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WALTER MINOR 6-III

AERO-ENGINE 160 BHP

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

Original in the Czech language was approved on 1994 by the CAA CZ

W A L T E R   M I N O R   6 - III

AIRCRAFT ENGINE MANUAL

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GENERAL INFORMATION . OPERATION . SERVICING AND MAINTENANCE .

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This Manual is devoted to the detailed treatment of the WALTER MINOR 6-III and MINOR 6-III S aircraft engines by presenting specific information about their operation, servicing and maintenance to complete the operating and maintenance principles related to aircraft engines in general.

Adherence to these instructions is of extreme importance in realising the reliability, long service life and operating economy of the engine in addition to its being a preliminary condition of the Manufacturer´s warranty obligations. Detailed knowledge otthese rules is, therefore, indispensable to all aircraft operators and engineers who are engaged on engine servicing.

We shall be pleased to present any additional information, expert advice and instructions asked for by those interested.

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PART THREE - ENGINE OPERATION.

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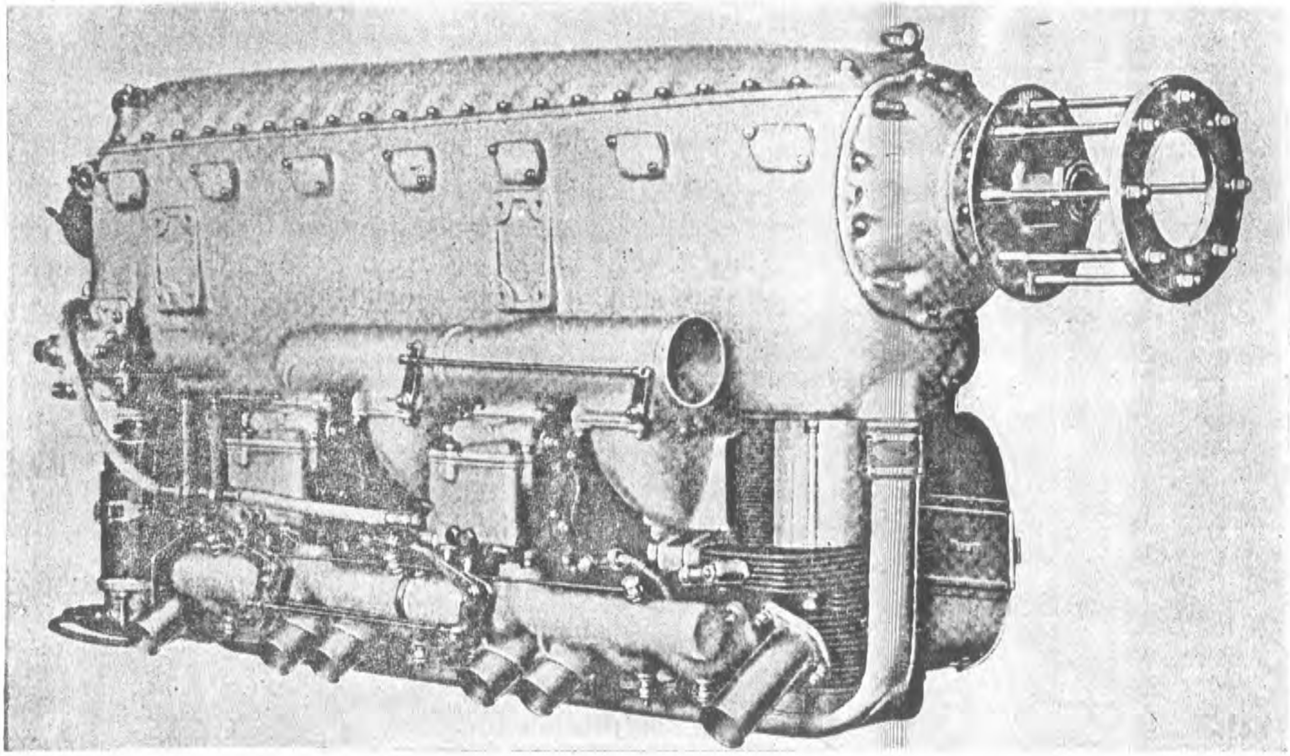

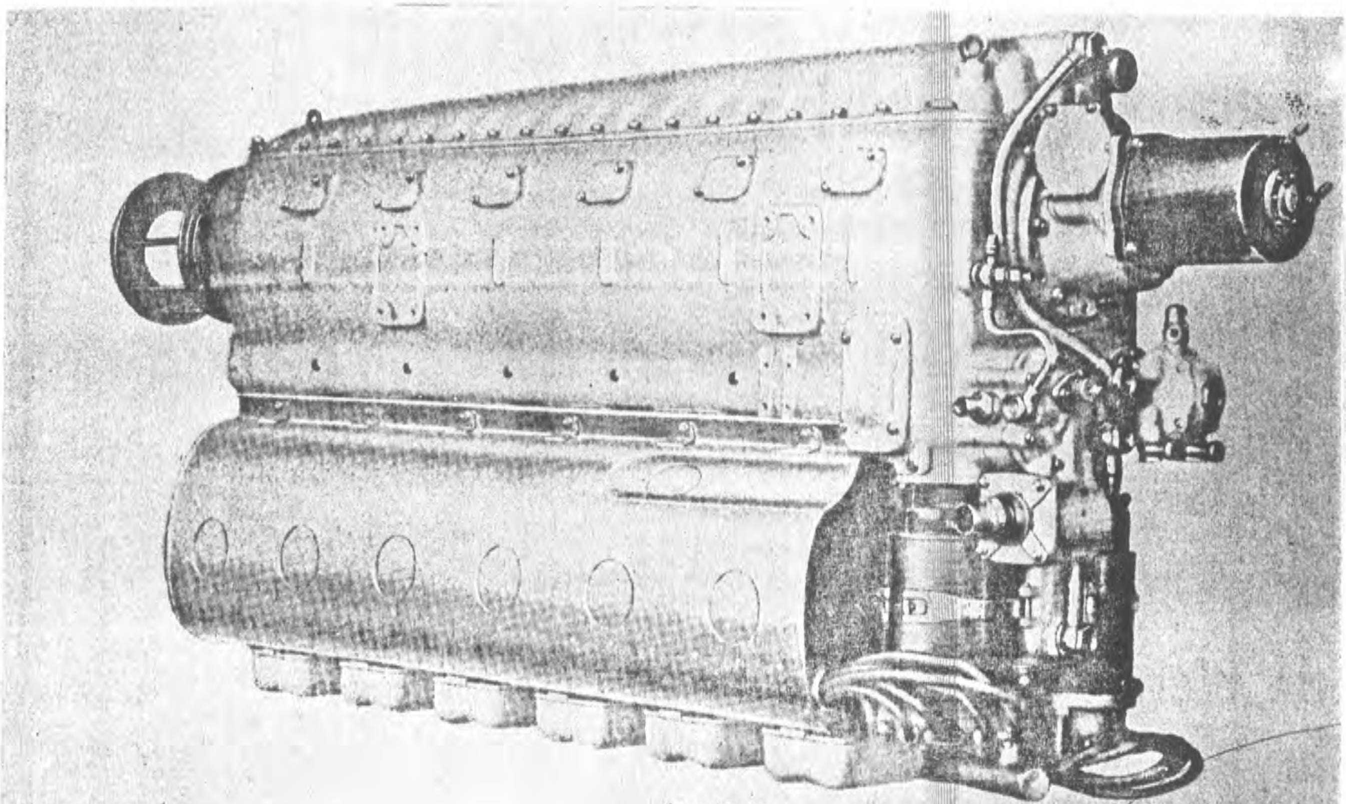

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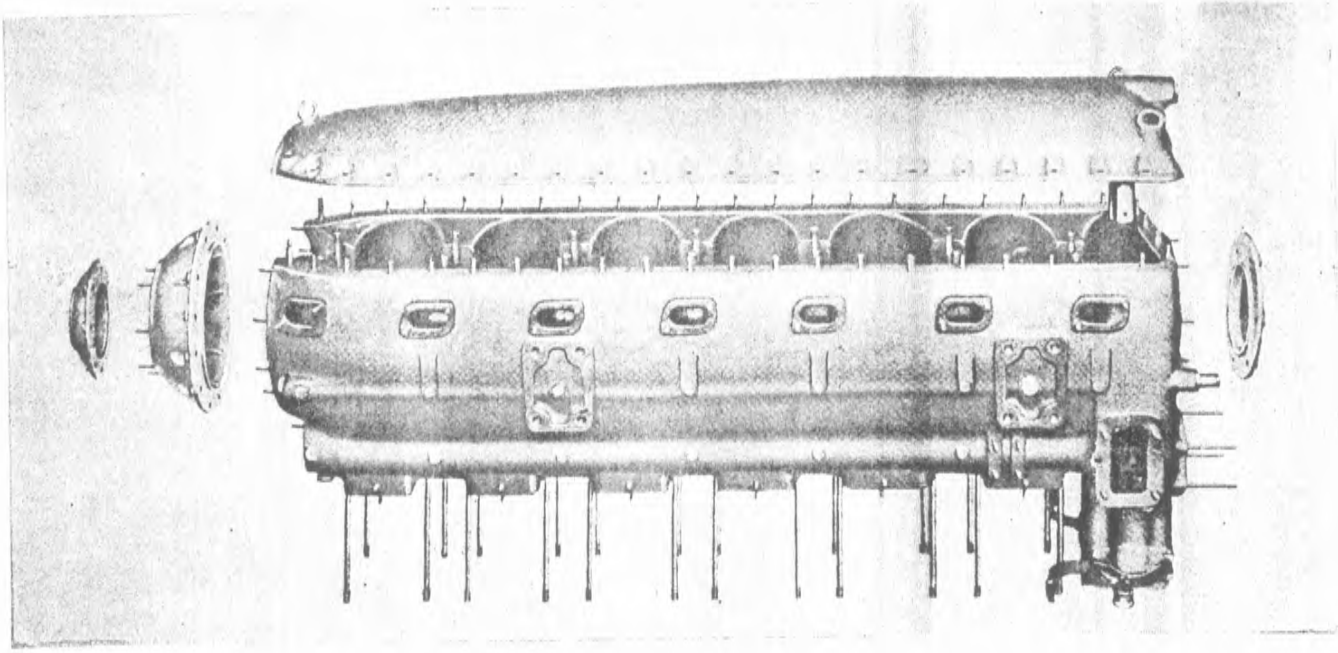
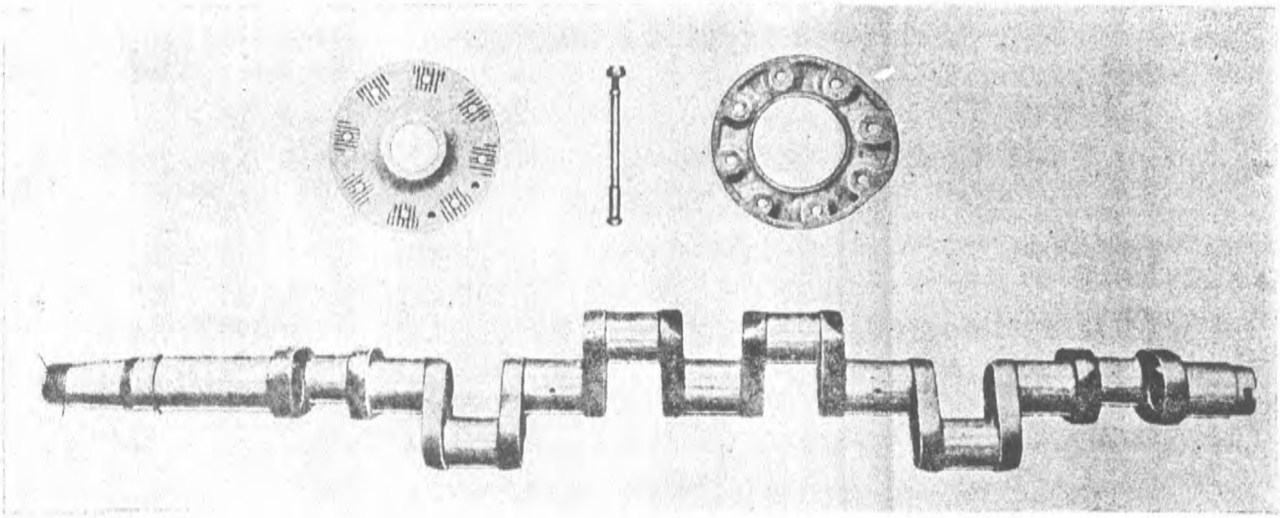
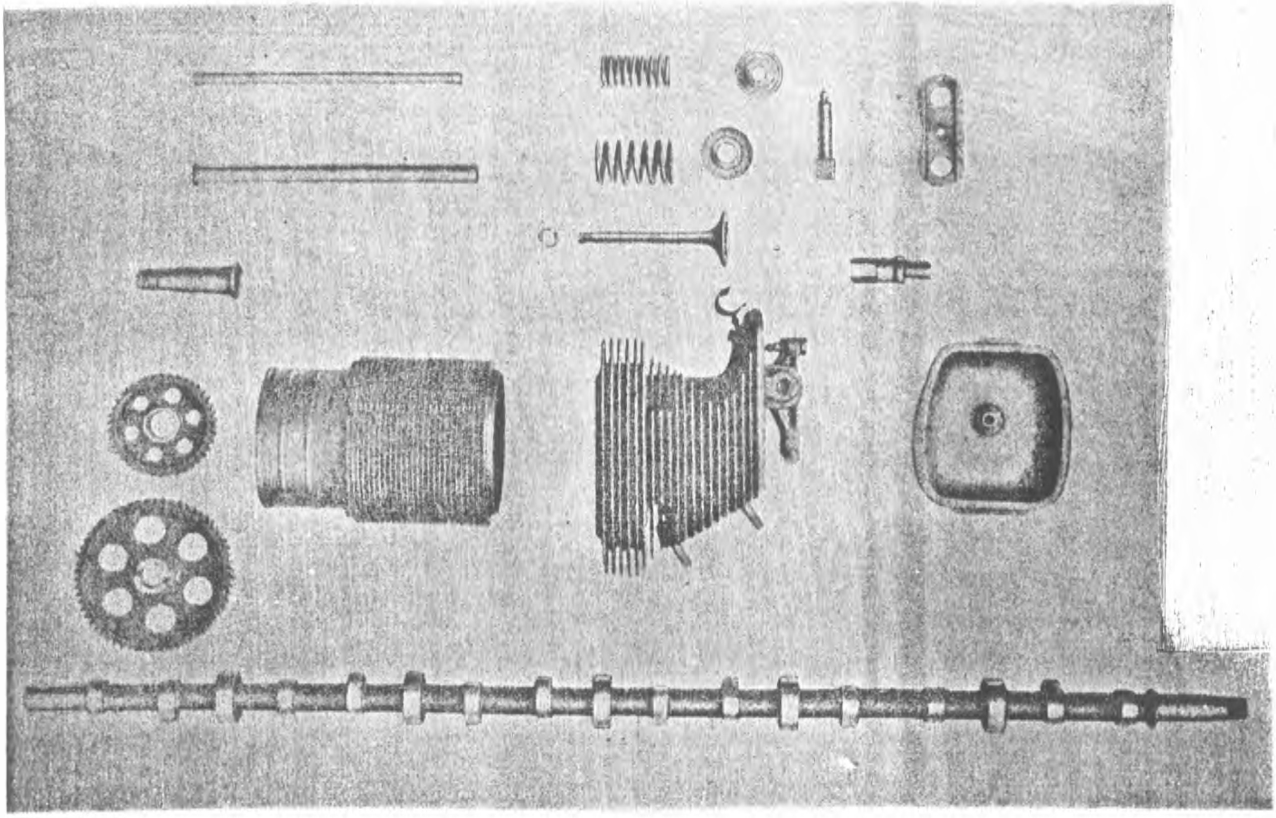
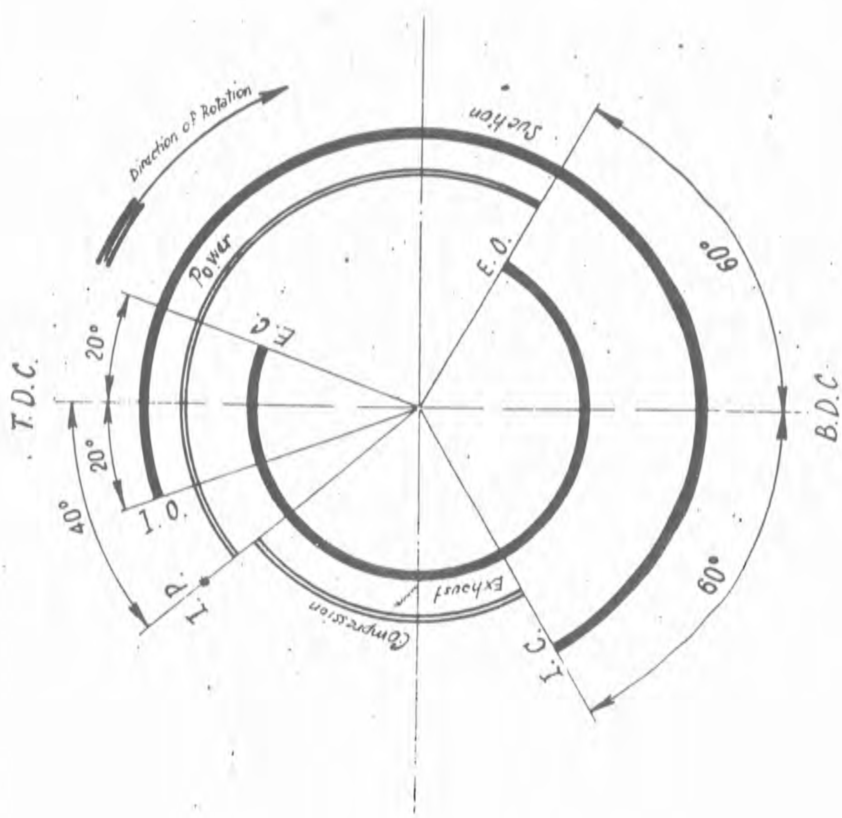


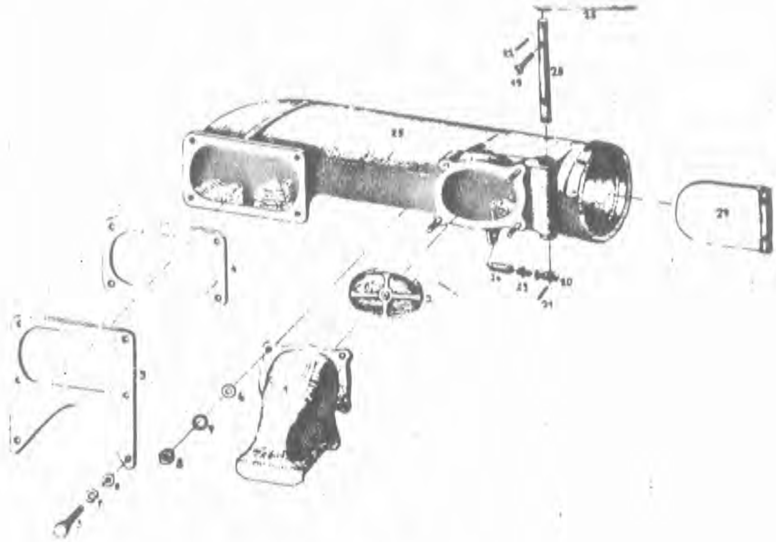






Direction of Rotation
Suction
Power
Exhaust
Compression
T.D.C.
B.D.C.
E.O.
E.C.
I.O.
I.C.
I.P.
20°
20°
40°
60°
60°

Fig. 6.



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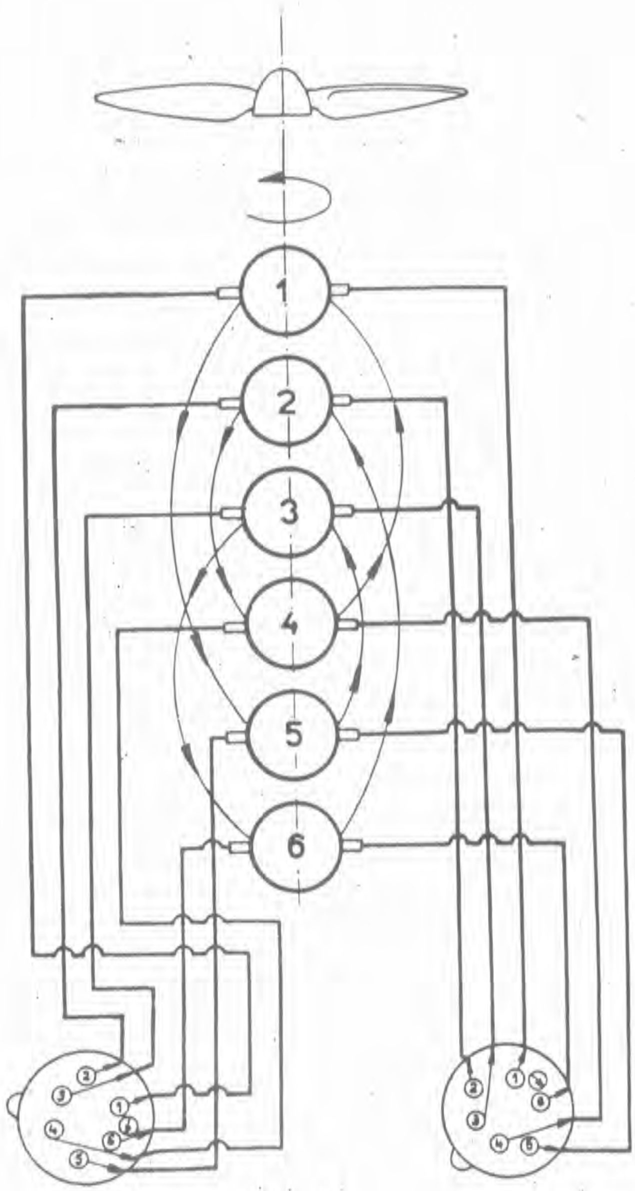

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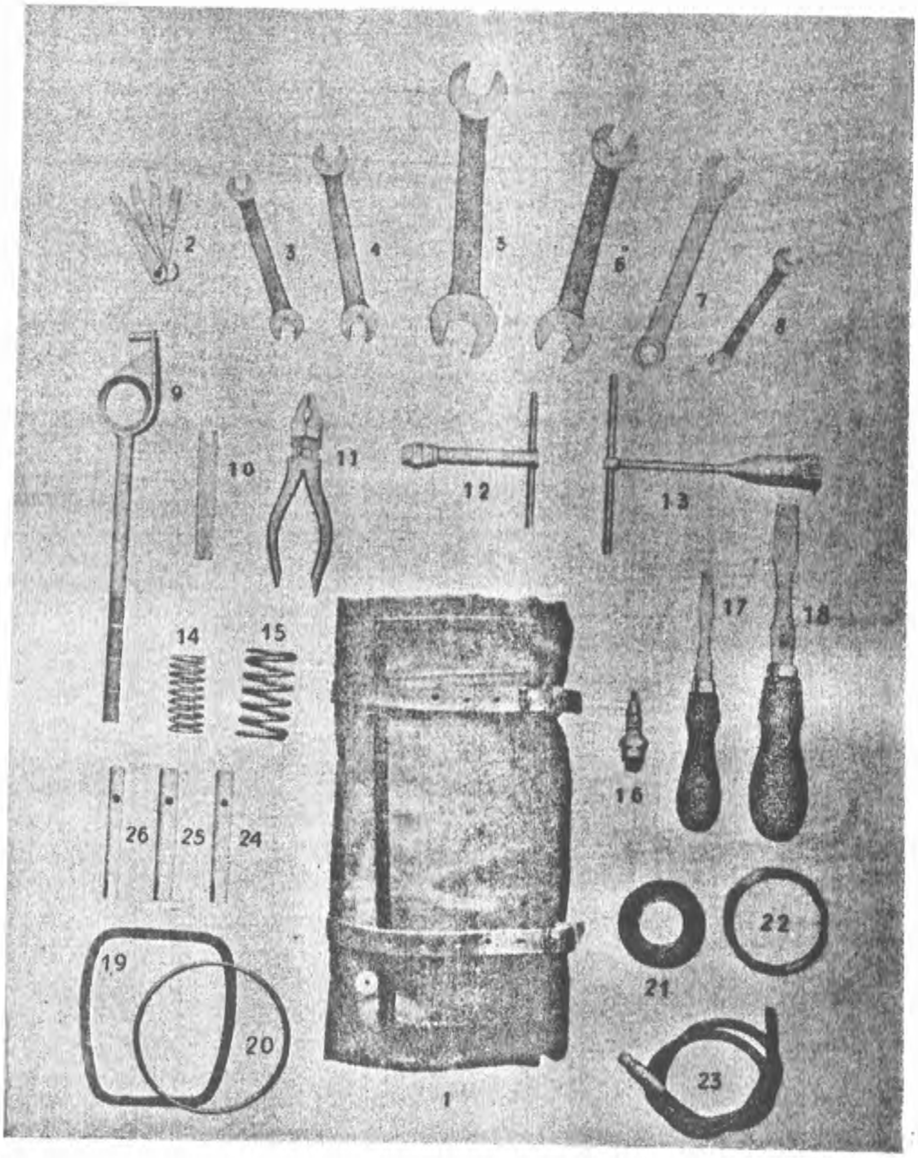
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L I S T O F C H A R T S .

