ROTAX®
AIRCRAFT ENGINES

SERVICE LETTER

IDENTIFYING ABNORMAL VIBRATIONS ON AIRCRAFTS EQUIPPED WITH ROTAX® ENGINE TYPE 912 S/ULS/ULSFR
SL-912-010

Repeating symbols:

Please, pay attention to the following symbols throughout this document emphasizing particular information.

▲ WARNING: Identifies an instruction, which if not followed, may cause serious injury or even death.

■ CAUTION: Denotes an instruction which if not followed, may severely damage the engine or could lead to suspension of warranty.

◆ NOTE: Information useful for better handling.

1) Planning information

1.1) Engines affected

All versions of the engine type:

- 912 S all
- 912 ULS all
- 912 ULSFR all

where abnormal vibrations as described in section 1.3 are experienced.

In case of doubt contact your aircraft manufacturer.

1.2) Concurrent ASB/SB/SI and SL

none

1.3) Reason

Field service reports have indicated that a number of aircraft equipped with ROTAX® engine types 912 S/ULS/ULSFR may demonstrate higher than normal vibration levels when operating engine at crankshaft speeds between 3600 and 4800 rpm.

One or more of the following could be the cause for higher vibration levels in the described speed range:

- Unauthorized and untested modifications of the engine
- Unsuitable engine suspension / vibration neutralization (not original ROTAX® engine suspension frame)
- Defects/damages on engine suspension
- Aging of the shock mounts
- Propeller balance out of tolerance
- Propeller moment of inertia out of tolerance
- Vibrations from bolt-on parts
- Damaged exhaust system
- Friction torque in the backlash range of gearbox is out of tolerance
- Inadequate maintenance
- Ground contact
- Improper carburetor synchronization

▲ WARNING: Rectify any of the above mentioned causes without any delay.

1.4) Subject

Identifying abnormal vibrations on aircrafts equipped with ROTAX® engine type 912 S/ULS/ULSFR.

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1.5) Compliance

Implementation of any of the recommended inspections and remedies described in section 3.1 herein is solely at the discretion of the owner. However, in case of occurrence of abnormal vibrations, the recommended inspections and remedies described in section 3.1 herein should be implemented immediately.

In case of doubt contact your aircraft manufacturer.

▲WARNING: In the case of abnormal vibrations, non-compliance with these instructions could result in engine damage, personal injury or death.

1.6) Manpower

Estimated man-hours:

engine installed in the aircraft - - - manpower time will depend on installation and therefore no estimate is available from the engine manufacturer.

1.7) References

In addition to this technical information refer to current issue of

- Operator's Manual (OM)
- Illustrated Parts Catalog (IPC)
- Installation Manual (IM)
- Maintenance Manual (MM)

2) Material Information

2.1) Material - cost and availability

- Both equipment and suitable additional material for vibration measurement are not of ROTAX® volume of supply.
- When retrofitting to the overload clutch design, the ROTAX® Authorized Distributor or their Service Center will inform of prices and availability upon request.

2.2) Company support information

Since the reasons and causes for abnormal vibrations as stated in Section 1.3 are entirely beyond the control of the engine manufacturer, there is no plan to share any cost of performing the recommended vibration measurement or expenditure associated with it. This also applies to a subsequent gearbox conversion to overload clutch design.

2.3) Special tools - cost and availability

A frequency analyzer (figure 1) with acceleration pick-up (figure 2) from a well-known manufacturer will be required to assist in diagnosing the specific cause of an abnormal vibration problem. Use of a Digital Audiotape to record vibration behavior during testing can also be helpful.

◆ NOTE: The adapter plate (4) and impact hammer (3) for initiating the test vibration is not part of the ROTAX® volume of supply. Neither are the frequency analyzer (1) and the acceleration pick-up (2).

Parts requirement:

Fig.no.	pos. no	p/n	Qty/engine	Description	Old p/n	Application
(1, 5, 8)	(1)	n.a.	1	frequency analyzer	n.a.	
(2, 8)	(2)	n.a.	1	acceleration pick-up	n.a.	
(5, 8)	(3)	n.a.	1	impact hammer	n.a.	
(7, 8)	(4)	n.a.	1	adapter plate	n.a.	

Bild / fig. 1 **frequency analyzer**

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Bild / fig. 2

acceleration pick-up

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◆ NOTE: The figures show a possible equipment configuration that has been used for ROTAX® tests. They serve to visualize the equipment, but they do not represent any obligation to use the product or brand as stated.

