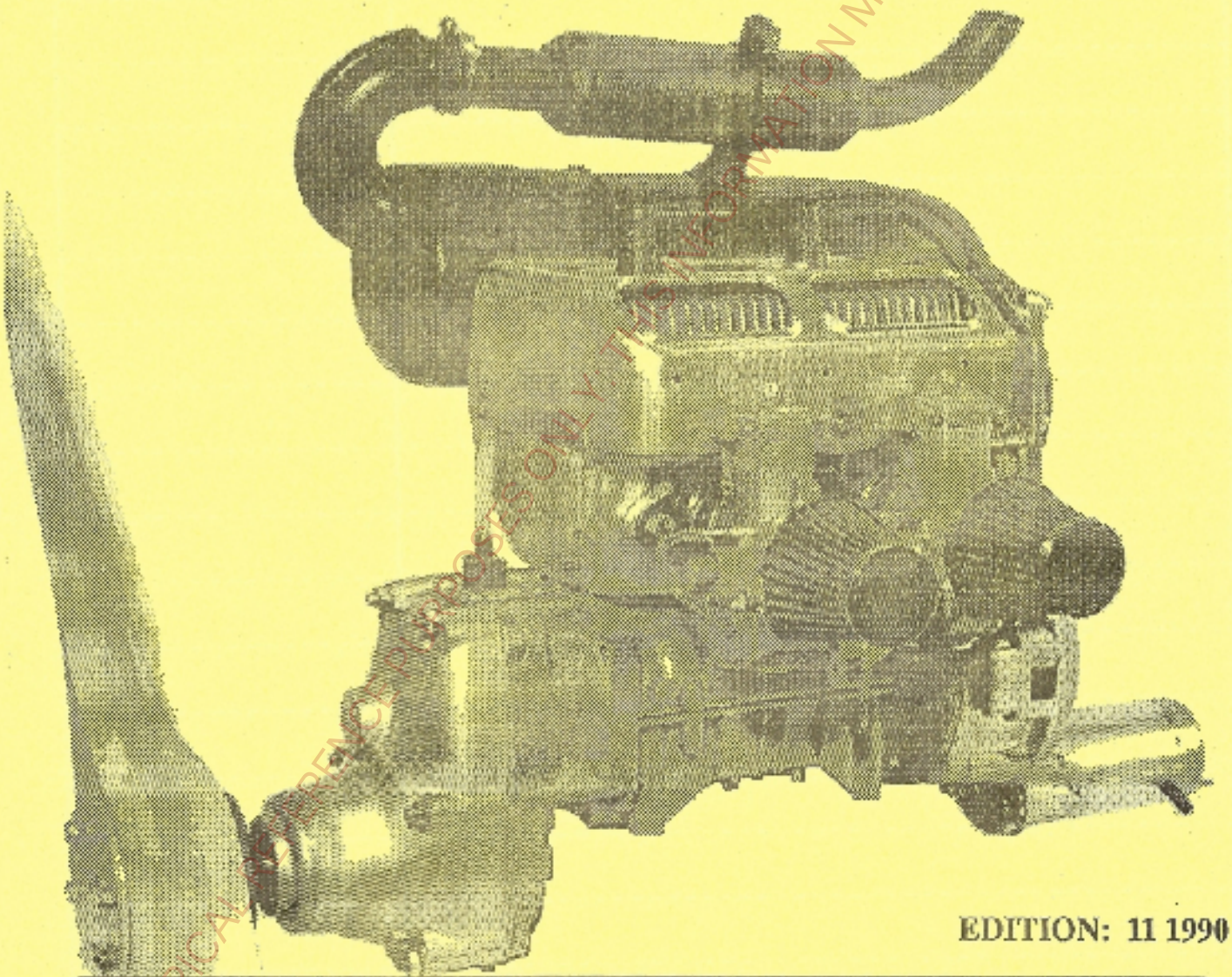
ROTAX.

OPERATOR'S MANUAL
ENGINE TYPES
377 - 447 - 503 UL

equipped with
contact breaker ignition system
and BING carburetor



EDITION: 11 1990

This manual contains important safety and maintenance information concerning your engine. It must remain with the engine at time of resale.

Modifications or special applications	Date

Index

Danger!

This engine, by its design, is subject to sudden stoppage! Engine stoppage can result in crash landings. Such crash landings can lead to serious bodily injury or death.

Never fly the aircraft equipped with this engine at locations, airspeeds, altitudes, or other circumstances from which a successful no-power landing cannot be made, after sudden engine stoppage.

Warning!

Although these engine types have undergone considerable durability testing, this engine is not a certified aircraft engine. It has not received any individual safety or durability testing and conforms to no aircraft standards. It is for use in experimental and ultralight uncertified aircraft and vehicles only, in which an engine failure will not compromise safety.

User assumes all risk of use and acknowledges by his use that he knows this engine is subject to sudden stoppage.

Section 1

1) Important preface:

Safety is everyone's business. We have included some of the important safety tips here, but the list is not complete. It would be impossible to list every way in which one may be injured. Please note the following symbols thrpughout the book:

▲ - SAFETY WARNING: Failure to obey a safety warning may result in injury to you or others.

■ -- INFORMATION vital to the operation or maintenance of your product (this should also be considered necessary for safety).

1.1) General safety points:

▲ - Never mix fuel in an enclosed area, or where fumes could reach an ignition point.

▲ - Make sure all engine controls are operative, that you know ON and OFF positions of throttle and ignition, that they are easily accessible, and that you can operate them instinctively without hesitation.

▲ - Never refuel if fuel could be spilled on hot engine components. Use only safety approved fuel containers and never transport fuel in an unsafe manner.

▲ - Check engine suspension frequently as well as the drive components, fuel lines, wiring, and fuel and air filters.

▲ - Check for fuel contamination, air vents, etc. Protect engine while not in use from any contamination entering fuel or carburetion system, but be sure to remove storage protection before starting engine.

▲ - Maintain your engine in top coudition and assume it's going to quit running at any time. Leave yourself a way out in the event of unexpected failure.

▲ - Never run the engine on the ground with the propeller turning, unless you are doing so in a run up area and can observe anyone or anything entering the danger area. An observer in a safe place is a definite asset.

▲ - Never leave your aircraft or other vehicle unattended while the engine is running. If operated by someone else you could be sued even if the use was unauthorized by you.

▲ - Keep an engine log and enter any unusual engine behaviour. Do not fly unless you have corrected a given problem and recorded the correction in the log.

Section 2

2) Foreword:

The ROTAX engine is an air-cooled 2-stroke engine. Careful and extensively tested design and rugged construction as well as the use of high quality parts increase reliability and durability. With proper maintenance and care and with the use of suitable fuel and oil the engine should give you good service for many years.

The ROTAX design incorporates the latest technical developments.In order to take advantage of future developments we reserve the right to make modifications in the ROTAX design without notice.

■ NOTE: All fasteners are metric with the exception of the internal thread of the P.T.O. crankshaft which is 1/2" national fine thread, and certain pipe fittings. It is to your advantage to read this manual carefully for the protection of your engine. There may be significant differences from other types of two cycle engines you may have worked on.

■ Always use genuine ROTAX parts.

■▲ Never run engine without proper loading, e.g. correct propeller. Refer section 18.

Section 3

3) Fuel and oil:

▲ Fuel contamination is a major cause of engine failure. The best place to avoid contamination is at the source. Once in your fuel container, a very harzadous potential exists.
Use a clean safety approved storage container. Filter all fuel entering and leaving this container. Do not over-fill container, allow for expansion.

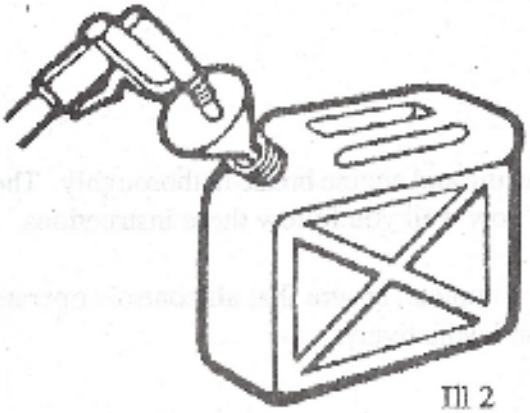
▲ WARNING: Gasoline is flammable and explosive under certain conditions. Always perform procedures in a well ventilated area. Do not smoke or allow open flames or sparks in the vicinity. Never add fuel while engine is running.

■ Refer to technical data. The engine is designed to operate a fuel mix with 2 % oil. Be sure to use products of at least the standard shown in the technical data section.
If the engine is to be used inverted (with spark plugs pointing down) select a lubricant which features low carbon deposits. Oil residue tends to drain to low points, i.e. spark plug cavities. If this residue fails to burn clean during normal operation, plug fouling will occur, possible pre-ignition also. Manufacturers of suitable lubricants will guarantee their products in writing.

▲ Do not use fuel which has been stored for a long period of time.

▲ Do not leave fuel exposed to sunlight in translucent containers.

3.1) Mixing procedure:



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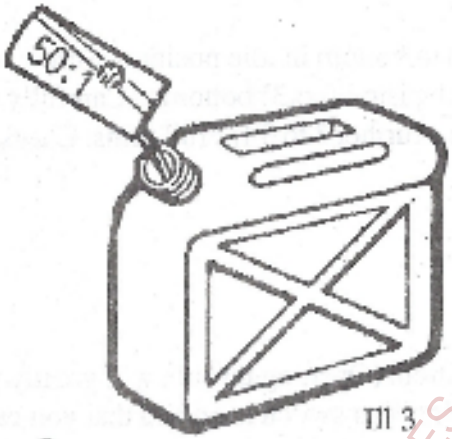
STEP no. 1: Use a clean approved container of known volume. To help predilute the oil, pour a bit of fuel into the container.



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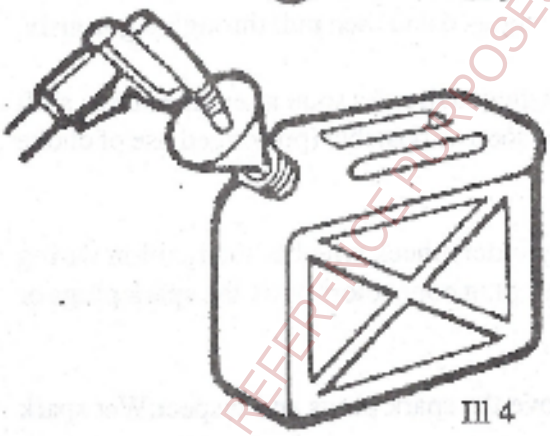
STEP no. 2: ■ Fill known amount of oil into container. Oil must be approved for air cooled engines at 50:1 mixing ratio. Agitate slightly to dilute oil with gasoline.



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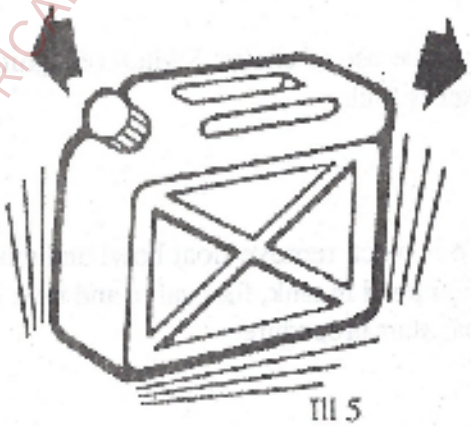
STEP no. 3: Add gasoline to obtain desired mixture ratio (use fine mesh screen).

■ Fuel must be of minimum M.O.N. 83 or R.O.N. 90 octane rating.



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STEP no. 4: Replace container cap and shake the container thoroughly. Then using a funnel with a fine mesh screen to prevent the entry of water and foreign particles, transfer mixture from container into the fuel tank.

Section 4

4) Starting procedure:

4.1) Pre-start check:

Before starting engine read section dealing with starting and engine break-in thoroughly. The service life of the engine is largely determined by how well you follow these instructions.

▲ Before starting engine be sure your installation is complete, ensure that all controls operate easily and smoothly, and that you can operate them instinctively.

▲ Always ensure that you are in a safe run-up area.

■ Ensure throttle linkage allows piston valve in carb to bottom in idle position. Screw out idle speed adjustment screw (no.14, section 7) until carb piston (no.3) bottoms. Carefully turn in adjustment screw until it engages piston and turn in a further 3 to 3 1/2 full turns. Check if fuel line is connected and tank vent is open.

4.2) Procedure:

On cold engine apply choke fully. Ensure idle position. (Opening throttle will greatly reduce choke effect resulting in hard starting). Make sure ignition switch is on and that you can shut it off instantly if necessary. Pull starter until firmly engaged and then pull through vigorously.

Above procedure should be repeated until engine begins to fire. As soon as engine starts, shift the throttle slowly to low speed and remove choke as soon as possible (prolonged use of choke can cause engine to flood.)

If the engine fails to start or operates only on one cylinder, check whether the ignition wiring is disconnected or incorrectly connected to the spark plug connectors or to the spark plugs or the ignition switch is in OFF position.

If preceding checks do not solve the problem, remove the spark plugs and inspect. Wet spark plugs indicate a flooded engine.

To correct, replace with dry plugs and discontinue use of choke. Switch off ignition. Crank engine with throttle fully open to clear the excess fuel.

