WALTER MINOR 4-III

AERO-ENGINE

105 BHP

Technical description, service instructions,
control and maintenance of the engine

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PREFACE

This book serves to acquire thorough knowledge of WALTER MINOR 4 - III and MINOR 4 - III S engines, and supplements universal principles about the service and maintenance of aero-engines by further special instructions about service, control, and maintenance of these engines.

Observation of these instructions is the presumption for obtaining reliable run, durability, and economy of the engine. In addition to this, consciencious observation of these instructions is the condition for the guarantees of our works. It is therefore in the interest of the possessor and attender of the engine to acquire thorough knowledge of them.

Should it be necessary, you will always find us ready to help you at any time with further sources of information, advice, and expert hints.

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PRAHA.

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NOMENCLATURE

Names used in this description possess the following unanimous meaning:

Front side of the engine is the side at the propeller hub. Similarly the word „front" on individual parts means their side turned to the propeller and „back" the one turned to the rear cover.

The cylinders are numbered in succession from the front; cylinder No. 1 is at the propeller.

By right and left the position of the engine or the side of individual parts is marked when viewing it from the back. Marked as top and bottom means the position of the engine or the sides of individual parts at normal position of the engine; the top part of the cylinders and their parts is, however, the one at the greater distance from the crankcase.

Direction of rotation of the engine is stated looking at the engine from the back; right hand direction agrees with the clockwise, left-hand with the anticlockwise direction.

Direction of rotation of drives and accessories of the engine is always determined when looking in the direction from the driving to the driven part. The direction of driven apparatuses is always the same as that of their drives.

Driving ratios are given by the number of revolutions of the driving to the number of revolutions of the driven part, and the resulting ratio by the number of revolutions of the crankshaft to the number of revolutions of the drive or its accessory.

Sign T. D. C. resp. B. D. C. means the top resp. the bottom dead centre of the piston. The top dead centre of the piston is the position in which the piston is situated at the greatest distance from the crankshaft.

PART I.

DESCRIPTION OF THE ENGINE

TECHNICAL SPECIFICATIONS.

WALTER MINOR 4-III aero engine is an internal combustion four-stroke, air-cooled, four cylinder inverted engine. The propeller is fitted directly on the front end of the crankshaft.

Production mark	WALTER MINOR 4-III
Direction of rotation of crankshaft and propeller	anti-clockwise

Cylinders.

Number and disposition of cylinders	4, inverted in one row
Bore	105 mm
Stroke	115 mm
Piston displacement	0,995 lit.
Total stroke volume displacement of engine	3,98 lit.
Compression ratio	6 : 1

Output and speed.

	Rating in BHP	Revolutions p. m.
Rated power at sea level	105	2500
Cruising power	80	2300
Maximum permissible revolutions by dive		2750
Specific output at rated power		26,4 BHP/lit.

Fuel and oil and consumption.

Values stated here are the average consumptions, when fuel and oil prescribed are used.

Fuel prescribed	Aviation petrol with min. 72 octan number satisfying the prescriptions for aviation fuels
Oil prescribed	Best mineral oil of specific weight max. 0,92 satisfying the conditions for aviation lubricants

Grease	Grease cups of SCINTILLA magnetos are filled with special SCINTILLA G grease, flexible shafts of tachometer and generator drives with a mixture of grease and graphite
Fuel consumption at rated sea level output	245 g/BHP/hour
Fuel consumption at cruising output	225 g/BHP/hour
Oil consumption at rated sea level output	2—8 g/BHP/hour
Fuel consumption per hour at rated sea level output (at specific weight 0,730)	25,7 kg i. e. 35,2 lit.
Oil consumption per hour at rated sea level output	0,8 kg, i. e. 0,9 lit.
Total fuel and oil consumption per hour at rated sea level output	26,5 kg

Valve timing and its adjustment.

The following figures are theoretical mean values. The really measured values for the first cylinder are indicated on the data plate of every engine.

Number of valves in the cylinder	2; 1 inlet and 1 exhaust valve
Arrangement of the valves	hanging, parallel
Valve operating mechanism	from the camshaft placed in the crankcase by means of tappets, push rods and rockers
The timing and checking are adjusted at a valve clearance of	0,35 mm
Inlet valves open	15° B. T. D. C.
Inlet valves close	55° A. B. D. C.
Exhaust valves open	55° B. B. D. C.
Exhaust valves close	15° A. T. D. C.
Cold clearance of inlet and exhaust valves	0,15 mm

Carburation.

Carburetor	WALTER 45	or WALTER 45 AK
Setting of the carburetor (jets given in hundredths of mm):		
Main jet	200 ± 10	200 ± 10
Enrichment jet at full throttle	110 ± 10	110 ± 10
Slow running jet	80 ± 10	80 ± 10
Inverted flying jet		140 ± 10
Throat diameter of choke	35 mm	35 mm
Weight of the float	45 g	45 g
Fuel level in float chamber	1 mm under the float pin axis	10 mm from top face of carburetor bottom body

The enrichment jet begins to act when the throttle is opened	in zero adjustment (i. e. the throttle lever is in horizontal position)
Super-pressure of the fuel before the carburetor when the fuel pump is fitted	0,2—0,28 kg/cm², by slow run even 0,30 kg/cm²
Super-pressure of the fuel before the carburetor when gravity feed take place	0,05 kg/cm²

Ignition.

Magneto on the left side of the engine	SCINTILLA VERTEX NVK-4 Z2
Magneto on the right side of the engine	SCINTILLA VERTEX AVK-4 Ø2 with impulse starter
Number of magnetos in the engine	2
Magneto speed ratio	2 : 1
Direction of rotation of magnetos	clockwise (when looking at their shaft)
Ignition point adjustment	automatic
Maximum ignition advance (measured on the crankshaft)	30 B. T. D. C. at the left magneto 35 B. T. D. C. at the right magneto
Range of the automatic ignition point adjustment (measured on the magneto shaft)	12½
The automatic adjustment of the ignition point begins to act at	approx. 1000 r. p. m. of the engine
Maximum ignition advance is reached at	approx. 1500 r. p. m. of the engine
Constant-distance of magneto-interruptors	0,3—0,4 mm
Firing order (according to cylinder numbers)	1—3—4—2
Numbering of cylinders	cylinder No. 1 is at the propeller
Sparking plugs	PAL 12 L/225
Number of sparking plugs in a cylinder	2
Sparking plugs thread	M 12×1,25, length of thread 8 mm
Electrode gap	abt. 0,4 mm

Lubrication.

System of lubrication	force-feed lubrication system with dry sump
Oil pump	double gear pump, with one pressure and one scavenge pump

Pump speed ratio	2 : 1
Output ratio of the pressure and the scavenge pump	2 : 3
Mean oil flow through the engine at nominal revolutions	abt. 120 kg/hour, i. e. abt. 130 lit./hour
Minimum amount of oil in the tank necessary for the ciculation	abt. 5 lit.
Normal oil pressure	3—4 at.
Minimum oil pressure at slow running	2 at.
Intake oil temperature	
minimum — for engine test and start	20° C
normal	40—80° C
maximum	85° C
Outlet oil temperature	
minimum — for engine test and start	30° C
normal	50—90° C
maximum	105° C

Cooling.

Cooling of the cylinders	by air
Air inlet orifice area in engine cowling by airplanes with velocity up to 250 km/hr	300 cm²
by airplanes with velocity over 250 km/hr	250 cm²
Width of the round slot behind the propeller hub cowling	10 mm
Air outlet orifice area behind the engine cowling	about double the size of the inlet
Pressure drop in the air stream between the inlet and the space inside the cowling behind the engine	
when climbing	min. 120 mm of water column
by horizontal flight	min. 150 mm of water column
Normal temperature of cylinder heads	190—230° C
Maximum temperature of cylinder heads (under the right sparking plugs)	260° C for a short while

Starting.

Flange and jaw for mechanical starter according to ČSN-AE	7,1 or SAE 5″
Direction of rotation of the starter (when looking at its flange)	clockwise
Turning starter (delivered at request)	WALTER R 25 handstarter or WALTER RE 25 hand and electric starter or P 320 electric starter
Fuel primers for starting (delivered at request)	2, in induction manifold

Drives and accessories.

* Accessories supplied on special request.

*Fuel pump	WALTER 2M 50, double, diaphragm-type
Fuel pump drive	by dog of right layshaft
Direction of rotation of the fuel pump drive	clockwise
Fuel pump speed ratio	2 : 1
Tachometer drive	according to ČSN-AE-5,15
Direction of rotation of the tachometer drive	clockwise
Tachometer drive speed ratio	2 : 1
*Generator	24 V, 300 W
Number of generators on the engine	1 or 2
Direction of rotation of the generators	anti-clockwise
Left generator drive by means of a gearing (the generator is fixed on the engine) gear ratio	1 : 2
Drive on the engine right side (may be used for any other apparatuses) of a ratio	1 : 2

Weights.

* Accessories delivered at special request.

Dry weight of the engine including accessories according to ČSN-AE 1,4B — weight B1	90,3 kg ± 2%
including the weight of:	
WALTER 45 carburetor	1,95 kg
2 SCINTILLA NVK-4, resp. AVK-4, Ø2 magnetos, sparking plugs, cables and cable tubes	7,4 kg
* WALTER 2M 50 fuel pump	0,70 kg
Air intake and cylinder baffles	1,6 kg
Specific weight of the engine at normal sea level output and weight B1	0,86 kg/BHP
* Weight of the propeller hub and retaining nut	2,2 kg
* Weight of four normal bearing feet and rubber dampers:	
with longer dampers	1,0 kg
with shorter dampers	0,75 kg
* Weight of the WALTER R 25 hand starter with a crank	4,25 kg
* Weight of the WALTER RE 25 hand and electric starter with a crank	7,25 kg
* Weight of the WALTER P 320 electric starter	6,35 kg
Weight of four exhaust pipes 125 mm long	1,00 kg
* Weight of the generator	abt. 4,8 kg

* Weight of the generator direct drive	1,65 kg
* Weight of the air intake with a regulating flap and a flame trap	1,2 kg
* Screened ignition (weight increase as compared to unscreened ignition)	1,3 kg
* Weight of the acrobatic lubrication system	0,6 kg
Total weight of the engine including all accessories according to ČSN-AE-1,4 B-weight B2 (with a hand turning starter)	110 kg ± 2%

Engine dimensions.

Length of the engine without propeller hub	958 mm
Overal length of the engine including the wooden type propeller head	1032 mm
Engine width without bearing feet	399 mm
Overal width of the engine with normal bearing feet	466 mm
Overal height of the engine	632 mm
Height of the engine above the propeller axis	158 mm
Height of the engine under the propeller axis	474 mm

Dimensions of pipes.

Inlet fuel-pipe	6 mm I. D.
Fuel primer pipes in the induction manifold	4/2 mm O. D./I. D.
Drain pipe in induction manifold	5/3 mm O. D./I. D.
Fuel pressure gauge pipe	6/4 mm O. D./I. D.
Oil inlet pipe	20 mm I. D.
Oil scavenge pipe	13 mm I. D.
Oil pressure gauge pipe	6/4 mm O. D./I. D.
Piping leading to subpressure apparatuses	6/4 mm O. D./I. D.

Engine transport box dimensions.

Length of a normal transport box	1352 mm
Width of a normal transport box	636 mm
Height of a normal transport box	870 mm
Weight of a normal transport box	90 kg
Total weight of the box together with the engine	190 kg

There is a type plate on every engine on the crankcase in the left with the number of the serie and of the engine and another plate underneath stating the principal datas giving instructions about the valve and ignition timing and principal informations about the operating of the engine, fuel and lubricants, their consumption, temperatures and pressures.

DESCRIPTION OF THE MAIN ENGINE PARTS.

Crankcase.

The crankcase is composed of the crankcase body, the top and the front cover including the thrust-bearing lid. All parts are cast in heat treated electron. The crankcase body is provided with double cross walls which carry the crankshaft and camshaft bearings. On the bottom side there are flanges with studs for attaching the cylinders to the crankcase. On the flanks of the crankcase there are four flanges for the bearing feet of the engine. On the rear case wall there is a standard flange for the starter and flanges for oil and fuel pumps, magnetos, tachometer drive and oil sump. On the top cover there are three hanging hooks and at the back a breather of the inner space of the crankcase. A bolted cover and the thrust-bearing lid closes the crankcase at the front. The crankcase front cover and the lid hold the thrust bearing in position.

Crankshaft.

The four-throw-crankshaft (pict. 4), a forging of special chromium-molybden-vanadium steel suitable for nitriding is machined all over. Main journals and crank pins are nitrided. Both kinds of pins are hollow and serve together with the channels in the crankshaft webs to distribute the lubrication oil from the main journal to the connecting rod bearings. The hollows are closed bothsides by sealing plate plugs.

The front end of the crankshaft is conical with a key groove and a thread for the propeller hub retaining nut. A timing driving gear and a starter jaw are attached to the rear end of the crankshaft and are engaged by radial grooves and secured in position by a jaw retainer. The crankshaft is supported in five journal bearings. These bearings are steel shells cast with lead bronze. A thrust ball bearing in the front absorbes the propeller thrust. The journal bearing shells are tigtened by removable bearing covers of aluminium alloy. The thrust ball bearing together with the thrower is retained to the shaft by a ring nut.

Propeller hub.

The wooden type propeller hub for fixed propeller is composed of two parts: the hub and the flange. The hub, a forging of chromvanadium steel, is keyed to the tapered extension of the crankshaft and held in position by a retaining nut secured by a circlip. The rear part of the hub enters the hole in the front cover and is provided with an oil return thread. When removing the propeller the hub remains on the shaft. The electron flange of the propeller hub is fixed to the hub together with the propeller by means of eight bolts.

Connecting rods.

The connecting rods (pict. 4) of H-section are stamped from special aluminium alloy and polished all over. The split big ends are clamped by two bolts each and fitted to the crank pin with a two piece steel shell cast with lead bronze. The gudgeon pin is supported directly in the bushless small end of the connecting rod.

Pistons.

The pistons (pict. 4) are drop forged from special aluminium alloy. Each piston is provided with three compression rings and one perforated scraper ring. The floating gudgeon pin is secured by circlips.

Cylinders.

A cylinder consists of a cylinder barrel and a removable head. The cylinder barrel is a nitrided steel forging turned in one piece with the cooling ribs and flange. The bore of the cylinder barrel is nitrided.

The cylinder head is a special alloy casting with dense cooling ribs. The base part of the rocker cover is cast in one piece with cylinder head. The induction and exhaust port opens on the right side of the head. Steel valve seats and bronze valve guides are pressed into the head and two bronze sparking plugs adaptors with thread M 12 × 1,25 are screwed tight into the head.

The cylinder head is set on the barrel and made gas-tight with a copper asbestos ring. Both parts are bolted together

and to the crankcase by four long studs screwed into the crankcase. The valve mechanism is protected by electron rocker cover.

Valve gear (Pict. 6).

The opening of the valves is actuated by the cams of the camshaft by means of tappets, push rods and rockers; the closing of the valves is achieved by valve springs. The timing is described in the chapter on ENGINE SPECIFICATIONS and shown on the timing diagram pict. 7. The opening of the valves of respective cylinders proceeds in the order 1—3—4—2.

The c a m s h a f t is housed in five journal bearings. The front electron bearing is fixed from the outside by the flange to the front wall of the crankcase; the rear aluminium alloy bearing is inserted in the last cross wall of the crankcase. The diameters of middle bronze bearings are large enough for the camshaft to pass through; they are pressed into the cross walls of the crankcase. The camshaft gear and the left magneto drive bevel are keyed to the camshaft rear end. The camshaft rotates at half the speed of the crankshaft. It is driven from the driving gear on the crankshaft rear end by means of a layshaft gear which rotates freely on a layshaft held in the rear wall of the crankcase.

The t a p p e t s possess at the side of the push rod insertions with ball ends. They move in special aluminium guides where they are secured against rotation by a slot adjusted to their square heads.

The p u s h r o d s of duraluminium tubes have a concave shaped ends. Each push rod is closed oil-proof in a housing of aluminium tube that is sealed on both ends by a tightening insertion of artificial rubber.

The r o c k e r s are supported on a common pin on needle bearings. Each rocker has a roller at the valve side and an adjusting screw for the adjusting of valve clearance at the side of push rod; the screw is secured by a lock nut.

V a l v e s. There are two parallel valves fitted to each cylinder, one inlet and one exhaust valve made of special steel. Both valves are interchangeable. The valve stems are nitrided and their top ends affected by the rockers are stelitted.

Each valve is closed by two coil springs which are the

same for inlet and exhaust valves. The valve spring top washer is held in position on the valve stem by a split cotter of conical form.

The valve mechanism on the cylinder head is enclosed in an oiltight box. The electron box cover is sealed through a cork joint washer and held tight by a nut. This cover is filled with oil when the engine is in service.

Induction system.

The engine receives fuel from a down-draught WALTER 45 carburetor provided with a manual mixture control, an acceleration pump and with device for normally acrobatic figures; when an endurance flight in inverted position is desired, acrobatic carburetor WALTER 45 AK must be fitted. This carburetor makes possible a high acrobatic flying at full throttle. The induction manifold is an aluminium alloy casting leading along the right side of the cylinders and is sealed both at the cylinders and the carburetor by joint washers. It is preheated by exhaust gases of the 2nd and 3rd cylinder whose exhaust pipes pass through the clamps of the induction manifold. A too great preheating of induction manifold becomes by direct contact of the exhaust tubes and induction manifold in summer weather. To prevent this preheating, special inserting clamps are to be removed, to make sure isolating gap of air between the exhaust tube and the induction manifold. This inserting clamp must be stored in pilot's tool roll, to be ready for installation in cold weather.

The throttle lever and mixture control lever on the carburetor are joined by means of pull-rods with a couple of intermediate levers on the induction manifold (enclosure III); control pull rods are connected to the ball joints of these levers. The movement of the mixture control intermediate lever of the mixture control is restricted by the engaging pin on this lever so that the maximum deviation in the direction of „Poor Mixture" is given by the instantaneous position of the throttle intermediate lever; in the extreme position of the throttle intermediate lever at slow run the mixture control lever must be in the position for „Rich Mixture". The range of the mixture correction increases gradually with the opening of the throttle.

There are two primming connections in the induction manifold; on the rear primer there is the connection joining the

tube of the primer pump, which is supplied on special order and placed directly on induction manifold and controlled by a bowden cable. Further below the elbow of each cylinder there is a fuel drain valve with a connection for joining the drain tube. On the rear wall of the manifold there is a plug instead of which a connection for sub-pressure apparatuses can be fitted.

Fuel is led to the carburetor either by gravity feed directly from the tank in the plane or by means of the WALTER 2M 50 fuel pump. The connection for attaching the fuel hose is placed in the rear on the bottom of the carburetor body. A simple sheet air intake or a combined warm and cold air intake (pict. 8 and encl. IV) may be attached to the flange of the carburetor orifice. In the electron body of the warm and cold air intake there is a two position flap controllable from the cockpit. In the one position of the flap air is sucked in through the air intake whose orifice is situated outside the engine cowling in the other position air preheated by the cylinders is drawn in. The warm air streams through a flame trap placed in the orifice under the flap. WALTER 45 AK carburetor is described in a special chapter at the end of this book.

Ignition.

The ignition is double and without or with screening. The ignition magnetos SCINTILLA VERTEX NVK-4 Z2 (left) and AVK-4 Z2 (right) unscreened type with automatic spark advance rotate in clockwise direction. The right magneto has an impulse starter. They hang next to each other on the rear wall of the crankcase and are retained by fixing bands. They are driven by bevel gears: left magneto from the camshaft, the right magneto from the layshaft rotating at half the speed of the crankshaft. The right magneto supplies current to right sparking plugs, the left one to left ones. Both magnetos possess clamps for the short circuit cable. They are fitted to the engine together with the engaging gears and the covers which are fixed to the neck of the magneto by means of a locating screw; the covers enclose the entrance of the crankcase for the passage of the gears and are retained to it and sealed by cork rings.

There are two sparking plugs on both sides of each cylinder head with M 12 × 1,25 thread. The ignition order is 1—3—4—2 according to the cylinder number (pict. 9). The cables

lead along the cylinders in protecting tubes. At the sparking plug ends they are provided with ball bear terminals which are set on the ball ends of the sparking plugs and secured with circlips.

Lubrication.

A dry sump lubrication force-feed system has been employed (encl. II). Its circulation has been secured by double gear type oil pump consisting of pressure and scavenge pump.

Circulation of oil in the engine.

Fresh oil is sucked in from the tank through an oil piping and an inlet filter into the pressure pump. From here it is delivered through the outer pipe system into the lengthwise channel in the left wall of the crankcase and then through the cross channels to the crankshaft main bearings, to the front and rear camshaft bearing and to the right gear layshaft bearing.

Lubrication of the journal bearings of the crankshaft:

Pressure oil at full pressure.

Lubrication of the crankshaft thrust ball bearing:

With oil flowing out of the front crankshaft journal bearing.

Lubrication of the connecting rod bearings:

By pressure oil of full pressure from the holes of the crank pin cavities. The oil is pressed into these hollows from the crankshaft main bearings through the bored pins and the crankshaft web channels.

Lubrication of gudgeon pins:

With oil scraped from the cylinder walls with the scraper ring on the piston and led through holes and channels into the inside of the piston: with oil flowing on the surface of the connecting rods from the connecting rod bearings; with splashed oil.

Lubrication of cylinders and pistons:

With oil splashed from the crankshaft mechanism.

Lubrication of the camshaft:

The front and the rear bearing with oil of full pressure; the rest of the bearings with splashed oil flowing down the crankcase walls.

Lubrication of cams and tappets:

With oil led through hollow camshaft from its front bearing and through the channels in the cams; with splashed oil.

