Technical Publication

Diesel Engine
12V 2000 G02
16V 2000 G02

Maintenance Manual
MR20103/00E

Version
535.923–34
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DETROIT DIESEL

mtu

DaimlerChrysler Off-Highway

Das Handbuch ist zur Vermeidung von Störungen oder Schäden beim Betrieb zu beachten und daher vom Betreiber dem jeweiligen Wartungs- und Bedienungspersonal zur Verfügung zu stellen. Außerhalb dieses Verwendungszwecks darf das Handbuch ohne unsere vorherige Zustimmung nicht benutzt, vervielfältigt oder Dritten sonstwie zugänglich gemacht werden.

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Wichtig – Important – Importante

Bitte die Karte „Inbetriebnahmemeldung“ abtrennen und ausgefüllt an MTU Friedrichshafen GmbH zurücksenden.

Die Informationen der Inbetriebnahmemeldung sind Grundlage für den vertraglich vereinbarten Logistik-Support (Gewährleistung, Ersatzteile etc.).

Please complete and return the “Commissioning Note” card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).

Veuillez séparer la carte “Signalisation de mise en service“ et la renvoyer à la MTU Friedrichshafen GmbH.

Les informations concernant la signalisation de mise en service constituent la base pour l’assistance en exploitation contractuelle (garantie, rechanges, etc.).

Rogamos separen la tarjeta “Aviso de puesta en servicio“ y la devuelvan rellenada a MTU Friedrichshafen GmbH.

Las informaciones respecto al aviso de puesta en servicio constituyen la base para H el soporte logistíco contractual (garantía, piezas de repuesto, etc.).

Staccare “Avviso di messa in servizio” e rispedirlo debitamente compilato alla MTU Friedrichshafen GmbH.

Le informazioni ivi registrate sono la base per il supporto logistico contrattuale (garanzia, ricambi, ecc.).

Postcard

MTU Friedrichshafen GmbH
Abteilung SCSD
88040 Friedrichshafen
GERMANY

Bitte in Blockschrift ausfüllen!
Please use block capitals!
Prière de remplir en lettres capitales!
¡A rellenar en letras de imprenta!
Scrivere in stampatello!

Motornr.: Engine No.: N^{o} du moteur: N^{o} de motor: Motore N.:	Auftragsnr.: MTU works order No.: N^{o} de commande: N^{o} de pedido: N. commessa:
Motortyp: Engine model: Type du moteur: Tipo de motor: Motore tipo:	Inbetriebnahmedatum: Date put into operation: Mise en service le: Fecha de puesta en servicio: Messa in servizio il:
Eingebaut in: Installation site: Lieu de montage: Lugar de montaje: Installato:	Schiffstyp / Schiffshersteller: Vessel/type/class / Shipyard: Type du bateau / Constructeur: Tipo de bugue / Constructor: Tipo di Barca / Costruttore:
Endabnehmer/Anschrift: End user‘s address: Adresse du client final: Dirección del cliente final: Indirizzo del cliente finale:	
Bemerkung: Remarks: Remarques: Observaciones: Commento:	

Inbetriebnahmemeldung

Commissioning Note

Notice de mise en service

Aviso de puesta en servicio

Avviso di messa in servizio

Contents – Maintenance Manual

Contents

A001 Important Information

This manual is intended for use by technical personnel responsible for the **maintenance and servicing of the 2000 series diesel engine**.

This manual describes

- scheduled service operations from maintenance echelons W6 as well as
- non-scheduled service operations on the individual assemblies.

Index sheets divide this manual into 3 main sections.

Section A	General
Section B	Work schedules
Section C	Task description

Section C is further subdivided into main function groups (MFG) and function groups (FG). The structure is oriented toward the logical structure of the parts list and Spare Parts Catalogues.

Intermediate index sheets bearing the MFG numbers subdivide Section C.

Each function group (FG) consists of no more than nine parts:

e.g.	C 011.05.**01**	Overview drawing
	C 011.05.**02**	Special tools
	C 011.05.**04**	Before-removal operations
	C 011.05.**05**	Removal
	C 011.05.**06**	Disassembly
	C 011.05.**08**	Inspection and repair
	C 011.05.**10**	Assembly
	C 011.05.**11**	Installation
	C 011.05.**12**	After-installation operations

Systematic searches for specific information and rapid orientation in the manual are supported by:

– The tables of contents on each main index sheet. They cross-reference the tables of contents of the individual groups.
– An alphabetical subject index in Section A provides direct access to the individual Groups.
– The Group Summary at the start of Section C lists the individual main function groups.

Basic requirements for maintenance and service work

Customers performing their own maintenance must ensure that the following conditions and basic requirements are satisfied:

– all safety regulations are observed
– good general-purpose tools are provided
– cleaning and testing equipment is provided
– work is performed by trained personnel
– special tools are provided
– service area is adequately equipped

**Certain components are available through the replacement procedure (Reman components).
Can be seen under function group C...06 Disassembly.**

General assembly instructions

- Component cleanness:

  Areas of all components that come in contact with oil, fuel, engine coolant and combustion air must be kept clean.
- Components requiring “special cleanliness” (e.g. oil- and fuel-carrying components) must be cleaned with suitable cleaning procedures before assembly, checked for particular cleanness and treated accordingly.
- Component packaging must only be removed immediately before installation.
- Elastomer components (e.g. rubber parts etc.) must not be washed with diesel fuel, solvents or cold cleaners.

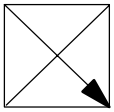
  Parts dirtied with oil and fuel must be cleaned immediately. The parts should be wiped with a dry cloth.

  Elastomer components such as engine mounts, damping elements, couplings and V-belts must not be painted. They can only be installed after painting the engine or must be covered before painting work is carried out.
- Radial-lip shaft seals treated by the manufacturer with oil show as a result definite signs of swelling when delivered. They must therefore be cleaned (not washed) only with an abrasion-proof paper cloth before installation.
- The surfaces of parts that slide against each other must be lubricated with SAE 30 engine oil when installed, unless otherwise specified.
- O-rings and surfaces moving against them during installation (bores and shafts) must be coated with petroleum jelly, unless otherwise specified.

  When installing O-rings with counterrings in coolant pumps, always follow the installation instructions.
- After installing O-rings in shaft grooves, in order to remedy twists caused by installation, pass a rounded marking tool under the sealing ring in the direction of the circumference if the O-ring diameter is sufficiently large. Make sure that the O-ring is not damaged.
- Before shaft seal assembly:

  On the shaft, the sealing lip of the shaft seal must be coated with petroleum jelly and the shaft running surface with thin-film lubricant or SAE 30 engine oil.

  In the support bore, the outer surface of metal outer jackets – unless otherwise specified in the drawing – must be coated with surface sealant. For elastomer outer jackets or combined metal/elastomer outer jackets, the outer surface must be coated with denaturated ethanol.



This symbol applies to radial-lip shaft seals and its significance depends on its position.
The arrow indicates the position of the sealing lip.

- Sealing paste must be used to fix the position of flat gaskets. Sealing paste is to be thinly applied in spots on the flat gaskets or mating faces. Immediately after application of the sealing paste, the flat gaskets must be fitted to the component and then (no more than 20 minutes later) the seal components screwed together. Oil, multi-purpose grease or other materials must not be used to fix the position.
- Before installing antifriction bearings, lightly lubricate the bearing seats.
  Only remove the bearings from their original packaging immediately before installation so they do not get dirty.
  Do not remove the corrosion inhibitor from the bearings in original packaging.
  Use petroleum spirit or acid-free kerosene to clean the antifriction bearings.
  After cleaning, relubricate the bearings with engine oil.

  During assembly, do not apply (axial) forces to antifriction elements and do not hit the bearing rings with a hammer (use assembly aids).

  Do not use an open flame to heat bearing inner races.

  The temperature should be between 80 °C and 100 °C and must never exceed 120 °C.

Deep-freezing for friction bearing installation is not permissible (risk of cracking, rusting through condensate).

- Dry bearings must not be oiled.
- When installing gears, the splines must be lubricated with SAE 30 engine oil.
- All support and mating surfaces of components (e.g. mating surfaces for centring devices, flange and sealing surfaces, joint surfaces of press fits) must be clean, polished or provided with the specified surface protection and free from warping and damage. Corrosion inhibitors (e.g. oil, grease) must be removed from support and mating surfaces.
- After parts are joined which are installed by means of cooling using liquid nitrogen, all condensate must be removed and the parts coated with SAE 30 engine oil.
- Sensors must be coated with long-life lubricant before installation in the immersion sleeves.
- Cable connections with cutting ring threaded connections must be installed in a vice and tightened, the thread first being coated with thin-film lubricant.
- If components are to be marked by etching, after the etching is completed the solution must be removed by means of neutralization agent. The affected parts must then be preserved with SAE 30 engine oil.
- Unless stated otherwise, parts used in hot-part areas (e.g. V-clamps, bellows, plug-in pipes, O-rings) must be coated at the mating faces with assembly paste.
- The assembly surfaces of screws, nuts, washers and of parts to be tensioned must be clean and polished or provided with the specified surface protection and free from warping and damage. Corrosion inhibitors (e.g. oil, grease) must be removed. Threads and screw heads must be coated with lubricant before assembly as per tightening specifications.

  Unless otherwise specified, the following lubricants should be used:

  – SAE 30 engine oil for general application

  – Assembly paste in hot part areas.

a) Threaded connections without tightening specifications

For threaded connections without tightening specifications, the tightening procedure can be selected as required, i.e. mechanical tightening with screwdriver or normal manual tightening with an open-end wrench or box wrench is possible.
In the event of mechanical tightening, the tightening torque must be taken from the general tightening specifications according to thread size and property class.

b) Threaded connections with tightening specifications

– Torque tightening

The screw connections must be tightened by hand with a torque wrench or angle-of-rotation torque wrench. The specified tightening torques must be set at the torque wrench without consideration of the specified tolerance. When using an angle-of-rotation torque wrench, the torque indicated must be within the torque specification limit value. Proceed in a similar manner with torsionally protected threaded connections. These instructions apply also to testing torque.

Note: If no tightening torque tolerance has been specified, the tightening tolerance is + 10% of the specified torque.

– Angle of rotation tightening:
The additional angles of rotation specified in the tightening specifications must be achieved and may be exceeded within the specified tolerance.
If no tightening tolerance is specified, the following tolerances must be observed:

+ 5° for additional angle of rotation less than or equal to	90°
+ 10° for additional angle of rotation greater than	90°

Before angle-of-rotation tightening, each screw head must be colour-marked so that after tightening it is possible to check that the angle of rotation is correct (exception: colour-marking is not necessary in the case of a self-monitoring NC screwdriver).

– Elongation tightening
Tightening must be carried out in accordance with tightening specifications taking the tightening tolerance into consideration.

A 002 Hazards in the Work Area

These Safety Instructions must be read and followed by any persons operating, carrying out maintenance or repairs on the machinery plant.

General Safety and Accident Prevention Regulations

- In addition to the instructions given in this publication, general safety and accident prevention regulations and laws must be taken into consideration; these may vary from country to country.
- This MTU engine is a state-of-the-art product and conforms with all the applicable specifications and regulations. Nevertheless, persons and property may be at risk in the event of:

– Incorrect use
– Servicing, maintenance and repair carried out by untrained members of staff
– Modifications or Conversions
– Noncompliance with the Safety Instructions

Correct Use

- The engine is to be used solely for the purpose stated in the contract. Any other use is considered improper use. The manufacturer will accept no liability for any resultant damage. The responsibility is borne by the user alone.
- Correct use also includes observation of the Operating Instructions and Maintenance Manual and compliance with maintenance and repair instructions.

Personnel Requirements

- Work on the engine must be carried out only by reliable personnel. The specified legal minimum age must be respected.
- Only fully-trained or qualified personnel must be employed. Responsibilities of the operating, maintenance and repair personnel must be specified.

Modifications or Conversions

- Modifications made by the customer to the engine may affect safety. No modifications or conversions must be implemented out without prior consent from MTU.
- No liability will be accepted for damage resulting from unauthorised modifications.

Organisational Measures

- This Operation Manual must be made available to maintenance and servicing personnel.
- The personnel must be instructed on engine operation and repair by means of the Operation Manual, and in particular the safety instructions must be explained. This is especially important for personnel who work on the engine only on an occasional basis.

Note: This copy is only subject to the Amendment Service if the acknowledgement of receipt card has been returned to MTU.This also applies to in-house use by MTU personnel.

Spare Parts

- Spare parts must at least satisfy the requirements specified by the manufacturer. This is guaranteed when original components are used.

Working Clothes and Protective Equipment

- Always wear protective shoes when working on plant.
- Select appropriate protective goggles for the work to be carried out. Always wear protective goggles when working with mallets, cutting tools, drift punches and associated tools.
- Work clothing must be tight-fitting so that it does not catch on rotating or projecting components. Do not wear jewellery (e.g. rings, chains, etc.).

Welding Operations

- Never use the engine as a ground terminal! – (This prevents the welding current from passing through the engine, resulting in burnt or scorched points on the bearings, friction surfaces and tooth flanks which can lead to bearing scorching and/or material damage).
- Welding operations on the engine or mounted plants are not permitted.
- Never place the welding cable across or near wiring harnesses of MTU plants. (The welding current could be induced in the cable harnesses which could possibly damage the electrical plant)
- The ground terminal of the welding unit must be connected to the welding point at a distance no greater than 60 cm.
- If welding must be carried out on components (e.g. exhaust pipe), these components must be removed from the engine beforehand.
- At the MTU electronics system, it is not necessary to remove the connector and connections to carry out welding operations if the master switch of the power supply is switched from “On” to “Off” and the cable has been disconnected from the negative and positive poles on the battery.
- During welding operations, always wear welding gloves, headgear/goggles, protective aprons and other suitable protective clothing.

Transport

- Lift the engine only with the lifting eyes provided.
- Use only the transport and lifting equipment approved by MTU.
- The engine must only be transported in installation position.

Engine Operation

- When the engine is running, ear protectors must always be worn in the engine room.
- The engine room must be well ventilated.
- To avoid injuries caused by falling, leaked or spilt engine oil and coolant must be cleaned up immediately or absorbed with appropriate bonding agents.
- Exhaust gases from combustion engines are poisonous and injurious to health if inhaled. The exhaust pipework must be leak-free and discharge exhaust gases to atmosphere.
- During engine operation, do not touch battery terminals, generator terminals or cables. Inadequate protection of electrical components can lead to electric shocks and serious injuries.
- If engine is running, never release coolant, oil, fuel, compressed air or hydraulic lines.

Maintenance and Repair

- Compliance with maintenance specifications is an important safety factor.
- Unless expressly permitted, no maintenance or repair work must be carried out with the engine running. The engine must be secured against inadvertent starting and the battery disconnected. Attach sign “Do not operate” in operating area or to control equipment. Persons not involved must keep clear.
- Never attempt to rectify faults or carry out repairs if you do not have the necessary experience or special tools required. Maintenance work must only be carried out by authorised, qualified personnel.
- Use only tools in perfect condition.
- Do not work on engines or components which are only held by lifting equipment or crane. Always support these components on suitable frames or stands before beginning any maintenance or repair work.
- Before barring the engine, ensure that nobody is within the danger area. After working on the engine, check that all guards have been reinstalled and that all tools and loose components have been removed from the engine.

- Fluids emerging under high-pressure can penetrate clothing and skin and may cause serious injury. Before starting work, relieve pressure in systems and H.P. lines which are to be opened.
- Never bend a fuel line and do not install bent lines. Keep fuel injection lines and connections clean. Always seal connections with caps or covers if a line is removed or opened.
- During maintenance or repair work, do not hit fuel lines with wrenches or other tools. To tighten connections when installing lines, use the correct tightening torque and ensure that all retainers and dampers are installed correctly.
- Ensure that all fuel injection lines and compressed oil lines have sufficient play to avoid contact with other components. Do not place fuel or oil lines near hot components.
- The H.P. lines for hydraulic installation and removal are tested with 3800 bar.
- Do not attempt to bend or apply force to lines.
- In order to avoid burning, take special care when handling hot components on products just taken out of use and when working with hot liquids in pipelines, pipes and chambers.
- Until the engine has cooled, the breather cap must not be opened. Release the breather cap and allow pressure to escape before cap removal.
- Take special care when removing ventilation or plugs from engine. In order to avoid being sprayed with highly-pressurised liquids, hold a cloth over the screw or plug. It is even more dangerous if the engine has recently been shut down as the liquids can still be hot.
- Take special care when draining hot fluids – risk of injury. Drain the fluids into a suitable container and wipe up any spillages.
- When changing engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.
- When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.
- To avoid damaging your back when lifting components weighing 25 kg (50 lb.) or more, use lifting gear or request aid from other workers. Ensure that all chains, hooks, slings, etc. are in good condition, are sufficiently strong and that hooks are correctly positioned. Lifting eyes must not be unevenly loaded.
- When operating electrical equipment, certain components of this equipment are live.
- Noncompliance with warning notices could result in serious physical injury or damage to property.
- Work must be carried out only by qualified personnel. Prior to working on electrical equipment, switch off live units.
- Gases released from the battery are explosive. Avoid sparks and naked flames. Do not allow battery acids to come into contact with skin or clothing. Wear protective goggles. Do not place tools on the battery. Before connecting the cable to the battery, check battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.
- Do not damage wiring during removal work and when reinstalling wiring and ensure that during operation it is not damaged by contact with sharp objects, by rubbing against another component or by a hot surface. Never connect wiring to a line which carries liquid.
- On completion of the maintenance and repair work, any cables which have become loose must be correctly secured.
- Always tighten connectors with connector pliers.
- If cables are present at mechanical components and there is a risk of wear, the cables must be retained in cable clamps.
- For this purpose, no cable straps must be used as, during maintenance and/or repair work, the straps can be removed but not installed a second time.
- Check security of all plug-in connections.
- It is not sufficient to tighten the connections by hand with a bayonet union. There is the risk of the lock not engaging properly and the connector coming loose during engine operation. Therefore pliers must be used for turning the bayonet union nut in clockwise direction.

Fire Prevention

- Rectify any fuel or oil leaks immediately; even splashes of oil or fuel on hot components can cause fires – therefore always keep the engine in a clean condition. Do not leave oil-soaked cloths on the engine. Do not store combustible fluids near the engine. Do not allow dirt or foreign matter to accumulate near the engine, as this constitutes a fire hazard.
- Welding work must not be carried out on pipes and components containing oil. Before welding, clean with a noncombustible fluid.
- Never mix petrol/gasoline with diesel fuel. If petrol/gasoline is added to diesel fuel, there is increased risk of fire.
- When starting the engine with a foreign power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the foreign power source to the ground lead of the engine or to the ground terminal of the starter.
- Always keep a fire extinguisher at hand and learn how to operate it.

Noise

- Hearing may be impaired at workplaces where the sound pressure level is in excess of 85 dB(A).
- Wear earplugs or earmuffs!

Environmental Protection

- Dispose of used fluids and lubricants and filters in accordance with local regulations.
- Manipulation of the injection or control system can influence the engine performance and exhaust emissions. As a result, compliance with environmental regulations may no longer be guaranteed.

Skin Complaints

- Barrier creams issued for prophylactic use are not suitable for treatment of skin complaints. Seek medical advice on skin rashes of any type, even if symptoms are very slight.

Warning Signs

- Before putting the engine into service and before working on the engine, read and follow all warning signs. Do not paint on warning signs. Replace illegible signs.

Auxiliary Materials

- Use only fluids and lubricants that have been tested and approved by MTU.
- Fluids and lubricants must be kept in properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions applicable to the product. Take special care when using hot and caustic materials. When using inflammable materials, avoid all sparks and do not smoke.

Lead

- When working with lead or pastes that contain lead, take care that the body does not absorb even tiny amounts of lead (from air-borne lead dust, smoke, dirty hands).

– Adopt suitable measures to avoid the formation of lead dust!
– Switch on extraction system!
– Wash hands before consuming food or beverages!

Chlorinated Hydrocarbons

- When working with chlorinated hydrocarbons (e.g. perchlorethylene, trichlorethane) or other cold cleaners which contain declared hazardous substances, health-endangering substances may be inhaled.

– Switch on ventilation and extraction systems!
– Observe fire-prevention regulations!
– No smoking and no consumption of alcoholic beverages!
– Do not permit substances to enter the waste-water system!

Acids and Alkalis

- When working with acids and alkalis, wear protective goggles or face mask, gloves and protective clothing.

– Immediately remove clothing wetted by acids and alkalis!
– Rinse injuries with plenty of clean water!
– Rinse eyes immediately with water from rinsing bottle or clean mains water!

Painting

- When painting in other than spray booths equipped with extractors, ensure good ventilation. Ensure that neighbouring workplaces suffer no detrimental effects.

– Always wear a mask providing protection against paint and solvent vapours!
– Observe all fire-prevention regulations!
– No smoking!
– No naked flame!

Liquid Oxygen

- Liquid oxygen is highly flammable.
- Store liquid oxygen only in small quantities and always in regulation containers (without fixed seal)! Do not bring into contact with parts of the body (hands); causes cold burns and severe frostbite.

– No smoking, no naked flame (risk of explosion)! Oxygen enrichment in the air causes flash combustion.
– Do not store any inflammable substances (e.g. oils and greases) within 5 m of the area of work.
– Under no circumstances wear oily or greasy clothing!
– Do not allow vapours to penetrate clothing! Oxygen enrichment in fabric can cause working clothes to ignite suddenly!
– After working with liquid oxygen, do not smoke until clothing is free of vapours!
– Take great care to avoid impact and shock when working with liquid oxygen!

Liquid Nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers (without fixed seal)!
- Do not allow liquid nitrogen to come into contact with parts of body (eyes, hands). Liquid nitrogen causes cold burns and severe frostbite.

– Wear protective clothing (including gloves and closed shoes) and protective goggles!
– Ensure good ventilation (suffocation if nitrogen enrichment in inhaled air reaches 88%)
– Do not subject containers, fittings and tools to impact or shock!

Compressed Air

- Compressed air is compressed, pressurised air and is stored in pressure vessels from which the compressed air is then extracted.
- The compressed air pressure can be read off at the pressure indicator (pressure gauge); the pressure vessels and compressed air lines must also be at this pressure.
- High pressure is harmful to the human body, especially if applied suddenly.

- When working with compressed air, safety precautions must be constantly observed:

– Pay special attention to the pressure level in the compressed air network and pressure vessel!
– Connecting devices and equipment must either be designed for this pressure or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection. Hose coupling and connections must be securely attached!
– Always wear protective goggles when blowing off tools or extracting chips!
– The snout of the air nozzle is provided with a protective disc (e.g. rubber disc), which prevents air-borne particles being reflected and thereby prevents damage to the eyes.
– First shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tool is to be replaced!
– Unauthorised use of compressed air, e.g. forcing flammable liquids (danger class AI, AII and B) out of containers, results in a “Risk of explosion”!
– Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks results in a “Risk of explosion”.
– Removing dirt on soiled clothes while still worn can result in a “Risk of injury”.
Even compressed air at low pressure penetrates clothing and, if the jet is directed at the back, the air can enter the anal cavity and fatally rupture the intestines!

Used Oil

- Used oil may contain health-threatening combustion residues.

– Rub barrier cream into hands!
– Clean hands thoroughly after contact with used oil!

Warning Notices

- Section “C” of this Publication contains especially emphasised safety instructions in accordance with the American standard ANSI Z535, which begin with one of the following signal words according to the degree of danger.

– Take extreme care in these situations!
– Read and become acquainted with all warning notices and symbols before operating or repairing this product!
– Inform operating and maintenance personnel on all Safety Instructions!

⚠ DANGER

An instruction of this type draws attention to an impending danger which, if ignored, may lead to serious injury or death.

⚠ WARNING

An instruction of this type draws attention to a possible danger which, if ignored, may lead to serious injury or death.

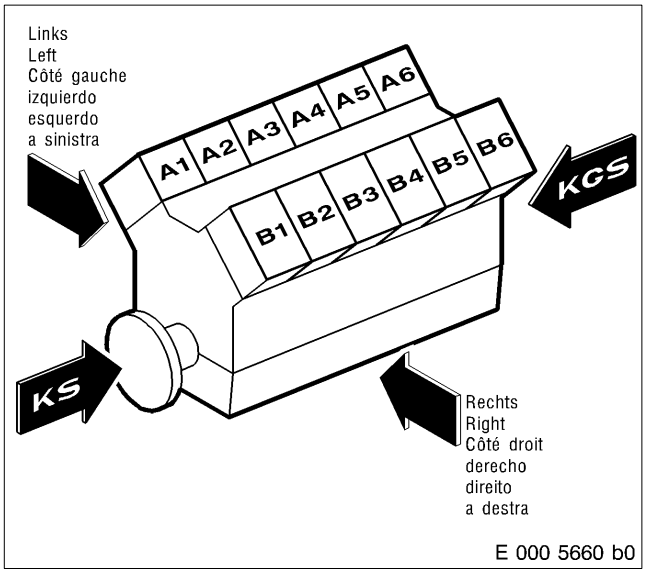
⚠ CAUTION

An instruction of this type draws attention to a danger which, if ignored, may lead to a minor injury.

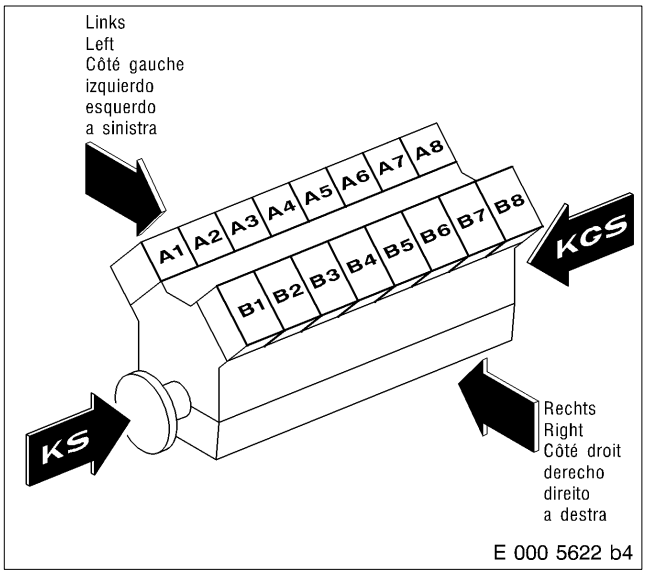
A003 Designation of Engine Sides and Cylinders

Engine sides are always designated as viewed from the driving end.
Cylinders are designated (to DIN ISO 1204) A on the left engine side and B on the right engine side.
The cylinders of each bank are numbered in consecutive order, beginning at No. 1 at the driving end.
The consecutive numbering of other components, too, always begins with No. 1 at the driving end of the engine.

12V



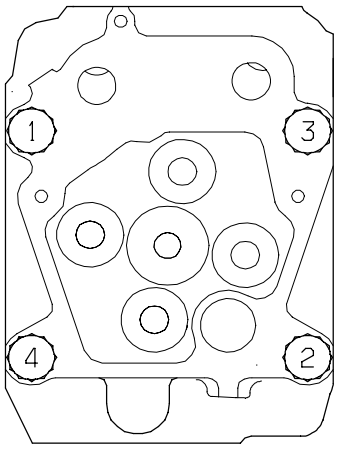
16V



Designations and Abbreviations

Driving end = KS
Free end = KGS
Left side
Right side
Top end
Bottom end

A 004 Tightening Specifications for Screws, Bolts and Nuts

Designation	Tightening Specification	Lubricant	See
Crankcase			
Centre hex screws for crankshaft bearing cap* Max. shaft length: 176 mm – Pretightening torque: – Additional angle of rotation:	 300 Nm + 30 Nm 90° + 10°	Engine oil	C 011.05 C 031.05
Side double-hex screws for crankshaft bearing cap*	140 Nm + 10 Nm	Engine oil	C 011.05
Plugs for main oil ducts (M30 × 1.5)	180 Nm	Engine oil	C 011.05
Screws for cover of Hengst oil separator	6 Nm + 2 Nm	Engine oil	C 018.10
Running Gear			
Screws for counterweights Max. shaft length: 84 mm – Pretightening torque: – Additional angle of rotation:	 140 Nm + 20 Nm 90° + 10°	Engine oil	C 031.05
Socket-head screws for viscosity vibration damper	31 Nm + 3 Nm	Engine oil	C 032.05
Threaded pin in expansion bore in drive flange	21 Nm + 3 Nm	Engine oil	C 032.05
Hex screws (M10) for side plate on vibration damper	52 Nm	Engine oil	C 035.05
Conrod cap screws Max. shaft length : 68.5 mm – Pretightening torque: – Additional angle of rotation:	 100 Nm + 15 Nm 90° + 10°	Engine oil	C 037.05
Cylinder Head			
Double-hex screws for cylinder head Max. shaft length: 212 mm Pretightening torque, in stages: – 1st stage – 2nd stage – 3rd stage – 4th stage additional angle of rotation, in stages: – 1st stage – 2nd stage <u>Cylinder head tightening diagram</u>  K 041 0017 b0	 10 Nm 50 Nm 100 Nm 200 Nm 90° + 10° 90° + 10°	Engine oil	C 041.05
Protective sleeve for injector	40 Nm + 5 Nm	Engine oil	C 041.05

***** Tightening sequence: hex screws before double-hex screws

Designation	Tightening Specification	Lubricant	See
Valve Gear			
Locknut on adjusting screw for rocker arm	50 Nm	Engine oil	C 055.05
Hex screws for rocker shaft support Max. shaft length: 91 mm – Pretightening torque: – Additional angle of rotation:	 60 Nm 90°	Engine oil	C 055.05
Collar screw for cylinder head cover	20 Nm	Engine oil	C 055.10
Fuel System – High-Pressure			
Screws for plug-in clips on injection pump	1 Nm ± 0.2 Nm	Engine oil	C 073.05
Double-hex screws for injection pump on crankcase	60 Nm + 12 Nm	Engine oil	C 073.05
Hex screw for clamping element on injector	50 Nm	Engine oil	C 075.05
Thrust screw for pressure pipe connections in cylinder head	40 Nm + 5 Nm	Engine oil	C 077.05
Union nut of H.P. line on high-pressure pump	30 Nm + 5 Nm	Engine oil	C 077.05
Union nut of H.P. line on injection nozzle	20 Nm + 5 Nm (max. 35 Nm)	Engine oil	C 077.05
Exhaust Turbocharger			
Hex nut for compressor housing clamp segment	15 Nm	–	C 101.01
Shaft nut for compressor wheel – Pretightening torque: – Additional angle of rotation:	 10 Nm 70° – 5°	–	C 101.01
Socket-head screw for rear wall	28 Nm	Loctite 640	C 101.01
Hex screw for turbine housing clamping segment	40 Nm	Ultra Therm MTU	C 101.05
Exhaust System			
Hex screws for exhaust elbow on cylinder head	30 Nm	Ultra Therm MTU	C 141.10
Lube Oil System			
Screws for oil spray nozzle	25 Nm	Engine oil	C 184.10
Cooling Air System			
Hex screws for bearing pedestal on equipment carrier	100 Nm	Engine oil	C 221.05
Mounting			
Hex screws for engine mount on crankcase	250 Nm + 25 Nm	Engine oil	C 231.05
Engine mount height-adjusting nut	180 Nm + 18 Nm	Engine oil	C 231.05
Monitoring, Control and Regulation Devices			
Charge air pressure sensor in charge air manifold	min. 20 Nm max. 70 Nm	Engine oil	C 507.10
Lube oil pressure sensor in filter head	min. 20 Nm max. 45 Nm	Engine oil	C 507.10
Level sensor in expansion tank	max. 30 Nm	Engine oil	C 507.10
Temperature sensor for charge air, coolant, lube oil, fuel	min. 15 Nm max. 30 Nm	Engine oil	C 507.10

Tightening specification for set screw and stud connections to works standard MTN 5008

This works standard applies to set screws subjected to little dynamic load as per MMN 384, DIN 912, EN 24014 (DIN 931–1), EN 24017 (DIN 933), EN 28765 (DIN 960), EN 28676 (DIN 961), DIN 6912 and to studs as per DIN 833, DIN 835, DIN 836, DIN 938, DIN 939 and associated nuts.

They do not apply to heat-proof screws in the hot component area.

Tightening torques M_A are for screws of strength class 8.8 (bright surface, phosphate coating or galvanised) and 10.9 (bright surface or with phosphate coating).

The values in the table are based on a friction coefficient μtot = 0.125. Precondition: Thread and mating faces of screws and nuts must be coated in engine oil prior to assembly.

When tightening manually (tightening specifications), an assembly tolerance of + 10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

When tightening mechanically, the permitted assembly tolerance is + 15%

Tightening torques = M_A

Thread	**Manual-tightened**		**Machine-tightened**	
	8.8	**10.9**	**8.8**	**10.9**
	M_A (Nm)	**M_A (Nm)**	**M_A (Nm)**	**M_A (Nm)**
M6	9	12	8	11
M8	21	31	20	28
M8 x 1	23	32	21	30
M10	42	60	40	57
M10 x 1.25	45	63	42	60
M12	74	100	70	92
M12 x 1.25	80	110	75	105
M12 x 1.5	76	105	72	100
M14	115	160	110	150
M14 x 1.5	125	180	120	170
M16	180	250	170	235
M16 x 1.5	190	270	180	255
M18	250	350	240	330
M18 x 1.5	280	400	270	380
M20	350	500	330	475
M20 x 1.5	390	550	350	520
M22	480	680	450	650
M22 x 1.5	520	730	490	700
M24	600	850	570	810
M24 x 1.5	680	950	640	900
M24 x 2	660	900	620	850
M27	900	1250	850	1175
M27 x 2	960	1350	900	1275
M30	1200	1700	1100	1600
M30 x 2	1350	1900	1250	1800

Tightening torques for stress bolt connections prescribed in standard MTN 5007

This standard applies to stress pin bolts and stress bolts which are subjected to static and dynamic load of strength class 10.9 and the associated nuts.

Shaft and transition dimensions as to MMN 209 standard and material and machining to MMN 389 standard (bright surface or with phosphate coating).

The values in the table are based on a friction coefficient μtot = 0.125. Precondition: Thread and mating faces of screws and nuts must be coated in engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of + 10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

The values in the tables are for manual tightening with torque wrench.

Tightening torques = M_A

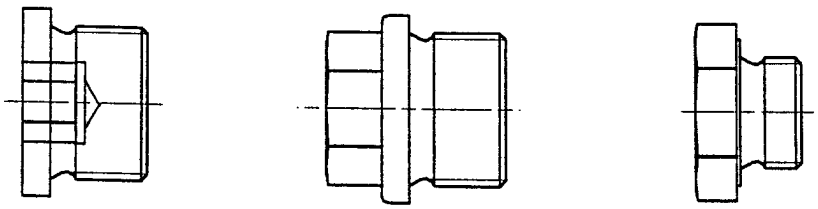
Thread	**Without torsion protection M_A (Nm)**	**With torsion protection* M_A (Nm)**
M6	9	12
M8	21	28
M8 x 1	24	30
M10	42	55
M10 x 1.25	46	60
M12	75	93
M12 x 1.5	78	99
M14	120	150
M14 x 1.5	135	160
M16	180	225
M16 x 1.5	200	245
M18	250	315
M18 x 1.5	300	360
M20	350	450
M20 x 1.5	430	495
M22	500	620
M22 x 1.5	560	675
M24	640	790
M24 x 2	700	850
M27	900	1170
M27 x 2	1000	1230
M30	1250	1575

*Protect shank against torsion when tightening.

Tightening torques for plugs prescribed in standard MTN 5183–1

This standard applies to plugs as per DIN 908, DIN 910 and DIN 7604 with screwed plug DIN 3852, model A (sealed by sealing ring DIN 7603–Cu).

DIN 908 **DIN 910** **DIN 7604A/C**



Tightening torques M_A are given for plugs made of steel (St) with surface protected by a phosphate coating and oiled or galvanised.

Thread and mating faces beneath heads must be coated in engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of + 10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

Tightening torques = M_A

Tightening torques for plugs DIN 908, DIN 910 and DIN 7604A (with short screwed plug)

Thread	inserted in	
	steel/gray cast iron M_A (Nm)	Al-alloy M_A (Nm)
M10 x 1	15	15
M12 x 1.5	35	25
M14 x 1.5	35	25
M16 x 1.5	40	30
M18 x 1.5	50	35
M20 x 1.5	55	45
M22 x 1.5	60	50
M 24x1.5	70	60
M26 x 1.5	80	70
M27 x 2	80	70
M30 x 1.5	100	90
M30 x 2	95	85
M33 x 2	120	110
M36 x 1.5	130	115
M38 x 1.5	140	120
M42 x 1.5	150	130
M45 x 1.5	160	140
M48 x 1.5	170	145
M52 x 1.5	180	150
M56 x 2	190	160
M64 x 2	205	175

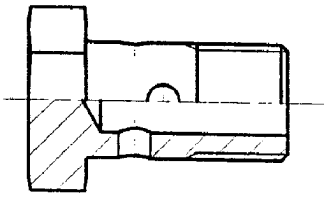
Tightening torques for plugs as per DIN 7604C (with long screwed plug)

Thread	**inserted in**	
	steel/gray cast iron M_A **(Nm)**	**Al-alloy** M_A **(Nm)**
M8 x 1	10	10
M22 x 1.5	80	65
M26 x 1.5	105	90
M30 x 1.5	130	130
M38 x 1.5	140	120
M45 x 1.5	160	140

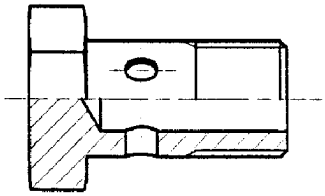
Tightening torques for banjo screws as per MTN 5183–2 standard

This standard applies to banjo screws as per MMN 223 and N 15011 sealed with sealing ring DIN 7603–Cu

MMN 223 (4 flow holes)



N 15011 (3 flow holes)



Tightening torques M_A are given for banjo screws made of steel (St) with surface protected by a phosphate coating and oiled or galvanised and for banjo screws made of copper-aluminium alloys.

Thread and mating faces beneath heads must be coated in engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of + 10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

Tightening torques = M_A

Tightening torques for banjo screws made of steel

Thread	**inserted in steel/gray cast iron/Al-alloy M_A (Nm)**
M8 x 1	10
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	25
M16 x 1.5	25
M18 x 1.5	30
M22 x 1.5	60
M26 x 1.5	90
M30 x 1.5	130
M38 x 1.5	140
M45 x 1.5	160

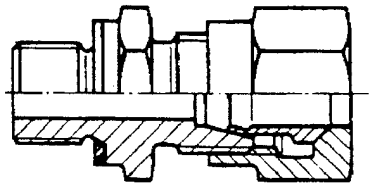
Tightening torques for banjo screws made of copper-aluminium alloys

Thread	**inserted in steel/gray cast iron/Al-alloy M_A (Nm)**
M10 x 1	15
M16 x 1.5	30

Tightening torques for male connector as per MTN 5183–3 standard

This standard applies to male connectors DIN 2353, row L with screwed plug DIN 3852, model A
(Sealed by sealing ring DIN 7603–Cu)

DIN 2353, model C



Tightening torques M_A are given for male connectors made of steel (St) with surface protected by a phosphate coating and oiled or galvanised.

Thread and mating faces beneath heads must be coated in engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of + 10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

Tightening torques = M_A

Thread	**inserted in steel/gray cast iron M_A (Nm)**
M10 x 1	10
M12 x 1.5	20
M14 x 1.5	40
M16 x 1.5	50
M18 x 1.5	60
M22 x 1.5	70
M26 x 1.5	100
M32 x 2	160
M42 x 2	260
M48 x 2	320

A005 Settings

Firing order

12V: A1 – B2 – A5 – B4 – A3 – B1 –A6 – B5 – A2 – B3 – A4 – B6

16V: A1 – B5 – A3 – A5 – B2 – B8 – A2 – A8 – B3 – A7 – B4 – B6 – A4 – A6 – B1 – B7

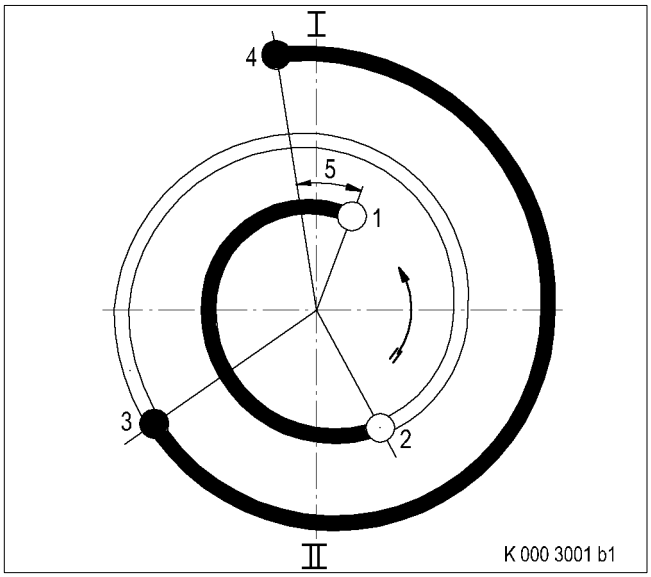
Direction of rotation as viewed from driving end

Crankshaft	counterclockwise
Camshaft	clockwise
Fuel Pump	counterclockwise
Oil pump	counterclockwise
Engine coolant pump	counterclockwise
Raw water pump	counterclockwise

Valve clearance, engine cold (20 °C)

Inlet	0.40 mm
Exhaust	0.60 mm

Valve timing, valve clearance adjusted



° Crank angle

1 Inlet valve opens . . . . . 12.4° before TDC
2 Inlet valve closes . . . . . 18.4° after BDC
3 Exhaust valve opens . . . . . 55.6° before BDC
4 Exhaust valve closes . . . . . 9.25° after TDC
5 Overlap . . . . . 21.6°
6 Start of delivery . . . . . Map based

I . . . . . Top dead centre (TDC)
II . . . . . Bottom dead centre (BDC)

Fuel injection pressure

Setting pressure with new spring	320 to 330 bar
Minimum pressure with run-in spring	260 bar

Cam and valve lift for camshaft adjustment

	Inlet	Exhaust
Cam lift at TDC	0.70 mm	0.60 mm
Valve lift at TDC (zero valve clearance)	0.85 mm	0.80 mm

A006 Conversion Tables

Length SI unit: m
Other permitted units: µm, mm, km

Unit A	multiplied by factor	=	Unit B
in	25.40	=	mm
ft	0.3048	=	m
yd	0.9144	=	m
stat. mile	1.609	=	km
yd	3	=	ft
yd	36	=	in

Unit B	multiplied by factor	=	Unit A
mm	0.03937	=	in
m	3.281	=	ft
km	0.6215	=	stat. mile

Area SI unit: m^2
Other permitted units: mm^2; a (Ar) = 100 m^2, ha

Unit A	multiplied by factor	=	Unit B
in^2 (sq in)	645.16	=	mm^2
ft^2 (sq ft)	0.0929	=	m^2
yd^2 (sq yd)	0.8361	=	m^2
stat. $mile^2$	2.5889	=	km^2

Unit B	multiplied by factor	=	Unit A
mm^2	0.00155	=	in^2 (sq in)
m^2	10.7643	=	ft^2 (sq in)
m^2	1.1960	=	yd^2 (sq yd)
km^2	0.3863	=	stat. $mile^2$

Volume SI unit: m^3
Other permitted units: l, mm^3, cm^3, dm^3

Unit A	multiplied by factor	=	Unit B
in^3 (cu in)	16387	=	mm^3
ft^3 (cu ft)	0.02832	=	m^3
yd^3 (cu yd)	0.7646	=	m^3
gallon (US)	3.787	=	dm^3
gallon (brit.)	4.546	=	dm^3

Unit B	multiplied by factor	=	Unit A
cm^3	0.06102	=	in^3 (cu in)
m^3	35.31	=	ft^3 (cu ft)
dm^3	0.2642	=	gallon (US)
dm^3	0.22	=	gallon (brit.)

Speed SI unit: m/s
Other permitted units: km/h

Unit A	multiplied by factor	=	Unit B
ft/s	0.3048	=	m/s
stat. mile/h (mph)	1.609	=	km/h
knot (brit.)	1.852	=	km/h

Unit B	multiplied by factor	=	Unit A
m/s	3.281	=	ft/s
km/h	0.6215	=	stat. mile/h (mph)
km/h	0.54	=	knot (brit.)

Measure SI unit: kg
Other permitted units: mg, g, t

Unit A	multiplied by factor	=	Unit B
lb	0.4536	=	kg
oz	28.35	=	g
ton	1.016	=	t

Unit B	multiplied by factor	=	Unit A
g	0.03527	=	oz
kg	2.205	=	lb
t	0.9843	=	ton

Force SI unit: N
Other permitted units: mN, kN, MN

Unit A	multiplied by factor	=	Unit B
lb	0.4536	=	kp
lb	4.4483	=	N

Unit B	multiplied by factor	=	Unit A
kp	2.205	=	lb
N	0.101972	=	kp
kp	9.80665	=	N

Pressure SI unit: Pa
Other permitted units: bar, mbar, µbar; 1 bar = 10^5 Pa

Unit A	multiplied by factor	=	Unit B
lb/sq in (psi)	703.1	=	kp/m^2 (mm WS)
lb/sq in (psi)	0.06895	=	bar
lb/sq ft	47.883	=	Pa
in QS	0.03386	=	bar
in QS	345.3	=	kp/m^2

Unit B	multiplied by factor	=	Unit A
atm	760	=	mm QS
atm	1.0133	=	bar
atm	10332	=	kp/m^2 (mm WS)
atm	1.0332	=	kp/cm^2 (at)
atm	14.696	=	lb/sq in
bar	14.503	=	lb/sq in

Density SI unit: kg/m^3
Other permitted units: g/cm^3, kg/dm^3, kg/l

Unit A	multiplied by factor	=	Unit B
lb s^2/ft^4	515.4	=	kg/m^3

Unit B	multiplied by factor	=	Unit A
kg/m^3	0.00194	=	lb s^2/ft^4

Torque SI unit: Nm

Unit A	multiplied by factor	=	Unit B
ft lb	1.3563	=	Nm

Unit B	multiplied by factor	=	Unit A
Nm	0.7373	=	ft lb

Mass moment, 2nd grade SI unit: kg m^2

Unit A	multiplied by factor	=	Unit B
ft lb s^2	1.3563	=	kg m^2

Unit B	multiplied by factor	=	Unit A
kg m^2	0.7373	=	ft lb s^2

Energy SI unit: J
Other permitted units: kJ, kWh

Unit A	multiplied by factor	=	Unit B
ft lb	1.356	=	J
kcal	4186.8	=	J
BTU	1055	=	J
CHU	1899	=	J

Unit B	multiplied by factor	=	Unit A
J	0.7376	=	ft lb
J	0.0002389	=	kcal
J	0.0009479	=	BTU
J	0.00052656	=	CHU

Power SI unit: W; 1 W = 1 J/s = 1 Nm/s
Other permitted units: kW, kJ/h

Unit A	multiplied by factor	=	Unit B
PS	0.7355	=	kW
HP	0.7457	=	kW
BTU/s	1.055	=	kW
kcal/h	1.163	=	W
HP	550	=	ft lb/s

Unit B	multiplied by factor	=	Unit A
kW	1.36	=	PS
kW	1.341	=	HP
kW	0.9479	=	BTU/s
W	0.8598	=	kcal/h
ft lb/s	0.0018	=	HP

Temperature SI unit: K
Other permitted units: °C; 1 °C = 273.15 K, °F = $^{9}/_{5}$ °C + 32

	Celsius	Kelvin	Fahrenheit	Réaumur
x°C	–	= x + 273.15 K	= $^{9}/_{5}$ x + 32 °F	= ($^{4}/_{5}$ x) × °R
x K	= x – 273.15 °C	–	= $^{9}/_{5}$ (x – 273.15) + 32 °F	= $^{4}/_{5}$ (x – 273.15) × °R
x°F	= $^{5}/_{9}$ (x – 32) °C	= $^{5}/_{9}$ (x – 32) + 273.15 K	–	= $^{4}/_{9}$ (x – 32) × °R
x°R	= $^{5}/_{4}$ x °C	= ($^{5}/_{4}$ x) + 273.15 K	= ($^{9}/_{4}$ x) + 32 °F	–

Specific fuel consumption

Unit A	multiplied by factor	=	Unit B
mile/gal (US)	0.4251	=	km/l
gal/mile (US)	2.3527	=	l/km

Unit B	multiplied by factor	=	Unit A
km/l	2.3527	=	mile/gal (US)
l/km	0.4251	=	gal/mile (US)

A007 Publication Summary

Other applicable Customer Service documents:

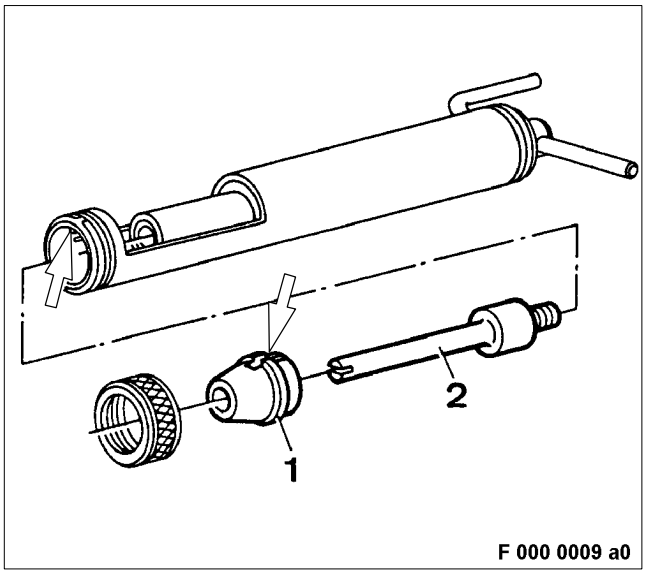
– Description
– Operating Instructions
– Fluids and Lubricants Specification
– Tools List
– Tolerance and Wear Limits List
– Test procedure, instructions for use for auxiliary materials, protective measures

Specialised information on subjects such as
– Fuel injection
– Governor setting
can be found in the Acceptance Test Record or Governor Record for the engine in question.

A008 Repairing Threaded Bores with Threaded Inserts (Heli-Coil)

Data

Thread	Core hole bore dia. (max./min.)	Twist drill dia.
M6	6.31 6.04	6.1–6.2–6.25
M8	8.35 8.04	8.1–8.2–8.25–8.3
M8 x 1	8.32 8.04	8.1–8.2–8.25–8.3
M10	10.40 10.05	10.25
M12	12.50 12.05	12.25–12.5
M12 x 1.5	12.43 12.05	12.25
M14	14.53 14.06	14.25–14.5
M14 x 1.5	14.43 14.05	14.25
M15 x 2	15.30 15.20	15.25
M16	16.53 16.06	16.25–16.5
M16 x 1.5	16.43 16.05	16.25
M 24x1.5	24.43 24.05	24.25
M26 x 1.5	26.43 26.05	26.25
M30 x 1.5	30.43 30.05	30.25



Repairing

If necessary, remove thread insert with suitable removal tool from bore (left).

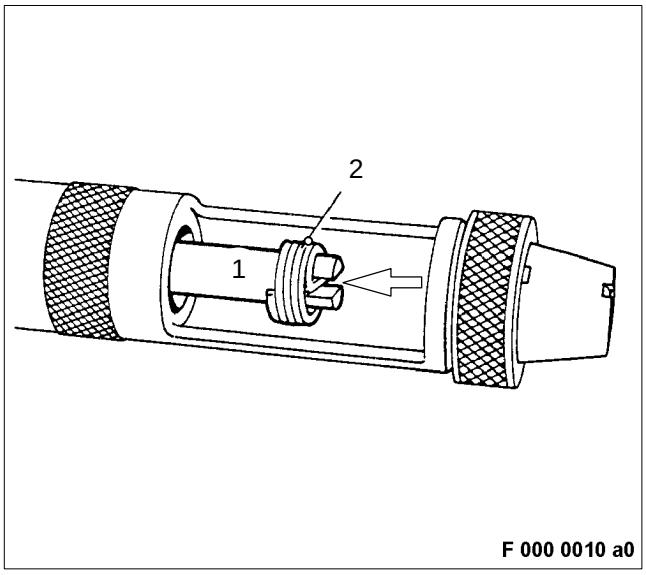
Bore core hole with suitable twist drill – see table.

Cut thread with special tapped bore.

Note: Do not countersink bore!

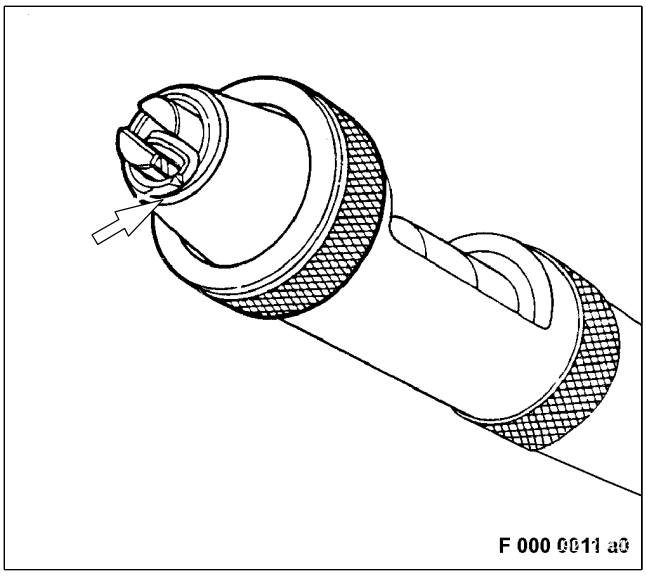
Mount spindle (2) and snout (1) corresponding with thread.

Groove on snout must be aligned with markings on installation tool (arrows).

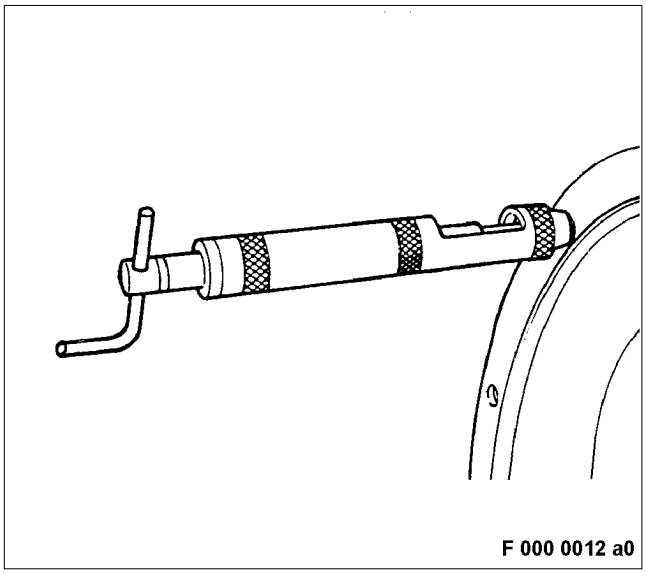


Insert thread insert (2) into spindle (1) in installation tool.

Driver journal of thread insert must be in groove (arrow).



Use spindle to turn thread insert through snout until it is flush at front (arrow).



Mount installation tool on threaded hole and install thread insert without applying pressure to spindle.

Note: Insert thread insert 1/2 to 1 1/2 turns deeper than threaded bore surface.

Use bolt shearer to remove driver journal to M14.

In event of threaded inserts over M14, move driver journal up and down with pointed pliers and remove.

A080 Abbreviations

ATL	**A**bgas**t**urbo**l**ader (Exhaust turbocharger)
brit.	**brit**isch (British)
bzw.	**b**e**z**iehungs**w**eise (and/or)
DBR	**D**rehzahl**b**egrenzungs**r**egler (Speed-sensitive fuel limiter)
d. h.	**d**as **h**eißt
DIN	**D**eutsche **I**ndustrie-**N**orm (German Industrial Standard)
ECS	**E**ngine **C**ontrol **S**ystem
ECU	**E**ngine **C**ontrol **U**nit
ISO	**I**nternational **O**rganization for **S**tandardisation
KGS	Freie Seite (**K**raft**g**egen**s**eite) (Free end)
KS	Antriebsseite (**K**raft**s**eite) (Driving end)
KW	**K**urbel**w**elle (Crankshaft)
LLK	**L**ade**l**uft**k**ühler (Intercooler)
MTU	**M**otoren- und **T**urbinen-**U**nion
NW	**N**ocken**w**elle (Camshaft)
usw.	**u**nd **s**o **w**eiter (etc.)
UT	**U**nterer **T**otpunkt (Bottom dead centre)
WP	**W**asser**p**umpe (Coolant pump)

A090 Keyword Index

T

V

W

Contents

B 001 Checking Engine Condition before a Major Overhaul

Before the engine is removed, a brief test should be conducted to assist in evaluating its condition and running behaviour. Deviations from the Engine Acceptance Test Record Data found during the test run provide valuable information for subsequent overhaul services.

Operations to be performed	**See**
Carry out before-operation services	Operating Instructions
Start engine	Operating Instructions
Carry out engine warm-up procedure	Operating Instructions
Test engine at highest possible power	–
Check engine speed, temperatures and pressures where gauges are installed	–
Check operating states with fault recorder, assess discrepancies	Operating Instructions
Check running noises; these should be restricted to normal operating sounds	–
During test run, visually inspect engine and external lines for leaks	Operating Instructions
Check colour of exhaust gas	Operating Instructions
Operate engine with adjustable zero-power speed	–
Check fuel line connections for leaks	–
Remove cylinder head cover	C 055.05
Check valve gear lubrication (visual inspection)	–
Extract engine oil sample	Operating Instructions
Analyze engine oil sample (spot test, water content, dilution with fuel)	MTU Test Kit
Extract sample of coolant	Operating Instructions
Analyze coolant sample	MTU Test Kit
Check operation of monitoring system and ECS	Operating Instructions
Shut down engine	Operating Instructions
Reduce coolant level in expansion tank and check level switch trip point (coolant level monitoring)	Operating Instructions
Drain coolant	Operating Instructions
Fill system with cleaning solution	–
Start engine	Operating Instructions
Flush cooling system	–
Shut down engine	Operating Instructions
Check compression pressure	Operating Instructions

B 002 W5 Maintenance Operations

Note: The following table contains all operations that may be necessary during a W5 maintenance echelon.
For an exact description of the work, see the contract-specific maintenance schedule.