3) General description

3.1) Findings

Numerous vibration analyses were conducted on various affected aircraft types. These tests showed that a strong vibration within the overall range of 60 to 80 Hz was evident on the airframe. This frequency range corresponds to an engine speed of 3600 to 4800 rpm when initiated by the first engine order vibration.

◆ NOTE: Usually the rotational irregularity of the second engine order vibration occurs strongly in a four-cylinder, 4-stroke engine in a way that depends on its construction. However, no perceptible resonance occurs in the increased idle range between 1800 and 2400 rpm because of limited excitation (limited rotational speed and weak power pulse), or it is not noticeable through the transitional area between idle and loaded state.

On the other hand, relatively weak excitation of the first engine order vibration causes, a resonance that cannot be completely suppressed with structural measures, in the operating range of 3600 and 4800 rpm.

In the cases examined, the engine mount or the aircraft cell acted as a significant amplifier of the normal excitation of the first engine order vibration. Therefore, the forces and inertia caused by the excitation of the first engine order vibrations must be balanced via a corresponding engine support system.

3.2) Specified limits

See figures 3 and 4.

The vibration level associated with the first engine order vibration depends not only on engine design, power rating, performance, crankshaft speed, and combustion conditions, but also on engine condition and engine hours of operation. Therefore, the engine suspension system and airframe need to be designed and adjusted to isolate and/or dampen out the normal engine vibrations to be expected over a wide range of conditions.

To avoid increased vibrations as described earlier, resonance should not occur on the airframe or on any other component that serves as a connecting element between airframe and engine. This means that no transfer signal overtravel beyond the 3 decibel (dB) acceleration range must exist within the overall range 50 to 200 Hz.

To find and remedy the cause of increased vibration perform vibration analyses and modify the mechanical transmission elements of the engine suspension system until the transfer signal is within the permissible range.

◆ NOTE: Retrofitting an overload clutch may also serve as remedy in some cases by slightly moving the vibration to a different range. See section 4.3.

3.2.1) Specified and permissible transfer signal range

A ..... amplitude [dB relativ 1 m/s²]
B ..... permissible range
s ..... measured transfer signal behavior
f ..... frequency [Hz]

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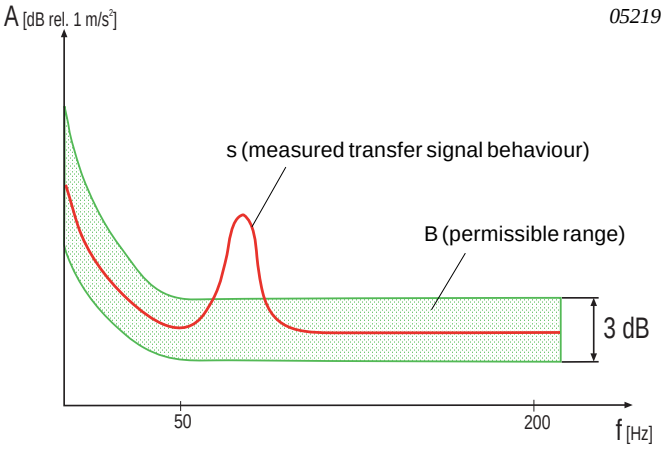

measurement with distinct resonance

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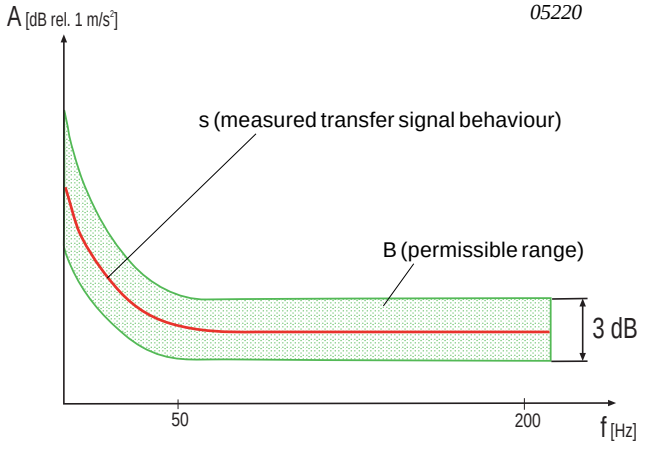