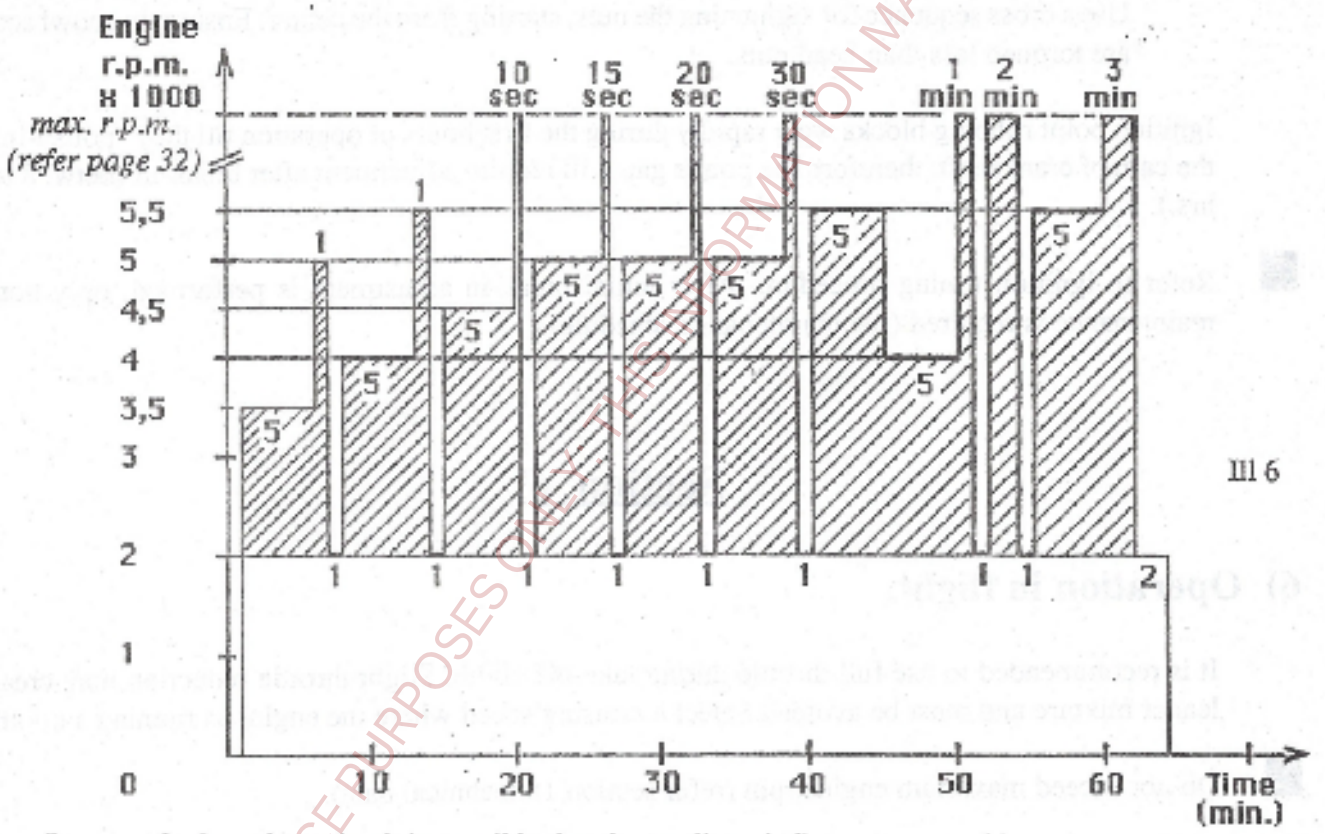
Repeat start procedure.

Dry spark plugs indicate no fuel in engine. To inspect, remove float bowl and ensure fuel is present in sufficient quantity. If not, inspect fuel level in tank, fuel valve and tank vent. Look for blockage or obstruction. Correct and repeat start procedure.

5) Break-in procedure:

for aircraft installation (in other applications proceed accordingly)

The break-in has to be performed with the engine installed, properly loaded, i.e. propeller installed, matched for max. r.p.m. In case of an aircraft, anchor the plane to the ground. Run the engine according to the following graph:



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▲ In case of a free air engine it is possible that the cooling air flow on ground is not enough to provide the necessary cooling for a longer period. Therefore it is necessary to observe carefully the cylinder head temperature (CHT) during break in procedure to avoid overheating. Before exceeding the maximum allowed CHT of 250 °C / 480 °F interrupt the run-in and cool down the engine at idle for approximately one minute and continue where you have interrupted.

▲ Be sure to use a safe run-up area, to anchor aircraft at those points approved by the airframe manufacturer, and to have someone present who is able to shut off the engine instantly and to prevent unauthorized people entering the danger area.

▲ Proper clothing, ear protection etc. should be used on any engine run-up test.

■ After this procedure the idle has to be adjusted. Then short take-offs can be conducted. After a few short full-load take-offs, but not later than 2 hours total running time, the cylinder head nuts have to be re-torqued to 22 Nm (195 in.lb.). For this procedure the cylinder cowl (if any) has to be taken off.

■ Engine must be cool for re-torquing of head.

Diagram for torque sequence when manifolds are in place

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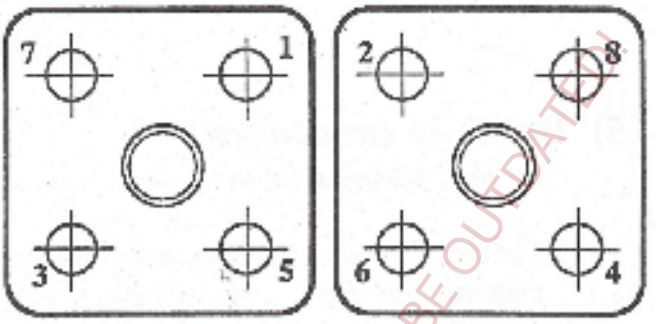


NOTE: Consider both cylinders as one unit because they are joined by exhaust and intake manifolds. Use a cross sequence for tightening the nuts, starting from the center. Ensure that cowl screws are torqued less than head nuts.

Ignition point rubbing blocks wear rapidly during the first hours of operation till they "polish-in" on the cam of crankshaft, therefore the points gap will require adjustment after break-in (betw. 8 to 20 hrs.).

■ Refer to ignition timing procedure. After initial break-in adjustment is performed, only normal maintenance is required (see maintenance schedule).

Section 6

6) Operation in flight:

It is recommended to use full throttle during take-off climb. Slight throttle reduction may create a leaner mixture and must be avoided. Select a cruising speed where the engine is running smooth.

■ Do not exceed maximum engine rpm (refer section 18 technical data).

During cruise and descending it is very important not to create a lean condition with high rpm and low throttle opening. The less fresh charge the engine gets, the more hot residual gas remains in the cylinder. This raises the temperatures to a critical level. For this reason, you may also experience higher exhaust gas and cylinder head temperatures at reduced throttle openings.

Idling r.p.m. is 2000 minimum. High idle setting will reduce enrichment action of starting system in carburetor (choke), making cold starting difficult.

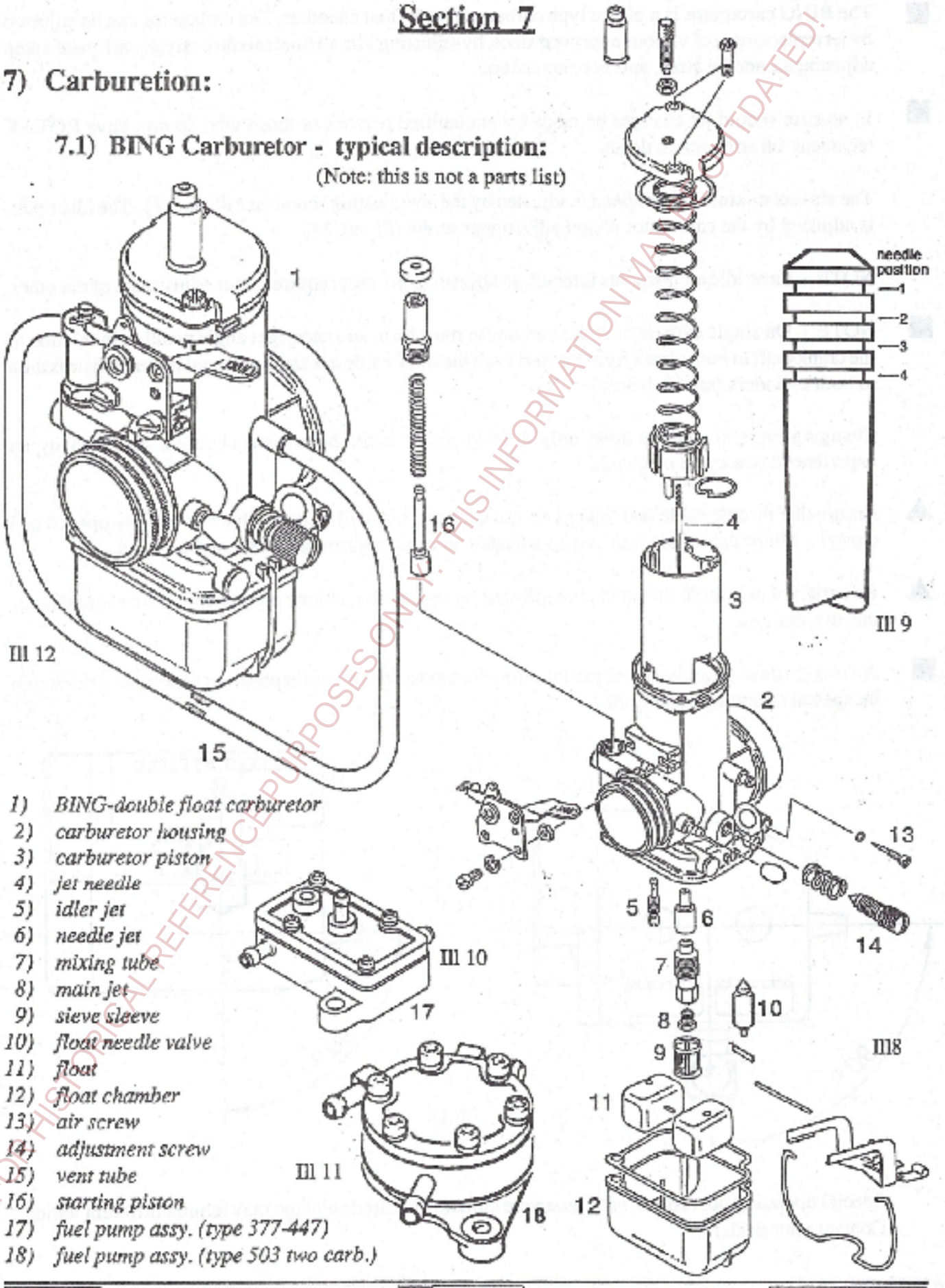
Prior to shutdown, engine should be run for a few minutes at the lowest smooth running r.p.m. to cool down, depending on previous power setting.

Do not idle for prolonged periods as normal rich condition at this power setting can cause unnecessary carbon deposits and spark plug fouling. Avoid running conditions where gearbox shaking occurs.

7) Carburetion:

7.1) BING Carburetor - typical description:

(Note: this is not a parts list)



1) *BING-double float carburetor*
2) *carburetor housing*
3) *carburetor piston*
4) *jet needle*
5) *idler jet*
6) *needle jet*
7) *mixing tube*
8) *main jet*
9) *sieve sleeve*
10) *float needle valve*
11) *float*
12) *float chamber*
13) *air screw*
14) *adjustment screw*
15) *vent tube*
16) *starting piston*
17) *fuel pump assy. (type 377-447)*
18) *fuel pump assy. (type 503 two carb.)*

■ The BING carburetor is a piston type carburetor with float chamber. The carburetor can be adjusted by jet replacement of various approved sizes, by adjusting idle air/fuel mixture screw, carb piston stop adjustment, needle sizes, and needle position.

■ In no case should jet changes be made by unqualified persons or those who do not have ROTAX technical information to do so.

The air/fuel mixture at idle speed is adjusted by the air adjusting screw (see ill. no. 13). The idle r.p.m. is adjusted by the carburetor piston adjustment screw (ill. no. 14).

NOTE - these idle adjustments interact, so adjusting one may require minor adjustment of the other.

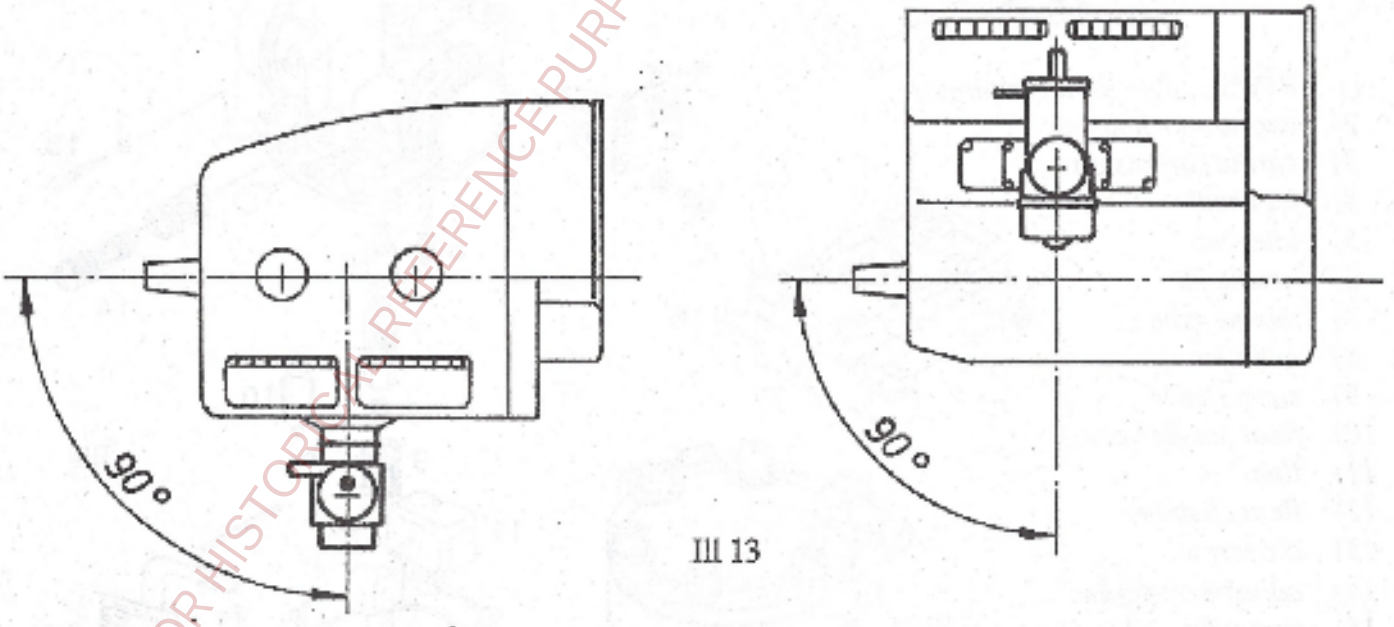
■ NOTE - On single carb engines the carburetor must be in an exact right angle position in relation to the crankshaft in both views from top and from the intake side to ensure an equal mixture distribution to both cylinders (see ill. below).

