressure warning unit and detach the oil delivery pipe-line from the latter. Unlock and turn off the nut, holding the oil pressure warning unit to the bracket; remove the oil pressure warning unit.

3. Remove the clamps securing the wire harness running from control panel ПУ-3 to the НР-10А fuel pump and to the magnetic valve.

4. Unlock and turn out the two bolts holding the control panel to the bracket; turn the nut off the third bolt. Arrange the control panel so that to ensure convenient removal of limit switch Л case from the control panel housing. While

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proceeding in this way, use care not to break the wires running from the control panel.

5. Unlock and turn out the two screws, remove the cover from the case of limit switch Л and remove limit switch Л, taking care not to break the wires.

6. Unlock adjusting screw К and slacken the nut. By manipulating screw К, adjust operation of limit switch Л, so that when stop Н is moved 2 to 4 mm, a click should be heard testifying to proper operation of limit switch Л.

7. Fasten adjusting screw К with the help of the nut, holding the screw against rotation. Lock the screw with 0.8 mm diameter brass wire.

8. Install the switch case into the control panel housing and arrange the cover so that stop Н fits into the cover slot. Fasten the cover by two screws, having fitted washers under their heads; lock the screws with 0.8 mm brass wire.

9. Mount the control panel on the bracket and secure it by three bolts fitted with new locking washers. Lock the bolts and the nut by bending the washer tabs over the flats of the bolt heads and nut, and over the control panel housing.

10. Install in position the clips securing the control panel wire harness.

11. Mount the oil pressure warning unit on the bracket (with the pipe unions up and the plug connector forward) and secure it with a nut. Lock the nut with 0.8 mm diameter brass wire.

12. Connect the oil delivery pipe-line and the component part of the plug connector to the oil pressure warning unit. Lock the nuts of the pipe-line joints and the nut of the plug connector with 0.8 mm diameter brass wire.

13. Couple the free moving link to the control panel lever.

14. Check limit switch Л for proper operation as instructed above.

10. Adjustment of Jet Nozzle Shutters Operation

Adjustment of jet nozzle shutters operation should be performed as laid down in Section 20 of Chapter VII.

11. Adjustment of Engines for Synchronous Operation

The construction of the lever of control panel ПУ-3 of the engine control bell-crank, and the link connecting the lever of control panel ПУ-3 to the bell-crank, provides for synchronous operation of both engines.

Asynchronous operation of the engines is allowed within the following limits:

(a) at speed of up to 8200 ±100 r.p.m. - not over 1000 r.p.m.;

(b) at speeds of over 8200 ±100 r.p.m. - not over 200 r.p.m. (with maximum speed being the same for both engines when the engine control lever is set at the "NORMAL" (НОМИНАЛ) stop).

In case the difference in engine speeds exceeds the specified limits, subject the engine control system to adjustment, with the engines being at standstill.

Check the engine control system for proper operation by smoothly shifting the engine control lever, located in the aircraft cockpit, from the CUT-OFF (СТОП) stop to the "AFTERBURNING" (ФОРСАЖ) stop, and then backward. The engine control lever should move without binding.

When the engine control lever is set in the CUT-OFF (СТОП) stop, the zero notches on the dials of control panels ПУ-3 should set against the notches provided on the control panel housings. The engine control lever should have a reserve travel of 1-2 mm.

With the engine control lever set at the idling speed retainer, the indicators of the levers of the HP-10A fuel pumps should be between the notches marking the idling rating sector on the dials of the HP-10A pumps.

When the engine control lever is moved to the CUT-OFF (СТОП) stop or to the "NORMAL" (НОМИНАЛ) stop the levers

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of the HP-10A pumps should fit snugly against the respective stops on the dials of the HP-10A pumps.

When the engine control lever is moved to the "MAXIMUM" (МАКСИМАЛ) and "AFTERBURNING" (ФОРСАЖ) stops, the engine control lever should be capable of moving additionally by 3 to 5° (as indicated on the control panel dial) after the click of the respective limit switch of control panel ПУ-3 has been heard.

Accuracy of operation of the engine control system is ensured by changing the length of the aircraft links as well as by changing the length of the control panel lever and of the aircraft bell-crank arms, which is accomplished by shifting the racks.

When carrying out adjustment of engine synchronous operation it is allowed, if necessary, to make use of the idling speed sector on the dials of the HP-10A pumps; in this case the pump lever should stop 1mm short of the notches.

CAUTION. When adjusting the engine control system with the purpose of ensuring synchronous operation of the engines, it is not allowed to change the length of the link, connecting the lever of the HP-10A pump with the lever of control panel ПУ-3, or the length of the HP-10A pump lever arm by shifting the lever rack.

12. Adjustment of Gas Temperature Aft of Turbine at Augmented Rating

The temperature of gases aft of the turbine during flight at augmented rating should be within 620 to 680°C; besides, when climbing at altitudes of over 10,000 m. with the afterburner turned on, the temperature of gases after the turbine may rise for a short period of time to 700°C.

If the РД-9Б engines of the fourth or fifth series are employed, with 40 mm wide plate of the afterburner diffuser flame arrestor, the temperature of gases aft of the turbine when climbing with the afterburner turned on should rise to 700°C for not more than 30 sec.

If temperature of gases aft of the turbine does not comply with the specified limits, adjust it using the following procedure:

1. If gas temperature aft of the turbine is to be decreased for all altitudes, turn out the screw of the spring of the HP-11A pump barostat valve.

Turning of the barostat valve spring screw through 0.25 turn causes gas temperature after the turbine to decrease by about 40°C. The barostat valve spring screw should not be turned out by more than 0.5 turn. In case the gas temperature aft of the turbine at all altitudes is below the required level, turn in the screw of the HP-11A pump barostat valve spring.

2. Should it be necessary to change temperature of gases aft of the turbine at altitudes of over 10,000-11,000 m., make use of the screw of the HP-11A pump fuel cock spring. Turning in of the screw causes the gas temperature aft of the turbine to drop, and vice versa.

Turning of the fuel cock spring screw by 0.5 turn causes the gas temperature aft of the turbine to change within the following ranges:

- at an altitude of 5000 m. - by 5°C;
- at altitudes of 10,000 to 11,000 m. - by approximately 15°C;
- at altitudes approaching the aircraft ceiling - by approximately 35 to 40°C.

The screw of the HP-11A pump fuel cock spring should be turned in or out by not more than one revolution.

CAUTION. 1. Adjustment of the screw of the HP-11A pump barostat aneroid spring is not allowed.

2. When adjusting gas temperature aft of the turbine by means of the barostat valve spring screw, do not fail to check fuel pressure downstream of the HP-11A pump before and after adjustment, with the engine operating at augmented rating.

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Chapter VII

REPLACEMENT OF ENGINE UNITS, ASSEMBLIES, AND PARTS

Some troubles may develop during engine operation, whose elimination calls for replacement of an engine unit, assembly or part. Defective units, assemblies, and parts should be replaced by new ones or overhauled in special repair shops provided with the necessary facilities and tools. If access to the engine units, assemblies and parts to be removed is difficult or impossible, detach the tail portion of the aircraft fuselage or dismantle the engine.

ATTENTION! When detaching the tail portion of the fuselage, suspend the afterburner as laid down in Section 5 of Chapter IX.

The aircraft carried tools kit allows to perform the required replacement of the engine units, assemblies, or parts on the aerodrome.

Listed below are the units, assemblies and parts of the engine which may be removed and installed by maintenance personnel during engine operation.

1. HP-10A and HP-11A fuel pumps.
2. ЦН-9 fuel booster pump.
3. Magnetic valve of starting fuel system.
4. Oil unit and its filter.
5. Fuel-oil unit 317A and its filter.
6. Oil pressure warning mechanism 2СДУ5-1.3-2.2 and ПУ-3 control panel limit switch Л drive.
7. Compressor air blow-off band control mechanism.
8. Centrifugal valve and magnetic valve controlling compressor air blow-off band operation.
9. Control panel ПУ-3 with wires.
10. Starter-generator ГСР-СТ-6000А.
11. Flame igniters and their spark plugs СД-96.
12. Afterburner spark plug СП-02 with adapter.
13. КП-21Б1М booster coil unit.
14. Afterburner booster coil КПМ-1А.
15. Fuel drain valve.
16. Oil drain cocks.
17. Drainage tank.
18. Minimum fuel pressure warning mechanism ДСД-2 (in afterburner fuel manifolds).
19. Afterburner tube with jet nozzle; middle tube of afterburner; jet nozzle; actuating cylinders; actuating cylinder shields; ejector; shutters and ring of jet nozzle.
20. Afterburner diffuser and diffuser flame arrestor.
21. Afterburner manifolds (front and rear).
22. Fairing and support of compressor inlet housing nose portion.
23. ДТ-3 tachometer generator.
24. Hydraulic pump (unit 623 or 435ВМ).
25. All external pipe-lines of fuel, oil, and hydraulic systems as well as of measuring instruments; wiring.
26. Studs, nuts, bolts, clamps and other hardware.

Prior to performing any mounting operations on the engine, fit a plug into the engine air intake duct and close the compressor air blow-off ports by manipulating the band. When replacing some units, assemblies and ports of the engine, close all openings with special covers, screw caps and plugs, to protect the engine against foreign matter, dust, and dirt.

Prior to dismantling the units and parts of the fuel system, close the fuel shut-off cock and drain fuel from fuel-oil unit 317A. Before dismantling the units and parts of the engine oil system, drain oil from fuel-oil unit 317A or from the sump of the compressor air inlet housing.

Before dismantling the units and parts of the hydraulic system, bleed pressure from the aircraft hydraulic system and drain off hydraulic fluid (АМГ-10 oil).

The units, assemblies and parts to be installed on the engine should be cleaned of slushing compound, while the units, assemblies, and parts removed should be subjected to corrosion-preventive treatment as recommended in the respective Service Logs or Instructions. The units, assemblies, and parts newly installed on the engine should be dry, clean, and free of mechanical damage. When installing the units on the engine, remove shipping caps directly before attaching the pipe-lines. To guard the pipe unions against loosening when turning off the shipping caps, the pipe unions should be kept against rotation by the use of the respective wrenches. When installing the units, assemblies and parts on the engine, all locking washers, gaskets and packing rings in the joints should be replaced by new ones. When replacing the engine units, assemblies, or parts, use hardware (clamps, nuts, bolts, locks, etc.) produced by the engine Manufacturer. Install the pipe-line and wiring clamps in the same places where they have been fitted prior to replacement of units, assemblies and parts.

Nuts (bolts) of the flange joints should be tightened uniformly, taking care not to perform the procedure in succession. The nuts (bolts) should be tightened alternately, that is first diametrically opposed nuts (bolts) should be tightened, and then the nuts (bolts) positioned perpendicularly to the former, etc. All threaded joints, and attachment fittings, operating at high temperatures should be liberally treated with chalk paste (a mixture of chalk powder with oil MK-8 or transformer oil) prior to installation. If the bolts turn out with some difficulty, the threaded joints should be moistened with kerosene for 10 to 15 min.

When mounting pipe-lines having joints fitted with rubber packing rings, inspect the rubber ring surface and check to see that its dimensions correspond to those of the hole (recess) provided in the union nut, and also to the nipple diameter. The rubber rings should be free of foliation, scores, or cuts. Irrespective of the joint dimensions, the nipple should fit into the pipe union with a diameter clearance of 0.06 to 0.4 mm. For inserting the rubber ring into

the recess, use a marking tool with a blunted point. Do not employ any sharp tools, to avoid damage to the rubber ring surface.

The union nuts with threads up to 22x1.5 should be tightened down by 1-1.5 flats, while those with threads from 24x1.5 should be tightened by 0.75 to 1 flat (as from the moment the mating surfaces come into contact). After being tightened the joint components should not move relative to each other by more than is allowed by rubber ring resilience.

The nuts of the pipe-line joints should be locked with 0.8 mm diameter wire as follows:

(a) the nuts of the pipe-line joints arranged before the joint between the rear portion of the compressor middle casing and the rear casing should be locked with brass wire (State Standard 1066-50);

(b) the nuts of the pipe-line joints located after the joint between the rear portion of the compressor middle casing and the rear casing, diffuser included, should be locked with wire of steel 1X18H9T (State Standard ГОСТ 5548-50);

(c) the nuts should be reliably locked, while the wire should be free of cracks or twists.

After carrying out replacement of the units, assemblies or parts of the fuel, oil and hydraulic systems, check the joints for leakage on a running engine. If leakage is detected, tighten down the pipe-line joint nuts by not more than 2 flats. If this is of no avail, replace the packing rings or gaskets.

Note: In the course of engine operation repeated tightening of one and the same joint may become necessary.

When installing plug connectors, care should be taken to line up the recess of the component part with the retaining lug of the plug.

To line up the lug and the recess of the plug connector components it is allowed to turn the adapter sleeve (with the block) of the plug connector through the required angle, for which purpose the securing screws should be loosened.

Having turned the adapter sleeve, tighten up the screws and lock them with brass wire. Twisting of the shielded cable

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or turning of the adapter sleeve without loosening the screw is not allowed. The block of the plug connector should be securely fastened in place.

After units, assemblies or parts of the fuel and oil systems have been replaced, fill the fuel system and crank the engine prior to starting as recommended in Section 7 of Chapter IX.

All operations pertaining to replacement of units, assemblies or parts should be duly recorded in the engine Service Log.

1. Replacement of HP-10A Fuel Pump

Replace the HP-10A fuel pump proceeding as follows:

1. Remove the clamps from the pipe-lines and electric cables, to facilitate dismantling.

2. Detach the oil pipe-lines from the magnetic cock of the compressor air blow-off band control mechanism and uncouple the plug connector.

3. Disconnect the engine control link from the ПУ-3 control panel lever.

Fasten the spherical bearing with wire or cord to prevent it from falling out of the link shackle.

4. Detach the free moving link from the lever of the HP-10A pump.

5. Disconnect the plug connector of the HP-10A pump.

6. Detach and remove the pipe-lines serving for air delivery to acceleration control unit and to the HP-10A pump starting control unit.

7. Disconnect the pipe-line for fuel delivery to the HP-10A pump.

8. Detach and remove the pipe-lines for delivery of fuel from the HP-10A pump to the fuel manifolds.

9. Detach the vent pipe-lines.

10. Detach the pipe-lines for fuel delivery to the centrifugal and drain valves from the HP-10A pump.

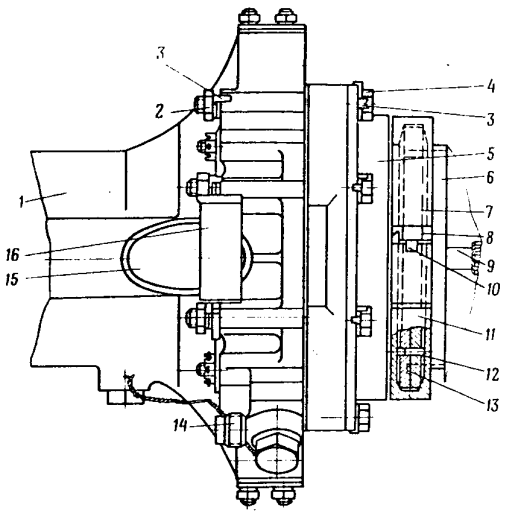

Fig.15. Attachment of HP-10A Pump

1 – HP-10A pump; 2 – ring securing nut; 3 – locking washer; 4 – ring securing bolt; 5 – ring of pump-to-engine accessory drive gear box quick-release joint; 6 – accessory drive gear box adapter flange; 7 – upper half-ring of pump-to-engine accessory drive gear box quick-release joint; 8 – bolt coupling half-rings of quick-release joint (2 pieces); 9 – pump rotor shaft; 10 – locking washer (2 pieces); 11 – lower half-ring of quick-release joint; 12 – retaining dowel; 13 – packing ring; 14 – drainage pipe union; 15 – pump name plate; 16 – clamp for securing magnetic valve controlling operation of compressor air blow-off band.

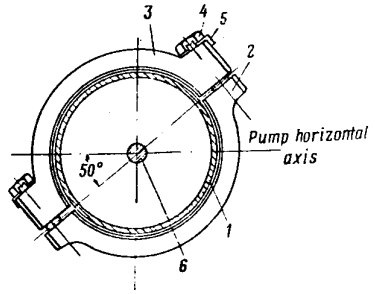

Fig.16. Arrangement of Half-Rings of HP-10A Pump-to-Accessory Drive Gear Box Quick-Release Joint

1 – pump quick-release joint ring; 2 – lower half-ring; 3 – upper half-ring; 4 – bolt coupling half-rings (2 pieces); 5 – locking washer (2 pieces); 6 – pump rotor shaft.

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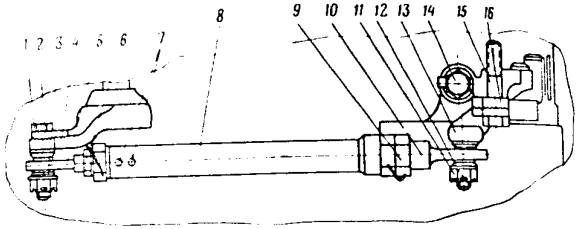

Fig.17. Attachment of HP-10A Pump to ПУ-3 Control Panel

1 - bolt attaching link to pump lever; 2 - rack; 3 - nut of bolt attaching link to pump lever; 4 - pump lever; 5 - free moving link shackle; 6 and 9 - locking nuts; 7 - check holes; 8 - free moving link; 10 - free moving link shackle; 11 - nut of bolt securing link to control panel lever; 12 - bolt securing link to control panel lever; 13 - control panel lever; 14 - bolt attaching control panel to engine; 15 - bolt securing engine control link to control panel lever; 16 - rack.

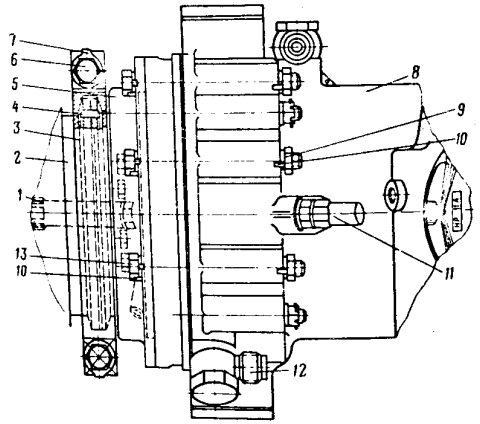

Fig.18. Installation of HP-11A Pump

1 - pump rotor shaft; 2 - front flange of accessory drive gear box; 3 - half-ring of quick release joint; 4 - retaining dowel; 5 quick-release joint ring; 6 - bolt securing half-rings of quick-release joint (2 pieces); 7 - locking washer (2 pieces); 8 - HP-11A pump; 9 - nut of ring securing bolt; 10 - locking washer; 11 - oblique washer stop cap; 12 - drain pipe union; 13 - bolt securing ring to pump.

11. Detach the pipe-line connecting the HP-10A pump to the HP-11A pump from the HP-10A pump.

12. Uncouple the plug connector of fuel pressure warning mechanism ДСД-2.

13. Detach the air delivery pipe-line from fuel pressure warning mechanism ДСД-2.

14. Unlock and turn out the bolts of the quick release joint holding the HP-10A pump to the accessory drive gearbox, and remove the half-rings while supporting the pump.

15. Remove the HP-10A pump complete with the magnetic cock of the compressor air blow-off band control mechanism.

16. Unlock the nuts securing the ring of the quick release joint to the flange of the HP-10A pump, and turn them off.

17. Remove the bolts and take the quick release joint ring and the bracket complete with the magnetic cock off the HP-10A pump flange.

18. Remove corrosion-preventive compound from the new HP-10A pump and check the latter for mechanical damage.

19. Check to see that the shank of the HP-10A pump fits properly onto the splines of the pump drive shaft on the accessory drive gearbox.

20. Place the quick release joint ring onto the flange of the HP-10A pump so that the right-hand hole for the retaining dowel should be located opposite to the bolt, to the right of the boss bearing the name plate; fit a gasket under the ring (Fig.15). Fit in the holding-down bolts, having placed locking washers under their heads.

21. Mount the bracket complete with the magnetic cock of the compressor air blow-off band control mechanism onto the bolts located on either side of the pump housing boss.

Turn nuts on the ring securing bolts, having fitted locking washers under the former, then tighten up the nuts.

22. Lock the bolts and the nuts by bending the tabs of the washers over the nut and bolt head flats.

23. Mount the HP-10A pump onto the accessory drive gearbox, having fitted a rubber packing under the pump flange;

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line up the hole with the retaining dowel provided on the rings and secure the pump with the half-rings of the quick-release joint.

24. Turn down the bolts securing the half-rings having fitted locking washers under the bolt heads; lock the bolts. The parting line of the quick-released joint half-rings should be located approximately at an angle of 50° relative to the pump horizontal axis (Fig.16).

Tighten the half-ring securing bolts by applying normal effort. The gap between the half-rings should be 0.4 to 2 mm. The difference between the gaps at one side should not exceed 0.2 mm.

25. Connect the fuel, air, oil and vent pipe-lines in the reverse order of their dismantling. The packing rings of the joints should be replaced by new ones. Lock the joint nuts with 0.8 mm diameter brass wire.

26. Join the plug connectors of the HP-10A pump and of the magnetic cock controlling the compressor air blow-off band operation. Lock the plug connector nuts with 0.8 mm dia. brass wire.

27. Install the clamps on the pipe-lines and electric cables in their proper places. Lock the clamp bolts with locking washers.

28. Attach the free moving link (Fig.17) to the lever of the HP-10A pump; check and adjust engine controls. With the HP-10A pump lever shifted to the "CUT-OFF" (СТОП) stop (causing the pump throttle cock to close), the notches on the lever and on the housing of control panel ПУ-3 should coincide, while the zero mark of the control panel dial should set against the notch provided on the panel housing.

When the lever of the HP-10A pump is shifted to the maximum speed stop (causing the pump throttle cock to open fully) the lever of control panel ПУ-3 should move to an angle of 70 $\pm 1^{\circ}$ from the "STOP" (СТОП) position. Notch 70 $\pm 1^{\circ}$ on the control panel dial should set against the notch on the control panel housing.

Make sure the positions of the HP-10A pump and the ПУ-3 control panel levers coincide; to accomplish this, change length of the pump lever arm by manipulating the lever

rack, and also change the length of the link by rotating the hexagon of the link body. The length of the pump lever arm should be changed in case of considerable lack of coincidence between the levers of control panel ПУ-3 and the HP-10A pump, when in the "STOP" (СТОП) position, while adjustment of the link should be performed when control panel ПУ-3 lever considerably deflects from 70 $\pm 1^{\circ}$ (on the panel dial), with the pump lever being shifted to the maximum speed stop. When increasing the length of the link, watch the shackle entering the link, making use of the check holes provided in the link body (See Fig.17).

The check hole located near the shackle should be closed by the latter. If the HP-10A pump lever stops short of the maximum speed position, while the control panel lever and the link are arranged parallelly, it is necessary to change the position of the pump lever on the splines of the pump throttle cock thumb-piece by not more than one spline. After changing the position of the HP-10A pump lever on the splines, check and adjust engine controls as detailed above.

CAUTION. Never remove and change the position of the lever (thumb-piece) turn limiter on the splines.

With the pump lever at the maximum speed stop, check to see whether control panel ПУ-3 lever is capable of additional movement to an angle of not less than 20 $\pm 1^{\circ}$ (as indicated on the control panel dial) from the 70 $\pm 1^{\circ}$ position due to expansion of the free moving link.

Check the control panel and pump levers for synchronous operation. With the control panel lever shifted from the "STOP" (СТОП) position to the 70 $\pm 1^{\circ}$ position (as indicated on the control panel dial), the pump lever should shift in step with the control panel lever.

29. Connect the engine control link to the ПУ-3 control panel lever and check the engine control system as recommended in Section 5 of Chapter IX.

30. After checking and adjusting the engine control system, cotter pin the nut securing the axle of the free moving link, connecting the levers of the HP-10A pump and

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control panel ПУ-8. Lock the free moving link check nut with wire. Lock the link axle and the engine control link as laid down in Aircraft Operating and Maintenance Instructions.

31. Start the engine and check its operation at all ratings as instructed in Section 4 of Chapter III. If necessary, perform adjustment of the engine units in compliance with the procedure outlined in Chapter VI. Prior to checking the engine at various ratings smoothly bring engine speed to 10,000 to 10,400 r.p.m., repeating the procedure 8 to 10 times, to remove corrosion-preventive compound from the acceleration control unit of the HP-10A pump.

2. Replacement of HP-11A Fuel Pump

Replace the HP-11A fuel pump using the following procedure:

1. Remove the clamps from the pipe-lines and electric cables, to facilitate dismantling.
2. Detach the fuel inlet pipe-lines from the pump.
3. Detach the fuel outlet pipe-lines from the pump.
4. Disconnect the vent pipe-line from the pump.
5. Detach the pipe-line for by-passing fuel from the HP-11A pump into the HP-10A pump.
6. Uncouple the plug connectors of the pump solenoid and of the afterburner spark plug limit switch.
7. Unlock and turn out the bolts, securing the half-rings of the quick release joint holding the HP-11A pump to the accessory drive gearbox; remove the half-rings, while supporting the pump.
8. Take the HP-11A pump off the accessory drive gearbox.
9. Unlock and turn off the nuts of the bolts holding the ring to the flange of the HP-11A pump and extract the bolts. Remove the ring.
10. Remove corrosion-preventive compound from the new HP-11A pump, wipe it with a dry piece of cloth and check if there are any defects.

11. Check the pump shank for proper fit on the splines of the respective accessory drive gearbox shaft.
12. Mount the quick release joint ring onto the flange of the HP-11A pump, as shown in Fig.18, having fitted a gasket under it. Insert the ring holding-down bolts after placing locking washers under the bolt heads. Turn the nuts, fitted with locking washers, on the bolts. Lock the nuts and the bolts with locking washers.
13. Place the HP-11A pump on the accessory drive gearbox, having fitted a rubber packing between the rings; attach the pump to the accessory drive gearbox with the help of the quick release joint half-rings.

The parting line of the half-rings should be at an angle of 30° relative to the pump horizontal axis (Fig.19).

14. Turn in and lock the bolts securing the half-rings of the quick release joint. Apply a normal effort when tightening the bolts. The butt joint of the half-rings should have a gap of 0.4 to 2 mm. The difference between the gaps at one side should not exceed 0.2 mm.
15. Connect the fuel pipe-lines to the HP-11A pump in the reverse order to the dismantling. When connecting the pipe-lines, replace the packing rings in their joints by new ones. Lock the nuts of the pipe-line joints with 0.8 mm diameter brass wire.
16. Connect the plug connectors of the pump solenoid and of the afterburner spark plug limit switch. Lock the nuts with 0.8 mm diameter brass wire.
17. Install the clamps on the pipe-lines and electric cables. Lock the clamp bolts with locking washers.

Start the engine and check its operation at augmented rating, as recommended in Section 4 of Chapter III.

Prior to checking the engine at the augmented rating bring engine speed to the maximum value and run the engine at this speed until gas temperature aft of the turbine reaches a specified level. Then turn on the afterburner and measure the actual drop or rise of gas temperature. A drop of gas temperature, as compared to the specified value should not exceed 20°C, whereas temperature rise must not be in excess

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of 5°C. In case gas temperature aft of the turbine drops by more than 20°C, bring gas temperature to the required level by more slow shifting of the jet nozzle shutters from the maximum rating position to the augmented rating position, never allowing the shifting time to exceed 2.5 sec. If gas temperature rise exceeds 5°C, shift the jet nozzle shutters more quickly, but not quicker than within 1.2 sec.

Adjustment of jet nozzle shutter shifting speed should be accomplished by choosing proper cylinder jets (part 3514642).

3. Replacement of ЦН-9 Fuel Booster Pump

Replacement of the ЦН-9 fuel pump should be carried out as follows:

1. Unlock and turn off the nuts holding the fuel inlet pipe-line to the ЦН-9 pump; detach the pipe-line.
2. Detach the outlet pipe-line from the ЦН-9 pump.
3. Detach the pipe-lines serving for venting the constant pressure valve spring chamber, and of the pump shaft gland.
4. Unlock and turn out the bolts securing the ЦН-9 pump; remove the pump from the accessory drive gearbox.
5. Wash a new ЦН-9 pump in clean gasoline and wipe it with a dry piece of cloth. Inspect the pump for mechanical damage.
6. Check the ЦН-9 pump shank for proper fit on the splines of the pump drive shaft.
7. Mount the pump onto the accessory drive gearbox, having fitted a new gasket under the pump flange. Secure the pump to the accessory drive gearbox after fitting locking washers under the bolt heads. Lock the bolts by bending the tabs of the washers over the flats of the bolt heads.
8. Connect the fuel and vent pipe-lines to the ЦН-9 pump in the reverse order of their detaching during dismantling.

When installing the pipe-lines, replace the packing rings in the joints by new ones. Lock the joint nuts with

0.8 mm diameter brass wire. There should be a clearance not exceeding 0.3 mm between the pump and return pipe-line flanges, when tightened.

9. Start the engine and measure fuel pressure upstream of the HP-10A pump; it should be within 1.6 to 2.6 kg/sq.cm.

4. Replacement of Starting Fuel System Magnetic Valve

Presented below is the procedure for replacement of the magnetic valve:

1. Detach the fuel pipe-lines from the magnetic valve. Unlock, turn off the union nut, and detach the tee-piece serving for starting fuel delivery to the fuel manifold.
2. Uncouple the plug connector of the magnetic valve solenoid.
3. Remove wrench 240Ж-12 serving for manipulating the compressor air blow-off band.
4. Unlock and back out the bolts securing the magnetic valve bracket and the stop of wrench 240Ж-12. Remove the bracket complete with the magnetic valve, and the wrench stop.
5. Unlock and turn out the bolts holding the magnetic valve to the bracket.
6. Wash a new magnetic valve in clean gasoline, and wipe it with a dry piece of cloth. Inspect the magnetic valve for mechanical damage. When washing the magnetic valve, see that no gasoline gets on the valve solenoid.
7. Connect the magnetic valve to the storage battery and check it for proper operation which is evidenced by a click in a solenoid. Repeat the procedure 2 to 3 times.
8. Mount the magnetic valve onto the bracket and secure it with bolts having fitted locking washers under their heads. Lock the bolts by bending the washer tabs over the flats of the bolt heads.
9. Mount the stop for wrench 240Ж-12 and the bracket complete with the magnetic valve onto the bracket of the compressor air blow-off band control mechanism and secure

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them with bolts, after fitting locking washers under the bolt heads. When turning in the bolts, arrange the stop for wrench 240Х-12 so that when the compressor air blow-off ports are closed by manipulating the wrench, the band should fit snugly against the flanges of the compressor middle casing ports. Lock the bolts by bending the tabs of the locking washers over the flats of the bolt heads.

10. Attach the tee-piece for starting fuel delivery to the fuel manifold, to the magnetic valve; connect the fuel inlet and outlet pipe-lines having fitted new packing rings under the nuts of the joints. Lock the nuts with 0.8 mm diameter brass wire.

11. Couple the magnetic valve plug connector and lock the nut with 0.8 mm diameter brass wire.

12. Disconnect the plug connector of booster coil unit КП-21Б1М and cut in switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ), for not more than 40 sec., repeating the procedure 2 to 3 times, to remove the corrosion-preventive compound from the magnetic valve and to check the joints for leakage.

13. Couple the plug connector of the booster coil unit КП-21Б1М; lock the nut with 0.8 mm diameter brass wire.

After replacement of the magnetic valve, first crank and then start the engine.

5. Replacement of Oil Unit and Oil Unit Filter

Replacement of Oil Unit

Replace the oil unit (Fig.20) using the following procedure:

1. Drain oil from fuel-oil unit 317A.

2. Remove the ДТ-3 tachometer generator as laid down in Section 29 of this Chapter.

3. Unlock and detach the oil delivery pipe-line from the oil unit. Unlock and detach the oil unit breather pipe from the pipe union of the oil unit cover and the breather pipe of fuel-oil unit 317A oil tank.

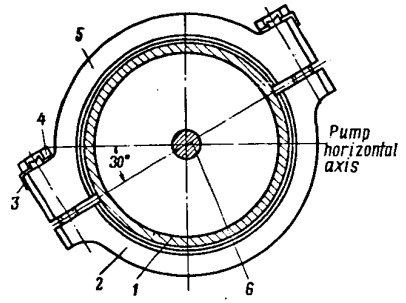

Fig.19. Arrangement of Half-Rings of HP-11A Pump-to-Engine Accessory Drive Gearbox Quick-Release Joint

1 - quick-release joint ring; 2 - lower half-ring; 3 - locking washer (2 pieces); 4 - bolt securing half-rings (2 pieces); 5 - upper half-ring; 6-pump rotor shaft.

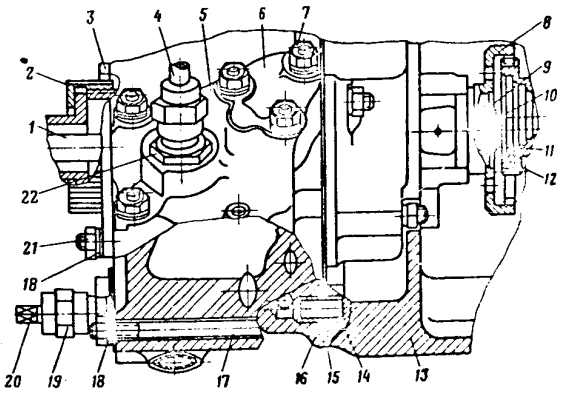

Fig.20. Attachment of Oil Unit to Accessory Drive Gearbox

1 - shaft of ДТ-3 tachometer generator; 2 - tachometer generator securing nut; 3 - adapter flange of tachometer generator drive; 4 - pipe for bleeding air from oil unit; 5 - oil unit; 6 - oil filter cap; 7 - oil filter cap securing nut; 8 - driven gear of oil unit drive; 9 - driven gear securing nut; 10 - oil unit drive shaft; 11 - locking washer; 12 - driving gear of oil unit drive; 13 - accessory drive gearbox shell; 14 - bush; 15 - gasket; 16 - packing ring; 17 - oil unit securing stud; 18 - locking washer; 19 - nut; 20 - reducing valve adjusting screw; 21- oil unit securing nut; 22 - pipe union for bleeding air from oil unit.

