

REPAIR MANUAL

FOR ROTAX ENGINES

TYPE 535

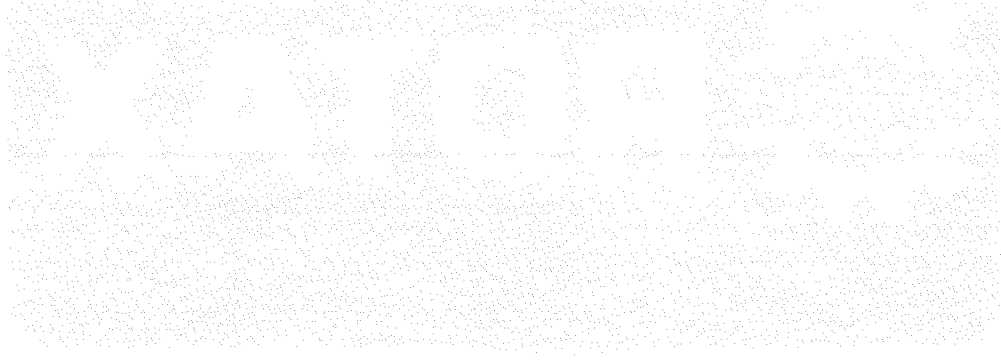
EDITION JULY 1984



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GENERAL REMARKS

This repair manual should give valuable hints to the professional and should make him acquainted with the particular characteristics of the engine.

Additional informations are given in the Operator's Manual and the Spare Parts List.

Important advice

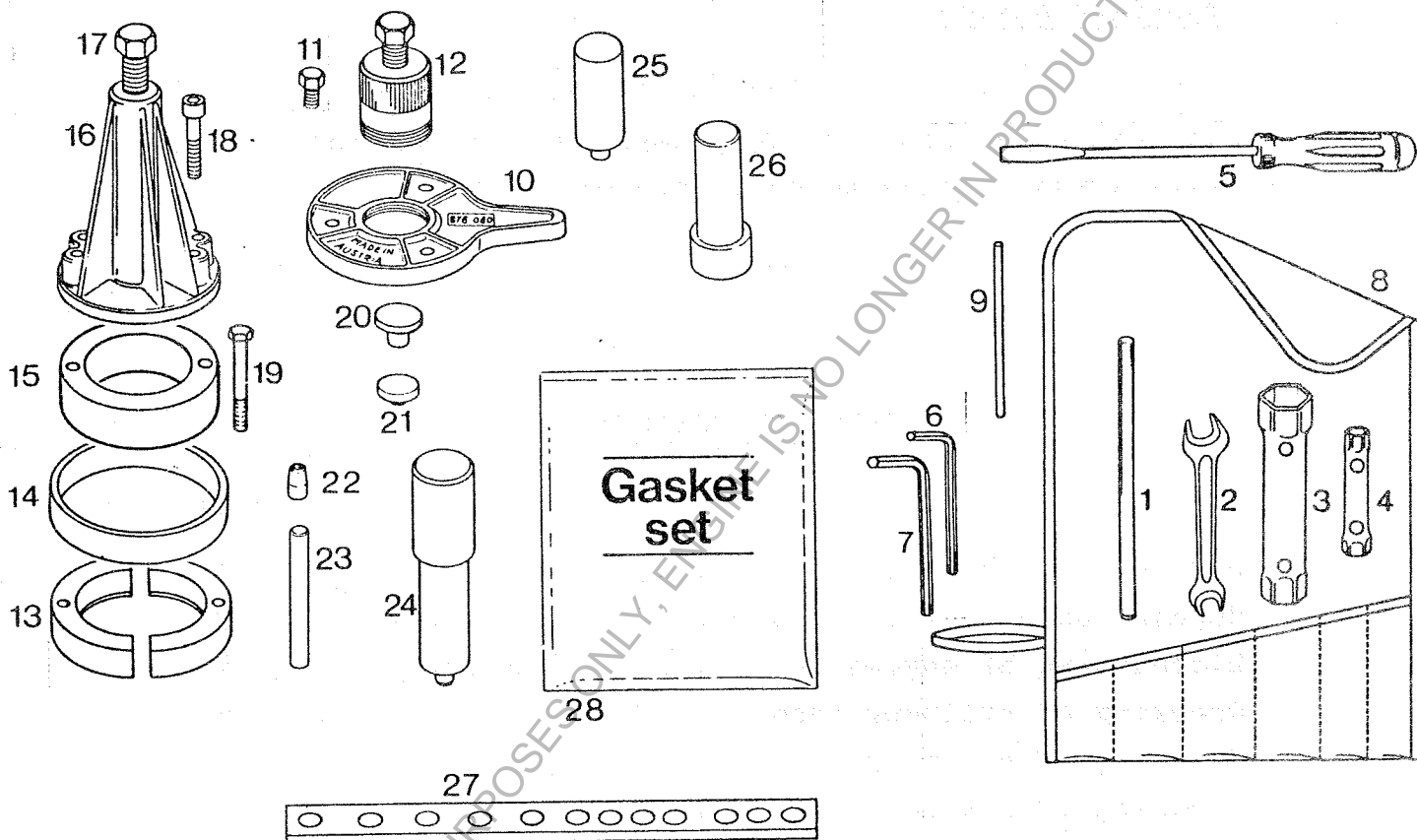
As this engine is used for motorized sailplanes, the national regulations of the competent Authorities for Civil Aviation have to be observed!

