ROTAX®
AIRCRAFT ENGINES

INSTALLATION MANUAL

FOR ROTAX® ENGINE TYPE 912 SERIES

Ref. No.: IM-912

ROTAX® **912 ULS 3** WITH OPTIONS

part no.: 898642

⚠ WARNING

Before starting with engine installation, please read the Installation Manual completely as it contains important safety relevant information.

Approval of translation has been done to best knowledge and judgement - in any case the original text in german language is authoritative.

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3) Preface

In this Manual the installation of all ROTAX 912 Series engines is described.

◆ NOTE: ROTAX 912 Series includes 912 A, 912 F, 912 S, 912 UL, 912 ULS and 912 ULSFR.

Before starting with the engine installation, read this Installation Manual carefully. The Manual will provide you with basic information on correct engine installation, a requirement for safe engine operation.

If any passages of the Manual are not completely understood or in case of questions, please, contact an authorized Distribution- or Service Center for ROTAX engines.

BRP-Powertrain GmbH & Co KG (hereinafter "BRP-Powertrain") wish you much pleasure and satisfaction flying your aircraft powered by this ROTAX engine.

3.1) Remarks

This Installation Manual is to acquaint the owner/user of this aircraft engine with basic installation instructions and safety information.

For more detailed information on operation, maintenance, safety- or flight, consult the documentation provided by the aircraft manufacturer and dealer.

For further information on maintenance and spare part service contact the nearest ROTAX distributor (see section 3.3).

3.2) Engine serial number

On all enquiries or spare parts orders, always indicate the engine serial number, as the manufacturer makes modifications to the engine for further development.

The engine serial number is on the top of the crankcase, magneto side.

3.3) ROTAX Authorized Distributors for Aircraft Engines

See latest Operators Manual or in the Internet at the official Homepage **www.rotax-aircraft-engines.com**.

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4) Safety

Although the mere reading of these instructions will not eliminate a hazard, the understanding and application of the information herein will promote the proper installation and use of the engine.

The information and components-/system descriptions contained in this Installation Manual are correct at the time of publication. BRP-Powertrain, however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on its products previously manufactured.

BRP-Powertrain reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

The illustrations in this Installation Manual show the typical construction. They may not represent in full detail or the exact shape of the parts which have the same or similar function.

Specifications are given in the SI metric system with the USA equivalent in parenthesis. Where precise accuracy is not required, some conversions are rounded off for easier use.

4.1) Repeating symbols

This Manual uses the following symbols to emphasize particular information. These indications are important and must be respected.

▲ WARNING: Identifies an instruction which, if not followed, may cause serious injury including the possibility of death.

■ CAUTION: Denotes an instruction which, if not followed, may severely damage the engine or other component.

◆ NOTE: Indicates supplementary information which may be needed to fully complete or understand an instruction.

|| I A revision bar outside of page margin indicates a change to text or graphic.

4.2) Safety information

▲ WARNING: Only certified technicians (authorized by the local airworthiness authorities) and trained on this product are qualified to work on these engines.

▲ WARNING: Never fly the aircraft equipped with this engine at locations, airspeeds, altitudes, of other circumstances from which a successful no-power landing cannot be made, after sudden engine stoppage.
Unless correctly equipped to provide enough electrical power for night VFR (according latest requirement as ASTM), the ROTAX 912 UL/ULS is restricted to DAY VFR only.

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- This engine is not suitable for acrobatics (inverted flight, etc.).
- This engine shall not be used on rotor wing aircraft (helicopters) or any similar aircraft.
- It should be clearly understood that the choice, selection and use *of this* particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler and owner/user.
- Due to the varying designs, equipment and types of aircraft, BRP-Powertrain makes no warranty or representation on the suitability of its engine's use on any particular aircraft. Further, BRP-Powertrain makes no warranty or representation of this engine's suitability with any other part, component or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application.
- Unless in a run up area, never run the engine with the propeller turning while on the ground. Do not operate engine if bystanders are close.
- To prevent unauthorized use, never leave the aircraft unattended with the engine running.
- To eliminate possible injury or damage, ensure that any loose equipment or tools are properly secured before starting the engine.
- When in storage protect the engine and fuel system from contamination and exposure.
- Never operate the engine and gearbox without sufficient quantities of lubricating oil.
- Never exceed maximum rated r.p.m. and allow the engine to cool at idle for several minutes before turning off the engine.
- The engine should only be installed and placed into operation by persons familiar with the use of the engine and informed with regard to possible hazards.
- Never run the engine without a propeller as this will inevitably cause engine damage and present a hazard of explosion.
- Propeller and its attachment with a moment of inertia in excess of the specified value must not be used and releases engine manufacturer from any liability.
- Improper engine installation and use of unsuitable piping for fuel,- cooling,- and lubrication system releases engine manufacturer from any liability.
- Unauthorized modifications of engine or aircraft will automatically exclude any liability of the manufacturer for sequential damage.

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- In addition to observing the instructions in our Manual, general safety and accident preventative measures, legal regulations and regulations of any aeronautical authority must be observed.
- Where differences exist between this Manual and regulations provided by any authority, the more stringent regulation should be applied.
- This engine may be equipped with an other than the ORIGINAL-ROTAX vacuum pump. The safety warning accompanying the air pump must be given to the owner/operator of the aircraft into which the air pump is installed.

4.3) Instruction

Engines require instructions regarding their application, use, operation, maintenance and repair.

- Technical documentation and directions are useful and necessary complementary elements for personal instruction, but can by no means substitute theoretical and practical instructions.
- These instructions should cover explanation of the technical context, advice for operation, maintenance, use and operational safety of the engine.
- All technical directives relevant for safety are especially emphasized. Pass on safety instructions to other users, without fail.
- This engine must only be operated with accessories supplied, recommended and released by BRP-Powertrain. Modifications are only allowed after consent by the engine manufacturer.

■ CAUTION: Spare parts must meet with the requirements defined by the engine manufacturer. This is only warranted by use of GENUINE ROTAX spare parts and/or accessories (see Illustrated Parts Catalog).

They are available only at the authorized ROTAX Distribution- and Service Centers.

The use of anything other than genuine ROTAX spare parts and/or accessories will render any warranty relating to this engine null and void (see Warranty Conditions).

▲ WARNING: Engine and gear box are delivered in "dry" conditions (without oil). Before putting engine in operation it must be filled with oil. Use only oil as specified (consult Operators Manual and SI-912-016 "Selection of suitable operating fluids" current issue).

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▲ WARNING: Exclusively use tools and supplementary materials as listed in the Illustrated Parts Catalog.

▲ WARNING: This Manual for engine installation is only part of the Technical Documentation and will be supplemented by the respective Operators Manual, Maintenance Manual and Spare Parts List.

Pay attention to references to other documentation, found in various parts of this Manual.

4.4) Technical documentation

The information given in the

- Installation Manual
- Operators Manual
- Maintenance Manual (Line Maintenance)
- Maintenance Manual (Heavy Maintenance)
- Overhaul Manual
- Illustrated Parts Catalog (IPC)
- Alert Service Bulletin
- Service Bulletins
- Service Informations
- Service Letter

are based on data and experience that are considered applicable for professionals under normal conditions.

The rapid technical progress and variations of installation might render present laws and regulations inapplicable or inadequate.

The illustrations in this Manual are mere sketches and show a typical arrangement. They may not represent the actual part in all its details but depict parts of the same or similar function. Therefore deduction of dimensions or other details from illustrations is not permitted.

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5) List of the effective pages

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6) Table of amendments

Approval*

The technical content is approved under the authority of DOA Nr. EASA.21J.048.

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7) Description of design

7.1) Designation of type

Basic type

e.g. ROTAX 912 version 2:

version 2: with prop flange for fix pitch propeller

version 3: with prop flange with drive of hydraulic governor for constant speed propeller

version 4: with prop flange for fix pitch propeller, but prepared for retro-fit of hydraulic governor for constant speed prop (not supplied by manufacturer anymore)

Optional extras to the above stated basic type:

	external alternator	vacuum pump	drive for rev-counter/ hour meter	governor
for version 2	yes	yes	yes	no
for version 3	yes	no	yes	yes
for version 4	yes	yes	yes	no

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◆ NOTE: Conversion of the version 2 / 4 to version 3 may be accomplished by ROTAX Authorized Distributors or their Service Center.

7.2) Standard engine design

- 4 stroke, 4 cyl. horizontally opposed, spark ignition engine, single central camshaft hydraulic tappets - push rods - OHV
- liquid cooled cylinder heads
- ram air cooled cylinders
- dry sump, forced lubrication
- dual ignition of breakerless, capacitor discharge design
- 2 constant depression carburetors
- mechanical fuel pumps
- prop drive via integrated gear box with torsional shock absorber and overload clutch (optional on configuration UL2, UL4, ULS2 and ULS4)

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- expansion tank (coolant)
- electric starter (standard or with extended power output)
- integrated AC generator with external rectifier regulator
- oil tank
- external start relay
- drive of hydraulic governor (on version 3 only)

Auxiliary equipment (optional)

■ CAUTION: Any equipment not included as part of the standard engine version and thus not a fix component of the engine is not in the volume of supply.

Components especially developed and tested for this engine are readily available at BRP-Powertrain.

Following auxiliary equipment has been tested on ROTAX engine type 912 for safety and durability to the standards of aviation.

The furnishing of proof in accordance to the latest FAR or EASA has to be conducted by the aircraft manufacturer.

- airbox
- external alternator
- engine suspension frame
- vacuum pump (feasible on version 2 and version 4 only)
- drive for rev-counter / hour-meter
- oil cooler with connections
- coolant radiator
- coolant overflow bottle

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9) Preparations for engine installation

■ CAUTION: The stated directives are measures to pay CAUTION to at engine installation to prevent any accidents and engine damage.

9.1) Transport

The engine to be lifted by two hooks or straps around the middle (A) of the intake manifolds.

See chapter engine views, numbering of cylinders and definition of main axes.

9.2) State of delivery

The engine could be attached with to steel angles anchored on a timber plate.

■ CAUTION: The attachment screws are only for transport and must not be used in the aircraft.

9.3) Engine preservation

The engine is preserved at BRP-Powertrain thus warranting proper protection against corrosion for at least **12** month after date of delivery from BRP-Powertrain.

This warranty is subject to the following conditions:

- the engine has to be stored in the packing as supplied by BRP-Powertrain.
- the covers on various openings must not be removed (see section of protective covering)
- engine has to be stored in a suitable place (at min. - 40 °C (- 40 °F) and max. + 80 °C (+ 176 °F)).

If the engine is stored for a period longer than 12 month perform every 3 months the tasks given in the current valid Maintenance Manual, section "Preservation of a new engine".

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9.4) Protective covering

All openings are protected against ingress of contamination and dampness. It is recommended not to remove these plugs until installation of the specific feed line.

◆ NOTE: If the engine will be sent to the manufacturer or distributor reuse transport equipment and replug openings.

List of protective covering:

- exhaust socket: ..... 1x cone plug
- connection for manifold pressure: ..... 1x cap
- airbox: ..... 2x cap
- fuel pump inlet: ..... 1x cap
- connection for fuel return ..... 1x plug
- connection for fuel pressure ..... 1x plug
- oil supply and oil discharge: ..... 1x each cap
- supply and discharge of coolant: ..... 1x each cone plug
- propshaft on version 3: ..... 1x disk plug
- carburetor (if not equipped with an airbox): .. 2x disk plug

▲ WARNING: Protective covering to be utilized for transport and at engine installation only. Before engine operation remove these protections.

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10) Engine suspension and position

■ CAUTION: At installation of engine be aware of engine weight and assure careful handling.

The engine suspension is determined essentially by the aircraft design. Twelve attachment points are provided on the engine (8 on engine and 4 on engine frame).

The engine can be supplied with a well tried and certified suspension frame for attachment on the fire proof bulk head. The airbox is supported on this frame too. The installation into the aircraft is as generally practised by captive rubber mounts which ensure also to balance out vibrations and sound from engine to aircraft frame.

▲ WARNING: If the engine suspension frame supplied by BRP-Powertrain is not used or if modified, certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

It is recommended to use the ROTAX engine suspension frame and the 4 stated attachment points R2, L2, R3 and L3 .

▲ WARNING: At least 4 of the given anchorage points must be used in a side symmetrical pattern of the left (L) and right (R) side.

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10.1) Definition of attachment points

See Fig. 8.

Fig. 8

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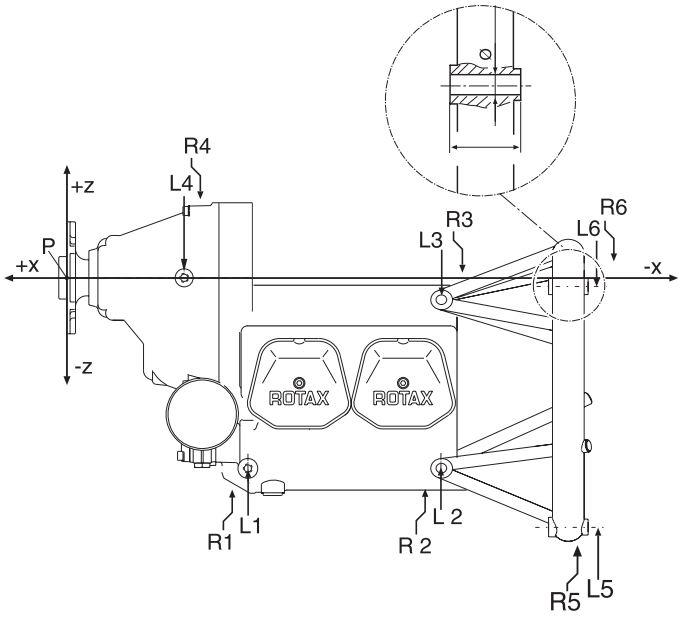

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	attachment point							
	L1	R1	L2	R2	L3	R3	L4	R4
thread size	M10							
max. usable thread length	25 mm						19 mm [1]	
							16 mm [2]	

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attachement point	Axes		
	x axis mm	y axis mm	z axis mm
L1	-200,8	71,0	-211,0
R1	-200,8	-71,0	-211,0
L2	-414,3	71,0	-211,0
R2	-414,3	-71,0	-211,0
L3	-414,3	75,0	-22,0
R3	-414,3	-75,0	-22,0
L4	-128,3	87,0	0
R4	-128,3	-87,0	0
L5	-564,0	105,0	-277,0
R5	-564,0	-105,0	-277,0
L6	-564,0	105,0	-7,0
R6	-564,0	-105,0	-7,0

[1] up to gearbox S/N 28986

[2] starting from gearbox S/N 28987

▲ WARNING: The engine suspension to be designed by the aircraft or fuselage manufacturer such that it will carry safely the maximum occurring operational loads without exceeding the max. allowable-forces and moments on the engine attachment points.

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Vertical axis:

- y-axis must be square to the longitudinal axis of the aircraft.

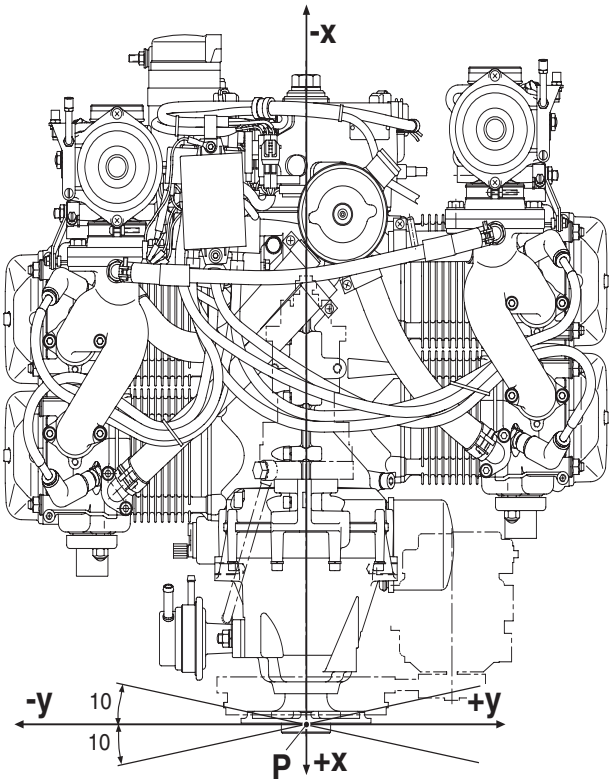

Fig. 11

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Tolerated roll deviation of Yaw tolerance: ± 10° (see Fig. 11)

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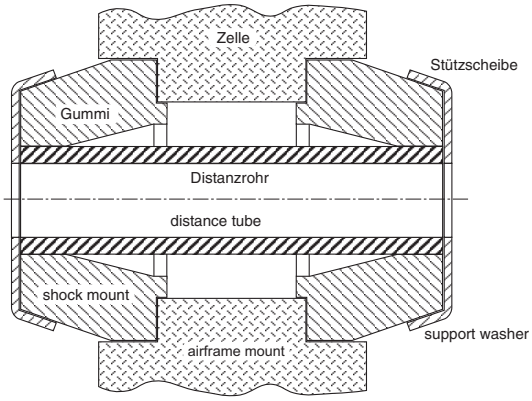
10.3) General directives for engine suspension

Rubber mounts to be used between engine and aircraft frame to neutralize vibrations.

Damping elements as generally used in the aircraft industry (e.g. LORD) are suitable. See Fig. 12.



