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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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COUNTRY	Czechoslovakia	REPORT	[redacted]
SUBJECT	Loading Manual for Military Cargo Version of the Av-14 (Il-14) Aircraft	DATE DISTR.	7 JUL 1964
		NO. PAGES	1
		REFERENCES	
DATE OF INFO.	[redacted]		
PLACE & DATE ACQ.			

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[redacted] English-language version of a Czechoslovak aircraft manual entitled "Loading Instructions, Military Cargo Version, Av-14," prepared by Avia (Automobile Plant Letnany, Jiri Dimitrov Plan) in Prague-Letnany. The manual is comprised of 16 pages of text and three pages of charts.

[redacted]

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Distribution of Attachment:
~~OCR~~
Army - retention

[redacted]

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STATE	DIA	ARMY	NAVY	AIR	NSA	AID	OCR	
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INFORMATION REPORT INFORMATION REPORT

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SECRET

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LOADING INSTRUCTIONS

MILITARY CARGO VERSION

Av 14

AVIA

Prague

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LOADING INSTRUCTIONS

FOR Av-14 MILITARY CARGO VERSION

/Appendix to Av - 14 Aircraft Operation Manual/

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Loading of the aircraft

1. The aircraft must be loaded with due consideration of the max. take-off weight, the minimum petrol corresponding to that weight, the computed normal landing weight with the necessary reserve of petrol on board, the zero fuel weight and the prescribed center of gravity limits, especially when the normal landing weight is high /around 17000 kg/.

Loading sequence:

a/ compute the max. take-off weight taking into account the airfield conditions /i.e. temperature, height above sea level, length of runway, obstructions, surface and prevailing wind and required one-engine performance,

b/ prepare the flight-plan and compute the necessary fuel for the given operation under the prevailing meteorological and tactical conditions /for planning purposes a consumption of 400 kg of petrol per hour may be taken/,

c/ from data obtained under a/ and b/ the max. payload which may be carried may be computed,

d/ the load in the fuselage has to be distributed according to the appendixed loading chart.

Note: Approx. rule for take-off weight reduction:
4 - 5% G for each 15°C above 15°C
3% G for the first 6000 ft airfield pressure altitude
/G = design take-off weight = 17500 kg/

Also, when standart take-off performance is required, use can be made of the take-off distance graph for the estimation of the take-off weight giving under actual condition the standart take-off performance.

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Note: Full design take-off weight 17500 kg may be used even in hot climate and on an airfield higher above the sea level when runway lenght is sufficient and the necessary one-engine performance during take-off may be obtained for the given airfield.

Note: In very urgent cases in order to achieve longer range with full pay load an overload take-off weight 18000 kg may be used. In this case a minimum of 1500 kg of petrol is carried and the IAS in level flight must not exceed 310 km/h. This take-off weight may be used only under explicit orders of the commanding officer since the one-engine performance even on take-off engine power in tropics is below the normal standards and landing requires more skill on the part of the pilot.

C.G. posn. near the rear C.G. limit should be used for the take-off.

2. Weights:

Aircraft weight empty . . . . 12 000 kg
Design take-off weight . . . . 17 500 kg
Overload take-off weight . . . . 18 000 kg
Min. petrol for take-off at 17 500 . . . . 1 000 kg
Min. petrol for take-off at 18 000 . . . . 1 500 kg
Min. petrol for take-off /operational minimum/ . . . . 800 kg
Max. total payload /freight/ . . . . 3 900 kg
Max. total load in zones 1-2 /front fuselage/ . . . . 1 700 kg
Max. total load in zones 3-4 /over the wing center-section/. . 1 500 kg
Max. total load in zones 5-8 /rear fuselage/ . . . . 2 000 kg
Max. zero fuel weight . . . . 16 550 kg
Max. landing weight . . . . 17 000 kg
/for take-off c.g. restrictions as a function of the take-off weight see appendixed loading chart/
Service load . . . . 80 kg
Aircrew /4x80/ . . . . 320 kg
Weight of one fully equipped man . . . . 100 kg

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3. Load distribution

Three main types of loading are considered:

a/ transport of paratroops with some light equipment in containers dropped by parachute,

b/ transport of airborne troops /30 fully equipped men/

c/ transport of cargo

The fuselage is divided into 8 loading zones. The individual zones are marked on the cabin wall together with the max. permissible load in the zone.

The max. single load is 1500 kg. This may by carried distributed over zones 3 and 4.

A single load of 1000 kg may be carried in zones 2,5 and 6.

The max. load in the individual zones are:

Zone 1	700 kg	
Zone 2	1 000 kg	
Zone 3	750 kg	or single load of 1500 kg
Zone 4	750 kg	
Zone 5	1 000 kg	
Zone 6	1 000 kg	
Zone 7	400 kg	
Zone 8 /rear cargo compartment/	500 kg	

The max. spec. floor loading is 600 kg/m² and the single loads have therefore be distributed over the appropriate area of the floor.

Note: Heavy items must not be placed over the floor lateral divisions and have to be accommodated inside the floor panel. This restriction does not apply to the floor divisions along the central channel and the division over the bulkhead No 21.

General loading rules.

When flying a mixed transport, containers or smaller items are placed along the middle of the cabin while the men sit along the cabin walls. All items have to be strapped to the floor. Heavy items /1000 kg/ have to be strapped to at least eight anchoring points. When carrying boxes, the largest dimensions should be in contact with the floor when any position of the box is permissible /boxes not marked "Do not tilt"/.

When loading very heavy items, the balance of the aircraft during loading should be considered to avoid the aircraft tail-sitting. Generally with some load in the front cabin there is no danger of the aircraft to become too tail-heavy during loading. When loading the aircraft, it should stand on level ground with chocks under the wheels and applied brakes.

When loading the rear cargo compartment take care not to come in touch with the batteries located in the rear corner. The load has to be so arranged, that during taxying, landing and flight in turbulence there is no possibility that it would damage the batteries.

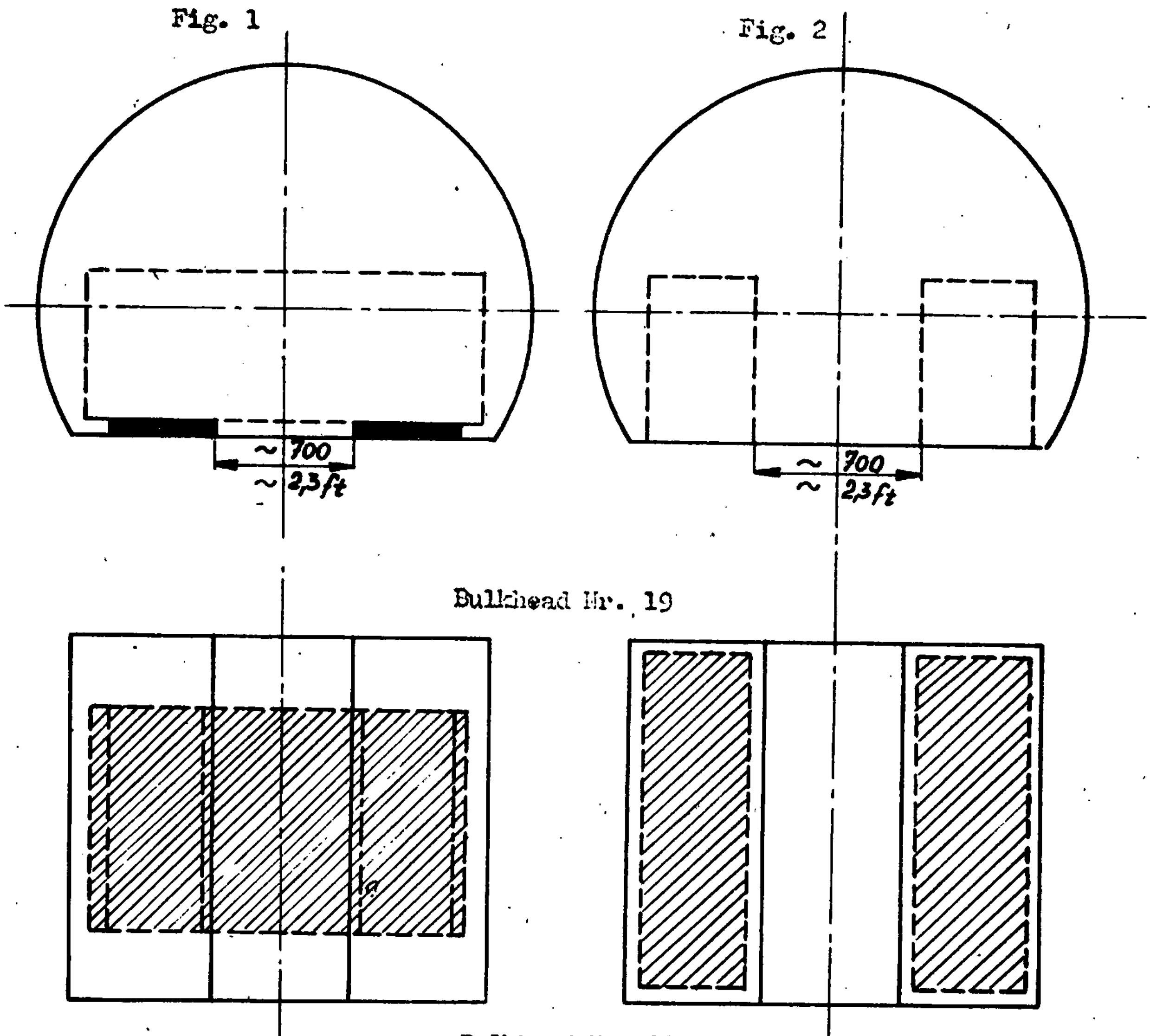
Note: When flying empty aircraft during testing, balast weight 600 kg must be carried in the rear cargo compartment /zone 8/.

Note, that the max. of 500 kg in zone 8 applies only for loading the aircraft as a cargo machine and does not apply to this case when aircraft is flying practically empty.

When dropping paratroops or airborne equipment, care must be taken during the loading to ensure that the center of gravity of the aircraft after the troops have been dropped, shall not move outside the prescribed limits. Usually it is necessary to take on board a minimum of 450 kg of ballast carried in the rear cargo compartment /zone 8/. This is based on the assumption that normal landing weight shall not exceed 14000 kg. Even so it is necessary to land at a higher speed in order to ensure enough control in bumpy weather and if possible use only 30° flaps and a bit of engine power during the flare-out.

EXAMPLES OF RECOMMENDED LOADING

/Loading zones Nr.3 and 4/



On fig. 1 is shown an example how to locate a load of 1500 kg /2207 lb/ resting on two or more supports.

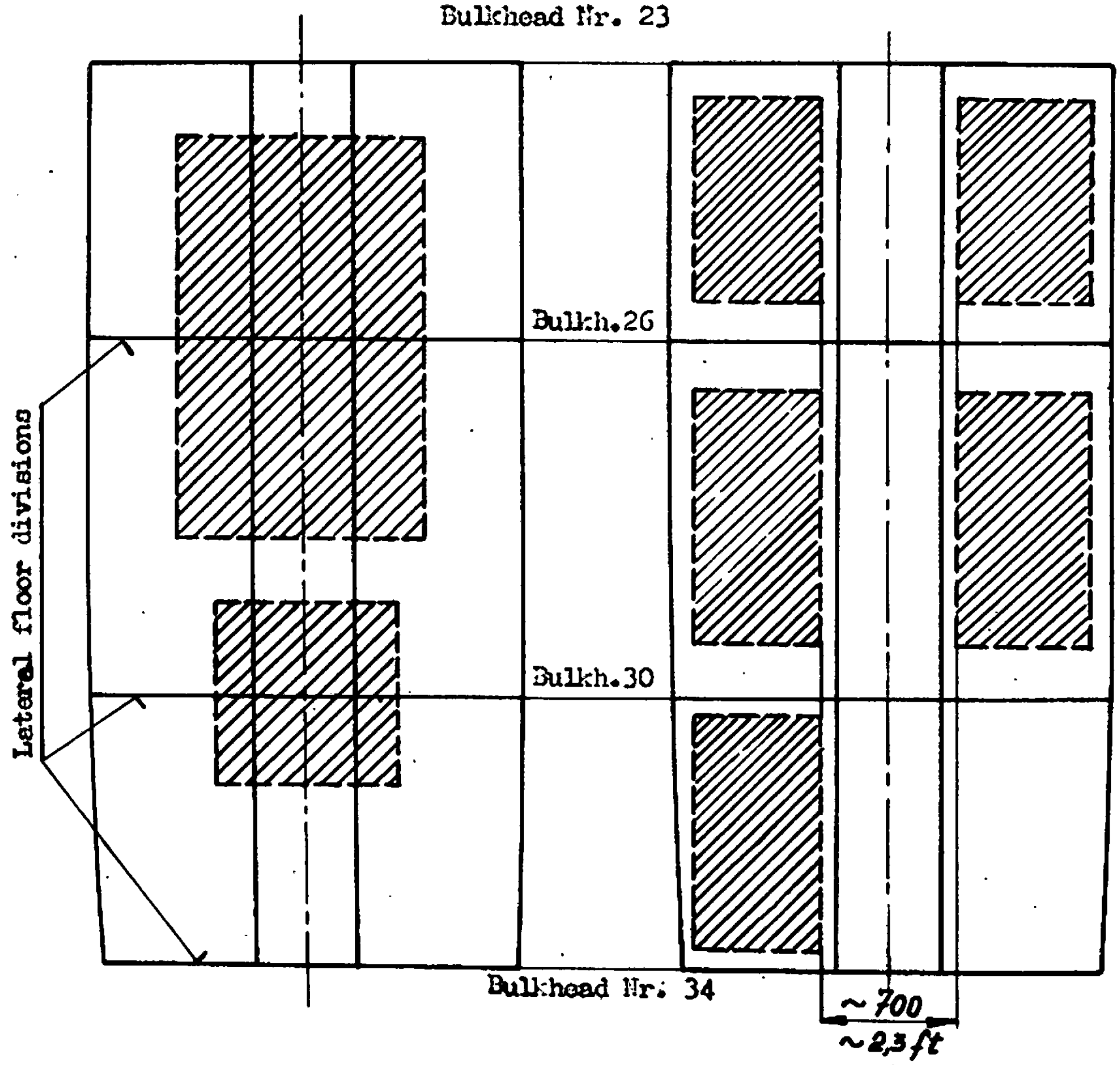
On fig. 2 is given an example how to locate a load of 2x750 kg /2x1103 lb/.

In both cases the load must be so distributed as not to exceed the maximum specific floor loading, i.e. 600 kg/m^2

EXAMPLES OF RECOMMENDED LOADING

/Loading zones Nr. 5,6,7/

Fig. 3 Fig. 4



On fig. 3 is shown an example how a load must not be located

On fig. 4 is shown the recommended way of locating a load of maximum weight as mentioned in the balance chart with due regard to the aircraft C.G. position. The contact area of the load supports must be so chosen that nowhere the max. specific floor loading of 600 kg/m^2 will be exceeded.

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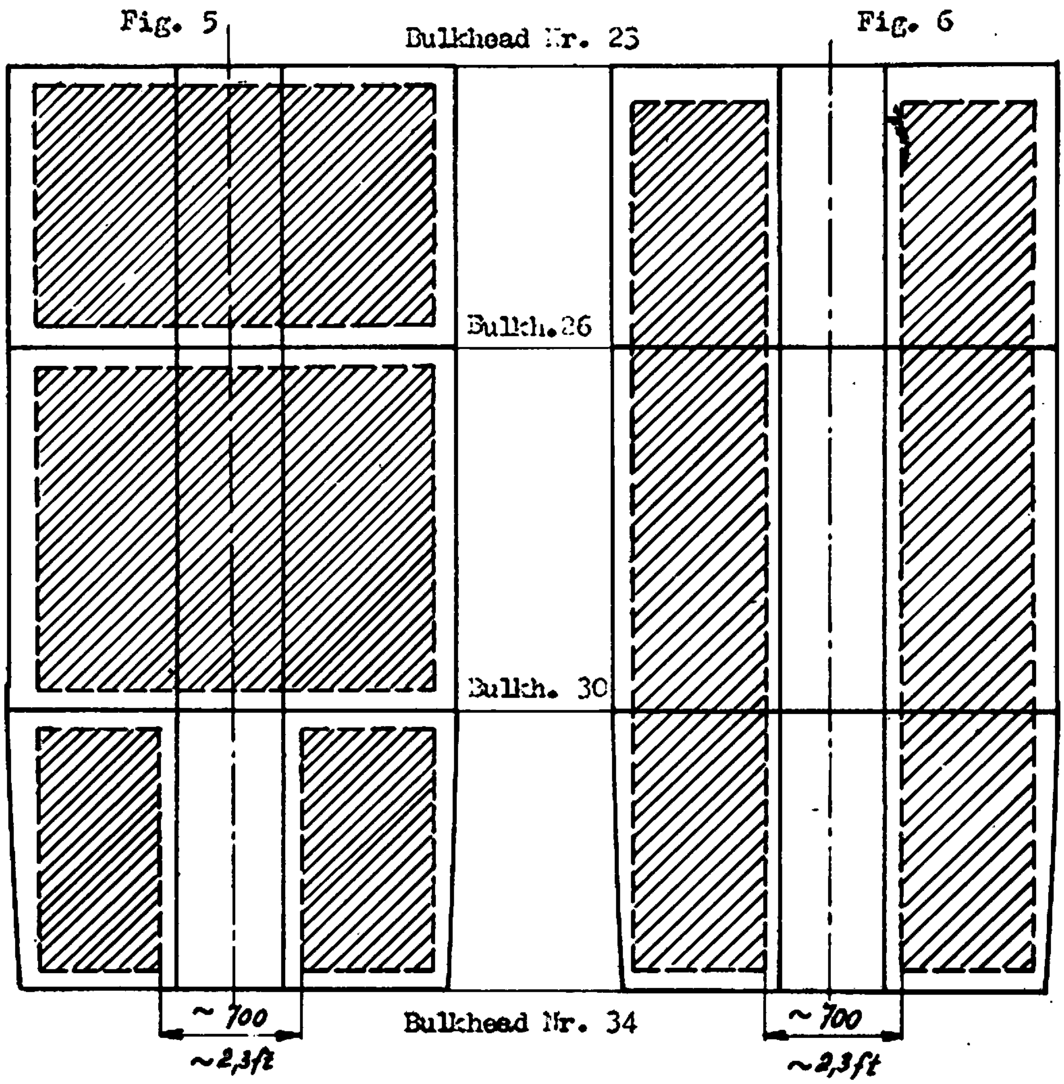
EXAMPLES OF RECOMMENDED LOADING

/Loading zones Nr. 5,6,7/



On fig. 5 is shown an example how to locate a load of the maximum total weight as mentioned in the balance chart with due regard to the aircraft C.G. position.

Caution! Analogical requirements concerning the location of loads, as illustrated on fig. 4,5,6 apply for zones 1,2.

On fig. 6 is shown an example how to locate long items in the cabin The contact area must be such that the specific floor loading is not exceeded. Long items of high rigidity should rest on supports in order not to overload the fuselage bulkheads under the floor divisions.

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INSTRUCTIONS FOR THE USE OF THE LOADING

& BALANCE CHARTS.

1. Determine the aircraft take-off weight using the take-off run and distance chart or the approximate rule when a standart one-engine performance is required. /4 - 5% W for first 15°C above 15°C, 3% W for first 6000 feet above sea level/.

2. Complete the flight plan on the basis of the latest meteorological forecast.

3. Compute the quantity of fuel necessary for the flight taking 400 kg of fuel per hour and adding additional 400 kg of potrol for diversion.

4. Using c.g. posn. chart select the range of C.G. for take-off. The forward C.G. limit is given by the intersection of the horizontal line going through the chosen value of the take-off weight and the dot-and-dash curve marked by the selected weight of fuel. The practical rear limit is 21% MAC.

5. Distribute the load approximately using data for the individual loading zones. With the aid of the balance chart determine the loaded index of the aircraft and check whether it falls into the selected range of C.G. for the take-off with the chosen quantity of petrol at the chosen take-off weight. Should this check come out unsatisfactorily, redistribute the load and check the loaded index again.

6. Fill the "Weight analysis" chart which is a document going with the aircraft testifying its proper loading. This chart must be signed by the officer in charge of loading and checked by the aircraft's captain.

7. Note: Empty aircraft weight and c.g. position given by the manufacturers are approximate figures only. Each aircraft's empty weight and c.g. should therefore be found exactly by weighing.

The empty aircraft index is found from the formula.

$$I_{empty} = 75 - \frac{W_{empty} /1,243-x/}{300}$$

W_{empty} /kg/ = weight of the empty aircraft

x /m/ = distance of the c.g. from the beginning of the MAC.

Should the c.g. position be given in % MAC, we have

$$x = \frac{x \text{ \% MAC}}{100} \cdot 3,412 \text{ m}$$

EXAMPLES OF USING THE LOADING CHARTS

Note: In the following examples an aircraft basic weight of 13000 kg is assumed purely for the simplicity of computation.
These examples are for training purposes only and cannot be used as actual loading cases for operational aircraft, when the basic weight is 12600 kg.

Assumptions:

a/ Basic weight - weight empty, crew, service load = 13000 kg
b/ Basic index - index of the aircraft basic weight = 27 units
c/ Fuel consumption = 400 kg/hour
d/ Average ground speed = 300 km/hour

Example 1.

Airfield pressure height H = 0
Temperature t = 15°C

It is required to transport maximum payload over a distance of 300 km.

1/ Take-off weight = design take-off weight = 17500 kg

2/ Fuel = $\frac{\text{consumption}}{\text{ground speed}}$. distance + 400 = 500 kg

3/ Read payload and loaded index range from dia. 2

Payload = 3700 kg

Index range = 37,6 - 44,4

4/ Distribute load as follows:

zone 2	1000 kg
zone 3	500 kg
zone 4	500 kg
zone 5	600 kg
zone 6	900 kg
zone 7	200 kg

Aircraft loaded index = 43

Example 2.

It is required to transport 2000 kg over a distance of 1200 km

H = 0, t = 15°C

1/ Permissible take-off weight = 17500 kg

2/ Fuel = $\frac{400}{300} \cdot 1200 + 400 = 2000$ kg

3/ From dia. 1 obtain range of loading index

Actual take-off weight shall be:

Basic weight	13 000 kg
Fuel	2 000 kg
Load	2 000 kg
	17 000 kg

Loading index range from dia. 1. 36,6 - 45,2

4/ Distribute load as follows:

zone 3	500 kg
zone 4	500 kg
zone 5	600 kg
zone 6	400 kg

Aircraft loaded index = 37

Example 3.

It is required to transport the highest possible load over a distance of 1500 km.

H = 4000 ft, t = 21°C

1/ Permissible take-off weight = 16800 kg

2/ Fuel = $\frac{400}{300} \cdot 1500 + 400 = 2400$ kg

3/ From dia. 1 obtain loading index range 36,2 - 45,6

4/ Compute payload:

Take-off weight	16 800 kg
A/C basic weight	13 000 kg
Fuel	2 400 kg
Payload	1 400 kg

5/ Distribute payload as follows:

zone 4	500 kg
zone 5	400 kg
zone 6	500 kg
	1 400 kg

Aircraft loaded = 38,5

Example 4.

30 airborne troops with about 200 kg of equipment are to be transported over 600 km.

H = 800 ft, t = 15°C

1/ Permissible take-off weight = 17430 kg

2/ Fuel = $\frac{400}{300} \cdot 600 + 400$ = 1200 kg

3/ Take-off weight /actual/:

Basic weight	13 000 kg
Fuel	1 200 kg
Troops	3 000 kg
Cargo	200 kg
	17 400 kg

From dia. 1 the index range is 36,8 - 44,5

4/ Distribute the load in the fuselage:

zone 1	6 men	/each 100 kg/
zone 2	6 men	/each 100 kg/
zone 3	2 men	/each 100 kg/
zone 4	4 men	/each 100 kg/
zone 5	4 men	/each 100 kg/
zone 6	6 men	/each 100 kg/
zone 7	2 men	/each 100 kg/
zone 8	200 kg cargo	
	3200 kg	

Aircraft loaded index is 37,5

Example 5.

12 equipped men /à 100 kg/ and 500 kg of cargo transport over a distance of 1 500 km.

H = 2000 ft, t = 17°C

1/ Permissible take-off weight = 17430 kg

2/ Fuel $\frac{400}{300} \cdot 1500 + 400 = 2\ 400$ kg

3/ Actual take-off weight:

Basic weight	13 000 kg
Troops	1 200 kg
Cargo	500 kg
Fuel	2 400 kg
	17 100 kg

4/ From dia. 1 the index range is 37,4 - 45

5/ Distribute the load as follows:

zone 3	200 kg	
zone 4	300 kg	
zone 5	400 kg	/4 men à 100 kg/
zone 6	600 kg	/6 men à 100 kg/
zone 7	200 kg	/2 men à 100 kg/
	1 700 kg	

Aircraft loaded index is 42,5.

Example 6.

2 groups of paratroops /2x12 men à 100 kg/ and 200 kg of cargo have to be transported over a distance of 300 km. The paratroops are drooped at the end of the outward journey and the aircraft returns empty to its base.

H = 1000 ft, t = 16°C

1/ Permissible take-off weight = 17430 kg

2/ Fuel $2x\frac{400}{300} \cdot 300 + 400 = 1200$ kg

3/ Actual take-off weight:

Basic weight	13 000 kg
Constant ballast carried in zone 8	450 kg
Troops	2 400 kg
Cargo	200 kg
Fuel	1 200 kg
	17 250 kg

From dia. 1 the index range is 36,6 - 44,8

4/ Distribute pay load as follows:

zone 1	4 men	/each 100 kg/
zone 2	6 men	
zone 3	2 men	
zone 4	4 men	
zone 5	4 men	
zone 6	4 men	
zone 7	200 kg	
	2 600 kg	

Aircraft loaded index = 43

Corresponding to c.g. posn. of 20,1% MAC.
After flying the 300 km and dropping the troops and 200 kg of cargo, the c.g. moves to 13,7% MAC.

Returning to base with 400 kg of reserve petrol, the aircraft lands at a weight of 13 850 kg and c.g. at 13% MAC.

Should a diversion be necessary and the aircraft would land with only 100 kg of petrol left, the landing weight would be 13 450 kg and c.h. at 12,3% MAC.

In this configuration, increased landing speed is necessary in order to obtain enough control in bumpy weather.

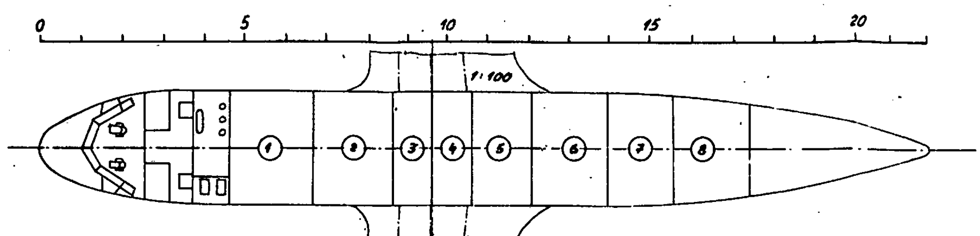
...ate ___ – Weight analysis Compiled by: ___

...ircraft: ___ Av 14-CM Approved by: ___

No.	Space	Load		Weight kg	Index units	C.g. posn. % MAC	Method of determining
1	Fuselage	Crew	2 pilots	160	- 40		Balance chart Av 14-CM
2			navigator	80	- 16		
3			radio-operator	80	- 16		
4		Service load	antifreeze	22	- 03		
5			summer covers	25	+ 08		
6			airborne stairs	43	+ 03		
7			airborne tools	20	- 03		
8	Wing	Oil quantity		200	- 09		
9	Basic load (standard)			600	- 76		Σ 1 + 8
10	Change of basic load						Balance chart Av 14-CM
11							
12							
13							
14							
15							
16							
17	Change of basic load - total						Σ 11 ÷ 16
18	True basic load						Σ 9 + 17
19	Empty aircraft weight and c.g. pos.						Airframe log book
20	True basic weight of aircraft						Σ 18 + 19
21	True basic index of aircraft						Σ 18 + 19
22	Payload						Balance chart Av 14-CM
23	Fuselage	①	Transport version / Parachute-dropping version				
24		②					
25		③					
26		④					
27		⑤					
28		⑥					
29		⑦					
30		⑧					
	Total payload						Σ 23 ÷ 30
	Loaded aircraft index						B.ch. Av 14-CM
	Wing	Fuel [max. 2600 kg]					C.g. pos. ch.
	Resulting take-off weight						Σ 20 + 21 + [illegible]
	Permissible c.g. posn. range for calculated fuel reserve				from / to		C.g. position chart
	Resulting c.g. position for take-off						
	Assumed landing weight						
	C.g. posn. for landing with 400 kg fuel reserve						
	Weight for "zero fuel"*) configuration						
	C.g. posn. for "zero fuel"*) configuration						

*) ...term "zero fuel" means the min. non-drainable fuel quantity - in this case 50kg.

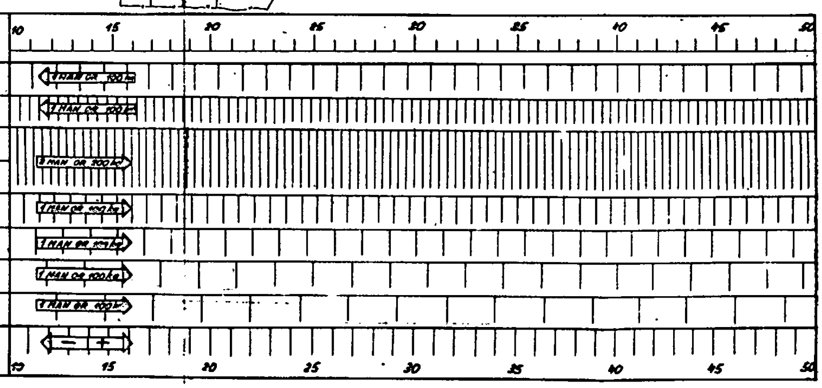
BALANCE CHART AVIA 14 CM

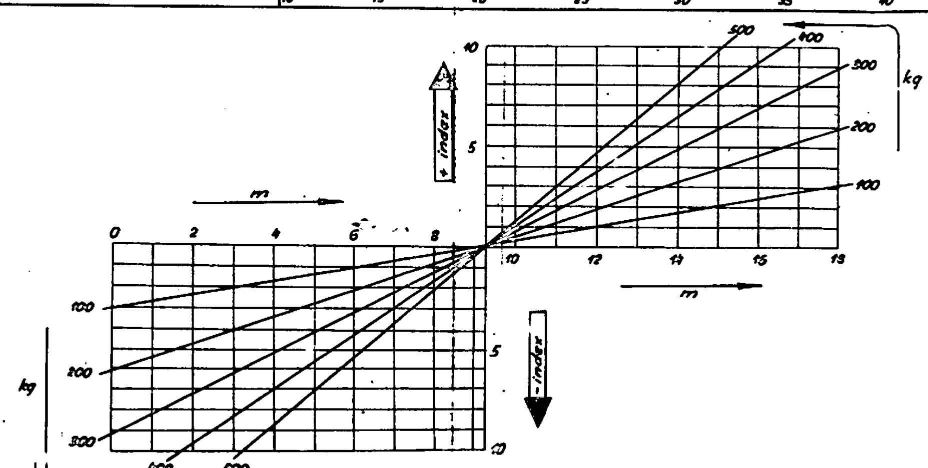


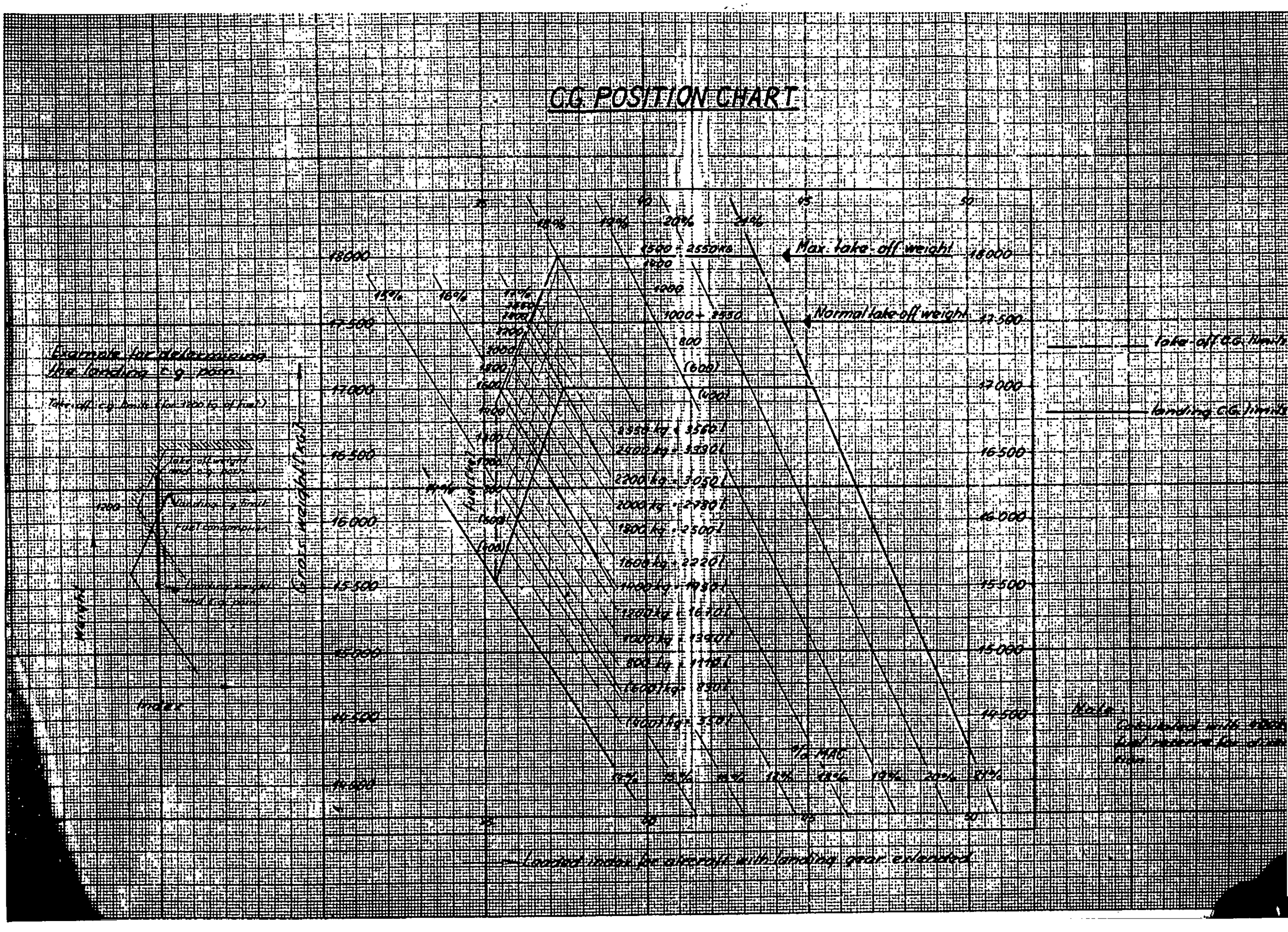
Loading zones	Max. permissible load [kg]	Max. total loading [kg]	Max. number of seats for paratroopers
1	700	1700	6
2	1000		6
3	750		2
4	750		4
5	1000	2000	4
6	1000		6
7	400		2
8	500		-

Aircraft basic index

Resulting index of loaded aircraft






C.G. POSITION CHART
Max. take-off weight
Normal take-off weight
take-off C.G. limits
landing C.G. limits
18000
17500
17000
16500
16000
15500
15000
14500
14000
Gross weight (kg)
% MAC
Loaded index for aircraft with landing gear extended
Example for determining the landing c.g. pos.
Index
Note

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INFORMATION REPORT INFORMATION REPORT

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COUNTRY	Poland	REPORT	[redacted]
SUBJECT	Manuals on the WN-3 Aircraft Engine: Technical Description and Maintenance	DATE DISTR.	8 SEP 1964
		NO. PAGES	1

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DATE OF INFO. [redacted]

PLACE & DATE ACQ.

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[redacted]

(1) a manual containing a technical description of the WN-3 engine and (2) a maintenance manual for the WN-3 engine.

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Distribution of Attachments [redacted]

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TECHNICAL DESCRIPTION
OF THE
WN-3 ENGINE

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TECHNICAL DESCRIPTION

of the

WN-3 ENGINE

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TECHNICAL DESCRIPTION

of the

WN-3 ENGINE

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1.0 WN-3 ENGINE GENERAL INFORMATIONS

1.1 Short description of the engine design

The WN-3 radial engine is of an air-cooled seven cylinders, unsupercharged type.

The nonrotating cylinders are arranged radially and in one plane on a crankcase split on the center line, which contains the single-throw crankshaft with ball bearings.

The values are operated by thrust rods and roller tappets. The cam drum is driven by a toothed gearing in the front crankcase.

Six connecting rods are connected in a joint to the head of the master rod operating upon the crank over two sturdy ball bearings.

The WN-3 engine is equipped as follows:

a/ Engine accessories: K-14-WN3 carburetter, two magnetoes BSM-7M, BNK-12AS fuel pump, WN-3 air distributor, AK-50M compressor.
Each cylinder head is provided with two SD-48BS sparkplugs as well as with a starting valve.

b/ Aircraft accessories: GSK-1500Z generator and AK-4S vacuum pump. On the front crankshaft piece there is mounted an adjustable pitch propeller of WR-1 mark.

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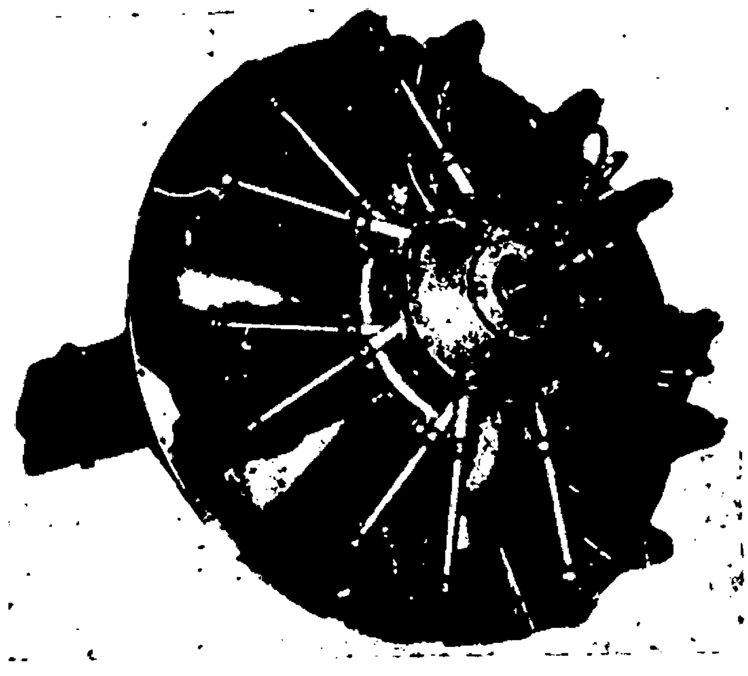

Fig.1 WN-3 engine /front view/.

The crankcase is an aluminium alloy casting divided into three sections: front lid, front part and rear one.

In the front lid there is placed a thrust ball bearing.

The front part of the crankcase is casted together with a chamber which forms a housing for the cam gear, respectively.

Into the hole of the partition separating the cam gear chamber from the crankshaft one is pressed in a steel seat into which a crankshaft front roller bearing is inserted.

The rear part of the crankcase is casted in common with rear chamber and with a mixture distribution chamber.

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The rear roller bearing of the crankshaft is pressed into the partition which separates the crankshaft chamber from the mixture distribution chamber, respectively.

The mixture distribution chamber in form of a ring is provided with seven outlets for separate suction pipes, whilst the rear chamber creates a lenghtened section to enable all the accessories to be fitted.

Inside the rear chamber there are placed some drive assemblies of the engine accessories.

The driving is being transferred from the crankshaft by means of pair of the bevel gear azotised.

Two halves of the crankcase are coupled together with aid of seven bolts.

The openings for the cylinders of both parts are machined in common.

On its outer surface the crankcase is provided with seven retention flanges and stud bolts into which the cylinders are fitted.

On the bottom part of the mixture chamber there is situated a flange for carburettor attachment.

In the centre plane between both parts of the crankcase there is placed a crankshaft assembly.

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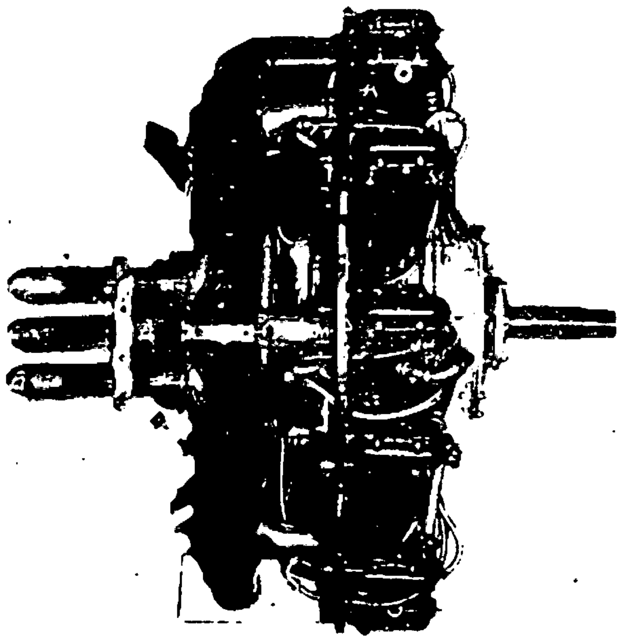

Fig.2 AM-3 engine /front view/.

The cylinders

The cylinder of the engine consists of the sleeve made of chrome-molybdenum stamped steel, azotised internally and machined respectively and also the finned cylinder head casted of aluminium alloy and screwed upon the sleeve after having been warmed up to the limits desired, previously.

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The cylinder head comprises several cooling fins as well as in its top part a rocker chamber covered by means of magnesium alloy cap.

The inlet and exhaust valves are arranged to both sides of the cylinder head and are inclined with an angle of 70 deg. each to other.

The valves are made of fire-resistant steel and are not interchangeable each other.

The combustion chamber between the piston and the cylinder head is of a hemispheric form.

Into the inlet channel of each cylinder head there is attached by means of studs suction manifold conducting the mixture to the cylinder from the mixture chamber.

A priming jet is screwed into each cylinder inlet channel enabling the engine to be primed during its starting.

Light metal pistons are used. They are machined to both surfaces the inner and the outer ones and comprise four piston ring grooves: three from them in the top part of the piston whilst the fourth one in the bottom.

In the both top grooves there are placed two compression rings, whilst in the remain two grooves - the oil scraper rings, respectively.

All the rings are made of a special cast iron and then externally chromium-plated.

The gudgeon pin made of steel is being inserted both to the pin and connecting rod in a manner enabling to form a "floating" construction which more evenly distribute the wear on the pin surface.

The gudgeon pin retention is being assured by means of two aluminium expanding plugs.

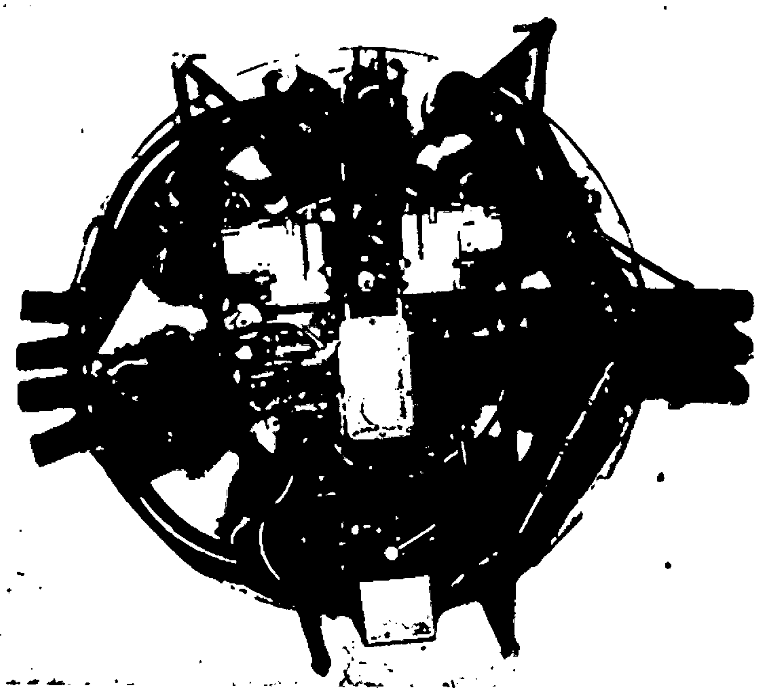

Fig.3 WN-3 engine /back view/.

The crankshaft is one of the parts subjected to the greatest strain and extreme care is needed in its construction and design, because the entire duty of transmitting the power generated by the engine to the propeller devolves upon it.

The crankshaft is made of hight- tensile strength alloy steel of special composition from a forging. It is heat-treated and comprises two pieces the front and rear one.

The complete shaft is carried on two main roller bearings and one thrust ball bearing, respectivelly.

The two pieces of the crankshaft are held together by a clamp bolt passing through the maneton.

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The crankpin as well as the main journals are drilled throughout for lightness, communicating holes and blanking plugs allowing of the resulting chambers utilized for oil circulation and distribution.

Both webs of the crankshaft are equipped with counterweights the front of which is attached rigidly whilst the rear one may be shifted, if necessary.

The crankshaft assembly conists of a master rod and six link rods.

The master rod is made of steel forging and comprises one-piece big end with holes for knuckle pins of link rods.

Into the big end there is pressed in the connecting rod steel bearing covered with anti-friction metal lining /lead-bronze/ and into the top end - the bronze bush.

All the link rods are aluminium alloy forgings of H-sections and operate without any bearings. Said rods are jointed to the master rod big-end by means of steel knuckle pins in such a manner that an axial shifting is assured.

Cam gear assembly consists of a cam assembly drive, cam drum, tappet quides with tappets and rollers, push-rods with covers, rocker levers and also the valves with the springs.

The cam ring is made as a thin walled steel-ring provided with an external toothing and equipped with double runways /distributor driving flange/ carbonised and grinded, respectively.

To enable the camrings to be turned they are driven from the crankshaft by means of driving shaft gear which engages with double indirect toothed gear driving the camdrum.

The timing of the camgear assembly phases is to be carried out by means of said indirect gear.

The engine is supplied with fuel by BNK-12AS fuel pump which enables the fuel to be conducted under constant pressure to the K14-WN-3 carburetter of membrane type.

The engine is lubricated by a forced - feed system with exception of cylinder sleeves, gudgeon pins, both the crankshaft and toothed wheel bearings which are lubricated by oil splash.

The oil pump of the gear type consists of one pressure stage and of two suction ones.

The pressure stage delivers the oil from the oil tank to the crankshaft hollow, to the rear chamber oil passages and also to the front part of the crankcase.

The large suction stage draws the oil out from the sump whereas the small suction stage draws oil only from a system of four cylinder heads of bottom cylinders.

The valve mechanism is lubricated by oil conducted through the tube dipped in the front part of the crankcase and through the push-rods to the rocker lever bearings resulting the valve stems to be lubricated splash, too.

To enable the inner cavity of the engine to be vented a special vent pipe on the rear chamber housing is installed.

For ignition the mixture two magnetoes of BSM-7M type with automatic ignition advancing are mounted.

The starboard magneto operates the front sparkplugs whilst the port one the rear sparkplugs, respectively.

In order to eliminate the radio disturbances the ignition system is braided, completely.

Engine starting is pneumatic. The air compressed is fed from the storage bottle to the air distributor mounted on the rear chamber housing and then through the separate air pipes and starting valves enters the cylinders. The pressure of the air should be about 50 kg/sq.cm.

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Before engine starting it is recommended to prime some fuel into the priming manifold by means of priming pump. The fuel is delivered then through the separate pipes and injectors directly to the induction pipe of each cylinder.

1.2 WN-3 engine main technical data

1.2.1 Design data

1. Engine mark	-	WN-3
2. Cooling	-	air-cooled
3. Number of cylinder	-	7
4. Engine type	-	single-row, radial unsupercharged.
5. Order of cylinder Nos.	-	clockwise, when viewed from behind Top cylinder is the first one.
6. Cylinder bore dia. /in mm/		135
7. Stroke /in mm/		
a/ for cylinder No.5 /with master rod/	-	134.00
b/ for cylinders No.4 and No.6	-	134.04
c/ for cylinders No.3 and No.7	-	134.03
d/ for cylinders No.1 and No.2	-	134.04
8. Displacement, all cylinders, ltr.	-	13,42
9. Compression ratio	-	6,2 ± 0,1
10. Direction of rotation	-	clockwise - when viewed from behind
11. Propeller mark	-	WN-1A.

1.2.2 Engine ratings

Power name	Power in h.p	r.p.m.	Specific fuel consumption g/h.p./h
Combat	330 - 2 %	2500 ± 1 %	250 - 270
Take-off	315 - 2 %	2350 ± 1 %	240 - 260
Rated	283 ± 2 %	2250 ± 1 %	220 - 235
Continuous work /0,8 rated/	235 ± 2 %	2100 ± 1 %	210 - 225

1.2.3 Crankshaft speed limits

1. Maximum permissible /never exceed/ r.p.m. when diving or by other aerobatic figures - overspeeding - 2650
2. Minimum r.p.m. - idling run - 500 - 650
3. Time required to speed up the engine from idling to full throttle speed in minutes - 2 - 3
4. Permissible operation period of the engine without interruption in min.
   - a/ overspeeding - 1
   - b/ combat power - 5
   - c/ take-off power - 15
   - d/ rated power - without limits
   - e/ continuous work power /0,8 rated power/ - without limits

1.2.4 Cylinder heads temperature in ^{o}C measured under rear sparkplug of cylinder No.5

1. Minimum temperature for reliable operation	-	100
2. Level flight temperature desired	-	150 - 200
3. Maximum temperature during long operation of the engine	-	220
4. Maximum permissible temperature during take off and climbing /within max. 15 minutes/	-	230

1.2.5 Fuel and fuel system

1. Fuel grade	-	aviatic petrol B-70
octane number	-	70
2. Carburetter		
a/ type	-	K-14WN
b/ No. of pieces	-	1
3. Fuel pressure before carburetter in kg/sq.cm	-	0,2 - 0,4
a/ at idling run	-	min. 0,20
b/ at other ratings	-	0,2 - 0,4
4. Fuel pump		
a/ type	-	BNK-12AS
b/ No. of pieces	-	1
c/ drive gear ratio	-	0,5
d/ direction of rotation	-	anti-clockwise.

1.2.6 Oil and oil system

1. Oil grade required for all year round operation	- MS-20, MK-22
2. Specific oil consumption during continuous operation in g/h.p./h	- max. 12
3. Lubricating oil pump	
a/ type	- gear, with one pressure stage and two suction ones.
b/ No. of pieces	- 1
c/ drive gear ratio	- 0,5
d/ direction of rotation	- clockwise.
4. Oil pressure in main pipe /measured in pressure transmitter on the rear chamber housing/ in kg/sq.cm.	- 4,5 - 6,5
Notice: When engine starting and warming up it is allowed the oil pressure increasing up to 10 kg/sq.cm.	
5. Inlet oil temperature in °C	
a/ desired	- 45 - 60
b/ minimum permissible /at warmed up engine/	- 40
c/ maximum during continuous operation	- max. 75
d/ maximum permissible within max. 15 min.	- max. 85
6. Outlet oil temperature in °C	
a/ desired	- 65 - 85
b/ minimum permissible /at warmed up engine/	- 55
c/ maximum permissible	- 110
d/ maximum permissible within max. 15 min.	- 115
7. Oil quantity flowing through the engine at rated power and at outlet oil temperature within limits 50 - 60°C in kg/min.	- 3 - 7

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1.2.7 Cam gear assembly

1. Timing the engine cam gear phase in reference to crankshaft revolution, in degrees /according to cylinder No.5 fig. No.4/

a/ inlet opens before T.D.C.	-	26 ± 4
b/ inlet closes after B.D.C.	-	64 ± 4
c/ exhaust opens before B.D.C.	-	57 ± 4
d/ exhaust closes after T.D.C.	-	27 ± 4
e/ inlet open	-	270
f/ exhaust open	-	264
g/ clearance between valve stem and rocker lever roller when timing the engine in coold condition - in mm:		
- for examine both valves for timing	-	1,7 ± 0,05
- for engine operation		
inlet valve	-	0,3 - 0,4
exhaust valve	-	0,4 - 0,5
h/ guaranteed servicing period up to overhaul	-	4 years.

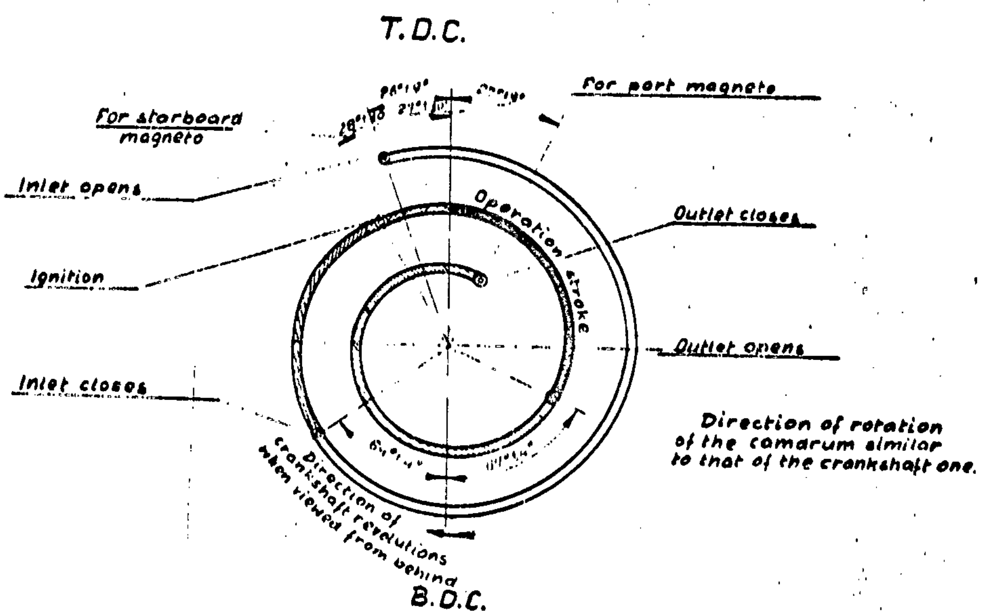

Fig.4 Timing diagram of the WN-3 engine in degrees of crankshaft revolution.

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1.2.8 Ignition system

1. Magneto	-	double spark, braided
a/ type	-	BSM-7M
b/ No. of pieces	-	2
c/ drive gear ratio	-	1,75
d/ direction of rotations:		
for starboard magneto	-	clockwise
for port magneto	-	counter-clockwise
2. Sparkplug		
a/ type	-	SD-48-BS, ceramic
b/ No. of pieces pro cylinder		2
3. Firing order	-	1-3-5-7-2-4-6
4. Maximum permissible drop of engine speed when running with one magneto at rated power as well as at continuous one in r.p.m.	-	80
5. Full spark advancing in degrees of crankshaft revolution:		
a/ for port magneto	-	27 ± 0,5
b/ for starboard magneto	-	28 ± 0,5

1.2.9 Starting system

1. Engine starting	-	pneumatic
2. Compressor		
a/ type	-	AK-50M, piston
b/ No. of pieces	-	1
c/ drive gear ratio	-	0,8
d/ direction of rotation	-	clockwise
3. Adjustment of compressed air distributor	-	8° after T.D.C. during expansion stroke for cylinder No. 5 and with a gap of 1+0,1 mm between the edge of distributing plate orifice and the edge of the orifice in the housing.

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1.2.10 Additional accessories

1. Revolution governor
   a/ type - R-2, centrifugal
   b/ drive gear ratio - 1
   c/ direction of rotation - counter-clockwise
2. Vacuum pump
   a/ type - AK-4S
   b/ drive gear ratio - 0,8
   c/ direction of rotation - counter-clockwise
3. Generator
   a/ type - GSK-1500Ż
   b/ drive gear ratio - 2,31
   c/ direction of rotation - clockwise
4. Revolution counter drive
   a/ drive gear ratio - 0,5
   b/ direction of rotation - clockwise

1.2.11 Weight and dimensions of the engine

1. Weight in kg accord. to PN/L standard - 240 + 2 %
2. Engine dimensions in mm:
   a/ diameter, overall - 1106
   b/ length, overall - 885

Note:
1. Direction of the accessories rotation is settled when viewing from the drive.
2. The weight of the engine not includes the weights of the following accessories: GSK-1500Ż generator, AK-4S vacuum pump, AK-50M compressor, exhaust pipe flanges, and the engine mounting together with component parts fastening it to the engine.

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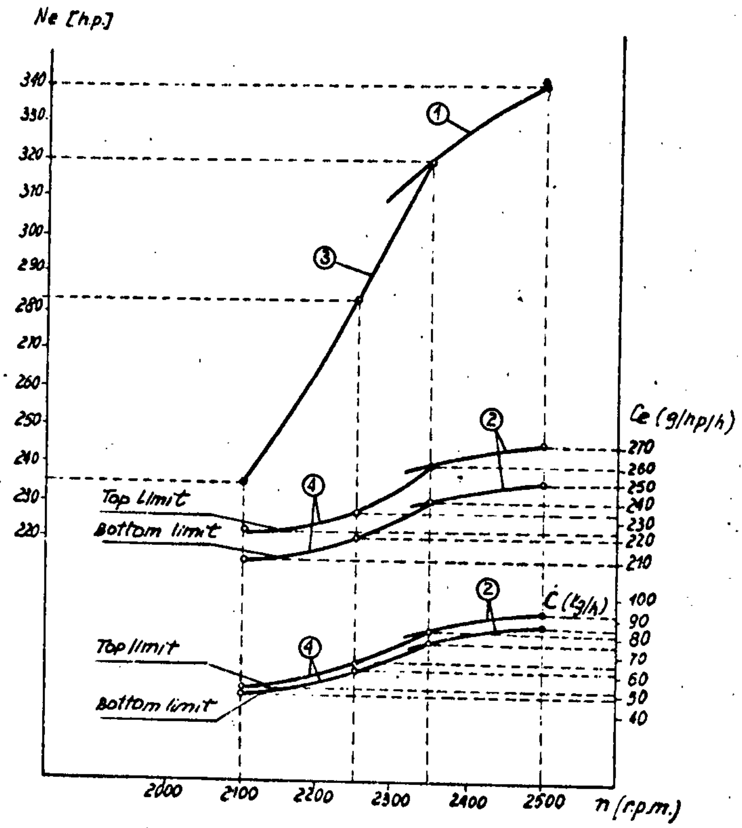

Fig.5 WN-3 engine full and braked power diagram.

Diagram 1

Characteristic at sea level.
Out put h.p. in relation to P_k.

Diagram 2

Altitude characteristic at full throttle speed out put is determined to in relation to formula:

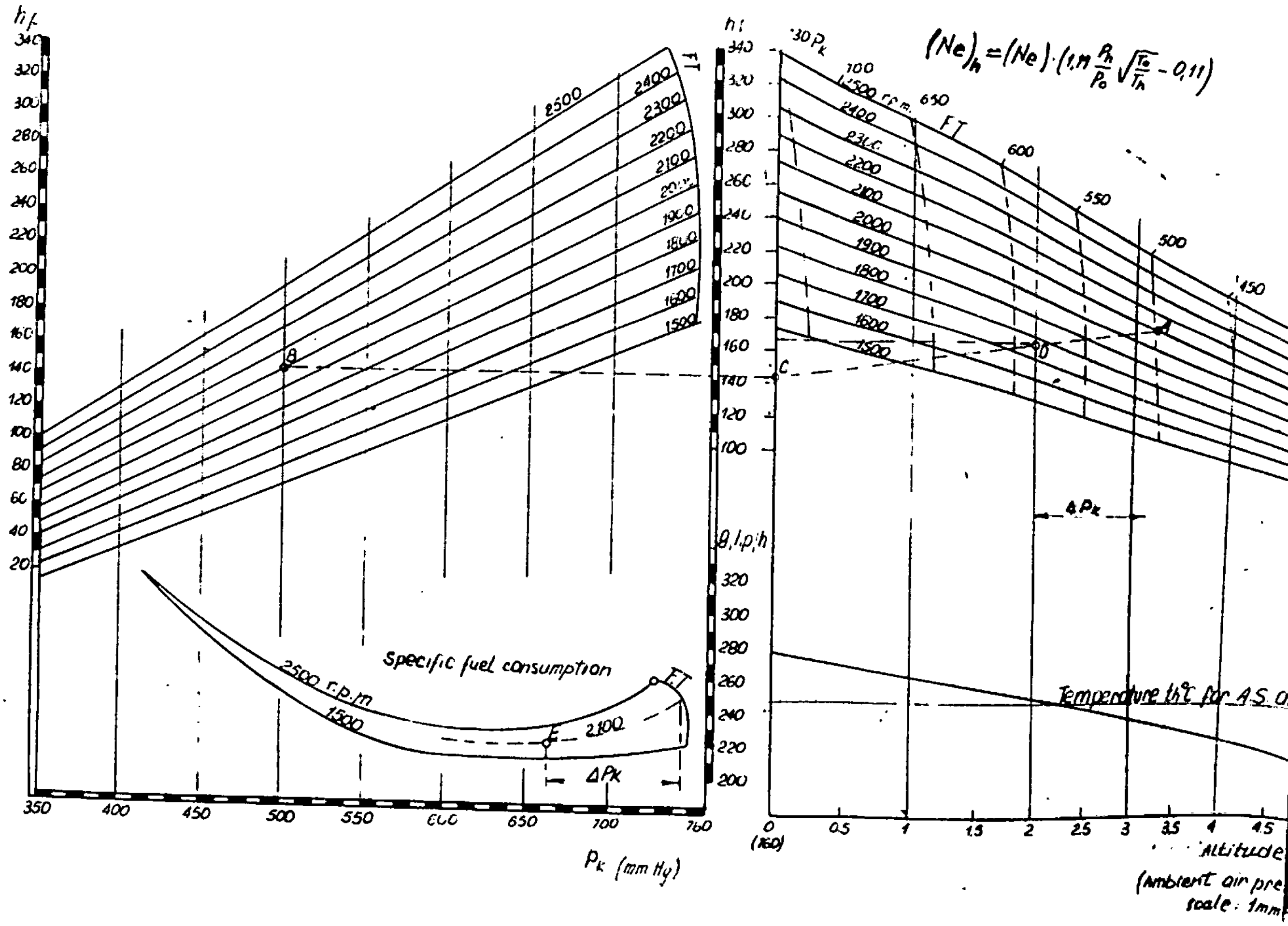

Fig.6 TN-3 engine altitude characteristic diagram.

Diagram 1

Characteristic at sea level. Out put h.p. in relation to P_k.

Diagram 2

Altitude characteristic at full throttle speed out put is determined to in relation to formula:

$$(Ne)_h = (Ne) \cdot (1.11 \frac{P_h}{P_k} \sqrt{\frac{T_k}{T_h}} - 0.11)$$

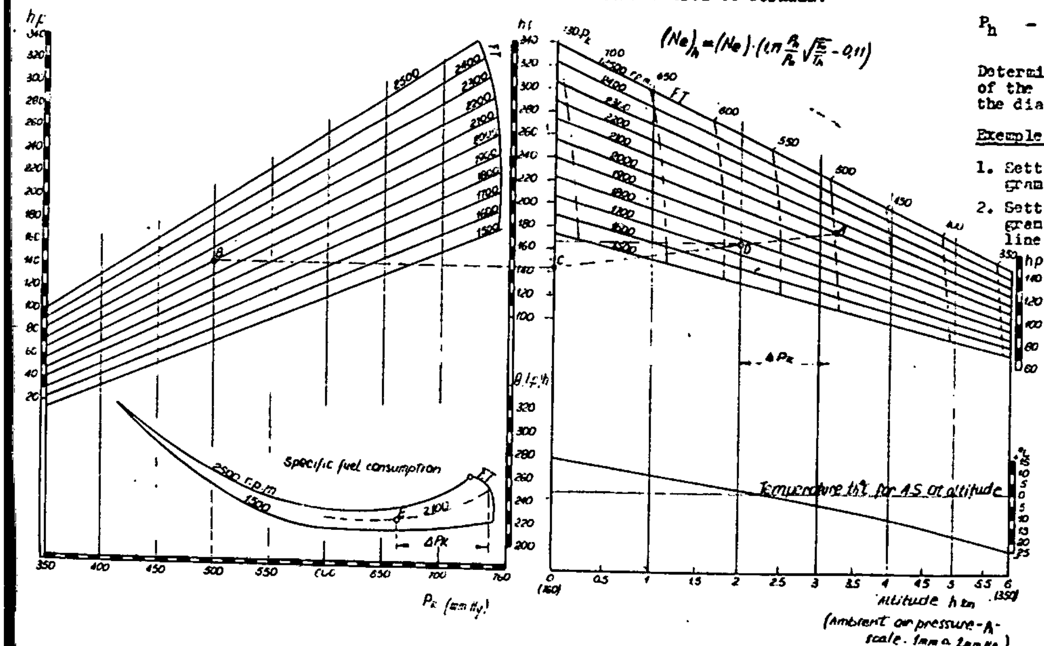

Fig.5 ...-3 engine altitude characteristic diagram.