Changing parts should be done only after all other items have been checked, and then by an experienced two cycle mechanic.

▲ Ensure that throttle cable and linkage do not stick and that carb piston valve can be fully opened and closed. Minor cable backlash can be adjusted at cable adjustment screw and lock nut.

▲ Be certain that throttle linkage is not affected by engine or airframe movement. This could change throttle settings.

■ Air intake filtration and/or noise reduction devices must be in place for proper carburetion. See section on special operating conditions.



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Special operating conditions, such as severe climate or altitude change may require different jetting. Contact your dealer.

Section 8

8.) Exhaust systems:

Considerable effort has gone into the design of the ROTAX exhaust systems. Any changes may severely deteriorate performance, reliability, engine life, fuel economy, and the system's ability to reduce noise to acceptable levels. Do not use other exhaust systems claimed to improve over the stock components. Do not make any changes to the exhaust system supplied.

■ Vibration due to improper suspension is any exhaust system's worst enemy. Properly mounted and maintained, your exhaust system will provide a long service life.

▲ Never remove coupling spring with a sharp object which could mark the spring material. A rounded screw-driver shank or a hook fashioned from 1/8" bar is ideal. Safety-wiring of springs is highly recommended. Exhaust ball sockets should be kept lubricated by a heat resistant grease to allow for movement between engine and muffler.

Section 9

9.) Propeller gear:

9.1) Mounting instructions:

9.1.1) Gearbox Type "A" (with adaptor):

Carefully clean contact areas between crankcase and adaptor flange, insert O-ring and install adaptor flange with 4 Allen screws M10 x 45 to crankcase. The seat of the screw heads must be plane and free of marks or burrs. Apply LOCTITE 221 to the thread and LOCTITE 648 on the seat of the screw head.

NOTE: Torque 55 Nm (485 in.lb.). Use wrench for int. hex. with centering extension, ROTAX part no. 277 817.

■ ATTENTION: Verify that heads of M10 Allen screws are free of marks or burrs to ensure full contact on their seat (version "A" only).

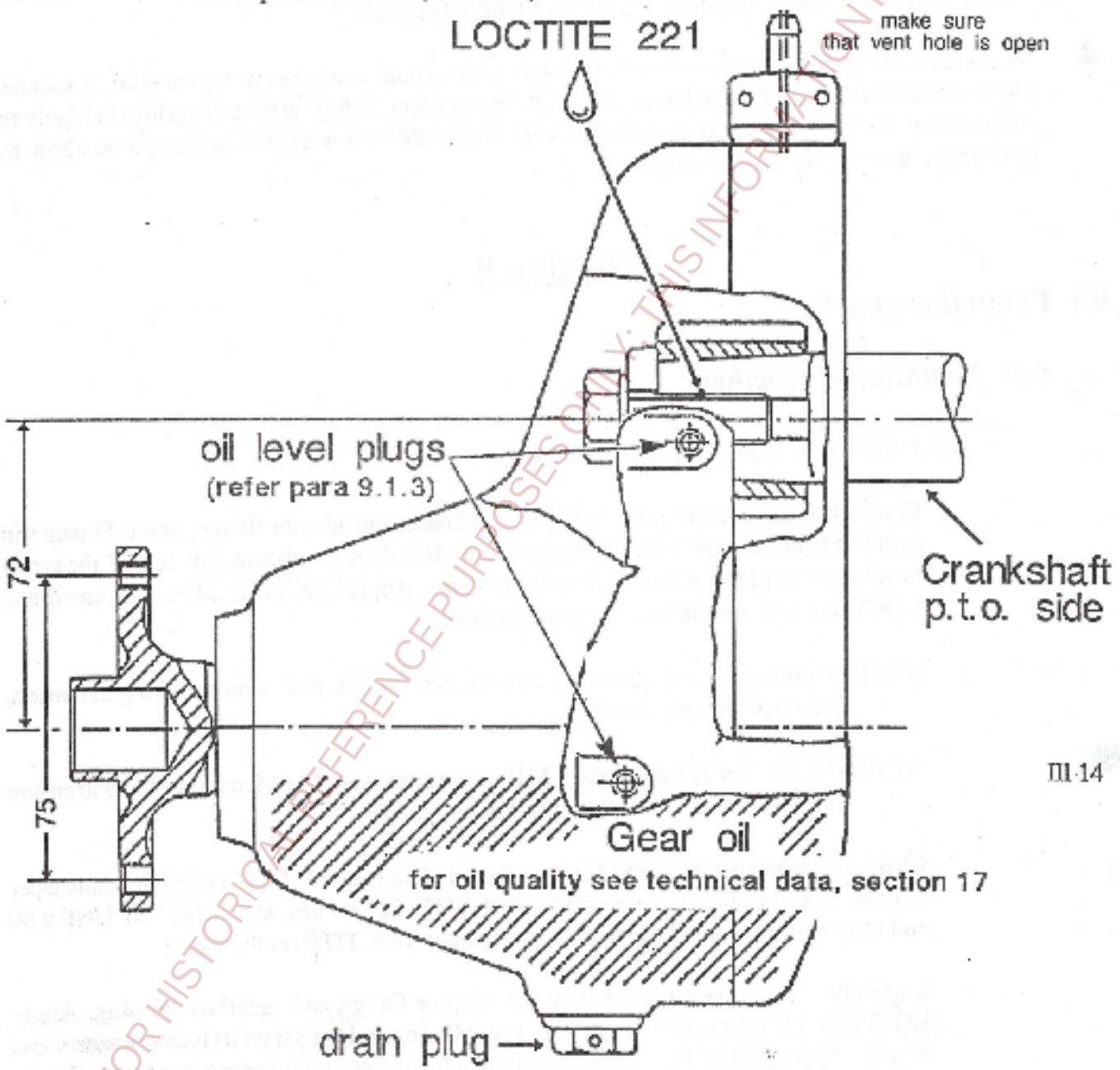
Clean and de-grease taper and 1/2" int. thread of p.t.o. crankshaft, as well as inside taper of drive gear. Install drive gear, apply LOCTITE 221 on hex. screw 1/2"-20 UNF x 50 and torque to 60 Nm (530 in.lb.). Do not apply LOCTITE on the taper!

Carefully clean contact areas between adaptor flange and gearbox housing. Apply LOCTITE 648 on adaptor flange, insert new O-ring and keep it on its location with some grease. Apply LOCTITE 221 on 4 stud threads M8 and screw them into adaptor flange. Install gearbox assembly and tighten it with 4 hex. nuts M8. All 6 nuts M8 to be torqued to 22 Nm (195 in.lb.).

9.1.2) Gearbox Type "B" (without adaptor):

Carefully clean contact areas between crankcase and gearbox housing. Clean and degrease taper and 1/2" interior thread of p.t.o. crankshaft, and interior taper of drive gear. Install drive gear, apply LOCTITE 221 on hex. screw 1/2"- 20 UNF x 50 and torque to 60 Nm (530 in.lb.). Do not apply LOCTITE to the taper!

Apply LOCTITE 648 on gearbox housing, insert new O-ring and keep it in its location with some grease. Apply LOCTITE 221 on 4 stud threads M8 and screw them into crankcase. Install gearbox assembly and tighten it with 4 hex. nuts M8. All 6 nuts M8 to be torqued to 22 Nm (195 in.lb.).



NOTE: Gearboxes for above engine types can be fitted alternatively with prop shaft below or above crankshaft axis (see also paragr. 9.1.3).

9.1.3) Gearbox type A or type B:

■ Inspect correct position of oil drain plug (bottom) and vent plug (top).

▲ Secure drain plug with approved locking wire.

Only applicable for configuration with separate propeller flange: Degrease gear propeller shaft taper, thread and bolt M12 x 1,5 LH (left hand). Fit propeller hub and apply Loctite 221 (violet) on taper and thread.

ATTENTION: left hand thread! Torque: 60 Nm (530 in.lb.)

NOTE: Propeller hub is threaded for 6 x 1/4" 28UNF-2B bolts (as well as 6 x M8). For proper bolts follow propeller manufacturer's specifications.

▲ Fill appropriate gear oil GL 5 or GL 6 (refer Technical Data Section) into gearbox (for both positions of propeller shaft, above and below crankshaft axis) up to lower oil level plug. Secure vent plug with approved safety wire.

9.2) Preflight Instructions:

▲ ATTENTION: As supplied by the factory, irrespective whether gearbox is separate from or fitted to engine, there is no oil in the gearbox.

Tighten drain plug, fill with specified oil to proper level. Install vent plug and oil level screws. Secure with approved safety wire before use! Check tightness of bolts and nuts.

9.3) Maintenance:

▲ Every 10 operating hours:

Check oil level on respective oil level screw and secure again with wire.
Change oil after 1st 10 hours of operation, and clean magnetic drain plug every oil change.
Check propeller tracking and tip clearance.

Change oil every 100 hours or every 2 years (which occurs first).

▲ NOTE: Mounting and maintenance operations must be done by skilled personnel only.

Section 10

10) Ignition system:

- The ROTAX engine is equipped with a magneto generator of 12V 110W + 30W rating, producing the current necessary for the spark and accessories. The ignition unit has been set to production tolerances by the factory. After initial break-in adjustments timing must be checked. Do not make adjustments as long as timing is within tolerance as specified in section 15, para 15.4. Timing must be re-adjusted at 20 hours (see Maintenance, section 15).

  For checking frequency refer Maintenance Schedule, section 15.

  In case of trouble observe the following:

  If the ignition fails intermittently or if there are other troubles that are due to neither spark plug, nor external components, nor carburetor, the contact breakers may be the cause. Contacts must be clean and correctly adjusted. If re-adjustment is required, the full timing procedure must be completed (refer following chapter).

  With new engines or new points the cam-follower of the contact breaker set wears rapidly initially. Resetting of contacts will therefore be necessary. The breaker contacts are accessible after removal of the rewind starter and the starting pulley. The magneto housing need not be removed. Once cam follower has "polished in" and points are re-adjusted, settings will hold for considerable time.

  To check whether the ignition timing is correct there is an arrow on the fan housing or mark on ignition housing for free air engines (refer ill. page 18). Further, there are two scribe marks on the magneto flywheel, one for each cylinder. When the scribe mark for the cylinder concerned lines up with the arrow, the ignition points should just have broken contact, thus triggering the ignition spark.

- The preferred method to check the timing is by using a dial indicator, installed into spark plug hole. With the piston in proper position before top dead center (refer section 19) the ignition points should just have opened.

- Crankshaft rotation on magneto side is clockwise.

10.1) Ignition timing:

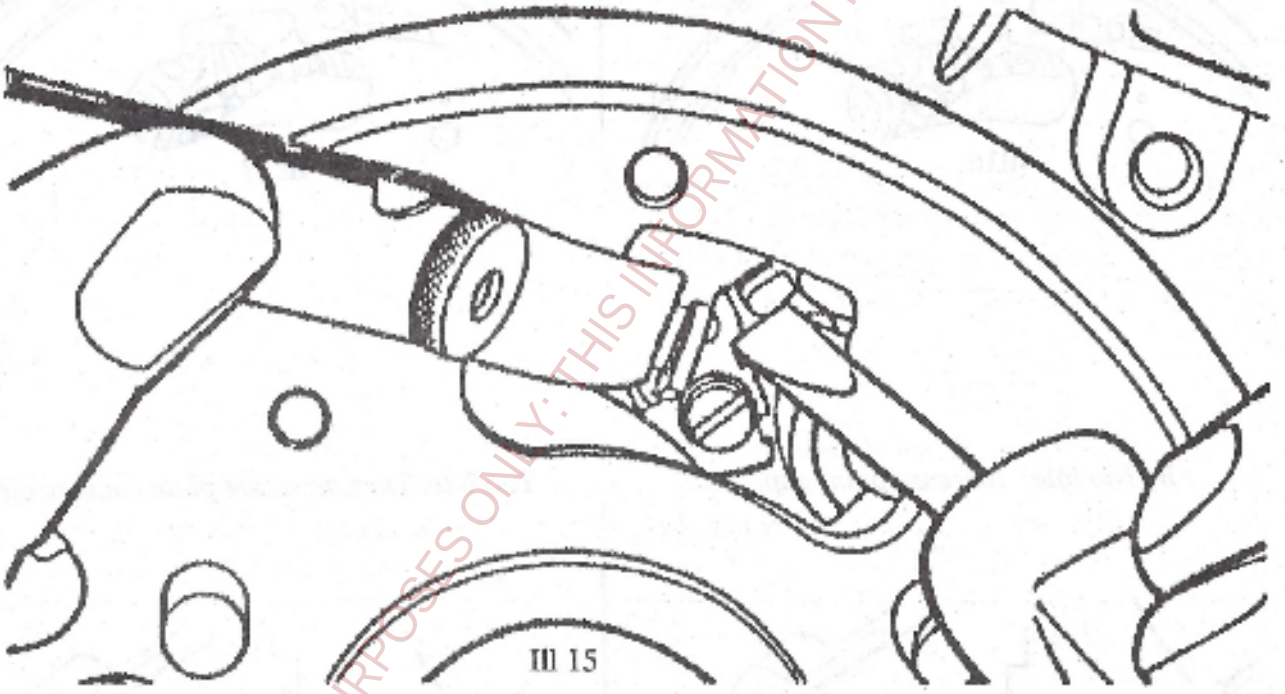
10.1.1) Disconnect spark plug wires and remove spark plugs.