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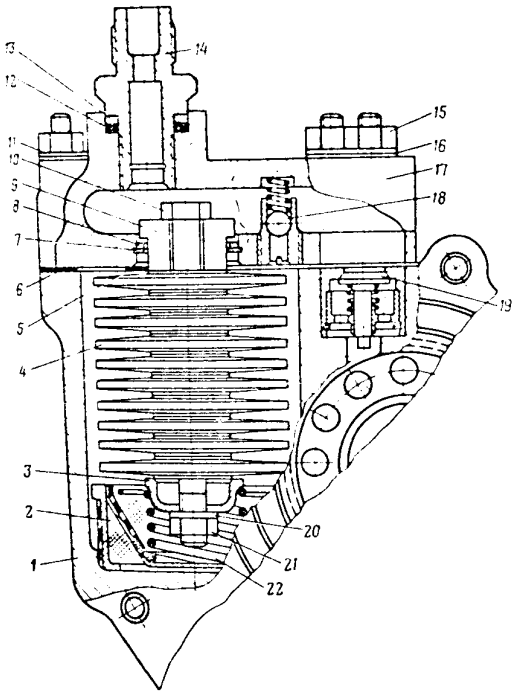

Fig.21. Oil Unit Filter

1 - oil unit housing; 2 - strainer; 3 - support bush; 4 - gauze discs; 5 - support ring; 6 - gasket; 7 - locking ring; 8 - washer; 9 - filter frame; 10 - coupling bolt; 11 - spring washer; 12 - packing ring; 13 - washer; 14 - pipe union for bleeding air from oil unit; 15 - cap securing nut (6 pieces); 16 - washer; 17 - oil filter cap; 18 - oil by-pass valve; 19 - return valve; 20 - locking washer; 21 - coupling bolt nut; 22 - filter spring.

4. Unlock and detach the pipe-lines for oil supply to the centrifugal valve and to the engine centre and rear bearings.

5. Unlock and turn off the nuts holding the oil unit to the accessory drive gearbox; remove the oil unit.

6. Wash a new oil unit in clean gasoline, without removing the shipping caps, and wipe it with a dry piece of cloth. Inspect the oil unit for mechanical damage.

7. Mount the oil unit onto the drive of the accessory drive gearbox, having fitted a gasket under the flange and a packing ring onto the adapter bush; secure the oil unit with nuts, after fitting locking washers under them. Mount the oil unit onto the accessory drive gearbox so that the pipe union for air bleeding is located on top.

8. Check the clearance between the gears of the oil unit and the gearbox drive by rocking the tachometer generator drive shaft manually. The clearance should be within 0.07 to 0.35 mm.

9. Check the oil unit securing nuts for proper tightening and lock them by bending the tabs of the locking washers over the flats.

10. Connect the oil and vent pipe-lines to the oil unit in the reverse order of their dismantling. Fit new packing rings into the pipe-line joints. Lock the nuts with 0.8 mm diameter brass wire.

11. Install the ДТ-3 tachometer generator as instructed under Section 29 of this Chapter.

12. Fill oil into the oil tank of fuel-oil unit 317A, as laid down in Section 1 of Chapter III.

13. Start the engine and check oil pressure in the pressure pipe-line. If necessary, perform adjustment of oil pressure as recommended in Section 8 of Chapter VI.

Check the joints for leakage with the engine running.

Replacement of Oil Unit Filter

If necessary, the following parts of the oil unit filter may be replaced (Fig.21):

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(1) gauze discs (all of them, or individual discs);
(2) filter frame;
(3) filter coupling bolt;
(4) filter spring;
(5) strainer at oil inlet into reducing valve.

The filter parts should be replaced as follows:

1. Detach the oil unit breather pipe from the pipe union of the oil unit cover and the breather pipe of fuel-oil unit 317A oil tank; remove the oil unit breather pipe. Turn off the oil filter cap securing nuts and remove the cap complete with the filter.

2. Remove the spring and take the strainer out of the oil unit housing. Mount cap 788П-7 onto the oil unit housing in place of the cover. When replacing the strainer and the spring, wash the oil filter (without stripping it) in clean gasoline. Prior to washing the filter, stop the hole in its cap, connecting the return valve with the filter, with rubber plug 532П-100, and turn screw cap 717П-7-10 onto the cover pipe union.

Having washed the filter, reinstall the strainer, spring and oil filter as instructed below (See Points 9-11).

3. When carrying out replacement of other parts, the filter should be disassembled, for which purpose unlock and turn off the nuts holding the gauze discs to the filter frame and remove the thrust bush, gauze discs and the supporting ring.

4. To replace the filter frame and the gauze disc securing bolt, remove the locking ring, the washer, and take out the frame complete with the bolt.

5. Fit a washer on the frame, insert the bolt into the frame and fit the frame into the filter cap; secure the frame with a looking ring.

6. When replacing the gauze discs check their supporting surfaces for proper contact on a plate by paint pattern method. The contact should be continuous around the entire circumference. The contacting surface should amount to not less than 75 per cent of the entire surface.

7. Wash the gauze discs and the cap with the frame in clean gasoline. To prevent dust and foreign particles from getting inside the gauze discs during washing procedure, stop the disc holes with rubber plug 533П-100.

When washing the filter cap, fit rubber plug 532П-100 into the hole connecting the return valve with the filter, and turn screw cap 717П-7-10 onto the cap pipe union.

8. Fit the gauze disc supporting ring, gauze discs proper, and the thrust bush onto the frame; tighten the nut, having fitted a washer under it.

9. Insert the strainer and the spring into the oil unit housing.

10. Mount the filter cap complete with the filter into the oil unit housing, after placing a gasket under the cap.

11. Secure the cap with nuts, having fitted washers and spring locking washers under them. Attach the oil unit breather pipe to the pipe union of the oil unit cover and to the breather pipe of the oil tank of fuel-oil unit 317A; fit new packing rings into the joints.

12. Start the engine, measure and adjust oil pressure in the pressure pipe-line as instructed in Section 8 of Chapter VI.

6. Replacement of Fuel-Oil Unit 317A and Its Filter

Replacement of Fuel Filter

Replace the fuel filter as follows:

1. Remove the seal, looking the wing nut, and the filter clamp; loosen the wing nut and hinge off the bolt complete with the wing nut.

2. Hinge off the clamp and by turning the fuel filter cap, carefully extract the filtering element complete with the cap out of the filter housing.

3. Use syringe НУ-46/2 to remove any remaining fuel from the filter housing.

4. Remove corrosion-preventive compound from a new fuel filter by washing it in clean gasoline; do not disassemble the filtering element.

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5. Insert new packing rings into the filter cap.

6. Fit the fuel filter into the housing so that the grooves on the filter cover should line up with the cutouts on the clamp, whereas the outlet hole in the cap should be in line with the respective duct in the housing. The fuel filter should be inserted carefully without cocking, to avoid damage to the filtering discs and rubber packing rings.

7. Place the clamp onto the cap, turn the hinge bolt so that it should fit into the clamp groove, turn the wing nut right home and lock it with wire.

Replacement of Fuel-Oil Unit 317A

Replace fuel-oil unit 317A as follows (Fig.22):

1. Remove the clamps from the pipe-lines to facilitate their disconnection from the fuel-oil unit.

2. Unlock and turn off the nuts holding the fuel delivery pipe-line to fuel-oil unit 317A.

3. Unlock and turn off the nut of the telescopic joint securing the pipe-line for fuel delivery to fuel-oil unit 317A remove the pipe-line.

4. Remove the pipe-line serving for fuel return from fuel-oil unit 317A, proceeding as laid down in Points 2 and 3.

5. Detach the pipe-line for oil delivery to the cooler from the pipe union of fuel-oil unit 317A.

6. Detach the pipe-line serving for oil delivery from the oil tank to the oil unit.

7. Disconnect the pipe-line for oil return from fuel-oil unit 317A from the rear pipe union located at the right-hand side of the unit (looking forward) of the left-hand engine, or from the front pipe union located at the left-hand side of the unit (looking forward) of the right-hand engine.

8. Detach the oil tank breather pipe from fuel-oil unit 317A.

9. Unlock and turn out the two bolts coupling the clamps securing fuel-oil unit 317A; remove the unit from the engine.

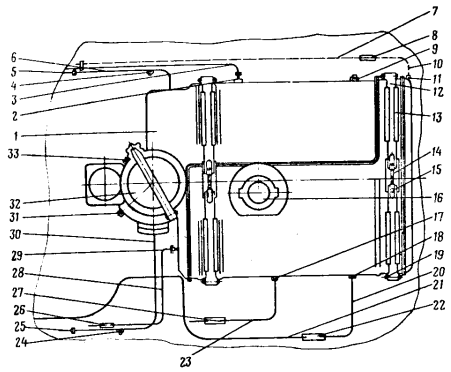

Fig.22. Attachment of Fuel-Oil Unit 317A and Connection of Pipe-Lines

1 - fuel-oil unit; 2 - pipe union for oil delivery to oil cooler; 3 - pipe-line for oil delivery to oil cooler; 4 - pipe union-valve for drainage of fuel from pipe-line serving for fuel delivery to fuel-oil unit; 5 - telescopic joint of pipe-lines serving for fuel delivery to fuel-oil unit; 6 - pipe-line for fuel delivery to fuel-oil unit; 7, 10 - pipe-lines for draining oil from oil tank of left-hand engine; 8 - pipe-line durite joint; 9 - pipe union for draining oil from oil cooler; 11 - pipe union for draining oil from oil tank of left-hand engine; 12 - fuel-oil unit securing strap; 13 -rubber gasket fitted under strap; 14 - fuel-oil unit strap clamping bolt; 15 - clamping bolt nut; 16 - oil tank filler cap; 17 - pipe union for draining oil from oil tank of right-hand engine; 18 - pipe union for oil delivery from oil tank to oil unit; 19 - pin securing strap to bracket; 20, 21 - pipe-lines for oil delivery from oil tank to oil unit; 22 - pipe-line durite joint; 23 - pipe-line for draining oil from oil tank of right-hand engine; 24 - pipe union-valve for draining fuel from pipe-line serving for delivery of fuel from fuel-oil unit to HP-10A and HP-11A pumps; 25 - telescopic joint of pipe-lines serving to deliver fuel from fuel-oil unit to HP-11A and HP-10A pumps; 26 - durite joint of oil tank drainage pipe-lines; 27 - durite joint of oil return pipe-line; 28 - oil tank drainage pipe-line; 29 - oil tank drainage pipe union; 30 - pipe-line for fuel delivery from fuel-oil unit to HP-10A and HP-11A pumps; 31 - pipe union-valve for draining fuel from fuel filter (on right-hand engine); 32 - fuel filter cap; 33 - pipe union-valve for draining fuel from fuel filter (on left-hand engine).

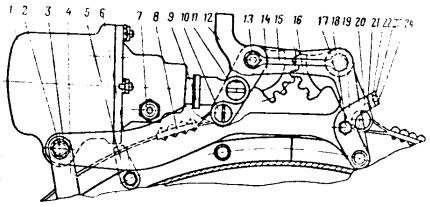

Fig.23. Attachment of Compressor Air Blow-Off Band Control Mechanism

1 - compressor air blow-off band control mechanism; 2 - mechanism securing bolt; 3 - mechanism securing bolt nut; 4 - mechanism securing bracket; 5 - band stop; 6 - bolt coupling middle casing front and rear portions; 7 - pipe union for drainage of band control mechanism; 8 - air blow-off band; 9 - mechanism driving sector; 11 - screw of pin connecting air blow-off band to rod to driving sector; 12 - rear bracket; 13 - driving sector axle securing nut; 14 - driving sector; 15 - locking plate; 16 - driven sector; 17 - driven sector axle securing nut; 18 - bracket securing screw with nut; 19 - driven sector stop bracket; 20 - screw of pin connecting air blow-off band to driven sector; 21 - adjusting washers; 22 - driven sector stop; 23 - locking washer; 24 - stop securing bolt.

10. Flush the oil cooler of fuel-oil unit 317A with oil heated to 65-75°C, making use of the oil delivery and return pipe unions.

11. Check the position of the pipe union-valve for draining fuel from the fuel filter.

To mount fuel-oil unit 317A onto the left-hand engine, it is necessary that the pipe union-valve be located at the right-hand side of the unit (looking from the rear end), while the hole provided at the left-hand side should be stopped.

To mount fuel-oil unit 317A onto the right-hand engine, the pipe union-valve should be arranged at the left-hand side of the unit (as viewed from the rear), whereas the hole provided at the right-hand side should be stopped.

12. Mount fuel-oil unit 317A on the engine and secure it with clamps, having fitted rubber pads under the unit and straps under the clamps. Lock the clamp coupling bolts with 0.8 mm diameter brass wire.

13. Attach the oil, fuel and breather pipe-lines to fuel-oil unit 317A in the reverse order of their disconnection during dismantling. Fit new packing rings in the pipe-line joints. Lock the nuts of the pipe-line joints with 0.8 mm diameter wire. There should be a clearance of not more than 0.3 mm between the flanges of the pipe-lines and the flanges of fuel-oil unit 317A, after they are tightened.

14. Fill oil into the oil tank of fuel-oil unit 317A as recommended in Section 1 of Chapter III.

Start the engine and check the joints of the fuel and oil systems for leakage.

7. Replacement of Oil Pressure Warning Mechanism 2СДУ5-1.3-2.2 and Control Panel ДУ-3

Limit Switch Д Drive

Replacement of Oil Pressure Warning Mechanism 2СДУ5-1.3-2.2

Replacement of oil pressure warning mechanism should be carried out in the following manner:

1. Disconnect the plug connector of oil pressure warning mechanism 2СДУ5-1.3-2.2.

2. Detach the oil delivery pipe-line from oil pressure warning mechanism 2СДУ5-1.3-2.2.

3. Unlock and turn off the nut holding the oil pressure warning mechanism to the bracket; remove the unit.

4. Mount a new oil pressure warning mechanism (with the pipe unions up and the plug connector forward) onto the bracket and secure it with a nut. Lock the nut with 0.8 mm diameter brass wire.

5. Connect the oil delivery pipe-line to oil pressure warning mechanism 2СДУ5-1.3-2.2.

6. Couple the plug connector of the oil pressure warning mechanism. Lock the nuts of the pipe-line and plug connector joints with 0.8 mm diameter brass wire.

7. Remove the cap from the pipe union serving for delivery of static air pressure to oil pressure warning mechanism 2СДУ5-1.3-2.2.

8. Connect a pressure gauge to the pipe union serving to measure oil pressure. Start the engine and check the oil pressure warning mechanism for proper operation at all ratings by the indications of the respective pilot lamp, as instructed in Section 4 of Chapter III; check oil pressure by the indications of the pressure gauge.

Replacement of ПУ-3 Control Panel Limit Switch Л Drive

The drive of limit switch Л should be replaced as follows:

1. Remove fuel pressure warning mechanism ДСД-2 as laid down in Section 19 of this Chapter.

Note: Do not remove fuel pressure warning mechanism ДСД-2 when carrying out replacement of limit switch Л drive on the left-hand engine.

2. Remove the clamp fastening the air cleaner installed on the pipe-line for air delivery to the acceleration control unit of the HP-10A pump.

3. Unlock and turn off the nuts holding the drive and the bracket of the HP-10A pump acceleration control unit air cleaner. Remove the bracket and the drive.

4. Wash a new drive of limit switch Л in clean gasoline and wipe it with a dry piece of cloth. Inspect the limit switch drive for mechanical damage.

5. Mount the drive on the bracket of the compressor air blow-off band control mechanism, engage the drive lever with the driven sector of the band, mount the bracket of the HP-10A pump acceleration control unit air cleaner and secure it with nuts, after fitting a locking washer under them. Lock the nuts by bending the washer edges over the nut flats.

6. Manipulate the band to open the compressor air blow-off ports; adjust the drive screw to ensure shifting of the stop of limit switch Л within 5 to 7 mm. Additional travel of the stop should not be less than 1.5 mm. The clearance between the rear side of the drive lever and the bracket of the compressor air blow-off band control mechanism should amount to at least 1 mm. The butt end of the drive screw should not project beyond the contour of limit switch Л stop of control panel ПУ-3.

Tighten up the locking nut of the drive screw and lock it with a washer.

7. Mount the clamp securing the HP-10A pump acceleration control unit air cleaner.

8. Install fuel pressure warning mechanism ДСД-2 as instructed in Section 19 of this Chapter.

Start the engine and check operation of oil pressure warning mechanism 2СДУ5-1.3-2.2 by the indications of the pilot lamp as laid down in Section 4 of Chapter III.

8. Replacement of Compressor Air Blow-Off Band Control Mechanism

Replace the compressor air blow-off band control mechanism (Fig.23) proceeding as follows:

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1. Remove the clamps from the pipe-lines and electric cables to facilitate dismantling of the pipe-lines and cables when carrying out replacement of the compressor air blow-off band control mechanism.

2. Detach the oil tank breather pipe-line from fuel-oil unit 317A.

3. Unlock and slacken the bolt of the clamp securing the durite joint of the oil tank breather pipe-lines and remove the pipe-line.

4. Detach the fuel delivery pipe-line from the compressor air blow-off band control mechanism.

5. Detach the vent pipe-line from the compressor air blow-off band control mechanism.

6. Remove the magnetic valve of the starting fuel system as recommended in Section 4 of this Chapter.

7. Dismantle fuel pressure warning mechanism ДСД-2 as laid down in Section 19 of this Chapter.

8. Remove oil pressure warning mechanism 2СДУ5-1.3-2.2 as instructed in Section 7 of this Chapter.

9. Dismantle the drive of control panel limit switch II proceeding as recommended in Section 7 of this Chapter.

10. Unlock and turn out the bolts securing the stop of the compressor air blow-off band driven sector; remove the stop. When backing out the bolts take care not to lose the adjusting washers of the stop.

11. Unlock and turn the nut off the bolt securing the cylinder of the air blow-off band control mechanism.

12. Remove the clamp of the HP-11A pump fuel delivery pipe-line from the bolt, fastening the band control mechanism cylinder.

13. Take out the mechanism cylinder securing bolt and extract the distance bush from the cylinder lug hole.

14. Disengage the compressor air blow-off band sectors.

15. Unlock and turn out the screw out of the pin coupling the air blow-off band control mechanism rod to the band driving sector. Extract the pin and remove the mechanism.

16. Wash a new air blow-off band control mechanism in clean gasoline, without removing the shipping caps; wipe the

mechanism with a dry piece of cloth. Inspect the control mechanism for mechanical damage.

17. Couple the air blow-off band control mechanism to the driving sector of the band by fitting in the pin; turn the screw into the pin, having installed a locking washer under the screw. Lock the screw.

18. Engage the band sectors.

The upper tooth of the driving sector should be positioned on top of the driven sector upper tooth.

19. Insert the distance bush into the hole of the mechanism cylinder fastening lug, line up the lug hole with the holes provided in the mechanism securing brackets, and fit in the cylinder holding-down bolt, having installed a locking washer under the bolt head.

20. Mount the clamp securing the HP-11A pump fuel delivery pipe-line onto the mechanism cylinder holding-down bolt. Turn the nut onto the bolt, having installed a locking washer under the nut. Lock the bolt and the nut by bending the washer tabs over the flats of the nut and the bolt head.

21. Mount the drive of control panel limit switch II onto the air blow-off band control mechanism bracket, as instructed in Section 7 of this Chapter.

22. Install the stop of the band driven sector and fasten it with bolts; make sure to fit adjusting washers and locking washers under the stop and the bolt heads respectively.

23. Mount the bracket complete with the starting fuel system magnetic valve, as laid down in Section 4 of this Chapter.

24. Remove the shipping caps from the pipe unions for fuel drainage from and fuel delivery to the cylinder of the compressor air blow-off band control mechanism. Fit in wrench 240К-12, and operate the air blow-off band 5 to 6 times to drain oil from the control mechanism cylinder and to check the band for smooth travel. Use wrench 240К-12 to close the compressor ports and check the band for snug fit to the collar of the compressor middle casing. A clearance of up to 0.1 mm is allowed between the rear compartment collar and the band on 40 to 50 mm portion of the circumference,

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while a clearance between the front compartment collar and the band on the entire circumference should not exceed 0.6 mm.

25. Install oil pressure warning mechanism 2СДУ5-1.3-2.2 as detailed in Section 7 of this Chapter.

26. Install fuel pressure warning mechanism ДСД-2 as instructed in Section 19 of this Chapter.

27. Attach the vent pipe-line and the fuel delivery pipe-line to the air blow-off band control mechanism. Fit new packing rings under the nuts of the pipe-line joints. Lock the nuts with 0.8 mm diameter brass wire.

28. Mount the breather pipe-line of fuel-oil unit 317A oil tank by attaching it to the pipe union of fuel-oil unit 317A; connect the above pipe-line to the other pipe-line by means of a durite hose. Fit a new packing ring under the nut of the pipe-line to unit 317A joint and tighten the nut and the bolt of the durite joint clamp. Lock the bolt and the nut with 0.8 mm diameter brass wire.

29. Reinstall the pipe-line and electric cable clamps. Lock the clamp bolts with locking washers.

30. Start the engine as instructed in Section 4 of Chapter III; check engine speeds at which the compressor air blow-off ports are opened and closed by the band. Adjust these speeds, if necessary, as instructed in Section 3 of Chapter VI.

9. Replacement of Magnetic Cock and Centrifugal Valve Controlling Compressor Air Blow-Off Band Operation

Replacement of Magnetic Cock

The magnetic cock controlling operation of the compressor air blow-off band should be replaced as follows:

1. Detach the oil pipe-lines from the magnetic cock. When turning off or on the union nut of the oil return pipe, support the front portion of the magnetic cock with a wrench, to guard the nib against coming out of the shaped nut slot.

2. Uncouple the magnetic cock plug connector.

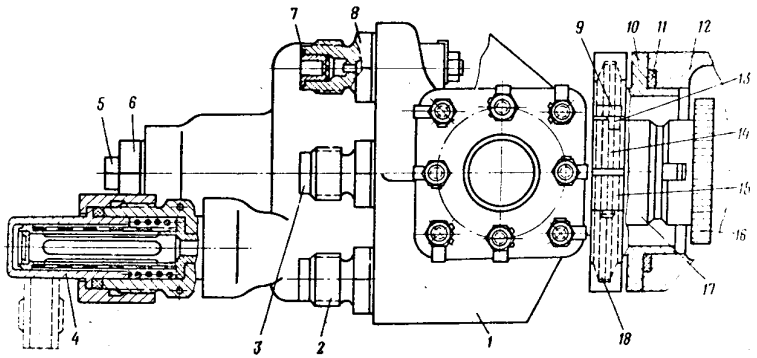

Fig.24. Attachment of Centrifugal Valve

1 - centrifugal valve housing; 2 - fuel drainage pipe union; 3 - pipe union for fuel delivery to cylinder of compressor air blow-off band control mechanism; 4 - ddapter with filter for pipe union serving to deliver oil to centrifugal valve of magnetic cock; 5 - adjusting screw; 6 - locking nut; 7 - filter frame with gauze; 8 - fuel delivery pipe union; 9 - bolt securing half-rings; 10 - adapter flange of centrifugal valve drive; 11 - packing ring; 12 - accessory drive gearbox shroud; 13 - locking washer; 14 - upper half-ring of quick-release joint; 15 - low half-ring of quick-release joint; 16 - centrifugal valve gear; 17 - centrifugal valve shaft; 18 - adapter flange of centrifugal valve.

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3. Detach the clamps holding the magnetic cock to the bracket and remove the cock.

4. Wash the magnetic cock in clean gasoline and wipe it with a dry piece of cloth.

When washing the cock, see that no gasoline gets into the plug connector or on the solenoid.

5. Mount the magnetic cock on its bracket and fasten by two clamps.

6. Connect the oil pipe-lines to the magnetic cock, having fitted new packing rings under the nuts of the pipe-line joints. Lock the nuts with 0.8 mm diameter brass wire.

7. Connect adapter T13-120 of the air blow-off band manual control to the plug connector of the magnetic cock.

8. Start the engine. With the engine operating at idling speed, push the adapter button; this should make the band close the compressor ports. Operate the band 2 to 3 times to close the ports for not more than 1 min.

9. Remove adapter T13-120 of band manual control from the plug connector of the magnetic cock.

10. Couple the plug connector of the magnetic cock. Lock the nut with 0.8 mm diameter brass wire.

Note: If no adapter T13-120 is available, check operation of the magnetic cock as follows:

(a) start the respective engine;

(b) start the other engine; this should make the blow-off band close the compressor ports of the first engine.

Replacement of Centrifugal Valve

Replace the centrifugal valve as follows (Fig.24):

1. Detach the pipe-line serving for oil delivery from the oil unit.

2. Detach the pipe-line for oil delivery from the magnetic cock.

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3. Disconnect the pipe-lines for fuel delivery from the HP-10A pump, for fuel feed to air blow-off band control mechanism and for drainage of the centrifugal valve.

4. Unlock and back out the bolts of the half-rings of the quick-release joint holding the centrifugal valve to the accessory drive gearbox and remove the half-rings.

5. Wash the centrifugal valve in clean gasoline without taking the shipping caps off the pipe union serving for delivery of oil to the centrifugal valve. Wipe the centrifugal valve with a dry piece of cloth and inspect it for mechanical damage.

6. Mount the centrifugal valve onto the accessory drive gearbox; take care to line up the hole on the centrifugal valve flange with the retaining dowel on the adapter; fit a rubber packing under the flange. Install the half-rings of the quick-release joint so that their parting line should be arranged along the vertical axis of the engine. Fasten the half-rings with bolts having fitted locking washers under their heads. Lock the bolts by bending the tabs of the locking washers over the flats of the bolt heads and over the half-rings. Apply normal effort when tightening the half-ring bolts. The butt-joint of the half-rings should have a clearance of 0.4 to 2 mm; the difference between the clearances on one side should not exceed 0.2 mm.

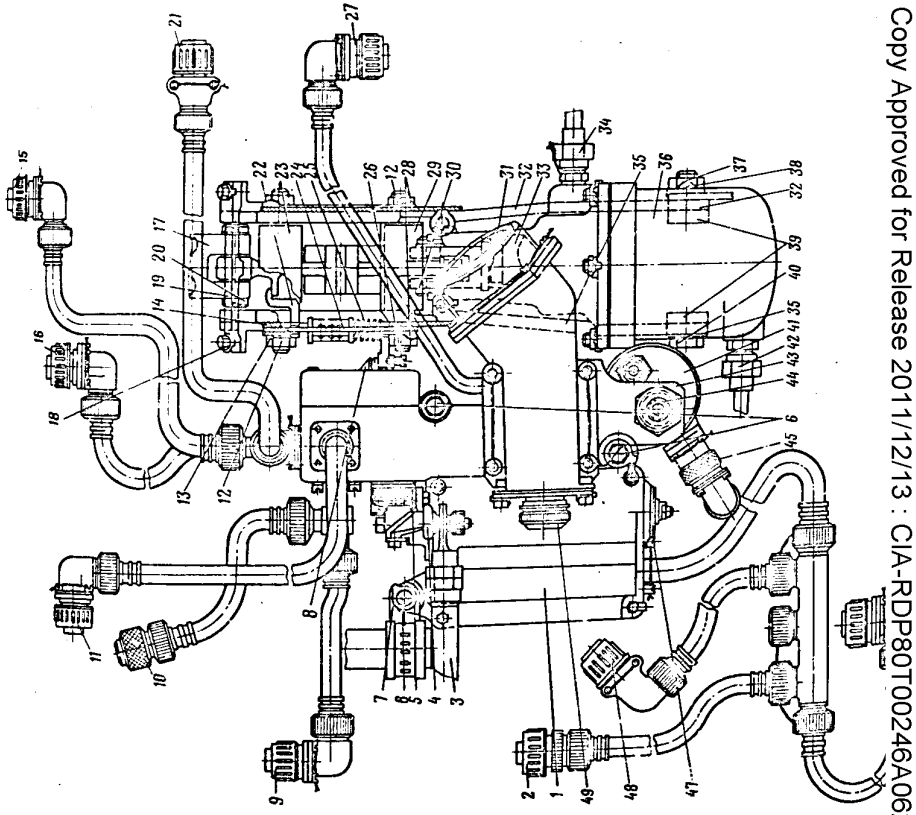
7. Attach the oil, fuel, and drainage pipe-lines to the centrifugal valve in the reverse order of their dismantling.

8. Start the engine and check the speed at which the air blow-off band opens the compressor ports. If necessary, adjust this speed as instructed in Section 3 of Chapter VI.

10. Replacement of Control Panel ПУ-3

Replacement of the control panel ПУ-3 should be carried out as follows:

1. Uncouple the plug connectors of the HP-10A pump, the HP-11A pump, the ДТ-3 tachometer generator, the oil pressure warning mechanism 2СДУ5-1.3-2.2, the fuel pressure



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fuel delivery from
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Panel ПУ-3

ПУ-3 should be carried

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2, the fuel pressure

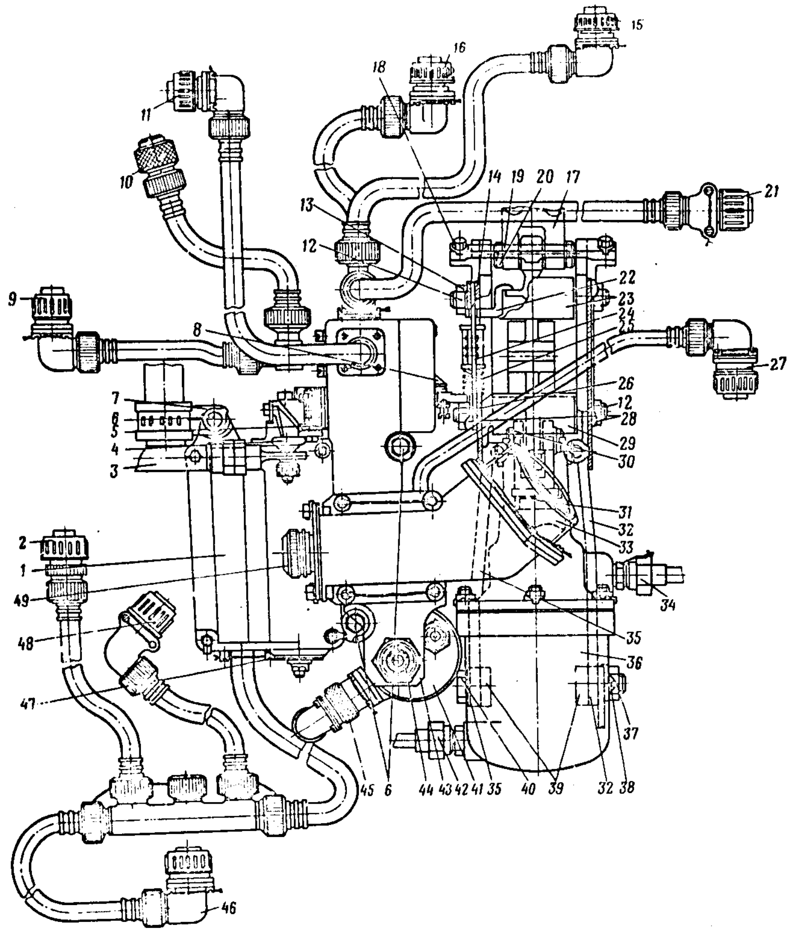

Fig.25. Attachment of Control Panel ПУ-3 , Control Panel Limit Switch Л Drive, Oil Pressure Warning Mechanism 2СДУ5-I.3-2.2, and Air Blow-Off Band Control Mechanism

1 - control panel ПУ-3 ; 2 - plug connector ШП-4 of electro-hydraulic contactor controlling afterburner spark plug; 3 - link connecting control panel and HP-10A pump levers; 4 - control panel lever; 5 - engine control link securing lever; 6 - bolts holding control panel to engine; 7 - clamp securing pipe-line for fuel delivery to HP-10A pump; 8 - control panel limit switch Л stop; 9 - plug connector of magnetic valve controlling air blow-off band; 10 - plug connector of fuel pressure warning mechanism ДСД-2 ; 11 - plug connector of HP-10A pump hydraulic decelerator limit switch; 12 - nut securing axles of driven and driving sectors; 13 - bracket securing fuel pressure warning mechanism ДСД-2 ; 14 - bracket of band control mechanism driven sector stop; 15 - plug connector of carburettor magnetic valve (on engines of fifth series with precombustion ignition; engines of fourth series do not employ this plug connector with wire); 17 - air blow-off band; 18-stop securing bolt; 19 - stop; 20 - pin coupling air blow-off band to driven sector; 21 - plug connector [illegible] of booster coil КПМ-IA ; 22 - drive stop; 23 - driven sector; 24 - control panel limit switch Л drive; 25 - drive spring; 26 - drive adjusting screw; 27 - plug connector ШУ-2 of magnetic valve; 28 - locking plates of axle securing nuts; 29 - driving sector; 30 - pin attaching air blow-off and control mechanism rod to driving sector; 31 - air blow-off band control mechanism rod; 32 - rear bracket for securing air blow-off band control mechanism; 33 - plug connector [illegible] of control panel ПУ-3 ; 34 - air blow-off band control mechanism drainage pipe; 35 - front bracket for securing air blow-off band control mechanism; 36 - air blow-off band control mechanism actuating cylinder; 37 - nut securing air blow-off band control mechanism actuating cylinder; 38 - locking washer; 39 - brackets; 40 - air blow-off band control mechanism securing bolt; 41 - oil pressure warning unit 2СДУ5-I.3-2.2 ; 42 - pipe for fuel delivery to air blow-off band control mechanism; 43 - oil pressure warning unit securing bracket; 44 - oil pressure warning unit securing nut; 45 - plug connector of oil pressure warning unit; 46 - tachometer generator plug connector ШУ-3; 47 - control panel dial; 48 - plug connector [illegible] of magnetic cock controlling afterburner operation; 49 - cap enclosing switch лК of control panel.

warning mechanism ДСД-2 of the starting fuel system magnetic valve, the magnetic cock controlling operation of the compressor air blow-off band, booster coil unit КП-21Б1М and of the КПМ-1А booster coil (Fig.25).