Lubrication of gears and auxilliary drive bearings; the bearing of the intermediate layshaft of the drives and the right layshaft drive bearing with pressure oil led through the channels in the crankcase wall; left layshaft drive bearing with oil of lower pressure led through the channels from the rear camshaft bearing.

Lubrication of the tachometer driveshaft:

Directly from the pressure oil pump.

Lubrication of rockers, valve springs and valves:

With oil filled in the rocker cover.

The splashed oil is accumulated in the bottom parts of the crankcase and flows down in the oil sump fixed to the bottom of the crankcase. From the sump it is returned by the scavenge pump through the returning pipe into the oil tank.

There is a connection to the oil gauge on the pressure oil pipe union on the crankcase.

Oil pump.

An oil pump (enclosure II, pict. 10) is fitted as a unit to the rear wall of the crankshaft in the camshaft axis and is driven from its rear end by means of a suitable slot. The pump is composed of two parts: from the rear narrower pressure pump and from the front wider scavenge pump. The pumps are separated by a steel interplate but they have a common driving shaft and a fixed pin.

There is an inlet oil filter before the pressure pump whose gauze can be removed for the purpose of cleaning.

In the body of the pressure pump the intake and the exhaust side of the pump are joined by a channel with a pressure relief valve which automatically maintains the prescribed oil pressure 3—4 at. The valve is loaded with a spring, whose tension and in this way also the oil pressure can be

changed by an adjusting screw secured by a nut. Turning the adjusting screw clockwise the pressure will increase and reversely it decreases.

The original normal realize pressure adjusted by the manufacturer should not be altered without cogent reason.

Air — breathing of the crankcase:

For this purpose a breather is fixed to the crankcase cover with an orifice for attaching the air hose. The gorge of the breather is provided inside with a tube connection for collecting the splashed oil.

Cooling.

The engine is cooled by air led during the flight by sufficiently great inlet of the sheet air baffle in front of the engine cowling. The rear end of the passage formed by this baffle along the left side of the cylinder row is closed and causes the air to flow across spaces between single cylinders. The passages are closed at the opposite sides by sheet baffles which force the air to flow between the cooling ribs of the cylinders and cylinder heads and all round the cylinders. Also the first cylinder is closed at its front by a sheet cover. The air baffle is collapsible and is fixed to the crankcase with nuts and with a joint on the cylinder heads. The access to the left sparking plugs is facilitated through holes in the air baffle closed by a removable sheet covering slide.

Starting.

In the crankshaft axis of the rear crankcase wall there is a standard flange of ČSN AE-7,1 („SAE 5") with the possibility of mounting an either WALTER R 25 hand starter with a crank or WALTER RE 25 hand and electric starter with a crank or WALTER P 320 electric starter. When operating the crank, the rotating starter jaw engages automatically with the jaw on the rear end of the crankshaft.

To facilitate the engine starting there are two primers in the induction pipe and an impulse starter in the right magneto.

WALTER R 25 hand starter, WALTER RE 25 hand and electric starter and WALTER P 320 electric starter are described in a separate chapter at the end of this book.

Accessory drives and equipment.
(Enclosures II. and III.)

On the rear wall of the crankcase are at the left hand side a tachometer drive and at the right hand side a flange and a drive of fuel pump. At the left and at the right side of the crankcase there is each a mounting flange and a drive for generators. To the left flange can be fitted a directly; to the right another apparatus can be fitted.

All the drives are derived from the driving gear on the rear crankshaft end. This gear drives the intermediate layshaft gear which rotates freely on a spindle held in the rear cross wall of the crankcase.

The intermediate layshaft drives the camshaft on the one hand and the right layshaft on the other.

The large gear on the camshaft receives the drive from the intermediate layshaft. Behind this wheel a left magneto driving bevel gear is set on the camshaft. The oil pump is driven by the rear end of the camshaft and the pump itself drives the tachometer; all these parts lie on the same axis.

The right layshaft is supported in an aluminium alloy bearing in the rear cross wall of the crankcase. Two gears are keyed to this shaft and retained by a nut; the large one receives the drive from the intermediate layshaft gear and drives the right drive: the other one placed behind is the bevel gear driving the right magneto. The layshaft rear end drives the fuel pump.

Tachometer drive.

The short shaft of the tachometer drive engages on its inside end with its tongue to the slot in the oil pump driving shaft. The end of the shaft in the rear is according to ČSN AE-5,15. The drive cover which is screwed to the body of the pressure oil pump is provided with a connection of the same standard for joining the flexible shaft of the tachometer drive. The tachometer drive rotates clockwise with half the speed of the crankshaft.

Fuel pump drive.

The fuel pump is driven directly from the shaft of the right layshaft gear drives by means of a tongue of the pump shaft which engages into its slot. The fuel is led from the

outlet pump connection through a flexible hose to the carburetor. On the outlet pump connection there is also a union for the fuel gauge pipe.

WALTER 2M 50 fuel pump is described in a separate column at the end of this book.

Generator left direct drive:

Direct gearing generator drive is housed in a case attached to the left side flange of the crankcase. The drive is transmitted from the large gear of the camshaft over the layshaft gear on the engaging gear of the generator drive housed freely on a spindle. There are grooves in the hollow of the engaging gear for the generator shaft. Both driving gears ride in bronze bushes; leakage of oil into the generator is prevented by a special packing on the engaging gear. The generator for 24 V 300 W provided with a flange has a grooved shaft and is attached to the front flange of the drive case and is fixed by two fixing bands to the support bolted to the crankcase. The generator rotates anticlockwise at twice the speed of the crankshaft.

If the engine is not provided with a generator, there is also no drive and the mounting flange on the crankcase is closed by a cover.

Attachment of the engine.

The engine is hang elastically on four points. Standard bearing feet or specially adapted feet to the engine bed construction and the placing of the engine in the fuselage in the wing of the aircraft are attached to the corresponding flanges on the sides of the crankcase. Ring shaped rubber vibration dampers are put on the feet.

PART II.

INSTALLATION OF THE ENGINE INTO AIRCRAFT

TRANSPORTATION OF THE ENGINE.

MINOR 4-III engine is transported in a special transport box, whose dimensions and weights are stated in the chapter of ENGINE SPECIFICATIONS. It is placed on a bracket, which is attached to the side walls of the box.

After opening the cover the bracket is released from the walls and together with the engine it is taken out of the box by means of a puller and engine lifting eyes. After lifting the engine from the box release first the engine feet and slip out the engine from the box. Instead of the fixing feet attach the bearing feet with rubber dampers and secure the bearing feet nuts by washers.

The location of the engine into the box proceeds in reverse order. Before placing the engine into the box it is necessary to close all openings: by suitable blind covers oil inlet and outlet connections, oil gauge connection, primer connection, fuel inlet connection on the fuel pump and fuel gauge connection the breather orifice (by a rubber cap), the connection on the tachometer drive cover (by a covering nut), exhaust orifices and the air intake orifice of the carburetor (by sheet blind cover).

MOUNTING THE ENGINE IN THE AIRCRAFT.

The mounting of the engine into the aircraft is accomplished in the following way:

1. Set the engine on its bed so that the bearing feet are seated on the bearings of the engine bed. Then set and screw tight the bearing covers.

2. Corresponding gaskets supplementally mounted must be inserted between the flanges on the engine. The nuts of the fixing screws should be secured by spring washers.
3. Attach the throttle pullrod to the throttle lever and a respective pullrod to the mixture control lever. The pins of the forks of both pullrods must be carefully secured by split pin. Remove the sheet blind cover from the carburetor air intake and connect the air intake tube instead. If temperature controllable air intake with a two-position flap is fitted, a controlled pull rod must be connected.
4. Attach the fuel inlet pipe to the fuel pump connection and a control bowden connect to the priming pump on the induction manifold, to make possible the control from the pilot's cockpit. At the same time connect the drain pipe to the valves draining the condensed fuel from the induction manifold.
5. Remove the blind covers from the oil inlet and outlet orifices. Connect the pipe, leading in fresh oil from the tank, to the inlet orifice of the fuel pump and the pipe, leading scavenged oil back to the oil tank, to the outlet orifice. The piping should be rinsed with pure oil before installation so as to remove all impurities. The connections of oil piping must be perfectly tight so as to prevent air from comming in and oil from leaking out of the piping. After removing the blind covers connect either the pressure oil relay or oil gauge pipe to the pressure feed oil connection on the crankcase.
6. Connect the short circuit cables, leading to the ignition switch to the terminals, on the cylindrical casings of both magnetos. The short circuit cable should be connected to clean metal of the engine and the lead checked. The complete electrical installation should be insulated and the cables must not interfere nor contact the aircraft construction; especially they must nowhere come into touch with sharp edges.
7. Unscrew the covering nut of the tachometer drive, set in the flexible shaft and attach it by a union nut. Before mounting the flexible shaft check for smooth rotation of the shaft in the hose and grease it with a mixture of fat and graphite.
8. Remove the blinding rubber cap from the breather on the crankcase and connect the corresponding piping instead.

9. If the engine is provided with a hand turning starter, it is necessary to see that the bearing leading the crank is fixed to the cowling in such a way as to enable an easy reach of the turning shaft with a crank.
10. Set on the propeller and fix it. The procedure is described in the following chapter.
11. Unscrew the sheet blinds of the 1st and 4th cylinder exhaust orifices and attach the exhaust pipes instead. Insert corresponding copper-asbestos packings under the flanges of the exhaust pipes. If there is an exhaust collector in the aircraft, it must never be hanged on cylinder heads.
12. Set the engine cowling on and fix it.

It is necessary to keep all the blind covers and rubber caps that have been taken off so as to be able to use them by next dismounting of the engine from the aircraft.

FUEL INSTALLATION.

Fuel is conducted to the carburetor through a flexible hose of 6 mm I. D. When installing the pipes, it is necessary to avoid sharp bends and knees especially in vertical plane as in these bends either air or water could easily be accumulated.

Fuel is usually delivered to the carburetor by a fuel pump. If this is not mounted on the engine, and the fuel is delivered to the carburetor by gravity feed, it is necessary that the fuel tank should be placed 600 mm above the level c, see ZP 13,5. If the engine is provided with a fuel pump, the tank must be placed lower i. e. at any place in the aircraft. A stop cock and fuel filter should be provided for in the supply piping. A hand drawing pump for filling the carburetor before starting the engine must also be fitted in fuel leading system. This claim is fulfilled, when the fuel pump is provided with a hand overflowing device. The sprayer nozzles in the induction manifold are connected with the priming pump in the pilot's cockpit by a pipe of 4/2 mm O. D./I. D. The priming pump sucks in the fuel from the fuel piping before the carburetor.

The contents of the tank (tanks) is determined by the flying range considering the maximum fuel consumption. Every tank must be ventilated. On the lowest spot there should be a deepening with a drain cock or drain plug for

water and grit. The fuel feed pipes should be located in such a way that fuel is delivered to the carburetor in any aircraft position, even at lowest fuel head; their mouths should be provided with a gauze. Also the tank filling orifice must be provided with a very fine gauze. A cock or a plug at the bottom of the mud sump serves to drain off the fuel. The outlets of all drain cocks, plugs, ventilation pipes etc. should be located on principle outside the engine cowling.

OIL INSTALLATION.

When installing the pipes, it is necessary to avoid sharp bends and knees. The I. D. of the oil feed pipe from the tank to the engine should be at least 20 mm, the I. D. of the drain pipes from engine to tank 13 mm. An oil filter with a gauze No. 50 of area abt. 200 cm^2 must be incorporated in oil installation. Having not received a sufficient oil cowling by suitable arrangement of engine cowling and oil tank, an oil cooler must be incorporated in scavenge piping system. A drain cock should be fitted in the lowest place of the oil system making possible to empty the tank, the piping and the engine.

Oil tank capacity should be at least 20% higher than the maximum oil consumption of 8 g/B. H. P./hr. for the duration of time corresponding to the fuel tank capacity plus abt. 5 lit. of oil, which is necessary for oil circulation. So as to take allowance for possible oil foam it is necessary to leave free space of 20% of total tank capacity above the highest oil level. The inside space of the tank should be ventilated by a tube the outlet of which should be led out either under the fuselage or on the top cover in the inside of the engine space. On its lowest spot the tank should be provided with a sump, collecting the oil impurities with a plug or a drain cock. The inlet of the return oil into the tank and the oil outlet from the tank to the engine must be so arranged as to allow the all impurities to descend. A filling orifice large enough to put in an electric heating device should be provided with a fine gauze. The oil tank should be located as near as possible to the engine so that the suction head of the oil pump (the height of the oil pump inlet above the lowest oil level) should not exceed 500 mm.

If the oil tank is located in the aircraft in such a way that the highest oil level in the tank is higher than the oil inlet to

the fuel pump the induction piping should be provided with a device preventing, when the engine is not in service, the flow of oil through the oil pump. It can be done by an easily accessible stop cock which must be always opened again before starting the engine. As a safeguard not to forget to open the oil cock before starting the engine it is necessary to connect the oil stop cock with the ignition switch. Also in this way of arrangement, the stop cock can be a source of troubles.

The oil pressure pipe line to the oil gauge of 4 mm I. D. is connected to the outlet union on the pressure pump. The piping must be sufficiently elastic and secured against vibration and fracture. We recommend to use a gauge reading from 0—7 at. The inlet and the outlet oil temperature should be checked during flight so that they never exceed the maximum permissible values. They are measured by thermometer bulbs placed into the oil pipe near the engine in a suitable way so as not to hinder the free oil flow.

Ignition.

The ignition switch, which is connected on the one hand with the corresponding terminals of the magnetos and on the other with the crankcase contact terminal (there is an insulation between the engine and the bed), is placed in the pilot's cockpit. The ignition switch must be provided with four distinctly marked positions, i. e. the „ON" and „OFF" positions and two further positions to switch on either only the right or only the left magneto. The wiring should be carefully carried out and protected against moisture as the safety of the people working on the engine or swinging the propeller depends on its good function. There is no special device necessary as the advance and retard proceed automatically.

Controls.

The engine is controlled by throttle lever and mixture control lever only. The engine running is checked by viewing the number of revolutions and the pressure and temperature of oil.

The movement of the mixture control lever is limited by the position of the throttle lever in such a way that the mixture control lever can only be moved in its extreme opened

position, when the engine is at full throttle and closing the throttle the mixture control is closed at the same time.

The connecting rods between the controls in the cockpit and the carburetor should be sufficiently stiff and well placed so that they cannot vibrate or bend. The connecting joints should be fitted exactly and without clearance.

The controls in the cockpit should give slightly more than sufficient movement in order to give full travel to the controls on the carburetor.

Carburetor air-intake.

Engines provided with carburetor air intake with a two position regulation flap make it possible for the pilot to control the temperature of air sucked into the carburetor.

In the cockpit the lever regulating the temperature of the sucked air has extreme positions „Warm Air" and „Cold Air" which must be distinctly marked as such. By getting the lever into one of these positions it is possible to adjust the temperature of the sucked air to the weather and flight conditions so that the run of the engine is calm.

Intake of warm air is very important especially in foggy weather and temperatures round 0^0 C, when the intake of cold air might cause freezing of the carburetor i. e. forming of an ice-accretion on the throttle and the choker.

Tachometer drive.

The tachometer drive is located on the rear side of the crankcase on the oil pump cover. The drive corresponds to ČSN AE 5,15. The tachometer drive rotates clockwise, at half the speed of the crankshaft. The tachometer dial should read from 0—2800 R. P. M.

Starter.

On the rear side of the crankcase there is a standard flange according to „ČSN AE 7,1 or SAE 5". WALTER R 25 hand starter with a crank, WALTER RE 25 electric and hand starter with a crank or WALTER P 320 electric starter according to request may be mounted on this flange.

Direction of rotation of the starter is clockwise when looking at its flange. The movable bearing of the crank must be fixed on the engine bed or on the fuselage.

When setting the starter into motion, the starter jaw is automatically engaged with the jaw of the crankshaft and the engine having been started, the starter jaw returns back into its base position. Eventual back-kicks of the engine are retained by the clutch so that they cannot be transmitted to the proper mechanism of the starter and to the crank.

Generator.

The generator is attached directly to the engine and driven by the gears. This direct drive is situated at the rear end of the crankcase at the left side of the engine, with a ratio 1 : 2. The weight of the generator with direct drive is carried by the engine. The symetric placed drive at the right side of the engine may be used for any other apparatus with a ratio 1 : 2.

Exhaust system.

Supplied with the engine are two exhaust tubes which pass through the induction manifold and two flanges of these tubes. The tubes which pass through the induction manifold serve to its preheating. Other two tubes are supplied only on special request.

Exhaust gases of corresponding cylinders are led through these tubes directly outside the engine or collected in the exhaust collector and then led under the fuselage. When constructing the exhaust collector it is necessary to see that no narrowed spots or sharp bends occur in the tubing. Increased resistance in the collector would namely cause decrease of the engine output and an increase in temperature. Cylinder heads must not be stressed by forces originating through heat expansion of separate parts of the exhaust system, its weight or vibrations. The exhaust tubing must be cooled by air stream.

Engine cowling.

The engine cowling must not hinder air entering into the air baffle leading, the air round the cylinders, on the contrary it should facilitate the air exit from the engine. It is necessary to place the outlet opening on spots with subpressure during flight; they must not decisively be placed where is even a slight super-pressure.

We recommend following openings in the cowling:

for engines with velocity under 250 km/hour about 300 cm^2
for engines with velocity above 250 km/hour about 250 cm^2
air intake opening to the carburetors . . . min. 30 cm^2
width of the circular slot behind the propeller hub cover (square to air stream direction) min. 10 mm
outlet opening of cooling air . . . . . about 600 cm^2

The mentioned values are theoretical and real values must be tried during the flight. The test of correct cowling of the cylinders is carried out by measuring the temperatures of cylinder heads during the flight. The temperature of the heads should be measured by a thermo couple namely under the right spark plug of the second and third cylinder. The temperature must not exceed 260° C; under normal conditions, when climbing, it should not be higher than 250° C and even then at short time only. Normal temperature is 190—230° C. The temperature of oil leaving the engine may only exceptionally reach 105° C. Under normal conditions it remains within the range of 50—90° C.

The propeller.

The propeller must be adjusted to nominal output of 105 BHP at 2500 R. P. M. at ground level flight and full throttle. The propeller must always be statically and dynamically balanced and centered.

The wooden propeller hole and the bed faces of the propeller hub flanges must be smoothly and exactly machined, to make sure a strictly fit of the propeller.

Also the bolt holes in the propeller must be bored precisely. All bolts must be well tightened and their nuts secured. The engine must never run with badly mounted uncentered or unbalanced propeller. It is necessary to check the tight fit of the propeller and the hub from time to time, and screw tight the nuts as case may be.

PART III.

RUNNING INSTRUCTION.

FUEL AND LUBRICANT.

Faultless operation of the engine requires the use of fuel and lubricant only that satisfies the further down mentioned prescriptions. Fuel and lubricant not satisfying these prescriptions can cause defects in engine operation or serious damage of the engine and therefore must not be used.

Fuel.

Aviation fuel with octane number at least 72 (according to C. F. R. Motor Method) is the prescribed fuel.

Fuel with lower octane number must not be used as it would cause detonation and troubles in engine operating, overheating and serious mechanical defects of the engine apart from decreasing of power and higher fuel consumption.

The used fuel must satisfy all terms of the valid fuel prescriptions for aviatic engines.

The tank is filled with fuel using a funnel with a fine gauze or through deer skin. No impurities, dust or water may penetrate into the tank. The filling orifice of the tank must not remain open without purpose. Also the safety instructions must strictly be kept.

Oil.

For both summer and winter operating best mineral oil is prescribed; specific weight max. 0,92, absolute kinetic viscocity at 50° C: 17—24° E, i. e. 130—172 cSt, at 80° C at least 5° E. i. e. 37 cSt; fluid at —10° C at least 10 mm.

The oil must satisfy all the conditions of valid lubricant instructions for aero-engines.

Fresh oil is poured into the tank through a funnel with a fine gauze. Filling vessels, funnels and tank orifices must be absolutely clean, free from dust and impurities whatsoever; no impurity or water must get into the tank while filling.

Grease.

Special SCINTILLA G. grease is prescribed for filling the grease cups of the magnetos. The flexible shaft of the tachometer drive is filled with mixture of prescribed grease and graphite. The same grease is used for greasing the crankshaft cone and thread when setting the propeller hub.

PREPARATIONS BEFORE STARTING.

The following operations serve only to test quickly the readiness of the engine for flight. All necessary examinations and work at regular attendance of the engine are described in a separate column. There is also mentioned the special attendance before the first starting of a newly mounted engine into the aircraft — either new or after repair.

1. See that sufficient oil is in the tank and fill up if necessary. The tank must not be completely full; there must be free space in the tank (about 20% of its volume) for the oil foam. On the other hand there must be oil enough at least to suffice for the presumed flight at its greatest specific consumption and in addition to it 5 litres as the least amount necessary to maintain the oil circulation. At a temperature near to the freezing point of used oil it is necessary to heat the oil to temperature of 50—60° C for sufficient fluid so that the engine after starting draws safely in. The oil may be heated by an electric heating device if fitted into the tank. Oil should be poured into the tank from clean vessels by a funnel with a dense sieve.
2. Carefully examine the oil piping for any leakage of oil. Open the stop cock if fitted into the feed piping.
3. Examine the amount of fuel in the tank, let out the settled water and grit from the filter and fill up the tank if necessary. Examine thoroughly the complete fuel pipe system. When filling the tank pour the fuel over deer skin to catch impurities and water and pay attention to all safety instructions.