◆ NOTE:
The Fig. shows rubber mount Lord J 3608-1 resp. J 3608-2.

▲ WARNING:
All elements to balance out vibrations have to be of captive design.

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Fig. 12

◆ NOTE: With suspension on the 4 top lugs L3, R3, L4 and R4 only, the tilting moment due to the pull of the propeller will be avoided while, if attached on the bottom lugs only, the moment of tilting has to be taken care of accordingly.

◆ NOTE: A certified engine suspension frame has been developed by BRP-Powertrain, especially for the magneto side engine attachment to the fireproof bulk head.

▲ WARNING: If the engine suspension frame supplied by BRP-Powertrain is not used the engine installation must by ground run tested to the specified loads and for vibration behaviour. Certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

▲ WARNING: The rubber mounts to neutralize vibrations and all the engine suspension components not in the supply volume must be ground run tested to the specified loads and for vibration behaviour. Certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

■ CAUTION: The engine suspension has to be designed to prevent any excessive engine movement and to minimize noise emission and vibration on air frame side.

See also SL-912-010 "Identifying abnormal vibrations on aircrafts", latest issue.

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11.2) operating limits

See Fig. 14.

- exhaust gas temperature (EGT):

  (both ignition circuits active) — nominal approx. 800 °C (1470 °F)

  max. 850 °C (1560 °F)

  max. 880 °C (1616 °F) at take off

  (readings of EGT taken approx. 100 mm (3.93 in.) from exhaust flange connections).

The exhaust gas temperatures (EGT) have to measured at the initial engine installation in an aircraft and must be verified in the course of test flights.

▲ WARNING: The exhaust system has to be designed and built such, that the operating temperatures are maintained and the max. exhaust gas temperatures will never be exceeded.

■ CAUTION: The listed engine performance is given at ISA ((15 °C) (59 °F)) conditions only on engine that is equipped with an unmodified ROTAX tuned exhaust muffler system and air intake box.

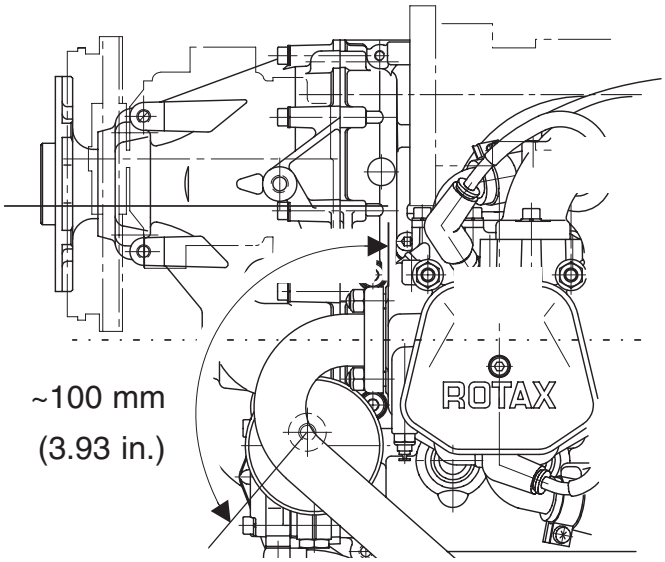

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Fig. 14

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11.3) General directives for exhaust-system

See Fig. 15.

A exhaust system, especially for universal application has been developed by BRP-Powertrain. Certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

The following recommendations should help the aircraft manufacturer to plan a suitable exhaust system.

◆ NOTE: These recommendations derive from years of experience and the results achieved are generally very good.

- A common transversal muffler serving all 4 cylinders and positioned under the engine is favourable.

◆ NOTE: Equal length of pipes from the cylinder to muffler is recommended for better tuning.

Distribution of the exhaust gases into 2 separate systems is not recommended. Single mufflers on either side cause power loss and increased noise emission.

- The 4 ball joints must be used to avoid damage due to vibration.

  Be aware that locked up stresses cause cracks!

  Attachment of exhaust bends by springs!

  Springs to be secured with safety wire to prevent FOD!

  All ball joints have to be greased regularly with heat resistant lubricant (e.g. LOCTITE ANTISEIZE) to avoid gripping and seizing of the joints.

■ CAUTION: Vibrations due to improper installation and maintenance is the most common reason for damage of the exhaust system.

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12) Cooling system

12.1) Description of the system

See Fig. 21.

The cooling system of the ROTAX 912 is designed for liquid cooling of the cylinder heads and ram-air cooling of the cylinders.

The cooling system of the cylinder heads is a **closed** circuit with an expansion tank and overflow bottle.

The coolant flow is forced by a water pump, driven from the camshaft, from the radiator to the cylinder heads. From the top of the cylinder heads the coolant passes on to the expansion tank (1). Since the standard location of the radiator (2) is below engine level, the expansion tank located on top of the engine allows for coolant expansion.

The expansion tank is closed by a pressure cap (3) (with pressure relief valve and return valve). At temperature rise and expansion of the coolant the pressure relief valve opens and the coolant will flow via a hose at atmospheric pressure to the transparent overflow bottle (4). When cooling down, the coolant will be sucked back into the cooling circuit.

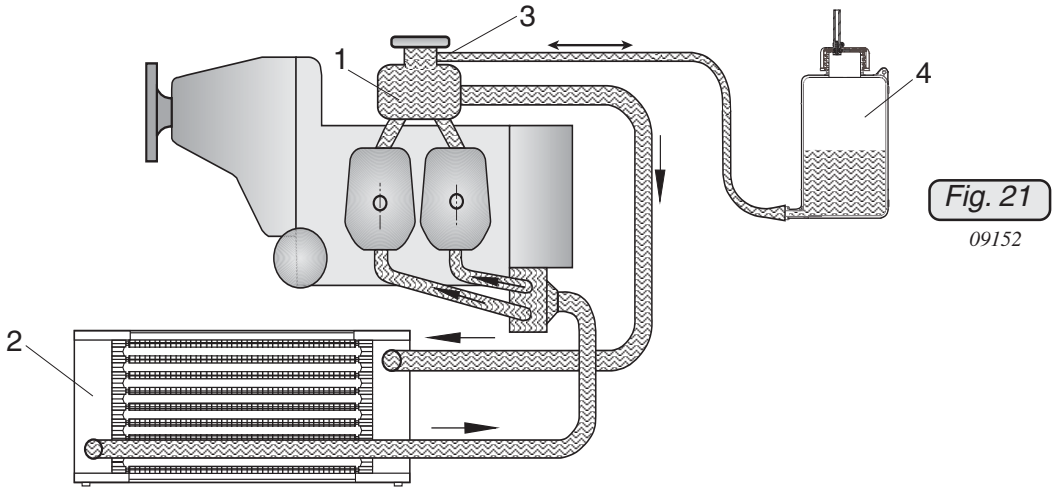

Fig. 21

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The shape, size and location of one or more radiators depend mainly on the space available.

On good installation in the airplane the radiator by BRP-Powertrain (optional) has enough cooling capacity to keep within the normal specified operating limits. Also the flow of coolant liquid through the radiator is not restricted and the tube size is sufficient.

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12.2) Operating Limits

Using conventional coolant:

Coolant temperature: (coolant exit temperature)

max.....120 °C (248 °F)

Cylinder head temperature:

ROTAX 912 UL/A/F: max.....150 °C (300 °F)

ROTAX 912 ULS/S: max.....135 °C (275 °F)

Permanent monitoring of coolant temperature and cylinder head temperature is necessary.

Using waterless coolant:

Cylinder head temperature:

ROTAX 912 UL/A/F: max.....150 °C (300 °F)

ROTAX 912 ULS/S: max.....135 °C (275 °F)

Permanent monitoring of cylinder head temperature is necessary.

Additional monitoring of the actual coolant temperature is possible but not necessary for waterless coolant.

▲ WARNING: The cooling system has to be designed so that operating temperatures will not be more than the maximum values.

Monitoring the cylinder head temperature is important to control the engine cooling and prevents detonation within the operating limits. It is also necessary to design the cooling circuit so that under no conditions the coolant does get near its boiling point, because a subsequent loss of coolant can quickly cause the engine to overheat.

The boiling point of the coolant is influenced mainly by:

- the type of coolant
- the proportion of the mixture (percentage water rate)
- the system pressure (opening pressure of radiator cap)

Correlation between coolant temperature and cylinder head temperature

There is in principle a regular relationship between coolant temperature and cylinder head temperature. The coolant transfers some of the combustion heat to the radiator. Thus, the coolant temperature is usually lower than the cylinder head temperature. But the temperature difference between coolant and cylinder head is not constant and can vary with different engine installation (cowling or free installation, tractor or pusher, flight speed, etc.).

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◆ NOTE: The basic requirement for safe operation is that boiling of conventional coolant must be prevented. The boiling point of conventional coolant is 120 °C (248 °F) with a 50/50 mixture proportion and a system pressure of 1.2 bar (18 psi).

12.3) Coolant types

In principle, 2 different types of coolant are permitted.

Type 1:

- Conventional coolant based on ethylene glycol

Conventional coolant is recommended as it is commonly available and has a greater thermal heat transfer capability. Its limitation is its lower boiling point.

Conventional coolant should be used with a mixture of 50 % concentrate and 50 % water.

◆ NOTE: Some conventional coolant is available pre-mixed by the manufacturer. In this case do not mix with water, follow the manufacturers instructions on the container.

Conventional coolant with a rate of 50% water cannot boil at a temperature below 120 °C (248 °F) at a pressure of 1.2 bar (18 psi). Thus, the coolant temperature limit is at max. 120 °C (248 °F).

Permanent monitoring of coolant temperature and cylinder head temperature is necessary.

Type 2:

- Waterless coolant based on propylene glycol

Waterless coolant is recommended if the design of the aircraft can not maintain the coolant temperature limit. Waterless coolant has a very high boiling point that prevents coolant loss due to „boiling over“ (vapor loss), but not to prevent detonation, which can occur with cylinder head temperatures higher than 150 °C (300 °F) (for ROTAX 912 UL/A/F) and 135 °C (275 °F) (for ROTAX 912 ULS/S). It does not require pressure to maintain its boiling point. Due to a lower thermal conductivity the engine temperature will typically run about 5-10 °C (41-50 °F) higher with waterless coolant.

Permanent monitoring of cylinder head temperature is necessary.

Additional monitoring of the actual coolant temperature is possible but not necessary for waterless coolant.

d04054

◆ NOTE: When using EVANS NPGR, NPG+ or added pure ethylene glycol as a coolant , note that these fluids have a flammability rating 1 (classification LOW at a scale from 0 to 4). The mentioned coolants are complying according to their material safety data sheet with a flammability classification, which has only low danger and a low risk of flammability. To date, no cases in engine operation or flight operation, laboratory conditions or from the field were reported, which show unsafe conditions of ROTAX aircraft engines in combination with the relevant coolants.

Marking of the coolant to be used

■ CAUTION: The coolant to be used and its concentration (percentage water rate) must be communicated to the owner in the correct form.

Waterless coolant must not mix with water, as otherwise it will lose the advantages of a high boilling point.

Example: EVANS NPG+. See Fig. 22.

1 Warning sticker
2 Radiator cap
3 Opening pressure information of radiator cap.

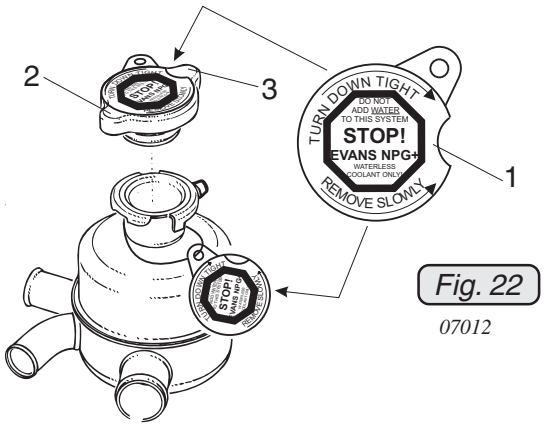


Fig. 22
07012

12.4) Check cooling system - Efficiency of the cooling system

For a measurement of the cooling system the maximum values for coolant exit temperature and cylinder head temperature must be found. According to the current specifications.

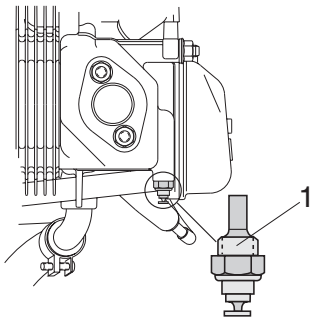


Fig. 23
00327

d04635

12.4.1) Measurement of cylinder head temperature and coolant exit temperature

There are two temperature sensors (1) (see Fig. 23) on the cylinder 2 and 3 for measuring the cylinder head temperature. During flight test the place with the highest cylinder head temperature must be found, this can vary with different engine installation (cowling or free installation, tractor or pusher, fight speed etc.).

The measuring of the coolant exit temperature is performed using a separate sensor, which has to be installed in the line between expansion tank (1) and radiator inlet (2).

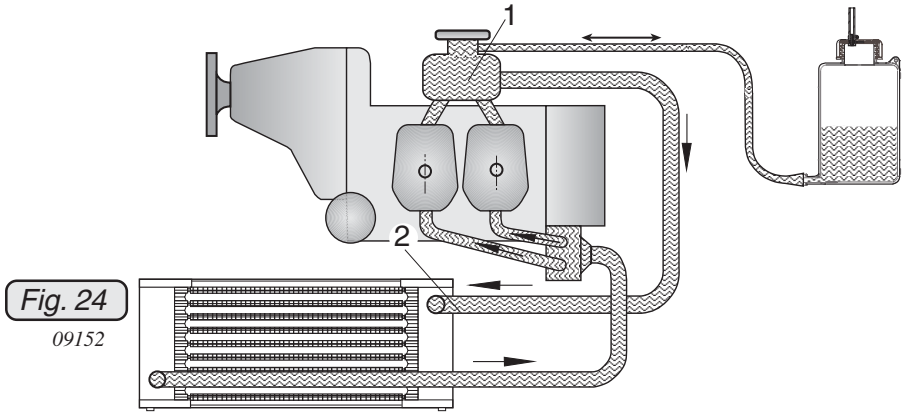


Fig. 24
09152

The sensor may be installed in a "TEE" inline with the fluid hose or the expansion tank may be modified to attach the sensor (not supplied by BRP-Powertrain).

▲ WARNING: Do not restrict the coolant flow with the sensor devise.

■ CAUTION: It is possible to receive a misleading reading when measuring fluid temperatures. If fluid volume is lost and the probe is not fully submerged in the fluid the display could show a lower temperature than actual (measuring air temperature instead of fluid temperature).

d04635

12.5) Determination of operating limits, Coolant and necessary modification on radiator installation

Depending on the achieved maximum values of the cylinder head temperature and the coolant temperature following action are necessary. *08358*

<table>
<tr><th colspan="2">maximum values for</th><th colspan="2">coolant used for tests</th></tr>
<tr><th>Coolant temperature</th><th>Cylinder head temperature</th><th>Conventional coolant</th><th>Waterless coolant</th></tr>
<tr><td>less than 120 °C (248 °F)</td><td>less than 135 °C [1] (275 °F)
150 °C [2] (300 °F)</td><td>Additional instruments for displaying coolant temperature is necessary
b)</td><td rowspan="2">Modifications to the instruments or limit not necessary
a)</td></tr>
<tr><td>more than 120 °C (248 °F)</td><td>less than 135 °C [1] (275 °F)
150 °C [2] (300 °F)</td><td rowspan="3">Cooling capacity too low. Check of the installation necessary
c)</td></tr>
<tr><td>less than 120 °C (248 °F)</td><td>more than 135 °C [1] (275 °F)
150 °C [2] (300 °F)</td><td rowspan="2">Cooling capacity too low. Check of the installation necessary
c)</td></tr>
<tr><td>more than 120 °C (248 °F)</td><td>more than 135 °C [1] (275 °F)
150 °C [2] (300 °F)</td></tr>
</table>

[1] engine type 912 ULS/S

[2] engine type 912 UL/A/F

a) Maximum cylinder head temperature is below operating limit. Operating with waterless coolant, is permissible without modification to the installation.

b) Maximum cylinder head temperature and coolant exit temperature is below operating limit.

For operating with conventional coolant it is necessary to monitoring constantly cylinder head temperature and coolant exit temperature.

◆ NOTE: For detection of possible indication error an additional monitoring of the cylinder head temperature is necessary which shows an exceedingin case of coolant loss.

The aircraft manufacturer has the option of converting the coolant temperature and the cylinder head temperature to an aircraft specific cylinder head temperature. This is possible by calculating the difference between the head material and the coolant temperature.

This is done by following the flight test procedure on page 53.

d04054

Expansion tank to overflow bottle hose:

- Hose connecting expansion tank to overflow bottle must be rated for vacuum/suction for min. 125 °C (257 °F). E.g. it must be strong enough to withstand high heat and suction during the cooling down period.

▲ WARNING: A soft walled hose is not suitable as it can collapse and cause coolant system failure.

12.7) Size and position of connections

See Fig. 26/27/28.

- expansion tank (1) with radiator cap (2)

to radiator (3):	outside dia. 25 mm (1")
slip-on length	max. 22 mm (7/8")
to overflow bottle (4):	outside dia. 8 mm (3/8")
slip-on length	max. 15 mm (9/16")

■ CAUTION: The hoses have to be fixed with appropriate clamps to prevent loss. E.g. with spring type clamps as used already for the water tubes between water pump and cylinder. Good field experience has been made with this type of clamps.