2. Remove the clamps securing the electric cables running from the control panel to the individual units, as well as from the pipe-lines, to facilitate dismantling.

3. Drain fuel from fuel-oil unit 317A.

4. Unlock and turn off the nut of the telescopic joint of the pipe-line serving for fuel delivery to the НР-11А pump.

5. Unlock and turn out the bolts securing the fuel delivery pipe-line to the НР-11А pump.

6. Unlock and slacken the bolt securing the clamp of the durite joint connecting the pipe-lines for fuel delivery to the НР-10А and НР-11А pumps, remove the pipe-line for fuel delivery to the НР-11А pump.

7. Detach two vent pipe-lines from the НР-11А pump.

8. Remove oil pressure warning mechanism 2СДУ5-1.3-2.2 as instructed in Section 7 of this Chapter.

9. Detach the engine control link from the control panel lever. Fasten the ball bearing in the engine control link shackle by means of wire or twine.

10. Detach the free moving link connecting the control panel lever to the lever of the НР-10А pump from the control panel lever.

11. Unlock and back out the two bolts holding the control panel to the bracket; turn the nut off the third bolt and remove the control panel.

12. Mount the new control panel onto the bracket and fasten it with bolts, having fitted new locking washers under the bolt heads and the nut.

Lock the bolts and the nut by bending the washer tabs over the flats of the bolt heads and nut and over the panel housing. Use the front bolt securing the control panel (looking forward) to fasten the clamp holding the pipe-line for fuel delivery to the НР-10А pump. Check and adjust the travel of the stop of control panel limit switch Л, as

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instructed in Point 6 of Section 7 (Replacement of control panel limit switch Д drive).

13. Connect the free moving link to the control panel lever and check the control system as laid down in Section 1 of this Chapter.

14. Attach the engine control link to the control panel lever and check the engine control system for proper operation as instructed in Section 5 of Chapter IX.

15. Check operation of the control panel according to the procedure outlined in Section 9 of Chapter VI.

16. Mount oil pressure warning mechanism 2СДУ5-1.3-2.2 as laid down in Section 7 of this Chapter.

17. Attach the vent pipe-lines to the HP-11A pump, having fitted new packing rings under the nuts of the joints. Lock the nuts of the joints with 0.8 mm diameter brass wire.

18. Install the pipe-line for fuel delivery to the HP-11A pump; connect it to the pipe-line for fuel delivery from fuel-oil unit 317A by means of the telescopic joint; use the durite joint to connect the pipe-line for fuel delivery to the HP-11A pump with that for fuel delivery to the HP-10A pump. Secure the pipe-line to the HP-11A pump with bolts; tighten the nut of the telescopic joint and the bolt of the durite joint clamp, having fitted new packing rings under the pipe-line flange and the nut of the telescopic joint. Lock the bolts and the nut with 0.8 mm diameter brass wire.

19. Couple the plug connectors of the units. Lock the nuts of the plug connectors with 0.8 mm diameter brass wire.

20. Reinstall the pipe-line and electric cable clamps. Lock the clamp securing bolts with locking washers.

21. Start the engine and check it for proper operation at all ratings. If necessary, adjust the units as laid down in Chapter VI.

11. Replacement of Starter-Generator ГСР-СТ-6000А

Starter-generator ГСР-СТ-6000А should be replaced as follows (Fig.26):

1. Detach the wires from the terminal box of the starter-generator. Move the wires aside to facilitate dismantling of the starter-generator.

2. Extract the rubber distance piece from the pipe connection serving for delivery of cooling air to the starter-generator.

3. Unlock and back out the bolts securing the half-rings of the quick-release joint; remove the half-rings while supporting the starter-generator.

4. Remove the starter-generator from the engine complete with the pipe connection for delivery of cooling air to the starter-generator.

5. Unlock and turn off the nuts holding the cooling air pipe connection to the starter-generator air scoop; remove the pipe connection.

Note: The pipe connection for cooling air delivery to the starter-generator may be removed before dismantling the starter-generator from the engine.

6. Unlock and back out the 6 bolts holding the ring of the quick-release joint to the flange of the starter-generator; remove the ring.

7. Remove corrosion-preventive compound from a new starter-generator as recommended in the respective Service Log.

8. Install the starter-generator air scoop in the required position, depending on arrangement of the engine on the aircraft (See Fig.26).

9. Mount the ring of the quick-release joint onto the flange of the starter-generator, so that the hole serving to accommodate the retaining dowel should be located on top, opposite to the starter-generator air scoop; secure the ring with bolts after fitting a gasket under it. Lock the bolts with 1.2 mm diameter steel wire.

10. Mount the air delivery pipe connection on the starter-generator air scoop and secure it with nuts fitted with locking washers.

11. Install the rubber distance piece on the pipe connection for cooling air delivery to the starter-generator.

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12. Mount the starter-generator on the engine so that the retaining dowel of the adapter on the accessory drive gearbox fits into the hole provided in the ring; make sure to fit a gasket under the ring.

Mount the half-rings of the quick-release joint and turn in the securing bolts, having fitted locking washers under the bolt heads. The butt joint of the half-rings should be arranged along the horizontal axis of the drive. Apply normal effort when tightening the bolts. The butt joint of the half-rings should have a clearance within 0.4 to 2 mm. The difference between the clearances on one side should not exceed 0.2 mm. The required clearance is ensured by selecting half-rings of proper thickness.

13. Attach the wires to the terminal box of the starter-generator.

14. After replacement of the starter-generator, crank the engine to check operation of the starter-generator as a starter. The starter-generator should race the engine to a speed of 800 to 1100 r.p.m.

Start the engine to check the starter-generator operation as a generator. With the generator functioning normally, the respective pilot lamp should go out.

12. Replacement of Flame Igniter Complete with Spark Plug and of Spark Plug

The flame igniter (Fig.27) should be replaced as follows:

1. Remove the clamps of the starting fuel manifold.
2. Detach the wire from the spark plug.
3. Unlock, turn out and remove the burner from the flame igniter.
4. When replacing the lower flame igniters, detach the drainage pipe-line from the flame igniter.
5. Unlock and turn out the bolts securing the flame igniter; remove the flame igniter from the rear casing.
6. Wash a new flame igniter in clean gasoline and wipe it with a dry piece of cloth. See that no gasoline should get into the spark plug shield.

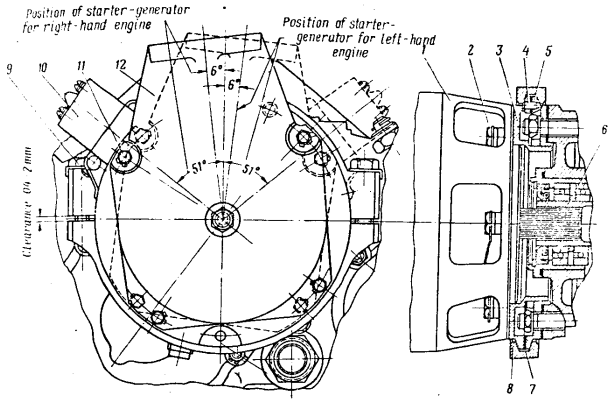

Fig.26. Attachment of Starter-Generator ГСР-СТ-6000А

1 - starter-generator; 2 - bolts securing quick-release joint ring to starter-generator flange; 3 - quick-release joint ring secured to starter-generator flange; 4 - retaining dowel; 5 - quick-release joint ring secured to starter-generator drive flange; 6 - starter-generator drive shaft; 7 - gasket; 8 - half-ring of quick-release joint; 9 - bolts securing half-rings of quick-release joint; 10 - starter-generator terminal box; 11 - bolts securing starter-generator air scoop connection; 12 - starter-generator air scoop connection.

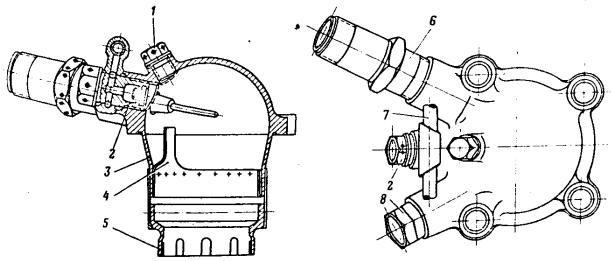

Fig.27. Flame Igniter

1 - plug (in two upper flame igniters); 2 - atomizer; 3 - flame igniter housing; 4 - baffle; 5 - flame igniter pipe connection; 6 - spark plug; 7 - starting fuel supply manifold; 8 - discharger.

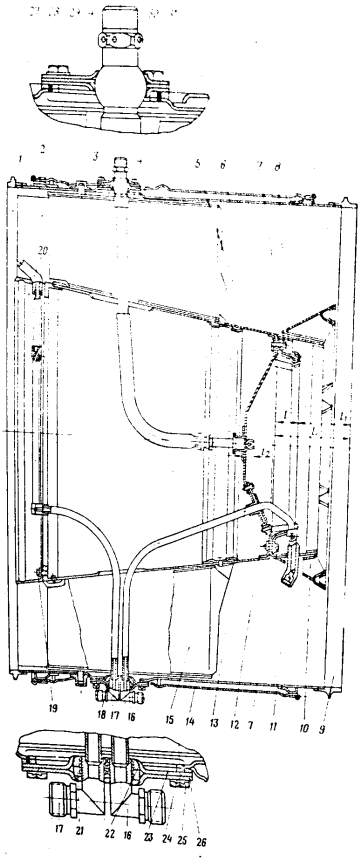

Fig.28. Afterburner Diffuser

1 – diffuser front flange; 2 – front flange of diffuser inner wall; 3 – spark plug fastening; 4 – afterburner spark plug with adapter; 5 – diffuser inner wall; 6 – diffuser housing; 7 – bolt securing flame arrester and rear fuel manifold clamp; 8 – rear fuel manifold clamp; 9 – diffuser rear flange; 10 – flame arrester; 11 – fuel nozzle of rear fuel manifold; 12 – rear fuel manifold flange; 13 – bolt securing rear fuel manifold flange; 14 – diffuser hood; 15 – diffuser fairing; 16 – rear fuel manifold; 17 – front fuel manifold; 18 – fuel manifold fastening; 19 – bolt securing diffuser inner wall front flange; 20 – fuel nozzle of front fuel manifold; 21 and 22 – attachment hemispheres of fuel manifolds; 23 – sphere lower cover; 24 – locking washer; 25 – sphere cover securing bolt; 26 – sphere upper cover; 27 – sphere cover securing bolt; 28 – locking washer; 29 – upper cover of spark plug adapter sphere; 30 – adjusting plate; 31 – lower cover of spark plug adapter sphere.

Inspect the flame igniter for mechanical damage.

7. Check the gap between the spark plug electrode and the discharger. The gap should be within 2 to 2.5 mm.

8. Mount the flame igniter onto the rear casing, having fitted a gasket under the flame igniter flange; secure the flame igniter with bolts after fitting locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the flats of the bolt heads and over the flame igniter body.

9. Turn the starting fuel atomizer out of the flame igniter and remove the shipping cap from the former.

10. Insert the atomizer into the nipple of the starting fuel manifold pipe-line, having fitted new packing rings to both sides of the nipple; turn the atomizer into the flame igniter. Tighten and lock the burner with 0.8 mm diameter wire of steel 1Х18Н9Т.

11. When replacing the flame igniters, arranged at the lower part of the rear casing, attach the drainage pipe-line to the flame igniter, after fitting new packing rings under the pipe-line nipple. Lock the pipe-union-plug with 0.8 mm diameter wire of steel 1Х18Н9Т.

12. Reinstall the clamps securing the pipe-lines of the starting fuel manifold. Fit new locking washers under the clamp bolts. Lock the bolts by bending the washer tabs over the bolt head flats and over the clamps.

13. Attach the wire to the spark plug.

14. Start the engine to check the flame igniters for proper operation on the ground.

To check the engine for reliable starting in the air, cut off the engine, operate switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) when the speed is brought to 2000-2500 r.p.m. and by shifting the engine control lever towards the idling and by shifting the engine control lever towards the idling rating retainer bring the engine to the idling speed.

Replacement of Flame Igniter Spark Plug

Replace the СД-96 spark plug, using the following procedure:

1. Detach the wire from the spark plug.

2. Turn the spark plug out of the flame igniter.

3. Wash the spark plug electrode in clean gasoline. See that no gasoline gets into the spark plug shield.

4. Check the plug for proper sparking as instructed in Section 2 of Chapter VIII.

5. Install a new spark plug into the flame igniter body, having fitted a new copper washer; tighten the spark plug with torque indicating wrench 318Ж-12.

6. Attach the wire to the spark plug and lock it with wire of steel 1Х18Н9Т.

7. Start the engine to check the starting system for proper functioning.

13. Replacement of Afterburner Spark Plug СП-02 with Adapter

The afterburner spark plug СП-02 should be replaced in the following manner:

1. Detach the wire from the spark plug.

2. Unlock and back out the bolts securing the sphere covers; remove the upper cover of the sphere and the adjusting plate.

3. Remove the spark plug complete with the adapter from the diffuser and take off the lower cover of the sphere.

4. Wipe a new spark plug and adapter with a dry piece of cloth, and inspect it for mechanical damage.

5. Put the lower cover of the sphere on the new spark plug and insert the spark plug complete with the adapter into the afterburner diffuser.

6. Put on the upper cover of the sphere, turn in the bolts securing the sphere covers finger-tight; be sure to fit washers under the bolt heads. Check clearance between the covers. The clearance should be within 0.1 to 0.3 mm. The required clearance is ensured by installing proper adjusting plate. If the clearance is less than 0.3 mm, the adjusting plate may be not installed.

7. Secure the sphere covers with bolts. Lock the bolts by bending the washer tabs over the bolt heads. Check the spark plug for proper projection in the diffuser (l_2). The distance between the diffuser plate and the spark plug electrode should be at least 7 mm.

8. Disconnect the component parts of the plug connectors from fuel pressure warning mechanism ДСД-2 and the limit switch of the НР-10А pump hydraulic decelerator.

Mount device 754П-7 onto the component part of the plug connector of the НР-10А pump hydraulic decelerator limit switch, and install device 834П-7 on the component part of the plug connector of fuel pressure warning mechanism ДСД-2.

Shift the engine control lever to the "AFTERBURNING" (ФОРСАЖ) position and check the plug for proper sparking. The afterburner should be cut in for not more than 5 sec.

9. Remove devices 754П-7 and 834П-7, connect the plug connectors of the НР-10А pump and of fuel pressure warning mechanism ДСД-2. Lock the nuts of the plug connectors with 0.8 mm diameter brass wire.

10. Start the engine and check the afterburner for proper switching.

14. Replacement of Booster Coil Unit КП-21Б1М

Booster coil unit КП-21Б1М should be replaced as follows (Fig.29):

1. Detach the component part of the plug connector from the booster coil unit.

2. Detach the high-voltage wires from the booster coil unit.

3. Unlock and turn out the bolts holding the booster coil unit to the shield, then remove the booster coil unit.

4. Mount new booster coil unit КП-21Б1М and secure it to the shield with two bolts. Be sure to place locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the bolt head flats and the coil unit flange.

5. Couple the booster coil unit plug connector, and attach the high-voltage wires. Lock the nuts of the joints with 0.8 mm diameter brass wire.

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After replacement of the booster coil unit, check the coils for proper operation during engine starting.

15. Replacement of Booster Coil КПМ-1А

Afterburner booster coil КПМ-1А (See Fig.29) should be replaced in compliance with the following procedure:

1. Detach the component part of the plug connector from the booster coil.
2. Detach the high-voltage wire from the booster coil.
3. Unlock and back out the four bolts holding the booster coil bracket to the shield, and remove the bracket complete with the coil.
4. Unlock and turn out the bolts holding the booster coil to the bracket; remove the coil.
5. Mount booster coil КПМ-1А on the bracket and secure it with bolts. Lock the bolts with 0.8 mm diameter brass wire.
6. Mount the bracket complete with the booster coil onto the engine and secure it to the shield with bolts. Lock the bolts with 0.8 mm diameter brass wire.
7. Couple the plug connector of the booster coil and attach the high-voltage wire. Lock the nuts of the joints with 0.8 mm diameter brass wire.
8. The replacement procedure over, check afterburner spark plug СП-02 for proper spark formation with the help of devices 754П-7 and 834П-7, as instructed in Section 13 of this Chapter (Points 8 and 9).

This done, start the engine and check the afterburner for proper switching.

16. Replacement of Drain Valve

The drain valve should be replaced as follows:

1. Detach the pipe-line for delivery of fuel from the НР-10А pump.
2. Disconnect the pipe-lines for draining the manifolds from the drain valve as well as from the main and auxiliary fuel system manifolds.

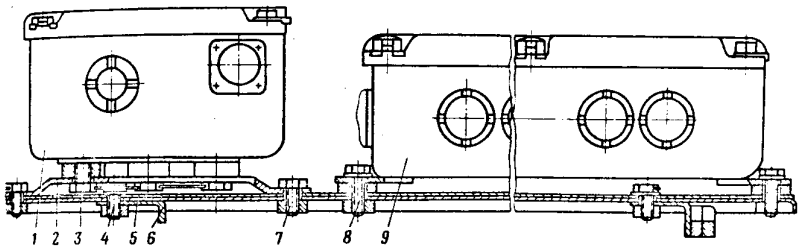

Fig.29. Attachment of Booster Coils

1 - booster coil КПМ-1А ; 2 - booster coil attachment bracket; 3 - bolt holding booster coil to bracket; 4 - shield securing bolt; 5 - shield; 6 - shield bracket; 7 - bolt securing booster coil bracket; 8 - bolt securing booster coil unit; 9 - booster coil unit КП-21БМ.

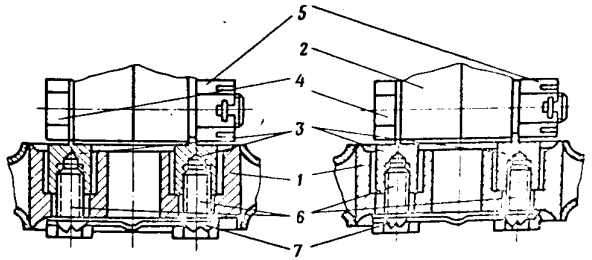

Fig.30. Attachment of Drainage Tank

1 - drainage tank; 2 - compressor middle casing; 3 - drainage tank attachment brackets; 4 - compressor middle casing coupling bolts; 5 - coupling bolt nuts; 6 - drainage tank securing bolts; 7 - locking washers.

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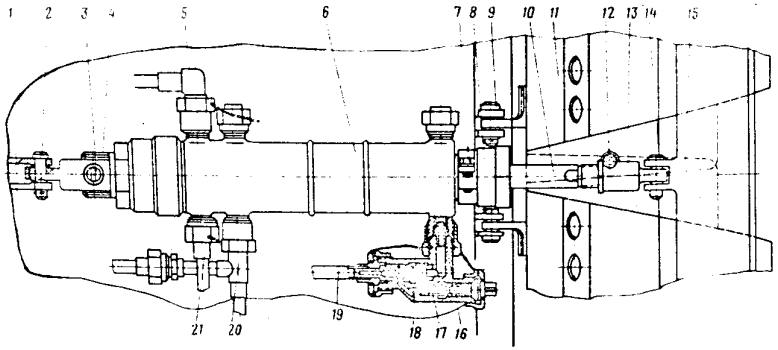

Fig.31. Jet Nozzle

1 - jet nozzle flange; 2 - pin coupling actuating cylinder to jet nozzle; 3 - adjusting bush locking screw; 4 - bush serving for adjustment of jet nozzle opening diameter (diameter of shutters) at normal rating; 5 - pipe for delivery of hydraulic fluid (AMT-10 oil) to other actuating cylinder; 6 - actuating cylinder; 7 - bush coupling bolt;8 - bush serving for adjustment of jet nozzle opening diameter (diameter of shutters) at maximum rating; 9 - pin securing shutter to jet nozzle rear flange; 10 - actuating cylinder rod; 11 - jet nozzle shutter; 12 - shank coupling bolt; 13 - actuating cylinder rod shank; 14 - pin coupling ring to actuating cylinder rod shank; 15 - jet nozzle ring; 16 - jet; 17 - return valve throttling unit; 18 - return valve; 19, 20 and 21 - pipes for delivery of hydraulic fluid (AMT-10 oil) to actuating cylinder.

3. Detach from the drain valve the adapter securing the cocks for draining oil from fuel-oil unit 317A and from the front sump.

4. Unlock and turn off the drain valve securing nuts, then remove the valve.

5. Wash a new drain valve in clean gasoline, wipe it with a dry piece of cloth and inspect for mechanical damage.

6. Mount the drain valve onto the engine and fasten it with nuts fitted with locking washers. Lock the nuts by bending the washer tabs over the nut flats and on the drain valve flange.

7. Attach to the drain valve the adapter securing the cocks for draining oil from fuel-oil unit 317A and from the front sump; be sure to place a new packing ring under the nut of the joint.

8. Install the pipe-lines for draining fuel from the fuel manifolds into the drain valve by connecting them to the drain valve and to the fuel manifolds. Fit new packing rings under the nuts of the pipe-line joints.

9. To the drain valve connect the pipe-line supplying fuel from the HP-10A pump; fit a new packing ring under the nut of the joint.

10. Lock the nuts of the pipe-line and adapter joint with 0.8 mm diameter brass wire.

17. Replacement of Cock for Draining Oil from Front Sump or from Fuel-Oil Unit 317A

The cock for draining oil from the front sump of the compressor inlet casing (or fuel-oil unit 317A) should be replaced as follows:

1. Shift the drain cock lever to the "OPEN" (ОТКРЫТО) position, and drain oil from the front sump (fuel-oil unit 317A).

2. Detach the vent pipe-line from the oil drain cock.

3. Detach the pipe-line for draining oil from the front sump (fuel-oil unit 317A).

4. Unlock and turn off the nut coupling the oil drain cock to the adapter, and remove the cock.

5. Wash a new oil drain cock in clean gasoline, wipe it with a dry piece of cloth and inspect for mechanical damage.

6. Connect the oil drain cock to the adapter, having fitted a new packing ring under the nut of the joint.

7. Attach the pipe-line for draining oil from the front sump (fuel-oil unit 317A) to the cock; be sure to fit a new packing ring under the nut of the joint.

8. Connect the vent pipe-line to the cock, having fitted a new packing ring under the nut of the joint.

9. Lock the nuts with 0.8 mm diameter brass wire.

10. Set the lever of the oil drain cock in the "CLOSED" (ЗАКРЫТО) position. After replacement of the cock for draining oil from the front sump of the inlet compressor casing (or the cock for draining oil from fuel-oil unit 317A), fill the oil tank with oil, as instructed in Section 1 of Chapter III.

18. Replacement of Drainage Tank

The drainage tank (Fig.30) should be replaced in compliance with the following procedure:

1. Remove the clamps from the following pipe-lines:

(a) for air delivery to the drainage tank;

(b) for fuel return from the drainage tank;

(c) for fuel delivery from the drain cock to the drainage tank;

(d) for directing air and fuel from the drainage tank to the pipe-line for draining fuel from the drainage tank.

2. Detach the pipe-lines listed under Item 1 of this Section from the drainage tank.

3. Unlock and back out the bolts securing the drainage tank and remove the latter.

4. Wash the new drainage tank in clean gasoline and inspect it for mechanical damage.

5. When installing the tank see that it does not rock on the bracket to avoid deformation when securing it with bolts; otherwise cracks may result. To accomplish this perform the following operations:

(a) unlock and slacken the nuts of the bolts securing the brackets of the drainage tank;

(b) mount the new drainage tank on the brackets and fasten it with bolts;

(c) tighten the nuts of the bolts securing the brackets of the drainage tank, taking care to aline the brackets according to the supporting surfaces of the tank;

(d) back out the tank attachment bolts and remove the tank;

(e) lock the nuts of the bolts, securing the drainage tank brackets, with cotter pins.

6. Mount the drainage tank on the brackets and fasten it with bolts, fitted with locking washers. Lock the bolts.

7. Connect the pipe-lines removed during dismantling of the drainage tank (See Item 1 of this Section); fit new packing rings under the nuts of the drainage tank pipe union-to-pipe-line joints. Lock the nuts with 0.8 mm diameter wire.

8. Reinstall the clamps. Lock the bolts of the clamps with new locking washers by bending the tabs of the locking washers over the bolt head flats and on the clamps.

19. Replacement of Fuel Pressure Warning Mechanism ДСД-2

Fuel pressure warning mechanism ДСД-2 should be replaced as follows:

1. Disconnect the plug connector of fuel pressure warning mechanism ДСД-2.

2. Detach the fuel delivery pipe-line from the fuel pressure warning mechanism. Unlock and turn off the union nut; remove the fuel delivery elbow from the fuel pressure warning mechanism.

3. Detach the pipe-line for delivery of gases from the afterburner to the fuel pressure warning mechanism.

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4. Unlock and slacken the nut securing the fuel pressure warning mechanism and remove the latter from the bracket.

5. Mount new fuel pressure warning mechanism ДСД-2 on the bracket and fasten it with the nut. Lock the nut with 0.8 mm diameter brass wire. Arrange the fuel pressure warning mechanism so that the plug connector flange surface should be in the horizontal plane.

6. Install the fuel delivery elbow and secure it with the union nut; fit a new packing ring into the joint. Connect the fuel delivery pipe-line to mechanism ДСД-2, having fitted a new packing ring under the nut of the joint.

7. Attach the gas delivery pipe-line to the unit, after fitting a new packing ring under the nut of the pipe-line joint. Lock the nuts with 0.8 mm diameter wire.

8. Couple the plug connector of mechanism ДСД-2; lock the nut with 0.8 mm diameter brass wire.

After carrying out the replacement of the fuel pressure warning mechanism, start the engine and check switching-in of the afterburner.

20. Replacement of Afterburner Tube, Afterburner Middle Tube, and Jet Nozzle

When replacing the afterburner tube or its individual assemblies, it is necessary to bleed pressure from the aircraft hydraulic system and to disjoint the fuselage.

Replacement of Afterburner Tube

The afterburner tube should be replaced as follows:

1. Bring a truck under the afterburner and place the latter on it. To avoid damage to the shrouds, place the afterburner with the steel flanges down.

2. Disconnect the pipe-line for draining fuel from the drainage tank, at the flanges of the diffuser-to-afterburner tube joint.

3. Unlock and turn the bolt (with a square head), retaining the afterburner tube in a certain position relative

to the diffuser, out of the upper half-ring of the telescopic joint.

4. Unlock and turn out the bolts securing the half-rings of the telescopic joint connecting the afterburner tube to the diffuser; remove the half-rings.

5. Take the afterburner tube from the truck and place a new afterburner tube on the truck.

6. Connect the afterburner tube to the diffuser and fasten it by means of the half-rings of the telescopic joint, having lined up the hole on the upper half-ring with the diffuser flange slot marked with "Б лев." (for the left-hand engine) and with "Б прав." (for the right-hand engine).

Turn the retaining bolt into the upper half-ring hole, having fitted a locking washer under its head and having treated the threaded portion of the bolt with chalk paste. Lock the retaining bolt by bending the tabs over the bolt head flat and on the half-ring.

7. Tighten the bolts securing the half-rings, having fitted new locking washers under the bolt heads.

Lock the bolts by bending the locking washer tabs over the flats of the bolt heads and over the half-ring.

8. Connect the pipe-line for draining fuel from the drainage tank, having fitted a packing ring under the nut of the joint. Lock the nut with 0.8 mm diameter wire of steel 1Х18Н9Т.

9. Remove the ejector and the jet nozzle cylinder shields, as instructed in Sections 24 and 25 of this Chapter.

10. Attach the pipe-lines of the hydraulic device, used when checking cylinder operation on the ground, to the jet nozzle cylinders.

11. Adjust the diameter of the jet nozzle opening in the positions corresponding to augmented, normal and maximum ratings as instructed in the Engine Service Log. Adjustment of the jet nozzle opening diameter and checking of jet nozzle operation should be done as follows:

(a) uncouple the plug connector of the НР-10А pump hydraulic decelerator switch, and mount device 754П-7 on the component part of the plug connector;

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(b) detach the component part from the plug connector of fuel pressure warning mechanism ДСД-2;

(c) manipulate the band with the help of wrench 240Ж-12 to close the compressor air blow-off ports;

(d) connect power supply to the aircraft electric system and turn on master switch "STORAGE BATTERY" (АККУМУЛЯТОР), circuit breaker АЗС-5 "AFTERBURNER EMERGENCY CUT-OFF" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА) and circuit breaker "OIL SHUT-OFF COCK"(ПЕРЕКРЫВНОЙ КРАН, МАСЛО);

(e) bring pressure of operating fluid (АМГ-10 oil) in the hydraulic system to 80-140 kg/sq.cm. to check the jet nozzle cylinders for proper operation;

CAUTION. Adjustment of the jet nozzle opening diameter and checking of jet nozzle operation should be first carried out with the jet nozzle in the augmented rating position.

(f) shift the engine control lever to the "AFTERBURNING" (ФОРСАЖ) stop. Close the plug of fuel pressure warning mechanism ДСД-2 for 1-2 sec. by using device 834П-7. This should cause the jet nozzle shutters to open to the maximum value, that is the jet nozzle ring should move to the extreme rear position. Slightly press the jet nozzle shutters to the ring by hand and measure the diameter of the jet nozzle opening with a special slide gauge. Carry out measurements in four diametrically opposed points. Arithmetical mean of the jet nozzle opening diameter should be equal to the value indicated in the Engine Service Log. If the diameter of the jet nozzle opening in the augmented position differs from the value indicated in Engine Service Log, adjust the diameter to the required value by changing the length of the rods of all four pistons, which is accomplished by screwing the piston rod in or out of shank [illegible] (see Fig. [illegible]). Prior to turning the piston rods unlock and slacken the coupling bolts of the rod shanks; turn the piston rods, with hydraulic pressure bled out of the cylinders.

[illegible] diameter of the jet nozzle opening, turn the rod out of the shank [illegible]; the rods of all the cylinders should be turned equally.

Use a slide gauge or a depth gauge to check cocking of the ring in a position corresponding to augmented rating. Carry out the check by measuring the distance between the ring face and the rear flange of the jet nozzle body in four points, opposite to every cylinder. Ring cocking is equal to a half-difference between the maximum and minimum values obtained, and should not exceed 0.5 mm. Cocking should be eliminated by turning the rod in the shank.

Having adjusted the diameter of the jet nozzle opening and the ring cocking, turn down the coupling bolts of all cylinder rod shanks. Tighten the coupling bolts as follows: fit a new locking washer on the bolt and turn the latter manually until the bolt head contacts the cylinder rod shank; draw the bolt through 3 to 5 flats using a wrench; hold the cylinder rod with the wrench to check tightening of the shank on the cylinder rod; the rod should not turn relative to the shank.

Having adjusted the diameter of the jet nozzle opening, check the number of free threads on the cylinder rod; their number should not exceed 15;

(g) shift the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop; this should cause the jet nozzle shutters to shift to the minimum opening, that is the jet nozzle ring should move to the extreme front position.

Measure the diameter of the opening of the jet nozzle in the maximum rating position, as instructed under Point 11f.

If the diameter of the opening of the jet nozzle in the maximum rating position differs from the value indicated in the Engine Service Log, adjust the diameter of the jet nozzle

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opening as required, with the help of bush 8 (See Fig.31) of the cylinder, located at the rod side.

When the bush is turned out the diameter of the jet nozzle opening is increased, and vice versa. The bushes of all four cylinders should be turned in or out the same number of threads. Arithmetical mean of the jet nozzle opening diameter should be equal to the value indicated in the Engine Service Log. Prior to adjusting the diameter of the jet nozzle opening, unlock and slacken the coupling bolts of the cylinder rear bushes. Turn the bushes after the hydraulic pressure is bled out of the cylinders.

Check the ring for cocking.

To check cocking of the ring in the maximum rating position, shift the engine control lever to the "AFTERBURNING" (ФОРСАЖ) stop. Close the plug of oil pressure warning mechanism ДСД-2 for 1-2 sec. with the help of device 834П-7; this should cause the jet nozzle shutters to shift to a position corresponding to augmented rating (maximum diameter of opening); this done, measure the distance between the rod shank faces and the bush faces. The difference between these distances should not exceed 0.2 mm.

Cocking of the ring in the position corresponding to the maximum rating should be adjusted with the help of bushes which are used for adjusting the diameter of opening of the jet nozzle in the position corresponding to the maximum rating. Having adjusted ring cocking and the diameter of the jet nozzle opening, tighten the coupling bolts of the bushes.

When tightening the bolts proceed as follows: fit a new locking washer on the bolt and turn the latter down manually until the bolt head contacts the cylinder adjusting bush. Then tighten the bolt with a wrench; rock the bush to determine the moment it is tightened up, after which turn the bolt additionally through 1.5 to 2 flats. Lock the bolt by bending the washer tabs onto the bolt head flats.

After carrying out adjustment of the diameter of the jet nozzle opening, check the number of free threads on the cylinder; their number should not exceed 15;

(h) remove wrench 240Ж-12 to open the compressor air blow-off ports, and shift the engine control lever to the "NORMAL" (НОМИНАЛ) stop; this should cause the jet nozzle ring to move to the intermediate position, which corresponds to opening of the jet nozzle in the normal rating position. Measure the diameter of the jet nozzle opening as instructed in Point 11f.