I N T E R P R E T A T I O N   O F   D E S C R I P T I O N S.

The following interpretation should be kept in mind when reading the ensuing descriptions:

"E n g i n e   f r o n t   s i d e " : this description applies to that engine side which is nearest to the airsrew boss. Same instruction applies to individual parts of engine, the expression "f r o n t " desfribing their side which is facing the airscrew, while "r e a r" describes their side which is facing the rear cover.

The cylinders are n u m b e r e d consecutively from the airscrew end, the No. 1 cylinder being that which is located next to the airscrew.

Description "r i g h t " /starboard/ and "l e f t" /port/ indicate a position on the sngine or the sides of individual component parts when viewing the engine from rear.
Desfriptions "u p p e r" /top/ and "l o w e r" /bottom/ refer to a position on the engine or the sides of individual component parts when the engine is in nornal position, the only exception being the cylinders and their component parts, their upper /top/ side being that which is farthest away from the crankcase.

The direction of "c r a n k s h a f t   r o t a t i o n" is given as seen from the engine rear, the R.H. rotation conforming to the clockwise direction, the L.H. rotation being anti.clockwise. The direction of "r o t a t i o n   o f   a u x i l i a r y   d r i v e s   a n d   e n g i n e   a c c e s s o r i e s" is laways given as seen from the driving to the driven member. The direction of rotation of driven instruments conforms to that of their respective drives.

The "a u x i l i a r y d r i v e g e a r r a t i o" is given by the ration of the driving member revolutions to the number of the driven member revolutions, the overall gear ratio being the ratio of the number of crankshaft revolutions to the number of revolutions of auxiliary drives and engine accessories.

Abbreviations "T.D.C." and "B.D.C." apply to top and bottom dead centres respectively, the t o p d e a d c e n t r e being that at which the piston is farthest away from the crankshaft.

P A R T   O N E

D e s c r i p t i o n   o f   E n g i n e

GENERAL INFORMATION.

The WALTER MINOR C-III is an air-cooled I.C. four-stroke six-cylinder inverted in-line aircraft engine with direct airscrew drive off the crankshaft front end.

Manufacturer´s type marking	WALTER MINIR 6-III
Direction of crankshaft and airscrew rotations	anti-clockwise

CYLINDERS:

Cylinder number and arrangement	six, inverted, in-line
Bore	105 mm
Stroke	115 mm
Capacity per cylinder	0,995 litres
Total swept volume	5,97 litres
Compression ratio	6 to 1

POWER AND SPEED DATA.

	Power b.h.p.	Speed r.p.m.
Rated power near ground	160	2500
Crusing power	125	2300
Maximum permissible engine speed in drive		2750
Power-capacity ratio at rated power near ground		26.8 h.p./lit.

FUEL AND OIL SPECIFICATION AND CONSUMPTION DATA.

Consumption figures as given hereunder are intermediary values achievable when using fuel and oil conforming to aviation specifications.

Specified fuel	72-octane /minimum rating/ aviation petrol conforming to aviation fuel specifications
Specified oil	best-grade mineral oil of maximum density 0.92, conforming to aviation lubricant spectifications
Specified grease	top-up lubricators of the SCINTILLA ignition magnetos with special SCINTILLA G grease. Use graphite-grease coumpond to lubricate the flexible speedometer drive
Fuel consumption at rated power near ground /specific/	245 g/hp/hour
Fuel consumption at cruising power /specific/	225 g/hp/hour
Oil consumption at rated power near ground /specific/	2 to 8 g/hp/hour
Fuel consumption per hour at rated power near grouned /density 0.730/	39,2 kg i.e. 53,7 litres
Oil consumption per hour at rated power near grouned ..	1,25 kg or 1,4 lit.
Total fuel and oil consumption at rated power near grouned ...	40,45 kg/hour

VALVE TIMING GEAR AND ITS ADJUSTMENT.

Figures as given hereunder are intermediate theoretical values. Values actually measured on No. 1 cylinder appear on the engine identification plate.

Number of valves per cylinder	2, one intake and one exhaust valve
Valve arrangement	overhead parallel valves
Valve control	off camshaft mounted in crankcase through tappets pushrods and rocker arms
Valve rocker arm clearence re-adjustment is called for at	0,2 mm valve clearence
Intake opens	20 deg. B.T.D.C.
Intake closes	60 deg. A.B.D.C.
Intake stroke time	260 deg.
Exhaust opens	60 deg. B.B.D.C.
Exhaust closes	20 deg. A.T.D.C.
Exhaust stroke time	260 deg.
Intake and exhaust valve clearence, cold	0,15 mm

INDUCTION SYSTEM.

2 carburettors	WALTER 45 or	WALTER 45 A.K.
Carburettor setting /jets in hundredths of mm/		
Main jet	190 ± 10	190 ± 10
Power jet	0 - 60	0 - 60
Slow-running /idling/ jet	80 ± 10	80 ± 10
Special jet for inverted flying		140 ± 10
Choke tube	35 mm	35 mm
Float weight	45 g	45 g
Float chamber fuel level .	1 mm below float pin axis	10 mm from upper face of bottom body
Throttle position for power jet operation		zero /carburettor lever in horizontal position

Fuel pressure ahead of carburettor at pump feed	0,1 to 0,25 kg/sq.cm, idling: up to 0,30 kg/sq.cm.
Dito at gravity feed	0,05 kg/sq.cm

IGNITION SYSTEM.

2 magnetos	port magneto: SCINTILLA VERTEX NVK 6-Z2 /no impulse coupling/, starboard magneto: SCTINTILLA VERTEX AVK 6-Z2 with impulse coupling
Total number of ignition magnetos	2
Driving gear ratio	2 to 1
Direction of magneto rotation when viewing the magneto shaft ..	clockwise
Ignition advance control	automatic
Max. advance, on crankshaft	30 deg. B.T.D.C. /port magneto/ 35 deg. B.T.D.C. /starboard magneto/
Range of automatic ignition advance, on magneto shaft	12,5 deg.
Automatic ignition advance control starts at about	1000 engine r.p.m.
Maximum advance obtained at	1500 engine r.p.m.
Magneto contact breaker gap	0,3 to 0,4 mm
Firing order /related to cylinder numbering/	1-5-3-6-2-4
Cylinder numbering starts	from front, with No.1 cylinder located next to the airscrew
Sparking plugs	BOSCH X 190 T3
Number of spark plugs per cylinder	2
Sparking plug thread	M 12x1,25 , thread length: 8 mm
Spark plug gap	about 0,4 mm

LUBRICATION SYSTEM.

Lubrication system	dry sump, pressure feed type
Oil pump	double-gear type, with one pressure and one scavenge stages
Drive gear ratio	2 to 1
Pressure to scavenge stage output ratio	2 to 3
Oil flow time-mean at rated r.p.m.	150 kg/hour i.e. about 165 lit./hour
Minimum oil quantity required for circulation	about 7 lit.
Oil nor al working pressure .	3 to 4 atm.

Oil inlet temperatures:

lowest, for engine running-up test and take-off ...	20 deg. C
normal	40 to 80 deg. C
maximum	85 deg. C

Oil oultelt temperatures:

lowest, for engine running-up test and take-off ...	30 deg. C
normal	50 to 90 deg. C
maximum	105 deg. C

COOLING SYDTEM.

Cylinder cooling	by air flow
Cooling air intake area on engine cowling:	
for 250 km p.h. speed aircraft .	/minimum/ 300 sq.cm.
Width of annular slot behind airscrew spinder	10 mm
Cooling air exit area	about 600 sq. cm.
Pressure drop between cooling air intake and cowling inside space behind engine:	
in climbing flight	min. 120 mm water column
in level flight	min. 150 mm water column

Normal cylinder head temperature /under starboard sparking plugs/...	190 to 230 deg. C
Maximum cylinder head temperature /under No.3 cylinder stbd. plug/...	250 deg. C, short-time peak: 260 deg. C

STARTING SYSTEM.

Flange and dog to mechanical starting gear conform to	ČSN - AE 7,1 or SAE 5
Direction of starter rotation /when viewing the starter flange/ .	clockwise
Cranking gear /optional/	WALTER R 25 hand starter or WALTER RE 25 combination electric and hand starter gear
Fuel primers for cranking and starting /optional/	3 in intake manifold

ACCESSORY DRIVES AND STANDARD EQUIPMENT.

+/ Asterisk-marked equipment is optional.

+/ Fuel pump	WALTER 2 M 50 double-diaphragm rotary pump
Fuel pump drive	off R.H. layshaft through a driving dog
Direction of fuel pump rotation ...	clockwise
Fuel oump drive gear ratio	2 to 1
Speedometer drive conforms to	ČSN-AE-5,15
Speedometer drive rotation	clockwise
Speedometer drive gear ratio	2 to 1
+/ Generator	24 V/300 W
Number of generators on engine	1 or 2
Direction of generator drive rotation	anticlokwise
Port generator drive:	
direct gear drive at a ratio of ...	1 : 2
remote control through flexible shaft drive at a ratio of	1 : 2

Starboard generator drive /applicable to driving other machines as well/ ...
flexible shaft drive at a ratio of ... 1 : 2

WEIGHT ANALYSIS.

Engine dry weight including accessories and equipment to ČSN-AE-1,4 B, weight B1 .... 126.8 kg ± 2 per cent

Where from:

2 WALTER 45 carburettors .... 3,80 kg

2 SCINTILLA VERTEX NVK-6-Z2 and AVK 6-Z2 ignition magnetos, 12 M 12x1,25 spark plugs and cable harness tubes .... 8,27 kg

+/ WALTER 2M 50 fuel pump .... 0,70 kg

Cooling air scoop and air baffles . 1,86 kg

Engine weight per horsepower at rated power near ground and at B1 weight .... 0,79 kg/hp

+/ Airscrew boss and nut weight ... 2,43 kg

+/ For standard-type bearer feet with rubber dampers and bolts ....

long-type .... 0,73 kg
short-type .... 0,65 kg
bolts .... 0,46 kg

+/ WALTER R 25 hand starter gear with crank .... 4,25 kg

+/ WALTER RE 25 combination electric and hand starter gear with crank .. 7,25 kg

Four exhaust stacks complete, 125 mm long and two exhaust flanges ...... 1,13 kg

+/ SCINTILLA generator and relay control .... 5,21 kg

+/ Generator direct drive gear .... 1,65 kg

+/ Generator remote control drive /including 0,5-metre flexible shaft/ .... 1,9 kg

+/ Hot air scoop with flap and flame-trap ..	1,6 kg
+/ Shielded ignition conduits /additional weight as compared against un-shielded system/	1,08 kg
+/ Adaptation of lubrication for inverted flying /anti-g/	0,6 kg
Total weight with full equipment to ČSN-AE.1, 4B, weight B2	143,0 kg ± 2 per cent

OVERALL DIMENSIONS OF ENGINE.

Overall length including fixed-pitch wooden-airscrew boss	1324 mm
Overall width less bearer feet	399 mm
Overla height	639 mm
Engine height above airscrew centre-line ...	165 mm
Engine height below airscrew centre-line ...	474 mm

PIPING SIZES.

Fuel feed piping inside diameter	6 mm dia.
Primer adaptors on intake manifold	4/2 mm dia.
Condensed fuel discharge pipe	5/3 mm dia.
Fuel gauge connection	6/4 mm dia.
Oil pressure feed pipe bore	/min./ 20 mm
Oil scavenge line bore	/min./ 13 mm
Oil pressure gauge connection	6/4 mm dia.
Vacuum-operated instrument piping	6/4 mm dia.

ENGINE PACKING CRATE.

Engine standard packing crate length	1680 mm
Engine standard packing crate width	722 mm
Engine standard packing crate height	890 mm

Engine standard packing crate weight	93 kg
Total weight of packing crate containing engine and full equipment	236 kg

Each engine bears on its crankcase port side a type plate with indication of engine serial number and engine number beside an identification plate on which appear main technical data, valve and ignition timing adjustment data as well as principal data related to engine operation such as fuel and oil specifications with respective consumption, temperature and pressure data.

DESCRIPTION OF PRINCIPAL PARTS OF ENGINE.

CRANKCASE.

The three-part crankcase consists of proper crankcase, of upper crankcase cover and front crankcase cover with the thrust bearing cap. All these parts are heat-treated magnesium-alloy castings. The crankcase proper /or main/ section is fitted witho double partitions accommodating the crankshaft and camshaft bearings.

Located in the bottom side are flanges with studs for holding-down of cylinders to the crankcase, while four flanges for engine bearer feet are arranged in the crankcase sides with one flange at either side for generator drive mounting. The crankcase rear wall carries a standard flange for the starting gear as well as special flanges for the oil and fuel pumps, for ignition magnetos and for oil collector. The crankcase top is shut-off by means of an upper cover carrying three lifting lugs and a crankcase breather at rear, the crankcase front being shut-off by means of a front cover and a thrust bearing cap, with the ball thrust bearing being tigten ed-up between them.

CRANKSHAFT.

The six.throw crankshaft is a forging of special nitriding chrome-vanadium alloyed steel and is machined all over. The crank pins and journals are nitrited. The pins and journals are hollow, serving together with crank arms as passages for oil circulation from main to connecting rod bearings, with dished plugs blanking-off the hollow sections at either end. The crankshaft front is tapered and splined to take the mounting key and a thread is provided for airscrew hub nut assembling.

The crankshaft rear end carries the valve timing gear drive and the starter dog actuated via radial splines and tightened-up to the crankshaft by means of a plug screw. The crankshaft is carried in seven steel-backed lead-bronze plain bearings tightened-up with detachable flush-mounted aluminium-alloy caps. A ball thrust bearing mounted in front is loaded with airscrew thrust forces. This bearing is tightened-up on the crankshaft together with the oil thrower ring by means of a ring nut.

FIXED-PITCH WOODEN AIRSCREW BOSS.

The fixed-pitch wooden airscrew boss is in two parts, viz. an airscrew hub and a front flange. The airscrew hub is a chrome-vanadium alloyed steel forging keyed to the crankshaft taper and tightened-up by a nut locked in place by a wire clip. The hub rear engaging a recess in the thrust bearing cap is fitted with a labyrinth packing. After the removal of blades the airscrew hub will remain on the crankshaft. The magnesium-alloy front flange is tightened-up together with the airscrew by means of airscrew retaining bolts.

CONNECTING RODS.

The H.section connectiong rods are stamped from Hiduminium RR 56 and are polished all over. The split big ends clamped together by two bolts contain twin-part steel bearing sockets /blocks/ with lead-bronze lining. The piston pin is located straight in the plain /nonbushed/ connecting rod small end.

PISTONS.

The pistions ate forged of the RR 59 aluminium-base alloy. There are three compression rings and one oil control ring per piston. The piston pin is secured in position by means of circlips..

CYLINDERS AND CYLINDER HEADS.

The cylinders consist of cylinder barrels and detachable heads. The nitriding steel barrels are solid for gongs with integrally machined closely spaced cooling fins and mounting flange and nitrided cylinder bores.

The cylinder heads are cast of a special aluminium-base alloy with closely spaced cooling fins, the rocker gear cover bottom portion being cast integrally with the cylinder head. The intake and exhaust ports open on to the right-hand side of the cylinder head. Steel valve seats and bronze valve guides are press-fitted into the cylinder head with two bronze bushings for sparking plugs being bolted down to the head.

The head is fitted to the barrel and sealed off with a copper--asbestos gasket, the two parts being held together and simultaneously screwed into the crankcase. A magnesium-alloy rocker gear cover protects the valve timing gear.

VALVE TIMING GEAR.

The valves are opened by cams on the camshaft through tappets, push rods and rocker arms and closed by coiled springs. Refer to "General Information" section for data on basic valve timing setting. The valvé timing order is 1-5-3-6-2-4 for individual cylinders.

The camshaft is supported by seven plain bearings. The front magnesium-alloy bearing is tightened-up by a flange from outside in the crankcase front wall. The intermediate bronze bearings of ample diameter allow the passing- through of the camshaft and are press-fitted into the transverse walls of the crankcase. Keyed-on and tightened-up by a nut to the camshaft rear is the large timing wheel and the L.H. magneto drive bevel gear. The camshaft itself is driven off the crankshaft gear through a layshaft gear rotating on a pin fitted in the crankcase rear wall.

The valve t a p p e t s are fitted with ballheads at the push rod end and move in hiduminium guides in whicg they are locked agaibst rotation by a square head slot.

The p u s h r o d s of duralumin tubing terminate in a cupped end, each pushrod being enclosed by an aluminium cover tube with synsthetic rubber seals at either end to provide an oil-tight seal. The r o c k e r a r m s are mounted on a common pin in needle roller bearings, each rocker arm being fitted with a roller for the valves, while an adjusting screw secured by a lock nut is fitted at the push rod end for valve clearence adjustment.

There are two parallel v a l v e s per cylinder, i.e. one inlet and one exhaust valve constructed of special high-alloy steel. The two valves are interchangeable, having nitrided stems to the end of which is fused a hard alloy layer against which the rocker arm rollers actuate.

Two springs are used on each valve, the springs being identical for inlet and exhaust valves. The upper spring cup is retained on the valve by means of a twin-part sleeve cone.

The valve timing located in the cylinder head is enclosed by an oil-tight cover with a cork gasket. The cover is tightened-up in place by a knurled nut. The cover cap is filled with oil when the engine is in service.

INDUCTION SYSTEM.

The engine draws-in fuel-air mixture supplied by the two WALTER 45 down-draught carburettors equipped with manual mixture or altitude control, an accelerator pump and a device for normal aerobatics. For inverted flights, however, WALTER 45 AK "anti-g" - type carburettors should be used, which enable high aerobatics to be performed at continuous full power. The intake manifold, which is an aluminium casting, is led along the R.H. side walls of the cylinders with special gaskets provided at the cylinder and carburettor ends to obtain required sealing. The intake manifold is pre-heated by exhaust fumes from Nos.2,3,4 and 5 cylinders the exhaust pipes of which are passed through the intake manifold socket rings.

In order to avoid excessive heating of the intake manifold through a direct contact with the exhaust during the hot weather period, the aluminium pots can be removed from the exhaust to create an air gap which is sufficient for keeping the intake manifold temperature within acceptable levels. In order to prevent the pots from being lost accidentally it is advisable to put them away among the airborne tools from which they can be taken and reinstalled at will.

Throttle and mixture /altitude/ control levers on the carburettors are connected by link rods to a pair of layshaft control levers on the intake manifold: connected-up to the ball sockets of these levers are the control link rods. The mixture layshaft control movement is restricted by a carrier pin on the lever so that the maximum displacement towards the lean setting is given by the momentary position of the throttle layshaft control, where as with the throttle layshaft control in limit position at idling, the mixture control should provide for rich mixture compensation. With the throttle being opened gradually the mixture compensation range is widened. There are three fuel primers in the intake manifold, the rear primer being fitted with an adaptor for priming pump connection. The priming pump can be fitted, upon customer´s request, with its bowden cable control directly to the intake manifold. Each cylinder intake elbow is moreover fitted with a drain valve for condensed fuel removal with a respective union for the drain pipe. A plug in the intake manifold rear wall can be replaced with a union to vacuum-operated cockpit instruments.

Fuel is fed to the carburettors either by gravity directly from the fuel tank mounted in the aircraft or it may be fed by the WALTER 2M 50 fuel pump. A union for fuel hose attachment is provided at the carburettor rear. Coupled to the carburettor air intake flanges are the magnesium-alloy bodies of the air scoop or of the cold and hot air scoop with two-position flaps controlled by link rods from the cockpit. At one flap position cold air is being drawn-in by the air scoop opening arranged outside the engine cowling, while engine-heated air is drawn-in with the flaps at the other position. Hot air is then passed through flat flame traps located in the intake throats below the flaps. The WALTER 45 AK carburettor description is given in a separate paragraph on the concluding pages of this Manual.

IGNITION SYSTEM.

Dual ignition systems functioning independently of each other, either shielded or un-shielded, are used on the engine. The clockwise rotating SCINTILLA VERTEX NVK 6-Z2 /port/ and AVK 6-Z2 /starboard/ ignition magnetos have automatic advance control. Starboard magneto is fitted with an impulse coupling. The two ignition magnetos are located side-by-side in a hanging position at the rear of the crankcase being tightened-up in place by means of fixing straps. Bevel gears are used for ignition magneto drive, the port magneto being driven off the camshaft, while the starboard magneto is driven off the R.H. layshaft gear. The magnetos rotate at half the crankshaft speed. The starboard magneto is firing into the R.H. row of sparking plugs, while the port magneto is serving the L.H. row of sparking plugs. Either ignition magneto has terminals for the shorting cable. The ignition magnetos are installed on the engine as complete assemblies together with their drive gears and covers which are fitted on the throat of either magneto by means of an adjusting screw. The covers shut-off the passages of the drive gears in the crankcase wall to which they are tightened-up and sealed by means of cork rings.