4. Examine the ignition system and check its correct functioning especially the ignition switch, and test the cables that they are in best condition. The safety of the flight and of the mechanic turning over the propeller depends on the correct functioning of these parts.
5. Make sure of the correct functioning of the control mechanism of the engine i. e. pull rods, throttle control, correction lever control, warm and cold air inlet, control, cocks etc.
6. Check the tachometer drive.
7. Turn over the engine for several revolutions by hand with the ignition off to see that there is no oil in the cylinders which could cause damage to the engine during the compression stroke; at the same time check the compression in each cylinder. In freezing weather it is necessary to turn over the engine for more revolutions, to make sure that the warm oil from tank reaches the main journal bearings and deminishes the resistance.
8. Check the tightness of all external nuts, bolts etc. on the engine and tighten them down if necessary. See that the propeller is mounted correctly and control carefully the engine bedding.
9. Turn on the fuel main cock and other cocks, as case may be, in the fuel pipe system according to the instructions of the aircraft producer.
10. By a few strokes of the hand fuel pump fill the pump on the engine and the carburetor with fuel (this does not concern engines fed by gravity fall).

STARTING THE ENGINE.

After carrying out the preliminary inspection and procedure outlined in the foregoing paragraph, open the throttle just a little. A wider opening would set the slow run device in the carburetor out of function. Never move the throttle lever quickly in succession into its „full open" position as the acceleration pump in the carburetor would flood the induction manifold with fuel.

The mixture control lever remains in the „Closed" position (according to the running of the engine on the ground).

Make sure that the ignition is „OFF".

If there is a priming pump on the engine or in the cockpit, inject fuel into the induction manifold when starting a cold engine (2—4 strokes). When WALTER priming pump is fitted, it is sufficient to draw twice to four times the lever at pilot and loose it. When drawing, the pump sucks in the fuel and after loosening it sprays the fuel into the manifold. If the priming device is not installed in the aircraft, it is possible to inject fuel into the carburetor and the induction manifold by opening and closing the throttle a few times by means of which the acceleration pump in the carburetor is set into function. Care must be taken not flooding the induction manifold by fuel, because the fuel is not sprayed sufficient in this way of priming.

Starting by hand (by rotating the propeller).

In this way of starting the person doing the starting must have a helper at the propeller. The helper first rotates the engine by the propeller, the ignition being switched off, a few times forward (in the direction of rotation of the engine) for the engine to suck in sufficient amount of fuel. On given signal the person in the aircraft then puts on the ignition. The helper rotates new the propeller sharply always over the compression in one of the cylinders; only till the engine starts, the utmost care is to be taken since the ignition was switched on.

Starting the engine by a handstarter with a crank.

In this way of starting it is not necessary to touch the propeller. The turning the engine proceeds with a crank turned by the helper of the starting person. When the engine after several revolutions has sucked in sufficient amount of fuel, the person in the aircraft puts the ignition on. The helper continues turning the crank till the engine starts. Also here care must be taken.

Starting the engine with electric and hand starter.

Switch on the ignition and press on the button on the panel so long till the engine starts. If the engine should not start after several revolutions, switch off the starter as by its use the battery discharges quickly.

When starting a hot engine, it is necessary to open a little

the throttle and decrease or omit altogether priming of fuel into the induction manifold.

If the engine will not start after a few attempts, switch off the ignition and search for the defect. Further priming of fuel is useless and causes overflowing the induction manifold and the cylinders by fuel. In this case open the throttle entirely and turn the propeller for several revolutions against its direction of rotation with ignition switched off.

Before any work near the propeller it is always necessary to see that the ignition has been switched off.

ENGINE TEST ON THE GROUND.

Warming the engine.

Having started a cold engine let it run 1—2 minutes at 500—1000 r. p. m. so as to get sufficiently warmed up and lubricated. The oil gauge must show the oil pressure 10—15 seconds after starting at the latest. By cold oil it is higher than normal. If the oil gauge does not show the pressure, it is necessary to stop the engine and investigate the cause (solidification of oil owing to a low outer temperature, defect in the oil piping, the relief valve or the oil gauge may be defective etc.). After 1—2 minutes running increase slowly the number of revolutions to about 1500 r. p. m.

Only when the oil pressure has reached about 3—4 at. and the inlet oil temperature is about 20° C or the oil outlet temperature 30° C (if there are respective thermometer bulbs) after abt. 5 minutes of engine running — longer time in winter and shorter in summer — it is permissible to increase revolutions gradually to full throttle and then accomplish the engine test.

The colder the outer temperature and the oil in the tank are, the more carefully must the engine be warmed up. For no reason whatsoever (burning out the oiled sparking plugs etc.) it is permissible to increase suddenly the number of revolutions shortly after starting the engine.

Sudden rise of the oil temperature or sinking of the oil pressure when warming up the engine would be a sign of some defect.

Operation test.

After the oil pressure has settled down to 3—4 at. and the oil inlet temperature to at least 20° C (or oil outlet temperature to 30° C) make the test. Give the full throttle (neither too slowly nor suddenly) and mark the maximum revolutions of the engine and the oil pressure. Then test the ignition by switching off one magneto for a short time giving a full throttle. The same is to be carried out, by switching off the other magneto. During the engine run with one magneto only the number of revolutions must not drop more than 50 R. P. M. compared to the number of the engine revolutions with both magnetos switched on. By several faster (not sudden) openings and closings of the throttle, test the accelerations from low to high revolutions and v. v.

Having accomplished these tests throttle down immediately to slow run. The engine test at full throttle on ground and when the aircraft is standing must not last longer than 30 seconds because the engine is not cooled properly and would get overheated within a short time.

Following values should be examined by the engine test:

Number of revolutions on the ground at full throttle (according to the aircraft and propeller type)	abt. 2000 R. P. M.
Oil pressure at these revolutions . . .	3—4 at.
Lowest permissible oil pressure at slow run	2 at.
Drop in the number of revolutions with one ignition off (at full throttle) . .	max. 50 R. P. M.

Don't prolong unnecessarily the slow run of the engine between an engine test and the start or between a landing and the consequent start of the aircraft as the sparking plugs would get impured.

Special care must be taken that all the sparking plugs really ignite. If any of them were deficient they should be changed immediately.

Don't start for flight sooner than the engine operates perfectly at any number of revolutions, also at slow run, and by accelerating without misfiring, backfiring and shocks.

When starting don't open to full throttle from slow run too quickly. Too sudden opening of the throttle is not sui-

table for a faultless acceleration to the full number of revolutions, which is reached by a quick (not sudden) opening of the throttle.

THE OPERATING OF THE ENGINE IN FLIGHT.

When in flight the engine is controlled by the throttle lever and the corrector lever only. Check its running by watching the tachometer, oil pressure gauge, and the thermometers.

Within the whole throttle range and in acceleration from one speed to the other the engine must operate without shocks, and misfiring.

The throttle opening should not be changed suddenly as sudden change in revolutions causes an increased exertion of the moving engine mechanism and its rapid wear.

If the engine is provided with an air intake with double position regulating flap, the pilot can control the air intake temperature to the carburetor according to the weather conditions, and so prevent the freezing of the carburetor. By position "Warm air" the engine revolutions drop commonly abt. of 100 R. P. M.

Revolutions.

It is necessary to watch the tachometer all the time during flight as it gives us the picture of the output and load of the engine. During horizontal cruising flight higher than cruising speed revolutions should not be used unnecessarily long.

Number of revolutions during flight:

Nominal revolutions	2500 R. P. M.
Maximum permissible revolutions, temporarily, by dive	2750 R. P. M.
Cruising revolutions	2300 R. P. M.

Make sure that the engine really reaches 2500 R. P. M. on full throttle by horizontal ground flight otherwise the propeller has not been chosen correctly.

Oil pressure and temperature. — Fuel pressure.

The state of the engine in run can be judged according to the oil pressure and temperature. It is therefore necessary to watch carefully the oil gauge and oil thermometers (as long as they are fitted in the oil piping during the engine run).

Permissible values:

Normal oil pressure	3—4 at
Lowest permissible oil pressure at slow run	2 at.
Oil inlet temperature:	
normal	40—80° C
maximum	85° C
Oil outlet temperature:	
normal	50—90° C
maximum	105° C.

Deviation from these values or their fluctuation is a sign of a defect. The given maximum values must not be exceeded when the oil installation and engine cowling have been rightly made even by most unformidable circumstances e. g. by long climb. With regard to long durability of the engine they should not even exceed permanently the normal values.

Considerable decline in oil pressure under the lower permissible limit 2 at. is a sign of a serious defect in lubrication; it is then necessary to land as soon as possible. The fuel pressure should be abt. 0,2—0,28 kg/cm², at slow run as much as 0,30 kg/cm², if the fuel is delivered to the carburetor by a pump or 0,05 kg/cm² by gravity fall.

Altitude correction.

The limit positions of the corrector lever by the pilot are marked with „Rich Mixture" (by ground flight) and „Poor Mixture" (by altitude flight).

The control of this lever enables:

1. to adjust the mixture which gets too rich during a flight in greater heights owing to the decreasing air density to right composition;
2. to adjust the poor mixture by horizontal cruising flight.

It is necessary to obey the prescriptions in this paragraph exactly for safe running of the engine. Due to incorrect manipulation of the corrector the mixture may become either too rich and has a waste of fuel in consequence or too lean especially in high altitudes or economical cruising flight a cause overheating of the engine and even seizing of the pistons.

1. Correction during altitude flight.
   In altitudes over 1500 m the mixture compositions must be corrected by the mixture control lever. A correct setting of altitude correction can be made by leveled ho-

rizontal flight only at constant throttle opening, so as the change of revolutions could be watched as a dependence of the correction change. The corrector lever is moved slowly at the same time from the position "Rich Mixture" in the direction of "Poor Mixture" within the limited permitted by the corresponding opening of the throttle as long as the number of revolutions rises. As soon as the revolutions begin to decrease, it is necessary to put the lever a little back towards "Rich Mixture". Thus we obtain the correct mixture composition at the given speed and altitude. When descending the mixture must be enriched succesively in the same way. When using the throttle and changing the revolutions the corrector must be first put to its basic position for "Rich Mixture" and then its correct position newly adjusted in the described manner. It is also necessary to fix the correct position after temporary throttling down during a flight as owing to the interdependence of the carburetor lever mechanism with the closing of the throttle, the corrector is automatically set to "Rich Mixture".

2. Correction to economic mixture ratio.

   Correction to economical cruising speed mixture ratio is accomplished in the same way. As the carburetor is set for cruising speed on leaner mixture it is practically possible to make use of correction in height over 1500 m only. Interdependent throttle and carburetor mechanism secures automatic setting the corrector lever back to "Rich Mixture" position when closing the throttle.

Stoppping the engine.

Before stopping the engine, throttle down and allow the engine to run a few minutes at "Slow run". The engine must have time to cool slowly so as to prevent dangerous heat deformations and tensions owing to sudden and uneven cooling of different parts, and to avoid water condensing on suddenly cooled parts, which would cause their corrosion. This method also prevents accumulation of greater quantities of oil in the engine.

Having cooled down the engine, turn off the fuel and wait till the engine sucks in all the fuel from the carburetor; at the moment when it begins to misfire switch off the ignition.

After stopping the engine, close the cock in the oil inlet into the engine (if there is an oil installation system in consequence of placing the tank above the engine) so that oil will not accidentally flood the inside of the engine. If the engine is to be stopped for a short time only — (before a new start etc.), it is also possible, after it has been cooled down at slow run with closed throttle, to switch off the ignition and at the same time open the throttle a little so that the cylinders are charged with suitable mixture which will facilitate the consequent starting of the engine. Also when the ignition is switched off greatest care must be taken when working at the propeller while the engine is still hot. The cock in the oil inlet (if fitted) must not be closed, when stopping the engine for a short time.

If the engine has been switched off in the open during significant frost (under —10° C) and if there is no heating device in the oil tank, it is recommended to let out oil from the oil tank, piping and from the engine immediately after stopping the engine while it is still hot. In this way the reheating of oil is facilitated.

When stopping the engine for longer time and daily after the last flight, examine and attend the engine as follows:

1. Make sure that the cylinders are not too hot.
2. Examine the tightness of the fuel and lubrication piping and see that no oil leaks out of the engine.
3. Measure the fuel and oil consumption and compare it with the flying time and engine output.
4. Some time after stopping the engine, examine the engine cowling, remove it and clean the whole engine, its accessories and all parts of the aircraft near the engine.

Running-in a new engine.

Although every new and repaired engine is run-in on brake before it is sent off from the works, it is unconditionally necessary that special care is taken during the first 10—15 hours of its run in the aircraft. The ground tests should be short; after starting the engine should be warmed up carefully, the revolutions should be increased slowly and evenly and a ground flight at full throttle should be restricted to the shortest possible time. Oil should be changed after first 10—20 hours of engine running, oil filters cleaned and valve clearance examined.

Acrobatic arrangement of the engine.

Acrobatic arrangement of the engine is provided on special request. This arrangement is based on special WALTER 45 AK carburetor which is constructed for high acrobatics by uninterrupted full throttle opening which is mounted instead of an ordinary carburetor. An automatic valve is mounted in the oil installation to guarantee the suction of the oil from the crankcase even in case of inverted flight and thus secures undisturbed exchange of oil and fluent lubrication. This arrangement on the engine conditions also an acrobatic arrangement of fuel and oil installation in the aircraft to make sure the fluent fuel and oil intake to the engine in every position of the aircraft.

Following instructions must be obeyed where engines with WALTER 45-AK acrobatic carburetor are supplied:

1. Before starting the engine the carburetor must be completely filled with fuel by means of a flooding device. If mounted, or by means of a hand pump in fuel installation so that the gauge in the pilot's cockpit should point the fuel pressure.
2. By inverted flight and loopings the throttle must be full open. It can be throttled down only just for a while as otherwise if the throttle were closed under 70% of the output, the carburetor could be flooded which would be connected with the danger of engine interrupting owing to mixture becoming too rich.
3. The time of inverted flight at full throttle is not limited if the engine is provided with acrobatic carburetor and acrobatic lubrication arrangement and supposing that also the aircraft is provided with acrobatic arrangement.

PART IV.

TROUBLES AND TROUBLE SHOOTINGS IN ENGINE RUNNING.

The engine will not start.

The cause may be:

a) want of fuel in the tank or insufficient fuel supply to the carburetor, leaks or obstructions in the feed pipe, defective fuel pump, float needle valve sticking or stopping the curburetor jets;

b) incorrect opening the throttle — when starting, the throttle lever should be c l o s e d for slow-running; if the engine is cold, the mixture is too weak and it may be necessary to make it richer by injecting of fuel into the induction manifold; on the other hand if the engine is hot, the mixture is too rich — turn the engine several times against its direction of rotation at full throttle and ignition switch off and then start it again without priming; the mixture may also be too rich owing to extreme priming or overfloating the carburetor (the float needle valve does not fit properly, damaged needle valve mechanism, excessive fuel pressure, defective float);

c) water in the tank or in the carburetor;

d) at low temperatures the stiffed oil causes great friction of pistons and the other components; fill the tank with warm oil or heat it in the tank by an electric heater;

e) oiled up or moist sparking plugs;

f) defect in the ignition system or defective start; if the engine will not start the first time after overhauling there may be the cause in the incorrect timing adjustment.

The engine runs irregularly.

The cause may be:

a) The engine is not warm enough after starting.

b) Mixture too poor.

c) Irregular fuel supply, pipes or filters obstructed, air in the feed pipe.

d) Water in fuel.

e) Defect in the ignition or faulty sparking plugs — check both ignition circuits separately, examine the gaps between the distributor contact points (0,3—0,4 mm) and the plug electrodes (0,4 mm); test the sparking plugs under pressure.

f) Overheating the engine due to insufficient cooling.

g) The valves do not open or close properly; examine the valve springs and see tha valve seats (unscrew the spark plugs and shine through).

h) Pistons are not tight.

Weak compression.

Weak compression in one of the cylinders (can easily be located when turning the engine by hand, with the ignition switch off. Possible causes are: leakage of valves (burned or worn valve, valve seat pitted, incorrect clearance between the valve and the rocker, broken valve spring), valve sticking in its guide, piston rings worn, broken or stuck in their grooves, excessive wear of cylinders, leakage of cylinder heads (defective head joint washer, loosening of the cylinder heads), leakage round the sparking plug etc.

The engine shows vibrations.

Check tightness of the propeller on the hub, the track of the blades and make sure, whether it is counterbalanced correctly. Examine the engine mounting in the engine bed. A possible cause of vibrations may be loosening of one of the engine components. When using a metal adjustable propeller, a different propeller blade angle, can also be a cause of vibrations.

The engine runs harshly and hammers.

Possible causes are: unsuitable fuel with low octane value causing the detonation; overheated engine causing selfignition of the mixture due to the hot cylinder walls and the red hot remainders of carbon in the combustion chamber. If the engine runs with metal sounds it may be due to excessive clearance of the crankshaft in the main bearings, in the connecting rods or in the gudgeon pins, or due to broken piston rings. In this case it is not only necessary to localize and to remove the trouble but also to find out the original cause of excessive wear of exchanged parts. This will be most probably in the lubrication system.

The engine stops suddenly.

Causes:

a) lack of fuel; fuel tank empty or obstructed feed pipe, air in the pipes; water in fuel; damage of fuel pump or its drive;
b) defect in the ignition system;
c) damage in the engine; crankshaft or piston ceizing due to the lack of fuel etc.

Overheating of the engine.

The cause may be either too great ignition advance or retard, unsuitable fuel or mixture too poor (unsuitable adjustment of the carburetor, unsufficient oil intake). Also excessive opening of the corrector or leakage of the induction manifold may cause overheating.

The engine does not reach full output, full number of revolutions, at full throttle.

The causes:

a) unsuitable fuel;
b) mixture too poor or too rich;
c) bad compression (causes were mentioned before);
d) engine too hot or too cold;
e) incorrect setting of timing gear;
f) trouble in the ignition system, no spark at the plugs, incorrect adjustment of the ignition advance;
g) propeller too heavy (i. e. it gives a great resistance when turning).

If the revolutions and the output of the engine drop without perceptible cause, throttle down, finish the flight as soon as possible and locate the trouble.

The exhaust fires.

The cause may be either retarded ignition, mixture too rich (carburetor overflows or excessive jet openings) or exhaust valves do not open properly. A special sign of mixture being too rich is black smoke in exhaust gases.

The engine backfires.

Causes may be:

a) mixture too weak; engine cold; insufficient fuel supply into the carburetor because of obstructed jets and filters; incorrect setting of the corrector; water in the carburetor;

b) incorrect setting of timing gear or inlet valves not sitting properly (a small or not any clearance between the valve and rocker, pitted valve seats, damaged valve springs, great friction in the valve guides). The cause of backfiring may also be the use of another fuel than to which the carburetor has been adjusted. The adjustment of the carburetor as well as the changing of the jets should be carried out only by an expert.

The engine works well at high speed but stops at low number of revolutions.

The engine is too cold or either the slow running jet or the slow running passage are obstructed; the carburetor overflows, sparking plugs dirty, their points are set too far apart; ignition too far advanced.

The oil pressure drops below its normal value.

No oil in the oil tank, leaks in oil circulation system; insufficient oil supply due to obstructed filters; the oil gauge does not indicate properly; the oil relief valve does not function correctly. First check the correct functioning of the oil pressure gauge and examine the oil pipes. Until you have experienced, then is no trouble to regulate the relief valve to correct pressure.

Excessive fuel consumption

may be caused by leaks in the pipe lines, by the carburetor overflowing or too large jets being used and also by incorrect functioning of the carburetor.

Troubles in the ignition system.

Troubles originating evidently in the ignition system should be traced systematically, beginning with sparking plugs. First of all remove the sparking plugs and check them under pressure to see the sparks. At the same time inspect the sparking plug installation, clean the surface and set the gaps between the electrodes correctly.

If all sparking plugs are in good condition and the trouble still exists, check first the cables and then the magnetos. If the magneto produces a good spark, the cables are at fault; they are either incorrectly attached or damaged causing a short circuit between the cables and the engine parts. If there is no spark from the magneto, the short circuit cable between the magneto and the ignition switch can be damaged, the contact breaker and distributor dirty or moist, the breaker points burnt or similarly damaged; also the rocker arms can be damaged. Renew the insulation, clean the contact points — file them if necessary — and re-set them correctly; clean the breaker lever and oil it slightly. A more serious defect in the magneto itself, in the coil etc. requires to be repaired by a specialist.

If all parts of the ignition system are found in good order the fault in the running of the engine may be caused by incorrect adjustment of the contact breaker or the distributor.

Defective ignition may cause certain troubles in the running of the engine.

The engine is hammering due to too much advance.

The engine is misfiring:

Probable causes: sparking plugs oiled up, gap between the electrodes set too far apart, breaker contacts dirty or oiled up, temporary short circuit between cables and engine parts.

The engine backfires due to self-ignition caused by red hot carbon on the sparking plugs, especially after long running at full throttle or because of incorrect magneto adjustment.

PART V.

ATTENDANCE AND OVERHAUL OF THE ENGINE.

REGULAR ATTENDANCE.

Correct and regular attendance and maintenance of the engine must be carried out carefully by an expert as it is an important presumption for the reliability and durability of the engine. Apart from hints mentioned before considering daily examination and attendance before and after every flight, fundamental hints are given further on, completing the total minimal program of correct attendance.

Maintain the outside of the engine in clean condition and see that the pickled layer of electron parts which is a protection against corrosion is not damaged by mechanical cleaning or water. Also the cooling fins of cylinders and cylinder heads are to be clean so as to secure proper cooling. When disconnecting the piping mind that no sand, dust or other impurities get into the engine or piping. It is best to do these operations in clean and quiet air — as far as possible in a hangar.

Pilot's tools.