Arithmetical mean of the diameter of the jet nozzle opening in the position corresponding to the normal rating should comply with the value indicated in the Engine Service Log.

For adjustment of the diameter of the jet nozzle opening use bush 4 (See Fig.31) of the cylinder, located at the lug securing the cylinder to the jet nozzle body (front bush).

Prior to adjusting the diameter, unlock and turn out the screw, checking the adjusting bush.

When the bush is rotated in the clockwise direction (looking from the cylinder securing lug) the diameter of the jet nozzle opening is increased, and vice versa. Turn the bushes of all four cylinders through the same number of turns. Check cocking of the ring, with the jet nozzle in a position corresponding to the normal rating. To check the ring cocking, measure the distance between the ring face and the jet nozzle body flange face in four points, opposite to every cylinder, using a slide gauge or a depth gauge. The ring cocking is equal to a half-difference between the maximum and minimum values obtained, and should not exceed 0.5 mm.

Adjust the ring cocking with the help of the bushes used for adjusting the diameter of the opening of the jet nozzle in the position corresponding to the normal rating.

Turn in the bush locking screw and lock it with 0.8 mm diameter wire of steel 1Х18Н9Т;

(i) shift the engine control lever from the NORMAL (НОМИНАЛ) to the "AFTERBURNING" (ФОРСАЖ) stop, repeating the procedure 2 to 3times; this should cause the jet nozzle ring to shift to its three positions. Noticeable cocking of the ring should not exceed 25 mm (with the ring free of bends).

12. Check and adjust time of jet nozzle shutters operation (according to shifting of the ring), with pressure of operating fluid in the hydraulic system amounting to not less than 80 kg/sq.cm.

Carry out adjustment and checking of shutters operation using the following procedure:

(a) close the compressor air blow-off ports by manipulating wrench 240Ж-12. Shift the engine control lever from the "NORMAL" (НОМИНАЛ) stop to the "MAXIMUM" (МАКСИМАЛ) stop. The shutters of the jet nozzle should move from the position corresponding to the normal rating to the position corresponding to the maximum rating within 2.5 to 5 sec. In case the time period is less than or exceeds the above values, replace the jets in pipe-lines 20 (See Fig.31) serving to deliver oil into the cylinder cavity, under the auxiliary piston.

To accelerate shutters operation, install jets with larger diameter orifices; to decelerate shutters operation; fit in jets with smaller diameter orifices (See Table 4);

(b) shift the engine control lever from the "MAXIMUM" (МАКСИМАЛ) stop to the "AFTERBURNING" (ФОРСАЖ) stop and close the plug of fuel pressure warning mechanism ДСД-2 for 1 to 2 sec., using device 834П-7. The shutters of the jet nozzle should shift from the position, corresponding to the maximum rating, to the position corresponding to the augmented rating. Operation of the shutters should take place within 1.2 to 2.5 sec. If the time period is less than or exceeds the above values, adjustment should be performed by replacing jets 16 (See Fig.31) located in the return valve-to-cylinder joints. To accelerate shutters operation, install jets with larger diameter orifices, and vice versa (See Table 5).

Table 4

Groups of jets used for adjusting time of shutters operation when shifting from the normal rating position to the maximum rating position

Group	Diameter, mm
Б	2
В	1.75

Group	Diameter, mm
Г	1.5
Д	1.25
Е	1.0
Ж	0.8
И	0.6
Л	0.7
М	0.5
Н	0.4

Table 5

Groups of jets used for adjusting time of shutters operation when shifting from the maximum rating position to the augmented rating position

Group	Diameter, mm
А	1.25
Б	1.0
В	0.8
Г	0.6
Д	0.7
Е	0.5
Ж	0.9
З	1.1

(c) shift the engine control lever from the "AFTERBURNING" (ФОРСАЖ) stop to the "MAXIMUM" (МАКСИМАЛ) stop. The shutters should operate within 5 to 7 sec. If shutters operation time is less than or exceeds the specified values, replace throttling units 17 (See Fig.31) of the return valves. To accelerate shutters operation install larger capacity throttling units and vice versa (See Table 6). The throttling units should be installed as follows: use a screw-driver to turn the throttling unit in as far as it will go; install the plug so that its lobe fits into the throttling unit slot, and tighten the union nut, while supporting the plug with a wrench.

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13. Remove wrench 240К-12, to open the compressor air blow-off ports.

14. Shift the engine control lever to the "CUT-OFF" (СТОП) stop. The shutters of the jet nozzle should shift to the position corresponding to the augmented rating.

Table 6

Groups of throttling units

Group No.	Capacity, cu.cm/min.
2	350 ±17.5
3	500 ±25
4	600 ±30
5	800 ±40
6	700 ±35
7	400 ±20
8	450 ±22.5

15. Remove device 754П-7 from the plug of the НР-10А pump hydraulic decelerator limit switch and couple the plug connector of the НР-10А pump hydraulic decelerator limit switch. Couple the plug connector of fuel pressure warning mechanism ДСД-2. Lock the plug connectors with brass wire.

16. Turn off all switches.

17. Install the cylinder shields and the ejector, as instructed in Section 24 and 25 of this Chapter.

18. Start the engine and check it for proper operation at all ratings. If necessary, adjust the engine as recommended in Chapter VI.

When turning on the afterburner, measure the actual drop or increase of gas temperature aft of the turbine; if necessary, carry out the required adjustment as instructed in Section 2 of this Chapter. The engine checked, enter the gas temperature value, obtained when checking the engine after replacement of the afterburner, in the Engine Service Log. The gas temperature aft of the turbine should not exceed the value registered prior to carrying out the replacement.

Replacement of Afterburner Middle Tube

Replace the middle tube of the afterburner using the following procedure:

1. Carry out the operations detailed under Items 1, 2, 3, and 4 of Subsection "Replacement of afterburner tube".

2. Disconnect the pipe-line for draining fuel from the drainage tank at the flanges of the middle tube-to-jet nozzle joint, and remove the pipe-line clamps from the middle tube.

3. Unlock and turn off the nuts of the bolts holding the middle tube of the afterburner to the jet nozzle body; remove the bolts and detach the middle tube.

4. Wash a new afterburner middle tube with clean gasoline, wipe it with a dry piece of cloth and inspect for mechanical damage.

5. Attach the middle tube of the afterburner to the jet nozzle so that the parting faces of the middle tube and jet nozzle hoods are in the same plane. Fit the bolts into the flange holes.

6. Turn on the nuts having fitted new locking washers under them. Lock the nuts by bending the washer tabs over the nut flats.

7. Connect the pipe-line for draining fuel from the drainage tank at the flanges of the middle tube-to-jet nozzle joint; make sure to place a packing ring under the nut of the joint. Lock the nut with 0.8 mm diameter wire of steel 1Х18Н9Т.

8. Mount the afterburner on the engine as instructed under Items 6, 7, and 8 of Subsection "Replacement of afterburner tube".

9. Subject the engine to checking as recommended in Item 18 of Subsection "Replacement of afterburner tube".

Replacement of Jet Nozzle

Replace the jet nozzle using the following procedure:

1. Carry out the operations, detailed in Items 1, 2, 3, 4, 5, 6, 7, and 8 of Subsection "Replacement of afterburner middle tube".

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13. Remove wrench 240Ж-12, to open the compressor air blow-off ports.

14. Shift the engine control lever to the "CUT-OFF" (СТОП) stop. The shutters of the jet nozzle should shift to the position corresponding to the augmented rating.

Table 6

Groups of throttling units

Group No.	Capacity, cu.cm/min.
2	350 ±17.5
3	500 ±25
4	600 ±30
5	800 ±40
6	700 ±35
7	400 ±20
8	450 ±22.5

15. Remove device 754П-7 from the plug of the НР-10А pump hydraulic decelerator limit switch and couple the plug connector of the НР-10А pump hydraulic decelerator limit switch. Couple the plug connector of fuel pressure warning mechanism ДСД-2. Lock the plug connectors with brass wire.

16. Turn off all switches.

17. Install the cylinder shields and the ejector, as instructed in Section 24 and 25 of this Chapter.

18. Start the engine and check it for proper operation at all ratings. If necessary, adjust the engine as recommended in Chapter VI.

When turning on the afterburner, measure the actual drop or increase of gas temperature aft of the turbine; if necessary, carry out the required adjustment as instructed in Section 2 of this Chapter. The engine checked, enter the gas temperature value, obtained when checking the engine after replacement of the afterburner, in the Engine Service Log. The gas temperature aft of the turbine should not exceed the value registered prior to carrying out the replacement.

Replacement of Afterburner Middle Tube

Replace the middle tube of the afterburner using the following procedure:

1. Carry out the operations detailed under Items 1, 2, 3, and 4 of Subsection "Replacement of afterburner tube".

2. Disconnect the pipe-line for draining fuel from the drainage tank at the flanges of the middle tube-to-jet nozzle joint, and remove the pipe-line clamps from the middle tube.

3. Unlock and turn off the nuts of the bolts holding the middle tube of the afterburner to the jet nozzle body; remove the bolts and detach the middle tube.

4. Wash a new afterburner middle tube with clean gasoline, wipe it with a dry piece of cloth and inspect for mechanical damage.

5. Attach the middle tube of the afterburner to the jet nozzle so that the parting faces of the middle tube and jet nozzle hoods are in the same plane. Fit the bolts into the flange holes.

6. Turn on the nuts having fitted new locking washers under them. Lock the nuts by bending the washer tabs over the nut flats.

7. Connect the pipe-line for draining fuel from the drainage tank at the flanges of the middle tube-to-jet nozzle joint; make sure to place a packing ring under the nut of the joint. Lock the nut with 0.8 mm diameter wire of steel 1Х18Н9Т.

8. Mount the afterburner on the engine as instructed under Items 6, 7, and 8 of Subsection "Replacement of afterburner tube".

9. Subject the engine to checking as recommended in Item 18 of Subsection "Replacement of afterburner tube".

Replacement of Jet Nozzle

Replace the jet nozzle using the following procedure:

1. Carry out the operations detailed in Items 1, 2, 3, 4, 5, 6, 7, and 8 of Subsection "Replacement of afterburner middle tube".

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2. Perform the operations described in Items 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18 of Subsection "Replacement of afterburner tube".

21. Replacement of Afterburner Diffuser

The afterburner diffuser (See Fig.28) should be replaced as follows:

1. Remove the afterburner tube from the engine as instructed in Section 20 of this Chapter.

2. Detach the wire from spark plug СП-02 and remove the thermo-couples.

3. Remove the clamps from the pipe-lines for fuel delivery to the afterburner manifolds, from the pipe-line for directing fuel from the drainage tank, and from the pipe-line for delivery of gases to fuel pressure warning mechanism ДСД-2.

4. Remove the pipe-lines for fuel delivery to the afterburner manifolds and for directing fuel from the drainage tank from the afterburner diffuser.

5. Detach from the afterburner diffuser the pipe-line for delivery of gases to fuel pressure warning mechanism ДСД-2.

6. Detach the pipe-line for draining the fuel collector of the lower half-ring of the diffuser-to-II stage nozzle ring casing quick-release joint.

7. While supporting the diffuser, unlock and turn the nuts off the bolts, securing the half-rings of the diffuser-to-nozzle ring quick-release joint. Remove the half-rings and the diffuser.

8. Wash a new diffuser with clean gasoline, wipe it with a clean piece of cloth, remove the shipping caps from the fuel nozzles, pipe union, and from the spark plug.

Inspect the diffuser for mechanical defects. When washing the diffuser, see that no gasoline gets into the spark plug shield.

9. Mount the diffuser on the engine so that the left-hand slot (for the right-hand engine), and the right-hand

slot (for the left-hand engine) (looking from the rear end) provided on the diffuser flange should coincide with the respective slots on the flange of the nozzle ring. Install the half-rings of the quick-release joint making sure the retainer of the upper half-ring fits into the slot provided in the flanges.

Fit in the bolts securing the quick-release joint half-rings and turn on the castellated nuts. Tighten the bolts with a wrench and lock them with cotter pins. When locking the nuts, it is allowed to draw them additionally by not more than 0.5 flat. To fit the cotter pin ends into the slots of the nut, turn the bolt and the nut simultaneously in the counter-clockwise direction.

With the bolts properly tightened, no clearance should be allowed in the half-ring joints.

10. Attach the pipe-line for draining the fuel collector of the quick-release joint lower half-ring, secure the pipe-line with bolts, having fitted a gasket under the flange and locking washers under the bolts Lock the bolts by bending the washer tabs over the bolt head flats and over the pipe-line flange.

11. Connect the pipe-line for delivery of gases to fuel pressure warning mechanism ДСД-2, having placed a packing ring under the nut of the joint.

12. Mount the pipe-line for fuel delivery from the drainage tank, having fitted packing rings under the nuts of the joint.

13. Install the pipe-line for fuel delivery to the afterburner manifolds having placed packing rings under the nuts of the joint.

14. Reinstall the clamps securing the pipe-lines.

15. Lock the nuts of the joints with 0.8 mm diameter wire of steel 1Х18Н9Т.

16. Attach the conductor to afterburner spark plug СП-02 and lock it with 0.8 mm diameter wire of steel 1Х18Н9Т.

17. Install the thermo-couples for measuring gas temperature aft of the turbine on the diffuser, so that the thermo-couple retainer should fit into the slot of the

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diffuser pipe-unions; fasten the thermo-couples. Lock the thermo-couple attachment nuts with 0.8 mm diameter wire of steel 1X18H9T.

18. Mount and secure the afterburner as instructed in Section 20 of this Chapter.

19. Having replaced the diffuser, start the engine and check it for proper operation at all ratings.

22. Replacement of Afterburner Diffuser Flame Arrester

Carry out the replacement procedure in the following manner:

1. Remove the afterburner, as recommended in Section 20 of this Chapter.

2. Unlock and back out the bolts securing the flame arrester and the clamps of the rear fuel manifold.

3. Displace and bring the four clamps securing the rear fuel manifold of the afterburner into the slot provided in the flame arrester flange. When turning the clamps, do not use the fuel manifold as a support, for this may result in stresses arising in the manifold pipes.

4. Remove the flame arrester.

5. Install a new flame arrester and fit the lower right-hand clamp securing the rear manifold of the afterburner on the flame arrester flange; turn in the flame arrester attachment bolt, having fitted a new locking washer under the bolt head.

6. Fit on the three remaining clamps and turn in all flame arrester securing bolts, having fitted new locking washers under the bolt heads. Prior to installing the bolts, treat them with chalk paste.

7. Tighten and lock the bolts by bending the locking washer tabs over the bolt head flats.

8. Mount the afterburner on the engine and secure it as instructed in Section 20 of this Chapter.

9. After replacing the flame arrester, start the engine and check it for proper operation at all ratings.

23. Replacement of Afterburner Fuel Manifolds

Replacement of Rear Manifold

The rear fuel manifold of the afterburner should be replaced as follows:

1. Remove the afterburner tube as instructed in Section 20 of this Chapter.

2. Remove the afterburner diffuser flame arrester as recommended in Section 22 of this Chapter.

3. Detach the pipe-line for fuel delivery to the afterburner manifolds.

4. Unlock and back out the bolts securing the rear manifold flange.

5. Unlock and back out the bolts securing the covers of the afterburner fuel manifold sphere; remove the two hemispheres and the covers. Remove the manifold from the diffuser.

6. Wash a new fuel manifold on the outside with clean gasoline, and inspect it for mechanical damage. Flush the fuel manifold with oil (MK-8, or transformer oil) heated to a temperature of 65-75°C, after which wash the manifold with clean gasoline.

7. Install the new manifold, put the sphere covers onto the front and rear manifolds, and insert the two hemispheres. Tighten the bolts securing the sphere covers, having placed locking washers under the bolt heads.

8. Tighten the bolts securing the flange of the rear manifold; prior to tightening the bolts, treat them with chalk paste, and fit locking washers under their heads.

9. Install the flame arrester of the afterburner diffuser as instructed in Section 22 of this Chapter.

10. Tighten up and lock the bolts securing the covers of the sphere of the afterburner front and rear fuel manifolds by bending the tabs of the locking washers over the flats of the bolt heads and the upper cover of the sphere.

11. Use a slide gauge to check projection of the rear manifold fuel nozzles above the surface of the diffuser inner wall.

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Projection of the fuel nozzles should be equal to 25 ±1 mm and must be determined (See Fig.28) by the following formula:

$$l = L - l_1,$$

where: L is sinkage value of the rear face of the diffuser inner wall relative to the face of the diffuser rear flange;

l_1 - sinkage value of the rear manifold fuel nozzles relative to the face of the diffuser rear flange.

If projection of the rear manifold fuel nozzles does not comply with the specified limits, replace the fuel manifold.

12. Connect the fuel delivery pipe-line to the afterburner fuel manifolds.

13. Mount the afterburner on the engine as detailed in Section 20 of this Chapter.

14. Having replaced the rear fuel manifold of the afterburner, start the engine and check it for proper operation at all ratings.

Replacement of Front Manifold

The front fuel manifold of the afterburner should be replaced in the following manner:

1. Remove the afterburner tube as instructed in Section 20 of this Chapter.

2. Remove the afterburner diffuser as detailed in Section 21 of this Chapter.

3. Unlock and back out the bolts securing the front flange of the diffuser inner wall; remove the flange.

4. Unlock and back out the bolts securing the covers of the sphere of the front and rear fuel manifolds. Remove the two hemispheres and the covers. Dismantle the front fuel manifold.

5. Flush the front fuel manifold with oil (MK-8, or transformer oil) heated to a temperature of 65-75°C, after which wash the manifold in clean gasoline.

6. Install a new manifold in the diffuser; reinstall the sphere covers and the two hemispheres of the front and rear fuel manifolds; turn in the bolts securing the covers having fitted new locking washers under the bolt heads. Prior to turning in the bolts treat their threads with chalk paste.

7. Mount the front flange of the diffuser inner wall and fasten it with bolts; prior to turning in the bolts, treat the bolt threads with chalk paste and place locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the flats of the bolt heads and on the flange.

8. Tighten the bolts securing the covers of the fuel manifold sphere. Lock the bolts by bending the locking washer tabs over the flats of the bolt heads and of the sphere covers.

9. Mount the afterburner diffuser on the engine as instructed in Section 21 of this Chapter.

10. Mount the afterburner tube on the engine as detailed in Section 20 of this Chapter.

11. After replacing the front fuel manifold of the afterburner, start the engine and check it for proper operation at all ratings.

24. Replacement of Jet Nozzle Ejector

The jet nozzle ejector should be replaced as follows:

1. Unlock and back out the bolts securing the ejector and the lower shields of the cylinders; remove the ejector and the lower shields.

2. Wash a new ejector in clean gasoline and wipe it with a dry piece of cloth.

3. Mount the new ejector and the cylinder lower shields, and fasten them with bolts, having treated the bolt threads with chalk paste and fitted new locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the bolt head flats.

4. Make sure there is a clearance between the ejector and the jet nozzle ring, as well as between the lower shields

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and the jet nozzle shutters. Any contact between the ejector and the ring, as well as between the lower shield and the jet nozzle shutters is not allowed.

5. Check the ejector diameter for out-of-round in two diametrically opposed directions, using a slide gauge or a scale rule.

Out-of-round should not exceed 5 mm.

If no specified clearances are ensured, or the ejector out-of-round exceeds the permissible value, carry out the necessary adjustment by means of dressing.

25. Replacement of Cylinder Shields

Replacement of Lower Shield

Replacement of the lower shield of the jet nozzle cylinder should be performed as follows:

1. Unlock and turn out the shield securing bolts; remove the shield.

2. Wash a new lower shield in clean gasoline and wipe it with a dry piece of cloth.

3. Mount the new shield and fasten it with bolts to the ejector, having placed new locking washers under the bolts.

Check the clearance between the shield, the cylinder, and the jet nozzle shutters. The shield should not contact the cylinder, or the jet nozzle shutters. To ensure a proper clearance, the shield may be slighuly bent. Prior to turning in the bolts, treat their threads with chalk paste.

Lock the bolts by bending the washer tabs over the bolt head flats.

Replacement of Upper Shield

Carry out the procedure as follows:

1. Unlock and back out the bolts securing the upper shield; remove the shield.

2. Wash the new shield in clean gasoline and wipe it with a dry piece of cloth.

3. Mount a new upper shield and fasten it with bolts, having fitted locking washers under the bolt heads. Prior to fitting in the bolts, treat their threads with chalk paste.

Check the clearance between the shield and the cylinder. No contact should be allowed between these parts. To ensure a proper clearance the shield may be slightly bent. Lock the bolts securing the shield by bending the washer tabs over the bolt head flats.

26. Replacement of Jet Nozzle Cylinders

When replacing the jet nozzle cylinders, proceed as follows (Fig.31):

1. Remove the ejector, as instructed in Section 24 of this Chapter.

2. Remove the shield from the cylinder to be replaced, as recommended in Section 25 of this Chapter.

3. Detach the pipe-lines for delivery of hydraulic fluid to the cylinder.

4. Unlock the pins holding the cylinder rod to the jet nozzle ring; unlock the pins holding the cylinder to the jet nozzle body. Extract the pins and remove the cylinder.

5. Wash a new cylinder in clean gasoline and wipe it with a dry piece of cloth, without taking off the shipping caps. Inspect the cylinder for mechanical damage.

6. Insert the spherical bush into the lugs of the cylinder body and rod.

7. Couple the cylinder to the jet nozzle body with the help of the pin. Lock the pin with a cotter pin.

8. Couple the cylinder rod to the jet nozzle ring by means of the pin. Lock the pin with a cotter pin.

There should be some play in the joints between the cylinder and the jet nozzle body and ring.

9. Attach the hydraulic fluid pipe-lines to the cylinder. Lock the nuts of the pipe-line joints with 0.8 mm diameter wire of steel 1X18H9T.

10. Adjust jet nozzle ring cocking in position corresponding to the augmented, normal, and maximum ratings, as instructed in Subsection "Replacement of afterburner tube" of this Chapter.

11. Having replaced the cylinder and adjusted the jet nozzle ring cocking, start the engine and check it for proper operation at all ratings. If necessary, perform the required adjustment, as recommended in Chapter VI of these Instructions.

12. Install the cylinder shield and the ejector in accordance with the procedure detailed in Sections 24 and 25 of this Chapter.

27. Replacement of Jet Nozzle Shutters and Ring

Replacement of Jet Nozzle Ring

Replace the jet nozzle ring as follows:

1. Remove the ejector in compliance with the procedure described in Section 24 of this Chapter.

2. Remove the cylinder shields as instructed in Section 25 of this Chapter.

3. Unlock the pins attaching the jet nozzle ring to the cylinder rods.

Extract the pins and remove the ring.

4. Wash a new ring in clean gasoline and wipe it with a dry piece of cloth.

5. Mount the ring and secure it to the cylinder rods with the pins. Lock the pins with cotter pins.

6. Check and adjust jet nozzle ring cocking, as instructed in Subsection 20 "Replacement of afterburner tube" of this Chapter.

7. Install the cylinder shields and the ejector, as recommended in Section 24 and 25 of this Chapter.

Replacement of Jet Nozzle Shutters

Replace the jet nozzle shutters proceeding as follows:

1. Remove the ejector and the cylinder shields as instructed in Sections 24 and 25 of this Chapter.

2. Unlock and extract the pins attaching the jet nozzle shutter to the jet nozzle body, and remove the shutter.

3. Wash a new shutter in clean gasoline and wipe it with a dry piece of cloth.

4. Mount the shutter onto the jet nozzle and engage the shutter plate with the plates of the neighbouring shutters.

5. Fasten the shutter on the jet nozzle body with the help of pins. Lock the pins with cotter pins. Check the shutters for easy shifting; the shutters should shift easily, without binding.

Note: If more than three shutters are replaced on one jet nozzle, check and adjust the diameter of the jet nozzle opening as instructed in Section 20 of this Chapter.

28. Replacement of Compressor Inlet Housing Fairing and Support

Replace the fairing and support of the compressor inlet housing as follows:

1. Remove the air inlet cowling from the engine. Unlock and back out the bolt holding the fairing to the nose portion of the compressor inlet housing, and remove the fairing.

2. Detach the pipe-line for air delivery to the HP-11A pump barostat, from the support.

3. Detach the pipe-line for air delivery to the anti-icing device of the support and fairing, from the support pipe.

4. Unlock and turn off the nuts located on the inner and outer flanges of the nose portion and securing the support; remove the support.

5. Mount the new support on the compressor nose portion, so that the hole for air delivery to the anti-icing device should be located below. Secure the support with nuts to the inner and outer flanges of the inlet housing, having fitted washers and locking washers under the nuts.

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Lock the nuts by bending the washer tabs over their flats.

The contour of the support and struts should coincide with the inlet housing; the permissible error is not to exceed 1 mm. Where the strips are fitted at the ends of the struts, the collars may hang down by not more than 2.8 mm. Slight bending of the strut straps is allowed.

6. Mount the fairing onto the support, so that the holes for air delivery, provided in the fairing, should register with the holes in the support, while the fairing retaining dowel should fit into the support recess. Secure the fairing with a bolt, having fitted spherical and locking washers under the bolt head. Tighten the bolt by turning it through an angle of 60 to 75°. Lock the bolt by bending the washer tabs over the bolt head flats.

7. Connect the pipe-lines serving for air delivery to the anti-icing device of the support and fairing as well as to the barostat of the НР-11А pump; be sure to place packing rings under the nuts of the joints. Lock the nuts of the pipe-line joints with 0.8 mm diameter brass wire.

29. Replacement of Tachometer Generator ДТ-3

Tachometer generator ДТ-3 should be replaced in accordance with the following procedure:

1. Uncouple the plug connector of tachometer generator ДТ-3.

2. Unlock, turn off the nut securing the tachometer generator, and remove the latter.

3. Check armature rotation and the fit of the tachometer generator shank on the drive shaft; mount the new tachometer generator on the drive shaft and secure it with a nut. Lock the nut with 0.8 mm diameter brass wire.

4. Couple the tachometer generator plug connector; lock the plug connector nut with 0.8 mm diameter brass wire.

5. Start the engine and bring its speed to the maximum (normal rating). Check engine speed by the tachometer indicator at the normal and idling ratings. If necessary, carry out adjustment, as instructed in Chapter VI.

30. Replacement of Hydraulic Pump 435ВН

The pump replacement procedure should be carried out as follows:

1. Detach the hydraulic fluid delivery and return pipe-lines; detach the drainage pipe-line.

2. Unlock and back out the bolts securing the clamping ring, while supporting the hydraulic pump. Remove the halves of the clamping ring and the hydraulic pump.

3. Unlock and back out the bolts holding the flange to the hydraulic pump; remove the flange.

4. Remove corrosion-preventive compound from a new hydraulic pump, as instructed in the respective Service Log. Check the hydraulic pump shank for proper fit on the drive shaft splines. Check the hydraulic pump shaft for proper rotation; it should rotate smoothly, without binding or pinching.

5. Mount the flange on the new hydraulic pump; be sure to place a new packing ring under the flange. Fasten the flange with bolts, having fitted new locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the bolt head flats.

6. Mount the new hydraulic pump on the drive shaft, taking care to fit the dowel into the hole provided on the hydraulic pump flange; place a new packing ring under the flange.

7. Secure the hydraulic pump with the clamping ring. Couple the halves of the clamping ring with bolts, having placed new locking washers under the bolt heads. The clamping ring joint should be arranged in the horizontal plane, while the bolt heads should face upwards. Lock the bolts by bending the washer tabs over the bolt head flats.

8. Connect the hydraulic fluid delivery and return pipe-lines, as well as the drainage pipe-line to the hydraulic pump.

9. Start the engine and check the hydraulic pump for proper operation by the increase of hydraulic fluid pressure in the system.

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31. Replacement of Pipe-Lines

Prior to mounting new pipe-lines they should be cleaned of the corrosion-preventive compound, which is done by flushing them with oil (transformer oil, or MK-8 oil) heated to a temperature of 65 to 75°C, and then with clean gasoline.

When mounting the pipe-lines, place new packing rings under the nuts of the joints. No external stresses are allowed when mounting the pipe-lines.

When installing the piping on the engine, arrange the clamps in such a manner as to avoid bending the pipes. By way of exception the pipes may be slightly bent, but at a distance of not less than 10 mm from a welded or soldered place. Do not bend the pipes where they are welded or soldered. After bending the pipe-lines should be tested by hydraulic pressure exceeding the operating pressure by one and a half times.

In securing the pipe-lines with clamps, extreme care should be exercised not to make any dents, the clamps being fitted in exactly the same places where they were installed before.

The nuts of the joints of the fuel, oil, and air system pipe-lines, with rubber packing rings and with threads up to 22x1.5 mm should be tightened by 1-1.5 flats, whereas the nuts with threads of over 24x1.5 mm should be tightened by 0.75-1 flat (as from the moment the mating surfaces contact). When tightened, the joint components should not displace relative to each other by more than it is allowed by the rubber ring resilience.

There should be a clearance of not less than 2 mm between the mounted pipe-lines and other components. Where the pipe-lines are rigidly fastened a clearance of not less than 0.5 mm must be ensured.

The nuts of the pipe-line joints should be locked with 0.8 mm diameter brass wire. The engine parts exposed to high temperatures should be locked with wire of steel 1X18H9T. Brass wire should be used for locking the ports located forward of the rear casing.

32. Replacement of Bolts, Nuts, and Studs

Replacement of Bolts and Nuts

When replacing bolts and nuts on the parts exposed to high temperatures, the threads should be treated with chalk paste to guard them against burning. The nuts and bolts should be tightened with wrenches of proper size. Never tighten bolts and nuts with the help of a hammer and a screwdriver. The nuts and bolts should be locked by means of locking washers of appropriate size or with wire. The washer tabs should fit tightly against the bolt head and nut flats. Wire should have no signs of twisting.

Replacement of Studs

Old studs should be replaced by new ones with full-size threads on the external diameter. The studs should be fitted with two nuts; the ends of the studs should project to a proper size.

After replacing a stud, crimp the metal around it, using a crimping device.

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Chapter VIII

PROBABLE TROUBLES, THEIR CAUSES, AND METHODS OF ELIMINATION

Whenever engine characteristics happen not to comply with the specified values, first check the respective instrument for proper readings, and only after finding that its operation is correct, take measures to eliminate the engine trouble.