10.1.2) Remove rewind starter assembly from engine, then remove the fan protector (if applicable) and starting pulley.

NOTE: The upper breaker set controls the timing of the magneto side cylinder and the lower breaker set controls the p.t.o. side cylinder.

10.1.3) Pull back the rubber boots from the double lead connector from both external ignition coils. Connect one end of a timing light (flash-light type) or a tone timer to the double lead wire connection (mag. side). Connect the other wire to a good metal connection on engine (ground).

10.1.4) Turn timing instrument on. If an ignition switch is installed, assure that it is in the ON position. Rotate crankshaft until mag. side piston approaches top dead centre and timing marks align or dial indicator indicates timing point (this is the firing point, NOT top dead centre). The timing light should fluctuate or tone signal vary. If not, adjust breaker points to achieve the correct timing point.



NOTE: Timing may change upon tightening screws. Recheck and correct as necessary.

10.1.5) Turn crankshaft to max. points gap and verify (refer section 19). If gap is out of tolerance, the armature plate must be turned and the timing procedure must be repeated!

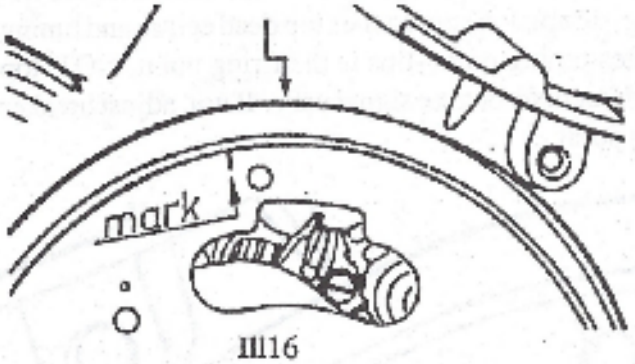
NOTE: Gap too small: turn armature plate clockwise.
Gap too large: turn armature plate counter-clockwise.

10.1.6) Disconnect timing instrument wire from mag. side connection, then reconnect it to the double wire connection on power take off ignition coil wire leading from engine. Rotate crankshaft until p.t.o. side piston approaches top dead centre. As soon as timing marks align, timing light should fluctuate, or tone signal sound level should vary.

NOTE: If it does not, proceed as follows:

- if timing is too early (see fig. A, page 18), decrease breaker point gap toward lower limit (see section 19), then recheck timing,
- if timing is too late, increase breaker point gap toward upper limit (see section 19), then recheck timing.

A) Too early: Decrease point gap



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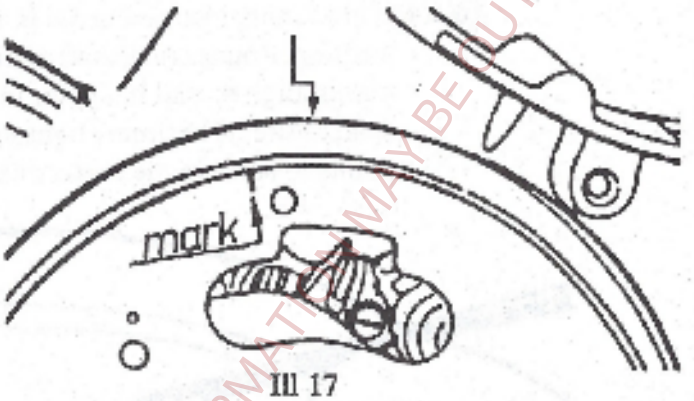
Too early: Turn armature plate clockwise



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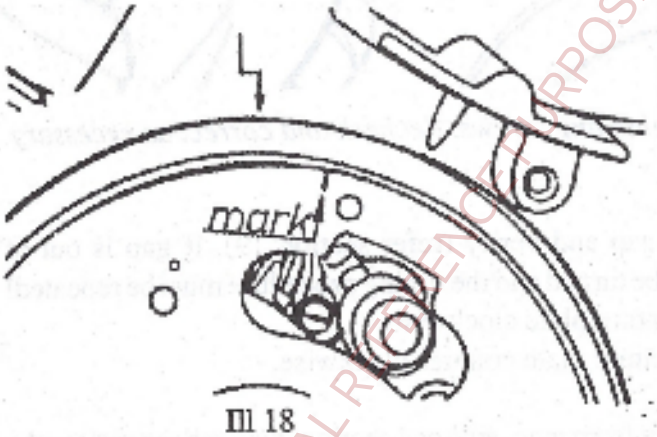
B) Too late: Increase point gap



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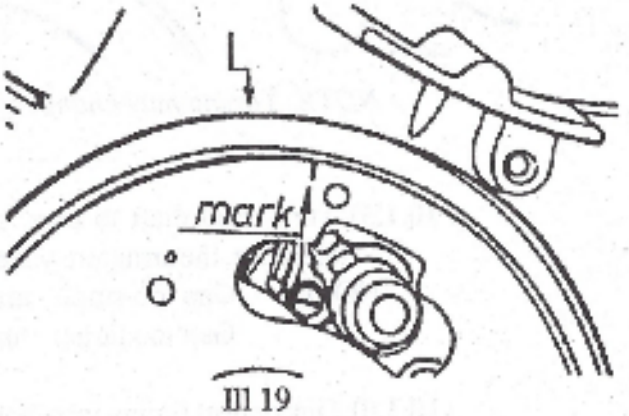
Too late: Turn armature plate counter-clockwise



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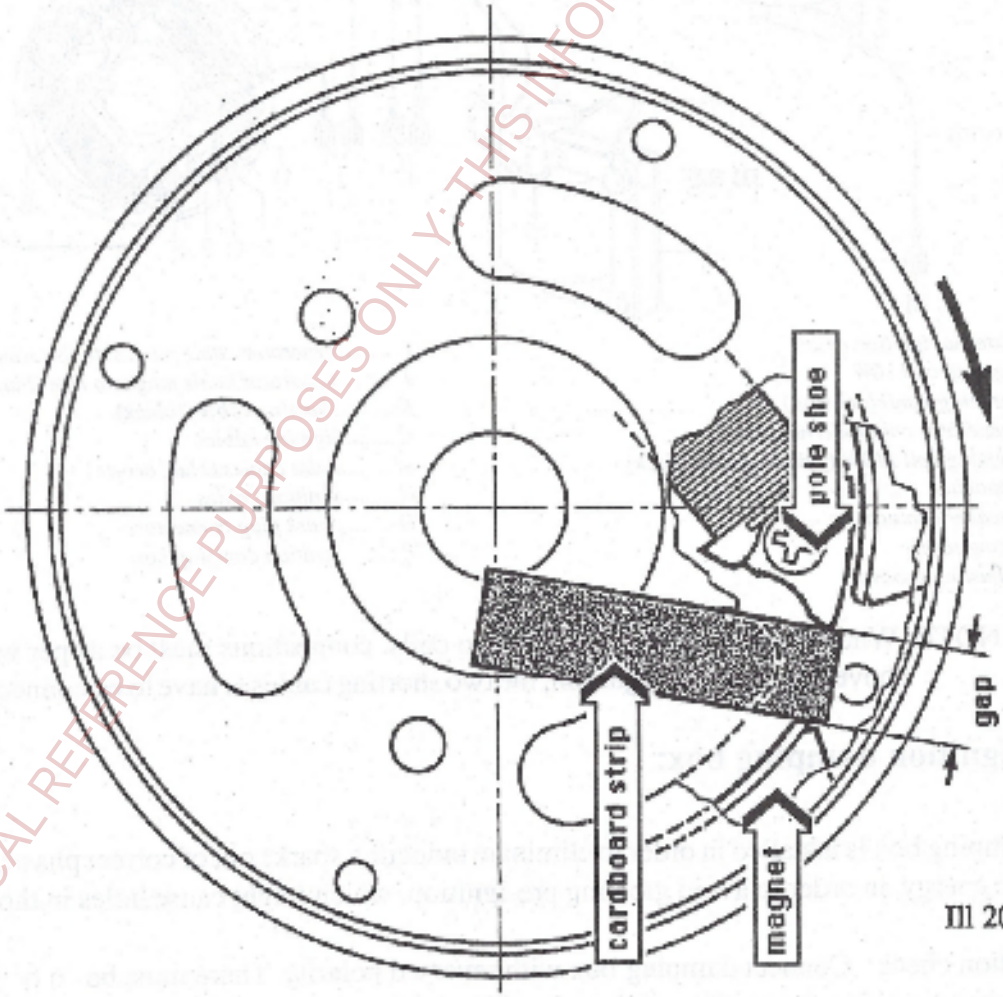
10.2) Break-away gap:

When correct timing is achieved, check pole shoe break-away gap. At the timing point, the gap must be as specified in section 18. If the break-away gap is out of tolerance, the flywheel may have turned on the crankshaft. Remove flywheel and inspect taper and key. Repair if necessary. If not, the break-away gap can be adjusted to a certain extent by rotating the armature plate in combination with the gap setting.

NOTE: If break-away gap is too small, turn armature plate counter-clockwise. Repeat timing procedure.
If break-away gap cannot be set maintaining the points gap tolerance, consult a service center.

Once completed, reconnect all wires, re-install "V" belt pulley and starting pulley. Re-install rewind starter and fan protector. If V-belt is removed: mark for direction to re-install it in same direction.



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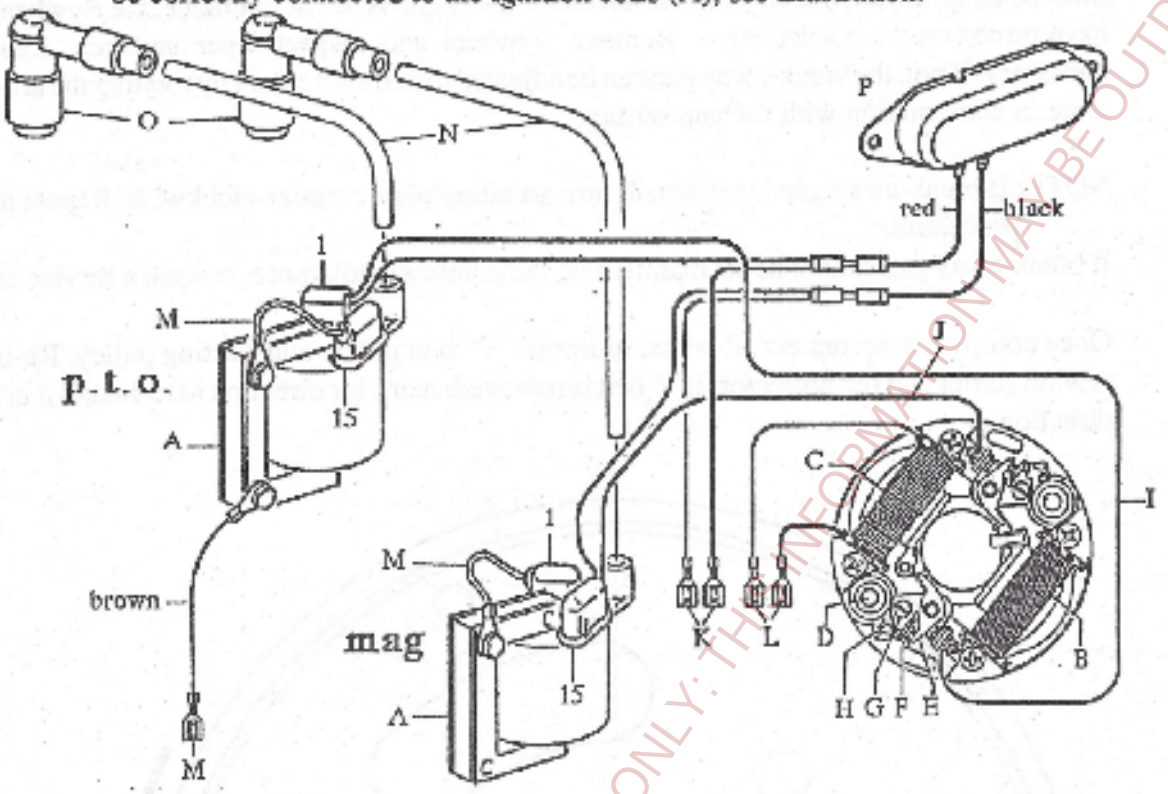
NOTE: Mag. and P.T.O. ignition coils are wired inversely for correct output of ignition. If in doubt, check wiring diagram.

10.3) Ignition wiring diagram:

Particular care has to be taken that the ignition generator cables (I+J) and the mass cables (M) be correctly connected to the ignition coils (A), see illustration.



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A .....External ignition coils
B .....lighting coil 30W
green-green/black (top)
generator coil(underneath)
C .....lighting coil 110W (yellow-yellow/black)
D .....capacitor
E , F ..breaker contacts
G .....fixing screw
H .....adjusting groove
I .....generator cable p.t.o. side (blue/black)
J .....generator cable magneto side (blue)
K .....shorting cables (black)
L .....lighting cables
M .....mass cables (blue, brown)
N .....ignition cables
O .....spark plug connectors
P .....ignition damping box

NOTE: When replacing wiring on ignition coils, connections must be as per wiring diagram above. To cut off the ignition, the two shorting cables K have to be connected to ground.