Key:

A.S. - atmosphere standard PN/L-02001

F.T. - full throttle speed.

P_k - air pressure behind the carburetter mm Hg

P_h - atmospheric pressure at altitude.

Determination of the effect. power of the engine at an altitude using the diagram.

Example:

1. Settle the point A on the diagram 2.
2. Settle the point B on the diagram 2, then trace the horizontal line up to point C.
3. Connect the point A to the point C. Intersection with altitude line point D gives the power value of 168 h.p.
4. Temperature correction t_h: 1 % of power for each 6°C difference from A.S. add, when t_h < A.S. subtract, when t_h > A.S. according to example: 168+1,68 ≈ 170 h.p.
5. Approximate determination of the power defined:

5.1 measure pressure difference P_k - ΔP_k between point A and D.

5.2 Plote on the diagram No 1 the specific fuel consumption curve for given r.p.m. Measure off from the point F.T. ΔP_k value /both diagrams have the same scale of P_k and P_h/. Point E determines the specific fuel consumption required - according to example: 220 g/h.p./h.

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level.
on to P_k.

Diagram 2

Altitude characteristic at full throttle speed out put is determined to in relation to formula:

$$(Ne)_h = (Ne) \cdot (1{,}11 \frac{P_h}{P_0} \sqrt{\frac{T_0}{T_h}} - 0{,}11)$$

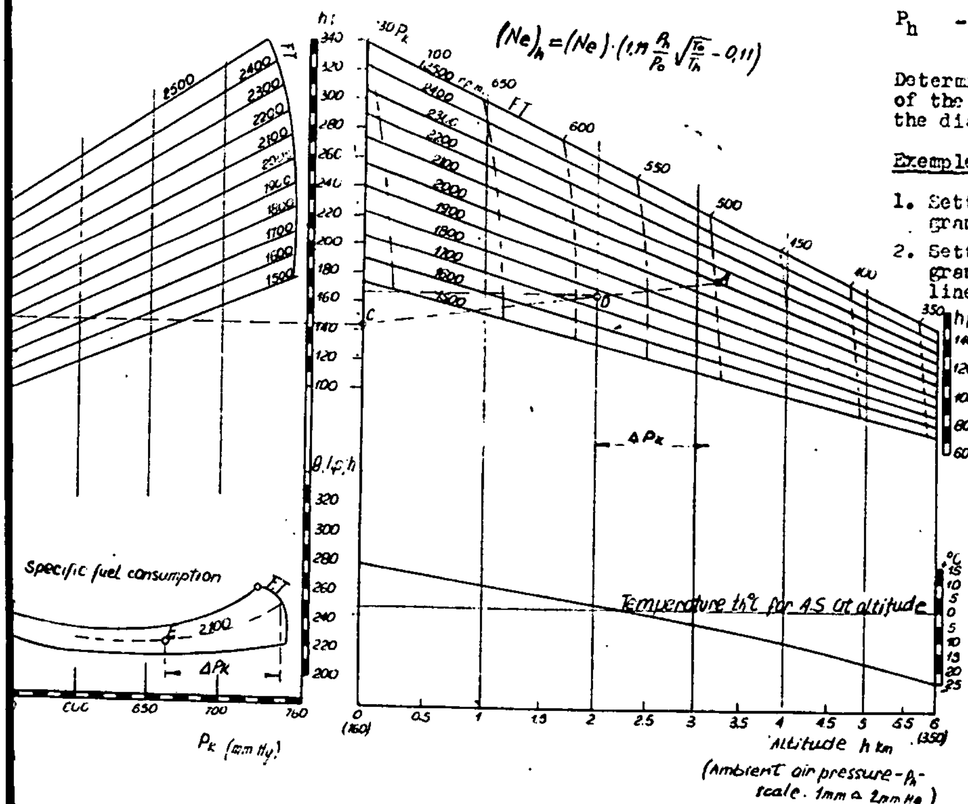

Fig.6 WN-3 engine altitude characteristic diagram.

Key:

A.S. - atmosphere standard PN/L-52001

F.T. - full throttle speed.

P_k - air pressure behind the carburetter mm Hg

P_h - atmospheric pressure at altitude.

Determination of the effect. power of the engine at an altitude using the diagram.

Example:

1. Settle the point A on the diagram 2.
2. Settle the point B on the diagram 2, then trace the horisontal line up to point C.
3. Connect the point A to the point C. Intersection with altitude line point D gives the power value of 168 h.p.
4. Temperature correction t_h: 1 % of power for each 6°C difference from A.S. add, when t_h < A.S. subtract, when t_h > A.S. according to example: 168+1,68 ≈ 170 h.p.
5. Approximate determination of the power defined:

5.1 measure pressure differention P_k - ΔP_k between point A and D.

5.2 Plote on the diagram No. 1 the specific fuel consumption curve for given r.p.m. Measure off from the point F.T. ΔP_k value /both diagrams have the same scale of P_k and P_h/. Point E determines the specific fuel consumption required - according to example: 220 g/h.p./h.

2.0 DETAILED DESCRIPTION OF THE ENGINE

DESIGN

2.1 Crankcase

The design of the crankcase enables all the accessories, assemblies, and component parts of the engine to be installed from inside as well as from outside. The crankcase withstands the forces arising when engine operation, *also*.

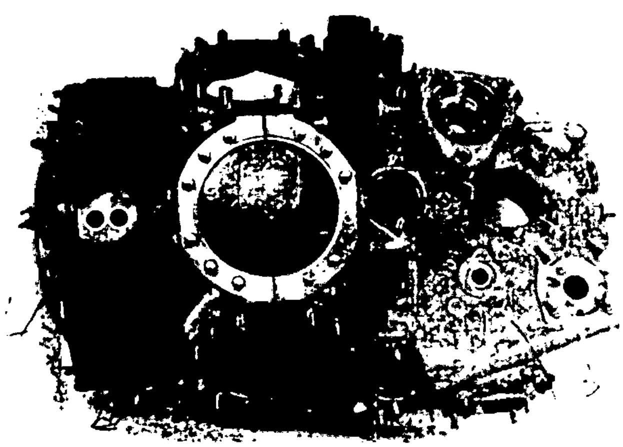

Fig.7 Crankcase general view.

The crankcase consists of three main assemblies: front cover /1/, crankcase front part /2/, and crankcase rear part /3/.

Said parts are coupled each other by means of stud bolts and attachment bolts.

The crankshaft bearing seats are reamed after assembling to enable the axial direction to be secured. The front cover /1/ is casted of an aluminium alloy in form of a cone and attached to the front part of the crankcase by means of 14 stud bolts being screwed into the front crankcase flange.

The base of the cone changes its shape gradually and at least creates a round flange machined from the side being attached to the front part of the crankcase.

On the said flange there is made a cylindrical projection the task of which is to centre the cover exactly in a respective cut-out situated inside the flange of front part of the crankcase.

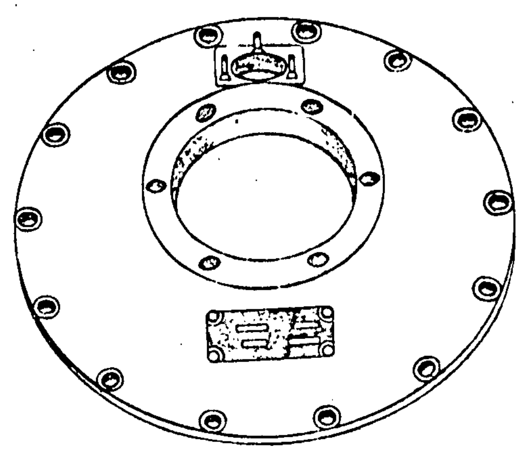

Fig.8 Crankcase front cover view.

On the flange of the front cover from its outer side there are placed 14 round bosses which front planes are machined. All the bosses are provided with the orifices for stud bolts.

In the centre of the cover there is an opening into which a bronze bush of the thrust bearing /2/ is pressed in.

Three stop-pins /3/ prevent the bush to be rotated.

On the flange there are arranged six orifices for attachment bolts /8/ coupling the front cover with the ring /7/ together. In the bottom part of the flange an oblique orifice for lubricating oil circulation is drilled through.

Inside of the front cover there are situated 14 reinforcing ribs running radially.

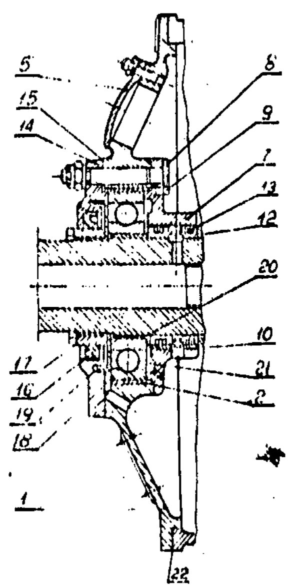

Fig.9 Front cover assembly sectional view.

1 - front cover; 2 - bronze bush; 3 - stop pin; 5 - cap

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7 - ring; 8 - attachment bolt; 9 - safety pin; 10 - bush; 12 - annular bush; 13 - seal ring; 14 - front cover gusset; 15 - seal ring; 16 - rubber gasket; 17 - crankshaft attachment nut; 18 - ball bearing; 19 - oil slinger; 20 - ball bearing bush; 21 - sealing shield; 22 - paranite gasket.

In the top part of the front cover there is placed an inspection hole with three stud bolts screwed in.

This hole is necessary to determine the position of the tappet rollers in reference to camring as well as to fill the engine with lubricating oil.

It is covered by a cap /5/.

Outside the front cover nearby the flange there is made a boss with a threaded hole inclined by 25° in reference to vertical axis for bent end-fitting of the front cover /see fig.8/.

On the top part of the front cover there is placed an arrow indicating the direction of engine revolutions.

To the smaller flange there is attached from inside the ring /7/ of the front cover by means of six attachment bolts.

The ring is casted of an aluminium alloy and comprises a shape of a bush with flange.

From one side the flange is fixed to the front cover. To ensure a proper attachment the flange is provided with a cylindrical recess going into the thrust bearing bush, respectively.

From other side on the flange there are placed six bosses with openings for attachment bolts /8/ as well as the orifices for safety pins /9/ preventing the attachment bolts to be rotated. The channels delivering the lubricating oil to the propeller hub are drilled out, also.

In the flange of the ring from the side being attached to the front cover there are provided a groove with five orifices for lubricating purposes.

In the centre opening of the ring there is situated a rectangular groove which is connected with the grooves arranged in the boss creating thus together with a bush /10/ a channel through which the lubricant is forced to the crankshaft hollow.

The bush is made of Cr-Mo steel. In order to increase its resistance against wear - the inner surface of bush is azotised.

The bush pressed into the ring opening comprises six orifices, symmetrically located around its contour from which five coincide with the annular groove.

The bush is fixed unmovable in the opening with aid of threaded pin screwed into the wall of the ring with its one end whilst the second one protrudes into one from several openings of the bush, respectively.

The channel in the ring delivering the oil to the propeller hub is pluged on its inlet with a threaded stop peg.

To the inner surface of the bush lie close six oil sealing rings made of a special cast iron.

Each channel of the ring bush comprises three sealing rings.

The annular bush /12/ is made of chromium steel and comprises outside three annular grooves.

In both extreme grooves there are placed the sealing rings /13/ whereas in the middle one there are drilled six orifices being connected to the ring groove inner the bush.

All these openings serve for delivering the lubricating oil to the revolution governor and also to the propeller hub.

The front surface of the bush comprises from the side of ball bearing six grooves enabling the oil to be discharged.

The front cover ring is fitted to the front cover by means of six attachment bolts. Said bolts are made of chromium steel and comprise close by their heads in plane of the ring flange an annular groove into which after drawing out the bolt through the annular opening a safety ring is inserted. Said safety ring prevents the attachment bolt to be shifted axially.

In the head of the attachment bolt there is made a groove into which enters the stop pin securing the attachment bolt against rotation when the front cover gusset nut is screwed in.

The attachment bolts serve simultaneously for fitting the front cover gusset /14/.

The gusset is made of aluminium alloy forging in form of a ring.

At the plane of attachment to the front cover it comprises a projection entering into the bearing bush as well as the annular groove for the sealing ring /15/.

The projection has in bottom part of the gusset a lubricating channel. In the gusset flange there are situated six holes serving for attachment bolts.

Into the center opening of the gusset is pressed in the rubber gasket /16/. Inner said gasket a steel insert for reinforcing purpose is being dipped.

Between the crankshaft attachment nut /17/ and the ball bearing /18/ is inserted a cone oil slinger /19/ made of steel.

Into the ball bearing is pressed the bush /20/ the flange of which tightens the steel sealing shield /21/.

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In order to prevent the lubricating oil to be leaked between contact planes of both front cover and crankcase front part a paranite gasket /22/ is inserted

The front part of the crankcase is made of an aluminium alloy sand casting.

In the front it comprises a ring shaped boss with a flange machined exactly into which there are screwed in 14 stud bolts connecting the front part of the crankcase to the front cover.

The surface of the flange is machined inside exactly and serves as a base for fixation of the front cover.

Ring-shaped boss divided from the crankshaft unit space by means of a partition creates a camgear assembly chamber.

Outside the camgear chamber there are arranged symmetrically seven small bosses which are increasing considerably inside said chamber.

In each boss there are drilled radially by two orifices one upon other into which are pressed ~~in the~~ tappet guides and also two opposite orifices into which there are screwed in the stud bolts fastening the bottom covers of the push-rods.

Besides there are drilled out in the bosses corresponding to cylinder Nos 1, 2, 7 by two orifices through which an excessive lubricating oil flows down from the valve rocker enclosures.

The tappet guides are made of bronze bush. On its one end the guide comprises a cylindrical flange whilst on the other one a slot for push-rod roller.

The flange of the guide is cut off from one side.

Each pair of the guides after having been pressed into the respective holes of the crankcase front part is then directed with cuts on the flange against each other, enabling the guides to be positioned properly.

Between the first and second cylinder there is situated a boss with a threaded hole being connected with oil supply pipe dipped into the crankcase.

Into this hole is screwed in an end-fitting which by means of a pipe connects to the elbow terminal being screwed into the top wall of the rear chamber.

In the bottom part of the chamber is placed a boss with an eliptical orifice through which the oil flows from the crankcase to the sump. Into said boss flange there are screwed in three stud-bolts fastening the front sump manifold to the crankcase.

Inside the camgear chamber there are provided eleven reinforcing ribs situated radially and one boss being coupled with two bottom ones for tappet guides.

Through said boss as well as through the boss placed on the partition there are drilled axially openings for double gear shaft of the camgear drive.

Inside the camgear chamber a steel annular tube is dipped. It passes between the openings through the bosses of the tappet guides and then into the opening in which the double gear shaft of the camgear drive is installed.

The inner diameter of the oil pipe is greater than the wall between the orifices of the tappet guides and for that reason the pipe is cut-out to both sides when said orifices are drilled.

Through said cut-outs as well as through the openings in the tappet guides the lubricating oil is penetrated into the interior of the tappets.

The bottom part of the partition is provided with a cylindrical opening enabling the oil to be drained to the sump.

The partition in its center part is thicked and comprises an opening into which a bearing bush is inserted. It is made of steel forging and is provided on its one end, from the side of front cover with a

Inside the guides nearby the flange there is made an annular channel against which are drilled out two orifices being connected with same. Said two orifices are running perpendiculary to the plane of the flange cut off and after inserting they are connected with the slots of the delivery pipe being dipped in the crankcase and conducting the lubricating oil to the tappets and then to the valve rocker housing.

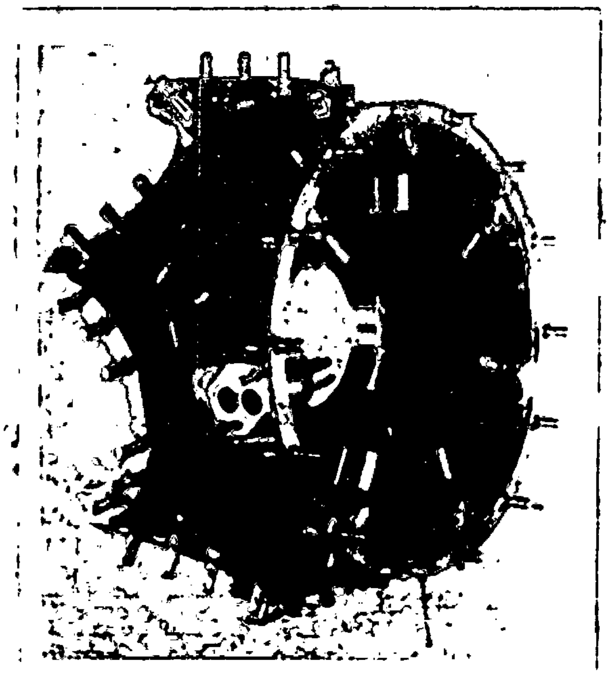

Fig.10 Crankcase front part view.

Outside the camgear chamber there are placed six bosses with threaded holes into which the threaded steel bushes are screwed in. Into said bushes there are also screwed in the bolts fastening the ignition collector to the crankcase.

Between the first and second cylinder there is situated a boss with a threaded hole being connected with oil supply pipe dipped into the crankcase.

Into this hole is screwed in an end-fitting which by means of a pipe connects to the elbow terminal being screwed into the top wall of the rear chamber.

In the bottom part of the chamber is placed a boss with an elliptical orifice through which the oil flows from the crankcase to the sump. Into said boss flange there are screwed in three stud-bolts fastening the front sump manifold to the crankcase.

Inside the camgear chamber there are provided eleven reinforcing ribs situated radially and one boss being coupled with two bottom ones for tappet guides.

Through said boss as well as through the boss placed on the partition there are drilled axially openings for double gear shaft of the camgear drive.

Inside the camgear chamber a steel annuler tube is dipped. It passes between the openings through the bosses of the tappet guides and then into the opening in which the double gear shaft of the camgear drive is installed.

The inner diameter of the oil pipe is greater than the wall between the orifices of the tappet guides and for that reason the pipe is cut-out to both sides when said orifices are drilled.

Through said cut-outs as well as through the openings in the tappet guides the lubricating oil is penetrated into the interior of the tappets.

The bottom part of the partition is provided with a cylindrical opening enabling the oil to be drained to the sump.

The partition in its center part is thicked and comprises an opening into which a bearing bush is inserted. It is made of steel forging and is provided on its one end, from the side of front cover with a

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ring groove of rectangular section into which is inserted a safety ring enabling the outer ball bearing ring against axially travelling to be secured.

From behind the front part of the crankcase comprises seven projections with faces machined and lapped thoroughly. All the projections are drilled out to enable the both halves of the crankcase to be coupled together with aid of the attachment bolts.

Inside the crankcase is provided with a special bosses for firmly fastening the stud-bolts of the cylinders.

The rear part of the crankcase is made of an aluminium alloy as sand casting in common with a mixture chamber and a rear chamber.

It is provided from the front with seven projections the faces of which are lapped exactly. Six projections are equipped with the attachment bolt openings whilst the seventh one situated between cylinder No.4 and No.5 is provided with a threated hole into which a double ended bolt of the crankcase is screwed in.

Both chambers the mixture and the rear one are separated from the crankshaft assembly chamber with aid of a partition.

In the center part the partition is thicked and comprises an opening to enable the roller bearing bush to be pressed in. Said bush is made of a steel forging and comprises on its one end from the side of the rear chamber a ring groove of rectangular section into which a safety ring is inserted preventing the outer ring of the roller bearing to be shifted axially.

The bush is safetied against rotation by means of three steel pins installed proportionately around its contour.

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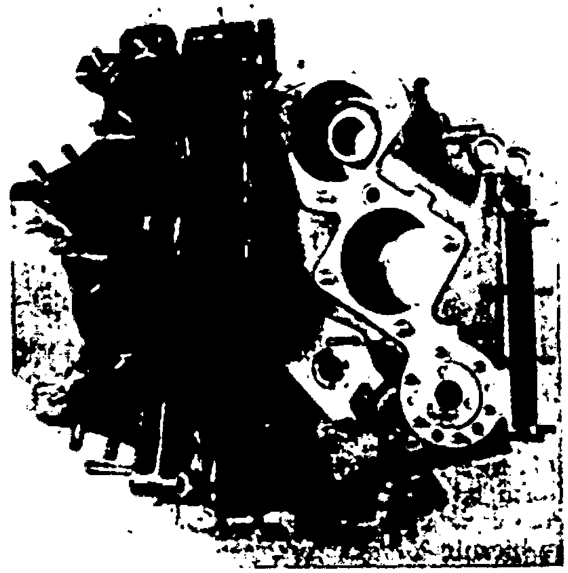
In the top part of the partition there is placed a vent orifico whereas on the bottom there is an opening permitting the lubricating oil from the crankcase to the sump to be scavenged.



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The rear part of the crankcase comprises the mixture chamber in shape of a ring equipped with seven conducting channels especially designed to reduce the mixture flow friction - so called the hydraulic loss.

The conducting channel flanges are provided with rectangular grooves into which are pressed in the rubber gaskets when screwing in the conducting pipe flanges. Besides there are drilled out two openings for the stud bolts fastening the said flanges to the crankcase, respectively.

Between the conducting channels of cylinder No.4 and No.5 there is situated an oil draining channel. Said channel is connected with its one opening to the crankshaft assembly chamber and with the second one to the rear chamber of the crankcase.

Into the channel flange are screwed in two stud bolts fastening the rear sump manifold to the crankcase.

For sealing purpose a peranite gasket between contact surfaces of the sump and the crankcase is inserted.

The mixture conducting channel flanges are provided with bosses into which are drilled out the holes for attachment bolts fitting the power plant to its mounting.

The mixture chamber is designed in a ring shape with a rectangular section.

On the mixture chamber wall from the rear chamber side there are arranged two bosses - one of them serves to stamp a specification numbers whilst to the other one is screwed in a stud bolt attaching the clamp with the pipes of the pneumatic starting system.

The flat rear wall of the mixture chamber changes its form against two parallel walls /to the vertical plane of the engine/ being closed from top and bottom.

In the bottom wall of the rear chamber is situated a flange with an opening divided with a partition which changes its form and creates at least a mixture channel.

The partition used causes the proper dividing of the mixture to be assured.

Four stud-bolts are screwed into the flange in order the carburetter to be installed.

From behind the flange there are drilled out in the bosses two openings going through to the mixture channel.

On a certain length the said openings are threaded and the mixture thermometer seats are screwed in.

The vent pipe is attached by means of three stud bolts to the flange placed on the top wall of the rear cover.

Slightly below there is situated a boss with two threaded orifices.

Into the orifice inclined to the engine axis there is screwed in the bent pipe which is connected to the oil delivery pipe dipped in the front part of the crankcase.

In a bottom sector of the orifice situated parallely to the engine axis is drilled out a smaller hole going through the delivery pipe dipped into the rear chamber and entering thereafter the ring channel build up by the bearing bush faces of the magneto shaft.

Into said hole is screwed in a bolt drilled out and connecting the oil pressure transmitter at inlet to the engine.

On the top wall of the rear chamber there are situated two cylindrical bosses with threaded openings into which the lugs of the engine are screwed in to enable the engine to be hoisted when transporting and assembling on the aircraft.

On the starboard wall of the rear chamber when viewed from engine back there are arranged four low bosses with flanges machined in a common plane.

In the top part there is placed a triangle flange with three stud-bolts for fitting the magneto and below a rectangular flange with three stud-bolts for fitting the generator.

Slightly lower is placed a circular flange with six stud bolts for fastening the compressor as well as the flange in T-shape with three stud-bolts for fixation the air distributor.

In the flange for compressor driving there are situated along the diameter two short openings of 6 mm dia. into which are drilled out inclined orifices of 2 mm dia. being connected to the annular cut-out.

Said cut-out comprises an opening drilled out connecting with a delivery pipe dipped in the rear chamber and supplied the compressor with a lubricating oil. Besides there are made three threaded holes for attachment screws fitting the compressor insert.

In the bottom part of the flange are drilled out two holes of 8 mm dia. to enable the lubricating oil to be drained from the compressor.

Into the central opening of the flange there is pressed in a bronze bush with a rectangular ring groove running outside into which are drilled two orifices lubricating the drive shaft.

The compressor flange insert is pressed into the flange annular groove. Said insert is made of an aluminium alloy and comprises from its one side on the contour an annular cut-out and also three orifices for attachment screws fastening it to the compressor flange.

After the insert having been pressed in an annular out-out creates a channel which connects with two openings conducting the lubricant to the compressor.

The attachment flange of the air distributor comprises a light annular groove with two orifices of 5 mm dia. for oil draining and the opening with a bearing bronze bush pressed in.

The bearing bush is provided on its outer surface with a rectangular annular channel with two orifices for drive shaft lubricating.

On the port wall of the chamber there are situated five bosses with flanges. Four from them are machined in a common plane whilst the contact plane of the port magneto flange is lowered by 8 mm. Said flange is made in a shape of triangle and comprises two stud-bolts and one opening.

Just below there is placed a large flange with three stud-bolts for governor insert fixation, and the small circular flange with threaded hole into which the oil pump seat is screwed in.

Said oil pump seat is made of carbon steel and is provided on its both sides with a thread.

Into the seat opening is screwed in the oil pump attachment bolt.

Below there i situated a flange with an opening into which the bronze bearing bush is screwed in.

The bush is provided with a flange and an annular channel on its outer surface with two orifices enabling the drive shaft to be lubricated.

In the oil pump attachment flange there are drilled out two orifices and the steel bushes screwed. in.

Nearby said flange there is situated a small round boss with threaded steel bush. All three bushes are destined for attachment bolts fitting the oil pump to the rear chamber of the crankcase.

The flange placed on the bottom of the side wall of the rear chamber with four stud bolts serves for fastening the vacuum pump.

The bush pressed into the flange opening comprises externally an annular channel of rectangular section with two orifices to enable the drive shaft to be lubricated.

Said channel after the bearing bush has been inserted connects to an oil delivery pipe being dipped into the rear chamber.

In the flange cut out there are drilled two openings of 8 mm dia. for lubricating oil draining.

In the flange there is made an orifices of 4 mm dia. which through the opening in rear chamber flange connects to the oil system and conducts the oil to the vacuum pump.

The rear chamber is ended with a rectangular flange into which are inserted the stud-bolts attaching the cover to the chamber.

The central part of the chamber is provided with a boss and a bronze bearing bush pressed in.

On the bush flange there are made radially three grooves to enable the main drive gear to be lubricated.

Inside the bush a rectangular groove with four holes is cut out.

Through said holes the oil is delivered from the oil pump to the engine crankshaft, respectively.

In the top part of the rear chamber there is situated a cylindrical boss with an axis perpendicular to the engine axis.

Into the opening of said boss are pressed in from both sides two bronze bushes in such a manner that their faces create inside the opening an annular channel with aid of which the supply pipe dipped into the rear chamber conducts the oil to the magnetoshaft.

The bush flanges comprise three radially and equally located grooves serving to lubricate the thrust surfaces of the insert as well as the gear being installed from both ends of the shaft.

Inside the rear chamber the oil delivery pipe is dipped. The shape of the delivery pipe is like a fork the arms of which embrace the chamber from a main drive shaft bush to the side walls of the chamber, respectively. The top part of pipe is connected to the end-fitting screwed into the top wall of the rear chamber.

The left conduit is connected to the hole drilled in the bottom of the attachment bolt seat of the oil pump enabling the lubricating oil to be fed to the governor and then to the bush of the crankshaft drive both the vacuum pump and the compressor.

The oil through the groove made on the external side of the bush and also through two orifices in said groove penetrates into the drive shaft and lubricates it.

The right conduit travels through the bush seat orifices of the shaft driving the oil pump and the air distributor as well as the shaft driving the vacuum pump and the compressor.

The oil is forced through openings and grooves made on the external surfaces of the bushes to the drive shaft in order to be lubricated.

The top part of the conduit connects the boss of the main drive shaft bush seat with the boss placed on the top wall of the rear chamber. In said boss there is made a threaded orifice into which the end-fitting is screwed in.

The oil conducted through the end-fitting, the pipe and the terminal screwed into the front part crankcase camgear chamber is penetrated at least to the tappets push-rods and rocker lever bearings in order to be lubricated.

The complete crankcase

The crankshaft openings placed in the front cover and in both the front and rear part of the crankcase are reamed when assembled in order the axial direction to be assured.

In reference to said condition the front cover may not be replaced without simultaneously replacing the remain parts being assembled together.

Both the front and rear halves of the crankcase are coupled together by means of six attachment bolts being inserted into the openings in partitions between the cylinders as well as by means of one double end bolt screwed into the partition of the rear half of the crankcase between cylinder No.4 and No.5.

The crankcase attachment bolts are made of chromium steel and comprise three projections with equal diameters enabling the both halves of the crankcase to be connected properly.

In order to assure the dividing surfaces of the crankcase to be jointed adequately as well as the oil leaking to be prevented both contact faces are lapped thoroughly.

On the contour of the crankcase there are situated seven machined flanges with openings and stud-bolts on each flange in order the cylinders to be fixed.

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The face of each flange is provided with the cylindrical groove into which is pressed the rubber gasket.

All the blind openings foreseen for the stud-bolts are provided with the vent orifices to prevent the craks when screwing in the stud-bolts.

2.2 The cylinder /fig. 12, 13/

The cylinder consists of a sleeve /1/ made of a chrome-molibdenum steel forging and machined as well as of a cylinder head /2/ casted of an aluminium alloy.

The cylinder sleeve is coupled to the cylinder head with aid of a trapezoidal thread of 3 mm pitch.

The cylinder head is screwed upon the sleeve being warmed up previously up to the temperature of 300° - 360°C owing them the joint is tight when engine run.

On the top part of the cylinder sleeve there is situated an annular strap without a thread securing the tightness additionally.

The cylinder sleeve comprises outside 24 machined fins to enable the engine to be cooled and the cylinder structure to be reinforced, too.

In its bottom part the sleeve is provided with an attachment flange connecting the cylinder to the crankcase by means of 12 stud-bolts.

On the cylindrical part close under said flange there is made an annular recess to assure a proper installing of the cylinder to the crankcase to be obtained.

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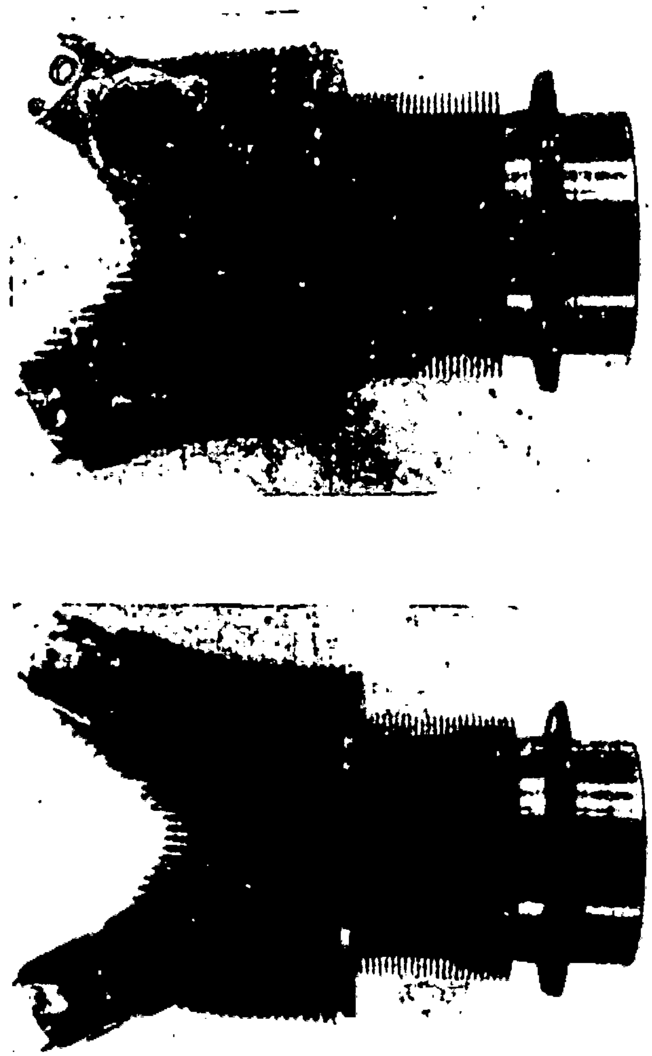

Fig.12 Cylinder general views.

Under the cylinder flange a rubber gasket is inserted. After the cylinder has been assembled the said gasket is pressed into a groove made in the crankcase cylinder opening enabling the proper tightening the cylinder sleeve to the crankcase.

In order to increase the wear resistance the cylinder sleeve working surface is azotised. The thickness of a layer azotised equals to 0,3 - 0,5 mm.

After the cylinder head has been screwed on the cylinder sleeve the working surface of the sleeve is grinded and honed finally.

The cylinder head comprises on its external surface horizontal and vertical fins casted in common with the head as a whole.

In order to enable the head to be cooled equally the horizontal fins are situated excentrically in reference to cylinder axis in such a manner that the higher fins are located in a vicinity of the exhaust valve because said part of the head is warmed up mostly.

The number and the height of the vertical fins is respectively greater in the exhaust valve area, also.

The bottom thick fin serves for increasing the cylinder construction rigidity.

Three bronze seats /16/ are screwed into the threaded openings placed on the front and rear part of the cylinder head, respectively.

Two seats situated in the plane of symmetry serve for screwing in both the front and rear spark plug.

The front seat is inclined by angle of 35° to the cylinder axis whilst the rear one with 45°, respectively.

Below the front spark plug at the side of the inlet pipe there is fitted third seat foreseen for the starting valve.

All the seats are screwed in with a tolerance of 0,08 - 0,140 into the cylinder head warmed up previously and then every one secured by means of two pegs.

The inner surface of the cylinder head in a form of a hemisphere is machined and comprises a trapezoidal thread to assemble it with the cylinder sleeve. Together with the piston bottom the hemisphere creates a combustion chamber.

The trapezoidal thread of the cylinder head is ended with an annular groove which changes its shape gradually and at least creates a cylindrical strap with a flange into which the face of the cylinder is pressed.

Inside the combustion chamber symmetrically to the vertical plane of the cylinder there are made cut-outs on the faces of the both inlet and exhaust channels. Into said cut-outs are pressed in and then flared out the bronze valve seats /13/ with a different diameter.

The diameter of the inlet valve seat is enlarged in order the mixture flow friction to be kept as low as possible enabling thus a better combustion of the cylinder.

Both valve seat working surfaces are inclined by 45°.

The combustion chamber is connected to the external surface of the cylinder head by means of two channels with the flanges on their inlets.

Into the flange of inlet channel there are screwed in three stud-bolts /14/ fastening the inlet pipe to the cylinder whereas into the outlet one there are inserted four stud-bolts fixing the exhaust pipes.

Inside the inlet flange contour there are situated two cut-outs enabling the inlet pipe to be installed adequately, as well as a phase into which the rubber gasket is to be pressed in.

On the front part of each cylinder head inlet channel is situated a cylindrical boss with a threaded orifice for the priming jet.

In common with the cylinder head there are casted the rocker lever housings.

Into each rocker lever housing there are installed inlet valve /22/ or exhaust valve /23/. two cylindrical valve springs /10 and 11/ with both top /9/ and bottom /12/ spring retaining collars, rocker lever /7/ with adjusting screw and cast iron valve guides /13/. placed under angle of 60° against each other and symmetrically to the vertical plane of the engine.

The valve guides are pressed into the openings arranged in the cylinder head bosses when in warmed up condition.

The openings for rocker lever shaft /21/ are placed in side walls of the rocker lever housings.

At the bottom of the said housings there are made in a valve guide plane the round bosses for threaded holes into which the end-fitting of the durite hose /26/ discharging the lubricating oil from the rocker lever housing is screwed in.

The special bosses are situated in the front and rear part of the housing. In the front boss there is drilled out an opening with a cut-out from inside into which a bolt /4/ is screwed in and locked with aid of a peg against rotation. Said bolt serves the engine cowling to be fastened.

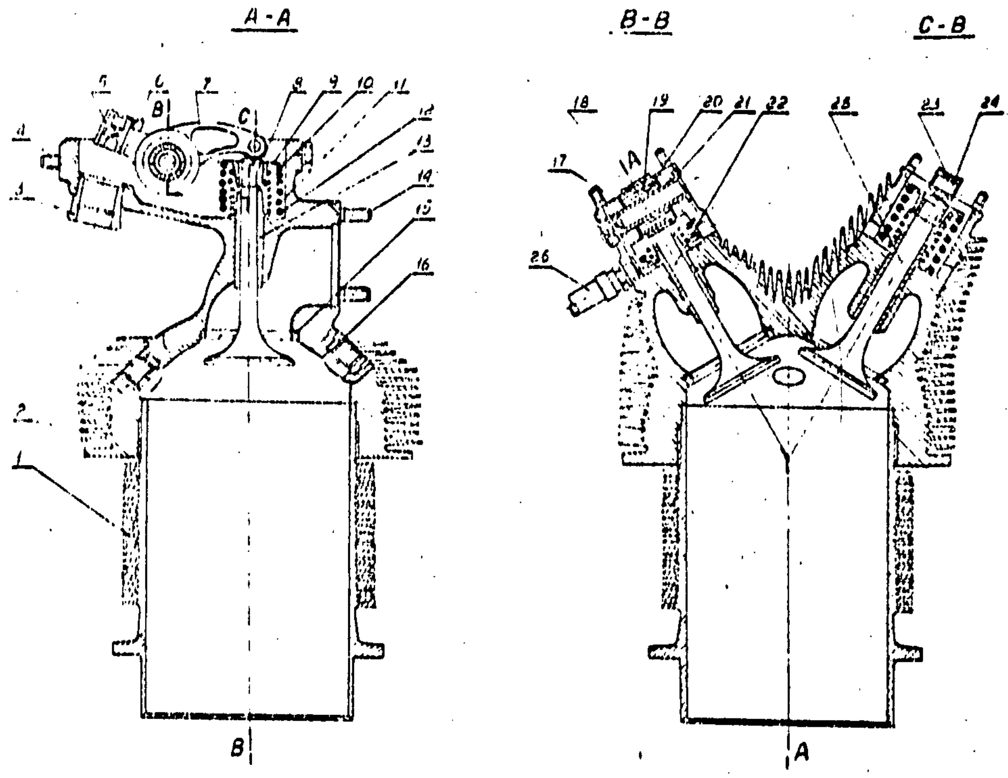

Fig.13 Cylinder /sectional view/.

1 - cylinder sleeve, 2 - cylinder head; 3 - top end of push-rod; 4 - stud-bolt; 5 - adjusting screw; 6 - stud bolt; 7 - rocker lever; 8 - retention cone; 9 - top spring retaining collar; 10 - outer spring; 11 - inner spring; 12 - bottom spring retaining collar; 13 - valve guide; 14 - stud-bolt; 15 - valve seat; 16 - spark plug seat; 17 - insert; 18 - roller bearing outer race; 19 - roller; 20 - roller bearing inner race; 21 - rocker lever shaft; 22 - inlet valve; 23 - rocker lever roller; 24 - rocker lever roller axle; 25 - exhaust valve; 26 - oil discharge end-fitting.

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In the rear boss there are made two threaded openings with brass seats-into small opening there is screwed in an attachment bolt of deflector mounting whilst into the large one the blanking plug.

Each rocker lever housing comprises four stud-bolts /6/ for fitting the rocker lever cover.

From behind the rocker lever covers there are cast out for four bottom cylinders the bosses with threaded orifices enabling the oil discharge end-fittings to be screwed in.

Between the rocker cover and the cylinder head there is placed a special gasket.

In the front part of the housings, there are flared out the top ends of the push-rods tubes /3/.

The inlet pipe /fig.14/ is made of a steel sheet and consists of two halves welded together.

A special form designed results the hydraulic loss to be reduced considerably.

For attachment purposes there is welded to the pipe end from the side of inlet channel an annular terminal made of steel.

With aid of said terminal the inlet pipe is attached to the inlet channel flange. In order to tighten the joint as a whole a rubber gasket is used.

The inlet pipe flange made of a duralumin alloy comprises on its contour three openings into which enter the respective stud bolts when assembling the inlet pipe to the cylinder head.

The bottom part of the inlet pipe is calibrated to enable the pipe to be installed firmly into the mixture chamber opening.

The bottom flange of the inlet pipe is made of duralumin forging and comprises on its periphery two orifices for fastening it to the mixture chamber. For sealing purposes the rubber gasket is inserted.

Fig.14 Inlet pipe general view.

2.3 The piston, piston rings and gudgeon pin /fig.15/

The piston is made of an aluminium alloy forging and machined externally as well as partly internally.

The piston bottom and also the working side walls are machined with aid of a diamant thoroughly to meet the requirements of a proper smoothness and to prevent the hard deposit to be collected.

The piston comprises four grooves for the rings. Three of them are situated in the top part of the piston /above the gudgeon pin/ whereas the fourth one in the bottom part, respectively.

Both the third and the fourth grooves are provided with orifices drilled radially in order the lubricant to be scavenged.

On the bottom contour of the piston is made a groove with a cut-out inclined by 30° and with a sharp edge resulting the oil to be removed from the cylinder wall more accurately when piston travelling downwards.

In order the weight as well as the friction resistance when travelling to be reduced the diameter of the piston between third and fourth grooves is decreased, respectively.

The piston inside comprises two bosses for the wrist pin. Between said bosses there are milled out from both sides some quantity of material in order the weight to be reduced.

The piston bottom comprises inside the ribs the task of which is to reinforce the rigidity of the bottom as well as to transfer the heat more effectively.

The piston from bottom up to third groove is of a cone shape. Such a construction is based on the temperature gradients on the piston and when in operation its shape is very near to the cylinder one.

The gudgeon pin /wrist pin/ made of Cr-Ni steel is drilled out inside. On its ends it is provided with cylindrical grooves which then changes its form against a cone one being connected in the center with aid of a cylindrical orifice.

Such a section of the gudgeon pin results the tension gradients along its axis to be equalled.

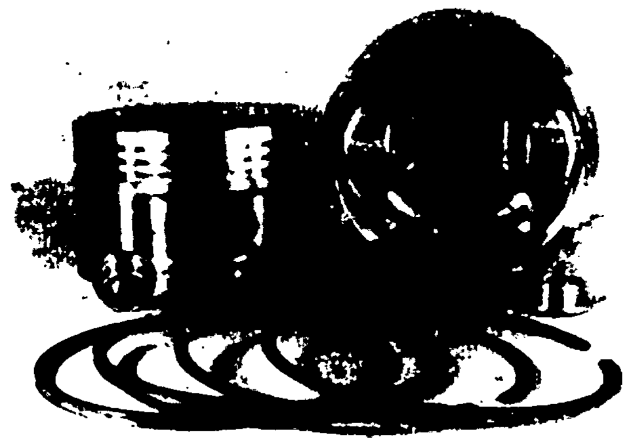

Fig.15 Piston, gudgeon pin and piston rings view.

In order to increase the strength of the gudgeon pin as well as the resistance against rubbing the external wall of the pin is carburised and then lapped, respectively.

To prevent the gudgeon pin ends to be chaffed against the cylinder walls there are inserted two expanding plugs made of duralumin with the spherical flanges.

In the cylindrical pin wall there is drilled out an opening enabling the air to be discharged when the plug is inserted into the gudgeon pin.

The piston rings are made of a cast-iron.

On each piston four rings are inserted. Into first and second groove the compression rings are placed whilst into third and fourth one the oil scraper rings, respectively.

The oil scraper rings are provided with an annular groove with orifices placed in centre of the working surface.

The lubricating oil collected from the cylinder wall is conducted to the groove and then through the orifices is discharged into the crankcase cavity.

The compression rings are of rectangular section. In order to increase the rubbing resistance the outer surfaces of the rings are chromium plated 0,06 - 0,1 mm thick.

After machining the piston rings are oxidised as this procedure increases their resistance against corrosion, considerably.

When assembling the locks of the piston rings should be shifted against each other in order the expension gases not to be pnetrated into the crankcase, easily.

When assembling the engine the pistons and the connecting rods are completed observing the weight with a great care.

The difference in weight of a separate pistons for one engine should not exceed of 4 grams.

2.4 Connecting rod assembly /fig. 16, 17/

Connecting rod assembly consists of one master rod /1/ and six link rods /2/ being coupled with the master rod swivelly by means of knuckle pins /8/ pressed into the opening of the master rod big-end.

The link rods are made of an aluminium alloy forging whereas the master rod of a Cr-Ni steel one.

In order to increase the fatigue strength the outer surfaces of the link rods are polished, thoroughly.

The master rod consists of a top and bottom part /big-end/ coupled each other by means of a rod with -section gradually decreased when going the big-end upwards.

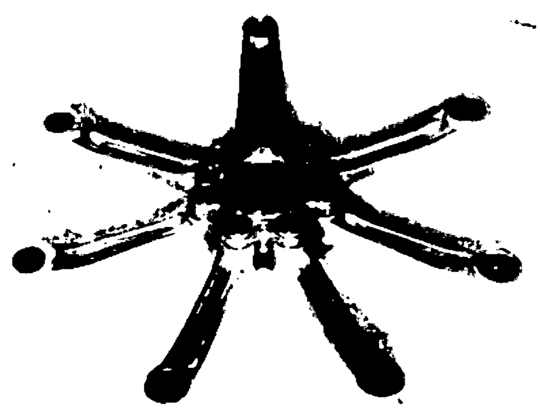

Fig.16 Connecting rod assembly general view.

The bearing bronze bush /3/ is pressed into the top end of the master rod. In the middle part of the bush there is placed externally an annular groove connected to the internal wall of the bush with aid of two orifices.

Slightly bellow from both sides of the rod web there are situated inclined by 45° two lubricating orifices enabling the gudgeon pin to be greased.

The big-end comprises two symmetrically placed flanges with six openings for knuckle pins and five light-openings between them.

The openings located in the front flange are slightly larger than that in the rear one. It is done in order the assembling to be simplified as well as the working surface of the pin not to be scratched or seizured.

To keep the compression ratio constant in all the engine cylinders the knuckle pin holes are placed at different distances from the master rod big-end axis, respectively.

Into the master rod big-end there is pressed in a steel bush /7/ covered inside with a lead-bronze composition /crankpin bearing/.

Said bush comprises from its one side a flange inserted into a cut-out machined in the opening contour of the master rod big-end.

After all the works required machining having been completed the master rod is being balanced, thoroughly.

The weights of the master rod in reference to both the top and bottom parts are stamped on the master rod flange, respectively.

The link rod similar to that of master rod consists of top and bottom parts coupled each other with aid of H-section rod.

The openings arranged to both parts are without any bushes and the pins are introduced into the material of the link rod, directly.

Such type of a construction simplifies the production and reduces the costs but the link rods may not be repaired after the openings have been enlarged /worked out/ resulting the complete link rod to be replaced by a new one, if necessary.

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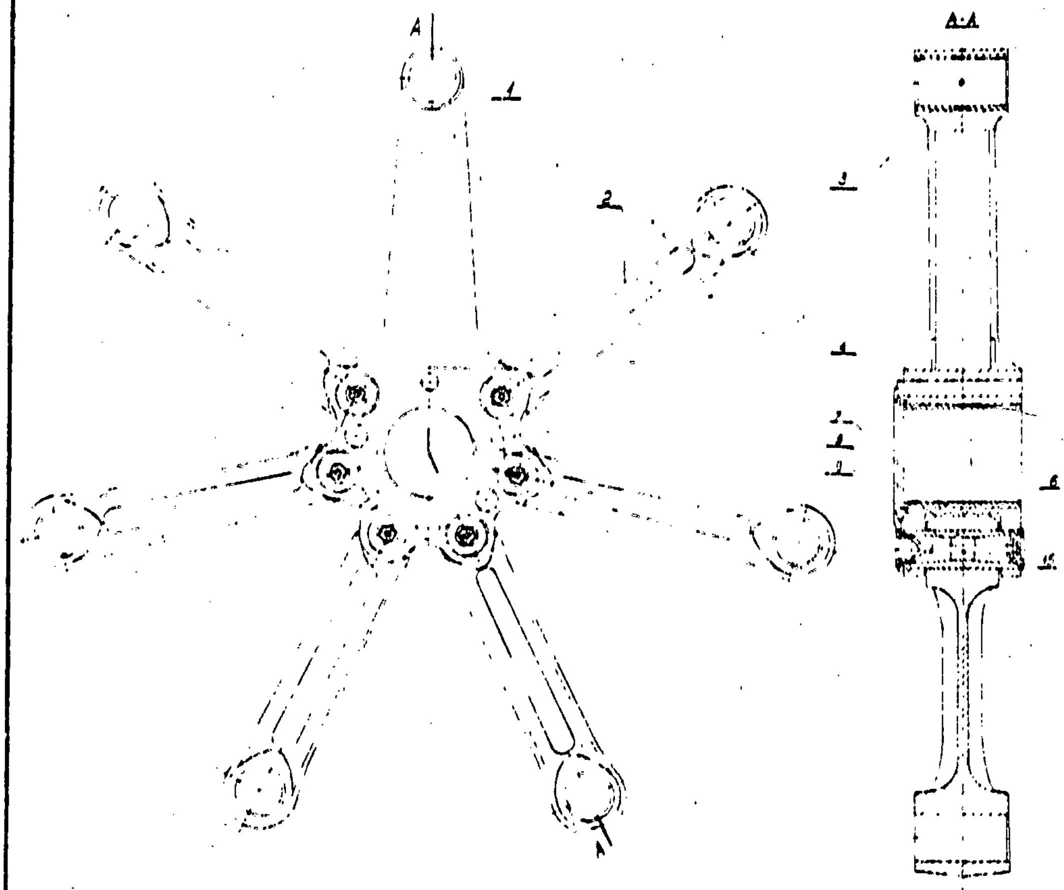

Fig.17 Connecting rod assembly sectional view.

1 - master rod; 2 - link rod; 3 - master rod top bush; 4 - oil scoop; 6 - nut; 7 - crank pin bearing; 8 - knuckle pin; 9 - oil scoop attachment bolt; 10 - collar.

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It is necessary to note that both said openings are hardened by means of drawing.

In the base of the top link rod there are drilled out from both sides two lubricating orifices inclined by 45^0 in reference to the axis. The oil splashed during the engine work penetrates into the said orifices resulting the gudgeon pin to be lubricated.

The link rods are balanced and the weight required is being obtained with aid of an additional machining. The value of the weight of top and bottom part is stamped on their faces, respectively.

The knuckle pin /8/ of the link rod made of Cr-Ni steel is of hollow type and comprises from its both sides annular grooves which are changing then their shape against a cone ones and are connected to the cylindrical orifice placed centrally.

Outer diameters of the piston pin change their value respectively to the component parts being in contact when in operation.

The diameter of the gudgeon pin in vicinity of the rear flange of the master rod big-end is smaller than that in the place of bottom part of the link rod and also smaller than that in vicinity of the front flange of the master rod big-end, respectively.

On the surface being in a contact with the link rod are made diametrally two grooves in the center of which two holes are drilled out.

Through said orifices the lubricating oil is forced from a piston pin hollow in order the link rod bottom part to be lubricated.

In order to increase the wear resistance as well as the fatigue strength the outer surface of the wrist-pin is carbonised and polished, ultimately.

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The oil scoop /4/ is made of duralumin sheet and comprises a shape similar to that of the master rod big-end flange one.

Six oil scoop attachment bolts are introduced into the orifices drilled out in the projections around the contour.

In the front of the oil scoop on the annular surface standing-up there are provided si· grooves enabling the contact surfaces of both the oil scoop and the crankshaft front part arm to be lubricated.

Inside the oil scoop there is situated an annular groove. From the rear side of the oil scoop there are made radially to each orifice beginning from its periphery the rectangular grooves. On the end of said grooves there are drilled out the orifices inclined by angle 45° which are connected to the common annular groove, respectively.

The lubricating oil from the master rod bearing bush reaches the annular groove and then through the separate orifices and the grooves lubricates each link rod pin /knuckle pin/.

The oil scoop attachment bolt /9/ made of chromium steel comprises from its one end a thread whilst from another one a hollow head.

The head is provided with a flange entering into a respective cut-out of the oil scoop.

On the outer surface of the hollow head is machined an annular channel being connected to six longitudinal grooves.

The oil from the oil scoop enters the annular channel of the hollow heat and through the grooves is being penetrated into the attachment bolt.

On the flange of the attachment bolt head are made two cut-outs enabling the bolt to be stopped when the nut /6/ to be screwed in.

The knuckle pin are locked from other side by means of a collar /15/ being made of chromium steel in a form of a bush, which comprises from one end a flange whilst from the another one the bottom with the opening.

Through the opening is passed the end of the oil scoop attachment bolt locked with aid of the nut /6/ and secured by a split-pin.

2.5 Crankshaft /fig. 18, 19/

The crankshaft is one of the parts subjected to the greatest strain and extreme care is needed in its construction and design, because the entire duty of transmitting the power generated by the engine to the propeller devolves upon it.

The crankshaft is divided and consists of both the front and rear pieces made of high-tensile strength alloy steel forging of special composition /heat-treated Cr-Ni-Wo- steel/.

The front piece /1/ is being coupled with the rear one /9/ by means of the maneton /24/ and the maneton clamp bolt /12/.

Both the crankshaft webs are equipped with the counter-weights from which the front one is rivetted to the web rigidly whilst the rear adjustable one is suspended with aid of the attachment bolts.

The crankshaft rests on three bearings placed in the crankcase.The main journals are installed together with the ball bearings /5/ into the front and rear part of the crankcase partition whereas the propeller drive shaft rests in the thrust ball bearing arranged in front cover of the crankcase.

The task of the front thrust ball bearing is to withstand the forces arising when propeller operated and to prevent the crankshaft to be shifted axially.

The front piece - propeller drive shaft /1/ consists of a front end, a central part and also of a main journal.

Both the front piece and the crank pin /25/ are drilled out in order the weight to be reduced. The hollows are then connected each other by means of a channel drilled out in the front crankshaft web. In the top part of the web said channel is threaded in order the plug /7/ to be screwed in.

The main journal in a form of a cylindrical tube is located just by the front web. On said journal the inner race of the front ball bearing is pressed in.

In front of the journal the diameter of the shaft is being decreased slightly and the thread is being machined, also.

On this part of the propeller drive shaft there are installed the following components: camgears, distance bush, camring bush, adjusting washers, oil distributor bush, and also the bush of the front thrust ball bearing.

• All detailed parts are jointed together with aid of a special nut.

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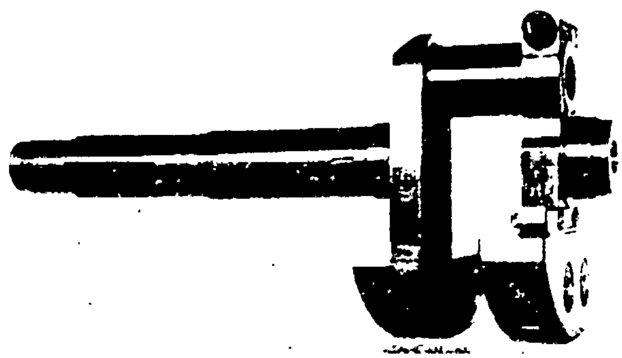

Fig.18 Crankshaft general view.

In the plane of symmetry there are drilled out two channels. The front channel serves for delivering the oil from the revolution governor to the propeller hub, whilst the rear one for the feeding with lubricating oil the surfaces of the camring and bushing being in contact.

Besides there are milled out on the cylindrical surface of the shaft between the main bearing and the rear orifice two grooves shifted each other by 90° enabling the wedges fastening the driving gear to be inserted.

In front of the thread the diameter of the shaft is reduced and 16 triangular grooves are milled out. In the groove situated in the plane of crankshaft symmetry there is made a blind orifice into which a steel peg /2/ is introduced.

Said peg results the propeller hub to be installed on the engine crankshaft in a proper position, only.

50X1

Between the grooves and the journal face there is installed the front cone of the propeller hub. At least the attachment nut of the crankshaft is screwed in and be locked with aid of a wire binding the 8 openings drilled out radially on the contour of the crankshaft journal wall.

The front journal comprises inside a cone hollow on the end of which an annular groove is machined. Just behind said groove the front duralumin plug /3/ is pressed in.

The plug comprises on its both faces a cone cut-out and in the center a threaded hole.

After the plug has been pressed in the front cut-out is flared out using the annular groove inside the journal for this purpose.

After flaring out in the face of the plug a small orifice is drilled out enabling the cutting of the washer of the propeller hub oil end-fitting to be entered.

On the second end of the hollow front piece there is made a cone channel, also, which is plugged with aid of a rear steel plug /4/ of a tube shape.

After the plug has been pressed in its rear flange is flared out, respectively.

The front piece of the crankshaft is coupled to the crank pin by means of a web with a triangular section.

The rigid counterweight /11/ is attached to the front web by means of two steel rivets /10/.

The counter-weight is made of carbon steel in form of a sector with a constant thickness.

In its middle part the counter-weight is provided with a rectangular cut-out into which enters the web and also with two holes for the steel rivets /10/.

On the counter-weight contour there are made two threaded openings to enable the balans-plugs to be installed.

On its one end the rivet comprises a head whilst the second one is flared out after installing.

The counter weight is assembled on the web from behind, the steel gusset, however, is installed from front.

The gusset face comprises from inside a round cut-out permitting the proper clearance between the gusset and the roller bearing seat flange to be obtained. The blanc plug is made of steel and consists of the stem and of a threaded head with a groove.

After the balans plug has been screwed into the counter-weight it is safetied by dotting resulting the material of the counter-weight to be pressed into the groove on the plug face, respectively.

The length of the balans plug is determined in dependence on the crankshaft unbalanced.

The main pin is drilled out from the front piece side. The plug /6/ is being screwed into the threaded orifices and then locked by dotting.

From starboard side of the main pin-when viewing from behind - there are placed two openings in order the copper tubes /13/ to be mounted.

Said tubes comprise a flange to prevent any radially displacement when in engine operation.

Externally the tube ends are flared out, whilst internally they are protruded beyond the inner surface preventing the mechanical particles to be penetrated together with the lubricating oil to the cooperating surfaces both the main pin and the master rod bearing.

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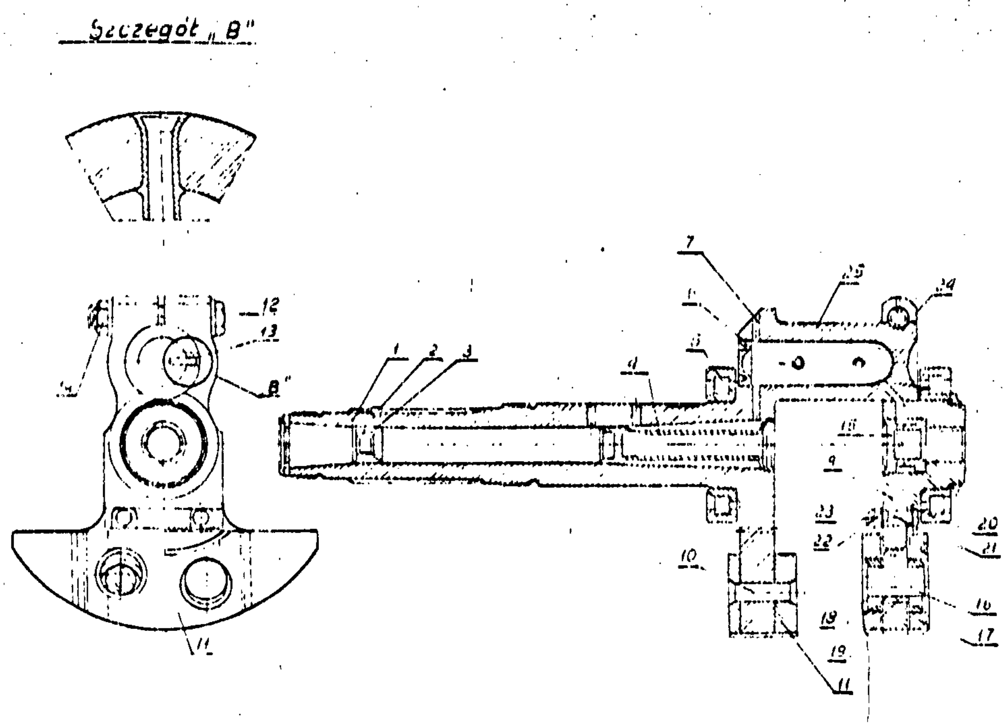

Fig.19 Crankshaft sectional view.

1 - front piece /propeller drive shaft/; 2 - steel peg; 3 - duralumin plug; 4 - rear steel plug; 5 - ball-bearings; 6 - crank pin plug; 7 - plug; 9 - rear piece; 10 - rivet; 11 - front counter-weight; 12 - maneton clamp bolt; 13 - copper tube; 14 - maneton clamp bolt nut; 15 - plug; 16 - attachment bolt; 17 - rear counter-weight; 18 - counter-weight bush; 19 - web bush; 20 - stop strap; 21 - stop strap attachment bolt; 22 - nut; 23 - split pin; 24 - maneton; 25 - crank pin.

During engine run the mechanical particles being forced with oil are throwed out by inertia forces and then pressed to the base of the copper tubes whereas the clear oil is being delivered to the master rod bearing.

In the bottom part of the crank pin there is drilled out a hole inclined by 45° being utilized for oil circulation.

After assembling said hole comes in connection with the orifice made in the maneton.

Top right crank pin is provided with a semi-circular cut-out made perpendiculary to the crank pin axis in order the maneton clamp bolt to be interposed. The rear piece of the crankshaft consist of the web with a rectangular section and of a short projection on which the rear roller bearing is being installed. Top part of the crank arm so called "maneton" enables the crank pin with the right crank web to be attached firmly by means of the maneton clamp bolt /12/.

When assembling the maneton orifice is deformed to enable its inner surface to the crank pin to be lain close.

The reliability of the union is examined by checking the clamp bolt lengthening. It should be within limits from 0,230 to 0,250 mm.

The clamp bolt as a forging of a Cr-Ni steel comprises on its end a flange resulting the pressure on the contact face to be reduced, respectively.

On the bolt stem close by the flange and by the thread there are made two cylindrical segments in order the bolt to be centered when introduced.

The threaded end of the bolt is provided with two cross-orifices into which the split pin enters to safety thus the attachment nut /14/.

The attachment nut made of the same material as the clamp bolt comprises from its end a cylindrical flange.

Besides on the other end there are drilled out three holes for safety split pin.

On the main journal of the rear piece of the crankshaft is pressed in the inner race of the rear roller bearing.

On the end of the journal the diameter is slightly decreased and a rectangular annular groove is machined. Into said groove is introduced a steel ring and a stop washer to prevent the inner race of the roller bearing to be shifted axially.

In the crank web there is bored out a hole with grooves. The duralumin plug /15/ is being pressed into same.

Said plug is ended with a bottom in the centre of which an orifice of 1 mm dia. is being made, to enable the lubricating oil to be injected to the crankcase in order the cylinder walls to be lubricated.

The plug comprises outside an annular cut-out limited from both ends by the flanges.

At the front flange there are bored out radially four orifices for oil circulation. On the face of said flange there is made an annular cut-out to enable the plug to be flared out in the crank web groove after being pressed in.

The cut-out made around the plug comes in contact with the main pin holow by means of the channel bored out in the top part of the rear crankweb.

Into the multigroove opening of the rear crankweb the main drive shaft end is introduced.

The section of the rear crankweb is variable one. Just below the main journal is made from outside a cut after which the crankweb width increased.

On the large part of the web there is suspended by means of two steel carbonized bolts /16/ the steel swivell counter weight /17/ the tack of which is to balance the inertia forces of first grade as well as to diminish torque-vibrations.

The attachment bolts /16/ are inserted into steel bushes from which four bushes /18/ are pressed into the counter-weight and other two /19/ into the rear crank-web, respectively.

The attachment bolts are with a flanges on their both ends which rest against the faces of the bushes placed in the counter-weight preventing the attachment bolts to be shifted axially.