Cause of trouble	Method of elimination
1	2
1. Starter-generator fails to turn engine or turns it at low speed (below 800 r.p.m.)	
1. Insufficient voltage across terminals of starter-generator	1. (a) Check storage battery for proper charging, boost charge or recharge it, if necessary; (b) check circuit from storage battery to starter-generator for leakage of current; (c) check contacts for proper condition; check resistance of circuit from storage battery to starter-generator; circuit resistance should not exceed 0.003 ohm; (d) replace starter-generator if the above checks fail to locate trouble

1	2
2. Main engine fuel fails to ignite	
1. Starting fuel is not delivered or is delivered at insufficient pressure (below 1.0 kg/sq.cm.)	1. (a) Check starting fuel content (gasoline) in aircraft tank; (b) prime starting fuel pipeline, by detaching fuel delivery pipe-line from ПНР-10-9М pump or by bleeding air through starting fuel discharge cock from aircraft fuel system; (c) check starting fuel delivery pipe-lines for leakage. If leakage is detected, tighten joints, replace packings or pipelines; (d) having ascertained that magnetic valve plug connector is energized, check the former for proper operation. Replace magnetic valve, if necessary; (e) use pressure gauge to measure starting fuel pressure, which should be within 1.0 to 1.75 kg/sq.cm. Should it be necessary, adjust starting fuel pressure by employing reducing valve of ПНР-10-9М pump; (f) if adjustment of starting fuel pressure cannot be accomplished with the aid of reducing valve, check voltage across plug connector of ПНР-10-9М pump which should not be below 12 V. If voltage is found to be normal, replace pump ПНР-10-9М;

1	2
2. Starting fuel pressure exceeds specified value (over 1.75 kg/sq.cm.)	2. (a) Turn valve spring screw to check reducing valve of ПНР-10-9М pump for binding. Eliminate binding, if detected; (b) measure starting fuel pressure and adjust it with the help of ПНР-10-9М pump reducing valve to within 1.0-1.75 kg/sq.cm.
3. Faulty ignition system	3. Detach plug connector from magnetic valve, and having turned on switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ), check flame igniter spark plugs for proper sparking; (a) if sparks are formed properly, check main plug connector (terminals 5,21) of control panel ПУ-3 for presence of current. If current is supplied to main plug connector properly, check operation of limit switch ХП of control panel ПУ-3; check also wires of ignition system and their connections on the engine for proper condition, and correct trouble, if detected. If main plug connector is deenergized (terminals 5,21), check ignition system in aircraft electric equipment and eliminate defects; (b) in case no sparks are formed on plugs, check storage battery for proper charging; check ignition system wires and their connections for proper condition. Check main plug connector of control panel ПУ-3

1	2
	(terminals 34, 35) for presence of current. If main plug connector is deenergized, check ignition system in aircraft electric equipment and eliminate trouble. In case main plug connector of control panel ПУ-3 is energized properly, check current supply to terminals of plug connector of booster coil unit КП-21Б1М (normal voltage should be not below 12 V). With plug connector of booster coil unit КП-21Б-1М properly energized, detach elbow for current delivery to spark plug, turn on switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ), and check spark formation between wire of elbow, serving for current supply to spark plug, and "ground" (distance between wire end and "ground" should be within 6 to 8 mm). If spark formation is normal, turn out spark plugs and check them for condition. If there is carbon deposit on spark plugs, wash working portions of plugs in clean gasoline, fit plugs in position, and connect elbows; check plugs for spark formation. Replace plugs, if defective. If no sparks are produced between elbow wire and "ground", detach elbow from wire supplying current, and check spark formation between wire end and "ground". In case spark formation is found to be normal, replace plug angle; if

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1	2
4. No delivery of main fuel	there is no spark between wire and body, replace booster coil unit КП-21БМ. 4.(a) Supply fuel into fuel system to expel air (See Section 7 of Chapter IX); (b) set switch of control panel ПУ-3 in "CORROSION-PREVENTIVE TREATMENT" (КОНСЕРВАЦИЯ) position and turn engine (engine control lever should be shifted to low throttle retainer). If this causes fuel to issue in continuous flow from drainage pipe of drainage tank, check pipe delivering fuel from HP-10A pump to drainage valve for leakage and clogging. If pipe is in proper condition, remove drainage valve and eliminate defect; replace valve, if necessary. To check pipe, dismantle it and flush with kerosene; (c) while cranking cold engine (with engine control lever at low throttle retainer) check fuel pressure aft of HP-10A pump. Elbow of HP-10A pump should deliver fuel normally. If no fuel is delivered replace HP-10A pump, having ascertained that booster pump ЦН-9 functions normally; (d) if no fuel pressure can be detected before HP-10A pump during engine cranking, replace fuel booster pump ЦН-9.
3. Engine starting time exceeds specified value	
1. Starter-generator turns engine slowly	1. Proceed as instructed in Section 1 of this Chapter

1	2
2. Engine control system defective: HP-10A pump lever shifts below idling speed sector, with engine control lever at low throttle retainer	2. Adjust engine control system so that when the engine control lever is shifted to low throttle retainer, HP-10A pump lever should set between pump dial notches marking idling speed sector
3. Insufficient supply of main fuel at starting	3. Blow and check tightness of pipe delivering air to starter control unit of HP-10A pump. If necessary, adjust starter control unit as instructed in Section 5 of Chapter VI
4. Engine starting is accompanied by "pops" and sharp rise of gas temperature aft of turbine	
1. HP-10A pump lever sets above idling speed sector with engine control lever shifted to low throttle retainer	1. Adjust engine control system so that when engine control lever is shifted to low throttle retainer HP-10A pump lever should be positioned between HP-10A pump dial notches marking idling speed sector
2. Increased delivery of fuel into engine at starting	2. Perform adjustment of HP-10A pump starter control unit as recommended in Section 5 of Chapter VI
3. Starter-generator turns engine slowly	3. Carry out operations outlined in Section 1 of this Chapter
4. When pressure is supplied into engine oil delivery pipe-line, compressor air blow-off ports are covered by band	4. Replace magnetic cock

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1	2
5. Engine speed at idling rating is in excess of or lower than specified value	
1. Engine control system is out of order: HP-10A pump lever is set above or below idling speed sector on pump dial, when engine control lever is shifted to low throttle retainer	1. Adjust engine control system so that when engine control lever is set at low throttle retainer, HP-10A pump lever should be positioned between notches marking idling speed sector on HP-10A pump dial
2. Fuel delivery into engine at idling rating is in excess of or lower than specified value	2. Adjust engine idling speed as recommended in Section 1 of Chapter VI
6. Engine speed at which band uncovers compressor air blow-off ports is in excess of or lower than specified value	
1. Adjustment of centrifugal valve is disturbed	1. Adjust engine speed to required value as recommended in Section 3 of Chapter VI
2. Pipe union-jet delivering fuel to centrifugal valve is clogged	2. Remove pipe union-jet and wash it with gasoline
3. Piston binds in cylinder controlling air blow-off band operation	3. Replace cylinder
4. Fuel escapes into spring chamber of air blow-off band control cylinder	4. Having ascertained that fuel drains out and drips along cylinder rod, replace air blow-off band control cylinder

1	2
7. Engine maximum speed is lower than or in excess of specified value	
1. Adjustment of maximum speed is disturbed	1. Adjust maximum speed as instructed in Section 2 of Chapter VI
2. Insufficient fuel delivery into engine (engine fails to develop maximum speed)	2. (a) Check fuel shut-off cock for proper operation; (b) check operation of fuel booster pump installed inside fuel tank and fuel booster pump ЦН-9 on engine; (c) inspect fuel filter of fuel-oil unit 317A. Wash filter with gasoline, if necessary. In case fuel filter is frozen (at ambient air temperature below -10°C), dry or replace filtering element and remove remaining fuel from filter housing with syringe НУ-46/2
3. With engine control lever shifted to "NORMAL" (НОМИНАЛ) stop, HP-10A pump lever stops short of pump throttle cock maximum opening position (engine fails to develop maximum speed)	3. Check and adjust engine control links
8. Elevated temperature of gases aft of turbine at speeds exceeding 9700_{-100} r.p.m.	
1. Air blow-off band remains in position, at which compressor air blow-off ports are open	1. (a) Check adjustment of speed at which air blow-off band control mechanism operates. Should it be necessary, adjust engine speed as laid down in Section 3 of Chapter VI;

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1	2
	(b) attach pressure gauge to pipe union of pipe delivering fuel to air blow-off band control mechanism cylinder, and check fuel pressure which should be equal to that aft of HP-10A pump. If fuel pressure in pipe does not comply with required value, replace centrifugal valve. In case fuel pressure in pipe is equal to fuel pressure aft of pump, replace band control mechanism cylinder
9. Engine acceleration from idling speed to normal rating takes too much time	
1. Air pressure in membrane cavity of HP-10A pump acceleration control unit is below specified value	1. (a) Inspect air cleaner on pipe delivering air to HP-10A pump acceleration control unit. Wash cleaner in clean gasoline, should it be necessary; (b) check air delivery pipe of HP-10A pump acceleration control unit for tightness and clogging. For this purpose detach air delivery pipe from acceleration control unit, blow it with air obtained from operating compressor, and check air pressure supply to HP-10A acceleration control unit
2. Insufficient fuel delivery at acceleration (low fuel pressure before HP-10A pump)	2. (a) Check fuel tank booster pump for proper operation. For this, measure fuel pressure before booster pump ЦН-9. Pressure should be not below 0.3 kg/sq.cm.;

1	2
	(b) check booster pump ЦН-9 for proper operation, for which purpose measure fuel pressure upstream of HP-10A pump. This pressure should amount to 1.6-2.6 kg/sq.cm.; (c) remove, inspect, and, if necessary, wash fuel filter of fuel-oil unit 317A in clean gasoline
3. Adjustment of HP-10A pump acceleration control unit is disturbed	3. Adjust acceleration control unit as recommended in Section 4 of Chapter VI
10. Engine acceleration is accompanied by excessive flame and pops, with temperature of gases aft of turbine rising beyond permissible level	
1. Excessive air pressure in membrane cavity of HP-10A pump acceleration control unit	1. Unlock and back air bleed jet out of pipe for air delivery to acceleration control unit, inspect jet. Blow jet with air, if clogged, wash it with clean gasoline and install in position
2. Adjustment of HP-10A pump acceleration control unit is disturbed	2. Adjust acceleration control unit as instructed in Section 4 of Chapter VI
11. It takes too much time for engine to accelerate its speed from that at which adjustment is accomplished automatically to normal rating	
1. Filter of HP-10A pump hydraulic decelerator throttling unit is clogged	1. Remove throttling unit of hydraulic decelerator, thoroughly wash filter in clean gasoline and reinstall it, or replace, if necessary

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1	2
12. Oil pressure is low	
1. Insufficient amount of oil in tank of fuel-oil unit 317 A	1. Check oil level in tank of fuel-oil unit 317 A. If necessary, add oil into tank to required level
2. Profuse oil leakage in oil system	2. Check engine oil pipe-lines and their joints for leakage. Replace defective pipe-lines or packings
3. Oil unit filter is clogged	3. Remove and inspect oil unit filter. Wash filter in clean gasoline. Determine cause of filter clogging. Do not start engine until cause of trouble is detected
4. Adjustment of oil unit reducing valve is disturbed	4. Adjust oil pressure with the help of oil unit reducing valve as instructed in Section 8 of Chapter VI
5. Oil intake of fuel-oil unit 317 A is binding	5. Eliminate trouble, or replace fuel-oil unit 317 A
13. Oil pressure exceeds specified value	
1. Adjustment of oil unit reducing valve is disturbed	1. Adjust oil pressure with the help of oil unit reducing valve, as instructed in Section 8 of Chapter VI
14. Excessive fuel consumption	
1. Oil leakage through oil system pipe-lines	1. Check oil pipe-lines for leakage. If necessary, replace packings or defective pipe-lines

1	2
2. Oil is thrown through ports provided in rear unloading chamber of compressor (on hot engine)	2. In case oil is thrown through ports provided in rear unloading chamber (on warmed engine) consult representative of Manufacturer as to fitness of engine for further service. On cold engine some smoke may issue from rear unloading chamber ports. After engine has been warmed up for 5 to 7 min. at 10,000 to 10,400 r.p.m. smoke should stop issuing from ports
3. Oil is thrown through front labyrinth packing of compressor (compressor blades are oily)	3. (a) Check to see that oiling of compressor blades is not due to excess oil accumulating in inlet housing as a result of some unsuccessful attempts to start or crank engine; (b) Check breather pipe for proper condition. In case breather pipe has been found sound, consult Manufacturer's representative as to fitness of engine for further service
4. Cocks for draining oil from fuel-oil unit and inlet housing are leaky	4. Eliminate defects or replace cock
5. Oil leakage through HP-10A pump drive drainage system, through starter-generator	5. Locate leaky place by oil issuing from drainage pipes during engine operation

1	2
ГСР-СТ-6000А drive drainage system, through oil unit glands and centrifugal valve membrane (through starter-generator drive oil should leak at a rate of not more than 5 drops per min., in tachometer drive oiling of gland, shaft, and cavity is allowed without signs of oil accumulation in lower part of housing; no oil leakage is allowed through drainage system of HP-10A pump drive, centrifugal valve membrane should be hermetically sealed)	If oil leaks through starter-generator drive drainage system, replace drive gland. Replace oil unit if considerable amount of oil accumulates in tachometer drive. Replace HP-10A pump gland, in case of oil leakage through pump drive. Replace centrifugal valve if its membrane is leaky. If oil leakage through HP-10A pump gland is detected, consult representative of respective Manufacturer as to method of trouble elimination
15. Oil escapes from tank of fuel-oil unit 317A at parking place	
1. Tightness of return valve of fuel-oil unit 317A is disturbed (when pipe is being turned out, oil leakage shows up) 2. Oil unit return valve is leaky 3. Cocks for draining oil from tank of fuel-oil unit 317A and inlet housing are leaky	1. Replace return valve of fuel-oil unit 317A 2. Replace oil unit 3. Eliminate leakage or replace drain cocks

1	2
16. Smoke in air delivered from compressor to cockpit	
Breather pipe is clamped (its inner diameter is reduced)	Check and, if necessary, straighten breather pipe. Replace breather pipe, if it wouldn't straighten
17. Fuel gets into oil	
1. Fuel-oil unit 317A is not tight 2. Fuel leakage through glands of HP-10A and HP-11A pumps 3. Tightness of ЦН-9 booster pump drive gland is disturbed 4. Centrifugal valve membrane is torn	1. Remove fuel-oil unit 317A and replace it by new one 2. Prior to eliminating trouble, consult Manufacturer's representative 3. Replace ЦН-9 booster pump 4. Replace centrifugal valve
18. Fuel leakage from drainage system with engine at standstill	
1. Engine control lever is not set at "CUT-OFF" (СТОП) stop 2. Valve mechanism of centrifugal valve is in intermediate position	1. Shift engine control lever to "CUT-OFF" (СТОП) stop. HP-10A pump lever should also be positioned at "CUT-OFF" (СТОП) stop 2. Detach centrifugal valve drainage pipe. Replace centrifugal valve, if fuel drips out of pipe

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1	2
3. Starter control unit of HP-10A pump by-passes low-pressure fuel into high-pressure duct	3. Detach pipe for fuel delivery to drain valve from elbow of HP-10A pump, and switch on booster pump of No.1 tank. If starter control unit by-passes fuel, the latter should flow from elbow of HP-10A pump. To eliminate trouble, turn down screw of starter control unit spring until fuel stops flowing from HP-10A pump angle, then perform necessary adjustment of engine starting as instructed in Section 5 of Chapter VI
19. Fuel leakage from drainage system with engine in operation	
1. Tightness of engine fuel system unit packings is disturbed 2. Valve mechanism of centrifugal valve is binding	1. Detach drainage pipes one by one, determine place of leakage, and replace defective unit 2. Detach centrifugal valve drainage pipe. If fuel drips out of pipe, replace centrifugal valve
20. Fuel seepage into afterburner at parking place	
HP-11A pump cut-off valve is leaky	Replace HP-11A pump

1	2
21. Afterburner fails to operate	
1. Defective ignition system	1. Check to see that main plug connector of control panel ПУ-3 (terminals 1:2) is properly energized. If no current is detected across main plug connector, check aircraft electric equipment and eliminate trouble. In case main plug connector is energized, check to see that current is properly supplied to low voltage plug connector of booster coil КПМ-1А. (a) If no current flows across plug connector of booster coil КПМ-1А check limit switch Ф of control panel ПУ-3 for proper operation by "click" or with the help of device (See Section 9 of Chapter VI). Should it be necessary, adjust operation of limit switch Ф as instructed in Section 9 of Chapter VI; (b) In case voltage is present across plug connector of booster coil КПМ-1А, check spark plug СП-02 for proper spark formation, without removing plug from engine. For this purpose, uncouple plug connectors

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1	2
	of fuel pressure warning mechanism ДСД-2 and of HP-10A pump hydraulic decelerator limit switch and mount device 834П-7 and device 754П-7 on component parts of fuel pressure warning mechanism ДСД-2 plug connector and hydraulic decelerator limit switch plug connector respectively. Cover compressor air blow-off ports by using wrench 240Ж-12 to manipulate air blow-off band. Supply pressure into engine hydraulic system. Shift engine control lever to "AFTERBURNING" (ФОРСАЖ) stop (switches in aircraft cockpit should be turned on). If no spark formation is observed on plug, first remove elbow from plug and then detach wire from elbow, after which check spark formation between elbow wire end and body, as well as between wire end and body. If no sparking is observed between wire and body, replace booster coil КПМ-1А
2. Fuel is not delivered into afterburner manifolds	2. Check wiring running to HP-11A pump valve solenoid by measuring voltage directly across terminals A and Б of plug connector. Eliminate defects, if any. If this is of no avail, replace control panel ПУ-3. With plug connector terminals A and Б properly energized, check fuel pressure in afterburner manifolds. Replace

1	2
	HP-11A pump if no pressure is present
3. No pressure of hydraulic fluid (АМГ-10 oil) in jet nozzle control cylinders	3. Measure hydraulic fluid pressure (АМГ-10 oil) in hydraulic system; it should be equal to 80–140 kg/sq.cm. If there is no pressure, detect and eliminate cause of trouble
4. Hydraulic switch УГ-34/1 is defective. With hydraulic fluid (АМГ-10 oil) pressurized in cylinders, contacts of hydraulic switch УГ-34/1 remain closed	4. Replace hydraulic switch УГ-34/1 (on aircraft)
5. Fine fuel filter of HP-11A pump is clogged	5. Wash filter in clean gasoline or replace it
6. Fuel pressure warning mechanism ДСД-2 is defective. With fuel in afterburner manifolds, pressurized contacts of fuel pressure warning mechanism ДСД-2 remain open	6. Replace fuel pressure warning mechanism ДСД-2
22. When engine control lever is shifted to lower r.p.m. afterburner continues operating	
1. Limit switch Ф of control panel ПУ-3 defective	1. Cut off afterburner with the help of АЗС-5 switch AFTERBURNER EMERGENCY

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1	2
	CUT OFF (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА), after which detect and eliminate cause of trouble
2. Excess pressure of fuel in afterburner manifolds over total pressure of gases in afterburner does not drop to 0.2 kg/sq.cm.	2. Turn off afterburner by manipulating fuel cut-off cock. After engine is stopped check solenoid of HP-11A pump for proper operation. Replace HP-11A pump, if any defect is found
23. With afterburner turned off jet nozzle shutters fail to close	
Fuel pressure warning mechanism ДСД-2 is defective	Replace fuel pressure warning mechanism ДСД-2
24. Engine will not gain maximum and augmented ratings	
1. Low fuel pressure before booster pump ЦН-9	1. Measure fuel pressure before booster pump ЦН-9 If fuel pressure is below 0.3 kg/sq.cm., find out cause of trouble and eliminate it
2. Fuel minimum pressure warning mechanism СД-3 defective	2. Replace fuel minimum pressure warning mechanism СД-3 (on aircraft)

1	2
3. Limit switch of HP-10A pump hydraulic decelerator fails to operate	3. Eliminate defect in limit switch of HP-10A pump hydraulic decelerator. Replace HP-10A pump, if necessary
4. Limit switch Л of control panel ПУ-3 fails to operate	4. Eliminate defect in limit switch Л of control panel ПУ-3
5. Limit switches of maximum and augmented ratings (in control panel ПУ-3) fail to operate	5. Adjust control panel limit switches operation as instructed in Section 9 of Chapter VI
25. Too high temperature of gases aft of turbine during flight at augmented rating	
Excessive fuel supply by HP-11A pump	Reduce fuel supply to afterburner manifolds, for which purpose either turn out screw of barostat valve spring, or turn in screw of HP-11A pump fuel cock spring, as recommended in Section 12 of Chapter VI
26. Insufficient engine thrust at intermediate and normal ratings	
Jet nozzle shutters at engine speed of over 6500 r.p.m. remain in position corresponding to augmented rating	(a) Check pressure of operating fluid (АМГ-10 oil) in engine hydraulic system. If pressure of operating fluid (АМГ-10 oil) is at

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1	2
	zero or reduced, determine cause of trouble and eliminate it; (b) Check limit switch 3 of control panel ПУ-3 (See Fig.12) for proper operation. If necessary, adjust limit switch 3 as instructed in Section 9 of Chapter VI; (c) Check fuel pressure warning mechanism ДСД-2 for proper operation. Replace fuel pressure warning mechanism if defective
27. When engine is stopped jet nozzle shutters remain in position corresponding to normal rating	
1. No pressure of operating fluid (АМГ-10 oil) in engine hydraulic system	1. Check pressure of operating fluid in engine hydraulic system. If pressure of operating fluid is at zero or reduced, determine cause of trouble and eliminate it
2. Limit switch Л of control panel ПУ-3 fails to operate	2. Adjust limit switch Л of control panel ПУ-3
3. Drive of control panel limit switch Л is bent	3. Replace drive of control panel limit switch Л

1	2
28. With engine in operation pilot lamp of oil pressure warning mechanism 2СДУ5-1.3-2.2 keeps on burning	
1. Oil pressure is too low 2. Oil pressure warning mechanism 2СДУ5-1.3-2.2 is out of order	1. Proceed as laid down in Section 12 of this Chapter 2. Replace oil pressure warning mechanism
29. Engine fails to accelerate properly (its speed remains at 5000-6000 r.p.m.) during acceleration check	
Acceleration control unit of НР-10А pump is disadjusted	Adjust engine acceleration as instructed in Section 4 of Chapter VI
30. Surge. Engine stops spontaneously when afterburner is turned on at altitudes of 12,000 to 13,000 m.	
1. It takes too much time for jet nozzle shutters to shift to position corresponding to augmented rating	1. Check and adjust time period required for jet nozzle shutters to shift from maximum rating position to augmented rating position as instructed in Section 20 of Chapter VII.

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1	2
	Check actual drop or rise of gas temperature aft of turbine when afterburner is turned on; perform required adjustment as detailed in Section 2 of Chapter VII
2. Sharp rise of fuel pressure in afterburner manifolds	2. Replace throttling unit of HP-11A pump afterburner cock by lower capacity throttling unit
31. Afterburner turns off spontaneously at altitudes of over 14,000 m.	
Insufficient fuel supply by HP-11A pump	Increase fuel supply to afterburner manifolds, for which purpose turn in screw of barostat valve spring and turn out screw of HP-11A pump fuel cock spring, as instructed in Section 12 of Chapter VI
32. Oil pressure warning unit pilot lamp keeps on burning for over 15 sec. at zero or negative overloads	
1. Oil pressure warning unit is defective	1. Replace oil pressure warning unit
2. Swivel mechanism of	2. Eliminate defect or

1	2
oil intake and breather of fuel-oil unit 317A tank is binding	replace fuel-oil unit 317A
3. Jet of oil unit breather pipe is clogged	3. Remove pipe, clean it and blow with compressed air
4. Oil unit is out of order	4. Replace oil unit

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Chapter IX

REPLACEMENT OF ENGINE

Engines removed from the aircraft for repair should be subjected to internal and external corrosion-preventive treatment to ensure their storage for 1 year.

1. Corrosion-Preventive Treatment of Engine Prior to Removal from Aircraft

The purpose of corrosion-preventive treatment is to provide for storage and shipment of the engine; therefore, the procedure should be carried out properly and in due time, using corrosion-preventive compounds mentioned in Chapter X.

Prior to removing the engine from the aircraft, do not fail to carry out internal corrosion-preventive treatment as instructed in Chapter X. External slushing is accomplished after removing the engine from the aircraft and placing it on a truck or on a packing box support.

2. Removal of Engine from Aircraft

Prior to removing the engine from the aircraft, detach the engine control rod and the aircraft pipe-lines and cables from the engine. Immediately after detaching the fuel, oil, hydraulic and air pipe-lines, stop them with special plugs.

Remove the engine from the aircraft in compliance with the procedure detailed in "Aircraft Operating Instructions". After disjointing the aircraft fuselage, do not leave the engine afterburner suspended without any support, with the

rear hangers detached. Fasten the afterburner on hoisting device TM-438 (Fig.32) or on a mounting truck in two zones. Turn off the nut and disconnect the drainage pipe-line at the upper portion of the engine, near the telescopic joint between the afterburner and diffuser. Unlock and turn the nuts off the telescopic joint bolts. Extract the bolts and remove the half-rings coupling the afterburner to the diffuser. Remove the afterburner; secure the half-rings of the telescopic joint complete with the fuel collector to the diffuser flange, making sure the upper half-ring stop fits into the recess provided in the diffuser flange. Fasten the half rings with bolts.

Secure the engine to a special mounting truck, detach the engine attachment fittings and remove the engine from the aircraft compartment using care not to cause damage to the engine parts and units.

To prevent any foreign objects from getting inside the engine, close the engine air intake duct with special cotton wool plugs, and put a cover on the afterburner diffuser. Stop all pipe unions, connections and other detached pipe line fittings with plugs, aviation fabric, or vinyl polimer film. Wipe the external surfaces of the engine and afterburner with pieces of cloth saturated with clean gasoline, and dry up the surfaces to be slushed.

Apply an even layer of gun grease to the steel and magnesium alloy parts having no paint coating (the external surfaces of the jet nozzles, the rear and middle housings) as well as to the steel oxidized and phosphated parts (studs, nuts, bolts, cotter pins). For thinning the gun grease when brushing it on, heat it to a temperature of 80-90°C; when applying it with the help of an atomizer, heat grease to a temperature of 100-110°C.

The magnesium alloy parts may be treated with petrolatum, instead of gun grease, heated to a temperature of 80-90°C and thickened by addition of 2 to 4 per cent kerosine.

The parts manufactured of non-ferrous alloys and those contacting the parts fabricated from ferrous metals,

as well as the galvanized and cadmium plated parts should be slushed with petrolatum applied by means of a brush. Treat the half-rings of the telescopic joint complete with the fuel collector with petrolatum.

The painted parts, as well as the electric equipment components and screened wires are not subject to slushing.

Corrosion-preventive treatment of the afterburner internal surfaces is accomplished during internal treatment of the engine by splashing oil delivered through the afterburner fuel manifolds.

The external surfaces of the cylinders, jet nozzle shutters and the afterburner ejector are not subject to corrosion-preventive treatment.

When washing or slushing the external surfaces, see that no gasoline or corrosion-preventive compound gets on the wiring, electric equipment components, or on the jets for bleeding air from the starter control and acceleration control units of the HP-10A pump.

Only clean and dry engine part surfaces should be coated with corrosion-preventive compound.

Caution. Avoid carrying out any corrosion-preventive treatment in rain or snow.

The corrosion-preventive treatment over, wrap the engine in paraffine paper or in a clean vinyl polimer cover, and pack it in a special box supplied by the Manufacturer.

To secure hoisting device ГМ-412 (Fig.33) make use of two long bolts, arranged at the sides of the inlet housing, and two holes provided in the upper portion of the flanges, where the nozzle ring of the turbine I stage is coupled to the nozzle ring of the II stage.

To fasten the lugs of the hoisting device on the long bolts, use the nuts holding the engine to the support.

Special bolts contained in the hoisting device set are utilized for securing the hoisting device lugs in the holes of the nozzle ring flanges.

Cautions. 1. Do not hoist the engine complete with the support, or use fuel, oil and air pipe-lines for hoisting or moving the engine.

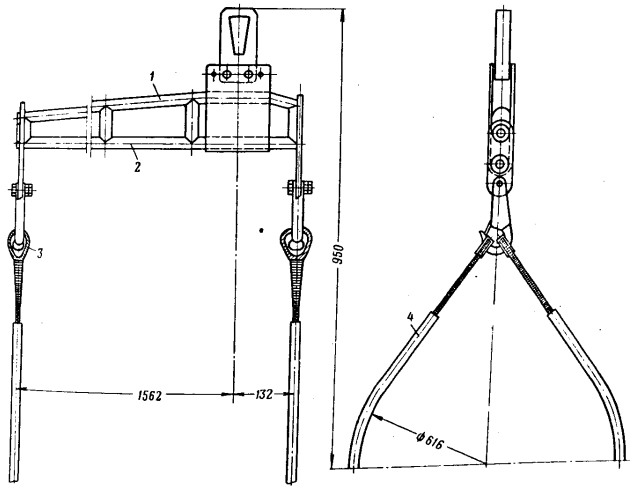

Fig.32. Diagram of Hoisting Device ГМ-438 for Handling Afterburner
1 - 25 mm diameter tube; 2 - rocker; 3 - cable; 4 - durite hose.
Test hoisting device applying load of 180 kg.

2. When removing the engine from the aircraft, do not place it (or the afterburner) on the ground, to avoid damage to the engine parts, assemblies, or units.

The engine is secured to the box support by means of four special shipping hangers, arranged at the engine sides. The front hangers are mounted on the two lower long bolts located on the inlet housing flange. Holes, provided in the flanges of the turbine nozzle rings are employed for mounting the rear hangers on the engine.

After the engine is packed, seal the box and put down the engine No. If boxes with removable covers are employed, apply seals to two opposed bolts coupling the box top to the base.

If the box has a detachable face wall, place two additional seals on the wall-to-cover angle joints, and one seal on the inspection port.

The engine afterburner is packed in a separate box. For handling the afterburner hoisting device ГМ-438 (See Fig.32) is employed. To secure the afterburner to the shipping support, a ring is used for the front portion and two hangers located on the jet nozzle flange.

Having packed the afterburner, apply two seals to the bolts holding the cover to the box base, and one seal to the inspection port.

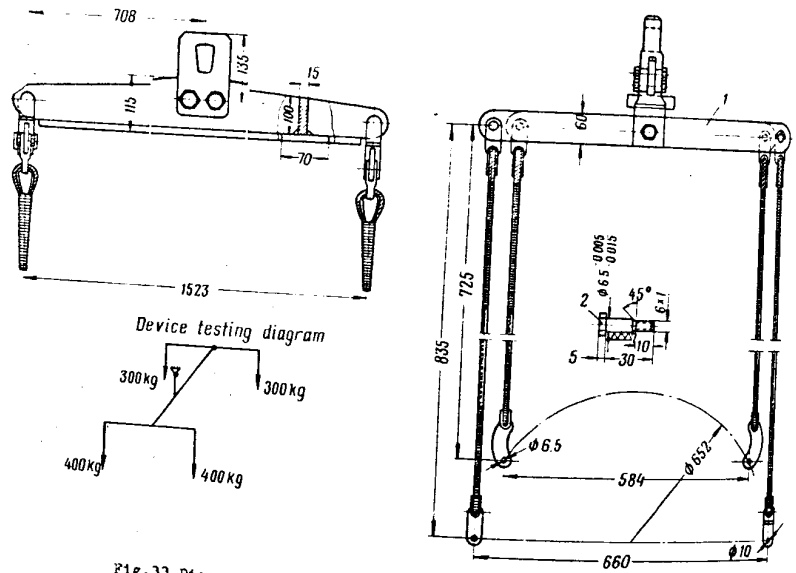

Fig.33 Diagram of Hoisting Device ГМ-412 for Handling Engine
1 - device ГМ-412 ; 2 - bolt for device, 2 pieces (material - 18ХНВА, R_c = 24 - 28)

3. Unpacking of Engine

The engine is delivered in a special wooden box, 3540 mm long, 1300 mm wide, and 1550 mm high.

The afterburner is shipped in a separate box, 3500 mm long, 1550 mm wide, and 1220 mm high.

For hoisting the box with the engine a 1.5-ton load carrying capacity crane is employed. The box should be suspended from the crane by means of a wire rope passed through the four rings provided on the crate cover, or with the help of device ГМ-259, diagrammed in Fig.34.

Prior to unpacking the engine and the afterburner, inspect the boxes visually for any damage, make sure the following seals are intact:

(a) on the inspection port;

(b) on the technical documents bag;

(c) on the detachable wall joints (two seals);

(d) on two bolts holding the cover to the box base.

To unpack the engine, turn the nuts off the bolts holding the cover to the box base. Lift up the cover by employing the hoisting device; exercise care to avoid damage to the packing cover or to the engine parts.

Note. If no hoisting devices are available or the ceiling is not high enough to allow lifting of the box cover, turn off the six nuts securing the detachable wall to the box cover, and remove the wall by shifting it aside.

Take out a box containing a single spare parts set, and the tools bag, delivered together with the left-hand engines (the left-hand engine is marked with an odd number, and the right-hand engine, with an even number). Carefully clip off the side seam of the vinyl polimer cover and roll it down. Take the wrapping paper and the silica gel bags off the engine parts and assemblies; check the number and arrangement of the silica gel bags against the engine corrosion-preventive Certificate.

To detach the cover from the support, use wrench 92 I-1 contained in the engine tools bag.

Check the parts and tools, packed together with the engine against the inventory, inspect the engine and register the results of the external inspection.

Inform the manufacturer of any defects detected.

4. Removal of Corrosion-Preventive Compound Prior to Installing Engine on Aircraft

Wash all external surfaces of the engine and afterburner coated with corrosion-preventive compound, with clean gasoline, using a brush, until the corrosion-preventive compound is completely removed; exercise care to prevent the wires and electric equipment components from contacting gasoline. Wipe the washed areas dry, using clean pieces of cloth. Turn the

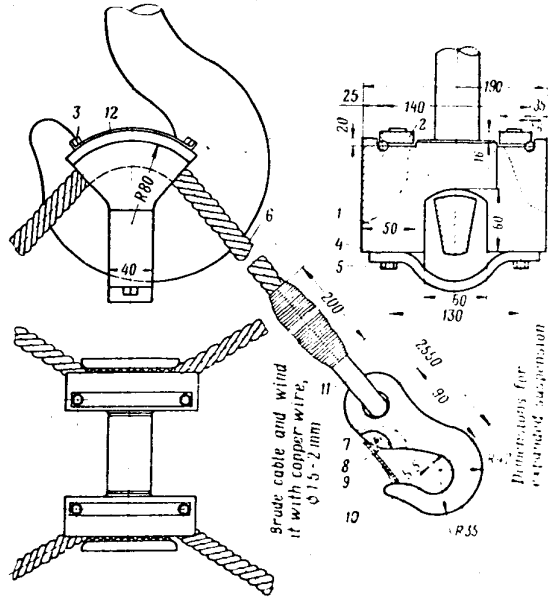

Fig.34. Diagram of Device [illegible]

1 - cross piece; 2 - strip; 3 - bolt M14x35; 4 - [illegible]; 5 - bolt M14x30; 6 - cable 6x19; 7 - jewel, Ø5 mm, l = 25 mm; 8 - spring; 9 - latch; 10 - hook; 11 - thimble; 12 - strip

Notes: 1. Original length of cable 6 is equal to 2950 mm.

2. Test device under load by hoisting and lowering the [illegible] for three times with the aid of an electric tackler.

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spark plugs out of the flame igniters, wash them with clean gasoline, dry up with compressed air and install in position.

Engine hoisting from the box support and its arrangement on the mounting truck should be accomplished in compliance with the instructions given in Section 2 of this Chapter. The covers and accessory plugs should be removed from the inlet and exhaust parts of the engine, from the unloading cavity ports (without causing any disturbance to the diaphragms), from the breather pipe-line, as well as from other places directly before connecting the aircraft pipe-lines and cables.

Prior to installing the engines removed from storage, check to see that they have been treated as laid down in the respective Certificates.

Check to see that the nuts of all pipe-line joints are properly tightened on all engines. Loose nuts should be tightened up through not more than 2 flats. In the event the loose nut is capable of being tightened by more than two flats, replace the rubber packing ring in this joint by a new one as instructed in Chapter VII.

After tightening up the nuts of the pipe line joints or replacing the packing rings, lock the nuts with wire as laid down in Chapter VII. When replacing the packing rings take the new ones from the spare parts set.

5. Installation of Engine on Aircraft

The МиГ-19 aircraft is fitted with two РД-9Б engines. Therefore, depending on the arrangement of the engines inside the aircraft fuselage, they are manufactured in two variants - left-hand and right-hand.

The left-hand engine differs from the right-hand engine by arrangement of the side attachment fittings, by a modified drainage system pipe-line as well as by arrangement of the air scoop on starter-generator ПСР-СТ-6000А. Therefore the left-hand and the right-hand engines are not interchangeable.

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To discriminate between the engines, the left-hand engine is marked with an odd number, the number registered in the respective Service Log being followed by the word "LEFT-HAND" (ЛЕВЫЙ); the right-hand engine is marked with an even number followed by the word "RIGHT-HAND" (ПРАВЫЙ) (in the respective Service Log).