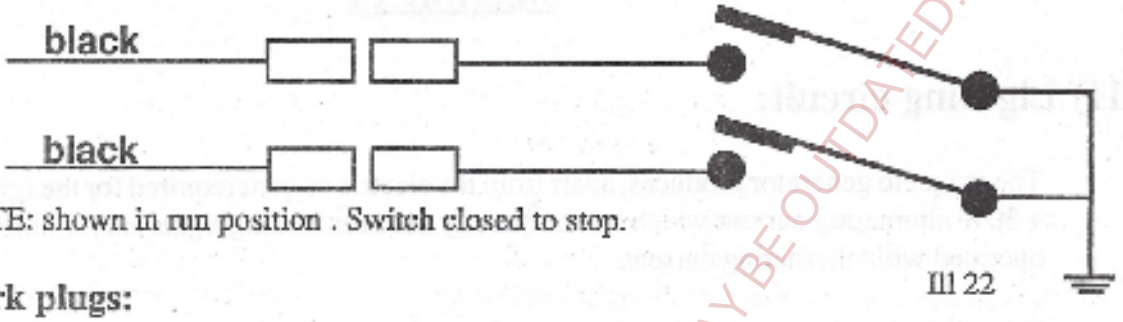
10.4) Ignition damping box:

The damping box is installed in order to eliminate induction sparks out of correct phase, and to reduce ignition energy, in order to avoid glowing pre-ignition, which might cause holes in the piston dome.

Precaution check: Connect damping box with reversed polarity. There must be n o spark on both plugs when cranking the engine. If there is still a spark, the damping box is defective.
In case of ignition troubles (no spark): disconnect damping box, if there is now a spark, the damping box is defective.If the engine performance is bad with the damping box connected, but good without it, this indicates a weak ignition system. See your dealer or service center.

■ Never run engine without damping box.

10.4) Ignition switch:



NOTE: shown in run position . Switch closed to stop.

Ill 22

11.5) Spark plugs:

Due to varying fuel properties etc., check every 10 hours of operation. Replace as required or annually. Provided that spark plug heat range and the carburetor calibration are correct, the spark plugs will have a brownish tinge at the electrodes of both spark plugs after full load operation.
On engines with single carburetor, one sooty spark plug by itself usually indicates a bad plug or a faulty ignition system of that particular cylinder. If both plugs are sooty with oil deposits, carburetion and air system should be checked. On engines with two carburetors you should interchange the carburetor to trace the problem.

■ Always change both plugs. Never interchange plugs from one cylinder to the other.

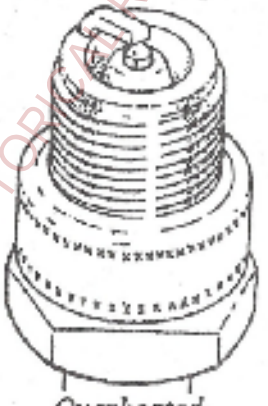
If both plugs have "white" electrodes with "melt" droplets, first suspect lean mixture. If calibration is correct and there is no evidence of manifold leaks, lack of fuel, or incorrect float settings, don't change the plugs to a colder range. Make sure that cooling system is operating correctly and that fan belt is in good condition and properly adjusted.

▲■ ATTENTION: Heavy oil deposits on the electrodes and insulator may cause engine problems. Exchange regularly every 20 hours, or at any indications of trouble.

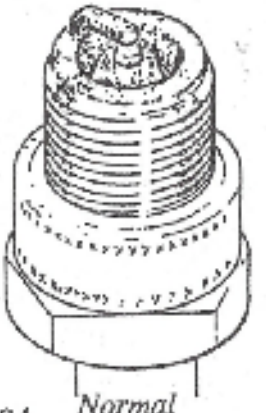
If, after cleaning or changing the spark plugs, you still have an ignition problem, check to see if only one cylinder is affected or both. Some thought to what is common to both systems or only one will isolate the problem more efficiently. If no external fault is found, the ignition unit must be checked.

■ Never clean spark plugs with an abrasive cleaner or a metal brush.

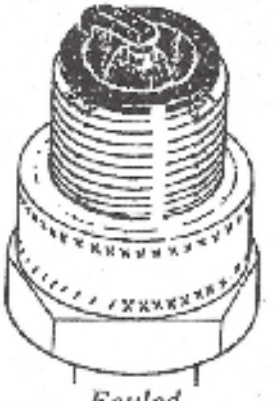
Remember to correctly gap your plugs with a wire gauge (see technical data, Section 18). Spark plugs must be torqued per torquing specifications.



Ill 23 *Overheated (light grey)*



Ill 24 *Normal (brownish)*



Ill 25 *Fouled (black)*

Section 11

11) Lighting circuit:

The magneto generator produces, apart from the electric current required for the ignition, 12V 110W + 30W alternating current which can be directly used for feeding lights and/or other users that can be operated with alternating current.

To avoid the voltage rising above permissible levels, a voltage regulator must be used.

To operate consumers requiring direct current (e.g. charging battery), a rectifier-regulator is required.

A rectifier-regulator, part no. 866 080, is available. For feeding lights only, this rectifier-regulator can also be used without battery. In this case the regulated RMS voltage will remain between 11 and 12 Volts as long as a minimum load of 1 amp is provided.

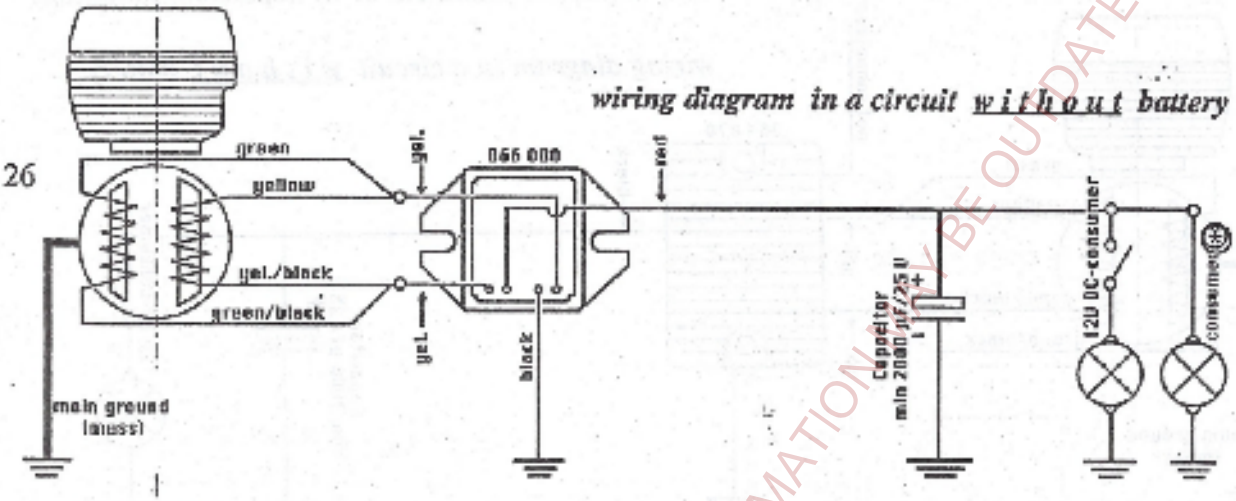
If no minimum load is provided, a three-phase rectifier-regulator, part no. 264 870, has to be used.

In case a battery is installed, it has to be capable to absorb approx. 1 amp. minimum continuous charging load, even with full battery (suggested minimum battery capacity: 9 Ah, resp. 16 Ah with electric starter). Regulated voltage is 13.5 to 14.5 volts. To extend battery life, an additional consumer of 12 to 15 volts is recommended.

11.1) Lighting wiring diagram for rectifier-regulator 866 080:

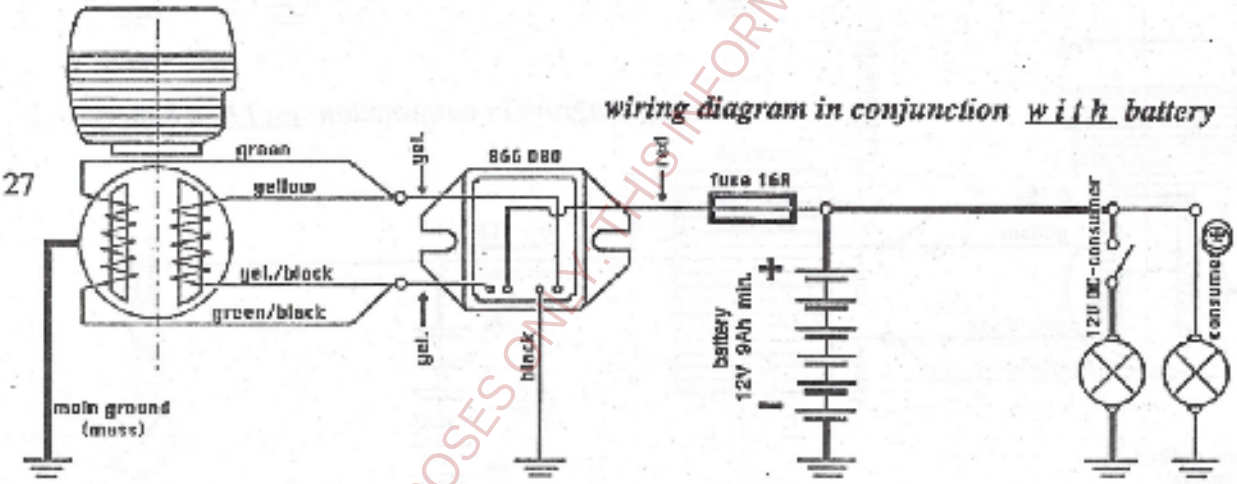
Ill 26

wiring diagram in a circuit without battery



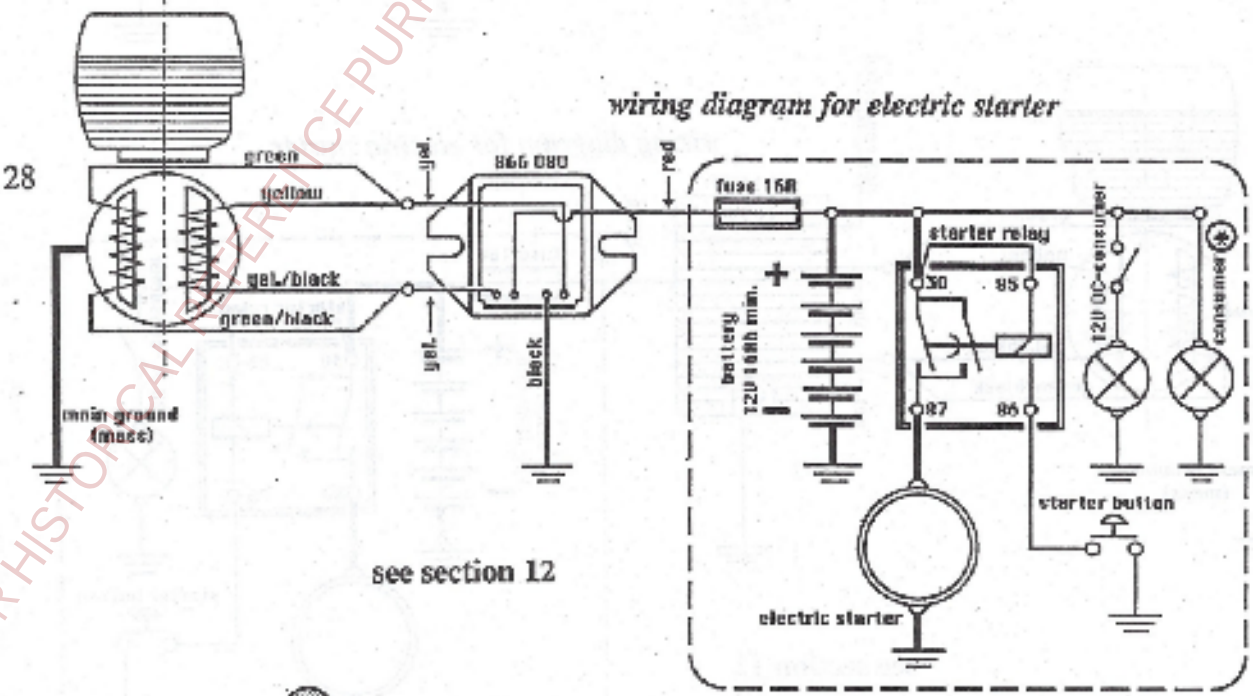
Ill 27

wiring diagram in conjunction with battery



Ill 28

wiring diagram for electric starter



see section 12

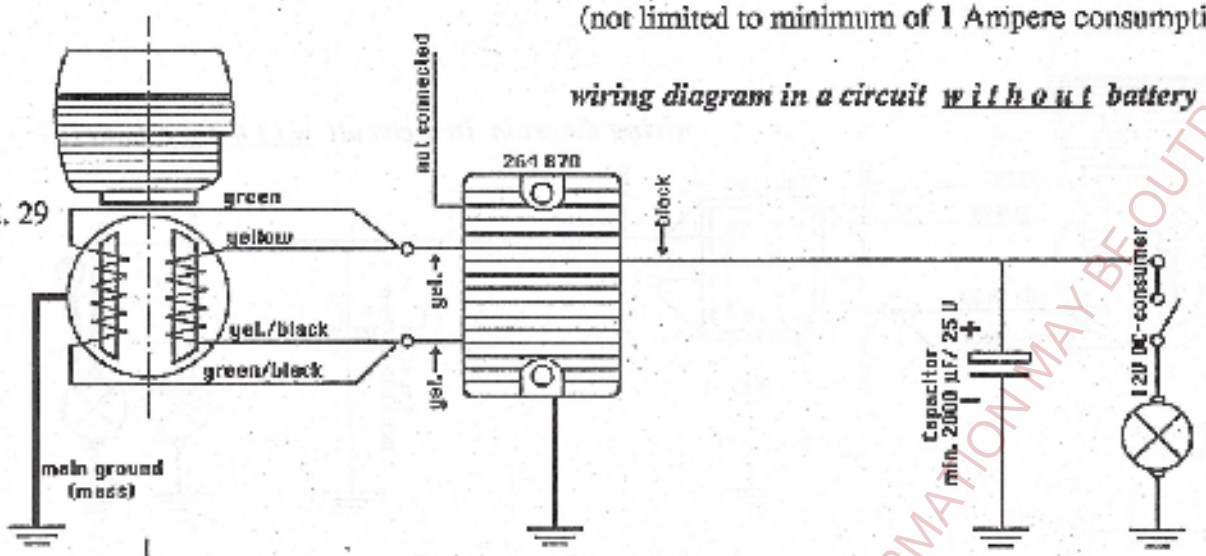
ATTENTION: ⊕ To avoid excessive voltage in conjunction with the rectifier-regulator 866 080, a constant minimum ballast load of 1 amp is required (example: lamp 12 V 15 W)