The proper position of the counter-weight is ensured by means of a stop strap /20/ fitted externally with aid of two stop strap attachment bolts /21/ tightened by the nuts /22/ and safetied by the split pins /23/.

The swivell counter-weight is made in form of a sector with a constant thickness.

In center part of the counter-weight is made a rectangular opening in order the rear crank web to be introduced. Perpendiculary to said opening there are bored symmetrically two orifices into which four bushes /18/ are pressed.

When in operation between the stop strap /20/ and the counter-weight exists a gap as a result of inertia forces actuated.

Coaxiality of both main journals the front and rear pieces of the crankshaft is being examined after having been assembled.

Maximum beating of the propeller drive shaft in the places of thrust bearing seat and the front cone of the propeller hub seat not exceed of 0,08 mm for bearing seat diameter and 0,15 mm for the cone hub seat dia. respectively.

After machining and assembling the crankshaft is balanced statically.

2.6 Camdrum assembly /fig. 20, 21/

Camdrum assembly is destined to control the mixture to be fed into the cylinders as well as the exhaust gases to be conducted into the atmosphere periodically.

The camdrum assembly consists of the toothed drive gearing /1, 2/, camdrum /3/, plunger guides /4/, plunger with rollers /5/, push-rods /6/, push-rod tubes /7/, rocker levers with adjusting screws, inlet valves, exhaust valves with spings, retention cones and sping collars.

Opening of the inlet-exhaust valves in a moment required is being performed due pressing with aid of the camming lobes against the plunger and then push-rods and rocker levers.

The valve spings result the valve to be closed.

The camdrum revolves upon the bush situated on the crankshaft and driven by means of a double spur gear /2/ engaged with the camdrum annulus /3/.

The main drive gear /1/ is made as a forging of a Cr-Ni steel in shape of a sleeve with external toothing in number of 30 teeth. Said gear is inserted upon the propeller drive shaft and secured against rotation with aid of two rebates placed into the grooves milled in the crankshaft.

The rebates are made of a steel and comprise on their face a special cut-outs to enable an easy removing, if necessary. The gear teeth are azotised and then grinded. Said gear cooperates with a double indirect drive gear /2/.

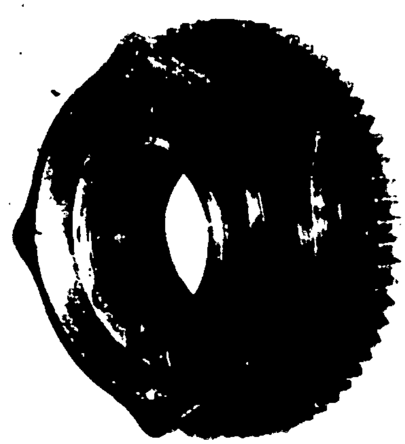

Fig.20 Camdrum general view.

50X1

The indirect gear /2/ made of a Cr-Ni steel forging comprises on its outer surface two toothed rings. On the large ring being in engagement with the main drive gear /1/ there are cut out of 48 teeth whilst on the small one 13 teeth, only.

In order the weight to be reduced there are drilled out in the large ring six openings symmetrically.

The teeth of both gears are azotised, and then the teeth of small gear are lapped whereas of large one grinded, only.

Bronze bush is pressed into the central orifice of the double gear, which rotates upon the axle installed into the front part of the crankcase. The axle of indirect camdrum drive gear is made of an alloy steel and drilled inside.

The axle is secured against axially shifting by means of a special stop screw introduced into the projection of a trapezoid section.

On the outer surface of the gear axle close by the bottom there are bored two orifices for lubricating purposes.

The duralumin plug is introduced into the right end of the axle and thereafter flared out.

External surface of the gear axle is being carbonized with exception of a narrow strap on the end of the axle enabling the end to be flared out.

The cam drum is made of an alloy steel forging and comprises two runways with four lobes on each as well as a ring with 65 teeth.

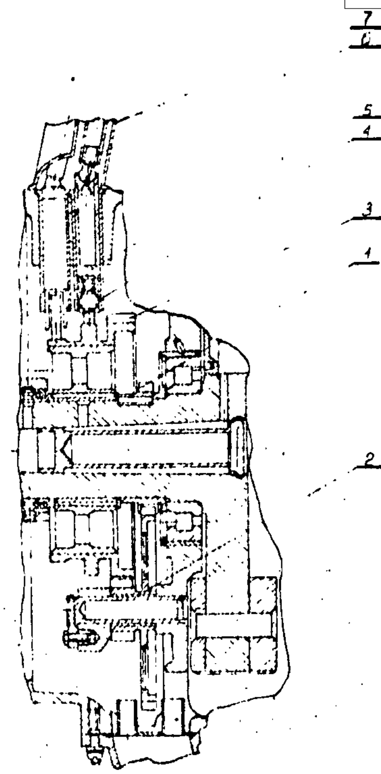

Fig.21 Cam drum assembly.

1 - main drive gear; 2 - indirect double gear; 3 - cam drum annulus; 4 - plunger guides; 5 - plunger with roller; 6 - push-rod; 7 - push-rod tube.

The cam runways and also the teeth are carbonized. The front camring actuates the rollers of the inlet valves whilst the rear one the rollers of the exhaust valves, respectively.

The nave-plate of the cam drum is made of a duralumin forging and comprises a shape of two bushes connected each other with aid of a transverse wall.

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In said wall there are drilled out 12 light-holes.

The bronze bush is being pressed into the center opening of the nave plate.

The cam drum rotates around the bush being inserted on the propeller drive shaft.

Said bush is made of a special alloy steel forging.

In the centre of the bush in its inner surface there is machined an annular groove which by means of the orifice is connected to the external surface of the bush. In order the operating surface to be lubricated properly an orifice on the external surface is ended with a groove, respectively.

The bush surface is azotized externally.

From both sides of the bush there are inserted on the crankshaft the distance washers.

Between the front distance washer and the face of the bush there are installed the adjusting washers the task of which is to regulate the position of the crankshaft in the crankcase and simultaneously the position of the plunger roller according to the run-way of the camring, also.

The shifting ratio from the crankshaft to the cam-drum is as follows:

$$i = \frac{Z_1}{Z_2} \cdot \frac{Z_3}{Z_4} = \frac{30}{48} \cdot \frac{13}{65} = \frac{1}{8}$$

where:

Z_1 - Number of teeth of main drive gear /1/

Z_2 - Number of teeth of indirect large gear /2/

Z_3 - Number of teeth of indirect small gear /2/

Z_4 - Number of teeth of cam drum gear /3/.

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The cam drum revolves eight times slower than the crankshaft and its direction of the rotation is similar to that of the crankshaft one.

4.3.4 Plungers, push-rods and push rod tubes /fig.22/

The plunger is made of Cr-Ni steel alloy in a form of a cylindrical stem with two external diameters.

From its one end the plunger comprises a deep hollow whilst from the other one a rectangular cut-out along the axis into which the plunger roller is being entered.

Perpendicular to the said cut-out there is drilled out an orifice in order the roller axle to be interposed.

In the plunger wall is drilled a lubricating orifice of 1 mm diameter through which the oil is being delivered to the rocker levers.

The plunger surface is carbonized outside in order the wear to be decreased.

At a distance of 10 mm from its face the hole inside the plunger is drilled out carefully.

Into said hole the plunger terminal made of Cr-Ni steel is pressed.

The plunger terminal is provided with a hemispherical seat carbonized into which the push-rod terminal is being placed.

In the terminal axis there is bored out a hole through which the lubricating oil is conducted.

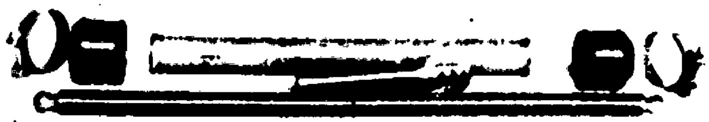

Fig.22 Plunger, push rod and push rod tube - general view.

The plunger roller is made of a Cr-Ni steel alloy and is being carbonized on its both external and internal cylindrical surfaces.

The roller is installed on the bronze bush revolving on the steel roller axle.

The push rod is made of Cr-M-Si steel alloy tube.

Into both tube ends drilled out inside are pressed Cr-Ni steel alloy terminals of the push-rods.

The terminal of the push rod is provided from its one end with a ball having carbonized and polished surfaces whilst from the other one with a cylindrical stem drilled inside which is pressed into the push rod, directly.

In the center of the terminal there is bored a hole for oil circulation.

The push rod tube is made of a duralumin alloy and comprises its both ends flared out, respectively.

One end of the tube enters the top terminal situated in the rocker lever housing, the second one enters the bottom terminal of the push rods.

The push rod tube is being coupled to said both terminals by means of a rubber connectors fixed by clamps.

The bottom terminal of the push rod tubes is made of an aluminium alloy casting as a two forked tubes connected from one side by means of a common flange.

In said flange there are made two openings for stud bolts fastening the terminal to the front part of the crankcase.

On their both ends the tubes are thicked respectively, and comprise the annular grooves to prevent the rubber joint pieces to be dropped.

2.6.2 Rocker levers /fig.23, 13/

The rocker levers /7/ are made of a special steel forging and placed in the rocker lever housing being casted out together with the cylinder head.

On the rocker lever end there is made a cut-out in plane of symmetry of the lever into which is installed the rocker lever roller /23/ rotating on its axle /24/.

The roller and the axle are made of Cr-Ni steel alloy and also carbonized.

The rocker lever axle is safetied against axially displacement by dotting after has been pressed.

The other end of the rocker lever is provided with an opening threaded into which the adjusting screw /5/ is screwed in.

The adjusting screw made of Cr-Ni steel comprises from its one end a hemispherical recess cooperating with the push-rod terminal and from the other one a hollow.

A rectangular groove made on the outer surface of the adjusting screw is connected by means of an orifice drilled radially with the hole bored in the axis of the hemispherical recess, respectively.

After the adjusting screw has been screwed into the rocker lever its groove connects with the hole inclined situated on the rocker lever, and then with the orifice by lever roller bearing seat.

The lever bearing consists of an outer race /18/ on inner one /20/ between which rollers /1/ are situated.

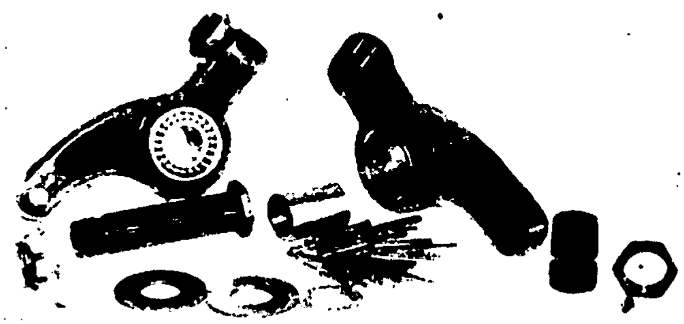

Fig.23 Rocker levers general view.

The outer race of the roller bearing is made of Cr-Ni steel alloy.

The outer surface of the race comprises an annular groove with three orifices drilled out radially.

After installing the race into the rocker lever opening said groove comes in contact with an inclined orifice in the lever through which the lubricating oil is being forced to rocker lever bearing.

The inner race of the roller bearing is made of Cr-Ni steel in a shape of a sleeve. Its outer surface is carburised.

In order to prevent the bearing rollers to be shifted axially there are placed from both sides of the lever the washer /17/ made of Cr-steel.

The rocker lever rotates around its hollow shaft /21/ made of Cr-steel which from its one end comprises a thread whilst from another one a hexagonal flange.

2.6.3 Valves and valve springs /fig. 13, 24/

Into each cylinder head there are installed one inlet valve /22/ and one exhaust valve /25/.

Both valves are made of Cr-Mo steel forging. Their valve seats are inclined by 45°.

With consideration of the high temperatures in which the exhaust valve works the diameter of its stem is greater than that of inlet one by 2,5 mm. It enables the head conductivity from the exhaust valve to be more intensive.

At the top end of each valve stem is machined an annular groove for insertion a retention cone /8/.

The flat surface of the top valve end as well as the side surface of the stem are hardened.

Two cylindrical spiral springs /10, 11/ are installed in order the valves to be closed.

Bottom ends of the said springs rest against bottom collar /12/ introduced on the valve guide flange /13/.

The spring collar made of Cr-steel is provided with an annular flange on its top front surface. Inside said flange the inner spring is inserted whilst outside it the outer one, respectively.

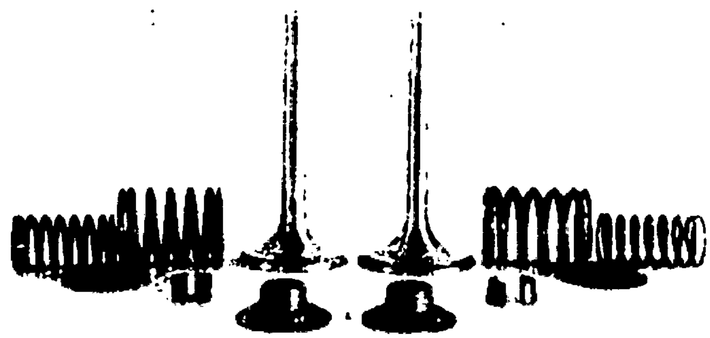

Fig.24 Valves and valve springs general view.

The both springs rest with their top ends against an upper spring collar /9/ fastened to the valve stem head by means of a double retention cone /8/ made of a chromium steel and introduced in an annular groove of the valve stem.

Top spring collar is made of a Cr-steel and comprises a cone orifice for valve retention cone as well as an annular flange similar to that of a bottom one, on which the valve springs are based.

2.7 Accessory drive assemblies /fig.25/

In the rear crankcase chamber there are installed all the accessory drive assemblies:

a/ magnetoes drive
b/ revolution governor drive
c/ generator drive
d/ oil pump, air distributor and fuel pump drive
e/ compressor and vacuum pump drive.

All the engine accessories are driven by means of a main drive shaft /fig.26/. It is mounted on the rear part of the crankshaft and cooperates with the bevel gear driving the revolution governor.

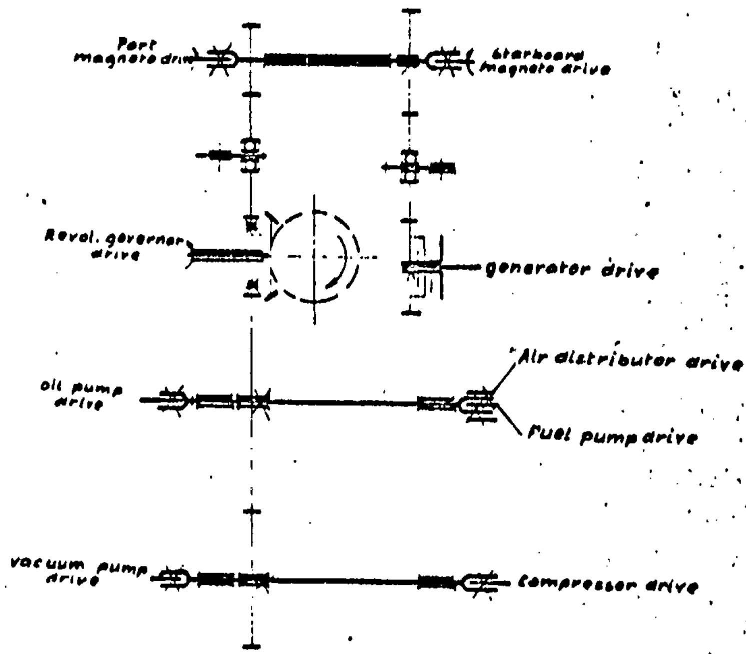

Fig.25 Accessories driving lay-out.

Together with the bevel gear rotates on a common axle a gear /fig.27/ which by means of remain toothed wheels drives all accessory shafts, fespectively.

Technical data about the number of the wheel teeth and the transmitting ratio in relation to the crankshaft rotations gives below table:

Item	Accessory drive name	Toothed wheels: Sign		No. of teeth		Transmitting ratio
1.	Revolution governor drive	A B		17 17		$i = \frac{A}{B} = \frac{17}{17} = 1$
2.	Magneto drive	A B C	D E	17 17 28	32 16	$i = \frac{ACD}{BDE} = \frac{17 \cdot 28 \cdot 32}{17 \cdot 32 \cdot 16} = 1,7$
3.	Generator drive	A B C D	E F G H	17 17 28 32	16 33 35 25	$i = \frac{ACDFG}{BDEGH} = \frac{17 \cdot 28 \cdot 32 \cdot}{17 \cdot 32 \cdot 16 \cdot}$ $\frac{\cdot 33 \cdot 35}{\cdot 35 \cdot 25} = 2,31$
4.	Oil pump drive Fuel pump drive Rev. gover. drive	A B C K		17 17 28 56		$i = \frac{AC}{BK} = \frac{17 \cdot 28}{17 \cdot 56} = 0,5$
5.	Compressor drive Vacuum pump drive					$i = \frac{ACK}{EKL} = \frac{17 \cdot 28 \cdot 56}{17 \cdot 56 \cdot 35} = 0,8$

The main driving shaft is made of chrome-molibdenum steel composition. It is drilled throughout and comprises on its one end a bevel gear whilst on the other one the splines. Besides there is made also from the front part an annular groove to enable the rubber gasket to be inserted preventing the oil supplied to the crankshaft to be leaked.

50X1

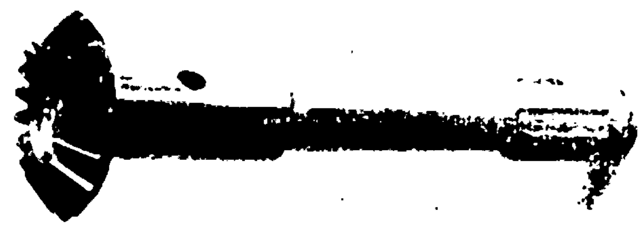

Fig.26 Main driving shaft general view.

With aid of the splined end the shaft is being connected to the rear end of the crankshaft.

From the side of toothed wheel the shaft diameter is being increased on a certain length.

This part of the shaft creates a journal rotating in the bearing placed in the rear part of the crankcase.

An orifice drilled out on the journal surface enables the lubricating oil to be forced to the shaft hollow.

The gear is provided with an annular channel into which an aluminium plug is pressed.

It is made in a shape of a hemisphere and after pressing into the channel prevents any leaking.

The external surface of the shaft together with the gear and a splined end is azotized.

2.9.1 Side drive assembly

The side drive assembly consists of a bevel gear for revolution governor driving, accessories drive gear and of the revolution governor shaft.

The bevel gear of the main drive shaft engages with the bevel gear of the revolution governor, which is mounted on the revolution governor drive shaft by means of a rebate.

On the bevel gear axle there is fixed the accessories drive spur gear, the task of which is to drive all remain accessories.

Fig.27 Revolution governor drive gears general view.

The revolution governor bevel gear is made of chrome-molibdenum steel alloy. It comprises an annular flange with eight projections placed around its contour proportionately.

Inside the opening there is cut a longitudinal groove in order the rebate to be introduced.

The drive gear of the accessories is made of Cr-Mo steel and is provided with a flange inside the opening with eight grooves into which a respective projections of the bevel gear are inserted and thereafter dotted firmly.

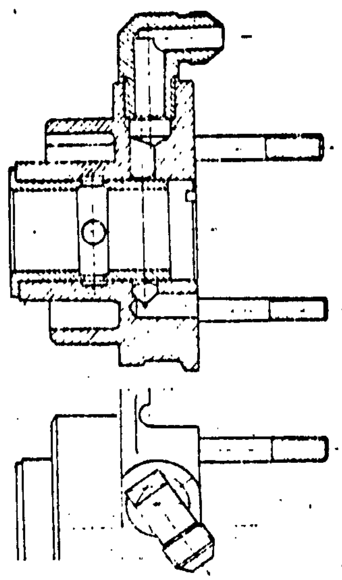

Fig.28 Revolution governor insert sectional view.

Both the gears are azotized. The shaft of the revolution governor drive is made of chrome-molibdenum steel alloy. The said shaft is drilled through and comprises from its one end a cylindrical surface with diameter decreased on which a longitudinal groove is cut-off.

The bevel gear is being installed on said shaft by means of a robate.

In its other end the shaft is splined internally to enable the revolution governor drive shaft to be coupled.

The side drive assembly revolves in the bush introduced into the revolution governor isert.

Above detailed insert is made of an aluminium alloy casting and comprises a flange in shape similar to that of revolution governor base one. In the flange there are drilled openings as follows: four threaded orifices for stud-bolts fastening the revolution governor, two holes of 8 mm dia. from which the first hole serves for delivering the oil from the oil pump to the revolution governor whilst the remain one conducts the lubricant from the revolution governor to the propeller hub, and at least an orifice of 4 mm dia. for the oil draining being drilled out in a flat rectangular groove connecting with the central opening, respectively.

In the central opening there are cut two annular grooves. In order the insert to be attached to the rear chamber three holes for stud-bolts are bored in the flange.

On the cylindrical part of the insert there is cut a groove connecting to the opening through which the lubricant oil is forced to the revolution governor.

50X1

Through said groove is drilled radially an orifice being in contact with a channel milled inside the opening in order the revolution governor drive shaft to be lubricated.

The insert aside between top and center flange there is placed a cylindrical boss into which is made a threaded hole enabling the end-fitting conducting the oil to the propeller hub to be screwed in.

In the bottom of said hole is drilled excentrically a smaller orifice passing through the top channel and connecting with the flat orifice situated in the governor insert flange.

In order the weight of the insert to be reduced the material excessive from the side to be attached to the rear chamber is being milled out, respectively.

Into the central opening of the insert there is pressed a bronze bush with a flange on the front of which three lubricating channels are cut off.

Inside the bush is machined an annular groove with four orifices which after the bush having been pressed in enable the oil to the governor driving shaft to be delivered.

The outer surface of the bush together with the insert top groove creates a channel being utilized for oil circulation from the revolution governor to the propeller hub.

2.7.2 Magnetoes drive /fig.29

The magnetoes drive consists of the magnetoes shaft and also of the indirect drive.

The hollow shaft is made of a chromium molibdenum steel alloy and comprises from its both ends the inner splines into which the splined bushes fixed to the magnetoes shaft are introduced.

On the cylindrical part of the shaft there is cut a spur gear being engaged with the indirect gear of the drive assembly.

On the other end there are milled the splines externally in order the generator drive gear to be inserted.

The central cylindrical part of the shaft is rotating in the bronze bushes situated in the rear chamber opening.

Both the teeth of the spur gear as well as the shaft surface being rotated are azotised.

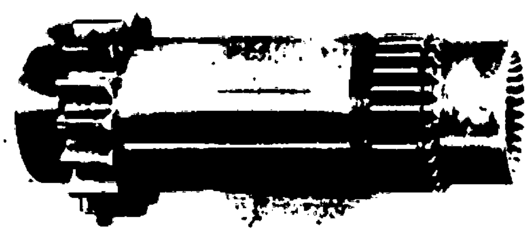

Fig.29 Magnetoes drive shaft general view.

The indirect drive consists of a shaft and an indirect gear made of Cr-Mo steel.

Around the gear nave contour ten light-holes are drilled.

Into the central opening of the gear the ball bearing is pressed in.

The indirect gear is placed on the shaft made of the chromium steel and also provided with both ends threaded.

In its middle part the shaft comprises a flange permitting the same in the rear chamber to be installed properly. Between the chamber web and the indirect gear bearing there is inserted a distance wahser by means of which the gear is positioned in plane of the gears collaborated.

2.7.3 <u>Generator drive</u> /fig.30/

Driving assembly of the generator consists of a spur gear, indirect gear and also of a clutch.

The spur gear installed on the magnetoes shaft comes in engagement with an indirect one which drives the clutch gear situated on the generator shaft.

The generator drive gear made of Cr-Mo steel is provided inside with the splines.

Fig.30 Generator drive assembly view.

The indirect drive is similar to that of the generator indirect one with exception to the number of teeth, only.

The threaded end shaft creates one stud-bolt from remaining four ones fastening the generator to the rear chamber of the crankcase.

The generator clutch comprises the following parts: hub /1/, spur-gear /2/, two clutch plates /3/, clamping collar /4/, spring /5/, stud-bolt /6/ and castle nut /7/.

The clutch hub made of chromium steel is provided with an inner splines in order same to be introduced upon the generator shaft. On the face of the clutch hub there are milled six grooves into which the splines of the clamping collar are being entered.

The cylindrical surface of the clutch hub serves the spur gear to be inserted.

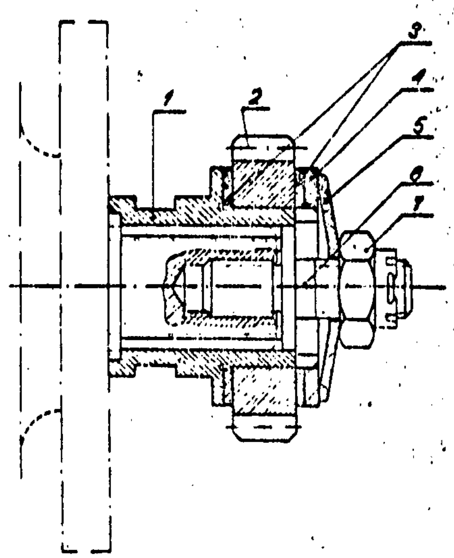

Fig. 31 Generator clutch sectional view.

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1 - clutch hub; 2 - spur gear; 3 - clutch plate; 4 - clamping collar; 5 - spring; 6 - stud-bolt; 7 - castle nut.

The spur gear is made of Cr-Mo steel alloy. Both its front surfaces are lapped exactly to enable two bronze clutch plates to be lain close after clamping with aid of the collar /4/, spring /5/ and stud-bolt /6/ with castle nut /7/.

All the front clutch surfaces collaborating together are lapped thoroughly.

With aid of the nut the clutch torque is adjusted within limits of 300 - 340 kgcm.

The stud bolt /6/ is made of chromium steel and is provided from both ends with a thread whilst in the center part there is placed a flange with six splines entering into the respective splines of the clutch hub.

The clutch operates as follows: should the crankshaft revolutions be changed very rapidly the slippage between the frictional surfaces will occur resulting both the generator and its drive assembly against excessive overloads to be secured.

2.7.4 Oil pump, fuel pump and air distributor drive

Said drive consists of a hollow shaft and a spur gear being fixed upon it by means of a ~~taper~~ anchor pin.

The hollow shaft is made of a chromium steel and comprises from its one end a cylindrical flange preventing the shaft to be shifted axially.

The bronze bush pressed into the port wall of the rear chamber enables the shaft to be rotated.

The spur gear is being inserted on the said shaft unmovably.

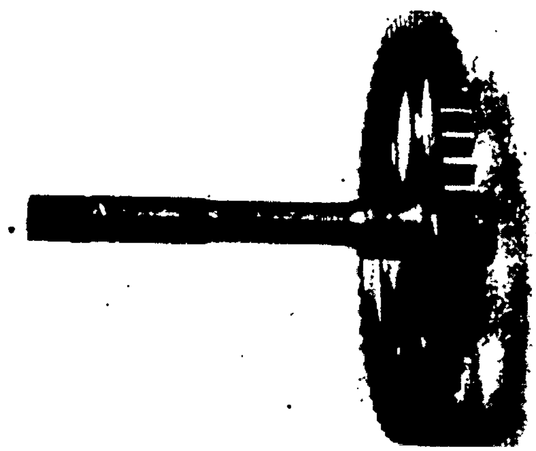

Fig.32 Oil pump and air distributor drive view.

The shaft end is being splined externally in order the splined bush of the air distributor drive to be interposed.

In vicinity of the splined terminal there is a cylindrical surface rotating in the bronze bush pressed into the starboard wall of the rear chamber. On said surface a spiral groove is cut for lubricating purposes.

From both ends of the drive shaft there are cut inside a rectangular openings serving to drive both the oil and fuel pumps, respectively.

In the fuel pump opening there are cut on its walls the rectangular grooves in order the spring pressing with use of fuel pump shaft against the air distributor shield to be fitted.

In middle part of the shaft there are drilled two channels serving for oil draining.

The spur gear made of a chromium steel is provided on its hub with six light-holes.

Said gear is attached to the shaft by means of the taper pin inserted throughout both the spur gear hub and the shaft and locked from it threaded end by a nut and split pin, respectively.

2.7.5 Compressor and vacuum pump drive

The compressor and vacuum pump drive is similar to that of oil pump, fuel pump and air distributor one and comprises the spur gear inserted on the drive shaft.

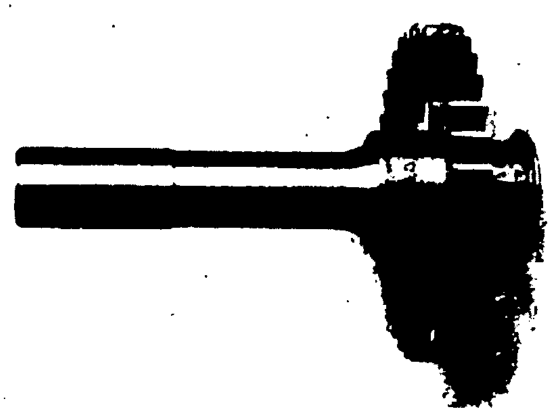

Fig.33 Compressor and vacuum pump drive view.

The hollow shaft is made of a chromium steel and is provided from its both ends with internal splines to enable both the vacuum pump shaft end and also the compressor shaft end to be attached, respectively.

The driving shaft is supported on two bronze bushes being pressed into the rear chamber walls.

The spur gear made of chromium steel comprises eight light holes. Said gear is attached to its shaft in a manner similar to that of oil and fuel pumps drive.

2.3 Engine mounting

The engine mount is made of Cr-Mo-Si steel tubes and comprises ring and eight struts /steel tubes/ welded together as well as six slilent-blocks /rubber pads/ being screwed into the ring.

Separate struts are coupled each other by means of the bushes welded to them enabling the attachment bolts fastening the engine mounting to the airframe to be introduced.

Inside the engine mount ring are welded six lugs with holes through which the suspension bolts fastening the rubber pads to the engine mount are passed.

The suspension pad consists of two covers /1/ between which there are placed two annular rubber pads /2/ separated from each other by means of an annular insert /3/.

Both the covers and the insert are made of the steel alloy similar to that of the engine mounting one.

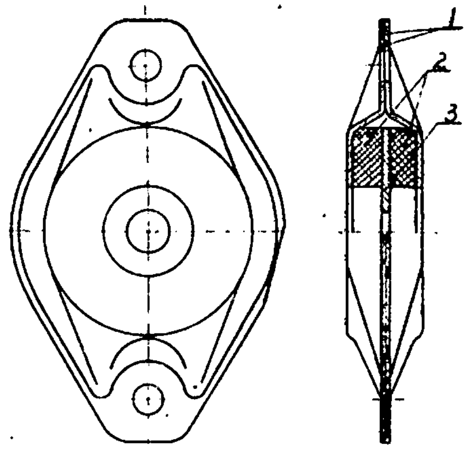

Fig.35 Suspension pad sectional view.

1 - cover; 2 - rubber pad; 3 - insert.

The rubber pads are glued to the covers and to the insert with aid of a special glue. Both covers are wel-ded a ... an opening for suspe ... spension pad there are ... tening the engine to

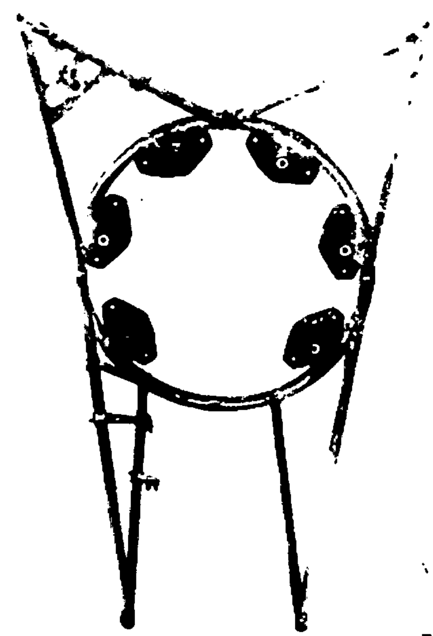

Fig.34 Engine mount.

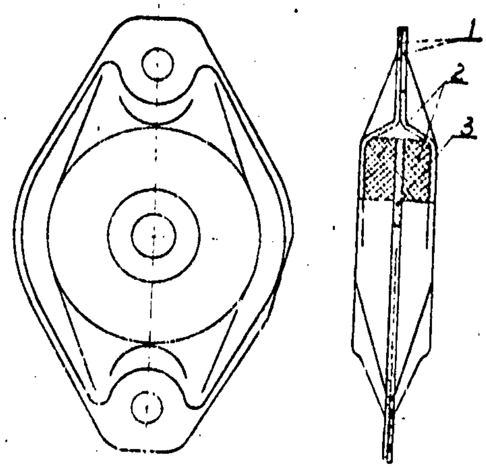

Fig.35 Suspension pad sectional view.

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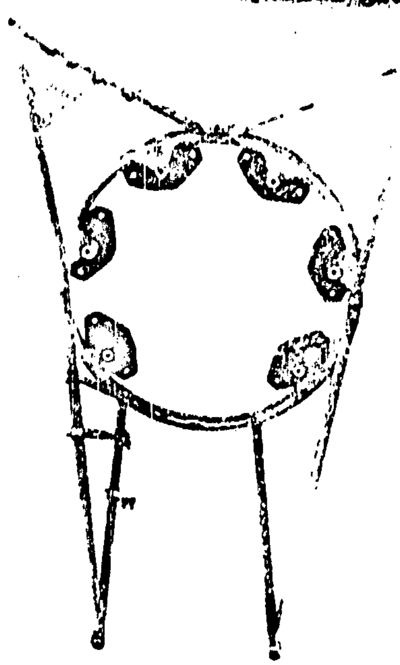

Fig.34 Engine mount.

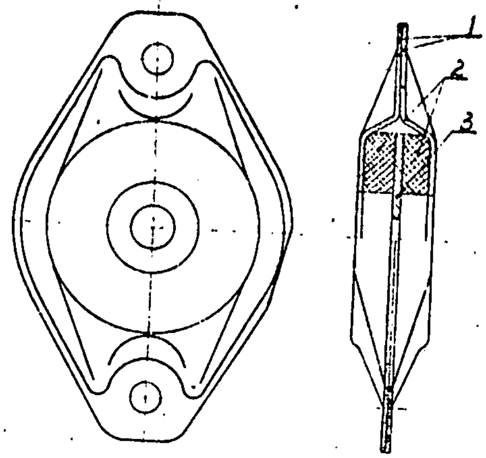

Fig.35 Suspension pad sectional view.

1 - cover; 2 - rubber pad; 3 - insert.

The rubber pads are glued to the covers and to the insert with aid of a special glue. Both covers are welded around its countour electrically.

In the center part there is made an opening for suspension bolt.

Through side openings of the suspension pad there are passing the attachment bolts fastening the engine to its mounting.

Fig.34 Engine mount.

3.0 LUBRICATION, VENTING AND COOLING SYSTEMS OF THE ENGINE

3.1 General informations about the engine lubrication

The engine is being lubricated in order the friction between the component parts cooperated to be reduced as well as the heat to be conducted from them.

The engine is lubricated by a forced-feed system, generally. The cylinder walls, pistons, wrist pins, ball bearings and toothed wheels are lubricated by oil splash, only.

The oil flowed down from the engine part is being collected in the sump situated at the lowest point of the crankcase from where is returned by the oil pump large stage to the oil tank, whilst the oil drained from the four cylinder heads of the bottom cylinders is returned by the oil pump small stage, respectively.

In order the oil system to be checked when the engine in operation the following instruments on the aircraft instrument panel are installed:

a/ thermometer for measuring the outlet oil temperature
b/ thermometer for measuring the inlet oil temperature,
c/ gauge for measuring the inlet oil pressure.

3.2 Circulation of the lubricating oil in the engine

The oil is being forced to circulate through the engine parts under pressure by means of the oil pump of gear type consisting of one pressure stage and two suction ones.

The oil drawn from the oil tank is conducted through the lubricating oil filter to the oil pump suction stage and then is forced through the channel to the disc filter.

After leaving said filter the oil flows through the hollow bolt and orifice in the rear chamber of the crankcase and enters the tube dipped in the rear chamber interior.

The steel tube dipped distributes the oil in the following four directions:

a/ for lubrication: the accessory drives /with exception to the magnetoes drive shaft/, compressor, vacuum pump and the air distributor mounted on the rear chamber;

b/ for lubrication: main drive shaft, connecting rod assembly and the camdrum assembly;

c/ for lubrication: the tappets /plungers/, rocker lever assembly, double gear cam drive shaft and magnetoes drive shaft;

d/ to the revolution governor and the propeller hub.

Ad a/ The tube branches dipped in the rear chamber are connected with all openings made in the side walls of the rear chamber into which there are inserted the bronze bushes for accessory drive shafts. The oil conducted through the annular grooves cut on the bushes outside and also through two orifices drilled in each groove lubricates the working surfaces of shafts and the bushes.

The attachment flanges of the compressor and the vacuum pump are provided with a special channels /detailed description was given in chapter 2.2/ enabling the respective parts of said accessories to be lubricated.

Through a special spiral cut on the air distributor drive shaft the oil is being penetrated to the distributor shield.

Ad b/ The oil forced from the oil pump flows through the tube dipped in the rear chamber to the cylindrical boss placed in the centre of the rear chamber and then through the orifice inclined enters the annular channel created by the inner faces of the bushes and lubricates the journal of the main drive shaft.

Thereafter the oil flows through the radial orifice drilled in the main drive shaft journal vis a vis the groove, enters the hollow shaft from where penetrates to the plug central groove pressed into the rear part of the shaft.

Through the orifice of 1 mm dia. drilled in the plug center the oil flows out to the crank-mechanism space and lubricates the cylinder walls gudgeon pins, and the roller bearings.

Using the radial openings drilled in the plug and being connected to the annular groove made on the outer surface of said plug, as well as through the orifice drilled in the rear piece of the crankshaft the lubricant enters the inclined hole made in the crank pin connecting both pieces of the crankshaft together and fills up the hollow space of the crank pin, completely.

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From the interior of the crank pin the oil is forced through two copper tubes in order the master rod bush to be lubricated.

The oil flowing out from the master rod bush enters the annular groove of the oil scoop and through the orifices and channels in the said scoop and its bolts penetrates into the knuckle pins /link rod pins/ interior.

Using the orifices drilled in the knuckle pins the oil lubricates the collaborating surfaces of the knuckle pins and the link rods.

Through the perpendicular hole drilled in the front piece of the crankshaft the oil is conducted to the annular space bordered with the hollow shaft surface and the outer surface of the tube insert pressed into the front part of the crankshaft, respectively. From there through the orifice drilled radially in the shaft as well as through the annular groove and the orifices in the bush inserted on the shaft the oil is directed in order the camdrum bush to be smeared.

Ad c/ The tube connecting the cylindrical boss made in the centre of the rear chamber to the boss placed on the top wall of the rear chamber delivers the oil for lubrication the magnetoes drive shaft and also the valve mechanism.

Into the boss situated on the top wall of the rear chamber there are screwed both the bent-pipe and the end-fitting of the oil pressure transmitter, respectively.

In the seat of the oil pressure transmitter end-fitting is drilled an orifice passing through the tube dipped in the rear chamber and coming in contact with the annular channel created by the faces of the magnetoes drive shaft bushes. With aid of said

orifice the oil is being delivered to the oil pressure transmitter and also to the shaft.
By means of the bent pipe connected to the tube dipped the oil flows to the steel tube and to the end fitting screwed into the front part of the crankcase.
Through said end fitting the oil flows to the steel tube dipped in the cam chamber and passes through the bosses of the tappet guides.
Using the radial orifice in the tappet guides the lubricant is forced to grease the tappets then through the orifices in the tappets enters their interiors.
Further way of the oil flow is as follows: from each tappet interior it passes through the orifices drilled in the terminals of the tappets and the push-rods then through the orifices and grooves in the adjusting screws of the valve rocker further through the inclined holes drilled in same.to the grooves cut on the external surface of the needle bearing race and through the holes made in the grooves lubricates the bearing.
The oil coming from the bearing lubricates then the springs and the valve stems.
The ends of the supply tube dipped in the cam gear chamber are jointed together in the front port of the cam drive double gear suspension and deliver the lubricant through the shaft holes in order the toothed wheel working surfaces to be greased.
The spur gears situated in the cam mechanism chamber as well as the cam drum run-ways and the thrust bearing are lubricated by oil splash.

Ad d/ Supplying the propeller revolution governor with lubricant. The oil is being forced from the oil pump through the oblique hole drilled in the seat of the propeller governor insert and then through the groove made in said insert and the orifice to the suction channel of the propeller revolution governor oil pump.
From the pressure-channel in the propeller governor oil pump the lubricant is led to the insert hole connected to the perpendicular channel into which the end fitting is screwed in.
Using said end fitting /bent pipe/ the connecting pipe and the terminal screwed into the front cover the oil enters the bracket of the front cover. Through the holes and the groove made in the bracket as well as through the holes and the groove made in bush bearing and in the crankshaft the oil is forced to the shaft interior and from there to the cylinder of the propeller hub.
From the propeller hub cylinder the oil returns to the revolution governor by the same way. The oil from the revolution governor is scavenged to the rear chamber through the scavenge hole connected to the orifice made in the governor insert, respectively.

3.3 Discharging the oil from the engine

The lubricating oil flowing from the gaps between the component parts of the engine when in operation as well as the oil from the revolution governor, vacuum pump and the compressor is being scavenged to the sump situated in the bottom part of the crankcase.

From the sump the oil flows through the filter, the oil pump and the oil cooler to the oil tank.

3.7.1 Oil draining from the rocker lever housing

In order to prevent the excessive amount of the oil in the rocker lever housings to be collected all the housings are connected together by means of the durite hoses.

From the rocker lever housings of three top cylinders the oil is drained through the push-rods tubes and also the holes drilled in the bosses of the bottom push-rod terminals to the crankcase whilst from the remain four bottom cylinders it is drained with aid of a small suction stage of the oil pump.

From both chambers of the first cylinder the oil is scavenged through the end-fittings screwed into the side walls of the chamber and through the durite hoses into the both adjacent chambers of the second and seventh cylinder, respectively.

The chambers of said cylinders are coupled each other in such a manner that the oil flows to the lowest point of the bottom chambers and from there through the push-rod tubes to the crankcase.

The oil from the top chambers of third and sixth cylinder is drained through the durite hoses connecting both chambers to the covers of bottom chambers of said cylinders.

The covers by means of hollow bolts and the end-fittings with durite hoses are connected to the covers of the both bottom cylinders, respectively.

Into the cover of exhaust valve of the fifth cylinder there is screwed a hollow bolt with a special end-fitting connected to the steel tube by means of the durite hose.

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50X1

Said steel tube is coupled with the terminal of the oil pump small suction stage discharging the oil from four bottom cylinders.

Owing them all the housings of the valve rocker levers remain dry when engine running preventing the oil to be penetrated into the combustion chambers through the valve stem guides.

3.4 Oil pump

General

The oil pump task is to keep the lubricant oil still in circular motion.

It assures the oil from the oil tank mounted on the aircraft to be forced to the engine oil system as well as the oil to be drawn from the sump and from the valve rocker lever housings of four bottom cylinders and also to be conducted to the oil tank, anew.

The oil pump is of three-stage gear type - one of them is pressing whilst the remain two are sucking.

The large suction stage draws the oil from the sump whereas the small one from the valve rocker lever housings of four bottom cylinders, only.

The pressure stage is placed in the bottom part of the oil pump, the large suction stage in the centre and the small suction stage in the top part, respectively.

The common length of wheel teeth of both suction stages is greater by twice than that of the pressure stage one. As a result of such design the out-put of both suction stages is greater to assure the hot oil to be discharged with a speed desired.

On the front end of the shaft driving the oil pump there is situated the bevel gear engaging with the similar one installed on the revolution counter drive shaft.

In order to assure the pressure of the oil forced to the engine to be adjusted properly the oil pump is equipped with the reducing valve.

Simultaneously the oil pump housing is provided with special chamber into which an oil filter of disc type is positioned.

The oil pump is mounted on the port wall of rear chamber of the engine.

3.4.1 Main technical data

1. Out-put at 1125 r.p.m.
   a/ pressure stages at counter pressure of 3 kg/sq.cm and oil temperature within limits of 50° - 70°C in litres per min. - 12
   b/ large suction stage at counter pressure of 0,2 kg/sq.cm and oil temperature within limits of 50° - 70°C in litres per min. - 22
   c/ small suction stage at counter pressure of 0,2 kg/sq.cm and oil temperature within limits of 50° - 70°C in litres per min. - 5,6
2. Number of revolutions of oil pump drive shaft in r.p.m. minimum 250, rated 1125, maximum 1300
3. Direction of rotation - clockwise
4. Gear ratio - 0,5

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3.[illegible] The oil pump design

The oil pump consists of the following main component parts and assemblies: housing, bottom cover, top cover, two pressure gears, two suction gears of large stage, two suction gears of small stage, drive shaft, gear axle, reducing valve, oil filter and revolution counter drive.

The oil pump housing /1/ is cast of an aluminium alloy. Inside the housing from its front part there are made two chambers: eliptical chamber for gears of both suction stages and the cylindrical one for oil filter installation.

Between said chambers there is situated a longitudinal chamber comprising the reducing valve and being connected with its whole vertical section to the chamber of the suction gears. From the oil filter chamber, however, it is separated with aid of a partition.

From behind the housing, vis a vis the eliptical chamber of the suction gears there is placed the chamber of the pressure gears with a section similar to that of suction gears one.

The last chamber is connected to the oil filter chamber by means of a channel situated under the reducing valve chamber.

Both the suction chamber and the reducing valve one are separated from the pressure chamber with aid of the cross wall into which three ports are cut-out.

In one port made in the gear chamber rests the drive shaft whilst in the second one the gear axle. The third port is positioned in the reducing valve chamber and serves the valve housing to be inserted.

3.4.2 The oil pump design

The oil pump consists of the following main component parts and assemblies: housing, bottom cover, top cover, two pressure gears, two suction gears of large stage, two suction gears of small stage, drive shaft, gear axle, reducing valve, oil filter and revolution counter drive.

The oil pump housing /1/ is cast of an aluminium alloy. Inside the housing from its front part there are made two chambers: eliptical chamber for gears of both suction stages and the cylindrical one for oil filter installation.

Between said chambers there is situated a longitudinal chamber comprising the reducing valve and being connected with its whole vertical section to the chamber of the suction gears. From the oil filter chamber, however, it is separated with aid of a partition.

From behind the housing, vis a vis the eliptical chamber of the suction gears there is placed the chamber of the pressure gears with a section similar to that of suction gears one.

The last chamber is connected to the oil filter chamber by means of a channel situated under the reducing valve chamber.

Both the suction chamber and the reducing valve one are separated from the pressure chamber with aid of the cross wall into which three ports are cut-out.

In one port made in the gear chamber rests the drive shaft whilst in the second one the gear axle. The third port is positioned in the reducing valve chamber and serves the valve housing to be inserted.

50X1

In the flange of the suction chamber are drilled six holes passing through special bosses placed on the side surface of said chamber.

Through detailed holes there are passed three bolts fastening simultaneously the oil pump to the rear chamber as well as three stud bolts to enable both covers the top and bottom one to the housing to be attached.

Besides there is cut in the flange a flat threaded orifice into which enters the attachment screw of the top cover. Nearby this orifice is placed a recess with a hole being in contact with a respective hole drilled in the boss.

The last orifice threaded is provided with a bent pipe to enable the oil from the valve rocker lever housings to be scavenged.

In the flange of the filter chamber there are made four openings threaded into which are screwed the stud-bolts in order the oil filter cover to be fixed.

Just by the flange inside the filter chamber there is machined a cylindrical narrow surface resulting the filter cover to be based properly.

The filter chamber creates in its bottom part a small cylindrical opening into which is interposed the filter pressing insert.

In the bottom of said opening there is drilled excentrically a hole and then pluged with a hollow bolt by means of which the oil is forced to the engine.

On its end the hollow bolt is provided with a cylindrical flange machined inside. In the flange there are made six symmetrically situated cuts into which enters the end of the safety pin whilst the other end of said pin enters one from two channels on the side surface of the larger opening.

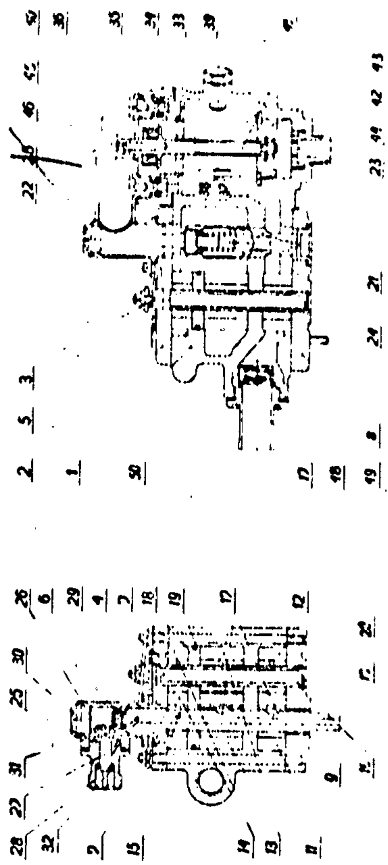

Fig.37 WN-3-09 oil pump sectional view.

1 - housing; 2 - top cover; 3 - top plug; 4 - rivet; 5 - gasket; 6 - bush; 7 - stud-bolt; 8 - bottom cover; 9 - bronze bush; 10 - plug; 11 - gear; 12 - gear; 13 - large suction stage gear; 14 - small suction stage gear;

15 - rivet; 16 - pump shaft; 17 - splin; 18 - insert; 19 - shaft; 20 - rear axle; 21 - reducing valve housing; 22 - bolt; 23 - spring; 24 - overflow valve; 25 - revolution counter housing; 26 - bevel gears; 27 - nut; 28 - end-fitting; 29 - adjustment anchor plate; 30 - duralumin plug; 31 - pin; 32 - gasket; 33 - filter housing; 34 - ball; 35 - spring; 36 - plug; 37 - rectangular pin; 38 - cleaning disc; 39 - top filter insert; 40 - gasket; 41 - stem; 42 - nut; 43 - bottom insert; 44 - steel insert; 45 - butterfly nut; 46 - stud; 47 - non-return valve housing; 48 - disc valve; 49 - spring; 50 - basket.

In the top wall of the reducing valve chamber there is made a cylindrical hole connected to the suction chamber. The oil from both suction stages is led to the oil tank through said hole and outlet end-fitting.

In the horizontal wall separating both the suction and the pressure chambers from each other there is drilled a smaller orifice as well as identical orifice in the bottom part of the reducing valve housing is introduced.

In the flange of the pressure chamber there is drilled an orifice threaded in order the attachment bolt fastening the bottom cover to be screwed in.

The housing surface outside close by the elliptical chamber there are made in the bottom part two large cylindrical bosses as well as detailed above a small cylindrical one in the top part of the housing.

50X1

The bottom boss is provided with a threaded hole connected to the oil pump pressure stage, into which the non-return valve is installed to enable the oil from the tank to the pump to be delivered.

The boss with a smaller diameter is provided with a short threaded orifice connected to the vertical channel situated in the boss above the cylindrical one.

The vertical channel with aid of a short horizontal one is coupled with the large suction stage.

Into the threaded hole there is screwed the end-fitting conducting the oil from the sump.

Between the sump and the end fitting there is placed the thermometer seat into which the thermometers measuring the outlet oil temperature are screwed in.

The top cover /2/ of the oil pump is cast of an aluminium alloy in a form of a plate.

From the side being attached to the oil pump housing the cover is smooth whereas on its top side, there are situated six bosses and one cut-out.

In the cylindrical boss changing its shape against a rectangular one there is made an opening in order the oil pump outlet terminal to be inserted.

To prevent the pipes to be connected to the oil pump incorrectly there is stamped on the rectangular boss "outlet".

In the triangle boss is drilled a large hole and three small ones around it for the rivets.

Into the central hole is pressed the top plug /3/ and then rivetted by means of three rivets /4/ to the cover.

The plug is made of steel in a shape of a triangle plate and comprises from its one end a stud bolt whilst from the other one a short cylindrical projection ended with a flat terminal, which enters the cut out made in the gear axle preventing it against rotation. Between the plug and the cover the gasket /5/ is introduced.

In the cover cut out there are made centrically one opening and three small ones for rivets. Into said opening there is put the bush /6/ of the revolution counter drive shaft.

It is made of bronze and comprises on its external surface a flange with three holes for rivets and also an annular groove into which there is drilled a hole being connected to the spiral groove inside the bush.

The remain bosses placed close by cover edge are provided with seven openings through which are passed three bolts fastening the pump to the rear chamber and three stud-bolts /7/ and one screw attaching the cover to the housing.

The bottom cover /8/ of the oil pump is cast of an aluminium alloy. From the side being attached to the oil housing it is smooth out from its opposite side there are situated three cylindrical bosses with holes and also one common boss with six holes. In the centre of said boss is situated a flange with the orifice into which the bronze bush /9/ is pressed in.

Close by the flange is positioned a hole with a cut outside. Into same enters the bottom end of the gear axle but into the cut the plug /10/ is introduced and flared, respectively.

In the hemispherical projection of the cover there is made an opening cut-out inside enabling the bottom part of the reducing valve housing to be inserted.

50X1

Said opening comprises from attachment side to the housing two flat channels into which enters the valve stop pin preventing the valve to be rotated during oil pressure timing.

The remain seven holes serve the cover to the housing to be attached. Three from them are threaded and comprise the double end bolts screwed in whilst remain three bolts are prepared for attachment bolts fastening the oil pump to the rear chamber. The last one is used by an attachment screw.

The pressure stage of the oil pump consists of two spur gears made of chromium steel.

The gear /11/ is provided with a longitudinal groove placed in its opening. In order the gears to be lubricated the second gear /12/ comprises in the bottom of its groove an orifice.

The gears /13, 14/ of both suction stages are similar to that of pressure stage ones with exception to their width only.

After the toothed wheel has been pressed on the oil pump drive shaft both detailed parts are jointed firmly by means of the attachment rivet /15/.

The oil pump drive shaft /16/ made of chromium steel comprises inside a hollow closed from the side of cylindrical journal by means of a bottom.

Two orifices inclined by 45° are drilled in said bottom in order the revolution counter drive to be lubricated.

The other end of the shaft is provided with a square terminal entering an opening of similar form in the drive shaft, respectively.

Cylindrical surface of the said shaft comprises four different diameters. The revolution counter drive bevel gear is being installed upon the short journal. The cylindrical part of the shaft comprising the greatest diameter creates a journal being in collaboration with the top bush. Thereafter said journal decreases its diameter slightly enabling the driving gear of the small suction stage to be mounted upon it.

The long cylindrical part of the shaft is provided with two longitudinal splines /17/ with cylindrical bottom and with one orifice.

On the center splin the driving gear of the large suction stage is installed whilst on the bottom one - the driving gear of the pressure stage, respectively. The said opening serves both collaborating surfaces of the shaft and the insert /18/ separating the small suction stage from the large one to be lubricated.

The said insert with an eliptical form made of aluminium alloy comprises two ports with equal diameters. In the one port rests the oil pump drive shaft whilst through the other one passes the gear axle.

The rectangular groove is made on the side surface of the insert into which the gasket /19/ is pressed.

The gear hollow axle /20 is made of Cr-Ni steel alloy and comprises on its one end a slot into which enters a respective terminal of the top plug securing the axle against rotation.

The external surface of the axle is carbonized.

The reducing valve

The reducing valve consists of the housing /21/, bolt /22/, spring /23/, overflow valve /24/ and washers /25/.

The valve housing /21/ made of Cr-Ni steel comprises from its one end an orifice with a short inner thread into which the reducing valve bolt is being screwed in. In its bottom part the orifice increases its diameter and creates a chamber enabling the spring and the overflow valve to be seated.

Nearby the end of said orifice there are drilled horizontally four holes through which the oil is being scavenged to the suction part of the oil pump. Thereafter the cylindrical orifice decreases its diameter and is stopped by a bottom at least.

The sharp edge of the orifice decreased creates a seat for the overflow valve.

The cylindrical surface placed the housing externally serves for insertion the housing into the opening in the partition separating from each other both cavities of the pump the pressure and the suction one.

Below the cylindrical surface the housing comprises four longitudinal channels by means of which the oil is carried into the interior of the housing.

The cylindricol surface is ended by a flange which when assembled enters the respective cut-out in the orifice of the oil bottom cover.

Between the housing flange and the cut-out in the bottom cover a gasket is introduced.

In order the weight to be reduced the housing is provided, from its face, with a special cut-outs.

The bolt /22/ of the reducing valve made of carbon steel comprises on its one end a head with a flange under which the gasket is inserted whilst on the other one there is placed a journal to enable the spring pressing the overflow valve to be based.

Above said journal there is situated a cylindrical opening threaded in order the bolt to be screwed into the valve housing.

In dependence on the oil pressure required at pressing side there are introduced on the journal between the spring and the bolt limiting surface some adjusting washers /23/ with different thickness, respectively.

From both ends of the bolt there are drilled out holes in order the weight to be reduced.

As a main component of the overflow valve /24/ is the ball bearing of 12 mm diameter.

Revolution counter drive

The revolution counter drive consists of the following main component parts: the housing /25/, two bevel gears /26/, axle /27/ and the end fitting bracket /28/.

The revolution counter housing is made of an aluminium alloy. It comprises on its one end a cylindrical flange on the external annular surface of which there are cut 36 teeth.

Between the slots of said teeth enter the teeth of the anchor /29/ the task of which is to adjust the drive in an angular position required.

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The revolution counter housing is drilled through. From the flange side the opening is machined inside exactly and serves as a base in order the housing to be installed on the outer surface of the bush.

Into the opening placed in other end of the housing there is screwed in a duralumin plug /30/.

On the side surface of the housing is provided a square flange in which perpendicular to the housing axis there is made an opening.

Simultaneously four threaded holes for stud bolts are drilled around central opening, respectively.

The bevel gears are made of chromium steel one from them is fixed on the drive shaft journal of the oil pump whilst the second one on the revolution counter shaft journal. Both gears are attached to their shafts by means of pins /31/ pressed into a respective holes.

The revolution counter shaft made of chromium steel comprises on its one end a journal in order the bevel gear to be installed and on the other one a special terminal being attached to the flexible shaft of the revolution counter.

Just by the special terminal there is made a cylindrical flange permitting, after it has been assembled, between it and the bracket a rubber gasket /32/ and a spring ring to be introduced.

From other end of the shaft between the gear and the front surface of the bracket there is put a distance washer to prevent the shaft to be shifted axially.

The angular terminal bracket is made of a duralumin alloy. It comprises inside an opening with diameter varied.

The opening with smaller diameter serves as bearing for the shaft but into the opening with larger diameter enters the flexible shaft terminal.

On the bracket surface externally there is situated a rectangular flange with four orifices through which are passed the stud-bolts fastening the bracket to the housing and also there is cut the tread for flexible shaft nut.

On the bracket face, from the side of a smaller opening there is made a cut /phase/ under angle of 30°. Perpendiculary to said cut there are drilled four orifices of 2 mm dia. connected to the inner opening with smaller diameter.

Detailed orifices serve for lubrication the collaborating surfaces of both the shaft and the bracket.

Oil filter

The oil filter consists of the housing /33/ and the filter of disc type.

The housing made of an aluminium alloy comprises on its top part a boss in a shape of three circles connected together which changes their form gradually creating at least a square flange.

In said boss there are drilled three openings. The side openings in the top part are threaded and comprise on their front faces a groove in order the gasket to be inserted.

The overflow valve consists of the ball /34/ which is pressed to its seat with aid of the spring /35/ inserted upon the aluminium plug /36/.

In the cone surface of the housing there are made three holes. Into all holes there are pressed in two cylindrical studs and one square stud, respectively.

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The cylindrical stud made of steel is ended from its one side with a journal diameter reduced. Inside the journal is drilled out within a distance of half its whole length.

After the journal having been pressed into the housing its end is dotted.
The studs enter with their bottom ends the orifices of the washer situated between the pressure insert and the bottom disc of the filter in order same to be, rigided when cleaning.

The square stud /57/ made of steel comprises on 1st end a cylindrical hollow journal being pressed into the housing and then dotted, too.

Upon the square part of the journal there are situated 170 cleaning discs /58/ which are entering between the cylindrical discs of the filter, respectively.

In the housing flange there are drilled four holes for stud bolts fastening the filter to the oil pump housing.

The housing flange is provided inside with a cylindrical projection the task of which is to center the filter housing in the filter cavity opening. when assembling.

In the centre of the housing there are made three cut-outs concentrically. Into the first cut-out the top filter insert /59/ is introduced.

In the side surface of the second cut-out there are drilled two orifices inclined by 60° which are connected to the respective openings in the overflow valve seat.

Should the excessive oil pressure be occured because of dense oil or dirt in the filter the overflow valves placed in the filter housing start to open and enable the oil to be passed directly to the filter interior and from there into the engine.

Into the third cut out with the smallest diameter there is placed the rubber gasket /40/ in a sectional view like a horse-shoe.

The filter of disc type consists of 141 circular plates and of 140 discs of a star form placed between them.

Both types of plates are made of steel strap 0,1 mm thick and differ from each other only with reference to a rim which is lacked on the star-disc. circumference.

In the centre of the plates there are cut out the rectangular openings in order the stem /41/ to be introduced.

It is made of steel and is provided with the cylindrical threaded terminal for disc attachment nut /42/. From its other end the stem comprises the cylindrical flange with two holes enabling the oil to be conducted to the gasket interior in order the gasket to be pressed to the housing as well as to the stem to prevent any oil leaking from the filter.

The stem is milled out from both sides at a distance between the threaded journal and the flange and comprises a diameter similar to that of the middle opening in the plates one.

From the top and bottom sides the plates are pressed together by means of the inserts made of duralumin.

The top insert /39/ made in form of a disc with four elliptical openings on the circumference and one rectangular opening in the centre through which the stem is passed.

The lower insert /45/ is made in form of a short cylinder closed with the bottom into which there are drilled the orifices similar to that of the top one.

On its outer surface from bottom side the insert is provided with a cylindrical cut out for steel insert /44/.

Three projections are placed on the insert circumference. In two projections are drilled circular openings whilst in the remain one the rectangular opening, respectively.

Into the circular openings enter the studs in order the filter to be rigided when cleaning whilst into the rectangular opening enters the stick upon which 140 cleaning discs are fixed.

All the cleaning discs are made of a steel sheet of 0,1 mm thickness in a shape of square and comprise the projections on the edges being entered between the filter circular discs.

The outer cylindrical surface of the bottom insert is centered in the filter cavity cut-out.

After the stem has been passed through the housing center opening on its top ends there is screwed in the butterfly duralumin nut /49/ and locked by means of a pin /45/ pressed into the orifice drilled through the nut and the stem simultaneously.

By turning the butterfly nut all the filter plates inserted on the stem are revolved, whilst the unmovable cleaning discs remove the soilness collected between the rings of the circular plates.

The oil is drawn from the tank to the oil pump through the non-return valve installed into the oil pump housing the task of which is to prevent the oil to be flowed down from the oil tank to the engine when the aircraft remains not in use within a long period.

The non-return valve consists of a steel housing /47/, disc valve /48/, spring /49/ and basket /50.

The valve spring is adjusted in a manner assuring the valve to be opened at pressure of 0,05 kg/sq.cm.

3.4.3 Oil pump operation

During engine run all the toothed wheels situated in the oil pump are set in operation, also.

Due to the vacuum created at the inlet of the pressure stage the non-return valve screwed into the oil pump boss will open enabling the oil from the tank to the inlet channel to be conducted.

Thereafter the oil fulfills the gear cut-outs and is forced between the said cut-outs and the housing wall to the pressing channel according to the direction of the toothed wheel rotation.

From the pressure channel the lubricating oil flows to the chamber of the disc filter from where it is penetrated throughout the slots between the discs to the filter interior and thence through the hollow bolt to the pipe dipped in the rear chamber which distributes the oil to all the engine component parts being lubricated under pressure.

Some quantity of the oil conducted through the pressure channel flows through the reducing valve to the suction cavity of the pump from where it is carried in to the oil tank, directly.

The oil from the engine flows down to the sump from where it is drawn by means of the large suction stage and conducted to the oil tank.

Owing to the fact that the oil in the engine is warmed up during engine work its volume will be increased. Taking this into account the teeth of the large suction stage gears are designed as longer ones than that of the pressure stage gear teeth, respectively.

Such construction enables all the oil collected in the sump to be drawn easily from it preventing the sump to be filled up whenever, completely.

The oil flowing down from the valve rocker housings of four bottom cylinders is drawn with aid of a small suction stage of the oil pump.

When engine operation the oil is conducted to the engine under pressure within limits of 4 - 6 kg/sq.cm.