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REPAIR TOOLS

For professional repair, the proper tools are necessary. Apart from the tool kit supplied with the engine, the following special tools are necessary for repair of ROTAX engine type 535:



Ill. no.	part no.	d e s c r i p t i o n	qty
1-12	876 634	tool bag with tools	1
1	977 420	bolt 8 x 130 for socket wrench	1
2	276 065	forkwrench 10/13	1
3	876 212	socket wrench 21/26 mm	1

Ill. no.	part no.	d e s c r i p t i o n	qty
4	876 225	socket wrench 10/13 mm	1
5	876 200	screwdriver	1
6	277 790	hexagon socket screw key 4 mm	1
7	277 810	hexagon socket screw key 6 mm	1
8	876 195	tool bag	1
9	876 640	crankshaft fixation pin	1
10	876 080	magneto flywheel holder	1
11	940 581	hex. screw M8 x 16	3
12	876 065	puller assy. M42 x 1,5, magneto flywheel	1
13	977 470	ring half for ball bearing	2
14	977 490	ring for puller	1
15	876 567	distance ring for puller	1
16, 17	876 296	puller assy.	1
17	940 755	hex. screw M16 x 1,5 x 145	1
18	840 680	cyl. screw with int. hex. M8 x 40 for puller	2
19	841 200	hex. screw M8 x 70	2
20	876 550	protection mushroom for crankshaft, p.t.o. side	1
21	876 557	protection mushroom for crankshaft, magneto side	1
22	876 490	guide sleeve	1
23	876 610	extrusion jig	1
24	876 500	insertion jig for ball bearing	1
25	876 510	insertion jig for oil seal	1
26	876 600	insertion jig for oil seal	1
27	876 570	cylinder aligning tool	1
28	994 408	gasket set	1

Further tools required

Torque wrench - up to 150 Nm (1360 in.lbs)
 insert 30 mm fitting torque wrench
 fork wrench 22 mm
 socket wrench 13 mm fitting torque wrench
 rubber hammer
 hex. socket screw key 4 mm
 hex. socket screw key 6 mm
 screwdriver

DISMOUNTING OF ENGINE

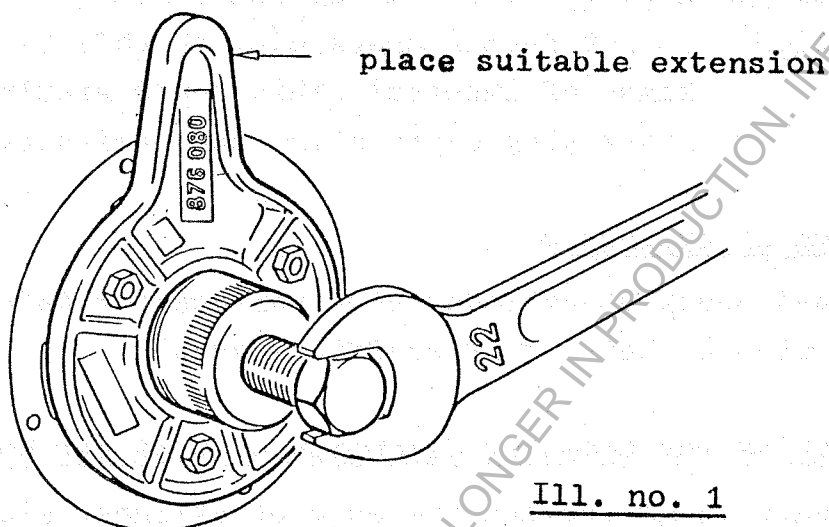
- 1) Clean engine before dismounting.
- 2) Disconnect fuel lines from carburetors.
- 3) Screw off carburetors and rotary valve cover (page 8, spare parts list)
Tool: Fork wrench 13 mm

Attention: Before removing the rotary valve, mark position on crankcase if original mark is no more visible (see also page 16).
- 4) Dismount exhaust manifold (page 6, item 15, spare parts list).
Remove adherent combustion deposits and oil carbon.
Tool: hex. socket screw key 6 mm
- 5) Screw off the cover washer (page 10, item 19, spare parts list).
Tool: Socket wrench 13 mm
- 6) Screw magneto housing fixation tool to the magneto housing with 3 hex. screws M8 x 16 (page 10, item 17, parts list).
Tools: Magneto housing fixation tool 876 080
 with suitable extension
 socket wrench 13 mm

CAUTION! Use of longer screws will result in coil damage!
- 7) Unscrew crankshaft nut, mag. side (page 4, item 8, in spare parts list).
Tool: Socket wrench 30 with extension (or torque wrench)
 Suitable extension for magneto housing
 fixation tool

- 8) Place protection mushroom on crankshaft and screw puller into magneto housing holder, then pull off the magneto housing (see ill. no. 1).