◆ NOTE: See therefore also SI-912-020 "Running modifications", latest issue.

The aircraft manufacturer has to carry out the check of coolant level in the expansion tank and note it in the daily inspection section of his flight manual according latest issue of Operators Manual ROTAX 912.

It is recommended to make adequate precautions for accomplishment of these inspections, e.g. a flap or panel on the cowling or a warning instrument in the cockpit for low coolant level.

d04635

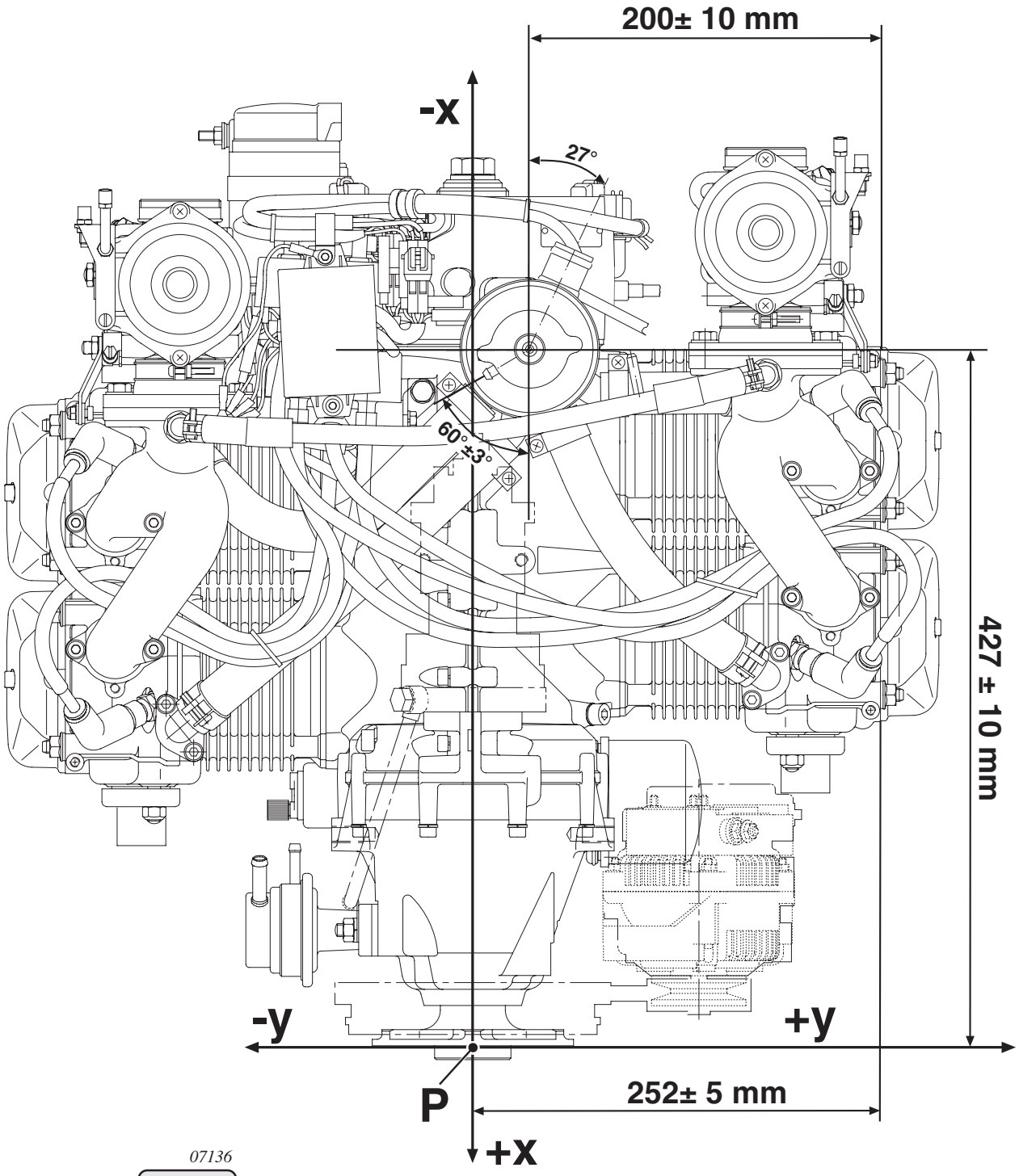


Fig. 26

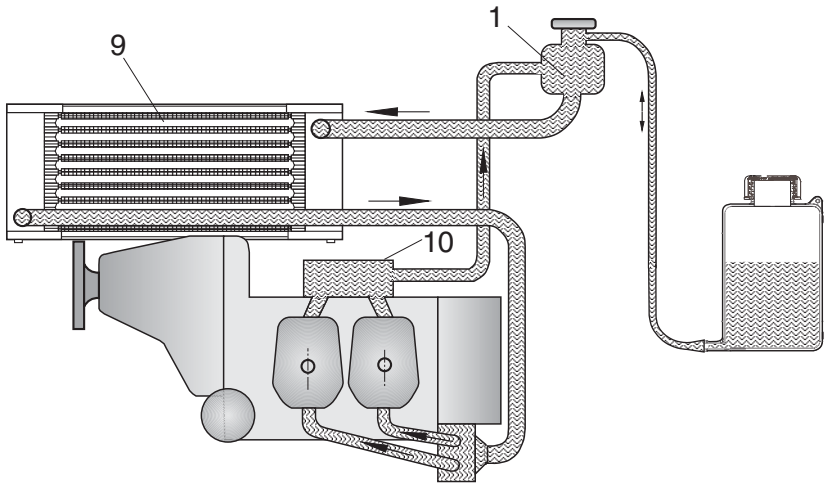
d04054

12.9) General directives for the cooling system

See Fig. 29.

BRP-Powertrain offers essential parts of the cooling system for this engine such as radiator, etc..

▲ WARNING: Certification to the latest requirements to FAR or EASA has to be conducted by the aircraft manufacturer.



08320

Fig. 35

In an installation as depicted with the radiator (9) in a higher position than the standard supplied expansion tank, a water accumulator (10) has to be fitted instead of the expansion tank. Additionally a suitable expansion tank (1) has to be installed at the highest point of the cooling circuit.

■ CAUTION: The size and type of radiator should be adequate to transfer thermal energy of

approx. 25 kW (24 BTU/s) (for ROTAX 912 A/F/UL) or

approx. 28 kW (26,5 BTU/s) (for ROTAX 912 S/ULS)

at take-off power.

◆ NOTE: Assessment data by experience. For troublefree operation at good airflow a radiator of at least 500 cm^2 (78 in^2) area has to be used.

The flow rate of coolant in the cooling system is approx. 60 l/min (16 US gal/min) at 5800 rpm. As reference value for the necessary cooling airflow approx. 0,75 m^3/s at full load can be assumed.

The flow resistance of the coolant in the optional ROTAX-radiator is properly designed for the cooling system.
Check flow rate and cooling capacity if other radiators are used.

d04635

No provision has been made for attachment of the radiator(s) on the engine.

■ CAUTION: Install the radiator without distortion or stressand free of vibrations (rubber mounts are recommended).

At installation of a non-original ROTAX radiator take care of sufficient cooling capacity. See section 12.7

d04054

12.10) Coolant capacity

4 cylinder heads: ..... 560 cm^3 (34.1 in^3)

water pump: ..... 100 cm^3 (6.10 in^3)

expansion tank: ..... 250 cm^3 (15.2 in^3)

2 m coolant hose
(18 mm (.71 in) inside dia.) : ..... 500 cm^3 (30.5 in^3)

total coolant quantity in engine: ..... approx. 1,5 l (0.4 gal (US))

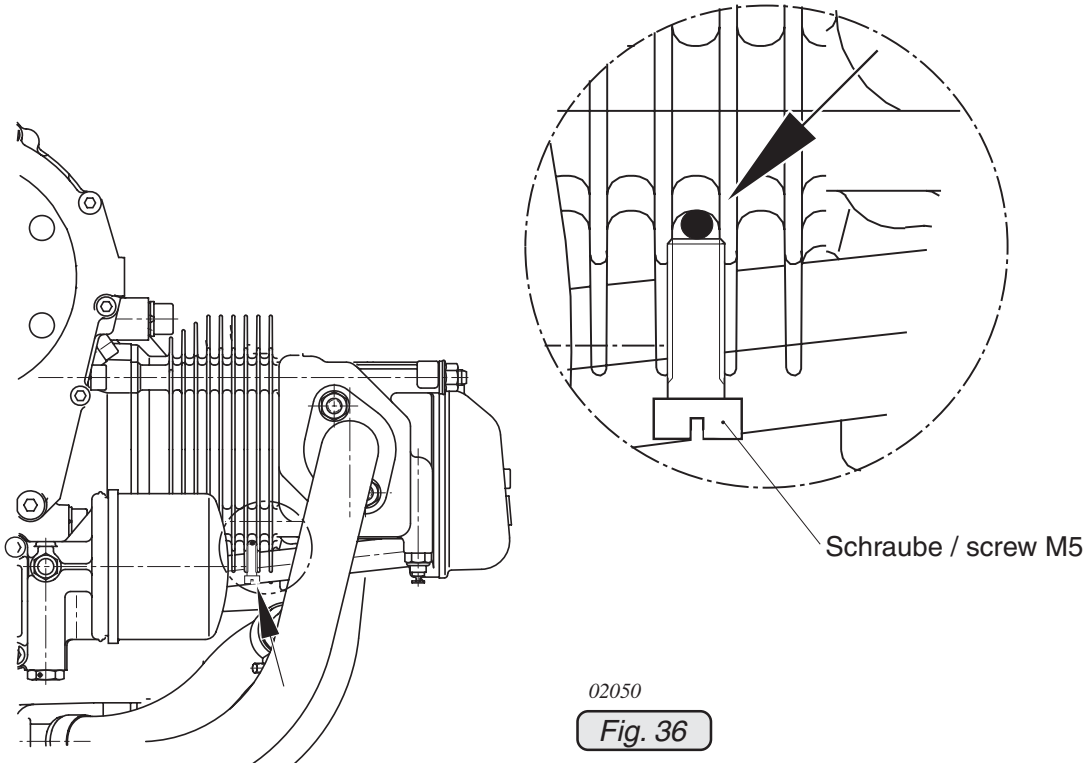
12.11) Cooling air ducting

Contrary to the cylinder heads, the cylinders are ram air cooled. Plan cooling air ducting according to installation requirement.

▲ WARNING: The cooling air ducting has to be designed and built such, that the operating temperatures are kept within the specified limits and maximum values are not exceeded.

This must also be warranted at "**hot day conditions**"!

Max. permissible cylinder wall temperature on cylinder 2....200 °C (392 °F) (see Fig. 36).



d04054

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Fig. 36

12.11.1) General directives for ducting of the cooling air

See Fig. 2/3/4.

For front installation in a closed fuselage, ducting of cooling air to the cylinders is recommended. In this case a costly horizontal partitioning (baffles) can be avoided.

◆ NOTE: The engine remains in this case completely on the warm side of the engine compartment and is very well accessible. In special cases a separate cold air supply to the air intake filters has to be provided.

BRP-Powertrain has developed especially for this application a non-certified cooling air ducting.

▲ WARNING: Certification to the latest requirements to FAR or EASA has to be conducted by the aircraft manufacturer.

The following recommendations should assist the aircraft manufacturer at the planning of a suitable cooling air ducting.

- The cooling air ducting to be adequate to transfer thermal energy of approx. 6 kW (5,7 BTU/s) at take-off power.
- required cross section of air duct: at least 100 cm^2 (16 in^2)
- material:
  glass fibre reinforced plastic or heat resistant non-inflammable material.
- attachment:
  formlocking on engine case and cylinders

◆ NOTE: In case formlocking attachment won`t be adequate, additional attachment is possible on two tapped lugs M8 on top side of engine.

d04635

13.3) Checking of the lubrication system

To control the proper function of the lubrication system the following readings have to be taken on the running engine as part of the test/qualification procedure.

◆ NOTE: The required pressure gauges and connection parts are not included in the BRP-Powertrain engine delivery.

13.3.1) Measuring of the vacuum

Measuring of vacuum in the oil suction line (1) (line from oil tank to oil pump via oil cooler) at a max. distance of 100 mm (4 in) from pump inlet (2).

At take-off performance the indicated vacuum (3) must not be more than 0,3 bar (4.35 psi) otherwise the oil hose (1) could collapse and thus blocking the oil supply to the engine (Fig. 41).

▲ WARNING: The vacuum (3) must be verified over the total range of engine operation. Specially on cold oil temperature the flow resistance increases, so that not enough oil can flow on suction side.

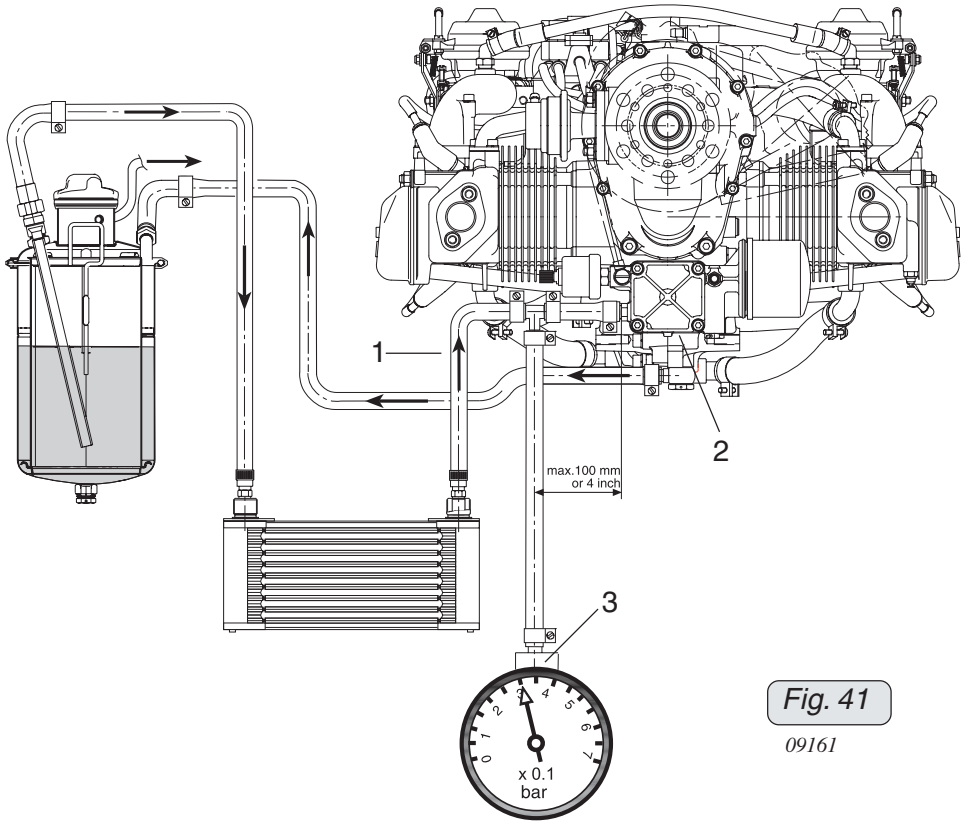

Fig. 41

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max. 0.3 bar (4.35 psi) below atmospheric pressure

13.3.2) Measuring of the pressure in the crankcase

Measure of the mean crankcase pressure at full load (blow-by gas pressure) responsible for proper oil return from crankcase to oil tank.

A pressure indicator (4) (pressure gauge with incorporated viscous damper) may be fitted instead of the magnetic plug (5) or the crankshaft locking screw (6) (see Fig. 42).

◆ NOTE: The connecting thread is M12x1.5 (metric) for the magnetic plug and M8 for the crankshaft locking screw (use always new gasket).

The pressure in the crankcase at full load must not exceed the prevailing ambient pressure by more than 0,45 bar (6.53 psi) at 90 °C (194 °F) oil temperature.

If both pressure readings are within the specified limits, under all operating conditions, the lubrication circuit should be working sufficiently.

▲ WARNING: If the readings exceed the pressure limits then the flow resistance of the oil from oil sump to oil tank (contamination, restrictions of cross-section etc.) is too high. This condition is unsafe and must be rectified without delay.

max. 0,45 bar (6.53 psi) above atmospheric pressure

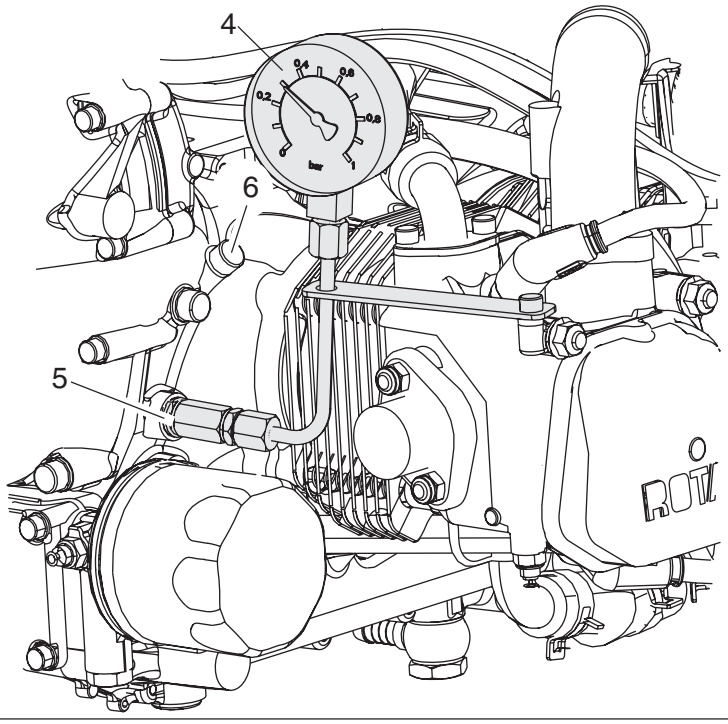

Fig. 42

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Oil pump inlet nipple (2): outside dia ..... 13,2 mm (0.52 in.)
slip-on length...max. 21 mm (0.83 in.)