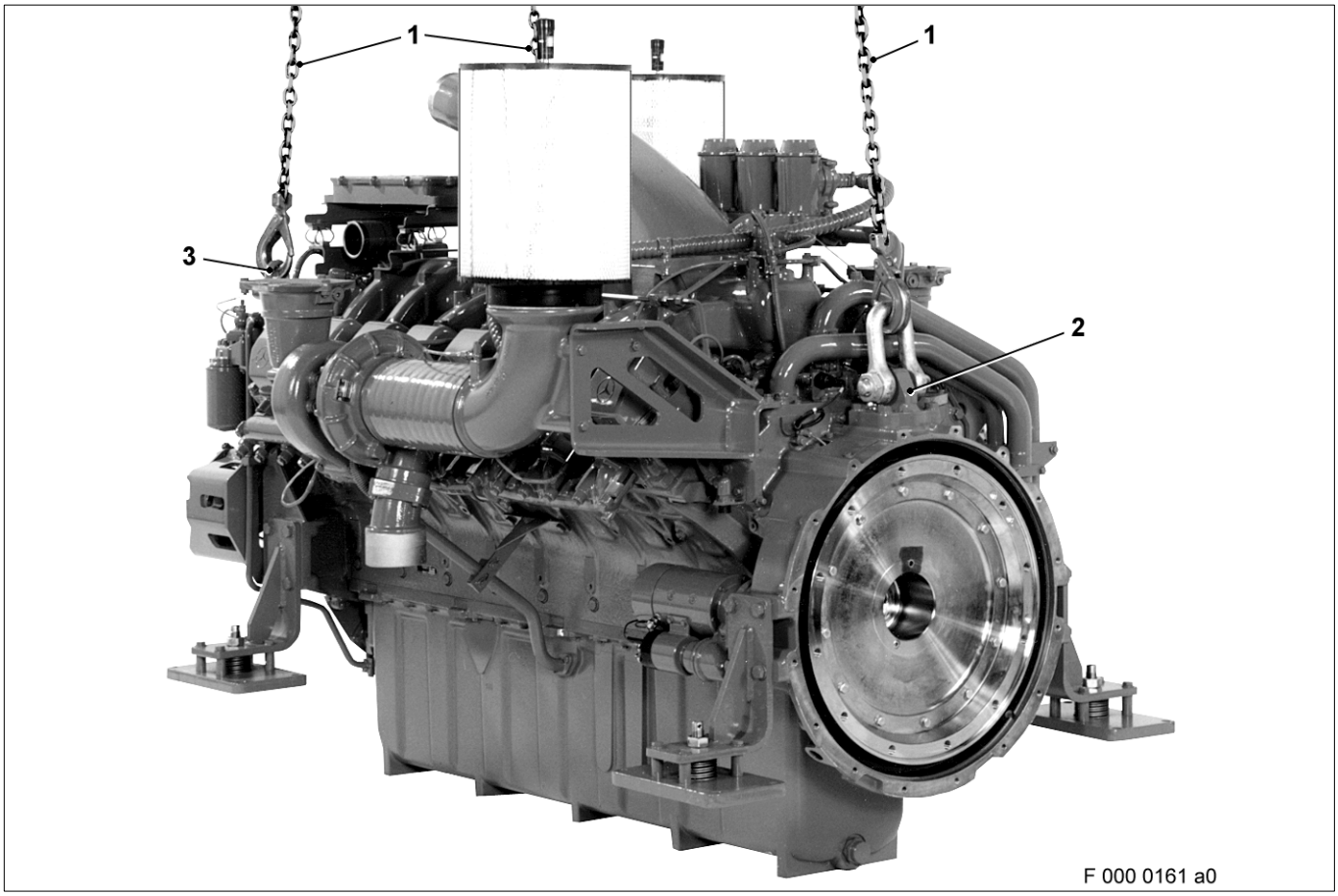
Operations to be performed	See
Disable engine start	Operating Instructions
Wash plant, without using chemical cleaning agents	Operating Instructions
Replace fuel injectors	Operating Instructions
Check compression pressures	Operating Instructions
Drain engine coolant	Operating Instructions
Drain engine oil Replace engine oil filter	Operating Instructions Operating Instructions
Replace throwaway filter of fuel duplex filter Clean fuel prefilter or replace filter elements	Operating Instructions Operating Instructions
Replace air filter cartridges Check contamination indicator	Operating Instructions
Check security of exhaust system	Operating Instructions
Check intake air system, intake side, for leaks and damage	Operating Instructions
Check exhaust turbocharger for ease of movement	Operating Instructions
Clean engine coolant cooler, check for leaks	Special Publication
Replace thermal elements of engine coolant thermostat	C 206.05
Remove, overhaul or replace engine coolant pump	C 202.05
Check condition and voltage of generator drive belt	Operating Instructions
Check condition and voltage of generator fan	Operating Instructions
Replace fuel injection pumps	C 073.05
Remove valve drive Remove valve roller tappets and pushrods Check individual components, repair or replace as necessary	C 055.05 C 054.05 C 054.05.08/055.05.08
Perform endoscope check of combustion chambers and valves	Operating Instructions
Remove oil separator from crankcase breather and clean	C 018.10
Replace filter elements in crankcase breather	C 018.10
Check securing screws of mounting for security	Operating Instructions
Check battery charge state, electrolyte specific gravity and electrolyte level	Operating Instructions
Check condition of engine control system and wiring and check for security	Operating Instructions
Check engine and external pipework for leaks	–
Reassemble subassemblies and reinstall as per engine assembly schedule	EOM 005
Fill engine oil system Fill engine coolant system Perform operations preparatory to engine start	Operating Instructions Operating Instructions Operating Instructions
Start engine Perform checks with engine running as for initial operation	Operating Instructions Operating Instructions

B 003 Engine Removal

Operations to be performed	See
Shut off fuel supply	Operating Instructions
Drain engine oil, if possible while engine is warm Examine oil sludge for metallic residues Drain engine coolant; coolant temperature must be below 60 °C	Operating Instructions Operating Instructions Operating Instructions
Wash plant, without using chemical cleaning agents	–
Disconnect all connections Seal open connections with non-linting plugs and covers Release engine securing screws Remove engine and place on trestles Use only the transport and lifting equipment approved by MTU Using a lifting device, attach engine only on suspension brackets provided as shown in installation drawing, taking centre of gravity and transportation specifications into consideration.	– – – – Operating Instructions

Engine weight

(dry weight)
12 V 2000 – approx. 2640 kg
16 V 2000 – approx. 2950 kg



1 Rope
2 Engine lifting device, driving end
3 Engine lifting device, free end

B 004 Engine Disassembly

Before beginning complete engine disassembly, it is advisable to take photographs of the engine from all sides or to record all components installed on the engine in writing.

The sequence of the required operations in the following list corresponds to the order in which actual disassembly is to be carried out.

The individual tasks are described in detail in the Groups listed in the right-hand column.

Operations to be performed	**See**
Remove air pipework from exhaust turbocharger to intercooler	C 125.05
Place engine on stand	–
Mark and disconnect electric cables	C 507.10
Remove ECU housing and bracket	C 508.10
Remove monitoring equipment	C 507.10
Remove air filter	C 121.05
Remove crankcase breather	C 018.10
Removing intake housing	C 123.01
Disconnect vent lines	C 202.65
Disconnect engine coolant lines	C 202.15
Remove engine lifting fixtures	C 015.05
Remove cover	C 114.05
Remove charge air manifolds	C 124.05
Remove fuel hand pump and lines	C 082.05
Remove fuel filter	C 083.05
Remove fuel delivery pump and lines	C 081.05
Remove wiring	C 507.10
Remove engine coolant pump	C 202.05
Remove generator	C 213.05
Install oil supply lines for gear train	C 184.20
Disconnect leak-off fuel lines	C 086.05
Remove exhaust pipe bellows and exhaust outlet housing	C 145.05
Remove exhaust manifolds	C 141.10
Remove oil supply lines to turbochargers	C 185.10
Remove oil return lines for turbochargers	C 185.25
Remove exhaust turbocharger	C 101.01
Remove starter	C 172.05
Remove fan drive	C 221.05
Remove PTO, free end	C 035.05
Remove oil filter	C 183.05
Remove oil heat exchanger	C 183.15
Remove coolant control housing and thermostat	C 206.05
Remove cylinder head covers	C 055.10
Remove injection lines	C 077.05

Operations to be performed	See
Remove injectors	C 075.05
Remove valve drive	C 055.05
Remove pushrods	C 054.05
Remove cylinder heads	C 041.05
Remove valve roller tappet	C 054.05
Remove injection pump	C 073.05
Remove fuel guide	C 084.05
Remove coupling	special publication
Remove flywheel	C 032.05
Remove dipstick and oil filler neck	C 182.10
Remove engine mounts	C 231.05
Install crankcase in assembly dolly	C 011.05.05
Remove oil lines from gear case to oil pan	C 024.05/C 181.15
Remove oil pan	C 014.05
Remove lube oil pump and lines	C 181.05
Remove piston with connecting rod	C 037.05
Remove gear case cover	C 024.05
Remove gear case, free end	C 024.05
Remove flywheel housing	C 021.05
Remove crankshaft	C 031.05
Remove cylinder liner	C 013.05
Remove oil spray nozzle	C 184.10
Remove crankcase from assembly dolly	C 011.05.11
Remove camshaft	C 051.05
Remove measuring wheel from camshaft	C 512.10
Remove plugs and covers	C 011.05
Remove plugs from oilways and coolant bores	C 011.05
Remove camshaft bearing bush	C 011.05

B 005 Engine Assembly

The sequence in which the following required procedures are listed corresponds to the order in which actual assembly is performed.

The individual tasks are described in detail in the Groups listed in the right-hand column.

Operations to be performed	**See**
Check and repair crankcase	C 011.05.08
Make sure that oilways are perfectly clean	C 011.05.08
Install plugs and covers	C 011.05.08
Install plugs for oil and coolant bores	C 011.05.08
Measure crankcase bores	C 011.05.08
Install camshaft bearing bushes	C 011.05.08
Install main bearing cap (without bearing shells)	C 011.05.08
Measure crankshaft main bearing bore	C 011.05.08
Remove graduated disc from camshaft	C 512.10
Install camshaft	C 051.05
Install oil spray nozzle	C 184.10
Install crankcase in assembly dolly	C 011.05.05
Install cylinder liner	C 013.05
Measure cylinder liner ID	C 013.05.11
Crankshaft mounting	C 031.05.08
Install crankshaft	C 031.05
Install flywheel housing	C 016.30
Install gear case, free end	C 024.05
Install gear case cover	C 024.05
Install piston with connecting rod	C 037.05
Install lube oil pump and lines	C 181.05
Install oil pan	C 014.05
Install oil lines from gear case to oil pan	C 024.05/C 181.15
Remove crankcase from assembly dolly	C 011.05.11
Install valve roller tappet	C 054.05
Install cylinder heads	C 041.05
Install flywheel	C 032.05
Install fuel guide	C 084.05
Install fuel injection pump	C 073.05
Install pushrods	C 054.05
Install valve drive	C 055.05
Adjust valve clearance	C 055.05
Check camshaft timing	C 051.05
Install coolant control housing and thermostat	C 206.05
Install oil heat exchanger	C 183.15
Install oil filter	C 183.05

Operations to be performed	See
Install injectors	C 075.05
Install injection lines	C 077.05
Install cylinder head covers	C 055.10
Install PTO, free end	C 035.05
Install fan drive	C 221.05
Install air filter	C 121.05
Install starter	C 172.05
Install dipstick and oil filler neck	C 182.10
Install wiring	C 507.10
Install exhaust manifold	C 141.10
Install turbocharger	C 101.01
Install oil supply lines to turbochargers	C 185.10
Install oil return lines for turbochargers	C 185.25
Install exhaust pipe bellows and exhaust outlet housing	C 145.05
Install oil supply lines for gear train	C 184.20
Connect leak-off fuel lines	C 086.05
Install generator	C 213.05
Install engine coolant pump	C 202.05
Connect engine coolant lines	C 202.15
Install fuel filter	C 083.05
Install fuel delivery pump and lines	C 081.05
Install fuel hand pump and lines	C 082.05
Install intake housing	C 123.01
Install charge air manifold	C 124.05
Install cover	C 114.05
Connect vent lines	C 202.65
Install engine lifting attachments	C 015.05
Install crankcase breather	C 018.10
Install air filter	C 121.05
Install engine mounts	C 231.05
Install coupling	Special publication
Install monitoring instrument	C 507.10
Install ECU housing and bracket	C 508.10
Connect electric cable	C 507.10
Pressure test coolant chambers	C 200.8
Install air pipework from exhaust turbocharger to intercooler	C 125.05

B 006 Engine Running-In

If pistons, piston rings or cylinder liners have been replaced, the engine must be run in as per the appropriate run-in schedule.

Conscientious running in is of critical importance as regards the durability and operational reliability of the engine.

Use a brake or alternator to absorb the power generated in the braking run.

Power must be transmitted from the engine to the load by means of a resilient coupling.

Settings

Set intake temperatures before engine in accordance with the temperatures stated for the engine in its MTU Engine Acceptance Test Record.

The engine coolant temperature depends on the operating range of the coolant thermostat.

Record readings for power, fuel, lube oil, coolant, charge air and exhaust gas at each test point (time, speed and effective power) of the run-in schedule and enter readings under “Engine Running-In” in “MTU Diesel Engine Factory Test” record.

Operations to be performed	**See**
Install engine on test stand	–
Connect engine to brake or alternator	–
Connect intake air, exhaust, engine coolant, raw water and fuel pipework.	–
Connect oil pressure line and oil temperature measurement feeler	–
Connect crankcase ventilation line	–
Connect all measuring hoses and cables	–
Connect dialogue unit to ECU	–
Fill expansion tank with coolant and 2% corrosion inhibitor oil up to max. mark	Operating Instructions
Check that fuel in service or supply tank is to specification	MTU Fluid and Lubricants Specification
Fill oil system up to max. mark with fresh oil	Operating Instructions
Check operation of engine governor and governor actuator before starting engine	–
Check operation of emergency shutdown system	–
Start engine via ECS	Operating Instructions
After operating engine at no-load for approx. 1 min, shut down engine, check oil level, remove valve gear cover, check valve gear lubrication	–
Start engine, check idling speed	–
Check for leaks at coolant, oil and fuel lines, crankcase seals, air system and exhaust lines	Operating Instructions
Run in engine and record measurements in accordance with running-in schedule	MTU Engine Acceptance Test Record
Check engine speed and brake load	–
Compare/check injection, temperatures, pressures and speeds at gauge dialogue units with Acceptance Test Record	–
Measure intake depression before exhaust turbocharger	–
Measure exhaust gas temperature after turbocharger	–
Check exhaust backpressure after engine	–
Check colour of exhaust gas	–
Enter barometric reading and relative humidity in record	MTU Engine Acceptance Test Record
Check engine for abnormal noises and for leaks	–

Operations to be performed	See
Check idle and full-load positions, adjust if necessary	–
Check oil filter	Operating Instructions
After running in, perform factory test run in accordance with MTU Acceptance Test Record	–
Enter operational values in enclosed Factory Test Record	MTU Engine Acceptance Test Record
Compare measured values with values in Acceptance Test Record	MTU Engine Acceptance Test Record
Shut down engine	Operating Instructions
Preserve engine if it is to be stored for a prolonged period	Operating Instructions
Adopt suitable protective measures if engine is scheduled for marine transport	–
Remove engine from test stand	–
Spray engine with protective paint	–

Running-In Schedule, 12V 2000 G22–82

Engine speed	**800**		**1400**		**2400**		**3200**	**3800**	**4400**		**F (N)**
(rpm)	**4**		**7**		**12**		**16**	**19**	**22**		**PE (bar)**
1000	80										**Peff (kW)**
1500			210		360		480	570	660		
1800					432		576	684	792		
Running time (t)	**5**		**5**		**5**		**5**	**10**	**10**		**(min)**

Note: Measurements to be recorded only at n = 1000 rpm and final power (complete measurement).
For load “F”, the brake constant is x = 1000

P = F x n (kW)

Running-In Schedule, 16V 2000 G22–82

Engine speed	**1070**		**1870**		**3200**		**4270**	**5070**	**5870**		**F (N)**
(rpm)	**4**		**7**		**12**		**16**	**19**	**22**		**PE (bar)**
1000	107										**Peff (kW)**
1500			280		480		640	760	880		
1800					576		768	912	1056		
Running time (t)	**5**		**5**		**5**		**5**	**10**	**10**		**(min)**

Note: Measurements to be recorded only at n = 1000 rpm and final power (complete measurement).
For load “F”, the brake constant is x = 1000

P = F x n (kW)

B 007 Engine Installation and Operation

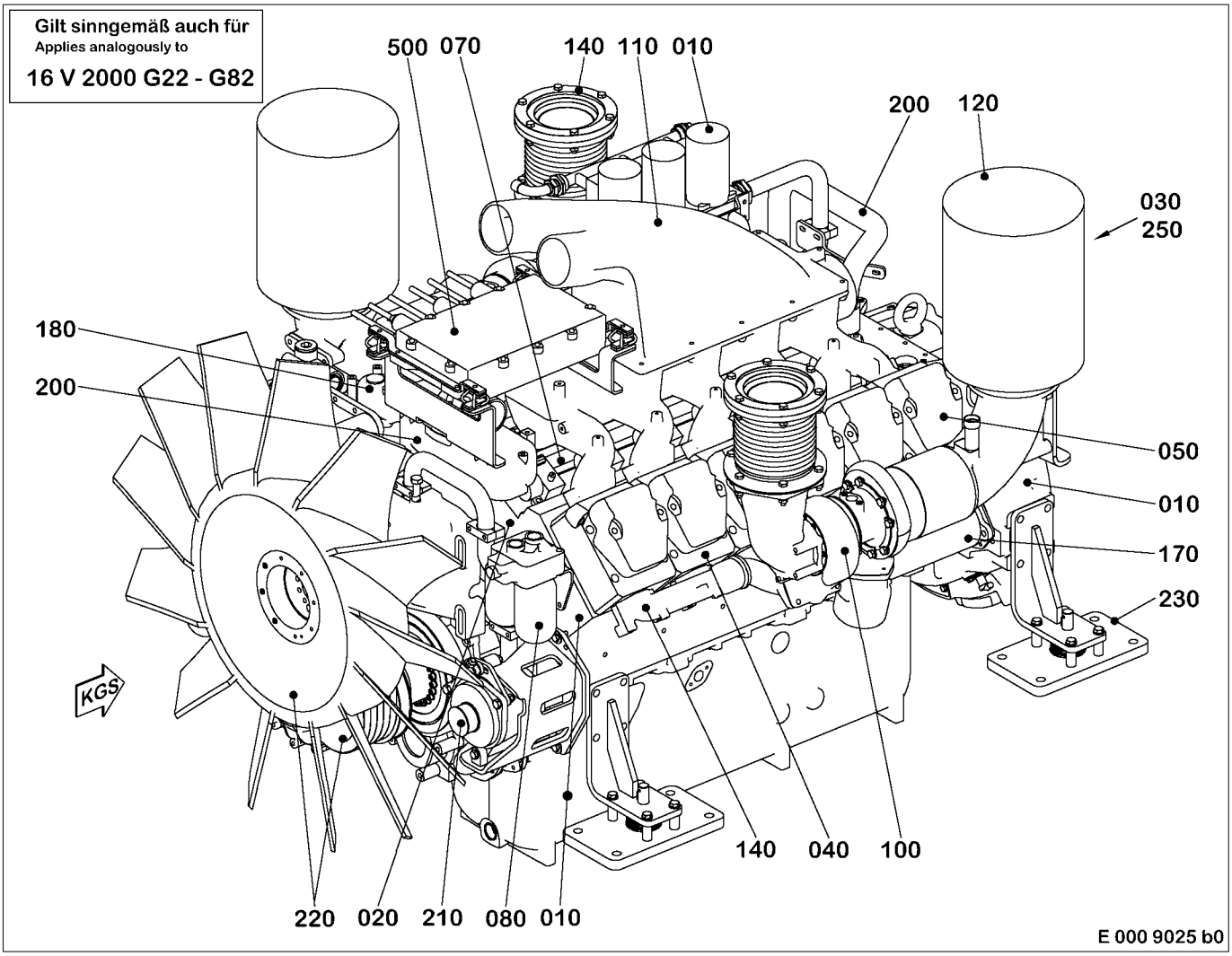
Operations to be performed	See
Open all connections, remove cover and rubber plugs	–
Attach engine only on suspension brackets provided as shown in installation drawing, taking centre of gravity and transportation specifications into consideration, and install in plant.	Operating Instructions B 003
Join connections appropriately	–
Fill engine cooling system	Operating Instructions
Fill oil system with engine oil	Operating Instructions
Align engine	C 231.05
Prepare engine for operation	Operating Instructions
Start engine	Operating Instructions
Perform checks while engine is running	Operating Instructions
Carry out test run	Operating Instructions
Shut down engine	Operating Instructions
Perform after-shutdown services	Operating Instructions
Preservation measures are required if an extended out-of-service period is intended	Operating Instructions

C Group Summary

010 Crankcase and externally mounted components
020 Gear train
030 Running gear
040 Cylinder head
050 Valve gear
060 Governor actuator*
070 Fuel system (high-pressure)
080 Fuel system (low-pressure)
090 Regulation*
100 Exhaust turbocharger
110 Intercooler
120 Air intake / air supply
130 – not assigned –
140 Exhaust system
150 – not assigned –
160 – not assigned –
170 Starting system
180 Lube oil system
190 – not assigned –
200 Cooling system
210 Power supply, engine side
220 Cooling air system
230 Mounting/support
240 Engine-gearbox connection*
250 PTO systems, driving end and free end (coupling)
290 Pumps driven separately*
– Blank register
360 Auxiliary systems, supplementary units*
– Blank register
500 Monitoring, control and regulation devices

*** not mounted on this engine**

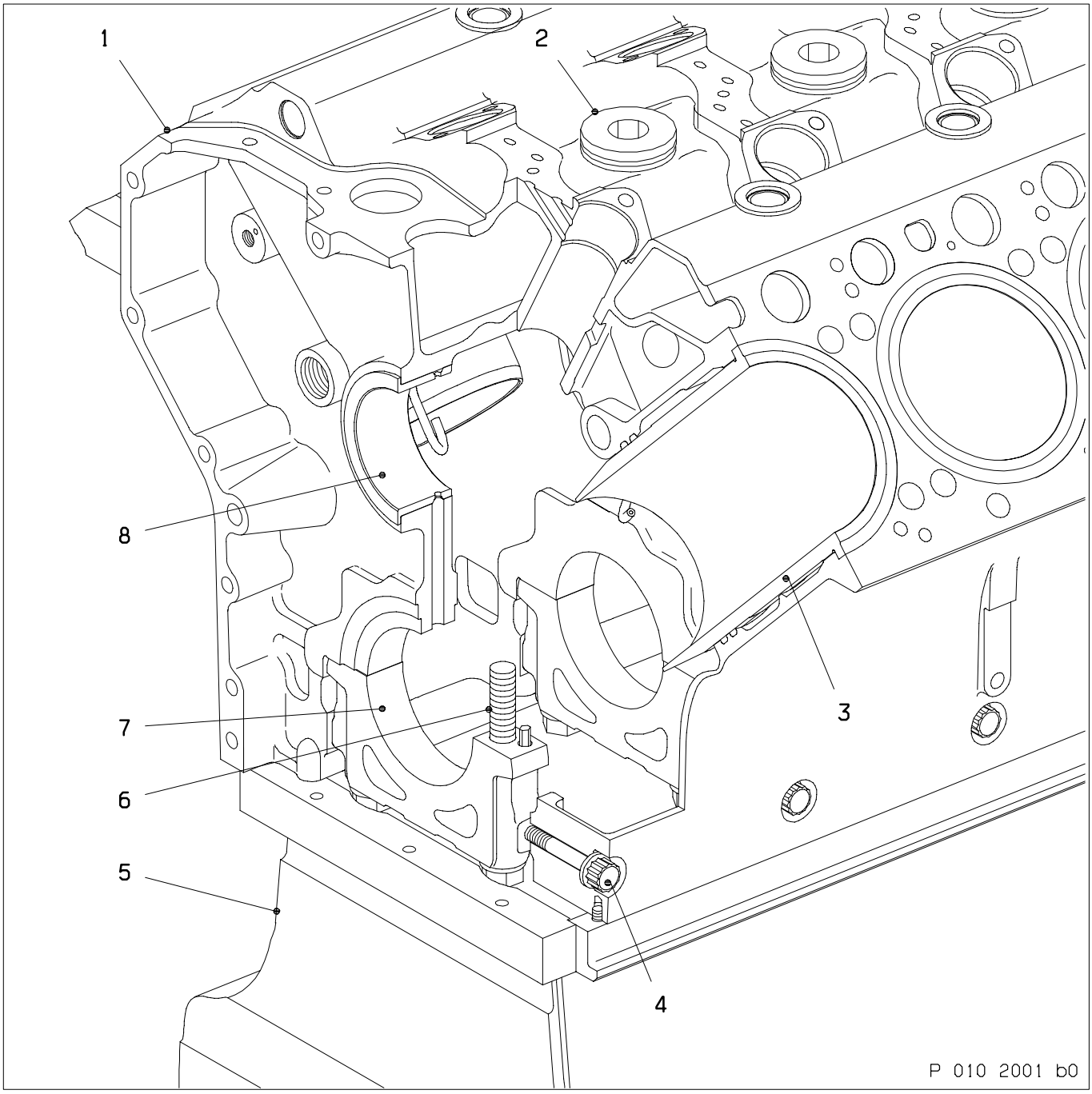
C Group Summary



010 Crankcase and externally mounted components
020 Gear train
030 Running gear
040 Cylinder head
050 Valve gear
070 Fuel system (high-pressure)
080 Fuel system (low-pressure)
100 Exhaust turbocharger
110 Intercooler
120 Air intake / air supply
140 Exhaust system
170 Starting system
180 Lube oil system
200 Cooling system
210 Power supply, engine side
230 Mounting/support
250 PTO systems, driving end and free end (coupling)
500 Monitoring, control and regulating devices

Contents

C 010 Crankcase and Externally Mounted Components



1 Crankcase
2 Plug
3 Cylinder liner
4 Double-hex screw
5 Oil pan
6 Hex screw
7 Crankshaft alignment bearing cover
8 Camshaft bearing

The following is a list of auxiliary equipment and materials needed for the assembly operations:

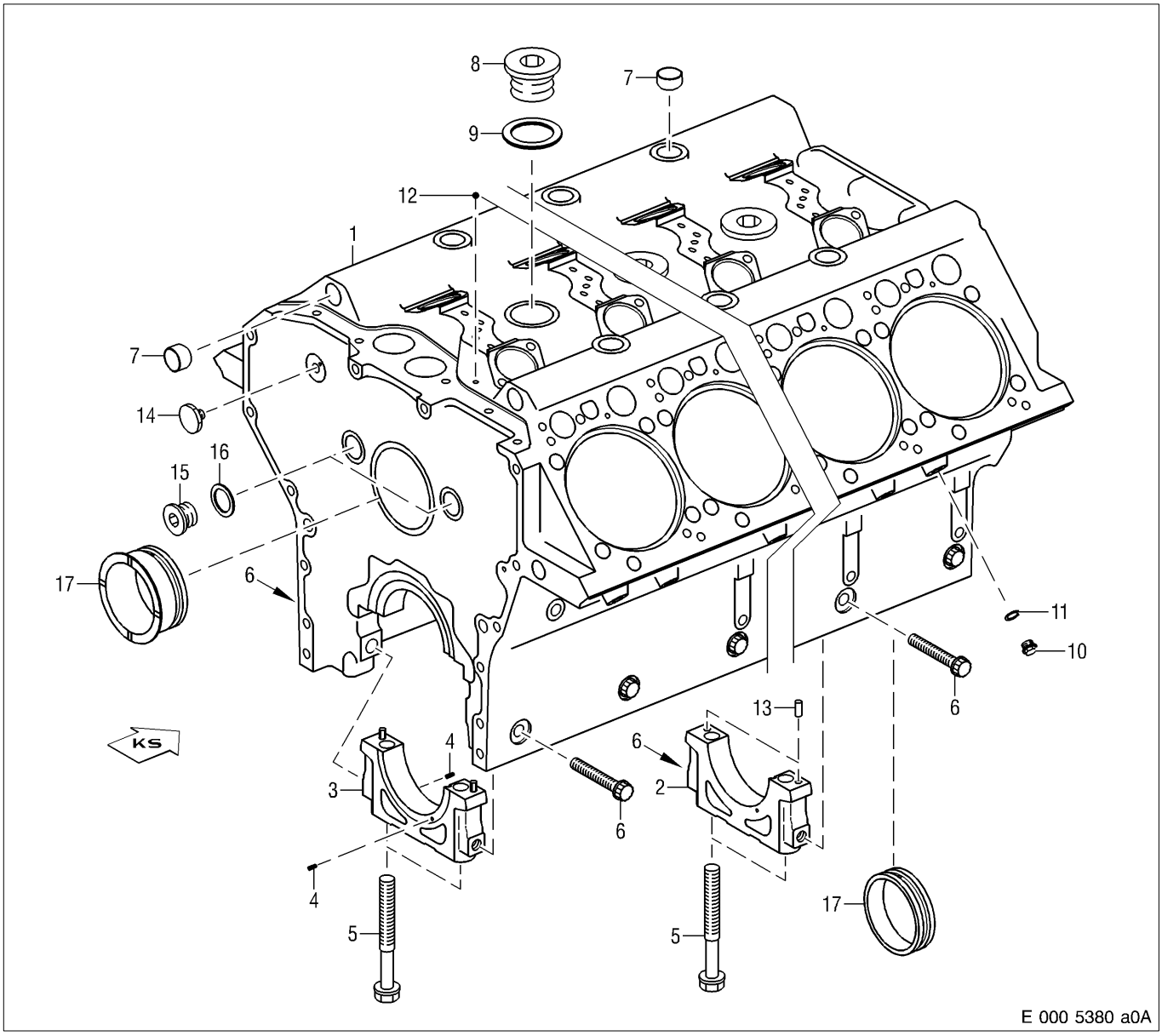
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Wire brush			
Bottle brush			
Magnifier			
Spray gun			
Inspection lamp			
Endoscope with cold light			
Liquid nitrogen			
Activator	Loctite No. 7649	50548	
Vaseline	Petroleum jelly, white	40317	
Thread-locking compound	Loctite No. 270	40083	Final strength at 20 °C ≈ 12 h
Surface sealant	Loctite No. 573	40031	Final strength ≈ 48 h
Thread-sealing compound	Loctite No. 586	40033	Final strength at 20 °C – 12 h
Engine oil			
Multipurpose grease	Shell Retinax	40333	
Hydrochloric acid			
Corrosion inhibitor	Pfinder AP 11 F	40355	
Cleaning agent	Solvclean KW	40022	
Cleaning agent (carbon-deposit remover)	Meister Proper	40377	
Kerosene or diesel fuel			
Sealing paste	Elastosil N 189	50545	
Denaturated ethanol		40250	
Engineer's blue	blue	40641	
Dry compressed air			
Corrosion inhibitor	Caramba Express	40008	
Magnetic crack-testing equipment with fluorescent magnetic powder			
Surface crack-testing equipment with red penetrant dye			
Surface crack-testing equipment with fluorescent penetrant dye			

C 011.05 Crankcase

C 011.05.01 Overview Drawing



1 Crankcase

2 Crankshaft bearing cap

3 Crankshaft alignment bearing cover

4 Grooved pin

5 Hex screw
- Max. shaft length: 176 mm
- Lubricant: Engine oil
- ***** Pretightening torque: 300 Nm + 30 Nm
- ***** Additional angle of rotation: 90° + 10°

6 Double-hex screw
- Lubricant: Engine oil
- ***** Tightening torque: 140 Nm + 10 Nm

7 End cover
- Securing agent: Thread-locking liquid

8 Plug

9 Sealing ring

10 Plug

11 Sealing ring

12 Sealing plug

13 Dowel pin

14 Screw

15 Plug
- Tightening torque: 180 Nm
- Lubricant: Engine oil

16 Sealing ring

17 Camshaft bearing

***** Tightening sequence: hex screws before double-hex screws

C 011.05.02 Special Tools

Designation – Application	Number
Stop pipe for crankcase and camshaft bearing	1
Shrink-on tool for camshaft bearing	1
Mandrel for end cover	1

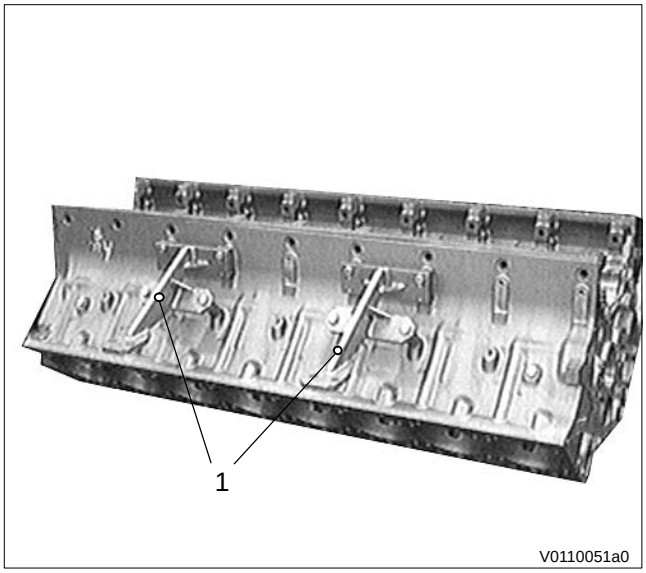
C 011.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

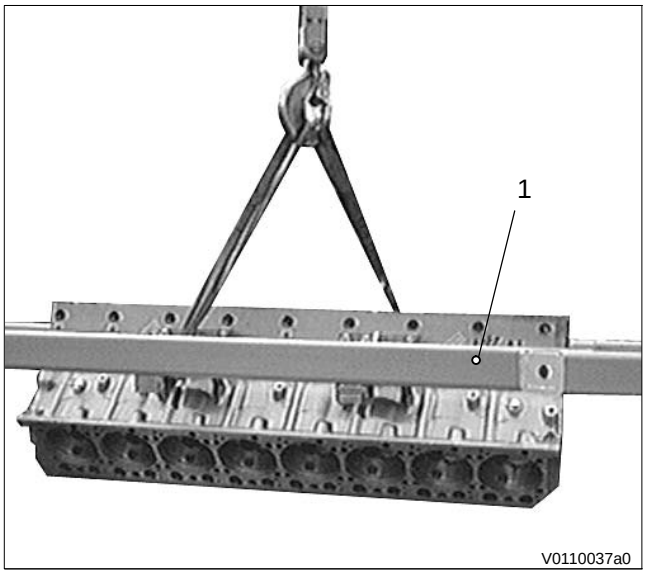
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	x	x	Removal not scheduled	–

C 011.05.05 Removal



Installing crankcase in assembly dolly

Install 2 supports (1) for assembly dolly on both left and right side of crankcase.

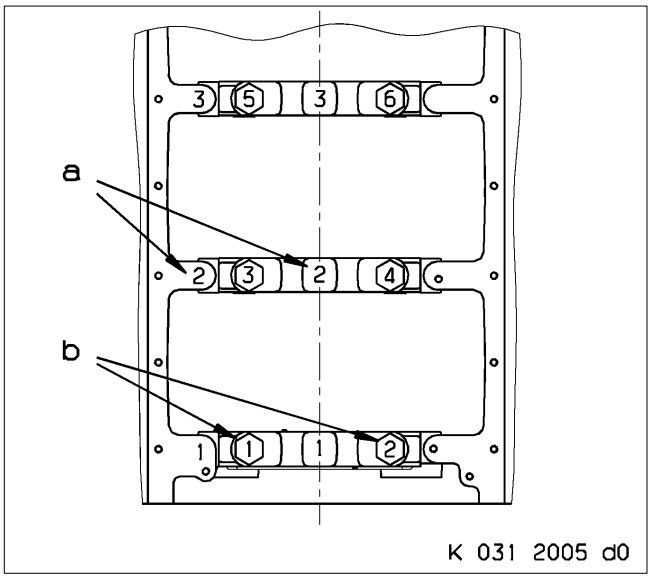


⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Using lifting gear and ropes, raise crankcase and lower into assembly dolly. Secure crankcase to dolly (1).

C 011.05.06 Disassembly

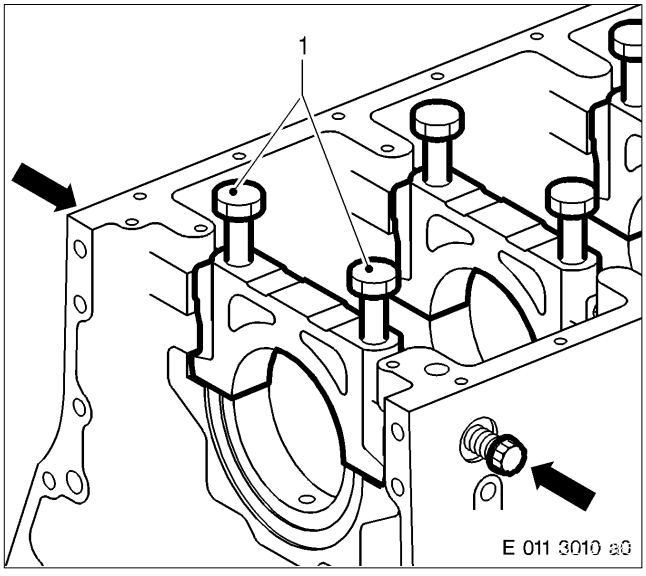


Checking markings of main bearing cap and hex screws

Check marking of main bearing cap in respect to crankcase and consecutive numbering of hex screws, and apply marks as necessary.

a – Starting at driving end, stamp number of main bearing with 6 mm numbers main bearing so that they can be read from same direction.

b – Consecutive numbering of the hex screws.

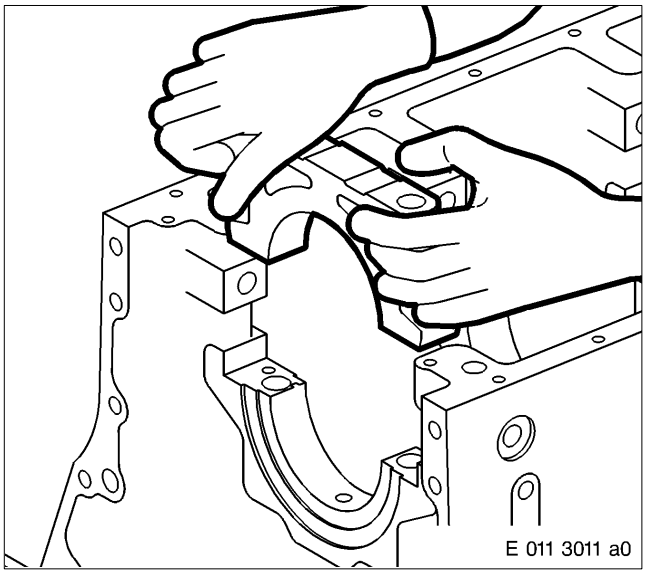


Removing main bearing caps

Crankcase is upside down, with oil pan mating face horizontal.

Note: Release screws on one bearing at same time.

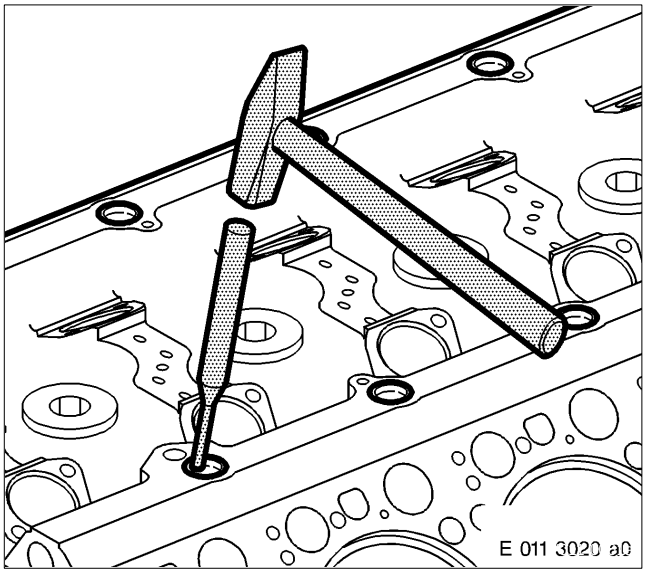
Remove all double-hex screws (arrows) and then all central hex screws (1) for crankshaft bearing cap.



⚠ CAUTION

Components have sharp edges.
Risk of injury!
Touch components only when wearing protective gloves.

Carefully raise all bearing caps vertically until clear of crankcase.



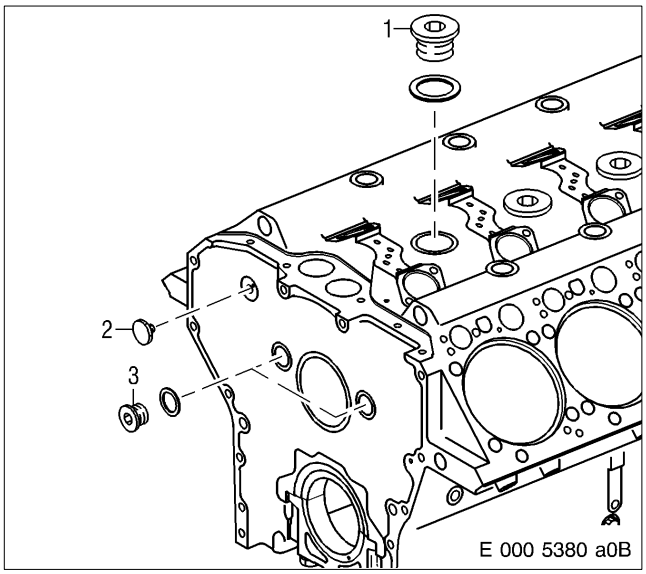
Removing end cover

Note: Remove end cover only if necessary (e.g. in event of leakages).

Using a mandrel (1) and hammer, carefully tap cover into bore at one side until it tilts. Use pliers to remove cover from bore.

When removing, take great care that cover does not fall into bore and that sealing face of bore is not damaged.

Never attempt to drill a hole in cover, as chips of metal in engine cooling jacket can cause localized overheating.



Removing plugs

Note: Remove plugs for coolant chamber (1) only if necessary (e.g. in event of leakages).

Remove plugs (3) for main oil ducts, driving end, screw (2) and if necessary, plugs for coolant chamber.

Remove sealing rings.

C 011.05.08 Inspection and Repair

Clean all parts.

Using the surface crack-testing method with red penetrant dye, check crankcase for cracks.

Check mating faces and upper and lower fits for cylinder liners in crankcase for wear, damage and cavitation.

In event of wear and damage to balcony seat and/or cylinder liner fittings, recondition all balcony seats and cylinder liner bores to next repair stage.

Consultation with MTU is required.

For limit values, see Tolerance and Wear Limits List.

Check camshaft bearing bushes for wear and damage; replace if necessary.

Check all mating faces, sealing faces and fits; rub down with an oilstone or emery cloth as necessary.

Check bores for dowel pins in crankcase for damage; recondition if necessary.

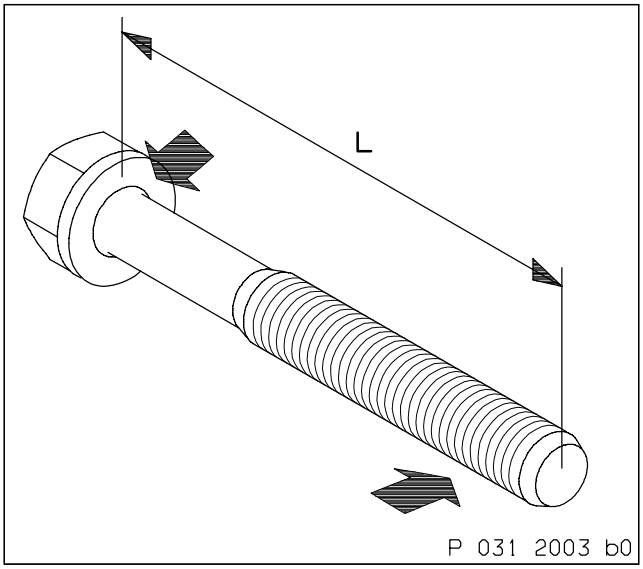
Check condition of all threads; rechase threads if necessary.

Replace sealing rings.

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

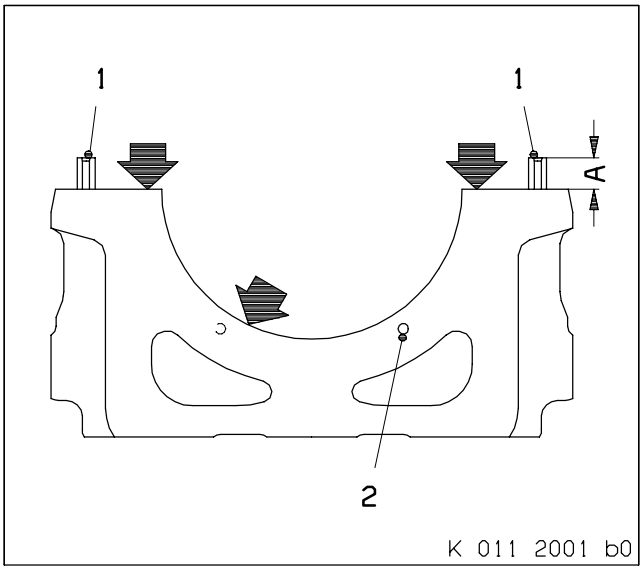
Flush oilways in crankcase, using as high a pressure as possible and blow clear with compressed air.



Checking hex screws for crankshaft bearing cap

Measure shaft length (L) of central hex screws for crankshaft bearing cap. For max. shaft length, see C 011.05.01.

Check that thread and screw head mating face (arrows) are in perfect condition; replace screw if necessary.



Checking crankshaft bearing cap and crankshaft alignment bearing cover

Using the magnetic crack-testing method and fluorescent magnetic powder, check crankshaft bearing caps for cracks, and replace as necessary.

Check separations and bearing shell mating faces (arrows), both grooved pins (2) and dowel pins (1) in alignment bearing cover and dowel pins in main bearing cap for damage.

Note: Replace grooved pins as part of every W6 overhaul.

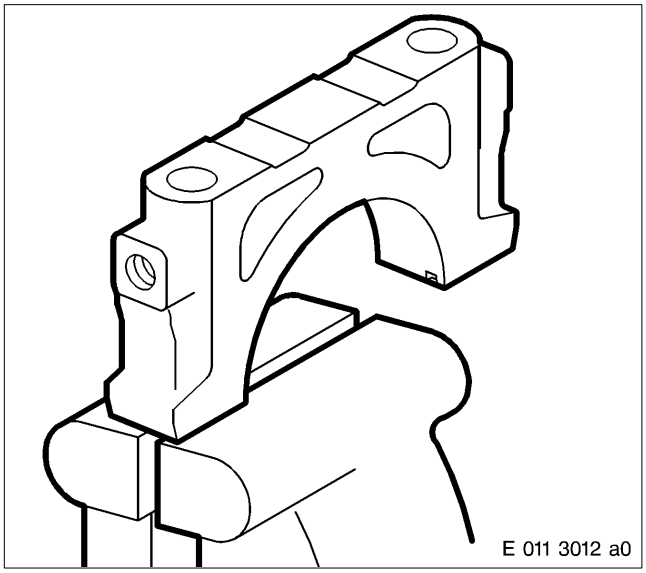
Measure projection of cylinder pins, dowel pins and grooved pins.

Projection (A) of cylinder pins and dowel pins = from 12 mm to 13.5 mm

Projection of grooved pins = from 4.5 mm to 4.7 mm

Check position of dowel pins in alignment bearing cover.

Wide end of the dowel pins must face parallel to longitudinal axis of crankshaft main bearing bore.



Replacing dowel pins for crankshaft bearing cap

Clamp crankshaft bearing cap on dowel pin in vice and carefully remove dowel pin.

Clean crankshaft bearing cap.

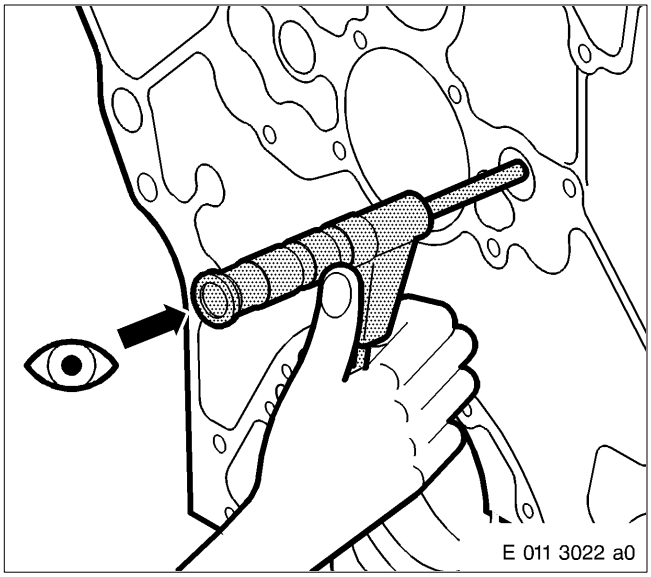
Use a copper hammer to drive in new dowel pin.

Measure projection (A) of dowel pins, see previous illustration.

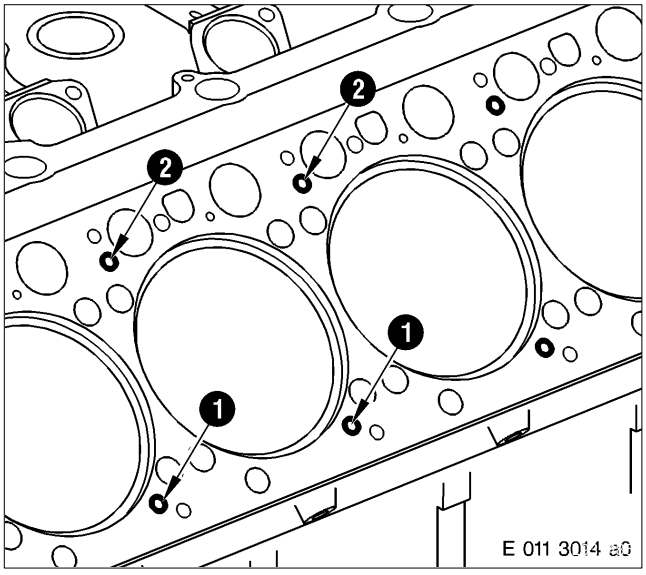
Checking oil bores

Note: All oilways must be thoroughly cleaned as part of every major overhaul or if metal chips penetrate engine oil system. Always make sure oilways are perfectly clean.

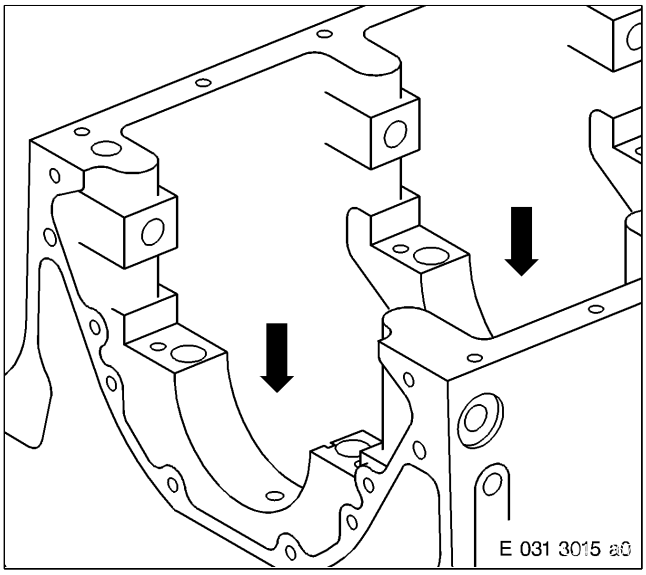
Use an endoscope and cold-light source to examine oilways and fuel bores shown in following illustrations, making sure they are perfectly clean.



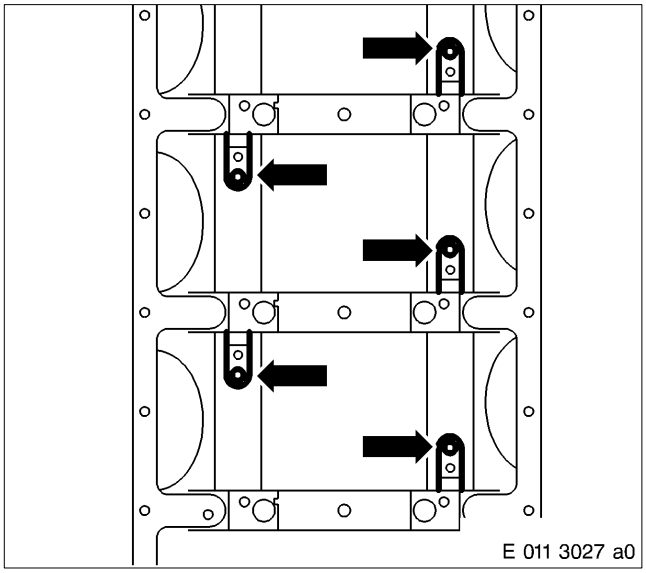
Both main oil galleries



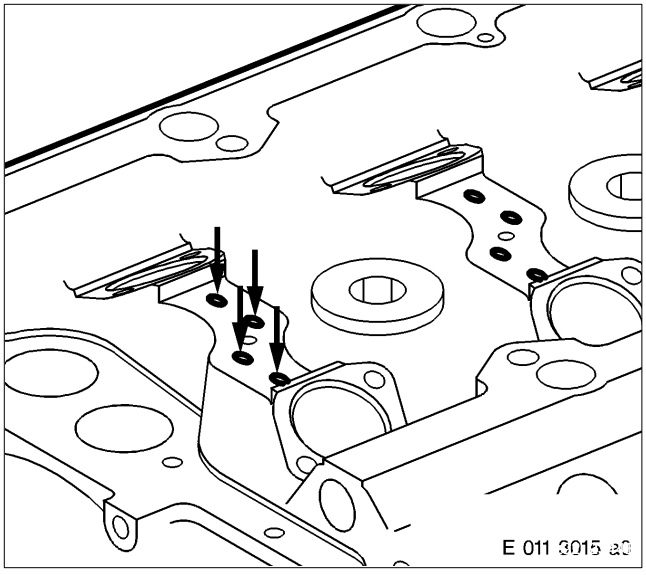
Oil bores (2) for camshaft bearing and valve gear, oil return bores (1)



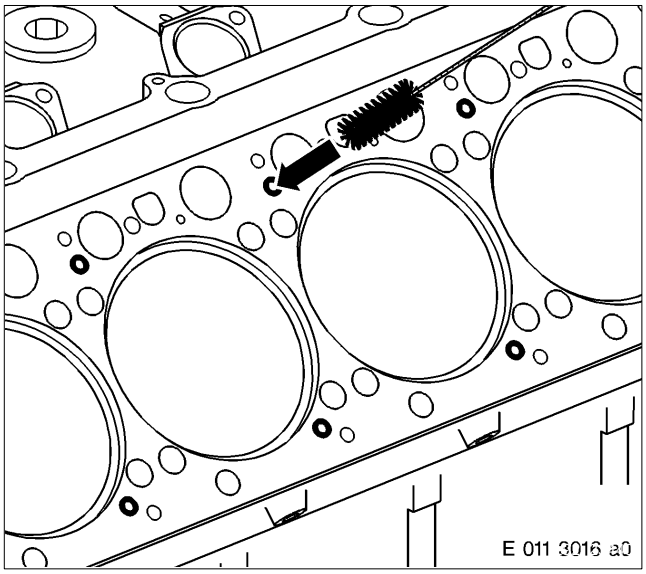
Oil bores (arrows) to main bearings



Oil bores (arrows) for oil spray nozzles

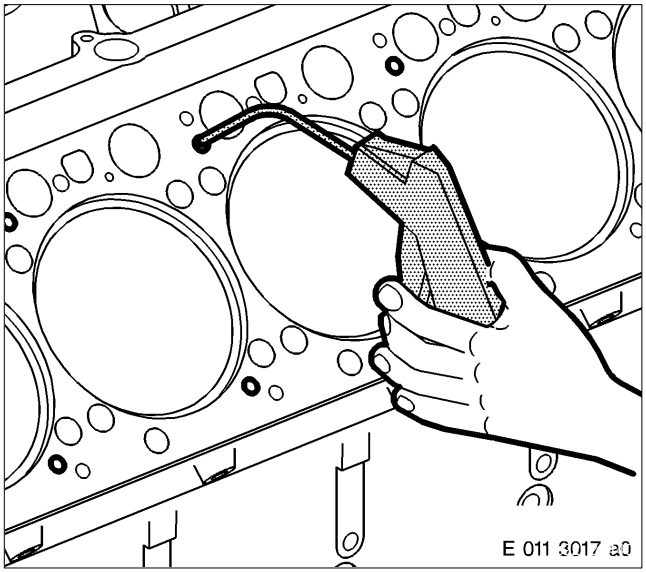


Fuel supply and return bores (arrows) on all webs



If necessary, clean oil bores (arrow) with bristle brush.

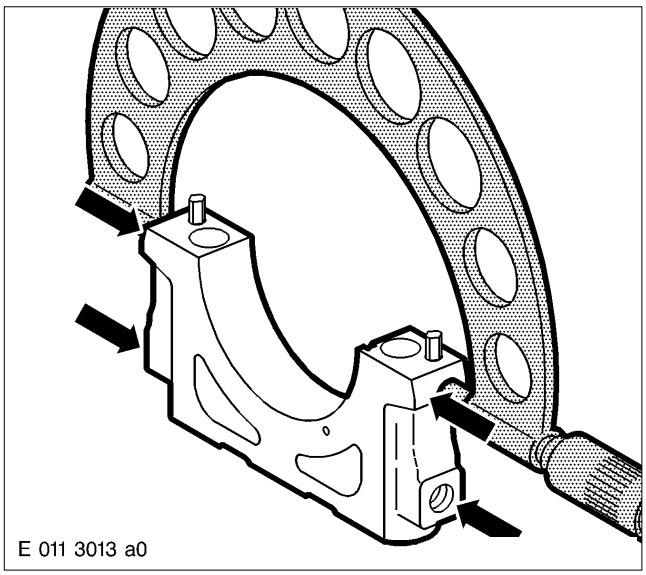
Note: Never use a wire brush!



⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

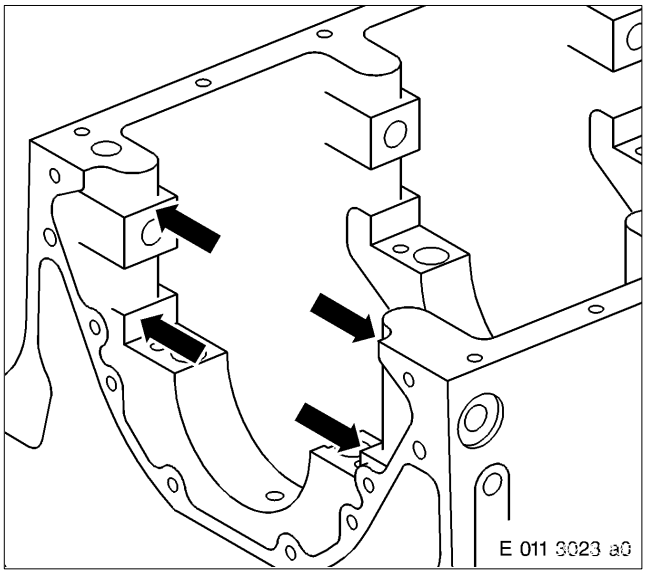
After cleaning, flush oilways (under pressure if possible) and blow clear with compressed air.



Measuring bearing cap width

Using micrometer, measure width of main bearing cap at upper and lower fits (arrows).

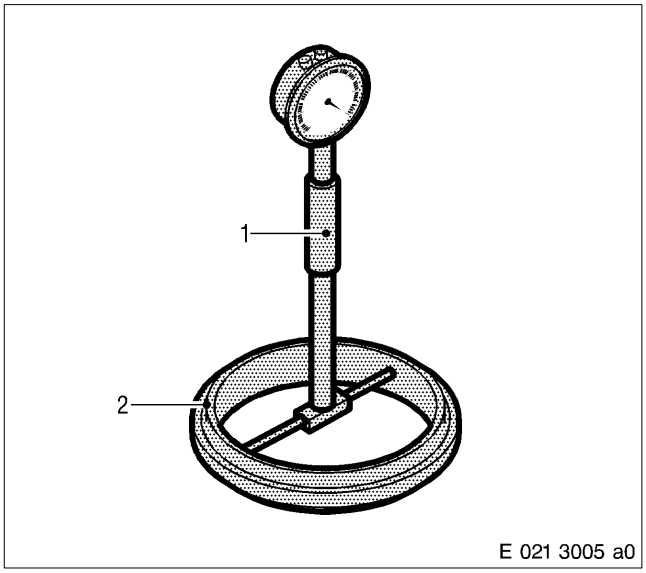
For limit values – see Tolerance and Wear Limits List.