Prior to installing the engine, thoroughly inspect the aircraft engine compartment for any foreign objects, dirt, dust, oil, or fuel. Fasten the engine on hoisting device ГМ-412 and by employing a 1-ton load carrying capacity crane, lift the engine off the support and place it on a special mounting truck serving to bring the engine into the aircraft engine compartment.

When hoisting the engine it should be taken into consideration that the centre of gravity of the engine is located 25-55 mm forward of the middle housing-to-rear housing joint.

Engine installation on the aircraft should be carried out in compliance with the procedure outlined in Manufacturer's Instructions.

When hoisting and mounting the engine, take care not to cause damage to the engine units and pipe-lines.

After the engine has been secured on the aircraft, mount and fasten the afterburner tube with the aid of the telescopic joint half-rings. Install the upper half-ring so that its retaining bolt fits into the corresponding recess on the diffuser (the left-hand engine diffuser is marked with "Б-ЛЕВ.", the right-hand-with "Б-ПРАВ.". Fasten the upper and lower half-rings with bolts and lock the bolt nuts with plate locks. Check the afterburner for proper installation by the clearance between the ejector and the aircraft fuselage skin which should be uniform all around.

CAUTION. Do not leave the engine afterburner suspended without any support under it, with the aircraft fuselage disjointed.

Prior to attaching the afterburner to the girder arrange it properly along the engine axis; to accomplish this, slightly swing the afterburner to find its maximum deflections: up, down, to the right, and to the left; then find the intermediate position along the vertical and horizontal axes of the engine and fasten the afterburner on the girder in this position.

Attach the following pipe-lines and wires to the engine:

Fuel system

1. Connect the aircraft fuel pipe-line to the flange of fuel booster pump ЦН-9.
2. Connect the starting fuel delivery pipe to the magnetic valve.

Oil system

Connect the engine breather pipe-line to the aircraft pipe-line by means of a durite hose.

Hydraulic system

Connect the aircraft hydraulic system pipe-lines, running from two-position slide valves ГА-21, to the adapters of the hydraulic system controlling operation of the engine jet nozzle shutters.

Electric system

1. Assemble and lock main engine and aircraft plug connector ШР55П35НШ3.
2. Attach wires to the terminals of starter-generator ГСР-СТ-6000А.
3. Connect the starter-generator air scoop.

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Engine control system

1. Connect the control link to the lever of control panel ПУ-3 and lock it with a cotter pin; adjust the stops in the cockpit.

2. Check the engine control system for proper operation by shifting the engine control lever through the entire range from the "CUT-OFF" (СТОП) stop to the "Afterburning" (ФОРСАЖ) stop and backward. The lever should move smoothly, without binding. When performing the check see that:

(a) the zero mark on the dial of control panel ПУ-3 is against the notch on the control panel housing, whereas the lever of the HP-10A pump is snug against the "CUT-OFF" (СТОП) stop of the pump dial, when the engine control lever is shifted to the "CUT-OFF" (СТОП) stop. Make sure the engine control lever is capable of travelling additionally by 1 to 2 mm;

(b) the notch on the lever of the HP-10A fuel pump is set between the notches, marking the idling rating sector on the pump dial, when the engine control lever is shifted to the idling rating retainer;

(c) the lever of the HP-10A fuel pump shifts to the maximum speed stop on the pump dial, whereas the 70° notch on the dial of control panel ПУ-3 is opposite the notch on the panel housing, when the engine control lever is set in the "NORMAL" (НОМИНАЛ) position;

(d) the click of limit switch М of control panel ПУ-3 is heard when the engine control lever is shifted through 75^{0}_{-1} on its way to the "MAXIMUM" (МАКСИМАЛ) and "AFTERBURNING" (ФОРСАЖ) stops, while the click of limit switch Ф is heard when the control lever is shifted through 85^{0}_{-1} (according to the dial of control panel ПУ-3).

The "MAXIMUM" (МАКСИМАЛ) and "AFTERBURNING" (ФОРСАЖ) stops in the aircraft cockpit should be adjusted in such a way that the engine control lever should be capable of travelling additionally through 3 to 5° after the clicks of limit switches М and Ф have been heard.

Drainage system

1. Connect the fuel and oil drainage pipe to the main drainage pipe-line.

2. Lead the fuel drainage pipe out of the HP-10A pump starter control unit.

Other connections

1. Connect the flange for air delivery from the compressor to the pipe-line running to the aircraft cockpit.

2. Air bleeding from the unloading cavity ports into the atmosphere is accomplished through the manifold which is usually mounted on the engine prior to installing it on the aircraft.

3. The nose bullet is also fitted in prior to installing the engine.

Cautions. 1. Inspect the aircraft pipe-lines prior to connecting them to the engine. Remove the plugs directly before connecting the particular pipe-line.

2. The diaphragms on the unloading cavity ports should comply with the specifications contained in the engine Service Log.

Measuring instruments

To check the engine characteristics it is necessary to connect the following instruments:

(1) tachometer 2ТЭ-15 with generator ДТ-3;

(2) thermo-couples ТВГ-11 for measuring gas temperature aft of the turbine;

(3) remove the cap from the pipe union supplying static pressure into oil pressure warning mechanism ЭСДУ5-1.3-2.2 (at the inlet into the engine).

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6. Checking Jet Nozzle Shutters for Proper Operation

After the new engine has been installed, check the jet nozzle shutters for proper operation, employing a cart mounted hydraulic installation for the purpose. See that no leakage of operating fluid (АМГ-10 oil) shows up in the aircraft hydraulic system.

Check operation of the jet nozzle shutters with the aircraft fuselage disjointed and the afterburner fastened to the girder.

The jet nozzle shutters operation should be checked in the following manner:

1. Uncouple the plug connector of the limit switch of the HP-10A pump hydraulic decelerator and install device 754П-7.

2. Uncouple the plug connector of fuel pressure warning mechanism ДСД-2.

3. Connect the cart mounted hydraulic installation to the aircraft hydraulic system and build up operating fluid pressure of 80 to 140 kg/sq.cm.

4. Connect the external power source to the aircraft mains and turn on master switch "STORAGE BATTERY" (АККУМУЛЯТОР), switch АЗС-5 "AFTERBURNER EMERGENCY CUT-OFF" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА), and switch АЗС-5 "OIL SHUT-OFF COCK" (ПЕРЕКРЫВНОЙ КРАН, МАСЛО).

5. Slowly shift the engine control lever to the "NORMAL" (НОМИНАЛ) stop. With the lever of control panel ПУ-3 turned through $23^{\pm 1}$° (according to the control panel dial) the jet nozzle shutters should shift from the augmented rating position to the normal rating position.

6. Use wrench 240 К-12 to cover the compressor air by-pass ports with the band.

7. Slowly and smoothly move the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop. With the lever of control panel ПУ-3 turned through 75°_{-1} (according to the control panel dial) the jet nozzle shutters should shift to the maximum rating position.

8. Smoothly and slowly move the engine control lever to the "AFTERBURNING" (ФОРСАЖ) stop, and close the component part of the plug connector of fuel pressure warning mechanism ДСД-2 with device 834П-7. With the lever of control panel ПУ-3 turned through 85°_{-1} (according to the control panel dial) the jet nozzle shutters should shift to the augmented rating position. In this case spark plug СП-02 should function.

Caution. Do not close the component part of fuel pressure warning mechanism ДСД-2 plug connector for more than 5 sec. to avoid premature failure.

9. Shift the engine control lever to the "MAXIMUM" (МАКСИМАЛ) stop. This should cause the jet nozzle shutters to shift to the maximum rating position.

10. Remove wrench 240 К-12 to open the compressor air blow-off ports, and shift the engine control lever to the "NORMAL" (НОМИНАЛ) stop. In this case the jet nozzle shutters should shift to the normal rating position.

11. Move the engine control lever to the idling rating retainer. The jet nozzle shutters should shift to the augmented rating position.

12. Set the engine control lever at the "CUT-OFF"(СТОП) stop. Disconnect the hydraulic installation. Remove device 754П-7 from the component part of the plug connector of the HP-10A pump hydraulic decelerator limit switch, couple the plug connector and lock it with brass wire.

Couple the plug connector of fuel pressure warning mechanism ДСД-2 and lock it with brass wire.

Turn off all the switches.

7. Removal of Corrosion-Preventive Compound Prior to Starting Engine

Check the turbine and compressor rotors for proper rotation, proceeding as follows:

(a) unlock and take the cap off control panel ПУ-3; set switch ВК in the "CORROSION-PREVENTIVE TREATMENT"(КОНСЕРВАЦИЯ) position;

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(b) turn on master switch "STORAGE BATTERY" (АККУМУЛЯТОР);

(c) turn on switch АЗС-25 "STARTER UNITS" (АГРЕГАТЫ ЗАПУСКА), switch АЗС-10 "TIMER" (АВТОМАТ ВРЕМЕНИ), switch АЗС-10 "ENGINE SHUTTERS" (СТВОРКИ ДВИГАТЕЛЯ), and switch АЗС-5 " AFTERBURNER EMERGENCY CUT-OFF" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА);

(d) press button "STARTING" (ЗАПУСК), releasing it 1 to 2 sec.later;

(e) turn the engine for 5-6 sec., after which turn off switch "STARTER UNITS" (АГРЕГАТЫ ЗАПУСКА) and listen for abnormal noises.

The turbine and the compressor should rotate easily, without any foreign noises. After the engine has stopped, turn on switch АЗС-25 "STARTER UNITS" (АГРЕГАТЫ ЗАПУСКА) and complete the interrupted starting cycle. Drain oil from fuel-oil unit 317A and from the engine inlet housing, after which pour 10.5 to 11 lit.of fresh oil into the tank.

Back out the plug located on the cap of the fuel filter of fuel-oil unit 317 A by 2 to 3 turns, start the booster pump and open the fuel shut-off cock. If fuel drips through the plug, tighten it up. Bleed air from the engine fuel system, for which purpose remove the caps from the pipe unions of the HP-10A and HP-11A pumps and attach device 546П-27. Start the booster pump of the aircraft fuel tank, open the fuel shut-off cock and press back the device needle. Do not cut off fuel supply until fuel starts flowing from the device hose in a continuous clear stream free of air bubbles. Air may be expelled from the fuel system through both the pumps simultaneously or in turn. Check the level of starting fuel in the respective aircraft tank; prime the tank to fill the delivery pipe-line. To remove corrosion-preventive compound from the engine starting system, turn on switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) for 1-2 sec.,repeating the procedure 2 to 3 times at an interval of not less than 1 min., until starting fuel begins to flow from the drainage pipe of the combustion chambers.

Remove corrosion-preventive compound from inside the engine.

To remove oil from the fuel system and from the inner

parts of the engine, crank the engine 3 to 4 times making use of an external power source, with the engine control lever shifted to the "NORMAL" (НОМИНАЛ) position.

For carrying out engine turning procedure with simultaneous supply of fuel proceed as follows:

(a) set switch ВК of control panel ПУ-3 in the "CORROSION-PREVENTIVE TREATMENT" (КОНСЕРВАЦИЯ) POSITION;

(b) turn on the master switch;

(c) turn on switch "STARTER UNITS" (АГРЕГАТЫ ЗАПУСКА);

(d) turn on switch "TIMER" (АВТОМАТ ВРЕМЕНИ);

(e) turn on switch "ENGINE SHUTTERS" (СТВОРКИ ДВИГАТЕЛЯ);

(f) turn on switch "AFTERBURNER EMERGENCY CUT-OFF" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА);

(g) switch on the booster pumps;

(h) set the engine control lever in the "NORMAL" (НОМИНАЛ) position. Press button "STARTING" (ЗАПУСК) and keep it pressed for 1-2 sec.

Turn the engine 3 to 4 times, employing an external power source.

Set switch ВК of control panel ПУ-3 in "OPERATING" (РАБОЧЕЕ) position, reinstall the cap, and lock it with wire.

Remove any remaining fuel from the engine by scavenging, for which purpose crank the engine with the engine control lever shifted to the "CUT-OFF" (СТОП) stop.

Cautions. 1. It is allowed to turn the engine successively not more than five times without cooling down the starter-generator.

2. When removing corrosion-preventive compound from inside the engine the latter should be inclined backward to prevent entry of fuel into the compressor.

Inspect the oil and fuel pipe-lines, eliminate any leakage and wipe the areas covered with fuel or oil.

8. First Starting of Engine

The purpose of the first starting is to check the engine measuring instruments, tightness of the fuel, hydraulic and

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oil systems, as well as operation of the engine at all ratings.

When preparing the engine for the first starting, particular attention should be directed to checking the engine for proper installation on the aircraft. Make sure there are no foreign objects on the engine or in the aircraft compartments. Prior to starting the engine, remove wrench 240Ж-12 to open the compressor air blow-off ports by hand.

Preparation of the engine for starting, starting proper, warming, checking and stopping of the engine should be carried out in compliance with the instructions given in Sections 1,2, 3,4 and 5 of Chapter III.

Note. If some variations in engine speed are observed during checking, make another attempt to expel air from the fuel system, as recommended in Section 7 of this Chapter.

The first starting and checking of the engine should be performed with the aircraft fuselage disjointed and the afterburner attached to the girder. Attachment of the afterburner to the girder should be carried out in compliance with the procedure detailed in Section 5 of this Chapter.

When the engine is being started for the first time after removal of corrosion-preventive compound, a slight rise in the temperature of gases aft of the turbine may be experienced, in excess of the specified value. If this is the case, stop starting the engine by shifting the engine control lever to the "CUT-OFF" (СТОП) position and make another attempt to start the engine without resorting to adjustment of the starter control unit. It is allowed to control starting by manipulating the engine control lever. The first starting is to a great degree dependent on how thoroughly corrosion-preventive compound has been removed from the fuel system of the engine.

When checking engine operation at the idling rating, make sure to detect any leakage of fuel, operating fluid (АМГ-10 oil), and oil. If leakage is detected, stop the engine, or eliminate the trouble with the engine running, if possible.

Engine warming procedure should be continued until smoke from burning corrosion-preventive compound ceases to issue from the engine.

Prior to checking engine operation, bring its speed to the normal value and check all accessible pipe-lines of the fuel, oil, drainage, and hydraulic systems for leaky joints. Particular attention should be directed to checking condition of the joints in the pipe-lines of the fuel and hydraulic systems operating under high pressures.

If leaky joints are detected, replace the packing rings as recommended in Chapter VII, with the engine stopped. After replacement start the engine and check the joints for leakage.

If leakage shows up in the joints of the hydraulic system pipe-lines, not fitted with rubber packing rings, tighten up the nuts until leakage stops.

Check engine operation at all ratings.

When turning on the afterburner measure and adjust a drop or a rise in the temperature of gases aft of the turbine, as instructed in Section 2 of Chapter VII.

After the engine has been stopped, remove the oil unit filter and the strainer installed at the inlet to the reducing valve, inspect them and, if necessary, wash in clean gasoline; carry out the operations which are to be performed during postflight inspection of the engine. Wash the oil unit filter as recommended in Subsection "Routine maintenance after first 5 ± 1 hours of engine operation" (Section 4 of Chapter V).

If metal particles or chippings are detected on the oil filters (irrespective of their amount) consult a representative of the Manufacturer as to further operation of the engine.

Fill in the Technical Papers according to the established procedure.

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Chapter X

CORROSION-PREVENTIVE TREATMENT AND STORAGE OF ENGINE INSTALLED ON AIRCRAFT

1. General

Corrosion-preventive treatment is a principal means of safeguarding the engine parts against corrosion; it provides for proper storage and normal operation of the engine. Therefore, it is important that the engines, inactivated for some time, should be subjected to proper corrosion-preventive treatment carried out in due time and with the use of specified corrosion-preventive compounds.

Neutral petrolatum or gun grease is used for slushing the external non-painted parts of the engine. The painted parts are not subject to slushing.

For corrosion-preventive treatment of the inner surfaces of the fuel and oil systems, MK-8 or transformer oil is used.

The corrosion-preventive compounds should be free of any moisture. Should moisture be detected remove it by heating oil to a temperature of 110-120°C, until foam disappears from the surface of the heated oil.

Reclaimed or used oils are not to be employed for corrosion-preventive treatment.

Prior to performing the treatment, thoroughly inspect the parts, assemblies and units of the engine for signs of corrosion. Clean the corroded areas with emery cloth (grain 200-230) treated with oil, polish the cleaned areas with ГОИ paste, wash with clean gasoline and treat with corrosion-preventive compound.

When installed on the aircraft the engines may be stored both in hangars and on the airfield. In either case the engine should be subjected to corrosion-preventive treatment depending on the aircraft parking period (if the engine is to be at standstill for more than 7 days). The engines installed on the aircraft, arranged on the airfield, should be fitted with tight covers to guard them against rain or snow. No corrosion-preventive treatment should be conducted in rain or snow.

Only clean and dry engine part surfaces should be coated with corrosion-preventive compound.

The date and term of corrosion-preventive treatment as well as any signs of rust detected should be duly entered in the engine Service Log.

2. Storage of Engine on Aircraft during 30 Day Idle Period

When the engine is inactivated for a period of 30 days, perform the following operation every 5 to 7 days:

1. Remove the plugs from the aircraft air inlet duct and from the jet nozzle, and open the aircraft hatches. Inspect the external parts of the engine (where possible) and check them for corrosion. Clean the areas attacked by corrosion using emery cloth (grain 200-230) treated with oil, then polish the cleaned areas with ГОИ paste and wash with clean gasoline.

2. Start the engine as recommended in Section 3 of Chapter III. Bring engine speed to 10,400 r.p.m., run the engine at this speed for 0.5-1 min., to warm it up, and change the speed from 10,400 r.p.m. to 8000 r.p.m., repeating the procedure 2 to 3 times, to flush the mechanism controlling operation of the compressor air blow-off band with fuel. Bring engine speed to the normal rating, then to the maximum rating, after which cut in the afterburner for 10 sec.

Stop the engine as instructed in Section 5 of Chapter III.

3. Close the aircraft hatches, fit the plugs into the air inlet duct and the jet nozzle. Close the inspection panels.

Cautions. 1. Do not carry out the above operations in rain or snow.

2. During the entire storage period on the aircraft, the engine fuel system should be filled with fuel.

3. Corrosion-Preventive Treatment of Engine to Be Stored for Period of Three Months

If the engine is inactivated for a period of from 30 days to three months, carry out corrosion-preventive treatment of the engine internal and external surfaces.

Corrosion-Preventive Treatment of Internal Surfaces

Before proceeding to the treatment run the engine at a speed of 10,000 r.p.m. for 3 to 4 min, then pass to the normal and maximum ratings, after which cut in the afterburner for 10 sec., and then stop the engine as instructed in Section 5 of Chapter III.

Caution. Corrosion-preventive treatment of the engine internal surfaces should be carried out within three hours after fuel has been drained out.

Treat the internal surfaces of the engine as follows:

1. Fill the tank of the device used for corrosion-preventive treatment of the internal surfaces with oil, passing it through a silk filter. If the ambient air temperature is below zero, use oil heated to a temperature of 30 to 40°C.

The oil tank employed for corrosion-preventive treatment should be equipped with a booster pump having a reducing valve and with filter ФТ-1 or ФТ-2 at the outlet.

2. Drain the oil system of the engine and pour 5 to 6 lit. of fresh oil into the engine oil tank.

Note. Oil may not be drained if used for not more than 10 hours.

3. Close the fuel shut-off cock.

4. Connect adapter 717П-7 to the tank used for corrosion-preventive treatment and fill the device pipe-lines with oil. After this the tank should still contain 25 lit. of oil. Connect the hoses running from the tank adapter to the following pipe unions:

(a) of the pipe-line delivering fuel to booster pump ЦН-9;

(b) of the magnetic valve;

(c) serving for measuring fuel pressure in the afterburner manifolds;

(d) of the pipe-line connecting the centrifugal valve drainage to the air blow-off band control mechanism cylinder.

5. Remove the caps from the teepieces delivering fuel to the main and auxiliary fuel manifolds and located at the outlet from the НР-10А pump; connect the pipe unions by means of a hose or a pipe-line.

6. Unlock and take the cap off control panel ПУ-3; set switch ВК of the control panel in the "CORROSION-PREVENTIVE TREATMENT" (КОНСЕРВАЦИЯ) position.

7. To turn the engine for corrosion-preventive treatment, it is necessary to turn on the following switches:

(a) electric system main switch "STORAGE BATTERY" (АККУМУЛЯТОР);

(b) switch "AFTERBURNER EMERGENCY CUT-OFF" (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА);

(c) switch "STARTER UNITS" (АГРЕГАТЫ ЗАПУСКА);

(d) switch "TIMER" (АВТОМАТ ВРЕМЕНИ)

8. Supply corrosion-preventive compound into the starting fuel system, for which purpose start the tank booster pump and turn on switch "STARTING IN AIR (ЗАПУСК В ВОЗДУХЕ) for 30 sec.

9. Set the engine control lever in the "NORMAL (НОМИНАЛ) position and turn the engine 4 to 5 times, setting the engine control lever in the "CUT-OFF" (СТОП) position each time the turning is over.

When carrying out the corrosion-preventive treatment, oil pressure at the inlet into the НР-10А and НР-11А pumps should be within 1.6 to 2.6 kg/sq.cm.

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Corrosion-preventive treatment may be considered completed, if the fuel system consumes 25 lit.of oil, and the latter starts to flow in a continuous stream from the combustion chamber drainage pipe.

10. Set switch BK of the control panel in the "OPERATING" (РАБОЧЕЕ) position, reinstall the cap and lock it with wire.

11. Remove the device for corrosion-preventive treatment from the engine and reinstall all the parts which have been dismantled.

Fit the plugs into the aircraft air inlet duct and the jet nozzle. Cover the compressor air blow-off ports with the band by using wrench 240Ж-12.

Corrosion-Preventive Treatment of External Surfaces

Carry out the procedure as follows:

1. Wipe the external surfaces of the engine and its units (where possible) with clean pieces of cloth saturated in clean gasoline Б-70, without removing the engine from the aircraft. Wipe the washed areas dry, or air-dry them for 10 to 15 min.

2. Thoroughly inspect the engine and eliminate any signs of corrosion.

3. Treat all metal surfaces having no protective paint coating with petrolatum or gun grease, using a brush.

When carrying out the above procedure, do not allow any slushing compound to get on the screened wires and the electric equipment components, or on the jets serving to bleed air from the acceleration and starter control units of the HP-10A pump.

The external surfaces of the shutter control cylinders as well as those of the jet nozzle and the afterburner ejector should not be subjected to slushing.

4. Fit the plugs into the aircraft air inlet duct and into the jet nozzle.

When storing the processed engine on the aircraft, inspect it at regular intervals for signs of corrosion on the parts and units.

After the three month term has expired, the corrosion-

preventive compound should be removed from the engine, and the latter may be treated for another three month period.

4. Removal of Corrosion-Preventive Compound from Engine

Corrosion-preventive compound must be removed from the engine in compliance with the following procedure:

1. Remove the plugs from the aircraft air inlet duct, and from the engine jet nozzle.

2. Wash all external parts of the engine and its units, coated with slushing compound, with clean gasoline, using a brush, until all traces of slushing compound are removed; wipe the washed surfaces with clean dry pieces of cloth.

3. Subject the engine to visual inspection.

4. Turn the spark plugs out of the flame igniters, wash them with clean gasoline and dry up with compressed air. Reinstall the spark plugs.

5. Remove corrosion-preventive compound from inside the engine as instructed in Section 7 of Chapter IX.

After the above operations are completed, the engine may be considered ready for starting.

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Chapter XI

ENGINE OPERATION IN WINTER TIME

1. Engine Winterization

With the advent of cold weather, check to see that the plugs are tightly fitted into the aircraft air inlet duct and into the jet nozzle, to prevent entry of snow.

At the ambient air temperature of -40°C or below, the engine should be warmed up prior to starting, using hot air supplied from ground installation МП-44; hot air stream should be directed into the compressor inlet duct and engine inspection holes.

The engine should be warmed up for 10 to 15 min., with the hot air temperature not exceeding 80°C.

The engine should be started not later than 30 min. after being warmed up, as instructed in Section 2 of this Chapter.

2. Starting, Warming, Checking, and Stopping of Engine

Starting, warming, checking of the engine on the ground and its stopping should be performed using the standard procedure. The following should be observed when starting or stopping the engine in winter time:

1. With the 24-48 V engine starting system still not in use, the first starting of the engine at low ambient air temperatures (at the beginning of a flying day) should be accomplished as follows:

(a) connect the external power source of 28-30 V to the

aircraft mains, and check starting pump ПНР-10-9М for proper operation, by turning on switch "STARTING IN AIR" (ЗАПУСК В ВОЗДУХЕ) for not more than 10 sec. This should cause pilot lamp "IGNITION" (ЗАЖИГАНИЕ) to come on; besides, smoke should start issuing from the jet nozzle;

(b) immediately after detection of the smoke, shift the engine control lever to 1/3 of its travel from the idling rating retainer to the "NORMAL" (НОМИНАЛ) stop, press button "STARTING" (ЗАПУСК) and keep it pressed for 1.5 to 2 sec.

(c) after the gas temperature aft of the turbine has increased to 650-700°C, and the engine starts accelerating, smoothly shift the engine control lever to the idling rating retainer. While proceeding in this way, see that the engine speed does not drop or remains at the same level. Following this, the engine speed should reduce to the idling r.p.m. with an instantaneous (up to 10 sec.) increase of gas temperature aft of the turbine to not more than 850°C.

Caution. Start the other engine only if the first one is running at the idling speed.

2. With the ambient air temperature below-40°C, start the engine by employing a powerful external supply source of АПА-7 type.

3. Reduction in the ambient air temperature causes a drop in the engine idling speed.

In case the idling speed on a hot engine drops below the values presented in Table 2 and Fig.5 (within 2 min. at 10,000 r.p.m.) due to reduction of the ambient air temperature, adjust the idling speed as instructed in Section 1 of Chapter VI.

4. Engine operation at low air temperature and excessive humidity may lead to icing of the aircraft air inlet duct which may cause engine failure.

Icing is most likely to occur during such precipitations as drizzle, rain or damp snow, with the ambient air temperature from +2 to -10°C. When the engine is running at the idling speed, check periodically the aircraft air inlet duct to see there are no signs of icing. In case icing does occur on the air inlet duct surfaces, stop the engine and

remove ice from the engine parts and the air inlet duct surfaces, using hot air supplied from the ground installation.

5. For more effective functioning of the engine anti-icing system at the atmospheric conditions favouring icing, the engine should be operated as follows: after the engine is started and brought to the idling r.p.m. accelerate its speed to not less than 9000 r.p.m. not later than 2.5 min. after button "STARTING" (ЗАПУСК) was pressed.

When checking or warming up the engine, and also during taxiing and in flight engine should not run at a speed below 8500 r.p.m. for more than 1.5 min..

Do not run the engine at a speed of below 8500 r.p.m. repeatedly, unless it has been operating at a speed of over 8500 r.p.m. for not less than 0.5 min.

6. At sub-zero ambient air temperatures particular attention should be directed to cooling the engine prior to its stopping, to prevent warpage of the hot section parts.

After shifting the engine control lever to the CUT-OFF (СТОП) position, check the turbine and compressor rotors for easy rotation at stopping. The rotors should come to a stop gradually within not less than 1 min.

3. Engine Operation in Air

Take-off, climbing, and level flight in winter should be performed at the same engine ratings as in other seasons.

4. Care of Engine

1. With the ambient air temperature dropping below -10°C, exercise great care to safeguard fuel and oil from water, to avoid ice formation in the fuel and oil systems.

In case the fuel filter of the fuel-oil unit gets clogged with ice due to some moisture finding its way into the fuel, the filtering element of the fuel filter should be dried up or replaced by a new one, while the remaining fuel should be drawn from the filter housing with the aid of syringe HУ-46/2.

2. At sub-zero ambient air temperatures, the rubber parts of the fuel and oil pipe-lines should be thoroughly checked for proper condition during regular inspections of the engine, for deteriorated elasticity of rubber may result in leakage. Leakage should be eliminated by tightening up the respective threaded joint or by replacing the defective rubber part.

3. If the aircraft is to be parked at an ambient air temperature of -40°C or below, drain oil from the oil tank of fuel-oil unit 317A and from the oil pan of the compressor inlet housing immediately upon stopping the engine.

5. Keeping Engine in Constant Readiness for Flight

To keep the engine in constant readiness for flight at ambient air temperatures below-40°C, it is necessary to periodically warm it to prevent temperature of oil in the oil tank of fuel-oil unit 317A to drop below -40°C.

To warm the engine start it at regular intervals and run it at a speed of 10,400 r.p.m. or use hot air (not over 80°C) supplied from the ground installation.

When warming the engine with hot air, give particular attention to fuel-oil unit 317A, as well as to the pipe-lines and units of the fuel and oil systems. Deliver hot air through the engine compartment inspection holes.

Plug the aircraft air inlet duct right after stopping the engine; plug the engine jet nozzle 10-15 min. after stopping the engine.

The aircraft storage battery should be always normally charged, with electrolyte level and density maintained at the specified values (in compliance with the instructions on operation of aircraft storage batteries).

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Chapter XII

OPERATION OF РД-9Б ENGINES OF FIFTH SERIES

1. General

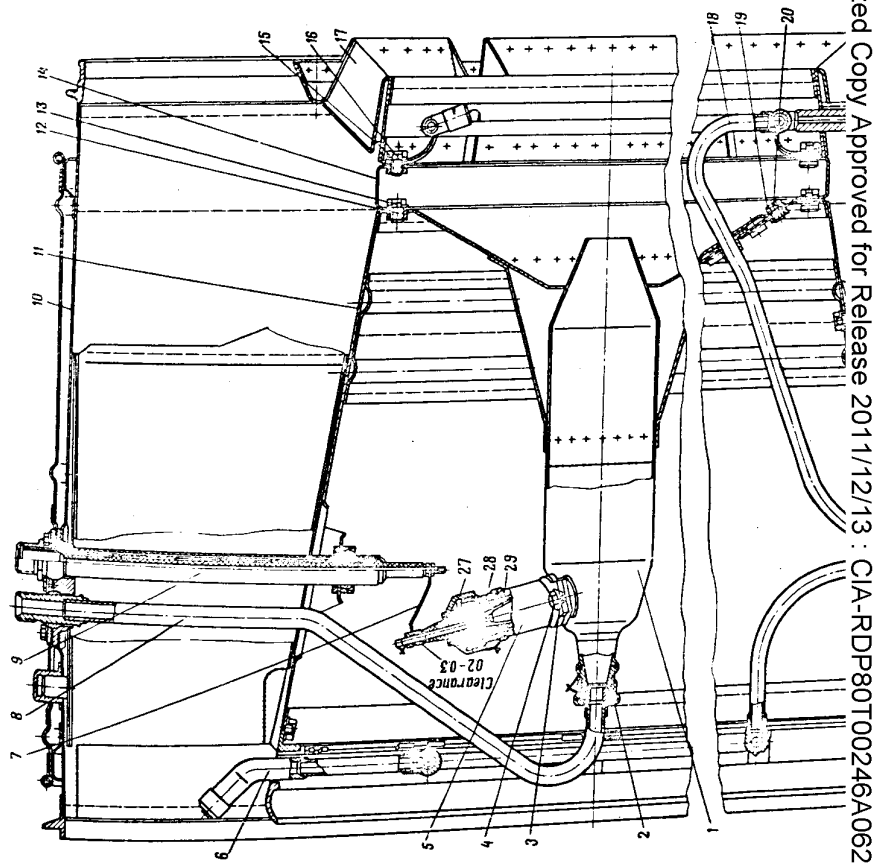
The РД-9Б engines of the fifth series are furnished with precombustion ignition system providing for reliable cutting-in of the afterburner at higher altitudes.

Ignition of this type of afterburner is accomplished by a torch produced in the flame igniter of the diffuser (Fig.35) as a result of burning of the air-fuel mixture delivered into the flame igniter from the carburettor (Fig.36). The torch is ejected from the flame igniter nozzle into the space where fuel is supplied from the starting burners of the afterburner rear manifold.

Besides, to prevent engine racing at high altitudes the engines of the fifth series are fitted with the НР-10А pump, whose minimum pressure valve limits the minimum output of the pump to $350^{}_{-30}$ lit/hr. This arrangement has allowed to eliminate the stop limiting the minimum angle of inclination of the pump wobble plate.

To improve engine acceleration ability, the speed, at which regulation of the НР-10А pump is accomplished automatically, has been changed to 9000±100 r.p.m., while the speed, at which operation of the hydraulic decelerator limit switch occurs, has been changed to 10,900±100 r.p.m. (with the engine control lever smoothly shifted from one position to another).