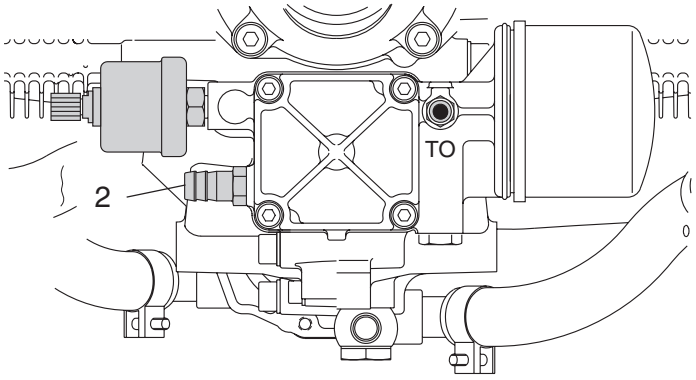

Fig. 45
00226

Oil pump (inlet) (3) ..... thread 3/4-16 UNF (AN-8)
Tightening torque of inlet line: .. 25 Nm (18.5 ft.lb)

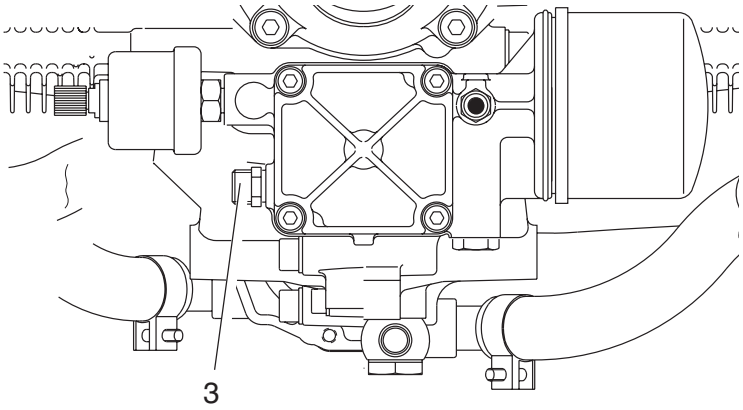

Fig. 46
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Oil return

■ CAUTION: The engine design is for a conventional, non-aerobatic, fixed wing tractor or pusher type configuration with the oil return port in the optimum position. With this consideration the engine is properly lubricated in all flight profiles. Aircraft that are not conventional (e.g. airship, gyrocopters, dive brake equipped aircraft etc.) that require engine load in steeply incline and decline angles (see also sec. 8.1, point 12) may require special lubrication considerations.

According to propeller configuration and oil system layout choose the appropriate connection for the oil return line.
Position **1** for tractor or position **2** for pusher configuration and connector-options (1), (2) and (5). See Fig. 47.

Option 1: - connection with slip-on connection (1):

hose nipple (3) ..... 10 DIN 7642
outside dia. ..... 13,5 mm (.53 in)
slip-on length ..... max. 24 mm (max. .94 in)

Tightening torque of banjo bolt (4) M16x1,5x28: ..... 30 Nm (22 ft.lb)

Option 2 and 3:-connection with screw connection (2) or (5):

- connection with screw connection (2):

thread ..... 3/4-16 UNF (AN-8)

Tightening torque of oil return line: ..... 25 Nm (18.5 ft.lb)

Tightening torque of screw connection (2) M16x1,5: . 25 Nm (18.5 ft.lb)

- connection with screw connection (5):

thread ..... 3/4-16 UNF (AN-8)

Tightening torque of oil return line: ..... 25 Nm (18.5 ft.lb)

Tightening torque of banjo bolt (4) M16x1,5x28: ..... 30 Nm (22 ft.lb)

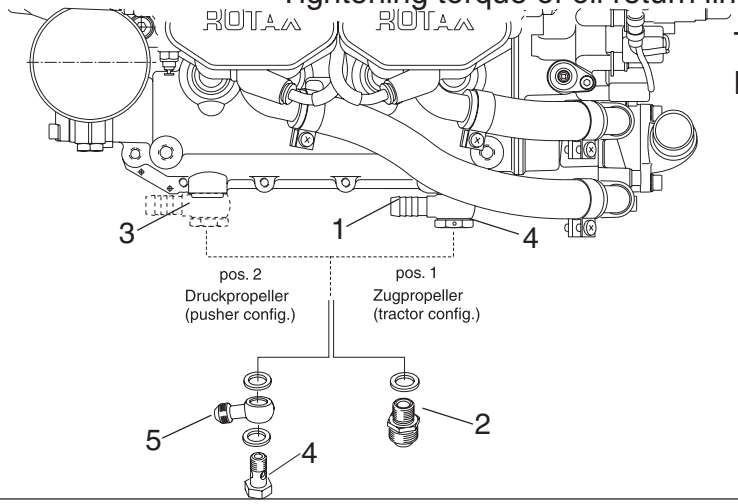

Fig. 47

08634

d04636

13.7) Feasible position and location of the oil cooler

See Fig. 50.

- On principle the oil cooler (5) has to be installed below the oil pump of the engine.

■ CAUTION: The oil cooler has to be installed with connections upwards i.e. in positive direction on z-axis. This will prevent an unintentional draining of the oil cooler at longer engine stop.

■ CAUTION: This will prevent an unintentional draining of the oil cooler at longer engine stop.

▲ WARNING: The oil cooler has to be planned and installed such that the specified operating temperatures are maintained and the max. values are neither exceeded nor fall below.

This state has to be warranted for **"hot day conditions"** too!

If need be, take appropriate measures like changing size of cooler, partial covering of cooler etc.

13.8) General notes on oil cooler

BRP-Powertrain offers for this engine an oil cooler (see Illustrated Parts Catalog, latest issue).

▲ WARNING: Certification of this cooler to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

■ CAUTION: The oil cooler has to be designed to dissipate approx. 8 kW (7,58 BTU/s) heat energy at take-off power.

◆ NOTE: From years of experience we recommend an oil cooler size of at least 160 cm^2 (25 in^2), provided that air flow is adequate.

■ CAUTION: The oil cooler must not restrict oil flow. Test system as per sec 13.3.

13.9) Filling capacity

- Oil quantity **without** oil cooler and connecting lines min. 3 l (0,8 US gal) depending on the respective installation

  Volume of oil tank

  up to the MIN.-mark ..... approx. 2,5 l (0.66 US gal)

  up to the MAX.-mark ..... approx. 3,0 l (0.8 US gal)

- Perform oil level check and add oil if necessary

d04636

13.10) Purging of lubrication system

See Fig. 51.

- Verify that oil tank connections are connected correctly and secured, and that the oil cooler (if fitted) is in the suction line (1) between the oil tank and the oil pump inlet. Verify that the oil tank is filled up to the maximum level (to the top of the flat portion of the dipstick). Additional oil (up to 0.5 litre) may be added to the tank for the purpose of this procedure.

■ CAUTION: Incorrectly connected oil lines to the oil tank or to the engine will result in severe engine damage.

- Disconnect oil line (2) at the oil tank connection.
- Place the free end (3) of the return oil line into a suitable container (4) below the engine.
- Plug open connection (5) at the oil tank with suitable air tight cap. See Fig. 51.
- Remove the spark plug connectors.
- For easier rotation of engine remove one spark plug from each cylinder.

■ CAUTION: Prevent entering of foreign substance through spark plug hole.

- Using a compressed air line, pressurize the oil tank through its breather connection (6) (on the neck of the tank). Adjust the compressor outlet regulator so that the air line pressure is between 0,4 (6 psi) and 1 bar (15 psi). Do not exceed 1 bar (15 psi).

◆ NOTE: Oil tank cover is not designed to hold pressure. Some air will escape.

▲ WARNING: Do not remove oil tank or cover before ensuring that air pressure has been completely released from the tank.

- The pressure in the oil tank has to be maintained during the following step.

■ CAUTION: It is possible to empty the oil tank and as a result introduce more air into the oil system. Pay attention to the oil level and fill tank as required.

- Turn the engine by hand in direction of normal rotation until the first pressure indication on the oil pressure gauge. Normally this will take approx. 20 turns. Depending on installation it may take up to 60 turns.

■ CAUTION: Do not use starter for this purpose. Fit propeller and use it to turn engine.

d04055

14.4) Connecting dimensions, location of joints and directives for installation

14.4.1) fuel manifold

See Fig. 2, 3, 4 and 55.

- position of z4 axis of the fuel manifold:

◆ NOTE: Dimensions always from point of reference (P).

- return line to tank (5):

  outside dia. ..... 7 mm (.28 in.)

  slip-on length: . max. 17 mm (.67 in.)

- pressure gauge connection (6):

  outside dia. ..... 6 mm (.24 in.)

  slip-on length: . max. 17 mm (.67 in.)

- fuel pressure switch connection (9):

  thread M10

  thread length: .. max. 9 mm (.35 in.)

  Tightening torque: 15 Nm (135 in.lb) and Loctite 221.

■ CAUTION: At loosening or tightening of the banjo bolt (7) (tightening torque 10 Nm = 90 in.lb.) support the fuel manifold appropriately.

◆ NOTE: The connection nipple (5) is furnished with an orifice (8) (0,35 mm = 0.014 in.) essential for operation of the fuel system.

If the pressure gauge connection (6) is not used and a hose nipple (10) installed, the banjo bolt assy. (11) marked with a colour dot or marked "FUEL" is furnished with an orifice (12) (0,35 mm = 0.014 in.). This is essential for operation of the fuel system as it prevents a loss in fuel pressure.

02772

	coordinates [mm]		
clamp block	x axis	y axis	z axis
	-385,0	-50,0	ca.110

d04637

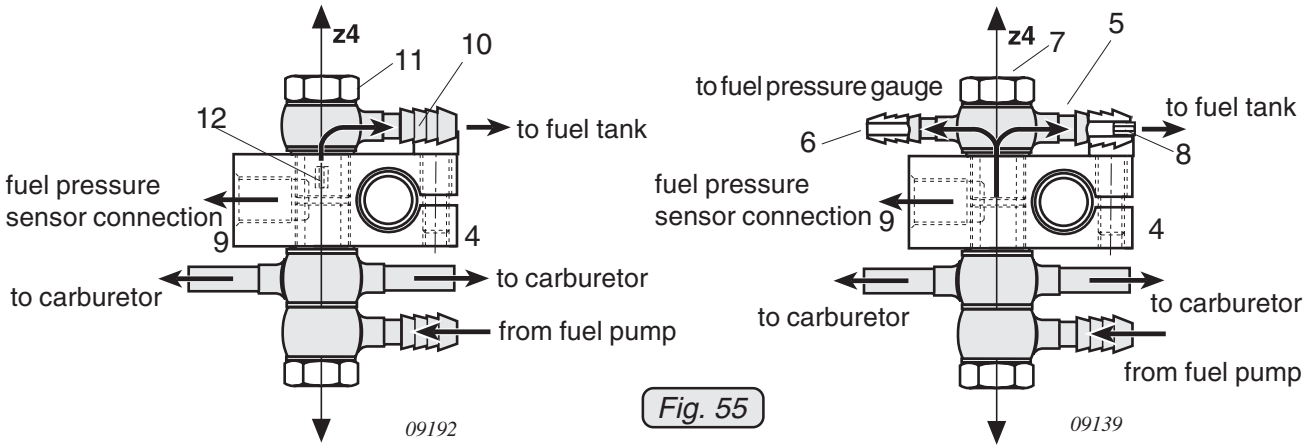

Fig. 55

14.4.2) Fuel pressure control

See Fig. 56 and 57.

- hose connection on fuel pump (1) inlet by slip-on joint. See fig. 56.

  Fuel intake connection (9)

  outside dia. ..... 9 mm (.35 in.)

  slip-on length: . max. 24 mm (.95 in.)

  Fuel outlet connection (10)

  outside dia. ..... 6 mm (.24 in.)

  slip-on length: . max. 24 mm (.95 in.)

■ CAUTION: Ensure at installation of the supply line to fuel pump that no additional moments or load will rest on the pump!

■ CAUTION: Utilize max. slip on length. Secure hoses with suitable screw clamps or crimp.

- hose connection on fuel pump (2) supplied with fire sleeved lines. See fig. 57.

  Fuel intake connection (12):

  fitting (15) ..... 9/16-18 UNF (AN-6)

  Tightening torque: 15 Nm (135 in.lb)

  Fuel outlet connection (13)

  hose nipple (14) 3/4 DIN 7642

d04056

15) Carburetor

See Fig. 58.

The carburetors on the standard engine are already attached by a flexible flange (and connecting hoses on the airbox). Only connections of the Bowden cable for pre-heating, choke and throttle have to be established.

It is recommended, to make the adjustment of the Bowden cable after engine installation has been completed, to ensure exact final adjustment.

▲ WARNING: The carburetor flange assembly has to carry the weight of the carburetor and intake system. Ensure that the screw of the clamp is positioned on the underside as supplied and the gap between the clamp plates is 8 mm (.31 in).

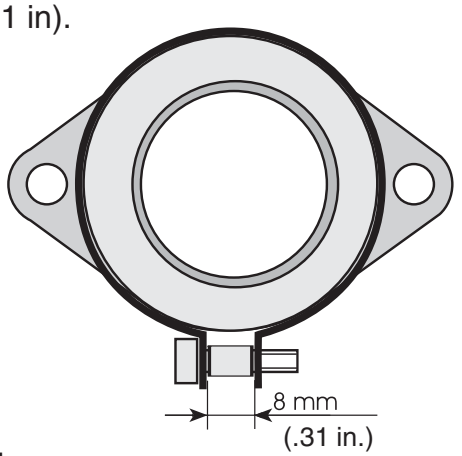

Fig. 58

05794

15.1) Requirements on the carburetor

See Fig. 59.

The carburetors are positioned above the exhaust sockets. Below the carburetors one each drip tray (1) with a draining connection (2) is fitted which serves as a heat shield as well.

■ CAUTION: The float chamber venting lines (3) lines have to be routed into a ram-air and vacuum free zone or into the airbox, according to the requirements and release of BRP-Powertrain. See section 16. These lines must not be routed into the slipstream or down the firewall.

Pressure differences between intake pressure and pressure in the carburetor chambers may lead to engine malfunction due to incorrect fuel supply.

▲ WARNING: In the area of the float chamber the temperature limit of the fuel must not be exceeded.

If necessary install additional insulation or heat shields. Certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

d04638

15.1.1) Drainage piping on airbox and drip trays

▲ WARNING: Connect drainage lines well, otherwise emerging fuel from a possible leakage could drip onto the exhaust system. RISK OF FIRE!

- The lines have to be routed such that in case of a damage the surplus fuel is drained off suitably.
- Route the lines without kinks and avoid tight bends
- Route the lines with a continuous decline.
- The lines have to be protected against any kind of blockage e.g. by formation of ice.

■ CAUTION: With closed or blocked leakage piping, fuel could end up on exhaust system. RISK OF FIRE!

■ CAUTION: The float chamber venting lines (3) lines have to be routed into a ram-air and vacuum free zone or into the airbox, according to the requirements and release of BRP-Powertrain. See section 16. These lines must not be routed into the slipstream or down the firewall.

Pressure differences between intake pressure and pressure in the carburetor chambers may lead to engine malfunction due to incorrect fuel supply.