Measuring bearing cap guides

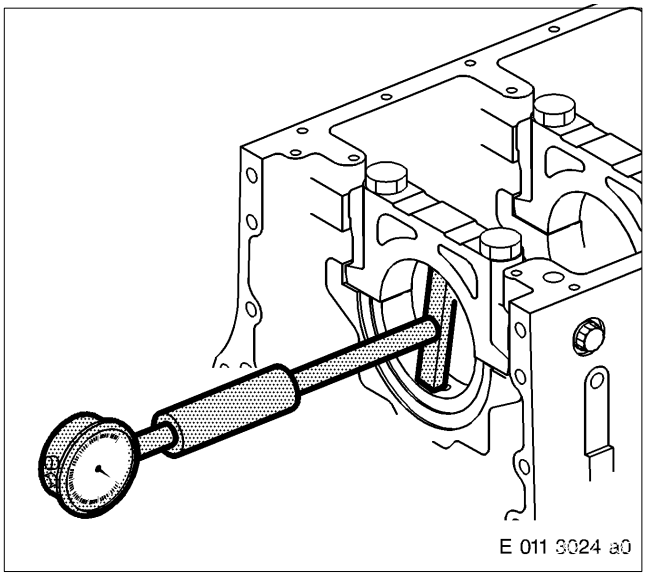
Using bore gauge (1), measure bearing cap guides at upper and lower fits.

For limit values, see Tolerance and Wear Limits List.



Setting bore gauge

Adjust bore gauge (1) and dial gauge with adjusting ring (2) or micrometer to basic size of respective bore to be measured.



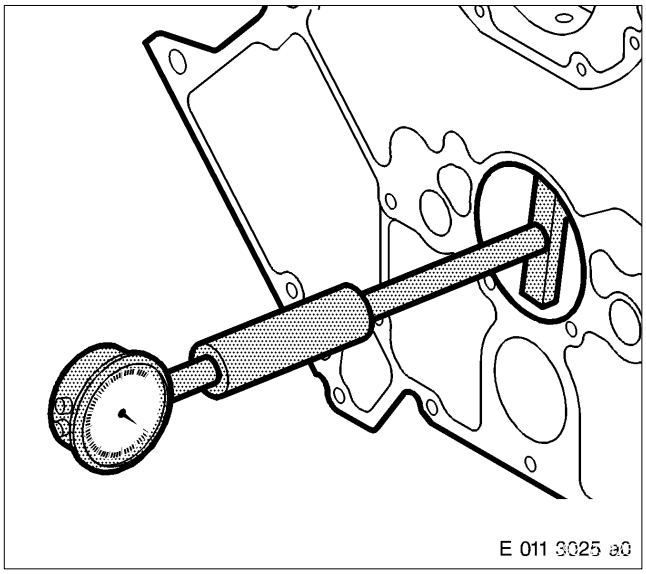
Measure crankshaft main bearing bore

Using bore gauge, measure crankshaft main bearing bore.

Enter measurement values in data sheet.

For measurement planes and limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, recondition main bore to next repair size.

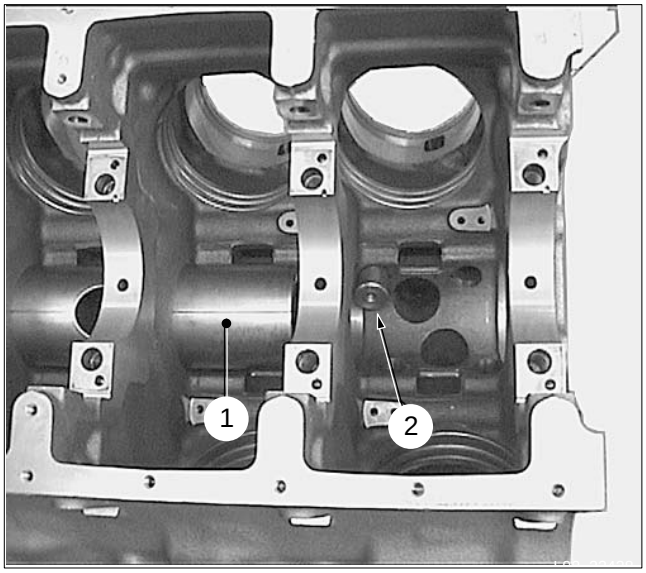


Measuring camshaft bearing bush bore

Using bore gauge, measure camshaft bearing bush bore.

For limit values, see Tolerance and Wear Limits List.

Replace camshaft bearing bushes if limit values are exceeded.



Replacing camshaft bearing shell

Using suitable mandrel, carefully drive camshaft bearing bushings out of crankcase.

Using bore gauge, measure main bore for camshaft bearing bush in crankcase.

For limit values, see Tolerance and Wear Limits List.

Enter measurement values in data sheet.

If limit values are exceeded, recondition main bore to next repair size.

For installing the camshaft bearing bushes, the oil pan mounting surface on the crankcase must be horizontal and face upwards.

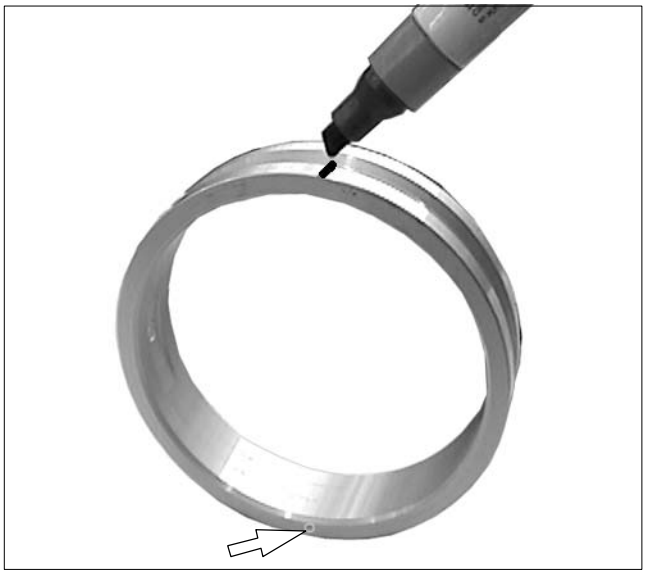
Note: Make sure parts are perfectly clean. Installation sequence of camshaft bearing, starting from free end, continuing in direction of free end.

Clean lube oil bores and ensure they are perfectly clean and unobstructed.

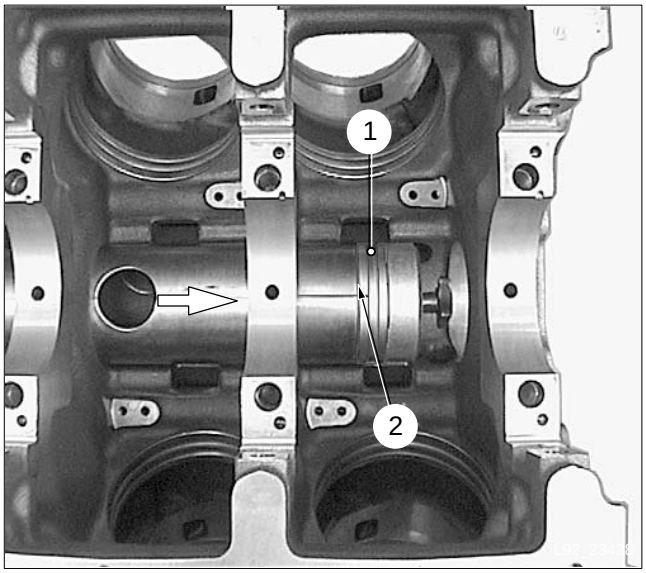
Insert guide tube (1) for camshaft bearing into crankcase before first bearing point on free end.

Insert stop pin (2) into second tappet bore of B side.

Observe fit of stop pin dowel pin in guide slot of roller tappet bore.



Mark new camshaft bearing bush 180° opposite markings applied at the factory (arrow) on jacket surface.



⚠ CAUTION

Nitrogen is liquid at –200 °C (–328 °F). Danger of freezing and suffocation!
Do not allow liquid nitrogen to come into contact with parts of body (eyes, hands).
Wear protective clothing (including gloves and closed shoes) and goggles.
Ventilate working area well.

Chill camshaft bearing bush (1) in liquid nitrogen and mount on guide tube so that the markings (2) on the guide tube are aligned with the markings on the camshaft bearing bush.

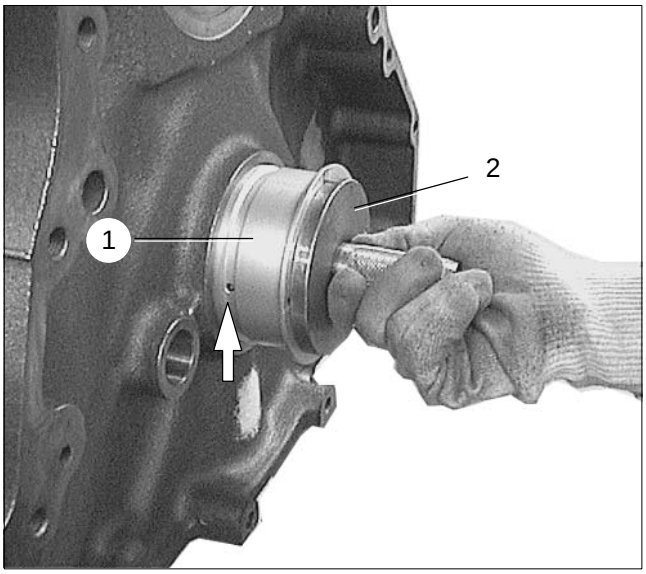
The position marking made in the factory on the front face of the camshaft bearing bush points towards the driving end of the engine.

Note: The oil bore of installed bearing bush must be at a 9^{00} hours position viewed towards driving end. The crankcase oil pan mounting surface faces upwards.

Insert guide tube in direction of free end (arrow) until it contacts stop on stop pin and insert cam shaft bearing bush in camshaft basic bore.

Once bearing bush has reached room temperature, remove guide tube and stop pin and install next camshaft bearing bush in method described.

Check position of oil bores of bearing bushes (9^{00} hours).

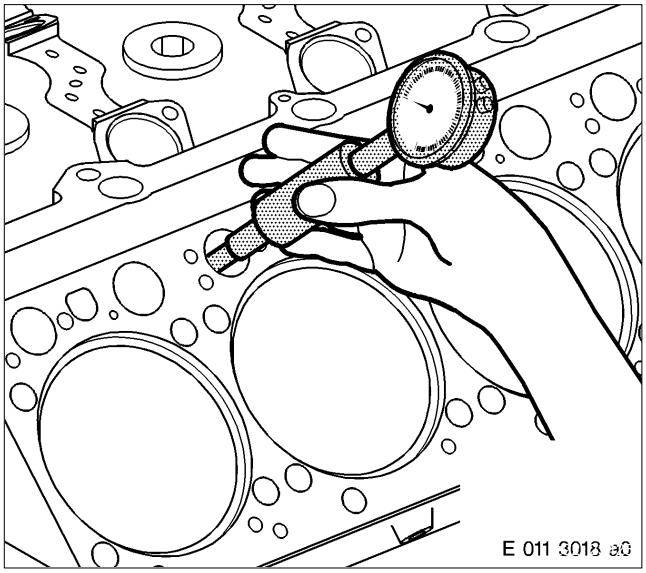


Chill last camshaft bearing bush (1) and, using shrink-on tool (2), insert flush into camshaft basic bore from driving end.

The oil bore (arrow) of bearing bush must be at a 9^{00} hours position viewed towards driving end. The crankcase oil pan mounting surface faces upwards.

After installation, measure diameter of camshaft bearing bush bores.

For limit values, see Tolerance and Wear Limits List.

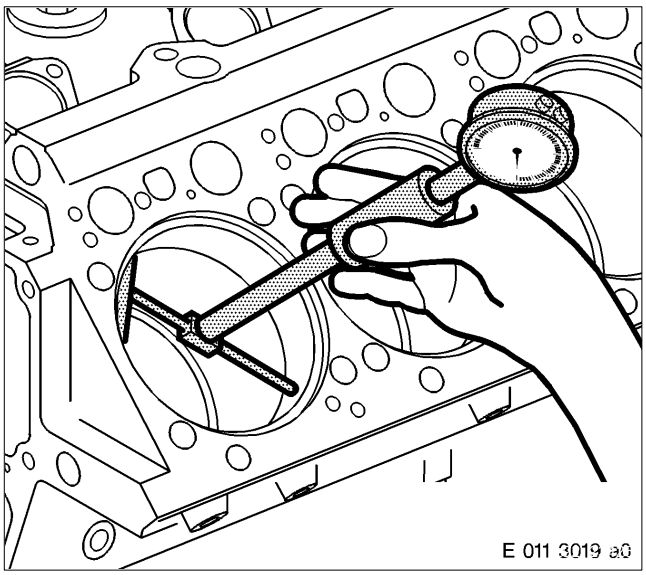


Measuring bore for valve tappet

Measure bore with bore gauge.

For limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, machine bore in question to repair size.



Measuring crankcase bores for cylinder liners

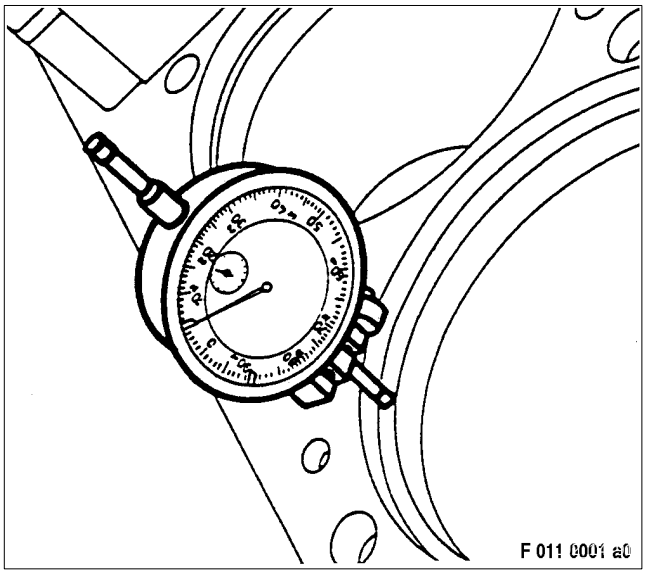
Using bore gauge, measure upper and lower fits of cylinder liner locating bores.

Enter measurement values in data sheet.

For limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, machine all collared bush recesses and cylinder liner bore in question to next repair size.

Consultation with MTU is required.



Measuring balcony depth

Secure dial gauge to dial gauge holder.

Fit dial gauge stylus on collared bush recess on crankcase.

Check preload (approx. 3 – 4 mm) of dial gauge.

Set dial gauge scale to zero.

Fit dial gauge stylus on end face of crankcase and read off balcony depth.

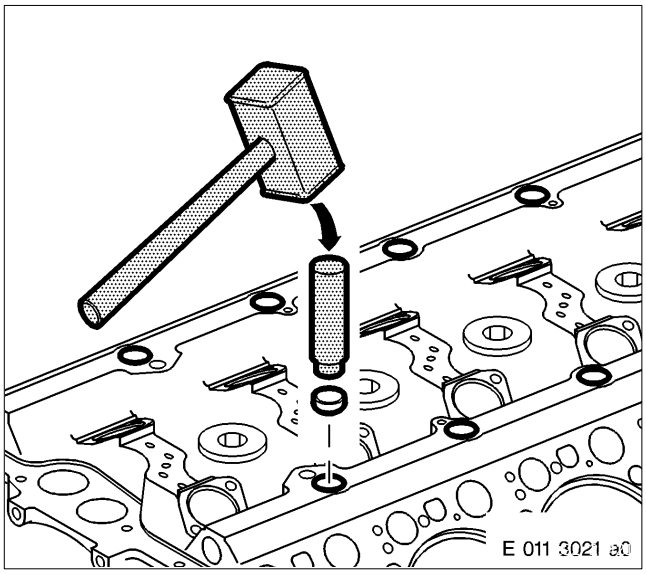
Enter measurement values in data sheet.

For limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, machine all collared bush recesses and cylinder liner bore in question to next repair size.

Consultation with MTU is required.

C 011.05.10 Assembly



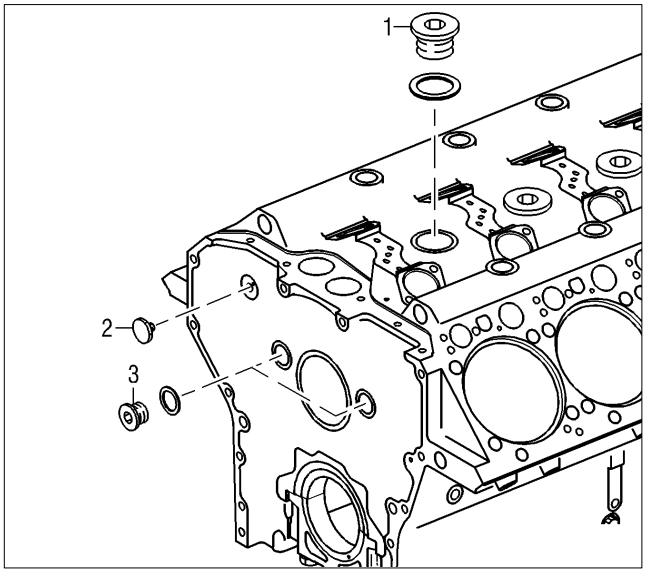
Installing end cover

Clean and degrease seating faces of cover and bore in crankcase.

Coat seating face of cover with thread locking compound.

Using mandrel and hammer, drive cover into bore.

Note: Ensure correct final strength of thread-locking agent, see C 010!



Installing plugs

Ensure that oilways are particularly clean.

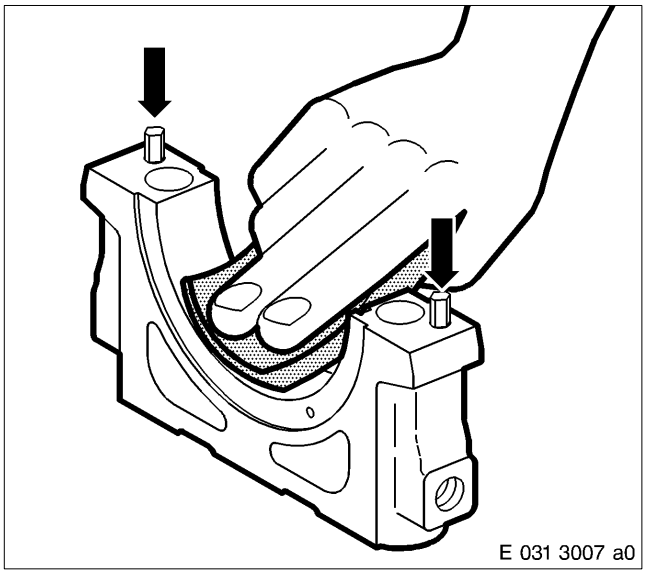
Insert plugs (3) and sealing rings and tighten to specified tightening torque, see C 011.05.01.

Clean and degrease threads of screw (2) and crankcase.

Coat thread of screw with surface sealant, insert screw and tighten.

Note: Ensure correct final strength of surface sealant, see C 010!

Install plug and sealing ring and tighten.



Installing main bearing caps

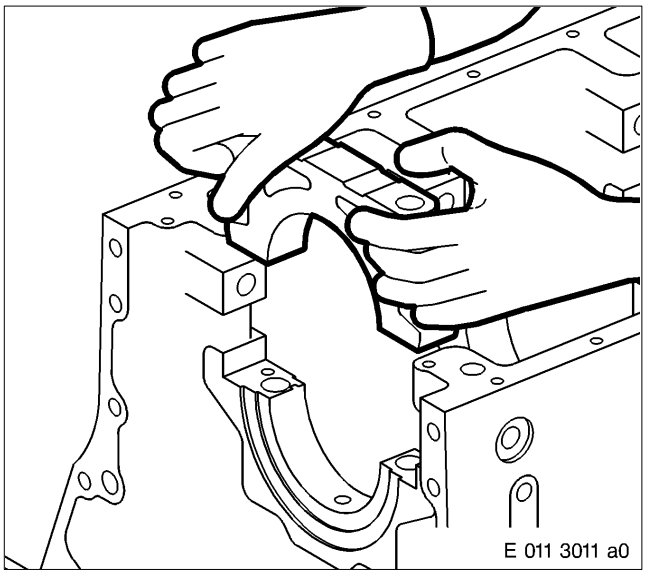
Crankcase is upside down, with oil pan mating face horizontal.

Wipe bearing shell mating faces at crankshaft bearing cap and mating faces at main bearing cap and crankcase with chamois leather.

⚠ CAUTION

Compressed air is air which has been compressed under pressure. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar (40 lb/in^2).

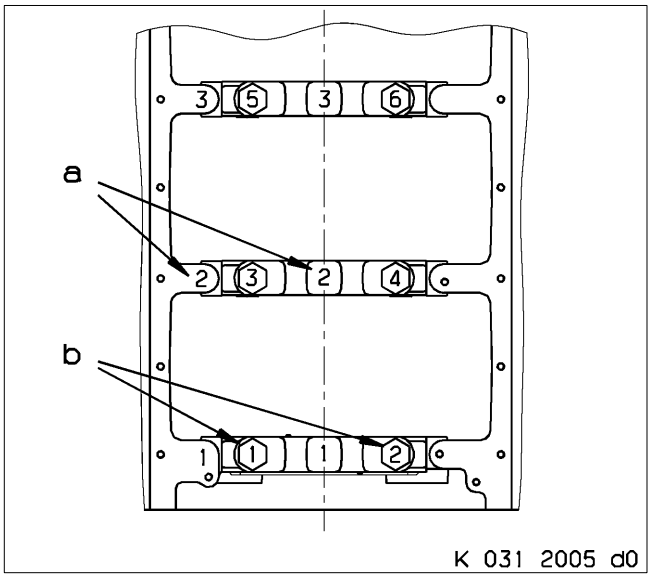
Blow out dowel pins (in crankshaft bearing cap) and dowel pins (arrows) in alignment bearing cover and their bores in crankcase with compressed air and check for that they are perfectly clean.



⚠ CAUTION

Components have sharp edges.
Risk of injury!
Touch components only when wearing protective gloves.

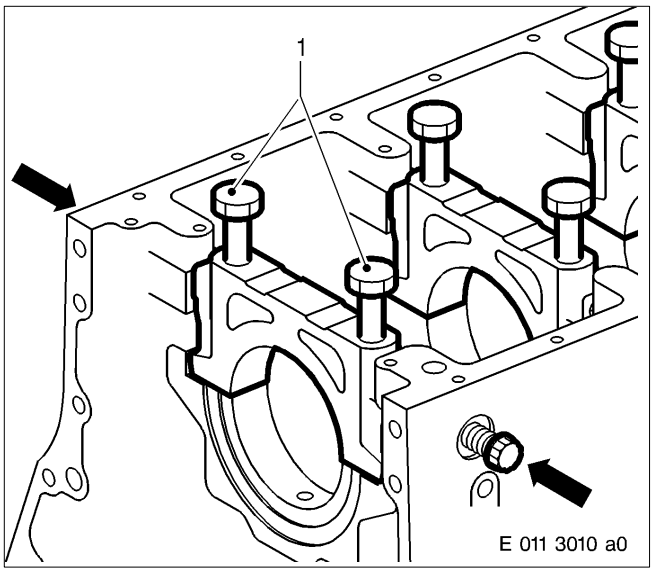
Fit bearing caps according to marking, (see next illustration), on appropriate crankcase bearing and secure by hitting with a copper hammer.



Note: Main bearing caps and their hex screws must not be interchanged.

a – Consecutive numbering of the main bearing starting from the driving end.

b – Consecutive numbering of the hex screws.



Coat thread and underside of screw of centre hex screws (1) with engine oil.

Fit, but do not yet fully tighten, hex screws as per markings – see previous illustration.

Coat thread and mating face of side double-hex screws (arrows) with engine oil and insert double-hex screws but do not tighten yet.

Note: Always tighten screws on one bearing at same time.
Tightening sequence, starting from alignment bearing.

Pretighten centre screws to specified pretightening torque – see C 011.05.01.

Mark screw heads.

Tighten screws through specified angle of further rotation.

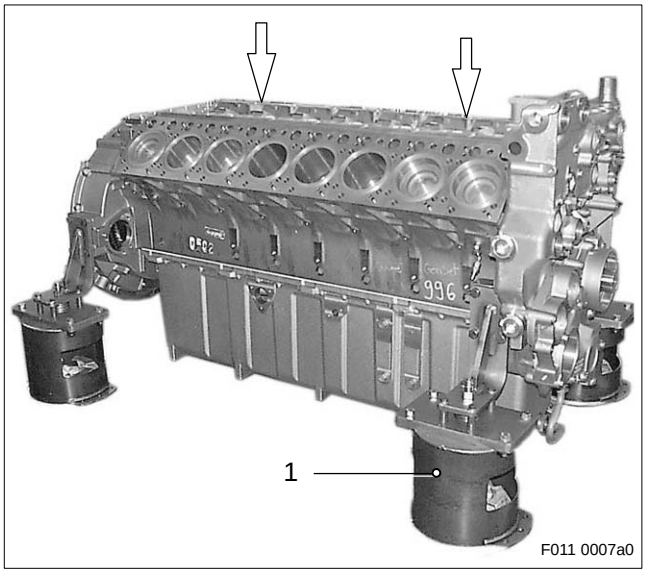
Note: Tighten lateral double-hex screws of one bearing simultaneously.

Simultaneously tighten side double-hex screws, starting from alignment bearing, in one work step to specified torque – see C 011.05.01.

C 011.05.11 Installation

Removing crankcase from assembly dolly

Note: Engine barring when engine is in assembly dolly is allowed only until running gear is installed and oil pan, gear case on free end and flywheel housing are mounted, i.e. without cylinder heads and other installation components.



⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Screw four eyebolts into crankcase (arrows).

Attach crankcase to eyebolts using lifting device and lifting ropes, ensuring that ropes are all equally tensioned.

Release crankcase from assembly dolly and remove supports.

Note: Crankcase must not be lowered onto oil pan.
Risk of oil pan breaking!

Use lifting device to remove crankcase from assembly dolly and set down on mounts (1).

C 011.05.12 After-Installation Operations

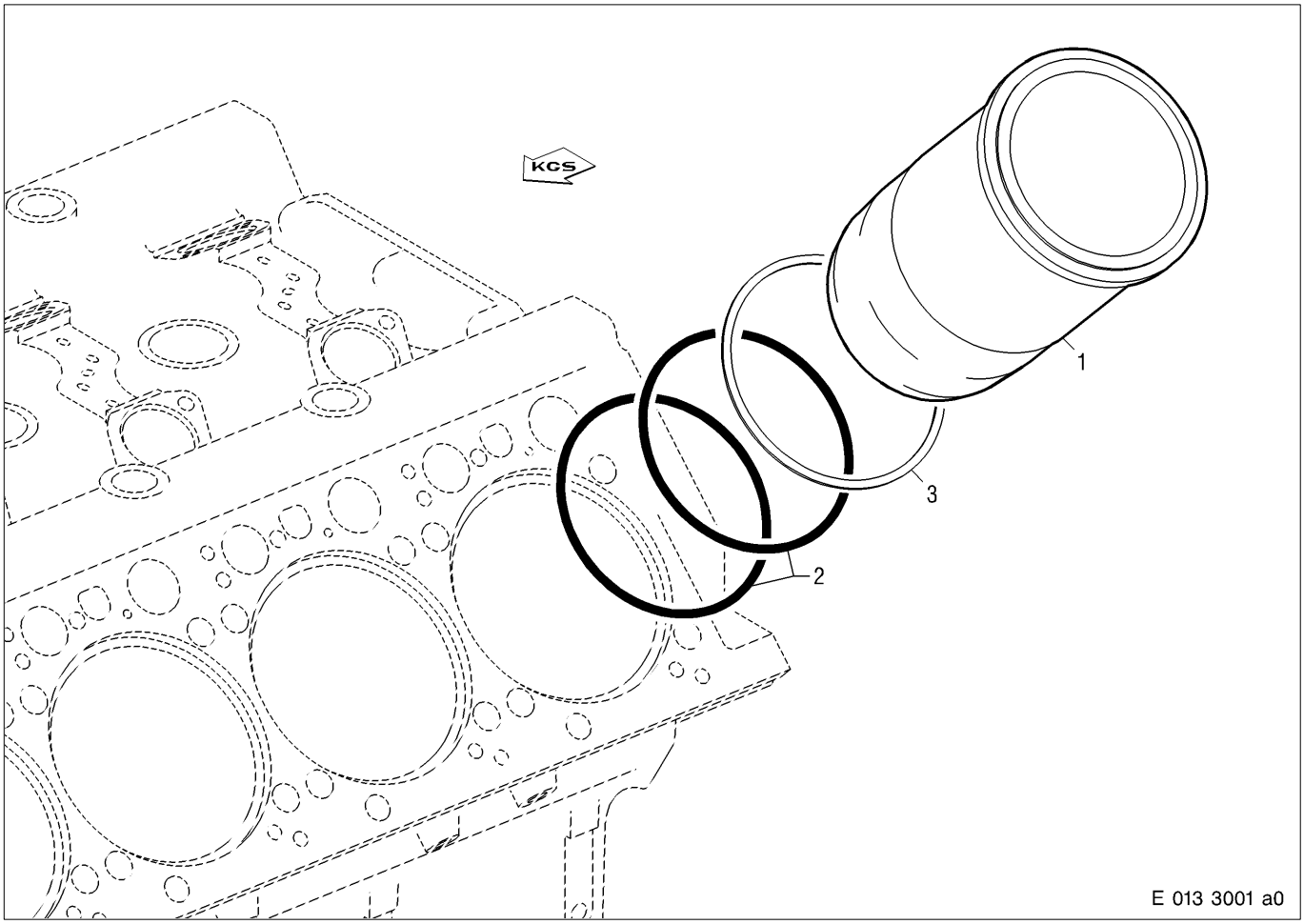
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007

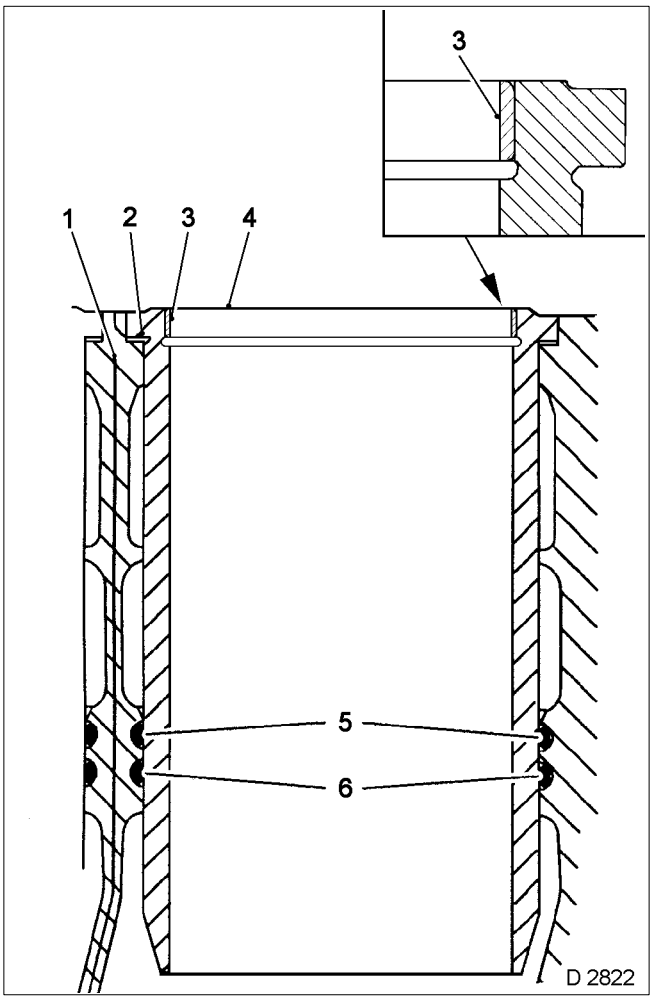
C 013.05 Cylinder Liner

C 013.05.01 Overview Drawing



1 Cylinder liner
2 Sealing ring, bottom
3 Sealing ring (Tombak)

Cylinder liner in crankcase



1 Crankcase
2 Sealing ring (Tombak)
3 Scraper ring
4 Bush
5 Sealing ring
6 Sealing ring

C 013.05.02 Special Tools

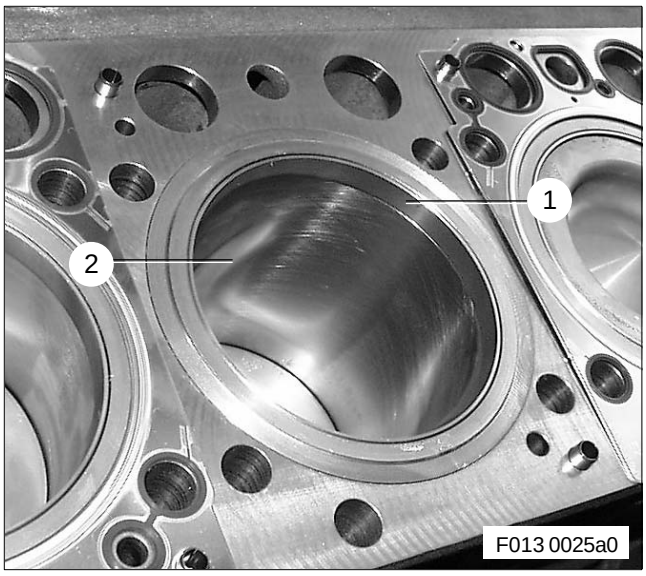
Designation – Application	Part No.	Number
Measuring plate for cylinder liner projection	541 589 00 21/00	1
Removal and installation tool for cylinder liner	541 589 01 33/00	1
Securing rail for cylinder liner in crankcase	F6 555 715	2

C 013.05.04 Before-Removal Operations

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

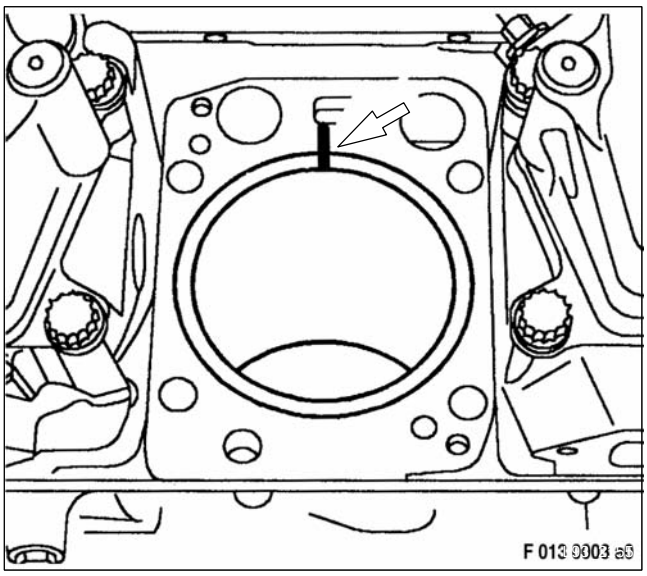
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65
–	x	x	Remove air filter	C 121.05
–	x	x	Remove intake housing	C 123.05
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove cover	C 114.05
–	x	x	Release or remove charge air manifolds	C 124.05
–	x	x	Remove exhaust turbocharger	C 101.01
–	x	x	Remove exhaust manifold	C 142.05
–	x	x	Remove cylinder head cover	C 055.10
–	x	x	Remove H.P. fuel line	C 073.05
–	x	x	Disconnect leak-off fuel lines	C 086.05
–	x	x	Remove rocker arm assembly	C 055.05
–	x	x	Remove pushrods	C 054.05
–	x	x	Remove cylinder head	C 041.05
–	x	x	Lower or remove oil pan	C 014.05
–	x	x	Remove piston and conrod	C 037.05

C 013.05.05 Removal



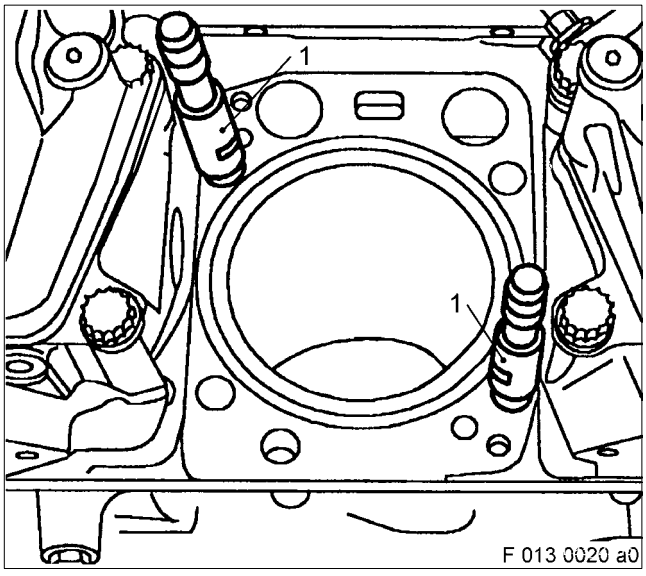
Removing scraper ring

Remove scraper ring (1) from cylinder liner fit (2).

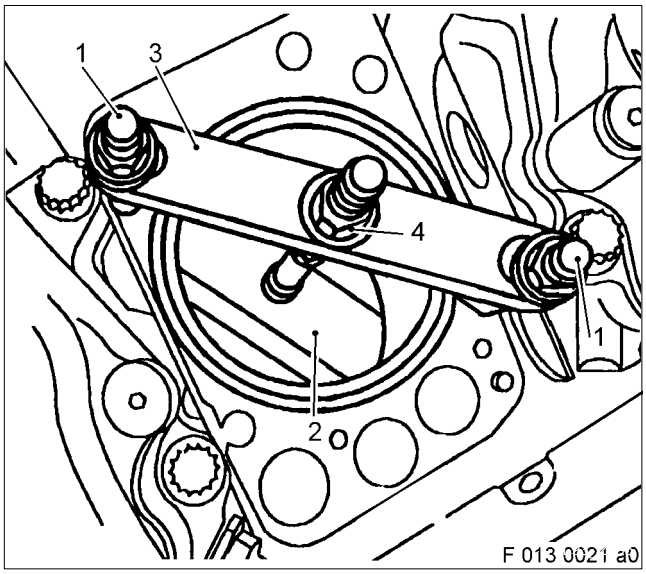


Removing cylinder liner

Mark installation position of cylinder liner in crankcase (arrow).



On the opposite side, screw studs (1) into threaded bores for cylinder head screws.



Insert removal plate (2) of removal tool into cylinder liner and fit on bottom collar of cylinder liner.

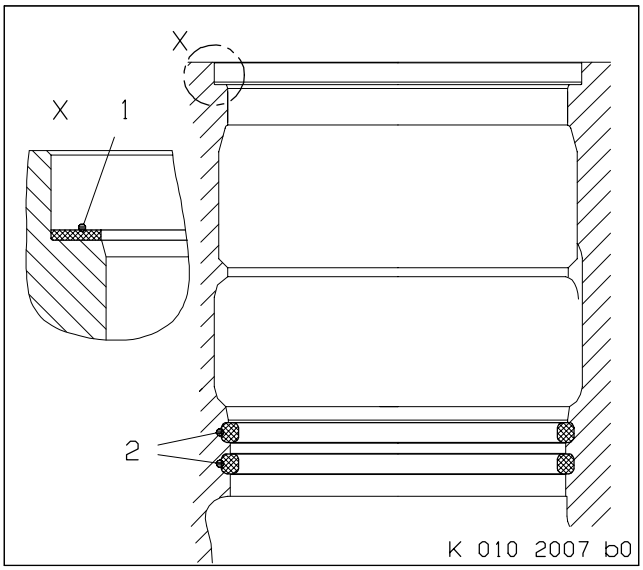
Make sure that removal plate is correctly seated.

Place support (3) on spindle and studs (1) and tighten.

Turn nut (4) to withdraw cylinder liner until it is released from crankcase bore.

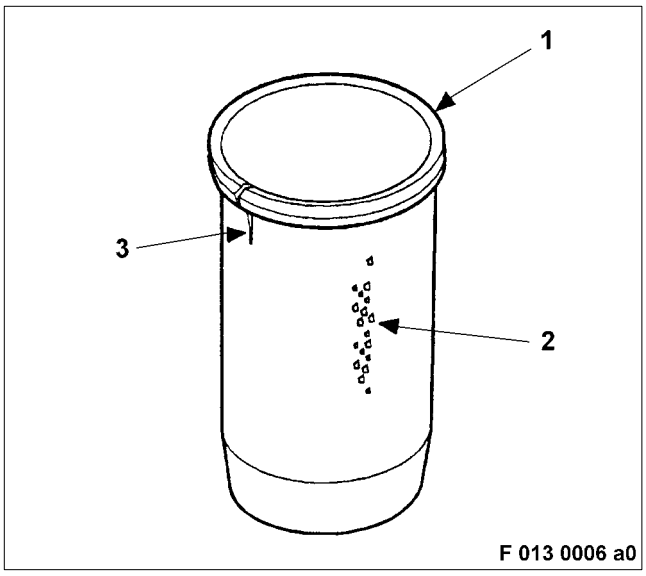
Remove removal tool.

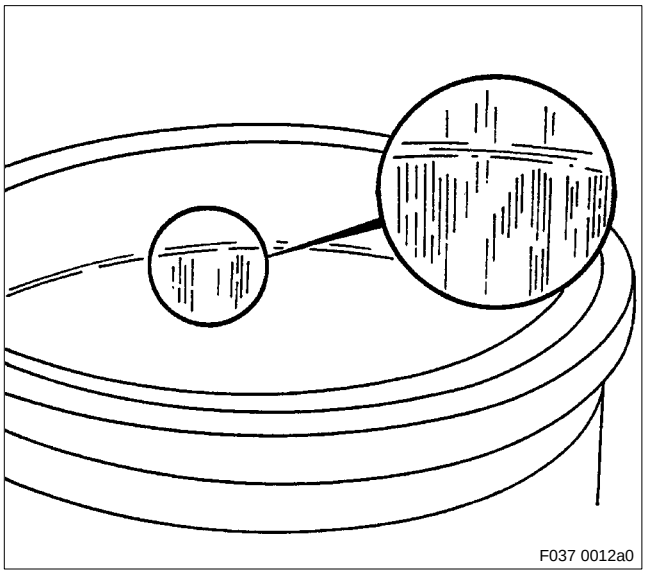
Remove cylinder liner from crankcase.



Remove Tombak ring (1) and sealing rings (2) from crankcase.

C 013.05.08 Inspection and Repair





Checking cylinder liner for cracks and cavitation

Clean cylinder liner and, using magnetic crack-testing method and fluorescent magnetic powder, check for cracks (3).

If cracks are found, replace cylinder liner.

Check outer wall for cavitation (2) and pitting; replace cylinder liner as necessary.

If minor cavitation and pitting are found, insert cylinder liner displaced by 90°.

If cylinder liner has to be turned for re-installation, re-hone liner bore.

Check sealing and mating faces on liner collar (1) for wear and damage; replace cylinder liner if necessary.

Replace sealing rings and Tombak ring at every assembly.

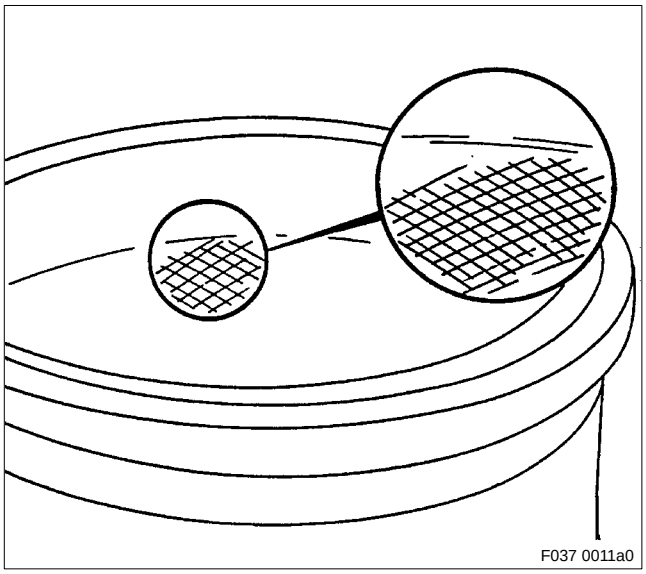
Checking wear pattern of cylinder liners

Check wear face for flats, scores, cracks and pitting; rehone or replace cylinder liner as necessary.

Note: If cylinder liner is rehoned, install new piston rings. Similarly, rehone liner if new piston rings are installed.

No burn marks must be evident on running surface.

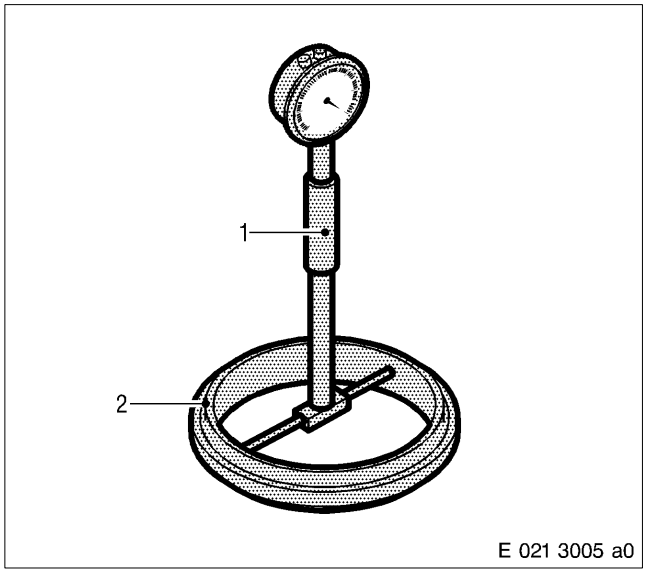
Check reversing point of initial piston ring for wear; replace cylinder liner if necessary.



When reusing cylinder liners which have not been rehoned, the honing must be more or less clearly recognisable over entire running surface.

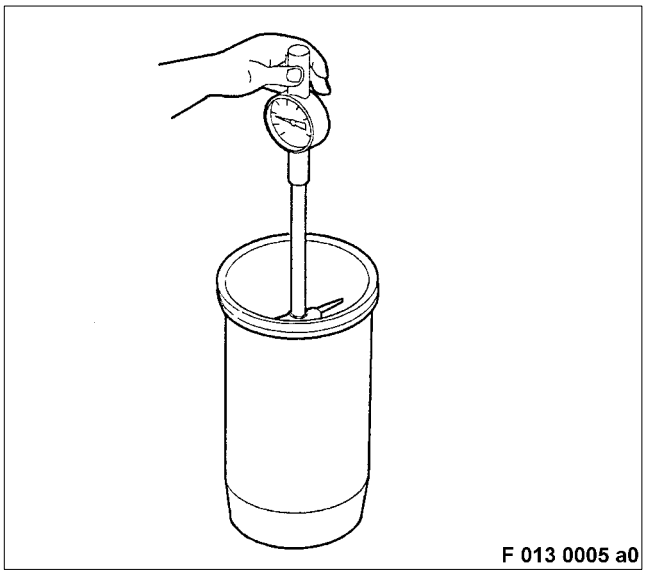
Isolated minor grooves are insignificant.

There must be no signs of wear at reversing point of initial piston ring.



Measuring cylinder liner ID

Adjust bore gauge (1) and dial gauge with micrometer or gauge ring (2) to basic size for cylinder liner as per Tolerance and Wear Limits List.

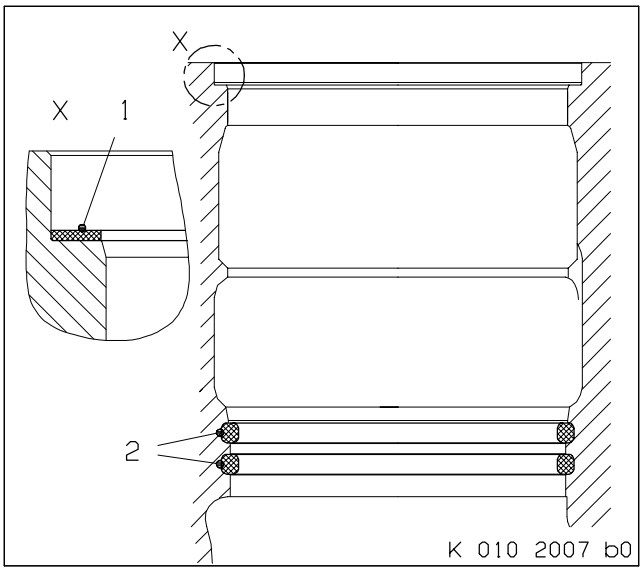


Measure cylinder liner ID with bore gauge.

For measuring points and limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, replace liner.

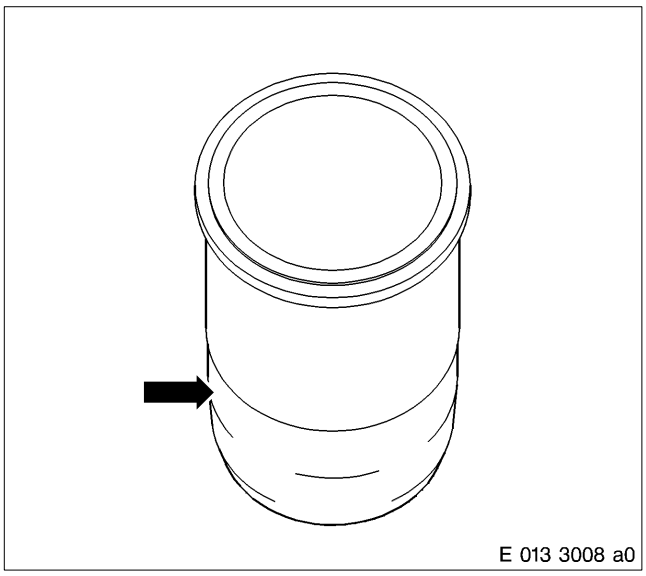
C 013.05.11 Installation



Installing cylinder liner

Coat new sealing rings (2) with petroleum jelly and insert into grooves in crankcase.

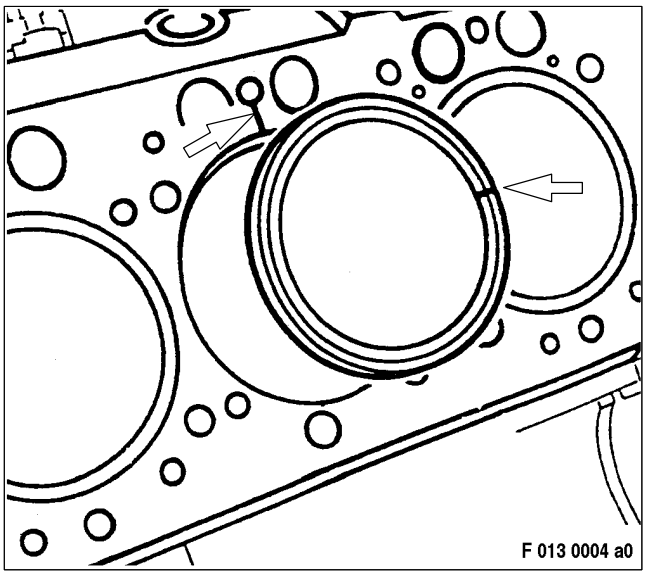
Fit new Tombak ring (1) on cylinder liner collar seat in crankcase.



Check cylinder liner repair stage as per Tolerance and Wear Limits List and assign according to crankcase data sheet.

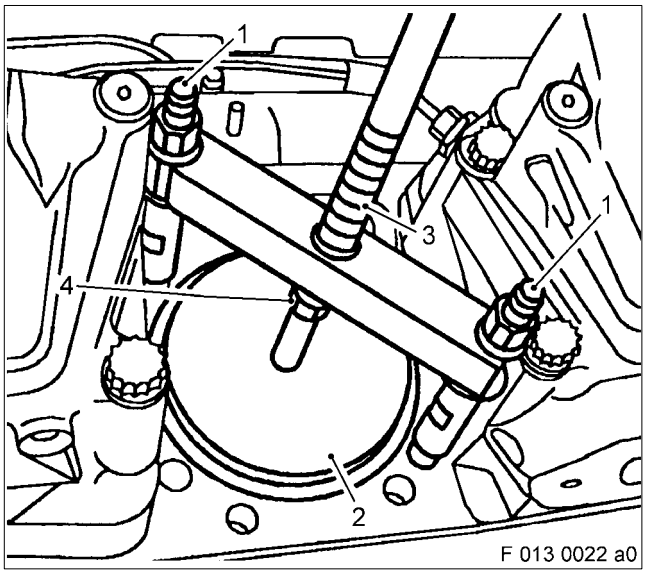
Note: The tolerance group designation is stamped on the edge of the liner.

Wipe cylinder liner at lower fit (arrow) and at chamfer inclination; then lightly coat with petroleum jelly.



According to markings, insert cylinder liner in same installation position in crankcase.

Note: In event of slight cavitation on the outer wall of cylinder liner, install liner offset by 90° (arrows) with regard to previous installation position.



On the opposite side, screw studs (1) into threaded bores for cylinder head screws.

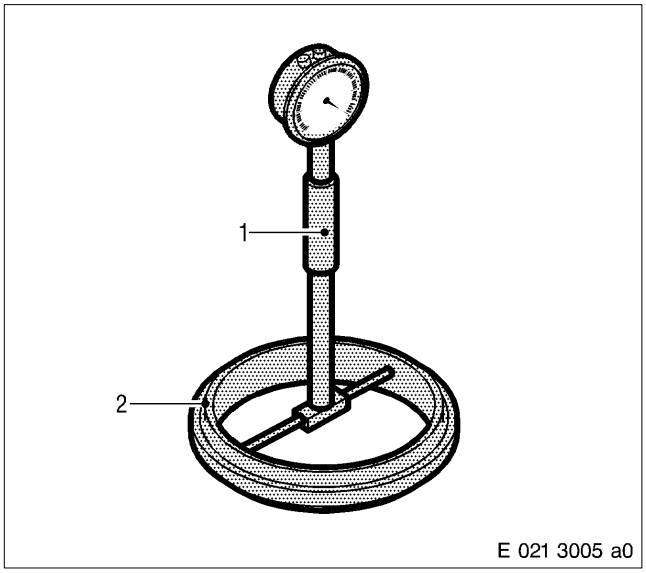
Fit pressure plate (2) on cylinder liner.

Place support and spindle (3) on studs and tighten.

Press cylinder liner into crankcase bore by turning nut (4).

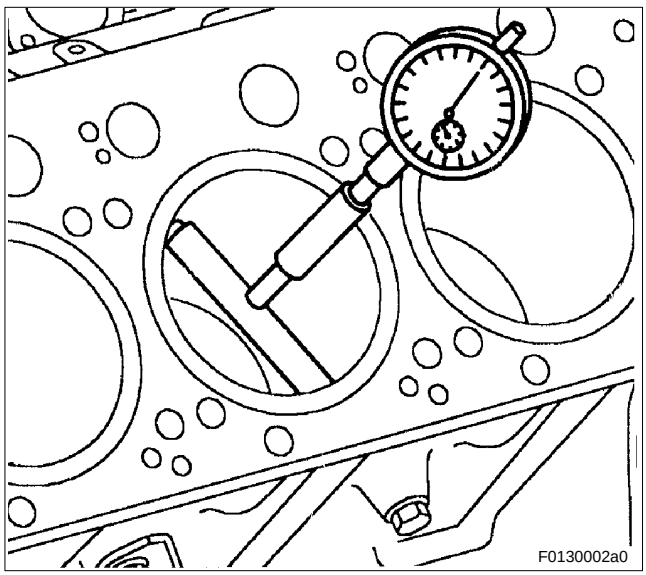
Remove installation tool and studs from crankcase.

Note: In order to prevent cylinder liner being released when piston is installed, prepare sleeves and cylinder heads to secure cylinder liners.



Measuring cylinder liner ID

Adjust bore gauge (1) and dial gauge with micrometer or gauge ring (2) to basic size for cylinder liner as per Tolerance and Wear Limits List.



Measure cylinder liner ID with bore gauge.

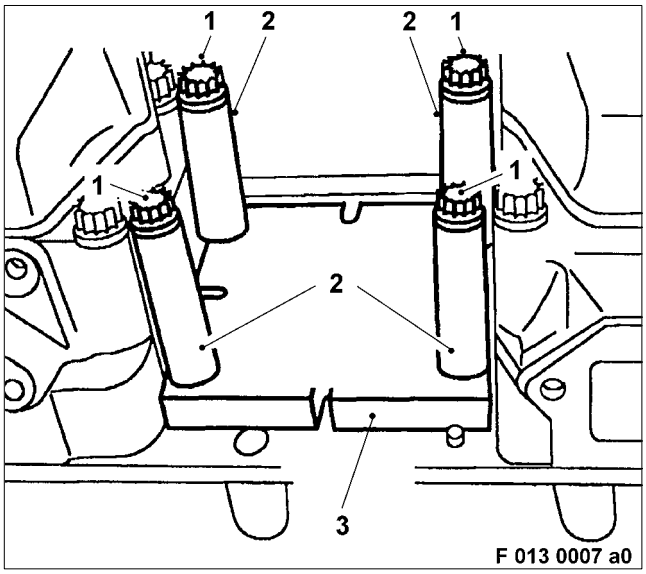
For measuring points and limit values, see Tolerance and Wear Limits List.

Enter measurement values in data sheet.

Remove cylinder liner if liner is out-of-round.

Check sealing rings are correctly positioned in crankcase and replace.

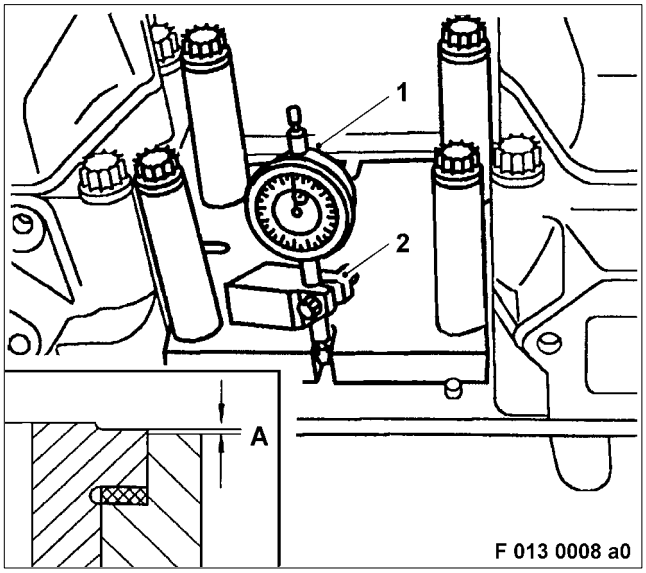
Clean both grooves in crankcase.



Measuring projection of cylinder liner

Mount measuring plate (3) and spacer tubes (2) with cylinder head screws (1) on cylinder liner.

Tightening torque of cylinder head screws: 50 Nm



Mount dial gauge (1) with extension on dial gauge holder (2) and, with preload, guide through one of the recesses in measuring plate.

Set dial gauge to “0”.

Shift dial gauge with dial gauge holder from cylinder liner collar to crankcase.

Record projection (A).

Measure projection of each recess (4X) in measuring plate.

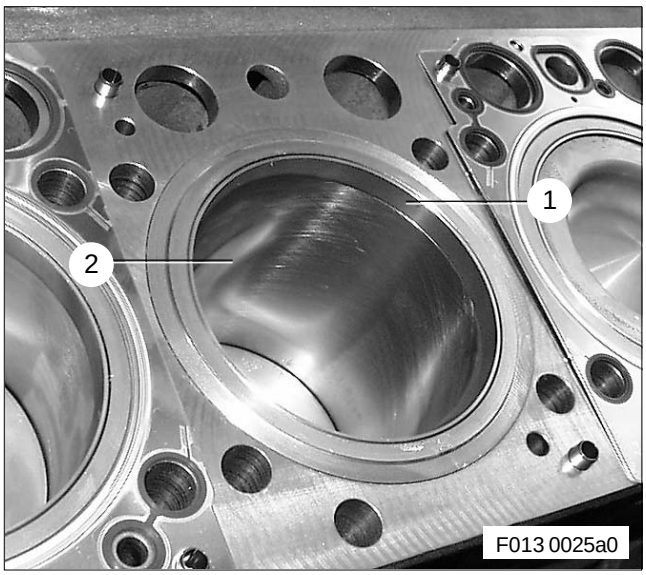
Set scale of dial gauge to “0” before each measurement.

Difference between 4 measuring points on each cylinder liner must not exceed max. 0.02 mm.

For projection (A), see Tolerance and Wear Limits List.