Tools: Protection mushroom (876 557)
puller for magneto housing (876 065)
fork wrench or socket wrench 22 mm



Ill. no. 1

ATTENTION: The magneto housing usually fits very tight. In case of difficulty, warm taper connection carefully up to 120°C and hit with a hammer on the screw of the puller. This helps to loosen the press fit on the crankshaft taper.

- 9) Mark armature plate position to crankcase for re-assembly. Screw off armature plate, remove cable grommet and connector housings and slip through wiring harness.

Tools: Chisel
hex. socket screw key 4 mm

- 10) Unscrew cylinder head nuts.

Tool: Socket wrench 13 mm

- 11) Mark cylinder heads, cylinders and pistons as they are paired.

- 12) Take off cylinder heads, cylinder head gaskets, cylinders and cylinder base gaskets.

13) Checking of cylinder head

- a) Remove adherent combustion deposits.
- b) Check for distortion of gasket surface.
- c) Check spark plug threads in cylinder head.

Caution: Do not repair spark plug threads by all kinds of inserts! This could result in spark plug overheating and preignition.

14) Checking of cylinders

- a) Visual check of cylinder bore surface for defects (scratches, seizing or scuffing marks).
- b) Checking the diameter dimension of cylinder bore

Measure 15 mm beneath the edge of cylinder sleeve, cylinder head side, and just above the exhaust port both in crankshaft direction and perpendicular.

Dimensions of bore in new cylinder

72 mm dia	0/+ 0,01 mm	for tolerance group red
72 mm dia	+ 0,01/0,02 mm	for tolerance group green

Wear limits:

72,20 mm dia

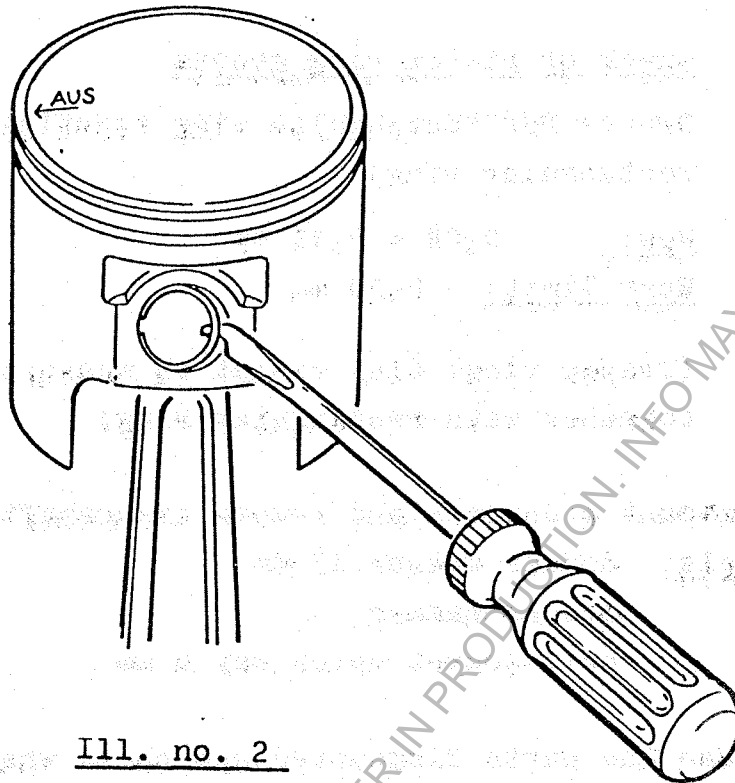
1st oversize is + 0,25 mm

2nd oversize is + 0,50 mm, tolerances as above

- 15) Cover opening in crankcase with a clean cloth.

- 16) Remove piston pin circlips (see ill. no. 2)

Tool: Small screwdriver, shaped as shown on ill. no. 2



Ill. no. 2

- 17) Push piston pins out by hand.

Tool: Suitable punch for piston pin.

ATTENTION: When pushing out the piston pin, the piston must be firmly held by hand to prevent bending of connecting rod!

- 18) Remove needle cage.

- 19) Checking of piston

- a) Piston crown: Remove carefully adherent combustion deposits.

- b) Checking of piston diameter

wear limit:

71,75 mm dia., measured in the area of piston pin bore, perpendicular to the piston pin axis.

- c) Check of piston rings

Piston ring gap (with piston ring inserted in new cylinder or in caliper ring).

New: 0,20 ÷ 0,35 mm

Wear limit: 1 mm

d) Check of piston ring groove

Groove for rectangular ring (vertical play of rectangular ring)

New: 0,04 ÷ 0,11 mm

Wear limit: 0,20 mm

(Trapez ring: Play cannot be measured, exchange together with rectangular ring)