ideal transfer signal behaviour

4) Determination of vibrational properties

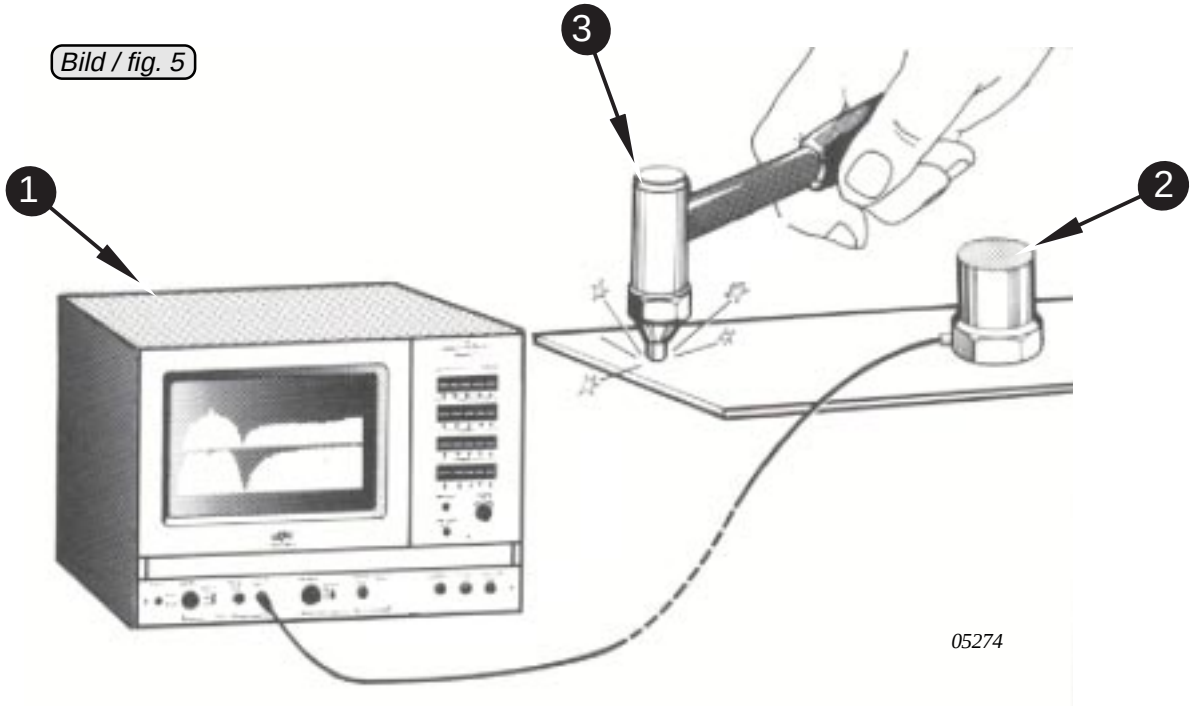
Transfer signal measurement from engine to airframe, as described below, is carried out by means of impact testing.

4.1) Description of measuring principle

See figure 5

The impact hammer (3) creates a release of excitation energy that spreads evenly across the system's overall frequency range. A frequency analyzer (1) receives the reply signal from the acceleration pick-up transducer (2) (preferably a three-axis type sensor), and represents the transfer of energy function graphically.

Bild / fig. 5



◆ NOTE: Schematic representation to excite a system and determine transfer function.

4.2) Accomplishment

See figures 6, 7 and 8.

All actions must be taken and confirmed by one of the following persons or facilities according to responsibility:

- Aircraft builders
- ROTAX® - Distributors or their Service Centers
- Persons approved by the respective Aviation Authority
- Persons with type-specific training (applicable only for non-certified engines)

▲ WARNING: Proceed with this work only in a non-smoking area and avoid sparks or open flames. Switch off ignition and secure engine against unintentional operation. Secure aircraft against unauthorized operation. Disconnect negative terminal of aircraft battery.

▲ WARNING: Carry out work on a cold engine only.

▲ WARNING: Should removal of a locking device (e.g. lock tabs, self-locking fasteners, etc.) be required when undergoing disassembly/assembly, always replace with a new one.

◆ NOTE: All work to be performed according to the appropriate maintenance manual.

■ CAUTION: The following work shall only be carried out by qualified personnel who is familiar with the measuring equipment and its function.

◆ NOTE: For determination of vibrational properties, we recommend the measuring equipment as described in section 2.3 ”Special tools”.