Each cylinder head has two sidewise-mounted M 12x1,25- threaded sparking plugs fitted with identification tags for proper wiring. The tags bear coloured numbers identical with the respective cylinder and magneto distributor cover terminal numbers. The firing order in individual cylinders is 1-5-3-6-2-4. Cable harness tubes are used for leading the cables along the engine cylinders. The cables are fitted with ball-headed and sleeves which are fitted over the ball-headed nipples of the sparking plugs and located in place by means of circlips.

LUBRICATION SYSTEM.

Dry-sump, pressure-feed type lubrication is used on the engine, with oil circulation being ensured by the double-gear type oil pump with one pressure and one scavenge stages.

ENGINE OIL CIRCULATION.

Fresh oil is drawn-in by the pressure pump from the oil tank across an inlet filter via oil piping. The pressure oil is then conveyed via external piping into a lengthwise channel in the crankcase port side and thence through transverse distributing passages it is supplied to the crankshaft main bearings, to the camshaft front and rear bearing as well as to the R.H. layshaft gear bearing.

C r a n k s h a f t p l a i n b e a r i n g s are lubricated under full pressure oil feed.

Crankshaft b a l l t h r u s t b e a r i n g is lubricated by oil flowing out of the crankshaft front plain bearing.

C o n n e c t i n g r o d b e a r i n g s are lubricated by low-pressure oil feed from connecting rod bearing journals, the oil being fed into the journals from crankshaft main bearings through the hollow crankpins and drilled passages in the crank arms.

P i s t o n p i n s are lubricated by oil collected off the cylinder walls by the oil control /scraper/ ring and ducted into the piston through channels and ducts; by oil gathered along the connecting rod surfaces from the connecting rod bearings; by splash oil.

C y l i n d e r s and p i s t o n s are lubricated by oil agitated by the revolving crankshaft.

C a m s h a f t b e a r i n g s /front and rear/ are lubricated under full pressure oil feed, the rest of bearings being splash-lubricated by oil gathering from the crankcase walls.

C a m s and t a p p e t s are lubricated by oil gathered through the hollow camshaft from the front bearing and through drilled passages in cams; additional lubrication is provided by splash oil.

A c c e s s o r y d r i v e g e a r s a n d b e a r - i n g s are lubricated in the following way: centre and R.H. layshaft bearings are lubricated by pressure oil ducted through crankcase wall passages, while L.H. layshaft bearing is lubricated by low-pressure oil conducted through channels from the camshaft rear bearing.

S p e e d o m e t e r d r i v e s h a f t is lubricated directly from the oil pressure pump.

R o c k e r a r m s a n d v a l v e s p r i n g s are supplied with oil from the rocker gear covers. Splash oil is gathering in the crankcase bottom to be drained into an oil collector screwed in place at the crankcase rear bottom. From the collector the oil is drawn away by the scavenge pump and returned through the oil return pipe back into the oil tank.

Coupled to the oil pressure line screw union at the crankcase is a connection for the oil pressure gauge.

OIL PUMP.

The double-gear oil pump is bolted as a unit at the rear of the crankcase just in the camshaft centre line, being driven off the camshaft rear by means of a dog. The oil pump consists in two parts, namely, a pressure and scavenge stages which are separated from each other by a steel partition, though they have not only a drive shaft but also a fixed pin in common. Ahead of the pressure pump is the inlet oil filter the filtering elements of which are removable for cleaning. The filter is shut-off with a cap threaded for inlet oil temperature installation.

The inlet and delivery sides of the oil pressure pump communicate via a passage with an oil pressure relief valve which automatically maintains the specific oil pressure of 3 to 4 at. The pressure relief valve is loaded by a spring the preload of which is regulated along with the oil pressure by means of an adjusting screw secured in place by means of a lock nut. Screw-in the adjuster screw for increased pressure and slacken it for pressure reduction. Do not disturb the initial factory setting unless strictly necessary.

CRANKCASE VENTILATION.

Ventilation of crankcase interior is taken care of by a breather in the crankcase cover terminating in a throat for breather hose connection which should be led into the oil tank. The breather throat is fitted from within with a tubular adaptor to trap the splash oil.

COOLING SYSTEM.

Engine cooling is by air flow drawn-in in flight into the cooling air scoop through an amply sized intake at the front of the engine cowling. The sheet-metal air scoop forms a duct which is led past the L.H. cylinder bank being shut-off at rear and distributing the cooling air through transverse gaps between the engine cylinders. The air gaps are shut-off at the opposite side by sheet-metal air baffle plates inducing the air to circulate among the cylinder barrel and head cooling fins around their entire circumference. The No.1 cylinder is faired at the front side by a sheet-metal shroud. The air scoop is bolted down to the crankcase while higeing on the cylinder heads. Slide flaps are provided for uncovering of air scoop tooling holes enabling access to the port row of the sparking plugs.

STARTING SYSTEM.

Fitted at the crankcase rear wall just in the crankshaft centre line is a standard mounting flange the design of which conforms to ČSN AE 7,1 /or SAE 5/ requirement and which accomodates wither the WALTER 25 mechanical hand starter gear with crank or the WALTER RE 25 combination hand starter gear and motor. For cranking, the starter dog extends to mesh with a dog or jaw on the engine crankshaft.

The starting is further facilitated by three fuel primers in the intake manifold as well as by an impulse coupling of the starboard ignition magneto.

Both the WALTER 25 hand starter gear and the RE 25 combination hand starter and motor are described on the concluding pages of this Manual.

ACCESSORY DRIVES AND EQUIPMENT.

/Appendices II and III/

Located at the rear wall of the crankcase on the left is the speedometer drive, with the fuel pump flange and drive being fitted on the right. The crankcase port and starboard carry each one mounting flange: there maybe a provision on the port side for generator drive with the generator fitted directly to the engine or else for generator remote control through a flexible shaft with the generator mounted elsewhere outside of the engine. The opposite side may take a remote control with flexible shaft either for the other generator or some other equipment.

All of accessory drives are derived from a drive gear mounted at the crankshaft rear and actuating the centre layshaft gear which revolves about a pin located at the rear transverse partition of the crankcase.

The centre layshaft gear actuates in turn both the camshaft and the R.H. layshaft.

The camshaft timing wheel is actuated by the centre layshaft gear, driving itself, in turn, the port generator. Keyed to the camshaft aft of the timing wheel is the port ignition magneto bevel drive gear. Driven off the camshaft rear through a dog is the double-gear oil pump driving itself, in turn, the speedometer drive: coaxical arrangement is used for all these parts. The R.H. layshaft is supported by an aluminium-base alloy bearing located at the rear transverse partition of the crankcase. Two gears are keyed to the R.H. layshaft with subsequent tightening-up by a nut, namely, a large-sized gear taking-up the drive from the centre layshaft gear and actuating itself, in turn, the R.H. remote control flexible shaft, while a bevel gear drive for the starboard ignition magneto is mounted aft of the large-sized gear. The fuel pump is driven off the layshaft rear end by means of a dog.

SPEEDOMETER DRIVE.

The speedometer drive shaft stub engages, at the inside end, a spline on the oil pump drive shaft, terminating at rear in a dog conforming to ČSN-AE 5,15 Standards. The drive cap, which is bolted to the oil pressure pump body, is fitted with a screw union in accordance with the above-mentioned Standard for connection of the speedometer drive flexible shaft. The speedometer drive rotates clockwise at half the crankshaft speed.

FUEL PUMP DRIVE.

The fuel pump is driven directly from the R.H. layshaft into the spline of which the fuel pump shaft dog is engaged. Fuel is displaced from the discharge pipe union through a flexible hose pipe to the carburettors. Also fitted to the fuel pump delivery union is a fuel pressure gauge connection.

The technical description of the WALTER 2M 50 fuel pump is given on the concluding pages of this Manual.

Geared drive of the port generator:

The generator geared drive is enclosed in a gear box bolted to the port side flange of the crankcase. The gear drive is transmitted from the camshaft large timing wheel through a layshaft gear on to the generator drive dog and gear which is a running fit on a pin. The dog is internally splined to engage the generator shaft. Both drive gears have bronze bushings, a special gland on the dog preventing oil leaks to reach the generator. The generator of 24 V/300 W is of the flange-mounted type with a spline shaft, being bolted to the drive gearbox front flange with an additional tightening-up to a mounting pad by two fixing straps. The mounting pad is, in turn, bolted to the crankcase. The generator rotates anticlockwise at double crankshaft speed. When the engine is not fitted with a dynamo, then the drive gearbox is also absent and the mounting flange on the engine crankcase is blanked-off by a cover.

Port generator remote control by flexible shaft:

The drive gearbox mounted on and bolted to the crankcase port side flange contains a drive shaft revolving on two needle roller bearings. A geared wheel keyed to the drive shaft is actuated by the camshaft timing wheel. The drive shaft is splined at its outer end for dog engagement and the gearbox cover is threaded to enable tightening-up of the flexible shaft cover tube by a union nut. A special-type gland is slid over the drive shaft to prevent oil from being spilled from the gearbox.

The flexible drive shaft terminates by internally splined dogs at either end, its cover tube being coupled to the drive gear-box by means of a union nut at the engine end, and at the opposite end to a flange for screwing-up to the generator.

The generator remote control by flexible shaft rotates anti-clockwise at double crankshaft speed. When the engine is not provided with a generator, then the crankcase flange is blanked-off by a cover.

S t a r b o a r d   r e m o t e   c o n t r o l   b y   f l e x i b l e   s h a f t :

This drive is entirely analogical to the port side remote control, being also anti-clockwise rotating at double crankshaft speed, and serving for driving either a starboard generator or some other equipment.

ENGINE MOUNTING.

A four-point resilient mounting system is used for the engine. Bearer feet are bolted to pertinene flanges in the crankcase sides with disc-type rubber vibration dampers slid over the bearer feet.

P A R T T W O .

I N S T A L L A T I O N O F E N G I N E I N T H E A I R F R A M E .

SHIPPING THE ENGINE.

For shipping, the WALTER MINOR 6-III engine is stowed in a packing crate, the overall dimensions and weight data of which are given in the GENERAL INFORMATION section. The engine rests in the packing crate on a bedplate screwed to the side walls of the crate.

After having opened the lid of the crate, unscrew the bedplate from the crate walls and pull the engine together with the bed-plate out of the crate using hoists attached to the lifting lugs on the engine crankcase. When the engine is clear off the crate, release the mounting thoes and take off the engine from the bedplate. Instead of shoes the bearer feet with slid-over rubber dampers are positioned and bolted to the engine. Lock washers are used for locking the bearer feet nuts in place.

Reverse the procedure for stowing the engine in the crate. Prior to putting the engine into the crate, however, all holes and openings must be blanked-off with suitable lugs. Use blanking plugs for blanking-off the oil inlet and outlet unions, oil pressure gauge union, fuel primer unions, fuel inlet union on the fuel pump and fuel pressure gauge union. The speedometer drive cover union is hut-off by plugs, the breather pipe is blanked off by a cap nut, while sheet-metal and wooden plugs are used for blanking off of cylinder exhausts and carburettor intakes.

INSTALLATION OF ENGINE IN THE AIRFRAME.

Installation of engine in the eiframe will be carried out in the following manner:

1/ Take care that proper gaskets are inserted between the flanges of the additionally fitted equipment and the engine flanges.Use lock washers for securing the fixing bolt nuts in place.

2/ Position the engine on its mount so that the bearer feet would engage pertinent engine mount bearings. Thereafter the bearing covers are positioned and screwed in place.

3/ Connect the throttle link rod to the throttle control lever and the mixture control link rod to the mixture /altitude/ control lever. See that the pins of either link rods are securely split-pinned. Remove the wooden blanking from the carburettor air intakes and fit the intake manifold to the air intakes of carburettors.

Should there a hot and cold air scoop with two-position regulating flap be fitted on the engine, connect-up the pertinent link rod of air intake temperature control.

4/ Fit the fuel hose to the fuel pump inlet union. Couple next the bowden control cable to the fuel priming pump on the intake manifold to enable fuel priming control from the cockpit. Connect, at the same time, the drain pipes to the drain valves to remove condensed fuel from the intake manifold.

5/ Remove the blanking plugs from the oil inlet and outlet unions connecting instead the fresh oil admission pipe from the oil tank to the oil pump inlet union and the oil return /scavenge/ pipe to the outlet union for routing scavenge oil back into the oil tank. All piping must be flushed with clean oil prior to fitting to be sure that all dirt has been removed from it. Care should be exercised to make the oil piping connections quite tight so as to prevent any air leaks into it and oil leaks out of it. Next connect the pipe to oil pressure gauge or the oil pressure capsule to the oil pressure inlet union on the crankcase.

6/ Connect shorting cables from the switch to terminals on the cylindrical bushings of the two ignition magnetos. Fit the cable from starting magneto to the distributor body terminal on one of the magnetos. Take care that the ignition switch-earth shorting cable is securely connected to a clean metallic surface on the engine and check it for easy earthing. The whole electrical installation must be insulated with care and cables are not allowed to contact neither between themselves nor anywhere on the airframe; sharp edges should especially be avoided to prevent chaffing.

7/ Unscrew the speedometer drive cap nut, fit the speedometer drive flexible shaft and tighten-up in place by a union nut. Prior to installing the flexible shaft, make sure of its easy rotation in the cover tube and lubricate the shaft with some grease-graphite compound.

8/ Take-off the rubber blanking cap from the breather on the crankcase and fit the breather pipe in its stead.

9/ If the engine is fitted with a hand crank starting gear care must be exercised to locate the crank guide bush in the cowling so as to enable the starter shaft end to be conveniently got at with the crank.

10/ Install and secure the airscrew in place. The procedure to be followed is described elsewhere in this Manual.

11/ Unscrew the paper blanks from the exhaust unions and pipes and connect all piping to the exhaust collector. Insert copper-asbestos gaskets under the exhaust pipe flanges. If the exhaust collector is already present in the airframe, take care that it is not hung anywhere on the cylinder heads.

12/ Top-off the sequence of operations by installing and securing the engine cowling in place.

Take care that all blanking plugs, covers and rubber caps are securely stowed for further use whenever the engine is to be removed from the airframe.

FUEL SYSTEM.

Fuel is routed to the carburettors by a flexible hose the inner bore of which is 6 mm. When installing the piping care should be exercised to avoid sharp bends and elbows, especially in vertical plane, to prevent air or water locks at these points.

Fuel is usually circulated to the carburettors by a fuel pump. Should the fuel pump be absent in the installation, and the fuel be fed to carburettors by gravity, take care that the gravity tank is located 600 mm above the plane c by referring to ZP 14,5 Drawing. If the engine is equipped with a fuel pump, then the fuel tank may be located even lower, i.e. anywhere in the airframe. A shut-off cock and an inlet filter must be interposed in the fuel admission line. Besides, the fuel system must be equipped with a hand-operated pump to "fill" the carburettor with fuel prior to starting the engine. In case that the engine fuel pump is equipped with a manually operated filling device, then the latter requirement is met. Fuel primers in the intake manifold are connected to the fuel priming pump by means of 4/2 mm dia. dia, piping. The priming pump draws-in fuel from the fuel line ahead of the carburettor.

The fuel tank capacity is calculated for a specific range at maximum fuel consumption. Each fuel tank must be vented. At the lowest section of the tank a sludge separator must be present and equipped with a drain tap or plug. The suction pipes must draw away fuel regardless of aircraft altitude even with the fuel in the tank at its lowest level and a thick-meshed screen must be provided for their delivery ends. For fuel draining use a drain tap or plug screw located in the fuel tank sludge separator bottom. Take care that all drain taps, plug screws, drain and breather pipes etc. are leading overboard.

OILING SYSTEM.

When installing the oil lines care should be taken to avoid sharp bends and elbows. The inner bore of the pressure line should be 20 mm, while that of the scavenge line from engine to the oil tank should be at least 13 mm. An oil filter with a No.50 screen of about 200 sq. cm. must be used for the oil inlet. Should the arrangement of the engine cowling and oil tank fail to ensure adequate cooling of oil, then an oil cooler must be interposed in the scavenge /return/ line. A drain tap must be provided at the lowermost section of the system for draining all of oil from the tank, pipe lines and from the engine as well.

The oil tank capacity should be by some 20 per cent larger than that which would correspond to a maximum oil consumption of 8 g /hp/ hour for a running time for which the fuel tank capacity is calculated, 7 litres being the smallest quantity which must be present to ensure oil circulation. An air space totalling about 20 per cent of the oil tank total capacity should be allowed for to accommodate oil frothing or foaming. The oil tank must be vented by a breather pipe leading out in the fuselage bottom side or to the upper cover into the engine interior. For extraction of dirt from oil, the oil tank must have a plug screw or drain tap-controlled sludge separator at its lowermost section. The scavenge oil and pressure oil ducting should be arranged so as to ensure an undisturbed sedimentation of all impurities. The oil tank filler neck should be of adequate size to allow an electric heater to be passed through it and it should be installed as close to the engine as possible so that the oil pump suction head /i.e. the height of the oil pump intake union above the lowermost oil level/ would not exceed 500 mm.

Should, however, the location of the fuel pump in the airframe be such that the oil tank highest level is higher than the oil pump intake union, then the inlet piping should be provided with some kind of restrictor preventing oil flow through the pump into the engine when the engine is at rest. This aim can easily be achieved by fitting an easily accessible oil tap to be opened always before the engine is being started. In order to prevent any possibility of the oil tap remaining shut by omission when starting the engine, the oil tap must be operationally linked with the ignition switch. Even so the oil tap is a potential source of trouble.

The oil pressure gauge connection pipe of 4 mm inner bore is coupled to the pressure pump delivery union. Care must be exercised that the pipe is of adequate flexibility and that it is ensured against vibrations and fracture. The pressure gauge should operate with a 0 - 7 at scale.

Both inlet and scavenge /outlet/ engine oil temperatures must be checked in flight lest they should exceed the specific values. For this purpose, the inlet filter cover on the oil pump is threaded for inlet oil thermometer installation; other thermometers /temperature gauges/ must be fitted to the piping in the proximity of engine so as not to impede free flow of oil. At least one oil thermometer must be used in the oiling system.

IGNITION SYSTEM.

The ignition system control is by a cockpit-installed ignition switch which is connected-up by way of shorting cables to appropriate ignition magneto terminals as well as to engine frame /the engine is insulated against its mount/. The ignition switch should have four well-marked and easily read positions /"ON", "OFF"/ and two additional positions for switching-on only starboard or only port ignition magneto. The ignition swicth must be operationally linked to the oil inlet pipe shut-off tap /refer to the proceeding OILING SYSTEM/. The ignition switch cable leads should be installed with the very best care and well protected against moisture as on their correct functionning depends the safety of the air mechanic and the operational safety in general. A special device for ignition advance setting is not required since with this engine the ignition adavnce control operates automatically.

ENGINE CONTROLS.

The throttle and altitude /mixture/ controls are the only controls required for engine operation. Engine running is checked by observing r.p.m., pressure and oil temperature indications.

The dispacement of the altitude /mixture/ control lever is restricted by the position of the throttle control lever, allowing full mixture control only with the throttle lever at full throttle position. Conversely, the altitude /mixture/ control is being restricted with gradual closing of the throttle.

The link rods connecting-up the cockpit controle with the carburettor should be of adequate rigidity and properly guided to minimize vibration and deflection. All articulations must by precision-made and clearence-free.

Somewhat greater mobility should be allowed for cockpit controls as compared against the carburettor lever displacement with the purpose of preventing any restriction in the movements of the latter levers.

HOT AND COLD AIR SCOOP.

On engines provided with a two-position regulation flap-fitted hot and cold air scoop, the pilot is capable of controlling the temperature of the air drawn-in into the carburettors by a manual adjustment of the cockpit-installed air temperature control lever either to the "HOT AIR" or to "COLD AIR" limit position which must be well-marked and easily read, thereby adjusting the temperature of intake air in accordance with prevailing weathers and flight conditions to obtain a regular, steady engine running.

Scooping of hor air is of importance especially wherever misty weather is encountered or temperature approaching zero deg. C with imminent hazard of carburettor freezing due to a build-up of ice on throttle or in diffuser.

SPEEDOMETER DRIVE.

The speedometer drive location is on the oil pump cover at the rear wall of the crankcase. The drive design conforms to ŠCN AE 5,15 Standard, the drive rotating clockwise with a 2 to 1 ratio, The speedometer indication range should be from 0 to 2800 r.p.m.

STARTING GEAR.

Installed on the rear wall of the crankcase is a standard mounting flange conforming to ŠCN AE 7,1 or SAE 5 Standards. The WALTER R 25 mechanical hand starter gear with a crank or the WALTER RE 25, combination hand starter gear and motor with a crank may be fitted on to this flange in compliance with the customer´s requirements.

The direction of starter gear rotation when viewing its mounting flange is clokwise. The starting crank swivel bearing should be tightened-up properly either on the engine mount or in the airframe.

When operating, the starter dog will expand automatically to mesh with the cranshaft dog or jaw and will retract into initial position as soon as the engine picks up. Engine kickbacks, if any, are neutralised by a multi-plate clutch of the friction type so that none of them would reach the starter gear proper or its crank.

GENERATORS.

There ate two types available of generator drive design, one being the direct drive, the other being a remote control through a flexible shaft. Both drives can be present on the engine simultaneously, if so required. The generator direct drive is led out at the crankcase rear on engine port side, while the remote control by flexible shafting, through being also led out at the crankcase rear, terminates on engine starboard. Starboard remote control drive can also be utilised for some other equipment operable by a flexible drive. Either drive has a 2 to 1 ratio and rotates in anti-clokwise fashion. Generator weight is supported by the engine as fas as the direct-drive generators are concerned, while with the remote control operating through a flexible shaft, the generator may be fitted elsewhere on the airframe. When installing the flexible shaft care must be exercised that is thas as few bends as possible and that those existing are of generous raddi only.

EXHAUST PIPING.

For exhaust pipes are being delivered along with the engine passing through the intake manifold and complemented by two mounting flanges. The exhaust pipes which are ducted through the intake manifold serve for its preheating. The remaining two exhaust pipes are optional items supplied on special order. Cylinder exhausts can be led by these pipes either directly outside the engine cooling or else they may be, ducted into an exhaust collector first and thence below the fuselage. When designing the exhaust collector care must have been exercised to eliminate any contractions or sharp bends in the piping. Increased resistance to flow in the exhaust collector would only result in reduced engine power and increased engine temperature. Cylinder heads should never be loaded with stresses due to thermal expansion of individual components of the exhaust system or to its weight or vibrations. The exhaust piping must be cooled by air flow.

ENGINE COWLING.

The engine cowling must not impede the entry of air into the scoop ducting the air towards the engine cylinders and it must, at the same time, facilitate the flow of the outgoing air in a sutibale manner. Care should be taken that the exhaust apertures are located at the points where depression is created in flight: they must not by any means be located where an excess pressure, through but slight, may be encountered.