The tool roll (pict. 12) includes the following equipment:
combination pliers,
2 ordinary screw driver handles,
a set of double spanners (# 6/8, 9/10, 11/12, 14/17, 19/22),
special spanner for cylinder nuts,
feeler gauges for valve clearances (0,1, 0,15, 0,2, 0,3 mm),
key for fixing and removing of cables,
a set of box spanners (# 9, 10, 11, length 95 mm),
spark plug spanner,
compressor for valve springs,
valve refacer.

Attendance before the first starting.

By „First starting" we mean the first starting of a new engine, of an engine newly mounted into the aircraft after foregoing partial or complete overhaul, or of an engine taken out of service for longer time.

a) Fill the rocker valve covers with oil.
b) Remove one sparking plug from each cylinder and inject about 20 cm^3 of oil warmed to abt. 50° C into a cylinder with a primer. The piston of the corresponding cylinder must be in this case in its bottom dead centre that is at the side next to the crankshaft so that the complete cylinder wall would get oiled.
c) Turn the engine by the propeller several times forwards and backwards.
d) Thoroughly breathe and refill the intake oil piping from the tank to the engine. Fill the engine with about 2 liters of oil through the connection for pressure oil coming from the pump into the engine (see picture) on the union No. 9, according to the installation drawing, and at the same time rotate the engine by the propeller, the ignition and the gas being switched off. After the complete breathing of the oil piping the barometer will show the oil pressure. This procedure is to be carried out also before every, refilling the engine with oil, after previous outlet or change of oil.

This procedure serves to oil sufficiently the timing mechanism and working surfaces of pistons for the first moment of engine running so as to make impossible the seizing of pistons.

Attendance after every 10 hours of engine running.

1. Clean all the oil and fuel filters.
2. Examine all cables on the engine and in the aircraft and make sure that they are correctly connected and secured.
3. Screw tight the grease cups on the magnetos.

Attendance after every 50 hours of engine running.

1. Accomplish all operations described in the previous column: "Attendance after every 10 hours of engine running".
2. Let out all the fuel from the tanks and the fuel filters. Take out, examine and clean all filters. Examine the piping connections and cocks and check if fuel flows

through. Rinse the tanks and refill them with pure, prescribed fuel poured over deer skin.

3. Let out all oil from the oil tank and the piping — best while the engine is still hot and the oil fluid. Rinse the tank first with paraffin oil then with petrol and let dry well. Similarly clean all the filters. Examine the piping and connections and try if oil flows through. Before filling up with new, pure oil, it is necessary to remove from the oil installation all traces of petrol or paraffin. When needed, clean or grind the pressure oil relief valve in the pump.
4. Check the valve clearance and set it. The prescribed cold clearance is 0,15 mm. Examine the valve mechanism and make sure that there are no traces of wear visible (ends of valve stems, ends of push rods, adjusting screws, rocker rollers etc.). Fill up oil in rocker covers.
5. Check the compression:

   Remove the sparking plugs from all cylinders except the one which is examined. Open the throttle completely and make sure of the right compression by turning the propeller by hand. Then remove the sparking plugs from the tested cylinder and fit them to the following one and examine its compression and proceed similarly at all the other cylinders.
6. When unscrewing the sparking plugs clean them at the same time, examine them, set the gap between electrodes to 0,4 mm, examine the insulation and the thread. Defective sparking plugs and plugs with points too much burnt out should be exchanged for new ones. Smear the thread of the sparking plugs and plugs with an admixture of grease and graphite, put on the joint washers and screw the plugs tight.
7. Fill up the magneto grease cups, examine and clean the interruptor contacts and set their gaps to 0,3—0,4 mm.
8. Examine the outside of the carburetor and of the fuel pump if there are no traces of leakage. When coloured petrols are used there are traces of the colour after evaporation of the petrol.
9. Make sure that the induction manifold fits to the carburetor and cylinder heads. Clean also their air intake tube.
10. Examine and screw tight the exhaust pipes, the exhaust collector and all single part connections of the exhaust system.

11. Examine the tightening and securing of following nuts and parts: nuts of crankcase studs, cylinder studs, tappet clamps, bearing feet and their bearings in the engine bed, accessories, of fuel and oil piping; of fixing parts of the air baffles and engine cowling.
12. Examine the propeller installing and if necessary, tighten the propeller bolt nuts.
13. Examine the flexible tachometer drive and grease it with an admixture of graphite.
14. Examine the complete pull rod and lever mechanism of the carburetor control and of the air intake or the cocks respectively and grease all the ball joints, pins and guides.

TOP OVERHAUL OF THE ENGINE.

The top overhaul is usually carried out after every 350 hours of engine running or as case may be. When often starting or flying at full throttle near the ground (e. g. in flying school) takes place it is recommended to overhaul the engine already after 300 hours of engine running. It can be achived without dismounting the engine by experts with prescribed tools as follows:

1. Let out all oil from the oil tank and the piping — best while the engine is still hot and the oil in fluid state. Rinse the tank first with paraffin and then with petrol and let it dry well. Similarly clean all the filters. Examine the pipings and the unions and make sure that oil really flows through. Before refilling with pure oil it is necessary to remove all traces of petrol or paraffin from the oil installation. If necessary clean or grind in the oil pressure relief valve in the oil pump.
2. Let out all fuel from the tank and the filters. Take out, examine and clean the filters. Examine the piping, unions, cocks and see that fuel flows through. Rinse the tanks and refill them with pure prescribed fuel poured over deer skin.
3. Remove the rocker covers and examine the valve clearances and the setting of the magnetos. Remove the cylinder heads and disassemble the rockers and valves. Examine the valves and decarbonize them. Replace damaged val-

ves with burned out seats — especially exhaust valves — by new ones. Faultless exhaust valves and inlet valves are interchanged. New valves always take place instead of exhaust valves. The interchanged valves must be newly marked (hammer in the old marks and stamp new ones) and by means of an emery paste well ground into the seats of the heads. After the grinding wash them properly and test them against leakage. Decarbonize the combustion chamber in the cylinder heads. After the decarbonization of the combustion chamber and after the grinding-in of the valves wash the head thoroughly so as to remove the emery paste, powder or carbon from the valve guides which might cause their seizing. Examine the sparking plug adaptors if they did not get loose. Then reassemble the valves and rockers into the head to make it ready to be mounted into the engine.

4. Remove the cylinders and the pistons and at this occasion examine the gudgeon pins and at the same time, test the clearances of the piston rings in their grooves. Then remove the rings and decarbonize properly the pistons (also in the grooves) and the rings so as to keep the prescribed side clearance of the rings in their grooves.

   Clearance of the 1st piston ring in the groove
   V 0,150 — V 0,177

   Clearance of the 2nd piston ring in the groove
   V 0,120 — V 0,147

   Clearance of the 3rd piston ring in the groove
   V 0,080 — V 0,107

   Clearance of the scraper ring in the groove
   V 0,030 — V 0,061

   Then replace the rings.

5. The cylinders and their heads being dismantled examine the timing mechanism (push rod ends, adjusting screws, rocker rollers, tappet ends) for marks of greater wear.

6. Replace the cylinders having supplied them with new paper joint washers and the heads. Before reassembling the induction manifold the heads must be set in line by means of a ruler and deficient gaskets (both suction and exhaust ones) exchanged. After tightening the cylinder heads adjust the valve cold clearance which should be 0,15 mm.

7. Examine the magnetos (for example to see that the condensators have not been loosed and that there is no oil under the cover), test and clean the interrupter points, set their gaps to 0,3—0,4 mm, examine all the cables on the engine (if they are not broken) and make sure if correctly connected. In case of deficient magnetos send them to the maker for a repair.
8. Screw out the sparking plugs, clean them, eventually test them and set the gap between the electrodes to 0,4 mm, examine their thread and insulation. Deficient sparking plugs with electrodes burnt out too much should be replaced by new ones. Smear the thread with a mixture of grease and graphite and supply new joint washers.
9. Tighten all magneto grease cups and if necessary fill up them with new grease.
10. Examine the securing of all nuts and tighten nuts of crankcase studs, cylinder studs, tappet clamps, bearing feet and their bearing in the engine bed, accessories of fuel and oil piping, fixing parts of the air baffles and engine cowling.
11. Remove the propeller from its hub, and the hub from the shaft, examine the bedding of the hub on the shaft (if it is not seized or rusty) set the hub again, fix it tighten by a nut and secure it. Before new setting of the hub smear the contact surfaces on the shaft and in the hub with mixture of oil and graphite. Then set the propeller on, check its concentration and screw tight the nuts of the propeller bolts.
12. Examine the flexible tachometer drive and grease it with an admixture of graphite.
13. Examine the complete pull rod and lever mechanism of the carburetor control and of the air intake and grease the all ball joints, pins and guides.
14. After the carburetor and fuel pump have been refilled with petrol, examine the outside of both, if there are no traces of leakage.
15. After the cleaning of the air intake tube, make sure that the induction manifold fits tight to the carburetor and cylinder heads.
16. Examine and screw tight the exhaust pipes, the exhaust collector and all single part connections of the exhaust system.

COMPLETE OVERHAUL OF THE ENGINE.

Complete overhaul of the transport aircraft engine is carried out after about 1000 hours of engine running, presuming that two top overhauls after 300—350 hours have been made during this period. When often starting or flying at full throttle near the ground (shool, acrobatic flying) takes place, the complete overhaul is carried out after about 600 hours presuming, that a top overhaul has been made after 300 hours of engine running.

Apart from this duration of time it is necessary to accomplish a complete overhaul when some defect or troubles have been detected inside the engine.

Also if the engine has been out of service without special attendance or stored for longer time under unfavourable conditions (moist or corrosion awakening conditions) it is necessary to check it in details before using it. It may be overhauled only in a special department provided with necessary tools and equipments, best at the maker's of the engine. Prescriptions about the overhaul are contained in the maker's instructions.

Dismounting the engine from the aircraft.

The dismounting the engine from the aircraft proceeds to the contrary as the mounting the engine.

1. Remove the engine cowling.
2. Dismount the exhaust collector if there is any in the aircraft. Unscrew the exhaust pipes and provide the exhaust blind covers on their place.
3. Remove the propeller resp. propeller together with the hub.
4. Disconnect the air-lifting piping from the breather and blank the hole by a rubber cup.
5. Release the flexible shaft of the tachometer drive and blank the drive with a covering nut.
6. Disconnect the cables connecting the engine to the aircraft (short circuit cables from the switch, short circuit ground cable from the switch).
7. Drain the oil from the engine and the oil piping. Disconnect the piping from the inlet and outlet orifices of the engine and stop both orifices by plugs. Also disconnect the pressure relais or the oil gauge pipe from the pressure oil inlet connection of the crankcase.

8. Disconnect the fuel piping from the fuel pump and blind the pump connections immediately. Release the piping of the primer connections from the priming pump or the bowden leading to the priming pump from the panel. At the same time disconnect the tubes of the drain valves on the induction manifold.
9. Release the pull rods from the carburetor levers (throttle, corrector), remove the air intake from the carburetor and provide the carburetor orifice with a blind sheet.
10. Having fixed the rope of the lifter to the engine realease the engine in its bed. After lifting the engine unscrew the bearing feet together with the rubber dampers and fix the suports of the engine for the bracket.

Then place the engine either on a transport bracket or on a mounting rotating stand.

Disassembly of the engine in single groups and parts.

A complete overhaul, dismantling and reassembly of the engine should always be carried out in a special repair department provided with the necessary tools and equipment. Such an overhaul can best be accomplished at the maker's where all special devices which are necessary are at hand.

Use only special tools delivered with the engine from the factory at special request. Throughout all operations it is of primary importance that cleanliness is rigidly maintained; keep the components systematically when dismantling the engine in order to avoid any mixing up when replacing them in the engine. Never use old split pins, elastic washers and paper joints. When clamping some components in a vice the jaws must be lined with aluminium or brass sheets.

Procedures for complete overhaul of the engine (pp. 63-75) are not included in this free copy of the service manual.

Running-in the engine after the reassembly.

If only grinding-in of the valves has been carried out without taking the engine off the aircraft, the engine should be run in at least 30 minutes increasing gradually the number of revolutions from 500 R. P. M. at the beginning up to 1200 at the end of the procedure. After shutting down check the valve clearances and inspect the tightness of the cylinder nuts.

After a complete overhaul but when no important part was replaced a running-in of at least 1½ hours is necessary beginning at 500 R. P. M. and gradually increasing to 2500 R. P. M. at the end. The running-in must be carried out on a test stand with a break propeller securing sufficient ccoling of the engine. After stopping the engine retighten the cylinder nuts and reset the valve clearances.

If an important part was replaced during a complete overhaul the running-in period should be increased accordingly — about 2½—3½ hours — to allow the new part a proper fitting. The running-in of the engine must be carried out on a test stand, fitted with a special cooling device. After running-in tighten the cylinder nuts and set the valve clearances. Even then during the first 10 hours in the aircraft the engine should be handled carefully and should not be run as far as possible at full throttle.

Attendance of the engine which is not in run.

Attendance of the engine in aircraft temporary taken out of service:

1. Before the last stopping of the engine let it run with fuel inlet closed at 1200 R. P. M. till it sucks-in all the fuel from the piping and the carburetor. If ethylised fuel has been used, it is unconditionally necessary to let the engine run for the last time at least 10 minutes on pure petrol with 1% addition of oil.
2. Let out all the fuel from the fuel tank.
3. Let out all oil and replace it completely with pure mineral oil. Then turn the engine several times.
4. Inject about 20 cm^3 of oil into each cylinder with a hand primer; the piston of the respective cylinder must be at its bottom dead centre. After each injection turn the engine about twice so that the oil should lubricate the cylinder walls and valves. Then screw the sparking plugs again. Repeat the same every month.
5. Grease all the metal surfaces on the engine with prescribed grease to prevent corrosion.
6. Close the exhaust parts and the air inlet orifice of the carburetor.
7. Cover the engine and the propeller with a waterproof canvas or oiled paper as protection against dust and moisture letting at the same time fresh air have an access to the engine.
8. Stop tight the entrances of the tanks.
9. Before newly giving the engine into the service proceed as described in the paragraph "Attendance before the first starting."

Attendance of the stored engine.

Points 1—4 as in chapter "Attendance of the engine in the aircraft which is not in run".

5. Remove the engine from the aircraft and place it on a bracket or on a mounting stand.
6. Close all the inlet and outlet orifices by corresponding blind covers (inlet and outlet oil orifices, primer union connection, fuel inlet connection on the fuel pump, breather orifice, tachometer drive connection, cylinder exhaust orifices, and carburetor induction air intake orifice).

7. Smear all the metal surfaces on the engine with prescribed grease to prevent corrosion.
8. Place the engine into the transport box — if there is none, cover it with a waterproof canvas or oiled paper as protection against dust and moisture.
9. The engine must be stored on a dry place so as to be best protected against changes of weather. Fresh air must have access to the engine.
10. From time to time control the storage, in mind point 4. Make sure that the machined surfaces are not affected by corrosion under the grease coating and keep the grease protection undisturbed.
11. If the engine has been out of service for a long time it must be sent to be inspected before it is used in the aircraft again to make sure that the value of some parts has not been diminished through long storage.
12. Before the engine is newly used in the aircraft proceed according to the chapter "Attendance before the first starting".

PART VI.

APPARATUSES AND ACCESSORIES.

WALTER 45 AND 45 AK CARBURETOR.

Both types of carburetor are constructed so that at partly opened throttle the engine running should be economical as far as possible whereas by full opening the maximum output should be reached by the enrichment of the mixture by the full throttle jet. The acceleration pump enriches the mixture at throttle opening by priming of addition fuel. The altitude correction is achieved by the corrector which gets poor the mixture in the whole range of the throttle opening without changing its composition.

WALTER 45-AK carburetor is besides constructed for high acrobatics at interrupted full throttle opening. WALTER 45 carburetor differs only a little in the internal arrangement and misses some of the devices making possible the inverted flight.

WALTER 45-AK carburetor is described in the next chapters.

Fuel intake.

The fuel flows into the carburetor through the union (1) with the thread M 14 $\times$ 1,5. It passes then through a cylindrical sieve (2) which must be cleaned from time to time and through four holes (3) into an exchangeable fuel inlet jet (4). This jet is provided with a steel ball (5) which is at horizontal flight in the position marked on picture 1. When flying in inverted position the ball closes the entrance (6) and the fuel can flow-in only through the calibrated entrance (7). From the fuel inlet jet the fuel flows to the valve seat and into the float chamber. The fuel intake valve is provided with a springed point (9) which prevents the valve seat from getting schocks and from overflowing the carburetor owing to tremble. From the valve the fuel flows further into

the float chamber on the one hand and into the space before the intake orifice (13) on the other. In this space there is adapted a breather slot (12) round the fuel intake valve. The space enables a quiet movement of the float and a quiet run of the carburetor in such a way that under normal running the consumed fuel comes directly from the valve into the intake orifice and only surplus or shortage is adjusted from the float chamber. Through the intake orifice the fuel enters the store chamber (17) pict. 3 and through the hole (14) pict. 2 it flows to the correction valve and through channels (15), (16) pict. 1 to the valve of the enrichment jet. From both valves the fuel flows further to the main (18) and the enrichment jet (19) pict. 4 which are well accessible after unscrewing the plugs (20) placed on the front wall of the carburetor. From the jets fuel comes through channel (21) pict. 4 to the diffuser (22) pict. 5. In the lower part of the diffuser it is mixed with air from air intake over the air jet (27) pict. 7 and over the slow running jet (28) pict. 6 into mixture which then passes further through circular ring space (25) pict. 5 to three diffuser openings (26).

The jet (23) and the tube (24) in diffuser serve as compensating organs when suddenly changing the throttle opening; during the change from slow run to cruising speed it adjusts the mixture ratio and at full run the jet (23) functions as a help diffusing jet.

Slow run.

The fuel for slow run is taken-in from the bottom part of the diffuser and streams through the slow running jet (28) in the opposite direction as air at full throttle and intermixes with air coming through the air jet (27) pict. 7. Lowest revolutions can be adjusted by the adjusting screw (29) pict. 8 on the back part of the carburetor.

Full throttle.

At full throttle the inducted mixture is enriched by opening the enrichment valve (30) pict. 1. The valve is controlled by the lever (31) pict. 11 firmly attached to the shaft of the throttle, a pull rod (32) and a lever (33) on the shaft (34) pict. 3 placed on the top body of the carburetor. In the cavity of the top part there is a cam (35) pict. 10 fixed on

the shaft (34) which presses the rocker (36) affecting the head (37) of the enrichment valve (30). The cam is connected by the pull rod (38) and a ball joint with the cylinder of the acceleration pump (39). When opening the throttle the fuel is pressed from the pump and streams through a system of channels to the jet (40) pict. 7. The enrichment jet serves at the same time as a tightening screw of the choke.

Altitude flight.

During an altitude flight the mixture is get poor by taking away fuel through the correction valve (41) pict. 3 which is controlled by the lever (42) attached firmly with the shaft in the top part of the carburetor.

The carburetor control.

The carburetor is controlled by two levers placed directly on the carburetor body. The one, throttle lever controls the opening and the closing of the throttle. The other one controls the valve of the altitude correction. Both levers should be connected sufficiently firmly with levers in the pilot's cockpit. Both levers controlling the carburetor should be adjusted in such a way that the corrector may be closed simultaneously when throttling down. Before starting the engine it is necessary to fill completely the carburetor.

Defects in the functioning of the carburetor.

The reason for deficient engine running may be: poor mixture caused by the stopping of some jet, by stopping of the fuel piping, seazing of the needle in the float chamber or leakage in the fuel piping; rich mixture caused by needle not sitting down or seizing in the float chamber and by flooding the carburetor.

The quality of the mixture may be easily stated according to the colour of the exhaust gases so far the engine is not provided with an exhaust collector. Short red or yellow flames are the sign of poor mixture, whereas long blue flames accompanied in case of a specially rich mixture by black smoke. Correct mixture ratio produces short light blue flames.

WALTER 2M-50 FUEL PUMP.

It is a double diaphragm, rotating pump. It is adjusted to the pressure 0,2—0,3 kg/cm². Direction of rotation — clockwise. It is fitted to the right side of the engine to a flange and driven by an engaging dog from the intermediate gear of the right magneto drive gearing down 2 : 1 to the fuel pump.

Description of the pump and its function.

The shaft of the fuel pump is engaged by the engaging dog of the drive. Inside the body of the pump the shaft is ended by an excentrically placed pin. When the fuel pump shaft rotates, the excentrically placed, rotating pin engages the eyes of the dishes between which the diaphragms are gripped. Two springs placed on the pins of the inner dishes between the two diaphragms return the diaphragms to their original position. On both sides of the pump case there are covers holding the diaphragms on their circumference which have one suction valve and one delivery valve each. On the bottom sides of the covers there are the inlet orifices and on the top side of the fuel pump body there is the outlet connection with the union to the fuel pressure gauge and the breather. A lever of the device for flooding the pump and the carburetor can be mounted on the rear side of the fuel pump body.

The work of the pump.

When revolving round the shaft the excentrically placed pin at the end of the pump shaft engages alternately the eyes of the diaphragm dishes. Each deviation of the diaphragm towards the centre of the pump opens the suction valve and closes the delivary valve (suction). Each return of the diaphragms to their original position under the influence of the springs, i. e. in direction from the pump centre closes the suction valve and opens the delivery valve (delivery). When the carburetor float chamber is filled and the needle valve shuts off the further flow of the fuel, the pressure in the delivery piping increases. The springs of the diaphragms cannot overcome this increased pressure, the diaphragms remain pressed against the centre of the pump the eyes of the dishes do not touch the excentric pin and the delivery valves remain closed. The pump neither sucks-

in nor delivers further fuel. Immediately after the pressure in the delivery piping has diminished again the pump begins to work. It is guaranted by this arrangement that the pump delivers only the amount of fuel that the engine can absorb and the pressure of the fuel remains the same at any number of revolutions. It must never happen that one of the inlets remains continually closed, only in exceptional case for example by using a reserve of fuel from the tank of the fuel inlet can be closed.