Connecting nipple (2) for leakage line

outside dia. ø	6 mm (1/4")
slip on length	max. 17 mm (11/16")

d04638

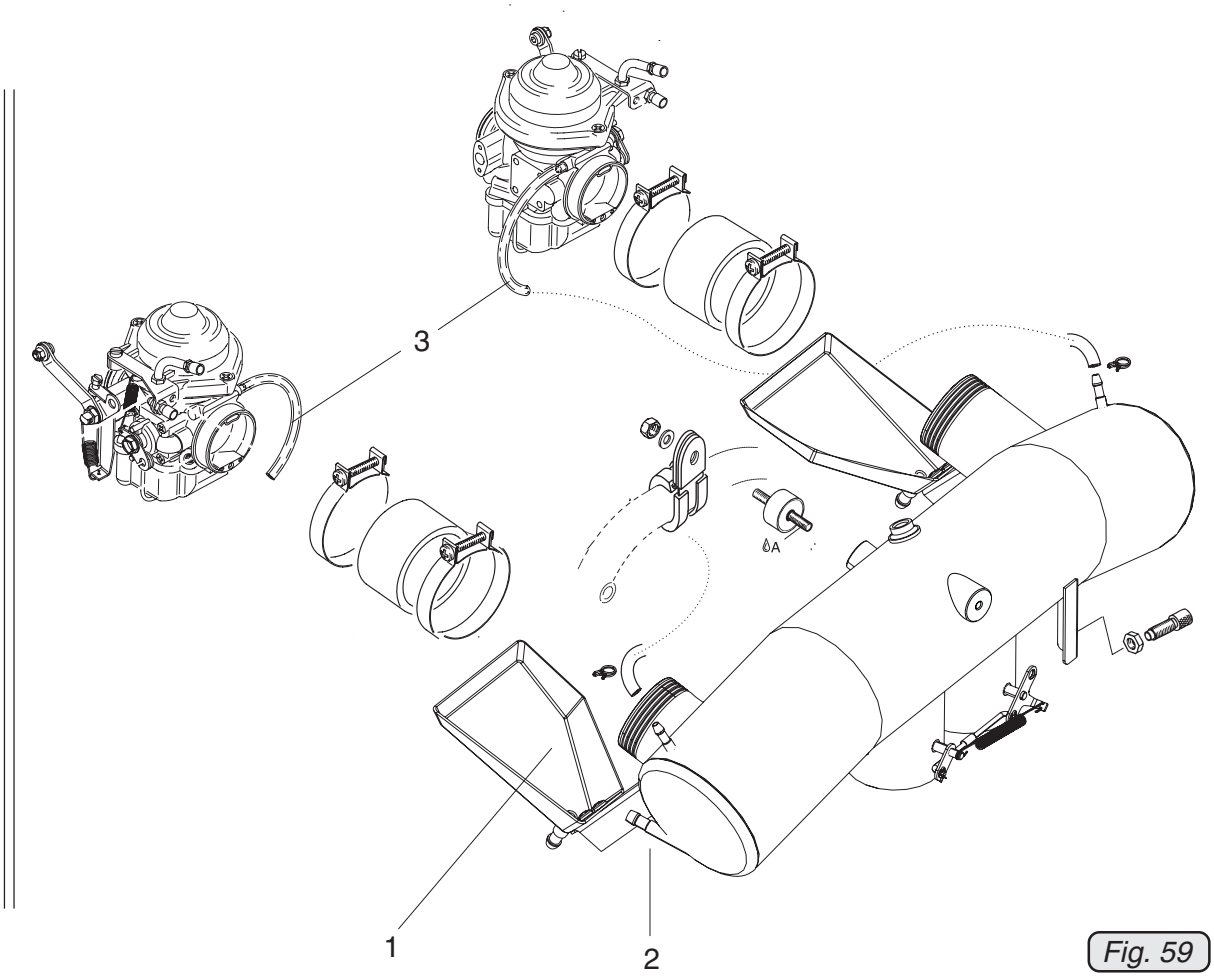

Fig. 59

08644

d04638

15.2) Connections for Bowden-cable actuation and limit load.

See Fig. 2, 3, 4, 60 and 61.

- centre position of carburetor socket (P1) of the respective carburetor:

◆ NOTE: All dimensions to point of reference (P)

- limit load on point of reference P2

■ CAUTION: The specified limit loads must never be exceeded.

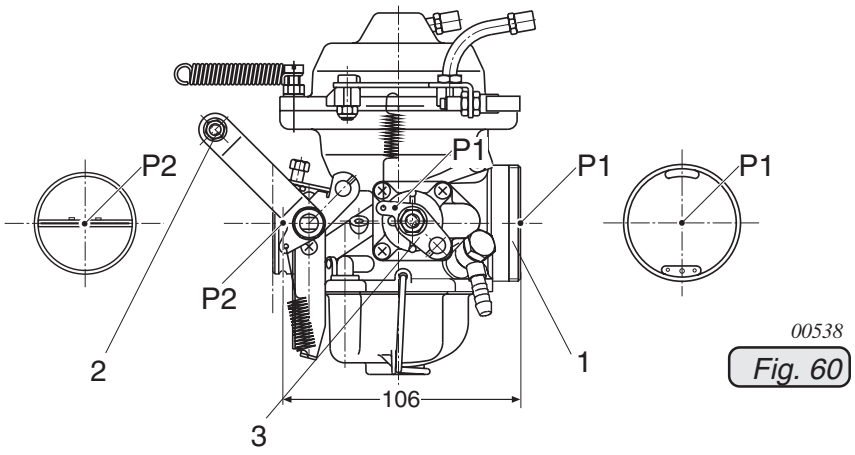

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Fig. 60

	reference point P2
max. allowable forces (limit load) in (N) in x,y and z axis	60
max. allowable bending moments (limit load) in (Nm) in x,y and z axis	4

02028

	coordinates P1 [mm]		
carburetor for	x Achse	y Achse	z Achse
cylinder 1/3	-521	-180	25
cylinder 2/4	-553	180	25

09190

- connection (1) for air filter or intake silencer

outside dia.:	50 mm (2 in.)
slip-on length:	12 mm (.47 in.)

- connection for throttle actuation (2)

connection on throttle lever:	set screw M 5x12 tightening torque: 4 Nm (35 in.lb) (suitable for 1,5 mm (.06 in.) steel wire)
action travel:	65 mm (2 $^{1}/_{2}$")
actuating force:	min. 1,5 N (.3 lb) max. 8 N (1,8 lb)
limit load:	20 N (4,5 lb)

◆ NOTE: Throttle opens by spring.

d04057

16) Air intake system

See Fig. 64.

The intake system is determined essentially by the demands of engine and of the acceptable noise emission on the intake side. An airbox can be supplied by BRP-Powertrain as an option.

Performance data as specified and limits of operation can only be warranted by employment of the genuine ROTAX airbox.

■ CAUTION: The performance is given at ISA (15 °C) (59 F°) condition only. Engine is equipped with unchanged ROTAX tuned exhaust muffler system and air intake box.

If it will be necessary to use a different airbox or a modified genuine ROTAX airbox for reasons of installation the certification to the latest requirements such as FAR and EASA has to be conducted by the aircraft manufacturer.

◆ NOTE: If an airbox or genuine ROTAX airbox is retrofitted at a ROTAX 912 (A, F, UL) Series, a change in the carb jetting is required. See Illustrated Parts Catalog 912/914 chapter 22 and/or SB-912-044 "Use of the ROTAX supplied airbox", latest issue.

16.1) Operating limits

Fuel-mixture distribution:
Low (cold) air temperature in the airbox is favourable for engine performance and to reduce knocking tendency at combustion.

The certification to the latest requirements such as FAR and EASA has to be conducted by the aircraft manufacturer.

■ CAUTION: Any changes on the air intake system (e.g. modification on the airbox etc.) can affect the flow rate in the air intake system and the fuel mixture ratio. In the course of certification the fuel mixture process must be proofed by a CO-measurement.

CO-Measurement:

CO-Emission ..... min. 3,0 % CO (wide open throttle (WOT);
an rpm of min. 5200 1/min needs to be achieved)

Measurement in original configuration of aircraft e.g. with installed cowling.

Measured on each single cylinder. Measuring point is the same as the EGT-measurement. See section "Exhaust system".

d04639

16.2) Requirements on the air intake system

▲ WARNING: Carb icing is a common reason for engine trouble. No implements are included in the supply volume for preheating of the intake air.

If an airbox of not ROTAX origin is used provisions for preheating the intake air have to be made to prevent formation of ice in the intake system.

Preheating of the intake air will result in performance loss because of the lower air density.

▲ WARNING: All items of the air intake have to be secured against loss.

▲ WARNING: The certification to the latest requirements such as FAR and EASA has to be conducted by the aircraft manufacturer.

Air intake socket (1) for fresh air or pre-heated air (intake side)

outside dia. ø ..... 60 mm (2 3/8")
slip-on length ..... max. 25 mm (1")

■ CAUTION: Utilize the full slip-on length on all connection. Secure hoses by suitable spring type clamp or screw clamp.

16.2.1) Requirements on the intake air ducting

- max. length of ducting 500 mm (20 in.)
- min. inside dia. at least outside dia. of the intake socket on airbox
- min. mean bending radius 100 mm (4")

High engine performance needs air temperature as low as possible at air intake. Therefore the air filter should be located in a recess of the engine cowling or separated from warm air by baffles such that fresh air can be aspirated.

16.2.2) Airfilter

■ CAUTION: A minimum flow rate of 6,23 m^3/min. (220 cfm) has to be warranted for all conditions.

The pressure loss must not exceed 2 hPa.

▲ WARNING: Use only filter elements which will not tend to restrict the flow when in contact with water.

BRP-Powertrain offers an air filter as described below.

d04639

▲ WARNING: The certification to the latest requirement such as FAR and EASA has to be conducted by the aircraft manufacturer.

The following points should assist the aircraft manufacturer at the choice of a suitable filter:

- four fold cotton fabric
- surface covered with metal screen
- total filter area at least 1400 cm^2 (220 in^2)
- a min. flow rate of 6,23 m^3/min. (220 cfm)

16.2.3) Airbox

See Fig. 64.

- volume at least 2,5 l (.66 US gal)
- outline dimension see Fig. 64

The airbox is furnished with 2 drain holes (1) at the lowest position possible.

The holes are necessary to drain fuel from flooding float chambers caused by badly closing float valve.

Drainage lines:

▲ WARNING: Connect draining lines without fail, otherwise emerging fuel could drip onto the exhaust system. RISK OF FIRE!

- The lines have to be routed such that in case of damage the surplus fuel is drained away suitably.
- Route the lines without kinks and avoid narrow bends.
- Route the lines with a continuous decline.
- The lines have to be protected against any kind of blockage e.g. by formation of ice.

■ CAUTION: With closed or blocked drainage bores fuel could flow into combustion chamber, possibly ruining the engine by hydraulic lock or emerging fuel could drip onto the exhaust system. RISK OF FIRE! .

d04058

■ CAUTION: The drainage lines (1) lines have to be routed into a ram-air and vacuum free or into the airbox, according to the requirements and release of BRP-Powertrain. See also section 15. These lines must not be routed into the slipstream. If the drainage lines of the airbox are connected with the drainge lines of the drip trays or the carburetors by a T-piece, these lines must not be routed down the firewall (drainage lines of the airbox spearately are allowed).

Pressure differences between intake pressure and pressure in the carburetor chambers may lead to engine malfunction due to incorrect fuel supply.

Connecting nipple (1) of drainage line

outside dia. ø ..... 6 mm (1/4")
slip-on length ..... max. 17 mm (11/16")

Provide connection to take readings of manifold pressure (2)

Provide connections for temperature sensor (3)

Outside diameter ..... 6 mm (.24 in.)

Slip-on length ..... 17 mm (.67 in.)

Connecting nipple (1) of float chamber venting lines

outside dia. ø ..... 6 mm (1/4")
slip-on length ..... max. 17 mm (11/16")

■ CAUTION: Utilize the complete slip-on length. Secure hoses by suitable screw clamps or by crimp connection.

■ CAUTION: If the engine has been installed without employment of the optional ROTAX engine frame which includes also support of the airbox, than provide an appropriately support (5) for the airbox.

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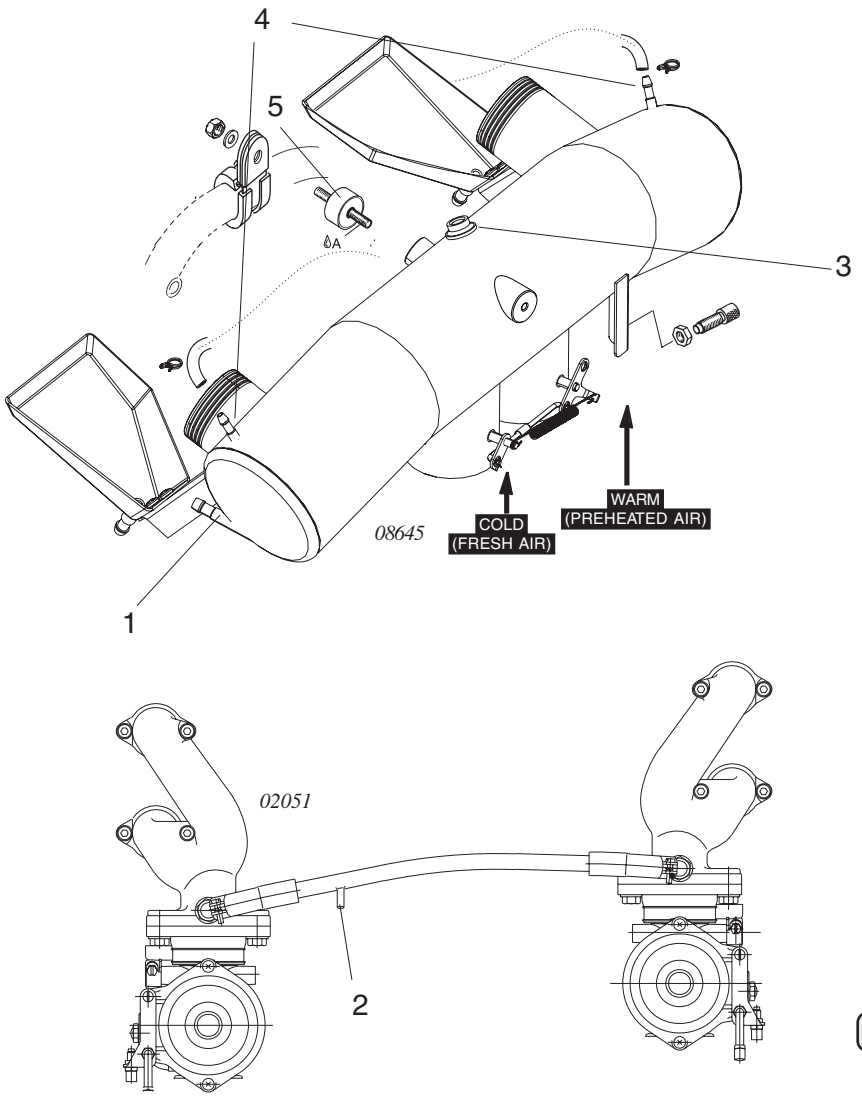

Fig. 64

◆ NOTE: Make sure that the air intake tubes of the airbox for fresh air and preheated air are connected correctly (see Fig. 64).

◆ NOTE: Fig. 64 shows the genuine ROTAX airbox.

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16.3) Data for optional components of air intake system

- air filter

  See Fig. 65.

  - weight: see section 8.

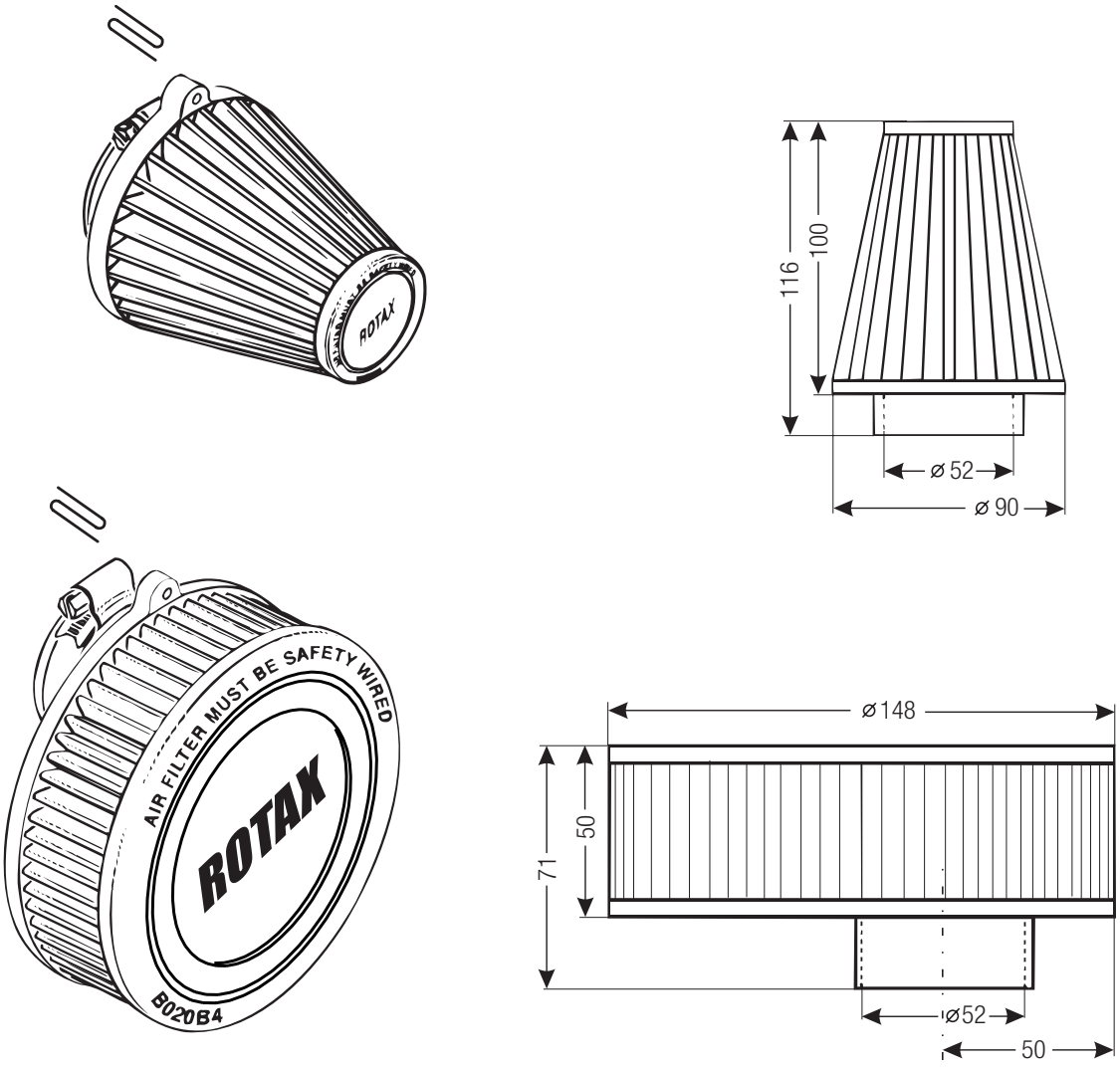

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Fig. 65

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- airbox (configuration part no. 867756)
  See Fig. 66.
  - weight: see section 8.