The following cooling air entry areas are recommended:

For a 250 km.p.h. aircraft .... min. 300 sq.cm
Air scoop entry ducting air
to carburettors .... min. 30 sq.cm.
Width of annular slot aft of
airscrew spinner /normal to air
flow direction/ .... min. 10 mm
Cooling air exit area .... approx. 600 sq.cm.

The above given values are theoretical, actual conditions must be tried out in flight. Proper engine cooling may be best checked by measuring cylinder head temperature in flight, using a thermocouple installed below the No. 3 cylinder sparking plug. Cylinder head temperature should never exceed 260°C, under normal circumstances, in the steepest climbing flight, it must to be allowed to exceed 250°C, and this only for a short time. Cylinder head normal temperature should oscillate between 190 and 230°C respectively. Oil outlet temperature is allowed to reach the 105°C peak in an emergency only, it should normally keep within the 50 to 90° C range.

AIRSCREW DATA AND MOUNTING.

The airscrew must be set-up to team with the engine of 160 b.h.p. rated power at a 2500 r.p.m. nominal speed in level flight and at full throttle. The airscrew should always be precision--balanced both statically and dynamically and precision-centred.

Both fixed-pitch wooden airscrew hub as well as the seating faces of the airscrew boss should be properly finished to precision to allow proper assembly of airscrew.

Likewise the bolt holes in the airscrew should be drilled with utmost precision. Make certains that all bolts are properly tightened-up and their nuts are securely locked in place. The engine should never be allowed to operate with the airscrew badly assembled, non-centred or out of balance. The tightness of both airscrew and boss should frequently be checked and the nute should be re-tightened if necessary.

PART THREE.

ENGINE OPERATION.

FUEL AND OIL RECOMMENDATIONS.

A trouble-free operation of engine requires utilisation of fuel and lubricants with strictly defined characteristic as in the following specifications: fuel or lubricants with characteristics non-complying with hereunder requirements are unsuitable and likely to bring on seriou damage or operational troubles to the engine and are, therefore, banned from use.

FUEL.

The fuel specified for use is aviation petrol, minimum fuel octane rating 72 /octane specification is by the CFR Motor method/. Lower-octane fuel is banned from use, as it would cause detonations, operational troubles and overheating with resulting serious damage to the engine. At the same time, it would lead to reduced engine power and higher fuel consumption.

The fuel which is being used should also comply with all valid official requirements concerning the avation fuels.

The fuel is filled into the tank through a thick-mesked screen funnel or through a piece of buckskin. Extreme care must be exercised to prevent entry of dirt, dust or water into the fuel tank during the filling operation. The filler neck should not be left open longer than is strictly necessary. All safety precautions must be strictly observed during the filling operation.

OIL.

For summer /hot weather/ and winter /cold weather/ operation the best-grade mineral oil of max. specific weight of 0,92 should be used; its absolute kinematic viscosity at 50°C should be 17 to 24 deg. E i.e. 130 to 172 cSt, at 80°C it should be at least 5 deg. E i.e. 37 cSt; pouring ability at 10°C below zero: 10 mm as a minimum.

The oil which is being used should also comply with all valid official requirements of aircraft engine lubricants. Fresh oil is filled into the tank through a thick-meshed screen funnel. Vessels and funnels which are used for oil filling as well as the oil tank filler necks must be scrupulously clean and free of dust or any dirt whatever. Extreme care must be exercised to prevent ertry of dirt or water into the oil tank during the filling operation.

GREASE.

For filling the lubrication fittings on the ignition magnetos use SCINTILLA G special grease to exlussion. Use a coumpound of this grease and graphite for filling the speedometer drive flexible shaft and the generator remote control. Use identical coumpound to grease lightly the crankshaft cone and thread when installing the airscrew boss.

PRELIMINARY INSPECTION AND TASKS BEFORE STARTING THE ENGINE.

Preliminary inspection and tasks described hereunder serve for a brief check on engine readings for flight operation. All routine inspections and tasks related to regular engine maintenance are given further in a separate chapter, specific servicing instructions related to engines recently fitted to the airframe to be run for the first time /i.e. factory-new or reconditioned engines/ being also given there.

1/ Check the oil level in tank and top-up, if necessary. Take care that the oil tank is not topped-up to full capacity since a space must be allowed for oil foaming, this space being some 20% of total oil tank capacity. The quantity of oil required as a minimum must enable carrying-out of the flight intended, this at the highest specific fuel consumption, in addition to leaving a safety-margin of about 7 litres as a minimum quantity which is necessary to keep the oil circulation going.

Should temperatures be encountered which are rather close to the congealing point of the lubricant in use, then the oil should be preheated to 50 - 60°C to be sufficiently freely-flowing for its being drawn-in by the engine during the starting procedure. For oil pre-heating an electric heater may be used, if it has been installed on the oil tank. Extreme care should be exercised to use only clean vessels and a funnel with a thick-meshed screen for oil filling into the tank.

2/ Check the entire oil piping for absence of leaks. If the oil inlet /feed/ pipe is fitted with a shut-off tap, then open the tap.

3/ Check the fuel level, in the fuel tank, drain sludge from the filter and top-up the fuel tank with additional fuel, if necessary. Check the entire fuel piping with utmost care. When filling or topping-up, let the fuel run through a piece of buckskin to separate dirt and water: all safety precautions should be adhered to during this operation.

4/ Check the ignition system and make certain of correct functionning of its units, especially of the ignition switch. Examine the ignition cables for proper condition. Both flying safety and the safety of aircraft mechanic when pulling-through the airscrew depends of proper operation of these units.

5/ Check the engine controls, i.e. link rods and lever controls governing throttle, mixture /altitude/ control, hot and cold air flap control as well as various taps etc. for correct operation.

6/ Inspect the speedometer drive.

7/ Crank the engine with the ignition off manualy several times to make certain that the engine cylinders are not flooded with oil which could bring on damage to the engine during the compression stroke.

Else this occasion to make certain of correct compression at all engine cylinders. During a freezing weather, however, be carefull to crank the engine several times to ensure that the hot oil from the tank is being supplied to all engine bearings with subsequent reduction in frictional resistance against rotation.

8/ Check and retighten, if necessary, all nuts, bolts and engine bolt connections. Use special care when tightening-up the airscrew and the engine fitting parts on the engine mount.

9/ Open the main fuel tap or additional switching taps in the fuel piping to conform to the airframe manufacturies specifications.

10/ By operating a lever on the fuel pump for manual filling by several strokes, fill the fuel pump, pipeline and carburettors with fuel unitl the fuel pressure gauge would register pressure. /This instruction does not apply in case that the fuel is being fed to the engine by gravity/.

STARTING THE ENGINE.

After being through width the checking operations and preparatory tasks described in the preceding chapter, start the engine at closed throttle, as opening the throttle to some extent would invariably lead to by-passing the carburettor slow-running /idling/ devices. Avoid rapid "pumping" the throttle control lever to the "full throttle" position as the carburettor accelerator pump would flood the intake manifold.

During starting, be sure that the mixture /altitude/ control lever is in the "rich mixture" position as benefits the ground or "near ground" operation.

Make certain that the ignition is safely off.

If there is a fuel priming pump fitted either on the engine or in the cockpit, operate it some two to four strokes, when starting from cold, to inject fuel into the intake manifold. Two to four priming strokes, which are sufficient with the fuel priming pump WALTER currently supplied, are effected by alternating pulls at the pilot cockpit-mounted lever and release. The fuel priming pump draws-in fuel at the pull and primes it into the intake manifold upon releasing the lever. If there is no priming device present on the airframe for starting, fuel can nevertheless be injected into both carburettor and manifold by repeating successive opening and closing the throttle several times to operate the carburettor accelerator pump. As with this method of priming proper atomisation of fuel cannot be obtained, great care must be taken to avoid the intake manifold becoming overprimed with non-atomised /raw fuel.

PULLING THROUGH THE AIRSCREW BY HAND.

This starting methos requires the presence of one more assistant /mechanic/ standing by the airscrew. First of all, the assistant will suring the airscrew a number of times in the direction of crankshaft rotation with ignition off for the engine to draw-in a sufficient quantity of fuel-air mixture. At a given signal the pilot will switch the ignition on and the assistant /mechanic/ will now crank the engine by a rapid pulling-through the airscrew, always only through the compression stroke in some of the cylinders: at that, extreme care must be taken after switching-on the ignition to avoid personal injury at the moment of engine pick-up.

STARTING BY USE OF HAND STARTER GEAR WITH CRANK.

The assistant /mechanic/ need not touch the airscrew if this method of starting is employed. He will crank the engine at first rotating the starter gear crank handle. After the engine has drawn-in a sufficient volume of fuel-air mixture following a number of cranking turns, the pilot will switch the ignition on. The assistant hand /mechanic/ keeps cranking the engine until it would pick-up: here also care must be taken to avoid personal injury.

STARTING BY USE OF COMBINATION STARTER GEAR AND MOTOR.

Switch-on the ignition, depress the panel-mounted starter push-button and keep it compressed until the engine picks up. If the engine fails to pick-up after a few turns, switch-off the starter motor to avoid an undue drain on storage batteries.

For starting a still warm engine give some more throttle and restrict or even omit priming the intake manifold with fuel.

If the engine does not start even after repeated attempts at starting, switch-off the ignition and find out what is wrong. Any further priming is to no purpose whatever and will only cause the cylinders and intake manifold to be loaded with raw fuel. In such case it is necessary to crank the engine backwards with ignition off and at full throttle.

Prior to undertaking any task in close vicinity of the air-screw always make certain that the ignition has been switched off first.

WARM ENGINE STARTING PRECAUTIONS.

On account of installation space reduction and proper and efficient heat control a down-draught type of carburettor has been chosen, which is located in the space underneath the cowling where hot air from the engine cylinders is present. This arrangement, which undoubtedly is very useful in many other respects, presents, however, a certain difficulty in starting the engine while still hot after previous flight or running-up testing, especially when an incorrect way of re-starting has been resorted to.

The fuel present in the still very hot carburettor will vaporise after the engine has stopped with the result that the heavy vapours would condense in the intake manifold thus enriching excessively the mixture so that it might become incapable of getting ignited. Things would be still worse if the throttle lever is pumped for starting causing the accelerator pump to inject more fuel into the intake manifold or even if the priming is being operated. No doubt the engine, unduly loaded with fuel, is very recalcitrant in getting started.

The following procedure is advised for starting a still warm engine:

Switch-on ignition without any preliminary cranking, open the throttle moderately and start the engine operating either the started motor, hand starter gear or by swinging the air-screw. If the engine fails to pick-up over 4 compression strokes, switch-off ignition, open full throttle and expel stale fuel by turning the engine backwards at least 8 to 10 full turns. Afterwards close the throttle, switch-on ignition and repeat the starting.

If you will observe these instructions and keep in mind all explanations given at the beginning of this chapter, you are unlikely to meet with any difficulties whatever when starting a still warm engine.

For starting from cold, however, make sure of proper atomisation of fuel primed-in by the priming pump. It is better to under-prime by quickly operating the fuel priming pump than to load the intake manifold with non-atomized /raw/ fuel. Therefore we suggest periodical check of priming nozzles for any sign of choking and for correct spray pattern, emphasizing again the fact that most of the warm-starting troubles are due rather to engines becoming loaded with fuel than to fuel supply restrictions.

There is one more thing to be closely watched when starting from cold; namely, the impulse /spring/ coupling operation on starboard ignition magneto: <u>the snap of the coupling should be clearly audible.</u>

ENGINE CHECK ON GROUND.

ENGINE WARMING-UP.

Let the cold engine run for 1 to 2 minutes at 500 to 1000 r.p.m. after pick-up to ensure a sufficient warming-up of engine and oil circulation. After 10 to 16 seconds of running /not later/ the oil pressure gauge should register oil pressure which should be higher then normal magnitude due to cold oil. If the pressure gauge fails to show oil pressure, stop the engine at once and find out what is wrong /the irregularity may be due to sluggish oil flow at low ambient temperature, to oil piping, pressure gauge or oil pump relief value failure etc./. After 1 - 2 minutes of running increase the engine speed gradually to about 1500 r.p.m.

When the oil pressure reaches about 3 to 4 at, with the oil inlet and outlet temperatures being about 20°C and 30°C respectively /if pertinent temperature gauges are installed in the oil line/ after some 5 minutes of operation /these values are attained sooner in warm weather and somewhat later in cold weather/, it is possible to speed-up gradually to full throttle for the purpose of engine checking.

Extreme care must be taken when warming-up the engine, and particular caution should be applied when the temperatures of ambient air and tank-contained oil are really low. Avoid racing the engine right off the start under any circumstances whatever /to clean oiled sparking plugs etc./.

Make certain that no sudden increase in oil temperature or decrease in oil pressure occurs during warming-up as it may indicate some trouble.

ENGINE RUNNING-UP CHECK.

The engine is ready for running-up check when the oil pressure has stabilised itself at about 3 to 4 at with minimum oil inlet and outlet temperatures being 20°C and 30°C respectively. Shift the throttle control lever to full throttle /neither too slowly nor too harshly/ and check maximum speed and oil pressure. Next check the operation of the ignition system by switching-off one magneto at full throttle for a short while. Make the same check on the other magneto. When the engine operates on one ignition magneto only, then the engine speed should not drop by more than 50 r.p.m. as compared to its speed with both magnetos in action. Check both engine acceleration and slow-down by repeated quick /though not harsh/ opening and part-closing of throttle.

After completing these tests close the throttle part-way at once for idling /slow-running/. Make sure that the engine running-up on groud and with the aircraft stationary does not take more than 30 seconds as the engine would become overheated in short time due to lack of cooling. The following data must be determined by the running-up check :

Full throttle r.p.m. on ground
/according to aircraft type and
airscrew design/ . . . . 2000 r.p.m. approx.
Oil pressure at specified r.p.m. . . . . . 3 to 4 at.
Minimum oil pressure in idling . . . . . . 2 at.
Drop in r.p.m. when switching-off
one magneto /at full throttle/ . . . . . . max. 50 r.p.m.

Prolonged slow-running between the running-up check and take-off or between interim landing and take-off should be avoided since it would only result in fouling the sparking plugs.

During the engine running-up test check the sparking plugs for correct firing. Renew at once any sparking plug that has been found to be defective.

Do not start to take-off unless the engine operates faultlessly throughout its speed range, at slow-running speeds as well as in acceleration pick-up, without misfiring, spitting-back or vibrations.

Beware of changing the throttle from idling to full throttle position too suddenly during take-off, as this is not a correct means to achieve a smooth pick-up and acceleration towards full throttle r.p.m. which are obtained sooner by a quick, though not overharsh opening of the throttle.

ENGINE IN-FLIGHT OPERATION.

The throttle and altitude /mixture/ controls are the only controls required for engine operation. Engine running is checked by observing r.p.m., pressure and oil temperature indications.

The engine must operate throughout the whole speed range including acceleration pick-ups and decelerations without noticeable vibrations and misfiring.

Throttle control should not be operated too harshly to avoid throwing undue strains on engine moving parts with resultant unduly high wearing rate.

If the engine is fitted with a two-position control flap air scoop, the pilot can regulate air intake temperature to meet existing weather conditions and to avoid carburettor icing. With the control flap in "hot air" position, engine speed will drop normally by some 100 r.p.m.

ENGINE SPEED.

Engine speedometer /revolution indicator/ must be constantly kept in view during flight as it gives a true picture of engine performance and loading. Higher r.p.m. than those which correspond to the cruising power should not be used in level flight longer than is strictly necessary.

Engine speed during in-flight operation:

Nominal /rated/ r.p.m. .... 2500 r.p.m.

Maximum engine speed in drive
/short-time peak/ .... 2750 r.p.m.

R.p.m. at cruising power .... 2300 r.p.m.

Make certain of the engine really attaining 2500 r.p.m. at full throttle in level flight near ground as otherwise an unsuitable airscrew is fitted.

OIL PRESSURE AND TEMPERATURE - FUEL PRESSURE.

Engine condition in operation can best be judged by checking both oil pressure and temperature. This makes it essential that the oil pressure gauge and the oil temperature gauges /if they are fitted in the oil piping/ be carefully observed while the engine is running.

Admissible values:

Normal oil pressure .... 3 to 4 at.

Minimum admissible oil pressure at
idling speeds .... 2 at.

Oil inlet temperature:
normal /desired/ .... 40 - 80°C
peak .... 85°C

Oil outlet temperature:
normal /desired/ .... 50 - 90°C
peak .... 105°C

Deviations from the above given values or their oscillation are a sure sign of trouble. Peak temperature values must not be exceeded with ocrrectly fitted oil installation and engine cowling even under the most adverse conditions /in prolonged climb etc./. With due regard to engine service life, however, not even normal /desired/ values should be exceeded for any greater length of time.

Oil pressure drop below the minimum specified 2 at point to some serious trouble in the lubrication system making a speediest possible landing necessary.

Fuel pressure is specified to be some 0,1 to 0,25 kg/sq.cm, reaching up to 0,30 kg/sq.cm if the fuel is fed to carburettors by a fuel pump or being 0,05 kg/sq.cm if gravity feed is used.

MIXTURE /ALTITUDE/ CONTROL.

The limiting positions of the cockpit-mounted mixture control lever are "rich mixture" /ground level run/ and "weak mixture" /altitude flying/ respectively.

By operating the mixture control lever, two advantages are obtained :

1/possibility to lean-out the progressively richer mixture to compensate for the decreasing density of the atmosphere at altitude;

2/possibility to adjust the mixture strength for economical cruising in horizontal flight.

Strict observance of the following instructions is of extreme importance for engine operational safety. Incorrect operation of the mixture control towards an over-rich mixture results in fuel squandering whereas a much too weak mixture, be in at altitude or at economical cruising, and especially in the latter case, causes the engine to be overheated with the possibility of piston jamming.

1/ Compensation for altitude :

Compensation for altitude should be operated at an altitude exceeding 1500 metres.

Proper and correct compensation can be only made at a steady level flight with unchanged throttle in order to enable the change in r.p.m. to be judged as related only to the change in mixture strength. Shift the mixture control lever slowly from the "rich mixture" towards the "weak mixture" position within the limits allowed for by the respective throttle position and keep the lever shifting as long as the engine r.p.m. are increasing. As soon as the engine speed begins to drop again shile the lever is shifted in the same direction, set the lever backwards a little towards the "rich mixture" position. This is the correct procedure to follow when adjusting the mixture setting at a given flight altitude and at a given engine speed. In descending flight, on the other hand, enrich the mixture progressively in a similar way. At each change in throttle or speed the mixture control lever should be reset to the initial rich mixture position with subsequent determination of proper mixture strength setting by proceeding in the above-described manner. The same way of proceeding must be adopted after each temporary shutting-down of throttle in flight since, due to the operational link between the engine layshaft controls and the throttle control, the mixture control will automatically be reset to the "rich mixture" position.

2/ Economical cruising adjustment :
Mixture strength adjustment for economical cruishing is made in the same way. Since the carburettors are adjusted for a leaner mixture at cruising power, the mixture control is practically used also only above 1500 m. Due to the operational link between the layshaft throttle controls and mixture control the mixture control will automatically be reset to the "rich mixture" position after the throttle has been closed down.

STOPPING THE ENGINE.

Before stopping the engine, shut the throttle dwon slowly and let the engine idle for a few minutes to enable the engine to be cooled down slowly as dangerous thermal distortions and stresses might develop due to a rapid and non-uniform cooling-down. The idling run is used, besides, to prevent any major accummulation of oil in the engine, particularly in engine cylinders which would lead to hard knocks of pistons and fouling of sparking plugs at subsequent starting. After the engine has cooled down, shut-off the fuel supply and allow the time necessary for the engine to start misfiring at 1200 r.p.m. owing to having used-up all fuel from the carburettors. Switch-off the ignition at this time. After the engine has come to a stop, shut-off the oil tap controlling the admission of oil into the engine /if any is provided in the lubricating system/ to prevent flooding the engine internal spaces with oil flowing down by gravity owing to the oil tank being installed on top of the engine. If the engine is to be stopped for a short time only so as between two flights following in a rapid succession, it is possible to switch-off the ignition after letting the engine cool down at "tick-over" /idling at closed throttle/ with simultaneous part-opening of the throttle, with the result that a properly set mixture will remain in the cylinders to facilitate future engine restarting. Even with the ignition off, however, particular care must be taken when performing sundry tasks in the vicinity of airscrew while the engine is still hot to avoid personal injury. The oil tap, however, /if any is present in the oiling system/ need not be shut-off for short-time engine stoppage.

If the engine is stopped in heavy frost /more than 10 degrees below zero/ it is advisable to drain all of oil from the tank and engine while it is still hot to facilitate warming-up of oil unless there is some other heating device at disposal.

When the engine is stopped for a longer time and also daily after the last day's flight the following inspection and servicing is to be done :

1/ Check whether the engine cylinders are not overheated.

2/ Check the fuel and oil lines for absence of leaks and examine the engine for any sign of oil leakage.

3/ Check fuel and oil consumption and compare these data against the flying time and engine performance.

4/ After a while following the stopping of engine inspect and open the engine cowling and clean all external surfaces of engine, its ancillaries and adjacent portions of fuselage.

ENGINE RUNNING-IN PRECAUTIONS.

Although each new or reconditioned engine has been brake-tested and run-in at the factory before its shipment, it will require an extra amount of care and servicing during the first 10 to 15 hours of running after its installation in the aircraft. Running-up checks on ground should be very short and the engine should be warmed-up after starting but slowly and carefully, engine speed should be increased but gradually and flying near ground at full throttle should be as short as possible. After the first 10 or 20 hours of engine operation renew oil, clean the oil filters and check valve clearances.

ENGINE AEROBATIC EQUIPMENT.

Engine aerobatic equipment is supplied on special request, consisting of fitting the WALTER 45 AK "anti-g" carburettors enabling high aerobatics at uninterrupted full throttle instead of standard carburettors. An overflow valve fitted to the oiling system enables oil to be drawn from the crankcase even during inverted flights thus ensuring uninterrupted oil circulation and continuous lubrication. In order to make proper use of this equipment, the aircraft itself must be equipped with "negative-g" facilities for the fuel and oil system enabling uninterrupted fuel and oil supply to the engine and oil re-circultion from the engine at any aircraft attitude.

The following special instructions apply to engines fitted with the WALTER 45-AK aerobatic carburettors :

1/ Before starting the engine these carburettors must be filled to capacity with fuel by operating the filling device on the engine fuel pump /if any has been fitted/ or the hand pump in the fuel system so that the fuel pressure gauge in the cockpit would register fuel pressure.

2/ Inverted flights and flight manoeuvres must be performed at full throttle. Closing the throttle /even part-way/ is allowed for an instant only, as carburettor flooding would result by closing the throttle below 70 per cent of full power, with a potential hazard of engine cut-out due to overrich mixture.

3/ There is no time limit for inverted flying at full throttle for an engine equipped with "anti-g" carburettors and with "aerobatic" modifications to the oiling system /provided that also the aircraft installations have been equipped accordingly.

P A R T   F O U R

E N G I N E   T R O U B L E   S P O T T I N G   A N D   R E M E D I E S .

ENGINE FAILS TO START.