If the checking measurements deviate, remove cylinder liner and determine cause.

Remove measuring plate and spacer tubes.

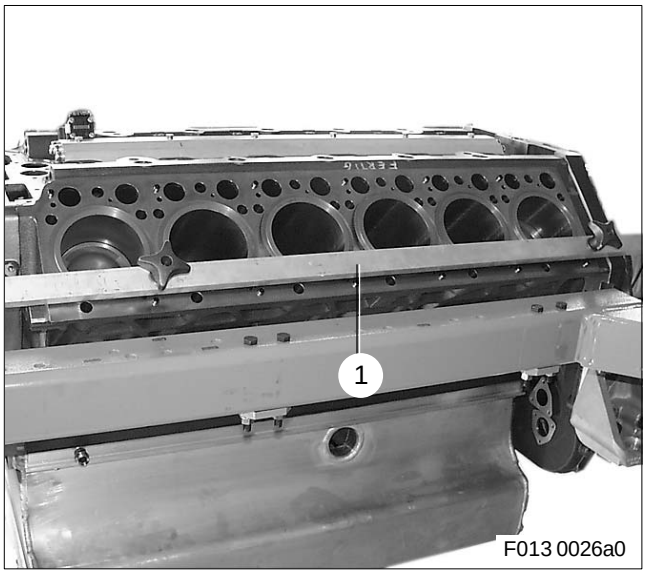


Installing scraper ring

Note: Install scraper ring only after piston has been installed.

Spray cylinder liner (2) and carbon scraper (1) ring with engine oil.

Insert scraper ring into fit of cylinder liner.



Securing cylinder liners against falling out

Install a securing rail (1) on each engine side.

C 013.05.12 After-Installation/Removal Operations

A distinction must be made as to whether:

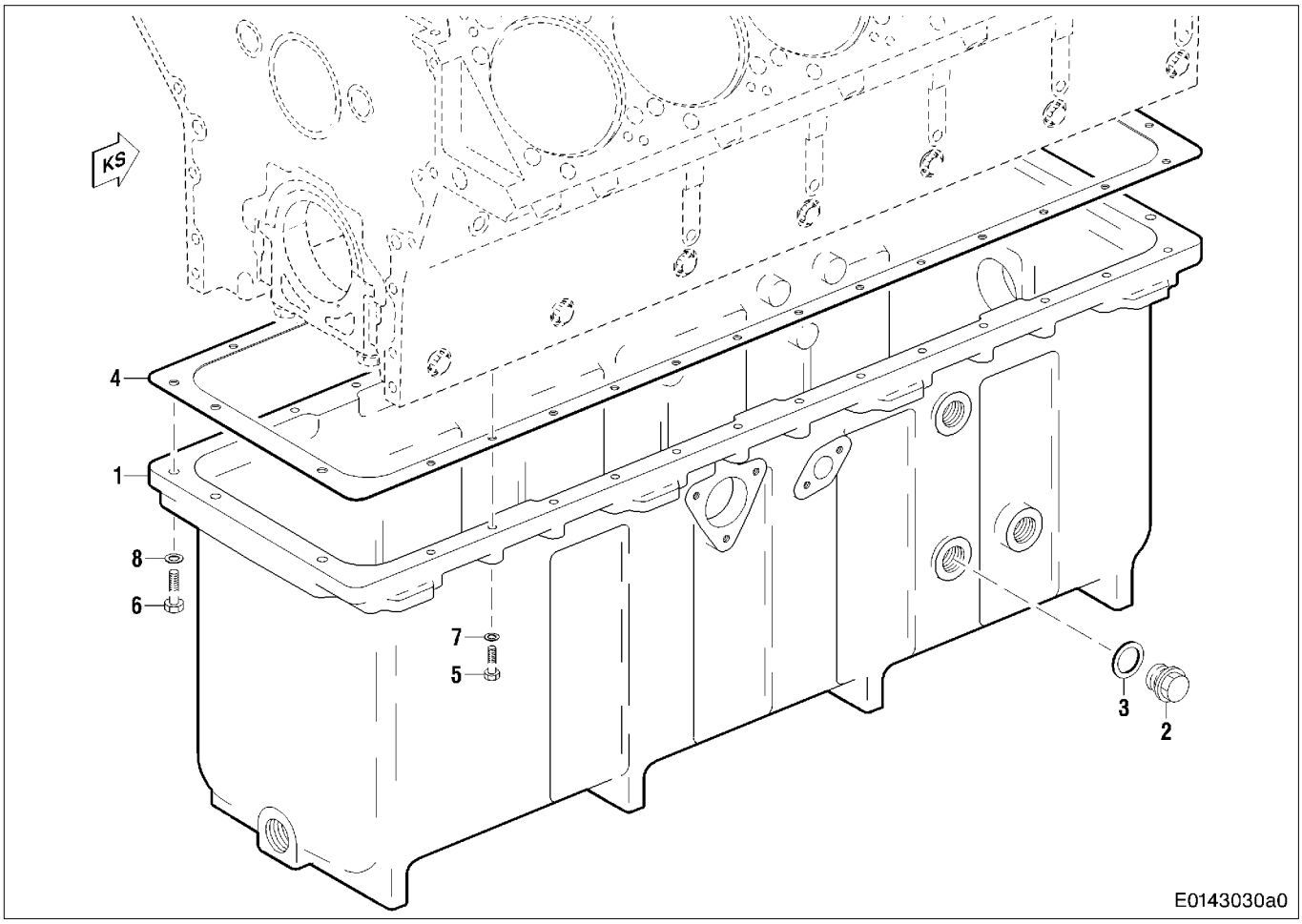
1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install piston and conrod	C 037.05
–	x	x	Install oil pan	C 014.05
–	x	x	Install cylinder head	C 041.05
–	x	x	Install pushrods	C 054.05
–	x	x	Install rocker arm assembly	C 055.05
–	x	x	Adjust valve clearance	C 055.05.11
–	x	x	Connect leak-off fuel lines	C 086.05
–	x	x	Install H.P. fuel line	C 073.05
–	x	x	Install cylinder head cover	C 055.10
–	x	x	Install exhaust manifold	C 142.05
–	x	x	Install turbocharger	C 101.01
–	x	x	Install charge air manifolds	C 124.05
–	x	x	Install cover	C 114.05
–	x	x	Install charge air lines	C 125.05
–	x	x	Connect vent lines	C 202.65
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Install crankcase breather	C 018.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 014.05 Oil Pan

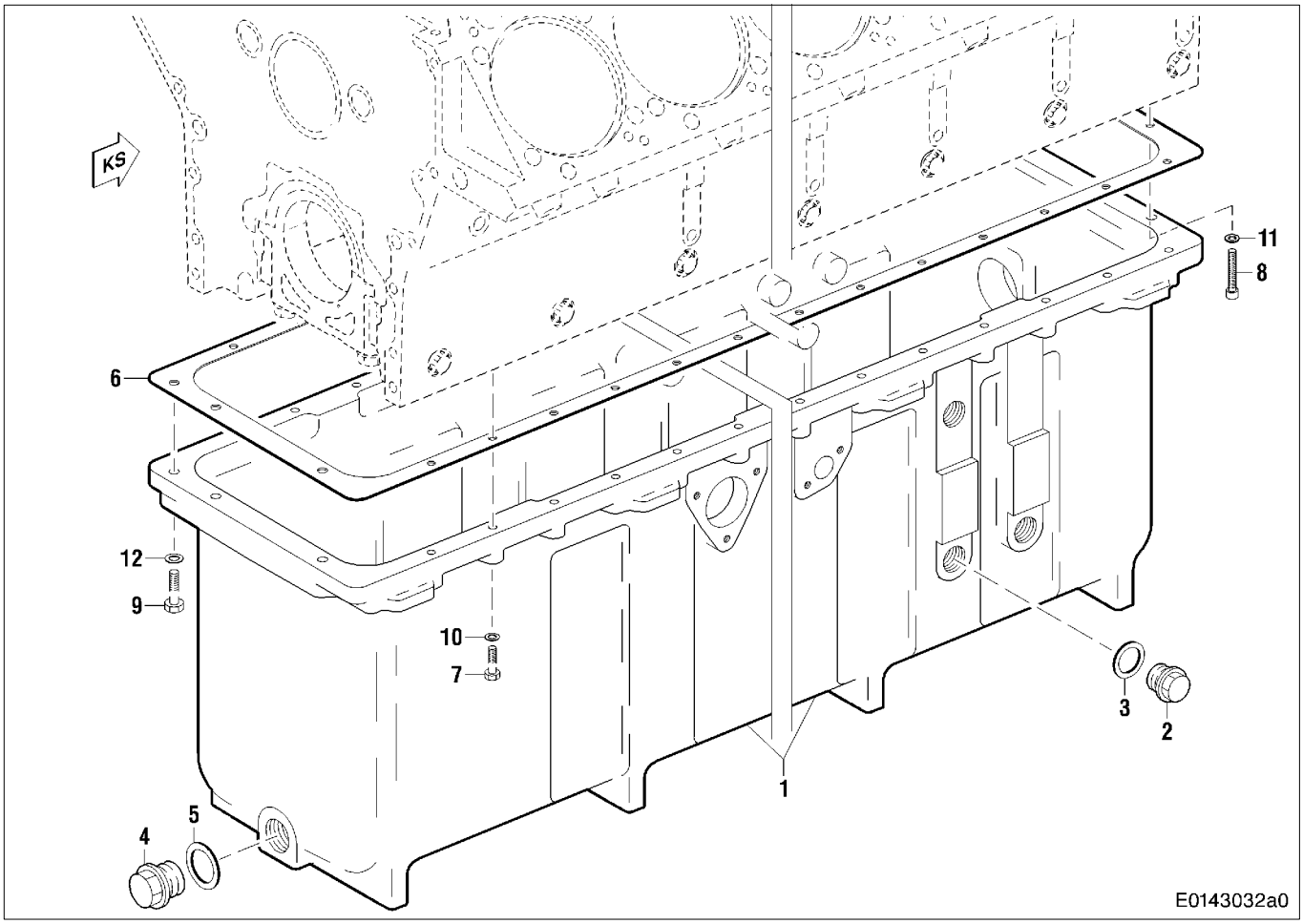
C 014.05.01 Overview Drawing

Oil pan, 12V



1 Oil pan 12V
2 Plug
3 Sealing ring
4 Gasket
5 Hex screw
6 Hex screw
7 Washer
8 Washer

Oil pan, 16V



1 Oil pan
2 Plug
3 Sealing ring
4 Plug
5 Sealing ring
6 Gasket
7 Hex screw
8 Socket-head screw
9 Hex screw
10 Washer
11 Washer
12 Washer

C 014.05.02 Special Tools

Designation – Application	Part No.	Number
Oil pan lowering device	F6 555 180	3

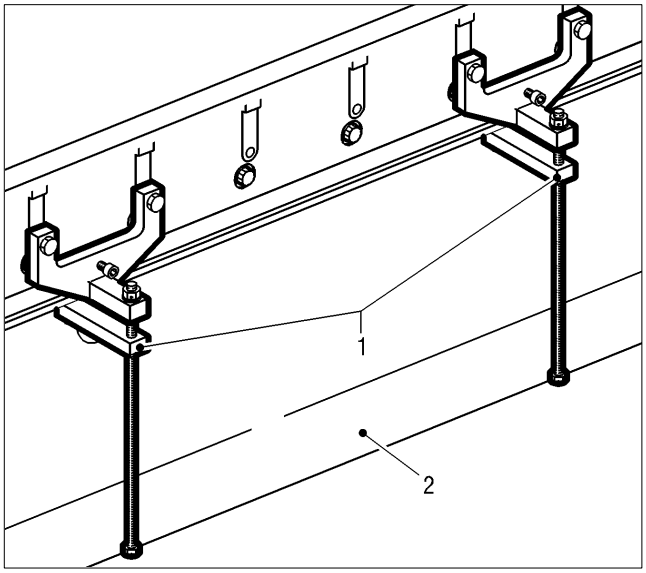
C 014.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Remove oil pan-gear case oil lines (free end)	C 024.05/C 181.05
–	x	x	Remove oil return lines for turbochargers	C 185.25
–	x	x	Remove crankcase ventilation pipework (bottom)	C 018.10
–	x	x	Release or remove oil filler neck	C 182.10

C 014.05.05 Removal



Lowering oil pan

Note: When engine is installed, oil pan can be lowered for purposes of assembly work.

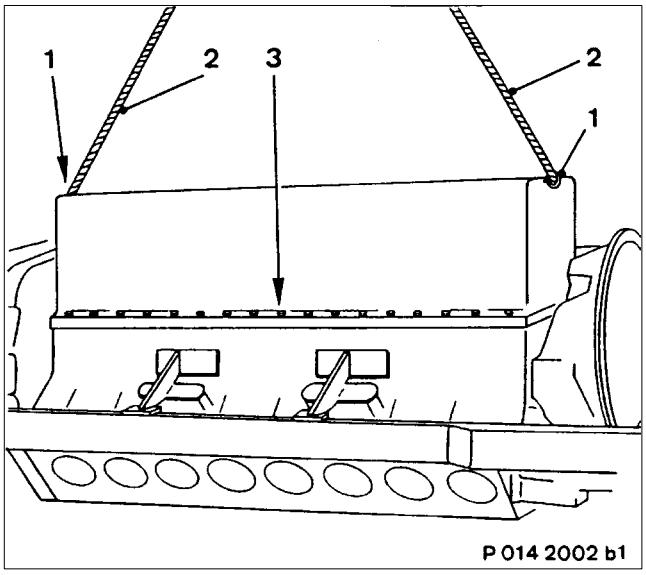
Remove all oil pan (2) hex screws and socket-head screws except the 4 corner screws.

Install two jackscrews (1) on every engine side.

Remove corner screws.

Lower oil pan by turning threaded rods of lowering devices uniformly.

Remove gasket.



Removing oil pan (in assembly dolly)

Install engine in assembly dolly and turn by 180°.

Remove all hex screws (3) and socket-head screws for oil pan.

Remove plugs and install two suitable eyebolts (1) in oil pan.

⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Carefully raise oil pan with lifting ropes (2) and crane and lower onto suitable support.

Remove gasket.

C 014.05.08 Inspection and Repair

Note: Make sure parts are perfectly clean.

Clean oil pan and carefully remove any remaining detergent.

Check oil pan for cracks using surface crack-testing method with red penetrant dye. Replace if cracks are detected.

Check mating face of oil pan with crankcase for surface irregularities.

In event of irregularities over 0.2 mm, recondition mating face.

Consultation with MTU is required.

Check sealing and mating faces for surface irregularities; rub down with oilstone or emery cloth if necessary.

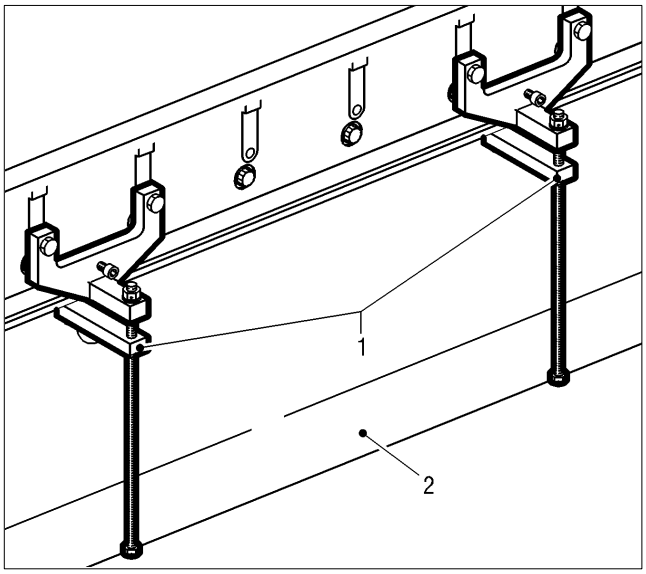
Check all parts for wear and damage; replace components as necessary.

Check threaded bores for ease of movement; recut thread if necessary.

Replace gasket and sealing rings.

C 014.05.11 Installation

Note: Always make sure that all components are perfectly clean.



Installing lowered oil pan

Clean and degrease mating faces of oil pan (2) and crankcase.

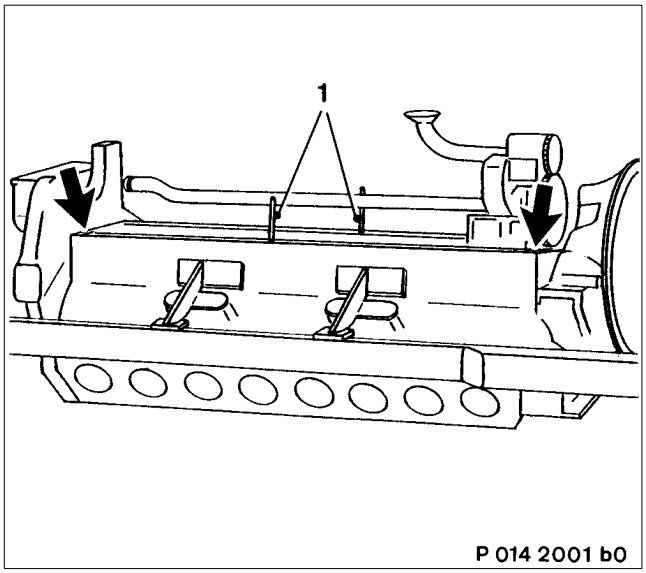
Coat mating face in area of crankcase-flywheel housing and crankcase-gear case partition with sealing paste, see following section – Installing oil pan.

Place gasket on oil pan sealing surface.

Position oil pan on crankcase by turning threaded rods of lowering devices uniformly (1).

Insert all hex screws and washers and socket-head screws and washers in oil pan (free end) and tighten evenly.

Remove lowering devices, install remaining screws and washers and tighten.



Installing oil pan (in assembly dolly)

Turn crankcase upside down in assembly dolly with oil pan mating face horizontal.

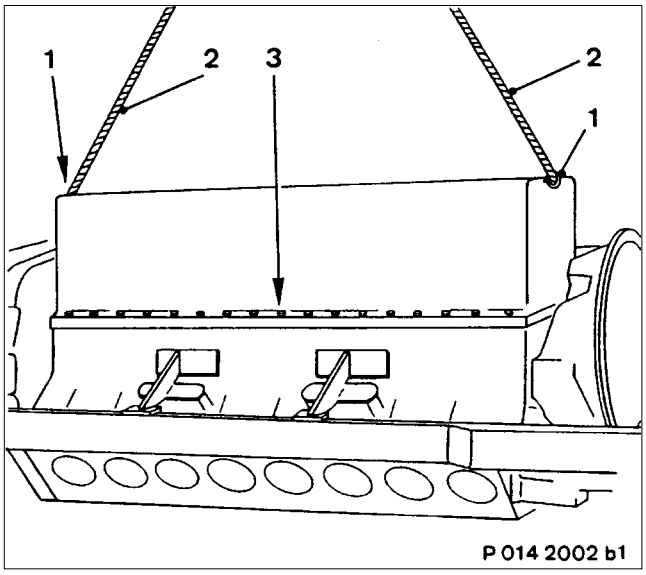
Clean and degrease mating faces of oil pan and crankcase.

Coat mating face in area of crankcase-flywheel housing and crankcase-gear case partition (arrows) with sealing paste.

Note: Lightly apply sealing paste to the four joints.

Insert two suitable guide pins (1) into two opposing threaded bores of oil pan securing screws.

Position gasket on sealing surface via guide pins.



⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Insert two suitable eyebolts (1) into oil pan bores for blanking plugs.

Raise oil pan with lifting ropes (2) and crane and carefully set on crankcase via guide pins.

Make sure that gasket is correctly seated along its full length.

Remove lifting device.

Remove guide pins.

Insert all hex screws (3) and washers and socket-head screws and washers in oil pan (free end) and tighten evenly.

C 014.05.12 After-Installation Operations

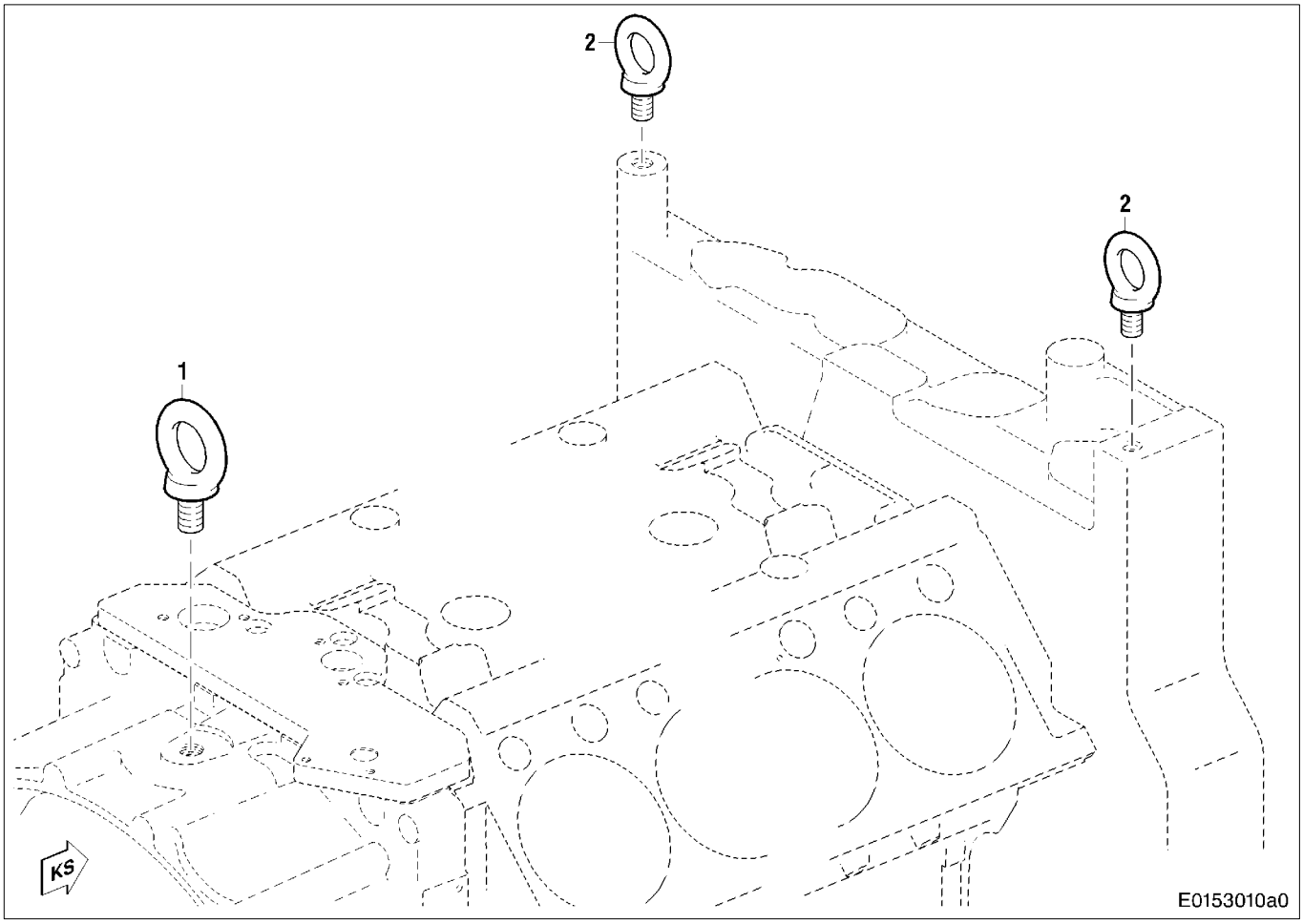
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install crankcase ventilation pipework (bottom)	C 018.10
–	x	x	Install oil return lines for turbochargers	C 185.25
–	x	x	Install oil pan-gear case oil lines (free end)	C 024.05/C 181.05
–	x	x	Install oil filler neck	C 182.10
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 015.05 Lifting Attachments for Engine and Running Gear

C 015.05.01 Overview Drawing



1 Eyebolt
2 Eyebolt

C 015.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 015.05.05 Removal

Remove eyebolts as per overview drawing – see C 015.05.01.

C 015.05.08 Inspection and Repair

Clean eyebolts and visually inspect damage and defects; repair as necessary.

Using the magnetic crack-testing method with fluorescent powder, check eyebolts for cracks; replace components if cracks are detected.

Check condition of mating faces and/or screw-down surfaces; rub down with oilstone if necessary.

Check condition of threads; rechase threads or replace component if necessary.

C 015.05.11 Installation

Screw in eyebolts as per overview drawing (see C 015.05.01) and tighten.

C 015.05.12 After-Installation Operations

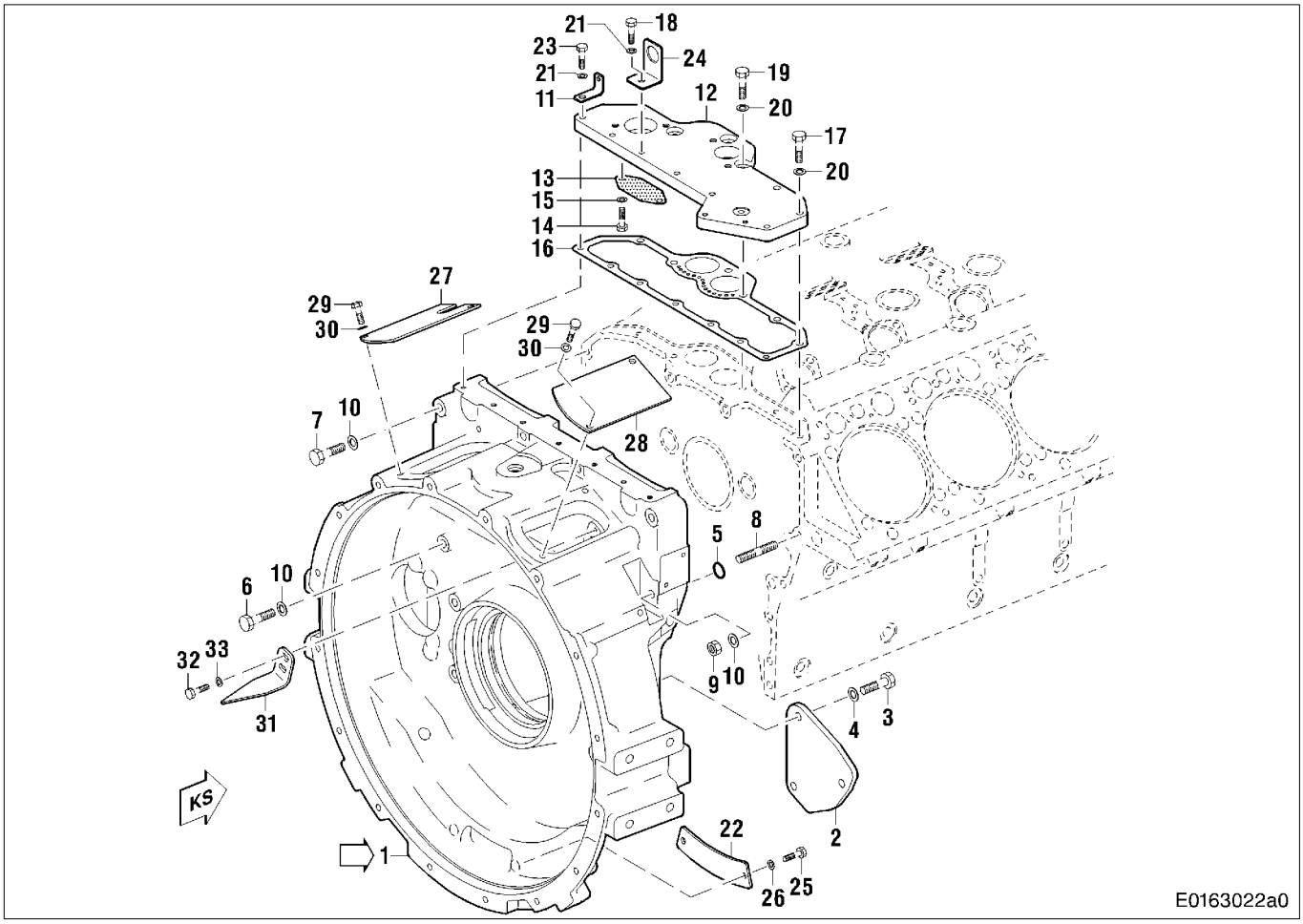
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

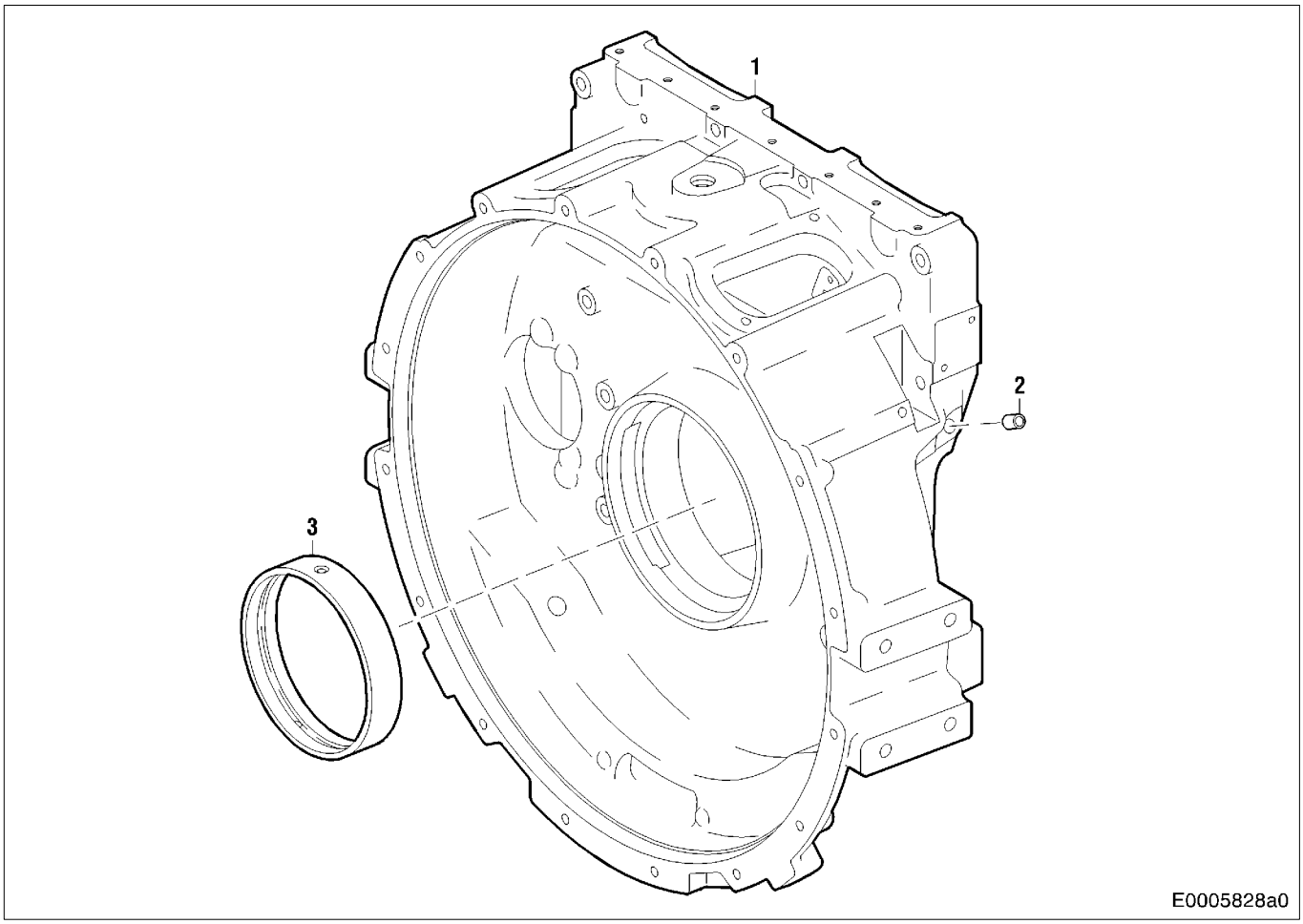
1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

C 016.30 Flywheel Housing

C 016.30.01 Overview Drawing



1 Flywheel housing
2 End cover
3 Hex screw
4 Washer
5 O-ring
6 Hex screw
7 Hex screw
8 Stud
9 Hex nut
10 Washer
11 Bracket
12 End plate
13 Deflector plate
14 Hex screw
15 Washer
16 Gasket
17 Hex screw
18 Hex screw
19 Hex screw
20 Washer
21 Washer
22 End cover
23 Hex screw
24 Bracket
25 Hex screw
26 Washer
27 End cover
28 End cover
29 Hex screw
30 Washer
31 Pointer
32 Hex screw
33 Washer



1 Flywheel housing
2 Sealing plug
3 Crankshaft bearing

C 016.30.02 Special Tools

Designation – Application	Number
Press-in plate for shaft seal	1
Crankshaft bearing press-out plate	1
Guide bush for flywheel housing	1
Alignment tool for flywheel housing	1

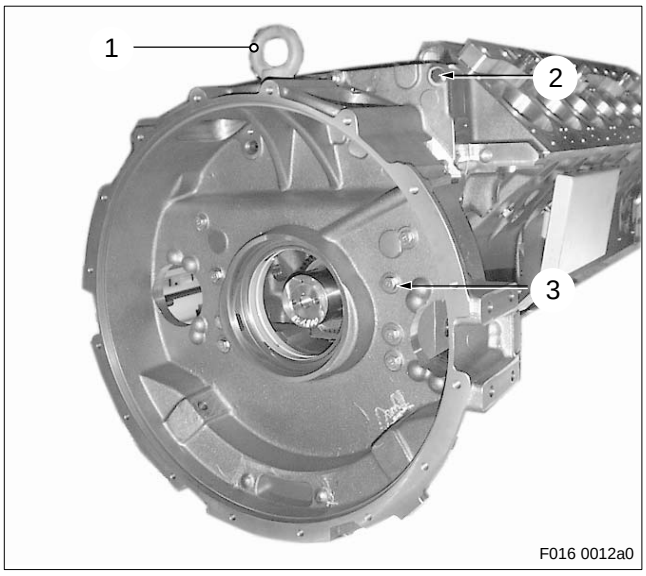
C 016.30.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	–	x	Separate engine from alternator	–
–	x	x	Remove coolant lines	C 202.15
–	x	x	Remove coupling	Special Publication
–	x	x	Remove flywheel	C 032.05
–	x	x	Lower or remove oil pan	C 014.05
–	x	x	Remove air filter, left engine side	C 121.05
–	x	x	Remove elbow, left engine side	C 123.05
–	x	x	Remove starter	C 172.05
–	x	x	Remove speed sensor	C 507.10
–	x	x	Attach engine to lifting device	B 003
–	x	x	Remove engine mount, driving end	C 231.05

C 016.30.05 Removal



Removing flywheel housing

⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Attach flywheel housing with rope and crane to eyebolt (1).

Mark all inner (3) and outer (2) screws (varying lengths and versions) and remove.

Carefully push flywheel housing under rope preload in direction of driving end until it is freed from crankcase.

Note: Remove studs from crankcase only if necessary (e.g. if damaged).

C 016.30.06 Disassembly

Removing radial-lip shaft seal and crankshaft bearing from flywheel housing

Note: Replace crankshaft bearing and shaft sealing ring as part of every W6 overhaul.

Remove pointer, end cover and end plates as per overview drawing – see C 016.30.01.

Check radial-lip shaft seal and crankshaft bearing – see C 016.30.08.

Using suitable mandrel and hammer, drive shaft sealing ring out of flywheel housing.

Cut axial groove in crankshaft bearing, leaving wall thickness of approx. 1 mm to relieve tension in bearing.

Using removal tool and manual press, force bearing out of flywheel housing.

C 016.30.08 Inspection and Repair

Clean all parts.

Check flywheel housing for cracks using surface crack-testing method with red penetrant dye. Replace if cracks are detected.

Thoroughly clean oilways and bores in flywheel housing and check that they are perfectly clean.

Check threads and shanks of hex screws for damage; replace screws as necessary.

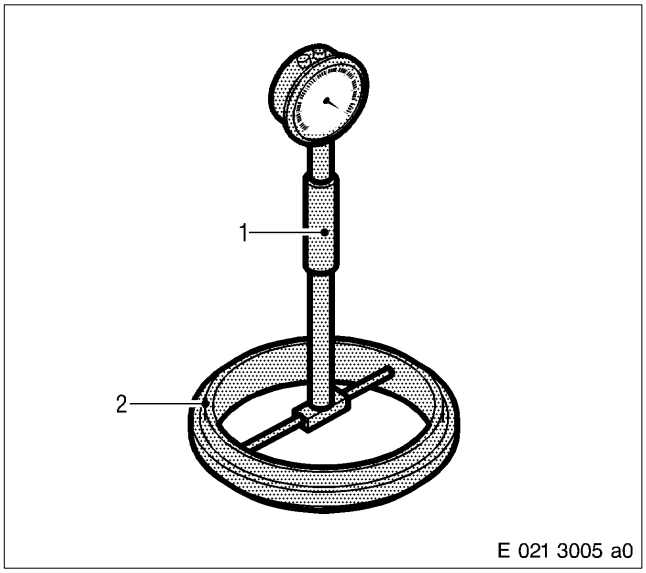
Check all mating and sealing faces and fits. Rub down with oilstone or emery cloth as necessary.

Check studs, replace as required.

Check condition of threads in flywheel housing; rechase threads as necessary.

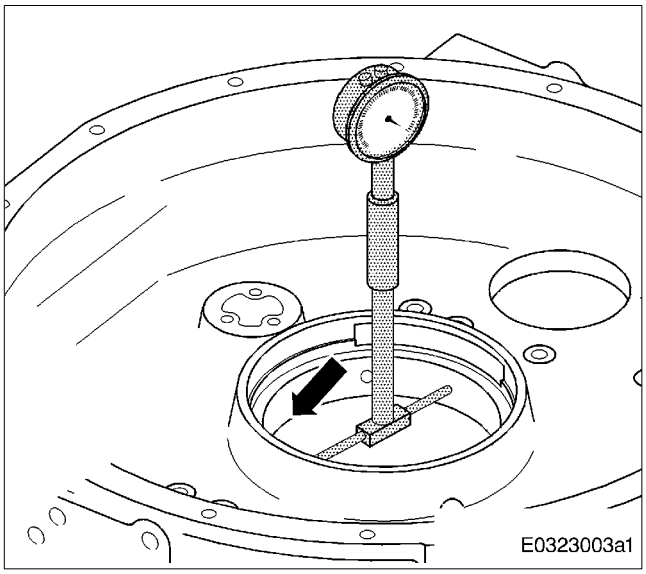
Replace crankshaft bearing and shaft sealing ring as part of every W6 overhaul.

Replace gaskets and O-rings at every assembly.



Measuring crankshaft main bearing bore

Adjust bore gauge (1) and dial gauge with adjusting ring (2) or micrometer to zero of crankshaft bearing main bore.

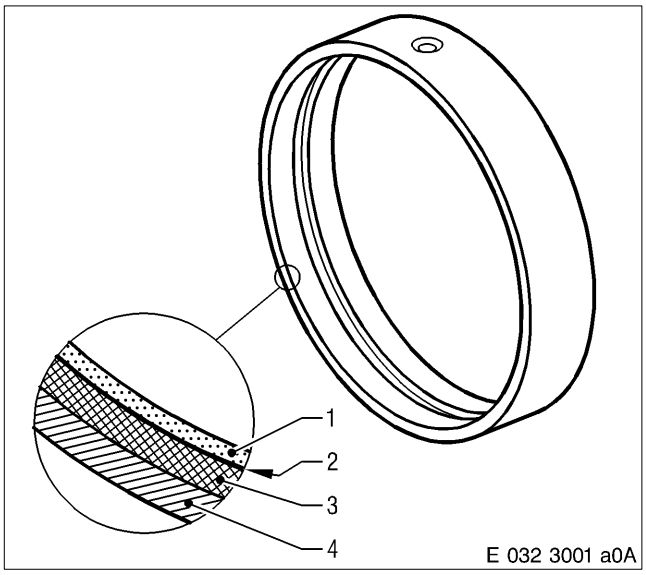


Measure diameter of crankshaft bearing main bore (arrow) with bore gauge.

Enter measurement values in data sheet.

For measuring points and limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, recondition bore to next repair stage.



Checking and assessing crankshaft bearing

Replace crankshaft bearing as part of every W6 overhaul.

Check surface condition of crankshaft bearings and check for wear; replace bearing if damaged.

Crankshaft bearing has the following material structure:

1 Sliding layer (from 20 µm to 25 µm)

2 Intermediate layer (nickel barrier)

3 Bearing metal

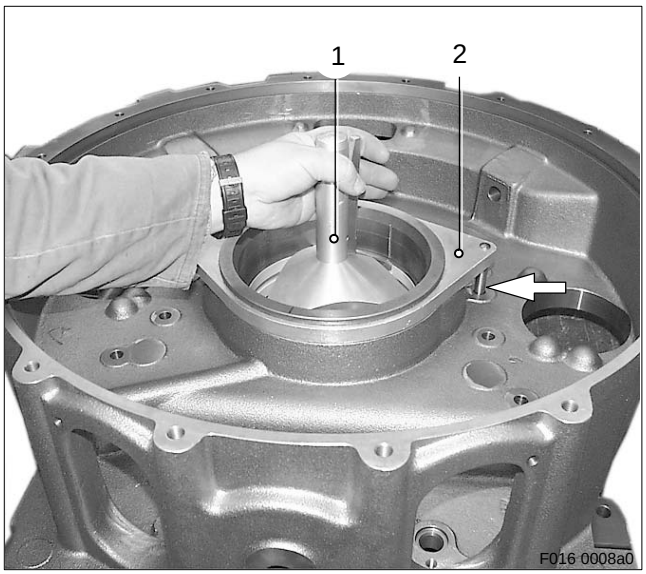
4 Steel support shell

An important criterion for assessing extent of wear on bearing is the shape and extent of nickel barrier being exposed.

Usability of bearing is restricted at 70% of sliding layer in friction area!

Note: It is often difficult to differentiate between the hard nickel barrier and softer sliding layer. If in doubt, consult a bearing specialist.

C 016.30.10 Assembly



Installing crankshaft bearing into flywheel housing

Note: Make sure that oil bores and oil chambers are perfectly clean.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Place flywheel housing on assembly bench.

Measure basic bore in flywheel housing – see C 016.30.08 Inspection and Repair.

Insert guide bush (2) into flywheel housing, paying attention to fits of the two dowel pins (arrow).

⚠ CAUTION

Nitrogen is liquid at –200 °C.
Danger of freezing and suffocation!
Do not allow liquid nitrogen to come into contact with parts of body (eyes, hands).
Wear protective clothing (including gloves and closed shoes) and goggles.
Ventilate working area well.

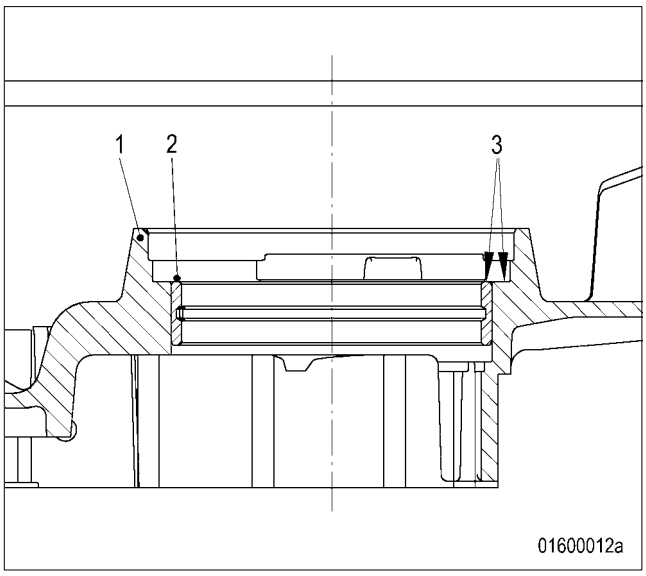
Chill main bearing in liquid nitrogen (Δt min = 110 °C).

Note: Observe position markings of oil feed bores and designation (dia. stage, part no.) on both faces of bearing shell.

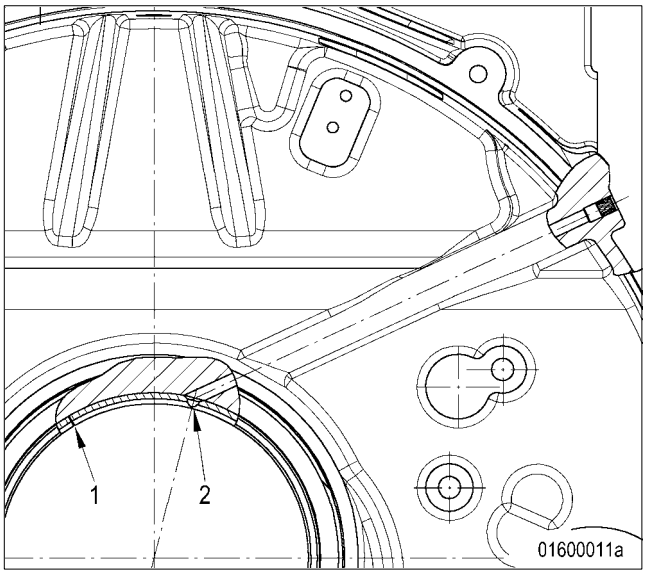
Install main bearing on shrink-on tool (1), making sure that the position markings on the face are towards the shrink-on tool.

Use shrink-on tool to insert chilled main bearing flush into flywheel housing; make sure the oil bores and position of the butting face are aligned – see following two illustrations.

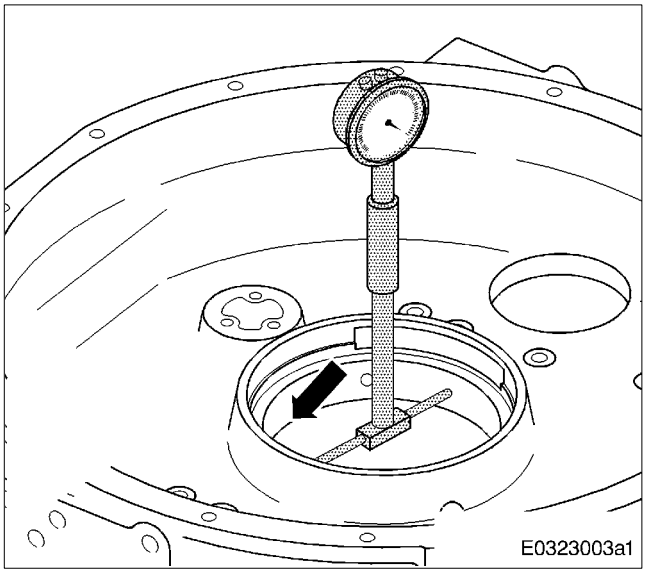
Make sure that oilway is free of obstruction.



1 – Flywheel housing
2 – Bearing shell
3 – Bearing shell inserted flush



1 – Bearing shell butting face
2 – Oil supply bore



Measuring crankshaft bearing bore

Allow flywheel housing to cool to room temperature.

Adjust bore gauge and dial gauge with adjusting ring or micrometer to basic size of crankshaft bearing bore.

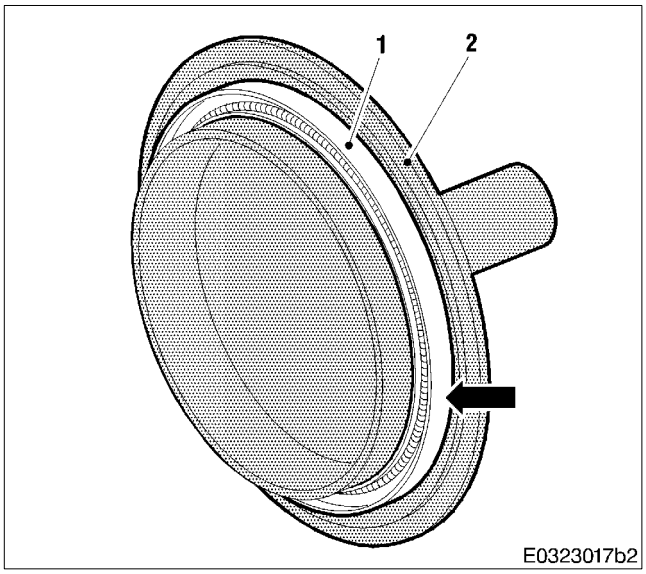
Coat friction face of crankshaft bearing (arrow) with engine oil.

Measure diameter of crankshaft bearing bore with bore gauge.

Enter measurement values in data sheet.

For measuring points and limit values, see Tolerance and Wear Limits List.

Replace crankshaft bearing or use repair-size shells if limit values are exceeded.

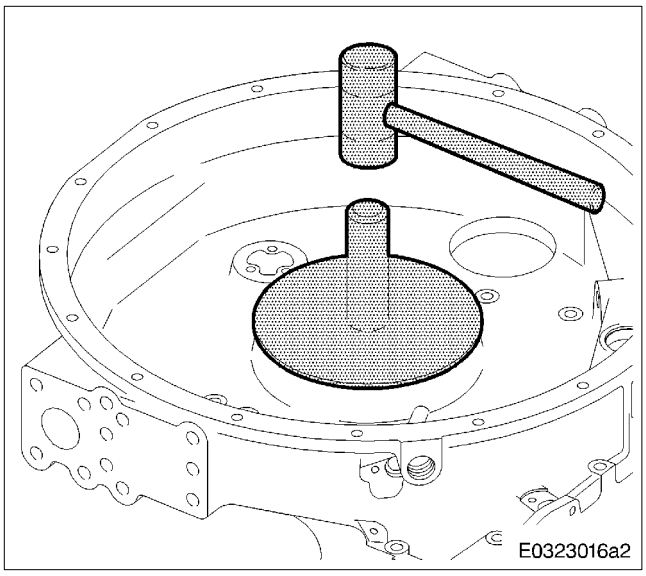


Installing radial-lip shaft seal into flywheel housing

Fit radial-lip shaft seal (1), with sealing lip facing outwards, on press-in plate (2).

Coat sealing face (arrow) of radial-lip oil seal with denaturated ethanol.

Note: Denaturated ethanol acts as lubricant for press-fitting.



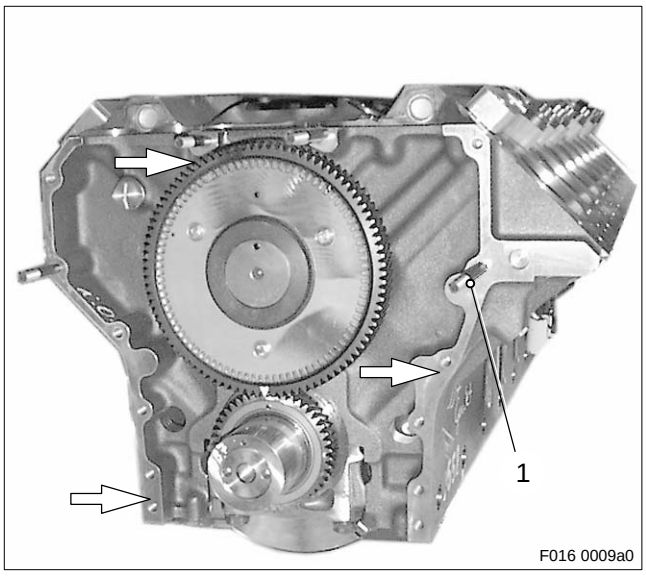
Clean and degrease sealing face for radial-lip oil seal in flywheel housing.

Use installation plate to drive radial-lip shaft seal flush in flywheel housing.

Note: If sealing ring running surface on flywheel is worn, drive in radial-lip shaft seal as far as it will go.

Complete flywheel housing as shown in overview drawing – see C 016.30.01.

C 016.30.11 Installation

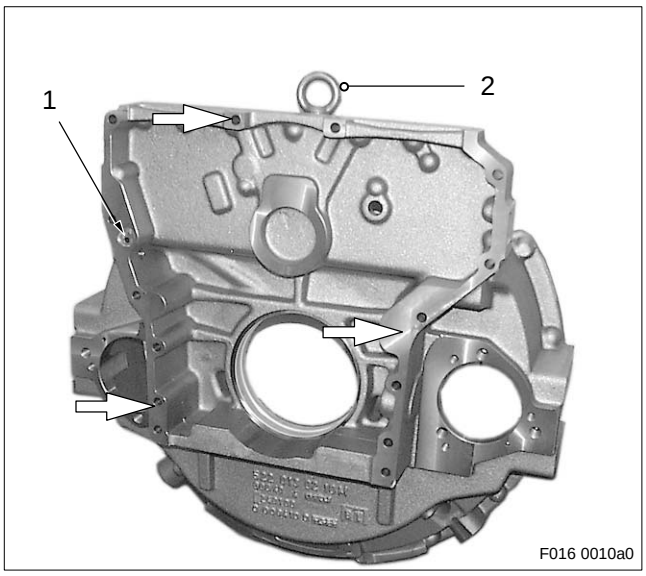


Installing flywheel housing

Note: Make sure that oil bores and oil chambers are perfectly clean.

Screw studs (1) into crankcase and tighten.

Clean and degrease mating face (see arrows) and coat with surface sealant.



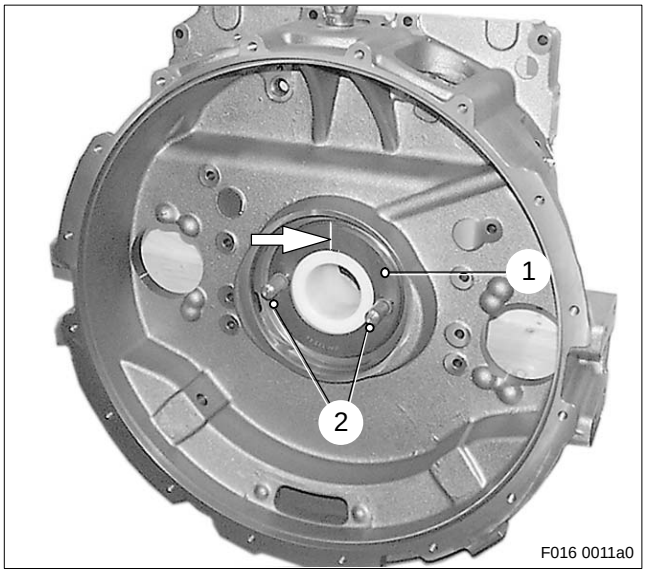
Clean and degrease mating face on flywheel housing (arrows).

Coat O-ring (1) with petroleum jelly and insert into countersink in flywheel housing.

⚠ WARNING

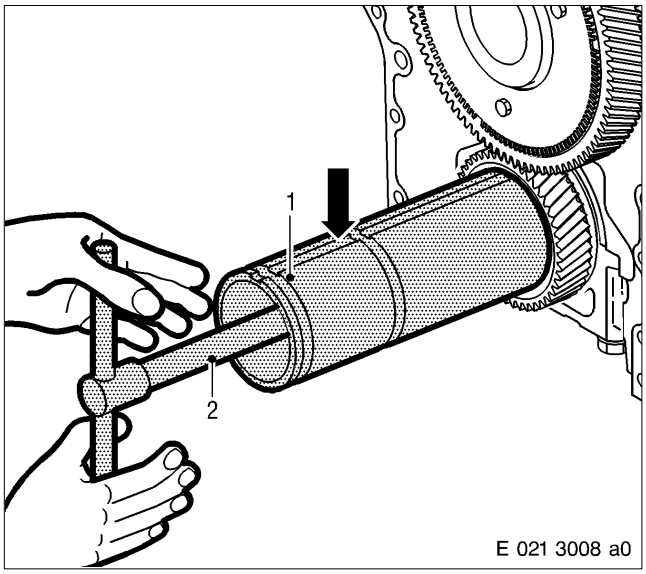
Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Attach flywheel housing with rope and crane to eyebolt (2).

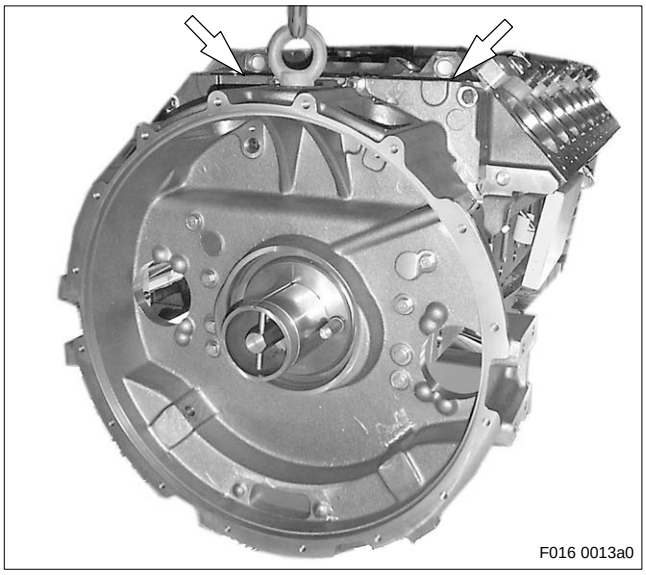


Insert centering ring (1) with marking (arrow) facing upwards into crankshaft bearing bore in flywheel housing.

Lock centering ring by turning locking pin (2) in crankshaft bearing bore.



Fit centering sleeve (1) with groove (arrow) facing upwards on crankshaft and attach with extension (2) and socket.



Move flywheel housing with crane carefully into position over centering sleeve (pin in groove) on crankcase.

Screw in two opposing hex nuts and tighten slightly.

Align flywheel housing with crankcase.

Measure height tolerance and slant on end plate flange surfaces (arrows) of flywheel housing and crankcase with bridge meter and dial gauge.

Max. height tolerance = ± 0.1 mm

Max. slant = ± 0.01 mm

The centering ring must not jam, i.e. it must be possible to turn.

Note: Pay attention to markings and note differing screw lengths and versions.

Install all hex screws, nuts and washers and tighten evenly.

Remove suspension rope and alignment jig.

Note: Ensure correct final strength of surface sealant, see C 020!

Measure axial play of camshaft, see C 051.05.11.