Should the engine out put be changed the oil pump out put will be changed, too, resulting the oil pressure at the engine inlet to be varied, respectively.

In order to maintain the oil pressure in the oil feed piping to be constant one as well as the oil pressure be adjustable one there is installed in the oil pump the reducing valve.

The reducing valve operation is based on a fact that the oil quantity circulated through the engine depends first of all on the totall friction of the engine oil system /tubes, channels

Said flow friction for the engine assembled and tested /braked out/ may be accepted as a constant one.

The quantity of the oil being delivered by means of the oil pump pressure stage is proportional to the revolutions, respectively.

In order to provent the excessive increasing of the oil pressure when the engine revolutions are increased there is installed on the pump pressure side the reducing valve enabling the surplus oil to be flowed down from the pressure channel to the suction stages of the oil pump.

Should the oil pressure in the oil system be decreased the oil out put through the reducing valve must be increased, respectively.

For this purpose it is necessary to unscrew an adjusting screw of the reducing valve and to replace the washer situated between the spring face and the bolt stop surface by a new one comprising its thickness reduced.

Owing them the pressure of the spring against the ball will be decreased resulting the ball to be put away from its seat as well as the oil flow through the reducing valve be increased.

And reversely - should the oil pressure be increased the adjusting screw must be unscrewed the washer with increased thickness be introduced resulting the pressure of the spring against the ball be increased, respectively.

It is necessary to remember the power plant factory adjusts the oil pressure when the engine is installed on the test stand where the oil system flow friction may be different to that of the aircraft one.

For that event it is recommended when assembling the engine on the aircraft to adjust the oil pressure according to the Technical Requirements.

3.4.4 Faults arising in the oil system and ways of their removal

Fault	Cause	Remedy
Low oil pressure or oil pressure equals to "O"	1. The cock of oil delivering from the oil tank to the oil pump closed or opened but not completely.	1. The cock to be opened.
	2. The oil quantity in the oil tank too small.	2. The oil to be replenished.
	3. Broken or failured the reducing valve spring.	3. Unscrew the reducing valve adjusting screw and replace the spring by a new one.
	4. The pipe delivering the oil from the oil tank to the oil pump stopped.	4. Remove the pipe, blow it through and rinse with kerosene. Should the oil in the pipe be frozen it must be warmed up in a space closed.
	5. The oil temperature too high.	5. The engine to be cooled at idling speed.
	6. The oil pump pressure stage not in operation.	6. Disconnect the pump from the engine and remove the defect discovered.
	7. Oil tank filter stopped.	7. Take out the filter rinse it by means of the kerosene and install anew.
	8. Manometer pipe stopped or the oil inside it frozen.	8. When the pipe stopped blow through with a compressed air, should however the oil be frozen in the pipe it must be warmed up, be blowed through and be rinsed with kerosene or denatured alcohol.
	9. The manometer or it pipe to be damaged.	9. Replace the pipe or the manometer by a new one.

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3.4.4 Faults arising in the oil system and ways of their removal

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Low oil pressure or oil pressure equals to "O"	1. The cock of oil delivering from the oil tank to the oil pump closed or opened but not completely.	1. The cock to be opened.
	2. The oil quantity in the oil tank too small.	2. The oil to be replenished.
	3. Broken or failured the reducing valve spring.	3. Unscrew the reducing valve adjusting screw and replace the spring by a new one.
	4. The pipe delivering the oil from the oil tank to the oil pump stopped.	4. Remove the pipe, blow it through and rinse with kerosene. Should the oil in the pipe be frozen it must be warmed up in a space closed.
	5. The oil temperature too high.	5. The engine to be cooled at idling speed.
	6. The oil pump pressure stage not in operation.	6. Disconnect the pump from the engine and remove the defect discovered.
	7. Oil tank filter stopped.	7. Take out the filter rinse it by means of the kerosene and install anew.
	8. Manometer pipe stopped or the oil inside it frozen.	8. When the pipe stopped blow through with a compressed air, should however the oil be frozen in the pipe it must be warmed up, be blowed through and be rinsed with kerosene or denatured alcohol.
	9. The manometer or it pipe to be damaged.	9. Replace the pipe or the manometer by a new one.

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Fault	Cause	Remedy
Oil pressure too high.	1. The reducing valve spring pressing too strong.	1. Unscrew the adjusting screw of the reducing valve and replace the washer by a thinner one.
	2. The oil circulated in the system too dense.	2. Set the engine to run on its different speeds or fill up the engine with an oil warmed up.
	3. Oil circulation system stopped.	3. Send the engine to the workshop in order all the oil channels and pipes of the oil system to be rinsed under pressure.
	4. The manometer failured.	4. To be replaced by a new one.
Oil pressure normal at full speed but too low at idling one.	The plays in the oil pump pressure stage to large.	The oil pump to be replaced.
The sump or the valve rocker housings are filled up with oil completely.	1. Inadmissible plays in both the large or the small suction stages of the pump.	1. The oil pump to be replaced.
	2. The pump not poured over with oil /the oil is not sucked by suction stages/.	2. The oil pump to be poured over with the oil.
	3. The pipes connecting the sump or the valve rocker housing to the oil pump to be leaked.	3. The oil pipes to be checked for leaking.

3.5 The sump /fig. 38/

The sump housing /1/ is made of a magnezium alloy and comprises two branches with the channels inside.

In the flange of the first branch there are drilled out three orifices whilst in the flange of the rear branch two orifices through which are passed stud bolts fastening the sump to the crankcase.

Between the crankcase and the sump flanges there are inserted the gambite gaskets.

The sump branch is ended by a cylindrical chamber with a flange. In the said flange there are made a large port with an annular groove and a cut into which is interposed, the sump bottom /7/ with the filter /4/, thereafter the orifice threaded in order the discharge valve seat /8/ to be screwed in, as well as four threaded openings with seats inserted enabling the attachment bolts fastening the air intake to be screwed in.

In the heads of two bolts there are drilled out a holes into which enter the ends of the springs /12/ securing the filter bolt /5/ and the hollow plug /10/.

The filter /4/ made in a form of harmony consisting of twelve rings jointed together externally and internally with aid of brass rings flared out.

Each of twelve rings is made of a brass gauze comprising 40 meshes per sq.cm.

The first ring of the filter is connected to the filter housing /6/ whilst the last one to the brass end ring /3/, respectively.

The filter is attached to the sump bottom by means of three special out-outs in the filter housing into which the stud bolts of the sump bottom are entered.

The seat /8/ of the discharge valve /9/ made of steel comprises the thread on both its sides the inner and outer one, respectively.

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Each of twelve rings is made of a brass gauze comprising 40 meshes per sq.cm.

The first ring of the filter is connected to the filter housing /6/ whilst the last one to the brass end ring /3/, respectively.

The filter is attached to the sump bottom by means of three special cut-outs in the filter housing into which the stud bolts of the sump bottom are entered.

The seat /8/ of the discharge valve /9/ made of steel comprises the thread on both its sides the inner and outer one, respectively.

In the bottom of the seat there is made an opening with a cut inclined 45°. It serves as the seat for the discharge valve.

The said valve is made of steel and comprises inside the stem a blind hole being connected to other five orifices drilled the stem arround.

The valve is pressed to its seat by means of a steel hollow plug /10/.

On the front faces of both the discharge valve seat and the hollow plug there are cut out the grooves for securing purposes.

Between the valve seat and the sump the fibre gasket is interposed.

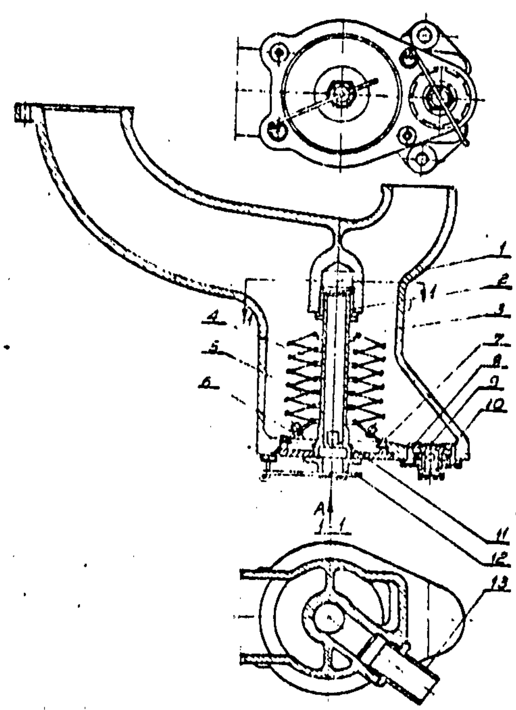

Fig.38 Sump sectional view.

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1 - sump housing; 2 - bush; 3 - ring; 4 - filter; 5 - filler bolt; 6 - filter housing; 7 - sump bottom; 8 - discharge valve seat; 9 - discharge valve; 10 - plug; 11 - steel ring; 12 - safety spring; 13 - end fitting.

Inside the sump there is made a special boss with orifice threaded into which is screwed a steel bush /2/ Into said orifice the oil filter bolt is inserted the task of which is to attach the sump bottom to the seat firmly. The bolt is made of a steel and comprises in its bottom part the flange and the groove into which after assembling the steel ring /11/ is put securing said bolt against falling out from the orifice.

The bolt is drilled out from its both sides. The hollow parts are separated from each other by means of the partition.

On its top part the bolt is provided with a thread and an annular flange on which rests the end ring of the filter.

In the bottom part, however, there are made from both sides the cut-outs being connected to the hollow, simultaneously.

At the front of the cylindrical chamber there is placed a boss with the orifice threaded which is jointed to the opening situated in the boss inside the sump. Into said opening the oil end fitting /13/ is screwed in by means of which the suction stage of the pump draws the oil from the sump.

The oil flowing down from the crankcase to the sump penetrates through-out the filter to its interior, from where it is drawn through the cut outs made in the filter bolt and through the end fitting screwed into the sump boss by the large suction stage of the oil pump.

3.6 Engine venting

During engine work some quantity of the exhaust gases penetrates from the combustion chamber through the piston rings to the crankcase. Besides the oil splashed inside engine is evaporated partially because of high temperature existing.

In such a case the pressure inside the crankcase will be increased considerably resulting the oil to be leaked through the contact places of the engine assemblies.

In order the pressure to be equalized between separate crankcase cavities there are made in the separating walls the vent-orifices whilst upon the engine crankcase the vent scoop is installed.

On the WN-3 engine the vent scoop is placed in the top wall of the rear chamber.

It consists of the plug, center part and the housing made of the duralumin and provided on its outer surface with a flange with three holes in order the vent-scoop to be attached to the rear chamber. On its cylindrical part the housing comprises an annular groove to enable the end of the center part to be rolled out after assembling.

The cap is made of an aluminium sheet and welded into the central part inside which there are installed four partitions made of aluminium sheet, the task of which is to prevent the oil to be thrown out the engine.

From its top the vent scoop is blinded by means of the duralumin plug drilled out inside. The plug is attached to the housing with aid of the rivet installed movably on the spring interposed inside the plug. The end of said rivet protrudes through the plug wall and enters the respective orifice in the housing after being inserted.

3.7 Engine cooling

The engine is cooled with aid of the air flowing throughout the shutters mounted in front of the engine.

In order the air conducted to be utilized completely as well as the cylinders to be cooled proportionately there are installed special cylinder fairings.

The task of them is to direct the air stream along the cylinder walls and cylinder head ribs enabling the respective cooling to be obtained.

Fig.39 Cylinder fairings general view.

The set of the cylinder fairings is made of an aluminium sheet and consists of six between-cylinder fairings and of seven cylinder head ones.

Every one between-cylinder fairing is situated between two adjacent cylinders and embrace their side surfaces.

From the side of the crankcase the said fairings are fastened by means of springs with terminals. The top lugs of the springs are jointed to the crankcase attachment bolt washers.

Each fairing is fastened to the special mount with aid of two attachment bolts. The mount segments made of duralumin sheet comprise on their front surface a leather strap riveted preventing the engine vibrations to be transfered upon the engine cowling.

Two lugs made of Cr-Mn steel alloy fastening the segments to the cylinder are riveted to each segment by means of two rivets. Outside the segments there are made openings into which the nut plates are riveted in order the fairings to be fixed.

4.0 FUEL SYSTEM

4.1 General informations

The engine is supplied with fuel by means of BNK-12AS fuel pump delivering the fuel from the aircraft tanks to the K-14BB3 carburetter.

Except of the fuel pump there is mounted also on the aircraft the priming pump connected to the priming collector, respectively.

The priming pump is used during engine starting in order the mixture to be enriched.

The fuel is delivered from the tank to the fuel pump throughout the filter. The fuel pump forces the fuel to the carburetter membrane mechanism fuel chamber under pressure of 0,2 - 0,5 kg/sq.cm. in the inlet pipe. From the fuel chamber the fuel is fed through the acceleration pump and the main jet partially mixtured with air enters the carburetter mixing chamber.

The air sucked through the carburetter intake flows throughout the diffuser and creates over the atomiser jet orifices the vacuum. This causes the fuel flowed from the jet orifices to be pulverized creating thus together with the air stream a mixture.

The mixture prepared by the carburetter as required is then conducted to the engine mixture chamber and from there to the separate induction pipes in dependence on the cylinder suction order and at least through the induction pipes and inlet valves to the combustion chambers, directly.

4.2 BNK-12AS fuel pump

The BNK-12AS fuel pump is of vane type and is intended for delivering the fuel from the aircraft fuel tanks to the carburetter.

It is fixed to the air distributor wover by means of four stud bolts.

The fuel pump rotor is driven by a square terminal which enters the square opening of the pump shaft pressing the spring of the air distributor shield, simultaneously.

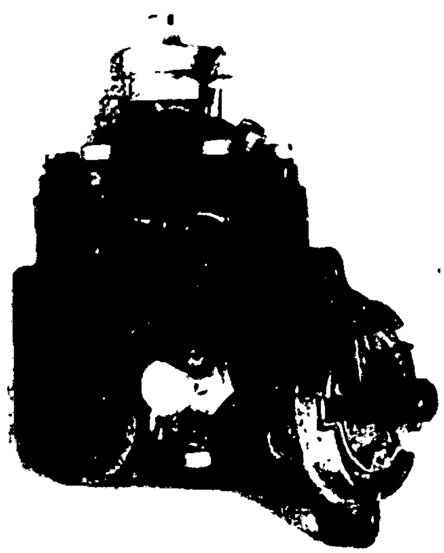

Fig.40 BNK-12AS fuel pump general view.

4.2.1 Main technical date

1. Out put in litres per hours /l/hr/:
   a/ at 2200 r.p.m. and fuel suction height of 1 meter - min. 1140
   b/ at the end of the warranty term - min. 1050
2. Number of revolution of the pump in r.p.m.:
   a/ maximum permissible /never exceed/ during 30 seconds - 2700
   b/ rated - 2200
   c/ minimum, without interruption the stream - 150
3. Vacuum produced by the pump in mm of Hg column:
   a/ at 1750 r.p.m. and dry operation - 250
   b/ at the end of warranty term - 170
4. Fuel grade - petrol specific gravity: 0,72-0,76 g/ccm.
5. Maximum permissible pressure at pressure stage in kg/sq.cm. - 2
6. Dry weight in kg - max. 1,425
7. Direction of rotation - reversible.

4.2.2 Fuel pump design

The fuel pump consists of the following main assemblies: rotor housing, rotor assembly with drive and sealing components, reducing cavity housing, reducing valve and reducing cavity lid.

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The reducing valve creates the single assembly in common with the passing valve leading the fuel to the pump when the fuel system and the carburetter are poured over before the engine starting.

The rotor housing is cast of an aluminium alloy together with a flange into which there are positioned four openings in order the fuel pump to be jointed to the engine drive.

From both sides of the housing there are made two openings with Briggs thread for suction and pressure end fittings, besides there is made in top a flange enabling the fastening to the reducing cavity housing.

From the side of the fuel pump flange there is made in the housing an opening to enable both assemblies the rotor assembly and the sealing one to be situated.

The rotor assembly consists of the steel bush /2/ azotised steel rotor /3/ azotised, which journals are revolving in bearings /4/ and /5/, floating steel bolt /6/ and of four steel and azotised vanes /7/ installed in the rotor cut-outs.

On the rotor assembly end from the drive side there is placed a special sealing preventing the fuel to be leaked from the pump.

Said sealing consists of a rubber ring /8/ inserted on the rotor end firmly and additionally being pressed against it by means of a steel ring /9/. The bush /10/ secures the rubber ring to be shifted axially.

On its external diameter the rotor assembly is sealed by means of the rubber gasket /11/.

In order to prevent the oil to be penetrated into the pump interior there are used the steel shield /12/ inserted on the drive terminal /13 and the bronze stop ring /14/ introduced into the nut of the gland /15/ as well as the rubber gaskets /16 and /17/.

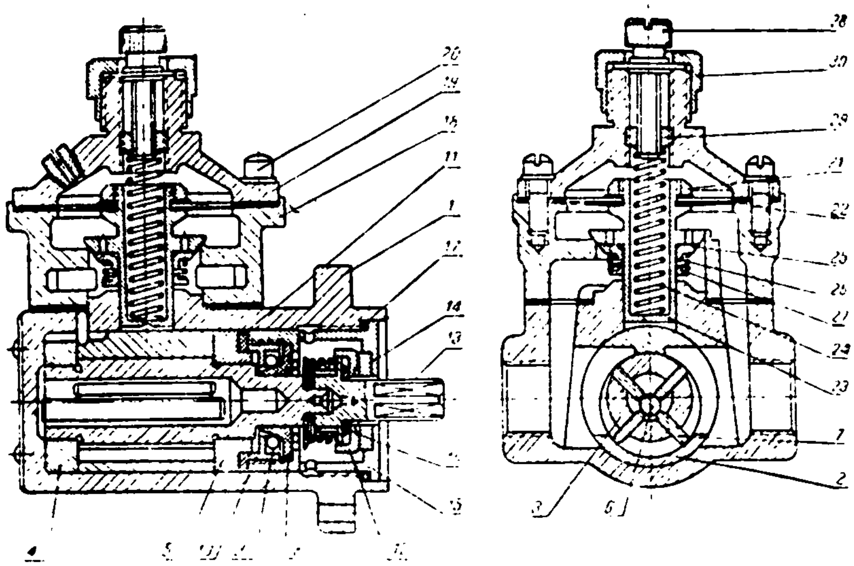

Fig.41 Fuel pump sectional view.

1 - rotor housing; 2 - steel bush; 3 - rotor; 4,5 - bearings; 6 - floating bolt; 7 - vanes; 8 - rubber ring; 9 - steel ring; 10 - bush; 11 - rubber gasket; 12 - steel shield; 13 - drive terminal; 14 - stop ring; 15 - gland nut; 16, 17 - rubber gaskets 18 - reducing cavity housing; 19 - lid; 20 - attachment screw; 21 - nut; 22 - rubber membrane; 23 - reducing valve; 24 - spring; 25 - passing valve; 26 - spring; 27 - reducing valve poppet; 28 - adjusting bolt; 29 - slide; 30 - cap.

The reducing valve is situated in the reducing cavity housing /18/ closed with aid of the lid /19/ being fixed to the housing by means of the attachment screws /20/.

Between the housing and the lid there is pressed by means of the nut /21/ the rubber membrane /22/ into which the reducing valve /23/ with the spring /24/ is attached.

On the stem of the reducing valve is installed the passing valve /15/ made of an aluminium alloy.

It is pressed by spring /26/ to the reducing valve flange resulting eight orifices to be closed.With its other end the spring rests against the tappet /27/ of the reducing valve.

In the center of the lid /19/ there is positioned an opening into which the adjusting bolt /28/ of the reducing valve in common with the slide /29/ is introduced.

The head of said bolt protrudes above the cap /30/ by means of which it is fixed in a respective position.

A threaded orifice made in the lid enables the plug connecting the ambient air to the space above the membrane to be screwed in.

4.2.3 Fuel pump operation

The fuel pump rotor creating in common with four movable vanes and floating bolt the rotor mechanism divides when in operation the internal opening of the sleeve on four chambers A, B, W and G changing steady their volumes.

The chamber volumes are changeable because the internal opening of the sleeve is made excentrically in reference to the outer diameter whereas the rotor is placed axially in reference to the outer diameter of the sleeve.

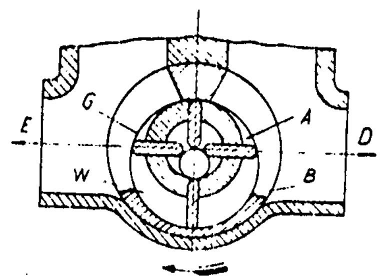

Fig.42 Fuel pump operation scheme.

If the rotor revolves in the direction of the arrow /see fig.42/ the volumes of "W" and "G" are decreased whilst the volumes of "A" and "B" are increased, respectively.

In the volumes increased the vacuum occurs resulting the fuel to be sucked through the end fitting D whereas from the volumes decreased the fuel is pressed out through the end-fitting E.

Should the pressure pipe be full opened the reducing valve will be pressed by means of the spring to its seat and will close the pump cavity completely resulting all the fuel to be delivered to the pressure pipe.

Should, however, the flowing out from the pressure pipe be reduced, the pressure at the pressing side of pump will increase and the fuel will lift the reducing valve /fig.41/ upwards.

As a result both cavities of the pump the suction and the pressure one are connected together, the some quantity of the fuel is passed through the reducing valve to the suction part and the fuel delivered to the carburettor is reduced, automatically.

At the pressure pipe full closed all the fuel is being directed to the suction stage of the pump, simultaneously the pressure increases its value in the pressure stage up to a certain limit. Said limit is depended on the strength of the reducing valve spring, proportionately e.g. the greater spring strength the greater pressure will occur.

The quantity of the fuel forced by the pump to the carburettor jet should be equal to that required by the engine one.

The fuel consumption depends on the engine r.p.m. and will vary with them, respectively.

The fuel output is larger than that used by the engine one. The surplus fuel is being passed throughout the reducing valve to the suction stage resulting the pressure in the fuel pipe to be kept within a respective limit.

The fuel pressure is to be adjusted by means of the reducing valve.

The adjustment range of the fuel pressure from 0,15 to 0,50 kg/sq.cm.

4.2.4 Fuel pump adjustment

For the WN-3 power plant the BNK-12AS fuel pump should be adjusted for the pressure of 0,2 - 0,4 kg/sq.cm. when at continuous /servicing/ engine run, and 0,15 - 0,25 kg/sq.cm. at idling run.

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Simultaneously the output of the fuel pump must be respectively from 300 to 350 litres per hour for servicing power and 23 - 30 l/hr at idling run.

It may be discovered after installing the engine on the aircraft that the fuel pressure gauge readings are different to that given above. In most cases it depends on the flow friction of the fuel system of the engine test stand on which the fuel pump has been adjusted. It may be lower or greater than that of the aircraft fuel system one.

Should the fuel manometer readings be varied to that given above proceed as follows: unscrew /by half the turn/ the cap /30/ of the adjusting bolt /fig.41/ and by turning the said bolt in both directions observe the gauge indications.

When turning the adjusting screw clockwise the slider /29/ will press against the reducing valve spring resulting the fuel pressure to be increased and reversely by turning counter-clockwise - the fuel pressure to be decreased.

After the required pressure has been obtained screw in the cap firmly and stop the engine.

4.3 K-14WN3 carburetter

The K-14WN3 carburetter is of non-float type and comprises the acceleration pump as well as a manually controlled altitude correction mechanism. It is made over of the K-14BP carburetter by which there are changed: the profile of the jet, adjustment mode, and also the choke free area.

4.3.1 Carburetter data

1. Mixing chamber diameter in mm - 70
2. Choke dia. in mm - 60
3. Fuel pressure in delivery pipe in kg/sq.cm - 0,2 - 0,4
4. Weight in gramms - max. 2700
5. Fuel pressure before the carburetter should be within limits in kg/sq.cm.:
   a/ at idling run - min. 0,20
   b/ at remain ones - 0,20 - 0,40
6. Carburetter adjustment data:
   a/ main air jet dia. in mm - 2,2
   b/ suction jet dia. in mm - 2,0
   c/ fuel flow with specific density of 0,705 - 0,725, for pressure of 500 mm, for suction jet dia. 2 mm in ccm per minute - 550 ± 1,75 %
   d/ profile of atomiser jet needle - No. 11WN.

4.3.2 Carburetter design

The carburetter consists of the following main assemblies: housing, mixing chamber and mechanism the task of which is to prepare and to deliver the mixture to the engine. All the components are installed in the separate chambers of the housing.

The housing of the carburetter cast of an aluminium alloy comprises a shape of the sleeve limited from its both ends with the flanges outside of which there are situated some chambers and bosses, respectively.

Said sleeve creates a mixing chamber /9/ with mounted inside a choke /8/, jet /7/ and air intake pipe /27/.

In front the mixing chamber there is positioned a rectangular chamber /22/ for lever mechanism.

Below said chamber is placed a cylindrical boss with orifice threaded into which the air filter /23/ is screwed in.

From the part side of the lever mechanism chamber there is placed the swivel mechanism chamber.

Above said chamber is made a cylindrical boss into which enters the seat with idling run jet /4/. From other side of the mixing chamber there is made the cylindrical chamber of accelerating pump with pressed in a bronze bush.

The fuel filter chamber /30/ with screwed into it bronze seat is placed below the accelerating pump chamber.

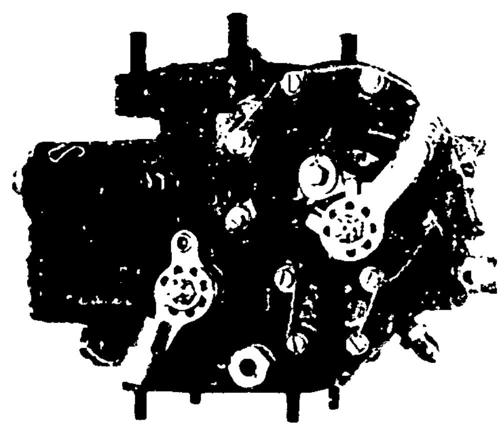

Fig.43 K-14WN3 carburetter general view.

From the starboard side of the accelerating pump there is made an air channel to enable the suction jet /16/ to be screwed in.

Below the fuel filter chamber, perpendiculary to its axis is positioned the fuel valve chamber inside of which there is made on a certain length an opening threaded for fuel valve /29/.

On the fuel valve chamber is situated oblique cylindrical boss into which the fuel pressure measuring end fitting is screwed in.

From the port side of the accelerating chamber, when viewed from behind the carburetter, is placed the membrane mechanism chamber.

Close by said chamber there is situated a boss with the orifice inside into which the sealing mechanism of the throttle shaft is being installed.

Below the boss from its both port and starboard sides there are made also two another bosses for inserting the air scoop /27/ and in order the attachment screw of the diffuser /8/ to be introduced.

The joint surfaces of all chambers are lapped thoroughly and comprise the orifices threaded for attachment screws of the chamber lids.

Between the joint surfaces of both the chambers and the lids there are inserted the gaskets made of paranite.

The carburetter is fixed to the joint piece screwed into the induction pipe of the mixing chamber by means of four stud bolts screwed to the top flange of the carburetter mixing chamber.

To the four stud bolts screwed to the bottom flange of the mixing chamber there is fastened the air intake.

4.3.3 Mixing chamber

In the carburetter mixing chamber there is placed the throttle /25/ which is inserted in the shaft cut out and fastened by means of two attachment screws.

The throttle axle revolves in two bronze bushes pressed into the housing. One end of the shaft protrudes externally and is sealed by means of the gland. On said end there is mounted the throttle control lever with double arms made separately and coupled each other by means of a special washer. Both arms of the control lever may be shifted against each other and be fixed in the position required.

Into one lever arm there is pressed in and then rolled out a stop pin in order the throttle revolutions to be limited in the range between the idling and full speed whilst into the second one there is inserted the ball joint connected to the terminal of the throttle control push-pull rod.

The throttle lever may be revolved by 85°. Said angle may be timed with aid of the adjustment screw placed in the carburetter housing boss.

In the mixing chamber there is positioned the diffuser /8/ into which there is made an orifice in order the mixture to be drawn from the idling speed system as well as the orifice for diffuser attachment screw.

The injector pipe /7/ with the atomiser jet needle enters the mixing chamber through the cut out in the diffuser.

Before the throttle in the mixing chamber there is situated the air scoop pipe through which the air is being conducted to the altitude correction mechanism /boost device/.

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The carburetter membrane mechanism consists of the membrane /34/ jointed to the control lever actuating the fuel valve stem.

The membrane made of rubberised linen is introduced between the housing flange and the membrane mechanism flange.

The membrane mechanism lid is cast in common with the altitude correction housing and is fastened to the carburetter housing with aid of ten attachment screws.

In the centre of the membrane there is made a catcher /13/ with a special cut out into which enters the ball terminal of the fuel valve double arm lever /33/. The fuel valve lever revolves on the axle inserted into the support which is pressed into a seat made in the carburetter housing. The support is fixed by means of the pin.

In order the fuel valve to be kept in closed position the spring /32/ is put both on the lever and its axle, respectively.

To enable the fuel valve /29/ to be installed in the carburetter housing there is made a chamber with an opening threaded. Into said opening is screwed the seat safetied with aid of the spring.

The fuel valve chamber is covered by means of the lid fixed with three screws.

The idling speed system /slow-run system/ consists of the timing device and also of the respective channels delivering the mixture to the mixing chamber.

The idling speed needle bush is screwed into a special boss on the carburetter housing.

The idling run needle /4/ made in form of a bolt comprises on its one end a cone whereas on the other one the head with a groove for the screw-driver.

The needle is equipped with a stopper enabling its position to be regulated as required.

Said stopper consists of two balls interposed in the needle head and pressed by means of the spring and twelve longitudinal grooves being cut outside the needle bush surface.

When turning the needle said balls are shifted to the next groove, respectively.

The end of the needle enters the opening made in the carburetter housing.

On the bush there is screwed a cap with a gasket.

The main atomising carburetter system consists of atomiser jet /7/, atomiser needle /6/ and the lever /1/ coupling the throttle axle to the atomiser needle kinematicaly.

The atomiser is made in a shape of a pipe which comprises from the accelerating pump side an orifice calibrated permitting the needle cone to be entered.

Inner surface of the atomiser creates a guide for atomiser needle.

In the center part of the atomiser there are made twenty three emulsion orifices placed in such a manner that the proportionate increasing of the orifice sections be secured during travelling of the atomiser needle stop edge.

On the second end of the atomiser there are drilled radially six orifices which are arranged in an annular groove of the bush inserted in the carburetter housing after having been assembled.

Throughout said orifices made in the bush as well as through six orifices made in the atomiser the fuel emulsified flows with the air together at idling run of the engine.

The atomiser needle /6/ comprises from its one side exactly made cone in order the fuel to be dosed properly. At the base of the cone there are drilled four oblique openings through which the fuel enters the needle interior.

On the outer surface of the needle there are made a wide cut out with fourteen orifices for conducting both the fuel and the air to the emulsion orifices of the atomiser.

Close by the second end of the needle there is made an annular channel with four orifices in order the fuel and the air to be delivered to the idling run orifices situated in the atomiser.

On the second end of the needle there is placed also the threaded orifice into which the catcher guide is screwed in.

In said guide is situated an opening callibrated /main air jet/ connecting the inner space of the atomiser needle with the lever mechanism chamber.

The catcher guide with aid of the adjustment screw /2/ may be shifted axially on the cylindrical surface of the catcher and may be fixed in a position required by means of the lock. The construction of such type permits the atomiser needle to be shifted indepedently upon the throttle position. The atomiser needle is coupled to the throttle axle kinematically by means of the swivel mechanism, but the axle and the atomiser needle lever are jointed each other, respectively.

The atomiser needle lever is fastened to the axle with aid of two attachment bolts and stopped with the pin.

The swivel mechanism consists of the lever, bronze swivel and the slide.

The slide enters with its cylindrical part the opening of the swivel device which serves as a slide guide.

The slide is attached to the lever swivelly by means of the axle inserted on the lever end and also in the opening made in the slide.

In order the collaborating surfaces of both the swivel mechanism guide and the slide to be greased inside the slide there is placed a wick with an oil saturated.

In the carburetter housing there is made a boss with threaded opening to enable the air filter /23/ to be attached.

Both chambers of the lever mechanism and swivel one are closed by means of lids fixed to the housing with six attachment screws.

The lever mechanism chamber lid comprises in its top part a boss with orifice threaded to enable an easy access to the adjustment screw of the atomiser jet.

Said orifice is blinded with a plug.

The accelerating pump of the carburetter consists of the bronze cylinder, piston /11/, poppet valve /10/ and also of the spiral spring /23/.

The spring rests with its one end against a special seat made in the accelerating pump lid whilst with the second one against the front face of the piston pressing it to the terminal of the atomiser jet, firmly.

The lid of the accelerating pump is fastened to the housing by means of three stud-bolts.

The altitude correction mechanism of the carburetter consists of the housing made as a whole together with the membrane mechanism lid, of the brass seat /17/ needle /18/, spring, axle, control lever /19/, correction needle, as well as of the levers shifting the needle.

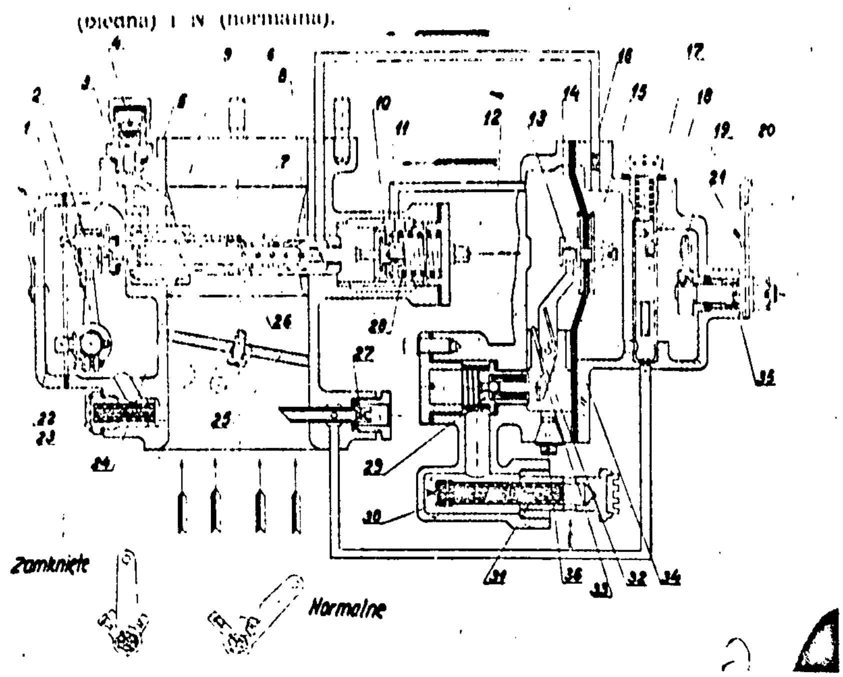

Fig.44 K-14WN3 carburetter lay-out.

1 - control lever; 2 - adjustment screw; 3 - idling channel; 4 - idling needle; 5 - jet; 6 - atomiser needle; 7 - atomiser jet; 8 - chone; 9 - mixing chamber; 10 - poppet valve; 11 - piston; 12 - vacuum pipe; 13 - catcher; 14 - fuel chamber; 15 - air chamber; 16 - suction jet; 17 - seat; 18 - needle; 19 - control lever; 20 - drive lever; 21 - stop lever; 22 - lever mechanism chamber; 23 - air filter; 24 - idling orifices; 25 - throttle; 26 - emulsion orifice; 27 - air intake; 28 - spring; 29 - fuel valve; 30 - fuel filter; 31 - end-fitting; 32 - spring; 33 - double arm lever; 34 - membrane; 35 - drive axle.

The brass seat is pressed into the housing and creates the guide for altitude correction needle respectively.

In front face of the seat there is drilled an orifice callibrated for air flowing into which enters the cone terminal of the needle.

On the side surface of the seat there is drilled a hole in order the air to the membrane mechanism air chamber to be conducted.

In the center part of the seat is cut a groove in which is travelled the pivot fixed to the needle control lever, unmovable.

The needle control lever is attached to the inner end of the drive lever /20/ axle by means of which the altitude correction is set in operation.

The drive lever axle revolves in a brass bush pressed into the altitude correction housing. Two rubber gaskets are inserted on the axle.

The drive lever journal enters the needle groove enabling the needle to be shifted when turning the lever. In order the play between the journal and the groove to be reduced a spiral spring is introduced.

Close by the drive lever /20/ there is installed the stop lever /21/. Both said levers are jointed each other by means of a special insert and create a double arm lever the arms of which may be adjusted under an angle required.

The stop lever in its extreme positions rests against the bosses placed on the altitude correction housing and marked "SD" /weak/ and "N" /normal/.

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4.3.4 Carburetter operation

Membrane mechanism

The fuel from the fuel tank mounted on the aircraft flows through the filter /30/ and the fuel valve /29/ into the fuel chamber /14/.

At the time of the engine starting in the cylinders arises the vacuum which by means of the induction pipes is transferred to the carburetter mixing chamber /9/. Thereafter said vacuum is being led through the idling channel /3/, the injector orifices, the atomiser needle orifices /6/ and the suction jet /16/ to the air chamber /15/ of the membrane mechanism.

To the fuel chamber the vacuum is penetrated through the idling channel /3/, the annular opening between needle cone and the injector and also through the pipe /12/.

As a result of this the pressure in the air chamber will be greater than that of the fuel chamber because the air is being penetrated throughout the altitude correction mechanism.

Under action of the air pressure the membrane /34/ will be shifted in direction to the fuel chamber, respectively, allowing the fuel valve to be opened. The fuel supplied to the fuel chamber will increase the pressure against the membrane, resulting the fuel valve to be shut as long as the pressure in the fuel chamber will not be equal to that of the air chamber one.

Should the pressure in one of said chambers be changed slightly the membrane will be shifted in the direction of a lower pressure resulting the fuel valve to be closed or be opened, respectively.

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This allows the constant fuel pressure to be kept in the fuel chamber at a given engine operation conditions.

The pressure in the membrane mechanism fuel chamber is determined by the engine operation conditions.

It depends also on the opening of the altitude correction needle /18/ as well as on the emulsion orifices /26/ of the atomiser jet /7/ by constant diameter of the suction jet /16/.

The pressure in the atomiser space depends upon the engine speed and on the value of the emulsion orifices opening.

The position of the atomiser needle cone /6/ in the atomiser opening is closely bound with a respective position of the throttle /25/ at a given engine rating and is regulated by means of the lever system coupling both the throttle and the atomiser needle each other.

The carburetter adjustment on the engine is performed by means of the adjustment screw /2/ which moves the atomiser jet in relation to the injector /within a narrow limits/ indepedently upon the throttle position.

The slow run system assures a normal work of the engine at idling run.

When the engine operates at idling speed the emulsion orifices /26/ of the atomiser are covered with aid of the cylindrical part of the atomiser jet, respectively.

The fuel passed through the annular opening between the cone of the needle /6/ and the atomiser opening /7/ is forced to the needle interior where it is mixed with the air conducted through the jet /5/.

The air - fuel mixture is delivered through a special orifices /24/ of idling system made in the needle as well as in the atomiser and also through the idling channel /3/ in the housing, under the idling needle /4/ to the mixing chamber /9/.

The needle of the idling speed enables the quantity of the mixture conducted to the mixing chamber to be adjusted properly.

When increasing the throttle opening the idling run injector orifices /24/ are gradually closed by a cylindrical part of the atomiser needle resulting the idling system to be shut off. Simultaneously there are opened the emulsion orifices /26/ of the atomiser jet and the carburetter main system is set i operation.

The main system of the carburetter assures a normal operation of the engine at both the (service) speed and the full one.

After the atomiser emulsion orifices having been opened the fuel flows through the annular orifice between the needle cone and penetrates through the injector opening to the needle interior and from there together with the air /preliminary emulsion to be created/ enters the mixing chamber throughout the atomiser jet orifices where is mixed with a main air stream, completely.

The accelerating pump serves the mixture to be enrichted if the throttle will be opened rapidly.

When the atomiser needle is shifted quickly the poppet valve /10/ with aid of the fuel will press against the piston /11/ resulting the fuel to be forced through the injector to the mixing chamber.

Should the atomiser needle be shifted slowly the pressure behind the piston will be also increased slowly and the poppet valve will not close the openings in the piston, to enable the fuel to be flowing freely from one side of the piston to the other one - the fuel should not be impeded.

The altitude correction device is incorporated in carburettor for the purpose of adjusting the fuel supply to the changed conditions met in higher altitudes.

A carburettor adjusted to deliver a properly proportioned mixture at sea level will supply an increasingly rich one as the aircraft mounts to higher altitudes, due to difference in temperature density and quantity of oxygen in the air.

Different value of air conducted to the membrane mechanism air chamber results the fuel pressure to be changed, owing then [illegible] the fuel consumption and the mixture composition to be varied, also.

The air quantity delivered is adjusted by means of changing the position of the altitude correction needle cone (1) in relation to the seat (2). The air is conducted [illegible] the air intake (3) to the air chamber (15) of the [illegible] mechanism.

The mixture is maximum rich if the altitude correction control lever rests against the limiter signal "[illegible]" the position at which the needle is mostly pulled out, and vice versa the mixture is maximum weak when the altitude correction control lever rests against the limiter "[illegible]" the needle is introduced into its seat, completely.

4.3.5 Carburetter timing

The throttle lever may be turned within limits of 85 degrees from position "closed" to "open", respectively. The altitude correction control lever revolves within limits of 60 degrees from position "N" /normal/ to position "BD" /weak/.

The engine adjustment at slow run should be performed after the magnetoes and the sparkplugs having been examined at speed of 400 - 500 r.p.m., previously.

The mixture quantity when at idling run is tuned with aid of idling needle /4/.

Clockwise screwing of the needle results the mixture to be weaked whilst unscrewing of said needle results the mixture to be enriched.

After the adjustment has been carried out the cap must be screwed in and then be safetied by means of the wire, firmly.

The engine revolutions when at idling run are timed by opening the throttle with the adjustment screw placed in the limiter.

When said screw is turned clockwise the throttle opening angle will increase resulting the engine r.p.m. to be also increased, and reversely when the adjustment screw is turned counter-clockwise the engine r.p.m. will decrease, respectively.

4.3.6 Carburetter adjustment at continuous ratings

Should the engine operation be incorrect one the engine must be stopped and the carburetter be tuned properly by using the screw /2/ for adjustment the initial position of the atomiser needle.

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It is necessary to remember that by turning the adjustment screw clockwise the mixture will weaken and by unscrewing /counter-clockwise rotation/ will enrich.

It is not recommended to rotate the adjustment screw by more than two locks in both directions when beginning from the position marked by a factory.

After the carburetter adjustment has been carried out properly the engine operation at idling speed must be checked without fail as the changed position of the atomiser needle results also the engine operation at idling run to be varied.

4.3.7 Carburetter adjustment at rated and take-off power

Should the engine work be unsufficient one during test at rated and take off power the carburetter adjustment must be performed by selection the suction jet /16/.

The increasing of the jet orifice diameter results the mixture to be weaked, the decreasing, however - to be enriched.

4.3.8 Adjustment of the mixture proportion by means of the altitude correction mechanism /boost/

When the engine is tested on the airfield the altitude correction control lever rests upon the limiter marked "N".

In order to obtain a normal mixture proportion during climbing of the aircraft the position of the altitude correction lever must be changed. It should be situated between both limiters "N" and "BD", respectively.

Beginning from the altitude of 500 meters upwards the altitude correction mechanism is to be used.

When using a manually controlled altitude correction mechanism observe strictly the Engine Maintenace Manual.

4.3.9 Faults arising when engine operation and ways of their removal

Fault	Cause	Remedy
Fuel leaking from drainage.	1. Fuel valve stopped /dirty/.	1. Rinse the valve by conducting the fuel to the carburetter under pressure of 0,2 - 0,5 kg/sq.cm., unscrew the membrane mechanism plug and press against the membrane, repeatedly.
	2. Membrane stretched excessively.	2. Loose the attachment screws fastening the membrane mechanism lid and by pressing the membrane through the lid opening tighten the attachment screws.
Carburetter "shoot" at engine starting.	1. Opening angle of the throttle too large.	1. Throttle opening angle to be adjusted.
	2. Air sucked between carburetter flange and rear chamber one.	2. The joint surface to be sealed.
	3. Mixture too weak.	3. The mixture to be tuned rich by means of idling needle adjustment.

Fault	Cause	Remedy
Engine interruptions and vibrations when running at maximum and rated speeds.	1. Fuel filter dirty. 2. Air intake pipe incorrect installed.	1. Filter to be cleaned. 2. Examine the position of the air intake pipe It must be directed with its cut against the air stream flowed in.
Engine will not start. It begins to operate and stops anew.	1. The carburetter not supplied with fuel. 2. Fuel pressure to small. 3. Too large or too small throttle opening angle.	1. Examine whether the fuel reaches the carburetter, check the fuel filter for cleanness, rinse and blow through the fuel system. 2. Adjust the fuel pressure with reducing valve of the fuel pump. 3. Place the throttle in position corresponding to 700 - 900 r.p.m.
Explosions in the exhaust pipes.	The mixture too rich.	Tune the mixture proportion with aid of supplying needle.
Engine will not increase its revolutions when at rated and take off powers.	The throttle is opened not completely.	Check the control system and secure a respective opening of the throttle.
The mixture remains allways rich when the engine operates at its all ratings.	The suction jet dirty.	Unscrew the plug and blow through the jet with aid of compressed air delivered under pressure of 0,8 - 1,0 kg/sq.cm.
The mixture remains weak during all the engine ratings.	The suction jet unscrewed.	Check and screw in the suction jet, if necessary.

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Fault	Cause	Remedy
Engine stops when decreasing its r.p.m. up to idling ones.	1. Incorrect adjustment of the idling speed. 2. Incorrect adjustment of the mixture proportion during idling run	1. Select a proper throttle opening angle by means of the adjustment screw. 2. Regulate the push-pull rods length.
Engine will not run on its full speed.	1. Incorrect timing of the carburetter or chaffing of the atomiser jet needle. 2. The fuel quantity delivered to carburetter to small. 3. The carburetter intake gauze or the fuel filter gauze dirty.	1. Check the carburetter timing and whether the atomiser jet needle operates fluently. 2. Check the fuel pipes for condition as well as the fuel pressure before the carburetter. 3. Both gauzes of the carburetter intake and the fuel filter to be cleaned.

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Fault	Cause	Remedy
Engine stops when decreasing its r.p.m. up to idling ones.	1. Incorrect adjustment of the idling speed. 2. Incorrect adjustment of the mixture proportion during idling run	1. Select a proper throttle opening angle by means of the adjustment screw. 2. Regulate the push-pull rods length.
Engine will not run on its full speed.	1. Incorrect timing of the carburetter or chaffing of the atomiser jet needle. 2. The fuel quantity delivered to carburetter to small. 3. The carburetter intake gauze or the fuel filter cause dirty.	1. Check the carburetter timing and whether the atomiser jet needle operates fluently. 2. Check the fuel pipes for condition as well as the fuel pressure before the carburetter. 3. Both gauzes of the carburetter intake and the fuel filter to be cleaned.

5.0 IGNITION SYSTEM

5.1 General

The engine ignition system enables the mixture in the combustion chambers to be ignited with aid of the sparks which occur between the spark plug electrodes due to the high voltage current generated by means of two magnetoes BSM-7M installed on the rear chamber.

The starboard magneto actuating all the rear spark plugs is driven clockwise whilst the port one actuating the front spark plugs has a counter - clockwise rotations.

During the engine starting the starting magneto is connected also to the ignition system additionally in order the mixture to be ignited in the cylinders.

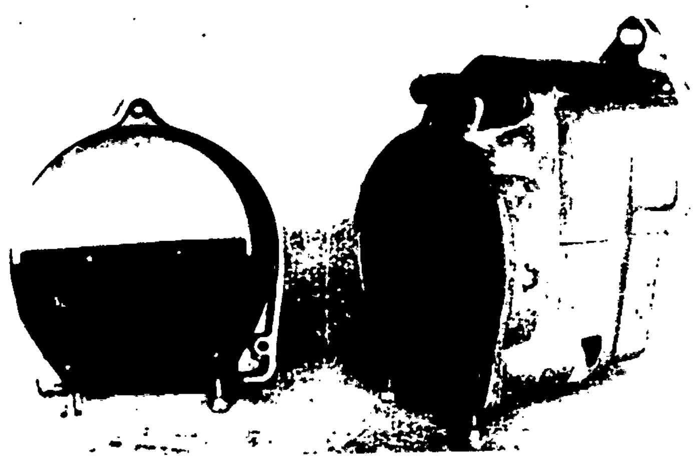
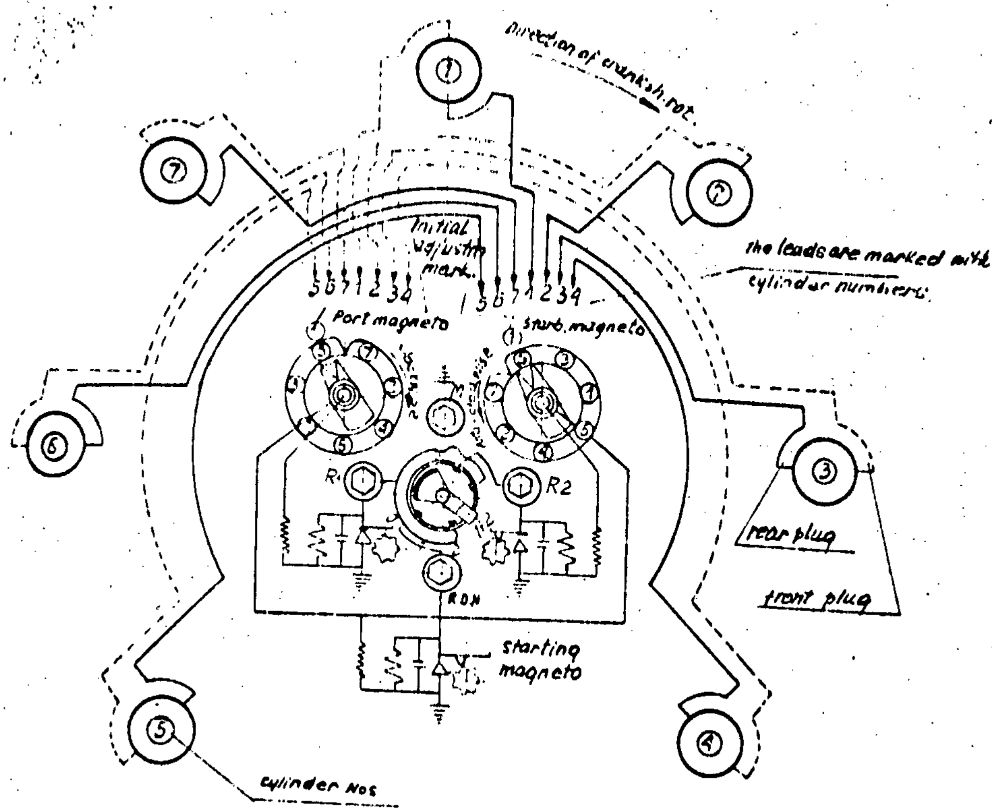


Fig.46 BSM-7M magneto general view.



Firing order

1—3—5—7—2—4—6

Fig.45 Engine ignition lay-out.

The current from the starting magneto flows to the starting electrode of the magneto distributing shield from where it is directed to the starting ring which is connected to the distributing lever starting electrode and then through the distributin shield electrodes enters the spark plugs.

The on-off switching of the magnetoes separately as well as simultaneously is obtained by means of the over-switch. The switch handle may be placed in four different positions, respectively.

When situated in "O" it indicates that both magnetoes as well as the starting one are switched off. When placed in position "I" the port magneto is set in operation, only, whereas the starboard one is switched off. When placed in position "2" the starboard magneto operates, the port one-switched off. When situaded: "1 + 2" all three magnetoes are switched on.

5.2 BSM-7M magneto

The task of the four-spark, braided /screened/ magneto of BSM-7M type with automatic timing of the ignition advancing angle is to create the high voltage current and to lead it to the separate spark-plugs.

The BSM-7M magneto is to be installed on the seven cylinder power plant, only.

In order the radio disturbances to be eliminated the magnetoes are braided.

5.2.1 Main technical data

1. Rotor speed at continuous operation, under load with the spark gap of 7 mm - in r.p.m. - 500 - 4500
2. Automaton characteristic:
   a/ adjustment range of the spark setting angle /according to the magneto rotor/ - 25° ± 2°
   b/ initial operation of the automaton - in r.p.m. - min. 900
   c/ final operation of the automaton - in r.p.m. - max. 2000
3. Adjustment data of breaker contacts:
   a/ gap between breaker contacts in mm - 0,25 - 0,35
   b/ breaker setting angle according to rotor shaft - 19° - 22°
   c/ spring pressure upon the breaker contacts in grammes - 650 ± 100

5.2.2 Magneto design

The BSM-7M magneto consists of the following assemblies: the front lid, housing with the transformer, rotor with the advanced ignition automaton, rear lid with breaker plate, distributor and the top lid.

The front lid /1/ cast of an aluminium alloy is made in form of a flange with three oval ports for the stud bolts fastening the magneto to the rear chamber.

Into the center port of the lid from outer side there is pressed the external race of the front ball bearing /3/. The said lid comprises four orifices for attachment bolts /15/ connecting both the front and the rear lids /16/ to the magneto housing /14/.

The magneto housing is cast of an aluminium alloy. On its faces there are made four guiding cut outs in order both the front and the rear lids to be introduced. In the housing there are installed two pole pieces of the magnet /33/. To said poles there is fixed by means of two clamps the transformer core /36/. Both the core and the magnet poles are made of the transformer steel sheet introduced upon each other.

Between the poles on the two ball bearings /3/, /17/ rests the magneto rotor with the angle automaton of the ignition advance.

The magneto rotor consists of the permanent magnet /12/ of a cylindrical shape cast of a special alloy comprising a high magnetic conductivity.

To the outer cylindrical surface of the magnet are fitted close four pole pieces /10/ made of the thin sheets of the transformer steel insulated from each other by means of the thin layer of the lacquer. The poles are separated from each other with a rubber insulators and placed between two cylindrical panels. Through said panels as well as through each pole piece are passed two attachment rivets.

In order the rigidity of the pole piece to be increased they are connected together with aid of the steel ring.

The magnet in common with the poles and the plates is inserted on the bronze hollow shaft /11/ mounted on the rotor axle.

On the splined terminal of the hollow shaft there is made a thread enabling the attachment nut to be screwed in. Afterwards there is introduced on the splined terminal a small gear /13/ engaged with the textolite gear /30/ driving the distributor arm /27/.

The front steel plate is equipped with two projections on which there are attached the bronze weights /7/ of the ignition advance angle automaton.

Each weight consists of two pieces jointed each other swivelly.

When in operation the mutual position of the weights of every pair is regulated with a flat springs selected on a respective load. Said weights are also attached to the automaton base /5/ into which there are rolled out two axles /6/.

In such a manner the automaton weights create the attachment between the magneto shaft and rotor shaft, respectively.

The automaton base is jointed rigidly to the shaft /4/ with aid of the flange made on same and out from its both sides.

The shaft terminal enters a respective slot in the automaton base.

The rear lid /16/ is cast of an aluminium alloy. The outer race of the rear ball bearing /17/ is pressed into the port of the lid bottom part.

The following component parts and assemblies are installed on the rear lid: large gear /30/ made of a textolite with an excenter /29/ enabling the play between the teeth to be regulated within a certain limit, the bush /32/ for transmitting the high voltage and the breaker plate /18/ into which by means of two screws /49/ there is attached the plate /48/ with a rigid contact.

On the plate /48/ there is installed the breaker lever /42/ with movable contact and a textolite pad the lever of which is pressed to the cam ring /28/ with aid of a spring /41/.

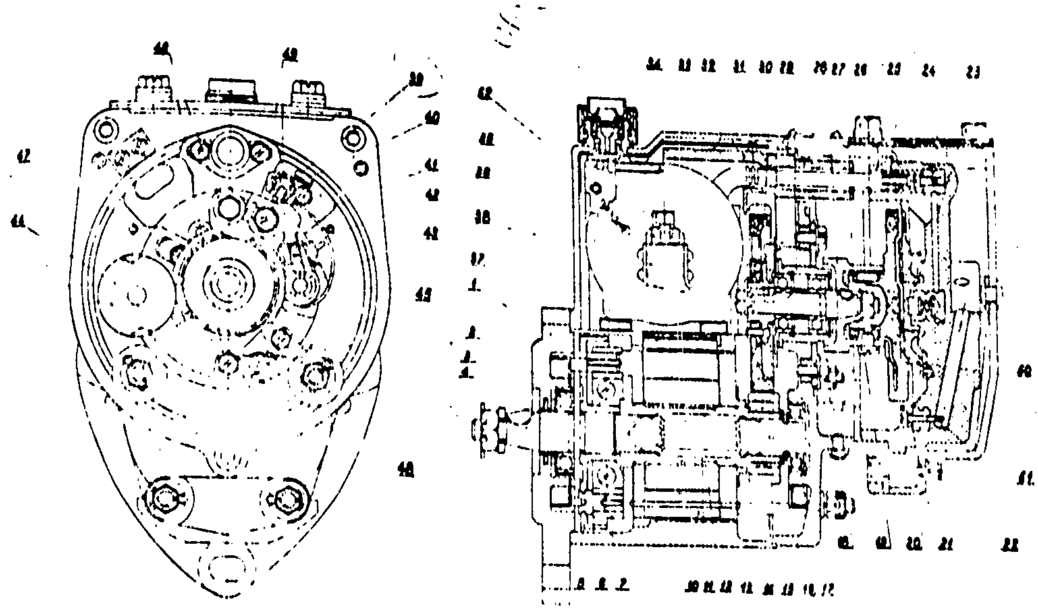


Fig.47 BSM-7M magneto sectional view.

1 - front lid; 2 - bearing seat; 3 - ball bearing; 4 - shaft; 5 - automaton base; 6 - axle; 7 - weight; 10 - pole piece; 11 - hollow shaft; 12 - permanent magnet; 13 - small gear; 14 - housing; 15 - attachment bolts; 16 - rear lid; 17 - ball bearing; 18 - breaker plate; 19 - screw; 20 - screen; 21 - side electrode; 22 - nut; 23 - central electrode; 24 - distributor shield; 25 - distributor; 26 - high voltage terminal; 27 - distributor arm; 28 -cam shield; 29 - excenter; 30 - textolite gear; 31 - axle; 32 - bush; 33 - top lid; 34 - clamp; 35 - bolt; 36 - transformer core; 37 - transformer; 38 - magnet pole; 39 - attachment; 40 - low voltage terminal; 41 - spring; 42 - lever; 43 - axle; 44 - greasing nipple; 45 - excentric bolt; 46 - bolt; 47 - excentric bolt; 48 - plate; 49 - attachment bolt; 50 - starting electrode; 51 - attachment screw; 52 - joint plate.

The breaker lever /42/ is mounted on the axle /43/ The breaker contacts are timed by shifting the plate /48/ with aid of excentric bolts /45/.

Before the contact play regulation is performed it is necessary rigorously to loose the bolts /49/.

The breaker setting angle adjustment is to be carried out by means of the excentric bolt /47/ by turning the plate /18/ together with the breaker contacts relative to the cam /26/.

The timing of the breaker setting angle is performed by a factory, only, and it is no allowed to carry out the above detailed timing procedures when the magnetoes are in service.

The breaker cam shield /28/ inserted unmovable on the shaft /31/ comprises seven lobes respectively to the number of the cylinders.

The lubrication of the cam shield is performed by means of a special lubricating nipple /44/.

On the cam shield there is fastened with the attachment screws /19/ the distributing arm /27/ made of a hard rubber with two electrodes - the working and the starting one.

The distributor shield /24/ made of a hard rubber comprises a central electrode /23/, seven side electrodes /21/ as well as the starting electrode /50/.

On the distributing shield in the place where the electrodes are installed there are positioned eight orifices and eight attachment screws /51/ serving for fastening the leads connecting the distributin shield with the spark plugs as well as the lead delivering the current from the starting magneto.

The transformer /37/ consists of the core /36/ on which there are wound, two windings: the primary and the secondary one. Between said windings there is placed the condenser of disc type.

The transformer is secured from both sides with the shields insulated into which the joint plate /52/ is fastoned.

The primary winding is connected with its one terminal to the transformer core whilst the second one is fixed to the joint plate from where throughout the low voltage terminal /40/ and the slide is led to the movable contact of the breaker.

The inlet terminal of the secondary winding is connected to the outlet terminal of the primary one whereas the outlet terminal is coupled with the high voltage terminal /26/.

The magneto condenser consists of two aluminium plates which are insulated with a condenser paper from each other. One condenser plate is connected to the mass whilst the second one to the transformer joint plate. The last is connected to the clamp /34/ situated on the top lid /33/ and farther by means of the lead is coupled to the switch.

When switching off the magneto the joint plate is being closed to the mass due the switch contacts.

The distributing shield is braided and also secured against mechanical damages by means of the screen /20/.

5.2.3 Magneto operation /fig.48/

The main assemblies of the magneto are: magnetic circuit, primary circuit /11/ and secondary circuit /10/.

The magnetic circuit consists of the permanent magnet /15/ and the magnetic lead which connects the rotor poles, the magnet poles, and the transformer core /8/.

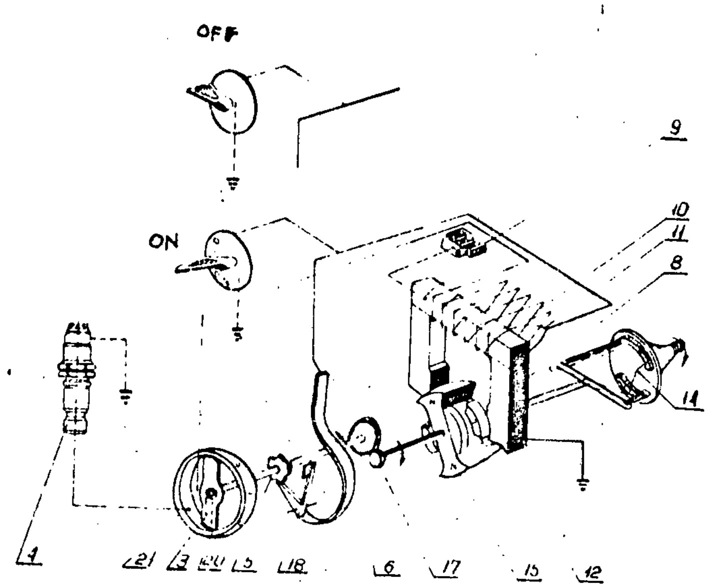


Fig.48 Magneto operation lay out.

3 - distributor arm; 4 - spark plug; 5 - cam; 6 - gear; 8 - transformer core; 9 - condenser; 10 - secondary circuit; 11 - primary circuit; 12 - magnet poles; 14 - springs; 15 - rotor magnet; 17 - gear; 18 - breaker contacts; 20 - working electrode; 21 - distributor shield contacts.

The primary circuit of the magneto consists of the transformer winding /11/ and the breaker into which there are connected the condenser /9/ parallely. The secondary circuit includes the secondary winding /10/, the high voltage electrode /20/ and the distributing device.

The high voltage current is generated in the magneto because of the magnetic flux variation in the transformer core with regard to its value and flow direction.

The rotor magnet /15/ revolves between the rigid magnet poles /12/ and produces in the transformer core /8/ the variable magnetic field which generates in the primary winding a low voltage current.

The cam lobes /5/ open the contacts of the breaker /18/ in a moment as the maximum current will flow through the primary winding, resulting the primary circuit to be interrupted whilst in the secondary one there will be induced the high voltage current.

The said current through the distributing arm /3/, working electrode /20/, distributing shield contacts /21/ as well as through the leads enters the spark plugs /4/.

The cam shield includes seven lobes and its revolutions are twice slower than that of the crankshaft ones

The condenser /9/ is connected parallely to the breaker contacts /18/. Such a connection reduces a tendency to sparking when the primary circuit is interrupted and increases discharge intensity on the spark plug electrodes considerably preventing simultaneously the contacts against the excessive wear.

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The operation of the ignition accelerating automaton is based upon the principle of the utilization of the centrifugal forces arising during rotor run and changed according to the engine r.p.m. variations.

When engine stopping or at its idling run the springs /14/ press the weights to the automaton axle. Should the magneto rotor revolutions be increased up to 900 r.p.m. the weight centrifugal forces will be greater than those of the spring ones resulting the weights to be shifted from each other and also will enable a rotary motion around their axle.