Possible causes may be :

a/ Lack of fuel in fuel tank or inadequate fuel supply to carburettors, leaky or clogged pipe lines, faulty operation of fuel pump, float needle getting stuck or carburettor jets getting clogged;

b/ incorrect throttle operation - for starting, the throttle control lever must be set to <u>closed</u> throttle for idling; if the engine is cold, then the mixture is too weak and must be richened by priming fuel into the intake manifold. If, on the contrary, the engine is hot, then the mixture is over-rich and the engine must be turned backwards several times at full throttle with ignition-off: finally, repeat the starting without resorting to priming this time; the trouble may also be due to an over-rich mixture owing to excessive priming or loading of carburettors /leakiness in float needle or damage to float needle, excessive fuel pressure, damage to float/;

c/ presence of water in carburettors or in tank;

d/ excessive friction in pistons and all crank gear during low temperature due to thick-flowing oil: fill the tank with heated oil or use an electric heater to heat-up oil in the tank: top-off this operation by cranking the engine a number of times for the hot oil to be circulated to the crankshaft bearings;

e/ fouled or wet sparking plugs;

f/ Ignition system or starting motor trouble ; if the engine will not start during initial starting after reconditioning, the trouble may also be due to incorrect valve timing.

IRREGULAR ENGINE RUNNING.

This fault is attributable to :

a/ engine warming-up after starting being still inadequate;

b/ weak mixture;

c/ irregular fuel feed due to clogged fuel lives or filters or air lock in fuel line;

d/ presence of water in fuel;

e/ ignition system or sparking plug trouble - check the two ignition systems, check the breaker point gap /0,3 to 0,4 mm/ sparking plug gap /0,4 mm/ and check the sparking plugs under compression;

f/ excessive engine heating due to inadequate cooling;

g/ sluggish valve operation: check the valve springs and check also the valve seats by unscrewing the sparking plugs and illuminating the seats by a portable lamp;

h/ leaky pistons.

POOR COMPRESSION.

Poor conpression on one or more cylinders /easily located by cranking the engine by the airscrew with switched-off ignition/ may be due to valve leakiness /burnt or worn valves/, valve seat failure, too close a rocker arm clearance, broken valve spring, valve getting stuck in its guide, worn piston rings, piston rings broken, jamming or clogged in their grooves, undue wear on cylinder, cylinder head leakiness /through gasket failure, cylinder head not tightened-down properly/ or leakage around the sparking plugs etc.

UNUSUAL VIBRATION OF ENGINE.

Check airscrew balancing and centering. Also check the engine mounting for signs of any looseness. This trouble may also be due to some component getting loose on the engine. If a controllable-pitch metal blade airscrew has been fitted, then the trouble may also be due to difference in pitch-angle setting of individual airscrew blades.

ENGINE KNOCKING OR PINGING.

This trouble may be due either to the utilisation of an unsuitable low-octane fuel causing detonations or engine overheating with subsequent auto-ignition owing to hot walls and to presence of carbon in the combustion space or to ignition being advanced much too far. Pinging noise may also be due to excessive clearances /backlash/ in crankshaft mounting, connecting rod or piston pin mounting or else to broken piston rings. In this case it is necessary not only to locate and remove the cause of knocking /pinging/ but to remove the basic fault causing undue wear in replaced items: this fault is mostly attributable to some lubrication trouble.

SUDDEN STOPPING OF ENGINE.

Possible causes are:

a/ lack of fuel due to empty tank, clogged fuel lines; air lock in pipe line; water in fuel; failure of fuel pump or its drive;

b/ ignition system trouble;

c/ engine trouble; seizure of crankshaft or pistons due to insufficient lubrication etc.

OVERHEATING OF ENGINE.

This fault is due to either too far advanced or too late ignition timing, to unsuitable fuel or weak mixture setting, to a faulty carburettor tune-up or restrictions in fuel flow, possibly also to the mixture control being opened too wide or to the occurrence of leaks in the induction system.

ENGINE LACKS POWER, DOES NOT GIVE MAXIMUM R.P.M. AT FULL THROTTLE.

May be due to :

a/ unsuitable fuel;

b/ weak or rich mixture;

c/ poor compression /see above/;

d/ engine being too hot or too cold;

e/ incorrect valve timing;

f/ some ignition trouble: sparking plugs defective; ignition timing maladjustment or failure;

g/ airscrew being too heavy, i.e. putting-up much too high resistance to rotation.

If a sudden drop in r.p.m. and engine power is experienced without the cause of it being clear, reduce the engine speed, land as soon as possible and investigate the cause of trouble.

ENGINE SPITTING BACK INTO EXHAUST.

This fault occurs owing to the ignition being too late, to an overrich mixture /carburettor overflows or nozzle bores too large/ or to an incorrect timing of valves. Overrich mixture is betrayed by a back exhaust smoke.

ENGINE SPITTING BACK INTO CARBURETTOR.

This fault is due to:

a/ weak mixture, cold engine, fuel supply to carburettors being restricted due to clogging of jets or filters, maladjustment of mixture /altitude/ control, present of water in the carburettor;

b/ valve timing maladjustment or leakiness around intake valves, rocker arm clearance being too close or non-existent; damaged valve seats or springs, excessive friction in guideways. Engine spitting-back into carburettor may also be due to the utilisation of a fuel brand different from that to which the carburettor tune-up has been made.

Carburettor tune-up and jet replacement must be entrusted to a carburettor craftsman.

ENGINE OPERATING SATISFACTORITY IN HIGH REVS? YET STOPPING AT IDLING SPEEDS.

This trouble is due to the engine being cold, to slow-running jet or pipe being clogged, to carburettor overflow, fouling of sparking plugs or too wide a sparking plug gap, ignition advanced too far.

OIL PRESSURE WILL NOT REACH NORMAL VALVES.

This trouble is attributed to an empty oil tank, damaged or leaky oil lines, oil supply restrictions due to clogged oil filters, oil pressure gauge faulty operation or oil overflow valve malfunctioning. First check the oil pressure gauge indications and examine the fuel lines. Only when no trouble has been revealed by this inspection, the relief valve should be adjusted to correct pressure.

EXCESSIVE FUEL CONSUMPTION -

may be due to fuel line leakiness, carburettor overflow unsuitably large jet bores or carburettor malfunctioning. Leakiness of coloured petrols is betrayed by colour traces around the leaky spot.

IGNITION FAULTS.

When spotting a trouble which has obviously developped in the ignition system, adopt a systematical way of proceeding by starting with the sparking plugs at first. Unscrew the sparking plugs and check them for correct firing on the spark plug tester, simultaneously examining their unsulators. Clean the sparking plug and electrone surfaces and readjust to correct sparking plug gap. If all sparking plugs are functioning correctly and the trouble persists, check cables and ignition magnetos next. If the ignition magnetos fire properly, then the fault is due to cables which may be improperly wired or else scuffed or damaged, thus occasioning shorts between the cables and engine framework. If the ignition magneto does not fire, check for a damaged shorting cable between ignition magneto and switch, for fouled or wet contact breaker or distributor, for burnt or otherwise damaged breaker points or damaged lever arms. Repair insulation, where necessary, clean or file-off contact points, readjust their gap, clean the contact breaker lever arms and lubricate them lightly with oil. A serious damage to ignition magneto, coil or similar equipment must be entrusted to an electric equipment craftsman.

If all components of the ignition system are found to be in orderm then the fault may be due to improperly set distributor or contact braker. Ignition faults themselves may occasion, in turn, some other engine malfunctioning such as engine knocking due to ignition advance being too far; engine misfiring due to oiled sparking plugs, excessive sparking plug gap, dirty or oiled breaker points or to intermittent shorts between cables and engine framework; engine spitting back into carburettors due to auto-ignition by fouled sparking plugs occurring particularly after prolonged running at full throttle or due to incorrect magneto adjustment.

P A R T F I V E

E N G I N E M A I N T E N A N C E A N D I N S P E C T I O N

REGULAR MAINTENANCE.

Correct and periodical engine servicing and maintenance must be entrusted to skilled and conscientious hands as it is of vital importance to ensure the reliability and long life of the engine. This section contains basic instructions for servicing and maintenance completing the overall minimum programme of maintenance work to be carried out in addition to the earlier described daily inspections and tasks before the take-off and after each flight.

Keep all external surfaces of the engine clean taking care that the surface treatment of all magnesium-alloy parts, which is a protection against corrosion, is not damaged by water or mechanical cleaning. Likewise the cooling fins of the cylinder heads and barrels must be kept clean in order to ensure proper cooling action. When disconnecting the pipes make certain that the entry of sand, dust and dirt into the engine or piping is safety prevented. All servicing jobs should be carried out in clean, undisturbed atmosphere, possibly in a hangar shed as a rule.

AIRBORNE TOOL KIT.

The airborne tool kit supplied in a bag /Fig.10/ contains the following tools:

combination pliers;
2 screwdrivers;

1 set of double-ended spanners /widths across flats: 6/8, 9/10, 11/12, 14/17 and 19/22;

cylinder holding-down bolt nut special spanner;

valve clearance feeler gauges /feeler thicknesses 0,1, 0,15, 0,2 and 0,3 mm respectively /;

sparking plug cable terminal spanner;

1 set of tubular /box/ spanners/ 9, 10, 11, length: 95mm/;

sparking plug socket spanner;

valve spring lifter;

valve-grinding-in holding-down spanner.

SERVICING PRIOR TO INITIAL RUNNING.

By "initial running" is described the initial operation of a new engine or of an engine newly installed in the airframe following a top or general overhaul or of an engine which has been taken out of long-time storage.

a/ Fill the rocked gear covers with oil.

b/ Unscrew one sparking plug per each cylinder and inject some 20 c.c. of oil heated to 50°C approx. into each cylinder using an oil pump. Care must be taken that the piston in the cylinder to be serviced is at its B.D.C. i.e. dispaced towards the crankshaft to enable all of the cylinder wall surface to be wetted by oil.

c/ Crank the engine by swinging the airscrew forwards and backwards for several times.

These precautions serve to ensure proper wetting with oil of all timing gears and cylinder working surfaces right from the start of engine operation in order to preclude any possibility of piston scuffing in the engine cylinders.

d/ Properly de-aerate and fill the oil inlet pipe from the tank to the engine. Feed about 3 litres of oil to the engine via a union /No. 9 connection in Installation Drawing/ feeding pressure oil from the pump to the engine /see illustration/ with simultaneous cranking of engine by pulling-through the airscrew with switched-off ignition at closed throttle. Following a complete de-reaction of oilways the oil pressure gauge will indicate oil pressure. This task must be carried out every time the engine is being refilled with oil following previous draining or oil change. The purpose of this operation is to ensure a continuous oil pressure feed to the engine immediately after its picking-up.

C a u t i o n : Do not omit blanking-off aii lunions again and locking them afterwards by a union nut.

SERVICING AFTER EVERY 10 HOURS OF RUNNING.

1/ Clean oil and fuel filters.

2/ Check all engine and airframe wiring for loose connections.

3/ Tighten-up lubrication nipples on ignition magnetos, if required.

SERVICING AFTER EVERY 50 HOURS OF RUNNING.

1/ Carry out all tasks included in the foregoing paragraph "Servicing After Every 10 Hours of Running".

2/ Drain all fuel from tanks and filters. Take off, inspect and clean the filters. Check all pipes, joints and taps for unrestricted fuel flow. Flush-out the fuel tanks and refill them with clean specified fuel through a piece of buckskin.

3/ Drain all oil from oil tank and oil pipes when the engine is still at its working temperature so that it will flow readily. Flush-out the oil tank with kerosene at first, then with petrol and let it dry-off properly. Apply similar cleaning procedure on all figures. Check the oil lines and connections for unrestricted oil flow. Prior to re-filling the system with clean fresh oil make certain of all petrol or kerosene traces being removed from the system. Clean or grind-in the oil relief valve in the oil pump, whichever may be necessary.

4/ Check the valves for proper clearence /which is 0,15 mm on valves cold/ and readjust, if required. Check the valve timing gear for any sign of undue wear on valve stem ends, push rod ends, setscrews, rocker arm followers etc. Top-up oil in rocker gear covers.

5/ Check proper compression by proceeding as follows: Unscrew all sparking plugs from all cylinders with the exception of the cylinder about to be tested. Open-up to full throttle and check proper compression by swinging the airscrew by hand. Next unsrew the sparking plugs from the just tested cylinder screwing them into the next cylinder about to be tested and check compression. Repeat this checking procedure successively on all cylinders.

6/ When unsrewing the sparking plugs, clean them at the same time, test them, if required and adjust the sparking plug gap to 0,4 mm. Check the sparking plug insulator and thread and check the sparking plugs for loose bushes. Renew any sparking plug which has been found to be faulty or having unudly burnt electrodes. Grease sparking plug threated portion using a graphite-grease coupound, fit new gaskets, screw-in and tighten-up the plugs.

7/ Top-up ignition magneto nipples with grease. Check the contact braker points and clean them, if necessary, and readjust them for the correct 0,3 to 0,4 mm gap.

8/ Check externally the carburettors and the fuel pump for any signs of leakage. Coloured petrols will leave couloured traces of evaporated fuel.

9/ Check the induction pipes at carburettors and cylinder heads for tightness. Clean the air scoop.

10/ Check and tighten-up the exhaust pipes as well as the exhaust collector and individual part connections of the exhaust system, if required.

11/ Check the following nuts and parts for proper tightening-up and locking in place: the crankcase bolt nuts, cylinders, valve guide yokes, bearer feet and bearer feet bearings on the engine mount and accessories, fuel and oil lines, air scoop engine cowling fasteners.

12/ Check the airscrew mounting, tightening-up the airscrew bolt nuts for correct airscrew centering, if required. Tighten-up the airscrew bolt nuts securely.

13/ Check the speedometer and generator flexible /remote control/ drives and lubricate them with a graphite-grease coumpond.

14/ Inspect and check all carburettorr and air scoop control lin rods and linkage as well as the taps and lubricate all pins, joints and guideways.

ENGINE TOP INSPECTION AND OVERHAUL.

Engine top inspection is carried out after some 350 hours of running or as may be required. If the operational service involves frequent take-off and near-ground flying at full throttle /as in pilot instruction/, then the engine top inspect-ion is indicated as early as after 300 hours of running. Engine top inspection does not require the removal of engine from the airframe. Only qualified personnel equipped with proper tools should be employed for the engine top inspection, in-volving the following sequence of operations:

1/ Drain all oil from the oil tank and oil lines while the engine is still warm so that the oil would flow easily. Flush-out the tank with kerosene first, then with petrol and let it dry-off thoroughly. Apply similar procedure,for cleaning of all filters. Check the pipes and connections for unrestricted oil flow. Before refilling with fresh specified oil take care to remove all petrol or kerosene traces from the oiling system. Clean or grind-in the relief valve in the oil pump, if necessary.

2/ Drain all fuel from the fuel tank and fuel filters. Remove, inspect and clean the filters. Check the piping connections /unions/ and taps for unrestricted fuel supply. Flush-out the tanks and refill them with fresh fuel of recommended specification by pouring it through a piece of buckskin.

3/ Take-off the rocker gear covers and check the valve rocker arm clearence and ignition magneto setting. Take-off the cylinder heads. Remove the rocker arms and valves from dismantled cylinder heads. Examine the valves and remove carbon. Replcae those valves /particurarly where exhaust valves are concerned/ showing damaged or burnt valve seats. Switch the exhaust valves the mechanical condition of which is sound to operate as intake valves, fitting the intake valves in lien of the exhaust valves. New valves, however, should always be fitted to operate as exhaust valves. Delete old marking on interchanged valves by hammering-in and stamping new marking in its stead. Grind-in the interchanged valves into the head seats using emery paste for the purpose. After grinding-in, wash them thoroughly and check them for tightenss by petrol. Remove all carbon from the cylinder head combustion spaces and grinding-in of the valves flush-out the cylinder head thoroughly to remove emery paste or emery powder and carbon from valve guides in order to prevent their seizure. Check the sparking plug bushes for signs of looseness. The operation terminates by refitting the valves and rocker arms into the head thereby readying it for reassembly to the engine.

4/ Take-off the cylinders and pistons checking, at the same instant the piston pins. Alsso check the piston ring groove clearence on dismantled pistons. Remove next the piston rings and decarbouise thoroughly the pistons /including piston ring grooves/ and piston rings to ensure the piston ring groove clearences as pecified hereunder:

Ring groove clearence, No. 1 piston ring V 0,150 - V 0,177
Ring groove clearence, No. 2 piston ring V 0,120 - V 0,147
Ring groove clearence, No. 3 piston ring V 0,080 - V 0,107
Oil scraper /control/ ring groove clearence
V 0,030 - V 0,061

Fit the piston rings in place again.

5/ While the cylinder heads and barrels are dismantled, check the valve timing gear /particurarly push rod ends, setscrews, rocker arm followes and valve tappet ends/ for any sign of major wear.

6/ Fit the cylinders together with new cylinder gaskets and assemble the cylinder heads. Prior to installing the intake manifold, however, the cylinder heads must be levelled-out by a rule and faulty gasket joints /either intake or exhaust/ must be renewed. Following the tightening-down of the cylinder heads, readjust the valve clearence which must be 0,15 mm on cold valves.

7/ Inspect the ignition magnetos /for loose or shifted condensers or capaciters. for presence of oil under the cover etc./ , examine and clean the contact breaker points adjusting their gap to be 0,3 to 0,4 mm, check all anegine cables for mechanical damage or failure or loose connections. Ship the ignition magnetos, if defective, back to the manufacturer for repair.

8/ Unscrew the sparking plugs cleaning and testing them, if necessary: readjust the sparking plug gap to 0,4 mm and check both insulator and thread. Renew any sparking plug which has been found to be defection or having unduly burnt electrodes. Lubricate the sparking plug threated portions with a graphite-grease compound and fit over new joints.

9/ Tighten-up the ignition magneto grease nipples and top-up with grease, if required.

10/ Check tightenss or retighten if necessary, the crankcase bolt nuts, cylinders, valve guide yokes, bearer feet and bearer feet bearings on the engine mount, fuel and oil lines and accessories, air scoop and engine cowling fasteners.

11/ Take-off the airscrew from its boss, remove the airscrew hub from the shaft, examine the airscrew hub mounting on the shaft for signs of mechanical damage or rusty condition; refit the hub in place and tighten-upwith a nut, locking it in place. Before the airscrew hub is refitted, lubricate the seating taper surfaces on the shaft and in the hub with a graphite-grease compound. Check also airscrew centering and tighten-up firmly all airscrew bolt nuts.

12/ C eck the speedometer /revolution indicator/ and generator flexible drives lubricating them with a graphite-grease compound.

13/ Inspect and check all carburettor and air scoop link rods and control linkage and lubricate all pins, joints and link rod guideways.

14/ After filling the carburettors and fuel pump with petrol check all these devices externally for indication of leakiness.

15/ After having cleaned the air soop check the intake manifold connections at the carburettors and at the cylinder heads for tightness.

16/ Inspect and tighten-up the exhaust pipes or the exhaust collector as well as individual part connections of the exhaust system.

ENGINE GENERAL INSPECTION AND OVERHAUL.

Engine general inspection and overhaul is carried out on touring aircraft after some 1000 hours of engine operation providing that two engine overhauls have been carried out after 300 to 350 running hours each within the 1000-hour period concerned. If the operational service involves frequent take-offs and near-ground flying at full throttle /as in pilot instruction or aerobaticsL, the engine general inspection period must be reduced in 600-hour service approx. providing that the engine top inspection will take place after 300 hours of engine running.

Disregard this time schedule if troubles or internal faults are developped by the engine in service, calling for immediate genral overhaul.

If the engine has been put out of use without proper servicing or if it has been stored under adverse conditions /moisture or corrosion-developping enviroument/, then the engine must undergo a general inspection or overhaul before being put into service again.

Engine general inspection and overhaul should be entrusted to a specialised repair workshop having all necessary equipment and tools at its disposal or else the engine should be shipped back to the manufacturer. Respective instructions regarding these operations are contained in the manufacturer's Service Shop Manual.

REMOVAL OF ENGINE FROM AIRFRAME.

When removing the engine from the airframe, reverse the procedure to be followed in engine installation in the airframe.

1/ Remove the engine cowlong.

2/ Dismount the exhaust collector, if any has been fitted in the airframe. Unscrew the exhaust pipes and blank-off the exhausts.

3/ Take-off the airscrew with or without the airscrew boss.

4/ Disconnect breather pipe from the breather, blanking-off the bore with a rubber cap.

5/ Disconnect the speedometer /revolution indicator/ flexible drive blanking-off the tube with a cap nut.

6/ Disconnect all wiring from the engine connecting the engine to the airframe /switch shorting cables and switch earthing cable/.

7/ Drain oil from the engine and oil lines. Disengage the pipes from both engine inlet and outlet blanking-off the two unions with plugs. Also disconnect either oil pressure relay or oil pressure gauge connection from the crankcase pressure oil inlet, blanking-off the respective bore.

8/ Disengage the fuel line from the fuel pump, blanking-off the fuel pump unions immediately. Disconnect the bowden cable from the fuel priming pump, dismantling, at the same time, the drain valve connectors on the intake manifold.

9/ Disconnect the link rods from the rear carburetter controls /throttle and mixture/ and dismantle the intake pipes from the carburettors, blanking-off the carburettor unions with plugs.

10/ After having attached the hoisting cable, disengage the engine from its mount. Following the lifting-up of the engine, unscrew the bearer feet and rubber dampers screwing on respective lugs in their stead for engine attachment to the bedplate. Conclude these operations by placing the engine on a dolly or a rotary assembly jig.

PLANNED ENGINE DISASSEMBLING OPERATIONS.

Engine general inspection, disassembling or assembling operations should be entrusted to a specialised repair workshop having all necessary equipment and tools at its diposal. Therefore it is best to ship the engine to the manufacturer where it will get all the special care that is necessary.

Only special tools should be used, which are supplied on order by the manufacturing plant along with the engine. Prime condition of all these operations is extreme cleanliness and a systematic sorting of all individual components after dismantling in order to prevent chri erroneous interchange during the reassembly. Make certain that all split, spring washers and paper gaskets are safety renewed before the reassembly. When clamping individual parts in a vice, ensure that its jaws are fitted with aluminium or brass cushion plates.

Procedures for complete overhaul of the engine (pp. 80-97) are not included in this free copy of the service manual.

ENGINE RUNNING-IN AFTER REASSEMBLY.

If only valve grinding-in has been carried out without actual removal of engine from the aircraft, the engine must be run-in for at least 30 minutes with gradual increase of engine speed from initial 500 r.p.m. up to the final 1200 r.p.m. towards the end of the running-in. After the engine has come to a stop, check the valve rocker clearances, checking also the cylinder holding-down bolt nuts for proper tightness.

A complete disassembly of the engine with none critical component being renewed requires 1 1/2-hour running-in with gradual increase of engine speed from initial 500 r.p.m. up to the final 2500 r.p.m. This method of running-in must be done by a braking airscrew on a test rig ensuring adequate engine cooling. After the engine has come to a stop, retighten the cylinder holding-down bolts and readjust the valve clearances. If some critical components has been renewed during the engine disassembly, then the running-in period should be extended accordingly to some 2 1/2 - 3 1/2 hours to obtain proper running-in and mating of newly fitted parts. Use a dynamometer test rig equipped with an adequate cooling facility for the purpose. After being through with the running-in operations, tighten-up the cylinder holding-down bolts and readjust the valve rocker clearances. Also during the next 10 hours or so of engine operation in the aircraft the engine must be spared excessive efforts and racing the engine to full speed should be avoided whenever possible.