To provide for more reliable cutting-in of the afterburner at altitudes of over 10,000–11,000 m., the engines of the fifth series have been furnished with the НР-11А fuel pump, whose barostatic characteristics have been modified;



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INES OF FIFTH SERIES

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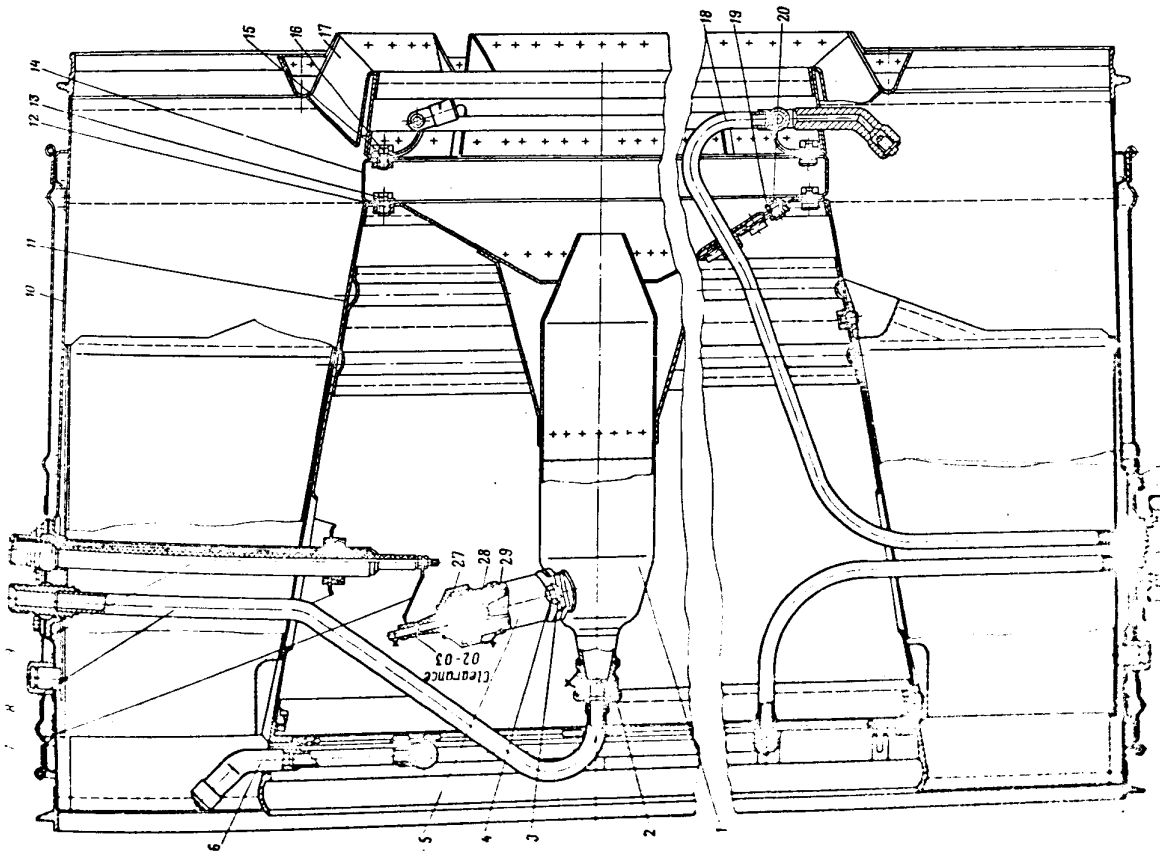

provision has been also made for closing the limit switch of the afterburner control 5 to 8.5 sec. after fuel pressure in the afterburner manifolds has reached its maximum value. This arrangement causes the spark plug as well as the precombustion ignition system magnetic valve to function for a longer period of time, thereby prolonging the afterburner ignition period to 8-14 sec.

Control panel ПУ-3Б installed on these engines has a modified connection to control panel limit switch BK and to the limit switch of the НР-11А pump afterburner control. The control panel is also connected with the precombustion ignition system magnetic valve.

For obtaining and igniting fuel-air mixture, the engines of the fifth series are furnished with the following additional equipment: a flame igniter with spark plug СД-108А and adapter П-11, a magnetic valve, supplying main fuel to the carburettor, the carburettor producing fuel-air mixture, a throttling unit, metering fuel supplied to the carburettor, and pipe-lines for directing fuel from the main manifold to the magnetic valve and further to the carburettor, for air delivery from the compressor to the carburettor, and for delivery of fuel-air mixture from the carburettor to the diffuser flame igniter.

Installation of a precombustion ignition system has called for modification of the afterburner diffuser (See Fig.35).

In contradistinction to the other engines, the engines of the fifth series have figure 5 in their numbers (the third one from the left).

Note. Some of the РД-9Б engines of the fourth series have been fitted with precombustion ignition system, which is duly recorded on page 1 of the engine Service Log.

2. Engine Specifications

Specifications of the РД-9Б engines of the fifth

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provision has been also made for closing the limit switch of the afterburner control 5 to 8.5 sec. after fuel pressure in the afterburner manifolds has reached its maximum value. This arrangement causes the spark plug as well as the precombustion ignition system magnetic valve to function for a longer period of time, thereby prolonging the afterburner ignition period to 8-14 sec.

Control panel ПУ-3Б installed on these engines has a modified connection to control panel limit switch ВК and to the limit switch of the НР-11А pump afterburner control. The control panel is also connected with the precombustion ignition system magnetic valve.

For obtaining and igniting fuel-air mixture, the engines of the fifth series are furnished with the following additional equipment: a flame igniter with spark plug СД-108А and adapter П-11, a magnetic valve, supplying main fuel to the carburettor, the carburettor producing fuel-air mixture, a throttling unit, metering fuel supplied to the carburettor, and pipe-lines for directing fuel from the main manifold to the magnetic valve and further to the carburettor, for air delivery from the compressor to the carburettor, and for delivery of fuel-air mixture from the carburettor to the diffuser flame igniter.

Installation of a precombustion ignition system has called for modification of the afterburner diffuser (See Fig.35).

In contradistinction to the other engines, the engines of the fifth series have figure 5 in their numbers (the third one from the left).

Note. Some of the РД-9Б engines of the fourth series have been fitted with precombustion ignition system, which is duly recorded on page 1 of the engine Service Log.

2. Engine Specifications

Specifications of the РД-9Б engines of the fifth series

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differ from those of the РД-9Б engines of the fourth series in the following.

Fuel system

1. Main fuel pump.

type	НР-10А (in compliance with series Л)
engine speed is regulated automatically	beginning from $9000^{+}_{-}200$ r.p.m.
minimum pressure valve maintains minimum output of pump at	350_{-30} lit/hr
2. Afterburner fuel pump type	НР-11А (in compliance with series Л)
3. Time period during which engine speed changes from maximum to augmented (determined by increase of fuel pressure in afterburner manifolds).....	5 to 8.5 sec.

Ignition, electric equipment and control systems

4. Afterburner ignition system	employs precombustion ignition and torch
5. Afterburner diffuser flame igniter spark plug type	СД-108А with adapter П-11
number	1
6. Control panel	ПУ-3Б
7. Safety-interlocking devices: limit switch of НР-10А pump hydraulic decelerator.....	prevents cutting-in of

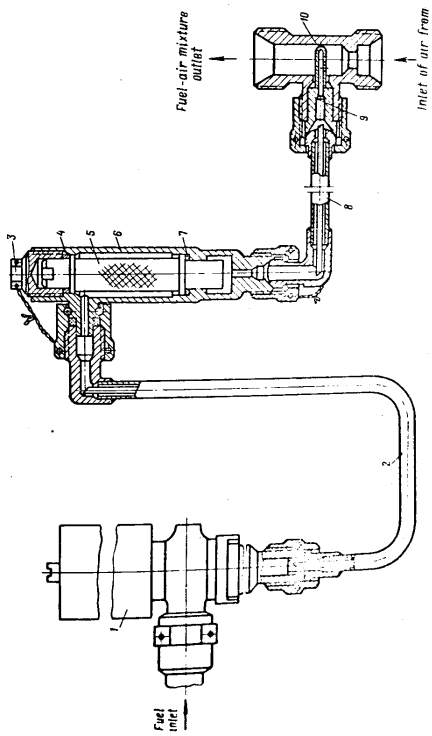

Fig.36. Magnetic Valve with Carburettor

1 – magnetic valve; 2 – pipe-line for fuel delivery from magnetic valve to throttling unit; 3 – pipe-line for fuel delivery from throttling unit to afterburner manifolds; 4, 5, 6, 7 – throttling unit; 8 – throttling unit housing; 9 – pipe-line for fuel delivery to carburettor; 9 – carburettor spray tip; 10 – carburettor housing.

maximum or augmented ratings when engine speed in below $10,900^{\pm 100}$ r.p.m., with engine control lever smoothly shifted to respective position.

Measuring instruments

8. Oil pressure warning mechanism,..... $2СДУ5\text{-}1.3^{+0.3}_{-0.2}$ membrane type, closes pilot lamp circuit (pilot lamp lights up) when oil pressure in oil pressure line drops below 1.3 kg/sq.cm. at engine speeds below 9700_{-100} r.p.m., or when oil pressure drops below 2.8 kg/sq.cm. at engine speeds of over 9700_{-100} r.p.m.

Engine ratings

9. Augmented rating period of engine continuous operation in flight ..... not over 15 min.
total operation period.... not over 10 hours

Engine weight

10. Dry weight of engine complete with fuel-oil unit... 701.5^{+2} per cent kg

3. Engine Operation

Operation of the РД-9Б engines of the fifth series, as well as of the engines of the fourth series equipped

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with afterburner precombustion ignition system should be accomplished in compliance with the present Instructions, taking into consideration the following.

Operation of engine during flight

Reliable cutting-in of the afterburner on the РД-9Б engines of the fifth series is ensured to an altitude of 14,500 to 15,000 m.

The afterburner should be turned on after running the engines at the maximum rating for 10 to 15 sec., in case the aircraft speed immediately prior to turning on the afterburner amounts to not less than 450-500 km/hr (as indicated by the respective instrument), with the air brakes retracted.

Continuous operation of the engine, with the afterburner turned on, at any altitude, or at climbing should not exceed 15 min.

Repeated cutting-in of the afterburner should be done after the engine has run at any other rating for not less than 30 sec. including the above period of operation at the maximum rating.

Total period of engine operation at the augmented rating should not exceed 10 hours throughout the engine service life.

Care of engine

Inspect the flame igniter and the flame arrester of the afterburner diffuser for burns, warpage, and cracks after each flight during which the afterburner has been turned on, and also when carrying out scheduled maintenance operations in accordance with section 4 of Chapter V. When conducting the above inspection, use a headlight or a portable lamp.

4. Adjustment of Engine Units

Adjustment of engine acceleration

Check and adjust engine acceleration as instructed in

Section 4 of Chapter III and in Section 4 of Chapter VI. Carry out the necessary adjustment to ensure automatic regulation at a speed of 9000±200 r.p.m. instead of 8200±100 r.p.m.

Adjustment of limit switch of НР-10А pump hydraulic decelerator

Checking and adjustment of the limit switch of the НР-10А pump hydraulic decelerator should be carried out as laid down in Section 6 of Chapter VI. The limit switch should operate at an engine speed of 10,900±100 r.p.m., when the engine control lever is smoothly shifted from the 10,000 r.p.m. position to the "NORMAL" (НОМИНАЛ) stop.

5. Replacement of Engine Units and Assemblies

On the РД-9Б engines of the fifth series the following units and assemblies may be replaced:

(a) precombustion ignition magnetic valve;
(b) carburettor;
(c) flame igniter;
(d) spark plug СД-108А.

Replacement of magnetic valve

The precombustion ignition magnetic valve should be replaced as follows:

1. Unlock and detach the fuel delivery and return pipe-lines from the magnetic valve.

2. Uncouple the plug connector of the magnetic valve solenoid.

3. Unlock and remove the two bolts securing the magnetic valve from the bracket located on the compressor air blow-off band control mechanism, and remove the magnetic valve from the engine.

4. Wash a new magnetic valve in clean gasoline, wipe it with a clean dry piece of cloth and inspect for mechanical damage.

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When washing the magnetic valve, see that no gasoline gets on the valve solenoid.

5. Connect the magnetic valve to the storage battery and check the solenoid for a proper click. For this purpose switch on the solenoid 2 to 3 times, each switching lasting for not more than 40 sec.

6. Mount the magnetic valve on the bracket, and secure it with bolts, having fitted new locking washers under the bolt heads. Lock the bolts by bending the washer tabs over the bolt head flats.

7. Connect the fuel delivery and return pipe-lines to the magnetic valve, having placed new packing rings under the nuts of the joints. Lock the nuts with 0.8 mm diameter brass wire.

8. Couple the plug connector of the magnetic valve and lock the nut with 0.8 mm diameter brass wire.

Replacement of throttling unit

Replace the carburettor throttling unit using the following procedure:

1. Unlock and turn the plug out of the throttling unit housing; extract the throttling unit with the help of a threaded rod.

2. Fit a new throttling unit of the same capacity into the housing, having placed a new packing ring under the collar provided on the outlet taper portion of the throttling unit frame.

Note. The РД-9Б engines of the fifth series are fitted with throttling units of the 6th group, whose capacity amounts to 250±15 cu.cm/min. The throttling unit capacity value is engraved on the cylindrical surface of the throttling unit frame outlet portion.

3. Turn the plug into the throttling unit housing, having installed a new packing ring.

Lock the plug together with the nut securing the fuel pipe-line to the throttling unit with 0.8 mm diameter brass wire.

Replacement of carburettor

Replace the precombustion ignition carburettor proceeding as follows:

1. Unlock and detach the air delivery and air-fuel mixture outlet pipe-lines from the carburettor.

2. Unlock and detach the fuel delivery pipe-line from the carburettor; remove the carburettor.

3. Wash a new carburettor in clean gasoline and wipe it with a clean, dry piece of cloth. Blow the carburettor sprayer with clean compressed air. Inspect the carburettor for mechanical damage.

4. Install the new carburettor on the engine and connect the pipe-lines for delivery of fuel, air from the compressor, and for outlet of fuel-air mixture. Lock the nuts of the joints with brass wire.

Replacement of fuel igniter

When replacing the afterburner diffuser fuel igniter, proceed as follows (See Fig.35):

1. Remove the afterburner diffuser from the engine, as recommended in Section 21 of Chapter VII, making certain to detach the pipe-line for delivery of fuel-air mixture.

2. Unlock and back out the six bolts holding the flame arrester and the clamps of the afterburner rear manifold to the distance piece. Shift the clamps securing the rear manifold until they fit into the recesses provided on the flame arrester flange; remove the flame arrester.

3. Unlock and back out the bolts holding down the hemispherical covers of the front and rear manifold attachment fittings; remove the covers and the hemispheres.

4. Unlock and turn out the six bolts securing the flange of the afterburner rear manifold; remove the rear manifold.

5. Unlock and turn the nut, securing the pipe-line for delivery of fuel-air mixture, off the flame igniter pipe union.

6. Detach the busbar from spark plug СД-103А, for which purpose unlock and turn off the nut holding it to the through electrode.

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7. Unlock and turn out the six bolts holding the distance piece and the flame igniter to the rear flange of the diffuser inner wall; remove the distance piece and the flame igniter.

8. Unlock and turn nut 27 off bush 5, supporting the bush with a wrench.

9. Extract through electrode 28 out of the bush by slightly rocking and turning it around the axis.

10. Unlock and turn out bolts 4 holding the bush to the flame igniter body; remove the bush.

11. Screw spark plug СД-108А (29) out of the flame igniter body.

12. Turn spark plug СД-108А into the new flame igniter, as far as it will go.

13. Mount the bush onto the flame igniter body flange and fasten it with two bolts, having fitted new locking washers under the bolt heads. Lock the bolts.

Prior to fitting in the bush securing bolts, treat the bolt threads with chalk paste consisting of clean chalk powder and oil МС-20.

14. Insert the through electrode into the bush and turn the union nut onto the bush so that the through electrode should be kept from rotation; when proceeding in this way, hold the bush with a wrench. Lock the union nut together with the bush, using 0.8 mm diameter wire of steel 1Х18Н9Т.

Istall the new flame igniter in the reverse order of its dismantling.

Prior to fitting in the bolts securing the flame arrester, distance piece, flame igniter, rear manifold flange and the hemispherical covers of the front and rear afterburner manifolds, treat the bolt threads with chalk paste consisting of clean chalk powder and oil МС-20 (State Standard ГОСТ 1013-49). Replace the bolt locking washers by new ones. Lock the bolts by bending the washer tabs over the bolt head flats.

Use 0.8 mm diameter wire of steel 1Х18Н9Т to lock the nuts securing the pipe-line for delivery of fuel-air mixture to the flame igniter, as well as the nut fastening the bus-bar of spark plug СД-108А.

When fastening the spark plug bus-bar check to see that there is a clearance of 0.2 to 0.3 mm between the lower nut of the spark plug through electrode and the bush.

Installation of the afterburner diffuser should be carried out as instructed in Section 21 of Chapter VII; be sure to attach the pipe-line for delivery of fuel-air mixture from the carburettor.

Replacement of spark plug СД-108А

Replace flame igniter spark plug СД-108А using the following procedure:

1. Remove the afterburner diffuser from the engine, as laid down in Section 21 of Chapter VII, having disconnected the pipe-line for delivery of fuel-air mixture from the carburettor.

2. Unlock and turn the nut off the spark plug through electrode; detach the bus-bar. Carry out the operations detailed under Items 8-14 of Subsection "Replacement of flame igniter".

3. Connect the bus-bar to the spark plug and fasten it with a nut. Check to see that there is a clearance of 0.2 to 0.3 mm between the lower nut of the spark plug through electrode and the bush. Lock the nut holding the bus-bar to the spark plug with 0.8 mm diameter wire of steel 1Х18Н9Т.

4. Mount the afterburner diffuser on the engine as laid down in Section 21 of Chapter VII, making sure to attach the pipe-line for delivery of fuel-air mixture from the carburettor.

After replacement of individual units and assemblies of the afterburner precombustion ignition system start the engine and check the pipe-line joints for leakage; check the afterburner for proper operation on the ground, as laid down in Section 4 of Chapter III.

Prior to starting the engine prime the fuel system as set forth under Section 7 of Chapter IX.

After checking engine operation on the ground, check the afterburner for proper cutting-in during flight.

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Chapter XIII

OPERATION OF РД-9Б ENGINES OF SIXTH SERIES

1. General

The РД-9Б engines of the sixth series differ from the engines of the fifth series in that they are equipped with a push-button system of maximum and augmented ratings control, allowing to regulate the thrust developed at these ratings by changing engine speed (by manipulating the engine control lever) within $11,150 \pm 50$ to $10,400^{+200}$ r.p.m. Besides, to maintain gas temperature aft of the turbine at a constant level irrespective of the altitude and speed of the aircraft flying with the afterburner cut in, the НР-11ВА pump (Fig.37) has been installed whose function is to handle the afterburner fuel. The pump is fitted with a regulator which controls automatically the amount of fuel injected into the afterburner using a principle of a constant ratio of air pressure after the compressor p_2 to gas pressure in the afterburner p_4. This arrangement has called for installation of additional pipe-lines serving to supply air pressure p_2 from the compressor IX stage and gas pressure p_4 from the afterburner diffuser to the НР-11ВА pump regulator. To allow for adjustment of air pressure p_2, supplied to the afterburner regulator, and consequently the temperature of gases aft of the turbine at the augmented rating, an adjusting needle (Fig.38) has been installed on the pipe-line supplying air pressure p_2.

Engine acceleration ability has been improved by adjusting main fuel pump НР-10АКС so that it starts regulating fuel delivery automatically at an engine speed of 9500_{-200} r.p.m.; the limit switch of the pump hydraulic decelerator operates when engine speed reaches $10,900_{-100}$ r.p.m. (with the engine control lever smoothly shifted to another position).

To guard the engine against racing at high altitudes, the minimum pressure valve of the НР-10АКС pump has been so adjusted as to limit the minimum output of the pump to 300 ± 20 lit/hr.

Note. The НР-10АКС pump differs from the НР-10А pump in that it incorporates a pressure relief valve (КС).

Push-button control of the maximum and augmented ratings as well as adjustment of engine thrust at these ratings is accomplished through the use of control panel ПУ-9Б which differs from control panel of the ПУ-3 type in that its electric circuit has been somewhat modified. Control panel ПУ-9Б incorporates additional limit switches Б and МБ, limit switches М and Ф being cut out.

Limit switch Б cuts in the maximum and augmented ratings only when the engine control lever is shifted to the "NORMAL" (НОМИНАЛ) stop; the limit switch has been so adjusted as to operate when the control panel switch is turned through an angle of 82^{+1} (as indicated on the control panel dial).

Limit switch МБ provides for adjustment of engine thrust at the maximum and augmented ratings by changing engine speed (by shifting the engine control lever) within $11,150 \pm 50$ r.p.m. up to the maximum and augmented rating retainer, as well as for cutting out these ratings at a speed of $10,400^{+200}$ r.p.m. Limit switch МБ has been so adjusted as to operate when the control panel lever is turned through an angle of $66 \pm 1^{\circ}$ (as indicated on the control panel dial).

Cutting-in of the maximum and augmented ratings is accomplished by pressing buttons "MAXIMUM (МАКСИМАЛ) and "AFTERBURNER" (ФОРСАЖ), respectively; the buttons are located in the aircraft cockpit.

As the maximum and augmented ratings are cut in by simple pressing of the respective buttons, the cam shaft of

the control panel has been fitted with a special double lever, which is coupled to the lever of the НР-10АКС pump throttle cock by means of a rigid adjustable link.

The levers of control panel ПУ-9Б and of the НР-10АКС pump, as well as the link connecting these levers have been so adjusted that complete opening of the НР-10АКС throttle cock, at which the engine gains the maximum speed, takes place when the control panel cam shaft is set at an angle of 90° (as indicated on the control panel dial).

Kinematic diagram of engine control is shown in Fig.39.

To provide for stable operation of the engine when flying at high altitudes with the afterburner cut in, the diffuser has been fitted with a flame arrester having a plate which is 40 mm wider than that of the early series.

To facilitate dismantling and installation of the oil unit filter cap its fastening is accomplished by the use of one coupling stud instead of six (Fig.40).

To differentiate between the РД-9Б engines of the sixth and other series the former have figure 6 in their numbers (the third figure from the left).

Note. Some of the engines of the fifth series have been also fitted with oil units, whose filter caps are secured by a quick-change fitting.

2. Engine Specifications

The specifications of the РД-9Б engines of the sixth series, as distinguished from the engines of the fifth series, are as follows:

General data

1. Diameter of jet nozzle exhaust area
   (a) at maximum rating ..... 438–452 mm
   (b) at normal and intermediate ratings (up to speed of 6500–4500 r.p.m.) 461–475 mm

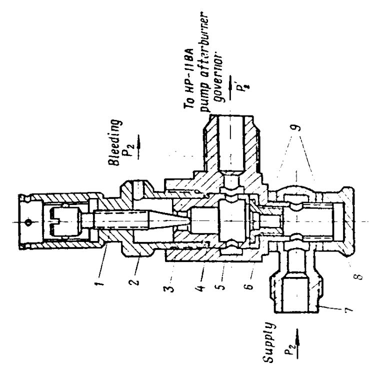

Fig.38. Adjusting Needle

1 – needle; 2 – needle housing; 3 – bush; 4 and 9 – packing rings; 5 – housing; 6 – jet; 7 – swivel elbow; 8 – nut (blind), p_2 – air pressure aft of compressor; p_2' – corrected pressure of air aft of compressor

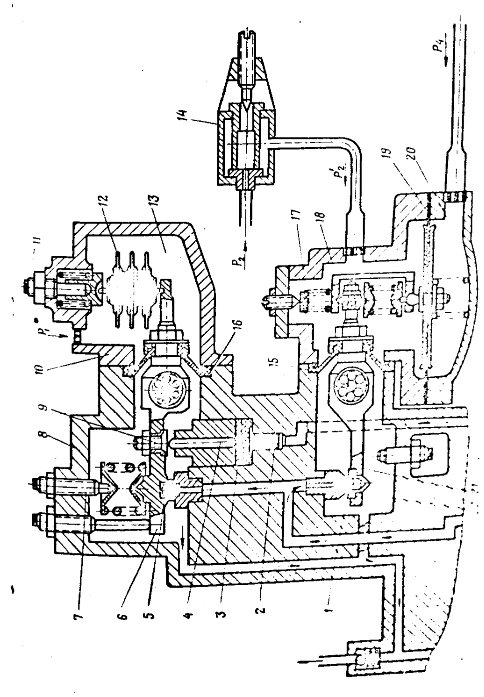

Fig.37. Afterburner Governor and Barostat of НР-11БА Pump

1 – afterburner governor valve; 2 – damper; 3 – sensing unit block; 4 – rod; 5 – barostat valve; 6 – barostat lever; 7 – barostat valve spring screw; 8 – pump housing; 9 – stop; 10 – barostat housing; 11 – barostat aneroid spring screw; 12 – barostat aneroid; 13 – barostat air chamber; 14 – adjusting needle (bleeder needle); 15 and 16 – flexible partitions; 17 – afterburner governor housing; 18 – air pressure chamber p_2; 19 – centrane; 20 – gas pressure chamber p_4; 21 – afterburner governor lever; [illegible] – fuel chamber of afterburner governor, p_2 – air pressure after compressor IX stage, p_2' – corrected pressure of air after compressor IX stage, p_4 – pressure of gases aft of turbine, p_1 – air pressure before compressor.

Fuel system

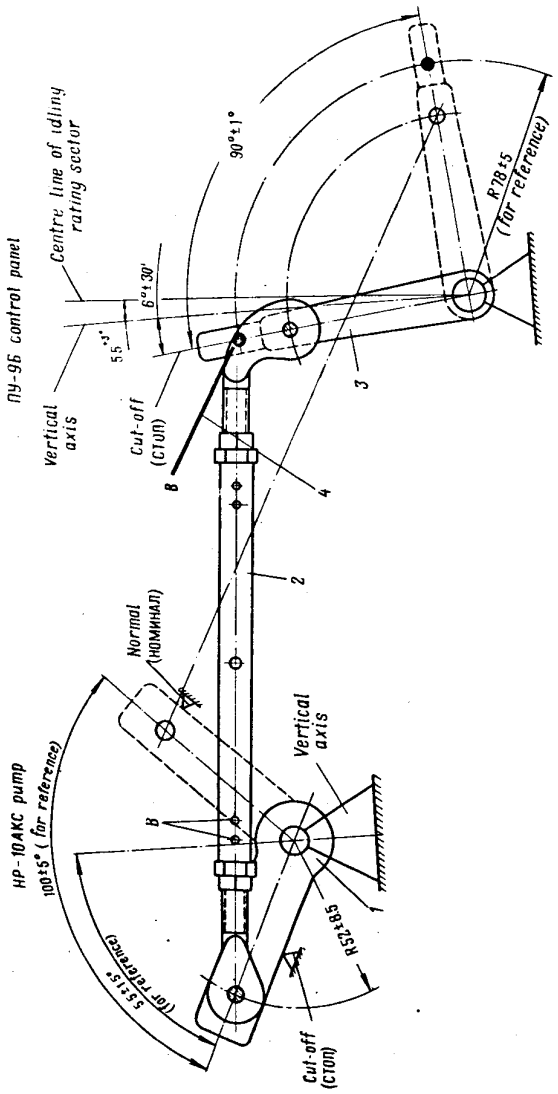

Fig.39. Kinematic Diagram of Engine Control

1 - lever of HP-10AKC pump; 2 - link; 3 - lever of ПУ-9Б control panel; 4 - engine control link. B - check holes

2. Main fuel pump	
type	HP-10AKC
engine speed is regulated automatically from	9500_{-200} r.p.m.
minimum pressure fuel valve limits minimum output of pump to	$300^{\pm}20$ lit/hr
3. Afterburner fuel pump type	HP-11BA; delivers fuel into afterburner to maintain constant ratio between air pressure after compressor and gas pressure in afterburner (P_2/P_4= const.); fitted with fuel feed limiter of barostatic type
4. Engine acceleration ability (time period within which engine gains maximum speed, shifting of engine control lever taking as much as 1.5 to 2 sec.)	
(a) from idling rating to normal rating....	11-14 sec.
(b) from speed at which regulation is accomplished automatically to normal rating.....	11-14 sec.
(c) from idling rating to maximum rating..	11-15 sec.
(d) from speed at which regulation is accomplished	

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automatically to maximum rating	11-15 sec.
(e)from idling rating to augmented rating, not over.....	18 sec.
(f)from speed at which regulation is accomplished automatically to augmented rating, not over	18 sec.

Oil system

5. Pressure oil unit type	gear, single-stage type with quick-change filter cap and constant breathing of oil filter cavity into engine vent system through pipe-line fitted with 0.8 mm diameter jet.

Electric equipment and control systems

6. Afterburner control unit (installed on aircraft)...	КАФ-5
7. Starter-generator control equipment (installed on aircraft);voltage regulator	Р-27
differential minimum relay	ДМР-400АМ
8. Control panel	ПУ-9Б
9. Safety-interlocking devices (a) limit switch of HP-10 AKC hydraulic decelerator	prevents cutting in of maximum or augmented rating with engine running at speed below $10{,}900^{-100}$ r.p.m.

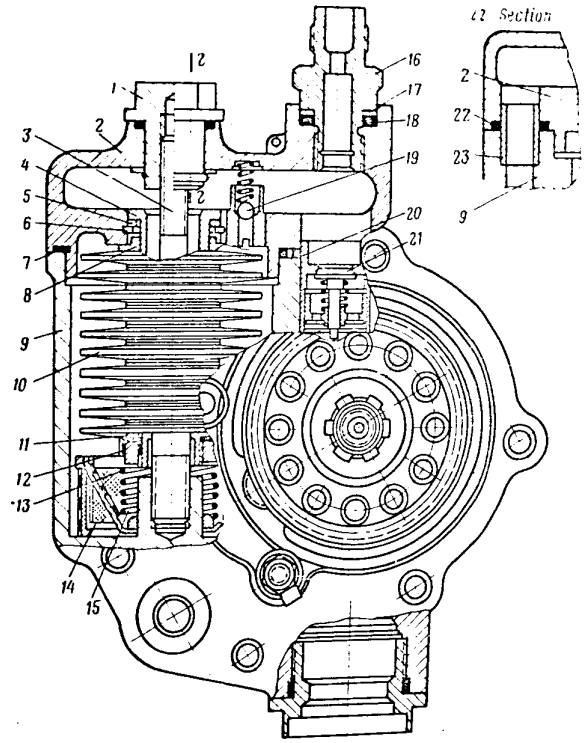

Fig. 40. Oil Unit

1 - nut; 2 - cover; 3 - coupling stud; 4 - filter frame; 5 - thrust washer; 6 - spring ring; 7 - packing ring; 8 - washer; 9 - oil unit housing; 10 - filter gauze discs (10 pieces); 11 - washer; 12 - locking washer; 13 - nut; 14 - strainer at oil inlet into reducing valve; 15 - spring; 16 - pipe union for bleeding air from oil unit (breather pipe union); 17 - washer; 18 - packing ring; 19 - oil by-pass valve; 20 - packing ring; 21 - return valve 22 - packing ring; 23 - bush.

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	when engine control lever is smoothly shifted to "NORMAL" (НОМИНАЛ) stop.
(b) limit switch Б of control panel ПУ-9Б	does not allow cutting in of maximum or augmented rating, if engine control lever is not shifted to NORMAL (НОМИНАЛ) stop
(c) limit switch МБ of control panel ПУ-9Б	interlocks limit switch Б of control panel ПУ-9Б and limit switch of НР-10АКС pump hydraulic decelerator, which makes it possible to change engine speed at maximum and augmented ratings within $11,150 \pm 50$ to $10,400^{+200}$ r.p.m.; cuts out maximum and augmented ratings at $10,400^{+200}$ r.p.m.

Measuring instruments

10. Oil pressure warning mechanism, 2СДУ5-1.3-2.8	membrane type, indicates (pilot lamp flashes up) drop of oil pressure in pressure line to less than 1.3 kg/sq.cm. at engine speed below 9700_{-100} r.p.m., and to less than 2.6 kg/sq.cm. at engine speed of over 9700_{-100} r.p.m.

Note. It is allowed to install oil pressure warning mechanism 2СДУ5-1.3-2.2

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Engine weight

11. Dry weight of engine complete with fuel-oil unit..... 708.1^{+2} per cent kg

Notes. 1. Dry weight of the engine does not include the weights of the following units and assemblies:

(a) starter generator ГСР-СТ-6000А;
(b) afterburner jet nozzle ejector;
(c) hydraulic pump 435ВМ and its drive;
(d) booster pump ЦН-9 with pipe-lines.

2. Dry weight of the engine includes the weight of two two-position slide valves ГА-21.

Engine ratings

12. Augmented rating:
temperature of gases aft of turbine, not over
in flight ..... 680°C
on ground..... 680°C.

3. Checking of Engine on Ground

Engine warming and checking for proper operation at the idling and normal ratings should be carried out in compliance with the instructions given in Section 4 of Chapter III.

The maximum rating should be cut in using the following procedure: bring engine speed to the normal value (the engine control lever should be shifted to the "NORMAL" (НОМИНАЛ) stop), open button "MAXIMUM" (МАКСИМАЛ) and keep it pressed for 1 to 2 sec. Cutting in of the maximum rating should be checked by the respective pilot lamp as well as by a rise of gas temperature after the turbine.

When checking engine operation at the maximum rating, make sure to check adjustment of the link, for which purpose smoothly shift the engine control lever from the "NORMAL" (НОМИНАЛ) stop to the maximum and augmented rating retainer, and backwards.

With the engine control lever moved towards the retainer, engine speed, and consequently gas temperature aft of the turbine should reduce. Engine characteristics should not exceed the permissible values as specified for the maximum rating.

Cutting-out of the maximum rating should be accomplished by shifting the engine control lever beyond the maximum and augmented rating retainer (to reduce the respective speed by 100 r.p.m.). The maximum rating should be cut out at an engine speed of $10{,}400^{+200}$ r.p.m.; this should cause the maximum rating pilot lamp to go out, while the jet nozzle shutters should shift to the normal rating position.

The augmented rating should be cut in as follows:

(a) shift the engine control lever to the "NORMAL" (НОМИНАЛ) stop without cutting out the maximum rating;

(b) press button "AFTERBURNING" (ФОРСАЖ) and keep it pressed for 1 to 2 sec.

Note. In case the maximum rating does switch off, prior to cutting in the afterburner bring the engine to the normal speed (the engine control lever should be set at the "NORMAL" (НОМИНАЛ) stop) and then successively press buttons "MAXIMUM" (МАКСИМАЛ) and "AFTERBURNING" (ФОРСАЖ) keeping them pressed 1 to 2 sec.each.