C 016.30.12 After-Installation Operations

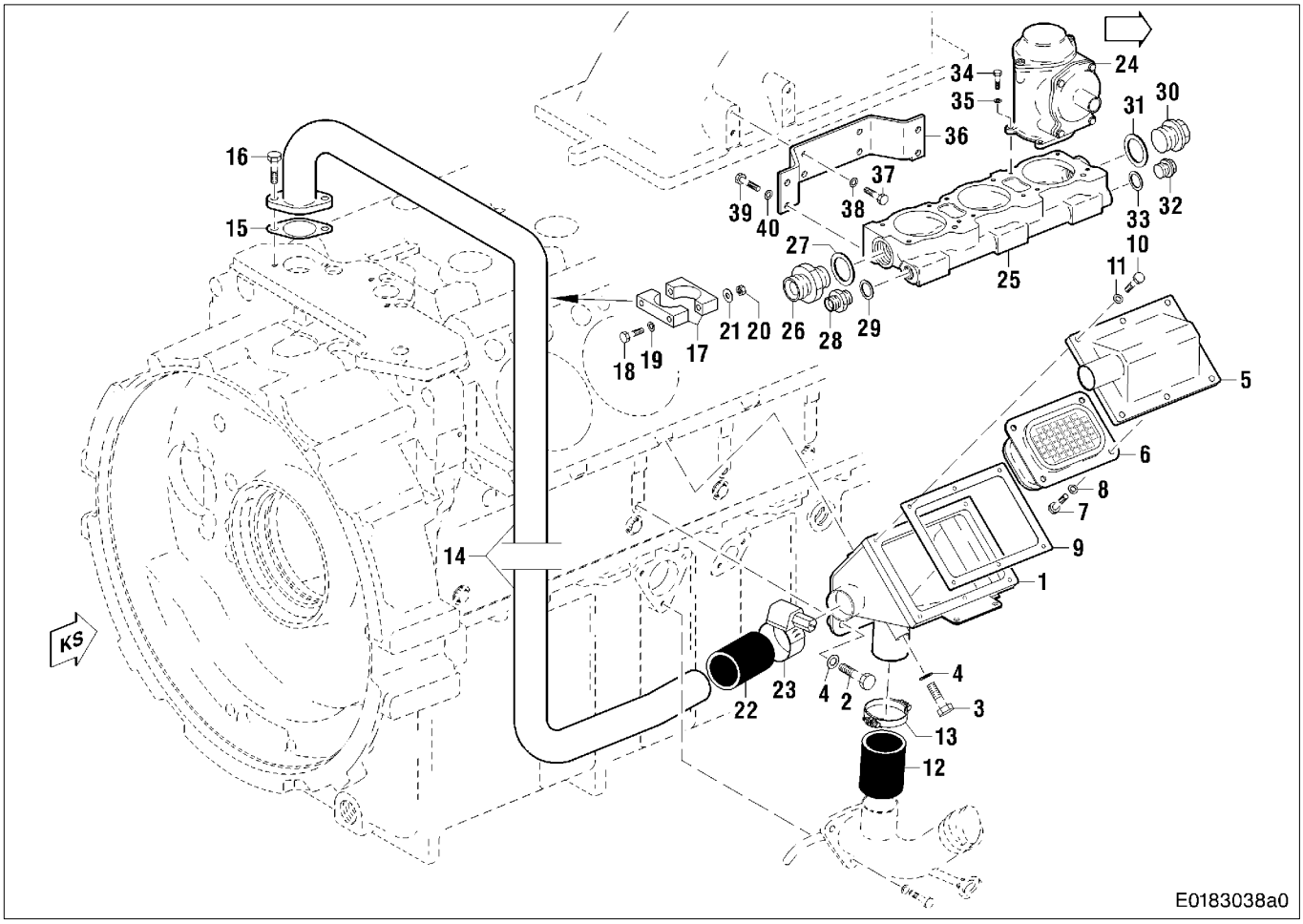
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install engine mount, driving end	C 231.05
–	x	x	Connect coolant lines	C 202.15
–	x	x	Install elbow, left engine side	C 123.05
–	x	x	Install air filter	C 121.05
–	x	x	Press on flywheel	C 032.05
–	x	x	Install oil pan	C 014.05
–	x	x	Install starter	C 172.05
–	x	x	Install speed sensor	C 507.10
–	x	x	Install coupling	Special Publication
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Connect engine to alternator	–
–	–	x	Release engine start	Operating Instructions

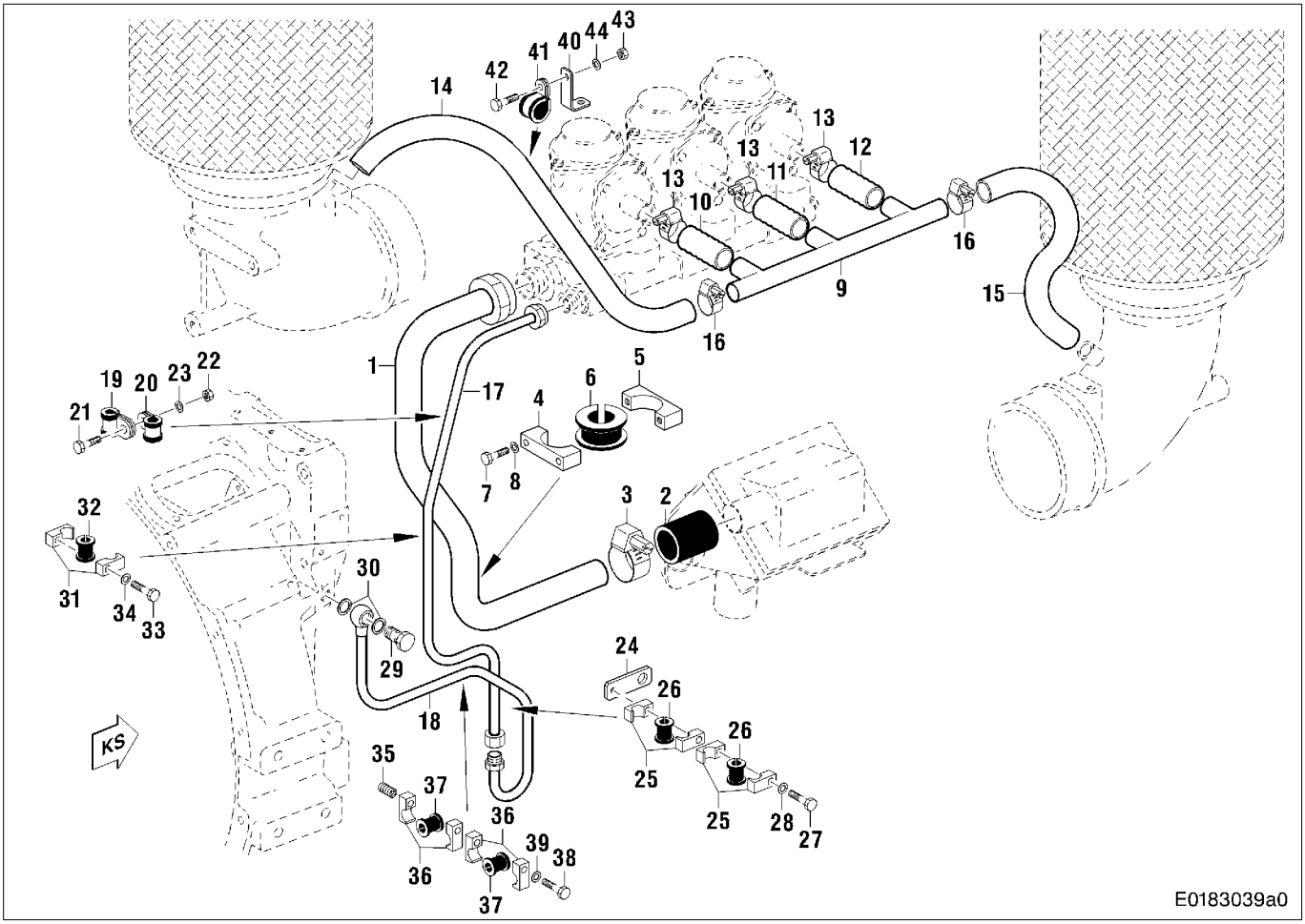
C 018.10 Crankcase Ventilation

C 018.10.01 Overview Drawing



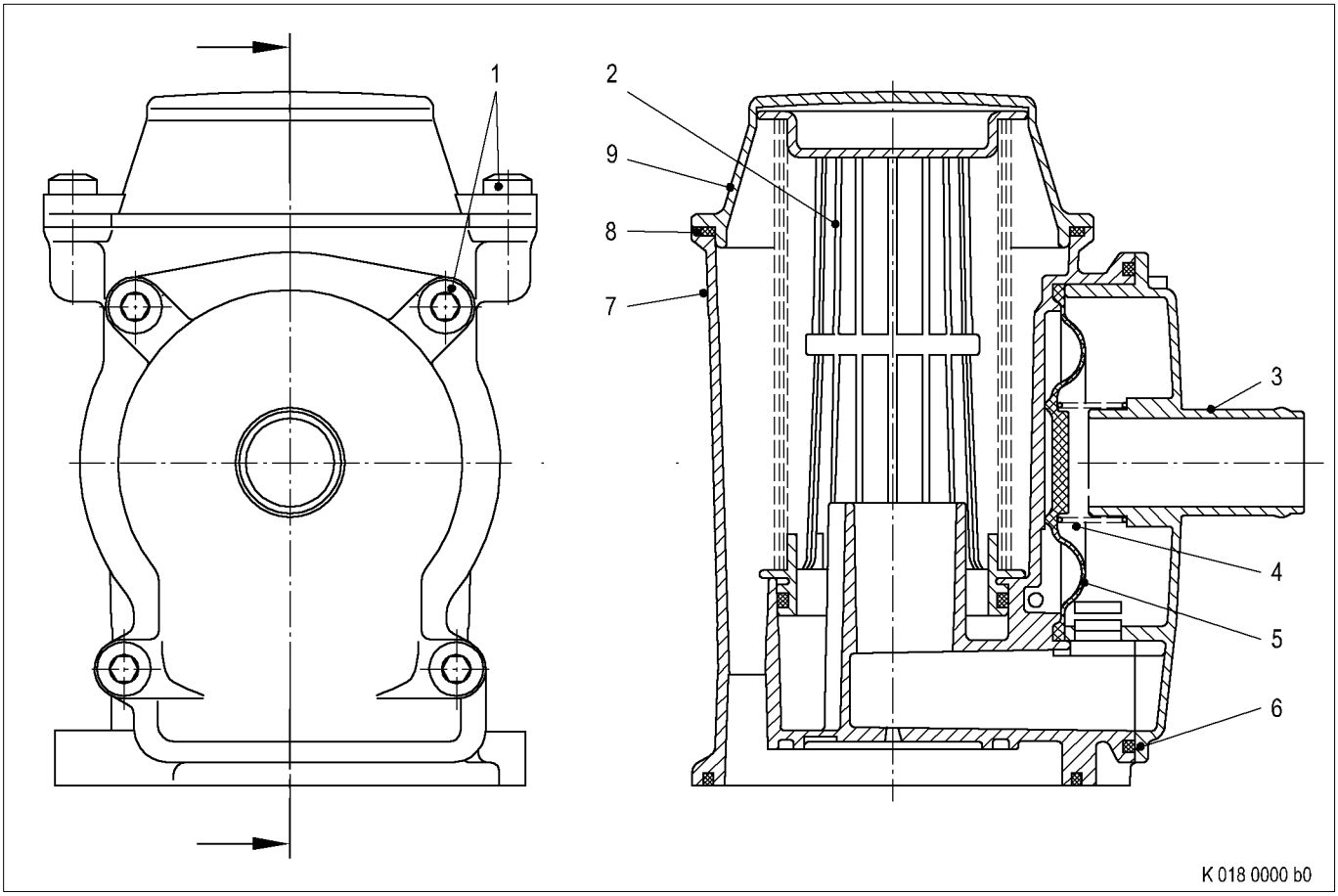
1	Housing	15	Gasket	28	Union
2	Hex screw	16	Hex screw	29	Sealing ring
3	Hex screw	17	Pipe clamp half	30	Plug
4	Washer	18	Hex screw	31	Hex screw
5	Cover	19	Washer	32	Sealing ring
6	Oil separator	20	Hex screw	33	Sealing ring
7	Hex screw	21	Washer	34	Hex screw
8	Washer	22	Rubber sleeve	35	Washer
9	Gasket	23	Clamp	36	Bracket
10	Hex screw	24	Oil separator	37	Hex screw
11	Washer	25	Carrier	38	Washer
12	Rubber sleeve	26	Reduction union	39	Hex screw
13	Clamp	27	Sealing ring	40	Washer
14	Vent line				

Crankcase ventilation



1 Vent line
2 Rubber sleeve
3 Clamp
4 Pipe clamp half
5 Pipe clamp half
6 Grommet
7 Hex screw
8 Washer
9 Vent line
10 Intake pipe
11 Intake pipe
12 Hex screw
13 Clamp
14 Intake pipe
15 Intake pipe
16 Clamp
17 Oil line, syphon
18 Oil line, syphon
19 Clamp
20 Clamp
21 Hex screw
22 Hex nut
23 Washer
24 Bracket
25 Pipe clamp half
26 Grommet
27 Hex screw
28 Washer
29 Banjo screw
30 Sealing ring
31 Pipe clamp half
32 Grommet
33 Hex screw
34 Washer
35 Thread insert
36 Pipe clamp half
37 Grommet
38 Clamp
39 Washer
40 Bracket
41 Clamp
42 Hex screw
43 Hex nut
44 Washer

Hengst oil mist separator



1 Screw
Lubricant: Engine oil
Tightening torque: 6 Nm + 2 Nm
2 Aerosol element
3 Cover
4 Spring
5 Diaphragm
6 O-ring
7 Oil separator housing
8 O-ring
9 Cover

C 018.10.02 Special Tools

Designation – Application	Part No.	Number
Tools from Tool Kits W4	F3 0378 864	1

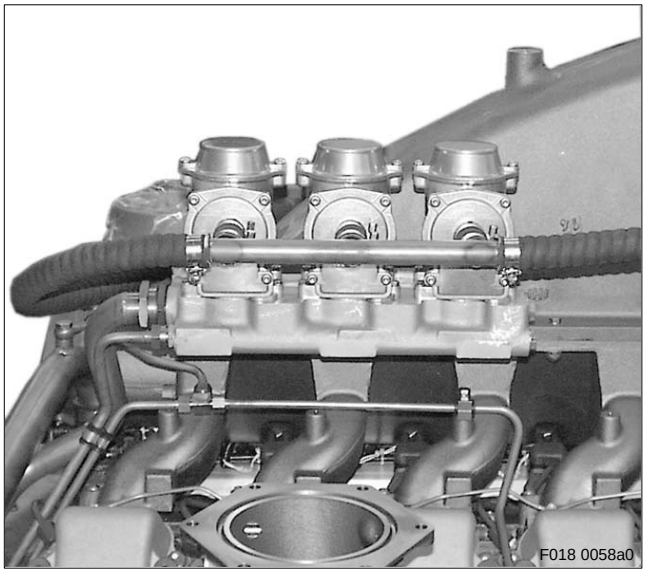
C 018.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 018.10.05 Removal



Removing Hengst oil separator

Note: Do not damage oil separator when removing. Slight irregularities, e.g. indented cover, can result in oil separator failure.

Release clamps and remove intake hoses.

Remove oil separator as per overview drawing – see C 018.10.01.

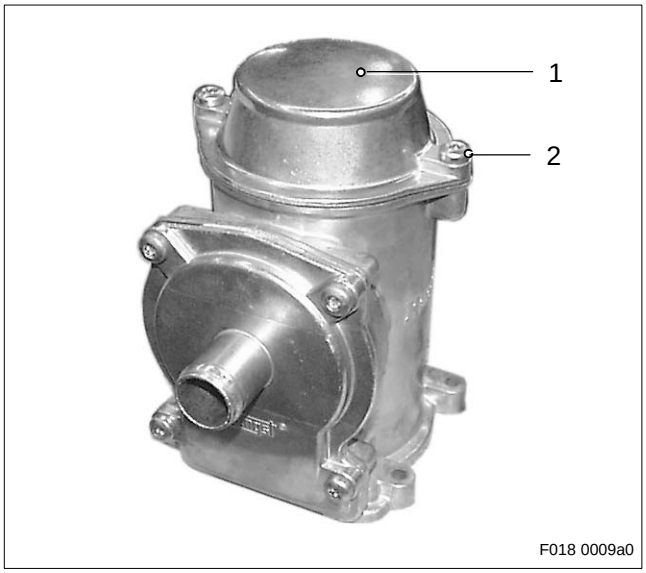
After removal, seal all connections with suitable plugs.

Removing pipes and preseparator

Remove pipelines and preseparator as shown in overall drawing – see C 018.10.01.

After removal, seal all connections with suitable plugs.

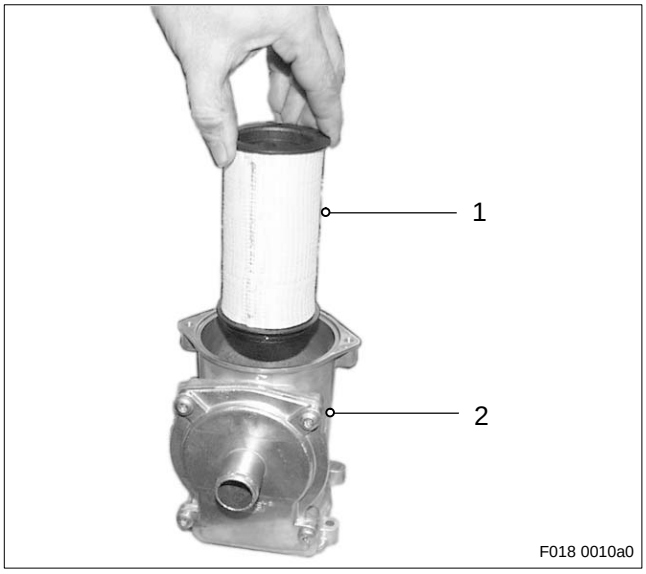
C 018.10.06 Disassembly



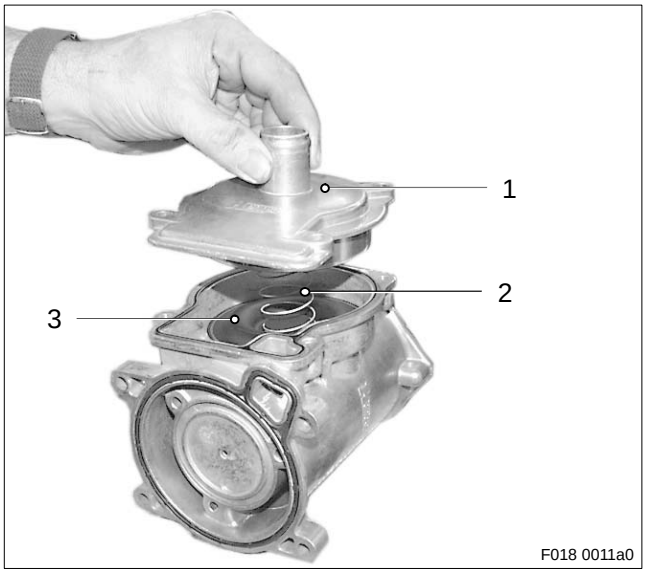
Disassembling Hengst oil separator

Remove securing screws (2) for cover (1) with screwdriver (Torx 30).

Remove cover and O-ring.



Remove aerosol element (1) from oil separator housing (2).



Remove securing screws for cover (1).

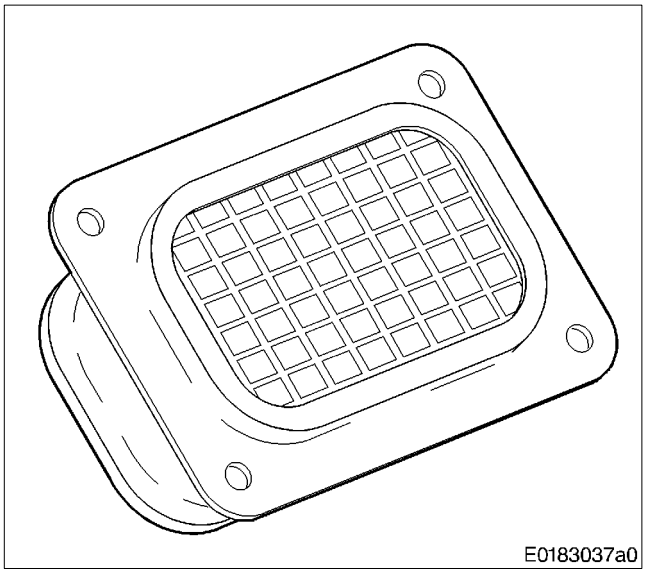
Remove cover, spring (2) and O-ring.

Remove diaphragm (3) from oil separator housing.

C 018.10.08 Inspection and Repair

Note: Make sure that air-carrying and oil-carrying components are perfectly clean.

Clean all parts.



⚠ WARNING

Fuels and fuel vapours are flammable and poisonous.
Risk of fire, explosions and poisoning!
When using fuel:
– No open flame
– No electric sparks
– Do not smoke
– Do not spill fuel
– Do not inhale
Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Wash out oil separator (wire mesh) in diesel fuel.

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar.

Blow out insert with compressed air.

Visually inspect components for damage and wear; replace components as necessary.

In event of oil separator filter section (Hengst oil separator) being clogged up with tough, sticky oil sludge, replace aerosol element.

Check sealing and mating faces for damage and defects; rub down with an oilstone or replace parts if necessary.

If necessary, check preseparator housing for leaks with air under water with corrosion inhibitor.

⚠ WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Air test pressure: 0.5 bar

Water temperature min. 30 °C, max. 40 °C.

Check condition of threads; rechase threads if necessary or replace threaded inserts if necessary.

Replace O-rings, gasket and sealing rings at every assembly.

Replace insert and diaphragm (Hengst oil separator), intake hoses, grommets, rubber sleeves and clamps during W 6 maintenance.

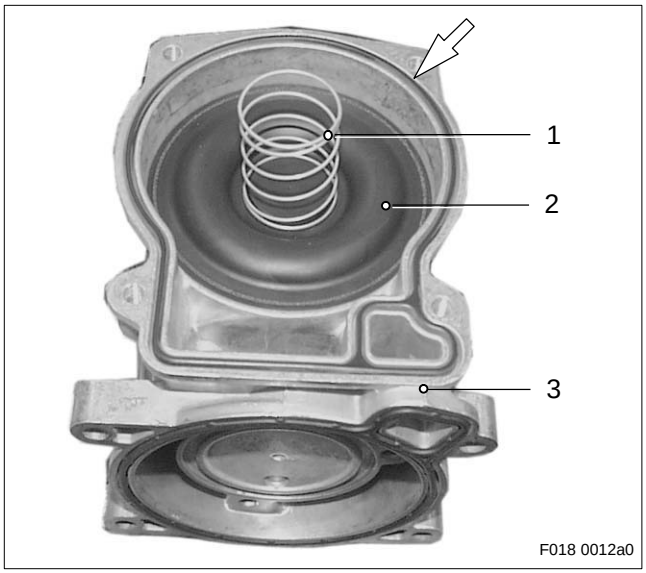
Checking Hengst oil separator

Hydraulically test oil separator with air (0.2 bar) in water bath and/or check diaphragm for leaks.

Replace diaphragm if leaking.

Note: Oil separator pressure control can only be checked when installed with engine in operation. Vacuum or overpressure is measured (e.g. with water manometer) over entire engine speed range. Values should lie between minus 10 mbar and plus 10 mbar (100 mm water column).

C 018.10.10 Assembly

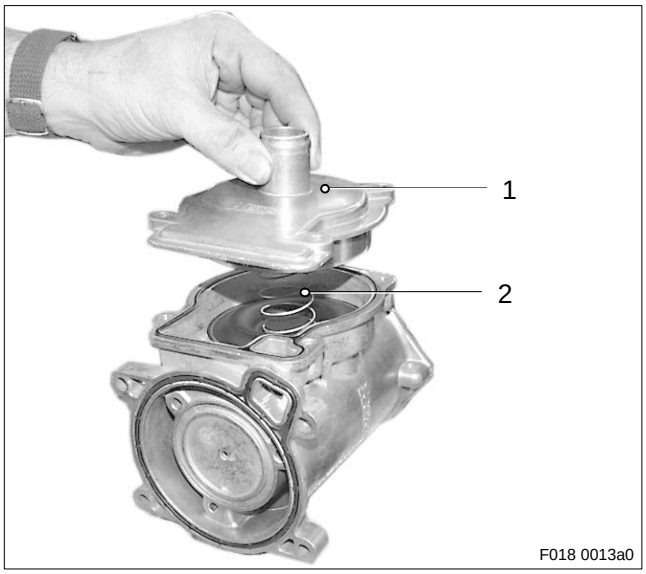


Assembling Hengst oil separator

Coat O-ring (arrow) with petroleum jelly and insert into groove in oil separator housing (3).

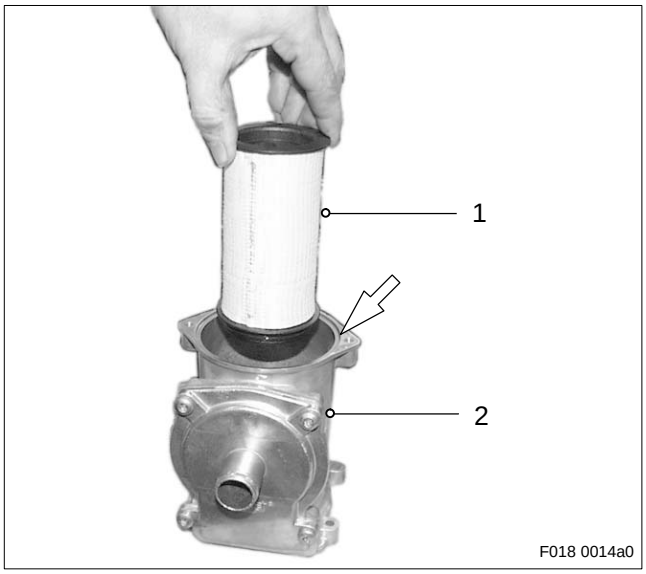
Insert diaphragm (2) (curve upwards) into oil separator housing, ensuring it is correctly positioned.

Fit spring (1) on diaphragm, ensuring it is correctly seated.



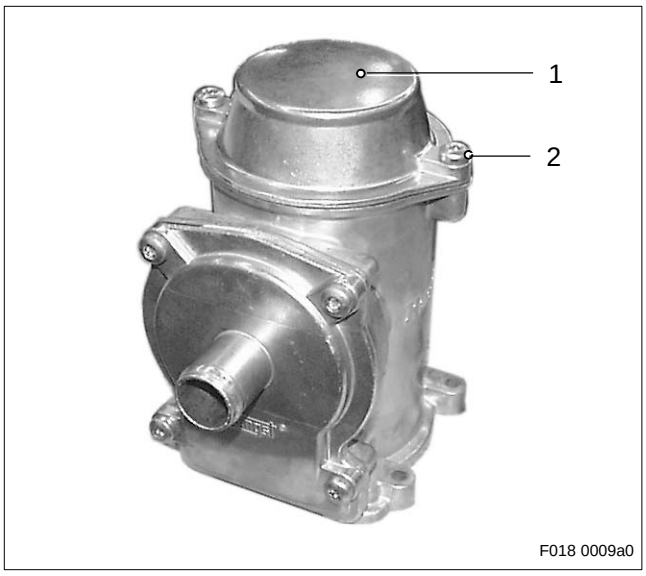
Fit cover (1) on spring (2), ensuring it is correctly positioned and that spring is correctly seated on cover.

Use screwdriver (Torx 30) to fit screws and tighten diagonally to specified tightening torque – see overview drawing C 018.10.01.



Coat O-ring with petroleum jelly and insert into groove (arrow) in oil separator housing (2).

Insert Aerosol element (1) into oil separator housing, ensuring it is correctly positioned.



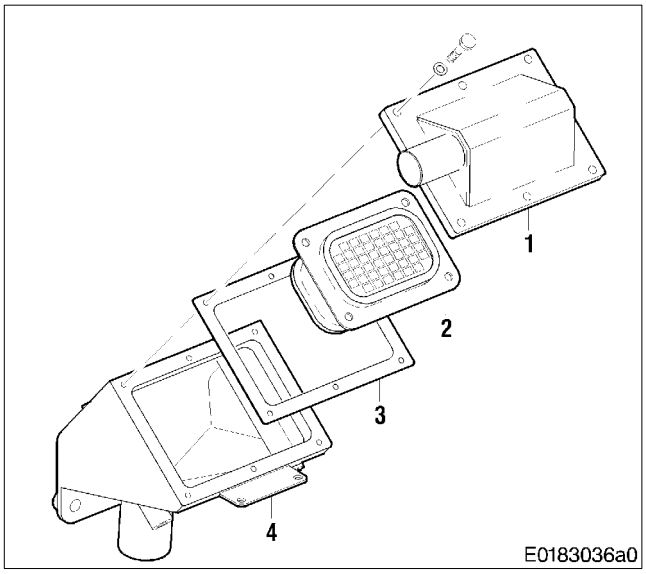
Fit cover (1) on housing and fit screws (2) with screwdriver (Torx 30).

Tighten screws to specified tightening torque – see overview drawing in C 018.10.01.

Check oil separator for leaks – see C 018.10.08 Inspection and Repair.

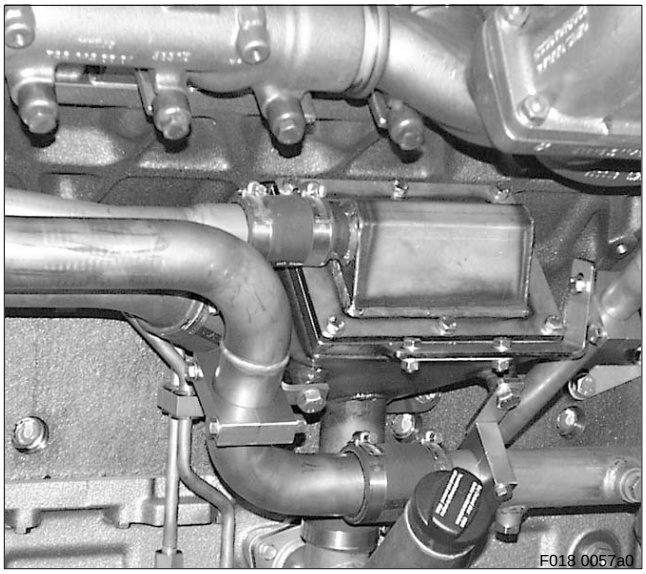
C 018.10.11 Installation

Note: Prior to installation, remove all blanking plugs and ensure oil- and air-carrying components are perfectly clean.



Installing pipes and preseparator

Complete housing (4) of preseparator with new gasket (3), oil separator (2) and cover (1).



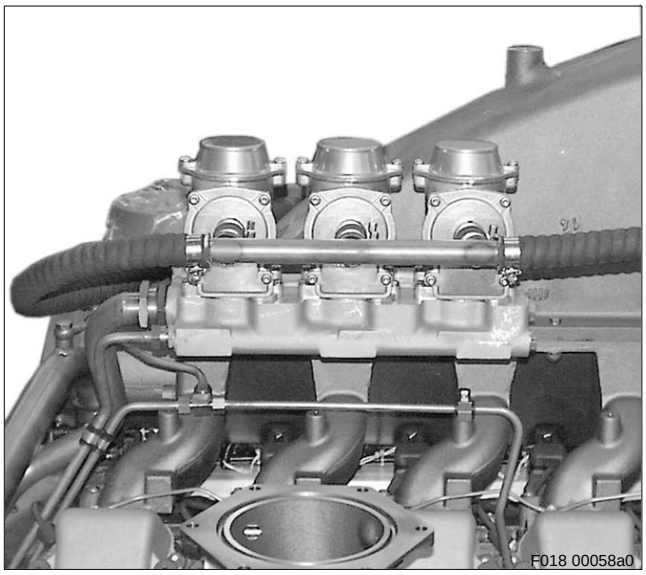
Install preseparator on right engine side – see also overview drawing C 018.10.01.

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar.

Before installation, blow pipes clear with compressed air and make sure that they are completely clean.

Install pipes with fixtures in accordance with overview drawing, ensuring they are tension-free.



Installing Hengst oil separator

Check sealing surfaces, clean if necessary.

Before installing, coat O-ring with petroleum jelly.

Install oil separator in accordance with illustration – see also overview drawing C 018.10.01.

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar.

Before installation, blow out oil intake hoses with compressed air and make sure all components are perfectly clean.

Install intake hoses with fixtures, ensuring they are free of tension, as shown in overview drawing.

C 018.10.12 After-Installation Operations

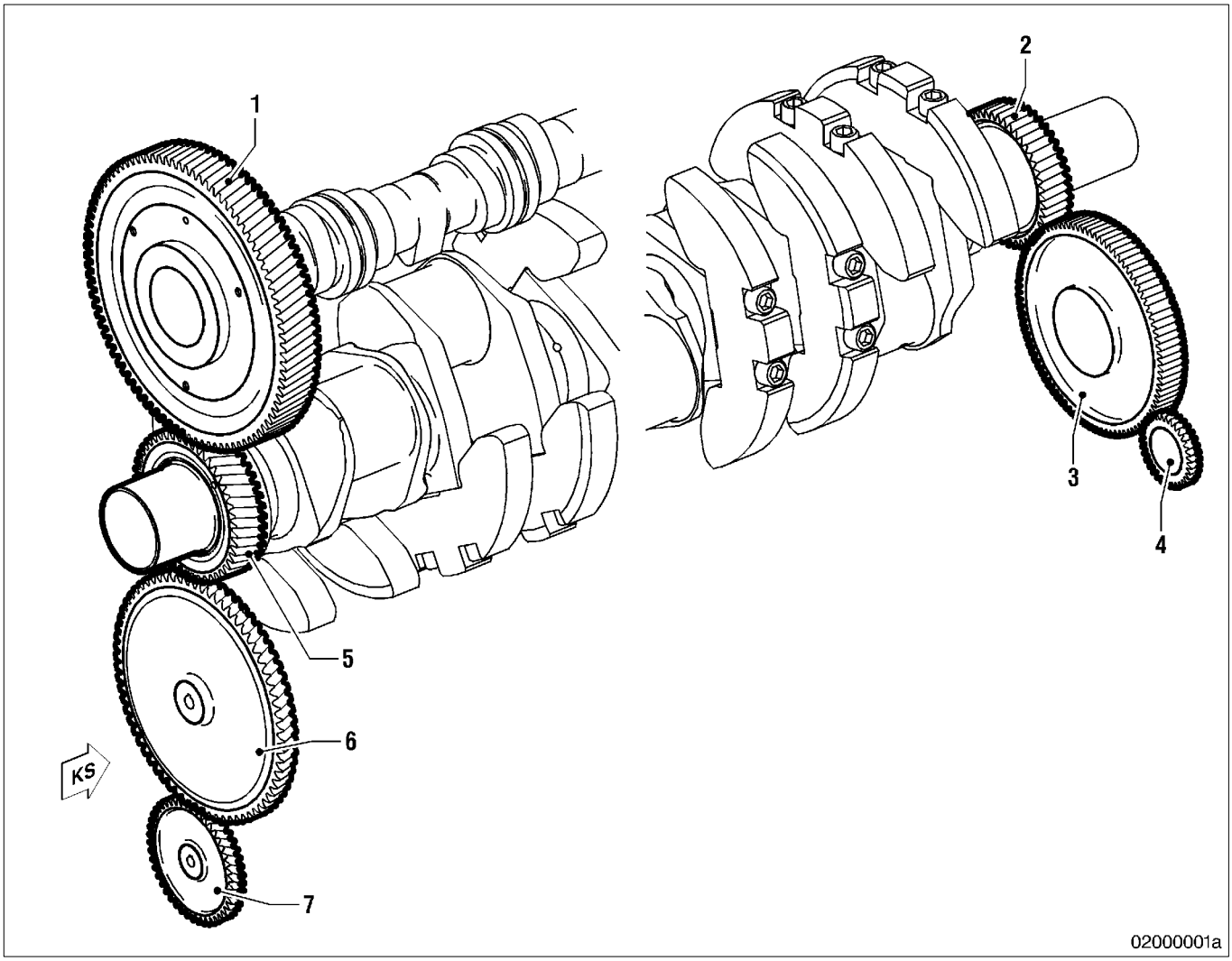
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 020 Gear Train



		Tooth backlash (mm)	Axial clearance (mm)
1	Camshaft gear	from 0.068 to 0.172 for gear 5	from 0.20 to 0.55
2	Crankshaft gear, free end	–	from 0.15 to 0.30
3	Idler gear	from 0.227 to 0.507 for gear 2	from 0.05 to 0.95
4	Drive gear (engine coolant pump)	from 0.088 to 0.302 for gear 3	–
5	Crankshaft gear, drive end	–	from 0.15 to 0.35
6	Drive gear (oil pump)	from 0.070 to 0.310 for gear 5	–
7	Drive gear (oil pump)	from 0.151 to 0.300 for gear 6	–

The following is a list of auxiliary equipment and materials needed for the assembly operations:

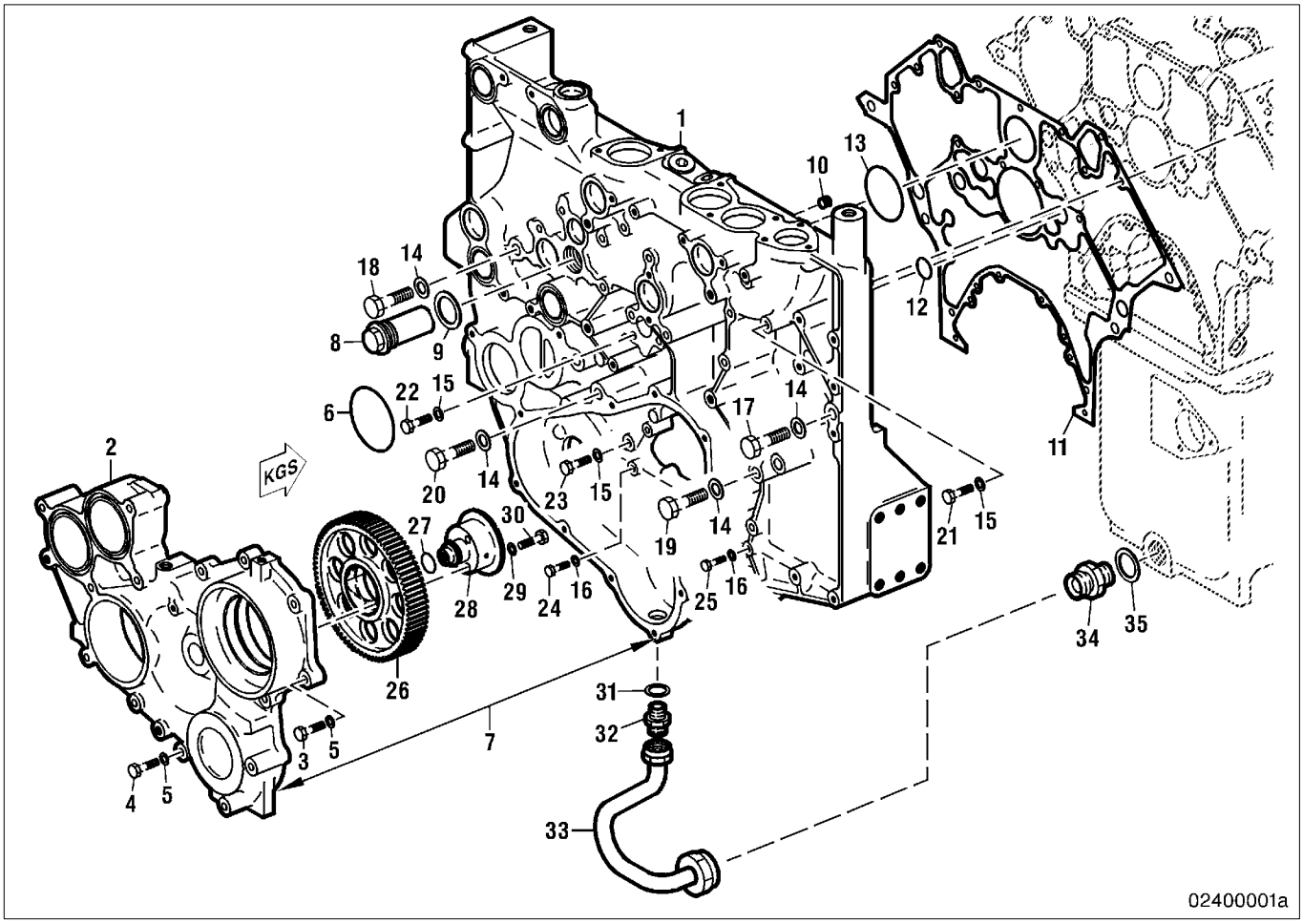
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Bottle brush			
Magnifier			
Liquid nitrogen			
Vaseline	Petroleum jelly, white	40317	
Corrosion inhibitor	Caramba Express	40008	
Thread-locking compound	Loctite No. 270	40083	Final strength at 20 °C ≈ 12 h
Surface sealant	Loctite No. 573	40031	Final strength ≈ 48 h
Multipurpose grease	Shell Retinax	40333	
Engine oil			
Cleaning agent	Solvclean KW	40022	
Kerosene or diesel fuel			
Sealing paste	Elastosil N 189	50545	
Denaturated ethanol		40250	
Engineer's blue	blue	40641	
Dry compressed air			
Magnetic crack-testing equipment with fluorescent magnetic powder			
Surface crack-testing equipment with red penetrant dye			

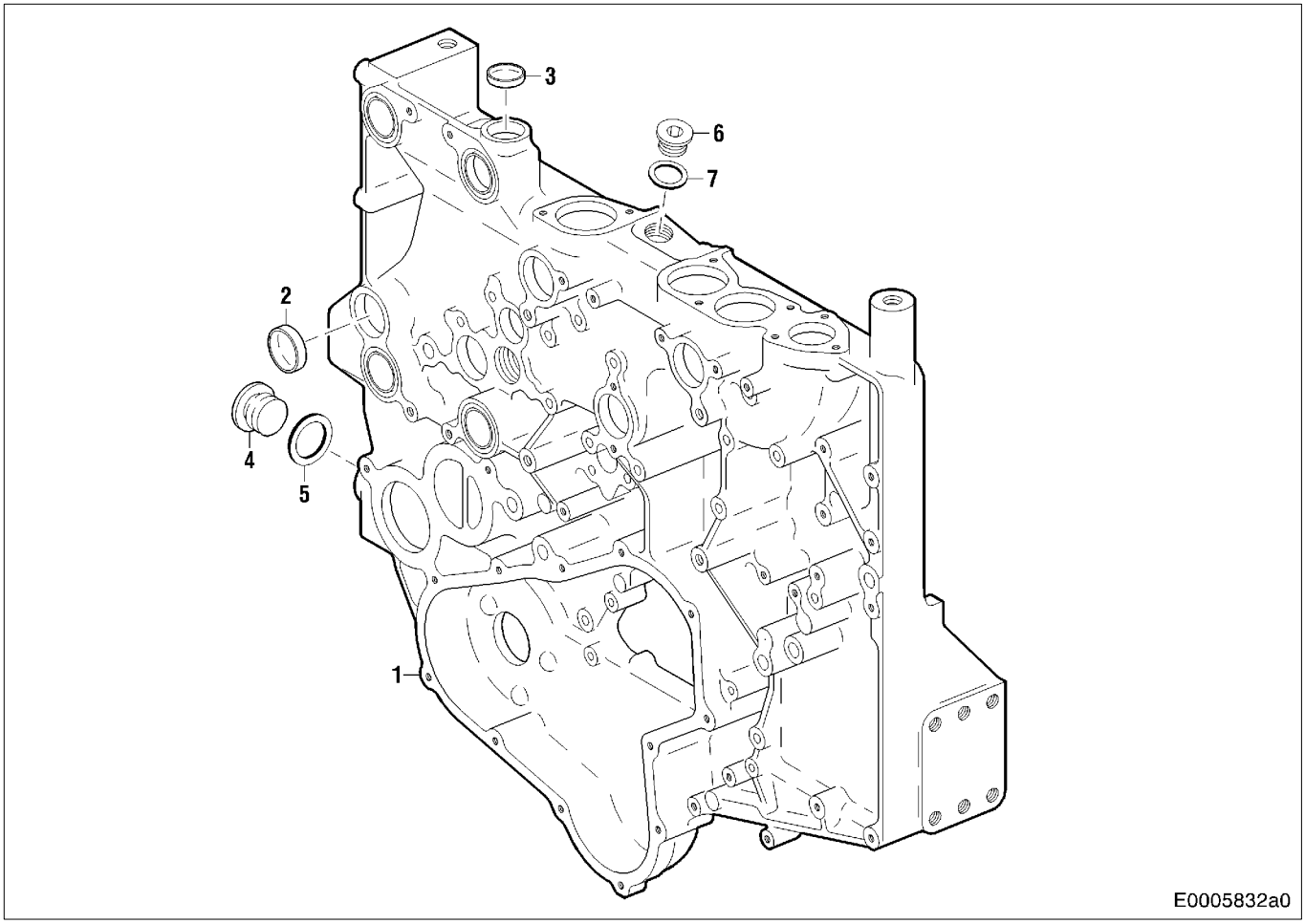
C 024.05 Gear Case, Free End

C 024.05.01 Overview Drawing



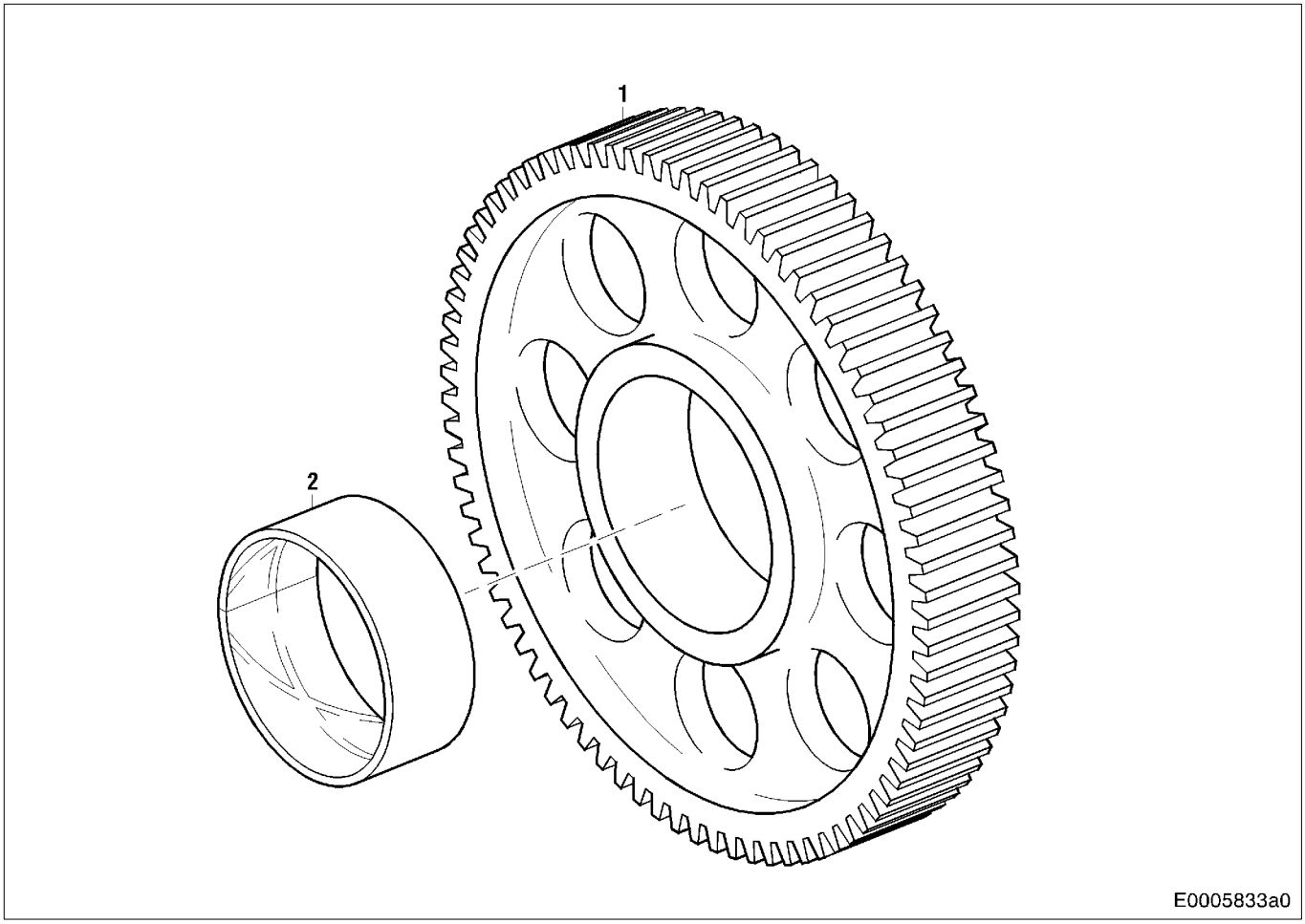
1	Gear case	13	O-ring	25	Hex screw
2	Gear case cover	14	Washer	26	Idler gear
3	Hex screw	15	Washer	27	Ring
4	Hex screw	16	Washer	28	Hub
5	Washer	17	Hex screw	29	Washer
6	O-ring	18	Hex screw	30	Hex screw
7	Surface sealant	19	Hex screw	31	Sealing ring
8	Plug	20	Hex screw	32	Union
9	Sealing ring	21	Hex screw	33	Oil return line
10	– not applicable –	22	Hex screw	34	Union
11	Gasket	23	Hex screw	35	Sealing ring
12	O-ring	24	Hex screw		

Gear case



1 Gear case
2 End cover
3 End cover
4 Plug
5 Sealing ring
6 Plug
7 Sealing ring

Idler gear



1 Gear
2 Bearing bush

C 024.05.02 Special Tools

Designation – Application	Number
Alignment tool for gear case cover	1
Press-in device for shaft seal	1
Guide pin for gear case	4
Mandrel for end cover	2

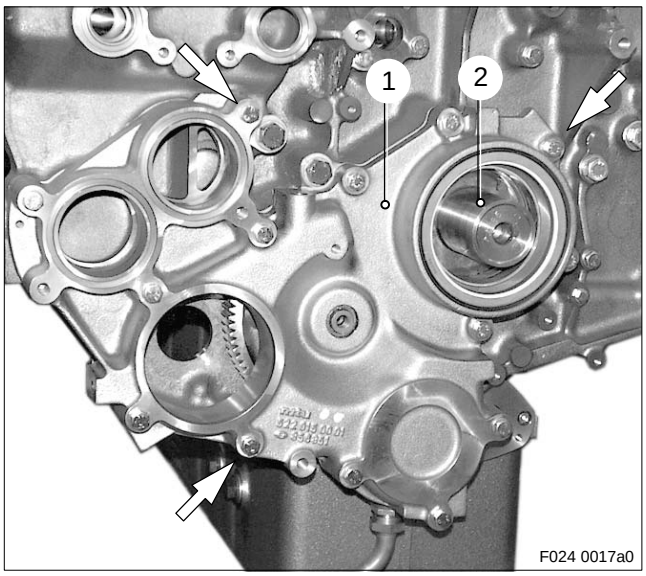
C 024.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Disconnect fuel lines	C 082.05
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove fuel delivery pump and fuel hand pump	C 081.05
–	x	x	Remove fuel duplex filter	C 083.05
–	x	x	Remove fan drive	C 221.05
–	x	x	Remove generator	C 213.05
–	x	x	Remove belt pulley	C 213.05/221.05
–	x	x	Remove coolant lines	C 202.15
–	x	x	Disconnect vent lines	C 202.55
–	x	x	Remove engine coolant pump	C 202.05
–	x	x	Remove vibration damper	C 035.05
–	x	x	Remove oil lines	C 181.20
–	x	x	Remove oil heat exchanger	C 183.15
–	x	x	Lower or remove oil pan	C 014.05
–	x	x	Remove thermostat housing	C 206.05
–	–	x	Release foundation screw	C 231.05
–	x	x	Attach engine to lifting device	–
–	x	x	Remove engine mounting, free end	C 231.05

C 024.05.05 Removal



Removing gear case cover

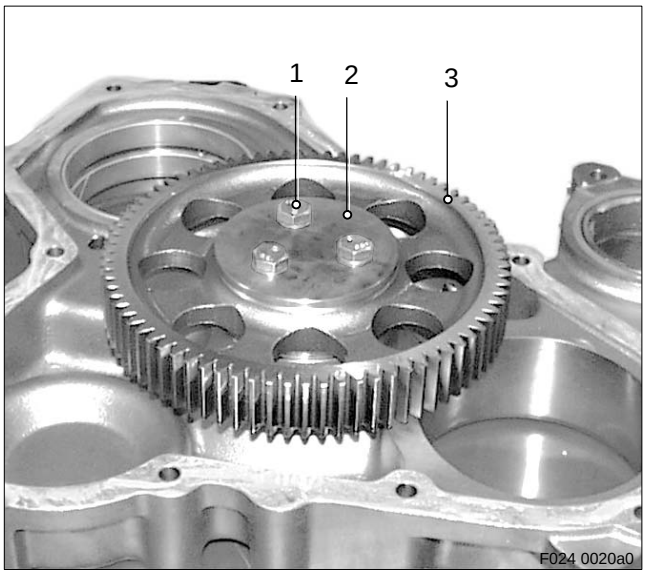
Remove oil return line as per overview drawing – see C 024.05.01.

Mark all securing screws around cover circumference (arrows) (differing lengths, versions) and remove as per overview drawing – see C 024.05.01.

In order to prevent damage to the sleeve bearing and crankshaft journal (2), secure gear case cover (1) against falling.

Carefully press off gear case cover from gear case using assembly lever.

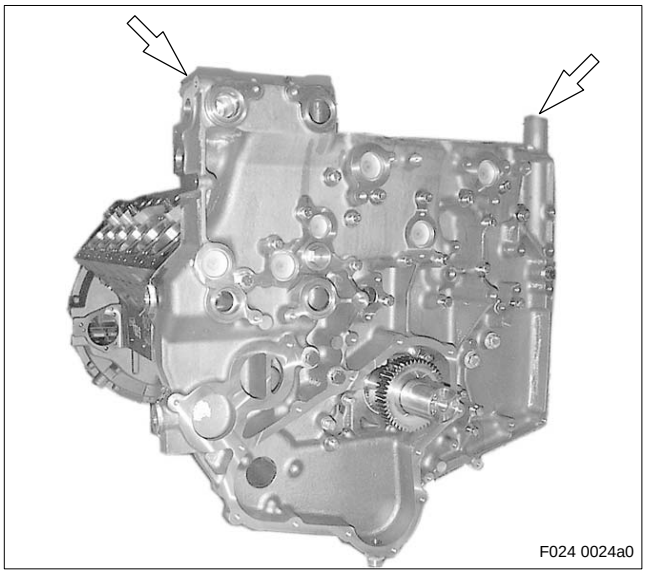
If necessary, use a suitable mandrel and hammer to remove shaft seal from gear case cover.



Removing idler gear and hub

Remove hex screws (1) and pull hub (2) with idler gear (3) from gear case.

Remove O-rings from hub.



Removing gear case

⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Screw two lifting eyes (arrows) in gear case.

Attach gear case to crane with ropes and tension ropes equally.

Mark securing screws for gear case (differing lengths, versions) and remove.

Carefully push gear case, with the ropes pretensioned, in direction of free end until it is freed from crankcase.

Remove gasket and O-rings.

C 024.05.08 Inspection and Repair

Clean all parts.

Thoroughly clean oil bores and oil chambers in gear case and gear case cover and ensure the components are perfectly clean.

Using the magnetic crack-testing method with fluorescent magnetic powder, check gear case, idler gear and gear case cover for cracks; if cracks are present, replace affected component.

Check crankshaft bearing for wear, scoring and marks; replace gear case cover if necessary.

Check condition of threads in gear case and gear case cover, rechase if necessary.

Using a magnifying glass, check the surface condition of the idler gear tooth flanks, replace idler gear if necessary.

Check running surface of hub, bearing bush in idler gear and axial friction face of idler gear for wear and scores.

Remove minor scoring and wear by rubbing down with emery cloth or oilstone; replace component if necessary.

Using micrometer, measure outside diameter of hub at gear running surface.

For limit values, see Tolerance and Wear Limits List.

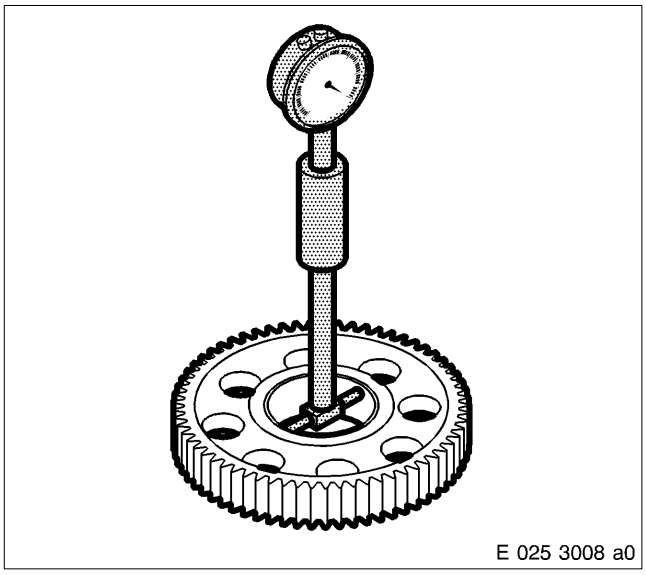
Replace hub if specified limits are exceeded.

Check all mating and sealing faces and fits. Rub down with oilstone or emery cloth as necessary.

Replace gasket, sealing rings and O-rings at every assembly.

Check screws for damage and check condition of threads; replace screws if necessary.

Thoroughly clean all hub oilways; make sure oilways are perfectly clean.


E 025 3008 a0

Measuring bearing bush bore or basic bore in idler gear

Note: Replace bearing bush during W6 maintenance.

Set bore gauge to basic size of bearing bush bore in idler gear.

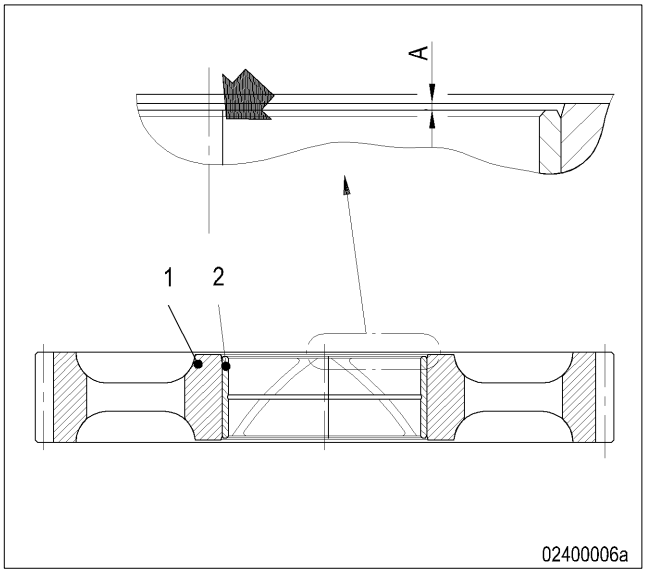
Measure diameter of bore.

For limit values, see Tolerance and Wear Limits List.

Replace bearing bush if limit values are exceeded.

After removing bearing bush, measure main bore in gear.

If limit values are exceeded, replace gear.



Replacing bearing bush in idler gear

Using manual press and suitable mandrel, press bearing bush (2) out of gear (1).

Measure basic bore in gear – see Measuring bearing bush bore or basic bore idler gear.

Clean and degrease gear bore and bearing bush.

⚠ CAUTION

Nitrogen is liquid at –200 °C.
Danger of freezing and suffocation!
Do not allow liquid nitrogen to come into contact with parts of body (eyes, hands).
Wear protective clothing (including gloves and closed shoes) and goggles.
Ventilate working area well.

Chill bush in liquid nitrogen.

⚠ CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.

Heat gear to 80 °C.

Use installation mandrel to press-fit new bearing bush into gear.

Select position of gap (arrow) as required.

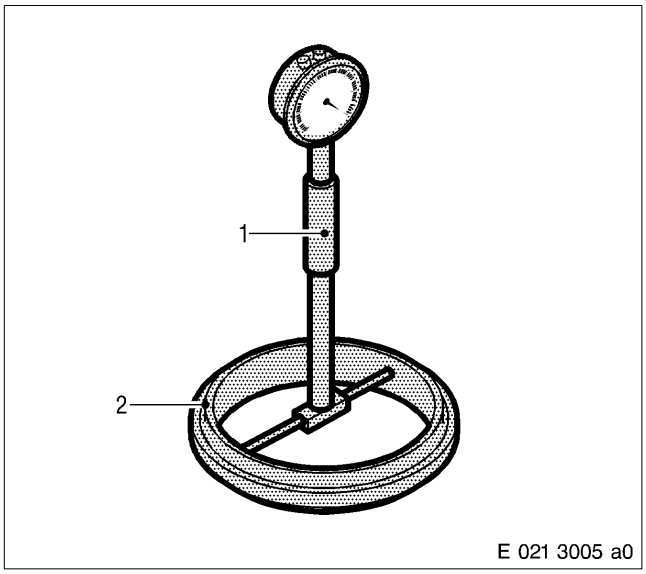
Check recess A of bearing bush in gear.

Permissible Recess A = 0.75 mm $\pm$ 0.2 mm

Finish-machine bearing bush on a lathe to finished dimension.

Note: Clamp evenly all around teeth!