Such travel of the weights will turn the rotor simultaneously in conformity with its revolution direction, to the automaton housing relatively. Since the cam shield of the breaker is connected to the small rotor gear /7/ by means of the large gear /6/ then the annular shifting of the cam shield will result the primary circuit to be disconnected earlier as well as the mixture to be ignited earlier.

5.3 Magneto timing on the engine

In order to assure an easy starting as well as a proper operation of the engine at idling run the magneto BSM-7M installed on the engine is timed according to the retarded ignition.

At full speed the advanced ignition is secured automatically.

The advanced ignition angle up to $25^{\circ} \pm 2^{\circ}$ according to the rotor shaft may be regulated.

Actual advance angle of each magneto is given in its certificate as well as it is stamped on the rear lid of the magneto.

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The most advanced ignition for starboard magneto is equal to 28° ± 0,5° whilst for the port one to 27° ± 0,5° before T.D.C. /during compression/, respectively.

The magneto should be timed on the engine according to the fifth cylinder where the master rod is situated.

Should the magneto setting angle according to the crankshaft be obtained the automaton advance angle must be subtracted from the full ignition advance angle, respectively.

In order to obtain the automaton advance value in relation to the crankshaft the number of degrees marked on the magneto cover is to be multiplied through 1,75 /gear ratio between the magneto and the crankshaft/.

Example:

On the magneto cover there is marked a value of 24,5°.

Automaton advance in relation to the crankshaft should be: 24,5°: 1,75 = 14°. The angle required for magneto timing equals to: 28° ± 0,5 - 14° = 13,5° - 14,5° before T.D.C. for starboard magneto and 27° ± 0,5 - 14° = 12,5° - 13,5° for port magneto.

There is given below a table for setting a retarded ignition before T.D.C. in angular graduation of crankshaft revolutions in dependence upon the automaton advance marking stamped on the magneto rear cover.

Max. advance angle of automaton stamped on magneto rear cover in degrees	Magneto setting angle in degrees of crank-shaft rotations /before T.D.C. during compression cycle in cylinder No.5/	
	Starboard magneto	Port magneto
23	14,8 ± 0,5	13,8 ± 0,5
23,5	14,5 ± 0,5	13,5 ± 0,5
24	14,3 ± 0,5	13,3 ± 0,5
24,5	14,0 ± 0,5	13,0 ± 0,5
25	13,7 ± 0,5	12,7 ± 0,5
25,5	13,5 ± 0,5	12,5 ± 0,5
26	13,2 ± 0,5	12,2 ± 0,5
26,5	12,9 ± 0,5	11,9 ± 0,5
27	12,6 ± 0,5	11,6 ± 0,5
27,5	12,3 ± 0,5	11,3 ± 0,5
28	12,0 ± 0,5	11,0 ± 0,5

In order to enable the magneto to be timed exactly a clutch with 31 teeth is installed on its shaft. The clutch hole of cone shape is provided with four grooves for magneto rebate /wedge/. Besides in the magneto flange there are made oblong orifices enabling the angular shifting the whole magneto within limits of 6°, respectively.

Turning of clutch by one tooth gives an angular displacement of magneto equal to 11,6°.

Should the exact timing of magneto be needed the clutch must be withdrawed from the magneto shaft and be interposed upon another rabete anew.

Turning of clutch by 180° gives an angular displacement equal to 5,8° whereas the turning by 90° - 2,9° respectively.

Because of magneto gear ratio being equal to 1,75 ≈ 2 all the angular displacements of the magneto shaft will result the readings obtained from the engine crankshaft to be about twice lowered /1,75/ and reversely.

It is necessary when timing to place the magneto exactly in relation to fifth cylinder by means of a proper clutch manipulation. The magneto should be fixed at first in the middle position of attachment flange and then a final timing within limits of ± 1° is to be done by twisting the whole magneto, respectively.

To obtain exactly a moment when the breaker starts to open the bulb indicator with the pocket battery /4,5 V/ should be used.

When there is no any bulb indicator the tissue - paper 0,03 mm. thick is to be used.

The sequence of operations when installing the magneto on the engine is as follows:

1. Place on the crankshaft front terminal the timing disc.
2. By means of the sound screwed into the orifice of front spark plug of fifth cylinder determine the piston T.D.C. when in compression cycle and fix the crankshaft in his position by means of the arrow fastened on the stud bolts in front part of the crankcase.
3. Remove the distributing shield from the magneto, read over the ignition advance angle stamped on the rear cover and taking into account the table given above determine the setting angle of the magneto in relation to the crankshaft.

4. By means of timing shield set the crankshaft according to the angle determined above.
5. Before installing the magneto on the engine set the magneto cam in a manner enabling the breaker contacts to be opened when the distributor arm revolves according to arrow marked on same. The cam lobe marked "1" begins to open the breaker contacts in a moment when the distributor arm electrode is in line with digid "1" stamped on the magneto housing flange, causing the spark to be appeared in fifth cylinder when in operation.
6. In such position install the magneto on the engine inserting previously the gasket on the stud bolts fastening the magneto.

   In case the magneto clutch will not start to operate because of distributing arm setting it is necessary to displace the clutch in a manner described above.
7. After introducing the magneto on the stud bolts tighten it with nuts firmly.
8. Turn the crankshaft reversely by 10° - 15° and by means of bulb indicator or tissue paper determine the angle at which the breaker contacts will open. The beginning of the breaker contacts opening should take place at the angle of crankshaft revolution defined according to given table. The clearance between the breaker contacts should be within limits of 0,25 - 0,35 mm.
9. The magneto timed properly attach finally to the engine.
10. Put on the magneto distributing disc, the braided screen and fix it by means of screws.

5.4 SD-48BS spark plug

The aviatic spark plugs enable the mixture in the cylinders of the aircraft power plant to be ignited.

The high voltage current flows from the magneto then through the ignition cable and the contact locks to the central electrode of the spark plug.

The air gap between the central electrode and the side ones will be jonized resulting the spark to be created and the mixture ignition be followed.

5.4.1 Spark-plug design

The SD-43BS spark plug design is of braid and undismantable type with a ceramic insulation of the central electrode.

It consists of the following component parts and assemblies: the housing with side electrodes, spindle, screen layer, and the contacting parts.

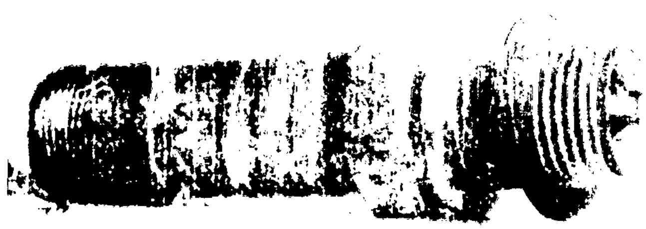

Fig.49 SD-48BS spark plug general view.

The housing of the spark plug is made of a steel and contains in its bottom part a thread enabling the spark plug to be screwed into the engine cylinder head as well as contains three side electrodes, additionally.

The external thread situated in the top part of the spark plug serves for attaching same to the ignition lead contact terminal. The hexahedral made around the external surface of the housing enables the spark plug to be screwed easily to its seat with aid of the spanner.

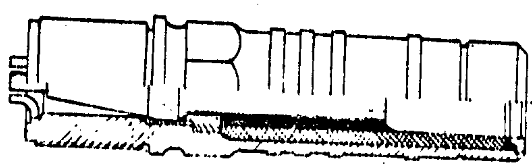

Fig.50 SD-48BS spark plug sectional view.

The spark plug spindle consists of the following main components: insulator, central electrode, and contact head. The insulator is inserted firmly in a copper bush pressed into the housing.

The spark plug screen is made of steel and serves the spindle in the housing to be fixed as well as the parts under current to be screened completely.

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5.4.2 Spark plug operation

In all types of the aircraft power plants the bottom part of the spark plug insulator should operate within a certain temperature range.

The temperature of the bottom part of the spark plug insulator must not be lower than that of the self-cleaning one /about 400°C/ at which the oil and the hard deposit set on the insulator are burnt as well as it must not exceed the mixture self-ignition temperature /750° - 800°/ at which the mixture is ignited when it will come in contact with the insulator red-hot surface but not from the electrical spark.

The spark plug works with voltage of 10000 - 12000 V. at the temperature up to 750°C.

All the electrodes as the central as the side ones are operating in warmed up condition resulting the oxidising processes in their materials to be speeded up.

The streams of the electrons jumping between the electrodes tear off from them the metal particles the number of which depends upon the temperature existing. The greater temperature of the electrode the greater number of the particles being knock out with each spark.

Simultaneously the electrodes are also pulverised because of action of the electrical field and the evaporation of the metal due to the high temperature existing.

Taking this into accont it is understandable that the electrode wear in the temperature increased will be greater than that of the normal operation conditions one.

Such an incorrect work results the gap between the electrodes to be increased and the flash-over voltage to be increased, too.

Should however the tollerance between the spark plug electrodes exceed of 0,7 mm the flash-over voltage will increase up to 12000 - 14000 volts.

In such a case even the magneto at its full loading may not secure the constant ignition within all time of operation.

9.5 Ignition braiding system

In order to eliminate the disturbances arised during operation of the wireless equipment installed on the aircraft the ignition system is braided as a whole.

The necessity the ignition system to be braided causes the phenomenons which appear during alternating current flow.

Should the alternating current be flowed through the cable the alternating electromagnetic field will be created around same and will also induce the electromagnetic forces in the electrical leads installed nearby.

After the ignition system has been set in operation in the wireless leads installed on the aircraft occur additional currents causing the disturbances in the radio receiving.

The task of the screening is to induce around same, during flow of the current through the ignition leads, a new magnetic field the direction of which is reverse to that of ignition cable one.

The action of both said magnetic fields causes same to be abolished mutually and also the radio disturbances be eliminated completely. The distributor shield is braided with an aluminium lid fastened to the magneto by means of the attachment screws.

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To the top part of said lid and to the magneto housing there is attached a special bent pipe-screen from which are led the high voltage cables through the main braided tube to the collector which creates a screen for all the leads coming from both magnetoes.

From the collector through a separate terminals, braided tubes and bent pipes the ignition leads are connected to the spark plugs braided also.

5.5.1 Braided collector of ignition leads

The braided collector consists of ignition collector, ignition lead screened tubes, main braided tubes, terminals with contacts and of high voltage leads.

The ignition collector consists of two halves of tube dia. 26/28 made of aluminium and connected together by means of a joint piece welded to the starboard half of the collector.

The collector assembled from two halves creates a ring with cut outs between the outlet terminals of ignition leads for fourth and fifth cylinder.

On the collector periphery there are welded radially fourteen small terminals leading the ignition cables to both front and rear spark plugs as well as two large terminals placed symmetrically on both halves in order the ignition cables to be led from the both magnetoes to the collector.

The terminals compise on their external surfaces a thread which serves the collector to the braided tubes of the ignition leads to be attached.

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On the inner diameter of the collector perpendiculary to its radius there are welded six lugs allowing the collector to be fitted to the front part of the crankcase.

From both sides of collector there are welded in the aluminium covers.

The ignition leads braided harness consists of the elastic spiral placed in the braid of thin wires. On both terminals of the braid are attached the outer and internal bushes between flanges of which the braid terminals are pressed and soldered.

By means of the attachment nuts it is fixed to the collector as well as to the spark plug bent terminal.

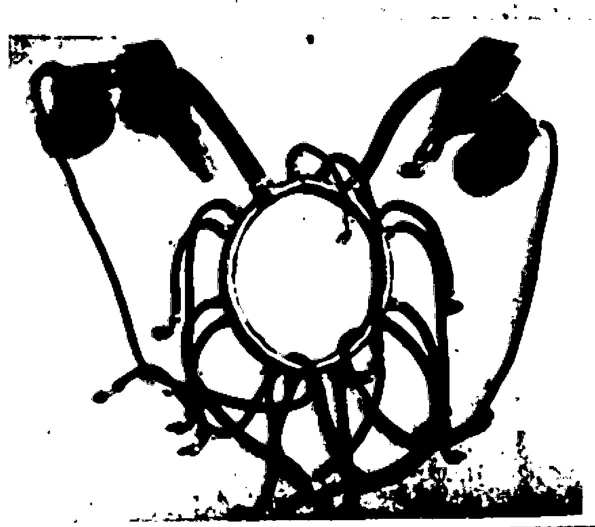

Fig.51 Ignition leads screened collector general view.

The spark plug bent terminal is made of the brass tube of 12/10 mm dia. bent by 80°.

The terminal comprises the flange flared out and two nuts from which the first nut connects the terminal to the spark plug whilst the second one connects the terminal to the braid. Between the terminal and the nut there is introduced the rubber gasket.

The contact device consists of the bakelite bush, eye rivet, insert and the spring.

The insert is pressed to the bush and into its opening enters the rivet with the spring.

Through the rivet eye is passed the ignition lead wire which thereafter is soldered to same.

Between the bakelite bush face and the bent terminal flange there is inserted fibre washer and also the rubber gasket.

The main braid differs from that of the ignition leads one by its diameter, only.

On its both ends there are placed the nuts by means of which it is attached to the collector terminal as well as to the magneto bent pipe. The last one is cast of the aluminium and contains the flange with four cut outs enabling the attachment bolts fastening the bent pipe to the magneto to be passed.

The flange creates then a cylindrical pipe junction terminated with the tread on which the nut of the main braid is screwed up.

On said pipe junction there is made a boss with a thread and an orifice through which is passed the starting lead whilst the thread enables the magneto bent pipe to the braid to be attached.

In order to prevent any chaffing of the braids as well as their breaking when the engine in operation all the braids are fastened by pairs to each cylinder with the clamps.

The cable braids of the rear spark plugs are passing through the ports made in the cylinder head fairings.

5.5.2 Ignition leads

The magnetoes are connected to the spark plugs with aid of the high voltage leads consisting of the copper thin wires screwed together into single lead and insulated with a rubber covering.

Said rubber covering consists of three or four centrically placed layers of white and black rubber vulcanized.

The order of connecting the leads from the magneto to the spark plugs is as follows: the number of lead seats: 1-2-3-4-5-6-7 situated on the distributing shield are corresponding to the spark plugs in the cylinders: 1-3-5-7-2-4-6.

The ignition leads are connected to the distributing shield electrodes by means of the screws which when screwing in cause the insulated layer of the lead to be cut through with their sharp end.

6.0 ENGINE STARTING INSTALLATION

6.1 General

The WN-3 engine starting installation comprises the following main assemblies:

1. AK-50M compressor
2. Compressed air bottle
3. Compressed air distributor
4. Starting valves
5. Air pipes
6. Priming system.

The sequence of operation of the engine starting system is as follows: when the engine is in operation the AK-50M compressor fulfills the storage bottle with the air compressed up to 50 kg/sq.cm. The said bottle connects by means of the pipe to the air distributor housing lid.

When engine starting the bottle valve is opened allowing the compressed air to be conducted from the bottle to the housing lid of the air distributor from where it is delivered to a respective port in the distributor housing and at least through the air pipe to the starting valve installed in the engine cylinder.

The starting valve under action of air compressed is forced to be opened permitting the air to be penetrated into the combustion chamber.

The compressed air distributor shield is adjusted in a manner enabling the air compressed to be entered the engine cylinders at beginning their decompression cycles, respectively.

The compressed air in the combustion chamber pressing against the piston results the crankshaft to be turned slowly and the mixture to be sucked into the cylinders.

Said mixture consists of the fuel primed with aid of manual priming pump and the primers into the induction channels as well as of the air flowed through the carburetter and the mixing chamber into the induction pipes.

Simultaneously with the crankshaft revolutions the air distributor shield starts also to rotate assuming the compressed air to be delivered to the remain cylinders according to their operation sequence.

As we know the engine starting follows because of the mixture ignition in the combustion chamber due to the spark occured between spark plug electrodes supplied with high voltage current from starting magneto or by means of the starting coil placed in the pilot's cockpit.

With increasing the crankshaft revolutions are set gradually in operation the magnetoes as well as the carburetter starts to operate supplying the engine mixing chamber with the mixture.

After the engine having been started the compressed air delivered from the storage bottle to the distributor must be shut off. This will result the engine starting system to be out of operation as a whole.

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6.2 AK-50M compressor

6.2.1 Main technical data

1.	Cylinder diameter of first stage in mm	- 46
2.	Cylinder diameter of second stage in mm	- 40
3.	Piston stroke in mm	- 20
4.	Suction valve stroke in mm	- 0,7 - 1,1
5.	Passing valve stroke in mm	- 0,7 - 1,1
6.	Pressing valve stroke in mm	- 0,7 - 1,1
7.	Sense of rotation of the compressor shaft	- counter-clockwise
8.	Gear ratio	- 0,80
9.	Air speed through a channel of 25x100 mm section area in m/sec.	- min. 20
10.	Cylinder temperature in °C	- max. 110
11.	Operating pressure obtained from the compressor in kg/sq.cm	- 50
12.	Time required the bottle of 8 litres volume to be fulfilled /at 1410 r.p.m. of compressor shaft / up to the pressure of 50 kg/sq.cm in minutes	- max. 22

6.2.2 Compressor design /Fig.53/

The AK-50M air compressor consists of the following main assemblies: crankcase, excentric shaft, connecting rod, piston with rings and the cylinder.

The compressor crankcase made of an aluminium alloy consists of two parts connected each other by means of the stud bolts.

The front part /4/ of the crankcase comprises two flanges with aid of which it is attached to the crankcase rear part /2/ and also to the power plant, respectively.

In the both parts of the crankcase there are made a cylindrical cut-outs in order the ball bearings /4/ of the excentric shaft /3/ to be pressed in.

The top part of the crankcase is terminated with a flange to enable the cylinder to be fastened.

The compressor cylinder consists of two parts: the first stage cylinder /15/ and the second stage cylinder /16/.

The first stage cylinder comprises the head cast of an aluminium alloy and also the sleeve /17/ pressed into it.

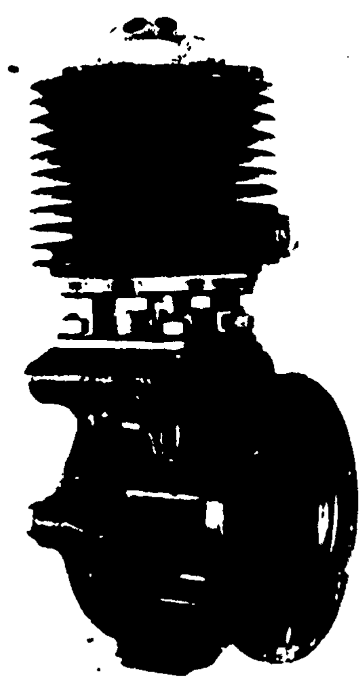

Fig.52 AK-50M compressor general view.

The second stage cylinder /16/ is made of a steel in shape of a sleeve with two flanges. To the one flange by means of stud bolts the first stage cylinder is fastened, whilst with the second one it is attached to the compressor crankcase with the stud bolts.

In the top part of the first stage there is situated the suction valve /18/ covered with a blanking cap /19/ with a gauze filtering the air sucked. In a special boss of aluminium head of the first stage cylinder there is screwed the pressing valve /20/ together with the end-fitting into which is connected the pipe conducting the air compressed in the second stage cylinder to the storage bottle.

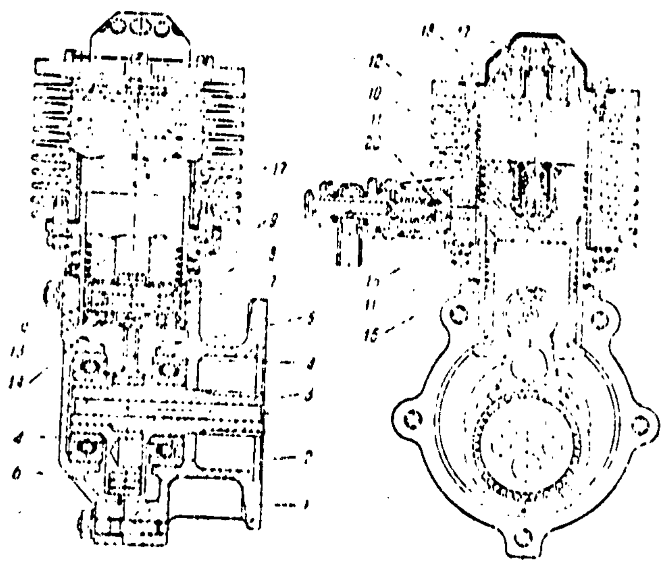

Fig.53 AK-50M compressor sectional view.
1 - crankcase front part; 2 - crankcase rear part; 3 - excentric shaft; 4 - ball bearings; 5 - connecting rod; 6 - needle bearing; 7 - bush; 8 - gudgeon pin;

9 - aluminium plugs; 10 - piston; 11 - compression rings; 12 - passing valve; 13 - bushes; 14 - peg; 15 - sleeve; 18 - suction valve; 19 - gauze; 20 - pressing valve; 21 - arm.

The excentric shaft /3/ made of a steel contains two stop-projections on which the ball bearings are introduced.

The front terminal of the shaft is splined enabling the shaft to be coupled to the drive. On the rear shaft journal there is inserted the arm /21/ with the journal placed excentrically which enters the shaft hollow.

On the central excentrical part of the shaft there is mounted the connecting rod /5/ with the needle bearing /6/. The connecting rod head into which is pressed the bronze bush /7/ is connected to the piston by means of the steel gudgeon pin /8/.

In order to prevent the steel wrist pin /8/ to be chaffed to the cylinder surface into the piston ports are inserted from both sides the aluminium plugs /9/.

The piston /10/ is of two stages type and is made of an aluminium alloy.

On the first stage of the piston there are made five grooves for compression rings /11/ whilst on the second one - six grooves, only, from which five ones are situated above the wrist pin part axis and the last one below said axis is prepared for the oil scraper ring.

In the top part of the piston there is placed the passing valve /12/ the task of which is to pass the air compressed in the first stage into the second one, respectively.

Into the wrist pin port there are pressed in two bronze bushes /13/ secured with the pegs /14/.

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6.2.3 Compressor operation /fig.54/

The excentric shaft of the compressor is driven with the engine. The piston /2/ is coupled with the connecting rod /1/ mounted on the excentric shaft.

When travelling the piston downwards the volume of the chamber "A" of the first stage will increase resulting the vacuum to be appeared owing them the suction valve /3/ starts to open and enables the air from the atmosphere to be sucked to the cylinder throughout the channels /4/.

Simultaneously the volume of the chamber "B" of the second stage cylinder will decrease resulting the air in the chamber to be compressed.

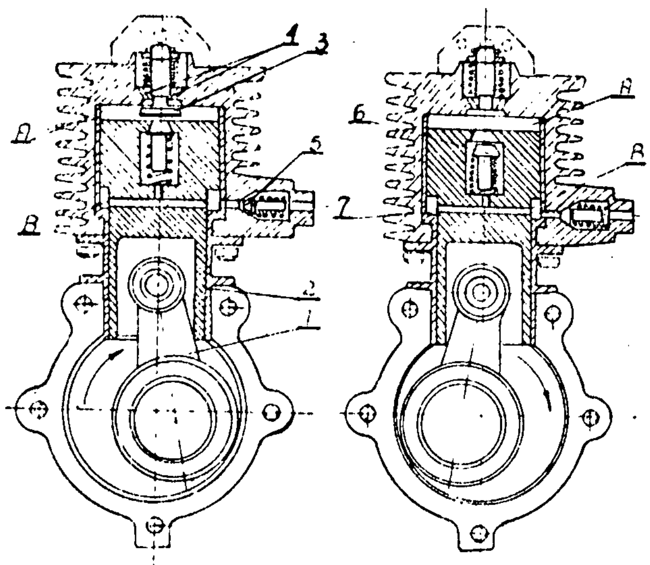

Fig.54 Compressor operation lay out.

A - first stage chamber; B - second stage chamber;
1 - connecting rod; 2 - piston; 3 - suction valve;

4 - suction channels; 5 - pressure valve; 6 - passing valve; 7 - channel.

The air compressed in the chamber "B" opens the pressure valve /5/ and enters the storage bottle.

When the piston travels upwards the volume of the chamber "A" will decrease causing the air contained inside to be compressed up to 5 - 6 kg/sq.cm. whilst the volume of the chamber "B" will increase enabling the vacuum to be occured.

Due to the pressure differention between both chambers "A" and "B" the passing valve /6/ starts to open and the air compressed in the chamber "A" of the first stage cylinder through the channels /7/ and /3/ in the piston flows to the chamber "B" of the second stage cylinder.

At the second stroke of the piston downwards the passing valve is closed resulting the secondary compression of the air in the chamber "B" of the second stage cylinder to be performed.

The air compressed is then delivered through the valve and the pipe to the storage bottle.

6.3 Compressed air distributor /fig.55/

The task of the air distributor is to deliver automatically the compressed air to the cylinders when engine starting.

It consists of the housing /1/, cover /2/ and the distributing disc /3/. Besides on the air distributor cover there is installed the fuel pump.

The housing /1/ is made of a duralumin alloy in shape of T-section. There are drilled three parts for stud bolts fastening the air distributor to the rear chamber.

From both sides of the housing there are made a cylindrical flanges in the centre of which an opening is drilled through.

Fig.55 Compressed air distributor general view.

The small flange serves for inserting the housing into the rear chamber opening.

The large flange comprises seven orifices drilled around its periphery. Just below between said orifices close by the centre opening there are cut the channels enabling the lubricant to be penetrated between working surfaces of the houcing and tho distributing disc.

From both sides of the vertical wall of the housing there are drilled out perpendiculary to the axis of the symmetry four holes threaded which are connected to the respective four holes made in the flange.

50X1

On the side top surface of the flange there are drilled out three threaded ports parallely to the symmetry axis of the housing. The center port is connected directly to the opposite port drilled in the flange whilst the remain two side holes are connected to the respective openings in the flange throughout the oblique openings drilled in the cut terminals of the flange.

The oblique openings are threaded and pluged with blanking screws and secured by dotting.

Into seven openings placed in side walls of the housing there are screwed the terminals of ten pneumatic starting pipes. Said terminals are made of carbon steel and comprise inside the hole whilst on the cylindrical outer surface the thread is made.

The terminals from the side to be attached to the pneumatic starting pipes comprise a cone. With their smaller diameter the terminals are screwed into the air distributor housing.

After the terminals having been screwed in they are safetied by pegs inserted into the blind orifices drilled in the front face of the housing from the side attached to the rear chamber.

The air distributor cover /2/ is made of the duralumin alloy in an irregular shape. In the centre of the cover there is made an opening which comprises from its both ends a centrically cut outs. The rubber gasket /6/ inserted to the smaller cut out is kept by means of the steel washer /5/ secured against axially shifting with the ring /4/.

To the both sides of the cover there are attached the housing and also the fuel pump flange, respectively.

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[illegible] and bolts [illegible] to be passed through [illegible] cover there is drilled [illegible] in the end-fitting [illegible] of distributor housing once [illegible] air end-fitting is connected the line [illegible] compressed air from the storage bottle to [illegible] distributor.

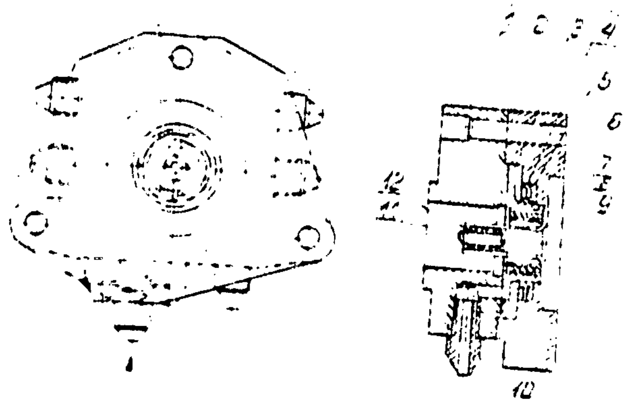

Fig.5[illegible] Compressed air distributor sectional view.

1 - housing; 2 - cover; 3 - disc; 4 - ring; 5 - washer; 6 - rubber [illegible]; 7 - safety ring; 8 - splined bush; 9 - spring seat; 10 - end-fitting; 11 - bolt; 12 - spring.

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Besides there are made also on the cover contour three openings enabling the stud bolts fastening the distributor to the rear chamber to be passed through.

In the top part of the cover there is drilled the hole into which is screwed in the end-fitting /10/ similar to those of distributor housing ones.

Into said end-fitting is connected the pipe delivering the compressed air from the storage bottle to the distributor.

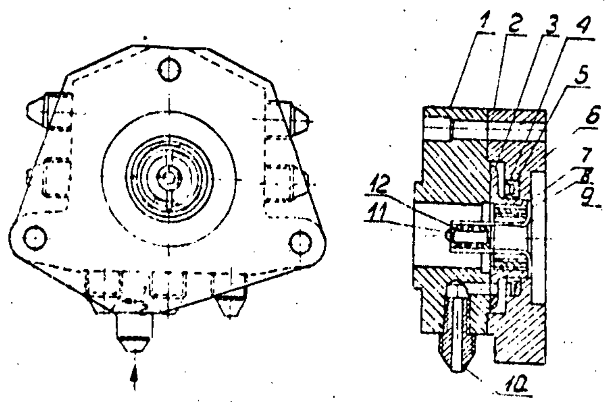

Fig.56 Compressed air distributor sectional view.

1 - housing; 2 - cover; 3 - disc; 4 - ring; 5 - washer; 6 - rubber gasket; 7 - safety ring; 8 - splined bush; 9 - spring seat; 10 - end-fitting; 11 - bolt; 12 - spring.

50X1

The distributing disc is made of Cr-Ni steel composition in a shape of a ring sector.

When rotating the disc channel opens successively all the orifices in the air distributor housing and enables the compressed air to be conducted through the pneumatic starting system pipes and valves to the separate cylinders of the engine.

In order the wear to be decreased as well as the proper sealing be secured the working surface of the flange is also carbonized and then lapped.

On the inner cylindrical surface of the said disc bush there is made an evolvente splin with 26 grooves. On the splined terminal there are made cut-outs. Into the cut out situated vis à vis the flange enters the safety ring /7/ in order to prevent the splined bush to be shifted axially into the distributor interior.

The splined bush /8/ made of steel comprises an evolvente splin on both its surfaces the outer and the inner one.

By means of setting the splined bush on the drive shaft splined terminal as well as in the distributor bush splin it is possible to adjust the air distributor exactly.

The distributing disc is pressed to the collaborating surface of the air distributor housing with aid of the spring /12/ placed in the seat /9/.

The spring seat is made of carbon steel sheet. Two parallel arms of the seat are terminated from one end with two straps which are pressing against the distributing disc and simultaneously secure the splined bush against axially shifting whilst from the second end - by means of the bottom in the centre of which the opening is drilled out.

In said opening is introduced the terminal of the duralumin bolt /11/ which is then rolled outside. The spring pressing against the disc is based on the bolt detailed.

The compressed air distributor is to be adjusted according to fifth cylinder by means of the splined bush and the distributing disc in the following sequence:

1. The piston of the fifth cylinder is to be set in a position corresponding to the crankshaft revolution by 5° after T.D.C. during decompression cycle.
2. The distributing disc must be so adjusted that the channel should open the orifice conducting the air to the fifth cylinder within limits of 1 mm in direction of the disc revolution.

The compressed air is delivered to the cylinders according to their operation order as follows: 1-3-5-7-2-4-6-1.

6.4 Starting valves and air conducting pipes

The installation conducting the air compressed to the separate cylinders consists of seven steel pipes of 4/6 mm dia. and also of seven starting valves.

From the side to be connected to the air distributor the pipe comprises a cylindrical terminal with the gasket. Said terminal is made as a bush with the flange upon which rests the flange of the nut attaching the pipe to the air distributor terminal.

In the cone opening of the terminal is inserted the pneumatic starting pipe the end-piece of which is rolled out.

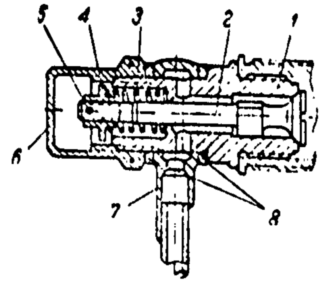

Fig.57 Starting valve sectional view.

1 - housing; 2 - valve; 3 - spring; 4 - spring seat; 5 - split pin; 6 - cap; 7 - terminal; 8 - washers.

From the other end of the pneumatic starting pipe there is soldered the ball terminal.

On the inner surface of the said terminal there is cut a channel which connects to the respective channel in the valve housing when assembled.

The pneumatic starting pipes are fitted individually to each engine and marked with a respective number of the cylinder.

The starting valve consists of the housing /1/, valve /2/, spring /3/, pressed with seat /4/, screwed on the valve stem and safetied by means of the split-pin /5/.

Tho starting valve housing made of steel is of hollow type. From the side to be inserted to the head seat it comprises an inner cone which creates a seat for the valve. From both sides of the housing on its outer surface there is made a thread and in the centre a hexahedral flange for the spanner as well as the orifices to enable the compressed air to be delivered.

The valve is made of steel and from its one end contains a taper head with the phase and a groove serving the valve head to be lapped to its seat.

From the other side, however, the valve comprises the thread with a hole in order the spring seat to be screwed in and be secured with aid of the split-pin.

The cylindrical surface with three cut-outs just by the valve head is provided to center the valve in the housing when assembled.

The complete starting valve together with the copper washer /9/ is screwed into the bronze bush of the cylinder head.

From the other end of the housing between two copper washers /8/ is inserted the ball terminal /7/ and then it is soldered to the pneumatic starting pipe.

The terminal is attached to the housing by means of the cap /6/.

6.5 Priming system

The task of the priming system is to create a normal mixture during engine starting when the fuel supplied to the cylinders through the carburetter is insufficient one.

The priming system consists of the priming pump, priming collector and seven injectors screwed into the cylinder induction pipes.

The priming collector consists of two parts joined to the Tee end fitting with aid of the attachment nuts.

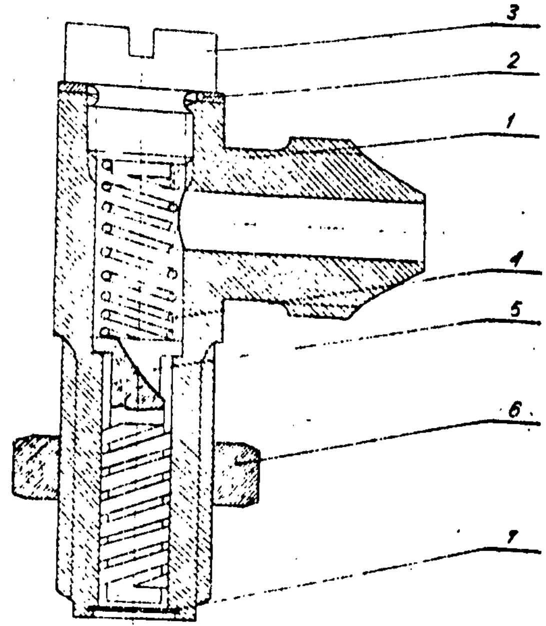

Fig.58 Fuel priming jet sectional view.

1 - housing; 2 - wahser; 3 - screw; 4 - spring; 5 - sprayer; 6 - attachment nut; 7 - injector plate.

Both said parts are made of 6/8 mm dia. tubes. To the collector there are welded radially four attachment lugs fastening it to the engine as well as seven terminals which using the durite hoses and pipes conduct the fuel to the injectors.

The injector consists of the housing /1/, sprayer /5/, screw /3/, spring /4/, attachment nut /6/, washer /2/, and injector plate /7/.

The housing /1/ is made of the brass forging in a shape of Tee pipe. Side end fitting of the injector is terminated conically and comprises the thread enabling the nut fastening the injector to the conducting pipe to be screwed in.

Inside the injector there is made two stage passing orifice terminated from its one end with the thread and from the second one with flat cut out. Into the threaded orifice is screwed the screw /3/ whilst into the cut out is introduced the injector plate /7/ with a hole of 0,5 mm dia. and fixed by rolling out the injector contour.

Into the smaller orifice of the injector the sprayer /5/ is inserted. It is made of a brass and comprises on its outer surface a spiral cut out as well as the flange with the longitudinal groove serving for the fuel delivering. The sprayer is pressed with the spring inserted on the screw stem.

Outside the injector there is made the thread enabling the injector to be screwed into the head port. The nut /6/ placed on the injector tightens the aluminium gasket as well as settles the injector properly.

During engine starting the fuel injected by means of the manual priming pump flows to the priming collector from where it is forced through the separate pipes to the injectors.

Thereafter the fuel flowing through the sprayer spiral is whirled owing them the fuel is sprayed properly and enters through the orifice in the injector plate the induction pipe of the engine where it is mixed with the air.

The mixture prepared in a manner detailed above enables the proper operation of the engine to be obtained.

50X1

7.0 WR-1 PROPELLER AND ITS CONTROL SYSTEM

7.1 General

WR-1 propeller of variable pitch type is installed in common with R-2 revolution governor on the WN-3 power plant and serves for driving the TS-8 "Bies" aircraft.

The incidence angle of the propeller blades is changed automatically because of both inertia and also hydraulic forces acting when rotated.

The propeller operates according to simple scheme as follows: should the propeller blades be rotated in order the incidence angle to be increased the moments occuring from the weight inertia forces must start to operate.

Should however the incidence angle be decreased, respectively, the oil must be pressed to the propeller hub cylinder from the oil pump of the R-2 revolution governor, causing the moments required to be obtained.

The propeller in common with the R-2 revolution governor keeps automatically the engine revolutions required within full servicing ranges.

7.2 VR-1 propeller

7.2.1 Main technical data

1. Mark	-	VR-1
2. Type	-	tractor, variable pitch
3. Propeller operation scheme	-	simple
4. Sequence of rotations	-	clockwise
5. Propeller profile	-	RAF-6
6. Profile thickness at R=825 mm	-	8,7 %
7. Propeller diameter in mm	-	2200 ± 4
8. Propeller number	-	2
9. Minimum setting angle of the blade at R = 825 mm	-	10°30'
10. Setting range of the propeller blades	-	about 32°
11. Setting angle of the counterweights according to sliding terminal	-	52°
12. Propeller weight in kg	-	36
13. Propeller moment of inertia in kgm. sk²	-	0,263
14. Admissible oil temperature in °C	-	95

7.2.2. Propeller design /fig.59/

VR-1 variable pitch propeller consists of the following main component parts and assemblies: housing, hub, synchroniser, bearing bushes, thrust bearings, propeller blades, counterweights assembly and cylinder assembly.

All the propeller components and assemblies are installed in the housing.

The propeller hub housing /1/ is made as a forging of a Cr-Ni-Mo steel composition in a form of a cylinder with two flanges on the side surface.

In the front flange there are made six projections of the lock by means of which the cylinder /2/ is attached to the housing.

In the [illegible] flange, however, there are drilled six passing orifices four from which are threaded and serve for fastening the hub /3/ whilst the rest ones for lock pins /4/ respectively.

Inside the cylindrical part of the housing there are made from both sides special seats for introducing the bearing bushes /5/ into which the propeller blades are screwed in.

In the seats close by the housing periphery is cut the thread to enable the nuts fastening the bearing bushes to be screwed on.

In the bottom part of each seat there are placed the stop flanges on which are installed the washers /6/ and then the bottom races of the roller bearings /7/.

On both terminals of the housing from the side of the front flange there are drilled by two orifices threaded serving for fitting the washers /8/ the task of which is to safety the bearing nuts.

Through the orifice drilled radially in the front flange passes the bolt fastening the adjusting wedge of the hydraulic cylinder position, respectively.

The propeller hub /9/ is forged of the chromium steel in a form of cylinder with the flange behind. Said flange comprises eight openings four from which placed proportionately are drilled with the hub housing together and serve for lock-pins whilst through the remain four openings pass the attachment bolts joining the hub to the housing.

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Inside the hub there is made a splin with sixteen grooves.

The cone seats made from both terminals of the hub enable the cut up cones to be entered into them in order the propeller to be fixed as well as be centered on the engine crankshaft, properly.

On the face from the front hub there are situated five cuts serving the clamping nut to be safetied, simultaneously on the inner surface there are machined two annular grooves. Into the first groove enters the safety ring whilst into the second one - the removing ring, the task of which is to enable the propeller hub to be withdrawed from the engine shaft.

The safety ring prevents the star fixator to be lost.

Upon the outer surface of the hub slides axially the synchroniser containing a textolite bush in order the friction to be reduced.

To prevent the synchroniser to be rotated there are inserted two limiters, the projections of which enter the longitudinal grooves placed outside the hub surface.

Each limiter is fastened to the synchroniser with two attachment screws.

The synchroniser consists of the housing and the textolite bush pressed into it. The housing of the synchroniser forged of the chromium steel comprises on its outer surface two, placed oppositely brackets with the guides for the bronze slide, into which enter the bearing bush terminals /5/ turning the propeller blades.

Between the housing brackets there are drilled the ports for the fixators as well as the orifices threaded for the attachment screws securing the fixators.

The textolite bush after being pressed into the housing from its one end rests against the flange made in the housing whilst from the second one is rolled off and then machined inside with diameter required.

In order to prevent the textolite bush to be damaged /swelled/ when in operation it is under-going a special heat - treatment - the bush is kept in an oil at temperature of 100°C within two hours.

The bearing bush /9/ made of Cr-Ni steel composition comprises outside a flange the both surfaces of which are carbonized and serve as the guides for thrust roller bearings, respectively.

Inside the bottom part of the bush there is machined a thread into which the propeller blades are screwed in.

In the top bush part, however there are cut out three slots placed proportionately around its periphery in order the blade stem to be safetied against rotation in the said bush.

The propeller blade stem inserted into the bush is clamped also by means of the counter-weight arm collar firmly.

On the bottom bush face there is placed a projection which after being assembled enters the orifice in the slide positioned in the synchroniser guide.

The synchroniser when in sliding along the hub results both the bearing bushes and the propeller blades to be rotated too.

The thrust bearing /10/ includes two rows of rollers introduced into the bronze seats and mounted in the hub housing, respectively.

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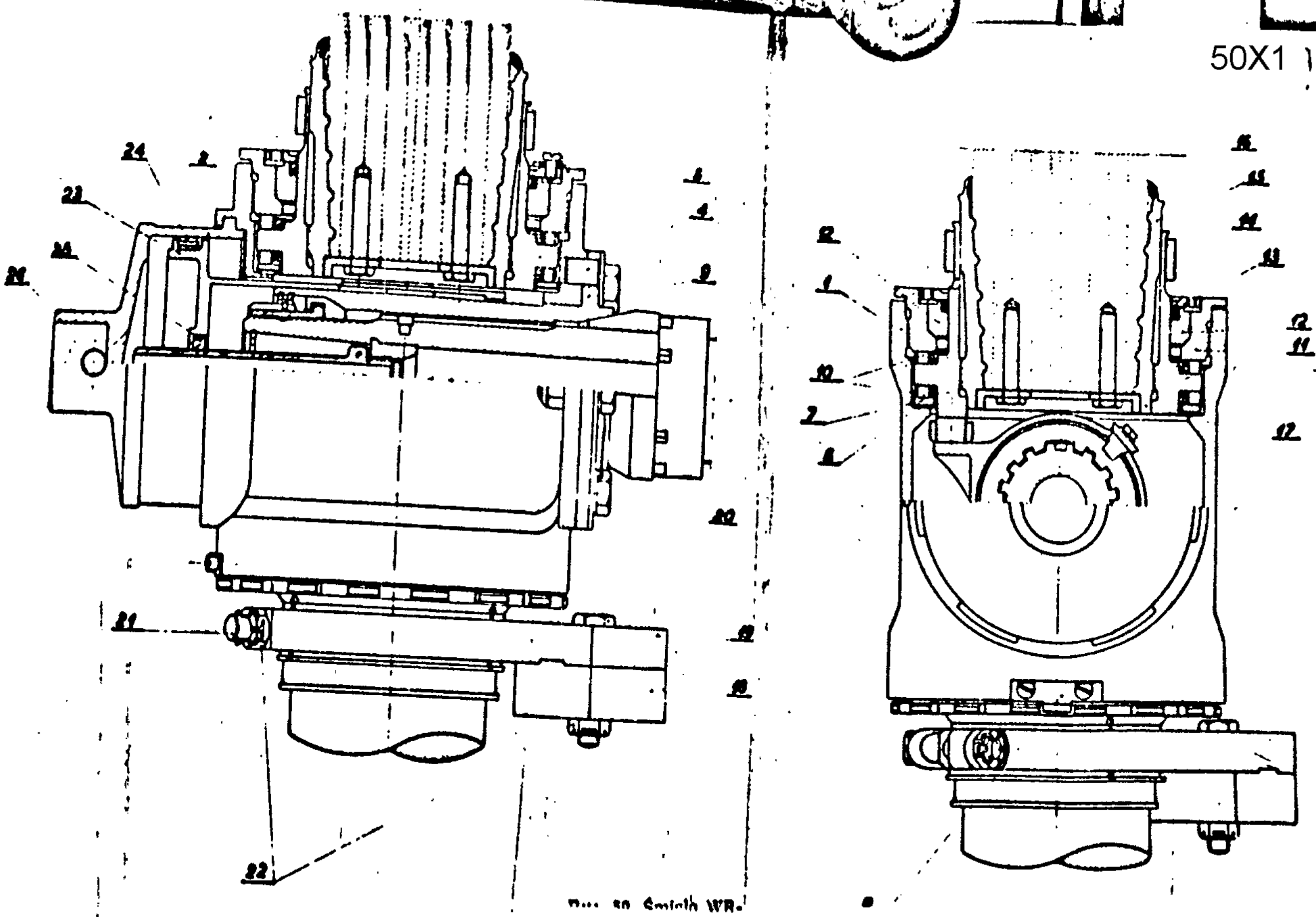

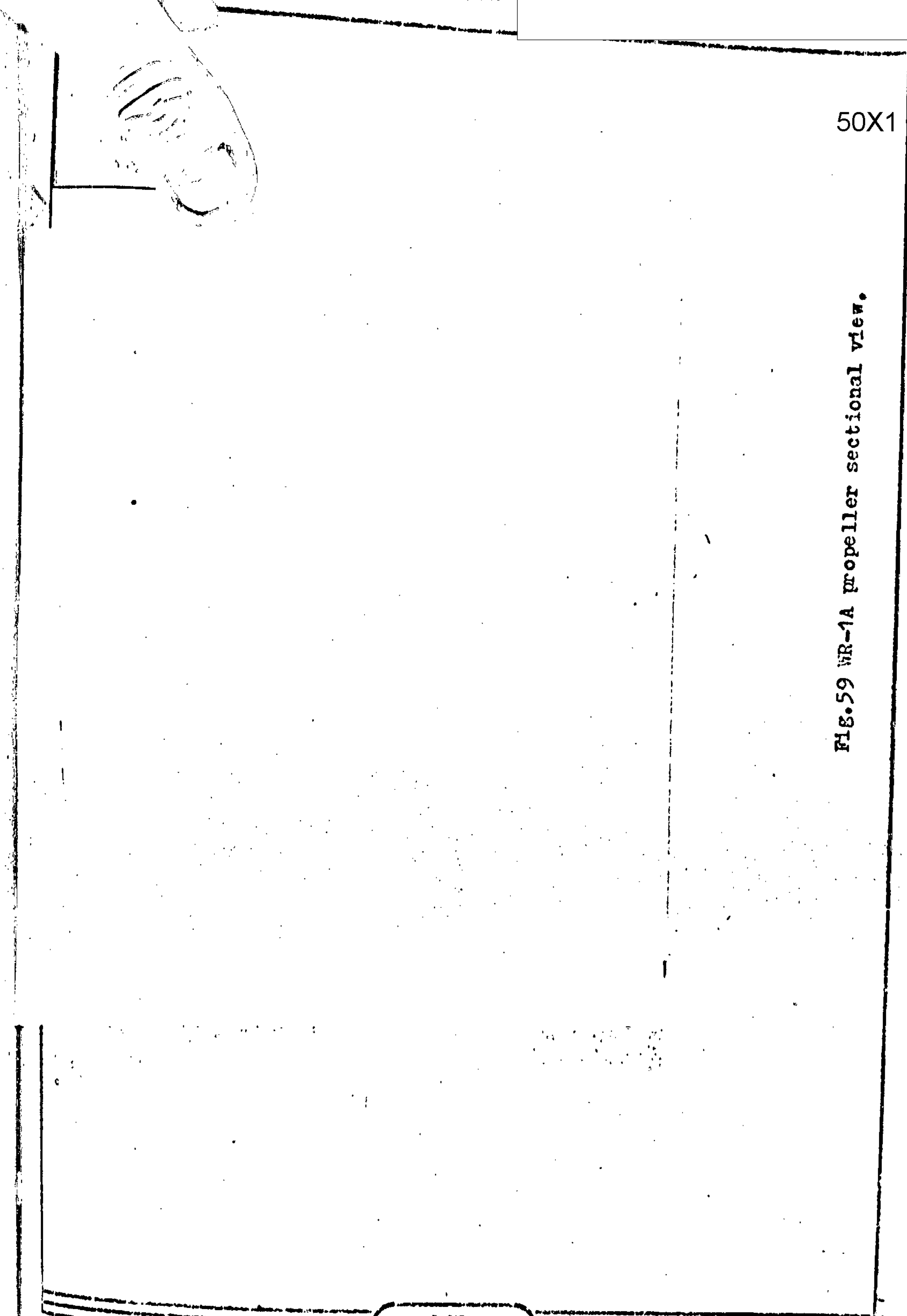

Fig.59 WR-1A propeller sectional view.

Fig.59

1 - housing; 2 - cylinder; 4 - fixating pin;
5 - bearing bush; 6 - washer; 7 - bearing race;
8 - washer; 9 - propeller hub; 10 - thrust bearing;
11 - bearing nut housing; 12 - bearing bush;
13 - gasket; 14 - ring nut; 15 - blade collar;
16 - rubber gasket; 17 - steel cap; 18 - weight;
19 - weight arm; 20 - attachment bolt; 21 - bolt;
22 - nut; 23 - piston; 24 - rubber gasket;
25 - rubber gasket; 26 - oil terminal.

50X1

Each bearing seat comprises fifty pieces of rollers with a diameter of 6 mm.

The bottom bearing seat with rollers together is placed between the bottom surface of the bearing bush flange and the bearing race /7/ inserted on the steel washer /6/ which rests against the hub housing flange.

Top bearing seat with rollers is introduced between bearing bush flange and the bearing nut, respectively.

The bearing nut consists of the housing /11/ bearing nut /12/ gasket /13/ and the ring nut /14/.

The housing of the nut is made of Cr-Ni steel composition and comprises on its outer surface a thread enabling the nut to be screwed into the hub housing as well as the flange with sixteen cuts for a spanner.

The textolite bush pressed into the nut housing comprises in its top part a cylindrical groove in order the rubber gasket to be introduced. The said gasket prevents the oil from the thrust bearing seats to be leaked.

The textolite bush is pressed by means of the ring nut screwed into the housing of the bearing nut.

Said bush is heat-treated in a manner similar to that of the synchroniser bush one.

The ring bush includes on its periphery twelve thread orifices placed equally which serve for attachment bolts fastening the propeller blade weights.

The propeller blades with RAF-6 profile are made of pine-wood lists glued then with a resin glue.

On the blade stem there is cut out a special thread upon which the steel collar /15/ is screwed.

On both the top and bottom parts of the collar surface there are made two centering parts as well as the thread for fixing the blade in the bearing bush, properly.

50X1

In the top part of the collar in front there is made also a cylindrical cut out with a web, into which is placed a rubber gasket /16/ when assembling.

Said gasket prevents the cement by means of which is screwed in the collar upon the blade stem to be crumbled out.

To the blade face there is attached with four bolts a steel cup /17/ securing the blade in its collar at a low temperatures to be loosened.

The counter weight assembly consists of the weight /18/ and the weight arm /19/.

The weight made of carbon steel in a shape of a rectangular contains the projection entering the arm channel and being fastened to it with aid of bolt /20/ passing through the openings drilled in both parts.

The counter-weight arm is made of Cr-Ni-Wo steel composition and comprises from its one end the collar whilst from the second one the channel with hole for introducing and fastening the weight.

The collar is cut out and comprises a thick terminal into which is drilled an orifice perpendiculary to collar axis. Throughout said orifices is passed the bolt /21/ clamping the collar around the top part of the bearing bush.

The counter weight arm is fixed on the bearing bush by means of the pin introduced into the bush the end of which enters the channel situated in the collar opening respectively.

The weight bolt nuts /22/ clamping the collar are safetied with the split pins.

The propeller cylinder assembly consists of the cylinder /2/, piston /23/, and two rubber gaskets.

Both the cylinder and the piston are made of an aluminium alloy.

On the outer surface of the cylinder from behind there are situated six projections enabling the cylinder to the hub housing to be fitted.

Fig.60 R-2 revolution governor general view.

Outside the cylinder bottom is made a hollow terminal upon which the propeller spinner is inserted.

A perpendicular opening drilled out in the terminal enables the cylinder to be rotated during hub assembling.

The rubber gasket /24/ is placed in an annular groove of the piston preventing the oil to be leaked. In the piston bottom is also drilled a hole with an annular channel for the rubber gasket /25/ which enters the terminal /26/ conducting the oil from the revolution governor oil pump to the propeller cylinder.

Both gaskets are designed in such a manner that any increasing of the oil pressure results their tightness to be increased, also.

The front face of the piston limits its travel in the cylinder in direction the blade setting angle to be increased whilst the rear one rests against the synchroniser face and shifts it in direction the setting angle to be decreased respectively.

7.3 The revolution governor

The R-2 revolution governor serves for automatic setting the propeller pitch in dependence upon the change of the engine operation conditions and the flight altitude of the aircraft.

It enables the required constant r.p.m. to be kept.

7.3.1 Main technical data

1. Sequence of rotation of the governor drive shaft /when viewed from drive/	-	clockwise
2. Guaranteed range of governor shaft revolutions at which a proper operation of the propeller is obtained in r.p.m.	-	1400 - 2700
3. Oil pressure at inlet to the governor - in kg/sq.cm.	-	4 - 5,5

4. Maximum oil pressure at outlet from the governor at 2500 r.p.m. of the shaft and oil temperature 85° - 90°C in kg/sq.cm.	-	15 ± 1
5. Out put of the governor oil pump at counterpressure at outlet of 13 kg/sq.cm. at shaft revolutions of 2500 r.p.m. and at oil temperature 85° - 90°C in litres per minute	-	min. 5
6. Weight of dry governor in kg	-	1,7

7.3.2 Governor design

The R-2 revolution governor consists of the following parts: gear oil pump, inertia regulator with the slide, reducing valve, and manual control mechanism.

The governor housing consists of three aluminium parts: bottom housing /3/, center housing of the oil pump /2/ and top housing of the governor /1/.

The bottom housing joints the governor to the drive and also to the engine oil system.

In the oil pump housing there are situated the spur gears of the pump and the reducing valve /16/.

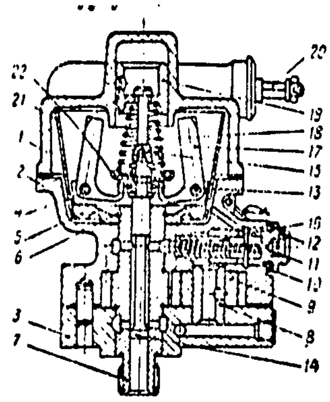

Fig.61 R2 revolution governor sectional view.

4. Maximum oil pressure at outlet from the governor at 2500 r.p.m. of the shaft and oil temperature 85° - 90°C in kg/sq.cm. - 15 ± 1
5. Out put of the governor oil pump at counterpressure at outlet of 13 kg/sq.cm. at shaft revolutions of 2500 r.p.m. and at oil temperature 85° - 90°C in litres per minute - min. 5
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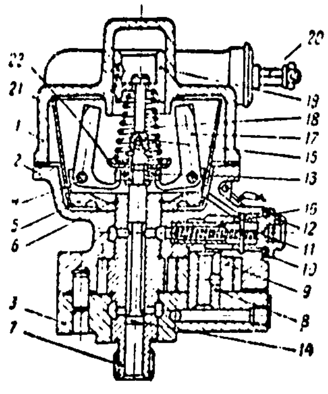

Fig.61 R2 revolution governor sectional view.

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1 - governor housing; 2 - oil pump; 3 - gear housing; 4 - axle; 5 - console; 6 - spring ring; 7 - drive shaft; 8 - axle; 9 - oil pump gear; 10 - washer; 11 - valve spring; 12 - valve cap; 13 - ball bearing; 14 - slide; 15 - stem; 16 - reducing valve; 17 - weight; 18 - cone spring; 19 - toothed axle; 20 - control shaft; 21 - taper ring; 22 - spring seat.

The governor housing covers the chamber into which there is mounted the inertia governor. In its top part is situated the manual control mechanism.

The bottom part of the gear housing includes the flange for attachment the governor to the engine as well as three openings: the inlet opening connects the suction side of the oil pump to the engine oil system, the outlet opening connects the pressure side of said pump to the propeller hub cylinder and third one enables the oil to the rear chamber to be drained, respectively.

The drive shaft /7/ made in common with oil pump gear is introduced into both the bottom and the central housing.

The bottom terminal of the shaft is splined and coupled to the bevel gear of the side drive assembly.

The oil pump gear /9/ rotates on the axle /8/ pressed with its bottom terminal into the housing.

Inside the oil pump housing there is made a cut out connected to the suction part of the pump as well as to the reducing valve.

The oil pressed from the pump enters the cut out and then through the channel in the top part of the drive shaft and two orifices penetrates into its interior.

Should the oil delivering to the propeller hub be stopped the oil will flow through the reducing valve driven gear hollow axle to the inlet port of the gear housing. In the center part of the hollow axle there is drilled radially a lubricating orifice.

The gear housing is attached to the oil pump housing by means of two attachment bolts and lock pin preventing the said housings to be shifted against each other.

The silk thread saturated with a sealing paste is inserted between both housings additionally.

The reducing valve is mounted in the oil pump housing port, directly.

The stretching of the valve spring /11/ is performed by means of the washer /10/ to be changed under the valve cap /12/.

The drive shaft comprises an opening turned exactly of 9 mm dia. in which the slide /14/ terminated with the piston is traveled.

In the bottom part of the shaft there are placed six openings which are opened or closed with slider piston, respectively.

In dependence upon the piston position through said openings the oil may be introduced to the propeller hub cylinder or be pressed with the piston from the cylinder to the engine crankcase.

The top end of the drive shaft comprises two cuts and enters the orifice in the console /5/ of the weights /17/ which is attached on the shaft by means of the spring ring /6/ inserted into the shaft groove.

The governor console is equipped with two weights balancing on their axles /4/.

In order to prevent the terminals of the weights to be chaffed against the governor housing wall there is welded and rolled out to the console the taper ring /21/.

On the top end of the slide by means of the stem /15/ there is clamped the spring seat /22/ as well as the ball bearing /13/. Upon the seat /22/ presses the cone spring /18/ the top terminal of which rests against the toothed axle /19/.

When in operation the bottom ends of the weights press from bottom against the outer bearing race in such a manner that all time the slide is being kept under action of both the spring and the weights, respectively.

Due to the ball bearing against which press the weight terminals the slide is shifted axially, only inside the shaft rotating resulting the friction between both the slide and the shaft to be reduced, considerably as well as the governor sensitivity to be increased.

The toothed axle /10/ is shifted in the governor housing and is engaged with the manual control shaft /20/. By turning the manual control shaft the toothed axle may be lifted and also lowered resulting the stretching of the cone spring to be changed, respectively.

In dependence upon the spring stretching the engine r.p.m. adjusted with the governor will be also changed.

7.3.3 Manual control mechanism

The shaft terminal of the manual control projected from the governor housing comprises a special sealing.

In order the shaft to be rotated there is installed on its end a roller or a lever. Said roller comprises on its periphery a channel for the cable both terminals of which are passed to the cockpit.

7.3.4 Propeller operation

Should the propeller pitch be reduced, the engine r.p.m. will be increased, automatically.

To decrease the propeller pitch the pilot has for duty to shift the slide /1/ into its extreme bottom position by means of manual adjusting the governor from the pilot's cockpit.

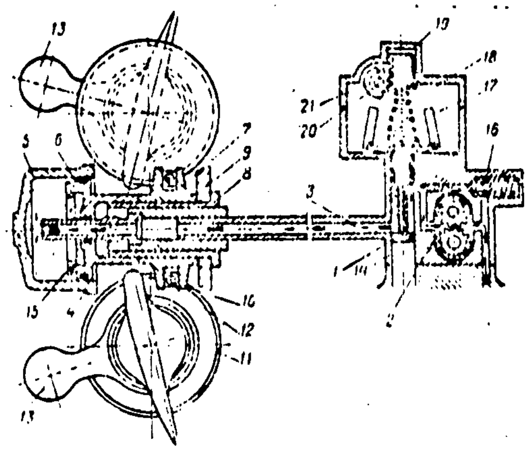

Fig.62 Propeller operation lay-out.
Propeller pitch is changed from large to small one.

1 - slide; 2 - governor oil pump; 3 - channel, 4 - terminal; 5 - cylinder; 6 - piston; 7 - synchroniser; 8 - bush; 9 - propeller housing; 10 - tang pin; 11 - sleeve; 12 - peg; 13 - counter weights; 14 - wall; 15 - ring 16 - reducing valve; 17 - weight; 18 - spring; 19 - toothed axle; 20 - axle; 21 - gear.

The oil conducted from the governor oil pump /2/ through the channel /3/ in the hollow crankshaft and also through the terminal /4/ enters the cylinder.

Under action of the oil pressure the piston /6/ rests against the synchroniser face /7/ and forces it to move along the bush /8/ in the propeller housing /9/

The synchroniser /7/ acts with aid of the tang pin /10/ against the pegs /12/ placed excentrically on the sleeves /11/ and despite the counterweights /13/ inertia forces existing changes the propeller blades pitch from the large to the small one, respectively.

The minimum propeller pitch is limited by the synchroniser which in its extreme position rests against the rear wall of the propeller housing.

Should however the propeller pitch be increased, the engine speed will be decreased, automatically.

The propeller blades are set from the small pitch to the large one in a manner reverse to that detailed above.

The pilot from its cabin shifts the slide /1/ over into its extreme top position by means of the manual control of the governor.

Owing them the oil conducted from the governor oil pump /2/ to the cylinder /5/ will shut off whilst the orifice scavenged the oil from the cylinder to the crankcase will open,

The oil pressure in the cylinder is being reduced and the propeller blades due to the counterweights /13/ inertia forces will be placed on a large incidence angle causing the engine r.p.m. to be decreased.

The maximum propeller pitch is limited with the front face of the piston which rests in its top position against the cylinder bottom.

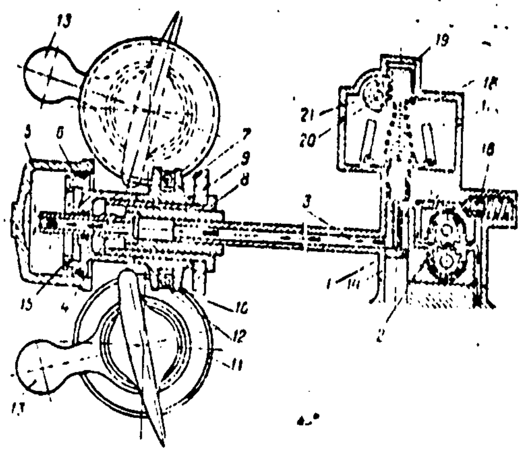

Fig.63 Propeller operation lay-out.
Propeller pitch setting from small to large one.

The oil delivered with the pump flows in a closed circuit-comprising also the reducing valve /16/.

Rated propeller revolutions.

The following conditions must be fulfilled to enable the rated propeller revolutions to be obtained: There must appear the balans between both the inertia forces of the governor weights rotated and the stretching forces of the spring /18/, respectively.

If as a result of any cause the engine r.p.m. will decrease up to a certain limit then the force coming from the weights and acting against the spring /18/ will decrease, also, resulting the slide /1/ to be shifted downwards and the channel /3/ be opened.

The oil from the governor oil pump starts also to flow through the channel /3/ and the terminal /4/ to the cylinder /5/ where it acts against the piston /6/ resulting the propeller blades to be rotated in direction that the propeller pitch to be reduced.

Owing them the engine r.p.m. will increase up to the value required.

Because of increasing the weight pressure forces against the spring the slide /1/ will be shifted upwards and also the channel /3/ be closed.

Further adjustment of the propeller pitch will be interrupted and the engine will work at the r.p.m. desired by a pilot up to the next change of the engine operation conditions.