MAINTENANCE OF ENGINE INSTALLED IN AIRFRAME WHEN TEMPORARILY NOT IN USE.

The following operations are recommended for maintenance of the engine installed in airframe when temporarily not in use :

1/ Before stopping the engine for the last time, let it run at 1200 r.p.m. at closed throttle until all fuel from fuel lines and carburettors is used up. If leaded fuel has been used throughout the operational service, it is essential to let the engine run for the last time at least 10 minutes on pure petrol with 1% oil addition.

2/ Drain all fuel from the tank.

3/ Drain all oil replacing it with fresh, scrupulously clean mineral oil. Crank the engine several times then.

4/ Using a hand pump /oil gun/ unject some 20 c.c. of mineral oil through the sparking plug fitting hole into each cylinder taking care that the piston in the relative cylinder is at the bottom dead centre. Crank the engine twice or so following each injection to obtain uniform spreading of oil over the cylinder and valve surfaces. Screw the sparking plugs into place again. Repeat this procedure at monthly intervals or so.

5/ Carefully grease all external metal surfaces of the engine using conservation oil to prevent their rusting or oxydising.

6/ Blank-off the exhaust bores and the carburettor air intake union.

7/ Cover the engine and the airscrew with a water-proof canvas or oiled paper to repel dust or moisture yet ensuring free access of fresh air to the engine.

8/ Seal-off the tank filler necks.

9/ Before putting the engine into active service again, carry out all precautionary measures, described in the paragraph "Servicing Prior to Initial Running".

SERVICING OF STORED ENGINE.

Point 1 to 4 are identical with those already given in the paragraph "Maintenance of Engine When Not in Use".

5/ Take-off the engine from the airframe and rest it on the bed-plate or on the assembly jig.

6/ Blank-off all intake and outlet or exhaust unions with pertinent blanking plugs /this precaution concerning all oil inlet and outlet unions, fuel primer adaptor unions, fuel inlet union on fuel pump, breather pipe, speedometer drive union, cylinder exhaust unions and carburettor intake unions/.

7/ Carefully grease all external metal surfaces of the engine using conservation grease to prevent their rusting or oxydisin

8/ Store the engine away in a crate - should no crate be on hand, cover it with a water-proof canvas or oiled paper to repel dust or moisture.

9/ Store the engine in a dry place under the best possible protection against weather changes. Ensure access of fresh air at all times, however.

10/Check the stored engine from time to time, repeating the servicing operations described in Point 4. Be particularly careful about rusting of machined surfaces even under the protective oil film and be sure that the protective oil film has nowhere been damaged.

11/If the engine has been out of use for a long time it must then undergo a general inspection to detect any part that has deteriorated unduly throughout the long period of storage.

mission valve is fitted with a spring-loaded needle "9" preventing seat damage /pounding/ and carburettor flooding. From the valve the fuel is conveayed partly to the float chamber, partly to the pressure-balance chamber "10" of the delivery throat "13". An air-bleed hole "12" is arranged around the fuel admission valve body in the pressure-balance chambers. The pressure-balance chamber "10" enables a steady float movement and a steady operation of the carburettor by routing the fuel directly from the valve to the delivery throat in normal service, only the balance being supplied by the float chamber. The fuel passes through the delivery throat into the induction chamber "17" /Fig.3/ wherefrom it is routed via hole "14" /Fig.2/ to the mixture control valve and through channels or ports "15" and "16" /Fig.1/ to the power jet valve. From either valve the fuel then flows to the main jet "18" and to the power jet "19" /Fig.4/ which are easily accessible after unscrewing the plugs "20" located in the carburettor face side. From the jets the fuel gets into the diffuser "22" /Fig.5/ via a channel "21" /Fig.4/ and mixes with air in the diffuser well to which the air is being supplied from the carburettor intake via air jet "27" /Fig.7/ and slow-running /idling/ jet "28" /Fig.6/. The fuel-air mixture is routed then via and annular slot "25" /Fig.5/ to three spray orifices "26".

Sudden changes in throttle position are counter-balanced by jet "23" and balance pipe "24" in the diffuser, correcting the mixture strength when changing from slow-running/idling/ into cruising speed, whilst at full throttle, the jet "23" serves as an auxiliary spray nozzle.

IDLING.

In idling /slow-running/, the fuel is taken from the diffuser well, flowing through the slow-running jet "28" in a direction

12/ Before putting the engine into active service again, carry out all precautionary measures described in the paragraph "Servicing Prior to Initial Running".

P A R T   S I X

I N S T R U M E N T S   A N D   A C C E S S O R I E S .

WALTER 45 AND 45-AK CARBURETTORS.

Both these carburettor types are designed for best economical engine performance at part-way opened throttle and for maximum power by mixture enrichment at full throttle. The accelerator pump enriches the mixture during throttle opening by injecting additional fuel. The mixture (altitude) control is operated by a mixture (altitude) control device leaning-out the mixture uniformly throughout the throttle range.

The WALTER 45-AK carburettor is of the pressure balance ("anti--g" or "negative g") type, ensuring full throttle fuel supply for high aerobaties and performance flying. The WALTER 45 carburettor is slightly different as to its internal design, since it is not fitted with those devices enabling inserted flights. The following paragraphs are devoted to the description of the WALTER 45-AK "anti-g" type carburettor.

FUEL INDUCTION.

The fuel flows into the carburettor through a threaded (M 14 x 1,5) inlet union "1" passing further across a cylindrical filtering sieve "2" which must be cleaned from time to time and by 4 holes "3" to the replaceable fuel jet "4" fitted with a steel ball "5" assuming the position as marked in Fig.1 during horizontal (level) flight. In inverted flight, this ball will shut-off the hole "6" so that fuel would flow-in through a calibrated bore "7" only. From the fuel jet the fuel is passing to the valve seat and to the float chamber. The fuel adopposite to that of the full throttle air and mixing with air ducted-in via air jet "27" /Fig.7/. The lowest /"tick-over"/ speed can be adjusted by rotating an adjuster screw "29" /Fig.8/ in the carburettor back side.

FULL THROTTLE POWER.

At full throttle the fuel-air mixture is enriched by opening the power valve "30" /Fig.1/. The valve control is by lever "31" /Fig.11/ solidly linked to throttle flap spindle, by link rod "32" and lever "31" on shaft "34" /Fig.3/ mounted in carburettor upper body section. Mounted on shaft "34" in the carburettor upper body section is a cam "35" /Fig.10/ actuating rocker arm "36" operating in turn the power valve /"30"/ head "37". The cam is operationally linked to the accelerator pump "39" cylinder by way of a small link rod "38" and a ball joint. When opening the throttle, fuel is delivered from the accelerator pump through a system of channels /bores/ to jet "40" /Fig.7/. The accelerator pump jet serves simultaneously as a tightening-down screw to the choke tube.

ALTITUDE FLYING.

The mixture is weakened /or leaned-out/ for altitude flying by operating the mixture /altitude/ control valve "41" /Fig.3/ actuated by a lever "42" solidly linked to a spindle in the carburettor upper body section.

CARBURETTOR CONTROLS.

Carburettor control is operated by two control levers located directly on the carburettor body, one lever being the throttle control lever operating the opening or closing of the throttle flap, the other lever actuating the mixture /altitude/ control valve. Links of adequate rigidity must be provided for either lever to connect it to the cockpit controls. Both levers must be interconnected to form an operational link so that the mixture control would automatically be reset to the "rich mixture" /closed/ position after closing down the throttle. Before starting the engine, the carburettor must be filled to capacity by means of the fuel pump-fitted flooding device.

CARBURATION TROUBLES.

Carburation troubles may be due to the following cause: a too weak mixture due in turn to some jet being clogged, restricted fuel line, float valve needle getting stuck or leaky fuel lines or an overrich mixture setting caused by faulty operation of the float valve needle and carburettor flooding.

Mixture setting may be judged by the tinge of the exhaust fumes unless the engine has been fitted with an exhaust collector. Short red or yellow flames betray weak mixture setting, where as long blue flames originate by rich mixture setting, being accompanied by black smoke from overrich mixture. With correct mixture setting the flames are short, with a weak bluish tinge.

ACCELERATOR PUMP BARREL REPLACEMENT ON WALTER 45 AND 45 AK CARBURETTORS.

Dismount the air scoop from the carburettor and disconnect both throttle and mixture control link rods. After unscrewing of 4 nuts take-off the carburettor from the intake pipe. By slackening the ball joint head remove the ball joint "a". Carefully located upon the circumference of the parting plane.

Dismount screw "b" and piece "c" from the lower body section. Using a fine grinding paste, grind-in piece "c" into the new accelerator pump cylinder or barrel "d", specified clearance between the two parts being V 0,016 - 0,070 mm. Make certain to remove all rests of paste from either pieces carefully.

Undo split-pin "e" in the upper body section and fit a new ground-in cylinder in stead of the old one. Refit pieces "b" and "c" to their relative places in the lower body section, retightening-up the screw "b" with care. When assembling the upper and lower body sections, the cylinder "d" is fitted over piece "c". Care should be taken to ensure proper contact of pieces "f" and "g" respectively. Tighten-up the screw assembling both carburettor halves by proceeding in diagonal sequence and with extreme care. After attachment of ball joint "a" make sure of correct operation of the accelerator pump by moving the throttle lever, which should be steady, continuous and resistance-free throughout its displacement range.

WALTER 2M-50 FUEL PUMP.

The Walter 2M-50 fuel pump is of the double-diaphragm rotary type, with clock-wise rotation of the pump drive, the fuel pump being adjusted to a pressure of 0,15 at. The fuel pump is flange-mounted on engine starboard side, being driven with a 2 to 1 ratio by a driver from the starboard ignition magneto intermediary gear.

FUEL PUMP DESCRIPTION AND OPERATION.

The fuel pump shaft is driven by a driver and terminates by an eccentric pin inside the pump body. During the fuel pump shaft rotation, the eccentric pin moves to pull the diaphragm cup kugs between which the diaphragms are clamped. Diaphragn return stroke to initial position is effected by two compression springs resting on inner cup springs between the two diaphragms. The covers located on either side of the fuel pump housing hold-down the diaphragms along their circumference. Each cover is fitted with one inlet and one delivery /outlet/ valves. Inlet connections are arranged at the cover bottoms, whilst the upper side of the fuel pump body features a delivery union with a connecting pipe to the fuel pressure gauge as well as an air chamber. A lever serving for manual filling of the fuel pump and carburettor is arranged at the fuel pump back side.

Fuel PUMP OPERATION.

The eccentric pin located at the end of the fuel pump shaft moves about the shaft axis to pull alternatively the diaphragm cup lugs. Each diaphragm deflection towards the fuel pump centre opens the inlet valve while shutting-off the delivery valve on the covers /"suction stroke"/. Each diaphragm return into initial position, i.e. away from the pump centre by the action of the compression springs closes the inlet valve while opening the delivery valve /"delivery or feeding stroke"/. Upon filling the carburettor float chamber and shutting-off of further fuel supply by the valve needle, the delivery pipe pressure will increase to overcome the diaphragm compression spring thrust so that the diaphragms would stay compressed towards the fuel pump centre and the delivery valves would remain closed due to lack of contact between the diaphragm cup lugs and eccentric pin with the result that no fuel is being drawn-in and delivered by the fuel pump. As soon as the delivery pipe pressure falls, the fuel pump operation will be re-started. This arrangement ensures fuel delivery rates compatible with engine actual requirements as well as a contact pressure of fuel feed regardless of engine speed. Permanent shutting-off of any inlet is prohibited with the exception of emergency operation such as using-up the fuel reserve from the tanks.

FUEL PUMP FILLING DEVICE.

Before starting the engine, the fuel pump, fuel line and carburettor float chamber must be filled with fuel by manual priming. A filling device operated by a hand lever at the fuel pump back-side is provided to actuated the diaphragms by the wobble lever. Manual pumping is carried out until the fuel inlet in the carburettor is shut-off and the pump ceases to operate, which condition will be determined by lack of hand lever resistance and by fuel pressure gauge registration.

WALTER 2M 50 FUEL PUMP DE-AERATION.

New pump design /II/ is fitted with de-aeration led below the engine. Due to this design change, manual filling /flooding/ is no longer necessary for the early pump design /I/ and has been discontinued.

Early design /I/ fuel pump, S.No.0780714 with manual filling /Flooding/ will therefore have the following parts discontinued :

fork /clevis/ complete.....	S.No.	3000511..............	/1/
pump plug..................	"	1012322..............	/2/
pump lever.................	"	1012372..............	/3/
joint washer...............	"	1012891..............	/4/
lever spring...............	"	1012901..............	/5/
taper dowel pin............	"	43 NW1 - KK1,5x14-0	/6/
cylindrical pin............	"	42 NW1 - VK2,5x16-0	
diaphragm inner cup complete	"	0305272..............	/7/

The above components have been replaced on the new design /II/ S.No.0780715 fitted with a threaded /M 12x1,5/ connection to the breather pipe /5/3 dia.dia./ instead of the manual flooding /filling/ device by the following parts :

breather union complete S.No.	3000951	/8/
union cone............ "	1012621	/9/
union nut .... "	1012651	/10/
lock washer .... "	1021411	/11/
diaphragm inner cup complete "	0355271	/12/

FUEL PUMP MAINTENANCE.

Fuel pump maintenance will not require special measures to be taken as it will do to check it externally for any sign of leakiness and top-up oil in the manual flooding device and renew the diaphragm washers within the periods prescribed.

Every 100 hours of operation unscrew the rear plug "a" at the fuel pump back-side together with the wobble lever for pump flooding /if fitted/ topping-up some 4 to 5 c.c. of lube oil in the cavity. Refit the plug and lock it in place. Special care should be observed when fitting the plug and wobble lever in place.

Owing to the established fact that the diaphragms are subject to progressive hardening due to utilisation of new fuels with possible loss of resiliency of diaphragm material after a service period extending beyond 200 hours, it is essential to establish an evidence logging-down the fuel pump operation time and renewing all diaphragms after 200 hours of operational service.

C a u t i o n : During the diaphragm renewal make certain that all 3 diaphragms are replaced on either fuel pump side.

FUEL PUMP FAULTS AND REMEDIES.

Fuel pump operational faults may be due to some of the following possible causes :

a/mechanical troubles due to wear or failure of some component /would occur but exceptionally/;

b/troubles due to leakiness or air leakage into pipeline or pump.

Check fuel line between fuel tank and pump, fuel pump as well as fuel line between the pump and carburettor for damage or rupture; check all unions and connections for absence of leaks.

c/ Fuel pump is leaky.

If fuel leaks appear between pump body and covers, recheck proper tightening of bolts. Tighten-up the bolts by proceeding in diagonal order. In the event of a diaphragm damage, which would occur but exceptionally, renew the faulty diaphragm. It is advisable, however, to ship the fuel pump back to the factory for repair and overhaul.

d/ Valves failing to close.

Take off the valve plugs, clean the valves in petrol and renew them. if necessary. Check also the valve seats and check valve seating. When reassembling, remember to check the valve for unrestricted operation.

WALTER RE 25 COMBINATION HAND AND ELECTRIC STARTER GEAR.

The WALTER RE 25 combination hand and electric starter gear is a mechanical clockwise rotating starter with an expanding dog and a standard flange for mounting on the engine in accordance with the ČSN-AE 7.1 or SAE 5 Standards.

This starter can be mounted with its crank either in horizontal position or with an angular deflection of 20 degrees above or below horizontal. The starter gear is fitted with a 300 W/24V starter motor the rotational speed of which is 5000 to 6000 r.p.m. With the starter motor in operation, the starter dog expands automatically to mesh with the crankshaft dog or jaw, this starter dog extension being caused by friction in the helical gearing. The engine is then cranked by the starter motor, with any engine kickback being neutralised by a multi-plate clutch of the friction type. As soon as the engine picks up, the crankshaft dog will overspeed with the result that the starter dog will retract into its original position.

The starter gear housing is filled with oil up to the oil plug level with the starter crank in horizontal position. The torque of the multi-plate clutch is factory-adjusted to 35 kgm. Only when the starter operation is inadequate for efficient engine cranking because of worn clutch plates, then the transmitted clutch torque can be increased by tightening-up the adjusting nut one or two threads.

A P P E N D I X

W A L T E R   M I N O R   6-III S   E N G I N E   W I T H   S H U T - O F F   C O N T R O L L E D   C E N T R I F U G A L   S U P E R C H A R G E R .

The WALTER MINOR 6-III S /supercharged/ engine, though otherwise identical with the normally aspirated WALTER MINOR 6-III engine, is fitted with an auxiliary centrifugal supercharger or air compressor for boosting of power for the take-off, for better climbing and for obtaining a higher ceiling. The supercharger has a shut-off control operated as may be necessary.

1. S u p e r c h a r g e d   E n g i n e   S p e c i f i c a t i o n :

Technical data and specifications are the same as those of the WALTER MINOR 6-III engine with the following differences :

P o w e r   a n d   S p e e d   D a t a

Take-off power with supercharger in operation /time limit: 3 minutes/	185 b.h.p.
Engine speed at take-off power.............	2600 r.p.m.
Rated power near ground /with shut-off superchanger/	155 b.h.p.
Nominal speed	2500 r.p.m.
Cruising power............................	125 b.h.p.
Cruising r.p.m............................	2300 r.p.m.

F u e l   C o n s u m p t i o n   D a t a

Fuel consumption at take-off power with supercharger in action /specific/	235 g/hp/hour
Fuel consumption at rated power near ground /with shut-off supercharger/....	255 g/hp/hour
Fuel consumption at cruising behind supercharger, near ground /at 2600 r.p.m./	1.12 atm.i.e. 825 mm mercury
Fuel octane rating specification	87

W e i g h t   A n a l y s i s

Engine dry weight including accessories and equipment to ČSN-AE-1,4 B, weight B 1	134.2 kg ± 2 p.c
Wherefrom :	
2 WALTER 45 carburettors	3.8 kg
2 SCINTILLA VERTEX NVK 6-Z2 and AVK 6-Z2 ignition magnetos with automatic advance control, M 12x1,25 sparking plugs, cables and cable harness tubes, cooling air scoop and air baffles	10,13 kg
RE 25 starting gear without starter motor..	6,68 kg
Engine weight per horsepower at rated power near ground and at B 1 weight	0,86 kg/hp
Equipment and accessory drives which are optional items only :	
Crank to hand starter gear with bearing	0,82 kg
Starter motor....................................	3 kg

O v e r a l l   D i m e n s i o n s

Overall length of engine including fixed-pitch wooden airscrew boss .... 1464 mm

II. D e s c r i p t i o n   o f   P r i n c i p a l   P a r t s   o f   S u p e r c h a n g e d   E n g i n e

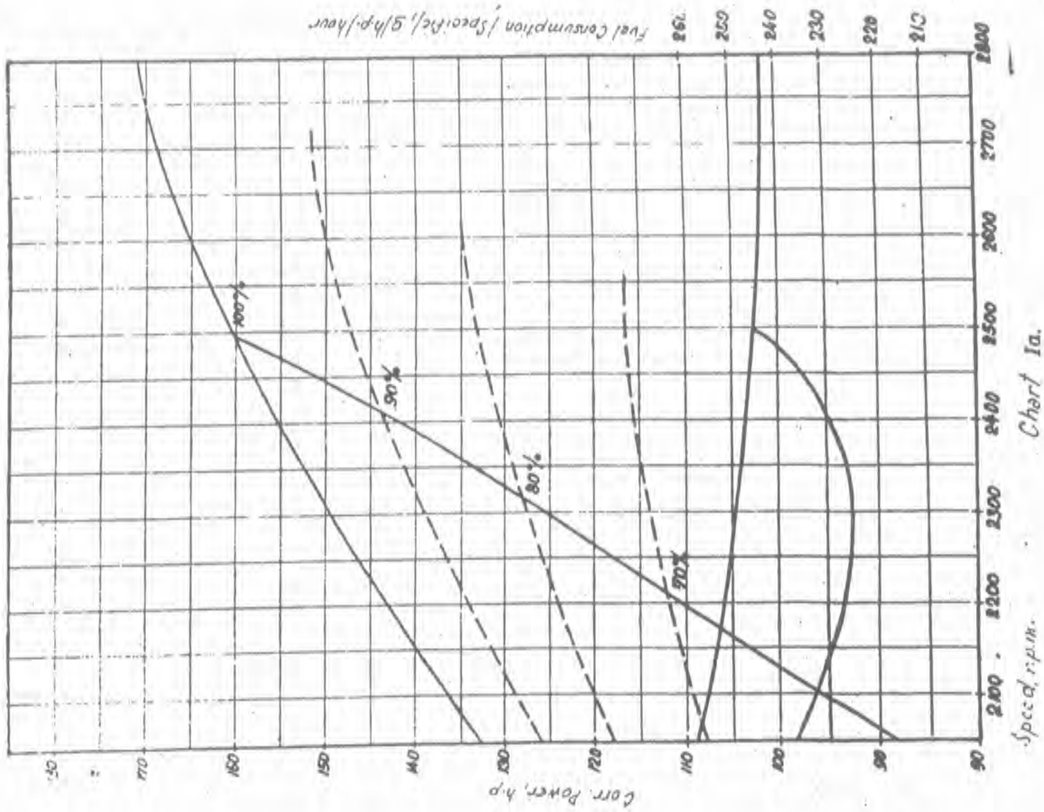
The engineering design of the WALTER MINOR 6-III S engine is the same as that of the WALTER MINOR 6-III type, differing but in the following points :

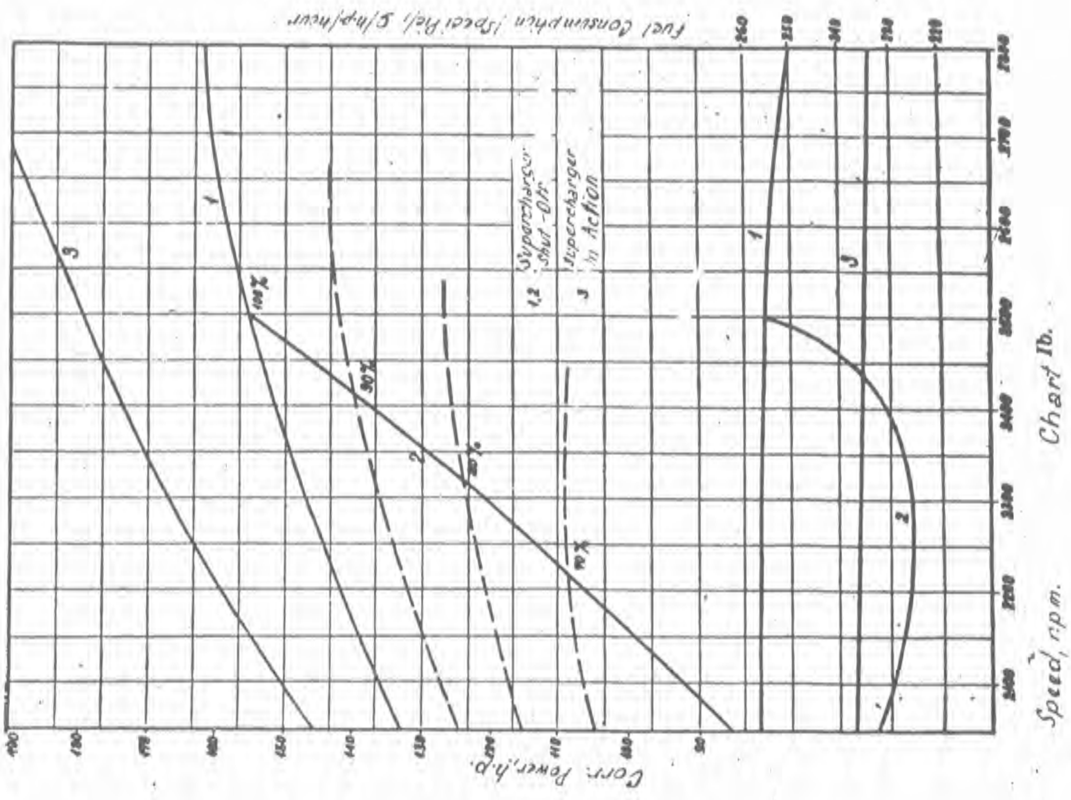
The c r a n k s h a f t rear carries a driver for the supercharger flexible coupling instead of the crankshaft dog or jaw actuating the starter gear.