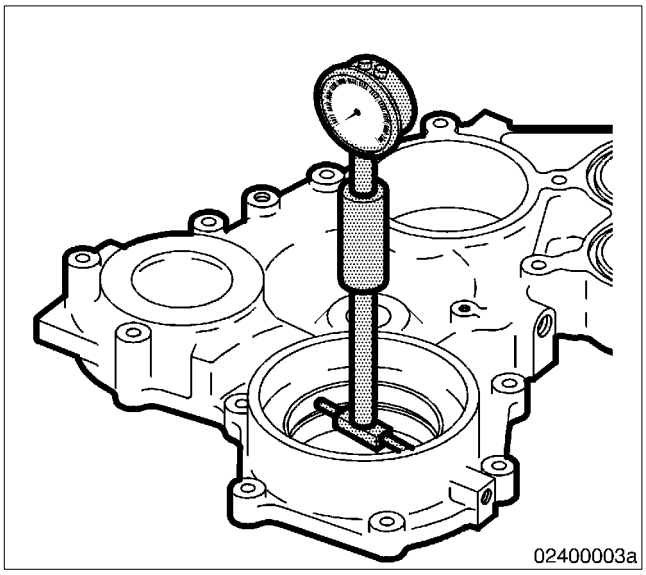
For dimensions and surface quality, see Tolerance and Wear Limits List.



Measuring crankcase bearing bore in gear case cover

Note: Replace crankshaft bearing as part of every W6 overhaul.

Adjust bore gauge (1) and dial gauge with micrometer or gauge ring (2) to basic size for crankshaft bearing bore as per Tolerance and Wear Limits List.



Measure diameter of crankshaft bearing bore with bore gauge.

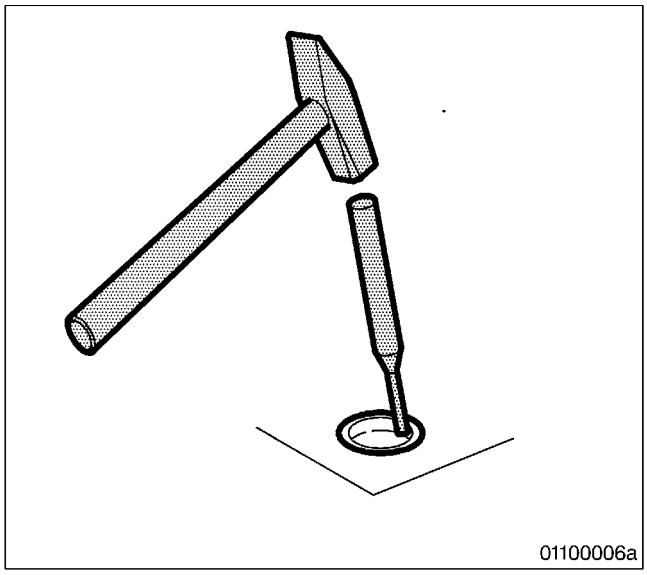
Enter measurement values in data sheet.

For measuring points and limit values, see Tolerance and Wear Limits List.

Replace crankshaft bearing if limit values are exceeded.

After removing main bearing, measure main bore in gear case cover.

If wear limits are exceeded, replace gear case cover.



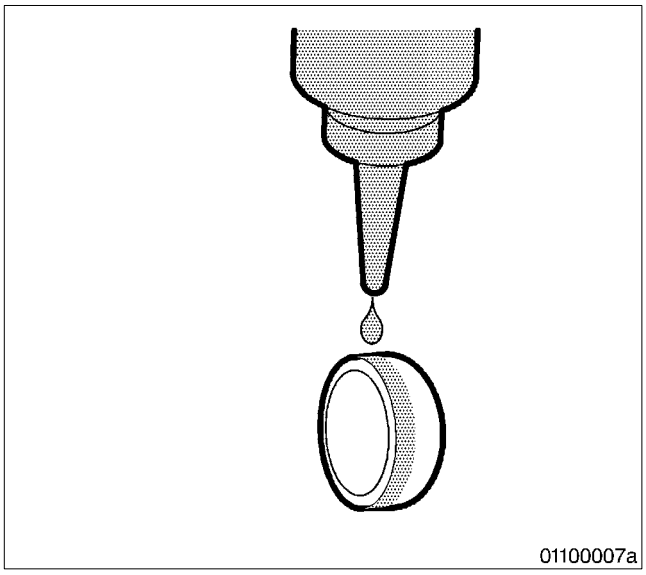
Replacing end cover

Note: Replace end cover only if necessary (e.g. in event of leakages).

Using a mandrel (1) and hammer, carefully tap cover into bore at one side until it tilts. Use pliers to remove cover from bore.

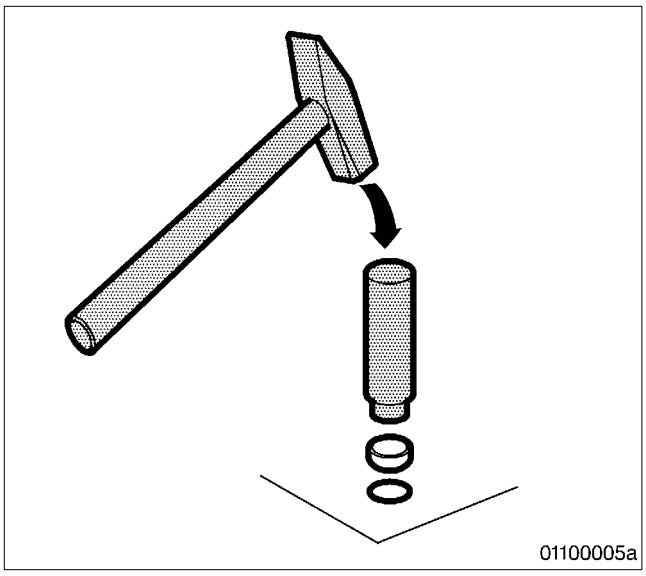
When removing, take care that the cover does not fall into the bore and that the sealing face of the bore is not damaged.

Never attempt to drill a hole in cover, as chips of metal in engine cooling jacket can cause localized overheating.



Clean and degrease seating faces of cover and bore gear case.

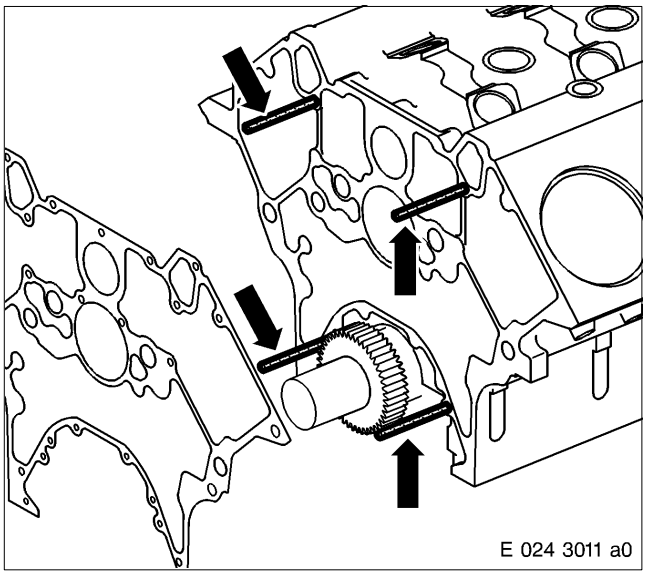
Coat seating face of cover with thread locking compound.



Using mandrel and hammer, drive cover into bore.

Note: Final strength of thread-locking agent at 20 °C after ≈ 12 h!

C 024.05.11 Installation



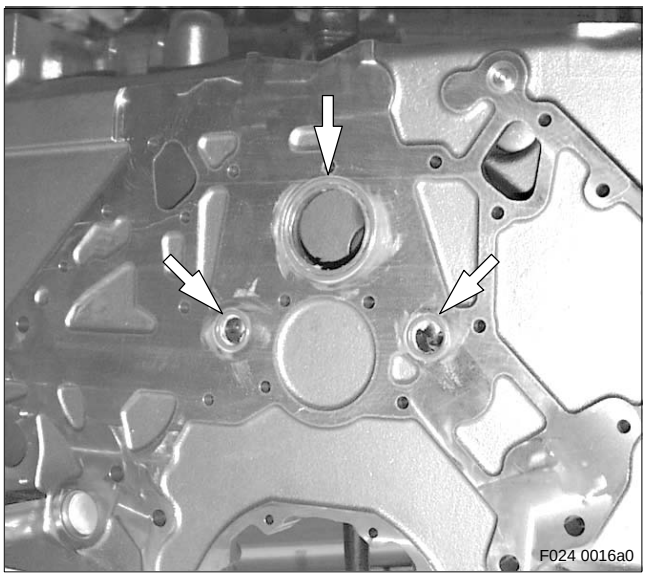
Install gear case

Clean mating face on crankcase and gear case, free end.

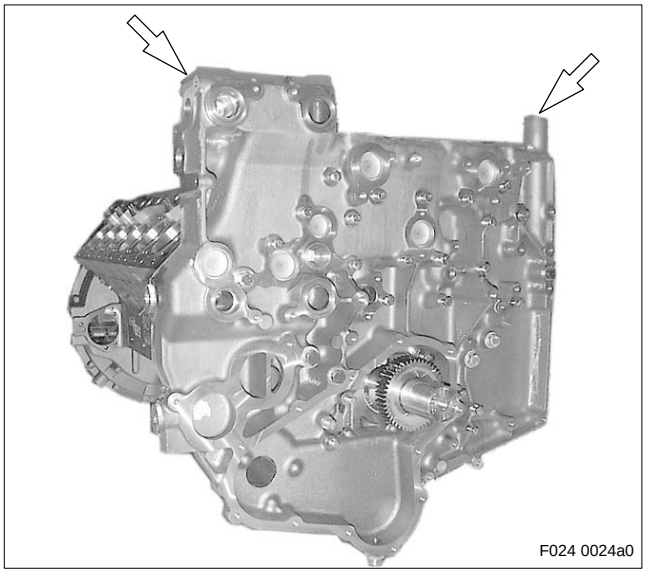
For positioning the gaskets, apply a thin, dotted coat of sealing paste to the mating surfaces of the crankcase.

Insert guide pins (arrows) into crankcase.

Place new gasket on top of the guide pins.



Coat O-rings (arrows) with petroleum jelly and insert in grooves on gear case.



⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

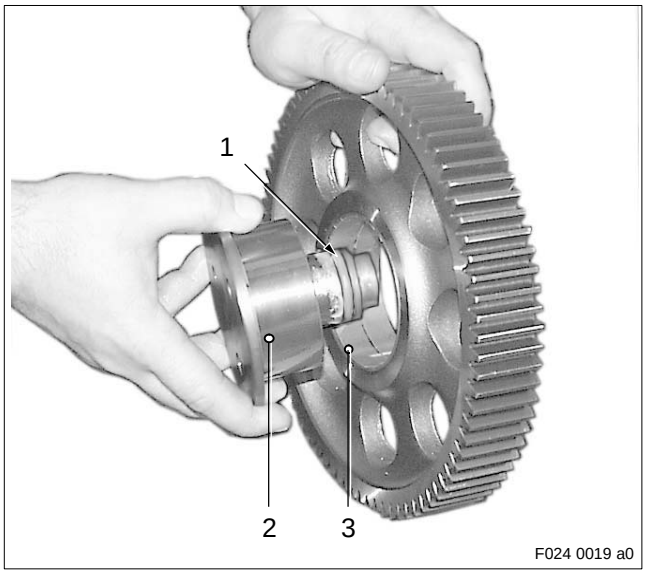
Screw two lifting eyes (arrows) into gear case and secure to crane with rope.

Carefully move gear case with crane via guide pins on crankcase.

Remove lifting ropes and eyes.

Note: Pay attention to markings and differing screw lengths – see overview drawing C 024.05.01.

Install all securing screws and tighten uniformly.



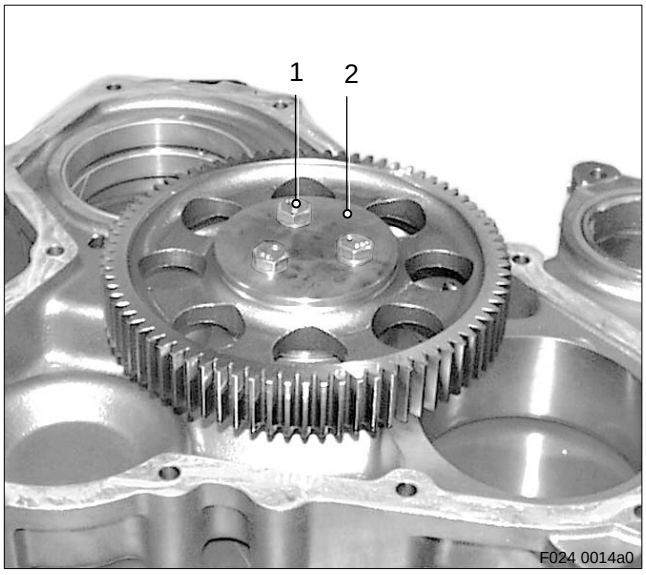
Installing idler gear in gear case cover

Note: Make sure all components are perfectly clean.

Coat hub (2) and bearing bush (3) in idler gear with engine oil.

Coat O-ring (1) with petroleum jelly and insert into groove on hub.

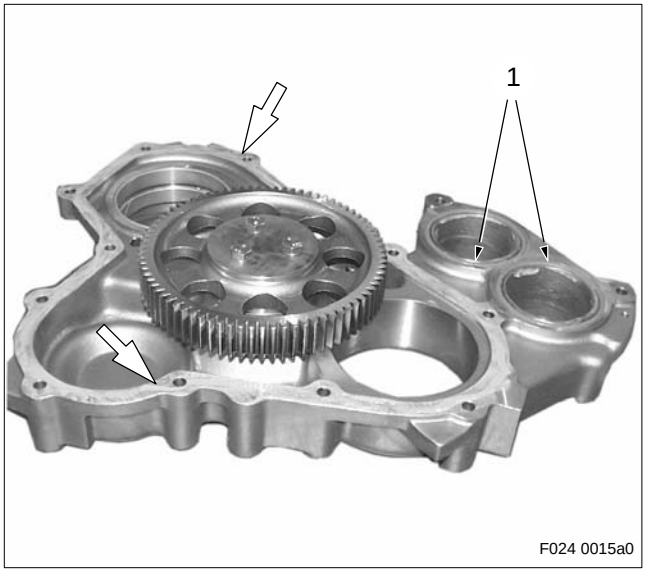
Insert hub into idler gear.



Press hub (2) into gear case cover up to stop.

Tighten hex screws (1).

Check ease of movement by turning the idler gear; the idler gear must turn easily.

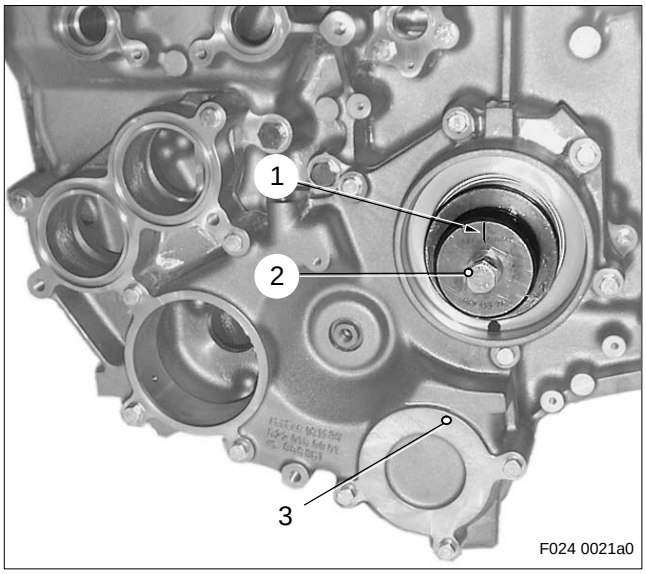


Installing gear case cover

Coat O-rings (1) with petroleum jelly and insert in grooves on gear case cover.

Clean and degrease mating faces on gear case and gear case cover.

Coat mating face (arrows) on gear case with surface sealant.



Back off jackscrew (2) on alignment tool, mount the alignment tool on the crankshaft and press on by hand in direction of driving end.

Marking (1) points upwards.

Note: The marking must always face upward, independently of the position of the crankcase.

Carefully move gear case cover (3) via alignment tool onto gear case.

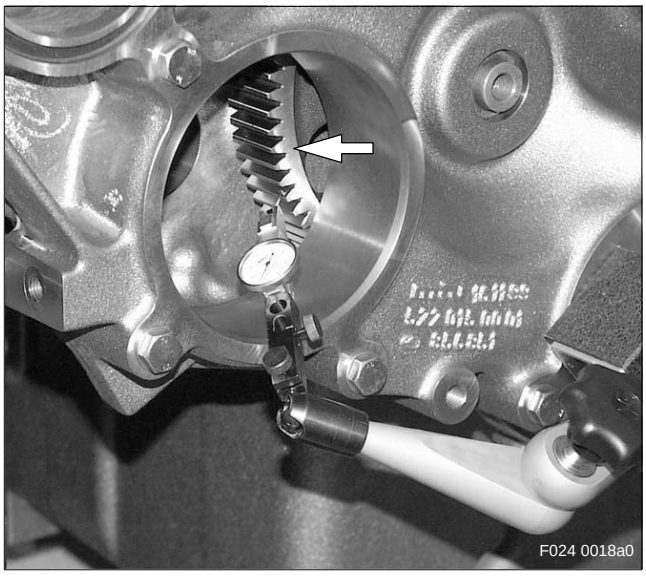
Note: Pay attention to markings and differing screw lengths and versions – see overview drawing.

Fit all securing screws and washers around cover circumference and tighten uniformly.

Note: Final strength of surface sealant after ≈ 48 h!

Press off alignment tool from crankshaft using jackscrew.

Install oil return line as per overview drawing – see C 024.05.01.



Checking backlash and axial clearance

Attach magnetic-base indicator holder with Puppi dial gauge (1) on gear case cover.

Place switch of Puppi gauge with preload on tooth flank of idler gear.

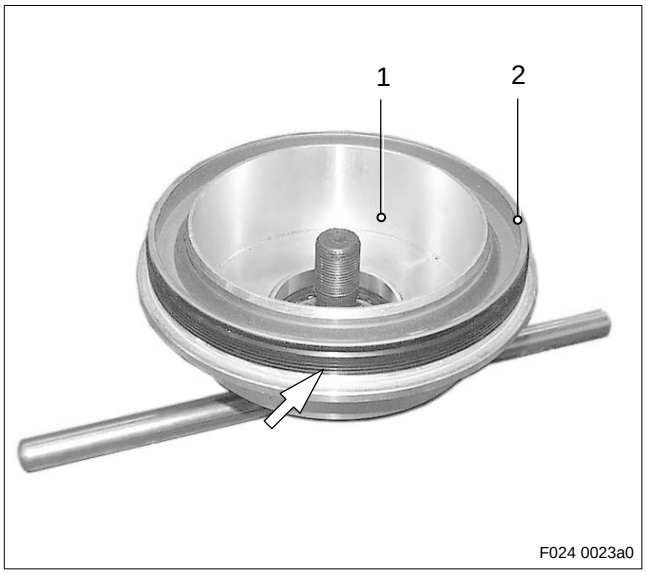
Move idler gear back and forth in radial direction to check backlash.

For axial clearance and backlash, see C 020.

To measure axial clearance, place dial gauge stylus with preload on side collar (arrow) of idler gear.

Set dial gauge to zero.

Check axial play by moving idler gear back and forth in axial direction.

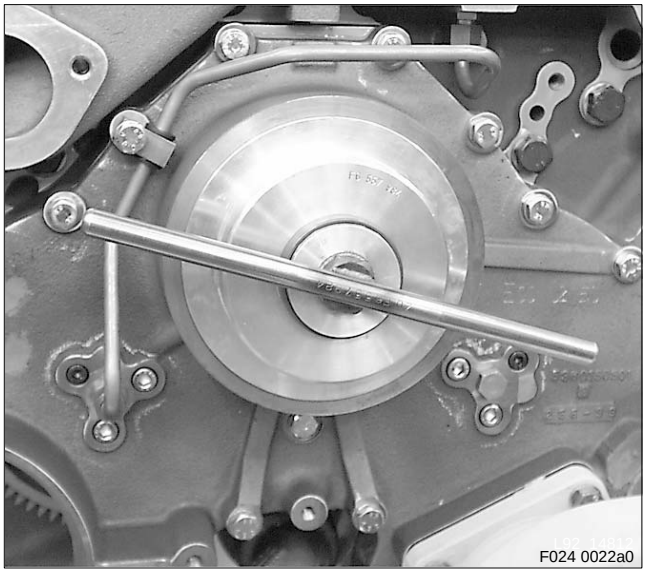


Installing radial-lip shaft seal in gear case cover

Fit radial-lip shaft seal (2), with sealing lip facing outwards, on press-in device (1).

Coat sealing face (arrow) of radial-lip oil seal with denaturated ethanol.

Note: Denaturated ethanol acts as lubricant for press-fitting.



Clean and degrease sealing face for radial-lip oil seal in gear case cover.

Press-fit radial-lip shaft seal with press-in device into gear case cover.

Check clearance of radial-lip shaft seal in gear case cover (3 mm to 0.1 mm). Clearance must be uniform around entire circumference.

C 024.05.12 After-Installation Operations

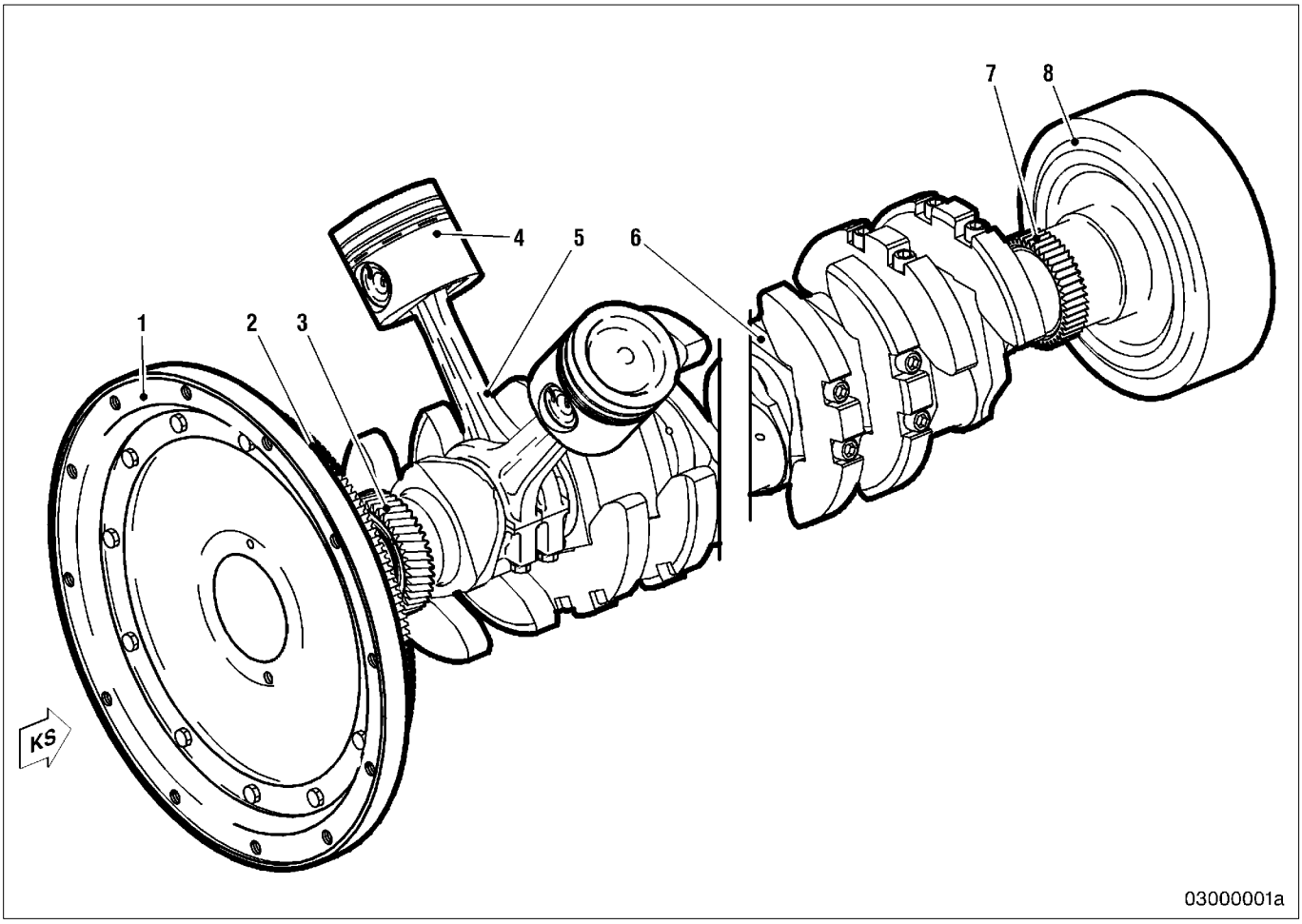
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install engine mounting, free end	C 231.05
–	–	x	Secure bearing elements to foundation.	C 231.05
–	x	x	Install oil pan	C 014.05
–	x	x	Install thermostat housing	C 206.05
–	x	x	Install fuel delivery pump and fuel hand pump	C 081.05
–	x	x	Install generator	C 213.05
–	x	x	Install fan drive	C 028.05
–	x	x	Install vibration damper	C 035
–	x	x	Install engine coolant pump	C 202.05
–	x	x	Connect coolant lines	C 202.15
–	x	x	Connect vent lines	C 202.55
–	x	x	Install fuel lines	C 082.05
–	x	x	Install fuel duplex filter	C 083.05
–	x	x	Install oil lines	C 181.20
–	x	x	Install oil heat exchanger	C 183.15
–	x	x	Install belt pulley	C 213.05/221.05
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

Contents

C 030 Running Gear



1 Flywheel
2 Ring gear
3 Crankshaft gear, driving end
4 Piston
5 Conrod
6 Crankshaft
7 Crankshaft gear, free end
8 Vibration damper

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

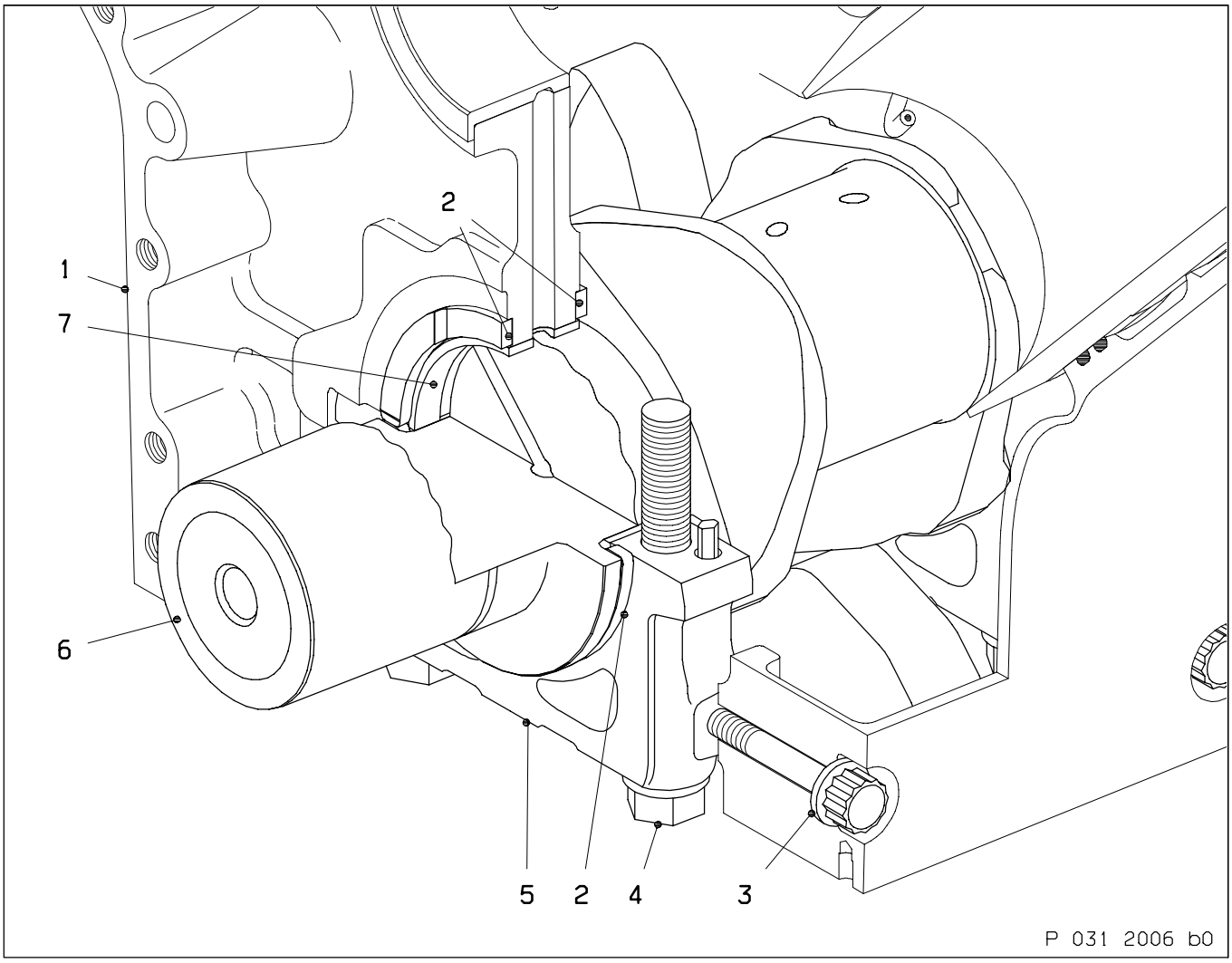
When using these miscellaneous materials, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Chamois leather			
Bristle brush			
Roller brush			
Brass brush			
Polishing cloth			
Magnifier			
Spray gun			
Inspection lamp			
Endoscope with cold light			
Liquid nitrogen			
Activator	Loctite No. 7649	50548	
Vaseline	Petroleum jelly, white	40317	
Denaturated ethanol		40250	
Surface sealant	Loctite No. 573	40031	Final strength ≈ 48 h
Thin-film lubricant	Molycote g-N plus	40041	
Engine oil			
Corrosion inhibitor	Anticorit OHK 380 A	40426	
Cleaning agent	Solvclean KW	40022	
Engineer's blue	blue	40641	
Kerosene or diesel fuel			
Synthetic shot-blasting pellets	Dry Strip Type 216/20	20098	
Cleaning agent (carbon-deposit remover)	Meister Proper	40377	
Dry compressed air			
Molykote D3484			
Molykote 111			
Magnetic crack-testing equipment with fluorescent magnetic powder			
Surface crack-testing equipment with red penetrant dye			
Surface crack-testing equipment with fluorescent penetrant dye			

C 031.05 Crankshaft

C 031.05.01 Overview Drawing

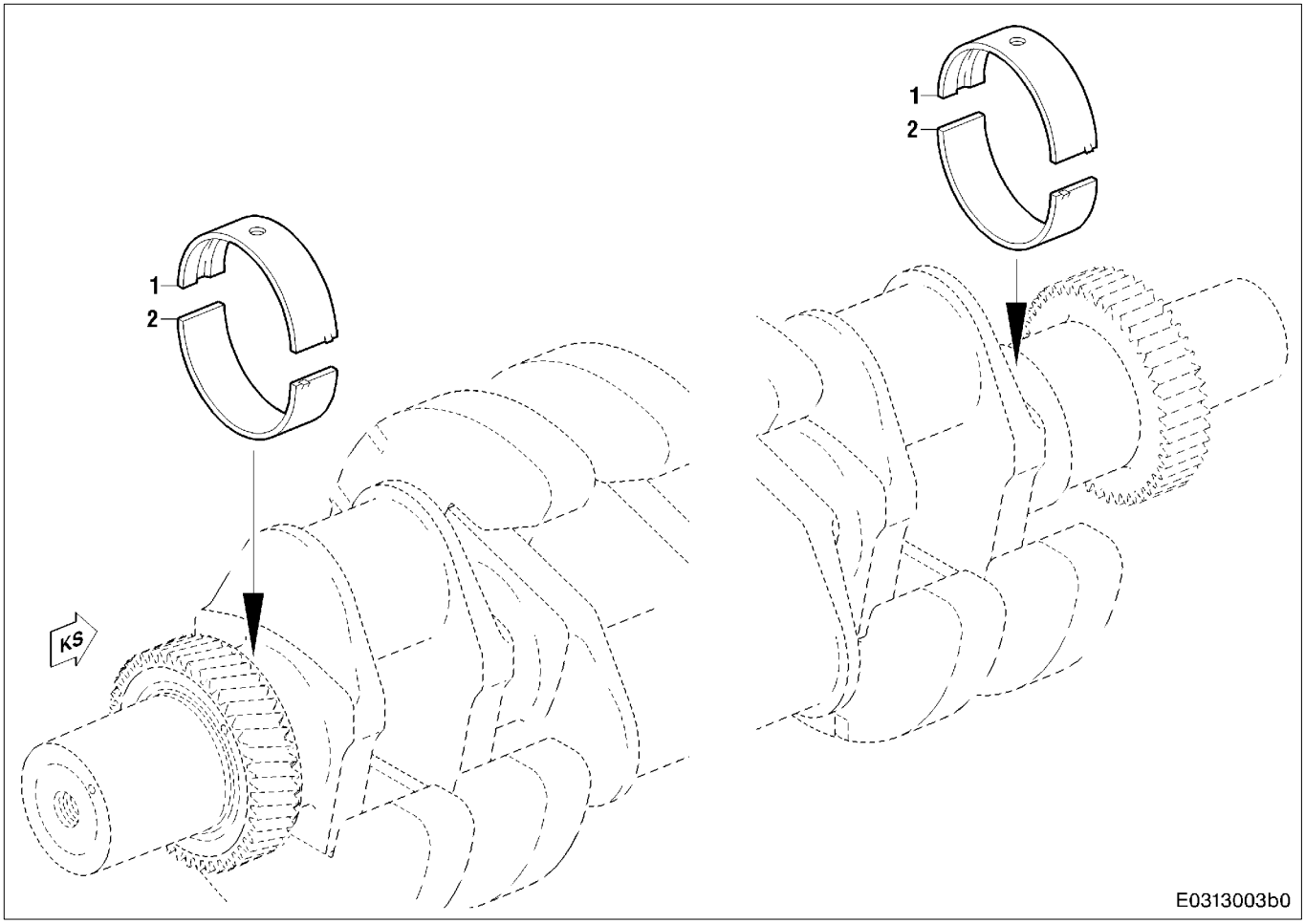
Crankshaft in crankcase



1 Crankcase
2 Friction washer
3 Double-hex screw
Lubricant: Engine oil
***** Tightening torque: 140 Nm + 10 Nm
4 Hex screw
Max. shaft length: 176 mm
Lubricant: Engine oil
***** Pretightening torque: 300 Nm + 30 Nm
***** Additional angle of rotation: 90° + 10°
5 Bearing cap
6 Crankshaft
7 Crankshaft bearing

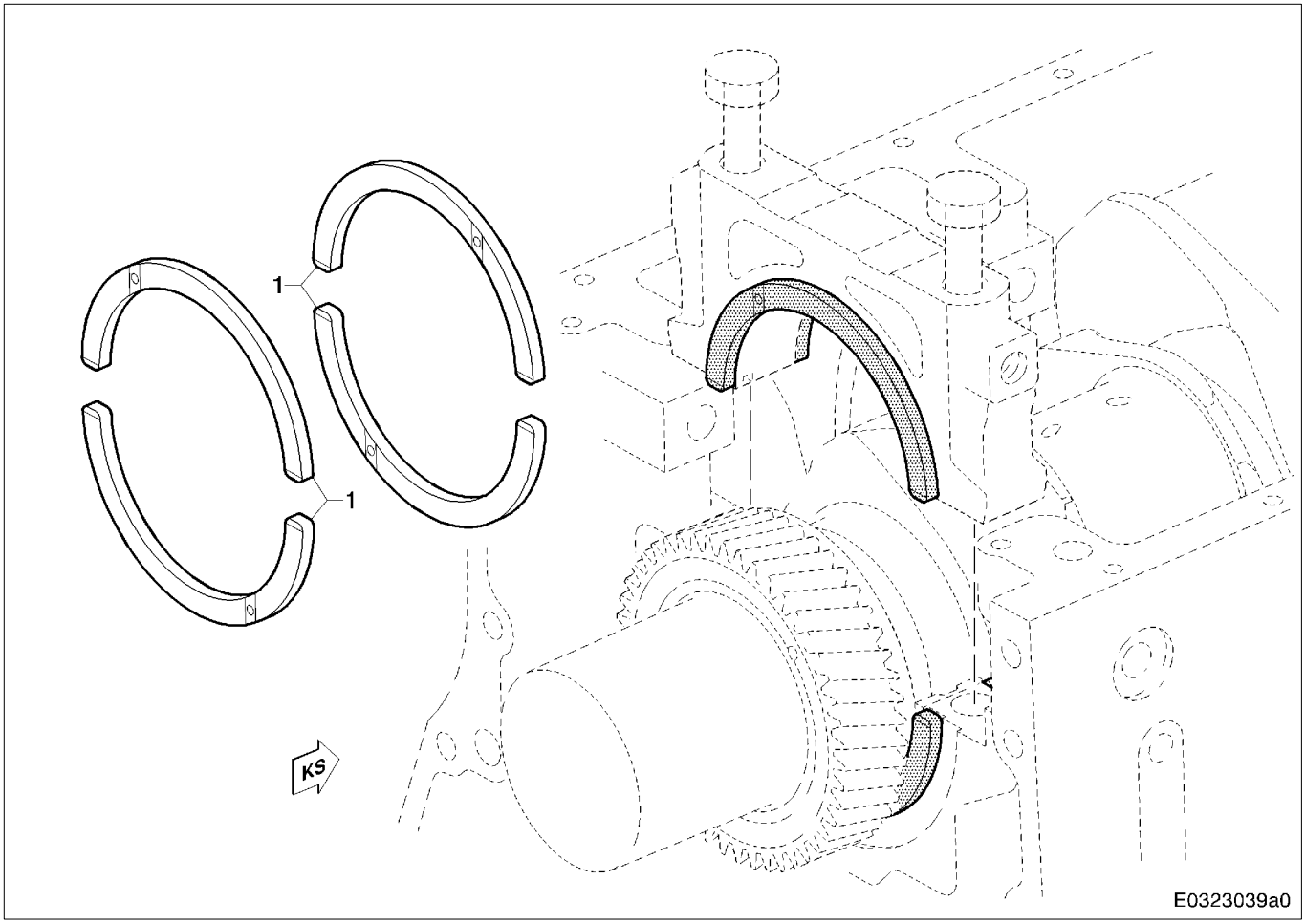
***** Tightening sequence: hex screws before double-hex screws

Crankshaft bearing shells



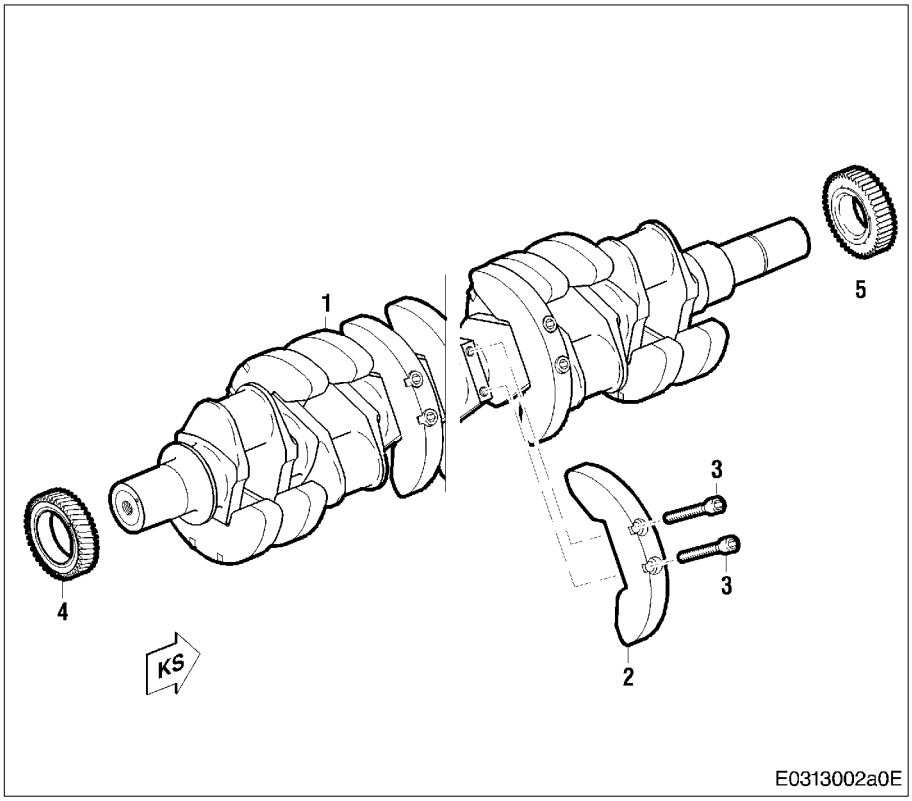
1 Main bearing, upper half
2 Main bearing, lower half

Axial alignment bearing



1 Friction washer

Crankshaft



1 Crankshaft
2 Counterweight
3 Screw
Max. shaft length: 84.0 mm
Lubricant: Engine oil
Pretightening torque: 140 Nm + 20 Nm
Angle of further rotation: 90° + 10°
4 Crankshaft gear, driving end
5 Crankshaft gear, free end

C 031.05.02 Special Tools

Designation – Application	Number
Assembly screws for crankshaft in crankcase	4
Puller for crankshaft gears	1
Assembly device for crankshaft gear, free end	1
Alignment tool (for crankshaft gear, driving end)	1

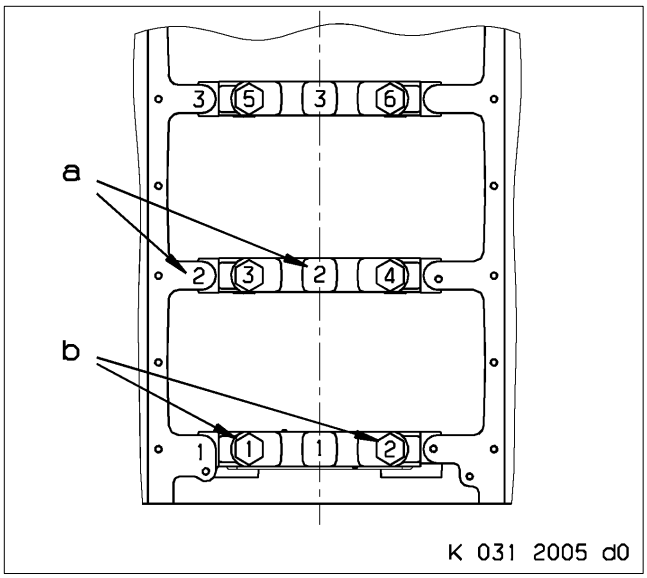
C 031.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	x	x	Removal of crankshaft not scheduled	–

C 031.05.05 Removal

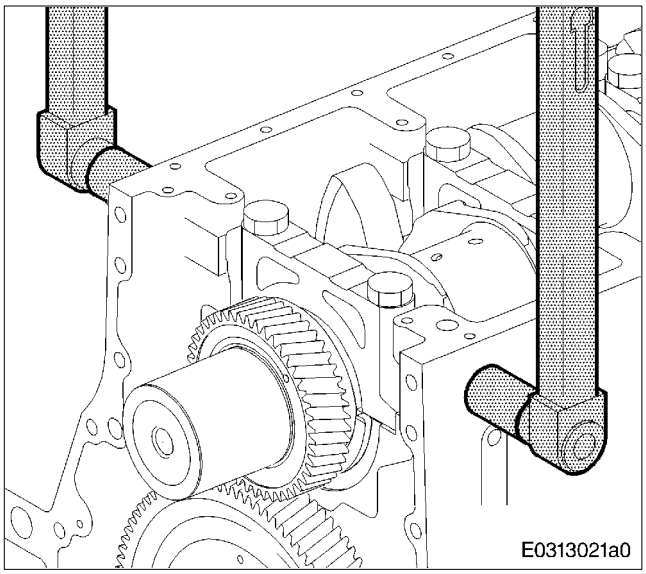


Checking markings of main bearing cap and hex screws

Check marking of main bearing cap in respect to crankcase and consecutive numbering of hex screws, and apply marks as necessary.

a – Starting at driving end, stamp number of main bearing with 6 mm numbers so that they can be read from same direction.

b – Consecutive numbering of hex screws.

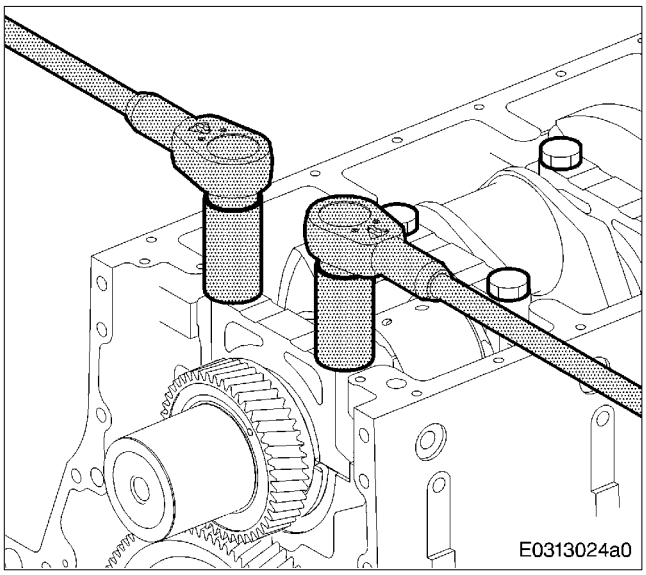


Removing main bearing caps

Turn crankcase upside down in assembly dolly with oil pan mating face horizontal.

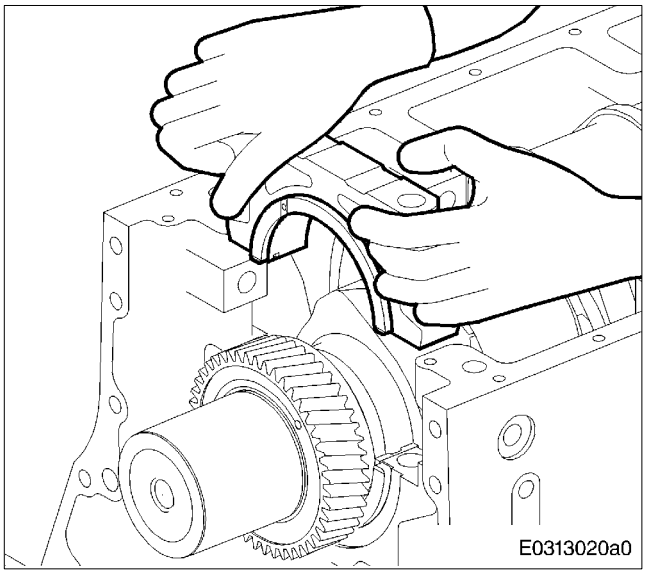
Note: Release screws on one bearing at same time.

Remove all side double-hex screws for crankshaft bearing cap with ratchet and socket.



Note: Release screws on one bearing at same time.

Remove hex screws for crankshaft bearing cap with ratchet and socket.



⚠ CAUTION

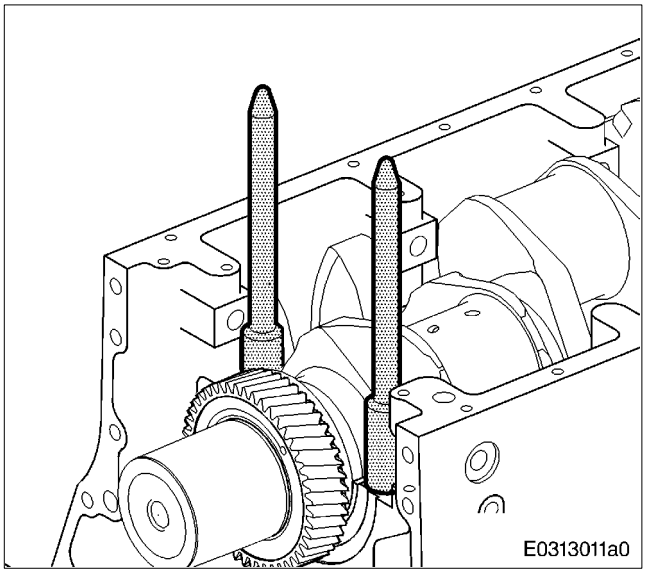
Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Carefully raise all bearing caps vertically until clear of crankcase.

Mark bearing shell of respective bearing cap and remove.

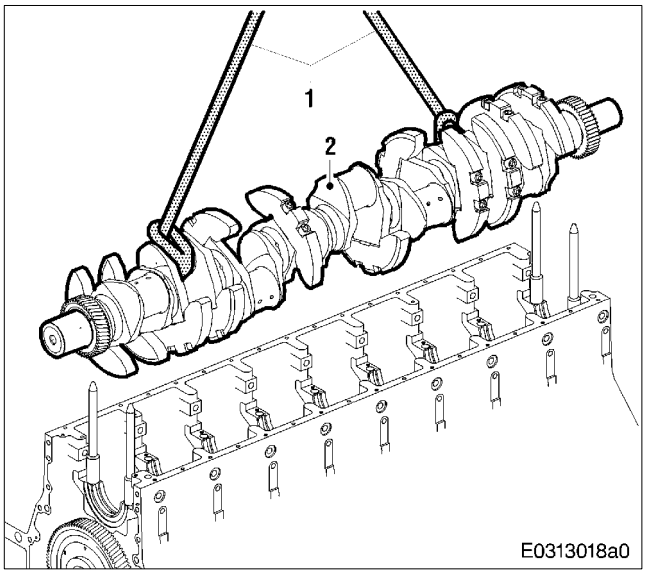
Note: Protect bearing shells from damage!

Remove friction washers.



Removing crankshaft

To protect crankshaft, insert four assembly screws on first and last bearing.



⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Using rope loops (1) and crane, raise crankshaft (2) clear of crankcase.

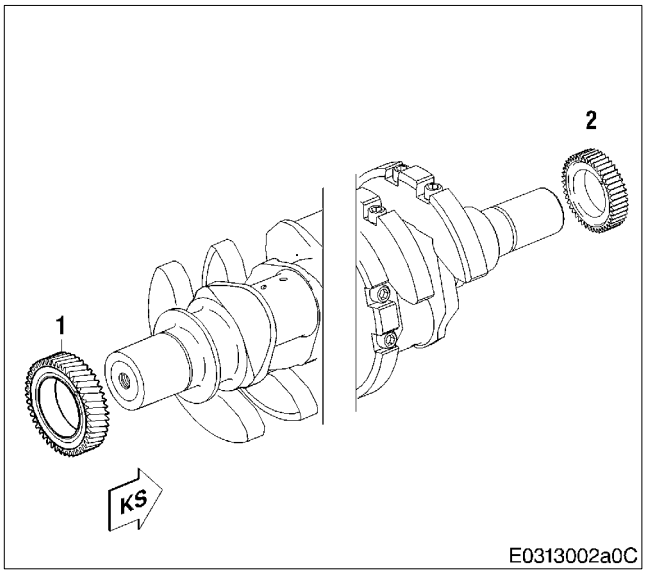
Take care to keep crankshaft horizontal.

Lower crankshaft onto sturdy assembly frame.

Remove assembly screws.

Mark bearing shells on housing side to crankshaft bearing cap and remove from crankcase.

C 031.05.06 Disassembly

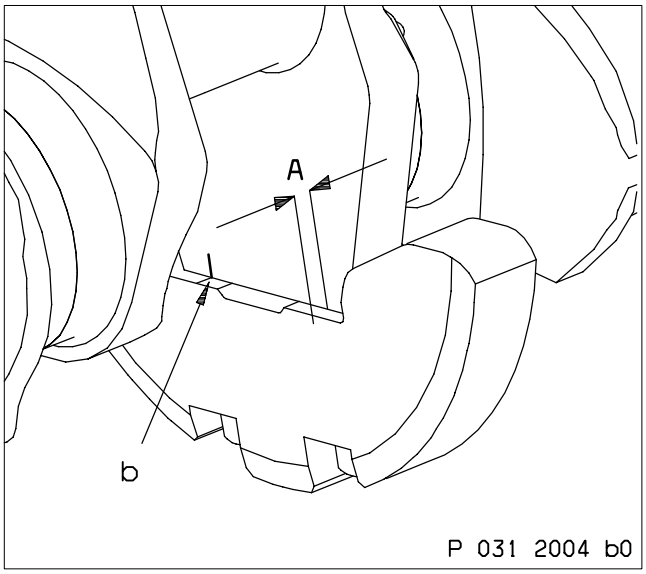


Removing crankshaft gear, driving end and free end

Note: Do not remove gear unless necessary (e.g. damage).

Remove crankshaft gear, driving end (1), or crankshaft gear, free end (2), from crankshaft.

Always consult MTU before removing gears.



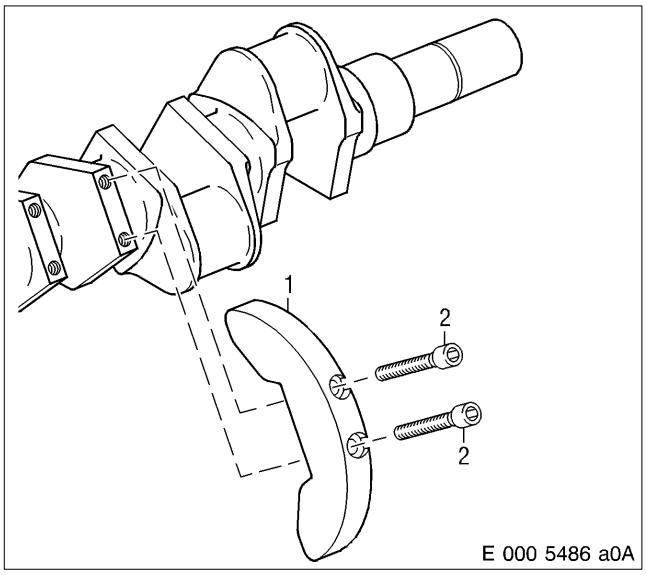
Removing counterweights

Note: If counterweights are removed after balancing, mark relevant counterweight in its installation position with regard to crankshaft beforehand.

Determine and record distance A (web to counterweight).

Apply mark b.

Check that counterweights are numbered in consecutive order; stamp new numbers if necessary.



Note: Remove counterweights with crankshaft in a sturdy stand.

Remove screws (2) and counterweight (1).

C 031.05.08 Inspection and Repair

Cleaning and checking crankshaft

Clean crankshaft with cold cleaner.

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

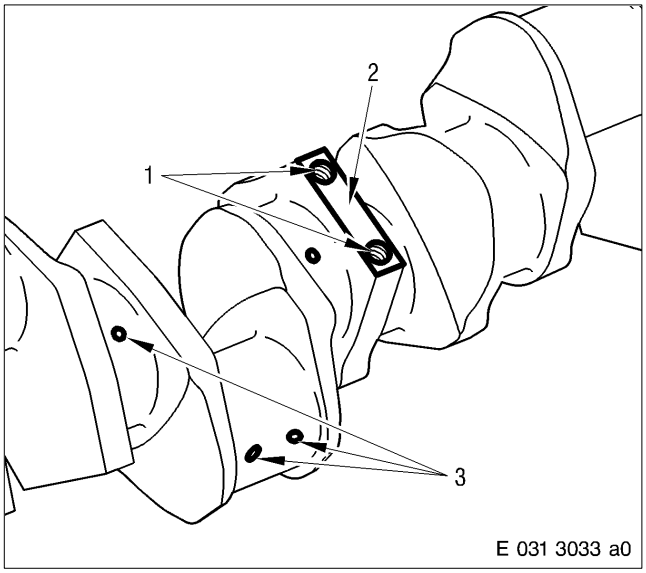
Using suitable bottle brush and cold cleaner, thoroughly clean all crankshaft bores and blow through with compressed air.

Note: Never use a wire brush!

Check that all threads are in perfect condition.

Check counterweight mating faces for wear; machine-grind if necessary.

Consultation with MTU is required.



Checking crankshaft for cracks

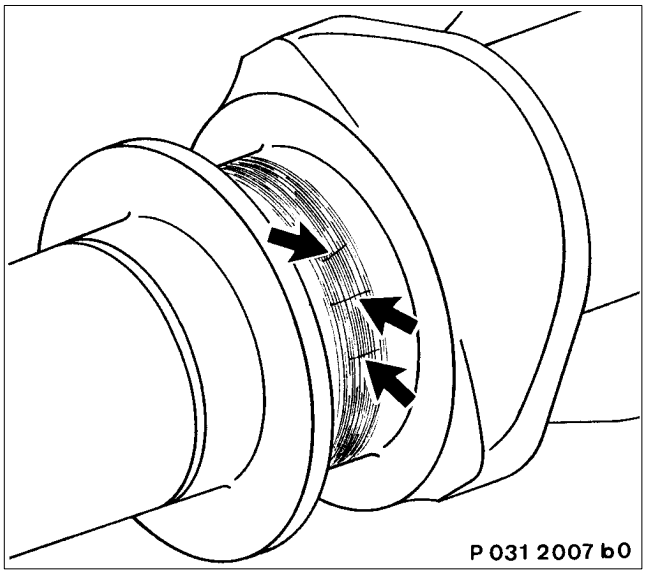
Using the magnetic crack-testing method with fluorescent magnetic powder, check crankshaft for longitudinal and transverse cracks. Include oil bores and journal bores (3), journal transition radii, counterweight mating faces (2) and threaded bores (1) in scope of inspection.

Install crankshaft in longitudinal direction between jaws of test device.

For the test, a magnetic electric field strength of 20 A/cm to 60 A/cm must be applied at every part of the component.

Demagnetize crankshaft after crack-testing. The maximum permissible residual field strength after demagnetization is 2.5 A/cm to 4 A/cm.

Note: A component is considered sufficiently demagnetised when a paper clip suspended on a thread is no longer attracted by the component.

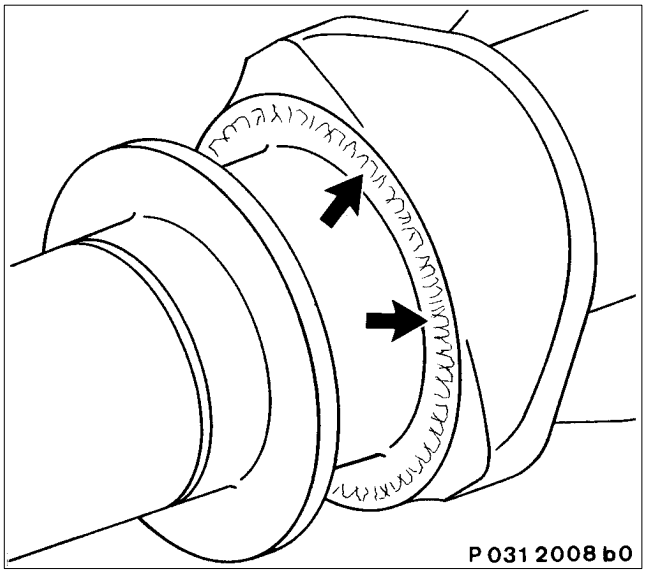


Information on thermal cracks

Characteristic of hot-running cracks is that they are almost always parallel to the axis of the component (see arrows).

Transverse cracks sometimes come out from these cracks. Heavy thermal cracks are mostly of a depth approximately corresponding to the thickness of the hardness layer. Replace crankshaft with such cracks.

Crankshafts exhibiting minor hot-running cracks can be repaired. This is provided that regrinding to a repair stage or local grinding will remove the damage. Consultation with MTU is required.