Flooding of the pump.

Before starting the engine it is necessary to flood the pump, pump line and the float chamber of the carburetor by a hand drawing. For this purpose the fuel pump can be provided with a flooding device. For this purpose a lever is provided at the rear side of the pump. By a swing movement of the lever the diaphragms are set into function. Move the lever till the fuel inlet is closed in the carburetor and the pump ceases to function which can be felt owing to no resistance of the lever.

Attendance.

There is no special attendance necessary besides inspecting the surface of the pump from time to time to see that the pump is everywhere well tight.

Fuel pump defects.

The pump can fail to function owing to the following reasons:

a) Mechanical defects owing to breakage or wearing of some parts which can occur only exceptionally.

b) Defects due to air leaks in the piping or in the pump. Check over air leaks in the inlet tubing between the tank and the fuel pump, the pump itself, and the piping between the pump and the carburetor; make sure that all connections and unions are tight.

c) Fuel penetrates between the parts of the fuel pump. If the fuel leaks between the body and the covers it is necessary to see whether the bolts are screwed tight. Always tighten the screws alternately at the opposite sides. If the diaphragm inside the pump should have got damaged, which could happen only exceptionally, it is

necessary to replace it; it is advisable in this case to send the pump to be repaired in the factory.

d) Valves will not shut.
Take out the valve plugs, clean the valves with petrol and if necessary, in case that they are damaged, replace them by new ones. Inspect the valve seats and test the sitting down of the valves. When reassembling the valves see that they move freely.

WALTER RE 25 hand and electric starter.

WALTER RE 25 hand and electric starter is mechanical clockwise rotating starter with a movable jaw and a standard flange for fixing to the engine according to ČSN AE 7,1 or SAE 5.

This starter can be mounted with a crank either in the horizontal position or deviated 20° above or under the horizontal plane and it is equipped with an electromotor of 300 W, 24 V, 5000—6000 R. P. M.

The shifting of the jaw into the engaging position with the jaw on the crankshaft happens automatically by the friction of the gears when rotating by crank, by further rotating of the crank the engine is turned over. Back kicks of the engine are caught by a lame clutch. When the engine starts, the revolutions of the crankshaft jaw increase and the starter jaw is pushed into its basic position.

The starter casing is filled up with oil to the height of the plug when the starter in position with horizontal crank. The lame clutch is set in factory to 35 kgm. When the starter is not sufficient for engine rotating owing to the lame wear the torque can be increased by tightening the adjusting nut about one or two threads.

WALTER P 320 electric starter.

WALTER P 320 is an electric righthand rotating starter, with a shifted jaw and standardized flange according to the ČSN AE 7,1 or SAE 5.

The starter is driven by an electric motor of 300 W, 24 V, 5000 r. p. m. The revolutions of the motor are reduced in ratio 129 : 1, by engaging of a triple planetary gear. The shifting of the jaw into the engagement with the jaw of the crankshaft becomes automatically owing to the revolution

differences between the second and the third planetary gear. The starter jaw is spring mounted to compensate smaller shocks of the engine. The back-kicks of the engine are absorbed by a friction lamellar clutch, the lamellas of which — according to the experience — are so tightened to give a torque of 35 kgm on the jav. When the lamellas are worn, the torque can be adjusted either by tightening the nut or by inserting the pads under the springs.

After the engine starts the number of revolutions of the crankshaft jaw considerably increase and the starter jaw is kicked out of the engagement back into its initial position.

The starter casing supporting on the rear wall the electric motor is partly filled with oil, which lubricates the all gear trains.

TECHNICAL DESCRIPTION OF WALTER MINOR 4-III S AERO ENGINE.

WALTER MINOR 4-III S engine is identical with WALTER MINOR 4-III engine; it is however provided with an auxiliary centrifugal compressor for increasing the output for a short while for starting or in necessary cases. The compressor can be engaded or disengaged as need be, by engine-off even engine-on.

I. Technical datas about the engine.

Technical datas are the same as for the WALTER MINOR 4-III engine with following differences:

Outputs and revolutions:	
Increased (starting) output with compressor on (max. 3 min.)	120 BHP
Increased (starting) revolutions . . .	2600 R. P. M.
Consumptions:	
Fuel consumption at increased output (at starting) with compressor on . . .	250 g/BHP/hr.
Suction pressure behind the compressor at sea lewel (at 2600 R. P. M.)	1,15 at. i. e. 845 mm Hg
Prescribed fuel with octane number . .	87
Weights:	
Weight of dry engine incl. accessories, according to ČSN-AE-1,4 B — weight B 1	97,3 kg ± 2%
including the weight of WALTER 45 carburetor	1,95 kg
2 SCINTILLA VERTEX NVK 4-Z2 and AVK 4-Z2 with automatic advance, sparking plugs M 12 × 1,25 cables and cable tubes, air baffles	10 kg
RE 25 starter without electromotor . . .	6,68 kg
Specific weight at nominal output at sea level and at the weight B 1	0,86 kg/BHP

Accessories and drives which can be delivered with the engine at special request:

Starter hand crank with a bearing . . . 0,82 kg
Starting electromotor . . . . . 3 kg

Dimensions:

Total length of the engine with the propeller hub . . . . . 1176 mm

II. Description of main engine parts.

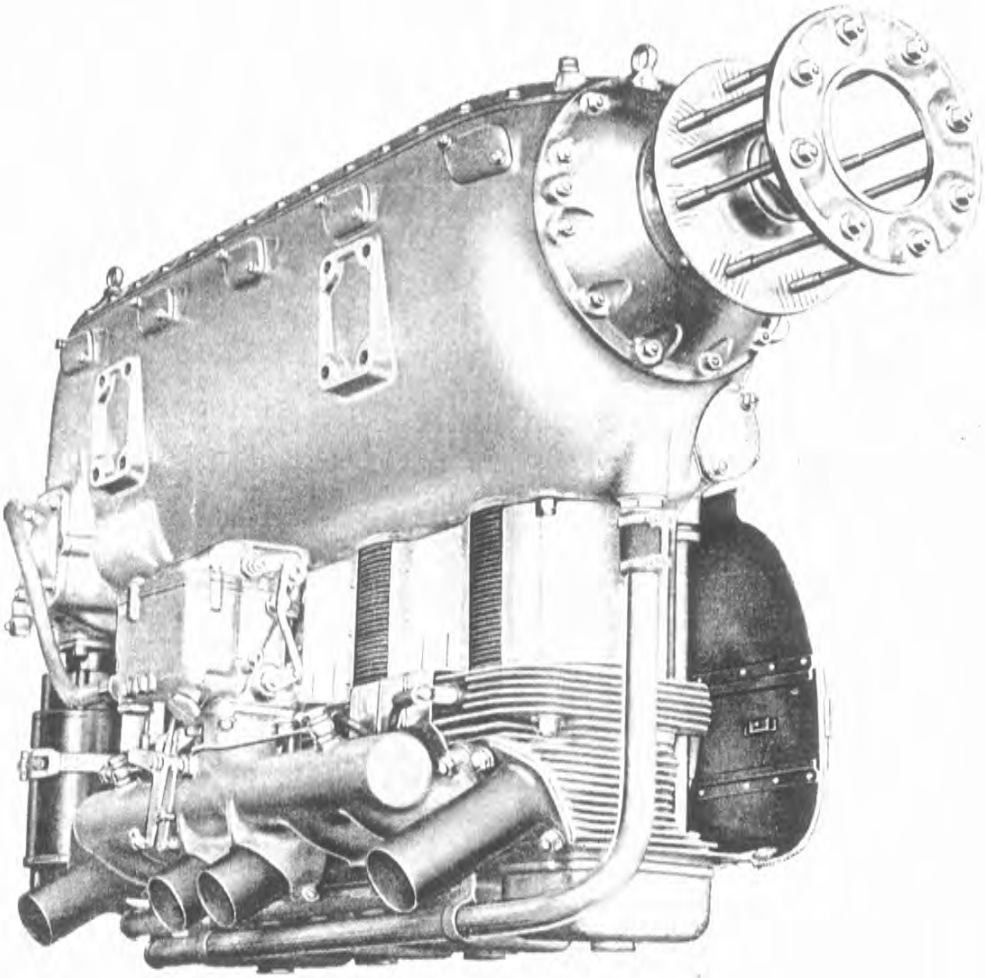
The construction of WALTER MINOR 4-III S engine is identical with the construction of WALTER MINOR 4-III engine with following differences:

Crankshaft is provided on its rear end with an engaging dog of the compressor drive clutch instead of the starter jaw.

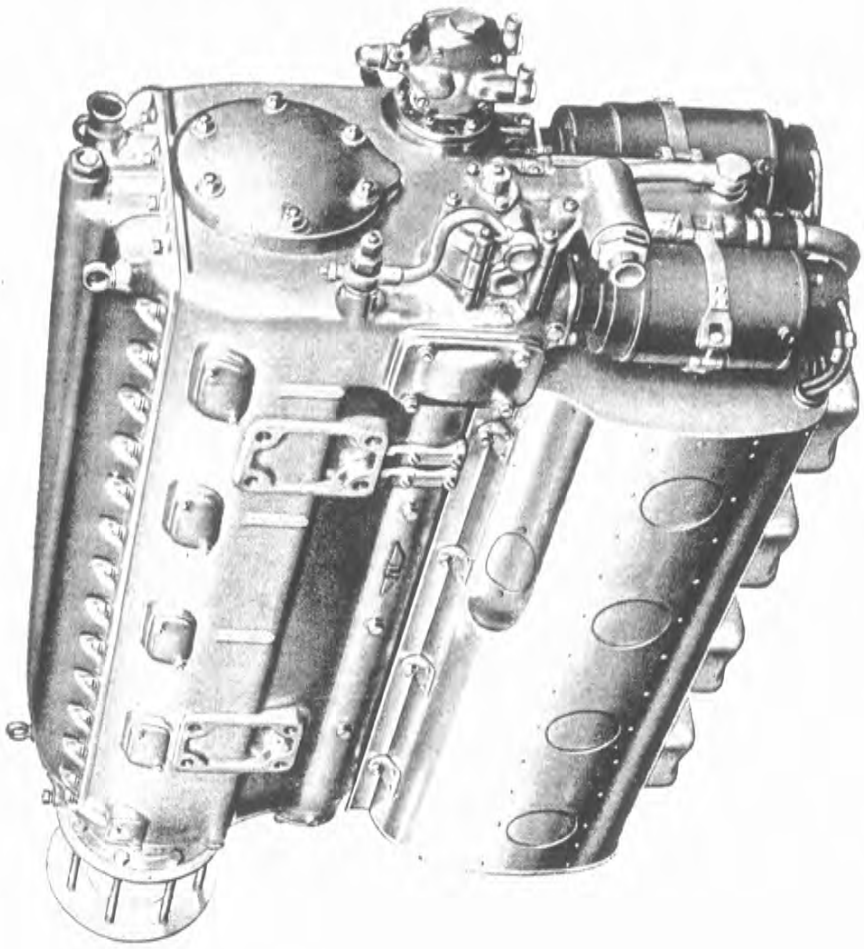
Lubrication. On the eye of the pressure feed oil pipe union from the pump to the crankcase there is a connection for the pressure feed lubrication of the compressor.

Compressor. The centrifugal compressor delivers clean air to the carburetor; it is connected to the flange on the rear wall of the crankcase, destinned normally for a starter. An impeller made of forged special aluminium alloy is driven from the rear end of the crankshaft by a friction clutch and a satellite drive with total gear ratio 1 : 7,4. It is possible to engage and disengage the compressor drive by braking the drum wheel of the satellite gear mechanism by means of a band brake whose engaging lever is controlled by a pull rod from the pilot's cockpit. The drum wheel of the satellite drive is bedded on a journal bearing, the satellits on needle bearings, the impeller in the front in a journal bearing and in the back in a special ball bearing. The gearing mechanism is lubricated by pressure oil delivered from the piping behind the pressure pump; the drained oil returns into the crankcase. Air is delivered from the compressor to the carburetor through a piping of aluminium tube connected to the carburetor by an elbow with leading shovels. There is a double union on the compressor wall for the piping to the induction gauge behind the compressor and for air pressure balance in the delivery chamber of the compressor and in the fuel pump.

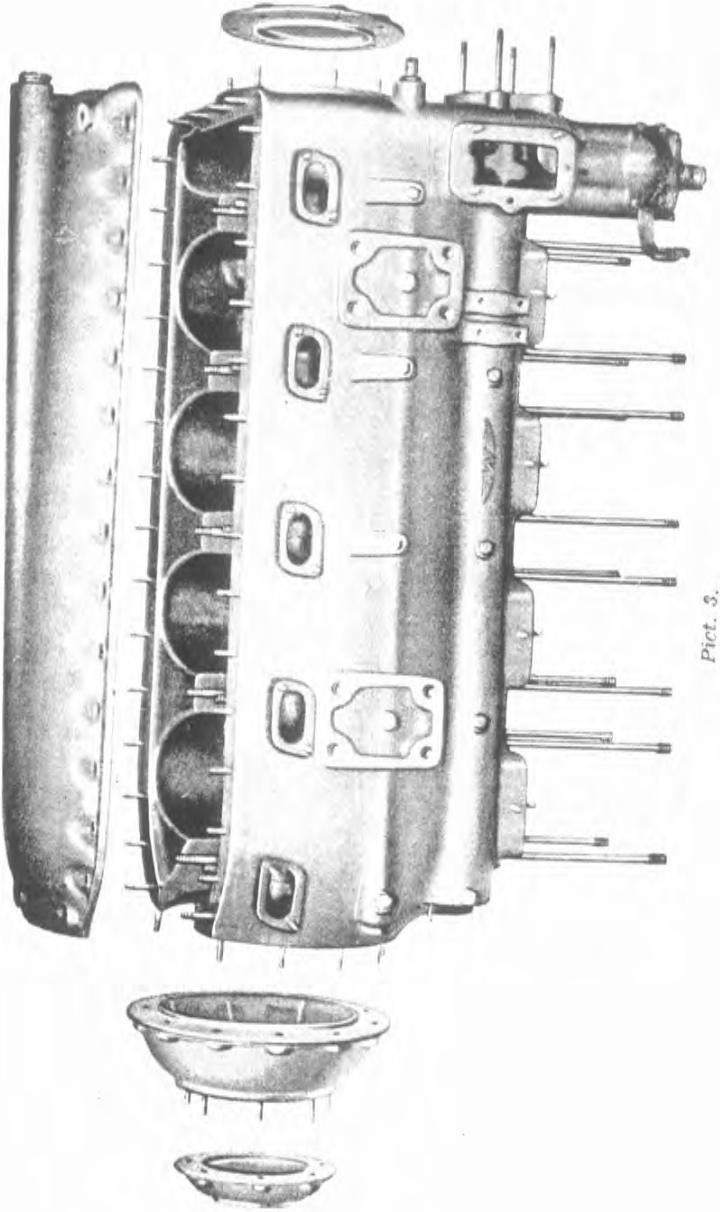
S t a r t i n g. In the rear part of the compressor there are a movable jaw, the engaging gear of the hand crank with a secure pawl against back kicks of the engine and the worm gear from the electromotor; the latter is mounted at special request. The compressor drive gear is at the same time a part of the gear mechanism of the starter and the compressor clutch functions as a securing clutch of the starter against a back kick of the engine. The rear part of the casing with the hand crank and the electromotor can be revolved round the crankshaft axis in 15° to a suitable position.



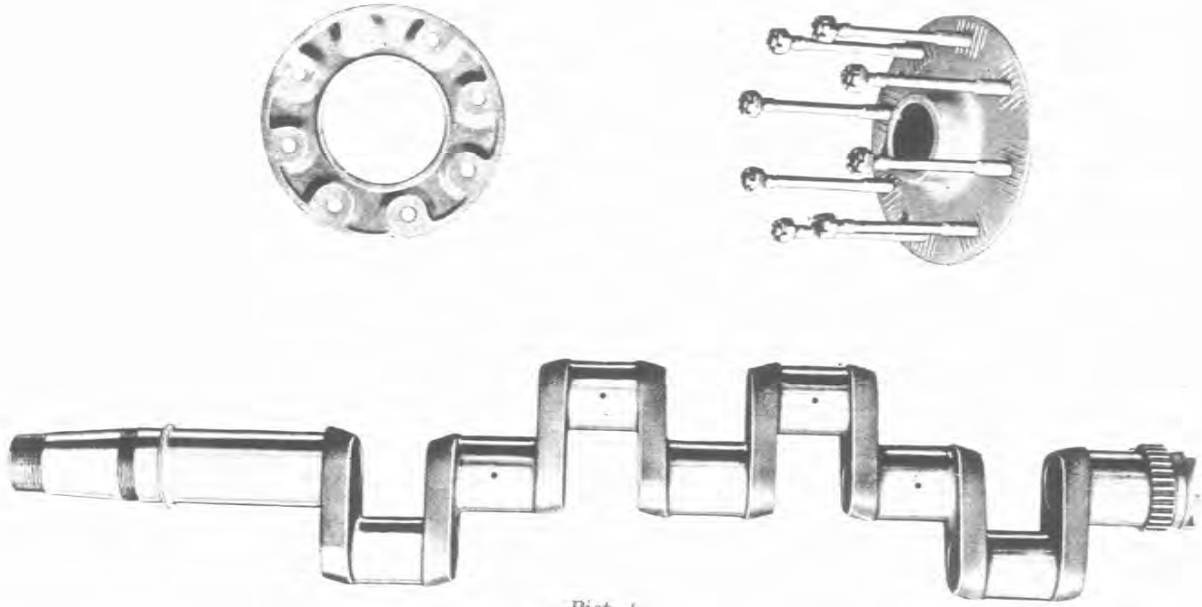
Pict. 1.
WALTER MINOR 4-III aero engine.
A three quarter front view from the right.



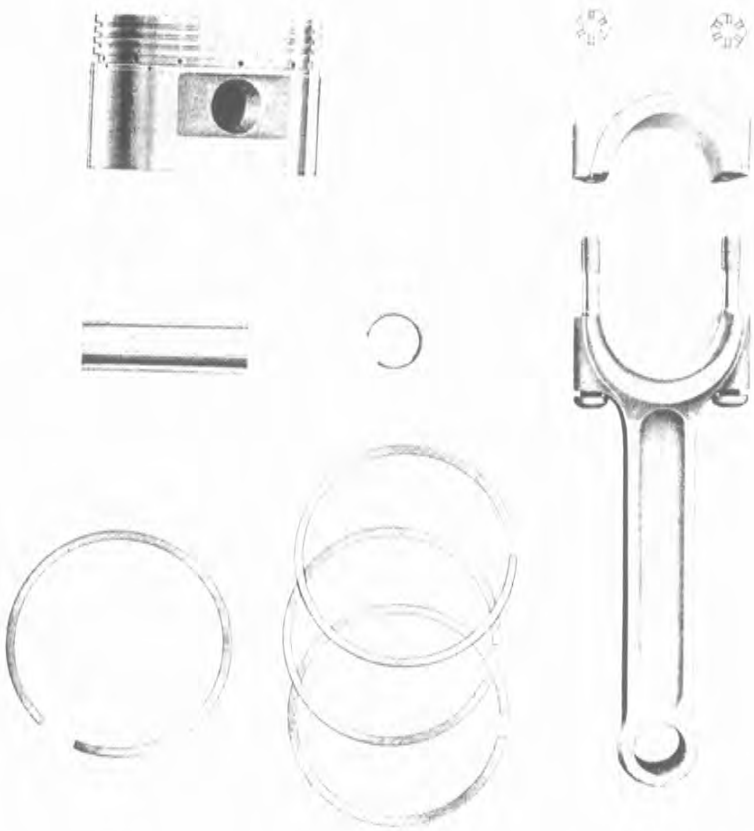
Pict. 2.
WALTER MINOR 4-III aero engine.
A three quarter rear view from the left.