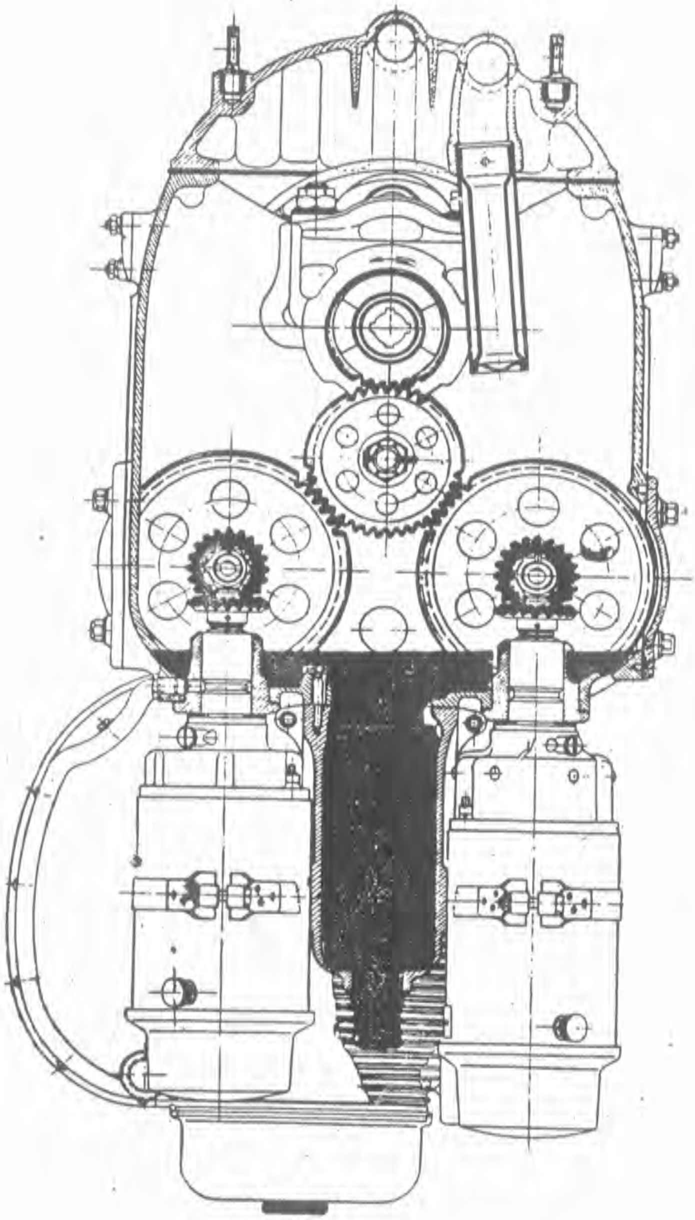
A pipe conduit for supercharger pressure feed l u b r i c a t i o n has been fitted to the pressure oil pipe union between the oil pump and the crankcase.

The centrifugal-type s u p e r c h a r g e r supplies clean air into the carburettor, being bolted to a flange on the crankcase rear wall which normally serves as a support to the starter gear. The impeller is a Hiduminium RR 56 forging, being actuated from the crankshaft rear through a flexible coupling and a satellite gear of an overall ratio of 7.4 to 1. The supercharger shut-off control is operated by the pilot by braking the satellite drum gear through a link-rod controlled band brake. The satellite drum gear is carried in a plain bearing, the satellites are supported by needle roller bearings, while the impeller is carried by a plain bearing at the front end and by a special-type ball bearing at the rear end. The transmission gear is lubricated by pressure oil taken-off of a pipe conduit behind the pressure pump, scavenge oil returning into the crankcase. The air charge from the supercharger is ducted to the carburettors via an aluminium pipe conduit coupled to the carburettors by means of elbows containing deflector vanes. A double union on the supercharger serves for connection of the intake manifold pressure gauge behind the supercharger as well as for equalisation of air pressures in the supercharger discharge collector and in the fuel pump.

The s t a r t i n g system comprises an expanding dog in the supercharger housing rear portion, a gear from the hand crank, a lock pawl against engine kick-back and a worm gear from the starter motor, the latter being an optional item. The supercharger drive gear forms simultaneously a part of the starter gear with the supercharger coupling functioning as an overload clutch to neutralise the engine kickback. The rear portion of the housing with the hand crank and starter motor can be swivelled 15 degrees either way about the crankshaft axis into desired attitude.


Fuel Consumption /Specific/, g/hp/hour
Corr. Power, h.p
Speed, r.p.m.
100%
90%
80%
70%
Chart Ia.


Fuel Consumption /Specif./, g/hp/hour
Corr. Power, h.p.
Speed, r.p.m.
1,2 Supercharger Shut-Off
3 Supercharger in Action
100%
90%
80%
70%
Chart Ib.



pressure-fed oil /red/
scavenge oil /green/
surplus oil /yellow/

Chart II.

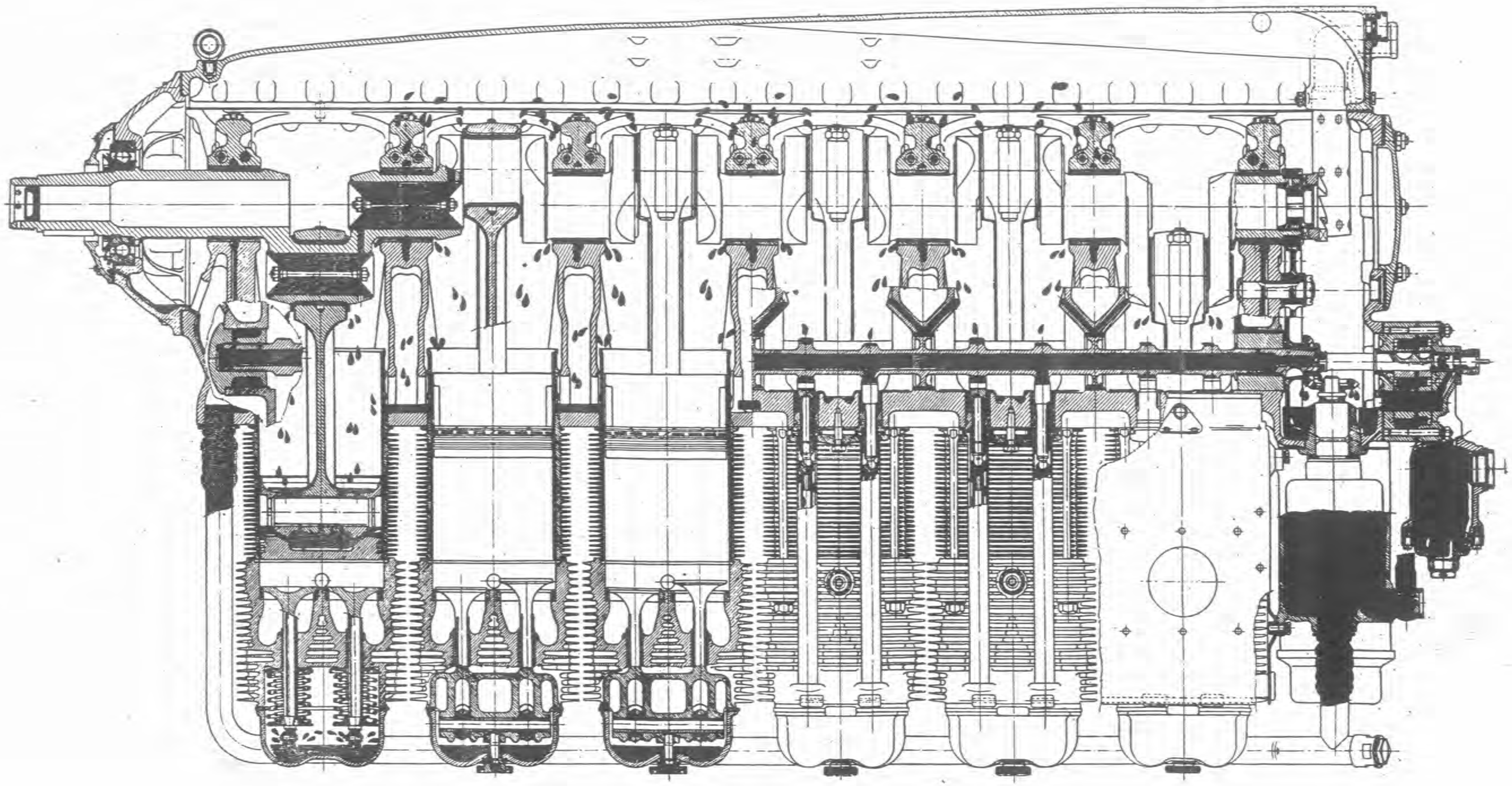


Chart II.

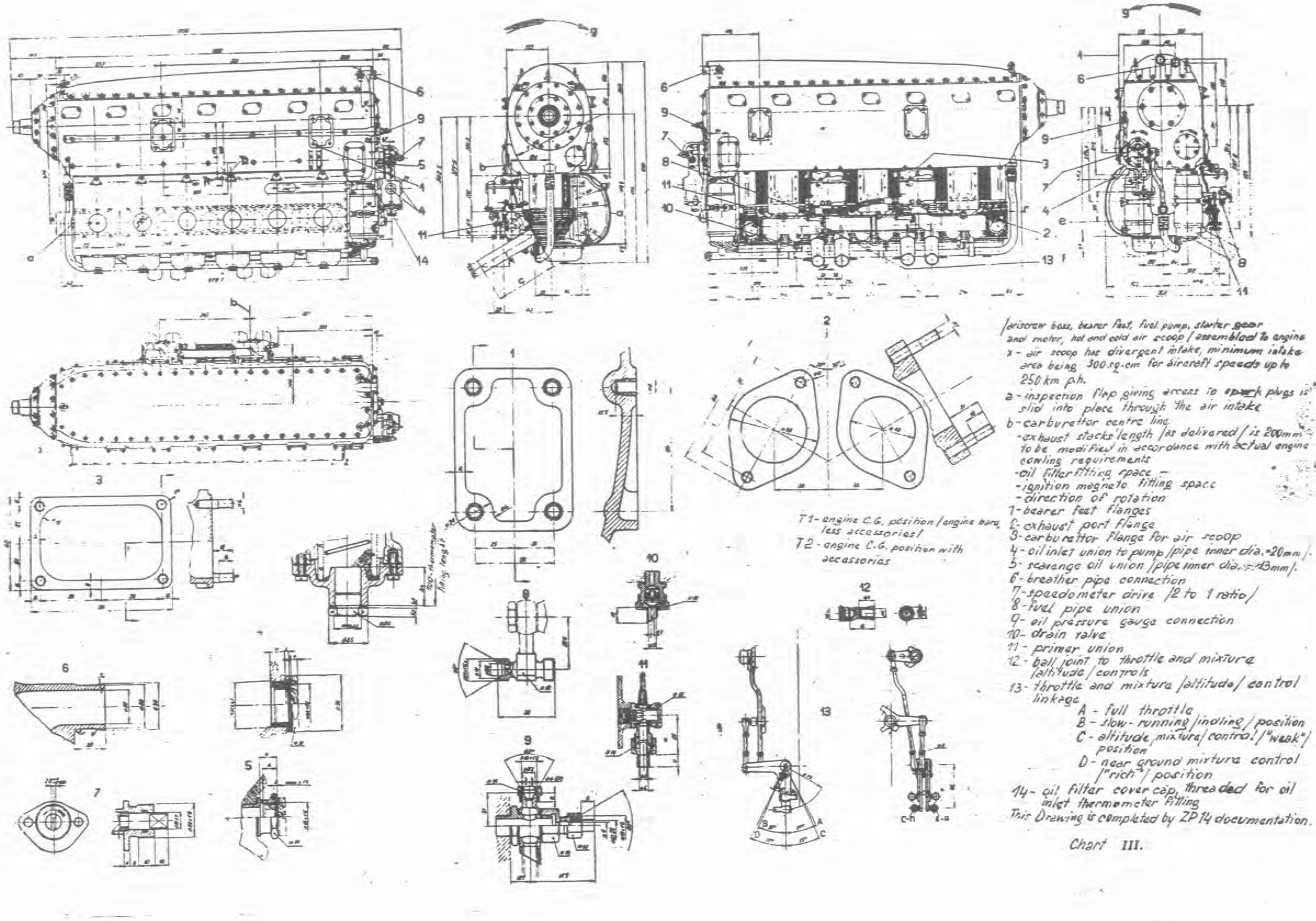
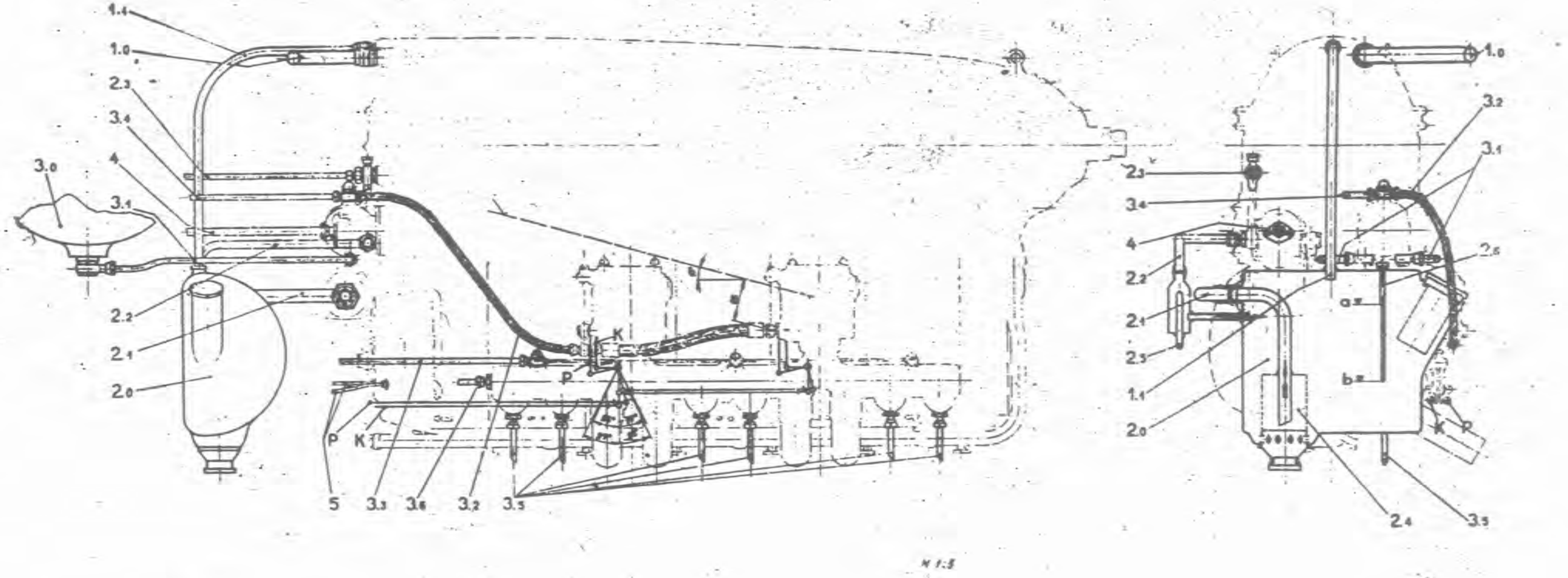
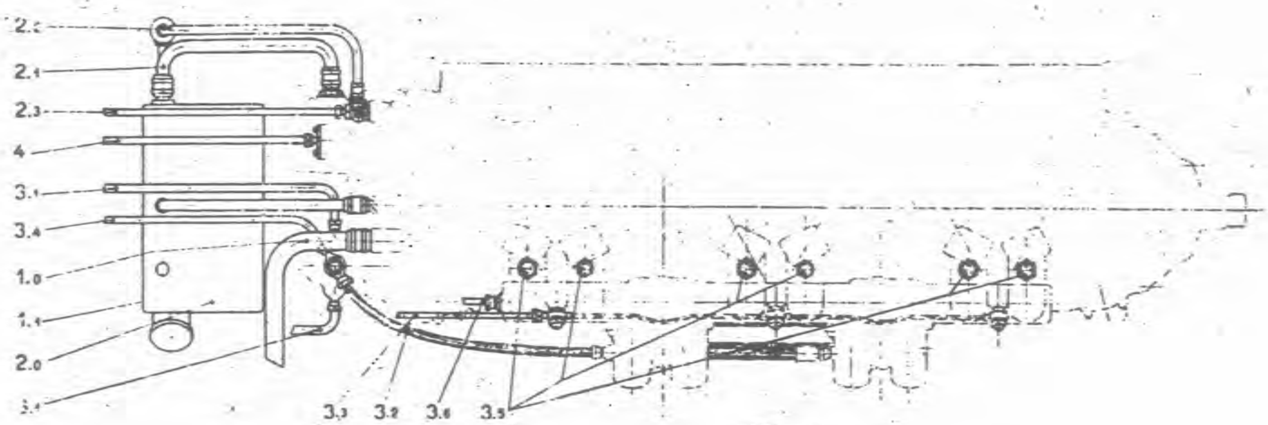

T1- engine C.G. position /engine bare, less accessories/
T2 - engine C.G. position with accessorias
/airscrew boss, bearer feet, fuel pump, starter gear and motor, hot and cold air scoop / assembled to engine
x - air scoop has divergent intake, minimum intake area being 300 sq.cm for aircraft speeds up to 250 km p.h.
a - inspection flap giving access to spark plugs is slid into place through the air intake
b - carburettor centre line
- exhaust stacks' length /as delivered/ is 200mm to be modified in accordance with actual engine cowling requirements
- oil filter fitting space
- ignition magneto fitting space
- direction of rotation
1 - bearer feet flanges
2 - exhaust port flange
3 - carburettor flange for air scoop
4 - oil inlet union to pump /pipe inner dia.=20mm/.
5 - scavenge oil union /pipe inner dia.=13mm/.
6 - breather pipe connection
7 - speedometer drive /2 to 1 ratio/
8 - fuel pipe union
9 - oil pressure gauge connection
10 - drain valve
11 - primer union
12 - ball joint to throttle and mixture /altitude/ controls
13 - throttle and mixture /altitude/ control linkage
A - full throttle
B - slow-running /idling/ position
C - altitude mixture /control/ /"weak"/ position
D - near ground mixture control /"rich"/ position
14 - oil filter cover cap, threaded for oil inlet thermometer fitting
This Drawing is completed by ZP 14 documentation.

Chart III.

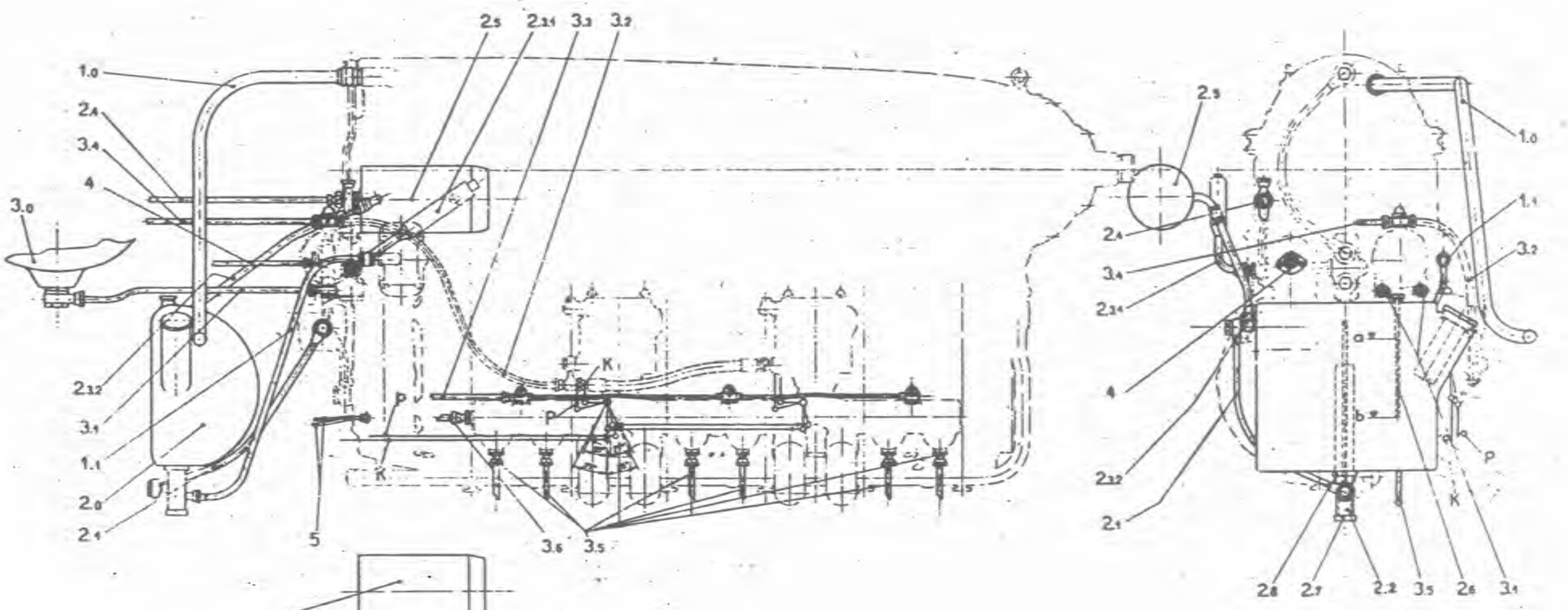


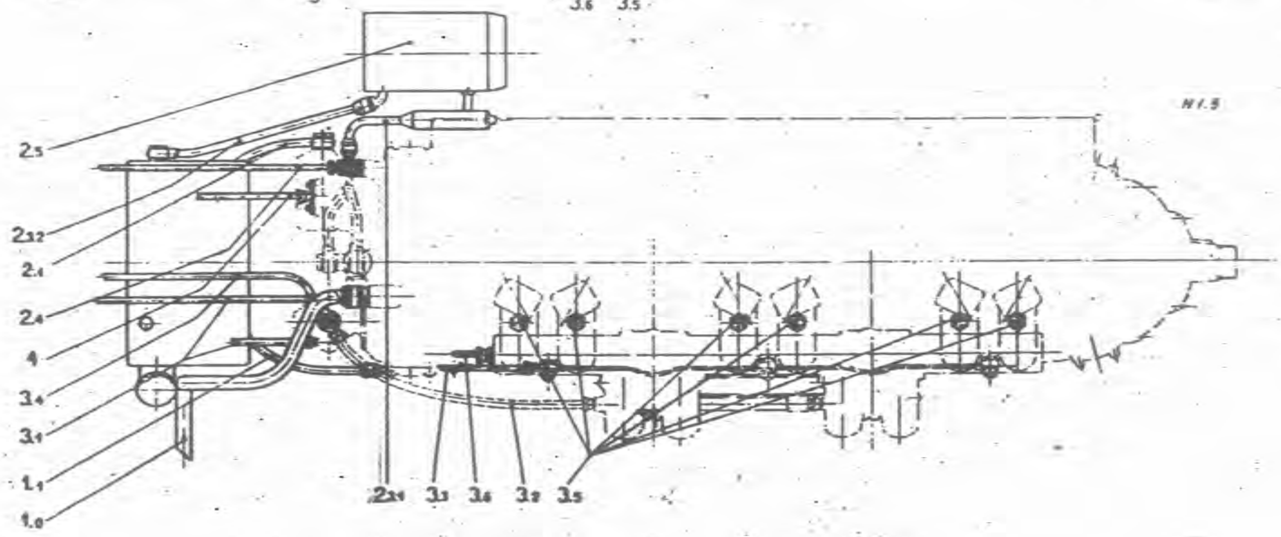


Details of Pipe and Speedometer Drive Unions are Shown on Drw. No. 3500331

Flexible Tubing Must Be Used Throughout For Pipe Connections Between Engine and Airframe

Chart IVa





Details of Pipe and Speedometer
Drive Unions are Shown on
Drw. No. 3500331

Flexible Tubing Must Be Used
Throughout For Pipe Connections
Between Engine and Air Frame

Chart IVb.