11.2) Lighting wiring diagram for rectifier-regulator 264 870:

(not limited to minimum of 1 Ampere consumption)

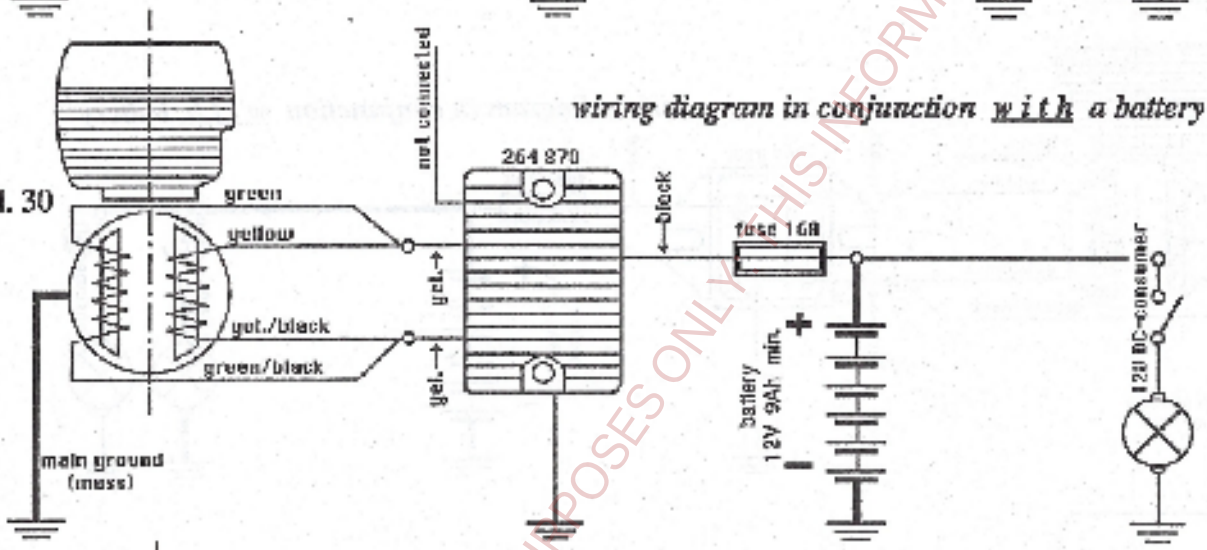
*wiring diagram in a circuit **without** battery*

Ill. 29



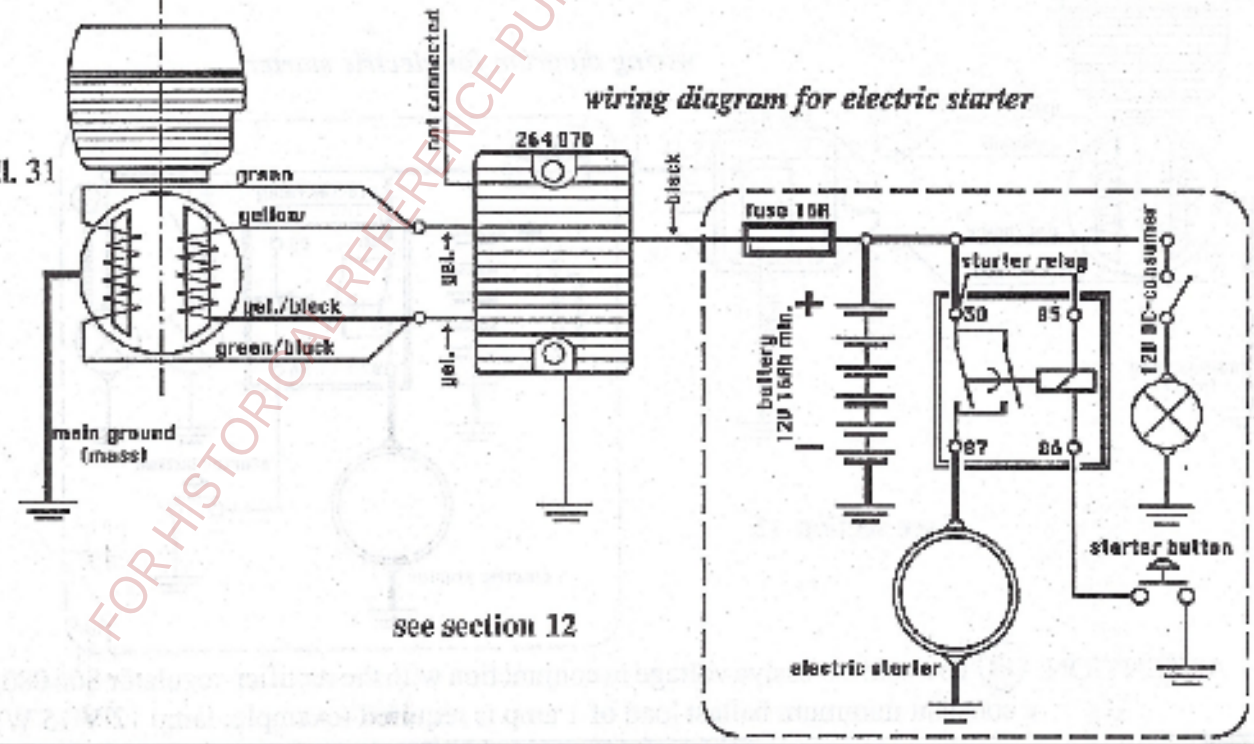
*wiring diagram in conjunction **with** a battery*

Ill. 30



wiring diagram for electric starter

Ill. 31



see section 12

Section 12

12) Electric starter:

Two types of electric starters can be fitted to ease starting procedures especially in flight.

12.1) Electric starter fitted to p.t.o. side:

Allows recoil starter to be retained, but cannot be fitted on engines using ROTAX gear reduction unit.

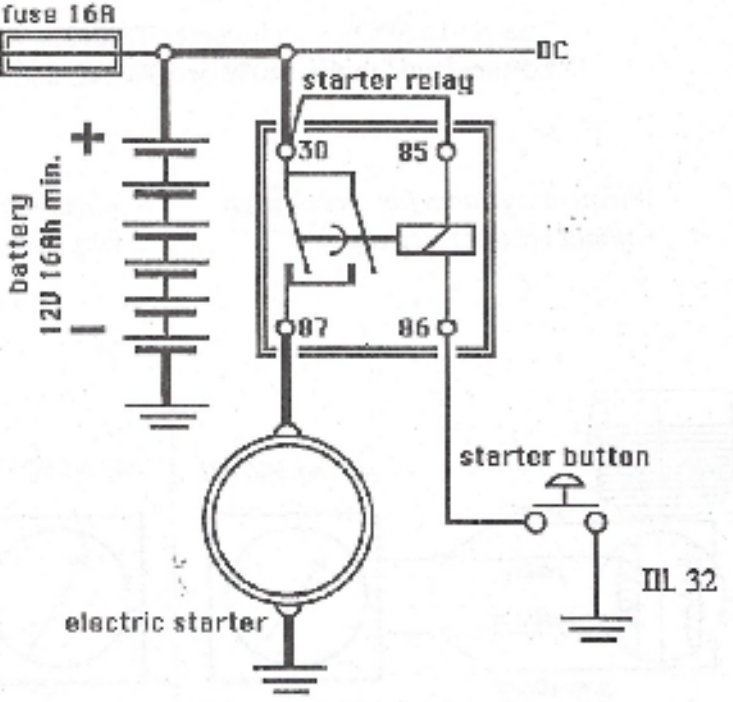
12.2) Electric starter fitted on magneto side:

For use with engines utilizing ROTAX gear reduction unit. This electric starter system however eliminates recoil start capability.

12.3) Battery:

Either case, to ensure reliable starting, a battery of at least 16 Ah (high-discharge battery) should be utilized. A higher battery amp- hour-rate would be preferable. Cables supplying power to the starter from the battery and to ground should be 10 mm² flexible multi strand.

from rectifier-regulator (see section 11)



12.4) Starter relay:

Starter control should be via a power relay (supplied with starter kit) wired as shown above. A Bosch relay is shown in above diagram. For other makes, refer to respective relay wiring.

12.5) Fuse:

■ A 16 Amp fuse must be installed between battery charging circuit and main power terminal.

Section 13

13) Instruments:

Instruments can be a valuable addition if they are of good quality, correctly installed, maintained, and if the operator understands what they are telling him. Poor quality instruments should never be used.

▲ Never use a tachometer directly connected to the ignition system. Use a tachometer operating on the lighting coil.

All instruments requiring power source must be overload protected. (Ref. section 11)

All wiring and sensor leads must be properly routed and protected from vibration and abrasion.

For correct operating speed refer Technical Data section.

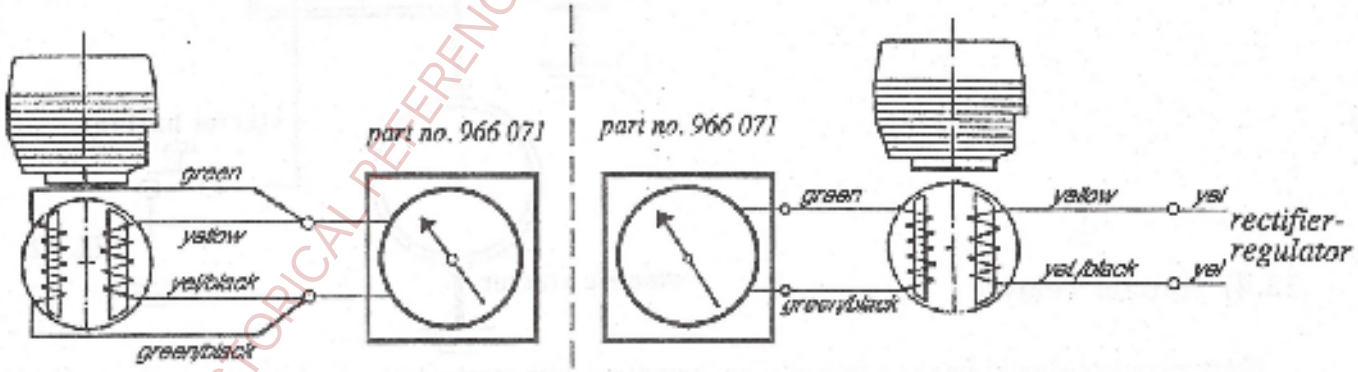
■ Cylinder head temperatures are taken at the spark plug seat. Exhaust gas temperatures are measured at 100 mm (4 in.) from the cylinder sleeve. See section 18 for temperatures.

13.1) Electronic tachometer:

The AVIASPORT tachometer T8K12D, part no. 966 071, has been specifically designed to be connected to the 140W or 30W AC and is usable for contact breaker ignition system only.

Wiring diagramm for tachometer without rectifier-regulator

Wiring diagramm for tachometer in conjunction with rectifier-regulator and battery



Ill 33

13.2) Hour-meter:

The hourmeter part no. 966 075 is suitable both for engines with contact-breaker ignition and electronic ignition unit.

13.2.1) Connections for contact breaker ignition:

The hourmeter is connected either to the llOW AC output (yellow and yellow-black wires) or to the 30W AC output (green and green-black wires).

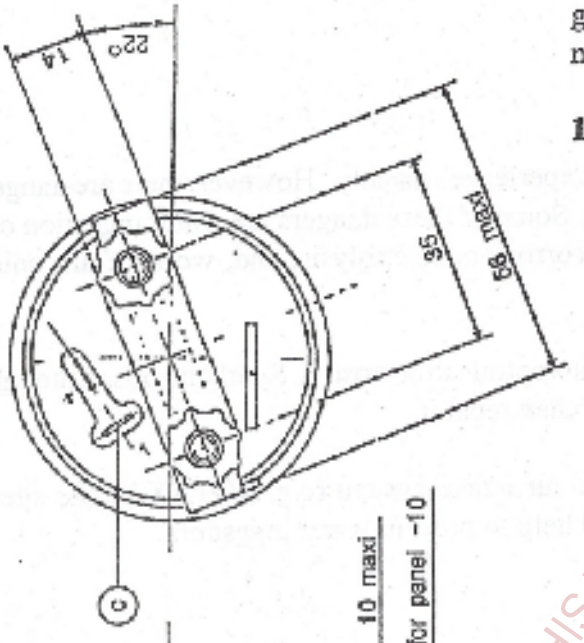
A tachometer, rectifier or auxiliary loads can be also connected to these outputs without interference with the hourmeter.

The symbols "+" and "-" on the black of the instrument do not need to be observed as it is AC powered.

Power supply: .....6-100 V AC or DC, 6 mA. max.

Weight: .....128 g.