20) **Dismount crankcase and remove crankshaft.**

Tools: Socket wrench 13 mm

rubber hammer

hex. socket screw key 6 mm

21) **Clean the parts dismounted and check whether they can be used again.**

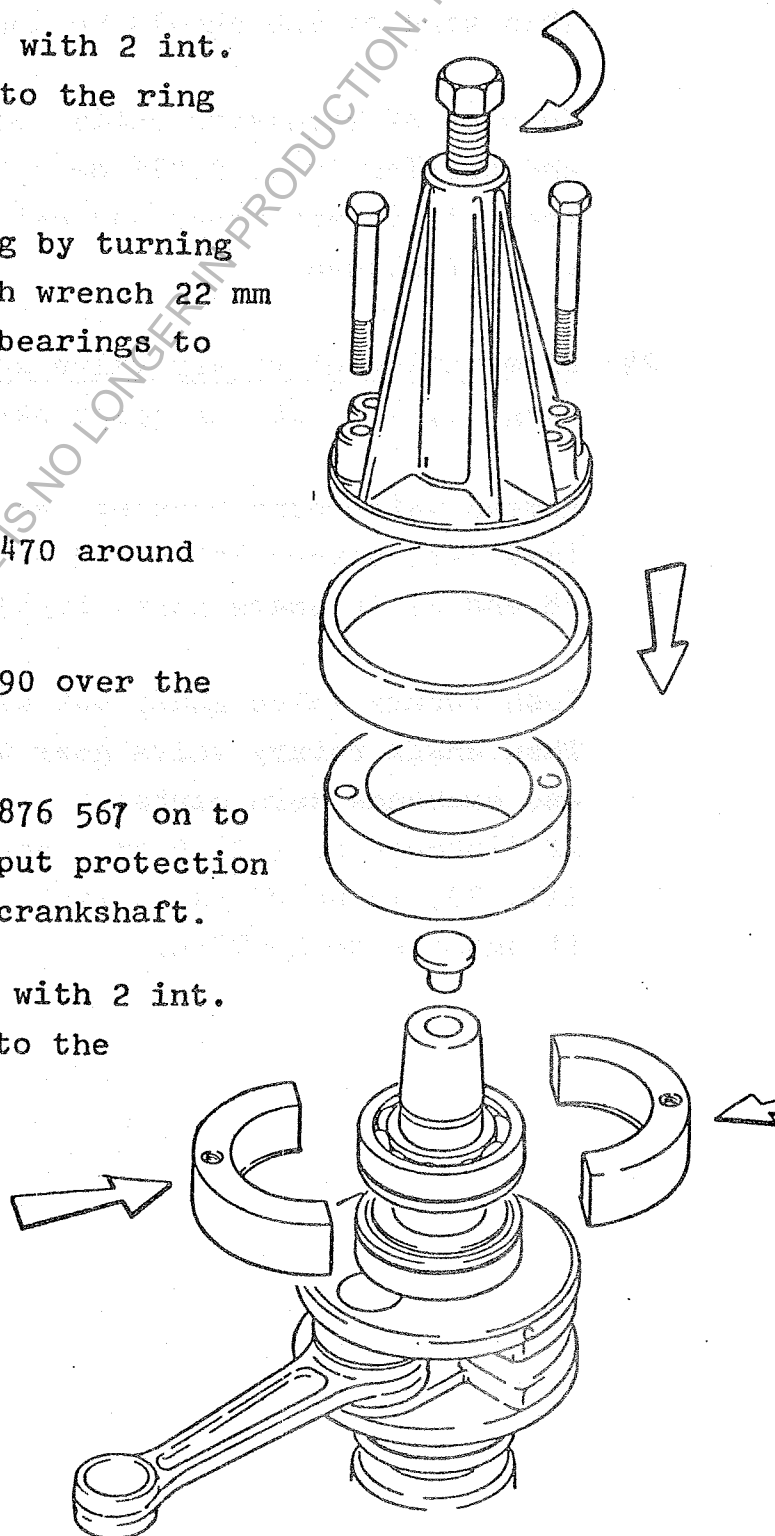
22) **Pull ball bearings off the crankshaft (ill. no. 3 shows power take off side of crankshaft).**

I) P.T.O. side (=power take off)

- a) Put ring halves 977 470 around the bearing.
- b) Put outer ring 977 490 over the ring halves.
- c) Place distance ring 876 567 on to the ring halves and put protection plug 876 550 on the crankshaft.
- d) Screw puller 876 296 with 2 int. hex. screws 841 200 to the ring halves.
- e) Pull off ball bearing by turning the puller screw with wrench 22 mm to the right. Allow bearings to turn while pulling.

II) Magneto side

- a) Put ring halves 977 470 around the bearing.
- b) Put outer ring 977 490 over the ring halves.
- c) Place distance ring 876 567 on to the ring halves and put protection plug 876 557 on the crankshaft.
- d) Screw puller 876 296 with 2 int. hex. screws 841 200 to the ring halves.
- e) Pull off ball bearing by turning the puller screw with wrench 22 mm to the right. Allow bearing to turn while pulling.



23) Checking the crankshaft

First check whether the 2 centering holes on the crankshaft are in order. If damaged, rework them. Place crankshaft between centers of a lathe or similar device and check crankshaft for centricity.

Maximum allowable run-out 0,08 mm (0,003 in) measured with dial gauge on the bearing seats. If run-out exceeds 0,08 mm (0,003 in), the crankshaft has to be re-aligned. This kind of job should be done by experts only.

In case of excessive radial clearance of the con rod big end bearing (max. 0,075 mm = 0,003 in.) or if the crankshaft is in any other way defective, the crankshaft has to be replaced.

24) Dismounting of rotary valve shaft (page 1, ill. 16, in spare parts list)

Remove water pump housing, securing nut M6, water pump impeller, rotary valve and circlip (ill. no. 39, 37, 35, 28 and 27 in spare parts list).