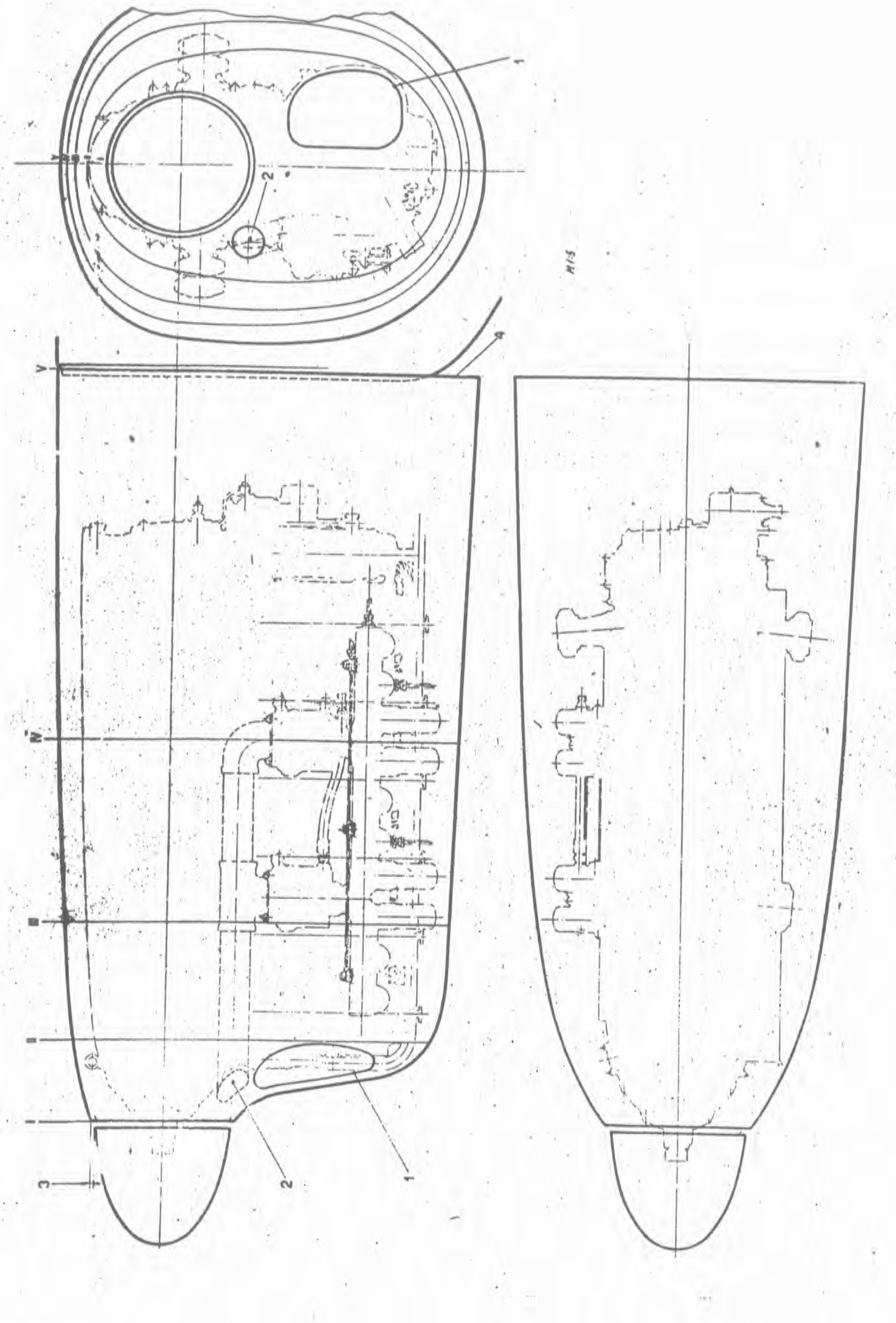


Chart V.

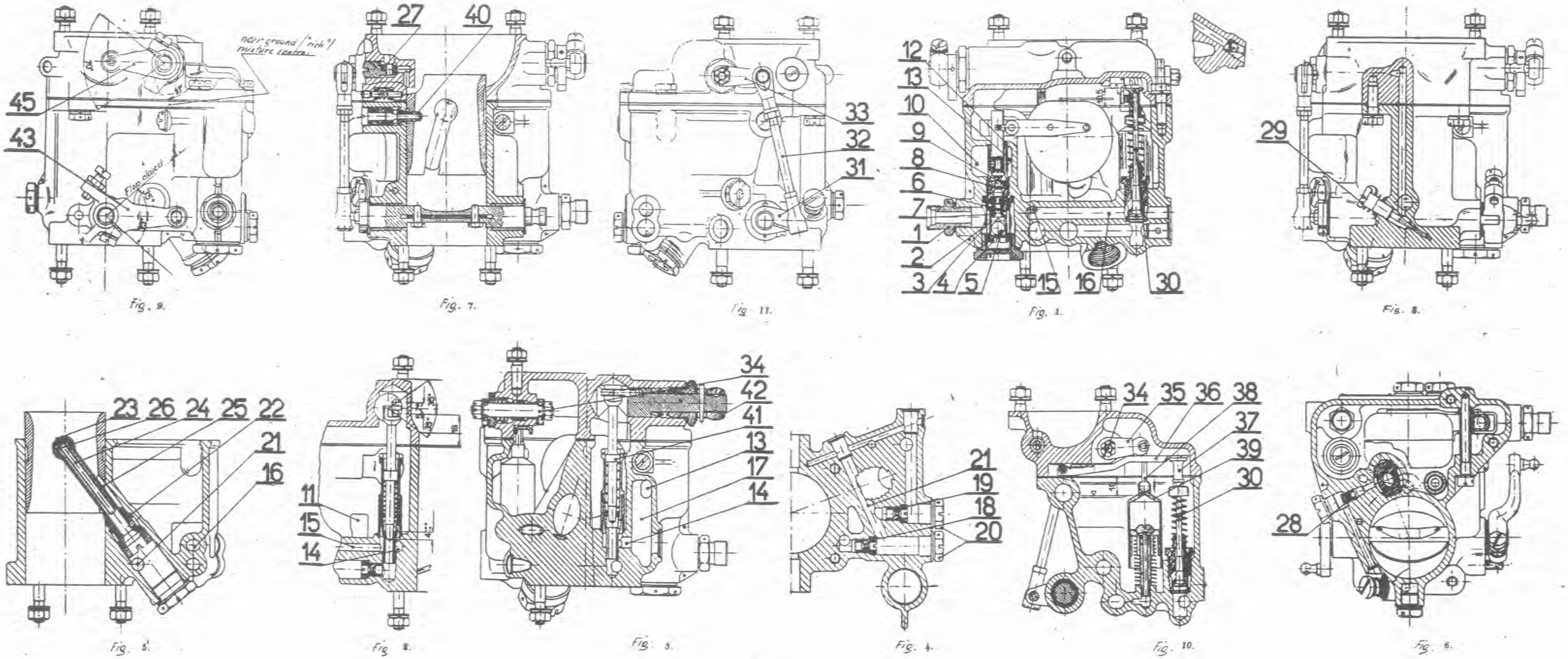

45
43
near ground ("rich") mixture control
Flap closed
Fig. 9.
27 40
Fig. 7.
33
32
31
Fig. 11.
12
13
10
9
8
6
7
1
2
3 4 5
15 16 30
Fig. 1.
29
Fig. 8.
23 26 24 25 22
21
16
Fig. 5.
11
15
14
Fig. 2.
34
42
41
13
17
14
Fig. 3.
21
19
18
20
Fig. 4.
34 35 36 38
37
39
30
Fig. 10.
28
Fig. 6.

Chart VI.

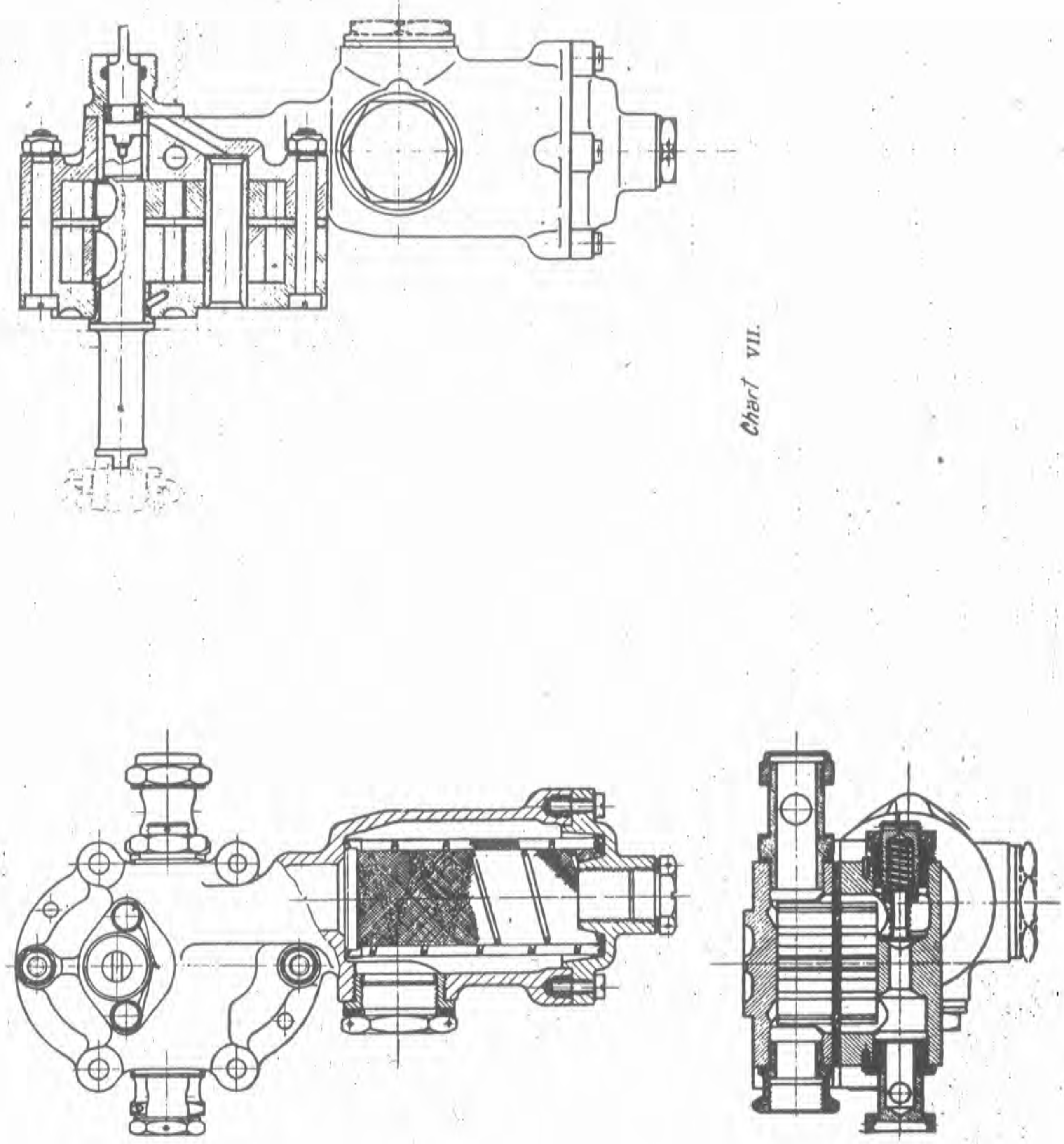


Chart VII.

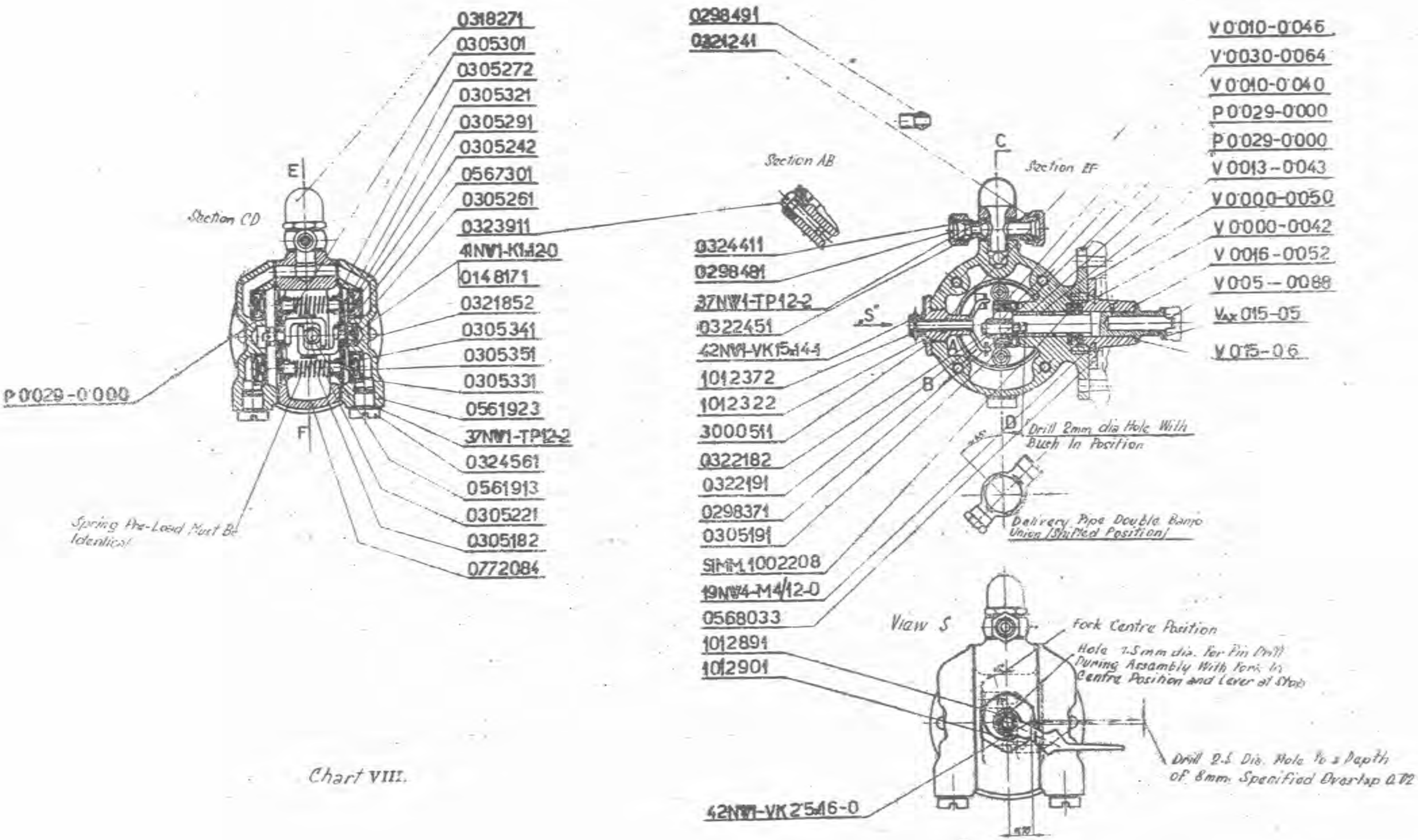
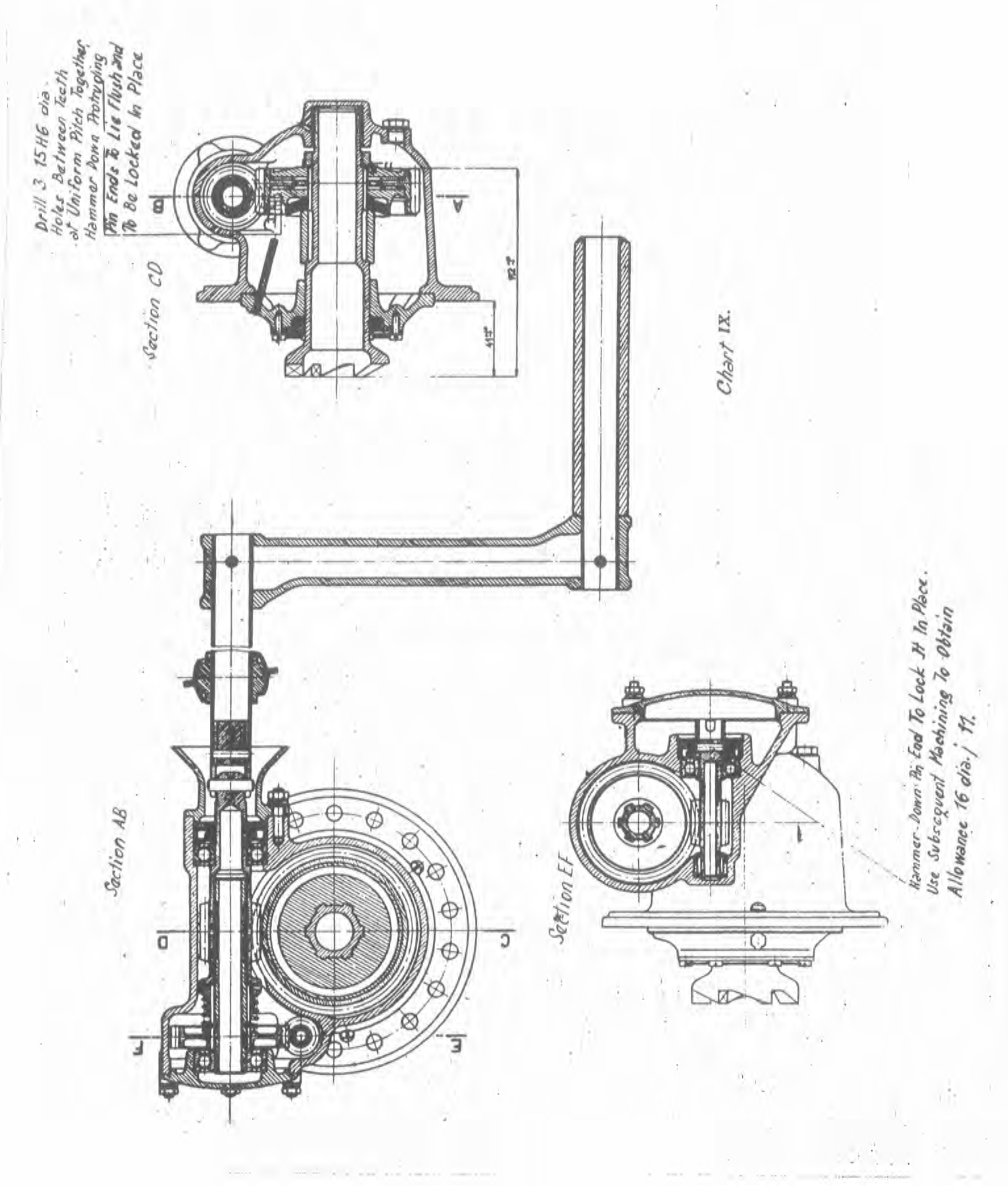

Section CD
E
F
P 0·029-0·000
Spring Pre-Load Must Be Identical
0318271
0305301
0305272
0305321
0305291
0305242
0567301
0305261
0323911
4NW1-K1,4-20
0148171
0321852
0305341
0305351
0305331
0561923
37NW1-TP12-2
0324561
0561913
0305221
0305182
0772084
0298491
0324241
Section AB
0324411
0298481
37NW1-TP12-2
0322451
42NW1-VK15,4-4-1
1012372
1012322
3000511
0322182
0322191
0298371
0305191
SIMM 1002208
19NW4-M4/12-0
0568033
1012891
1012901
42NW1-VK 2·5-46-0
S
A
B
C
D
Section EF
V 0·010-0·046
V 0·030-0·064
V 0·010-0·040
P 0·029-0·000
P 0·029-0·000
V 0·013-0·043
V 0·000-0·050
V 0·000-0·042
V 0·016-0·052
V 0·05-0·088
Vax 0·15-0·5
V 0·15-0·6
Drill 2mm dia Hole With Bush In Position
Delivery Pipe Double Banjo Union (Shifted Position)
View S
Fork Centre Position
Hole 1.5mm dia. for Pin Drill During Assembly With Fork in Centre Position and Lever at Stop
Drill 2.5 Dia. Hole To a Depth of 8mm. Specified Overlap 0.72

Chart VIII.


Drill 3. 15H6 dia. Holes Between Teeth of Uniform Pitch Together, Hammer Down Protruding Pin Ends To Lie Flush and To Be Locked In Place
Section CD
Chart IX.
Section AB
Section EF
Hammer-Down Pin End To Lock It In Place. Use Subsequent Machining To Obtain Allowance 16 dia.; f1.