Check the afterburner for proper cutting-in by watching the respective pilot lamp, which should light up, and also by the value of gas temperature aft of the turbine.

When the afterburner is being cut in, an instantaneous drop of gas temperature may be experienced, which should not exceed 50°C as compared to the gas temperature at sustained maximum rating, with subsequent temperature rise which should not exceed the level specified for the augmented rating. Instantaneous rise in gas temperature is not to be allowed when cutting in the afterburner.

The afterburner may be cut in both with the engine running at the maximum or normal rating. If the afterburner is to be cut in at the normal rating, both the engines should run at a speed exceeding 9700_{-100} r.p.m. In case one of the engines is

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running at idling speed or is inoperative, the afterburner of the other engine may be cut in only at the maximum rating.

Engine thrust at the augmented rating should be checked in the same manner as when checking it at the maximum rating.

For cutting out the afterburner, shift the engine control lever beyond the maximum and augmented rating retainer (to reduce the respective speed by 100 r.p.m.) to attain a speed of $10{,}400^{+200}$ r.p.m. When the afterburner is being turned off, the pilot lamp goes out, while gas temperature aft of the turbine drops. With the afterburner cut out, the jet nozzle shutters shift to the nominal rating position.

When the afterburner is switched on, instantaneous acceleration of maximum speed (for 3 to 5 sec.) should not exceed 11,500 r.p.m.; when the afterburner is switched off acceleration should not exceed 11,600 r.p.m. The engine should gain maximum speed of $11{,}150^{\pm 50}$ r.p.m. not later than 3 to 5 sec after acceleration has been experienced.

Should it be necessary, cut off the afterburner by using "AFTERBURNER EMERGENCY CUT-OFF" switch (АВАРИЙНОЕ ВЫКЛЮЧЕНИЕ ФОРСАЖА); in this case engine speed should not exceed 10,400 r.p.m.

Caution. When checking engine operation at the maximum and augmented ratings, it should be taken into consideration, that when the maximum and augmented ratings are cut in on one of the engines, the same ratings will be cut in on the other engine, if its speed exceeds that which is necessary for operation of the limit switch of the НР-10АКС pump hydraulic decelerator (over $10{,}900_{-100}$ r.p.m.) though the control lever of the engine in question is not shifted to the "NORMAL" (НОМИНАЛ) stop.

Engine operation within the range of automatic regulation should be checked within 9500_{-200} to $11{,}150^{\pm 50}$ r.p.m. Engine speed should not lag behind movement of the control lever (in both directions), if the latter is moved (in the above range) within not less than 20 sec.

Engine acceleration from the speed at which automatic regulation takes place to the respective rating should be checked from 9500_{-200} r.p.m.

When checking engine acceleration up to the maximum and augmented ratings, shift the engine control lever within 1.5 to 2 sec. from the speed at which acceleration ability is checked to the "NORMAL" (НОМИНАЛ) stop, and then press either button "MAXIMUM" (МАКСИМАЛ) (when checking acceleration ability up to the maximum rating) or buttons "MAXIMUM" (МАКСИМАЛ) and "AFTERBURNING" (ФОРСАЖ) simultaneously (when checking acceleration ability up to the augmented rating) keeping them pressed until pilot lamp "MAXIMUM" (МАКСИМАЛ) or "AFTERBURNER" (ФОРСАЖ) flashes up (depending on the rating up to which engine acelration is being checked).

Time period during which the engine accelerates its speed from the idling rating and beginning of automatic regulation to the respective rating should be within the limits presented in Section 2 of this Chapter.

When checking acceleration ability, instantaneous (for 3 to 5 sec.) increase of maximum speed should not exceed 11,500 r.p.m. Engine should slow down to its maximum speed of $11{,}150^{\pm 50}$ r.p.m. not later than 3 to 5 sec. after the speed increase has been experienced.

4. Operation of Engine in Air

Operation of the РД-9Б engines of the sixth series during flight should be performed in compliance with the instructions given in Chapter IV and in Section 3 of Chapter XII, taking into account the following particulars:

The maximum and augmented ratings should be cut in as laid down in Section 3 of this Chapter.

When flying with the afterburner cut in, temperature of gases aft of the turbine, irrespective of the altitude and flight conditions should not exceed 680°C.

It should be taken into consideration that when the maximum or augmented rating is cut out during flight, engine thrust is reduced to 0.8 of the normal value, that is the shutters of the jet nozzle shift to the position

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corresponding to the normal rating, while engine speed does not exceed $10{,}400^{+200}$ r.p.m.

At the maximum and augmented ratings, engine thrust may be regulated by changing engine speed with the help of the engine control lever shifted from the "NORMAL" (НОМИНАЛ)stop to the maximum and augmented rating retainer, and backwards. When flying at the throttled maximum or augmented ratings at altitudes of over 15,000 m., the engine control lever should be moved within not less than 5 to 6 sec.

With the aircraft flying at controllable maximum or augmented ratings, engine speed will correspond to the position of the engine control lever; therefore, temperature of gases aft of the turbine will be lower than when the engine control lever at the above ratings is shifted to the "NORMAL"(НОМИНАЛ) stop.

Quick shifting of the engine control lever towards higher speed (acceleration) should be done as instructed in Section 3 of this Chapter. When flying at the throttled maximum or augmented ratings at altitudes of over 15,000 m., the engine control lever should be shifted within not less than 5 to 6 sec.

Caution. When flying at altitudes of over 16,000 m. do not regulate engine thrust at the augmented rating, to avoid sudden cutting out of the afterburner.

5. Routine Maintenance

Carry out routine maintenance operations in compliance with the instructions given in Section 4 of Chapter V, observing the following:

1. When dismantling the oil unit filter, substitute the cover by cap 738П-100.

When washing the filter, stop the holes in its cap with rubber plugs 532П-100 and БИ-8; close the hole in the filter frame with plug 0919013.

When mounting the filter cap onto the oil unit, change three packing rings by new ones.

2. Tighten the nut, securing the oil unit filter cap, using the following procedure:

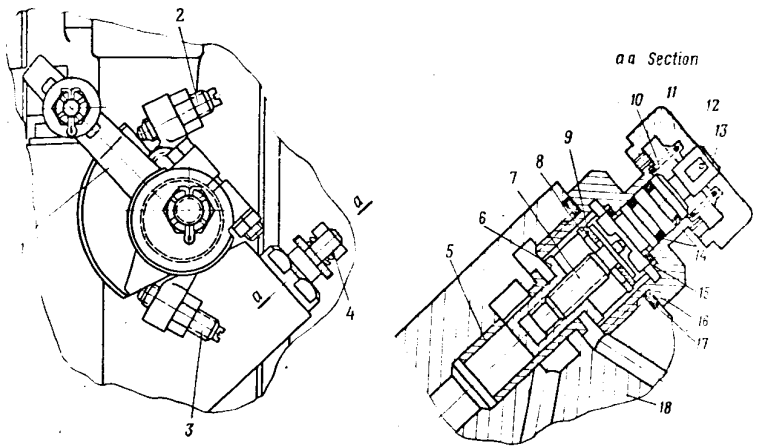

Fig.41. Idling Speed Adjusting Head

1 - lever of НР-10АКС pump; 2 - maximum speed stop; 3 - CUT-OFF (СТОП) stop; 4 - adjusting head; 5 - bush; 6 - valve; 7 - screw; 8 - spring ring; 9 - washer; 10 - spring; 11 - adjusting head knob; 12 - dowel; 13 - shaft; 14 - packing ring (2 pieces); 15 - washer (set); 16 - pipe union; 17 - packing ring; 18 - pump governor housing.

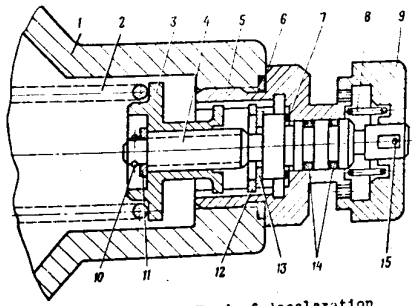

Fig.42. Adjusting Head of Acceleration and НР-10АКС Pump Starting Control Units

1 - acceleration (starting) control unit housing; 2 - acceleration (starting) control unit spring; 3 - stop; 4 - shaft; 5 - pipe union; 6 - packing ring; 7 - washer (set); 8 - spring; 9 - adjusting head knob; 10 - locking ring; 11 - bush; 12 - spring ring; 13 - washer; 14 - packing ring (2 pieces); 15 - dowel.

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(a) mount the cap onto the housing without fitting in packing rings, and turn on the nut until the cap contacts the oil unit housing. With the nut in this position, make a notch on the nut and on the cap. Remove the cap;

(b) mount the cap on the housing having fitted new packing rings under it; tighten the nut with wrench 72E-1 until the cap contacts the housing and the notch on the nut registers with that on the cap; this done, turn the nut down through an angle of 30 to 60° (by 0.5 to 1 flat).

Caution. In case leakage of oil shows up around the parting face of the filter cap and the oil unit housing, replace the packing rings by new ones and turn down the cap nut as instructed above.

It is prohibited to eliminate oil leakage by tightening up the nut securing the filter cap.

3. With the engine at standstill, the shutters of the jet nozzle should be shifted from the maximum rating position within 2.1 to 2.5 sec.

6. Adjustment of Engine Units

Adjustment of the engine units should be carried out in compliance with the instructions given in the respective Section of Chapter VI, taking into account the following.

Adjustment of idling speed

To adjust idling speed, turn the knob of the HP-10AKC pump adjusting head (Fig.41), having disengaged the knob by pressing it off. When the adjusting head knob is turned in the clockwise direction engine speed decreases; turning of the knob in the counter-clockwise direction will cause engine speed to increase. With the adjusting head knob turned by one turn idling speed will be changed by 700-900 r.p.m.

Adjustment of engine acceleration

Engine acceleration should be adjusted as detailed

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in Section 4 of Chapter VI, taking into consideration the following:

(a) engine speed at the beginning of automatic regulation should be set at 9500_{-200} r.p.m.;

(b) time period of engine acceleration should be within the limits set in Section 2 of this Chapter;

(c) manipulate the knob of the acceleration control unit adjusting head (Fig.42) to adjust fuel pressure drop in the auxiliary pipe-line at an engine speed corresponding to the engine control lever position at the "NORMAL" (НОМИНАЛ) stop, with the jet for bleeding air from the acceleration control unit turned out, and at idling speed; perform additional adjustment of engine acceleration, if no proper jet for bleeding air has been selected. Prior to be turned, the knob should be disengaged by pressing it off.

Adjustment of automatic starting

Time period within which engine speed is accelerated to 2000 r.p.m. should be adjusted by turning the knob of the starter control unit adjusting head (See Fig.42); prior to turning the knob should be disengaged by pressing it off.

After adjustment of automatic starting has been completed, the knob of the adjustment head should be capable of turning in both directions by not less than half a turn.

Adjustment of operation of HP-10AKC pump hydraulic decelerator limit switch

The limit switch of the hydraulic decelerator of the HP-10AKC pump should operate at an engine speed of $10,900_{-100}$ r.p.m., with the engine control lever smoothly shifted from the 10,000 r.p.m. position to the "NORMAL" (НОМИНАЛ) stop.

Checking and adjustment of the speed at which the hydraulic decelerator limit switch operates should be carried out as instructed in Section 6 of Chapter VI.

Adjustment of gas temperature aft of turbine at augmented rating

With the engine operating at the augmented rating on the ground, gas temperature aft of the turbine should exceed that at the maximum rating by 20 to 50°, but must not be in excess of 680°C.

When flying with the afterburner cut in, gas temperature aft of the turbine (irrespective of altitude and conditions of flight) must not exceed 680°C.

Do not perform any adjustment of gas temperature aft of the turbine in case it does not exceed 680°C.

If gas temperature happens to be in excess of the specified value, adjust it proceeding as instructed below.

Prior to adjusting gas temperature aft of the turbine, check for leakage the joints of the pipe-lines for delivery of gas pressure p_4 and air pressure p'_2 to the afterburner regulator of the HP-11BA pump. Leaky joints of the pipe-line supplying gas pressure p_4 cause an increase in gas temperature, while leakage in the pipe-line supplying air pressure p'_2 tends to reduce gas temperature .

Adjustment of gas temperature by means of bleeding needle

If gas temperature aft of the turbine at the augmented rating exceeds 680°C, with the aircraft flying at altitudes of up to 10,000 m., adjust it with the help of needle 1 (See Fig.38).

Turning of the needle in the counter-clockwise direction reduces gas temperature and vice versa. Turning of the needle through an angle corresponding to one click will change gas temperature by 3 to 5°C.

If gas temperature will not be adjusted with the help of the needle, replace jet 6 or bush 3. A jet with a less diameter orifice reduces gas temperature, and vice versa. A bush of a larger inner diameter reduces gas temperature, and vice versa.

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To replace the jet, turn out needle housing 2, remove bush 3 and then turn out jet 6 (See Fig.38). The newly installed jet should have an orifice diameter of 2.6 to 3 mm, while the inner diameter of the bush should be within 5.5 to 6 mm.

Having replaced the jet or the bush, adjust gas temperature with the help of the needle.

Adjustment of gas temperature by means of screw of HP-11BA pump afterburner regulator spring

If gas temperature aft of the turbine at the augmented rating exceeds 680°C, when flying at altitudes of over 10,000 m. carry out the necessary adjustment using the screw of the spring of the HP-IIBA pump afterburner regulator, for which purpose unlock and back out the plug.

Turning of the screw in the counter-clockwise direction will reduce gas temperature, and vice versa.

The screw of the afterburner regulator may be turned in the counter-clockwise direction only by not more than two turns.

After manipulating the screw of the afterburner regulator spring, adjust gas temperature with the help of the bleeding needle, should it be necessary.

Adjustment of gas temperature by means of screw of HP-IIBA pump barostat spring

If gas temperature aft of the turbine drops suddenly, when the aircraft is flying with the afterburner cut in at an altitude of over 14,000 to 15,000 m. this temperature drop indicates that the barostatic regulator of the HP-11BA pump starts operating.

To avoid sudden drops in gas temperature it is necessary to turn in (clockwise) the barostat spring screw by half a turn.

Note. Adjustment of gas temperature aft of the turbine by means of the screw of the afterburner regulator spring, and the screw of the spring of

the HP-11BA pump barostat is carried out by representatives of the HP-11BA pump manufacturing plant.

Adjustment of operation of control panel ПУ-9Б limit switches Б and МБ

Adjustment of operation of control panel limit switches Б and МБ should be carried out in case some engine troubles have been traced to the control panel.

Prior to carrying out the adjustment, make sure the engine control system is properly connected to the control panel lever; check the engine control system as laid down in Section 8 of this Chapter.

Adjust operation of limit switches Б and МБ as follows:

1. Unlock and back out the bolts securing the upper cover of the control panel; lift off the cover.

2. Unlock the coupling and worm screws of limit switches Б and МБ. Slacken the coupling screw by backing it out two to three turns.

3. By rotating the worm screw of the limit switch cam, adjust operation of limit switches Б and БМ depending on the angle of turn of the control panel lever (as indicated on the control panel dial), with the engine control lever being shifted from the "CUT-OFF" (СТОП) to the "NORMAL" (НОМИНАЛ) stop.

Limit switch МБ should operate when the control panel lever is turned through an angle of $66^{\pm 1}$° (as indicated on the dial), and limit switch Б should operate when the control panel lever is turned through an angle of 82^{+1}°. Operation of the limit switches should be checked with the help of a special device or by a characteristic click inside the control panel.

With the engine control lever shifted backwards, that is towards the "CUT-OFF" (СТОП) position, limit switches МБ and Б should operate at the same angles of turn of the control panel lever (as indicated on the dial) but in the reverse sequence.

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4. Tighten the coupling screw of the limit switch in question.

5. Check limit switches МБ and Б for proper operation, with the engine running.

To determine engine speed at which limit switch Б operates, bring engine speed to 10,000 r.p.m. and press button "MAXIMUM"(МАКСИМАЛ). Keeping button "MAXIMUM" (МАКСИМАЛ) pressed, smoothly increase engine speed and determine the speed at which limit switch Б operates by the indications of the maximum rating pilot lamp, which should flash up. Engine speed should amount to $10{,}950^{+100}$ r.p.m.

Engine speed at which limit switch МБ operates, should be checked by smoothly reducing engine speed with the maximum rating cut in. Operation of limit switch МБ is indicated by the pilot lamp, which should go out; limit switch МБ should operate at an engine speed of $10{,}400^{+200}$ r.p.m.

If necessary, adjust operation of limit switches МБ and Б at the required engine speed by rotating the worm screw of the limit switch cam, as instructed above. When the worm screw is turned in engine speed at which the limit switch operates is reduced, and vice versa.

Tighten the coupling screw and lock it together with the worm screw, using brass wire.

6. Mount the upper cover onto the control panel and bolt it down having placed new locking washers under the bolt heads. Lock the bolts.

Adjustment of afterburner

If the afterburner would not cut in in flight, proceed as follows:

1. In case the engine is fitted with the HP-11BA pump, manufactured before November 11, 1957 and having no notes in its Certificate as to tightening the screw of the stop ensuring minimum angle of inclination of the wobble plate, turn the screw in question through one revolution, for which purpose dismount the HP-11BA pump from the engine.

2. Check and if necessary install a 0.7 to 0.8 mm damper and a 1.2 mm jet on the pump.

After the above operations are completed, check fuel pressure increase in the afterburner diffuser manifolds, with the engine running and the afterburner cut in, proceeding as follows:

1. Detach the fuel pressure supply pipe from the HP-11BA pump afterburner regulator.

2. Start the engine, warm it up, and cut in the afterburner.

If, with the afterburner cut in, the jet nozzle hutters shift to the augmented rating position, the minimum output of the HP-11BA pump and fuel pressure increase in the afterburner diffuser manifolds are sufficient to provide for reliable cutting in of the afterburner in flight.

Caution. The aircraft is allowed to fly only if the jet nozzle shutters shift to the augmented rating position, when fuel pressure in the diffuser manifolds is being checked for proper increase.

3. Connect the air pressure supply pipe to the HP-11BA pump afterburner regulator and check engine for proper operation at all ratings.

Check the afterburner for proper cutting-in when performing the next flight at an altitude of up to 14,500 -15,000 m.

Notes. 1. Tightening of the screw of the stop ensuring minimum angle of inclination of the plate as well as replacement of the damper and jet of the HP-11BA pump servopiston is carried out by the representatives of the HP-11BA pump manufacturing plant.

2. Operations enumerated in this Subsection should be also carried out when installing a new engine and HP-11BA pump.

7. Replacement of Engine Units and Assemblies

Engine units and assemblies should be replaced in compliance with the instructions given in Chapters VII and XII, taking into consideration the following particulars.

Replacement of HP-10AKC pump

After installing the new HP-10AKC pump and connecting the control link to the pump lever, check and adjust the engine control system, proceeding as follows:

1. Set the lever of control panel ПУ-9Б in the zero position (as indicated on the dial), with the lever of the HP-10AKC pump at the "CUT-OFF"(СТОП) (the throttle cock is completely closed).

2. Shift the control panel lever to an angle of $90\pm1^{\circ}$; the HP-10AKC pump lever moving in step with the control panel lever should set at the "NORMAL" (НОМИНАЛ) stop (the throttle cock is fully open).

To ensure that the positions of the HP-10AKC pump lever at the "CUT-OFF" (СТОП) and "NORMAL"(НОМИНАЛ) stops should coinside with the positions of the control panel lever in the zero and $90\pm1^{\circ}$ positions (respectively), change the position of the link on the pump lever by shifting the lever rack, or change the length of the link, rotating it by the hexagon. When increasing the length of the link watch the shackle travel in the link, looking through the check holes. The shackle should not be extracted as far as to uncover the first hole.

3. Connect the engine control link to the control panel lever, and check the engine control system as recommended in Section 8 of this Chapter.

Replacement of HP-11BA pump

When removing the HP-11BA pump from the engine, make sure to detach the pipes for supply of air pressure p_2' and gas pressure p_4 from the pump afterburner regulator; connect the above pipes after installation of a new HP-11BA pump.

Having replaced the HP-11BA pump,start the engine, warm it up, and cut in the afterburner as instructed in Section 3 of this Chapter; check gas temperature aft of the turbine at the augmented rating, which should exceed gas temperature at the maximum rating by 20 to 50°C, but must not be in

excess of 680°C. Should it be necessary, adjust gas temperature aft of the turbine at the augmented rating as instructed in Section 6 of this Chapter.

When cutting in the afterburner measure the actual drop or rise of the gas temperature aft of the turbine, as compared to the gas temperature at sustained maximum rating. Temperature drop should not exceed 50°C; no temperature rise should be allowed. If necessary, adjust jet nozzle shutters so that it should take 2.1 to 2.5 sec. to shift the shutters from the maximum rating position to the augmented rating position; proceed as instructed under Section 2 of Chapter VII.

Note. When installing a new HP-11BA pump, it is necessary to carry out the operations enumerated in Section 6 of this Chapter (See "Adjustment of afterburner").

Replacement of oil unit filter parts

Should it be necessary the following parts of the filter may be replaced (See Fig.40):

(a) gauze discs (the entire set or individual discs);
(b) filter frame;
(c) filter spring;
(d) strainer at oil inlet to the reducing valve.

Replace the filter spring and strainer proceeding as follows:

1. Detach the fuel-oil unit breather pipe from the fuel-oil unit pipe union and from the breather pipe of fuel-oil unit 317A oil tank; remove the breather pipe.

2. Unlock the nut of the coupling stud of the oil unit filter cover and remove the cover complete with the filter by turning the nut.

3. Remove the spring and take the strainer out of the oil unit housing. Mount cap 733П-100 onto the oil unit housing in place of the cover.

4. Wash the oil filter (without disassembling it) in clean gasoline, as recommended in Section 4 of Chapter V and in Section 5 of this Chapter.

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5. After the washing procedure is completed, install in position the strainer, spring and oil filter, having removed the cap from the oil unit housing, and after fitting new packing rings (3 pieces) under the filter cover. Fasten the filter cover with a nut as instructed in Section 5 of this Chapter.

6. Connect the oil unit breather pipe to the cover pipe union and to the fuel-oil unit oil tank breather pipe; be sure to fit new packing rings into the joints.

Replacement of the gauze discs and the filter frame should be done as follows:

1. Remove the cover complete with the filter as laid down above (See Points 1 and 2), and mount cap 733П-100 on the oil unit housing.

2. Unlock and turn off the nut securing the gauze discs to the filter frame; remove the washer, the gauze discs, and another washer.

When replacing the filter frame, extract the spring ring from the cover, remove the thrust washer and the filter frame.

When replacing the gauze discs, check their supporting surfaces for proper contact on a plate, using paint pattern method. The paint pattern should be continuous around the entire circumference. The total contact surface should amount to not less than 75 per cent of the entire disc surface.

3. Wash the gauze discs in clean gasoline. To prevent dust or foreign matter from getting inside the gauze discs during washing, stop the disc holes with rubber plug 533П-100.

4. Insert the filter frame, thrust washer and spring ring into the filter cover (when replacing the filter frame).

5. Fit the washer, gauze discs and another washer onto the frame; turn on the nut, having placed a new locking washer under it. Lock the nut.

6. Install the filter in position as instructed above.

Replacement of control panel ПУ-9Б

After installing the new control panel and connecting the control link to the panel lever, check and adjust the engine control system in compliance with the instructions given above (See Subsection "Replacement of НР-10АКС Pump").

Checking and adjustment of operation of control panel limit switch Л should be done as laid down in Section 9 of Chapter VI.

Final checking and adjustment of operation of control panel limit switches З, МБ and Б should be performed with the engine at standstill, as detailed in Section 7 of Chapter VI and in Section 6 of this Chapter.

Replacement of afterburner tube, middle tube, and jet nozzle

On the engines manufactured after July 15,1957 the bolts securing the half-rings of the afterburner-to-diffuser quick-release joint should be locked with cotter pins.

When replacing the afterburner tube (complete with the jet nozzle), or the jet nozzle, checking and adjustment of the jet nozzle diameter in position corresponding to the augmented, maximum and normal ratings, as well as checking and adjustment of the time period within which the jet nozzle shutters shift from the normal rating position to the maximum rating position, and from the maximum rating position to the augmented rating position, should be carried out in compliance with the instructions given in Section 20 of Chapter VII. Shifting of the jet nozzle shutters from the normal rating position to the maximum rating position and from the maximum rating position to the augmented rating position should be accomplished by setting the engine control lever at the "NORMAL" (НОРМАЛ) stop with subsequent pressing of buttons "MAXIMUM" (МАКСИМАЛ) or "AFTERBURNING" (ФОРСАЖ) respectively (for 1 to 2 sec.).

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The jet nozzle shutters should shift from the maximum rating position to the augmented rating position within 2.1-2.5 sec., and from the normal rating position to the maximum rating position – within 2.5 – 5 sec.

Shifting of the jet nozzle shutters from the maximum and augmented rating positions to the normal rating position should be done by moving the engine control lever beyond the maximum and augmented ratings retainer.

Note. When the maximum or augmented rating is cut out the jet nozzle shutters always shift to the normal rating position.

When checking engine operation after replacement of the afterburner tube (complete with the jet nozzle) or of the jet nozzle, measure the actual drop of gas temperature aft of the turbine caused by cutting in the afterburner, as compared to gas temperature at sustained maximum rating. A drop of gas temperature should not exceed 50°C; sharp temperature rise is not to be allowed. Should it be necessary, adjust the jet nozzle shutters so that they shift within 2.1-2.5 sec; proceed as instructed in Section 2 of Chapter VII.

8. Replacement of Engine

On the engines manufactured after July 15, 1957 the bolts securing the half-rings of the afterburner-to-diffuser quick-release joint should be locked with cotter pins.

The engine control system should be checked for proper operation by smoothly shifting the engine control lever from the "CUT-OFF" (СТОП) stop to the "NORMAL" (НОМИНАЛ) stop and backwards. The lever should move smoothly, without binding. Check to see that:

1. When the engine control lever is set at the "CUT-OFF" (СТОП) stop, the zero notch on the control panel dial should set against the notch provided on the control panel housing, while the lever of the НР-10АКС fuel pump should fit tightly to the "CUT-OFF" (СТОП) stop on the pump dial.

In this position the engine control lever should be capable of additional travel by 1-2 mm (towards closing).

2. When the engine control lever is set at the idling rating retainer, the notch on the lever of the НР-10АКС pump should set between the extreme notches, marking the idling rating sector on the pump dial.

3. Shifting of the engine control lever to the maximum and augmented rating retainer causes control panel limit switch МБ to be turned on, which means that the control panel lever is turned to an angle of $66\pm1^{\circ}$.

Note. The maximum and augmented rating retainer should be set in position where engine speed exceeds the speed, at which the maximum and augmented ratings are cut out, by 100 r.p.m.

4. When the engine control lever is shifted to the "NORMAL" (НОМИНАЛ) stop, the fuel pump lever sets at the maximum speed stop on the dial of the НР-10АКС pump, whereas notch $90\pm1^{\circ}$ on the control panel dial lines up with the notch on the control panel housing. In this case engine control lever should be capable of additional travel towards opening by 1-2 mm.

5. Turning of the control panel lever causes the control panel limit switches to operate (characteristic clicks are heard) at the angles (as indicated on the control panel dial) presented in Table 7.

Table 7

Limit switch designation	Angle at which limit switch operates (as indicated on control panel dial), degrees
ХП	3_{-1}
З	25^{+2}
МБ	66 ± 1
Б	82^{+1}

Check the shutters of the jet nozzle for proper shifting in compliance with the instructions given in Section 6 of Chapter IX, taking into consideration the particulars presented in Section 7 of this Chapter.

Preparation of a new engine for starting, starting proper, warming, checking, and stopping should be carried out as instructed in Section 4 of Chapter III, taking into account the particulars laid down in Section 8 of Chapter IX and in Section 3 of this Chapter.

Note. Final checking and adjustment of control panel limit switch operation are performed on a running engine (See Section 6 of this Chapter).

When cutting in the afterburner, measure the actual drop of gas temperature aft of the turbine, as compared to gas temperature at sustained maximum rating; the temperature drop should not exceed 50°C. No sharp rise in gas temperature should be allowed when cutting in the afterburner. If necessary, adjust the jet nozzle shutters so that their shifting from one position to another should take 2.1-2.5 sec., proceeding as laid down in Section 2 of Chapter VII.

Note. When installing a new engine, carry out the operations described in Section 6 of this Chapter (See Subsection "Adjustment of afterburner").

APPENDIX

Aircraft-Carried Tools Used in Engine Maintenance

Nos	Tool No.	Name	Quantity	Purpose
1	2	3	4	5
1	A $\frac{\text{OHK-1}}{118}$	Wrench, S=19-22	1	General-purpose
2	A $\frac{\text{OHK-1}}{114}$	Wrench, S=14-17	1	General-purpose
3	A $\frac{\text{OHK-1}}{107}$	Wrench, S=9-11	1	General-purpose
4	A $\frac{\text{OHK-1}}{101}$	Wrench, S=5-7	1	General-purpose
5	141K-8	Wrench, S=9	1	Star-shaped wrench for oil unit securing nuts
6	91K-2	Wrench, S=19-24	1	General-purpose
7	53K-1	Wrench, S=11	1	For bolts of air relief connection flanges
8	89K-2	Wrench, S=7	1	For bolts securing pipe-line clamps
9	318K-12	Torque indicating wrench	1	For flame igniter spark plugs
10	0919802	Wrench	1	Socket wrench for changeable heads, S=9,11, and 14

1	2	3	4	5
11	A $\frac{\text{ОНЕ-12}}{11}$	Wrench, S=14-17	1	General-purpose star-shaped wrench
12	A $\frac{\text{ОНЕ-12}}{4}$	Wrench, S=9-11	1	General-purpose star-shaped wrench
13	47Е-1	Wrench, S=9-11	1	General-purpose star-shaped wrench
14	НУ-9/6	Pliers, l=150	1	General-purpose
15	0919801	Cable for checking electric system	1	General-purpose
16	20Е-13	Screw-driver, l=150	1	General-purpose
17	21Е-13	Screw-driver, l=200	1	General-purpose
18	17Е-13	Screw-driver, l=300	1	General-purpose
19	$\frac{\text{НУ-31-2}}{11}$	Hammer, 200 gr	1	General-purpose
20	НУ-50/5	Marking tool	1	General-purpose
21	НУ-46/2	Syringe	1	For washing parts
22	119-546	Brush	1	For washing filter gauze discs
23	10У-28	Mandrel	1	For bending locking washer tabs
24	149Е-12	Changeable head, S=9	1	General-purpose
25	150Е-12	Changeable head, S=11	1	General-purpose
26	151Е-12	Changeable head, S=14	1	General-purpose
27	546П-27	Hose	1	For bleeding air when filling fuel system
28	65Е-1	Wrench, S=8-12	1	General-purpose
29	66Е-1	Wrench, S=27-30	1	General-purpose
30	88Е-2	Wrench, S=4	1	Square wrench for adjusting elements of HP-10A and HP-11A pumps

1	2	3	4	5
31	223Е-8	Wrench, S=38	1	For union nut of low-pressure fuel system pipe-lines
32	240Е-12	Wrench	1	For closing compressor ports with air blow-off band (not to be found in tool bag, for it is supplied with engine)
33	72Е-1	Wrench, S=17-19	1	For nuts of high-pressure fuel system pipe-lines
34	73Е-1	Wrench, S=27-30	1	For nuts of oil system pipe-lines
35	92Е-1	Wrench	1	Wrench for mounting tachometer generator ДТ-3
36	717П-7[x]	Adapter	1	For corrosion-preventive treatment of engine inner surfaces
37	532П-100	Plug	1	For stopping hole in oil unit filter cover
38	533П-100	Plug	1	For stopping holes in gauze discs of oil unit filter
39	534П-100	Lock	2	Lock of snap hook type for securing tools when performing work
40	90Е-2	Wrench, S=22	1	Split, star-shaped wrench for nut of centrifugal valve drain pipe union

1	2	3	4	5
41	85Ж-2	Wrench, S=30	1	For nut of pipe delivering oil from fuel-oil unit 317A to oil unit
42	86Ж-2	Wrench (Г-shaped)	1	For bolts securing flanges of low-pressure fuel pipes and for nuts securing oil unit filter cover
43	754П-7 x	Plug connector	1	Plug connector ВШ-4 for simulating operation of limit switch of НР-10А pump hydraulic decelerator, when checking operation of jet nozzle shutters
44	95Ж-1	Wrench, S=36-41	1	For mounting low-pressure fuel pipes
45	788П-7	Cap	1	For oil unit housing
46	54М-Б-28	Drift	1	General-purpose
47	54М-Б-29	Wrench, S=9	1	For bolts securing jet nozzle cylinder shields
48	833П-7 x	Adapter	1	For connecting plug connector of НР-10А pump to plug connector of wire harness of warning unit 2СДУ5-1.3-2.2

1	2	3	4	5
49	834П-7 x	Three-point instrument connector	1	For simulating operation of warning unit ДСД-2 when checking spark formation on afterburner plug
50	54М-Б27	Aircraft-carried tool bag	1	For stowage of tools
51	717П-710 x	Cap	1	For pipe union of oil unit cover
52	0919013 xx	Cap	1	For oil unit filter frame
53	БМ-8 xx	Plug	1	For oil unit cover
54	733П-100 xx	Cap	1	For oil unit housing

Notes. 1. Each of the tools, whose Nos are marked with one asterisk, is supplied with every 20 engines.

2. Stowed in the aircraft-carried tool bag are also the tools for fuel-oil unit 317A: wrench for filler (1 piece), oil gauge (1 piece per 6 engines).

A funnel for pouring oil into the oil tank of fuel-oil unit 317A is packed together with the single set of engine spare parts.

3. Tools marked with two asterisks are supplied with the РД-9Б engines of the sixth series.

C O N T E N T S

CONTENTS

50X1-HUM