Push rotary valve shaft out with extrusion jig 876 610. Then check rotary valve gear 935 730, oil seal and bearing and exchange worn parts.

If distance tube 24,5 mm, part no. 847 280 (page 1, ill. 20, in spare parts list) has to be taken off, secure it again with LOCTITE.

ENGINE RE-ASSEMBLY

- 1) Remount rotary valve shaft, always using a new securing nut for water pump impeller.

Attention: The supporting ring 827 530 (page 1, ill. no. 15 in spare parts list) should point with its open side towards the leak oil bore.

Put ball bearing grease between the oil seals of water pump.

- 2) Crankshaft (p.t.o. side): First place radius shim on crankshaft and press on one of the ball bearings (back of cage showing towards crankblade, see spare parts list).

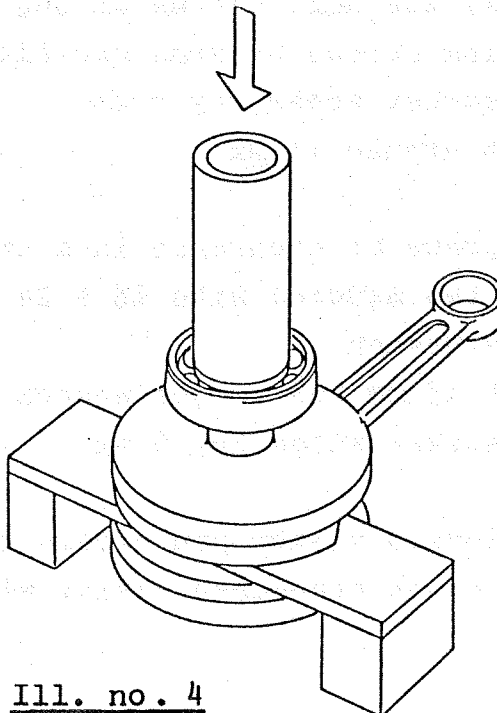
- 3) Mount labyrinth ring (page 4, item 11, in spare parts list), plane surface towards crankblade, then press on second ball bearing (with back of cage towards oil seal).

Check: O-ring groove of labyrinth and groove of ball bearing have to correspond with crankcase recesses.

Attention: Apply pressure only to inside ring of ball bearing. Use a suitable tube. In any case of pressing on ball bearings, place a mounting support between crankshaft blades (see ill. no. 4). The ball bearings have to be warmed up to $70 \div 80^{\circ}\text{C}$ ($160 \div 180^{\circ}\text{F}$) before pressing them on.

Gap between labyrinth ring and ball bearing: $0,2 \div 0,4 \text{ mm}$ ($0,008 \div 0,016 \text{ in.}$).

Tool: Suitable pressing device (hammer)



Ill. no. 4

4) Crankshaft (magneto side)

Place radius shim on crankshaft. Press on ball bearing (back of cage must show towards crankshaft).

Attention: O-ring groove in the outer ring of bearing must correspond with recess in crankcase.

5) Fill groove between oil seal lips with high melting point bearing grease, then mount oil seals.

6) Clean sealing surface of crankcase and warm crankcase up to $50 \div 60^{\circ}\text{C}$ ($120 \div 140^{\circ}\text{F}$), then place crankshaft in upper half of crankcase. Take care that the oil seals close up flush with outside of crankcase resp. fit in the crankcase groove.

7) Coat sealing surface of lower crankcase half thinly with LOCTITE 572 white or 515 red. Mount it on upper crankcase half, using a rubber hammer.

8) Screw on the armature plate provisionally.

Reason: The crankcase halves have to be pulled together into the correct axial position. If necessary, knock the crankcase halves in correct position with a rubber hammer.

Tool: Hex. socket screw key 4 mm

9) Tighten slightly the hex. screws of the crankcase, loosen the fixing screws of armature plate again.

Tool: Hex. socket screw key 4 mm
socket wrench 13 mm

10) Tighten hex. screws of crankcase in a cross sequence (starting from the middle) with $18 \div 24 \text{ Nm}$ ($160 \div 210 \text{ in.lbs}$)

Tools: Torque wrench
insert 13 mm for torque wrench
hex. socket screw key 6 mm

11) Lubricate and insert piston pin needle cages in connecting rod small ends, close crankcase cavity with a clean cloth.

- 12) Warm up piston to $40 \pm 50^{\circ}\text{C}$ ($100 \pm 120^{\circ}\text{F}$). Take care not to mix up the pistons, cylinders and cylinder heads paired together. Place piston over small end of connecting rod, the arrow on top of piston showing towards exhaust.
- 13) Insert guide pin for piston pin through the piston hole and connecting rod bore. Take care not to scratch the piston hole or to damage the needle bearing.
- 14) Coat piston pin with oil, place it on guide pin and insert it into the piston hole. All punch impact must be absorbed by your hand to avoid bending of the rod.

- 15) Secure piston pin with circlips.