Ill 34



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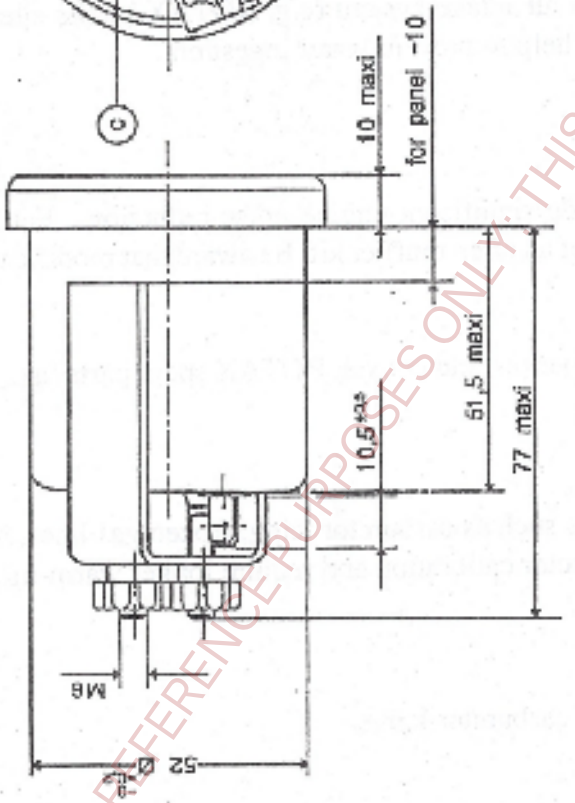

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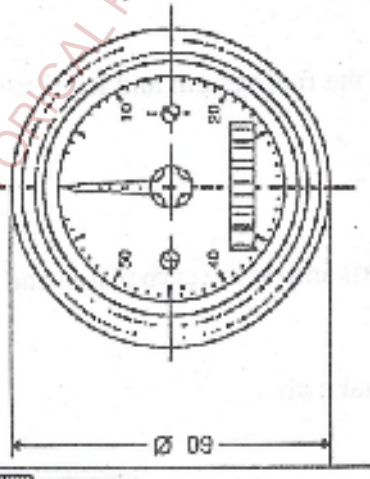


Section 14

14) Special operating conditions:

14.1) Water:

Off water operation is a real pleasant experience - usually. However, there are dangers to your engine you won't experience on land. Some of these dangers are water ingestion on take-off or landing due to spray and splash, corrosion, electrolysis, and, worst of all, unintentional submersion.

▲■ Bearings, crankshaft etc., are highly susceptible to corrosion. Synthetic oils, although good lubricants, often attract moisture rather than repel it.

A well designed and well maintained air intake system (e.g. ROTAX intake silencer with K & N oil impregnated air filter) will help to prevent water ingestion.

14.2) Noise:

The air intake silencer kit will provide significant engine noise reduction. Further noise reduction may be obtained by the use of an after-muffler kit. Be aware that modifications will require a different carburetor setting.

Enquire at your dealer for more information, and consult ROTAX spare parts list.

14.3) Winter:

■ Winter can create additional problems such as carburetor icing, frozen gas lines, higher air densities etc., which may affect carburetor calibration and require longer warm-up periods.

14.3.1) Carburetor icing:

Distinguish between two kinds of carburetor icing,

14.3.2) Icing due to water in fuel:

■ Water in fuel will accumulate at the lower parts of the fuel system and leads to freezing of fuel lines, filters or jets.

13.3.3) Icing because of high air humidity:

■ Carb icing due to humidity may occur on the fuel exit and on the carb piston and leads to performance loss and changes the mixture.

Effective remedy is possible only by preheating intake air.

14.3.4) Remedies:

- Fuelling without traces of water (use shammy as filter).
- Generously sized water separator.
- Fuel lines routing inclined.
- Prevent condensation of humidity, i.e. avoid temperature differences between aircraft and fuel.
- Add up to 2 % isopropyl alcohol to the fuel.

■ ATTENTION: Fuels containing alcohol always carry a small amount of water in solution. In case of temperature changes or increase of alcohol content, water or a mixture of alcohol and water may settle and could cause troubles.

Section 15

15) Maintenance:

15.1) Maintenance schedule:

▲ WARNING:

1) Maintenance on engines and systems requires special knowledge and tools. It is therefore recommended to have these works performed by authorized service centers or dealers.

2) Disconnect spark plug leads with a turning motion for all maintenance and inspection procedures.

3) Putting spark plug connector back on, make sure that spark plug terminal is tight on plug.

■ Service times are based on average use, assuming engine is run at least once per week for a normal duty cycle or average flight. Total time before teardown is determined by the frequency and conditions of usage. If the engine is not going to be used for a period of 2 months or more, consult storage procedures in this section.

After initial break-in period certain inspections and checks must be made to ensure all components and settings have remained tight and are within the specified tolerance. Failure to do so could lead to premature engine failure.

POST BREAK-IN INSPECTION CHECK LIST	✓
Engine timing check, adjust if necessary	
Spark plug(s) condition	
Carburetor adjustment	
Engine head nuts	
Engine suspension nuts	
Tighten all loose bolts, nuts and linkages	
Muffler attachment	
Engine coolant system	
Air filtration system	
Fuel filtration system	
Electrical wiring (loose connections, stripped wires, damaged insulation)	
Operation of lighting system	

We highly recommend that you have your dealer sign this inspection.

....

Date of Break-in inspection Dealer signature

15.2) Rewind starter:

Check cord condition every 10 hours. Replace when worn or frayed.

To change the starter rope, follow the procedure outlined (the numbers stated in brackets refer to the illustration).

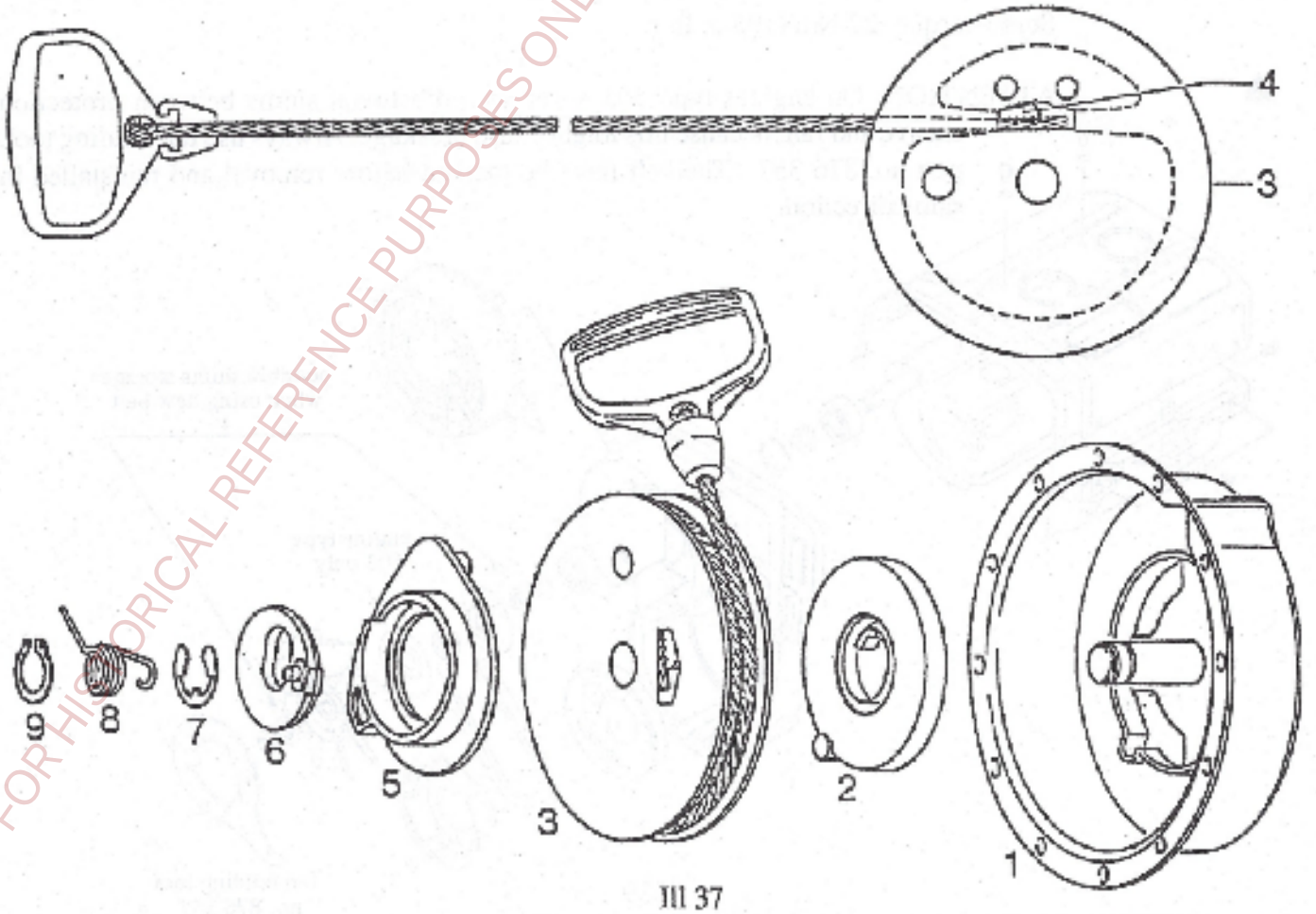
First remove the rewind starter assembly from the engine.

Second, remove the snap ring ❾, loop spring ❽, circlip ❼, pawl lock ❻, and the pawl ❺.

Pull out the starter rope fully to the end, hold starter housing ❶ and rope sheave ❸ together in their position. There is an opening in the rope sheave. The key clamp ❹ visible in the opening has to be pushed out in the opposite sense of the pulling direction. Pull the rope out of the rope sheave.

Then insert the new starter rope into the rope sheave, fit the key clamp in the same position as it was and push it to be tight. Refit the parts ❺, ❻, ❼, ❽ and ❾.

▲ WARNING: Do not remove spring container ❷, this might cause injuries.
Do not operate the engine if the rewind starter is defective.
Most starter problems are due to improper operation.



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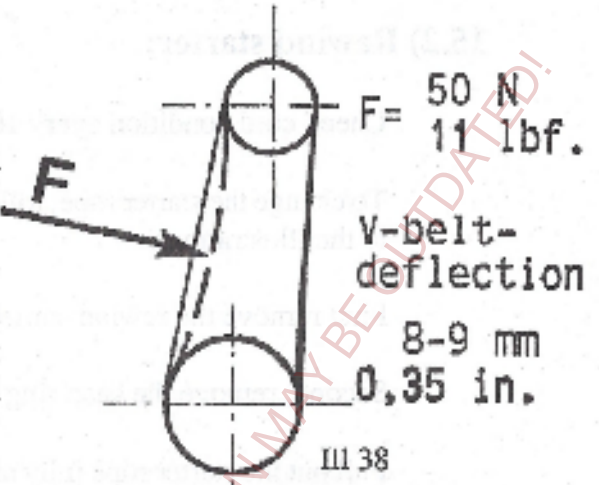
15.3) Cooling system:

Inspect fan belt tension every 10 hours. Replace belt if frayed or if it can no longer be tensioned to specification.



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The tension of the V-belt can be adjusted by shims between the V-belt pulley half and the fan (resp. the protection sheave on 503). The V-belt is correctly tensioned when it can be depressed 8 - 9 mm (.31 - .35 in.) for engine type 377 - 447 and 9 - 10 mm (.35 - 39 in.) for engine type 503 with normal finger pressure "F" (in the middle between the 2 V-belt sheaves).

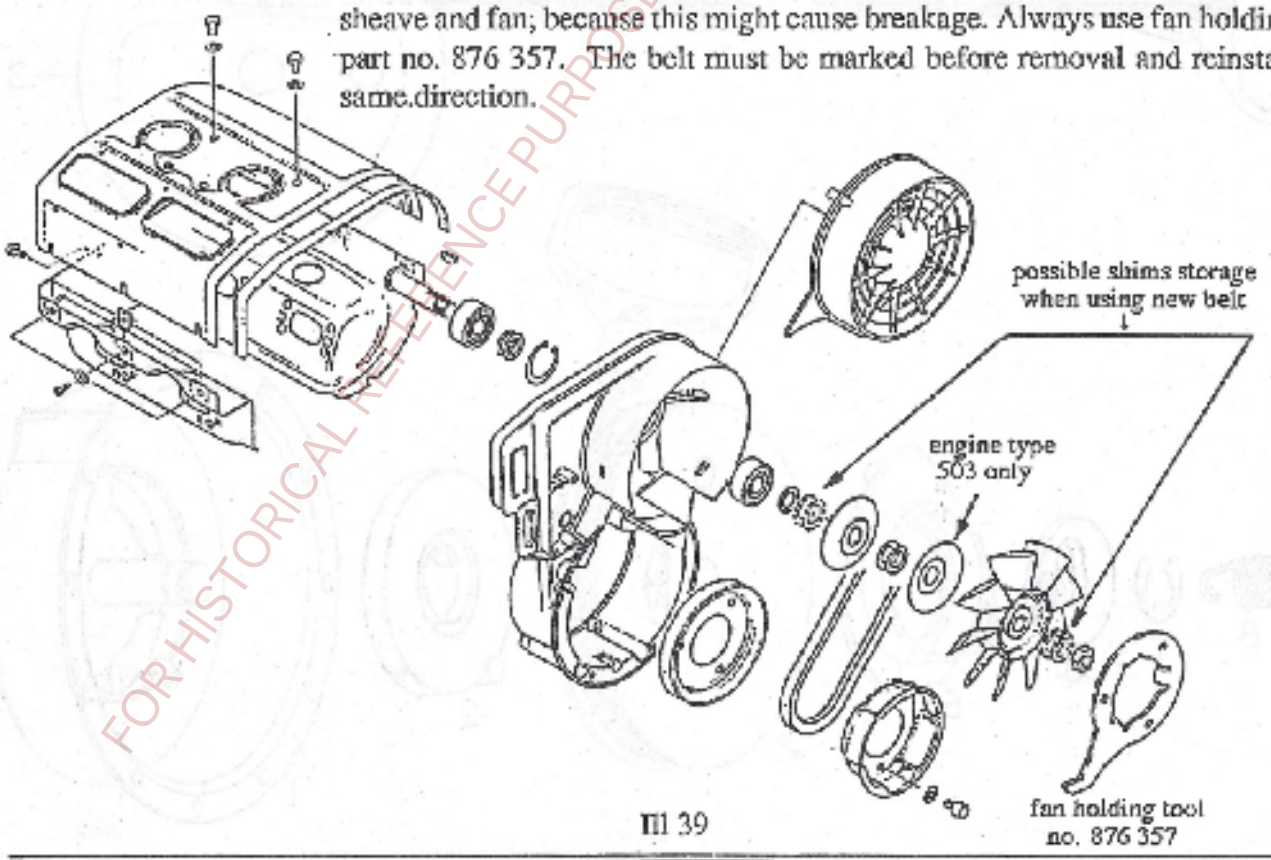
15.3.1) Mounting of V-Belt:

Install the fan (without V-belt) as per illustration.