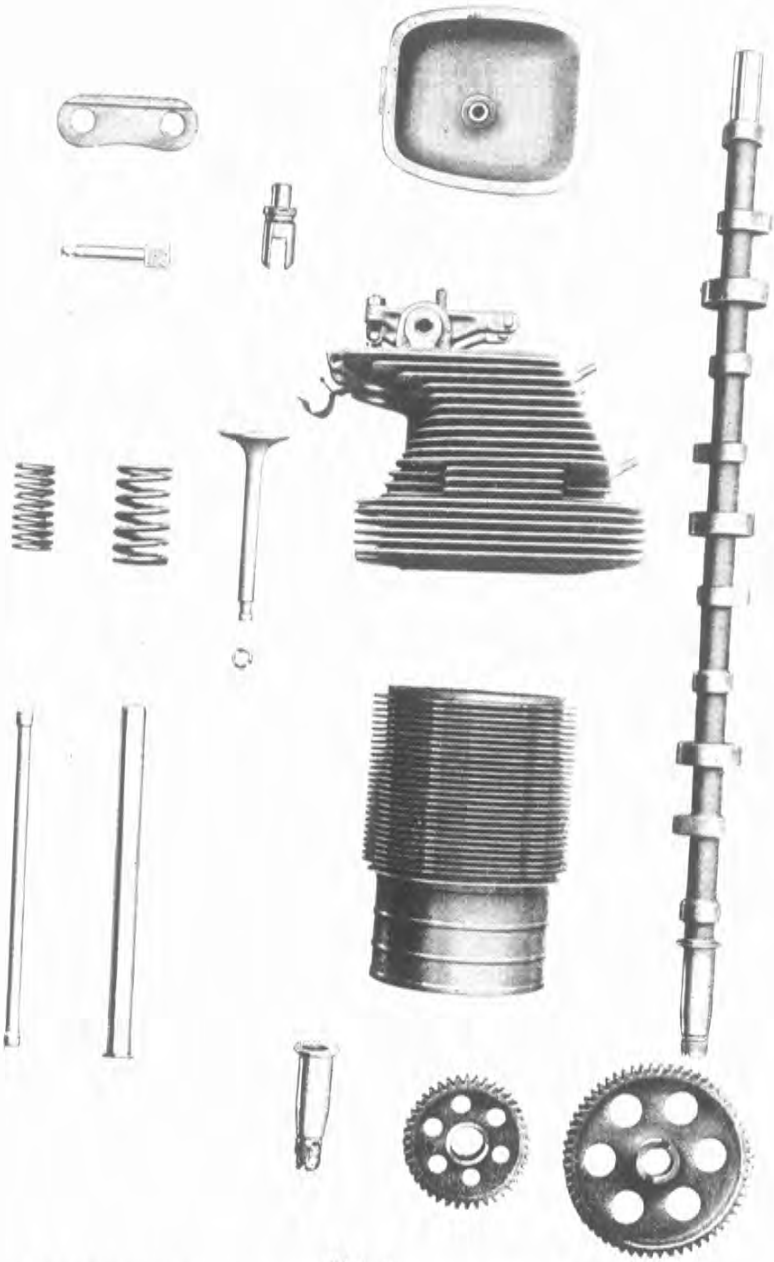
Pict. 3.
Crankcase.



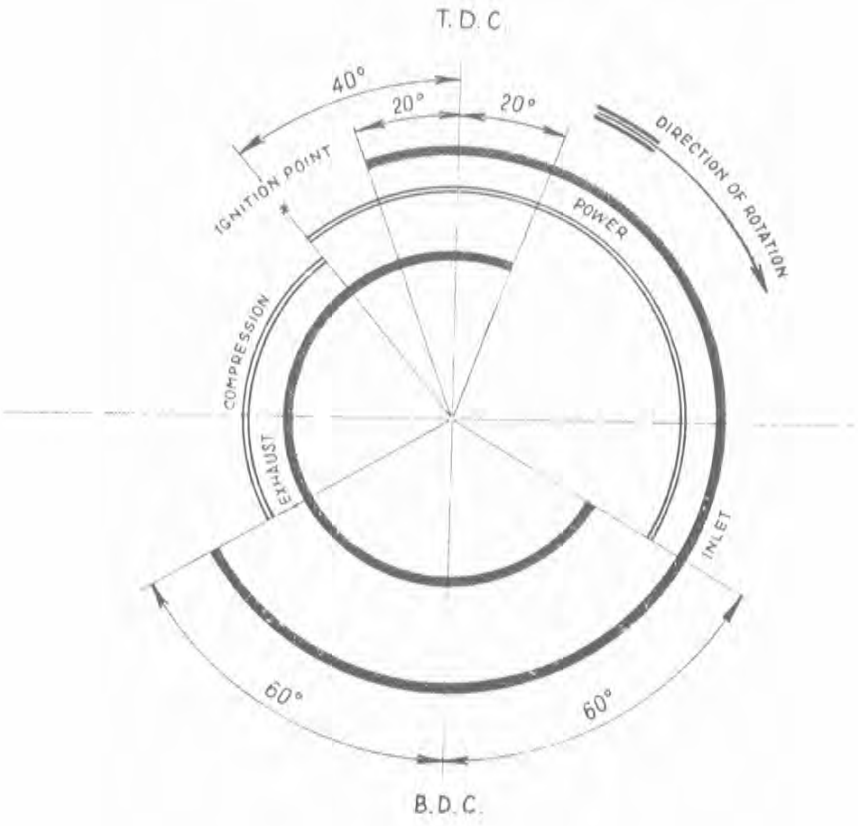
Pict. 4.
Crankshaft and airscrew hub for wooden-type propeller.



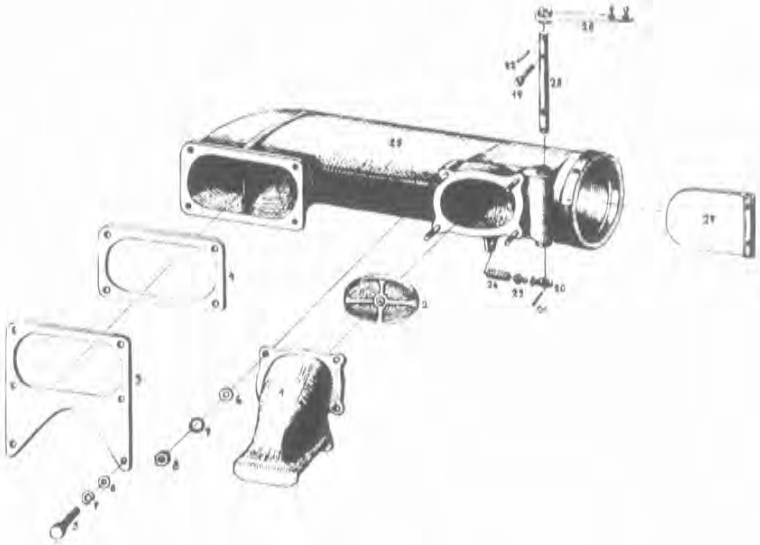
Pict. 5.
Piston, piston rings and connecting rod.



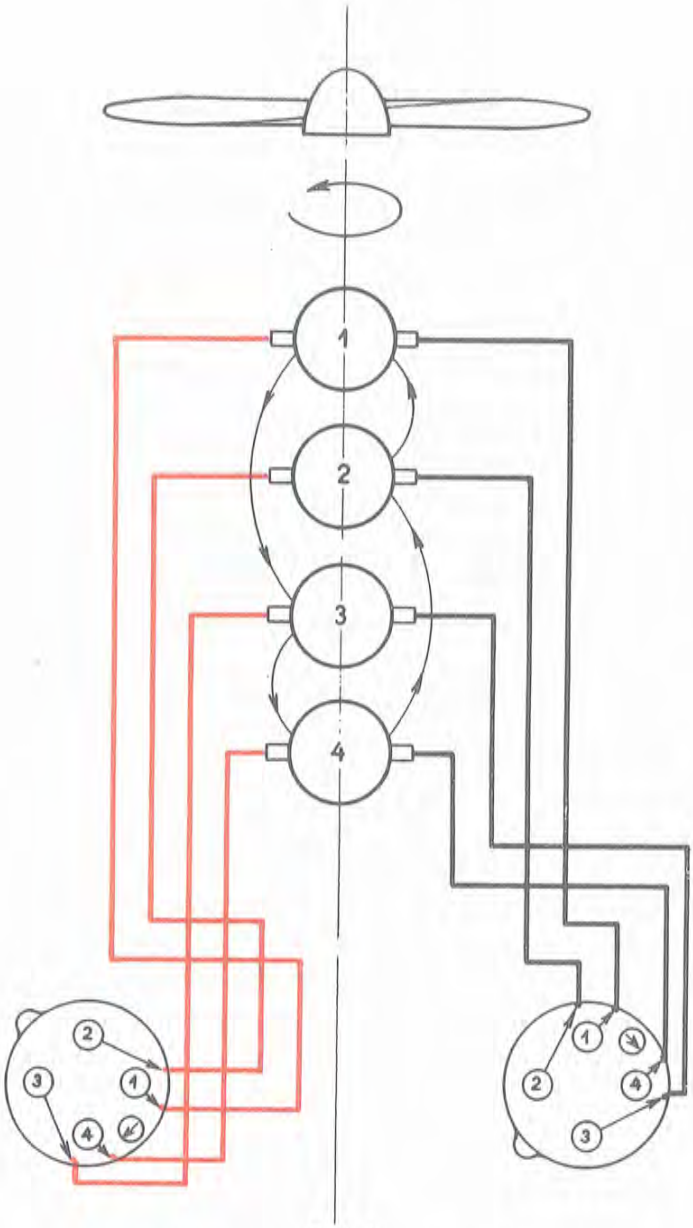
Pict. 6.
Cylinder barrel with head, valve gear and valve timing drive.



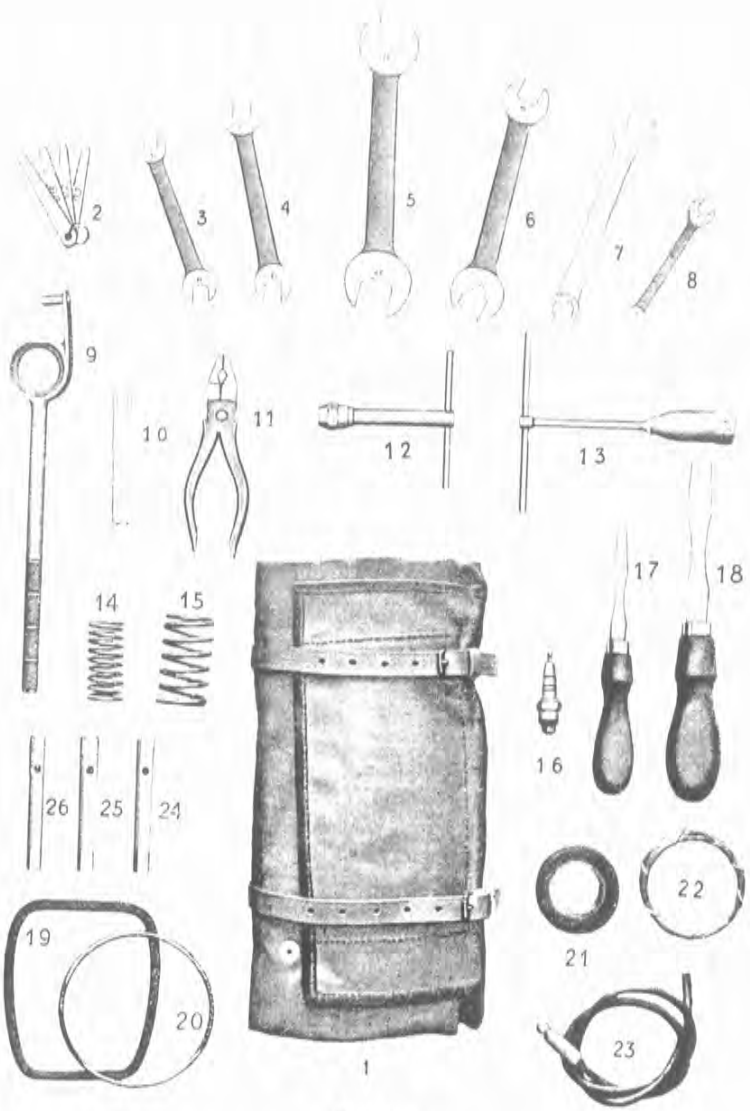
Pict. 7.
Theoretical setting of timing at the cam clearance of 0,2 mm.



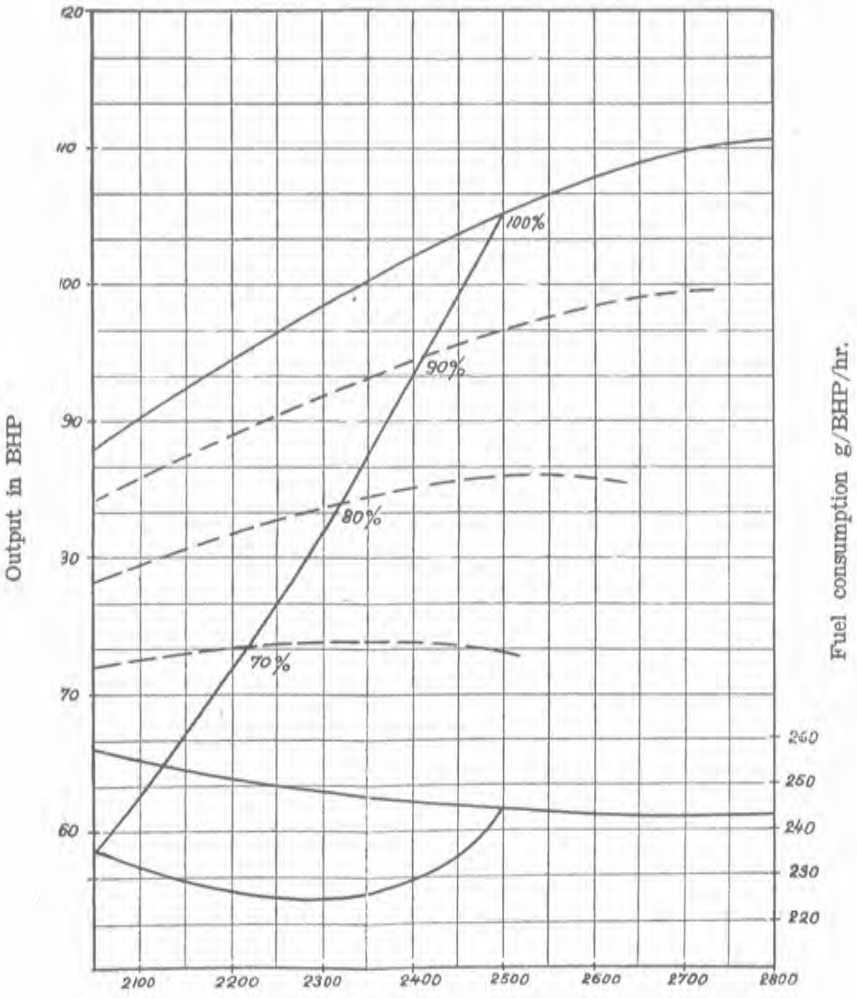
Pict. 8.
Carburetor air intake with flame trap.



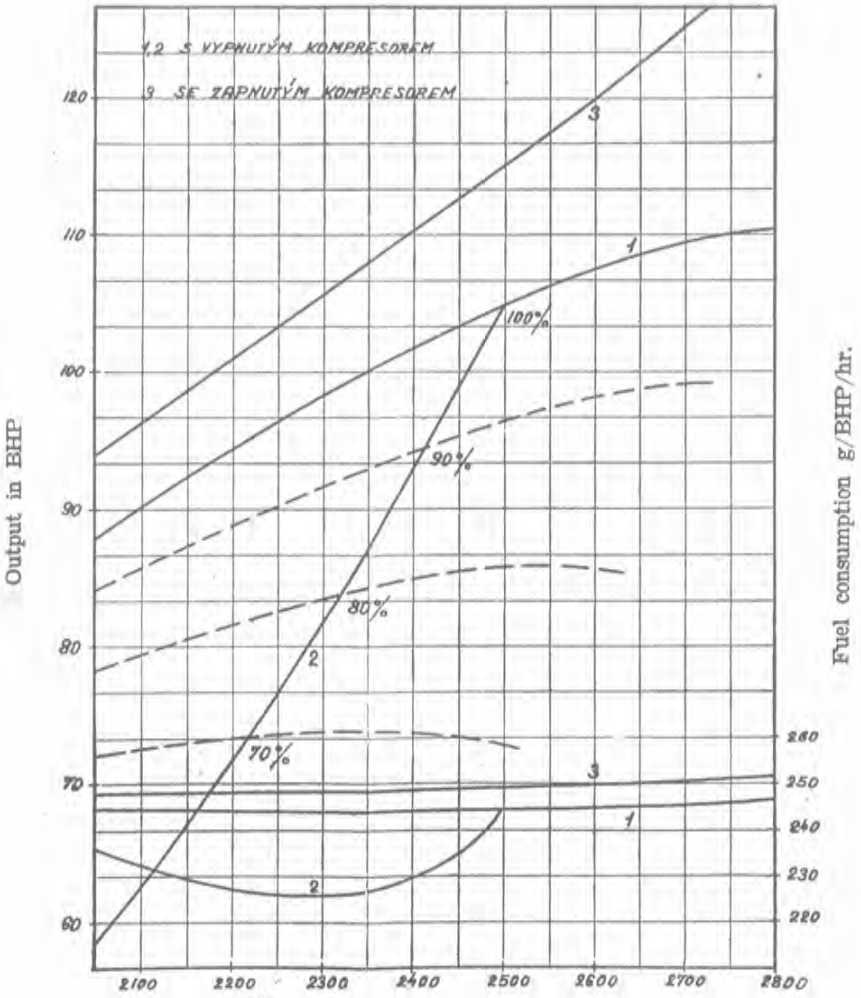
Pict. 9.
Wiring diagram and ignition order.



Pict. 10.
Pilot's tool



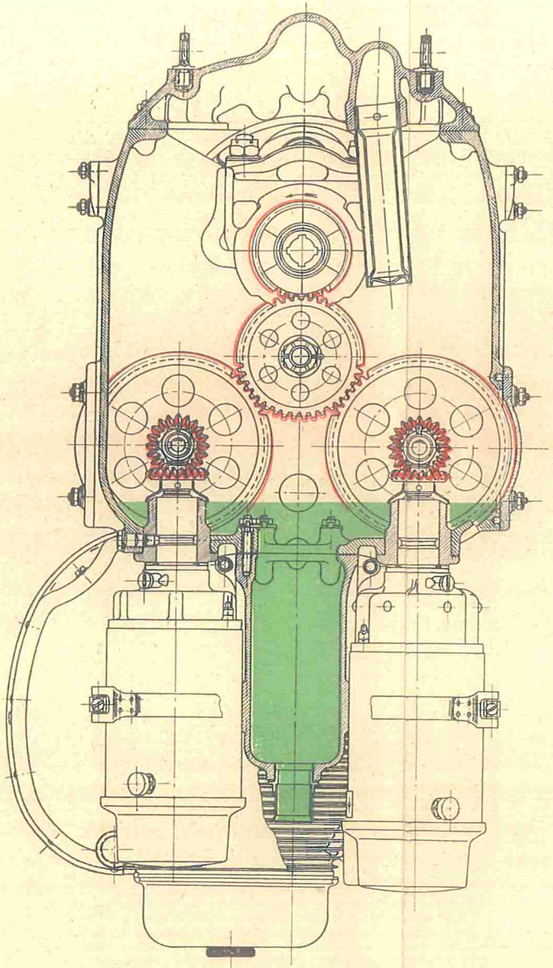
Enclosure Ia.
Power and consumption curves.
(for Walter Minor 4-III engine).



Enclosure Ib.
Power and consumption curves.
(for Walter Minor 4-III S engine).