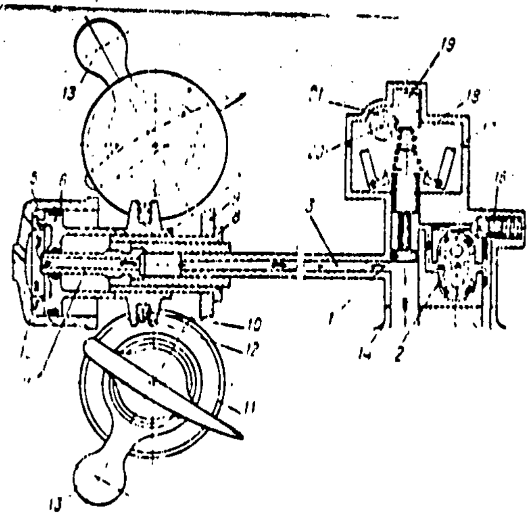

Fig.64 Propeller operation with R-2 revolution governor at constant r.p.m. lay out.

When increasing the engine r.p.m. the weight forces acting against the spring /18/ will increase, also, resulting the slide /1/ to be shifted upwards as well as the cylinder cavity /5/ be connected throughout the terminal /5/ , channel /3/, channels situated in the front cover to the rear chamber.

The oil pressure in the propeller cylinder will decrease. The propeller blades under action of the counterweight inertia forces start to rotate increasing the propeller pitch, simultaneously.

The setting angle of the propeller blades will increase it value as long as the propeller revolutions reduced will be equal to that of desired ones.

After the channel /3/ has been covered with aid of the slide /1/ completely the engine will operate at rated revolutions.

When the engine works normally the revolutions desired remain constant and only a rapid change of the operation conditions may cause the engine r.p.m. to be differed from those of required ones but within 1- 3 seconds the revolutions must establish its value as needed.

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8.0 ACIRCAFT ACCESSORIES

8.1 GSK-1500Ż generator

The GSK-1500Ż generator is destined to supply the low-voltage electrical circuit of the aircraft network and may operate parallelly with the storage batteries at nominal voltage of 27,5 V.

The generator is attached to the engine in horizontal position /with collector up/ by means of the flange and four stud bolts screwed into the rear chamber.

The GSK-1500Ż generator operates at two ranges of rated output in dependence on the cooling methods applied.

At self cooling /strap without terminals/ the generator generates the rated output of 1000 W whilst at selfcooling with an additional air flow /strap with terminals/the output equals to 1500 W.

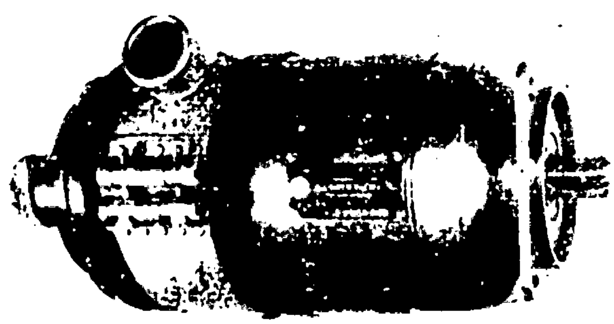

Fig.65 GSK-1500Ż general view.

Should the generator be used with output of 1500 W it must be coupled together with the adjusting box of RK-1500 W type and with two network filters of SF-1500 type.

Should however the output of 1000 W be needed the adjusting box type RK-1500 W timed in conform to output of 1000 W and the network filter SF-1500 must be used.

The adjusting box task is to keep the generator voltage constant independent on the load and r.p.m. /within limits detailed/, to secure the generator against overloading, to switch on the generator to the network as well as to secure the parallel operation of the generator to the storage battery and with others generators, respectively.

The network filter is intended to decrease the disturbances of high frequency arising in the electrical network when both the generator and adjusting box are in operation.

The generator is driven from the engine by means of the dry disc clutch mounted upon the generator splined shaft.

The generator is foreseen to operate at optional direction but the oil baffle must be replaced previously as well as the arrow in the clamping seat to be displaced, respectively.

On the WN-3 engine there is mounted the generator which comprises both the oil baffle and the over switch arrow prepared for clockwise rotations.

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8.1.1 Main technical data

Denomination	Cooling method: Self ventilation and blowing	Cooling method: Selfventilation
1. Output nom.. al in W	1500	1000
2. Voltag. nominal in V	27,5	27,5
3. Current intensity nominal in A	54	36
4. R.P.M.	3800 - 5900	3800 - 5900
5. Operation period at nominal conditions	continuous	continuous
6. Permissible current at generator overloaded in A	81	54
7. Overloading time in min.	2	2
8. Current excited in warmed state at 3800 r.p.m., nominal voltage and at current intensity in A	1,55	
9. Warmed air output required for flowing in litres/sec.	min.30 at normal atmospheric pressure	
10. Gasket type	MGS-8 7x25x22	MGS-8 7x25x22
11. Spring pressure upon the carbon brush in grams	900 - 1000	-00 - 1000
12. Weight in kg.	[illegible]	12,6

8.1.2 Generator design description

The GSK-1500Ž generator is of four-pole direct current type with the shunt exciting.

The cooling of the generator is performed by means of the blower /1/ installed upon the shaftterminal /11/ from the collector side.

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The blower is covered with the cap /2/ which directs the air stream. The said blower draws in the air through central cap opening and then delivers it along the housing causing the external surface of the generator to be cooled.

The generator is provided with an internal air circulation in order the heat to be conducted from the component parts most warmed up /e.g. rotor, collector/. Said air circulation is caused with the front parts of the rotor winding /3/ serving simultaneously as a blower shovels in order the air to be forced throughout the rotor channel.

Should the generator be operated at output of 1500 W the air must be blowed around the collector additionally by using a respective terminals on the safety tape for this purpose.

The generator housing welded is made as a whole in common with the collector lid as well as with a square flange enabling the generator to be fixed to the engine.

The attachment flange comprises four openings and a guiding projection. To the outer surface of the housing there are attached with aid of bolts four poles /5/ with exciting coils together. The terminals of the exciting winding are connected to the clamps of the seat /7/.

The poles are made of an electrotechnical steel sheet packets. The rotor /3/ consists of the thick wall cylinder, collector winding /10/ and shaft /11/.

The cylinder made of a special steel sheet packets comprises outside a longitudinal grooves into which the windings are introduced.

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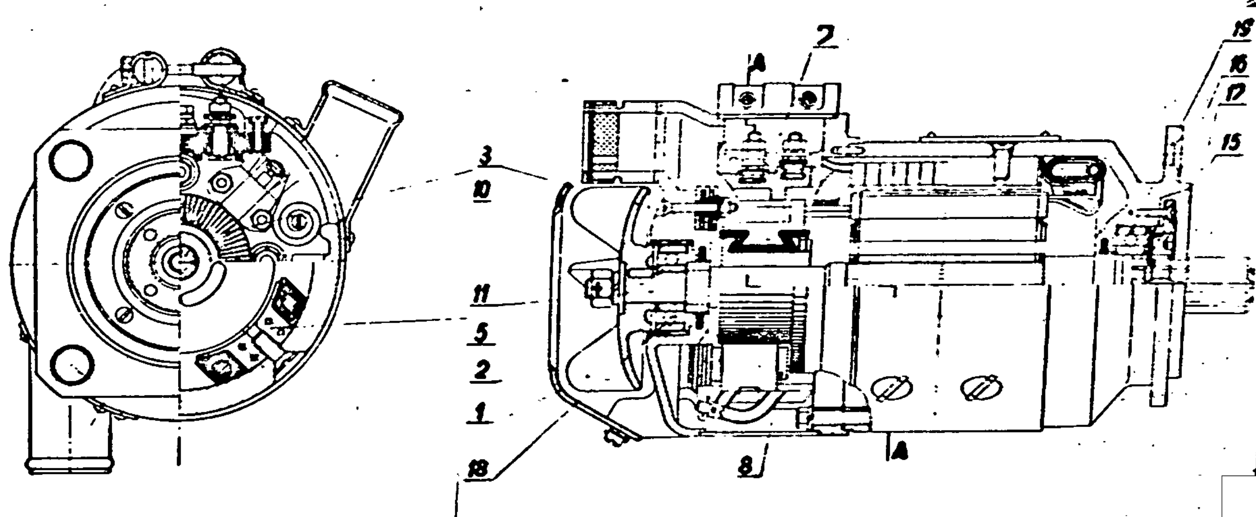

Fig.66 GSK-1500Ž generator sectional view.

1 - blower; 2 - cap; 3 - rotor winding; 5 - pole; 7 - seat; 8 - support; 10 - collector; 11 - shaft; 15 - oil baffle; 16 - flange; 17 - stop washer; 18, 19 - ball bearings.

For cooling the rotor winding a special vent channels are provided.

The rotor winding is made of the copper plates insulated from each other by means of the cotton and inserted into the rotor grooves insulated also with a cardboard.

The winding terminals are placed in the collector grooves and soldered with aid of the pure lead correctly.

To prevent the winding to be shifted during generator operation there are installed on its ends a special bandages made of steel wires. The winding however is kept in its seat by means of the wedges made of insulating cardboard.

Said bandages are separated from the winding with the cardboard, also.

The rotor together with the winding after has been bandaged is saturated with sealing la.:.

The rotor is balanced out dynamically by means of the lead welded upon the bandage.

The collector /10/ is made of a separate copper plates with a special profile insulated from each other with aid of mica washers. The collector plates are introduced on a steel bush and retained by means of the clamping shields insulated from the plates with a mica rings.

It is necessary to remember any scratches and cuts on the collector working surface are inadmissible as well as a radial beating of the ball bearing shall not be greater than 0,02 mm.

The generator steel shaft rotates on two ball bearings /18/ and /19/. One of them is pressed in the housing seat whilst the second one in the collector lid seat, respectively.

The collector lid together with the joint box is made of an aluminium alloy. On the joint box there is situated the seat /7/ and fastened to the lid ribs properly.

To the outer lid wall there is fixed the support /8/ in common with the brushes.

Said support is insulated from the lid by means of the textolite washer. The support attachment nuts as well as the bottom parts of the holders are covered with lac to prevent the short circuit to be appeared when the carbon dust from the brushes is settled upon them.

There are made in the housing two ports to enable an easy access to the brushes and the collector, respectively.

Both the distributing bridge and the ports are covered by means of the safety tapes of two types in dependence upon the output serviced.

The tape with the terminal is inserted in a manner enabling the terminals to be placed vis à vis the ports.

The terminals are set properly if the split on the tape and the collector lid will come in line.

The support /8/ is made of two brass rings insulated from each other, respectively.

The brush holders with the brush and the springs are attached to the support.

The generator shaft is secured against an axially displacement by means of the oil baffle /15/ which rests with its face against the stop washer /17/ and the inner race of the ball bearing /19/. The outside diameter of the oil baffle enters the opening of flange /16/ fastening the outer race of the ball bearing with a small clearance and comprising on its periphery a thread which serves also as an oil baffle.

During the generator shaft rotation and also the oil baffle the task of the thread is to throw out the oil and the small clearance between the baffle and the flange prevents the oil to be penetrated to the generator interior.

8.2 AK-4S vacuum pump

The AK-4S vacuum pump is destined to drive some giroscopic instruments of the aircraft.

8.2.1 Main technical data

1. Direction of rotation	-	reversed
2. Pump r.p.m.:		
- maximum /within max.30 min/.	-	3000
- nominal	-	2200
- minimum	-	900
3. Oil consumption when the pump adjusted at following conditions: r.p.m. 2250; oil pressure at inlet - 3 kg/sq.cm; pump housing temperature to be greater by 50° - 60°C than that of the ambient air one - in ccm per hour		10 - 35 /at the end of the service period for a given adjustment the oil consumption may reach of 75 ccm/hour/.

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4. Vacuum obtained from the vacuum pump at 2200 r.p.m. with closed cock at suction side and zero counter pressure at pressure side - in mm Hg column	-	minimum 600 /at the end of service period min. 520/.
5. Vacuum pump output on ground at 2200 r.p.m.; with vacuum at inlet - 100 mm Hg and with counterpressure at outlet from the pump of 50 mm Hg - in litres/minutes	-	min.400
6. Power required the pump to be driven - in HP	-	0,6 - 1,4
7. Dry weight - in grams	-	max. 3200.

8.2.2 Vacuum pump design

The construction of the AK-48 vacuum pump is of vane type. The said pump comprises four vanes which are travelling freely in the rotor cut-outs as well as the oil consumption timing mechanism serving for regulating the oil quantity supplied to the pump in order to be lubricated.

The pump housing cast of a special cast iron is provided with two bosses drilled and equipped with a conical thread enabling both inlet and outlet air end fittings to be attached.

The centering pin /18/ fixes the proper position of the drive assembly housing upon the pump housing flange.

In the pump housing rotates a steel rotor /11/ with four vanes made of azbesto-textolite material which travel in a special cut-outs of the rotor freely when rotated.

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Fig.67 AK-4S vacuum pump general view.

The rotor rotates on the ball bearings /13/ and /24/. The ball bearing /24/ is installed in the vacuum pump housing whilst other one /13/ in the driving assembly housing /10/ fastened to the pump housing by means of six attachment bolts /15/.

Between both the pump housing and the drive one there is introduced the paranite gasket /14/.

In the pump housing /10/ cast of an aluminium alloy in common with the attachment flange there is installed both a mechanism the task of which is to regulate the oil consumption and the driving clutch.

The steel bush /26/ pressed into the drive assembly housing serves as the cylinder of the oil regulator /21/. Inside said bush the piston /27/ is placed. The worm wheel /25/ is mounted on the outer surface of the bush, respectively.

The piston is forced to be operated with aid of the worm wheel and a special pin pressed into the piston rod.

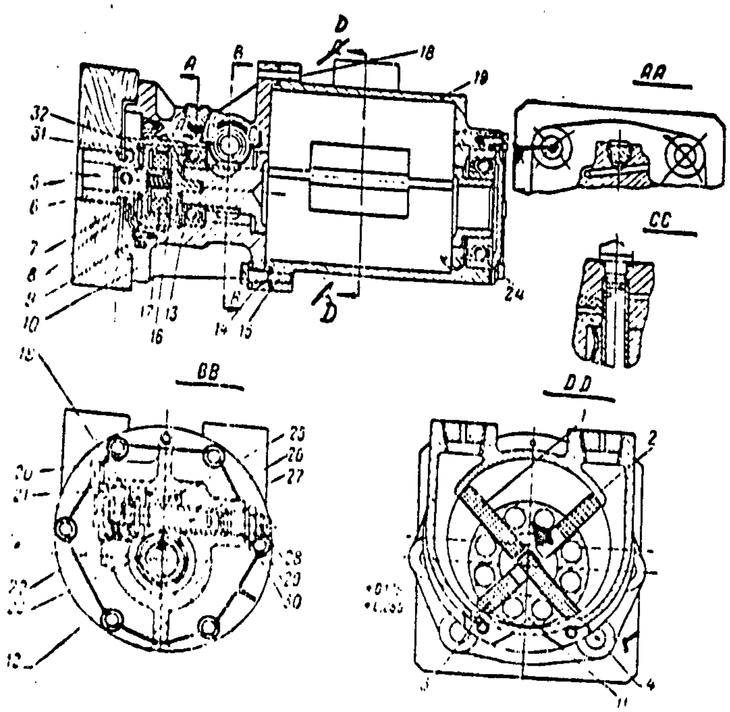

Fig.68 AK-48 vacuum pump sectional view.

1, 2, 3, 4 - vanes; 5 - disc; 6 - bush; 7 - spring; 8 - safety strip; 9 - attachment screw; 10 - drive housing; 11 - rotor; 12 - worm; 13 - ball bearing; 14 - gasket; 15 - bolt; 16 - rotor disc; 17 - rubber shock absorber; 18 - centering pin; 19 - pump housing; 20 - bolt; 21 - oil regulator cylinder; 22 - pin; 23 - rebate; 24 - ball bearing; 25 - worm wheel; 26 - steel bush; 27 - piston; 28 - adjustment bolt; 29 - nut; 30 - lead gasket; 31 - shock absorber bush; 32 - nut.

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Besides the piston has a forward-return movement. Such a movement is reached by means of the oblique cut channel in its rod enabling the pin /22/ screwed into the oil regulator /21/ to be entered.

The oil regulator is to be attached with two screws.

The worm wheel is driven from the worm /12/ installed in the rotor terminal by means of the rebate /23/.

Into the pump drive housing there is screwed the adjusting bolt /28/ which cylindrical part enters the bush creating thus in common with the piston a working cavity of the oil pump.

The adjusting bolt is fixed with aid of the nut /29/ under which the lead washer /30/ is introduced.

The oil is fed to the drive housing through a special end-fitting screwed into same.

The lubrication regulator piston /27/ works simultaneously as the piston and also the oil pump distributing slide.

The piston is driven from the worm gear /12, 25/ with gear ratio of 0,025.

The piston /27/ when in operation is forced to travel rotory and with forward - return movements simultaneously with a stroke of 0,75 mm.

Each point of the piston surface draws then a closed curve.

The piston backwards travelling results the oil to be entered the cylinder whilst the forwards one causes the oil to be forced throughout the orifices and slots in the cylinder into the pump housing and enables the collaborating surfaces of the pump rotor mechanism to be lubricated.

The adjustment of the oil quantity delivered is provided by changing the beginning of opening and closing both the inlet and outlet ports. It is done by turning the oil regulator /21/ over and also together the pin /22/ entering the oblique annular cut out in the piston terminal.

In order to prevent the lubricant to be leaked from the feeding pipe and be dropped on the engine components said pipe is attached to the exhaust gases collector.

The vaccum pump rotor /11/ is connected to the driving terminal by means of the elastic clutch consisting of the rotor disc /16/, drive disc /5/, rubber shock absorbers /17/, and the spring /7/.

On the disc faces there are made a special cut-outs with a rubber shock absorbers inside. The walls of the cut outs of one disc enter between the shock absorbers situated in the second one, respectively.

The elastic clutch task is to eliminate any shifting of the drive terminal occured, as well as to diminish the torque variation if existed.

The spring /7/ situated between both discs secures the collaborating surfaces of the discs to be pressed against the thrust bearing as well as against the inner side of the drive nut /32/. The gasket /3/ made of an oil resistant rubber is inserted also between the inner face of the drive nut /32/ and the drive shield respectively.

The drive nut assembles all elastic clutch components in the drive housing. It is secured by means of the safety strip /8/ and the screw /9/.

8.2.3 Principle of operation of the vacuum pump

The vacuum pump vanes under action of the centrifugal forces are pressed against the housing wall when rotated.

Since the rotor is placed in the pump cavity excentrically thus the volumes bordered with a separate vanes will vary their values as the rotor starts to operate.

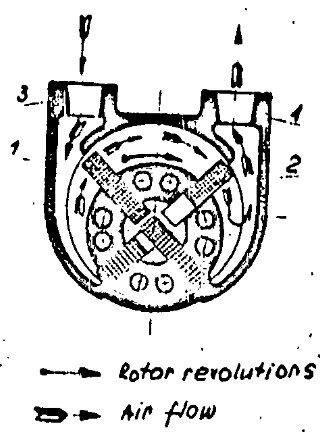

Fig.69 Vacuum pump operation lay-out.

1 - vane; 2 - vane; 3 - inlet; 4 - outlet.

Should the rotor be revolved as shows the arrow /fig.69/ the volume between vanes will be steady increaced resulting the new air to be sucked into the cavity through the inlet port /3/.

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Further travelling of the vanes causes the air contained between the pump housing and the vanes to be forced to the outlet port /4/.

Within one its revolution the vacuum pump will press four such air volumes, respectively.

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Appendix 1

TOOL KIT FOR ENGINE MAINTAINING

Part No. or assembly No	Name of part	Application	Remarks
S-4398	Universal joint spanner small	a/ for cylinder segment nuts b/ for cylinder head nuts c/ for tighening the conical stud bolt nut d/ for use on oil pump and compressor shafts e/ for push rod bottom cover stud bolts and nuts f/ for use on air distributor.	
S-4413	Universal joint spanner large	a/ for fastening the front cover b/ for use on oil sump c/ for magneto nuts d/ for oil filter bolt	
S-4450	Oil pump spanner	For passing bolt	
S-4466	Stick for checking Top Dead Center		
S-4486	Timing angular shield	For setting the air distributor cam mechanism and ignition timing.	
S-4515	Cap lock spanner		
S-4541	Valve stem punch		
S-4567	End wrench 8x11	a/ for air distributer setting. b/ for carburetter assembling.	

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Part No. or assembl.	Name of part	Application	Remarks
S-4569	Socket wrench 20x22	a/ for starting valves b/ for putting in and taking out spark plugs in cylinders.	
S-4571	Flat spanner 27x41	For ignition harness.	
S-4572/L	Special spanner 18x24	a/ for magneto nuts b/ for carburetter and oil pump assembly.	
S-4575	Crankshaft nut wrench	For adjusting crankshaft nut.	
S-4578	Eye spanner - 14	For carburetter.	
S-4577	Valve lever	For valve installation.	
S-4579	Special spanner 17	For screwing injector into cylinder.	
S-4586	Valve driver	For valve adjustment.	
S-6188	Extractor	For cam gear shaft.	
S-6283	Pliers	For gudgeon pin springs.	
S-6398	Spanner	For carburetter metering needle timing.	
S-6390	Sprayer plug spanner		
	Screwdriver 7/PN/M-64953	For general use.	
	Screwdriver 10/PN/M-64953	For general use.	
S-6409	Valve lever	For valve hoisting.	
03.18.102	Socket wrench	For oil scoop.	
03.18.105	Magneto spanner		
03.18.106	Crankshaft spanner		
03.18.107	Cylinder spanner		
03.18.108	Bent socket spanner 19	For rocker arm axle nuts.	
03.18.109	Bent rocket spanner 17	For crankcase assembly.	
03.18.110	Cylinder spanner	For fastening cylinder to crankcase.	

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Part No. or assembly Nº	Name of part	Application	Remarks
03.18.111	Feeler gauge	a/ for valve stem clearance measuring. b/ for gear clearance measuring. c/ for magneto breaks.	
119.518	Flat wrench 9x11	a/ for level gear nut b/ for ignition collector c/ for injector	
119.519	Flat wrench 14x17	a/ for engine mount b/ for air distributor piping c/ for generator drive cover d/ for fastening vacuum pump e/ for magneto clutch.	
119.520	Flat wrench 19x22	For ignition collector	
119.529	Flat eye wrench 19x22	a/ for oil piping b/ for injector nuts	
119.561	Eye wrench 9x11	For fairings assembly	
03.18.112	Flat universal pliers	For nut locking with wire	
S-6725	Screwdriver	For sprayer replacement	
14.232.04	Box spanner 17	For magneto fastening	
S-7011	Crankshaft lug	For engine hoisting.	

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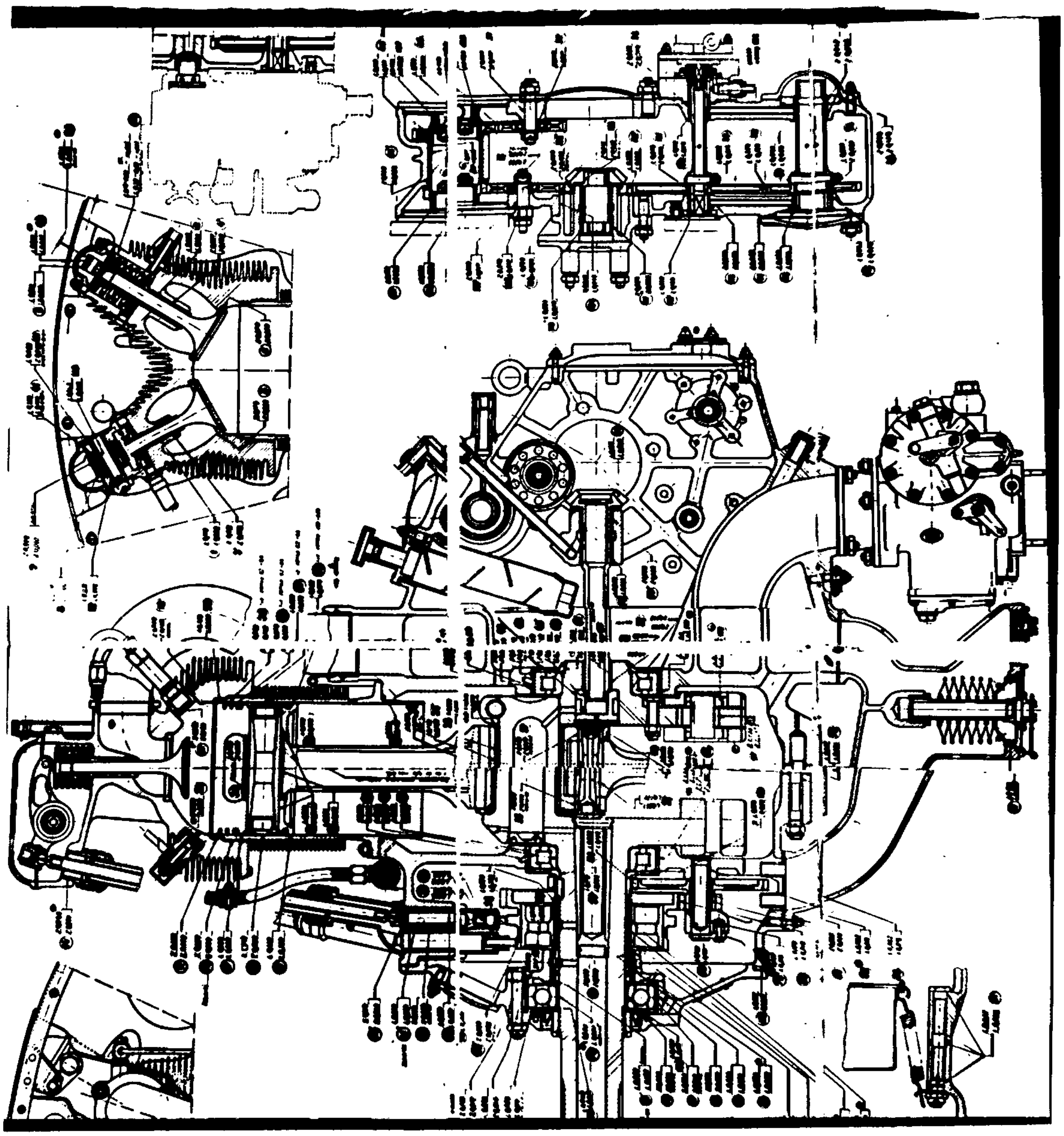

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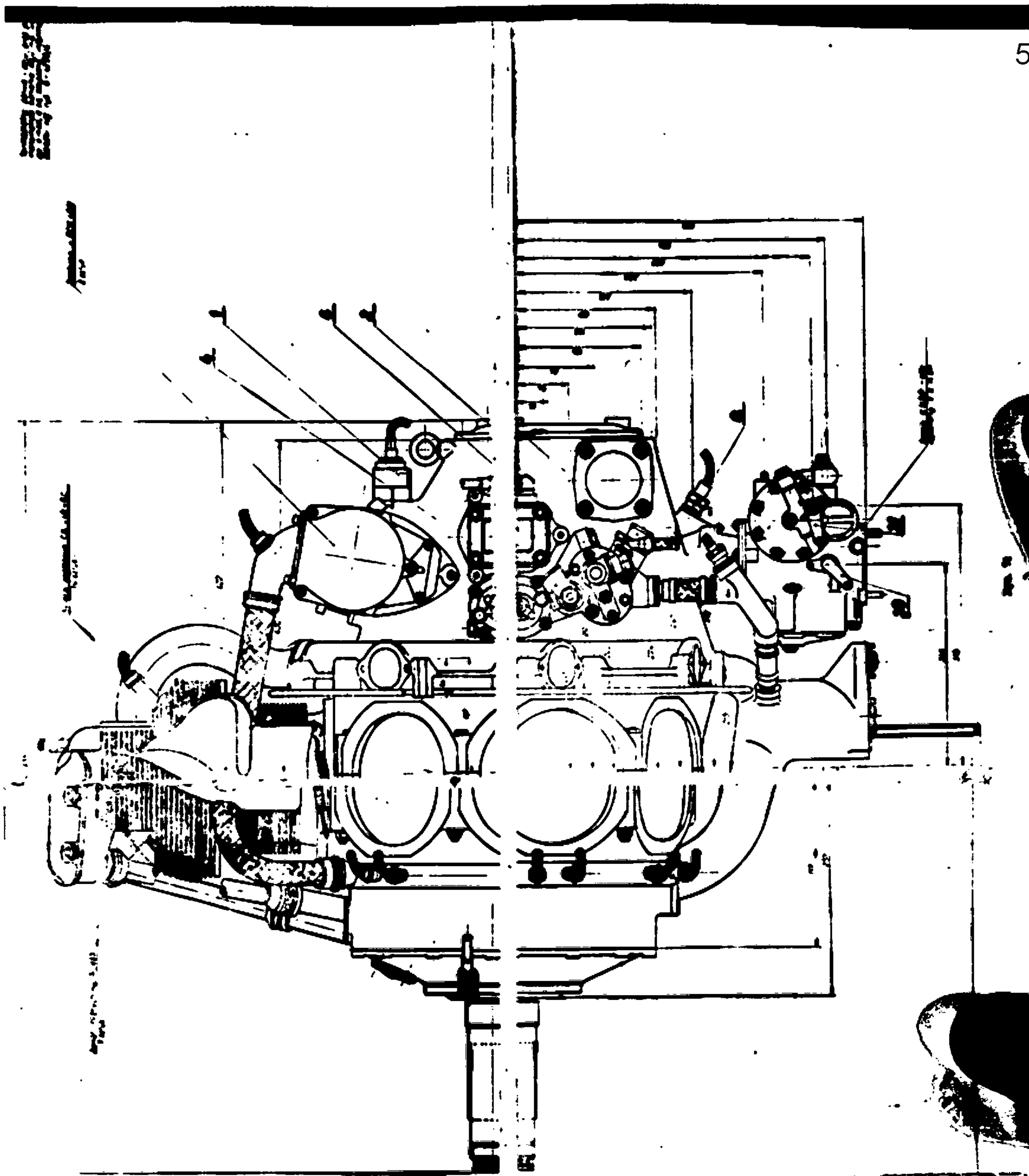

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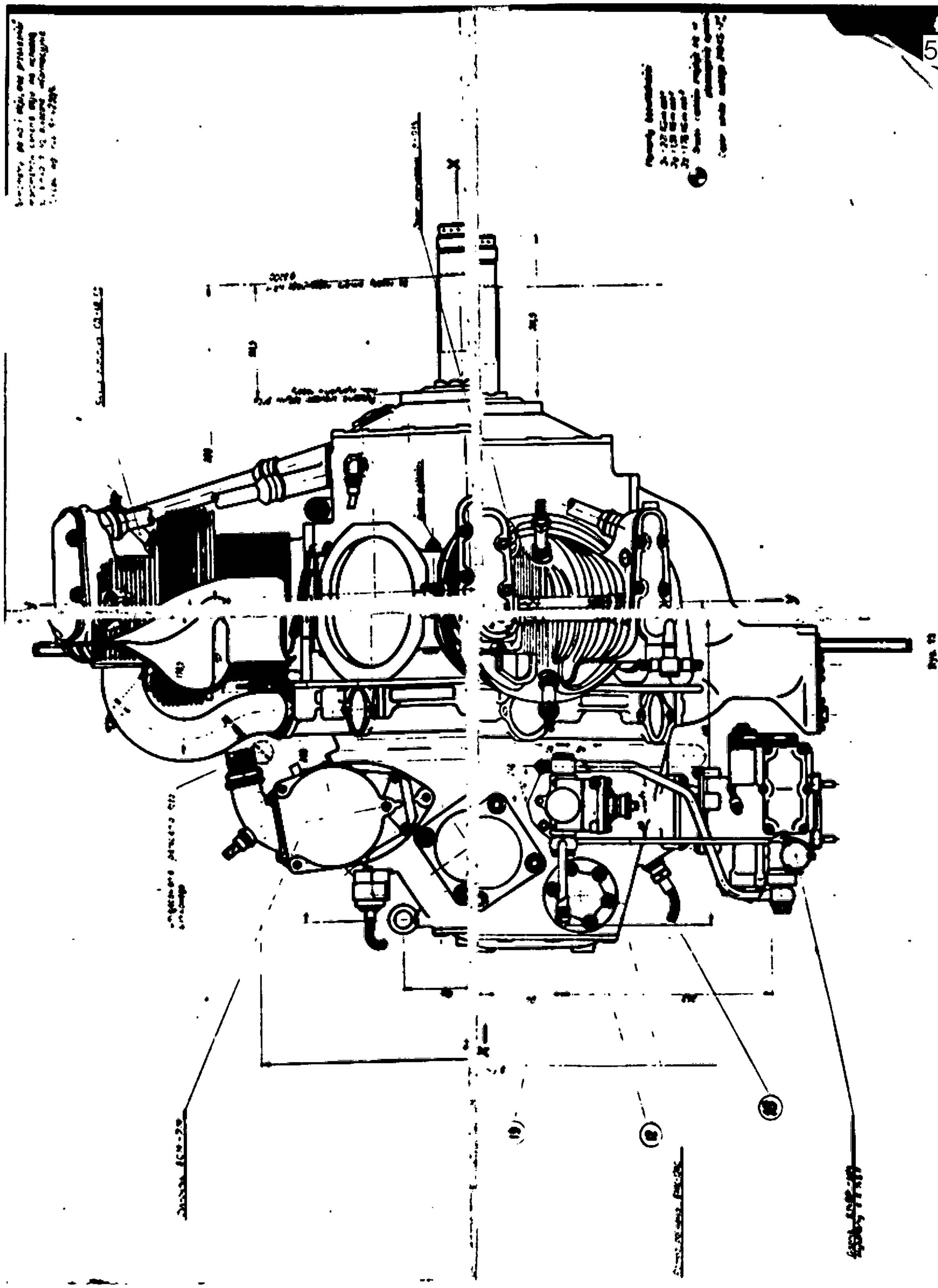

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WN-3 ENGINE

MAINTENANCE MANUAL

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GROUP 1
Excluded from automatic downgrading and declassification

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WN-3 ENGINE MAINTENANCE MANUAL

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WN-3 ENGINE

MAINTENANCE MANUAL

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Contents

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1.00 GENERAL INFORMATIONS

1.01 Short description of the WN-3 engine

WN-3 piston engine /Fig. 1, 2, 3/ is of seven-cylinders, air-cooled, radial, unsupercharged, and with direct drive type.

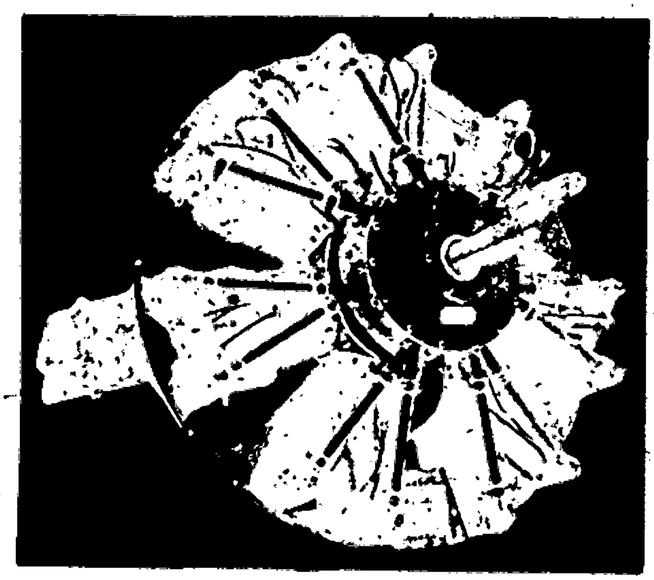

Fig. 1 WN-3 engine /front view/.

As a fuel the aviatic petrol without admixture of tetra ethyl of lead of B-70 grade is to be used.

The engine is destined for operation with an adjustable pitch propeller and for that event a respective canalization for a high pressure oil is provided, too.

Fig.2 WN-3 engine /side view/.

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Crankcase

The crankcase of the engine is being made of AL-4 silumin alloy as a sand casting.

The front part of the crankcase comprises a cam and tappets drive, and is covered by means of a front lid made of AL-4 alloy, too.

In the front lid there is pressed in a thrust ball bearing of the crankshaft.

The rear part of the crankcase is casted as a whole in common with a rear chamber and also with a mixture chamber.

The mixture chamber in form of a ring is provided with seven outlets for separate suction pipes, respectively.

On the bottom part of the chamber there is situated the attachment flange of the carburetter.

In vicinity of separate chamber outlets there are placed some [illegible] to enable six shockabsorbers of an engine elasti[illegible] suspension to be fastened.

The rear chamber as a narrow and lengthened rear part of the crankcase is provided symmetrically to both port and starboard sides with the planes for the engine accessories attachment.

The axis of everyone accessory is perpendicular to the engine axis.

The engine accessories are driven by means of the spur gears.

All the shafts of accessory drives are lubricated with aid of the oil being conducted under pressure through special orifices and also through a steel tube dipped in the crankcase.

In the top part of rear chamber there is placed a vent pipe adapted for an inverted flight within a short period, only.

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The oil flows down from both the front and the rear crankcase parts to the sump made of AL-5 alloy and equipped with a lubricating oil filter.

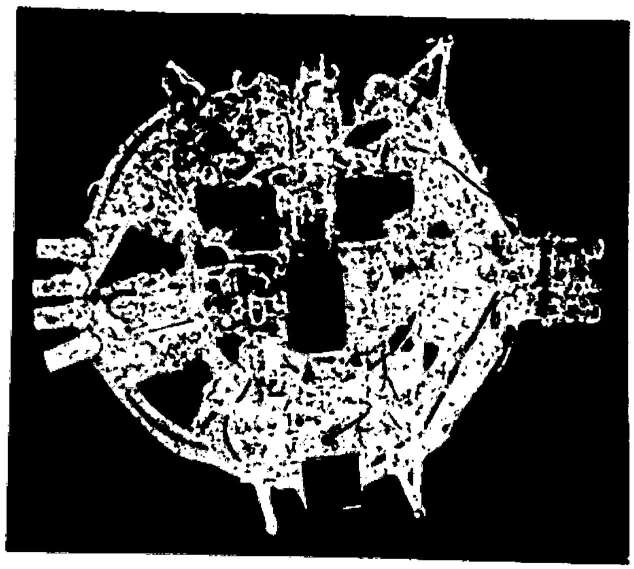

Fig.3 WN-3 engine /back view/.

The draining plug of a special design is being installed at the lowest part of sump cavity.
The lubricating filter may be easily removed for cleaning or replacement, too.

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Crankshaft mechanism

The crankshaft is made of high-grade heat-treated steel alloy of 25ChNWA mark.

It is divided and rests against two roller bearing, respectively.

The balance-weights are rivetted to both arms of the crankweb.

Both parts of the crankshaft are coupled by means of attachment bolt.

Lubricating oil under pressure is being forced through the crankshaft hollow and then it passes to the main bearing and the crankpin as well as to the front part in order to lubricate the camring bearing. On leaving the various lubricating points the oil returns to the sump for filtration and recirculation. The front crankshaft journal is made according to S.A.E. No.20 standard.

The crankshaft mechanism consists of the master rod and of six link ones. The link rods are coupled with the master one by means of link rod pins /Knuckle-pin/ drilled out and carbonised, respectively.

The master rod made of a heat-threated steel alloy of 18ChNWA mark is provided with a main lead-bronze bearing and also with a gudgeon pin bearing made of zinc bronze alloy.

On the master rod base there are situated six double holes being dectined for remaining link rod pins.

The link rods as a precision drop stampings are made of AK-6 aluminium alloy.

The side surfaces of said connecting rods are not machined. The gudgeon pins are inserted into the link rod material directly without using any bronze bushes. In that event the design is simplified and technological operations are reduced, considerably.

The link rods are not subjected to be repaired but to be replaced by a new ones, only.

Cylinder and piston

The cylinder sleeves are made of 38ChUJuA stamped steel. The inner surface of cylinder sleeve is azotized.

Each cylinder is provided with a flange to enable the attachment of the cylinder to the engine body by 12 stud-bolts of the anti-fatigue type to be secured.

Finned cylinder heads being cast of AL-5 aluminium alloy are screwed upon the cylinder after having been warmed-up, to the limit required, previously.

The heavily ribbed die-cast light metal cylinder head comprises the combustion space and valve passages.

The inlet and exhaust passages are arranged to both sides of the cylinder head and are inclined with an angle of 70 deg. each other.

Two bronze spark plug seats with a thread of M18 x 1,5 as well as one seat of the starting valve with the same thread are placed in the cylinder head, too.

The rocker chambers are cast in common with the cylinder head and are secured by means of covers made of ML-5 magnesium alloy.

Light metal pistons are used /AK-4 alloy/. Each piston carries two compression rings with high tangential close load, as well as two oil scraper rings.

All the rings are made of a special cast-iron and then chromium-plated, externally.

The gudgeon pins are lubricated by oil splash, whilst the connecting rod ones are lubricated by means of a special scoop delivering the oil.

Both the pins are made of 18ChNWA steel carbonized.

Cam gear assembly

Cam gear assembly of the engine consists of: double camrings with four cam lobes, valves, valve guides, push rods with hardened thrust pads and cups at the ends, rocker arms as well as of push rods tubes.

The camrings are made as a thin walled steel ring with an external toothing and also with double runways of camrings being carbonised and grinded thoroughly.

To enable the camrings to be turned they are pressed firmly on the duralumin nave which revolves with the crankshaft together.

The tappets made of a steel carbonised are drilled through and equipped with the rollers. The tappets are running in the guides made of aluminium bronze firmly attached to the front crankcase part.

The lubricating oil is being forced under pressure to each guide and thence it is passed through the orifice in the tappet wall into the push rod and also into the rocker arm.

The push rods are covered by means of duralumin tubes and sealed between the cylinder heads and the crankcase with aid of rubber hoses and the clipses.

The inlet and exhaust valves are made of chromium steel of Ch12M mark.

The stem of the valve is surface hardened and is sliding when in work inside the guides made of a special cast iron and inserted into the cylinder heads.

The rocker arm as 25ChNWA steel stamping is being not machined externally. It comprises a needle bearing as well as a roller pusher.

Around each valve two spiral springs are installed.

The rocker mechanism is lubricated with the oil conducted through the push rod to the rocker arm bearing.

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The rocker arm as well as the valve stem are lubricated by oil splash.

The rocker chambers are connected with aid of tubing by groups: 1, 2, 7 cylinders, and 3, 4, 5, 6 ones, respectively. Surplus oil from rocker chambers of 3, 4, 5, 6 cylinders flows down to the lowest point from which is being drawed through a special pipe leading to the oil pump.

Surplus oil from rocker chambers of 1, 2, 7 cyl. flows down into the crankcase, directly.

Ignition

For ignition the mixture two screened magnetoes of BSM-7M type with automatic ignition control are installed. Both the magnetoes are arranged in the top part of the rear chamber.

Gear ratio is being equal to 7/4 in relation to the crankshaft revolutions.

The ignition cables braided enable the current to be flown to each cylinder being equipped with two plugs of SD-48-BS mark.

Lubrication

The engine is lubricated by a forced-feed system. A gear pump driven from the crankshaft draws oil from the oil tank through the lubricating oil filter and forces it to crankshaft as well as to oil systems of the rear chamber and the front part of the crankcase.

The oil flows to the pump through a check valve preventing the lubricant to be flown by gravity from the oil tank into the engine when not in operation within a long time period.

The reducing valve of ball-type maintains a constant oil pressure when in work within limits from 5 to 6 kg/sq.cm. and also is being connected to the outlet of the drawing space.

In this event it is possible to keep the lubricating oil still in circular motion to ensure the oil temperature to be equalized in the oil system as a whole.

The engine comprises two drawing spaces /stages/ the large one collects the oil from the sump through the thermometer chamber whilst the small one collects the oil from the cylinder head oil system, only. The lubricating oil collected from the whole engine as well as from the reducing valve is being conducted to the oil tank, anew.

The oil pump transmitting ratio equals to 0,5 . On the top cover part there is installed a terminal of the revolution counter generator shaft.

Fuel supply system

The task of the MNK-12AS fuel pump is to supply the engine with a fuel. It is mounted on the top part of the air distributor. Transmitting ratio equals to 0,5:1.

The fuel is being supplied under constant pressure of 0,2 - 0,4 kg/sq.cm. to the K-14WM-5 carburetter of membrane type.

The K-14WM carburetter is being made from the K-14BP one. For this purpose the injection needle must be replaced with simultaneoms changing the timing and the carburetter inlet choke.

Starting

Engine starting is pneumatic. Air distributor of WN-3 engine is arranged on the rear chamber and serves as a base of the fuel pump.

Compressed air is delivered by means of steel piping to the starting valves placed on each cylinder of the engine.

1.02 WN-3 engine general data

1.02.01 Design data

Engine mark	-	WN-3
Engine type	-	single-row, radial
Cooling	-	air-cooled
Cylinder number	-	7
Cylinder bore	-	135 mm dia.
Stroke	-	134 mm
Displacement, all cylinders	-	13,42 ltr.
Compression ratio	-	6,2
Crankshaft rotation direction	-	clockwise, when viewed from behind
Starting	-	pneumatic.

1.02.02 Engine ratings

	Combat power	Take-off power	Rated power	Continuous work power
Power - HP	330-2 %	315 - 2 %	283- 2 %	235-2 %
R.P.M.	2500±1 %	2350± 1%	2250± 1%	2100±1 %
Specific fuel consumption g/h.p/hr	250-270	240-260	220-235	210-225
Specific oil consumption g/h.p/hr	-	-	-	max. 12
Permissible operation period - min.	5	15	continuous	continuous

Minimum constant r.p.m. - not exceed of 500 r.p.m.

Warning: Engine operation at 2650 r.p.m. may not be longer than max. one minute.
WN-3 engine is subjected to be operated at full throttle within 2100 - 2500 r.p.m. when using WR-1 propeller, too.

1.02.03 Equipment

WN-3-09 oil pump	-	1 pce.
K14-WN carburetter	-	1 pce.
BSM-7M magneto	-	2 pces /port and starboard/
BNK-12-AS fuel pump	-	1 pce.
WN-3-11 air distributor	-	1 pce.
WR-1 propeller /variable pitch or rigid pitch/	-	1 pce.

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1.02.03 Additional accessories

R-2 rotation governor, transm.ratio	-	1
AK-4C vacuum pump	"	$\frac{4}{5}$
GSK-1500" generator	"	2,31
AK-50M compressor	"	$\frac{4}{5}$

1.02.04 Weight and dimensions

Engine weight dry	-	240 kg
Diameter /overall/	-	1106 mm
Length, overall	-	885 mm
Propeller crankshaft journal according to SAE	-	No. 20

1.02.05 Cylinder head temperature

Desired	-	150°C
Minimum	-	100°C
Maximum - during take-off and climb /within max. 15 min./	-	230°C
Maximum - rated power-continuous operation	-	220°C

1.02.06 Fuel and fuel system

Fuel grade	-	B-70 /acc.to GOST 1012-54/
Octane number	-	70 min.
Carburetter: a/ type	-	K-14WN
b/ No.of pieces	-	1
Fuel pressure before carburetter	-	0,2 - 0,4 kg/sq.cm
Mixture temperature	-	5° - 12°C

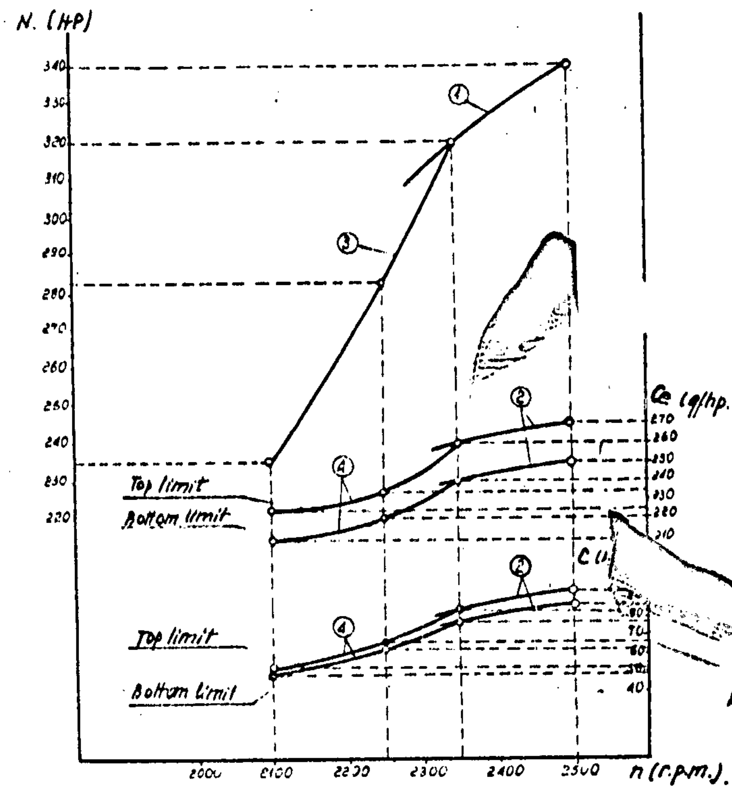

Fig.4 VN-3 engine-propeller unit power diagram.

1 - external characteristic; 2 - fuel consumption with reference to external engine characteristic; 3 - propeller characteristic; 4 - fuel consumption with reference to propeller characteristic.

Fuel pump:	a/ type	-	DNK-12AS
	b/ No.of pieces	-	1
	c/ drive gear ratio	-	0,5.
	d/ rotation direction	-	counter-clockwise.

1.02.07 Oil and oil system

Oil grade:

a/ required for all year round operation	-	MS-20 or MK-20 /according to GOST 10 13-49/.

Oil pump:

a/ type	-	WN-3-09
b/ No. of pieces	-	1
c/ transmitting ratio	-	0,5:
d/ direction of rotation	-	clockwise

Oil pressure:

a/ at continuous rating	-	5 - 6 kg/sq.cm.
b/ at idling run	-	min. 2 kg/sq.cm

Specific oil consumption at continuous rating	-	max. 12 g/h.p./hr.

Outlet oil temperature:

a/ desired	-	65 - 85°C
b/ maximum permissible /within max. 15 min./	-	95°C
c/ max. permissible for continuous work	-	90°C
d/ permissible lower limit	-	55°C.

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1.02.08 Cam gear adjustment

/according to crankshaft revol. in degrees/

Inlet valve:

a/ opening before T.D.C. - 26 ± 4°

b/ closing after B.D.C. - 64 ± 4°

Exhaust valve:

a/ opening before T.D.C. - 57 ± 4°

b/ closing after B.D.C. - 27 ± 4°

Play between valve stem and the rocker lever roller in coold condition:

a/ in reference to engine operation -

inlet valve - 0,3 - 0,4 mm

exhaust valve - 0,4 - 0,5 mm

b/ in reference to cam gear adjustment - 1,2 mm.

1.02.09 Ignition system

Type of the system - screened

Magneto:

a/ type - BGM-7M

b/ No.of pieces - 2

c/ transmitting ratio - 7/4

d/ direction of rotations

for starboard magneto - clockwise

for port magneto - counter-clockwise

Setting of the magneto on the engine - according to cylinder No. 5

Advance of ignition measured in deg. of crankshaft rotations:

for starboard magneto - 28°

for port magneto - 27°

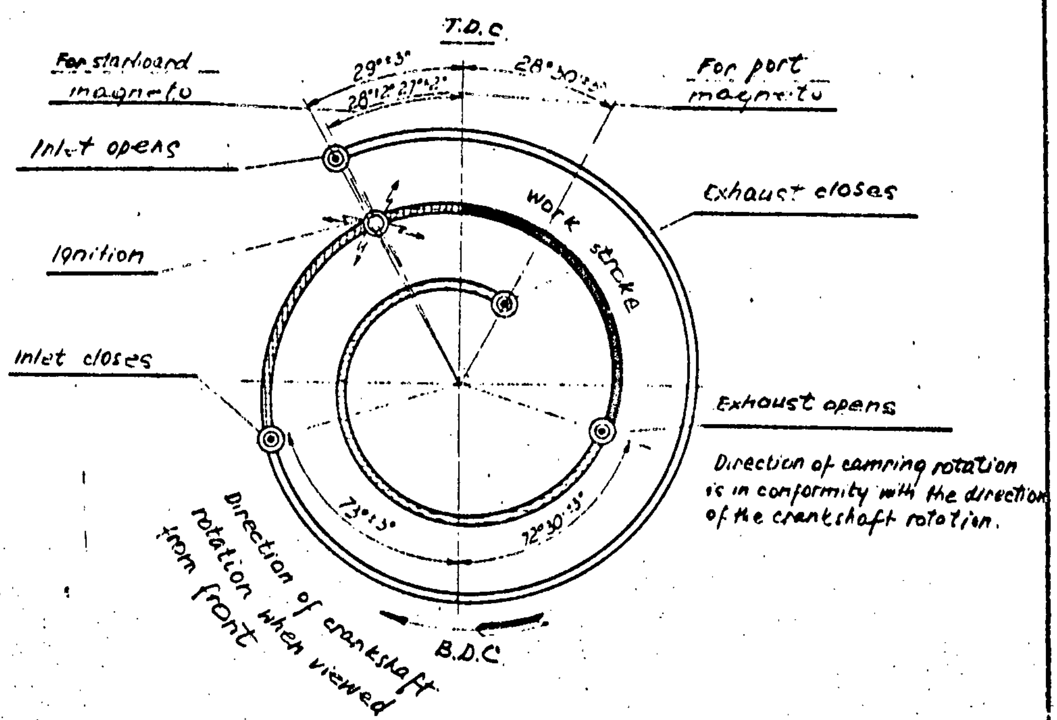

Fig.5 Timing diagram of the [illegible]-3 engine.

Cylinder ignition sequence	-	1, 3, 5, 7, 2, 4, 6, 1
Spark plugs		
a/ type	-	SD-48-BS ceramic
b/ No. of pieces pro cyl.	-	2

1.02.10 Starting system

Distributor type	-	WN-3-11 /disc/
Transmitting ratio	-	0,5
Direction of rotation	-	counter-clockwise
Servicing period guaranteed up to first overhaul	-	400 hrs.

Notice: Direction of the accessories rotation is being settled when viewing from drive.

1.03 Fuels

As a basic fuel for WN-3 engine an aviatic petrol, nonleaded of B-70 mark /according to COST 1012-54/ with an octane number not lower than 70 is to be used.

1.03.01 B-70 petrol chemical data

/COST 1012-54/

Octane number	-	70
Initial temperature of distillation	-	min. 40°C
10 % of distillation at temp. max.	-	88°C
40 % " " min.	-	75°C
50 % " " max.	-	105°C
90 % " " max.	-	145°C
97,5 % " " max.	-	180°C
Deposit and loss. /together/ max.	-	2,5 %
Remainder after distillation max.	-	1,5 %
Vapour tension accord. to Reid max.	-	360 mm Hg
Coagulation temperature max.	-	-60°C

Acides contents in 100 cu.cm of petrol max.	-	1,2 mg KOH.
Contents of real resines in 100 cu.cm of petrol max.	-	2 mg
Contents of real sulphur in 100 cu.cm of petrol max.	-	0,05 mg
Contents of water solutions of acides and lyes	-	inadmissible
Contents of mechanic soilness and water	-	inadmissible
Corrosion test	-	bears up
Transparency	-	transparent
Colour	-	colourless.

1.03.02 Servicing instructions

1. Check before filling up the aircraft tanks whether a fuel prepared is being of that grade as given in a certificate as well as whether there are no signs of mechanical soilness or water.
2. When filling up the funnel with a thick gauze and a chamois should be used.
3. Before fuel tankage the aircraft should be earthed thoroughly.
4. Aircraft tankage during raining must be avoided.
5. The aircraft fuel system should be filled up according to TC-3 "Bies" Aircraft Inspection and Scheduled Maintenance Works.
6. Before engine test and take off remember to ascertain whether the shut off valve /of anti-fire cock/ is opened.

1.04. Lubricants

For both summer and winter servicing of MN-3 engine the oil MS-20 or MK-22 /GOST 1013-49/ is to be used.

Should the ball-joints of control levers be greased as well as the engine parts cadmium and zinc-plated be preserved the technical vaseline must be used /GOST 782-47/.

Metalic parts not protected with lacquer coating are to be preserved by means of gun grease /GOST 3005-45/.

1.04.01 MS-20, MK-22 oil chemical data

Item	Physical-chemical properties	Oils	
		MS-20	MK-22
1.	Specific gravity max.	0,895	0,905
2.	Viscosity at 100°C /in CST syst./min	20	22
3.	Ignition temperature according to Martens-Penski - min. °C	225	230
4.	Acid number in mg of KOH/g	0,05	0,1
5.	Contents of coke acc.to Kondradson max. %	0,3	0,7
6.	Colour acc.to Diuboski /mixture consisting from 15 parts of oil and 85 parts of colourless ligroine/	No. RA7	15
7.	Coagulation temp. not exceed /in°C/	-18	-14
8.	Mechanic soilness	absence	-
9.	Water	absence	-
10.	Contents of water solutions of acides and lyes	absence	-
11.	Ash-contents max.%	0,004	0,004

1.04.02 Servicing instructions

1. Before oil tankage the air-mechanic has for duty to check the certificate of petrol fitness as well as whether there are no signs of mechanical soilness or water.
2. Filling up of the oil tank must be carried out with aid of a clean funnel with a thick gauze.
3. The aircraft oil system is to be filled up according to "TS-8 Bies Aircraft Inspection and Scheduled Maintenance Works".
   Special care must be taken to avoid the possibility the oil tank to be over filled as the oil has a tendency to enlarge its volume due to warming up when engine run.
4. Before engine starting check the oil cocks for reliable position.
5. When performing the procedure of an oil diluting by means of petrol a respective instruction should be observed.

2.00 UNPACKING, DEPRESERVATION AND MOUNTING OF THE ENGINE ON THE AIRCRAFT

2.01 Engine unpacking

The transport box of the engine is of a cube form. It consists of two parts: the base /bottom/ and the cover. The engine packed into the transport box is being fixed to the bottom by means of four attachment bolts inserted into the orifices of the engine mount lugs.

Except of the engine there are placed in the transport box: the bag with tool kit, the set of spare parts 1:1, the engine log book, and the specification form of the transport box.

The unpacking procedure of the engine is as follows:

a/ withdraw the lead seals placed on the bottom part of the transport box;
b/ draw out the bolts coupling the hinges;
c/ remove the cover by lifting it upwards, gradually;
d/ remove the cover from the engine;
e/ inspect the engine by visual examination and check: the engine No. and also the accessories No., the date of preservation works performed and its condition, the contents of transport box in respect to the specification form, and the engine documentation for completness.

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In case the engine or its accessories are failured, the equipment packed in does not to be in agreement with specification form enclosed, as well as the tool-kit or the spare parts are not complete the reclamation report should be draw up and be sent to the factory.

2.02 Engine and its accessories depreservation

In this sub-chapter is described the engine and its accessories depreservation works carried out in field conditions /being preserved for a period of one year with aid of 58M grease/.

Engine and its accessories depreservation should be performed in an airplane factory according to a special instruction delivered by engine factory.

It is necessary to remember the depreservation works must be carried out with a great care, as in other case the engine work may be incorrect one.

The engine should not be depreserved when its temperature remains below that of +10°C /the most suitable space is the room closed/.

2.02.01 Engine depreservation

Should the protecting grease be removed from the engine the following procedures must be done:

a/ When the piston remains in B.D.C. position inject thru the top spark-plug holes into the cylinders /by means of manual pump/ some 200 - 300 cucm of oil at temperature of 80 - 100°C and thence turn the crankshaft by 10 revolutions, approximately. When turning with crankshaft the top spark-plug holes must not be pluged.

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b/ Unscrew the blanking plugs of bottom /rear/ spark-plugs and by turning the crankshaft drain the oil from cylinders, completely.

c/ Perform the accessories depreservation works in accordance with a special instructions.

d/ Depreserve the external parts of the engine. The protecting grease withdraw by means of a hair brush moistened in the petrol.

Notice: Special care must be taken when performing depreservating works to prevent any petrol to be penetrated on the ignition cables as well as into the front thrust bearing.

e/ Wipe the engine dry by means of clean rag.

f/ Fill up the crankcase /thru the vent orifice/ with an oil warmed up to 80 - 100°C using a funnel with thick gauze and then wait within 5 - 10 minutes.

Thereafter drain the oil from the engine completely through a special drain plug arranged in the sump.

The procedures detailed above /item f/ must be carried out after the engine has been installed on the aircraft, if there are no possibility to place it vertically on the engine trestle.

g/ Unscrew the blanking plugs from the bottom exhaust pipes. Should the blanking plugs be lacked the exhaust pipe from fourth and fifth cylinder must be withdrawed and the oil from mixture chamber as well as from the exhaust pipes be drained thoroughly.

Notice: It is not allowed to use anew the oil drained from the engine without checking its moisture grade, previously.

2.02.02 Carburetter depreservation

Carburetter should be depreserved in workshop conditions when the ambient air temperature is not lower than +20°C.

When depreserving the carburetter is to be dismantled from the engine and the following works to be carried out:

a/ Depreserve the carburetter externally using the hair brush moistened in petrol.

b/ Performing the inner depreservation proceed as follows: conduct the petrol under pressure not greater than 0,5 kg/sq.cm thru the inlet end-fitting within time period not lower than five minutes until the clean petrol appears in the orifices of the needle. Simultaneously conduct the air /under pressure not greater than 0,2 kg/sq.cm/ through the intake pipe to enable the ball valve to be opened.
When supplying with the fuel the throttle must be 5 - 6 times closed and then opened, completely.
Notice: Should the pneumatic system with a pressure required /0,2 kg/sq.cm/ be lacked it is permitted to open the fuel ball-valve by pressing against the membrane through the plug orifice arranged in the cover.

c/ Wash and then blow through the carburetter pneumatic system by injecting the petrol and also conducting the air through the dynamic pressure pipe and suction jet orifice.
The pressure of air blowed through must not exceed of 0,2 kg/sq.cm.

d/ After the depreservating works have been carried out wipe off the carburetter with clean rag moistened slightly in petrol, if necessary.

e/ Unscrew and check the fuel filter for cleanness.

Notice: It is necessary to remember when depreservating an absolutely cleanness to be ensured.
The petrol should be checked for mechanical particles and whether it is stored in a proper conditions.
For depreservating works the clean petrol of B-70 grade must be used.

2.02.03 Fuel pump depreservation

For removing the preventing oil from the fuel pump it is necessary to pour in into the inlet end-fitting some petrol and thence to crank the engine shaft, repeatedly.

Should the clean petrol be flowed out from the pump it is a sign the fuel pump is being depreserved, completely.

2.02.04 Magneto depreservation

When depreservating the magneto proceed as follows:

a/ Withdraw a distributor shield, remove a preventing grease using a hair brush moistened in petrol and also wipe out dry by means of chamois the following parts: cam, distributor spring, contact device, castle nuts of attachment bolts, and breaker contacts.

b/ Grease the spring with thin layer of turbine oil by means of brush.

Notices: 1. When greasing the spring may not be deformed. The grease must not penetrate on the breaker contacts. For security reacons the breaker contacts with aid of dry chamois should be wipped out.

2. When performing the depreservating works after a long period of storage /not lower than one year/ pour into the grease box some 10 - 15 drops of turbine oil according to GOST 32-47 standard.

3. The places corroded wipe out thoroughly by means of emery cloth of "000" grade and then smear slightly with a preventing oil.

After the corrosion products have been discovered on the springs, breaker contacts or on the cam working profile the said parts should be replaced by new ones.

It is not allowed the above detailed parts corroded to be wipped out with emery cloth.

2.02.05 Generator depreservation

Generator depreservation is being restricted to with-drawing of a preventing grease from the bolts fastening the poles. It should be removed by means of a rag moistened in a clean petrol or with aid of a brush.

When removing the grease by means of brush take care the petrol not to be penetrated into the generator cavity.

Places free from grease wipe out with a clean and dry rag, thoroughly.

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After the depreservating works of the engine and its accessories have been carried out enter into the engine log book a respective annotation about operations performed.

2.03 Engine mounting on the aircraft

When performing the engine suspension on the aircraft the below detailed procedures must be carried out:

1. Fix the wire cable both to front crankshaft journal and to the rear lugs, respectively.
2. Unscrew four bolts fastening the engine mount to the transport box.
3. Lift the engine in common with its mount.
   Notice: A lift with disposable load exceeded of 500 kg must be used.
4. Fix the engine mount to the aircraft.
5. Connect the fuel and oil system as well as the engine control one according to aircraft assembly instruction.
6. Screw in the sparkplugs applying slightly their threads with a graphit grease simultaneously, and connect the ignition leads,
7. Wipe clean the crankshaft journal. Apply the grooves and cones slightly with a graphit grease, insert on the crankshaft the hub with propeller together, tighten the propeller attachment nut with a torque loaded spanner /50 - 60 kgm/ and safety it correctly.
8. Check the propeller for beating according to "Propeller Maintenance Manual".