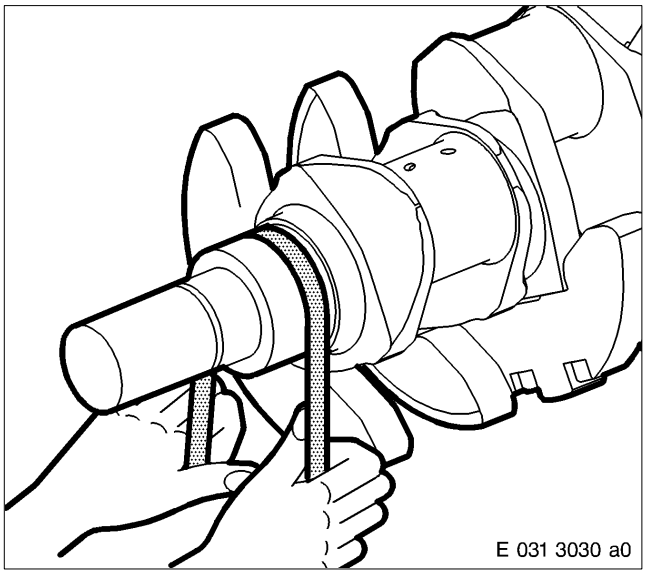


Information on grinding cracks

Fine branching is characteristic of thermal cracking, (arrows). The illustration shows a bearing journal with grinding cracks.

Replace crankshaft with such cracks.

Grind cracks occur on account of insufficient cooling during grinding or through excessive feed.



Checking crankshaft journal

Burnish all journals with emery cloth (granulation P 320).

Standardised roughness height (R_z) of journal sliding surface = 1 μm

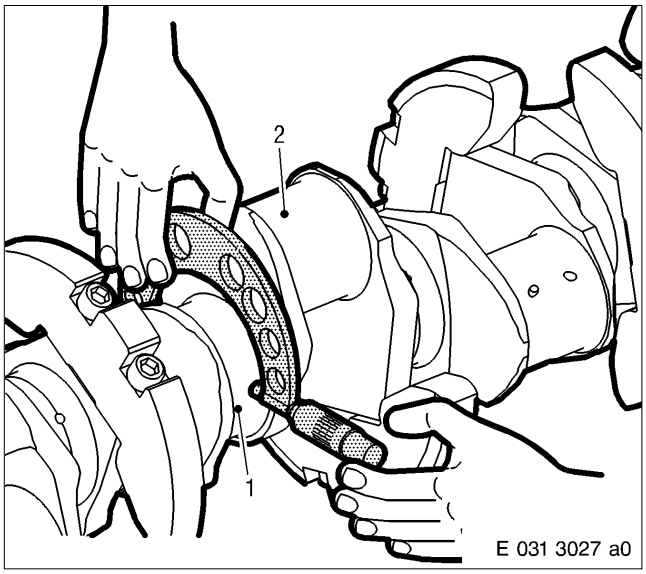
Polish all fillets and transitions.

Check main bearing and crankpin surfaces for scoring and damage. If necessary, regrind relevant journal to next repair stage.

Check friction washer sliding surface of first main bearing for wear. Regrind to next repair stage if necessary.

For limit values, see Tolerance and Wear Limits List.

Remove minor scoring and damage by polishing with emery cloth.

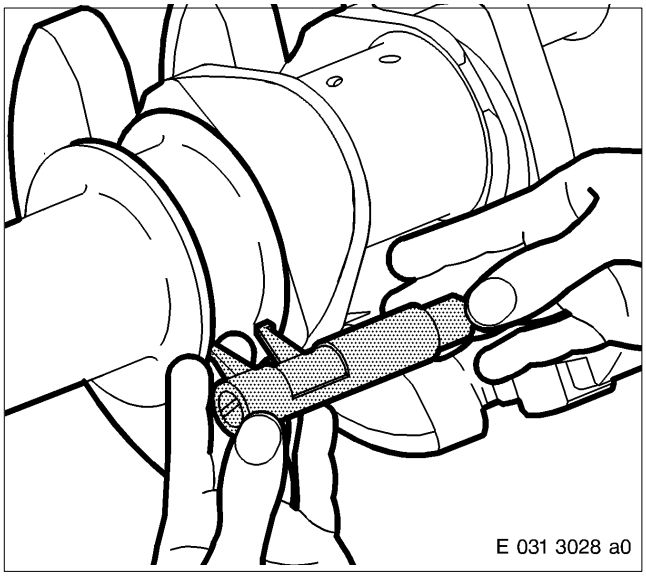


Measuring crankshaft journal

Using micrometer, measure main bearings (1) and crankpins (2) of crankshaft for out-of-round and surface irregularities; record measured values in Data Sheet.

For limit values, see Tolerance and Wear Limits List.

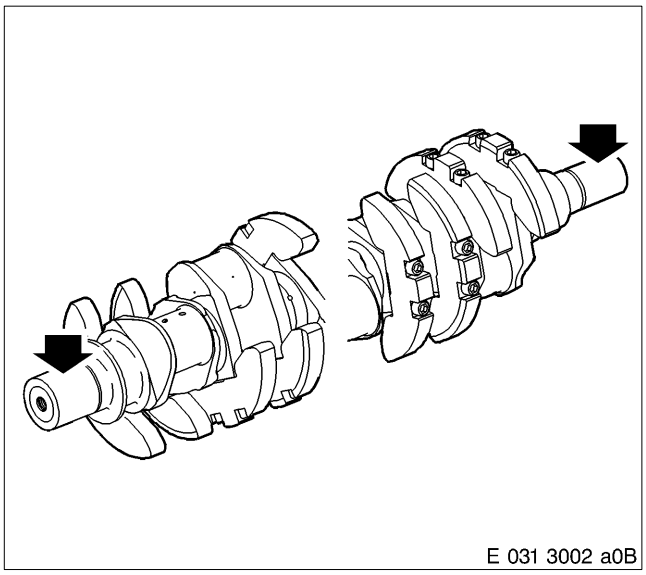
If limit values are exceeded, grind crankshaft to next repair size.



Measure width of guide bearing with inside micrometer and enter values in Data Sheet.

For limit values, see Tolerance and Wear Limits List.

If limit values are exceeded, grind crankshaft to next repair size.



Checking crankshaft taper

Check taper surfaces (arrows) for scoring and damage.

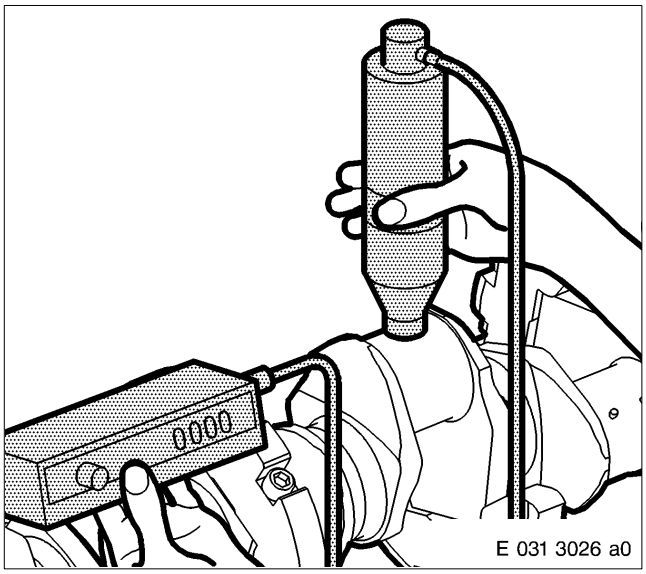
Remove minor scoring and damage by polishing with emery cloth.

Mean roughness height (R_z) of taper surface = from 2.5 μm to 6.3 μm

Mean roughness height (R_z) of gear seat surface = 6.3 μm

Check tapers 1:50 with taper gauge.

If necessary, machine taper to MTU specifications.



Checking hardness of journals

Check hardness of all journals using the Microdur tester or other suitable hardness tester.

Test hardness of each journal at four points at 90° intervals around circumference.

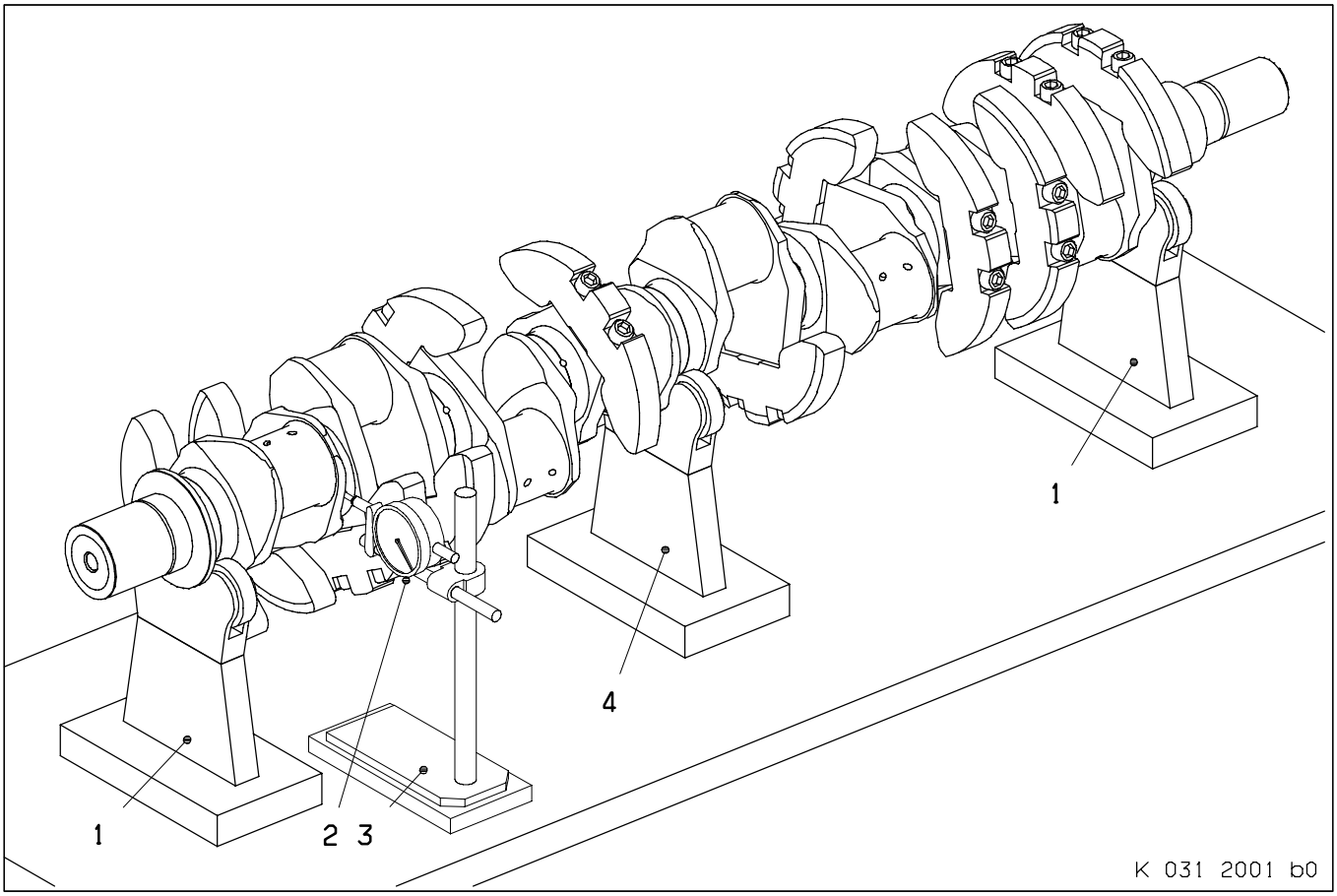
Specified hardness = from 49 HRC to 53 HRC

Replace crankshaft if a bearing journal has lost its hardness on account of bearing scuffing.

Important: Hardness tests on installed or ready-to-be installed crankshafts are not permitted.

Checking crankshaft concentricity

Illustration showing 16V crankshaft



1 Fixed mount (roller stand, rigid)
2 Dial gauge
3 Magnetic-base indicator holder
4 Support bearing (roller stand, sliding version)

Place crankshafts with roller stands under following bearing journals:

12V: Journal 1 and 7 = fixed mount

16V: Journal 1 and 9 = fixed mount
Journal 5 = floating support mount

Using adjustable dial gauge holder and dial gauge, check main bearing journal concentricity.

If wear across circumference of journal is irregular, check at transition from cylindrical section of journal to radius.

For limit values, see Tolerance and Wear Limits List.

If measured values differ from those specified in Tolerance and Wear Limits List, grind relevant journals to next repair stage.

Note: Do not straighten crankshaft!

Always consult MTU before grinding crankshaft journals.

Regrinding crankshaft

Only journals which are not dimensionally stable must be reconditioned to next repair stage.

When regrinding, make every effort to remove only as much material as is required to achieve next repair size.

Adhere strictly to all specifications for sizes and tolerances.

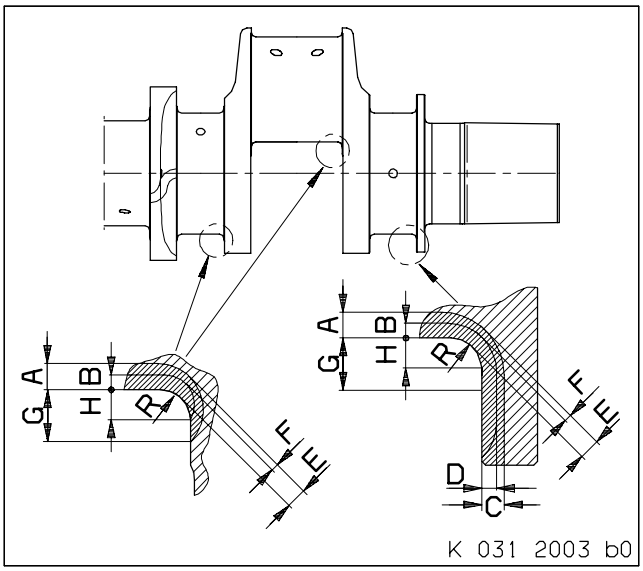
This also applies to transition radii and surface finish.

Record main bearing journal and crankpin diameters, guide bearing width, concentricity values and journal hardness values in Crankshaft Data Sheet.

Thoroughly clean oil bores after grinding.

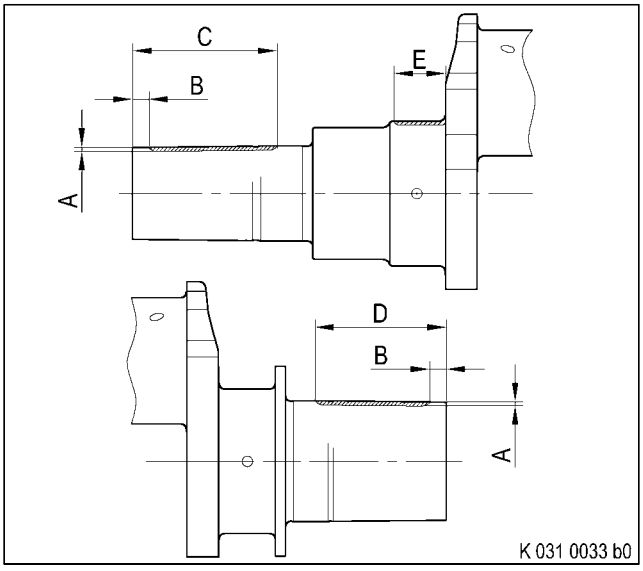
Necessary checks after grinding:

– Check dimensions and surface finish of all bearing journals
– Check radii at bearing journals
– Check that oilway bores are correctly radiused and polished;
  (perform this check with meticulous care, in order to prevent damage to the bearing shells and ensure adequate lubrication.)
– Check concentricity and axial runout
– Check hardness
– Check for cracks



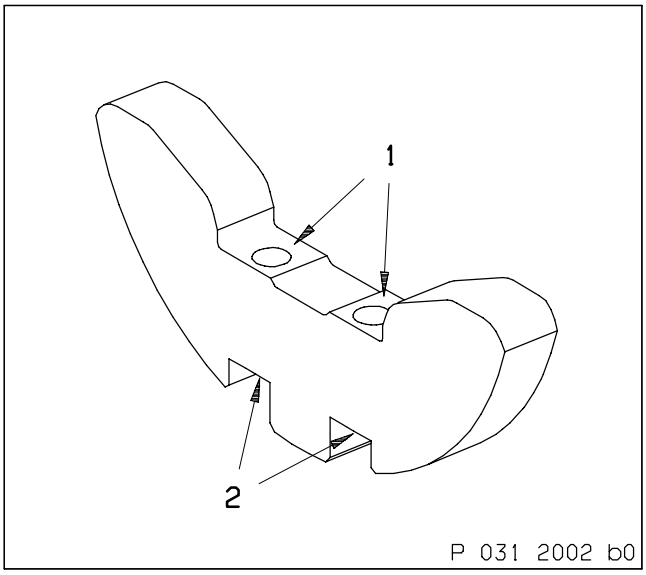
Hardness transient across journal

A = 4.5 mm (Max. hardened zone depth)
B = 2 mm (Min. hardened zone depth)
C = 4 mm (Max. hardened zone depth)*
D = 2 mm (Min. hardened zone depth)*
E = 3.8 mm (Max. hardened zone depth at radius area)
F = 1.8 mm (Min. hardened zone depth at radius)
G = 6 mm (Max. hardened zone height at radius)
H = 4 mm (Min. hardened zone height at radius)
R = from 3.5 mm to 4 mm
Max. mean roughness height (R_z) of radii = 6 µm
*only alignment bearings



Hardness pattern on crankshaft taper

A = 3 mm ± 1.5 mm (hardened zone depth)
B = 12 mm ± 3 mm
C = 108 mm ± 3 mm
D = 98 mm ± 3 mm
E = 38 mm (min. hardened zone width)



Checking counterweights

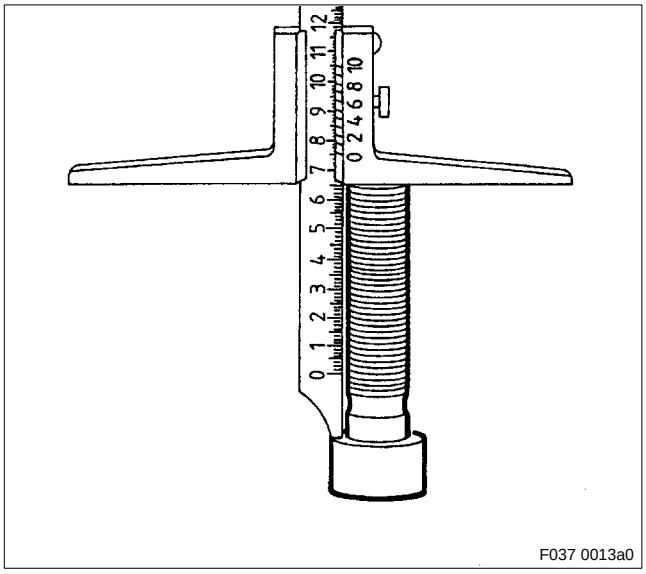
Using the magnetic crack-testing method with fluorescent magnetic powder, check counterweight for cracks.

If cracks are detected, replace counterweight.

Check crankshaft mating face (1) for wear; machine-grind if necessary.

Consultation with MTU is required.

Using engineer's blue, check contact pattern of mating face (2) for stress bolt heads; remove surface irregularities as necessary.



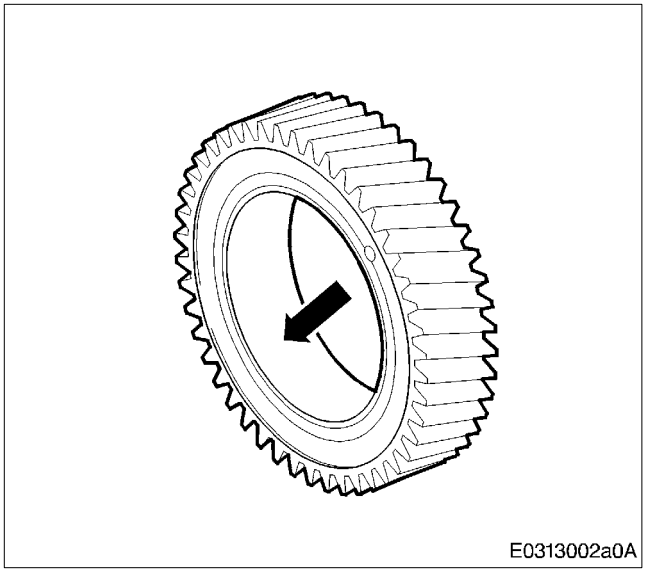
Checking screws for counterweights

Measure shaft length of screws with depth gauge; max. permissible shaft length, see C 031.05.01. Replace screws if necessary.

Using the magnetic crack-testing method with fluorescent magnetic powder, check screws for cracks.

Replace screw if cracks are found.

Make sure that threads are in perfect condition.



Checking drive gear, driving end, and drive gear, free end

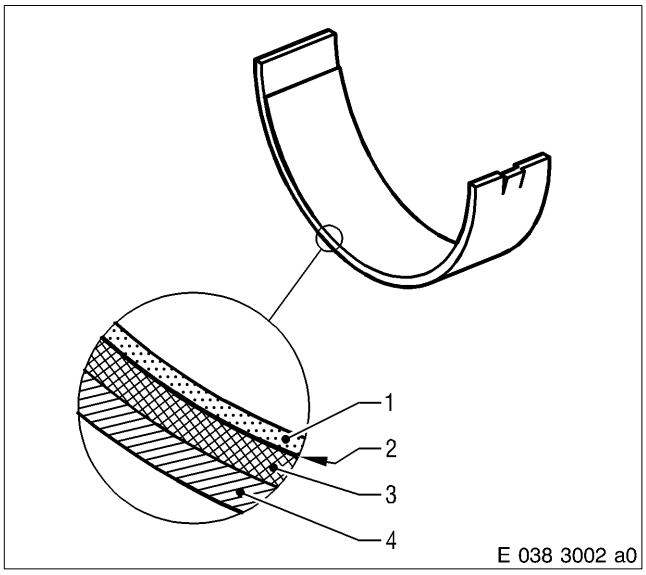
Using the magnetic crack-testing method with fluorescent magnetic powder, check gear for cracks.

Replace gear if cracks are found.

Check gear for wear, smooth with oilstone or polishing cloth if necessary, or replace gear.

Check bore surfaces (arrows) for scoring and damage.

Remove minor scoring and damage by polishing with emery cloth.



Checking and assessing crankshaft bearing shells

Check surface condition of bearing shells and check shells for wear. Replace worn or chipped bearing shells.

Replace bearing shells as part of every W6 overhaul.

Bearing shell has the following material structure:

1 Sliding layer (from 12 µm to 20 µm)

2 Intermediate layer (nickel barrier)

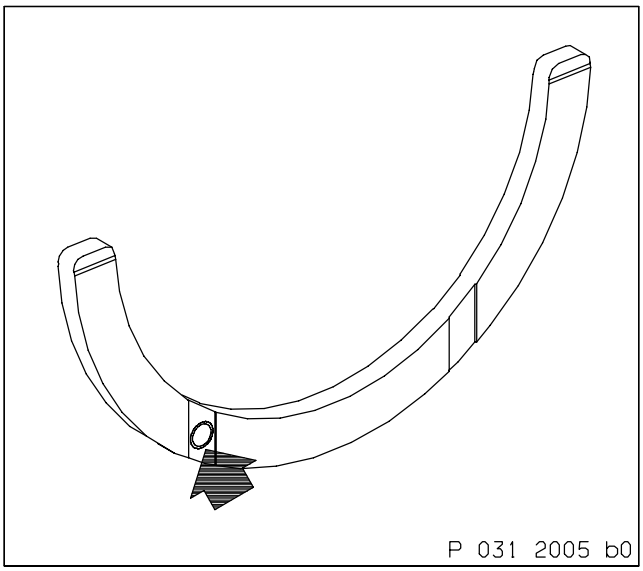
3 Bearing metal

4 Steel support shell

An important indicator for assessing extent of wear on bearing shell is the shape and extent of the nickel barrier areas exposed.

Usability of bearing shell is restricted at 70 % of sliding layer in friction area!

Note: It is often difficult to differentiate between the hard nickel barrier and softer sliding layer. If in doubt, consult a bearing specialist.



Checking friction washers.

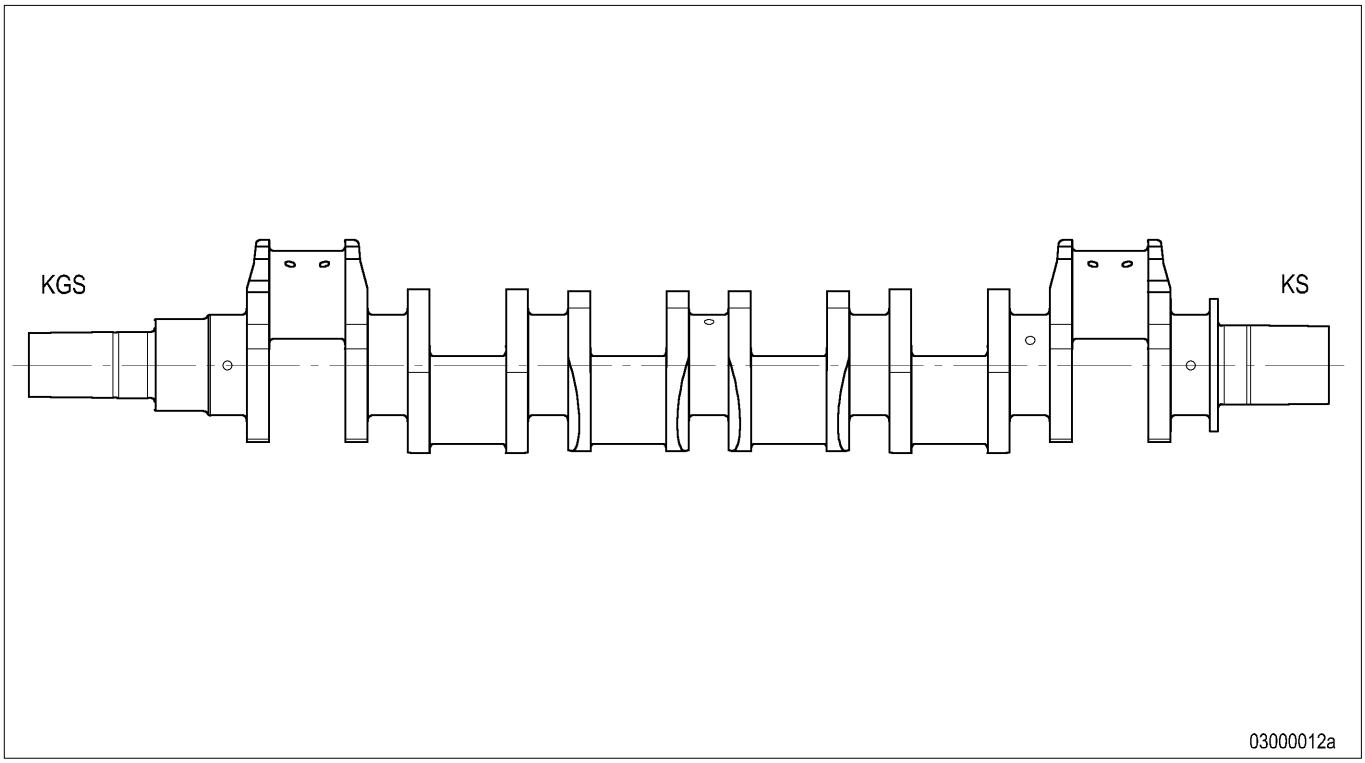
Replace friction washers during W6 overhaul.

Check friction washers for scoring and damage and replace if necessary.

Check steel bush (arrow) is securely seated and check bore for wear. Replace friction washer if necessary.

Dynamic balancing

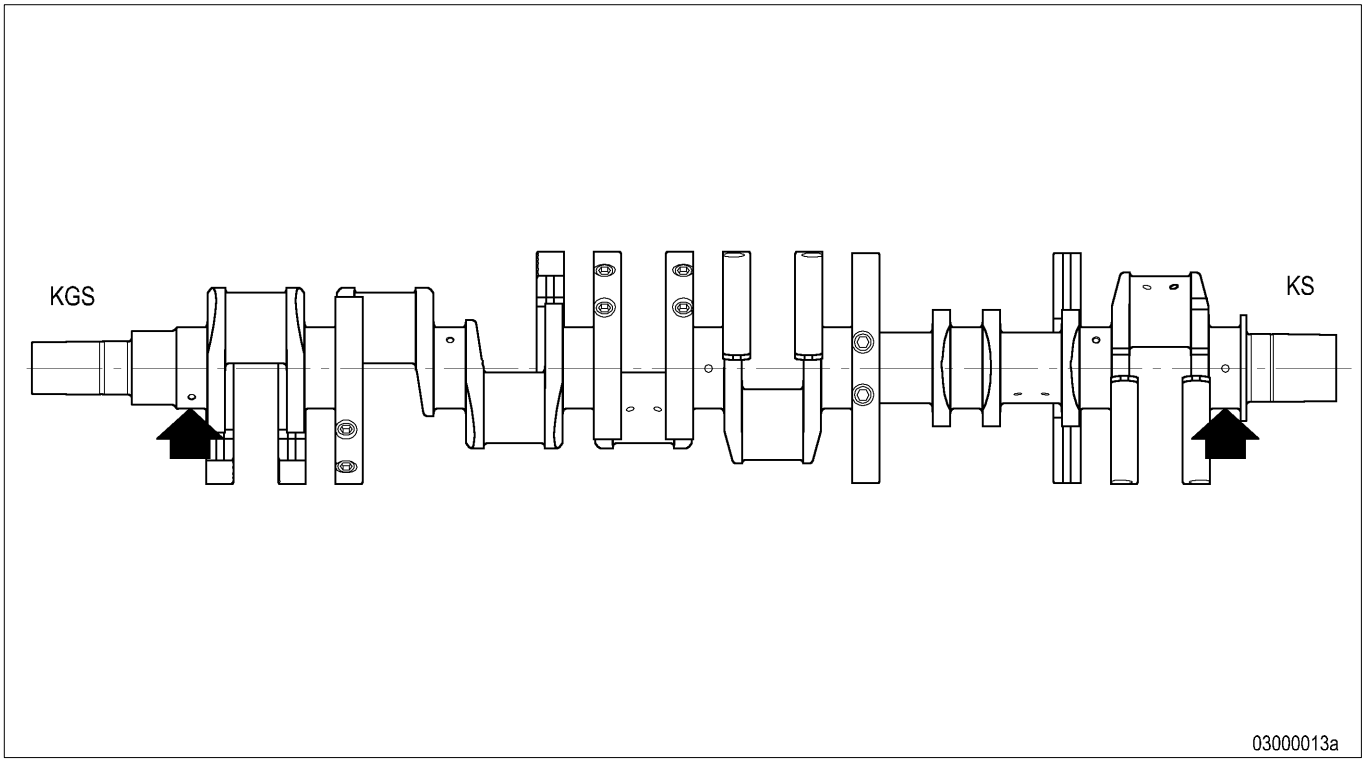
Illustration showing 12V crankshaft



Note: The 12V crankshaft does not require dynamic balancing as no counterweights are installed.

Dynamic balancing

Illustration showing 16V crankshaft



Prior to balancing, seal all oilways to prevent the ingress of foreign matter.

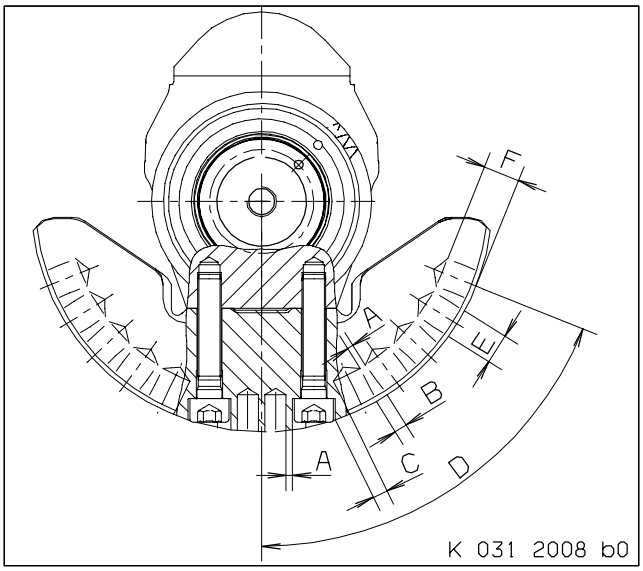
16V: Place crankshaft in main journals 1 and 9
For dynamic balancing, attach counterweight to each crankpin.
Counterweight G = 11000 g ± 10 g
Mass of balancing group: 300 kg

Max. operating speed:	2300 rpm
Balancing speed:	150 rpm
Permissible residual imbalance per balancing plane for initial balancing:	80 gcm
Permissible residual imbalance per balancing plane for comparative balancing in different configuration or balancing machine:	240 gcm

Remove material to balance crankshaft only from counterweights by drilling radially with twist drill.

For specified bore values – see following illustrations.

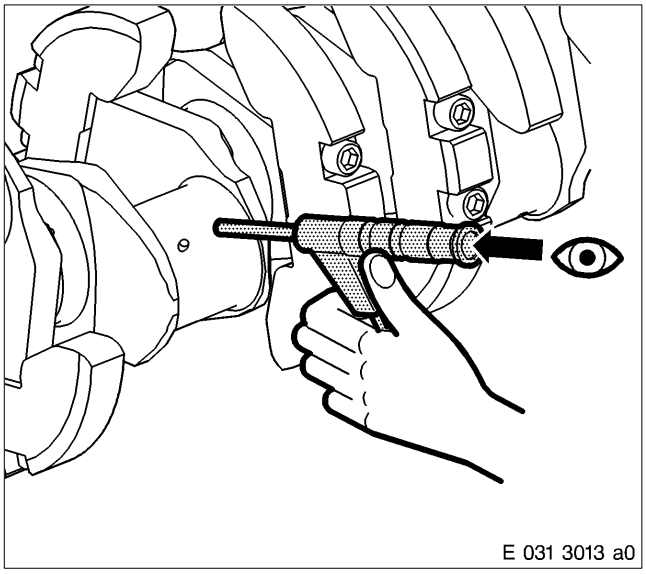
After balancing, recheck numbers on counterweights and renumber if necessary.



Bore values for counterweights

A = 4 mm (min.)
B = 9 mm (min.)
C = 10.3 mm (min.)
D = 72° (max.)
E = 22 mm (max. bore diameter)
F = 25 mm (max. bore depth)

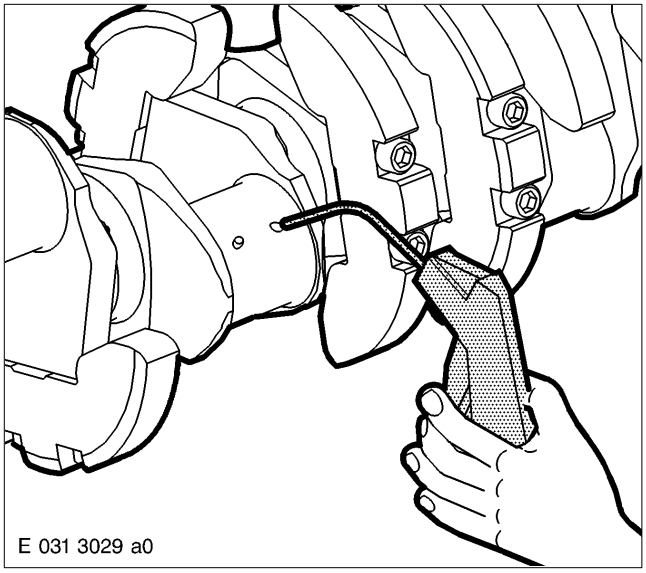
Minimum wall strength around balancing bores: 4 mm.



Checking oil bores

Endoscopically inspect all oilways with cold light source and make sure they are perfectly clean.

If necessary, clean oil bores.



Cleaning oil bores

Thoroughly clean crankshaft oilways with cold cleaner and suitable bristle brush.

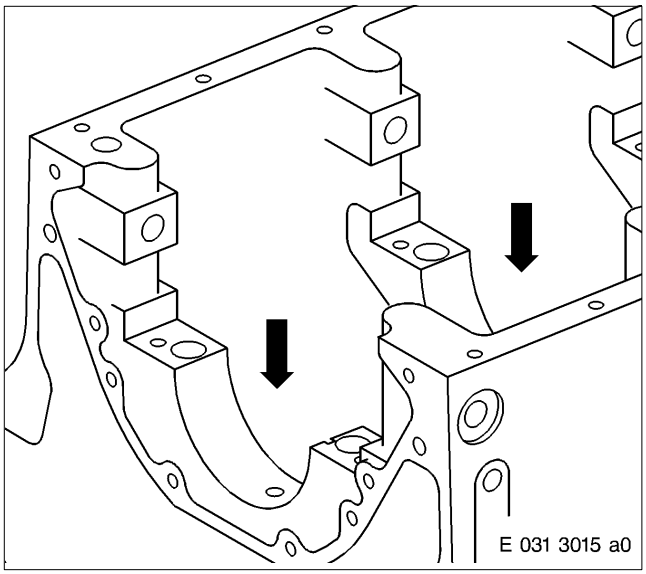
Note: Never use a wire brush!

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

After cleaning, flush oilways (under pressure if possible) and blow clear with compressed air.

Crankshaft bearing

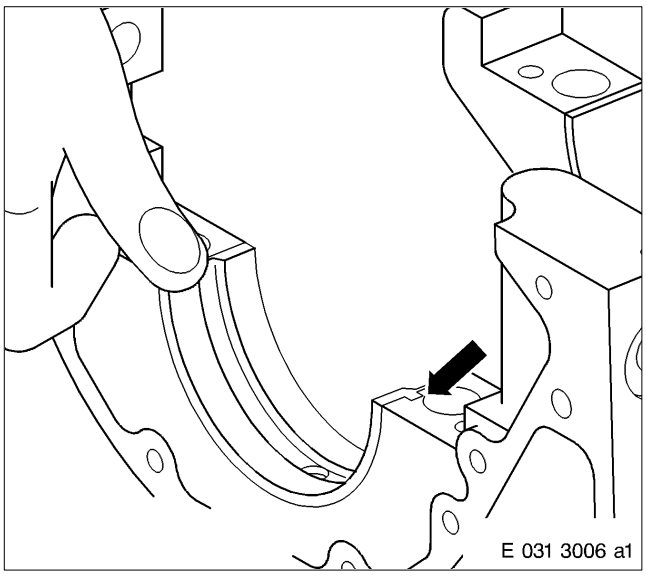


Installing bearing shells

Note: Always make sure that all components are perfectly clean.

Turn crankcase upside down in assembly dolly with oil pan mating face horizontal.

Wipe bores (arrows) for crankshaft bearing in crankcase and bearing shells on both sides.



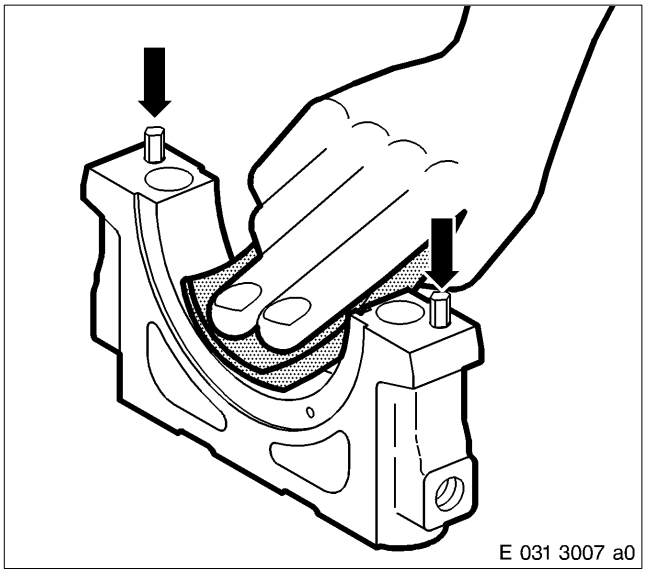
Note: Top and bottom bearing shells have different part numbers.

Check codes for repair stage and journal diameter on new bearing shells and bearings numbers on run-in bearing shells
Compare crankcase inspection sheet with crankshaft data sheet.

Manually insert bearing shells (bearing shells with oil groove and oil bore) on housing side in accordance with bearing number into housing bore to form a positive connection.

Securing lug (arrow) of bearing shell must sit in groove in crankcase.

Oil bores in bearing shells and crankcase must be aligned.



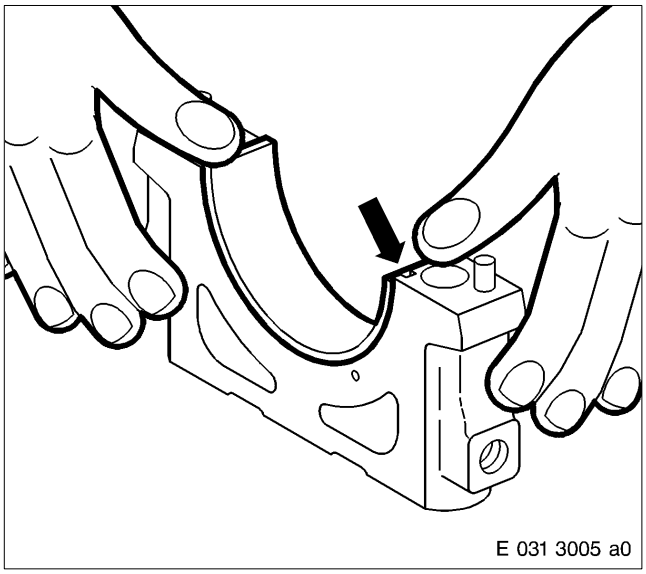
Installing main bearing caps

Wipe bearing shell mating faces on crankshaft bearing cap.

⚠ CAUTION

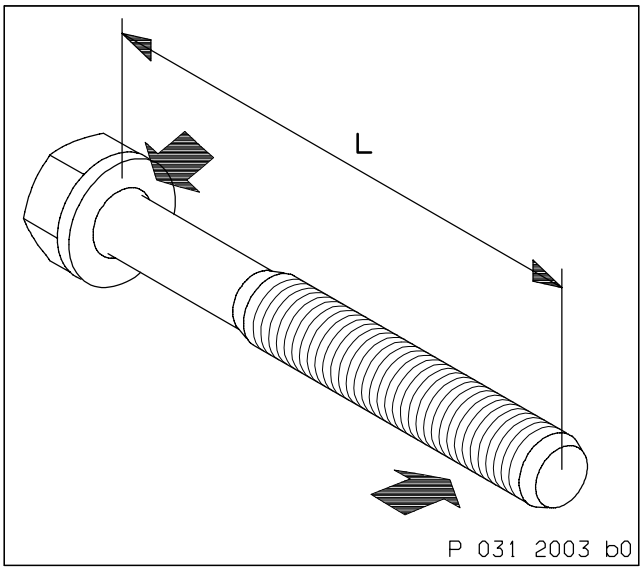
Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

Blow out partitions on crankshaft bearing cap and crankcase, cylinder and dowel pins (arrows) and related bores in crankcase with compressed air and check for that they are perfectly clean.



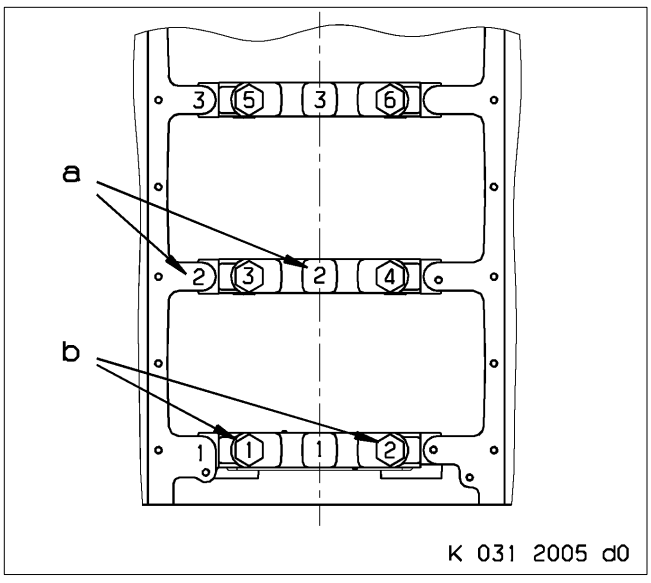
Wipe lower bearing shell (bearing shell without oil bore) on both sides and insert into main bearing cap according to markings or bearing number.

Securing lug (arrow) of bearing shell must sit in groove in crankshaft bearing cap.



Measure shaft length (L) of central hex screw for crankshaft bearing cap. For max. shaft length – see C 031.05.01.

Coat thread and screw head mating face of centre hex screws (arrows) with engine oil.



Note: Main bearing caps and their hex screws must not be interchanged.

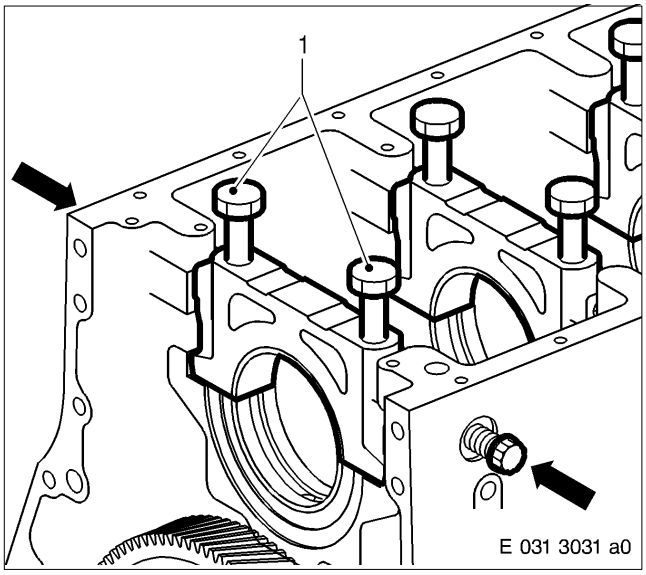
⚠ CAUTION

Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Match bearing cap in accordance with crankcase marking to bearing cap and insert into crankcase.

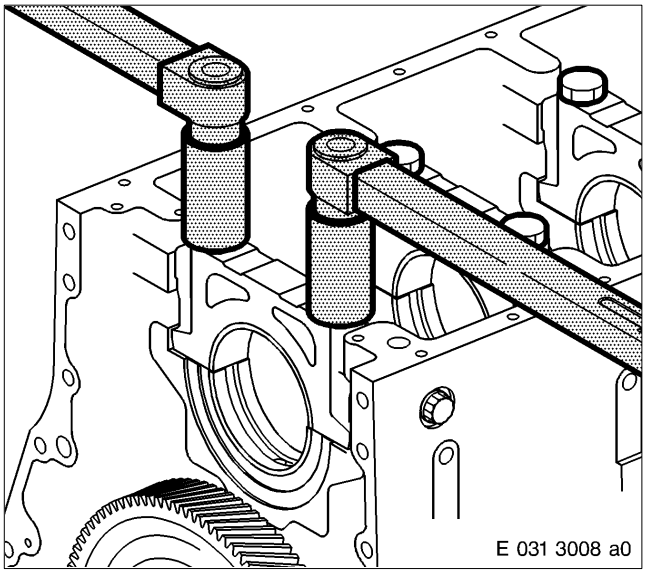
a – Consecutive numbering of the main bearing starting from the driving end.

b – Consecutive numbering of hex screws.



Fit, but do not yet fully tighten, hex screws (1) as per markings – see previous illustration.

Coat thread and mating face of side double-hex screws (arrows) with engine oil and insert double-hex screws but do not tighten yet.

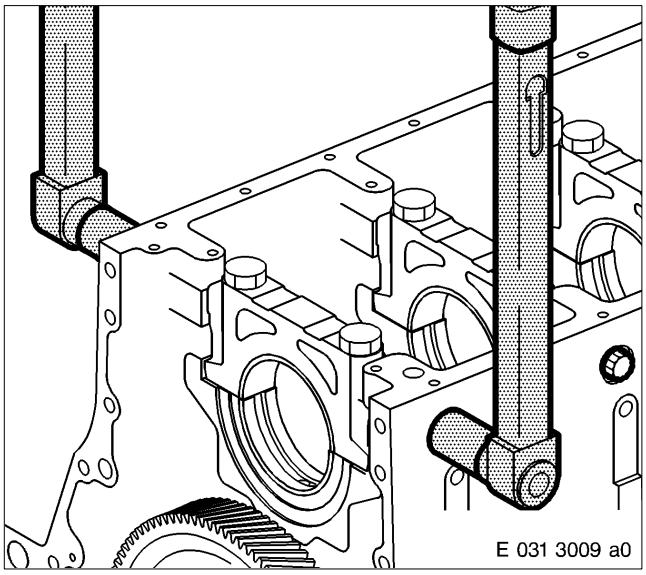


Note: Always tighten screws on one bearing at same time.
Tightening sequence, starting from alignment bearing.

Pretighten centre screws to specified pretightening torque – see C 011.05.01.

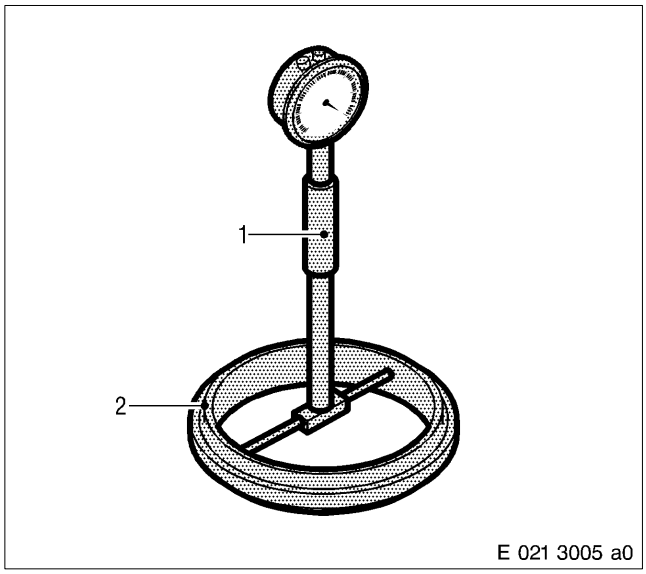
Mark screw heads.

Tighten screws through specified additional angle of rotation.



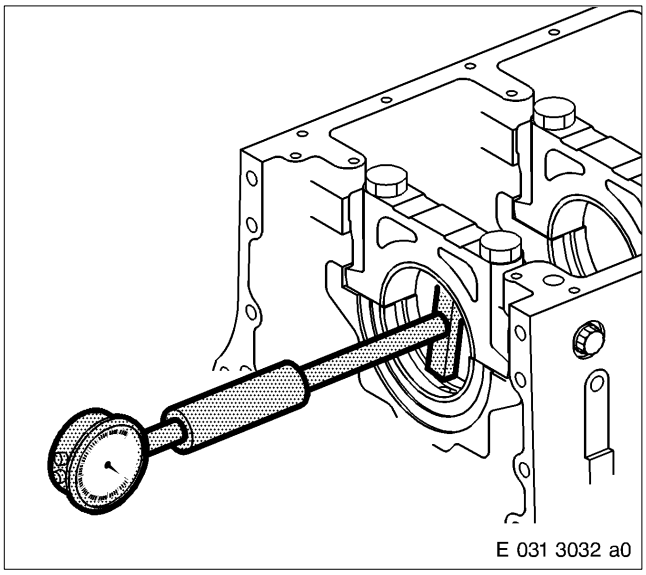
Note: Tighten lateral double-hex screws of one bearing simultaneously.

Simultaneously tighten side double-hex screws, starting from alignment bearing, in one work step to specified torque – see C 031.05.01.



Measuring crankshaft bearing ID.

Adjust bore gauge (1) and dial gauge with micrometer or gauge ring to basic size for crankshaft bearing bore as per (2) Tolerance and Wear Limits List.



Coat wear faces of main bearing shells with engine oil.

Measure ID of main bearing bore with shells installed.

Enter measurement values in data sheet.

For measuring points and limit values, see Tolerance and Wear Limits List.

Replace bearing shells or use repair-size bearings if limit values are exceeded.

After measuring main bearing bore ID, if necessary mark bearing shells according to bearing shell number.

Note: Release screws on one bearing at same time.

Remove side double-hex screws and then central hex screws in reverse sequence as to when installing.

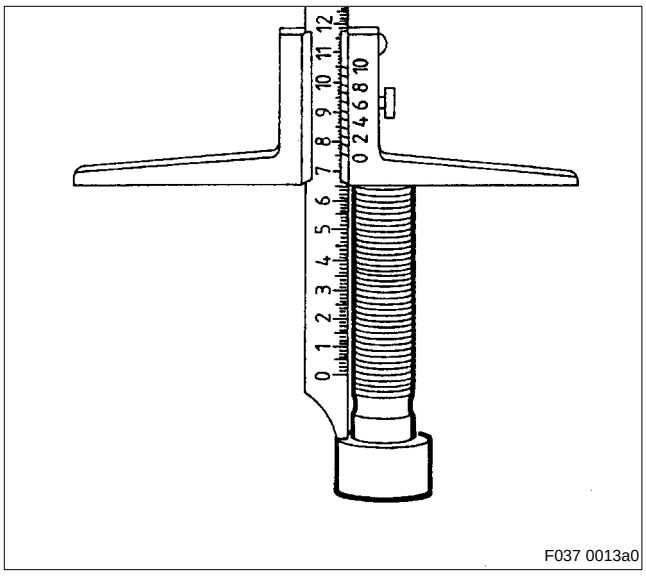
⚠ CAUTION

Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Remove bearing cap and bearing shells.

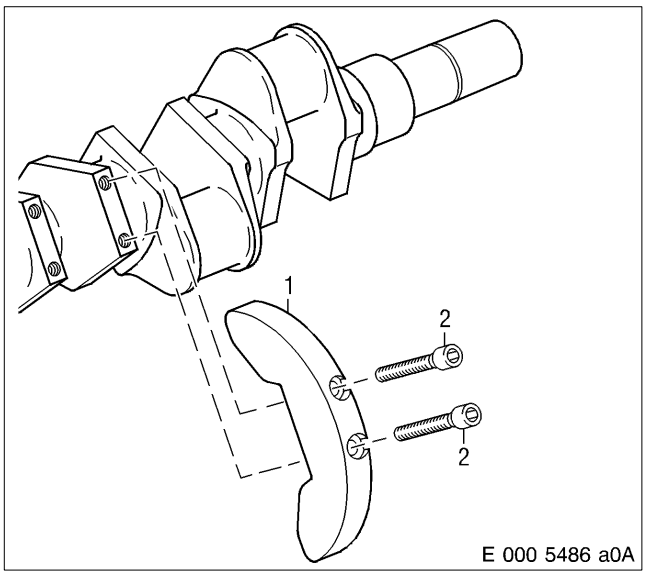
Note: Protect bearing shells from damage!

C 031.05.10 Assembly



Installing counterweights

Measure shaft length of screws for counterweights; for max. shaft length, see C 031.05.01.

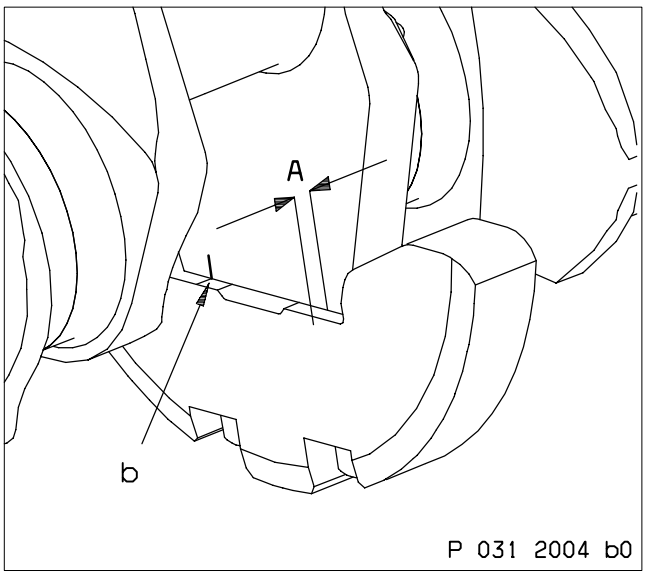


Clean and degrease mating face on crankshaft and counterweight (1).

Coat threads and screw head mating face of screws (2) with engine oil.

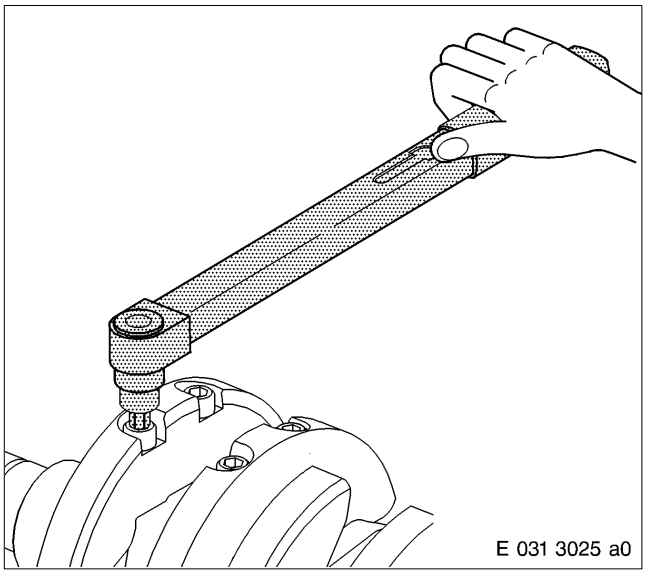
Note: Install counterweights in accordance with markings.

Fit counterweight on crankshaft and tighten slightly with screws.



Set counterweight to marking b and dimension A and pretighten screws to specified pretightening torque – see C 031.05.01.

Check that marks applied prior to disassembly and measured distances are correct.

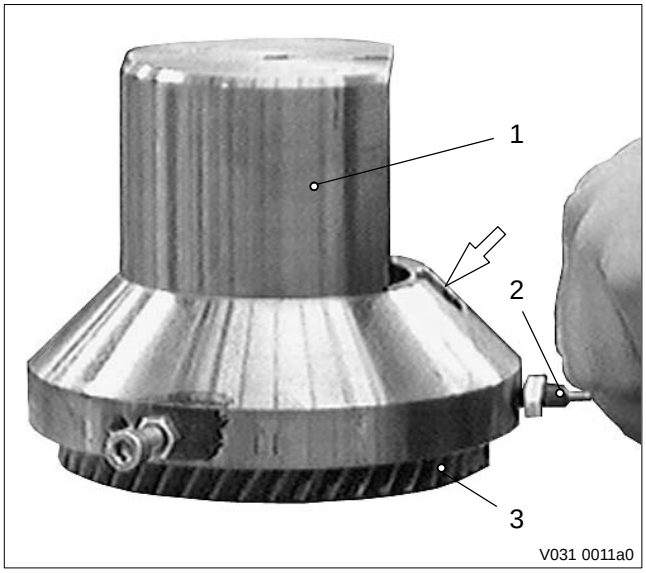


Mark screw heads.

Tighten screws through specified additional angle of rotation.

After installing counterweights, recheck identification marks on counterweights and webs.

Note: If new counterweights have been installed, dynamically balance crankshaft. Also apply identification numbers to counterweights using punch numerals and beginning at driving end.



Installing crankshaft gear, driving end

Clean and degrease surface of main journal and gear bore.

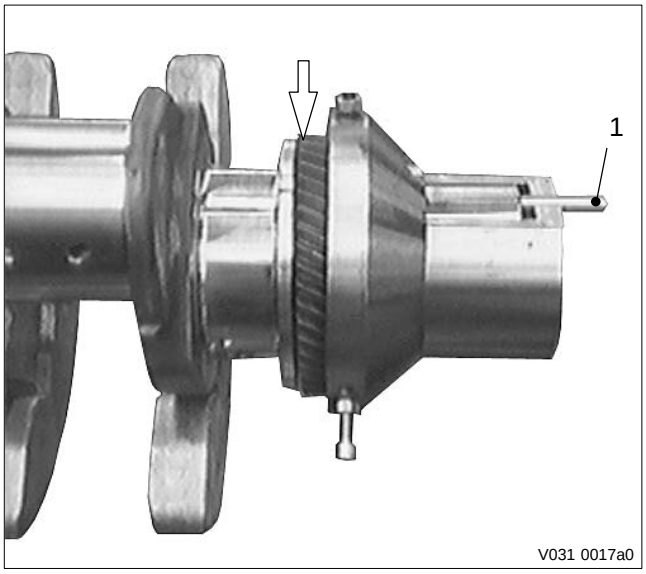
Install crankshaft gear, driving end (3), in alignment tool (1) in such a way that spring pin bore in crankshaft gear is aligned with bore (arrow) of alignment tool.