1,2 compressor disengaged

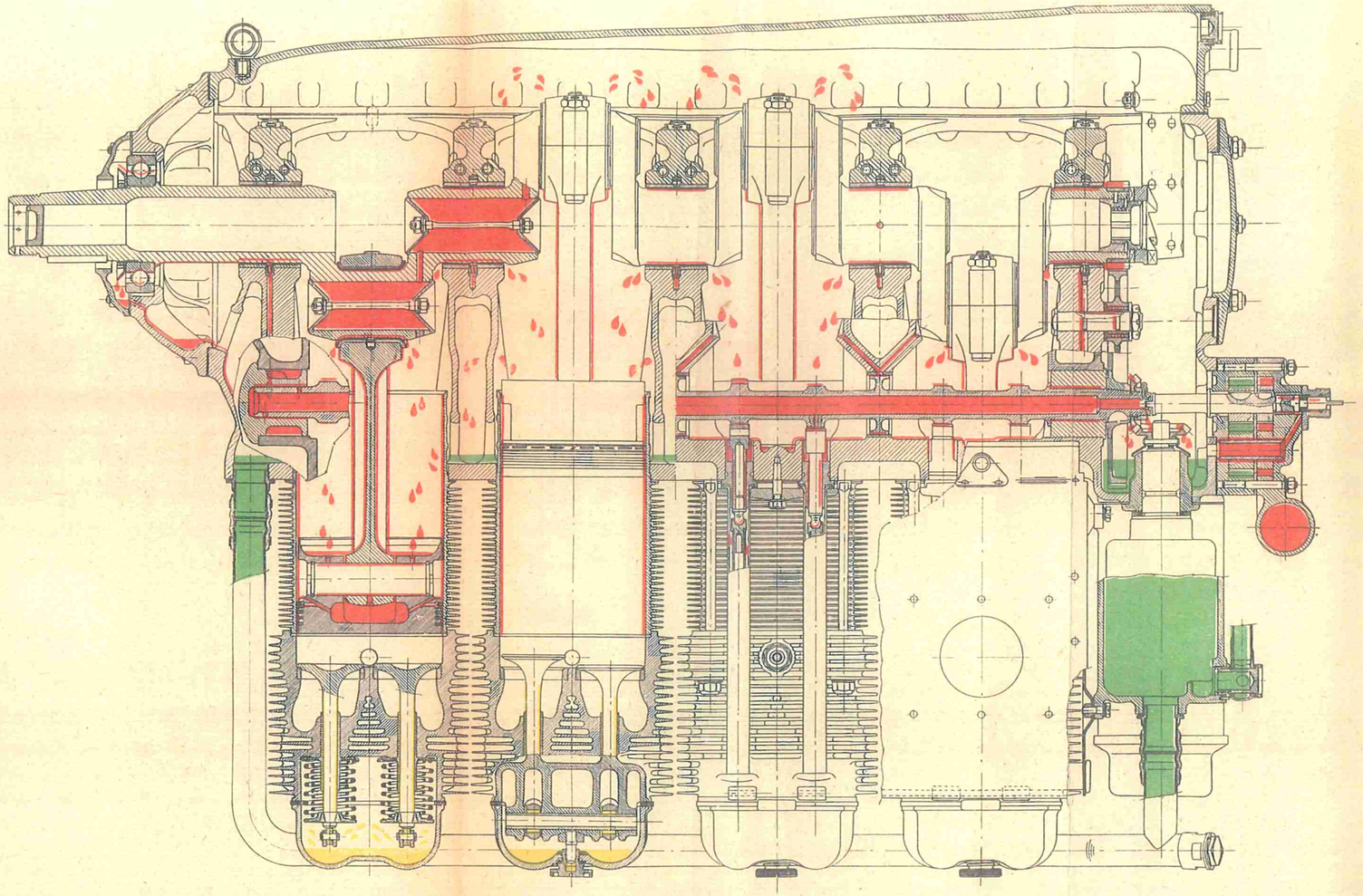
3 compressor engaged



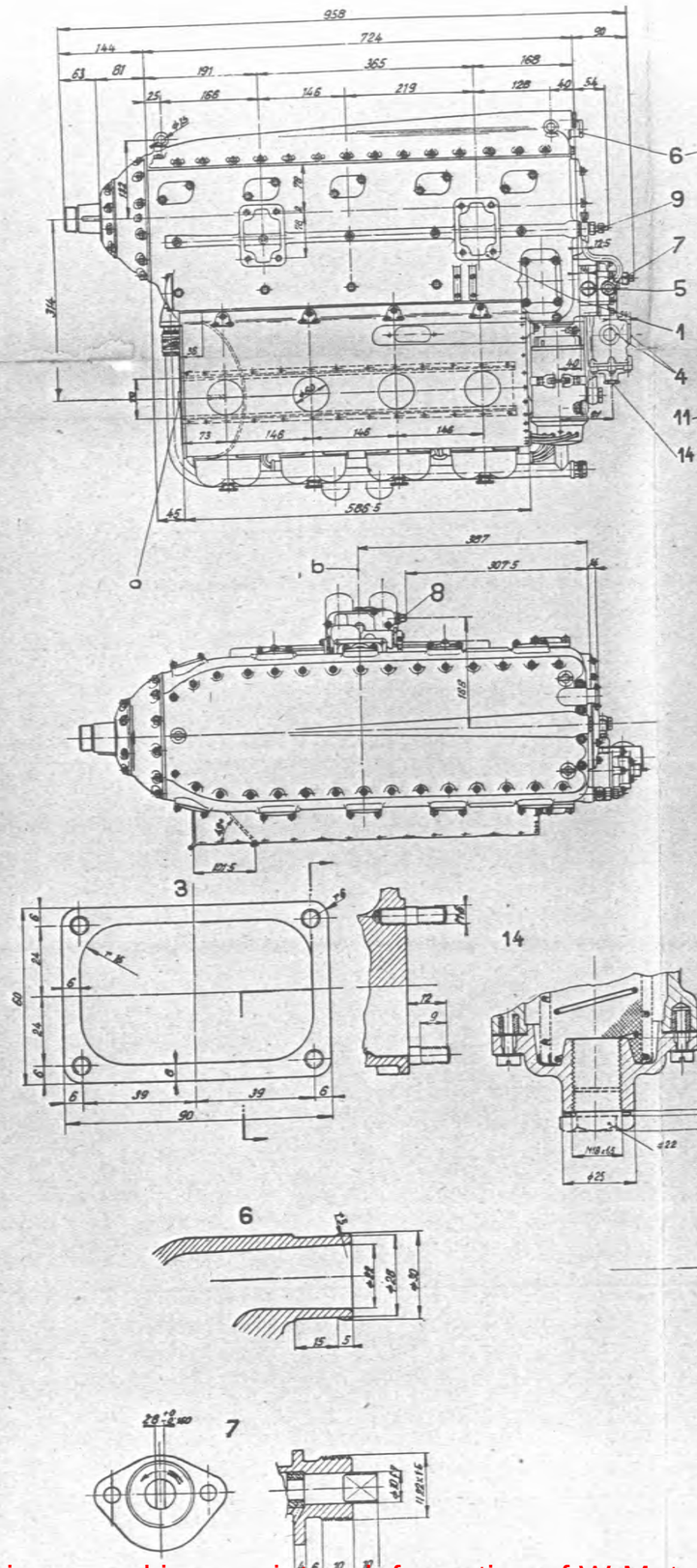
pressure oil

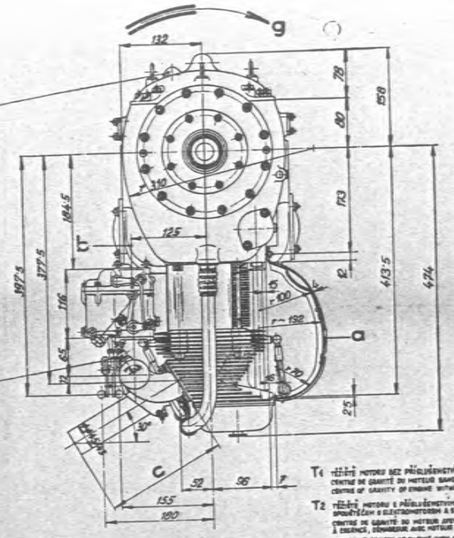
return oil

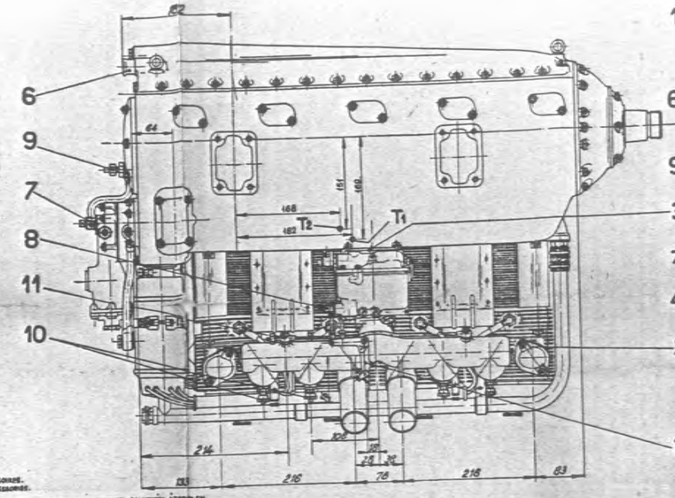
constant oil

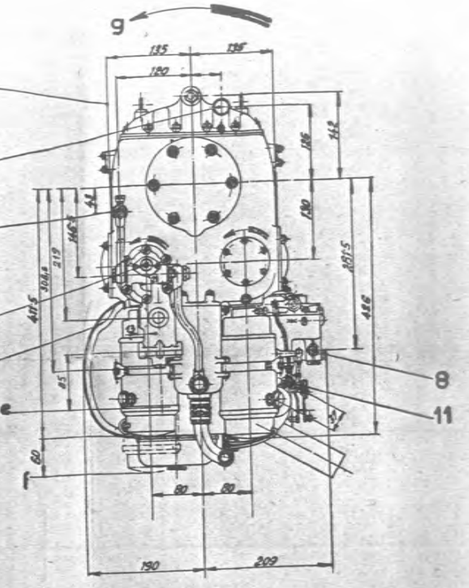


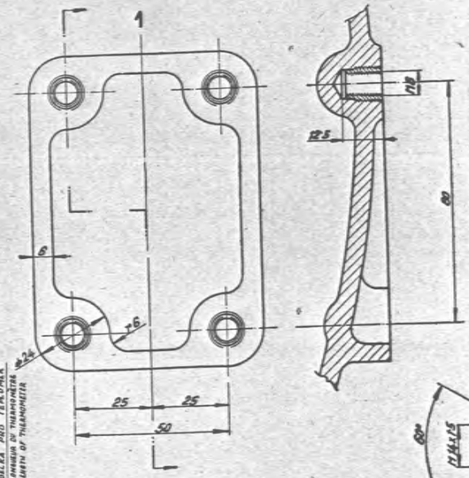
Enclosure II.
Sections through the engine. Oil circulation. Drives.

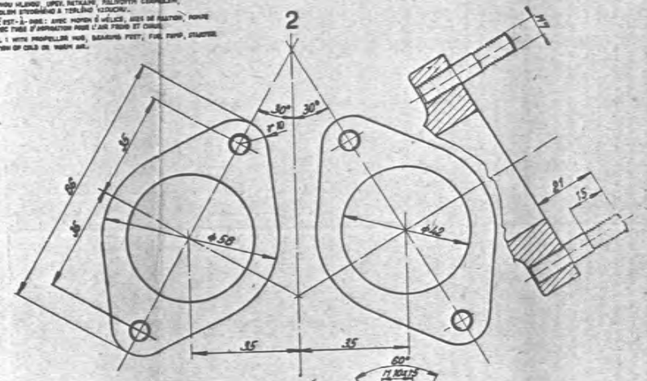


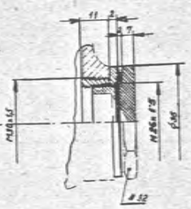


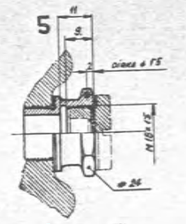


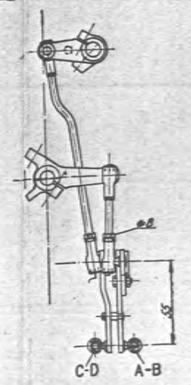


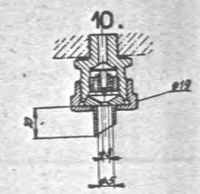


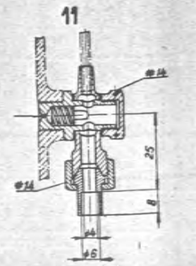


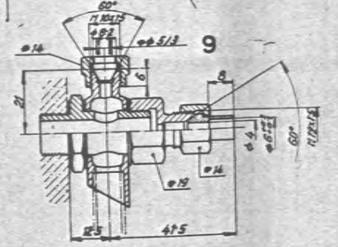








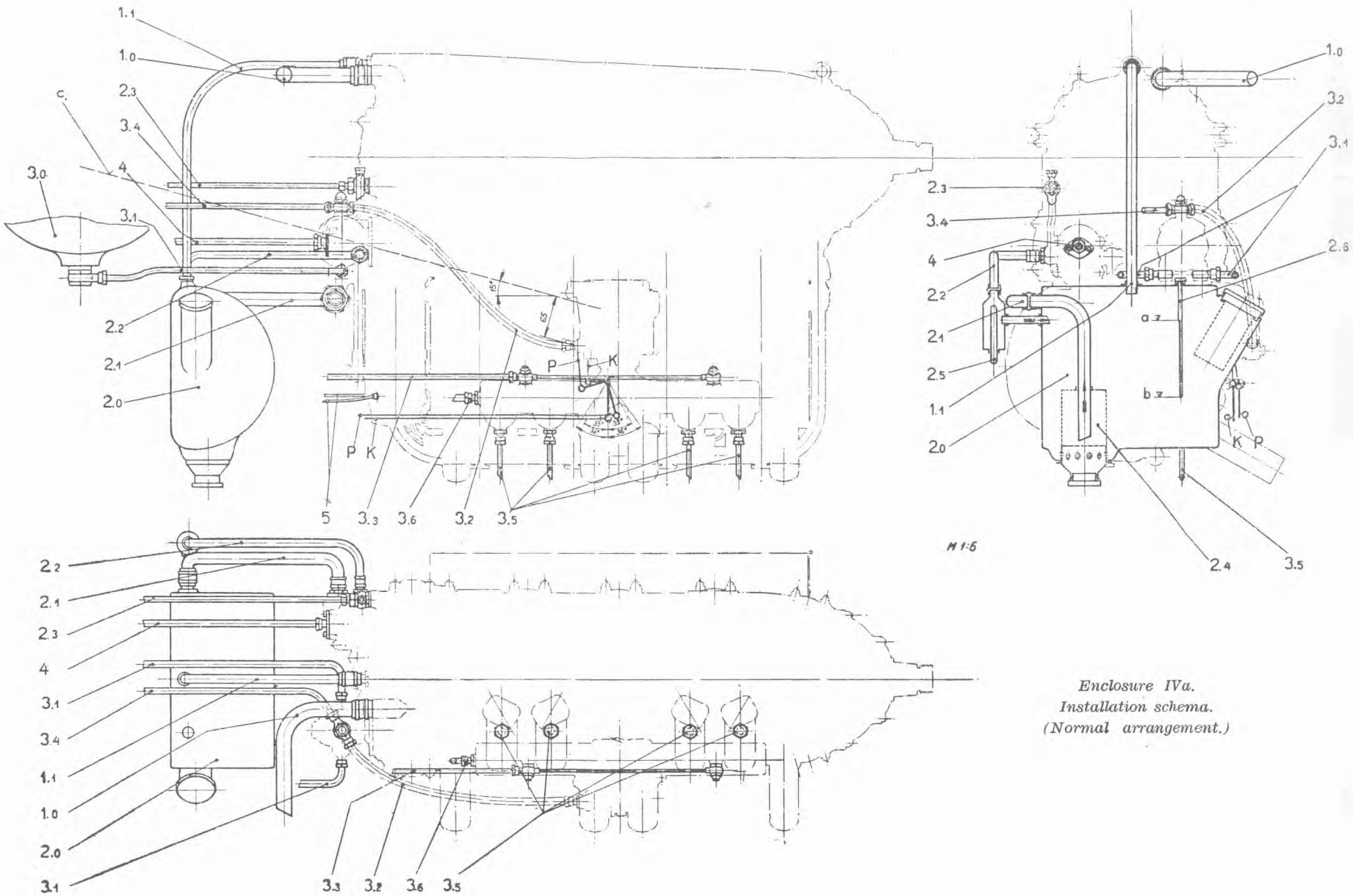




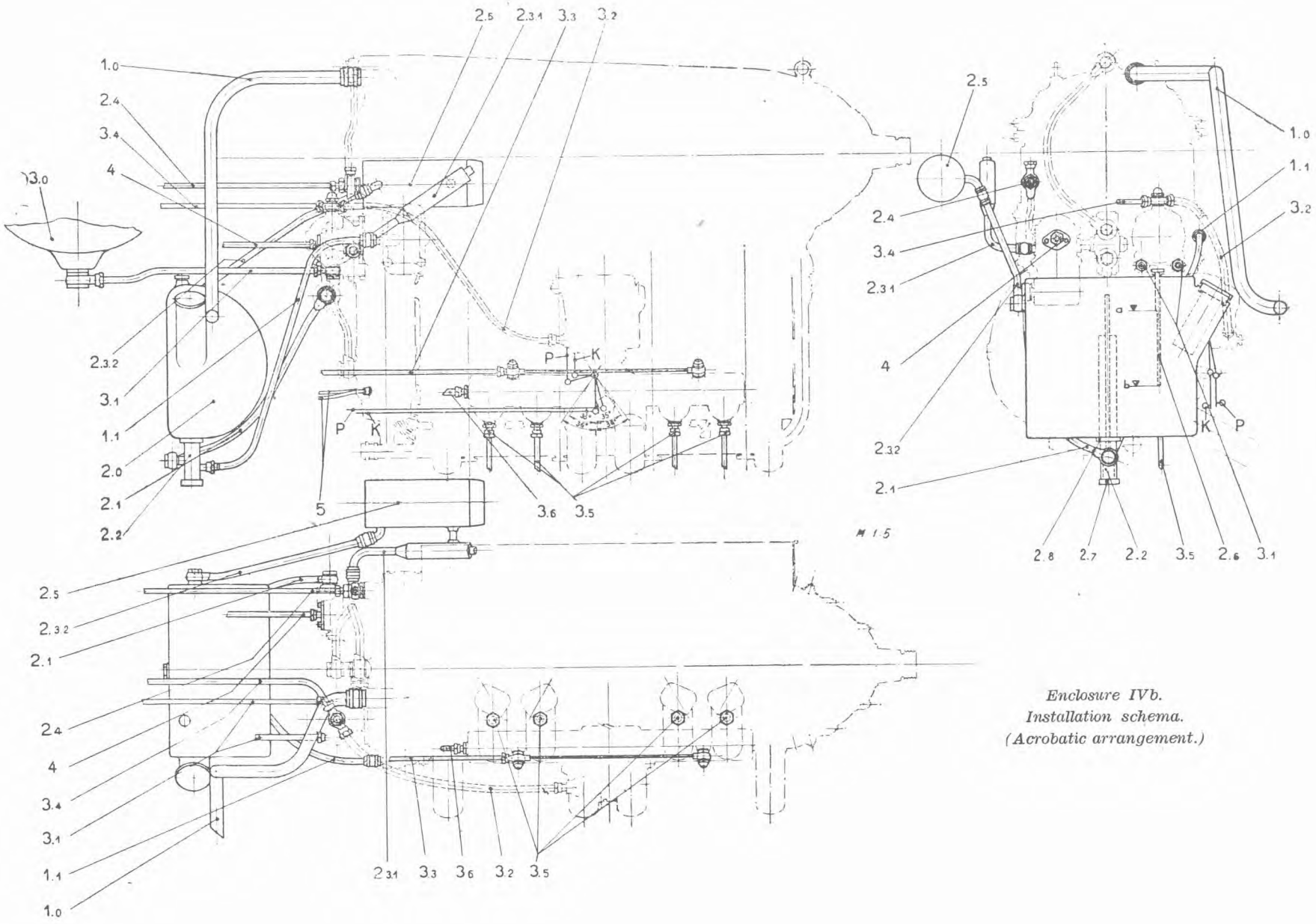
a — Plate which can be removed to enable acces to sparking plugs going through air intake.
b — Carburettor center line.
c — Lenght of exhaust stacks when delivered 125 mm this lenght should be adapted by the aircraft manufacturers according to respective engine cowling design.
e — Space for dismouting oil cleaner.
f — Space for dismouting magneto.
g — Direction of rotation.
1 — Flanges for bearer feet.
2 — Exhaust port.
3 — Carburettor air intake.
4 — Oil inlet union (20 mm I. D.).
5 — Oil outlet union (13 mm I. D.).
6 — Breather pipe connection.
7 — Tachometer drive 2 : 1.
8 — Fuel pipe union.
9 — Oil pressure gauge connection.
10 — Drain valve.
11 — Priming pipe connection.
12 — Ball joint for throttle and mixture controls.
13 — Throttle and altitude control lever. *A* full throttle; *B* slow running; *C* alt. contr. weak; *D* alt. contr. rich.
14 — Oil filtr cover with thread for oil intake thermometer.

This drawing is completed by the Drawings Z. P. 13.

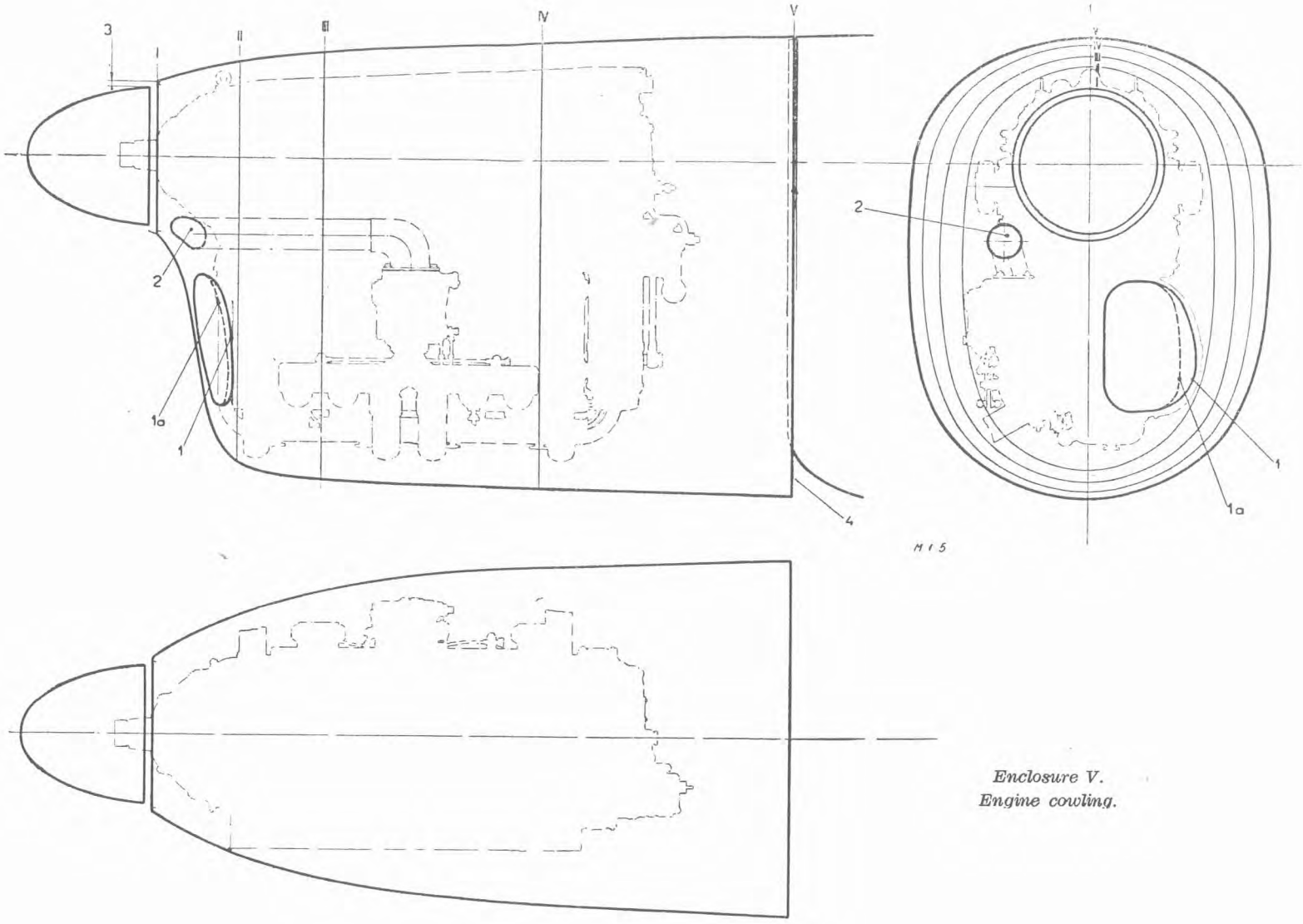
Enclosure III.
Installation drawing of engine with complete equipment.