Place V-belt diagonally between two blades of the fan, turn the fan until the V-belt has moved into the pulley. Fix V-belt pulley and starting pulley loose with one of the3 screws. Put V-belt in the pulley groove and turn crankshaft in order to tension the belt and to center the pulley on the flywheel. Now the 2 remaining screws can be fitted.

Screw torque: 22 Nm (195 in.lb.).

▲ ATTENTION: On engines type 503 never put adjustment shims between protection sheave and fan; because this might cause breakage. Always use fan holding tool, part no. 876 357. The belt must be marked before removal and reinstalled in same.direction.



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15.4) Engine timing:

Check at Post Break-In Inspection. Thereafter at 20 hours of operation. Thereafter at every 50 hours. Parts replacement is only required when breaker points can no longer be adjusted within specifications. Procedure - see ignition system, section 10.

15.5) Engine head nuts:

After break-in inspection they require only annual check. For re-torquing, see break-in procedure (section 5).

15.6) Engine suspension nuts:

Inspect visually regularly (pre-flight check). Re-torque annually. Check procedure with airframe manufacturer.

15.7) Air filtration system:

Inspect frequently (10 hours) for cleanliness depending on type used (see special operation conditions, section 6).

15.8) Fuel filtration system:

Check at least every 10 hours (see fuel mixture section 3). Ensure clean fuel at all times.

15.9) Check for carbon build-up and piston ring condition:

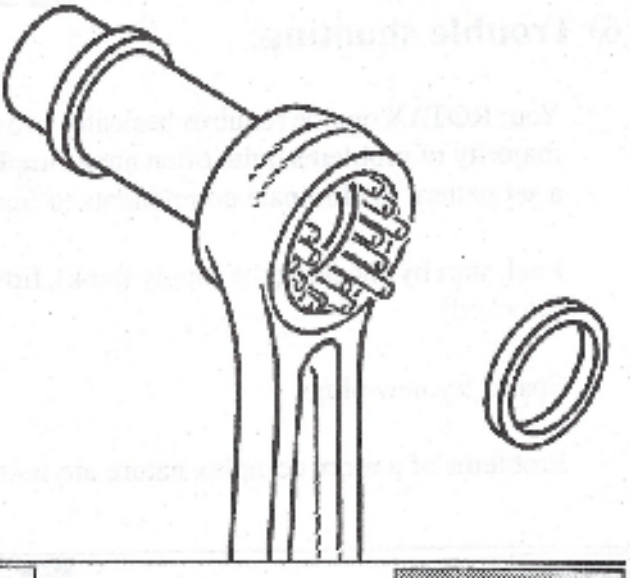
After approximately 50 hours of use, the combustion chamber may require de-carbonizing. To inspect, remove exhaust manifold and check for deposits on piston crown. Decarbonizing is required if deposit thickness is in the range of 1 mm (.04 in.). On re-assembly of manifold, replace gaskets if necessary. Re-torque after first 10 hours of operation.

De-carbonizing is considered to be a technical operation and should therefore be performed by an authorized service center only. To check for piston rings sticking in grooves, move pistons laterally to determine free movement of the top ring. If piston rings are stuck, consult your service center.

15.10) Piston pin bearing:

The piston pin is supported in the con rod eye by 31 needle rollers, without a cage.

For disassembly a special piston pin puller and particular training for its use is necessary. Piston disassembly is allowed to be done only by an authorized workshop.



15.10) Gear box:

■ **15.10.1) To be performed every 10 operating hours:**

Check oil level on respective oil level screw and secure again with lock wire.
Change oil after first 10 hours of operation.
Check propeller clearance and tracking.
Change oil every 100 hours or every 2 years (whichever occurs first).

15.11) Storage:

■ If your engine is not going to be run for a period of 2 months or more, certain precautions must be taken to protect the engine and fuel system from heat, direct sun, corrosion and the formation of deposits. The following schedule is a guide for storage procedure:

15.11.1) Internal engine components:

Remove air filtration system, start engine and allow to idle. Using an oil-can, flood the engine by injecting oil through the carburetor till the engine stalls, then proceed with fuel system draining.

15.11.2) Fuel system:

▲ Drain float chamber, remove fuel from tank, drain fuel lines. Follow all safety rules and do not run for a prolonged period above idle.

15.12) After storage check:

Inspect engine and engine environment for possible foreign materials. Ensure all residue oil is drained or removed by cranking the engine, and spark plugs are clean and and properly gapped. Refill fuel tank, purge fuel line of air. Proceed with starting procedure (section 4).

Section 16

16) Trouble shooting:

Your ROTAX engine requires basically two essentials to run: Spark and correct fuel/air mixture. The majority of problems quite often are a simple lack of one or the other. Organize yourself and follow a set pattern to eliminate components to find your trouble.

Fuel: start by checking the supply (tank), fittings (loose), filter (clogged), float chamber (fouled), jets (blocked).

Spark: try new plugs.

Problems of a more complex nature are best left to a ROTAX engine technician: see your dealer.

Section 17

17) Engine repair log:

Record any repairs or service on your ROTAX engine and use as a reference.

Purchase Date : _____

First Use : _____

Break-in Inspection: _____

Repair date	Summary of work done

	Engine repair log: cont.
Repair date	Summary of work done

Section 18

18) Technical data:

DESCRIPTION:	twin cylinder-, two stroke Otto engine, lubricated by fuel/oil mixture, air-cooled by fan		
BORE:	type 377:	62,0 mm	(2,44 in.)
	type 447:	67,5 mm	(2,66 in.)
	type 503:	72,0 mm	(2,84 in.)
STROKE:	61 mm (2,40 in.)		
DISPLACEMENT:	type 377:	368,3 c.c.	(22,48 cu.in.)
	type 447:	436,6 c.c.	(26,64 cu.in.)
	type 503:	496,7 c.c.	(30,31 cu.in.)
COMPRESSION RATIO: (theoretical)	type 377: 11,6		
	type 447: 9,6		
	type 503: 10,8		

POWER OUTPUT:		peak power	r.p.m.
	type 377:	26,0 kW (35,0 hp)	6500
	type 447 1 carb.:	29,5 kW (40,0 hp)	6600
	type 447 2 carb.	31,5 kW (43,0 hp)	6600
	type 503 1 carb.:	35,0 kW (47,6 hp)	6500
	type 503 2 carb.:	37,0 kW (50,0 hp)	6600

MAX. RPM: for all above types 6800 1/min.

CYLINDER: 2 light alloy cylinders with cast iron sleeve

PISTON: Aluminium cast piston with 2 piston rings, one semi-trapez ring (top) and one rectangular ring (bottom)

TEMPERATURES OPERATIONAL VALUES:

CHT: (cyl. head temperature)

normal:	180-220 °C	(355-430 °F)
max.:	250 °C	(480 °F)
difference between 2 cyl.	20 °C	(36 °F)

EGT: (exhaust gas temperature)

normal:	460-580 °C	(860-1080 °F)
max.:	650 °C	(1200 °F)
difference between 2 cyl.	25 °C	(45 °F)
crankcase temp. max.:	80 °C	(175 °F)

IGNITION SYSTEM:	flywheel magneto generator SCP2 with contact breakers
GENERATOR OUTPUT:	AC 12V 110W + 30W
RECTIFIER- REGULATOR (optional):	a) 866 080, requires minimum load 12 W (1A) to regulate. b) 264 870, no minimum load required.
SPARK PLUG:	14 mm B8ES
ELECTRODE GAP:	0,4 ÷ 0,5 mm (.016 ÷ .02 in.)
RADIO FREQUENCY INTER-FERENCE SUPPRESSION:	optional with or without rectifier-regulator
CARBURETOR:	type 377: 1 x Bing 36 mm (1,42 in.), hand or cable choke type 447: 1 x Bing 36 mm (1,42 in.), hand or cable choke type 447: 2 x Bing 32 mm (1,26 in.), hand or cable choke type 503: 1 x Bing 36 mm (1,42 in.), hand or cable choke type 503: 2 x Bing 36 mm (1,42 in.), hand or cable choke
FUEL PUMP:	type 377: pneumatic fuel pump DF 44 type 447 1 carb.: pneumatic fuel pump DF 44 type 447 2 carb.: pneumatic fuel pump DF 44 type 503 1 carb.: pneumatic fuel pump DF 44 type 503 2 carb.: pneumatic fuel pump DF 52
LUBRICATION OF ENGINE:	2-stroke oil (for high performance air cooled 2-cycle engines, proposed ASTM/CEC standard TSC3) for instance: Castrol TTS or Blizzard oil
MIXING RATIO:	2 % oil (1 part oil with 50 parts fuel)
STARTER:	rewind starter optional: a) Rewind starter with electric starter, p.t.o. side (for engine without reduction gear-box) or b) Electric starter, magneto side, without rewind starter (gear-box is possible)
REDUCTION GEAR-BOX, TYPE B (optional):	reduction gear-box with torsional shock absorber, max propeller inertia 3.000 kg cm^2 ratios available: i = 2,0 / 2,24 / 2,58 ratio i = 3,0 only up to 40 hp and supplied only installed on engine e.g.: only for 377/447

REDUCTION GEAR-BOX, TYPE C (optional):	reduction gear-box with torsional shock absorber, for propeller inertia up to 6.000 kg cm² ratios available: i = 2,66 / 3,00 / 3,47 / 4,00
LUBRICATION OF GEAR-BOX:	gear oil API-GL5 or GL6, SAE 140 EP or 85 W-140 EP, as temperature requires.
DIRECTION OF ROTATION:	view on p.t.o. crankshaft end: counter clockwise reduction gear box shaft: clockwise to order suitable propeller for engine with reduction gear on tractor application: specify left-hand propeller on pusher application: specify right-hand propeller
COOLING:	air cooled by axial fan, or free air for special applications
ENGINE WEIGHTS:	without carburetor, intake silencer, fuel pump, exhaust system, type 377 : ..... 26,80 kg (59,0 lb.) type 447 : ..... 26,80 kg (59,0 lb.) type 503 : ..... 30,20 kg (66,6 lb.)
ADDITIONAL WEIGHTS:	carburetor with rubber socket and clamps: ..... 0,9 kg (2,0 lb.) Exhaust system assy. approx ..... 4,90 kg (10,8 lb.) Intake silencer with air filter ..... 0,84 kg (1,9 lb.) Electric starter kit, p.t.o. side ..... 3,42 kg (7,6 lb.) Electric starter kit, magneto side ..... 3,50 kg (7,7 lb.) Reduction gear-box, dry ..... 4,50 kg (9,9 lb.)

Section 19

19) Ignition setting:

IGNITION TIMING:	type 377: type 447: type 503:	2,10 mm ± 0,1 = .083 ± .004 (19 °) BTDC.
MAXIMUM DIFFERENCE BETWEEN CYLINDERS:		0,1 mm (.004 in)
CONTACT BREAKER POINTS GAP:		lower limit 0,30 mm (.012 in.) upper limit 0,40 mm (.016 in.)
BREAK-AWAY GAP:		13 - 17 mm (.5 - .7 in.)

Section 20

20) Piston - cylinder clearance:

PISTON/CYLINDER CLEARANCE: (NEW PARTS)	type 377:	0,09 mm (.0035 in.)
	type 447:	0,09 mm (.0035 in.)
	type 503:	0,08 mm (.0032 in.)

These service specs. are rounded to the nearest metric or inch. values.

Section 21

21) Main torquing specifications:

	Nm	in.lb.
1) Crankcase screws M8	22	195
2) Crankcase screws M6	10	90
3) Crankcase nuts (or screws) M10	38	335
4) Crankcase studs M10	10	90
5) Cylinder studs M8	7	60
6) Cylinder head nuts M8	22	195
7) Allen screws for stator plate M5	6	55
8) Fan housing allen screws M6	10	90
9) Fan nut M16 x 1,5	60	530
10)Magneto housing nut M22 x 1,5	90	800
11)Allen screws for starting pulley M8	22	195
12)Hex. screws for rewind starter M6	10	90
13)Hex. screws for cylinder cowling M8	15	135
14)Intake manifold screws M8	22	195
15)Intake manifold screws M6	10	90
16)Intake rubber flange screws M8	14	125
17)Spark plugs 14 (cold engine)	27	240
18)Hex. screws for starter gear M8	22	195
19)Lock nuts for electric starter M8	22	195
20)Taptite screws for ignition coil	6	55
21)Allen screws for adaptor M10	40	355
22)Studs for gear box M8	8	70
23)Hex. screw for drive gear 1/2-20 UNF	60	530

SUBJECT TO MODIFICATION WITHOUT NOTICE.

ENGINE TYPE: _____

SERIAL NO.: _____

PURCHASE DATE: _____

INSTALLATION IN: _____

_____

_____

DEALER IMPRINT AREA

BOMBARDIER-ROTAX GMBH

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