Attention:

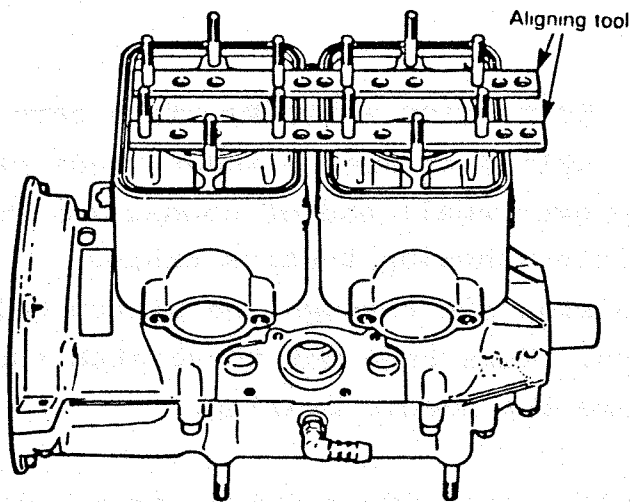
The circlips must engage in the grooves of the piston. Always use new circlips! Insert circlip in such a way that open ends are not over the rectangular slot of the piston, as otherwise the circlip would have to be turned when disassembling later on. Circlips must sit tightly in the groove.

Tool: Screwdriver shaped as shown on ill. no. 2.

- 16) Lubricate pistons and bring piston rings in correct position (securing pin between ends of piston ring).
- 17) Press piston rings into the grooves and push oiled cylinder over the piston.
- 18) Mount cylinder aligning tool on cylinders (see ill. no. 5). and fix cylinders with $20 \pm 24 \text{ Nm}$ ($180 \pm 210 \text{ in/lbs}$) in a cross sequence.

Remove cylinder aligning tool.

Tool: Cylinder aligning tool 876 570



Ill. no. 5

- 19) Fit cylinder head sealing rings and mount cylinder heads. Tighten hex. nuts M8 at $20 \div 24$ Nm ($180 \div 210$ in.lbs) in a cross sequence.

Tools: Torque wrench

insert 13 mm for torque wrench

- 20) Install wiring harness and mount armature plate so that marks on armature plate and crankcase correspond. If there are no marks on crankcase or armature plate, mount armature plate so that fastening screws are about in the middle of the slots of the armature plate.

Attention:

Check ignition timing on running engine at 3000 r.p.m. with a stroboscope. If necessary, correct position of armature plate.

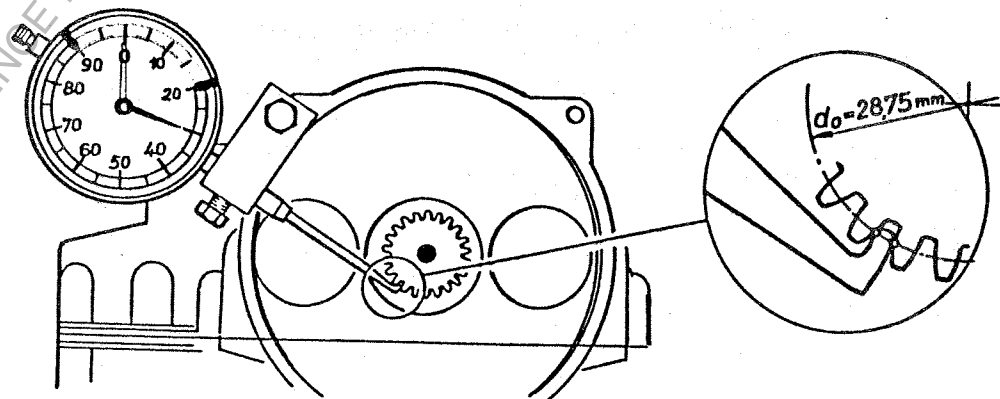
- 21) Fix armature plate with allen head screws and insert cable grommet.

Tool: Hex. socket screw key 4 mm

- 22) Mount Woodruff key on crankshaft taper.

- 23) Clean crankshaft taper and taper in magneto housing with degreasing agent (e.g. trichloroethylene).

- 24) Coat crankshaft taper with LOCTITE 242 blue (899 786).
- 25) Mount magneto housing assembled with magneto ring and starter gear on the crankshaft.
Attention: Before mounting magneto housing with magneto ring on the crankshaft, take care that the ignition unit and especially the magnets are clean and free of foreign material.
- 26) Secure thread of hex. nut M22 x 1,5 with LOCTITE 242 blue, 899 786, and tighten hex. nut with torque 140 Nm (1200 in.lbs).
Tools: Torque wrench
insert 30 for torque wrench
magneto housing fixation tool 876 080
with suitable extension or
fixation bolt 876 640 to prevent turning of crankshaft
- 27) Check resp. adjust ignition (see Operator's Manual).
- 28) Fasten exhaust manifold with gaskets.
Tool: Hex. socket screw key 6 mm
- 29) Checking of gear play of rotary valve drive on rotary valve shaft:
Correct play: $0,2 \div 0,9 \text{ mm}$ ($0,008 \div 0,035 \text{ in}$)