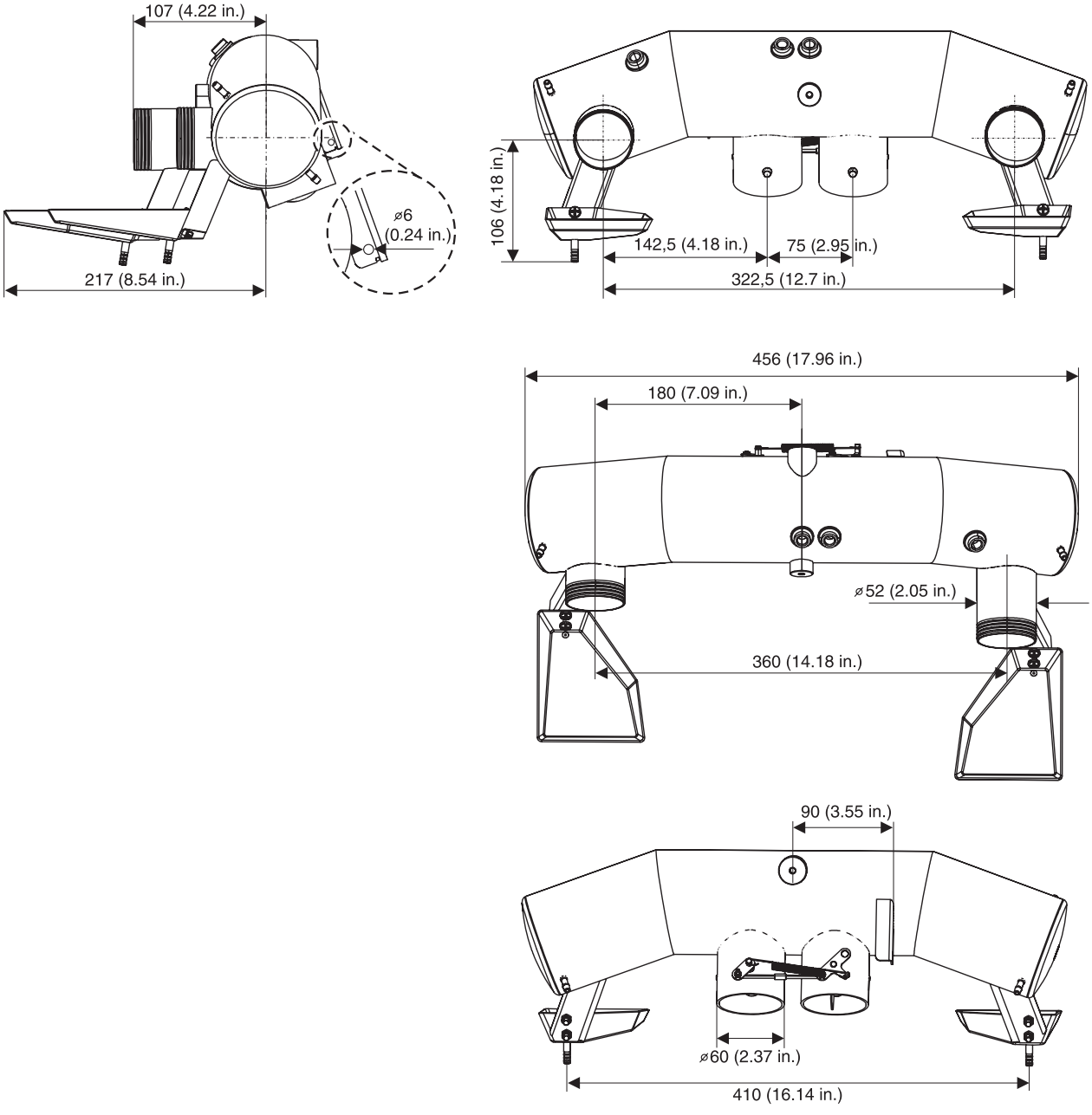

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Fig. 66

- airbox (new version part no. 667355 in comparison to the old version) See Fig. 66-1.
  - weight: see section 8.

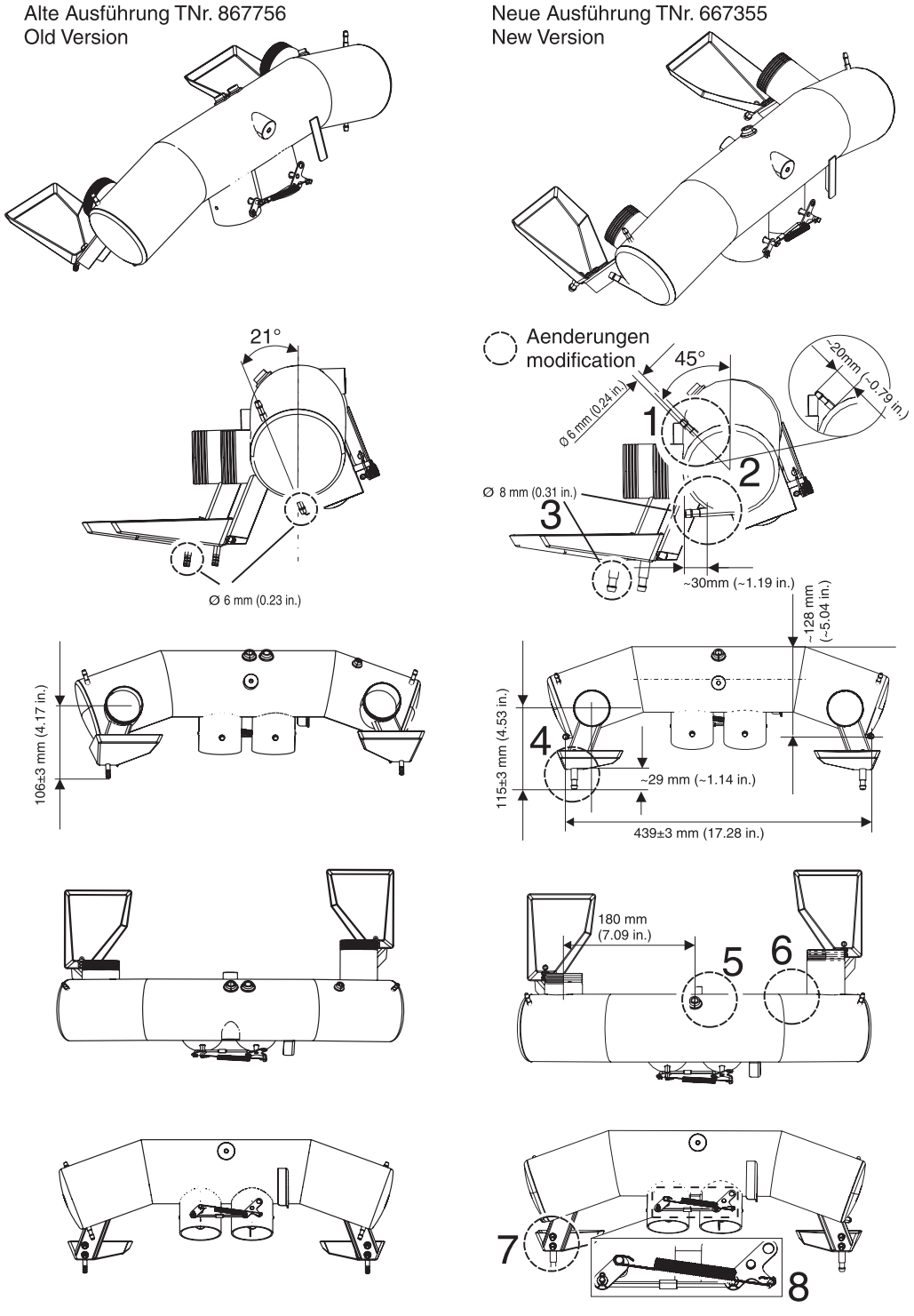

Fig. 66-1

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17) Electric system

See Fig. 67.

The engine is supplied with the wiring completed and ready to operate. Only the following connections to the aircraft have to be established.

- integrated generator
- external rectifier-regulator
- electronic modules
- electric starter
- start relay
- items conditional for operation like circuit breakers, ON-OFF switches, control lamps, relays, instrumentation and capacitors

Optional extras

- external alternator (as option if the output of the integrated generator is inadequate)
- electric rev counter (accessory)
- consumer (battery)

17.1) Requirements on circuit wiring

■ CAUTION: The connections have to be completed by the aircraft manufacturer in accordance to effective certification and wiring diagram (Fig. 67).

The electromagnetic compatibility (EMC) and electromagnetic interference (EMI) is greatly affected by the wiring and has to be checked for each installation.

▲ WARNING: The supply to the various consumers (e.g. battery) has to be protected adequately by fuses (consult wiring diagram). Using fuses too large may result in damage to electric equipment.

Under no circumstances route consumers cables (e.g. battery) side by side with ignition cable. Induction could cause problems.

■ CAUTION: An excess-voltage protection has to be realized by the aircraft manufacturer in accordance to effective regulations.

▲ WARNING: The certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer.

d04059

▲ WARNING: Do not bend, kink, pinch or otherwise improperly stress the wiring harness. Use proper routing, clamping and strain relief on wiring harnesses.

17.1.1) Electromagnetic compatibility (EMC/EMI)

Electromagnetic interference (EMI) and lightning:

The engine complies with the EMI and lightning requirements per DO-160C, sections 18, 20-22 as noted in the following paragraphs.

Emission

Conducted RF Interference:

Narrowband and broadband emissions meet RTCA DO160C Section 21-1 Cat. B (AZ) except in the frequency range of 150kHz - 2MHz where emissions are up to 20dB higher than allowable limits.

Radiated RF Interference:

Narrowband and broadband emissions meet RTCA DO160C Section 21, Fig. 21-6 and 21-7, Cat. B except in the frequency range of 190kHz - 2MHz where emission are up to 35dB higher than allowable limits.

▲ WARNING: Consult the manufacturer if further interpretation is needed. These exceedances do not affect engine operation.

17.2) Wiring diagram

See Fig. 67.

Legend to wiring diagram (Fig. 67)

Items 1-9, 24-25 are included in the standard volume of supply of the engine

Items 10-14 are available as accessory

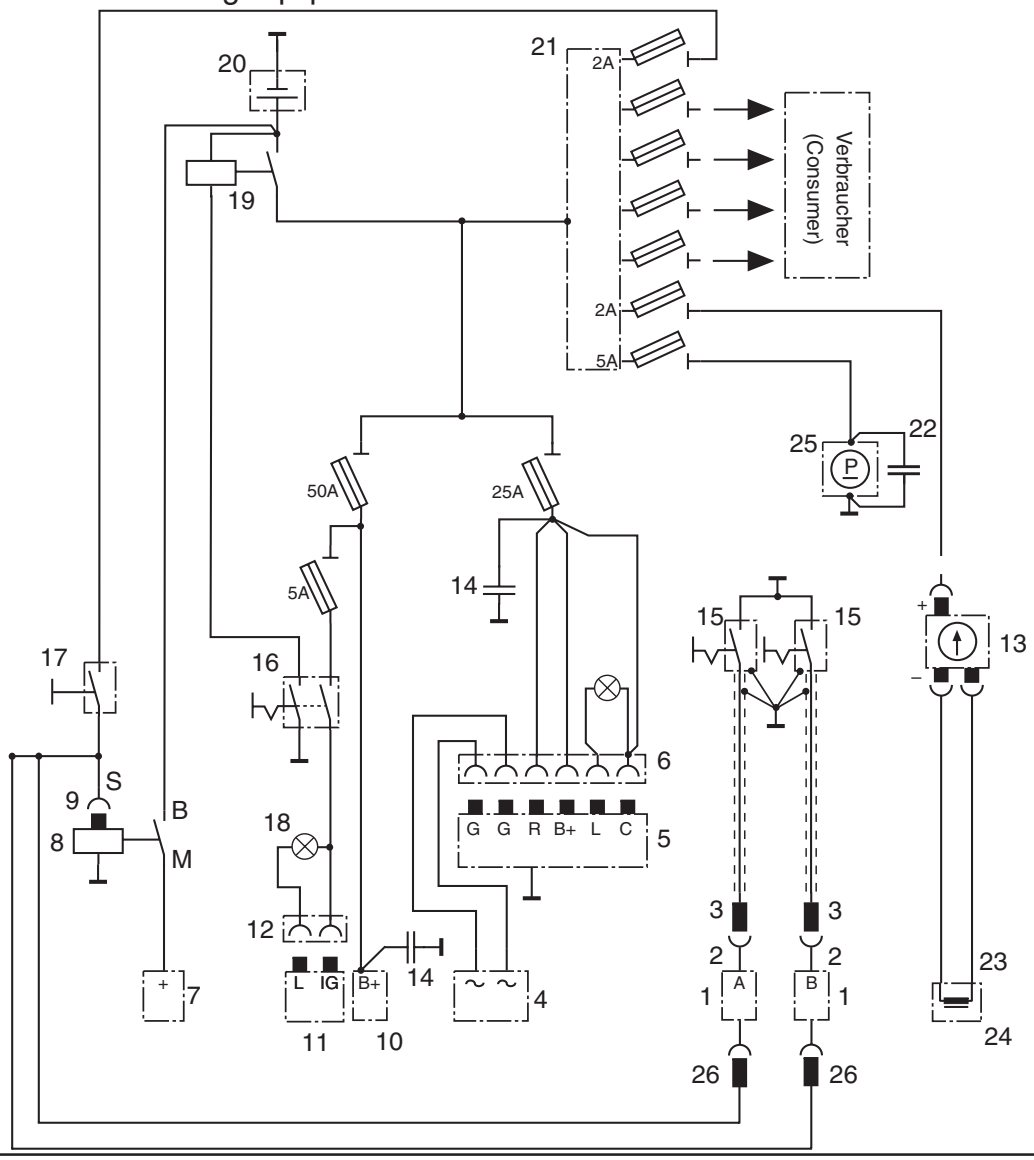
Items 15-23 can't be supplied by BRP-Powertrain

▲ WARNING: The certification of items/components which are not included in the standard volume of supply of engine has to be conducted by the aircraft manufacturer to the latest requirements such as FAR or EASA.

1 2 electronic modules (A and B)
2-3 plug connection for ignition switch
4 integrated generator
5-6 external regulator - rectifier with plug connections
7 electric starter
8-9 starter relay with plug connection
10-12 external alternator with connections
13 electric rev-counter

d04640

14 capacitor
15 2 ignition switches
16 master switch
17 starter switch
18 control lamp
19 battery relay
20 battery
21 bus bar
22 capacitor
23 plug connection for trigger coil assy.
24 trigger coil assy. (tachometer)
25 electrical fuel pump
26 starting equipment at the electronic modules



Wiring symbols to DIN 40712, 40713, 40716 and 40719.

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Fig. 67

17.3) Technical data and connection of the electric components

17.3.1) Integrated generator

See Fig. 68

Feeding wires (1) from the generator to rectifier-regulator on left side of ignition housing (see Fig. 68).

- 2 flexible cables, 1,5 mm^2 yellow (in shielding metal braid)
- length approx. 660 mm (26 in.) starting from ignition housing
- with on each plug socket 6,3 x 0,8 to DIN 46247

◆ NOTE: approx. 250W AC output at 5800 (r.p.m.)

For DC output in connection with rectifier-regulator see section 17.3.2.

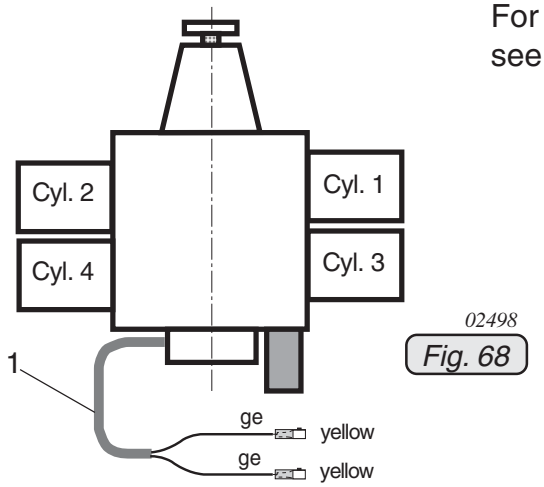

Fig. 68

17.3.2) Rectifier-regulator

See Fig. 69/70.

- type: electronic full-wave rectifier regulator
- effective voltage: 14 ± 0,3 V (from 1000 ± 250 r.p.m.)
- current limit: max. 22 A
- max. permissible component temperature: +80 °C (176 °F) (measured in area (1))
- weight: see section 8.