9. Insert the propeller spinner.
10. Regulate the tightening of the engine cowling locks and secure the locks adjustment.
11. Fill up both the fuel and oil systems and vent them with a great care.
12. Check the engine installing on the aircraft for correctness.

    Notice: When inspecting a special attention must be paid against:
    a/ tightening of both fuel and oil systems;
    b/ proper adjustment of the engine control;
    c/ all security devices.
13. Prepare the engine to starting.

    Notice: All the works required when engine installing must be performed by means of a proper tools.
    The nuts and the bolts should be tightened with a torque spanner to prevent the threaded pins and bolts to be failured. All the provisional /temporary/ methods of engine mounting are forbidden.
    Proper installing of the engine on the aircraft must be checked by a ground engineer.

3.00 ENGINE PREPARATION FOR FLIGHT

3.01 Pre-flight inspection

Pre-flight inspection and engine ground test is necessary to secure a reliable and correct operation of engine run when airborne.

Before beginning the inspection of the engine ensure whether the magnetoes are switched off.

The inspection procedure should then be as follows:

1. Check both the fuel and oil systems for tightening; all the drain valves and also passing ones for correct position and for security.
2. Check the engine control system.
3. Check both the fuel and oil systems for refueling.
4. Check the propeller for condition, propeller spinner for fastoning and all the engine cowling latches for correctly locking.
5. Check by visually examination the engine as well as its accessories for condition.

3.02 Preparation of engine to start

A number of additional operations must be done however, before the engine will be ready to starting and the following sequence of operations should be adopted:

1. Carry out the engine inspection before flight.
2. Inject into each cylinder some 30 - 50 g of MS-20 oil while the pistons remain in their B.D.C. positions. This procedure should be performed before

first starting of the engine as well as after the engine is to be out of service for a period of more than five days.
Pour into the crankcase some 3 ltr of MS-20 new oil through an auxiliary oil system of the aircraft /or thru the front vent-orifice/.
Should the temperature of ambient air be lower than 5°C it is necessary to pour into the crankcase and cylinders before each engine starting an oil warmed up to temperature of 70 - 80°C. After making this ensure that both magneto switches are "OFF", then crank the engine by 3 - 5 revolutions.

Notice: It is strictly forbidden to fill the cylinders with oil quantity greater than that detailed above.
Should any excessive resistance when cranking be noted the plugs must be unscrewed or suction pipes from 4 and 5 cylinder be removed, enabling the surplus oil to be drained. For this purpose the engine crankshaft with 8 - 10 revolutions must be rotated, simultaneously.
Failure to observe such instruction may result in damage to connecting rods or cylinders because a surplus oil remaining in the combustion chamber results the hydraulic shocks to be occured.

A quantity of oil filled the crankcase as well as the oil tank may not exceed a quantity permissible detailed in "Aircraft Maintenance Manual".

3. Place the rotation governor control lever in position "large pitch" /for a propeller operating in accordance with a simple scheme/.
This procedure eliminates the oil from the main oil system by the governor pump during starting to be sucked out.

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4. Place the altitude correction lever in normal position "H".
5. Check the air pressure in the aircraft pneumatic system. It should remain within limits: 45 - 50 kg/sq.cm. Should the engine starting be performed by means of an airfield bottle it must be connected to a respective end fitting of aircraft pneumatic system.
6. Open the shut valve and with aid of hand pump obtain before the carburetter a fuel pressure of 0,15 - 0,18 kg/sq.cm. Ensure whether there are no leaking of fuel from the carburettor. If any exists, however, a defect must be withrawed by cleaning the ball valve.
7. Drain from the sump filter some 0,5 - 1 ltr of fuel.
8. Should some doubts exists the oil pump is to be filled up completely, it is necessary to unscrew the drain plug and to check the presence of the oil in the compression part of the oil pump during rotation of the propeller.
   After discovering the oil system is to be stopped at its intake by an air plug disconnect the pipe from the oil pump inlet end-fitting and also vent the oil system thoroughly.
9. Place the pads under the aircraft wheels and withdraw from the area of some meters before the aircraft all the loose objects.

3.03 Engine starting

After the pre-flight inspection as well as all the procedures required to prepare the engine for starting having been completed it is allowed to start the engine directly.

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In this event it is necessary:

1. To put the throttle lever in position corresponding to 700 - 800 r.p.m.
2. To give the engine several strokes of the priming pump. In summer some 2 - 3 whereas in winter 3 - 5 strokes are usually necessary.

   Note: It is not allowed to prime the engine with an excessive amount of fuel because of the oil washing off the cylinder walls resulting the pistons and sleeves to be seized or the fuel in the intake to be fired when engine starting.

   A hot engine does not ordinarily require priming.
3. Give also the command: "be clear of propeller" and after the reply: "all clear" switch on battery, open the compressed air valve, switch on the magnetoes and the ignition coil. The engine should beginn to work after 2 - 3 revolutions of the propeller.

   After the engine has been started close the starting valve and the priming pump. In case of irregular run of the engine at 700 - 800 r.p.m. an increasing of r.p.m. up to 1000 - 1100 r.p.m. will be allowed. When the engine begins to work observe the oil pressure gauge. It should not be lower than 3 kg/sq.cm. after 10 - 15 seconds of engine rung. Should the oil pressure be lower than that recorded above the engine must be stopped immediately and the defect be discovered.
4. When engine operation there is not allowed to get out from the front cockpit, to stay in the plane of propeller revolutions as well as to stay nearby the propeller,

5. When the engine has not started - switch off the magnetoes, turn the propeller repeatedly, prime the fuel into the cylinders, and repeat the engine starting procedure anew according to item 3.
If an excessive amount of fuel is being primed into the cylinders /the petrol is dropping from bottom cylinders and the carburetter/ switch off the magnetoes, shift the throttle lever into position "full speed", and turn over the propeller in opposite direction by 3 - 4 revolutions in order the cylinders to be vented.
If the engine fails to start after 3 - 4 attemps, consult the instructions that follow on engine trouble to ascertain the possible cause.
It is noticed oftly the troublesome engine starting is being caused by unsatisfactory depreservation of the carburetter as well as by air plugs in fuel system.
In case the carburetter is being not supplied with fuel correctly it is necessary to open the throttle completely, to unscrew the plug of the air chamber /Fig.9/, to vent and also to pour over the carburetter by pressing against the membrane attachment screw.
Should the incorrect depreservation of carburetter be noted it must be dismantled from the engine and be depreservated anew.
<u>Note:</u> To avoid the possibility of any inadvertent accident when propeller to be turned all the precautions must be taken into consideration.

3.04 Warming up and engine test

The task of the engine test is to check all the parameters of engine work securing it correct operation when airborne.

Before the test the engine must be started and also be warmed-up to temperature required permitting a normal operation within a full power limits.

1. After engine starting and increasing the oil pressure up to the limit required warm up the engine at 700 - 1100 r.p.m. until the temperature of outlet oil reaches of 30°C.
   Thereafter increase the engine speed gradually by 100 - 200 r.p.m. up to 1400 - 1500 r.p.m.
   The temperature of the oil as well as of the cylinder heads must be increased continuously, too.
   Warning: It is strictly forbidden to use the full throttle speed before the engine is being warmed up, respectively.
   Should the time of engine warming-up be decreased, the engine shutters must be closed, previously. When increasing the engine r.p.m., open its shutters in dependence on the temperature of both the oil and the cylinder heads, respectively. The engine is warmed-up adequately when the outlet oil temperature reaches at least of 55°C, the cylinder heads temperature min. 100°C, and the oil pressure within limits from 5 to 6 kg/sq.cm.
   Notice: Set the heater of carburetter in such a manner that the mixture temperature will be within limits from +5°C to +12°C. If the temperature of the mixture is lower than +5°C the carburetter heater should be opened completely and also when it is higher than +12°C - closed completely.

2. After the engine has been warmed-up satisfactorily, brake the wheels and perform the engine test by pushing smoothly the throttle lever forwards till to stop.

The engine ought operate without any interruption and also any visible vibrations.

The readings of instruments should be as follows:

R.P.M. of engine:

a/ with a fixed pitch propeller	-	1650 - 1720 rpm.
b/ with an adjustable pitch propeller	-	2500 r.p.m.
- oil pressure	-	5 - 6 kg/sq.cm.
- fuel pressure	-	0,2 - 0,4 kg/sq.cm.
- outlet oil temperature	-	max. 95°C
desired		65° - 85°C
- cylinder heads temperature	-	max. 230°C
desired	-	150 - 200°C

It is not allowed to keep the engine run at full speed for a period longer than max. 30 seconds, if the heads temperature measuring equipment is not installed on the aircraft.

3. Decrease the engine speed to 1500 r.p.m. and check the following accessories:

a/ magnetoes and sparking plugs for operation /for adjustable pitch propeller - with light propeller/	-	R.P.M. decreasing permissible at single magneto: 80 r.p.m.
b/ generator for operation	-	for this purpose switch on the storage battery and check the net work voltage - it should be within limits of 27,5 V.

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c/ altitude correction for operation /for adjustable pitch propeller - with light propeller/ - when shifting the throttle lever by 1/4 - 1/3 its full travel distance the engine r.p.m. must remain constant. The continuation of the throttle lever travel results the engine r.p.m. to be decreased.

4. Check the engine operation at idling run by shifting the throttle lever to closed position. The engine work should be regular one and without any interruption, too.

The readings of the instruments should be as follows:

a/ R.P.M.	-	500 - 600 r.p.m.
b/ oil pressure	-	min. 2 kg/sq.cm.
c/ fuel pressure	-	min. 0,2 kg/sq.cm.

5. Check the engine operation for transition. This can be done by placing the throttle lever in position which corresponds to 500 - 600 r.p.m. of engine run and then by moving it gently within 2 - 3 seconds forwards till to stop.

The engine must increase its r.p.m. fluently without interruptions in its work and also without shooting into carburetter or from the exhaust pipes.

6. Check the propeller pitch governor for operation. Put also the throttle lever in position corresponding to nominal engine speed /2250 r.p.m./ thence change the propeller pitch by shifting the revolution governor lever to 2000 r.p.m. and fix it in this position.

By moving the throttle lever to both directions between a certain range ensure whether the engine r.p.m. do not change their values. If the engine r.p.m. remain constant it is also a sign the propeller pitch governor operates correctly.

3.05 Engine stopping

1. Before the engine is stopped after the test or the flight having been completed it should be cooled at 500 - 600 r.p.m. till the cylinder heads temperature drops to 100°C.
   If the aircraft is not equipped with cylinder heads temperature measuring installation it must be cooled within a period of 2 - 4 minutes in dependence upon the temperature of ambient air.
   The engine shutters must be opened, too.
   After the engine has been cooled the sparking plugs should be burned out by increasing the engine speed up to 1100 - 1300 r.p.m. during 10 - 15 seconds, thereafter place the throttle lever in idling position, switch off the magnetoes, storage battery and close the fuel cock.
   Notice: It is not allowed to stop the hot engine suddenly as the oil flows down along the cylinder walls and this would result to damage of the engine at the next starting because of piston seizure.
   On the engine there are screwed in the ceramic sparking plugs of SD-48-BS type and for this reason the engine is not to be kept to long at idling run.
   It is recommended for engine cooling to burn out repeatedly /after a few minutes/ the sparking plugs by increasing the engine speed up to 1100 - 1300 r.p.m. within a short time.
2. Inspect by visually examination the engine as a whole for eventual leaking of the fuel and the oil.
3. Wipe the propeller and put the cover on the blades and the engine if the aircraft is to be out from service.

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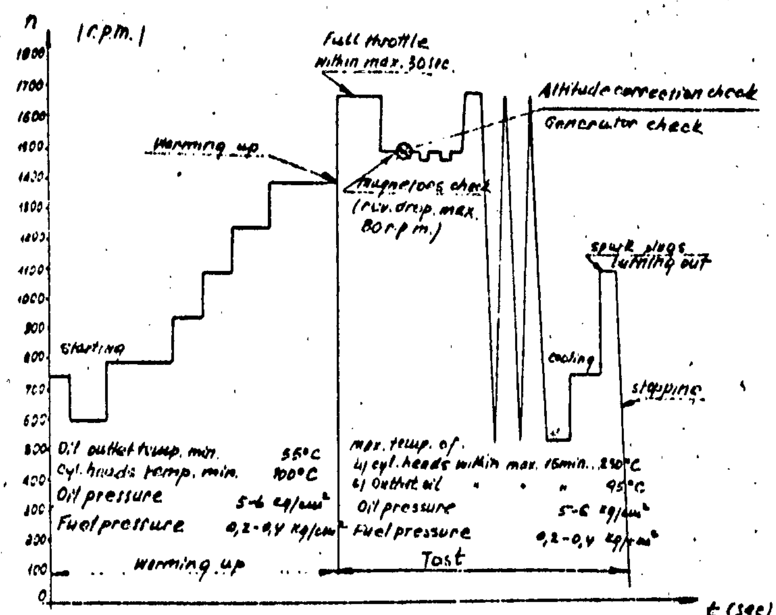

Fig.6 Engine test diagram with fixed pitch propeller

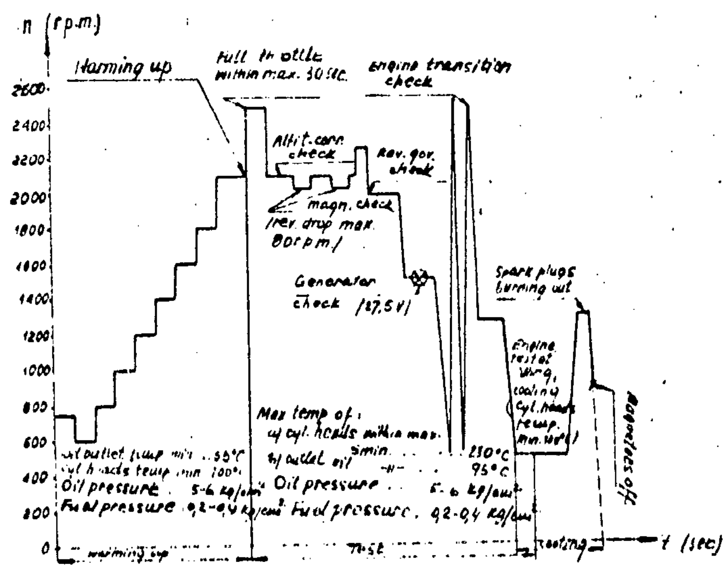

Fig.7 Engine test diagram with adjustable pitch propeller.

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4.00 ENGINE MAINTENANCE WHEN AIRBORNE

The engine operation during flight must be trouble free one and for this reason all the works recorded in chapter 3.00 "Engine preparation for flight" should be carried out carefully.

4.01 Taxying

It is not permitted to taxy in a slipstream behind other aircraft because of dust which influences badly on the engine.

To prevent the engine to be overheated when long taxying it is necessary to open the engine shutters.

4.02 Take-off and climbing

Before take-off the engine must be warmed up and be tested as well as both the altitude correction control lever and the revolution governor control lever must be checked, additionally.

The altitude correction control lever should remain in closed "H" position, whilst the revolution governor control lever position should equal to a "small pitch".

The readings of the instruments should be as follows:

a/ cylinder heads temperature	-	min. 100°C
desired		120°C
b/ outlet oil temperature	-	min. 55°C
desired		70°C

c/ fuel pressure - 0,2 - 0,4 kg/sq.cm.
d/ oil pressure - 5 - 6 kg/sq.cm.
e/ mixture temperature - from +5° to 12°C.

After above detailed parameters having been checked, open the engine shutters /if closed/, burn out the sparking plugs, and perform the take-off by increasing the engine speed gently up to full throttle.

Notice: When using B-3 fixed pitch propeller the engine speed during take-off is equal to 1620 - 1720 r.p.m. /max. r.p.m. on ground/ and then is being increased when rolling /speeding up/.
During climbing at V = 175 km/hr engine run equals to 1800 - 1900 r.p.m.

After take-off continue climbing at full throttle but for a period not longer than 15 minutes. Observe simultaneously the instrument readings - the cylinder heads temperature must not exceed of 230°C; outlet oil temperature: 95°C; oil pressure 5 - 6 kg/sq.cm; fuel pressure 0,2 - 0,4 kg/sq.cm, and mixture temperature 5 - 12°C.

Should the outlet oil temperature exceed of 95°C, and also the cylinder heads temperature exceed of 230°C when climbing the flight parameters /engine r.p.m. and the angle of climb/ must be altered.

Observe the instrument readings after recovering to level flight and altering the engine parameters. If the cylinder heads temperature or the oil temperature has no tendency to be decreased the flight must be interrupted and also the landing be carried out.

At the altitude above 2000 m use the altitude correction in accordance with "Aircraft Maintenance Manual".

4.03 Level flight

The level flight may be performed at all the ranges of engine ratings.

Engine ratings

Power	R.P.M.	H.P.	Permissible operation period in min.
Combat power	2500	340	5
Take-off power	2350	320	15
Rated power	2250	283	60
Continuous work power	2100	235	continuous
r.p.m. never-exceed	2650	160	1 /at closed slightly throttle

The readings of instruments should be as given below:

a/ cylinder heads temperature - 100° - 230°C
desired 150° - 200°C

b/ outlet oil temperature - 55° - 95°C
desired 65° - 85°C

c/ mixture temperature - 3° - 12°C
desired 5° - 12°C

d/ oil pressure - 5 - 6 kg/sq.cm

e/ fuel pressure - 0,2 - 0,4 kg/sq.cm.

If there are no special thermo-couples installed under the sparking plugs the outlet oil temperature should be kept within limits of 80 - 90°C.

The temperature of the cylinder heads as well as of the oil is to be regulated by opening the engine shutters.

When in flight it is not recommended to cool the engine below the temperature of cylinder heads 100°C and the outlet oil 55°C, otherwise the engine transitions may be incorrect ones because of interruptions during the engine run.

At the temperature of mixture 3°C the engine power is being the greatest one, whereas at temperature of 0°C it has been found that the engine begins to work incorrectly.

It is necessary to remember the incorrect operation of the engine must not be tolerable and be avoided.

The temperature of the mixture is to be adjusted by means of the air heater opening.

It is recommended to open the air heater as the temperature of the ambient air is dropped below 0°C as well as the flight is being performed in the fog or also in very moist air, otherwise the carburetter may be covered with ice.

The most reliable engine ratings in dependence on a flight speed and also an altitude are given in "Aircraft Maintenance Manual".

In order to prevent the oil in the propeller hub to be become dense it is necessary when in durable flight at the engine constant ratings and at the low-temperature of the ambient air to change several times the incidence angle of the propeller blades after every 20 - 30 minutes of flight - if the adjustable pitch propeller is to be used.

4.03.01 General instruction how to use the altitude correction mechanism

The task of the altitude correction mechanism is to regulate the fuel mixture ratio which varies with altitude, considerably.

The altitude correction is to be switched on gradually above 2000 m when the mixture will be to rich. A rich mixture may be quickly discovered by colour of exhaust gases issuing from the exhaust ports.

The travel of the altitude correction control lever should be smooth and small respectively.

A lean mixture should be avoided because of surplus air used will tend to overheat the engine cylinders, and may result the engine operation to be interrupted or also the vibrations to be occured.

When descending place the correction control lever in its normal position to ensure the best mixture proportion at the ground to be obtained.

When in level flight at an altitude not lower than 2000 m the carburetter is to be adjusted by means of an altitude correction in the following manner:

a/ with aid of the throttle lever keep the engine r.p.m. constant;

b/ without shifting the throttle lever open the altitude correction gently up to the maximum engine speed thereafter shift it back slightly in direction of its initial position.

After the carburetter adjustment procedures having been carried out as recorded above the temperature of the cylinder heads may be increased slightly but not exceeding of 10°C.

Should the cylinder heads temperature increase be greater than 10°C it is a sign the mixture is too lean and the adjustment procedures of the carburetter must be repeated from beginning anew.

4.04 Dive and descent

1. Shut off the engine shutters when in dive or descent.
2. During diving the engine r.p.m. should not be greater than 2650 r.p.m. within max. one minute. In that event it is recommended to adjust the shutters position, before diving, respectively.

   Note: Overspeeding of the engine/never exceed r.p.m/ at full throttle run is not permitted.

3. Take care the engine not to be overcooled. The temperature of the cylinder heads should not be lower than 100°C, the outlet oil temperature min. 55°C.
4. When descending at idling run it is not recommended to speed up the engine rapidly. The transition from idling to full throttle is to be carried out within a period of 2 - 3 sec.
5. When approaching before landing as well as during dive from a high altitude put the altitude correction control lever in normal position /altitude correction mechanism closed-position "H"/.
6. When descending from a high altitude /or in winter conditions/ at idling run it is necessary to pull out the aircraft and to increase the engine r.p.m. to enable the spark-plugs to be burned out as well as the engine not to be cooled too much. When using the adjustable pitch propeller remember before approaching to landing to shift the revolution governor control lever at "small pitch" to enable the transition on climbing to be secured, if the necessity will occur.
7. After flight it is necessary to enter into the engine log book the flight time, and also the readings of engine operation instruments. Incorrect engine work discovered must be reported to aircraft mechanic.

5.00 PECULIAR PROPERTIES OF THE ENGINE

SERVICING IN WINTER

5.01 General remarks

The low temperature of the ambient air results some changes in the engine maintenance to be occured.

The ground personell has for duty to know all the peculiar properties of engine servicing in cold weather.

In this chapter there are detailed the properties of winter engine maintenance being different to that of summer one.

For both winter and summer engine maintenances the MS-20 or MK-22 oil is to be used.

To facilitate the engine starting when in cold wheather it is recommended to pour into the warmed-up engine crankcase a hot oil /temperature of 70 - 80°C/.

Diluting of an oil by means of a petrol may be used, too. It is however worse method as the first one /warmed-up oil/.

Should the temperature of the ambient air be equal to +5°C as well as be lower one the engine maintenance instructions for winter servicing must be taken into account.

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5.02 Preparation of the engine-propeller unit for winter servicing

1. Before the frost will occur prepare and adapt the winter coating of the engine. The engine covers must be made in a manner enabling without their removing the oil tank refuelling as well as worming-up the engine by means of a hot air delivered from the APL-1 lamp or other airfield heating devices.
2. For winter period only install the cylinder heads covers delivered together with the engine.
   Wrap up the mixture intake pipes by means of cord or azbestos tape.
   Wrap up the oil metallic pipes with aid of double layer of insulating material /flannel and tape/ thereafter apply a protective coating consisting of a waterglass and bronze paint.
   The hoses, rubber connections as well as the electric leads are not to be insulated provided that they are not situated directly in a stream of an air warmed-up. In this case said piping should be secured by means of azbestos cord and be applied with a waterglass.
3. Fill up the pipe of the oil gauge with a mixture consisting of a glycerine and a spirit /70 % of glycerine and 30 % of spirit by volume/. Said procedure should be performed if on the aircraft there is installed a gauge without a transmitter.
4. Check the air heater for operation and adjust the control rods, if necessary.

5. Examine periodically the vent orifices of both systems the oil and fuel one.
   The tanks may be damaged in case the vent orifices are frozen.
6. It is necessary to adjust the carburetter to rich mixture when the temperature of ambient air drops below 0°C. The engine works then correctly when changing its R.P.M.
   The adjusting of the carburetter is to be carried out by means of replacement of the suction jet against a smaller one.
   The diameter of a new jet should be smaller by 0,1 - 0,2 mm.
   After the adjusting of the carburetter having been completed perform the engine test on the ground observing especially thoroughly the engine operation when changing its revolutions as well as the colour of the exhaust gases.
   Excessive smoking from the exhaust pipes indicates the mixture used is too rich.

5.03 Preparation, starting and engine test on the ground in winter

1. If a new engine is to be prepared for its first starting it is recommended to fill up the engine crankcase as well as the oil tank with an oil warmed up to temperature from 70°C to 80°C. For warming up the oil system /at a distance from the oil tank to the engine/ some 3 - 4 litres of oil must be drained to the clean vessel.

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2. At a temperature of ambient air below $-5^{o}C$ the MS-20 and MK-22 oil is to be diluted by a petrol, whilst at a temperature of $-20^{o}C$ the oil must be drained from the system completely and also the drain cocks remain opened. When tanking the oil system anew use the oil warmed up to temperature of 70^{o} - $80^{o}C$. The oil indiluted is to be drained from the system at a temperature of $-5^{o}C$.
3. The engine must be warmed up before being started in case the temperature of ambient air drops below $+5^{o}C$ whilst at the temperature of $-5^{o}C$ a diluted oil should be used, additionally.
When warming up the temperature of air conducted may not exceed of $180^{o}C$. The stream of a hot air should be directed against the cylinders and also the crankcase. The warming up should be performed as long as the cylinder heads temperature will equal to 20^{o} - $40^{o}C$.
4. Crank the engine warmed up by means of propeller some 3 - 4 revolutions. The magnetoes must be switched off, previously.
Note: Cranking the cold engine is not allowed.
5. Starting, warming up and testing of the engine is to be performed in a sequence similar to both in winter and in summer one.
6. In order to obtain a proper mixture the air heater should be switched on and the mixture temperature be kept within limits from 5^{o} to $12^{o}C$.
7. Before stopping the engine set the control lever of revolution governor in position of "large pitch" /for a propeller being operated according to direct scheme/.

8. Excessive priming when engine starting is not recommended and must be avoided. Failure to observé this instruction may result the piston to be seizured because of oil being washed out from the cylinder surfaces.
9. During engine operation observe with a great care the oil pressure gauge for indications.

5.04 Diluting of an oil with a petrol and engine operation with oil diluted

1. At a low temperature of the ambient air the oil filled up the crankcase and the oil system becomes dense making difficult the engine starting and may result in damage to its individual components. In order to decrease the time required for engine preparation to starting as well as for easily starting the oil diluted with a petrol may be used
2. If the engine is being not kept in warm condition and the temperature of ambient air drops below -5°C the aviatic oil of MS-20 and MK-22 grade should be diluted by means of B-70 petrol. It is recommended to drain the MS-20 or MK-22 diluted oil from the aircraft oil system completely at the ambient air temperature below -20°C.
3. Diluting of an oil with a petrol is to be performed after the flights have been completed. The petrol required is to be determinded volumetrically from all the oil filling up the oil system/engine, piping, tanks/. The petrol used for diluting purposes should not exceed of 10 % - 12,5 % of all the oil filling up the oil system of the engine.

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When performing these procedures take into account that in the oil system may remain however some quantity of petrol being added to the oil previously.

It is necessary to remember the petrol used for diluting purposes evaporates, however, after 50 - 60 minutes of engine operation, completely.

The most suitable temperature when diluting equals to 30° - 40°C.

The instruction how to dilute the engine oil is detailed in the "Aircraft Maintenance Manual" and depends upon its oil system, respectively.

It is not recommended to pour the petrol into the oil tank directly.

Should any special diluting system be installed on the aircraft it must be used, without fail.

4. Observe the oil pressure gauge when engine run with diluted oil.

It may be lower by 0,5 - 1 kg/sq.cm. in reference to normal pressure of the oil, but within 20 - 30 minutes should be increased up to value required.

If during the engine operation at idling speed when ground testing with an oil diluted the oil pressure drops below of 2 kg/sq.cm /because of an excessive diluting/ the oil must be drained from the system and be replaced by a new clean one being warmed up to 70° - 80°C, previously.

After doing this check the oil pressure when engine running.

<u>Notice:</u> Fuel quantity after diluting may not be greater than the permissible one detailed in the "Aircraft Maintenance Manual".

5.05 Engine operation airborne in winter conditions

During winter period it is important to remember not to overcool the engine /the temperature of the cylinder heads and the oil/ as well as to maintain the engine operation readings within the limits prescribed.

For that reason the engine instruments must be observed continuously and, if necessary, the engine shutters must be used, respectively.

During descending, diving and also when in level flight to enable the mixture temperature to be kept in a proper value and to prevent the carburetter to be iced the air heater should be opened, respectively.

When using adjustable pitch propeller to prevent the oil in the propeller hub to be thicked, it is necessary to change the propeller pitch from a "small" against a "large" one, and reversely, after 20 - 30 minutes of operation.

6.00 ENGINE HANDLING DURING ITS SERVICING

Engine operation general period as well as its reliable work when airborne depends seriously on the proper servicing of the engine-propeller unit.

The engine maintenance being done incorrectly may result in the failure of the engine and its accessories and cause the accidents, too.

For that reason both the ground personnel and the crew have for duty to know exactly the engine design, principle of operation of the engine and its accessories as well as the principle of maintenance and handling, too.

To secure an undisturbed operation of the engine during its warranty term there are foreseen some procedures and the periodic inspections of the engine and its accessories which must be carried out, without fail.

In this chapter there are detailed the periodic inspections being foreseen for the engine, only.

Full details of all periodc inspections of the engine accessories will be found detailed in chapter 7.00 "Handling, adjustment, and replacement of the accessories on the engine".

6.01 Inspection of the engine after flight

The task of the engine inspection after flight is to discover and to remove all the troubles occured during engine work when airborne.

It is a basic inspection of the engine from which depends a reliable operation of the engine when in flight.

The engine inspection is to be performed by aircraft mechanic just after the flights having been completed as follows:

1. Inform by a pilot about engine defects, if appeared.

   Should any be noted they must be withdrawed and the engine be tested /on the airfield,of course/.
2. After stopping the engine open all the inspection doors and inspect by visually examination the engine and its accessories and check:
   a/ fuel and oil systems. Examine said systems for tightness, proper position and security of the drain and check valves;
   b/ engine control for condition /carburetter, revolution governor, air heater, ignition/;
   c/ the propeller for condition and the engine cowling for reliable locking;
   d/ fastening of the accessories to the engine as well as the engine to the airframe;
   e/ the engine as a whole for condition. Discovered defects are to be removed, at once.
3. Clean the engine thoroughly from dust and oil.
4. Examine and wash the oil filter in gravity tank.
5. Drain the condensation water from the compressor sump and blow through the pipe by means of a compressed air when in winter service.
6. Replenish both the oil and the fuel tanks.

6.02 Scheduled maintenance works of the engine

WN-3 engine scheduled maintenance works are as follows:

a/ after first test flight of the aircraft equipped with a new engine;

b/ after first 10 hours of engine run;

c/ after each 25 hours of engine run;

d/ after lock 50 hours of engine run.

Note: Full details of the engine accessories scheduled maintenance works will be found detailed in chapter 7.00.

After the periodic works having been completed the mechanic has for duty to record a respective inscriptions into the engine log-book.

6.02.01 Scheduled maintenance works after first flight of the aircraft with a new engine

1. Perform after flight inspections of the power plant and remove the defects, observed.
2. Examine all the filters of fuel and oil systems with exception of the oil pump filter which should be examined only in case if there are found some sediment in gravity tank filter strainer.
3. Check the nut fastening the propeller hub on the engine crankshaft for firmly tightening.
   The nut should be tightened by means of torque-spanner loaded with a moment of 50 - 60 kgm and be secured.

4. Examine the following systems: fuel, oil, pneumatic, and ignition for vibration, chafting and fastening.
   Should any trouble be found it must be withdrawed immediately.
5. Replace the oil in the engine and in the oil system by a new one.

6.02.02 Scheduled maintenance works after first 10 hours of a new engine run

1. Perform after flight inspections of the engine and remove all the defects deserved.
2. Withdraw the propeller and tighten the thrust ball bearing nut.
3. Ascertain whether the attachment nuts of thrust ball bearing gusset are tightened firmly.
4. Rinse a grease from the crankshaft journal, from the propeller hub as well as from the thrust cones.
   Check the grooves on the crankshaft and in the propeller hub as well as the thrust cones for condition. Cracks and seizure are inadmissible. Should some be found on the cones they must be replaced.
5. Examine the propeller blades for condition and their fitting to the propeller hub.
6. Grease the crankshaft journal by means of a graphit paste and insert the propeller.
   Tighten the propeller nut using a torque spanner with a moment equal to 50 - 60 kgm thence safety and install the propeller spinner.
7. Examine the propeller beating according to "Propeller Maintenance Manual".

8. Check the exhaust gases collector and the air heater for reliable fastening.
9. Examine the connections of the oil and fuel systems as well as the pipes for fastening. It is not permitted the pipes to be vibrated or be chaffed each to other.
   Check the springs and valves for condition.
   Examine the valve clearances, and perform the timing of the valves by measuring the play between the valve stem and the valve rocker, if necessary.
   The clearance for the inlet valve should be 0,3 - 0,4 mm whilst for the exhaust valve 0,4 - 0,5 mm.
10. Examine and rinse the oil filter of the gravity tank as well as all the filters of the fuel system as a whole.
11. Ascertain whether the accessories are properly fitted to the engine housing and also the engine to its mount.
    Examine the engine mounting for condition - craks inadmissible.
12. Change the position of the "Kuno" filter of the oil pump. This procedure should be carried out after each 5 - 10 hours of the engine run.
13. Replace the oil in the crankcase and in the oil system by a new one.

6.02.03 <u>Scheduled maintenance works after each 25 hours of engine run</u>

1. Carry out after flight inspections and remove the defects, observed.
2. Examine the thrust bearing nut for tighteness.

3. Examine the engine accessories for attachment as well as the air heater, exhaust gases collector, engine shutters, propeller spinner, and engine cowlings,
4. Check the cylinder deflectors for condition and fastening.
5. Examine by visual inspection the engine mounting and also shock absorber pads for condition. Any craking is inadmissible. Examine also the fastening of the engine to the mount and the engine mounting to the airframe.
6. Examine the oil, fuel, air, and the ignition systems for connections and proper security. Any chaffing and vibration of the pipes must be avoided immediately.
7. Inspect and rinse all the filters of fuel and oil system in common with the oil pump filter.
8. Withdraw the valve rocker covers and examine the valve spring collars, valve springs, retention cones, valve rockers, and the valves for condition.
9. Wash, examine and grease the gymbals of engine control system.
   Backlash discovered on the engine control system must be removed.
10. Wash out the gauze of an air intake mouth.
11. Replace the oil by a new one.
12. Perform the scheduled maintenance works for a carburetter. See chapter 7.00 "Handling, adjustment and replacement of the accessories on the engine".

6.02.04 Scheduled maintenance works after each 50 hours of engine run

1. Perform all the periodic works foreseen after each 25 hours of engine run.
2. Carry out the periodic works foreseen for engine accessories. See chapter 7.00 "Handling adjustment and replacement of the accessories on the engine".
3. Examine the propeller blades for condition their fastening to the hub. Ensure whether the nut fastening the propeller hub to the engine crankshaft is firmly tightened and securely locked.
4. Examine the propeller blades beating according to"Propeller Maintenance Manual".
5. Examine the cylinder deflectors. Should any cracks be discovered it must be drill stopped using a drill of 3 - 3,5 mm dia. for this purpose.
6. Examine the cylinders and the suction pipes for reliable fixation.
7. Examine and regulate the valve clearances. Inlet valve clearance should be within limits: 0,3 - 0,4 mm; exhaust valve clearance 0,4 - 0,5 mm.
8. Examine the thrust bearing nut for tightness /after each 50, and 100 hours of operation/.

Note: The oil in the crankcase and also in the oil system should be replaced not lower than once within a year independently on the engine operation hours being done.

7.00 HANDLING, ADJUSTMENT AND REPLACEMENT OF THE ACCESSORIES ON THE ENGINE

7.01 K-14WN carburetter

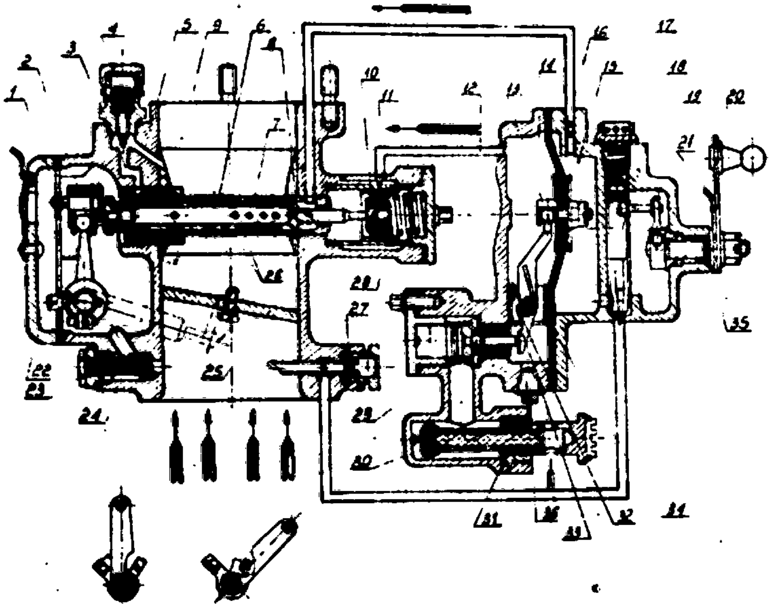
7.01.01 General

The K-14WN carburetter is being designed from the K-14BP one by changing some details e.g. the profile of delivery needle, the choke dimensions and the carburetter control. The carburetter enables a normal operation of the engine at optional its positions when airborne.

7.01.02 Technical data

1. Diffuser dia.	-	70 mm
2. Suction jet dia.	-	1,8; 2,0; 2,2 mm
3. Weight dry	-	2,7 kg
4. Operation period guaranteed	-	400 hours of operation during 3 years - therein 2 years in direct servicing.

Fig.8 K-14ЛН carburetter sectional view.



1 - needle drive control lever; 2 - needle position adjusting screw; 3 - idling run needle socket; 4 - idling run needle; 5 - main air jet; 6 - delivery needle; 7 - sprayer; 8 - diffuser; 9 - mixing chamber; 10 - piston valve of delay pump; 11 - delay pump piston; 12 - delay pump full supply pipe; 13 - capsule catcher; 14 - fuel chamber; 15 - air chamber; 16 - suction jet; 17 - altitude correction needle socket; 18 - altitude correction needle; 19 - altitude correction needle control lever; 20 - altitude correction needle drive control lever; 21 - altitude correction needle drive stop lever; 22 - control lever chamber; 23 - dust filter; 24 - idling run orifices; 25 - throttle; 26 - sprayer emulsion orifices; 27 - pressure pipe; 28 - delay pump spring; 29 - fuel valve; 30 - fuel filter; 31 - fuel supply end-fitting; 32 - spring; 33 - fuel valve control lever; 34 - membrane; 35 - fixator; 36 - drain plug.

7.01.03 Carburetter adjustment

1. Idling run adjustment

The idling run adjustment is to be performed on the engine warmed-up normally.

The mixture proportion when idling run of the engine is being regulated by means of idling run needle.

When screwing in the needle the mixture becomes weak and when unscrewing - becomes rich /fig.11/.

The engine r.p.m. at idling run /500 - 600 r.p.m./ are to be adjusted by changing the throttle opening, using the throttle control lever stop screw for this purpose.

When screwing in the adjusting screw - engine r.p.m. will increase, when unscrewing - will decrease, respectively /fig.9/.

2. Continuous power adjustment

Should the engine operation be incorrect one within a range up to continuous power inclusively because of an improper mixture adjustment it is necessary to perform a proper adjustment by means of carburetter delivery needle.

When screwing in the adjusting screw the mixture will become weak, whilst during unscrewing it will become rich /fig.10/.

It is not allowed to screw in or out the adjusting screw by more than o[illegible]ooth or two ones, going out from the fact[illegible]djustment position as a base.

After the mixture adjustment has been carried out by means of delivery needle check the engine operation when at idling run.

It is important to control said adjustment because any change of position of the delivery needle results the engine operation when idling to be varied, too.

3. Rated and maximum power adjustment

When observing the engine operation at rated and also maximum power to be incorrect one because of improper mixture adjustment it is desired to obtain a correct mixture proportion by replacement of the suction jet.

The adjustment method by means of changing the position of the delivery needle is unefficient one.

Should the suction jet diameter be decreased the mixture will become rich, and inversely if the suction jet diameter will increase the mixture will become weak /fig.9/.

4. High altitude adjustment

When the engine is being operated on ground the altitude correction control lever limiter should rest on "H" position.

Performing the high altitude flights the altitude correction mechanism should be set in operation gradually above 2000 m altitude to enable the normal mixture percentage to be assured /see chapter 4.03.01 "How to use the altitude correction mechanism/.

7.01.04 Engine handling when servicing

Scheduled maintenance works:

1. Inspection before engine test and flight:
   a/ examine the throttle control lever and the altitude correction mechanism for reliable coupling;
   b/ examine for tightening and secury locking: fuel supply end-fitting, drain plugs, and fuel pressure gauge terminal;
   c/ check the fuel valve for tightness. Conduct for this purpose, the fuel under pressure 0,15 - 0,18 kg/sq.cm. Should no leaking from the sprayer tube be observed it is sign the valve as well as the membrane mechanism remain in a good condition;
   d/ after the engine test have been performed inspect the carburetter chambers for tightness. Any fuel leaking is inadmissible.
2. Scheduled maintenance works after each 25 flight hours:
   a/ examine and clean the fuel filter;
   Notice: Should any new pipes or fuel tanks be installed on the aircraft it is necessary to examine the fuel filters before each flight being done.
   b/ examine the throttle control mechanism as well as the altitude correction one. Remove the backlash, if existing. Grease the gymbals.
3. Scheduled maintenance works after each 50 flight hours:
   a/ remove through the drain plugs a sediment from the fuel chamber;
   b/ rinse and blow through by means of compressed air the suction jet, thoroughly.

Warning: Be sure the air pressure used will not exceed of 0,2 kg/sq.cm. Failure to observe such warning results the membrane to be damaged.

7.01.05 Carburetter replacement on the engine

1. Before installing a new carburetter on the engine the carburetter certificate should be examined.
2. Perform the depreserving procedures according to instruction /chapter 2.02/.
3. Dismantle the carburetter damaged from the engine. The procedures when dismantling are as follows:
   a/ disconnect from the carburetter the air intake with air heater;
   b/ disconnect the fuel system;
   c/ disconnect the controls of the throttle lever and of the altitude correction;
   d/ unscrew four carburetter attachment nuts and withdraw the carburetter in common with a gasket.
4. Install a new carburetter performing the procedures in a manner reverse to that detailed in item 3.
5. Check the throttle lever and the altitude correction for reliable operation.
   The travel of the control lever must be smooth within its full range without any sign of seizing.
6. Carry out the ground engine test. Regulate the mixture percentage and the engine r.p.m. at idling run, according to the necessity.
   Engine operation period: minimum 15 minutes at all engine ratings.

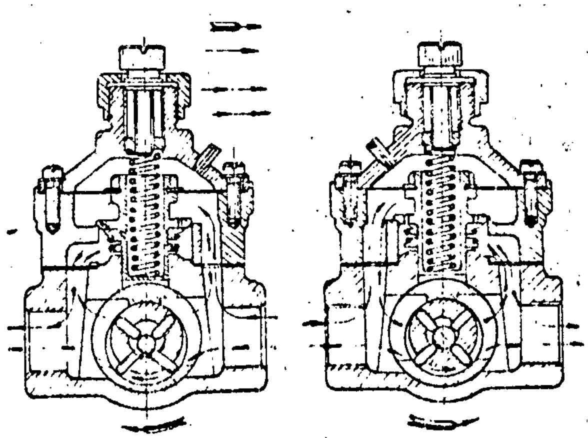
7. Record on to the engine log book a respective notice after the carburetter has been replaced by another one.

Note: When in an airfield servicing it is not recommended to carry out a complete dismantling of the carburetter as well as to repair it by completing the separate parts and assemblies from other carburetters being not in use.
Such a completing requires the carburetter assembled to be tested on a special stand exactly.

7.02 BNK-12AS fuel pump

7.02.01 General

On the WN-3 engine the BNK-12AS anticlockwise rotating /to an observer facing the driven end/ fuel pump is mounted.



clockwise   anticlockwise

Fig.9 BNK-12AS fuel pump operation diagram.

7.02.02 Fuel pressure adjustment

Fuel pressure before carburetter should be within 0,2 - 0,4 kg/sq.cm.

If the fuel pressure value differs from above values it should be adjusted to a correct value in a way as follows:

1. Unlock the reducing valve adjustment screw cap.
2. Undo the cap to 1/2 of full turn holding simultaneously the adjustment screw by means of a screw-driver.
3. To increase the fuel pressure turn the adjustment screw in clockwise direction /to decrease the fuel pressure - in anticlockwise direction/. One turn of adjustment screw results in fuel pressure change of 0,1 kg/sq.cm.
4. Holding the adjustment screw by means of screw-driver tighten the cap and secure it.
5. Check the fuel pressure when testing the engine on ground.

7.02.03 Replacement operations of the fuel pump on the engine

1. Disconnect all fuel pipe-lines from the fuel pump.
2. Unscrew the four fastening screws and take away the pump from the engine.
3. Take a new pump having the required sense of rotation from the storage place.

   Note: The required sense of rotation of the pump can be established by turning the body with reducing valve of the pump by 180°.

4. Take off the pump from packing, remove the plugs and depreserve it in a way as follows:
   a/ wash with brush wetted in petrol the outer layer of preserving grease;
   b/ dip the pump in a bath filled with pure petrol and wash the grease from inside of the pump by turning the pump rotor reversly to its normal rotation.
5. Wash and check the condition of the pump flange stop surface on engine. Small scratches are to be made even by means of sharp scraper.
6. Install a new gasket and join the driven end of the pump with driving assembly on the engine.
7. Install washers and tighten the pump attaching nuts on engine.
8. Connect the fuel pipe-lines to the pump end-fittings.
9. Inspect the pump operation when testing the engine on ground. If required adjust the fuel pressure. Engine test run duration on ground minimum - 15 min. over the all power ranges.
10. Pump replacement record enter to the engine log book.

7.02.04 <u>Pump servicing during maintenance</u>

During maintenance of the pump within guaranty period the scheduled /periodical/ works are not foreseen. When carrying out the scheduled works for engine, the condition of pump attachment to engine is to be checked. Check the tightness of the pump during service. When one or several members of the pump is uncorrect the repair of the pump in field condition is not recommended but the pump should be replaced by a new one.

7.03 BSM-7M magneto

7.03.01 General

Two BSM-7M magnetoes are mounted on the WN-3 engine. They produce two sparks each one per one revolution of the shaft. The gear ratio magneto shaft to crankshaft amounts 7:4.

Ignition advance angle value measured in degrees of magneto shaft rotation angle is stamped on the rear magneto cover. To see it the distributor disc cover must be removed.

To obtain the automatic ignition timer advance value in relation to the crankshaft the number of degrees stamped on the magneto cover must be divided by the gear ratio between magneto and crankshaft.

E.g. on the magneto body is stamped the value of 24,5°. The advance value of the automatic ignition timer relatively crankshaft can be computed as follows:

$$24{,}5^\circ : \frac{7}{4} = 24{,}5^\circ \cdot \frac{4}{7} = 14^\circ$$

7.03.02 Adjustment of magnetoes on the engine

On the WN-3 engine the ignition advance angle setting of the starboard magneto amounts $28 \pm 0{,}5^\circ$ and of the port magneto amounts $27 \pm 0{,}5^\circ$ before top dead centre.

Advanced ignition setting depends on the advance angle value of the automatic ignition timer of given magneto.

E.g. on the starboard magneto is stamped 24,5°. Relatively to the crankshaft the automatic ignition timer advance angle amounts 14°. Taking this into account the advanced ignition setting should be adjusted at 28° - 14° = 14° before top dead center relatively to the crankshaft.

With allowance of ± 0,5° the magneto setting should be within 13,5 - 14,5°.

The beneath presented table gives the advanced ignition settings before top dead center in degrees of crankshaft rotation angle in dependance /as function/ on the magneto automatic ignition timer advance angle values.

Automatic ignition timer advance angle value		23	23,5	24	24,5	25	25,5	26	26,5	27	27,5	28
Magneto setting ± 0,5°	starb.	14,8	14,5	14,3	14,0	13,7	13,5	13,2	12,9	12,6	12,3	12
	port	13,8	13,5	13,3	13,0	12,7	12,5	12,2	11,9	11,6	11,3	11

To facilitate the correct magneto setting it is provided with a clutch with 31 teeth. The tapered hole of the clutch is provided with four grooves to be coupled with magneto splined end. Except this the magneto flange has cut the longitudinal fastening openings to allow for the angular shifting of whole magneto within 6° /six/.

Turning of the clutch by one tooth results in the magneto angular displacement of:

$$\frac{360^\circ}{31} = 11,6^\circ$$

For more exact setting the clutch must be taken off the magneto shaft and be installed on the other slot on the shaft. The turning of the clutch by 180° gives the angular displacement of 5,8° and turning by 90° gives 2,9° of the angular displacement.

Due to the gear ratio of the magneto drive the appropriate angular displacements read on the crankshaft will be about two times smaller and inversely. In dependance on the above used manner the following correction values /about/ are to be obtained on the crankshaft:

1. Displacement of the clutch by one tooth ±6°
2. Taking down of the clutch and resetting it on the other slot by 180° ±3°
3. Taking down of the clutch and resetting it on the other slot by 90° according to direction of rotation -1,5°
4. Taking down of the clutch and resetting it on the other slot by 90° opposite to direction of rotation +1,5°
5. Turning the magneto on its flange 3°

The magnetoes have to be adjusted with full exactness relatively to the top dead center of the fifth cylinder inside of which travels the master rod. When handling the clutch the magneto flange holes have to be in their middle position relatively to the attachment bolts and then the final adjustment within ± 1 degree should be carried out by turning the whole magneto.

To establish exactly the breaker contact opening moment a bulb indicator with flash lamp battery 4,5 V is best to be used.

A cellophane sheet 0,03 mm thick can be also used placing it between contacts of the breaker.

7.03.03 Servicing of the magneto during maintenance

For magneto in operation should be constantly watched. Magneto and its assemblies as: clutch, breaker, distributor are subjected to the planned /scheduled/ revisions. Damaged part or assembly should be replaced by a new one from spare part set. Disassembling of magneto without certainty of damage of it is rigorously forbidden. Before deciding about magneto failure the spark plugs and all cables must be first thoroughly revised.

7.03.04 Periodical works after every 50 hours operation

Take off the screening housing and distributor disc, inspect following assemblies:

a/ breaker mechanism - check all the bolt joints /tightening of nuts/, securings and for the easy turning of the lever on its axle.
Measure the clearance on the breaker contacts. Its value should be within 0,25 - 0,35 mm;

b/ distributing disc - check for the condition of the spring, carbon, high voltage cable and cable attachment. When needed exchange the used up /worn out/ members for new ones;

c/ transformer - examine its attachment;

d/ high voltage cable - examine its condition and attachment. When needed replace by a new one.

7.03.05 Works at the magneto replacement on the engine

1. Take a new magneto with its certificate from a storage place.
2. Depreserve the magneto by removing the grease from following parts: breaker contacts, spring, breaker cam and castle nuts.

3. Screw out the front spark plugs, attach the adjustment disc with angular scale on the crankshaft, fasten a sound to the fifth cylinder, determine top dead center at the compression stroke and mark this position of the crankshaft by means of the arrow fastened on the bolt of the stop flange.
4. Dismount the old magneto from the engine. Unscrew three fastening nuts and remove three washers, thereafter take off the magneto and its gasket.
5. Inspect the stop plane /surface / of magneto and engine. The existing injuries should be smoothed by a smoother or scraper.
6. Adjust the magneto according to the point 7.03.02 of this chapter.
7. Recheck the adjustment of the firing point.
8. Attach the magneto on the engine, screw in the spark plugs and connect the cables.
9. Examine the engine operation on all power ranges.
10. Enter the note about magneto replacement to the engine log book.

<u>Note:</u> When carrying out the firing point adjustment turn the crankshaft according to the propeller rotation to eliminate the influence of the gear teeth backlash in the crankshaft to magneto shaft gear.

7.04 WN-3-09 oil pump

7.04.01 General
/Design and operation description/

WN-3 engine oil pump /fig.10/ consists of two suction sections and one pressure section accomodated in a pump body cast of AL5-T7 alloy. The bottom oil cavity form the pressure section which draws the oil from the oil tank through the end fitting, a check valve and delivers it under pressure through the filter and drilled bolt to the main oil manifold in the crankcase. The excessive oil in the pressure pump cavity flows through the spring ball reducing valve to the suction section. Top pump cavity accomodates two suction sections separated from each other by a dural insertion sealed with rubber ring.

The middle gear /toothed wheel/ pair forms one suction section drawing the oil from the oil sump.

The upper gear pair forms other suction section drawing the oil from the chambers of valve levers. Oil from both these sections is delivered to the oil tank by one end fitting having possibility of its outlet direction to be regulated. Pressure section is closed at bottom by a cover from AL5-T7 alloy with fixed stud bolts. Upper cover also from AL5-T7 alloy, body and lower cover are screwed together by these bolts. Oil filter cover is screwed to the pump body by means of stud bolts and nuts. The check valve on the pressure section does not allow for flowing back of the oil from oil tank into the pump at non working engine from one side and from the other makes possible the oil flow backwards when the engine changes suddenly direction of rotation e.g. during kick-out when starting the engine.

The pump is provided with draining and venting plugs. The pump shaft drives through the bevel gear the r.p.m. counter teominal position of which can be changed.

The pump is attached to the port rear part of the crankcase by means of one main and three additional bolts.

7.04.02 Principal data of the pump

1. Pump designation	-	WN-3-09 gear pump
2. Gear ratio	-	0,5
3. Sense of rotation	-	clockwise /facing the driven end/.

7.04.03 Oil pressure regulation

The oil pressure is regulated by change of thickness of the S-3664 regulation washers. When the washer thickness is greater the oil pressure increases when the washers are thinner the oil pressure decreases. The total thickness of washers depends on their number fig. 10a.

Note: At the pressure regulation pay particular attention that the S-3664 adjustment washers does not drop in the pump when unscrewing the S-3663 bolt. Dropping in of the washers can result in emergency of the pump.

50X1

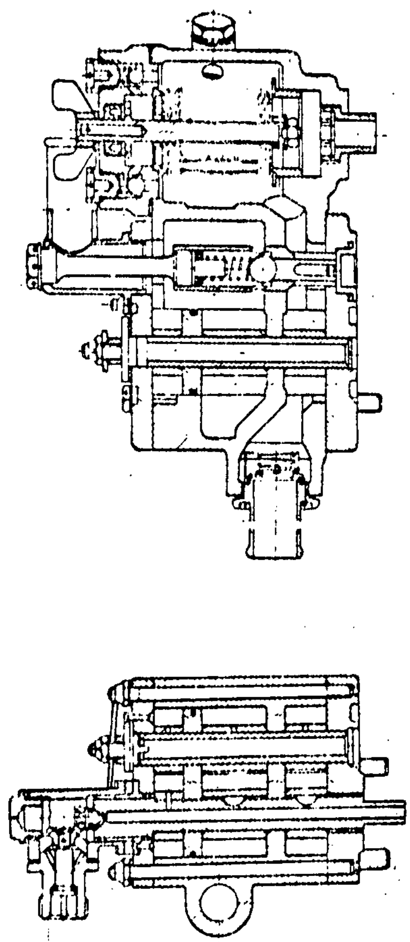


Fig.10 WN-3-09 fuel pump.

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7.04.04 Works done during pump replacing on the engine

1. Disconnect the oil tubes from the pump and the flexible shaft of the r.p.m. counter.
2. Unscrew four filter body nuts, take off the washers and take away the filter.
3. Unlock /take off the securing/ the drilled bolt, fastening the forward pump part and unscrew it.
4. Unscrew three bolts which fasten the pump body, take away the pump and gaskets.
5. Examine the condition of the pump stop surface on the engine and clean it of gasket remainder.
6. Take a new pump of storage place and remove the outside preservation.
7. Install the new pump on the engine. Operations under 1, 2, 3, 4 should be carried out in reversed order.
8. Start the engine, check the oil pressure during ground testing. The endurance of the test minimum 15 min. on all power ranges of the engine.

7.05 WN-3-11 air distributor

7.05.01 General

On the WN-3 engine an air distributor is mounted which directs the compressed air into the cylinder combustion chambers when starting engine.

Succesion of compressed air delivery into the cylinders corresponds to the ignition succesion /1, 3, 5, 7, 2, 4, 6/.

The compressed air is delivered into the combustion chamber of each cylinder at the 8° /degrees/ piston position after top dead center /t.d.c./.

7.05.02 Adjustment of the air distributor

1. Install on the engine crankshaft the disc with angular scale, screw in the sound in the forward spark plug hole of the first cylinder, and fasten the arrow to the crankcase peg opposite to the 1-st cylinder.
2. Bring the piston of the 1-st cylinder in the 8° after t.d.c. position during expansion stroke.
3. Cover the operating surface of the distributor disc with thin layer of technical vaseline and fit it over the distributor body coaxial to the shaft.
4. Adjust thus the distributor disc that its annular cutout forms with compressed air delivering opening of the first cylinder a gap of 1 mm.
5. Holding the disc in this position select through the turning of the bush such a position of it, to slip it easily simultaneously on the shaft and distributing disc.
6. Locate in the cutout of the driving shaft the basket and the spring.
7. Install a gasket on the distributor body, then the distributor cover and mount the fuel pump.
8. Install 3 washers on the studs and tighten the nuts.
9. Put on the stud bolt screwed in the mixture chamber a buckle with downwards bent ends in such a manner that it covers the pipes of cylinders No.1 and 2 then put the washer and tighten the nut.

7.05.03 Compressed air distributor replacement on the engine

1. Dismount the fuel pump.
2. Dismount the air pipes from the air distributor.
3. Dismount the air distributor from the engine.
4. Take a new air distributor from the storage place and depreserve it.
5. Install on the stud bolts of the air distributor cover the fuel pump gasket.
6. Install the fuel pump on the cover /mount the fuel pump with its reducing valve upwards/.
7. Install four washers on the stud bolts and tighten four nuts.
8. Install gasket to the mounting studs of the rear crankcase part and the air distributor body with lapped surface outwards.
9. Connect the proper pipes to the air distributor end fittings in such a succesion 5, 7, 4, 6, 2, 1, 3.
10. Install the air distributor according to point 7, 05, 02, 1 and attach it.
11. Unscrew the sound from the cylinder No.1 remove the regulation disc from the crankshaft and the arrow too.
12. Check the compressed air distributor operation.

7.06 SD-48BC spark plug

7.06.01 General

On the WN-3 engine the aircraft ceramic spark plugs of the SD designation are installed.

When using the SD ceramic spark plugs pay special attention to the maintenance instruction regulations to be exactly observed.

7.06.02 Storing and forwarding of the spark plugs

The guaranteed storage period of the spark plugs in original packing amounts two years under following conditions:

1. The storage compartment for the spark plugs should be completely dry.
   Storing together with packed spark plugs the chemical agents and other corrosive materials is strongly forbidden to avoid the danger of corrosion.
2. The spark plugs must be stored on shelves in original /manufacturer's/ packings.
3. The spark plugs should be forwarded to the place of use in the original packings.

7.06.03 Installing and dismounting of the spark plugs on the engine

1. Get acquainted with spark plug maintenance instruction regulations.
2. The unpacked spark plugs must be immediately installed. The leaving of the spark plugs in unpacked state is not allowed.
3. Damage to the threads on the spark plugs and in the spark plug openings in the cylinder is not allowed.
4. Install under the spark plug one sealing ring only. When a terminal of the thermocouple is installed under the spark plug do not install a sealing ring too.
5. Before installing coat the spark plug threads with thin layer of graphite NK-50 grease.
6. Screw in the cylinder openings the spark plugs by hand and tighten them with spanner with torque of 5 - 6 kgm what corresponds to the spanner arm length of 200 - 220 mm.

7. Dismount the spark plugs from the engine after its cooling down only.
8. Unscrew the spark plugs with 9 - 10 kgm torque what corresponds to the spanner arm lenth of 300 - 500 mm. Spark plugs unscrewed with a too great torque should be obligatoryly checked for the tightness and spark operation.
9. The dismounted spark plugs should be individually packed best in the special cardboard boxes.
10. Spark plugs delivered for use in unpacked state or with damaged packings are suspected to be of minor goodness and should be checked before installing for tightness and spark operation.

7.06.04 Periodical works

1. After 200 working hours dismount the spark plug from the cylinder, rinse it with petrol and dry. When rinsing do not dip the entire spark plug in petrol. The body with electrodes should be dipped only.
2. Clean the body and electrodes from carbon deposits.
3. Inspect whether the electrodes are not burnt.
4. Inspect the spark plugs for the tightness at 25 kg/sq.cm. pressure.
5. Inspect the spark plugs for spark producing at 9 kg/sq.cm. pressure.

7.07 GSK-1500Ż generator

7.07.01 General

On the WN-3 aircraft engine the GSK-1500Ż generator is mounted /fig.11/. GSK-1500 generators are produced in two versions: with rigid and with flexible shaft. Designation for rigid shaft is "Ż" and for a flexible one "M" /for example GSK-1500Ż or GSK-1500M/. GSK-1500 generators of both versions cooperate with RK-1500W regulation box and SF-1500 network filter. They are calen-lated for a long period operation at two power ranges: 1000 W when operating with self produced cooling and - 1500W with additional cooling taken from the propeller airstream. When the 1000W power is consumed the regulation box RK-1500W should be properly regulated.

7.07.02 GSK-1500 generator principal technical data

Ord. No.	Name of data	Cooling system: Selfcooling plus add. cooling	Cooling system: Selfcooling
1.	Nominal power in Watts	1500	1000
2.	Voltage - in Volts	27,5	27,5
3.	Nominal current - in Amp.	54	36
4.	r.p.m.	3800 - 5900	3800 - 5900
5.	Nominal power consumption	lasting	lasting
6.	Allowed overloading in Amp.	81	54
7.	Maximum overloading time in min.	2	2
8.	Current in the exciting winding at 3800 r.p.m. voltage 27,5 V and nominal current consump. in Amp.	1,55	1,35
9.	Specific airflow required for additional cooling	30 l/sec at p=760 mm of merc.col.	

Ord. No.	Name of data	Cooling system: Selfcooling plus add. cooling	Cooling system: Selfcooling
10.	MGS-8 mark brushes		7x25x22 mm
11.	Spring force exerted on the brush in gr.		900 - 1000
12.	Weight in kg		12,6
13.	Guaranteed operation period		600 working hours during 3,5 years

7.07.03 Generator servicing during maintenance

Periodical works

Generator is attached to the engine by means of the flange and four stud bolts. Not less then once for 3 months or after every 100 working hours inspect as follows:

1. Condition of the collector.
   At the normal generator operation on the working collector surface form slight dark spots which should be washed away with a rag soaked in the petrol. When slight burns occured clean them off with emery cloth mark "00". When greater burns occured direct the generator for repairing.
2. The easy movement /without seizing/ of the carbon brushes in their holders and the condition of the brush pressing springs and of brushes themselves. Spring pressing force should be within 200 - 1000 gr. The damaged brushes /crumbled/ and worn /shorter than 15 mm/ should be replaced.

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3. Whether the electrical installation is not damaged.
4. The tightening of the fastening and attaching nuts.
5. Condition of generator attachment to the engine.
6. After 250 - 300 working hours complete the grease in the ball bearing 302P. For the lubricating of bearings use the grease mark CJATIM-201. To lubricate the ball bearing the generator must be dismounted from the engine and partially disassembled to obtain the acces to the bearing. The used grease remove with clean rag moistened with petrol.
In the ball bearing No. 80205K class P of closed type /from the driven end/ the grease is not to be interchanged during whole guaranted working period of 600 hours within 3,5 years.

7.07.04 Replacement and lapping of brushes

When the seizing of the brush in its holder is detected it should be fit with emery cloth mark "OO". The brush should travel in its holder easily and without seizing.

The newly installed brushes should be lapped to the collector. The contact area should amount 70 - 80 %.

Lapping of brushes carry out in following manner:

1. Encircle the collector with emery cloth "OO" or "COO" on the whole width.
2. Install the brushes in their holders and press them to the emery cloth with springs.

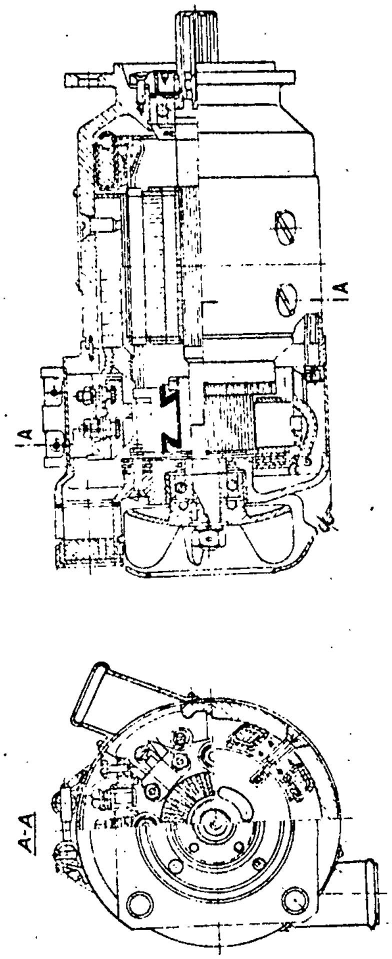

Fig.11 Cross section of the GSK-1500 generator.