30) Adjustment of rotary valve timing

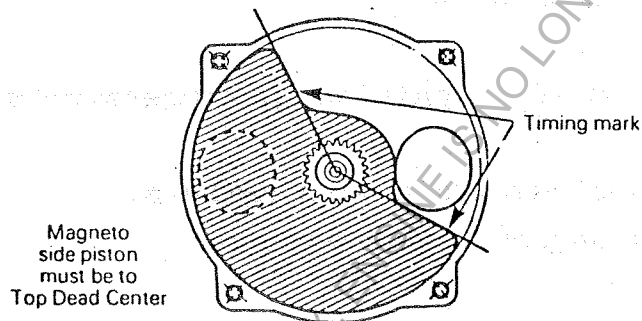
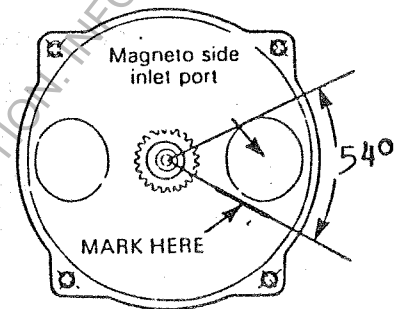
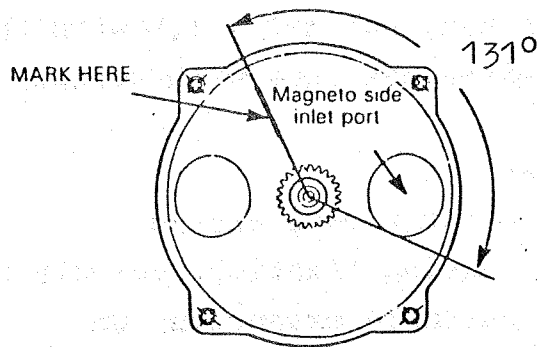
Place magneto side piston to top dead center.

Put rotary valve over the respective mark.

If no mark exists:

Place magneto side piston to top dead center.

Make marks as shown on ill. no. 6.



Ill. no. 6

Then mount rotary valve so that best possible correspondence with mark is achieved. If necessary, turn over the rotary valve to achieve that.

CARBURETOR

2 Tillotson carburetors HR 177

A) General

- 1) The diaphragm carburetor works in all positions and has proven most efficient due to its simple construction.
- 2) The carburetor has to be fed by a fuel pump. A filter has to be placed in the fuel line before fuel inlet into the carburetor (nipple with big bore) to avoid clogging of needle valve and jet. Take care that pump capacity is sufficient (35 litres per hour).
- 3) The return line remains closed.
- 4) The fuel inlet flow is regulated by a diaphragm controlled, guided needle valve.
- 5) The control of fuel flow is provided by a fixed main jet (size see manual page 5). The jet is inside the plug screw besides the "H" cast on the carburetor body and is effective particularly at full load operation.
- 6) The adjustable idle jet tommy screw besides the "L" cast on the carburetor body has influence on the idle run and essentially on the part-load operation.
- 7) The idle r.p.m. is regulated by the idle speed regulating screw which adjusts the throttle valve lever (see manual page 11, par. 8.8).
- 8) For easier starting there is a choke. When starting a cold engine, the choke has to be fully closed. During operation it has to be open.
- 9) The requested operational r.p.m. is regulated by the throttle valve.
- 10) The 2 carburetors have to be set simultaneously as regards idle speed and throttle valve position.

B) CARBURETOR ADJUSTMENT

1) Idle r.p.m.

See Operator's Manual, page 11, par. 8.8

2) Setting of adjustable idle jet "L"

Recommended setting

Screw the jet (tommy screw) out by 1/2 to 5/8 turn.

If engine operation is too lean at part load, turn further out (1/8 turn to the left).

If engine operation is too rich at part load, turn jet further in (approx. 1/8 turn to the right).

- 3) The fixed main jet must not be changed without approval by the engine manufacturer resp. the competent aviation authorities.

C) CLEANING THE CARBURETOR FROM DIRT PARTICLES

(for illustrations see parts list no. 448, page 12)

1) Dismounting

Screw off cover (11), loosen carefully diaphragm and gasket (9 and 10), loosen screw (23). After removal of the inlet control lever (21, 22), the needle valve (24 and 25) can be taken out. After removal of main jet (17, 18, 19, 20) and the idle jet (13, 14, 15, 16), the carburetor can be cleaned with fuel and compressed air.

2) Re-mounting

When remounting the carburetor, particular care has to be taken of the sealing elements (9, 15, 16, 18, 20, 25) and spring (26). After installation of the inlet control lever (21) and of the needle valve (24), the needle valve must move freely (without tendency of sticking). Exchange defective parts.

3) Needle valve test

Pressurize fuel inlet gradually with air. The needle valve has to keep pressure up to $8 \div 10$ psi ($0,5 \div 0,7$ bar), then air is released suddenly.

When fixing the fuel line, take care that no dirt gets into the tubes.