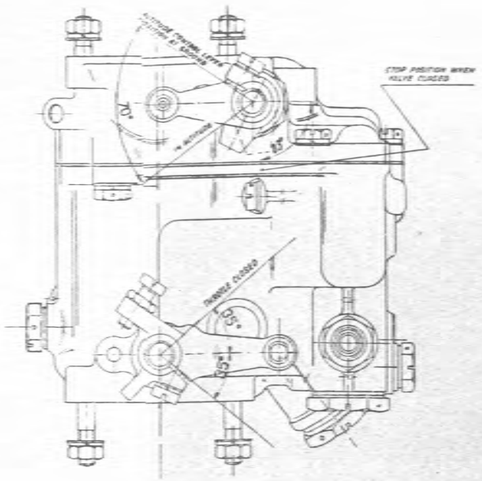
Enclosure IVa.
Installation schema.
(Normal arrangement.)

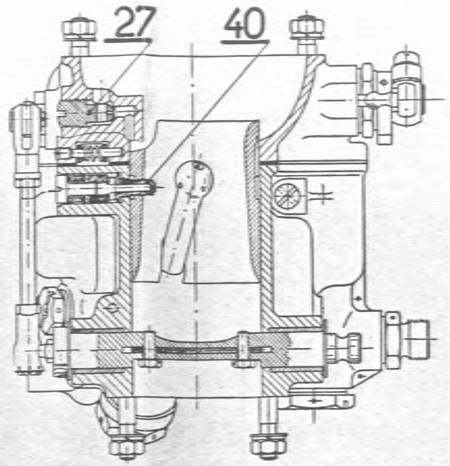


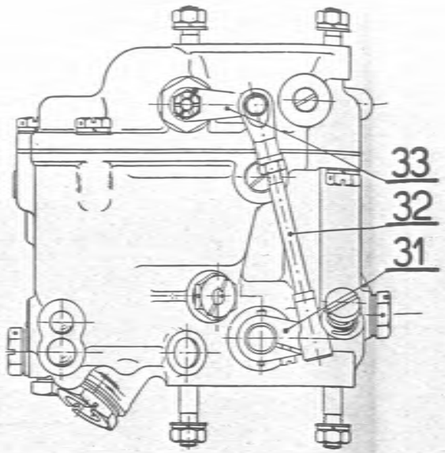
Enclosure IVb.
Installation schema.
(Acrobatic arrangement.)

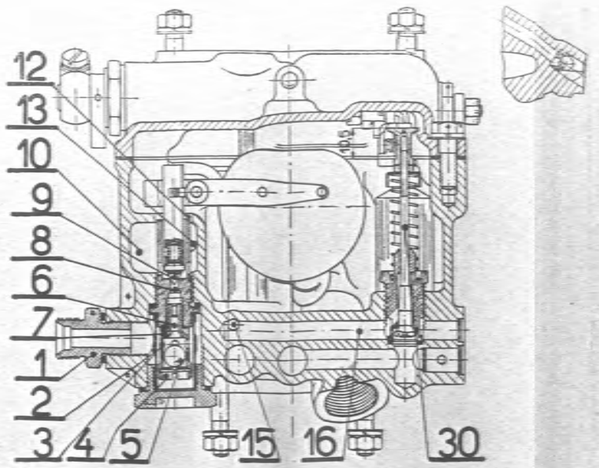


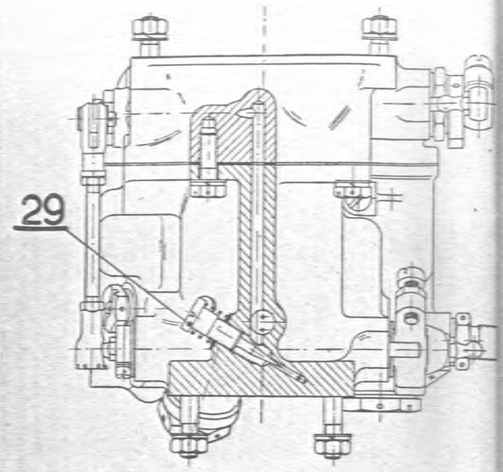
Enclosure V.
Engine cowling.

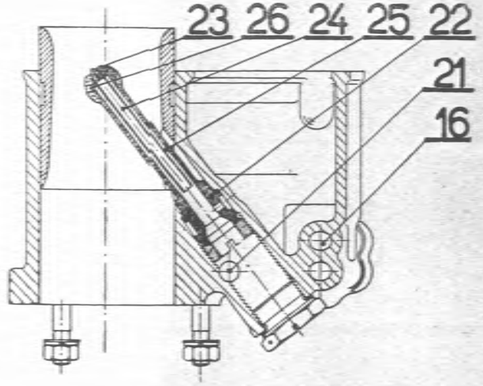


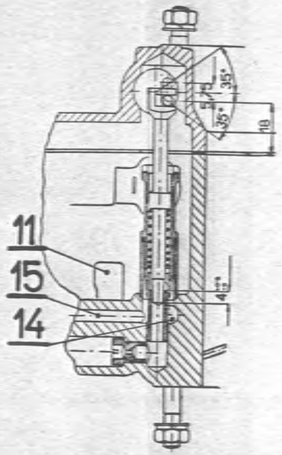


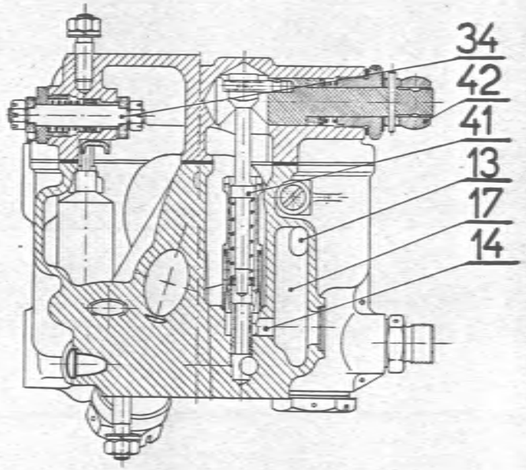


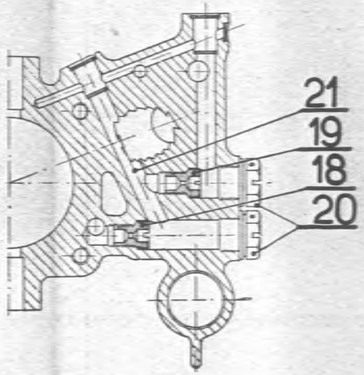


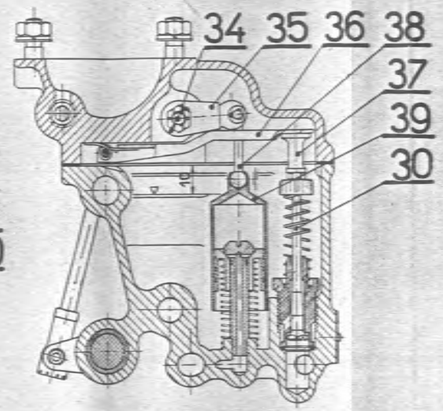


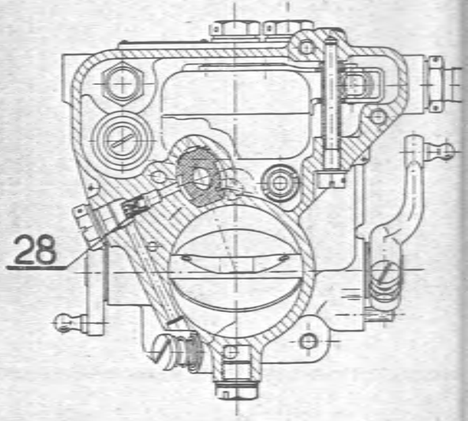






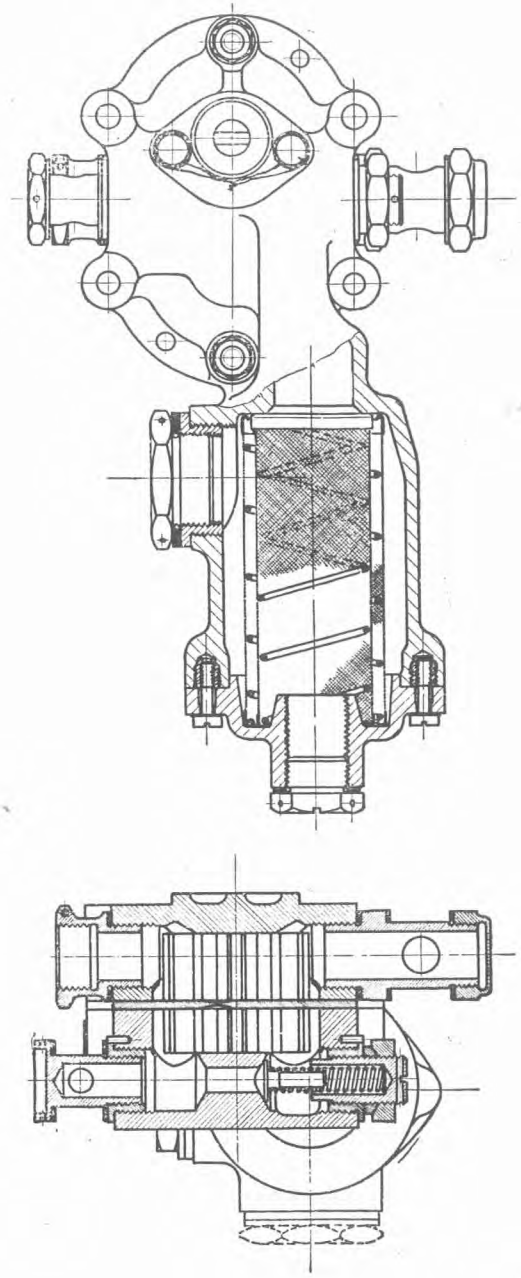


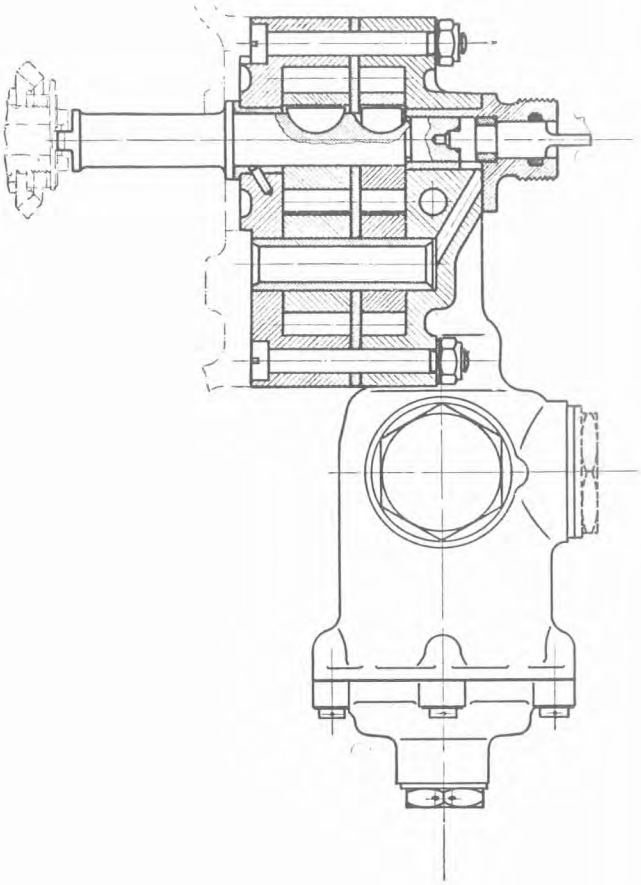




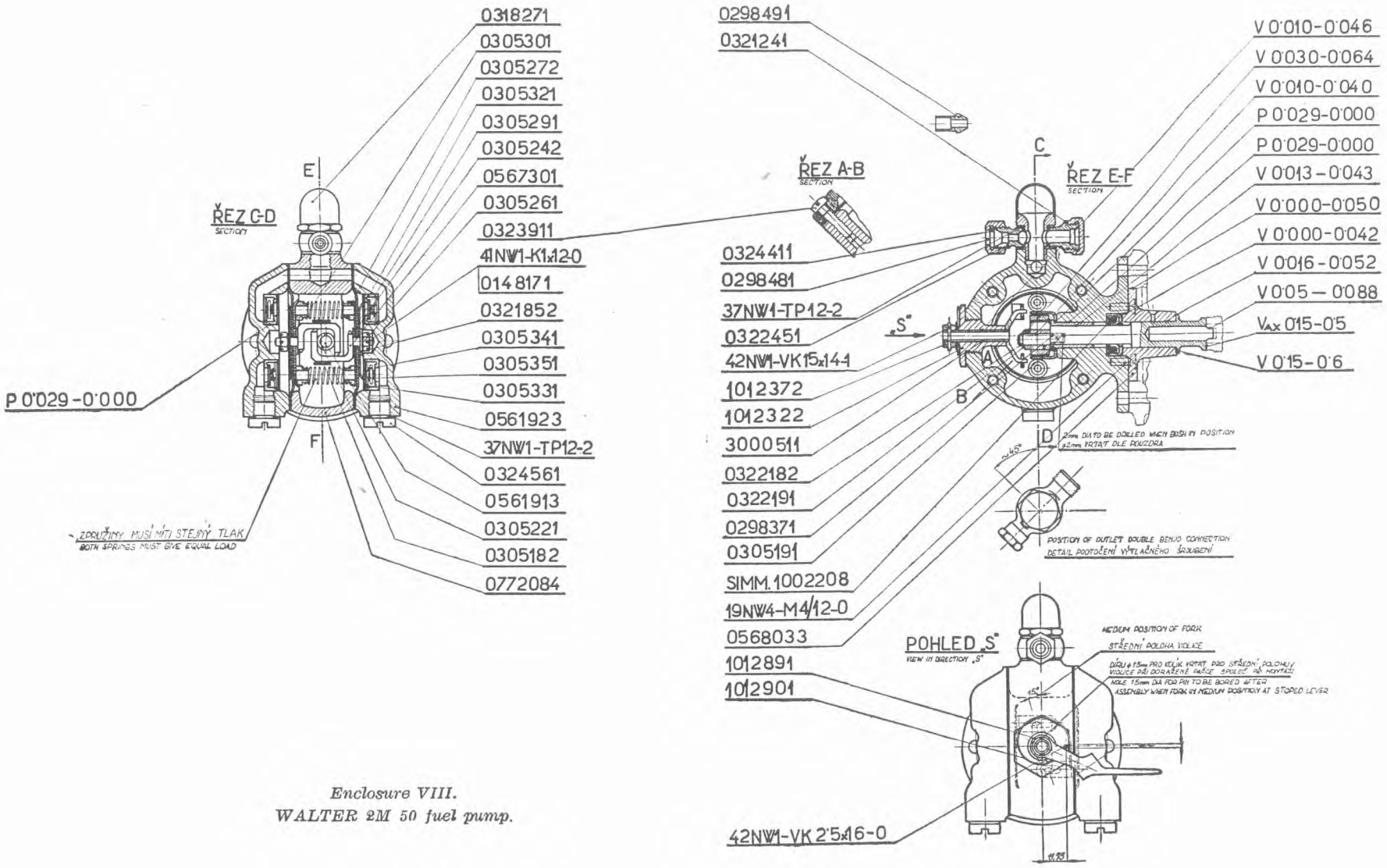
Enclosure VI.

Weber 45 4E Carburetor

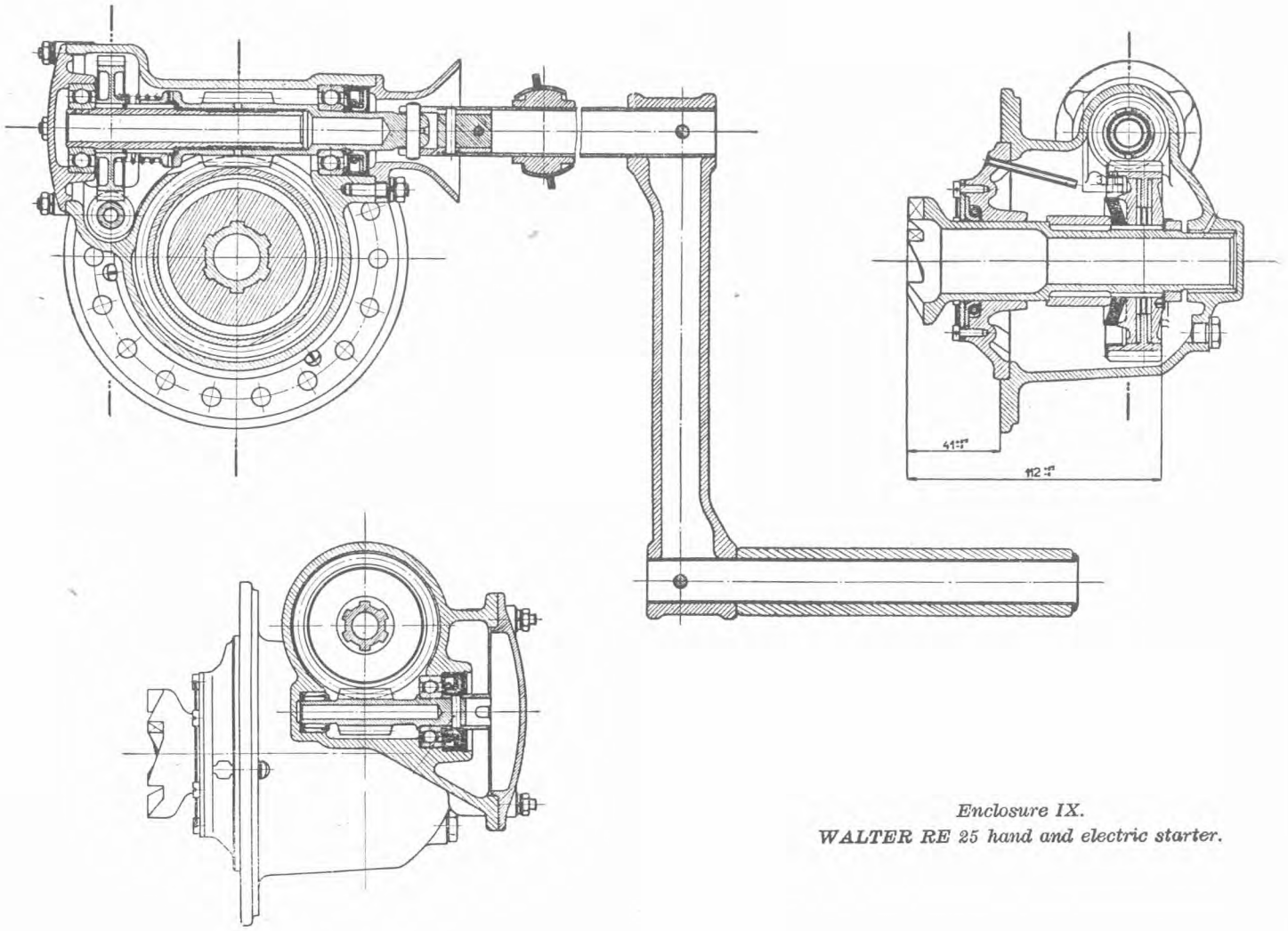




Enclosure VII.
Oil pump.



Enclosure VIII.
WALTER 2M 50 fuel pump.



Enclosure IX.
WALTER RE 25 hand and electric starter.

SERVICE BULLETIN

AVIATION WORKS, NATIONAL CORPORATION, PRAGUE-JINONICE

Date: August 24,1949. Service bulletin No.: 66-8/1

Object: Replacement of Acceleration Pump Cylinder-Assy of the WALTER 45 and 45 AK Carburetor.

Disassemble the air intake from the carburetor and disconnect the throttle and altitude control rods. After unscrewing the four nuts remove the carburetor from the induction manifold. Loose the ball joint "a" by loosening the head.After unscrewing the 5 bolts,placed on the circumference of the joint plane,take off the top part of the carburetor body.Remove the bolt "b" and detail "c" from the bottom part of the carburetor body. The detail "c" is to be ground into the new acceleration pump cylinder "d" by means of fine emery paste. The clearance of 0,016 - 0,070 mm must be kept between these both details.After grinding-in remove carefully the emery paste rests from the both details.

Remove the split pin "e" in the top part of the body and assemble the new acceleration pump cylinder instead of the old one. Replace the details "b" and "c" into the bottom part of the body into their original positions.The bolt "b" must be carefully tightened again. When assembling the top and bottom part together put the acceleration pump cylinder "d" on the detail "c". Care must be taken that the part "f" and "g" touches correctly. Tight carefully and alternately the bolts fastening the both parts of the body. After connecting the ball joint "a" the correct function of the acceleration pump is to be checked by moving the throttle lever,which must be continuous and without resistance.

See Fig.on the next page.

SERVICE BULLETIN

AVIATION WORKS, NATIONAL CORPORATION, PRAGUE-JINONICE

Date: September 1,1949 Service bulletin No.: 62/1

Object: Filling up the 2M-50 fuel pump with oil.

After every 100 hours of flight remove the rear plug of the pump together with overfloating lever /if mounted/ and pour 4 - 5 ccm of lubrication oil into the cave. Then screw in the plug with overfloating lever in position and secure it.
The chapter "Attendance" of the 2M-50 fuel pump deacription in the instruction book is to be thus completed.