◆ NOTE: The performance specifications are given for optimal cooled components. If necessary, use a separate heat sink for the rectifier regulator.

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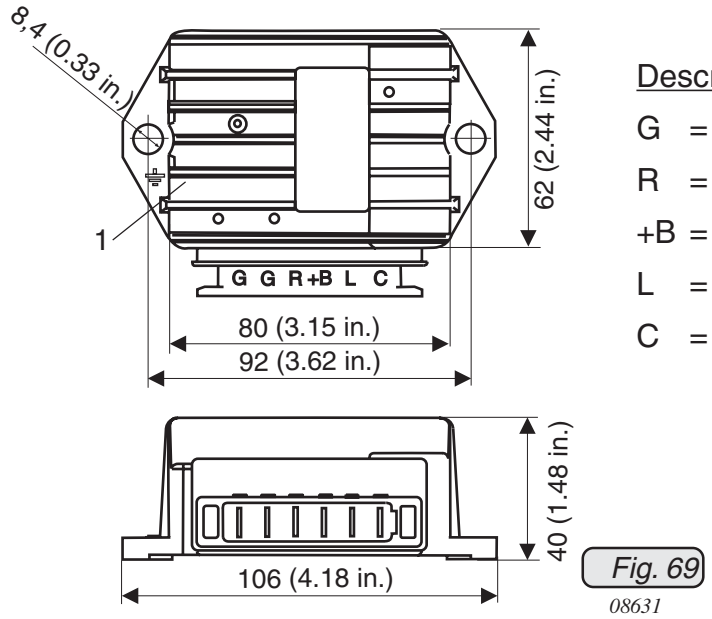

Fig. 69

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Description of connections:

G = yellow - from generator

R = red - to battery, positive terminal

+B = battery positive terminal

L = warning lamp circuit

C = control or field circuit

Requirements for flawless operation of the rectifier-regulator

- body of regulator must be grounded with no restance allowed
- the rectifier-regulator has to be protected by a slow blowing 25A fuse.
- wire size of the main circuit of at least 2,5 mm^2 (14 AWG)
- a capacitor (Fig. 67 Pos. (25)) of at least 22 000 µF / 25 V is necessary to protect the correct function of regulator and to flatten voltage. The regulator is not designed to store any electrical charge. If for any reason the battery or bus system is disconnected from the regulator while the engine is running (i.e. the master switch is shut off) the capacitor will safely absorb and dissipate the electrical charge produced by the generator. Otherwise the regulator would be damaged.

■ CAUTION: The voltage difference between battery and terminal **C** of regulator should be less than 0,2 V.

Use cables in this area as short as possible and with adequate cross section.

■ CAUTION: Never sever connection between terminal **C** and **+B** of regulator (e.g. by removal of a fuse) while the engine is running. Overvoltage and regulator damage can occur.

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During engine stop break circuit between battery and terminal C to avoid discharge of battery! (see Fig. 67)

◆ NOTE: A charge-indicating lamp 3W/12V (Fig. 67, pos. (18) may be fitted on the instrument panel.

Current:

■ CAUTION: The graph current over engine speed has been determined and is valid only at the following conditions.

ambient temperature: ..... 20 °C (68 °F)

voltage: ..... permanent 13,5 V

tolerance: ..... max ± 5%

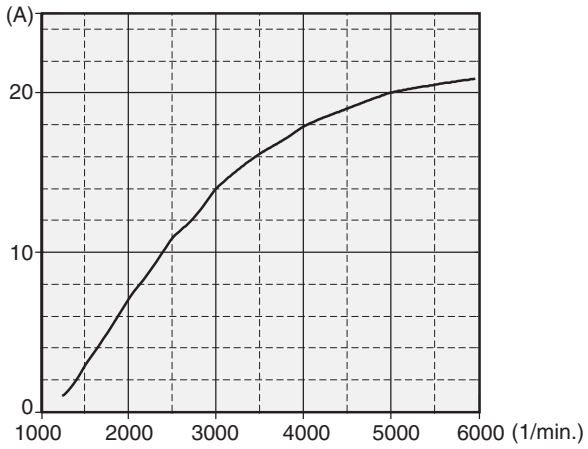

Fig. 70

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17.3.3) Electronic modules

See Fig. 4 and 71.

Ambient temp. for the electronic modules (1): max. 80 °C (176 °F).

17.3.4) Ignition switches (MAG switch)

See Fig. 71, 72 and 73.

- type: two separate, suitable on-off switches (Fig. 67, pos. (15))
- switching voltage: min. 250 V
- switching current: min. 0,5 A

Wires from the ignition switches connect to the electronic module (see Fig. 71).

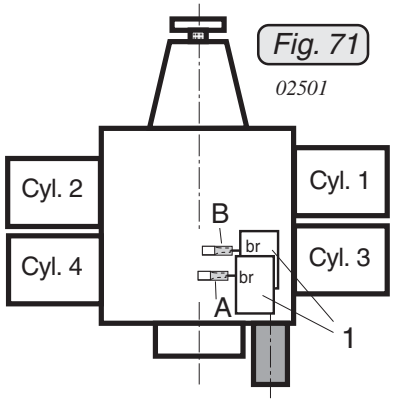

Fig. 71

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Requirements for correct operation of the integrated rectifier-regulator:

- the rectifier-regulator has to be protected by a slow blowing fuse or circuit breaker. Fuse or circuit breaker rating must be determined by load, wire size and length.
- cross section of the main circuit at least 4 mm^2 (10 AWG)
- a capacitor (Fig. 67 Pos. (14)) of at least 22 000 µF / 25 V is necessary to flatten voltage.
- current:

■ CAUTION: The current over speed graph has been determined and is effective only at the following conditions:

ambient temperature: 20 °C (68 °F)

voltage: permanent 13,5 V

tolerance: ± 5%

◆ NOTE: The speed of the auxiliary generator is 1,24 or 1,32 times crankshaft speed or 3 times the prop speed.

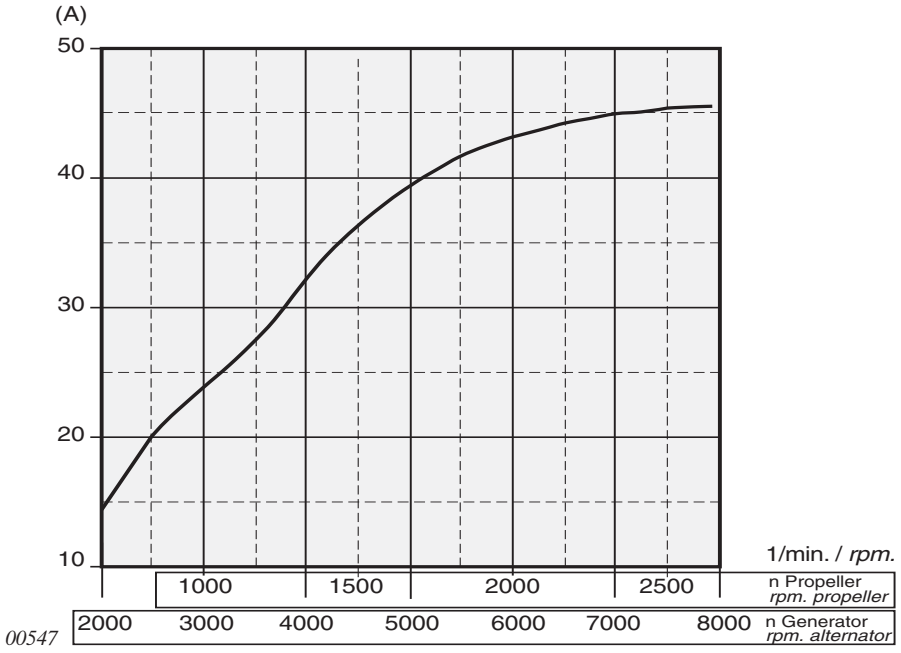

Fig. 78

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17.3.8) Connection of the electric rev-counter (tachometer)

See Fig. 67/79.

Feeding wiring to electric rev counter on left side of ignition housing.

- connections: 2 flexible cables 0,5 mm², white/yellow and blue/yellow (in insulation wrap)
- length approx. 600 mm (24 in) starting from ignition housing.

◆ NOTE: BRP-Powertrain developed especially for this application a non-certified electric rev-counter. Certification to the latest requirements such as FAR or EASA has to be conducted by the aircraft manufacturer. See also SI-13-1996, latest issue.

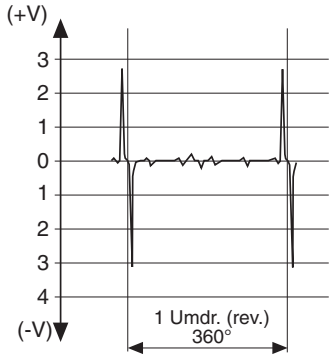
■ CAUTION: The graphs depicting output signals have been determined and are effective only at the following conditions.

Ambient temperature: 20 °C (68 °F)

Tolerance: ± 5%

The pick-up for the rev-counter generates one pulse per revolution. Pulse shape and pulse voltage as per recordings (oscillogram).

speed 500 rpm (load 100 Ω)



speed 500 rpm (load 100 kΩ)

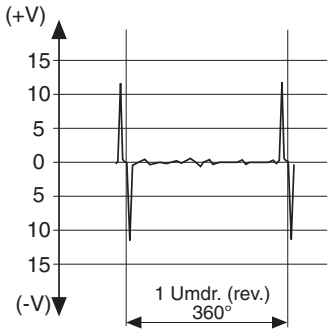


Fig. 79

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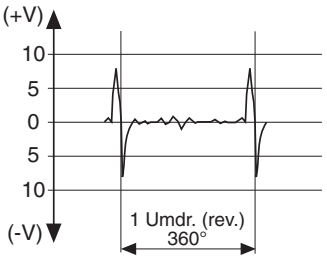
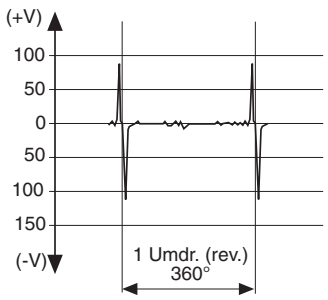
speed 6000 rpm (load 100 Ω)



speed 6000 rpm (load 100 kΩ)



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17.3.9) Battery

See Fig. 67.

■ CAUTION: To warrant reliable engine start use a battery of at least 16 Ah capacity.

17.3.10) Capacitor (Option electrical fuel pump)

See Fig. 67.

■ CAUTION: To warrant reliable operation of the electrical fuel pump the use of capacitor of at least 22 000 µF / 25 V is necessary.

17.3.11) Easy start function on the electronic module (optional)

See Fig. 67 and 79/1.

In order to use the easy start function the relevant connections to the starter relays and ignition switch need to be made.

The start function can be used for aircraft, which have an engine start problem in cold conditions.

◆ NOTE: In addition also a modified fly wheel hub is offered, which aids improved starting.

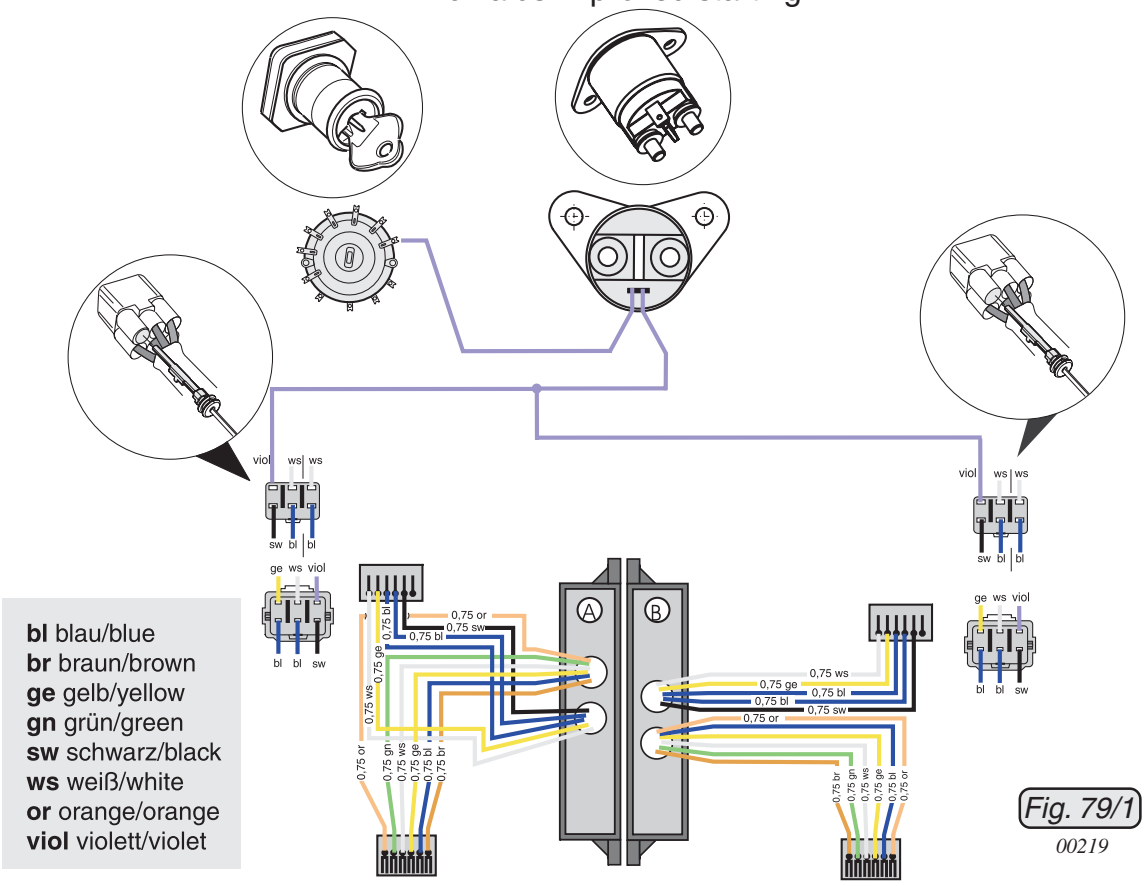

Fig. 79/1

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NOTES

18) Propeller drive

The propeller in tractor or pusher arrangement has to be fitted on the propeller flange in accordance to current certification. As required utilize one of the three possible pitch circle diameters (P.C.D.) on the flange.

Certification of the propeller sizing and arrangement to the latest requirement such as FAR or EASA has to be conducted by the aircraft manufacturer.

▲ WARNING: Never run the engine without a propeller installed as engine would suffer severe damage by overspeeding.

Never fit propeller directly on crankshaft.

18.1) Technical data

See Fig. 80.

- direction of rotation of the prop flange: counter clockwise, looking towards face of flange
- attachment of propeller on prop shaft flange:
  - P.C.D 75 mm (2,95"): 6 bolt holes of 8 mm (.32 in.) dia
  - P.C.D 80 mm (3,15"): 6 bolt holes of 11,5 mm (.45 in.) dia
  - P.C.D 101,6 mm (4"): 6 bolt holes of 13 mm (.51 in.) dia.
  - hub diameter: 47 mm (1.85 in.)
- ratio of gear reduction: 2,2727 (50 Teeth/22 T)

  2,4286 (51 T/21 T)
- max. torque:

  ROTAX 912 UL, A, F for i=2,2727: 238 Nm (176 ft.lb.) (at propeller)

  ROTAX 912 UL, A, F for i=2,4286: 255 Nm (188 ft.lb.) (at propeller)

  ROTAX 912 ULS, S for i=2,4286: 315 Nm (232 ft.lb.) (at propeller)
- max. moment of inertia :
  - normal between 1500 kgcm^2 (3.559 lb.ft.^{2}) and 6000 kgcm^2 (14.238 lb.ft.^{2})
  - max. moment of inertia on propeller: 6000 kgcm^2 (14.238 lb.ft.^{2})
- max. permitted static out-of-balance on a prop: max. 0,5 gm (.043 lb.in.)
- max. extension of the propeller shaft: 120 mm (4.72 in.)

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■ CAUTION: No modification of propeller shaft permitted.

◆ NOTE: In the course of certification a vibration analysis of the whole system (engine, suspension, propeller etc.) should be done.

If there are no limits found in the technical literature, a max. of 0.1 IPS (inches per second) at 5000 rpm can be assumed.