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D) CARBURETOR - TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE OF DEFECT	REMEDY
Carburetor too "rich" (carburetor supplies too much fuel)	Dirt in needle valve	Cleanas per C)
	Needle valve sticking (ill. 24)	See C 2) and C 3)
	Spring for inlet control lever jumped out (ill. 26)	Replace spring
	Regulating diaphragm (ill. 10) defective or mounted incorrectly	Mount as shown in parts list or replace
	Choke (ill. 7) closes by itself	Repair choke indexing
	Pressure builds up in the fuel tank	Check tank vent
	Regulating lever (ill. 21) bent	Bend it straight or replace it
Carburetor too "rich" at operation in high altitudes (aerodrome above 1500 m = approx. 4500 feet sea level)		Use smaller main jet

Engine does not accelerate (does not accept gas)	Idle fuel/air mixture too lean / (rich)	Turn idle jet (idle regulating screw, ill. 13) out (in) by approx. 1/16 - 1/8 turn
	Carburetor loose on intake manifold, gasket between carburetor and intake manifold leaking	Seal carburetor connection, tighten carburetor fixation
	Carburetor cover (ill. 11) loose	Tighten resp. seal carburetor cover
	Gasket (ill. 9) defective	Exchange gasket
	Fuel passages and fuel lines clogged, jets and needle valve dirty	Clean carburetor and fuel lines
	Regulating lever (ill. 21) bent	Bend it straight or replace it
	Lack of fuel	Refill tank

Bad or no idle run of engine	Wrong carburetor regulation	Ajust carburetor as per B)
	Carburetor passages clogged	Clean carburetor as per C)
	Regulating lever (ill. 21) bent	Bend straight or exchange
	Needle valve or regulating lever clamping	Clean or replace
	Throttle valve doesn't close and causes too high idle r.p.m.	Adjust throttle valve and actuation elements
	Plug washer (ill. 2) not closing hermetically	Seal or replace
	Vent bore in carburetor cover (ill. 11) blocked	Clean
	Tank ventilation not functioning	Clean or repair

Engine operation too lean	Fuel line (inlet) clogged	Clean
	Fuel line between tank and fuel pump leaking	Seal fuel line or replace it
	Fuel pump doesn't supply sufficient fuel	Check flow passage as per A 1)
	Fuel passages in carburetor clogged	Clean as per C)
	Filter clogged	Install new filter
	Idle speed regulating screw incorrectly set	Check adjustment as per B 2)
	Regulating lever (ill. 21) bent	Bend it straight or replace it
	Too little fuel in the tank	Refill with fuel
Carburetor supplies too much fuel (engine operation too "rich"), although idle speed regulating screw is fully closed	Plug washers (ill. 2) not sealing	Seal or replace
	Carburetor adjustment too "rich"	See paragr. 1 of carburetor trouble shooting chart

IGNITION UNIT

BOSCH - magneto generator SCPK 422, 12V 100W

Engine type 535 has 2 independent ignition circuits. It is equipped with a BOSCH electronic C.D. ignition unit with magneto generator for alimentation of the electrical system of the aircraft.

The ignition unit is adjusted by the engine manufacturer. If for any reason there are troubles, proceed for trouble shooting as follows:

- 1) The cut-in r.p.m. (i.e. when the ignition unit gives the first sparks) is approx. 300 1/min. Therefore the battery must be sufficiently charged to achieve at least the above minimal cranking r.p.m. (normal cranking r.p.m. with fully loaded battery is approx. 500 1/min.)
- 2) Shorting cables (black cables) must not have mass connection when ignition switch is at position "ON", neither must they have connection one with the other. Check ignition switch and cables.

Check for good mass connection of electronic box with engine crankcase.

- 3) For further trouble shooting, the connectors of electronic box 1 should be interchanged with those of electronic box 2. If the defect then appears on the other ignition circuit, one of the electronic boxes is defective and has to be replaced. Which box is defective can be found out by alternatively short-circuiting the shorting cables (black) with mass directly on the electronic box.
- 4) If the defect remains when interchanging the electronic box connectors on one of the ignition circuits, the defect is on the trigger coil(s) or charging coil(s).

To check: Pull out connecting plug from the electronic box, turn ignition switch to position "ON", measure the resistance:

- a) of charging coil: between the white resp. white-red cable and engine mass; there should be a resistance between 250 and 400 ohms;
- b) of trigger coil: between the white resp. white-red cable and engine mass. There should be a resistance between 50 and 90 ohms.

Charging coils can be replaced one by one. If the trigger coils are defective, the whole armature plate has to be replaced.

In the latter case, check the ignition timing and correct, if necessary, by turning the armature plate accordingly.

The ignition timing should be $1,36 \pm 0,25$ mm B.T.D.C., checked with a stroboscope at 3000 (± 200) r.p.m. The timing is correct when the mark on the starter gear corresponds with the mark on the crankcase (exhaust side).

Starting and operating the engine with spark plug protector taken off can damage the electronic box. Check for spark only with spark plug fitted and spark plug body having mass connection.

5) Generator

If battery does not load:

Check all connections on the rectifier-regulator, in particular

- a) the connection between the rectifier-regulator housing (resp. the black cable) and the minus-pole of the battery, and
- b) the connection between the black (resp. red) cable of the rectifier-regulator and the plus-pole of the battery.

Check fuse in between.

Disconnect the yellow cable(s) from the rectifier-regulator and test the coil resistance of the light coil (resistance approx. 0,2 ohms). There must not be any connection between one of the yellow cables and mass (resistance ∞).

If with the forementioned tests no defect can be discovered, the rectifier-regulator is defective and has to be replaced.

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