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3. Rotate the shaft according to the rotation direction of the generator.
4. Brushes are considered as preliminaryly lapped when the contact area amounts 50 - 60 %.
5. Remove the emery cloth, lift the brushes and blow the collector with compressed air.
6. Lower the brushes and continue lapping during operation of the generator.
7. Brushes are considered as lapped when the contact area amounts 70 - 80 per cent and the lapped surface is glassy even and without visible fissures.

7.07.05 Generator replacement on the engine

1. Unlock and unscrew four nuts fastening the generator to the engine and take off the generator together with clutch.
2. Remove the generator gasket and examine its condition. When damaged replace by a new one.
3. Dismount the clutch from the generator.
4. Take a new generator from a storage place and depreserve it according to maintenance instruction.
5. Inspect the new generator for the proper sense of rotation and for the easy rotation.
6. Mount the clutch on the generator driven shaft terminal in following manner:
   a/ fasten the generator to the substitutional flange attached on the table border to enable the measurement of the torque by means of DT-564/2 lever /see fig.12 generator clutch mounting diagram and fig.13 diagram of DT-564/2 lever for lapping the generator clutch;

b/ fit over the shaft the clutch and tighten the S-4318 castle nut till to obtain the torque of 300 - 340 kgcm value. When tightening the nut S-4318 hold the generator shaft with spanner /27 mm jaw distance arm length 400 - 600 mm;

Generator GSK-1500Ż.

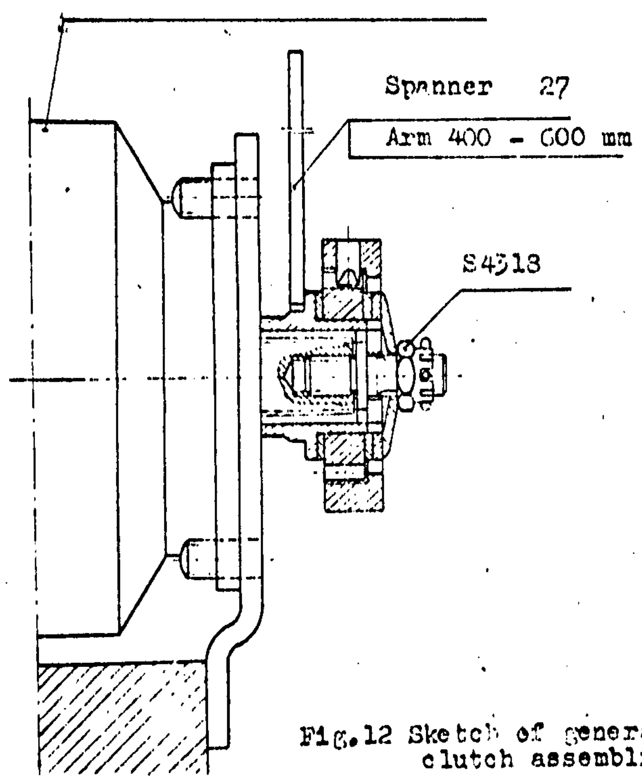

Fig.12 Sketch of generator clutch assembling.

c/ inspect the clutch torque which should amount 300 - 340 kgcm;

d/ check with feeler the gear /toothed wheel/ pitch diameter tolerance. It may not exceed 0,10 mm. When this tolerance /beat of the wheel/ exceeds 0,10 mm the position of the gear on the shaft should be changed /by turning/ and repeat the works under a, b, c, d;

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e/ secure the castle nut S-4318 with split pin dia 2 x 20.

7. Install the generator on the engine and connect the electrical cables.
8. Check the generator operation during engine ground test.
9. Generator replacement enter to the engine log book.
10. Damaged generator rinsed and preserved deliver to the storage place to forward for repairing.

7.07.06 Generator clutch lapping instruction

The unadequately lapped generator clutch does not guarantee the troublefree operation of the generator. As a result of this fault the power delivery by the generator is limited because of sliding on the clutch. To provide the normal generator operation the clutch should be thoroughly lapped.

1. Dismount the clutch from the generator and rinse thoroughly.
2. Cover slightly the frictional surfaces of both discs with Indian /drawing/ ink.
3. Mount the clutch on the DT-564/1 substitutional shaft /fig.14/ and slightly tighten the S-4318 nut.

Turn the clutch thereafter dismount it and examine the adhesion of the discs. The adhesion should be equally disposed over the entire disc surface.

The ink coating should amount at least 80 %. When needed stone the discs.

Caution: Do not lap the clutch as a whole or its parts with emery powder to avoid incrustation of its crystals into the bronze.

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4. Rinse thoroughly all parts of the clutch with pure petrol lubricate with towot grease and reassembly on the DT-564/1 substitutional shaft.
5. Fix the shaft into the lathe chuck and install the DT-564/2 /fig.13/ lever on the clutch gear. On the lathe saddle install the lever movement limit to the about 10 degrees.
6. Lap the clutch at 20 - 25 r.p.m. tightening graduall the S-4318 castle nut and increasing the loading on the lever according to the following programme:

torque in kgcm	time in min.
100 - 150	5
200 - 250	5
300 - 340	3

The clutch is properly lapped when at the last lapping phase the lever under loading of 300 kgcm torque is distinctly lifted and under 340 kgcm torque loading is distinctly lowered.
7. Take off the clutch from the shaft and not separating the frictional surfaces remount it on the generator shaft, fix the torque according to point 7.07.05 of this chapter.

Fig.13 DT-534/2 lever for lapping the generator clutch.

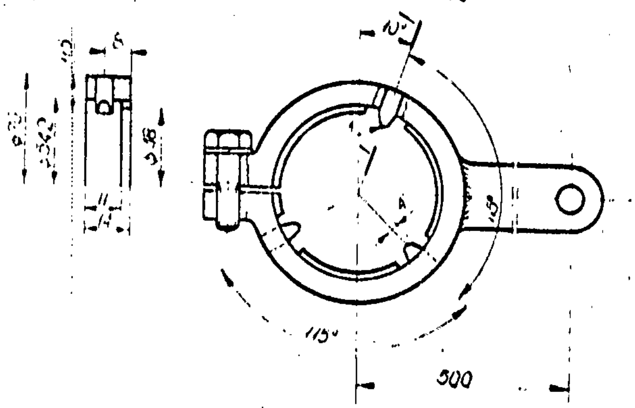
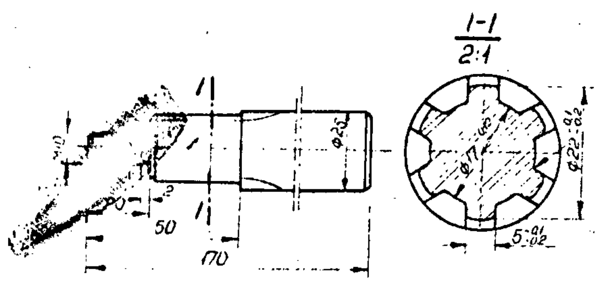


Fig.14 Shaft for lapping the generator clutch.



7.08 AK-50M compressor

7.08.01 General

On the WK-3 engine can be installed the AK-50M compressor to supply the aircraft pneumatic system with compressed air.

The compressed air serves for starting the engine and actuates the different aircraft accessories.

The compressor drive is disposed on the rear part of the crankcase. When the compressor is not installed it should be plugged with S-3594 cover. When replacing the compressor pay special attention to installing the gasket opening opposite to the oil opening of the drive crankcase. When the oil opening is only partially closed this may cause already the seizure.

Before installing a new compressor should be depreserved in following manner:

a/ dip the compressor into the MK-22 or MS-20 oil heated to 90 - 100°C and hold about 3 min;

b/ turn the shaft /5 - 7 revolutions/;

c/ remove the oil from the outside surface of the compressor with rag moistoned with petrol or by means of the brush.

<u>Note:</u> Dipping of the compressor in the petrol to rinse off preservation grease is forbidden.

7.09 Revolution regulator

7.09.01 General

The WN-3 engine is designed to work with adjustable pitch propeller. For this reason it is provided with high pressure oil system for propeller control and with r.p.m. regulator drive.

When the engine operates with fixed pitch propeller, the r.p.m. regulator drive located on the rear part of the crankcase should be plugged with S-3616 cover. The task of the regulator is to control automatically the propeller blade setting angle.and to secure the engine operation with constant r.p.m.

7.09.02 Installing of the r.p.m. regulator

1. The r.p.m. regulator should be depreserved before installing on the engine. The grease from the outside surface of the body and from the shaft must be rinsed off. The internal depreservation is not needed.
2. Check for the correct rotation of the regulator.
3. Inspect condition of the regulator contact surface on the engine and remove the gasket remainder.
4. Install a new gasket to the mounting studs of the crankcase.
5. Install the regulator and engage the drive.
6. Install the washers and tighten the fastening nuts.
7. Join the regulator control and inspect its operation on ground during minimum 15 min. on all power ranges.

7.09.03 Controlling of the r.p.m. regulator

Controlling of the r.p.m. regulator should fulfil following requirements:

1. When the controlling lever travels within its extreme positions, the regulator shaft should rotate by an angle of 160 degrees.
2. At the control lever position in cockpit corresponding to the maximum r.p.m. of the engine the regulator shaft should not reach its extreme position through 5 degrees /it should have then 5 degrees to its extreme position/ what is reached through fixing of a stop /a limit/.

3. The controlling should be without any sensible backlash. When the control lever is blocked the regulator shaft should not have any smallest sensible /with hand/displacement.
4. A maximum r.p.m. stop should be fixed according to the control lever position corresponding to maximum r.p.m. and power in flight.
5. The regulator operation should be inspected on ground with heated engine.
6. At take off and landing the controlling lever of the r.p.m. regulator should occupy the maximum engine r.p.m. position /small pitch/.
7. At diving or gliding to secure the engine before exceeding of maximum r.p.m. it is recommended to set the controlling lever to the position corresponding to great pitch.
8. In level flight the pilot can establish required r.p.m. value answering best to the flight condition. At flight at low ambient temperature the propeller pitch should be changed every 20 - 30 min. to avoid the oil thickening in propeller hub.
9. Before starting of the engine set the r.p.m. regulator lever to position of maximum pitch /for propellers operating after a straight /direct/ diagram. In that manner suction of oil by regulator pump from main engine manifold is avoided.
10. When the cylinder accomodated in the propeller hub is damaged or leaks /at propeller operating after straight/direct/ diagram/ the regulator control lever should be set to position of great pitch.

7.10 AK-4S vacuum pump

7.10.01 General

On the WN-3 aircraft engine may be installed AK-4S vacuum pump. For this reason on the rear part of crankcase a driving terminal is installed. When the pump is not installed the driving terminal is plugged by S-3611 cover.

7.10.02 AK-4S vacuum pump installing on the engine

1. Take a new pump from storage place and depreserve it in following manner:
   a/ fill the pump through the inlet opening of the end fitting with MK-22 or MS-20 oil heated to 75 - 85°C;
   b/ rotate the pump shaft and then drain the oil through the outlet end fitting. The oil from the inside of the pump should be entirely removed otherwise the pump may be damaged during operation. Rinsing of the oil with petrol is not recommended.
2. Install the pump gasket to the mounting studs on crankcase paying attention to set gasket opening and crankcase oil inlet opening exactly opposite each other.
3. Check for the ease of rotation by turning the pump shaft.
4. Check for direction of rotation of the pump and for setting of lubricate regulator.

For pump with clockwise direction of rotation the lubricate regulator should be positioned on the letter "P" and for pump with counter-clockwise direction of rotation it should be positioned on letter "L".

5. Install the pump body to the mounting studs, join to the engine driving terminal and set the lubricating openings opposite each other.
6. Attach the pump on the crankcase.
7. Join the air tubes.

8.00 GENERAL DIRECTIONS TO THE ENGINE REPAIR DURING MAINTENANCE

8.01 General

During maintenance of the engine can occur smaller damage to the engine or its parts, or cases of precocious wearing of parts and assemblies without replacement of which the engine cannot operate.

In this chapter typical failures of the engine will be discussed as well as their causes and their remedies.

The most frequent causes of premature wear of the engine component parts are unskilful engine maintenance and careless engine servicing.

Failures occur also as a consequence of the faulty assembling or part machining. The servicing personnel should exactly analyse all these failures and take measures to their preventing and removing.

To the typical failures of engine parts and assemblies belong:

1. Breaking of stud bolts.
2. Cracking of tubes, cylinder deflectors and engine cowling.
3. Premature wear or cracking of piston rings.
4. Burning of valves and their seats.
5. Breaking of valve springs.
6. Piston seizure.

7. Seizure of sleeve bearings or of bearing bushes or shells. Same of these troubles can be remeded in field condition by simple replacement of the damaged part or assembly for a new one. For this reason serves a spare part set, which is an inseparable part of engine equipment.

8.02 Cause of breaking of the stud bolts and technology of their replacement

The most frequent reason of stud bolt breaking at the engine is too strong torque exerted by means of improper spanner /too strong tightening moment/ at the tightening of the stud bolts.

To replace the damaged stud bolt should be done:

a/ file away the protruding part of the stud bolt to the square shape of dimensions according to these of the box spanner.

Caution: When filing pay attention to the thoroughly preventing the engine inside before getting in of chips.
In places with difficult access when the protruding part of the broken stud is threaded, the screwing over of two nuts under the spanner is recommended.

b/ put over the protruding broken stud the box spanner and screw out the stud bolt. When unscrewing the stud bolt with help of two nuts, the upper nut should be strongly tightened then put the flat spanner around the lower nut and unscrew the stud;

c/ clean the threaded opening, inspect it and eventually calibrate to the other dimensions;

d/ take a new stud bolt of appropriate size from the spare part set, coat it with oil and screw in with help of special spanner or two nuts and box spanner

Caution: When the threads in opening are damaged the part or the assembly should be dismounted of the engine. The damaged thread should be drilled away with hand reamer to the by 2 mm greater new diameter, and then a new thred should be cut. The chips should be thoroughly removed. Take or machine a special /stronger/ stud bolt and screw in it to the assembly maintaining thereat the properly determined tightening moment /torque/.

8.03 Troubles of threaded joints and their remedies

When the nuts are uncorrectly tightened or the connectors uncorrectly screw into their openings /too strongly/ the first scrolls of the thread on the connector and in opening or in nut or on stud bolt can be damaged.

Failures of the outside tread may be recovered by recalibrating of the thread with a dia.

The damaged thread in the opening should be improved by means of hand top with appropriate size. Connectors and stud bolts with strongly damaged threads should be replaced by new ones.

8.04 Cracking causes of the tubes deflectors and their remedies

One of the main causes of cracking is the loose attachment of these members on the engine.

The unadequate attachment is a cause to the vibrations what results after a longer time of operation in cracking.

The cracking on deflectors can be stopped by drilling of openings dia. 3 - 3,5 mm.

8.05 Causes of breaking of piston rings and the technology of their replacement

The breaking of the piston rings is a result of following causes:

a/ Baking of the piston rings in the piston grooves as result of use of the improper oils or of operation at raised temperature than a normal admissible cylinder head temperature.

b/ Uncorrect fit when assembling on the piston /to small lock clearences/.

c/ Ring material faults, slag inclusions, porosity, improper micro-structure.

The visible results of the excessive wear or cracking of the piston rings are power loss, smoking from the exhaust pipes /white smoke/ increase in oil consumption and loss of cylinder compression. Worn or damaged piston rings to one or two cylinders may be replaced in maintenance /in service/.

8.06 Established technology to the replacement of piston rings

1. Install the piston in the top dead center and dismount the cylinder.
2. Take off the piston with piston rings.
3. Rinse the cylinder and piston in petrol.

4. Inspect the cylinder inside and the piston for the dip cracks and other injuries.
5. Take new piston rings /normally seized/ and fit the required lock gaps in cylinder barrel.
6. Rinse again the cylinder, piston, gudgeon pin, rings in petrol.
7. Install the piston rings on the piston and check the clearances with feeler gauge.
8. Install the piston on the connecting rod.
9. Lubricate with oil the piston in neighbourhood of piston rings and the cylinder inside.
10. Stagger the ring locks every 120 degrees each other around the piston circumference.
11. Install the cylinder, adjust the valve clearances /the proper lash/ and connect the electrical cables to the spark plug terminals.
12. Carry out the engine ground testing. When the whole set of piston rings was installed the engine should be run in during 15 - 20 min. within 500 - 1500 r.p.m. increasing gradually the revolutions every 100 - 150 r.p.m. After running in check the engine operation at all power ranges.
13. Enter the engine log book with notice upon replacement of piston rings.

8.07 Established technology of cylinder replacement

1. Unscrew and pull out the bolt attaching the engine to the engine mount.
2. Disconnect the ignition cables and dismount the spark plugs.
3. Dismount and take off the deflector.
4. Disconnect and take off the air delivery pipe to the starting valve and the priming pipe.

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5. Dismount and take off the induction pipe.
6. Take off the cylinder cover.
7. Undo the draw bolts of push rod housings and draw down the rubber connectors.
8. Unlock and remove the cylinder hold down nuts and the washers.
9. Install the piston to the top dead center /by hand/.
10. Catch strohghly the cylinder and pull it out to the position enabling removing of the push rods from the housing.
11. Pull out the cylinder from the crankcase. Pay attention at this operation that the gudgeon pin does not fall out of the piston.
12. Take off the rubber gasket from the cylinder.
13. Clean the piston and piston rings from the carbon deposits.
14. Take a new cylinder from the storage place, depreserve it, inspect for the mechanical injuries and corrosion signs.
15. Inspect condition of the piston and piston rings. Replace the damaged piston rings selecting proper gaps. Stagger gaps in piston rings on the piston so, that they are evenly distributed around the piston circumference to prevent blow by.
16. Mount the new cylinder carrying out the works under 1 - 12 in reversed order and adjust the valve train clearances.

    Note: For compressing the piston rings use the clamping band. Before mounting a new cylinder coat the inside of cylinder barrel and the piston with a thin layer of aircraft oil.
17. Inspect the quality of assembling.

18. Start the engine and let it run in with light propeller /small pitch setting/ within 500 - 1300 r.p.m. during 30 min. increasing r.p.m. gradually every 100 - 150 r.p.m.
19. Check the engine operation ever the all power ranges.
20. Enter the engine log book with notice upon cylinder replacement.

8.08 Established technology of the piston replacement

1. Dismount the cylinder.
2. Dismount the piston from the connecting rod.
3. Take a new piston from the storage place /weight allowance not greater than ± 5 gr/.
4. Fit /by filing/ the required circumferential gaps of piston rings.
5. Install the piston rings on the piston and inspect the side clearances of the piston rings in their grooves.
6. Install the piston on the connecting rod, press in the gudgeon pin and install its plugs.
7. Coat piston rings, piston and inside cylinder barrel with oil. Stagger the piston ring locks so that they are evenly distributed over the piston circumference for preventing the blowing by. Compress the piston rings with clamping band and install the cylinder.
8. Mount the cylinder.
9. Inspect the reliability of the assembling.
10. Start the engine and carry out its running in on the ground with light propeller /small pitch setting/ during 30 min. increasing gradually r.p.m. every 100 - 150 r.p.m. within 500 - 1300 r.p.m.

11. Check the engine operation on all power ranges.
12. Enter the engine log book with notice upon piston replacement.

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9.00 TYPICAL TROUBLES IN ENGINE AND ACCESSORIES OPERATION AND THEIR REMEDIES

Trouble	Cause	Remedy
	9.01 Troubles at engine starting	
1. Crankshaft rotates too heavily.	1. Oil is thickened for reason of ambient cold.	1. Fill hot oil into the crankcase, heat the engine by means of a heating device.
	2. One piston or more are damaged.	2. Dismount cylinders and replace the damaged pistons.
	3. In lower cylinders excessive amount of oil.	3. Unscrew the plugs from induction pipes of the fourth and fifth cylinders and remove the oil by turning the propeller. In case of lack of plugs take off the induction pipes from above cylinders.
2. When starting engine with compressed air the propeller does not rotate.	1. Pressure in bottle below required value.	1. Complete the air pressure to the required value of 40 - 50 kg/sq cm.
	2. Compressed air distributor faulty adjusted.	2. Readjust the air distributor disc setting.
	3. Starting device pipes faulty installed.	3. Examine mounting of the pipes and when needed install them according to the ignition succession of the cylinders.
	4. Leakage in starting device.	4. Repair leak and examine joints of the pipes.
	5. Distributor disc damaged /seizures/.	5. Replace distributor or lap the disc and inspect it with India ink. Adhesion surface minimum 80 per cent.

Trouble	Cause	Remedy
Cylinder compression below normal value.	1. Gap between valve face and seat when valve seated.	1. Dismount the cylinders lap in the valve contact faces into valve seats and check for the condition of lapping by means of kerosene.
	2. Piston rings baked in or broken.	2. Replace the piston rings.
	3. Permissible out-of round condition of the cylinders is exceeded.	3. Replace the cylinders.
	4. Closing of valves is not tight.	4. Examine and adjust looseness.
	5. Starting valves are not tight.	5. Replace starting valves or lap them and examine with kerosene.
Delayed starting or without result.	1. Oiled spark plugs.	1. Clean and dry spark plugs.
	2. Excessive throttle opening.	2. Reduce the throttle opening.
	3. Altitude /height/ correction opened.	3. Close the altitude correction.
	4. Too small number of fuel injections.	4. Inject the fuel with priming pump.
	5. Excessive number of fuel injections.	5. Turn crankshaft 3 - 5 full revolutions in opposite direction to normal rotation at the opened throttle.
	6. Insufficient compression.	6. Pour into the cylinder 30 - 50 gr. hot oil and turn the crankshaft.
	7. Weak spark.	7. Regulate the starting coil.
	8. Engine not heated.	8. Heat the engine with heating device.
	9. Low battery voltage.	9. Replace the battery.

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Trouble	Cause	Remedy
5. Engine starts up and after several seconds goes out /gives up operation/.	1. Ignition circuit troubled.	1. Examine the cable and the magneto control switch over for the contacting to the aircraft metal mass /short circuit/.
	2. Fuel pressure below normal value.	2. Adjust the fuel pressure.
	3. Fuel pipeline and filters obstructed.	3. Blow through pipeline and wash filters.
	4. Air bubbles in fuel system.	4. Remove them from installation and overflow carburetter.
	5. Unproper mixture strength /ratio/ at idling.	5. Control the correct mixture ratio.
	6. Suction section not tight.	6. Inspect the suction section of the fuel installation and remove the troubles.
6. When starting the engine makes the propeller several revolutions backwards.	1. Too advanced ignition.	1. Inspect and carryout ignition timing.
	2. Engine overheated.	2. Cool down engine.
	3. Air distributor faulty adjusted.	3. Check and adjust air distributor.
7. Carburettor shooting.	1. Too great throttle opening /particularly in winter/.	1. Reduce the throttle opening.
	2. Weak mixture.	2. Enrich the mixture on idling.
	3. Suction section of fuel installation untight.	3. Restore the installation tightness.

9.02 <u>Troubles in operation</u>

Trouble	Cause	Remedy
8. Intermittent or trembling engine operation.	1. Damage to ignition cables or spark plug terminals are badly contacting.	1. Examine cables under voltage and interchange the damaged ones. Check the spark plug terminals contacting and attaching. Check the terminals condition and replace the damaged ones.

Trouble	Cause	Remedy
	2. One or more spark plugs do not operate.	2. Inspect the sp 50X1 lug for sparking, rince it or eventually replace it.
	3. Untight contact of valve faces with their seats.	3. Inspect and adjust the valve strain clearances /looseness/.
	4. Water in fuel.	4. Drain three litres of fuel from filter and when this does not help drain the whole fuel and refill with fresh fuel.
	5. Induction pipes and suction installation untight.	5. Check the tightness of induction pipes attachment and of suction installation and remove the trouble.
	6. Icing of the throttle.	6. Switch on heater.
	7. Improper setting of the altitude correction lever.	7. Set the altitude correction lever to the position "closed" - "H".
	8. Oiling of the breaker contacts or too small gaps.	8. Clean contacts and readjust gaps within 0,25 - 0,35 mm.
	9. Too poor mixture.	9. Regulate fuel strength to the proper value.
	10. Undoing of engine to engine mount or engine mount to airframe attachment bolts.	10. Check these attachments and tighten the bolts.
	11. Propeller not balanced.	11. Examine the blade setting, blade beat and balance propeller statically with allowance ± 5 gr.
9. Engine "Knocks".	1. Breaking of piston rings.	1. Replace piston rings.
	2. Incorrect ignition timing /too early ignition/.	2. Regulate ignition.
	3. Mixture becomes poor and overheating of engine.	3. Regulate mixture ratio.
	4. Wear of crankshaft mechanism parts.	4. Direct the engine for overhaul.

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Trouble	Cause	Remedy
10. Engine becomes overheated.	1. Wrong indications of thermocouples or of oil temperature indicators.	1. Examine thermocouples and thermometers.
	2. Improper quality of oil, great deal of foam.	2. Replace oil.
	3. Too poor mixture strength.	3. Regulate mixture ratio
	4. Improper ignition timing.	4. Check and regulate ignition.
	5. Penetration of combustion gases into the crankcase.	5. Dismount the leaky cylinder and replace the piston rings.
	6. Great carbon deposits on piston and combustion chamber walls.	6. Take down cylinders and remove the carbon deposits.
	7. Insufficient oil flow.	7. Inspect oil valve opening, oil quantity in tank, pressure and tightness of the installation.
	8. Valves are seated with gaps in their seats.	8. Dismount cylinders lap valve contact faces into seats and check for tightness with kerosene.
	9. To small clearances in valve strains causing the lack of tightness of valves.	9. Examine and adjust the valve clearances.
	10. Blowing through of combustion gases from the spark plug openings.	10. Dismount cylinder and replace spark plug insertion with proper fit or replace cylinder.
11. Low oil pressure.	1. Oil pump reducing valve badly adjusted.	1. Adjust the oil pump.
	2. Soiled valve or the spring lost its elasticity.	2. Dismount valve and clean it, replace spring and adjust pump.
	3. Wrong indications of the manometer.	3. Check and replace manometer.
	4. Overheating of the oil.	4. Interchange oil.
	5. Leaky installation /air suction at the pump inlet/.	5. Check installation restore tightness.

Trouble	Cause	Remedy
	6. Obstructed filters.	6. Rinse filters.
	7. Crankshaft assembly bearings excessively worn.	7. Send the engine for overhaul.
	8. Oil excessively solved with kerosene.	8. Replace oil.
12. Oil flowing out from the vent plug.	1. Overfilled tank.	1. Check the oil quantity in circulation.
	2. Incorrect oil scavange of the engine.	2. Check oil quantity in crankcase after test.
	3. Blowing through engine of combustion gases into crankcase.	3. Interchange the piston rings.
	4. Air bubbles in scavange pump.	4. Overfill with oil the scavange pump.
13. Engine smokes.	1. Mixture too rich.	1. Decrease the mixture strength with needle or by suction nozzle.
	2. Piston rings excessively worn.	2. Replace piston rings.
	3. Excessive out of round of the cylinder.	3. Replace the cylinder.
	4. Piston burnt.	4. Direct the engine for overhaul.
	5. Excessive oil quantity in crankcase.	5. Inspect the oil pump.
	6. Seizure /jamming/ of piston rings.	6. Check the compression, dismount the cylinder and replace piston rings.
14. Engine does not reach maximum r.p.m.	1. Maximum r.p.m. improperly adjusted by the r.p.m. regulator.	1. Check and regulate the maximum r.p.m.
	2. Wrong indications of the r.p.m. counter.	2. Examine the r.p.m. counter and replace it.
	3. Obstructed oil filters.	3. Clean filters.
	4. Thickening of oil in the propeller hub.	4. Heat the propeller hub.

Trouble	Cause	Remedy
	5. Improper ignition timing.	5. Check and regulate the ignition.
	6. Control looseness. Throttle does not fully open.	6. Examine the throttle opening, adjust and remove clearances.
	7. Air intake screen obstructed.	7. Clean the air intake screen.
	8. Gaps between valves and seats.	8. Check and regulate clearances of valve strains.
	9. Faults of ignition.	9. Check spark plugs, cables and magnetoes setting.
	10. Engine overheating.	10. Cool down engine.
	11. Compression loss.	11. Replace piston rings inspect cylinders and valves.
	12. Leaky suction section of the installation.	12. Check induction pipes, gaskets, restore tightness.
15. Carburetter does not operate.	1. Ruptured membrane.	1. Replace membrane.
	2. Ball valve seizing.	2. Rinse or replace valve.
16. Fuel flowing out from the carburetter.	1. Obstruction of the fuel valve.	1. Rinse and blow through the valve, overfill carburetter pressing on the membrane.
17. Excessively poor mixture at all r.p.m. range.	1. Undoing of the suction nozzle.	1. Check and screw in suction nozzle.
18. Engine operates on to rich mixture. Correction is not active.	1. Suction nozzle obstructed.	1. Take off plug and blow through the nozzle with air under pressure not greater than 0.5 kg/sq.cm.
19. Engine operation intermittent and shooting at maximum and cruising r.p.m.	1. Fuel filter obstruction.	1. Rinse filter.
	2. Dynamic pressure pipe obstructed.	2. Blow through and clean pipe.
20. Cylinder heads overheated.	1. Excessively weak mixture.	1. Enrich mixture.
	2. Induction installation leaky.	2. Restore tightness.

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Trouble	Cause	Remedy
	3. Exhaust pipes burnt through. Combustion gases swim round the cylinder heads or thermocouple terminals.	3. Check and replace exhaust pipes.
	4. Faulty thermocouples.	4. Check and replace thermocouples.
	5. Faulty operation of shutters.	5. Check shutters control
	6. Combustion gases blowing through the spark plug inserts.	6. Replace cylinder or spark plug insertions.
11. Rupture of the fuel pump membrane.	1. Improper material	1. Replace membrane or pump.
	2. Too long storage period.	2. As above.
	3. Incorrect assembling	3. As above.
12. Fuel pump glands are leaking.	1. Gaskets worked out.	1. Replace pump.
	2. Incorrect assembling	2. As above.
13. Pump does not react to the adjustment.	1. Reducing valve obstructed.	1. Replace pump.
	2. Springs are broken.	2. As above.
	3. Blades or internal body channel worn.	3. As above.

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10.00 PRESERVATION OF THE ENGINE ON THE AIRCRAFT

10.01 General

Preservation of the engine is one of the main protecting methods of the engine parts and assemblies against corrosion. For this reason engines remaining out of service should be to proper time and thoroughly preserved. For preservation procedure should be only used the recommended by maintenance instruction preservation means.

10.02 Recommended greases for the preservation of engine and engine spare parts

a/ For preservation of outside surface of the engine and its assemblies as well as for aluminium and steel spare parts serves the grease of designation 59/GOST 5699-51. For lack of this grease gun grease of designation GOST 3005-45 or technical vaseline of designation GOST 782-47 may be used. For cadmium or zinc plated parts use only the technical vaseline.

Dope coated parts are not to be preserved.

b/ For internal preservation should be used: for preservation period of one year grease of designation 58M /SP-1/ - GOST 4807-49, for preservation period of six months grease of designation 59C SP-3/ - GOST 5702-51, for preservation period of one month aircraft oil of designation MK-22, MS-20 GOST 1013-49.

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c/ For the internal preservation of the carburettor and fuel pump aircraft oil of designation MK-22 or MS-20 are recommended.

10.03 Storing of the engine on aircraft

Engines suspended on aircraft may be stored in field condition or in hangars. In both cases of storing in dependance, on the required storage time the engines should be preserved by one of below described methods. For five days interruption in operation engines have not to be preserved. Engines on aircraft in field conditions have to be tightly covered for protection against [illegible] snow and dust. Carrying out of preservation during adverse atmospheric conditions is not allowed.

After completing of each [illegible] or depreservation an appropriate [illegible] should be made to the engine log book.

10.04 Engine preservation for 15 [illegible] period

1. Let run engine during [illegible] within 1000 – 1200 r.p.m. and afterwards stop it.
2. On the heated engine /cylinder head temperature 30 + 50°C/ unscrew the [illegible] spark plugs and turn crankshaft 8 – 10 times at fully open throttle, to remove the remaining [illegible] gases from the cylinders.
3. Inject into the compressor through the filter screen 40 – 50 gr of MK-22 [illegible] oil heated to the 70° – 80°C temperature [illegible] crankshaft 3 – 5 times.

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4. Inject into each cylinder 50 - 100 gr of [illegible] oil [illegible] MK-22 or MK-20 heated to the temperature of [illegible]° - 80°C at the bottom dead center piston position and thereat necessarily grease seats and exhaust valve stems. Turn crankshaft 2 - 3 times. Screw in spark plugs.
5. Wipe the engine with clean rag moistened with petrol. Ignition cables and rubber joints with clean dry rag.
6. At temperature above 0°C every 5 - 7 days turn 6 - 8 times the crankshaft at fully opened throttle.
7. Enter the notice upon completed engine preservation into the engine log book.
8. Validity of preservation period should not be prolonged.
9. Engine preserved for the 15 days period is not subjected to depreservation before starting /putting in service/.

10.05 One month period engine preservation

1. Start and heat engine .
2. Drain oil from tank and engine.
3. Refill the engine system with fresh oil.
4. Let run engine 10 - 15 min within 1000 - 1200 r.p.m. and thereafter stop it.
5. On the warm engine /cylinder head temperature 30° - 50°C/ screw out the front spark plugs and turn crankshaft 8 - 10 times at fully opened throttle to remove the remaining combustion gases from the cylinders,
6. Inject into the compressor through the filter screen 40 - 50 gr. of MK-22 or MK-20 oil heated to the temperature of 60° - 80°C, thereafter turn crankshaft 3 - 5 times,

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7. Inject into each cylinder 50 - 80 gr. of aircraft oil of designation MK-22 or MS-20 heated to the temperature of 60° - 80°C at bottom dead centre piston position and thereat grease necessarily the exhaust valve seats and stems.
   Turn the crankshaft 2 - 3 times to distribute oil over the cylinder barrel.
8. Inject again through the spark plug holes 50 - 80 gr. of oil without turning of crankshaft and screw in the spark plugs.
9. Inspect visually the engine and remove the corrosion traces.
10. Wipe the engine with clean rag moistened in petrol the ignition wires and rubber joints wipe with dry rag.
11. Preserve with grease of designation 59 or with technical vaseline the engine and accessory outside. Dope coated parts have not to be preserved.
12. At the ambient temperature above 0°C every 7 - 10 days turn the crankshaft 8 - 10 times at fully opened throttle.
13. Validity of preservation period should not be prolonged.
14. Engine preserved for period of one month should be depreserved externally and internally before starting /putting in operation/. External preservation grease should be rinsed with brush or rag wetted in petrol. Oil from upper cylinders remove with help of hand pump, from lower cylinders drain it through the plugged holes of induction pipes. When the induction pipes are without plugs they should be dismounted to drain the oil.
15. The appropriate notice about completed preservation should be made to the engine log book.

10.03 Engine preservation for period of one year

All engines with worked out guaranty operation period or damaged and therefore classified to the revision or overhaul should be preserved for period of one year according to this instruction.

The properly executed engine and its accessory preservation will prevent to engine damage by corrosion and will reduce therefore the time and costs of the overhaul.

It is not recommended to preserve according these regulations the engines being in service and for other reasons foreseen for storing for period of one year, because the preservation in field conditions could appear insufficient

To preserve the new engines for period of one year special compartment and tooling is required.

1. Carry out operations under points 1, 2, 3, 4 of engine preservation instruction for the period of 15 days.
2. All above outlined operations should be carried out without greater delay.
3. Drain oil from engine and tank.
4. Drain the petrol from carburetter and pump.
5. Fill the crankcase fully with 58M lubricant through the front vent.
6. Inject into every cylinder 200 - 300 gr. 58M lubricant at the bottom dead center piston position. Thereat the valve stems and seats should be thoroughly greased.
7. Plug the outlet holes, turn 8 - 10 times the crankshaft and drain fully the lubricant from the crankcase.
8. Fill the fuel pump inside with MK-22 or MS-20 oil heated to the 60° - 80°C and turn engine crankshaft 2 - 3 times.

9. Plug the spark plug openings.
10. Screw out the drain plugs from the carburettor and fill the fuel chamber with oil MK-22 or MS-20 heated to the temperature of 40° - 50°C till it flows out through the nozzle openings. Afterwards make several movements with throttle lever, drain the oil and screw in drain plugs.
11. Clean the engine from lubricant and dust.
12. Carry out the external preservation of the engine and its accessories by spraying the 59 lubricant.
13. Take down propeller, wash the crankshaft end with petrol, wipe till it is dry and preserve with 59 lubricant or gun grease, wrap up with paraffin paper and bind with string.
14. Take down the engine from the aircraft, locate it in the transport case and secure by attachments.
15. Wrap up the engine with paraffin paper, bind the paper with string and close the case cover.
16. Make the appropriate record upon the completed engine preservation to the engine log book and direct the engine together with its log book to the storage place to render it further for the overhaul.

    Note: It is allowed to heat the 58M grease to the 15° - 30°C temperature and lubricants 59 and 59C to the 50° - 70°C temperature.

10.07 Removal of corrosion traces

Preservation of the engine and its accessories may be carried out after removal of corrosion signs. It is allowed to remove the corrosion spots by mechanical way.

The corroded steel parts can be cleaned with emery cloth mark "000" soaked with oil. The cleaned places wipe with rag soaked in petrol and afterwards with dry rag and coat with preservation grease.

Corrosion spots from aluminium and magnesium parts should be cleaned out with help of scraper and emery cloth "000".

On the magnesium alloy parts the corrosion spreds in short a time and therefore the perceived corrosion signs should be immediately liquidated.

The cleaned places on magnesium alloy parts should be necessarily oxidized.

Composition of oxidizing solution is following:

1. Na_2SeO_3 /sodium selenite/ - 20 gr.
2. H_3PO_4 /phosphoric acid/ - 6 gr.
3. Water - 1000 cu.cm.

Solution temperature - ambient room temperature.
Bath time - 1 - 2 min.

When the part to be treated cannot be dismounted from the aircraft it should be oxidized by wiping with wadding soaked in solution. When oxidized the part should be dryed and coated with appropriate dope or greased with gun grease.

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11.00 STORING OF ENGINES AND SPARE PARTS

11.01 Requirements to the storing compartments

1. Storing compartments should be dry, sufficient ventilated and heated. The inside air temperature should be within +10°C to +30°C. The relative air humidity admitted within 45 - 70 per cent. Sudden changes of air temperature and humidity are not allowed.
2. Measurement of the temperature and air humidity should be performed every day in the morning and at the end of working hours. The measured values should be recorded to the special diary.
   Note: The daily temperature difference should not exceed 6°C.
3. The storing compartment floors should be wooden, of xylolite or of plates. The concrete floors are inadmissible.
4. The stands for storing of spare parts should be made of wood with relative humidity of 18 per cent max.
5. The racks of the stands should be oil-coloured and maintained clean.
6. The stands should be thus built and disposed that the distance of the lower rack from the floor and this of the stand from the wall should amount at least 40 cm.
7. The racks inside should be protected by shutters to prevent the stored parts before penetration of the dust and before exposing by sun rays.

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8. Rising of dust when tidying up the storing compartment must be avoided. The racks should be wiped with rags soaked in oil. To tidy up the floor [illegible] humide sawdust or vacuum-cleaner should be used.

   The washing of the floor with water or dry tidying up is strongly forbidden.

9. The storing compartment should be separated from the entrance by a partition /a vestibule should be arranged. Loading and unloading of engines should be carried out in the vestibule or under covered ramp /under roof/. Unloading of the engines on ramps without roof is not allowed. Storing of engines and their spare parts in vestibule should not take place.

10. Behind vestibule should be detached a separate place where the coming in engines and spare parts reach the ambient temperature. In this compartment the unpacking and similar works are also carried out. The air humidity, temperature and devices of this place are similar to these of the storage compartment.

11. The storing compartment for engines and spare parts must be fully protected against penetration of any gases and vapours /smoke, exhalations of chemical plants, oxide of sulphur, ammonia, chlorine etc. Storing together of chemical products acids, lyes, batteries and hygroscopic materials is strongly forbidden.

11.02 Storing of engines and spare parts

1. Engines and spare parts sent to the storage should be recorded into the storage place diary /noticed date and hour of coming in and date of preservation by the manufacturer.

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2. Spare part boxes should be stored in other compartment then the engines.
3. Spare parts should be stored in packed state /in boxes/ as only the validity of preservation period is not expired before coming for the storing. The rubber parts should also be stored in packed state.

   Note: When accepting the parts for storing, it is not allowed to unpack them and by this to damage the preservation of parts by manufacturer. The contents of the cases and parcels should be checked according to the enclosed with list on which the spare part type and number of pieces are given.
4. Engines are stored in unpacked state. They should be attached on the stands and protected with covers what enables their watching and revision. The stands should be made from wood with humidity contents not exceeding the value of 18 per cent. The stations of the stands adjacent /contacting/ to the engines should be oil paint and besides this should be covered with paraffin paper.
5. The single sets of engine spare parts should be placed on racks with distance from the floor at least 10 - 12 cm.
6. The storing of the parts on the floor is rigorously forbidden.
7. When transporting the engines and their parts they should be protected against atmospheric influence using for this reason all available protecting means.
8. All engines and their spare parts accomodated in the storage should be regularly watched. A special diary for inspection records succesion and dates should be kept.
To the engines and spare part packings should be attached labels with inspection dates and inspection executing person signatures.

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All works on engines should be recorded into the engine log books independently from the records to the storage diary and labels.

9. It is not allowed to touch the metal parts with hands. When needed the gloves should be used.
10. All engines are subjected to the revision every three months according to following succession:
    a/ check through the spark plug holes with help of torch and the mirror condition of barrel /for traces of corrosion/;
    b/ check for corrosion signs on the crankshaft end;
    c/ remove the exhaust holes covers and revise valves.
11. After 6 months from the preservation date by manufacturer 2 /two/ per cent of the whole number of engines are subjected to the partial disassembling and to revision according to following program:
    a/ remove the cylinder and inspect the barrel condition. Specially inspect the contact places of the piston rings to the barrel. Revise valves and piston rings;
    b/ through the hole after removed cylinder inspect crankshaft counterpoises and bearings.
12. After expiring of preservation period 5 per cent of stored engines is subjected to disassembling and revision according to point 11. To the number of engines selected for this revision should be destined one of the engines revised previously as outlined under point 11.
13. When the corrosion signs are detected before expiring of preservation period the appropriate reclamation should be directed to the purveyor /manufacturer/.
14. When needed to depreserve and represerve the engines and spare parts these measures should be executed according to appropriate instructions.

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[illegible]. After six months from the date of preservation by the manufacturer of the spare parts, their state should be inspected.

For this reason take from one set several parts most susceptible for corrosion, depreserve them and thoroughly revise. If the corrosion signs detected, depreserve and inspect the remaining spare parts sets.

If the revision detects the corrosion traces excluding further storing and if the cause of the corrosion is the improper preservation by the manufacturer an appropriate reclamation should be directed to the manufacturer's plant.

1. [illegible]ICATION OF FLIGHT TOOLS FOR THE WN-3 ENGINE

Designation of part	Name of part	Number of pieces
S-2136	Flat tongs	1
S-43[illegible]	Small joint spanner	1
S-4413	Big joint spanner	1
S-4414	Big spanner tommy bar	4
S-4459	Hub spanner	1
S-4460	Sound for checking the top dead center	1
S-4486	Angular disc	1
S-4515	Spinner lock spanner	1
S-4575	Crankshaft spanner	1
S-4577	Valve installing lever	1
S-4578	Spanner for carburettor	1
S-4579	Box spanner 17	1
S-4586	Valve adjustment tommy bar	1
S-6183	Device for pulling out the valve operating mechanism wheel shaft	1
S-6283	Pliers for the spring ring,	1
S-6285	Tool bag No.2	1
S-6286	Box for spanner terminals	1
S-6287	Tool bag No.1	1
S-6409	Lever for valve installing	1
03.18.102	Fox spanner	1
03.18.105	Spanner for generator, long	1
03.18.106	Spanner for assembling of the crankshaft	1
03.18.107	Ring spanner for the cylinder	1
03.18.108	Socket spanner 19	1
03.18.109	Socket spanner 17	1
03.18.110	Foxcylinder spanner /drilled bolt/	1
S-4450	Oil pump spanner	1

Designation of part	Name of part	Number of pieces
S-3833	Lever stop nut	2
S-4843	Cylinder gasket	7
S-3903	Bolt M6 x 12	2
S-3945	Drawbolt complete dia. 22	2
S-3948	Bolt	4
S-3955	Drawbolt complete dia. 16	5
S-3975	Connector	6
S-3979	Sealing piston ring	4
S-3981	Self locking nut M6	10
S-3982	Selflocking nut M8	4
S-3983	Selflocking nut M10	1
S-3984	Regulator gasket	1
S-3985	Infuction pipe gasket	4
S-3986	Cylinder head gasket	14
S-3907	Magneto gasket	2
S-3988	Gasket dia. 24x30	2
S-3991	Gasket dia. 12x18	7
S-3992	Gasket dia. 10x14	2
S-3995	Carburetther gasket	1
S-3996	Generator gasket	1
S-3997	Vacuum pump gasket	1
S-3998	Selflocking nut M5	10
S-3999	Well gasket	1
S-4000	Drain valve gasket	2
S-4005	Cylinder head flange nut M8	6
S-4006	Plug M12	1
S-4011	Cylinder bolt securing washer	50
S-4032	Gasket dia. 18 x dia. 2	2
S-4034	Cylinder nut	12
S-4037	Gasket dia 16,2 x 20	3
S-4115	Anchor nut	2
S-4145	Crankcase bolt washer	2
S-4146	Drawbolt complete dia. 36	5
S-4284	Screw M5x12	4
S-4328	Washer dia. 5,1/10x0,8	15
S-4329	Washer dia. 6,1/10x0,8	15
S-4330	Washer dia. 8,2/1[illegible]x1,2	15
S-4332	Washer dia. 10,2/1[illegible]x1,5	5

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Designation of part	Name of part	Number of pieces
S-4500	Flat fork spanner 30x36 for the oil pipe	1
S-4541	Nail punch for the pusher lever bolts	1
S-4557	Fork flat spanner 8 x 11	1
S-4569	Box spanner 20x22 /starting valve and spark plugs/	1
S-4570	Spanner for the well socket /small/	1
S-4571	Flat forkspanner /for cable coreoping/	1
S-4572	Flat spanner 18x24 special for generator	1
S-4573	Ring spanner 7 /fuel pump/	1
S-6398	Needle regulator spanner	1
S-6399	Sprayer plug spanner	1
119-518	Spanner 9 x 11	1
119-519	Spanner 14 x 17	1
119-520	Spanner 14 x 20	1
119-529	Ring spanner 19 x 22.	1
119-561	Ring spanner 9 x 11	1
	Assembling screwdriver 7/PN/N-64953	1
	Assembling screwdriver 10/PJ/N-54953	1
	Feeler gauge /sheet thickness within 0,05 – 1 every 0,05 mm/.	1

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13.00 SPECIFICATION OF SPARE PARTS

1:1 set

Designation of part	Name of part	Number of pieces
S-3994	Washer	4
S-275	Spark plug washer	14
S-935	Starting valve	1
S-940	Starting valve gasket	7
S-941	Starting valve washer	14
S-942	Starting valve cap	1
S-3545	Inlet valve	1
S-3546	Outlet valve	2
S-3551	Outlet valve ring /pair/	2
S-3552	Outer valve spring	4
S-3553	Inner valve spring	4
S-3555	Inlet valve ring /pair/	1
S-3567	Drilled bolt	1
S-3571	Terminal	1
S-3577	Washer	1
S-3586	Front cavity gasket	2
S-3613	Protecting ring dia. 12	5
S-3632	Gasket	2
S-3683	Gasket	1
S-3685	Oil pump gasket	2
S-3686	Oil pump gasket	2
S-3709	Air distributor gasket	1
S-3733	Gasket dia. 22x dia.24	1
S-3735	Distributor gasket	1
S-3736	Compressor gasket	1
S-3737	Vent gasket	1
S-3751	Rear cover gasket	2
S-3778	Well gasket	1
S-3809	Regulator insert gasket dia.2,5xdia.68	2
S-3831	Lever stop	2

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Designation of part	Name of part	Number of pieces
S-4333	Washer dia. 14,5/22x2	2
S-4351	Cylinder head flange nut M8	3
S-4365	Ring scraper	2
S-4368	Ignition cable	3
S-4392	Pusher lower housing gasket	4
S-6372	Air distributor gasket	2
S-6418	Induction pipe lower gasket	4
	Spark plug CD-48BS	14
	Split pin dia. 1,5 x 30	14
S-3664	Reducing washer	1
S-3688	Gasket	2
S-3732	Reducing washer	1
S-3989	Gasket dia. 30/36	1
S-3990	Gasket dia. 20/24	1
S-4012	Securing washer	1
S-4276	Gasket dia. 14/18	1
S-4287	r.p.m. counter gasket	1
S-4288	Gasket	1
S-6102	Rubber gasket	1
S-6106	Valve pin /peg/	1
	Steel stud dia. 2 x 18	1
	Generator spare parts set	
	Magnetoes spare parts set	
	Compressor spare parts set	
	Fuel pump spare parts set	
	Carburetter spare parts set	
	Oil pump spare parts set.	
	Air distributor spare parts set.	

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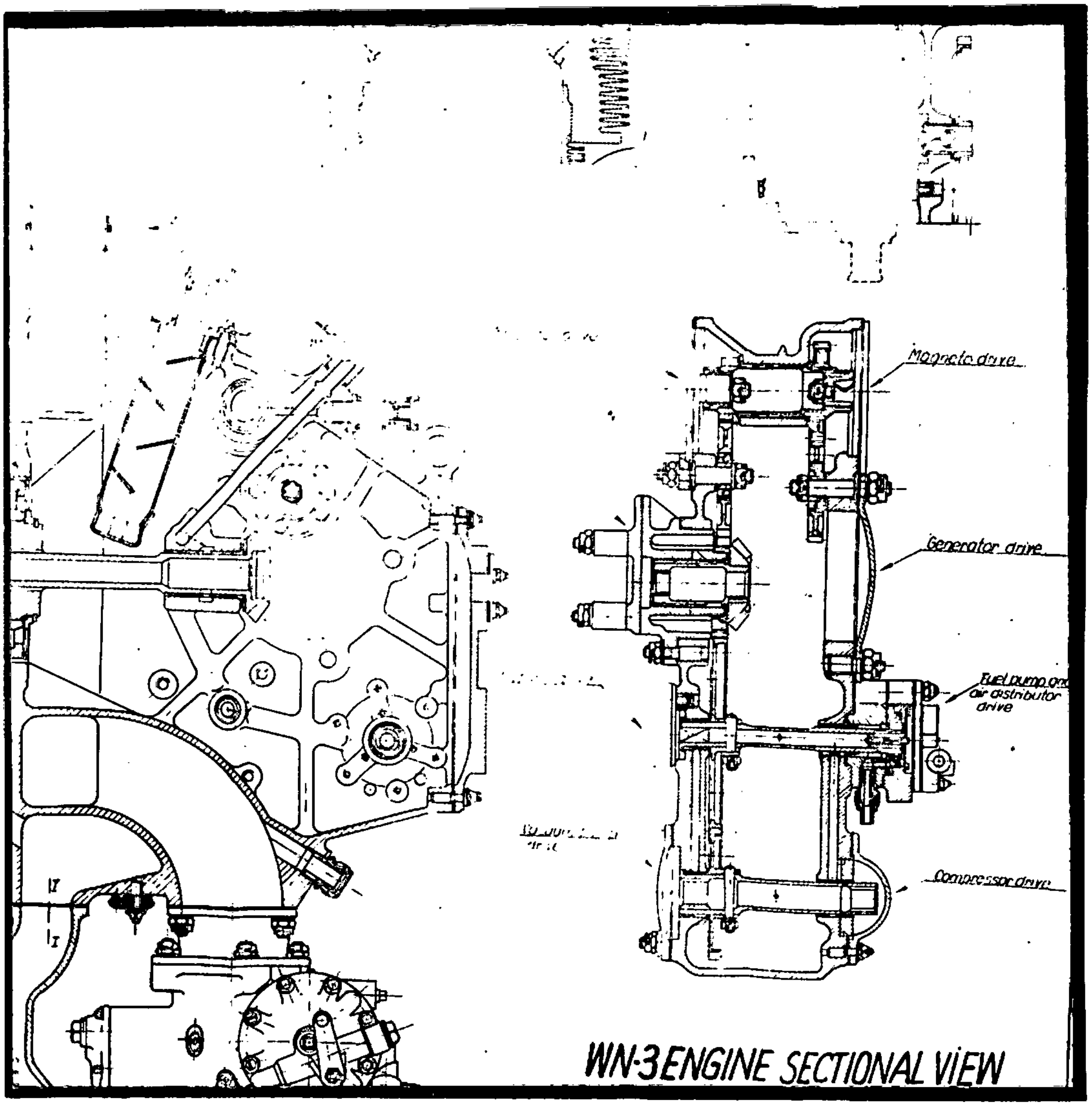

WN-3 ENGINE SECTIONAL VIEW

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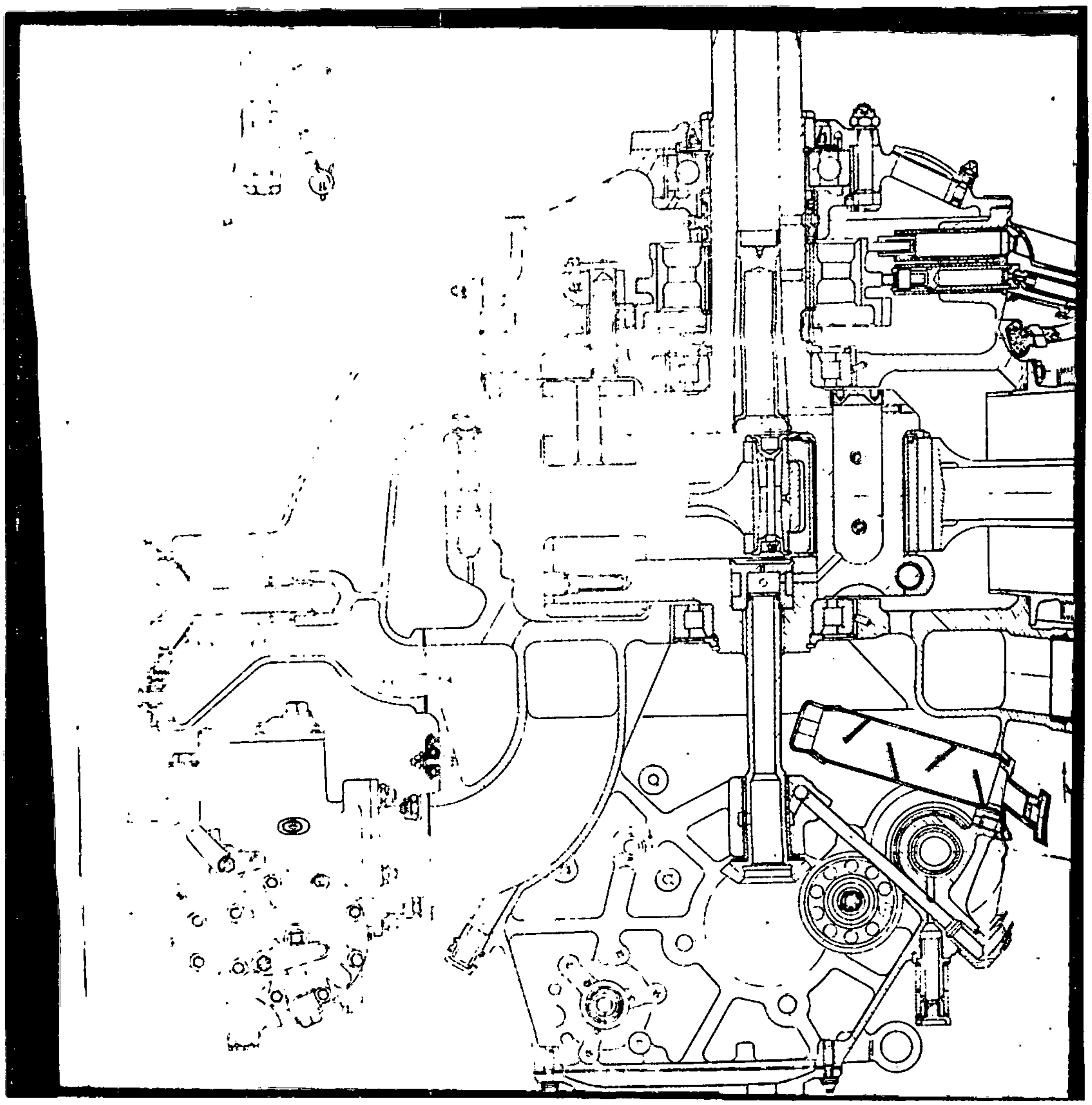

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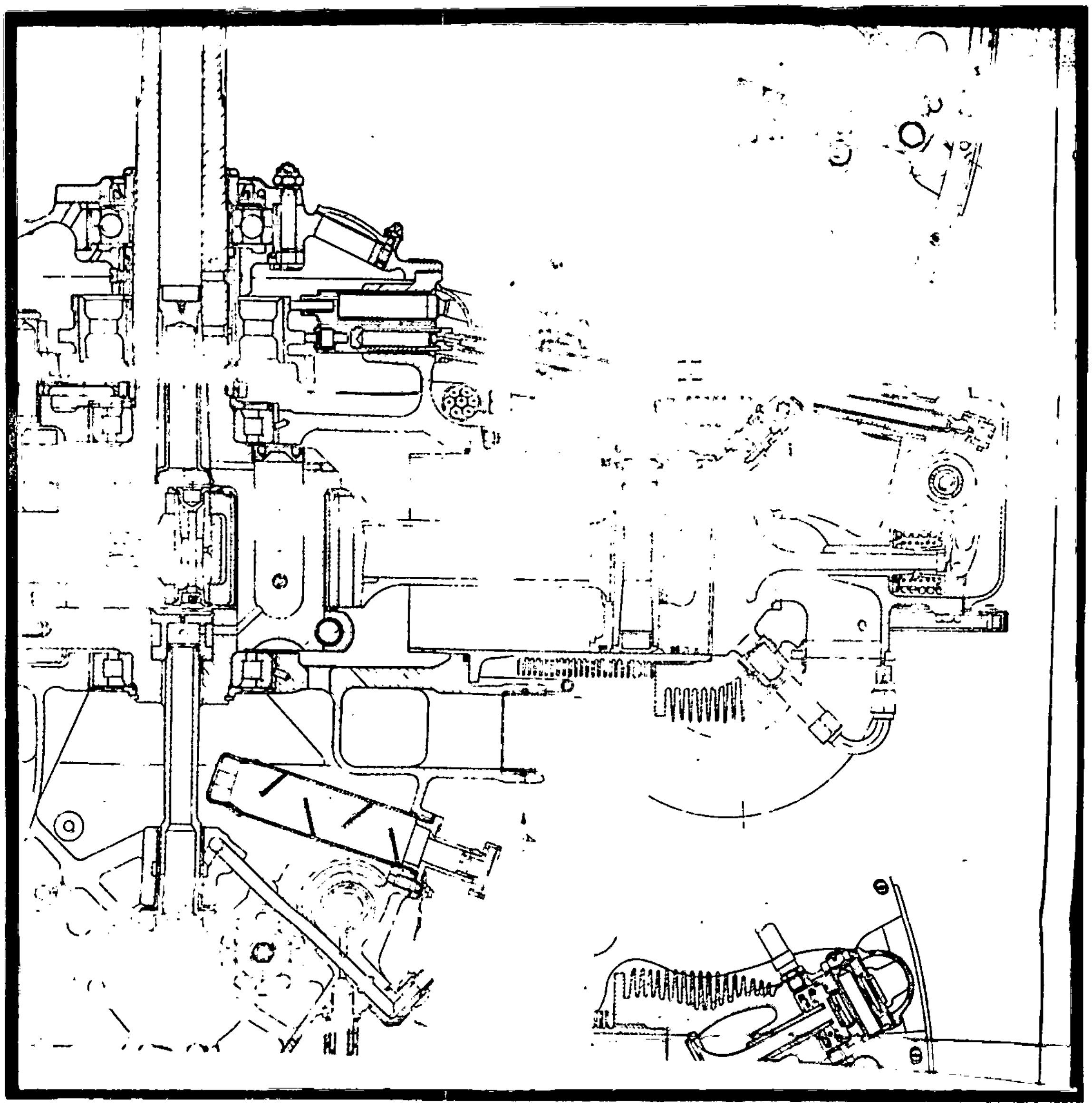

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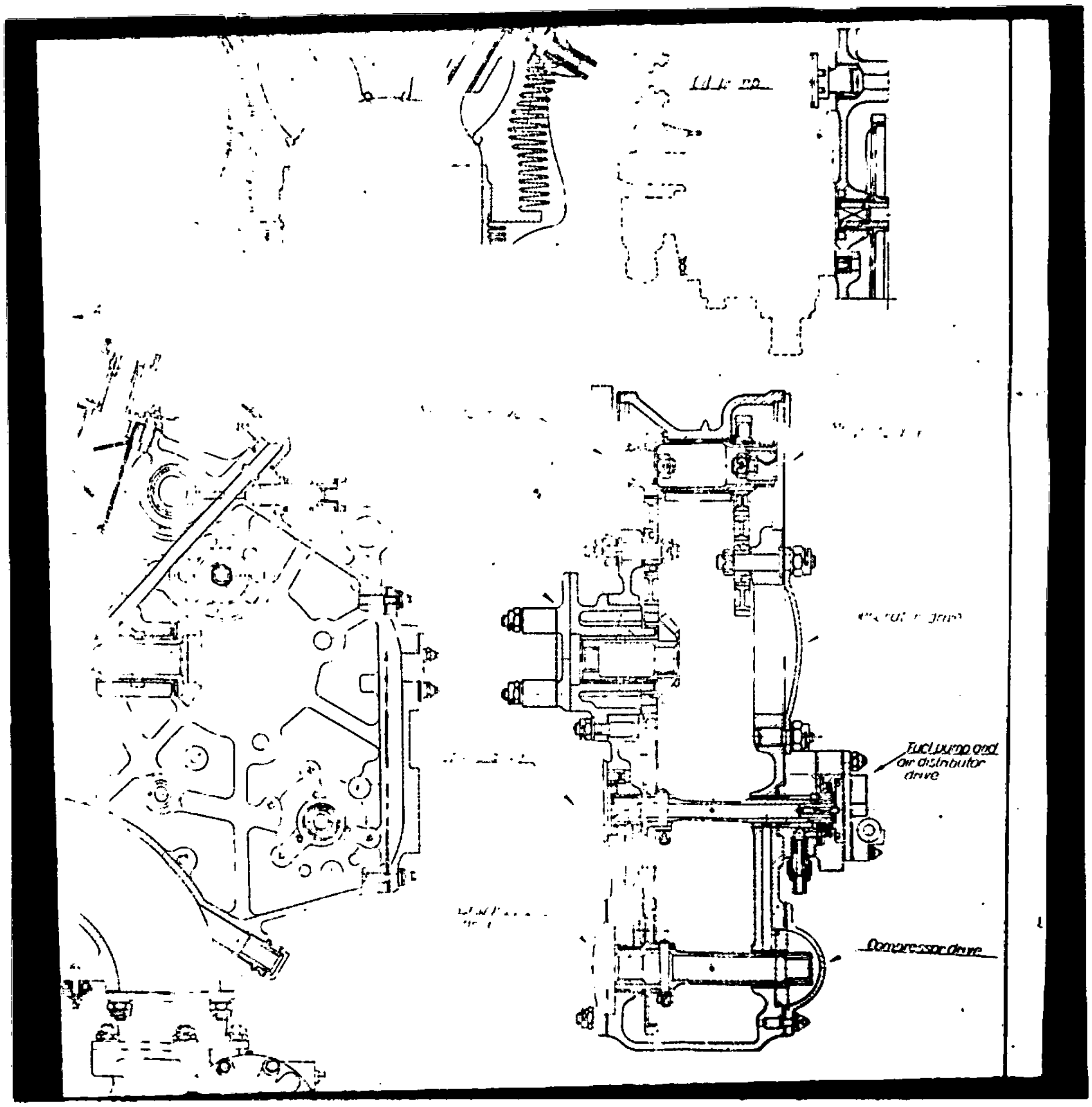

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