4.2.1) Following preconditions must be met for the aircraft

- Installations on the aircraft must be completed.
- Aircraft must be in original condition.
- Aircraft must be ready for operation.

4.2.2) Mounting/installing the test equipment

See figures 7 and 8.

- Mount adapter plate (4) to attachment point (6) of cylinders no. 1 and no. 2 with pan head screw (5) M6x20 and tighten with tightening torque of 8 Nm (5.92 lbft).
- Install acceleration pick-up (2) onto the joining elements to the airframe (see figure 8).

◆ NOTE: Acceleration pick-up (2) installation depends on engine suspension (8) design and needs to be selected individually. However, the acceleration pick-up (2) should be mounted as close to the airframe interface (e.g. firewall) as possible or directly onto the airframe supporting structure.

- Make all connections to the measurement recorder (1) and place it to readiness for operation.

4.2.3) Accomplishment of measurement

■ CAUTION: Measurement with the engine cut off, ignition in the ”OFF” position.

- Knock adapter plate (4) with impact hammer (3) (possibly also soft hammer with 150 g (5.3 oz)) slightly in one coordinate direction and save vibration record.
- Repeat this procedure for all three coordinate axes (longitudinal, transverse, and vertical axis).

◆ NOTE: We recommend to repeat each measurement five times at least in order to identify and exclude faulty measurements.

- Repeat the procedure described above on all existing joining elements to the airframe.

4.2.4) Evaluation of measurement/remedy

The spectral behavior of the engine suspension system elements (8) obtained using the method described above must conform to the behaviors described in section 3.2.1.

In the event that resonance peaks occur outside the range as shown in figure 3, you will need to carry out constructive modifications on the airframe-sided (9) engine suspension system elements (8) until the energy transfer function is within the permissible range (see figure 4).

◆ NOTE: Contact the aircraft manufacturer for more detailed information.

4.3) Engine-sided stop-gap measures

See figure 6.

In a number of tests, reductions in vibration level were obtained by the installation of an overload clutch (optional accessory) (7) in the gear reduction drive. In these cases, vibrations may be dampened by the different profile of the gear dogs so that the resonance in the airframe is less pronounced. However, in all the cases where an improvement was observed, excessive wear and tear of gear and engine components could not be excluded since the original source of the abnormal vibration was not eliminated. In some cases, the improvement attributed to the installation of the overload clutch may in fact have been due to other engine vibration causes that were corrected during the course of overload clutch installation. Therefore, no conclusion can be drawn as with respect to the long term effectiveness of installing the overload clutch as a means to reduce vibration.

■ CAUTION: No statement with respect to long-term engine performance under the conditions described is possible.

◆ NOTE: Overload clutch (7) is standard on all certified aircraft engines and non-certified aircraft engines of configuration 3. Refer to latest appropriate operator's manual for detailed type description.

◆ NOTE: The figure depicts a gearbox "configuration 3" with integrated overload clutch (7).

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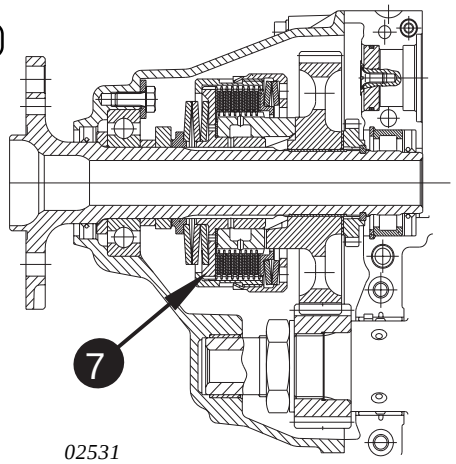

◆ NOTE: Ask your ROTAX® Authorized Distributor or Service Center for more information on overload clutch installation and availability.

4.4) Airframe-sided stop-gap measures

◆ NOTE: Basically the aircraft manufacturer specifications need to be followed.

◆ NOTE: Since the reason and causes for abnormal vibrations as stated in section 1.3 are entirely beyond the control of the engine manufacturer, the actions stated below are only indicative of possible corrective measures. Any modification measures taken need to be reviewed and approved by the airframe manufacturer before implementation.

4.4.1) Engine suspension elements

Modify the element dimensions so that the limits as determined in section 3.2.1 are not exceeded.