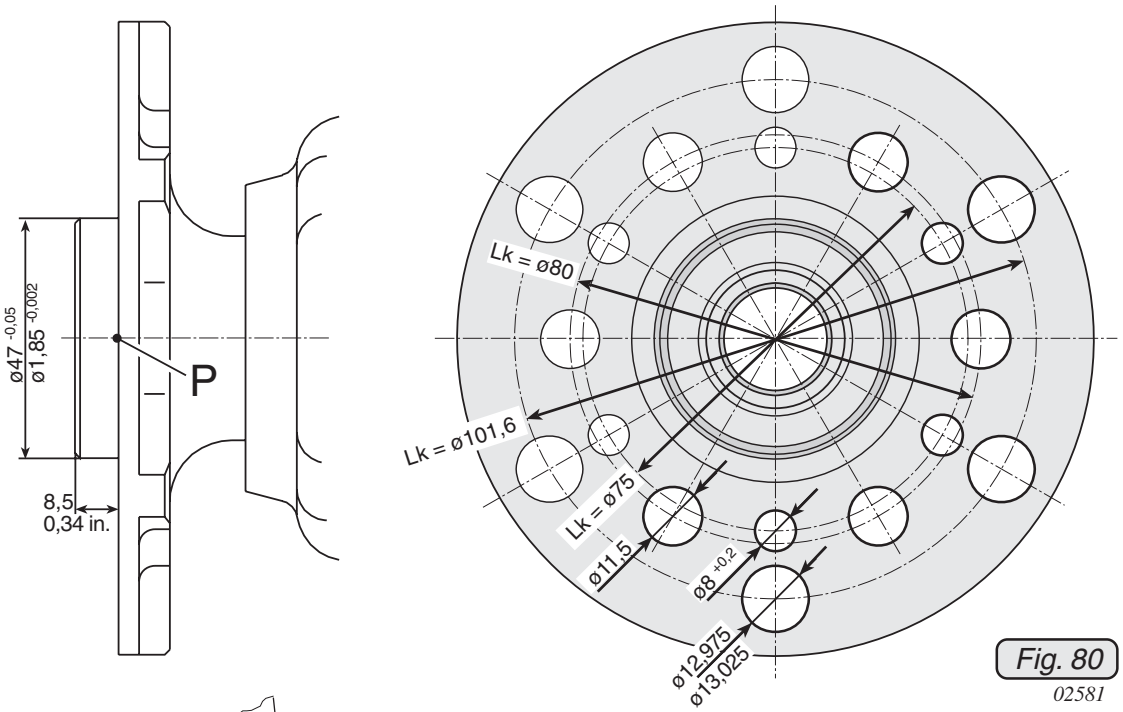

Fig. 80

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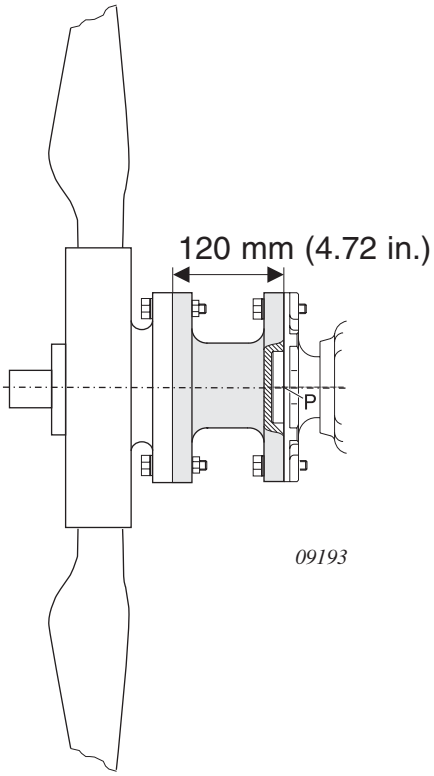

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21) Connections for instrumentation

These connections to be established in accordance to certification and/or national specifications.

The certification for connections and connection lines have to be conducted by the aircraft manufacturer to the latest requirements like FAR and EASA.

For notes regarding the electric rev-counter consult the section 17.

21.1) Sensor for cylinder head temperature

See Fig. 4, 84 and 85.

◆ NOTE: A direct reading of the coolant temperature is not provided for.

The temperature sensor (1) is directly fitted into cylinder head i.e. a direct temperature reading of the cylinder head material is taken.

- location: in the cylinder head of the cylinders 2 and 3, see Fig. 4.
- connection: spade terminal 6,3x0,8 to DIN 46247
- grounding: via engine block
- graph of sensor resistance over temperature

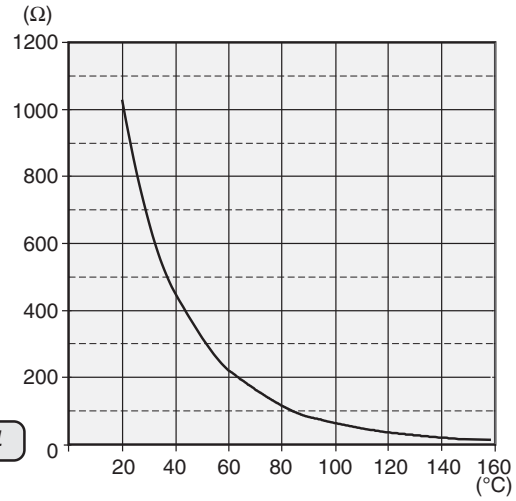


Fig. 84

00227

04868

	Axes		
cylinder head	x axis mm	y axis mm	z axis mm
2	-200,0	241,0	-157,0
3	-387,0	-241,0	-157,0

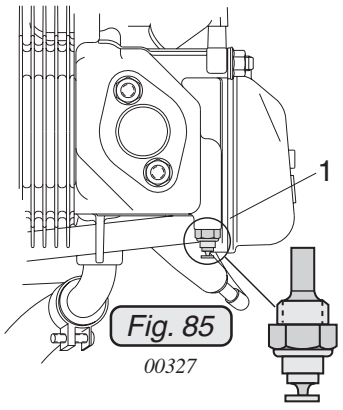


Fig. 85

00327

■ CAUTION: The graph resistance over temperature has been determined, and is effective at the following conditions only.

ambient temperature: 20 °C (68 °F)
tolerance: ± 10%

d04060

21.2) Sensor for oil temperature

See Fig. 86 and 87

- location: oil pump housing
- marking (2): marked with "TO" (temperature oil) on oil pump flange

■ CAUTION: To avoid any mix-up with indication wiring, mark this particular cable also with "TO".

	Axes		
point of support	x axis mm	y axis mm	z axis mm
	-115	46	-150

04869

- position of the temperature sensor (1) on the oil pump flange:
- connection of sensor wiring: spade terminal 6,3 x 0,8 to DIN 46247
- grounding: via engine block
- graph of sensor resistance over temperature

■ CAUTION: The graph resistance over temperature has been determined, and is effective at the following conditions only.

ambient temperature: 20 °C (68 °F)

tolerance: ± 10%

BRP-Powertrain offers a non-certified temperature indicating instrument. Refer to Illustrated Parts Catalog, latest issue.

▲ WARNING: Certification to the latest requirements such as FAR of EASA has to be conducted by the aircraft manufacturer.

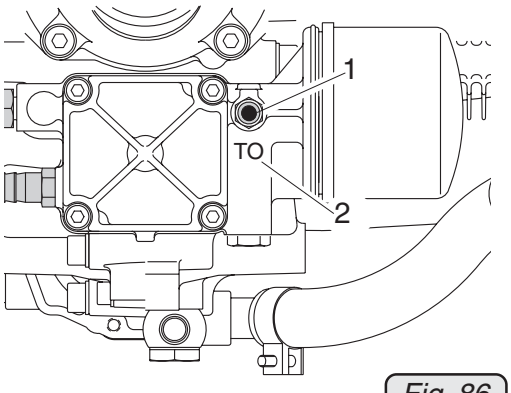


Fig. 86

00226

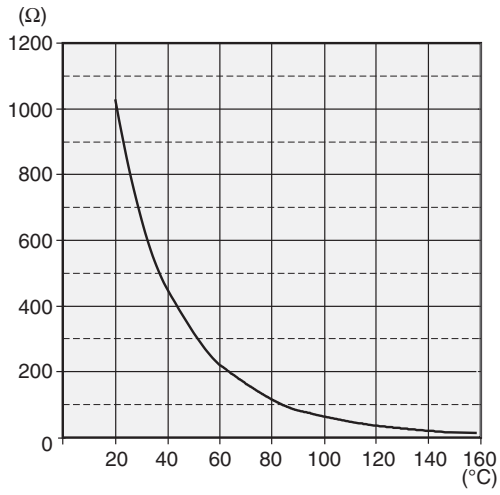


Fig. 87

00227

d04641

21.3) Oil pressure sensor

See Fig. 88 and 89.

- location: oil pump housing
- wiring connection for instrument:

  The sensor cable is approx. 3 m long and has 3 leads. The **Black** lead is not to be connected and has no function. The **Red** lead from the sensor has to be connected to the positive bus via a fuse or circuit breaker. The **White** lead (output signal) has to be connected directly to the instrument. See also the relevant instructions of the instrument supplier/aircraft manufacturer for correct connection and wiring.

◆ NOTE: The sensor cable can be modified in its length according to the installation situation, e.g. shortened or extended. For extension an appropriate, commercially available cable can be used. A resistance cable or similar is not necessary.

- wire gauge: stranded wire, 0,5 mm² (AWG 20)
- cable length: 3 m (118 in.)
- operating temperature range: min.: - 40 °C (-40 °F)

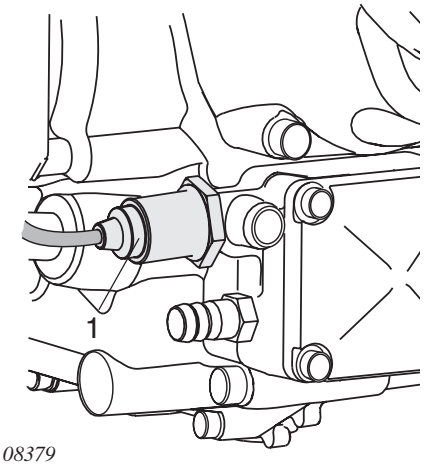
  max.: + 125 °C (+ 257 °F)
- grounding: via engine block/airframe ground
- output signal: In contrary to the oil pressure sensor offered up to now, which was providing the signal on the basis of a sensor resistance variation, the new oil pressure sensor (1) operates on basis of a current variation. This has to be taken into account for the selection of the appropriate cockpit instrument.

■ CAUTION: The graph current over pressure has been determined, and is effective at the following conditions only (see fig. 89).

ambient temperature: 20 °C (68 °F)
tolerance: max. ± 3%

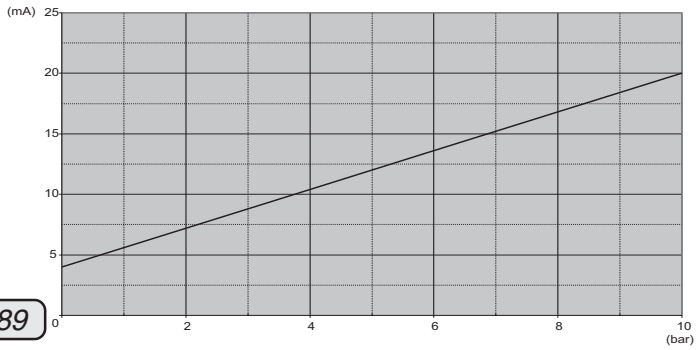
- tightening torque: 15 Nm (98 in.lb) and LOCTITE 243

Fig. 88



08379

Fig. 89



08442

d04641

As the instruments need a separate power supply and a different design for the electrical oil pressure sensor, the resistance type instrument (type VDO), which was supplied by BRP-Powertrain up to now, is not suitable anymore. Suitable instruments are offered by various instrument manufacturers (e.g. ROAD or Aviasport).

▲ WARNING: Certification to the latest requirements such as FAR of EASA has to be conducted by the aircraft manufacturer.

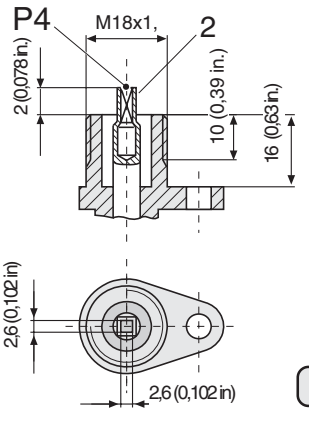
21.4) Mechanical rev counter (tach drive):

See Fig. 90 and 91

- location: ignition housing (1)
- direction of rotation of the rev counter shaft (2): clockwise, see figure below.
- position of rev counter drive:
- installation dimensions: see figures above.

04871

	Axes		
point of engagement P4	x axis mm	y axis mm	z axis mm
	-465	87	-160



05483

Fig. 90

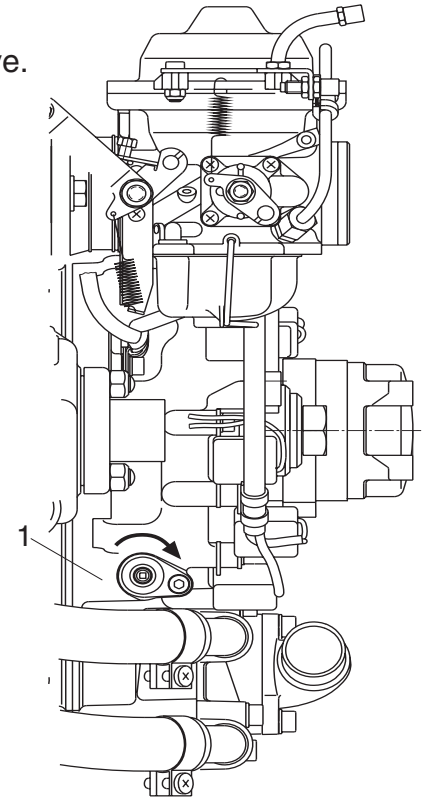


Fig. 91

00562

- reduction ratio: i = 4 i.e. 1/4 of engine speed

d04641

21.5) Monitoring of the intake manifold pressure

See Fig. 92.

Connection nipple (1) to measure manifold pressure:

outside dia. ø ..... 6 mm (1/4")
slip-on length . max. 17 mm (11/16")

■ CAUTION: Utilize the total slip-on length on all joints. Secure hose by suitable screw clamps or crimp connection.

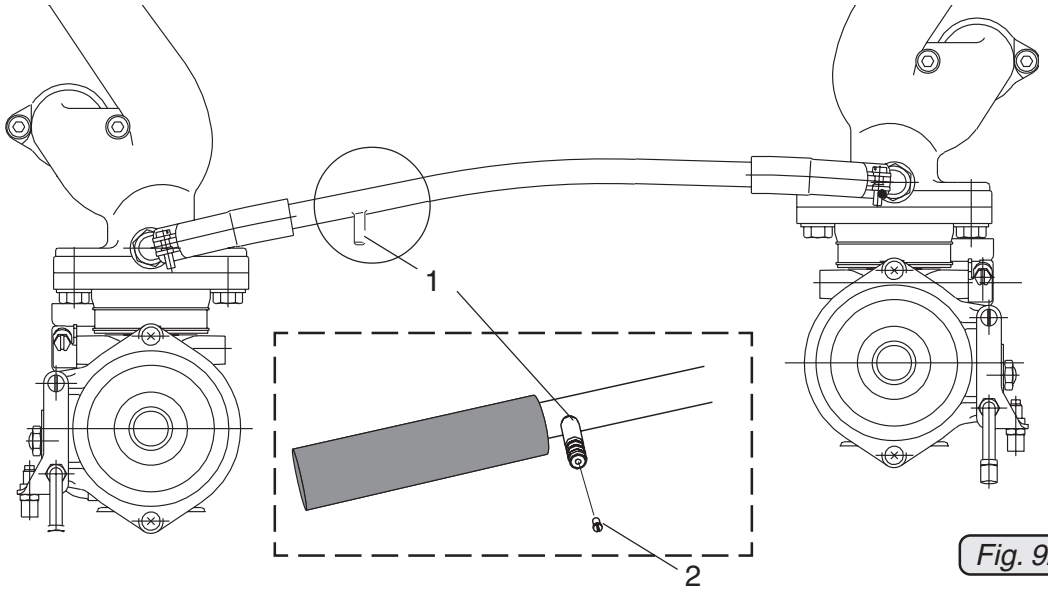


Fig. 92

02051

▲ WARNING: Protective covering to be utilized for transport and at engine installation only. If connection for pressure reading is not employed it has to suitably plugged. New style compensating tubes have plugged this connection by a screw M3.5x6 (2).

■ CAUTION: Flawless operation of the indicating instrument needs the installations of a water trap between engine and instrument for the fuel condensate.

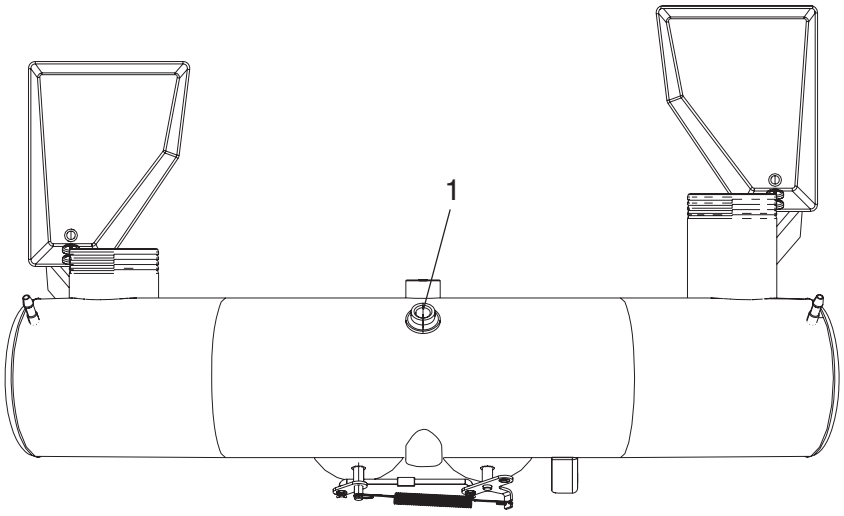
d04641

21.6) Air temperature in the airbox (optional)

See Fig. 93.

To take air temperature readings in the airbox a connection is provided. This connection is closed on the standard engine by a plug screw.

- connection: thread M6
  thread length approx. 9 mm (3/8")



08647

Fig. 93

d04641