4.4.2) Engine suspension frame (airframe-sided)

Modify the engine suspension frame dimensions so that the limits as determined in section 3.2.1 are not exceeded.

4.4.3) Integrating elements in the airframe

Modify any integrating component (engine suspension in the airframe) dimensions so that the limits as determined in section 3.2.1 are not exceeded.

4.4.4) Propeller

Balance propeller system under consideration of the prop-manufacturer specifications so that the limits as determined in section 3.2.1 are not exceeded.

- Restore aircraft to original operating configuration.
- Connect negative terminal of aircraft battery.

4.5) Test run

Conduct test run including ignition check and leakage test.

5) Appendix

Following drawings should convey additional information:

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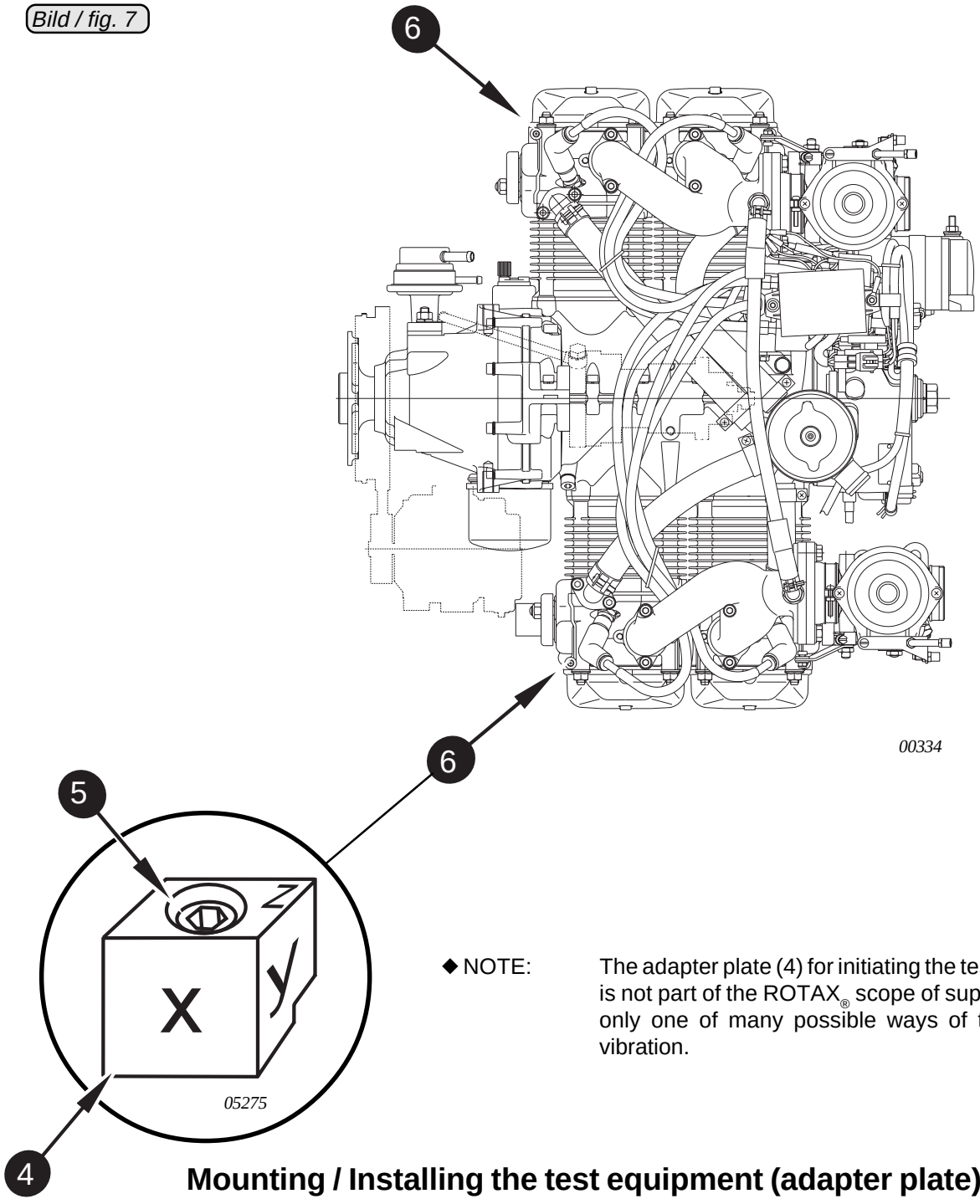
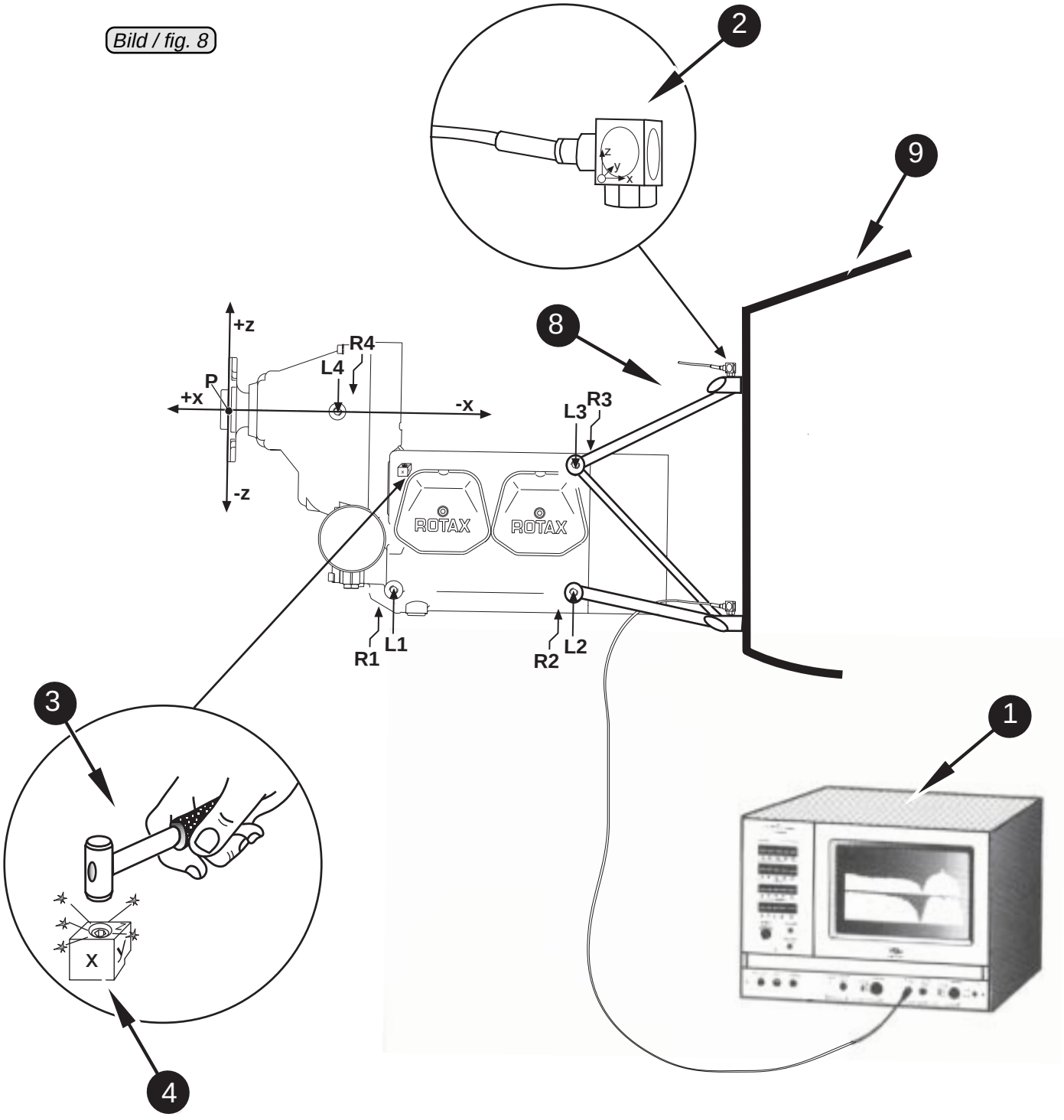


◆ NOTE: The adapter plate (4) for initiating the test vibration is not part of the ROTAX® scope of supply. This is only one of many possible ways of testing the vibration.

Mounting / Installing the test equipment (adapter plate)

Approval of translation to best knowledge and judgement - in any case the original text in German language and the metric units (SI-system) are authoritative.

Bild / fig. 8



Arrangement / Procedure of measurement

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

Exploded views are **not technical** drawings and are for reference only. For specific detail, refer to the current documents of the respective engine type.