Position and fix crankshaft gear with threaded pin (2).

Use heating unit to heat crankshaft gear, driving end, to approx. 190 °C + 10 °C.

⚠ CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.



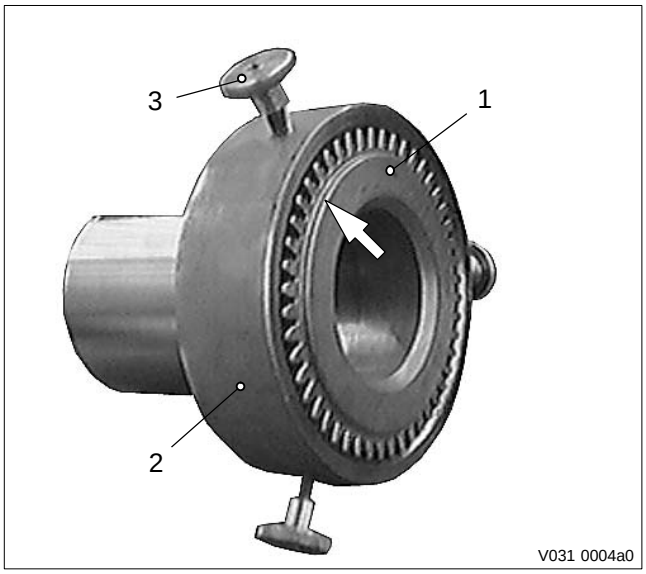
Insert guide pin (1) into bore of crankshaft, driving end.

Mount spacer tool (arrow) on crankshaft and fit crankshaft gear, driving end, using alignment tool on crankshaft.

Once the components have cooled to room temperature, remove alignment tool.

Check distance (arrow) between gear and crankshaft collar.

Specified distance: 2.0 +0.2 mm.



Installing crankshaft gear, free end

Clean and degrease surface of main journal and gear bore.

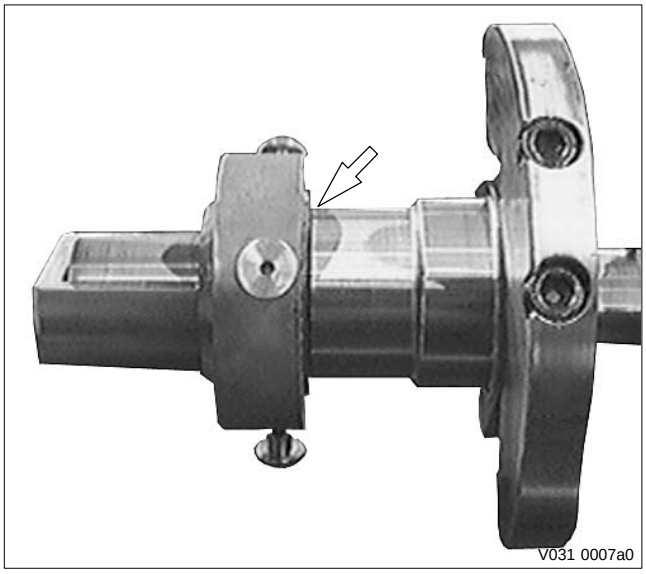
Insert crankshaft gear, free end (1), into assembly device (2) and fix with knurled nuts (3).

Ensure chamfer (arrow) is correctly positioned.

Heat crankshaft gear, free end, with heating unit to approx. 220 °C + 20 °C.

⚠ CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.



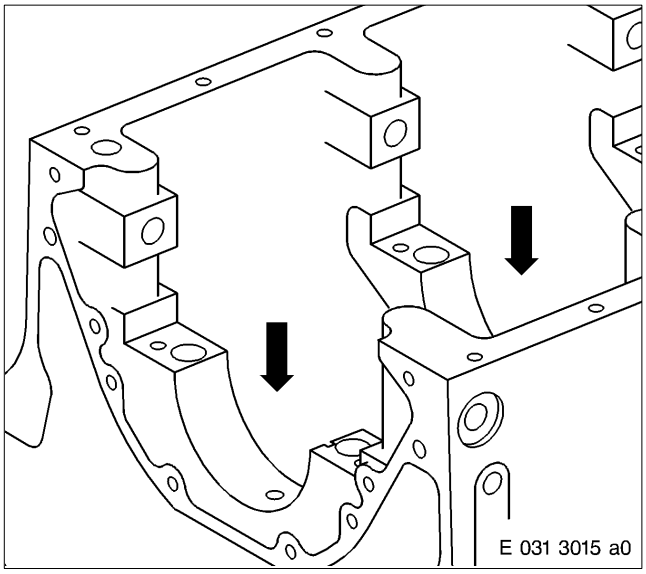
Using assembly tool, fit heated crankshaft gear, free end, on crankshaft.

Adjust spacing (arrow) between crankshaft and crankshaft gear, free end, with feeler gauge.

Specified spacing = 0.2 mm

Once the components have cooled to room temperature, remove assembly tool.

C 031.05.11 Installation



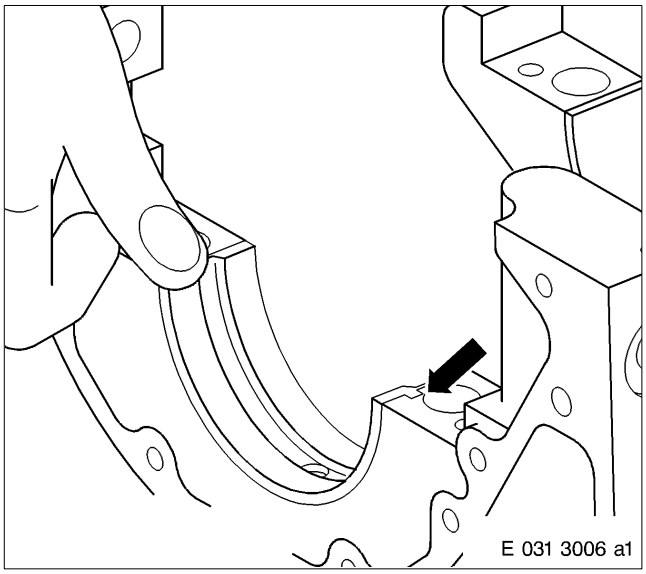
Installing crankcase bearing shells

Note: Always make sure that all components are perfectly clean.

Turn crankcase upside down in assembly dolly with oil pan mating face horizontal.

Wipe bores for crankshaft bearing in crankcase and bearing shells on both sides.

Light up oil bores (arrows) to main bearings in crankcase with cold light and check that they are perfectly clean.



Note: Top and bottom bearing shells have different part numbers.

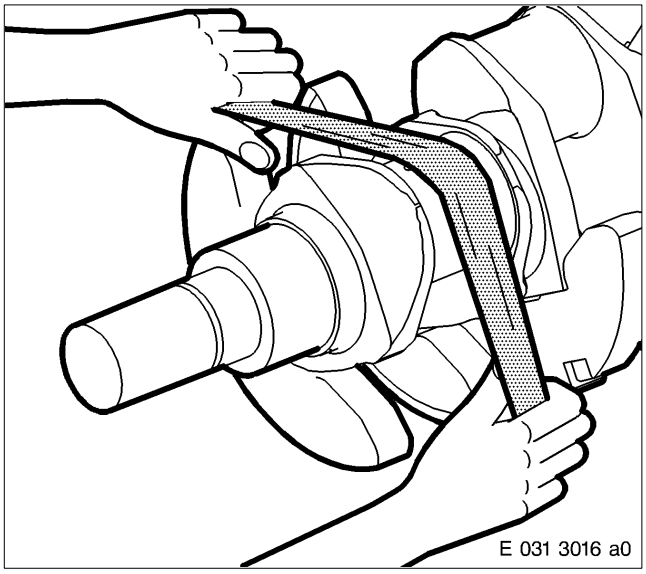
Insert bearing shells (bearing shells with oil groove and oil bore) in housing bore according to bearing numbers by hand to form a positive connection.

Check repair stage of crankshaft main bearing bore and repair stage of bearing shells – see crankcase data sheet and crankshaft characteristics record.

Securing lug (arrow) of bearing shell must sit in groove in crankcase.

Oil bores in bearing shells and crankcase must be aligned.

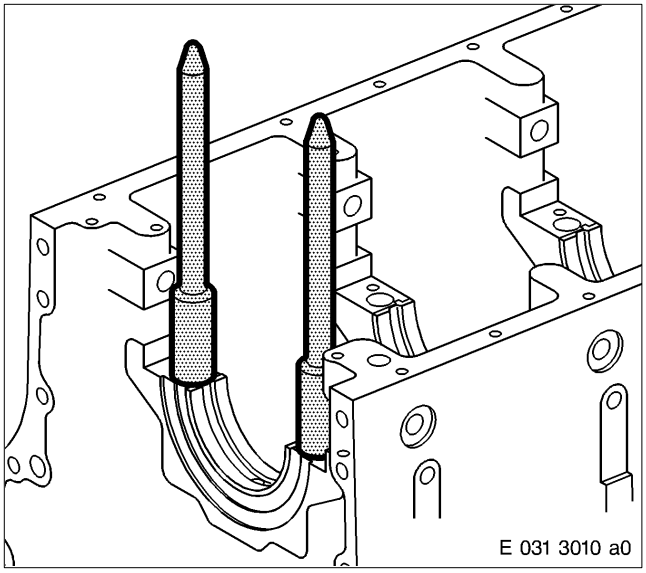
Spray running faces of crankcase bearing shells with engine oil.



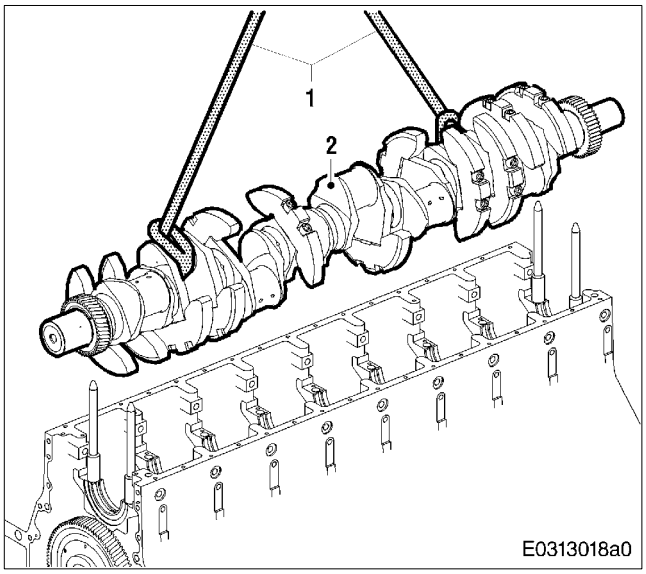
Installing crankshaft

Wipe crankshaft bearing surfaces.

Inspect oil bores with lamp and ensure they are perfectly clean.



To protect crankshaft, insert four assembly screws on first and last bearing.

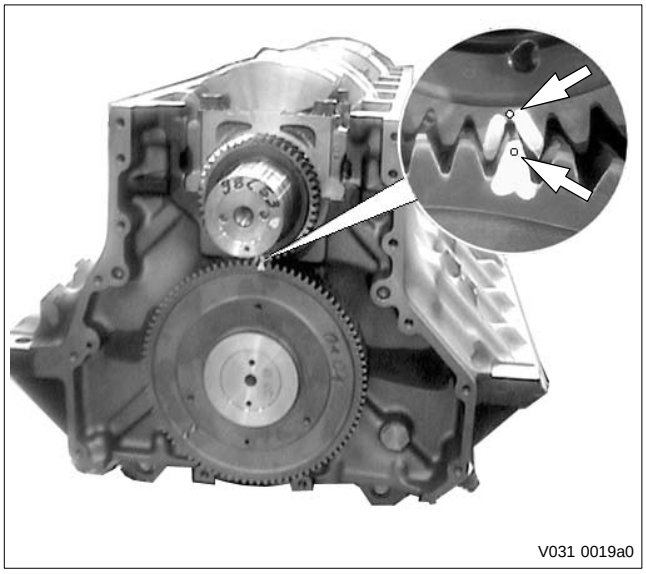


⚠ WARNING

Suspended load.
Risk of fatal injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Lift crankshaft (2), using rope slings (1) and crane.

Align crankshaft horizontally and vertically with line of bores in crankcase and gradually lower crankshaft.

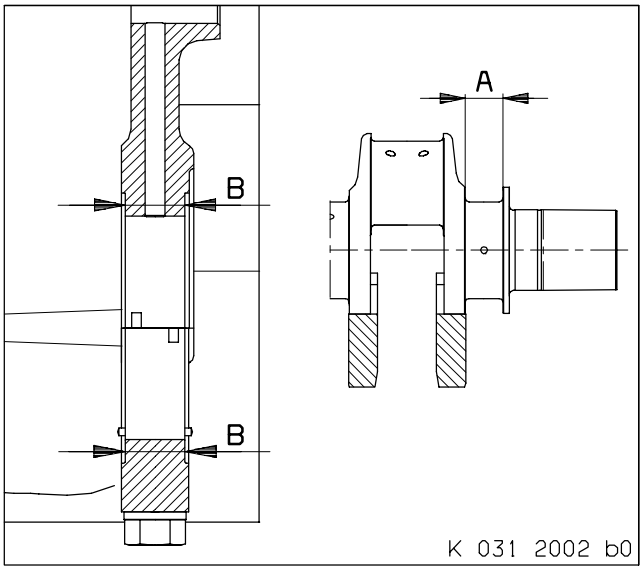


With the camshaft installed, before the crankshaft reaches its end position in the bearing shells, ensure that the markings (arrows) on the crankshaft gear and the camshaft gear are aligned.

Carefully lower crankshaft into bearing shells.

Remove assembly screws.

Note: Do not rotate the crankshaft until the axial alignment bearing has been installed.



Determining wall thickness of friction washers

In order to achieve specified axial clearance in accordance with Tolerance and Wear Limits List after crankshaft is installed, thickness of friction washers must be determined as follows.

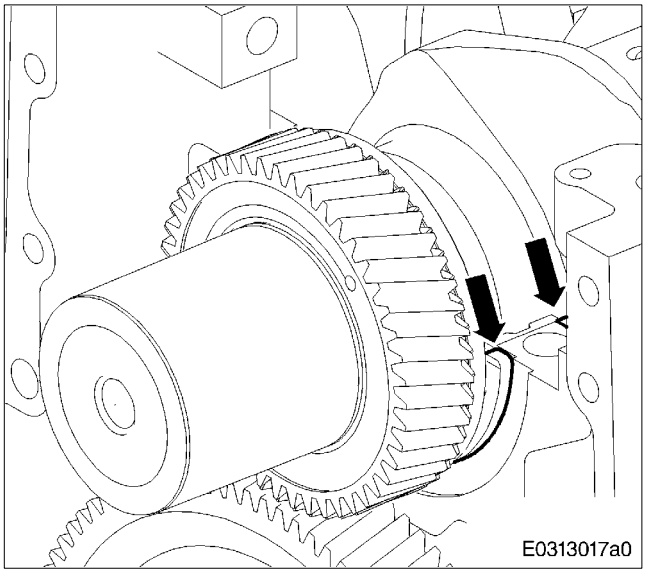
Measure and record alignment bearing width A of crankshaft.

Measure and record crankshaft alignment bearing cover thickness and crankcase web thickness B at fit for friction washers.

To calculate friction washer wall thickness:

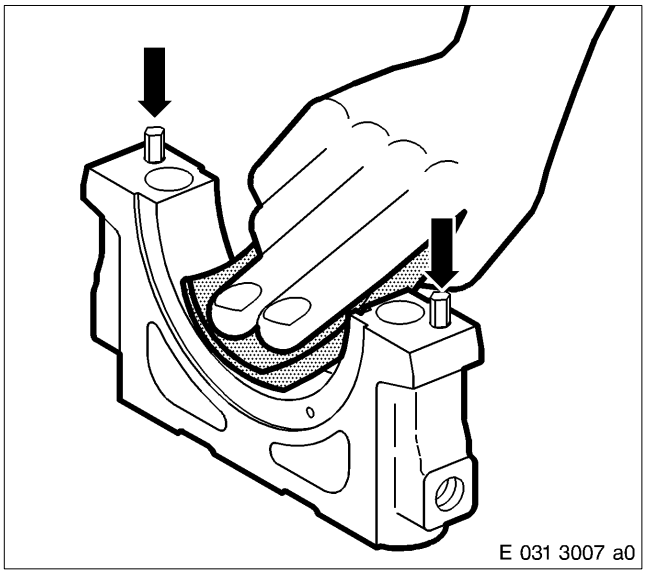
Wall thickness = (A – B + mean axial clearance): 2

Note: Friction washers of equal thickness must be installed on both crankshaft alignment bearing sides.
Friction washers are ready for installation ex works and also delivered in larger sizes for purposes of repair.
No reconditioning must be carried out!



Installing upper friction washer halves

Coat friction washers (arrows) with engine oil and slide into guides between crankshaft alignment bearing and mating face in crankcase on both sides of first bearing.



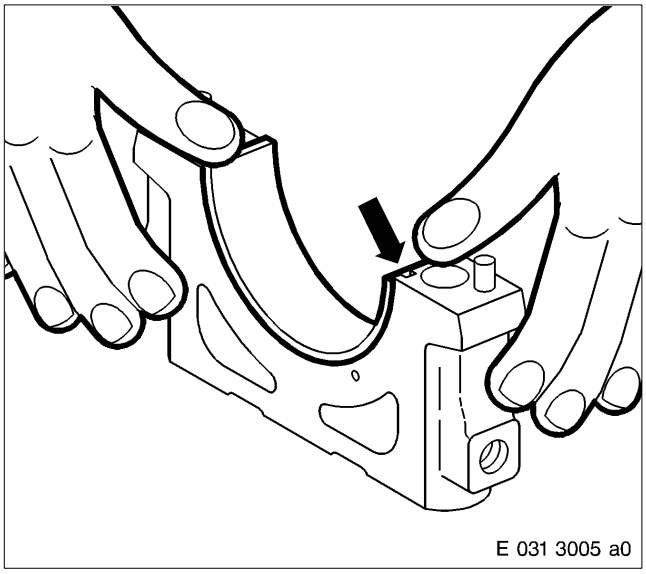
Installing main bearing caps

Wipe bearing shell mating faces on crankshaft bearing cap.

⚠ CAUTION

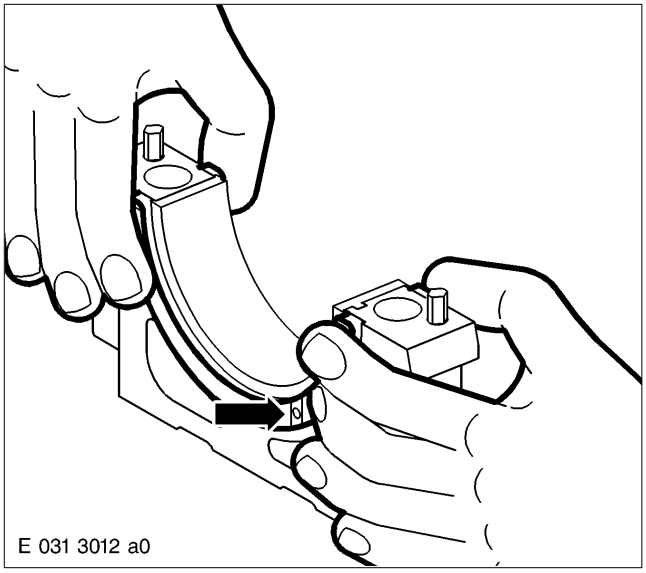
Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

Blow out partitions on crankshaft bearing cap and crankcase, cylinder and dowel pins (arrows) and related bores in crankcase with compressed air and check for that they are perfectly clean.



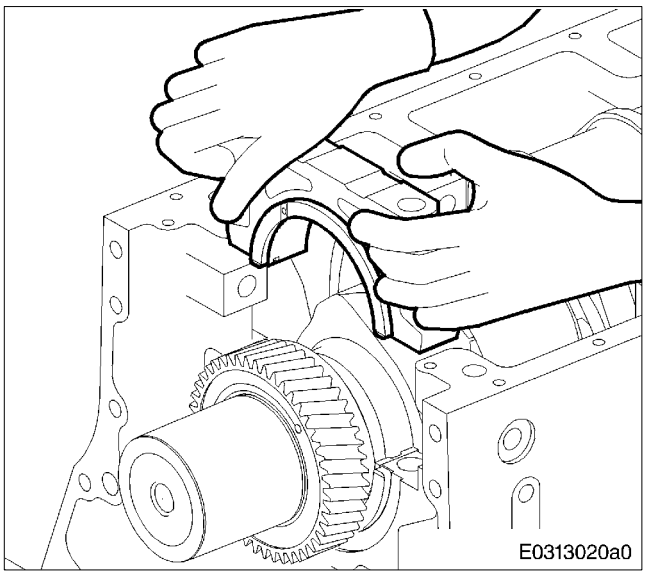
Wipe lower bearing shell (bearing shell without oil bore) on both sides and insert into main bearing cap according to bearing number.

Securing lug (arrow) of bearing shell must sit in groove in crankshaft bearing cap.



Coat friction washers with engine oil.

Install friction washers on both sides of crankshaft alignment bearing cover, ensuring that grooved pin fit (arrow) is not damaged.



Spray crankshaft bearing journals with engine oil.

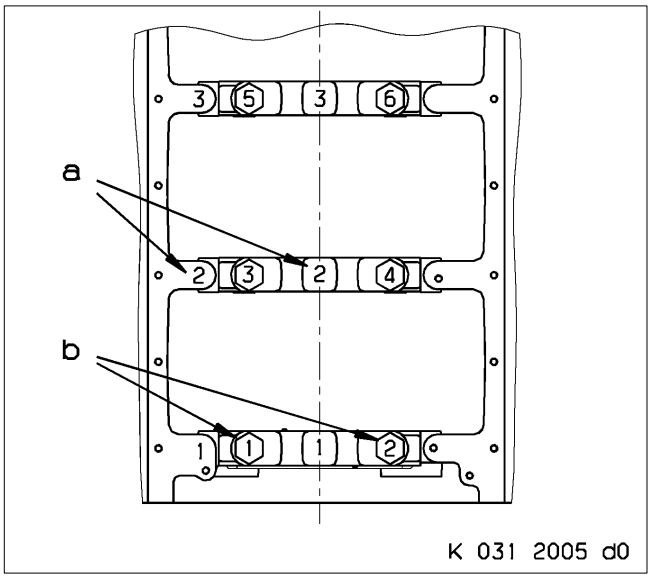
⚠ CAUTION

Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Note: Main bearing caps must not be interchanged!

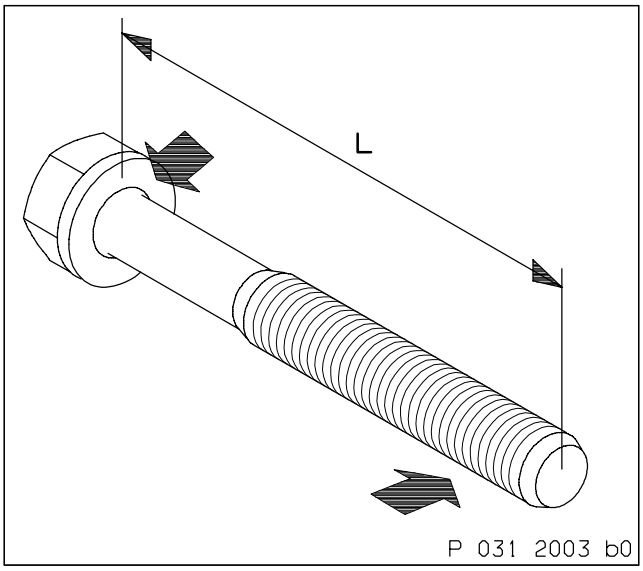
Fit bearing caps according to marking, (see next illustration), on appropriate crankcase bearing and install in crankcase.

Note: Prior to installing bearing cap No. 1, ensure that counterweight is in lower position.



a – Consecutive numbering of the main bearing starting from the driving end.

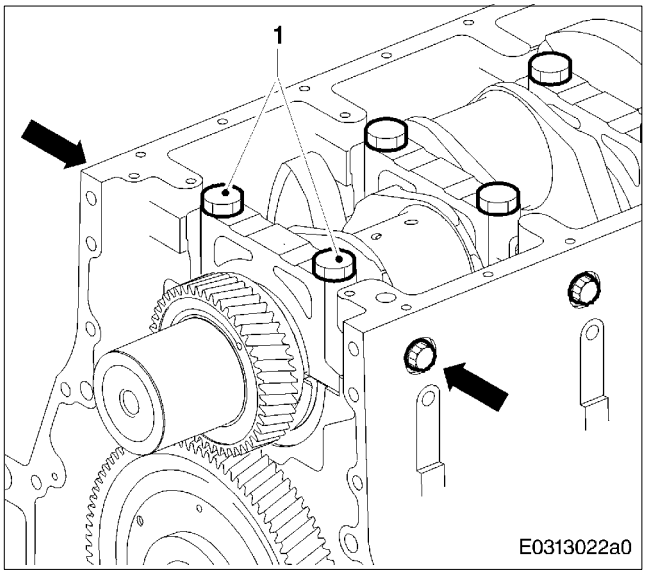
b – Consecutive numbering of hex screws.



Measure shaft length (L) of central hex screw for crankshaft bearing cap. For max. shaft length – see C 031.05.01.

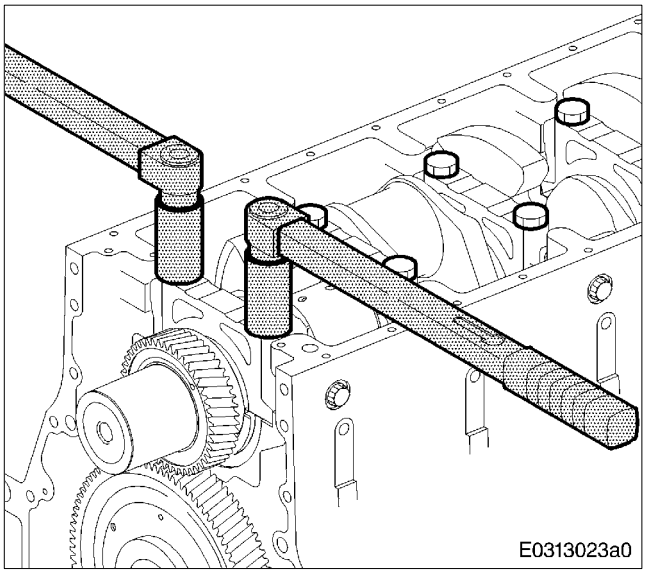
Coat thread and screw head mating face of centre hex screws (arrows) with engine oil.

Fit hex screws as per markings – see previous illustration.



Insert hex screws (1) and tighten by hand.

Coat thread and mating face of side double-hex screws (arrows) with engine oil and insert double-hex screws but do not tighten yet.

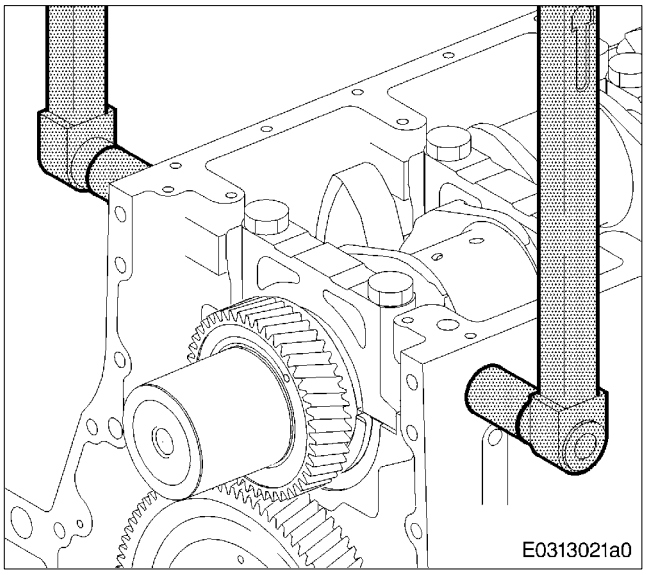


Note: Always tighten screws on one bearing at same time.
Tightening sequence, starting from alignment bearing.

Pretighten central screws to specified pretightening torque – see C 031.05.01.

Mark screw heads.

Simultaneously tighten screws on one bearing according to specified angle of further rotation.

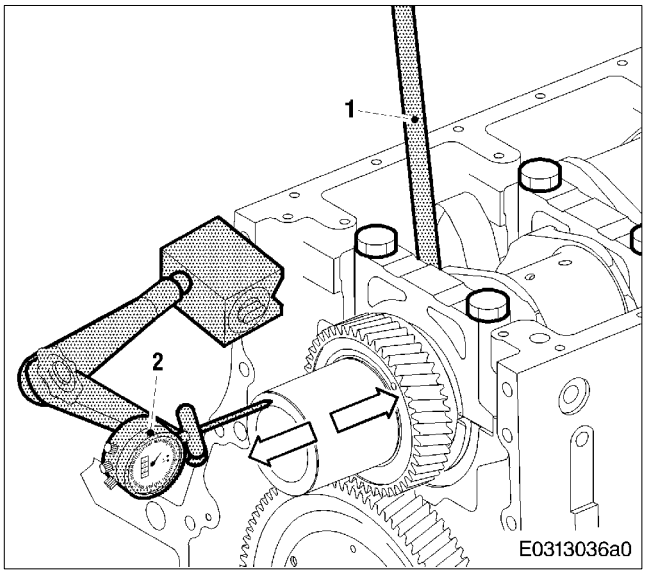


Note: Always tighten screws on one bearing at same time.
Tightening sequence, starting from alignment bearing.

Tighten side double-hex screws to specified torque – see C 031.05.01.

Bar crankshaft manually and check for ease of movement.

Crankshaft must turn freely.



Measuring crankshaft axial play

Mount magnetic dial gauge holder with dial gauge (2) on crankcase.

Position dial gauge stylus against front face of crankshaft.

Using pry bar (1), press crankshaft axially as far as it will go.

Set dial gauge with preload to zero.

Move crankshaft from stop to stop (arrows) and enter measured value (axial clearance) in data sheet.

If determined measured value is outside permissible tolerance – see Tolerance and Wear Limits List, remove crankshaft and check cause.

C 031.05.12 After-Installation Operations

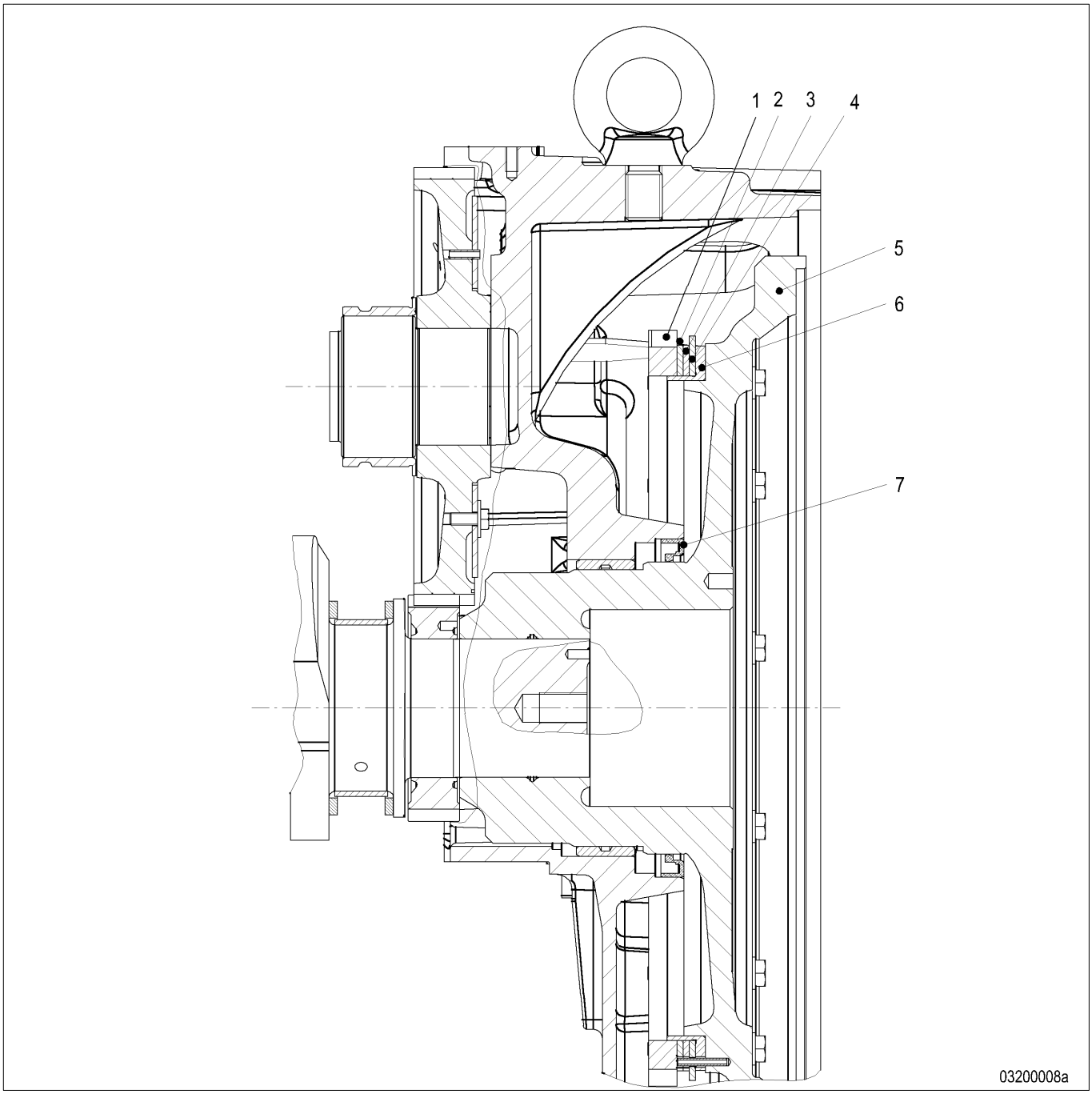
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

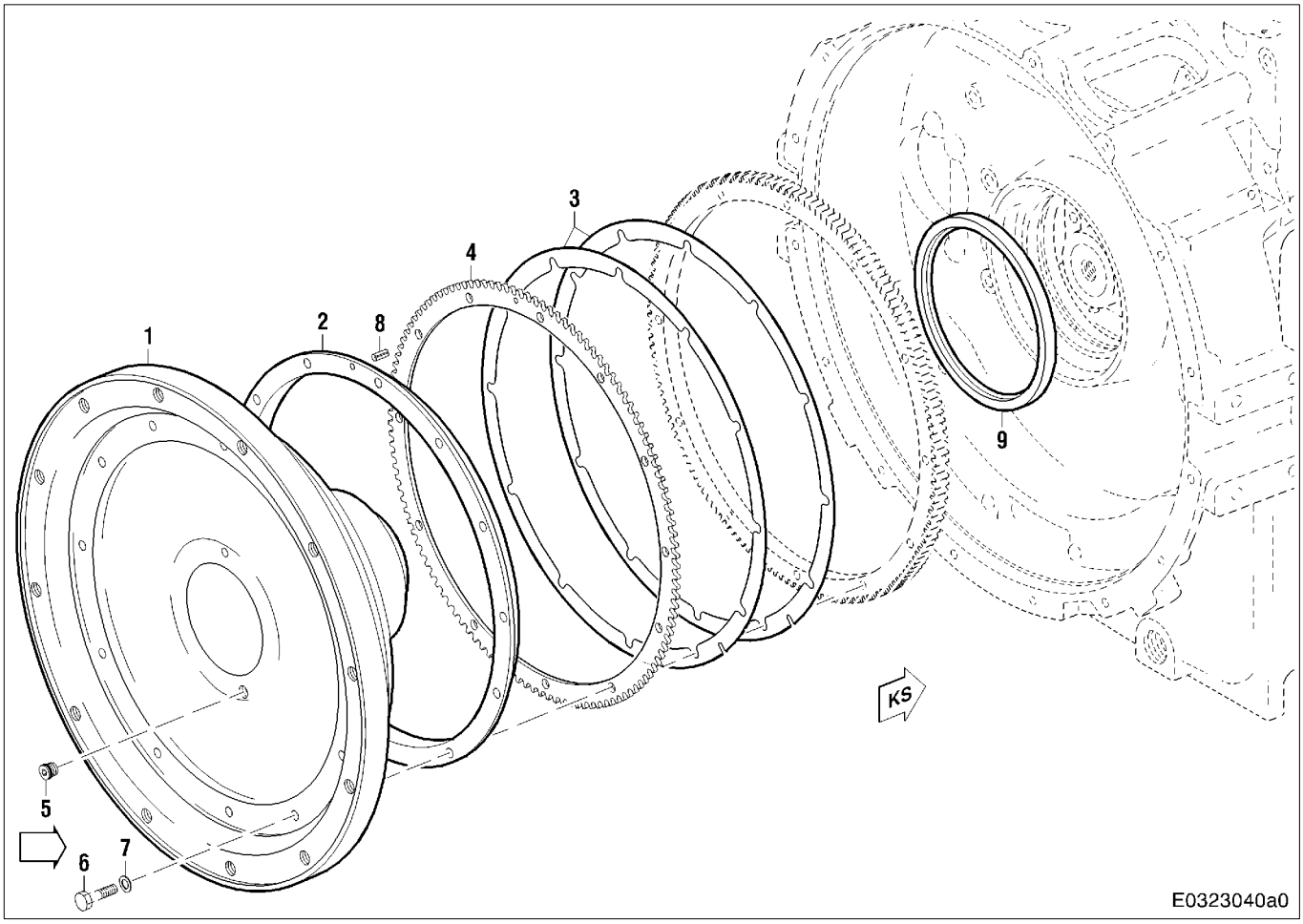
1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007

C 032.05 PTO, Driving End

C 032.05.01 Overview Drawing

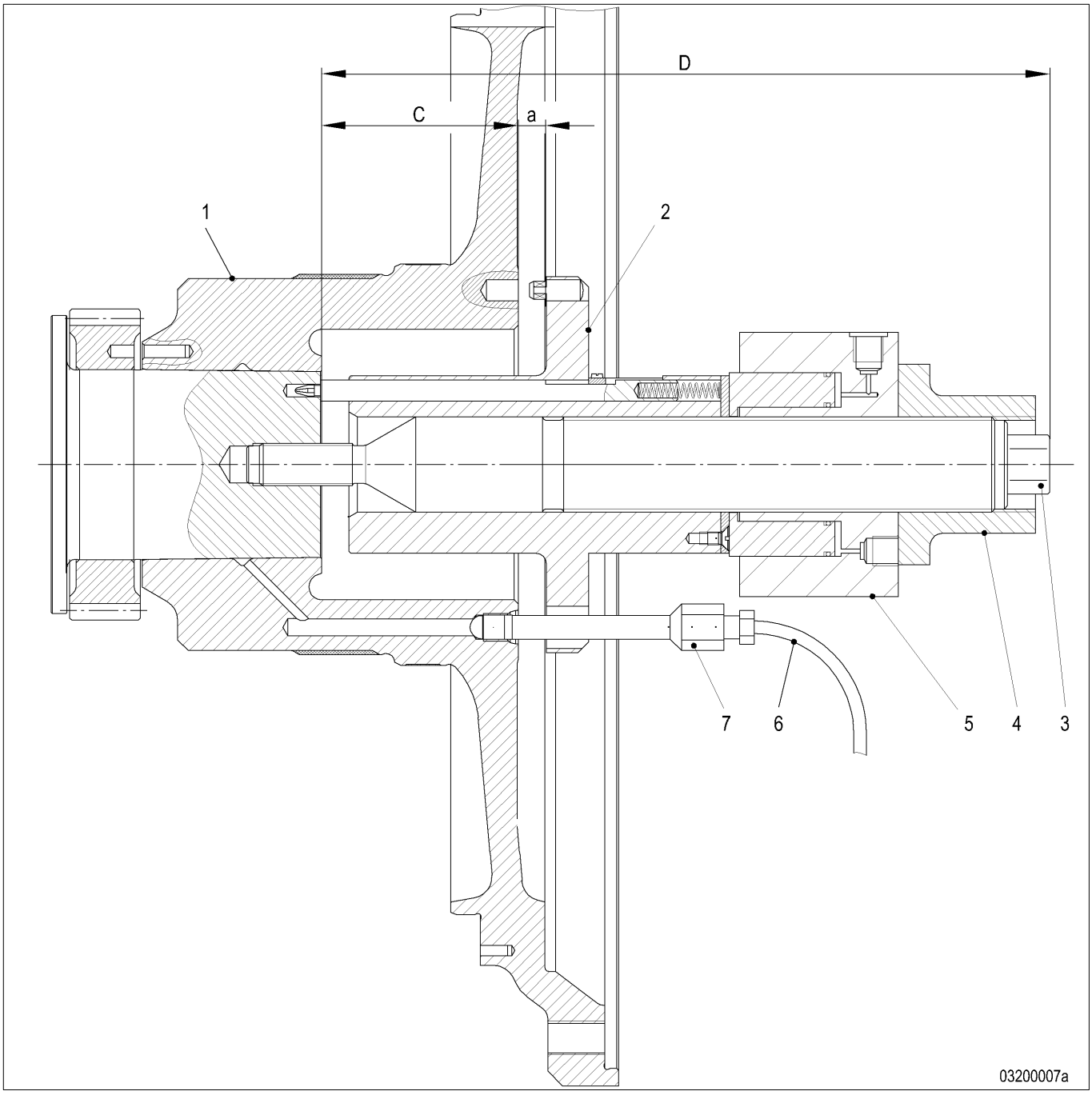


1 Ring gear
2 Intermediate washer
3 Intermediate washer
4 Measuring wheel
5 Flywheel
6 Ring
7 Radial-lip shaft seal



1 Flywheel
2 Ring
3 Intermediate washer
4 Measuring wheel
5 Plug
6 Hex screw
7 Washer
8 Spring pin
9 Radial-lip shaft seal

Layout for installation/removal tool for flywheel



1 Flywheel
2 Thrust bush
3 Draw spindle
4 Nut
5 Hydraulic press
6 H.P. line
7 Reducer

Push-on dimension	C = 93.5 mm ± 0.5 × mm
Reference dimension	D = 345 mm
Push-on distance	a = from 12.1 mm to 14.6 mm

C 032.05.02 Special Tools

Designation – Application	Number
Installation/removal tool for flywheel	1
Oil pressure hand pump 0–3500 bar	1
Lukas hand pump	1

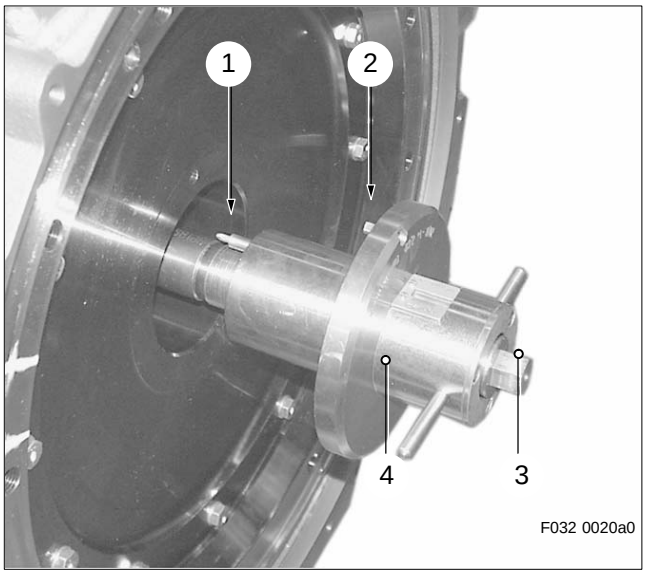
C 032.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Separate engine from alternator	–
–	x	x	Remove coupling	Special Publication

C 032.05.05 Removal



Remove flywheel

⚠ WARNING

Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off and cause serious injury.
Risk of knocks or crushing!
Liquids emerging under high-pressure can lead to serious injury!
Hydraulic installation/removal must be carried out only by qualified personnel. Only use specified and tested equipment.
The specified expansion and push-on pressure must not be exceeded.
No-one is permitted to enter the danger zone behind the device while installation/removal is in progress. Do not attempt to bend or exert force on h.p. lines.
Always wear protective gloves and protective goggles/safety mask.

Arrangement of installation/removal tool – see overview drawing C 032.05.01.

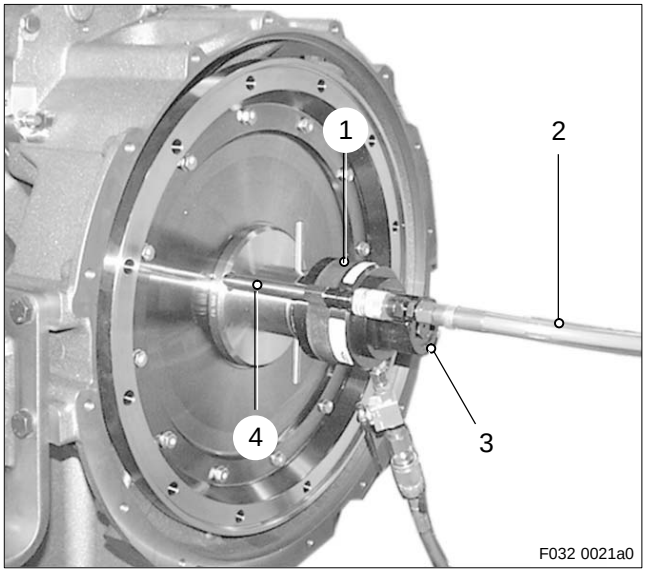
Screw draw spindle (3) into crankshaft.

Measure reference dimension (D) draw spindle mating faces to crankshaft mating faces.

D = 345 mm

Remove plug from expansion bore in flywheel.

Fit pressure bush (4) on draw spindle, ensuring correct fit of positioning pin (1) in crankshaft and dowel pin (2) in flywheel.



Screw reducer (4) into flywheel and tighten.

Fit hydraulic press (1) over draw spindle up to pressure bush.

Fit nut (3).

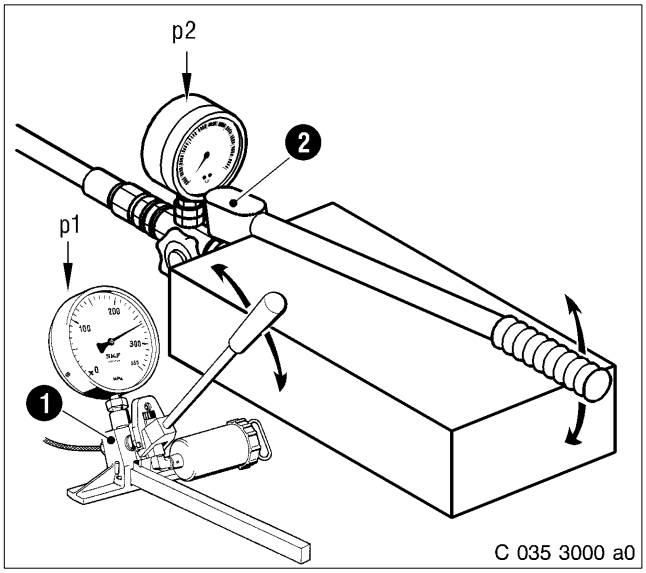
Connect H.P. line (2) to reducer.

Connect H.P. line of Lukas hand pump to hydraulic press.

Fully tighten nut then back off nut distance equal to push-on dimension.

Push-on dimension “a” is stamped on flywheel.

Note: Before tightening nut, make sure that hydraulic press is in initial position (0 stroke).



Fill hydraulic hand pumps with SAE10 engine oil.

Vent pumps and pipework until bubble-free oil emerges.

Tighten high-pressure line.

Operate Lukas hand pump (2) for hydraulic press and, by applying minimum pressure (p2) (start of pressure increase), seat press against flywheel.

Note: The hydraulic press acts as a buffer, stopping the flywheel as it slips off its taper seat.

Operate hydraulic hand pump (1) for expanding the flywheel taper until expansion pressure is half the permitted maximum (p1).

Maintain this pressure for approx. 5 minutes.

Maximum expansion pressure p_{max} is stamped on flywheel.

Increase expansion pressure in stages of 0.1 · p_{max}, waiting approx. 2 minutes between increases, until flywheel is released from crankshaft.

Do not exceed the maximum permissible expansion pressure p_{max}.

Operate pump to maintain constant expansion pressure.

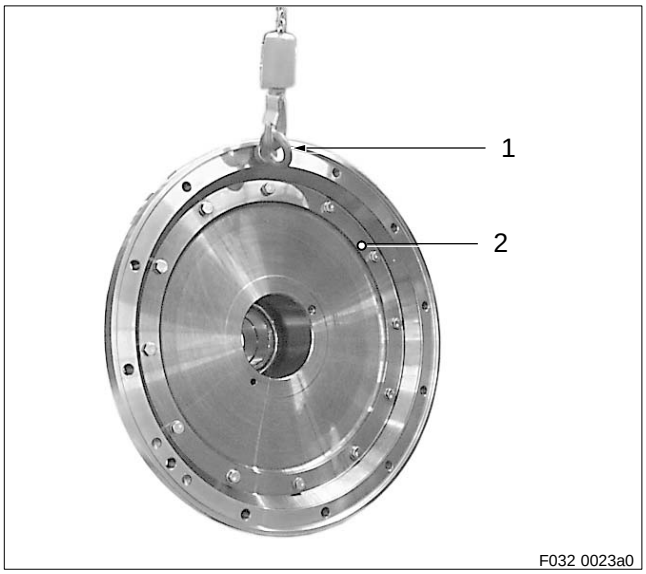
An increase in pressure (p2) at the hydraulic press indicates that the flywheel is released from tapered seat.

Gradually relieve pressure in hydraulic press while steadily operating pump for expansion fluid.

Relieve pressure in hydraulic hand pumps.

Remove high-pressure line and reducer.

Remove nut, hydraulic press, pressure sleeve, and draw spindle.



⚠ WARNING

Suspended load.
Risk of injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Insert eyebolt (1) into flywheel (2).

Attach flywheel with crane and ropes.

Remove vibration damper from crankshaft.

C 032.05.06 Disassembly


F032 0027a0

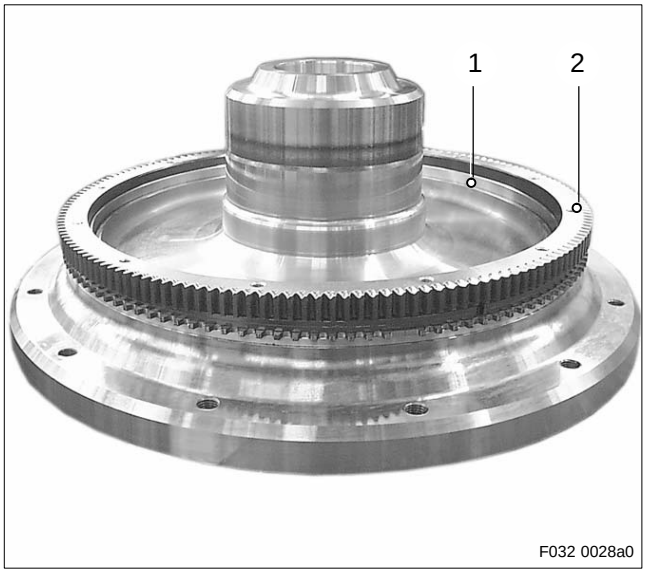
Disassembling flywheel

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Lay flywheel on workbench.

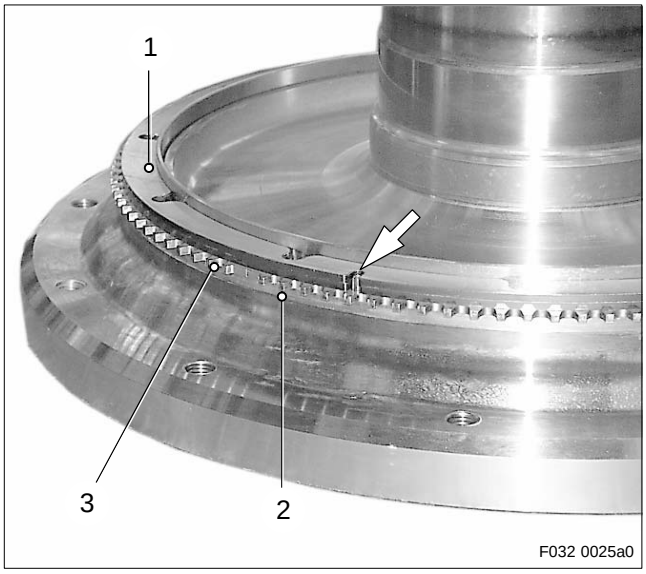
Remove hex screws (arrows) and washers.



F032 0028a0

Turn flywheel on assembly bench by 180°.

Use crowbar to press ring gear (2) from ring (1).



F032 0025a0

Remove intermediate washers (1), graduated disc (3) and ring (2) from flywheel, taking care not to damage spring pin fit (arrow).

If necessary (e.g. due to damage), remove spring pin from flywheel.

C 032.05.08 Inspection and Repair

Clean all parts.

Using the magnetic crack-testing method with fluorescent magnetic powder, check flywheel for cracks.

Replace flywheel if cracks are found.

Check mating faces on flywheel for evenness, wear, scoring and indentations; recondition if necessary.

Renew flywheel if scoring and indentations are greater than the maximum permissible material removal – see Tolerance and Wear Limits List.

Check all sealing, mating and bearing faces on flywheel for wear, scoring and indentations.

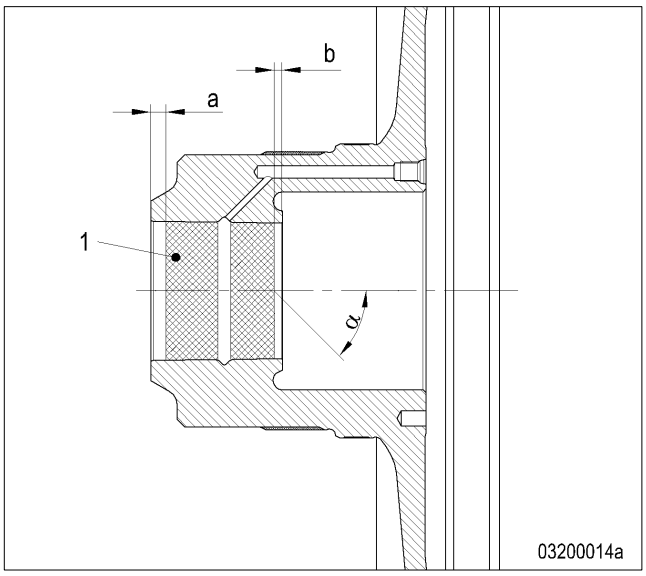
Remove minor wear, indentations and scoring by rubbing down with emery cloth or an oilstone; replace flywheel if necessary.

Check thread of expansion bore; rechase if necessary.

Check thread in ring gear for perfect condition and ease of movement, recut if necessary.

Check ring gear for wear, replace if necessary.

Remove slight burrs and chipping from teeth by grinding or filing.



Check taper surface (1) of flywheel for wear, scoring and damage.

Remove minor scoring and damage by polishing with emery cloth.

Roughen smooth wear caused by assemblies etc. with emery cloth (graining 60) until roughness corresponds to remaining surface.

Mean roughness height (R_z) of taper surface = from 10 μm to max. R 16 permissible.

Observe dimensions and angles as per illustration.

α = from 15° to 45°

a = from 10 mm to 15 mm

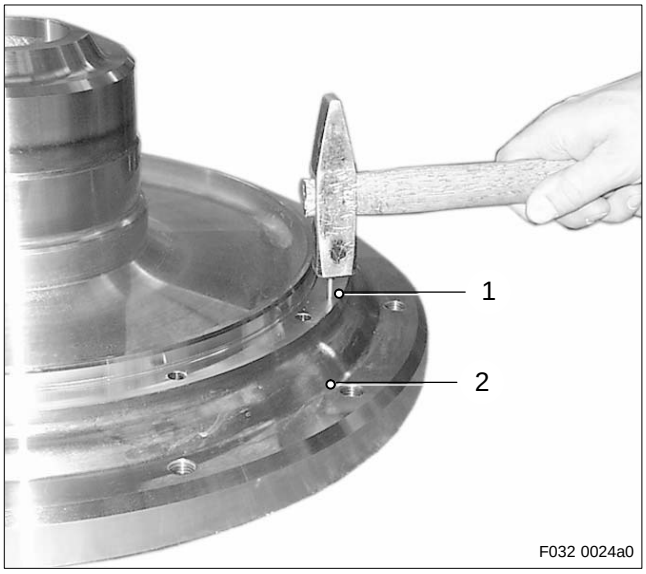
b = from 5 mm to 10 mm

After roughening, clean taper surface and oil bore and check for particular cleanness.

Check taper 1:50 with taper gauge.

Replace flywheel if taper bore is oversized.

C 032.05.10 Assembly



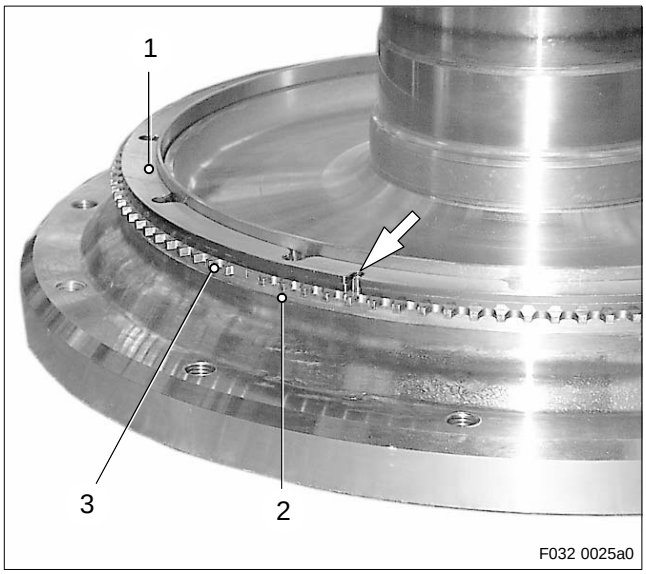
Assembling flywheel

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Lay flywheel (2) on workbench.

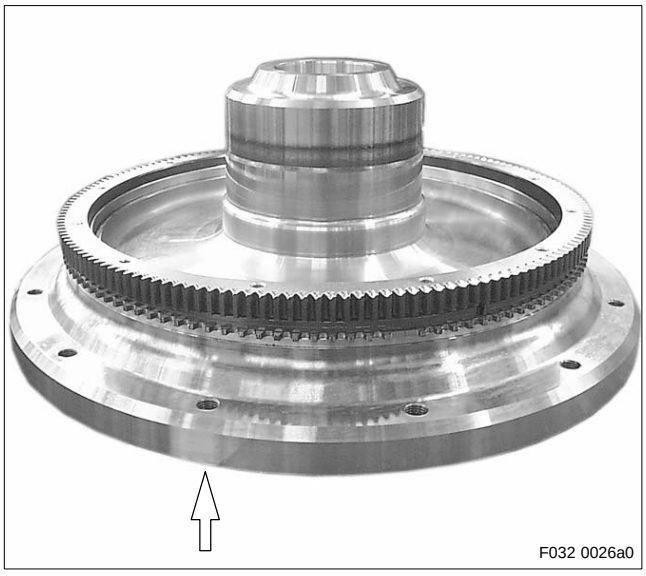
Drive new spring pin (1) into flywheel to a protrusion of 18 mm.



Check that mating faces are particularly clean, clean if necessary.

Mount ring (2), graduated disc (3) and intermediate washers (1) on flywheel.

Take care not to damage spring pin fit (arrow) in ring, measuring wheel and intermediate washers.



Mount ring gear on ring; to position, insert a screw (arrow) into ring gear from beneath.

If necessary, drive in ring gear with plastic mallet.


F032 0027a0

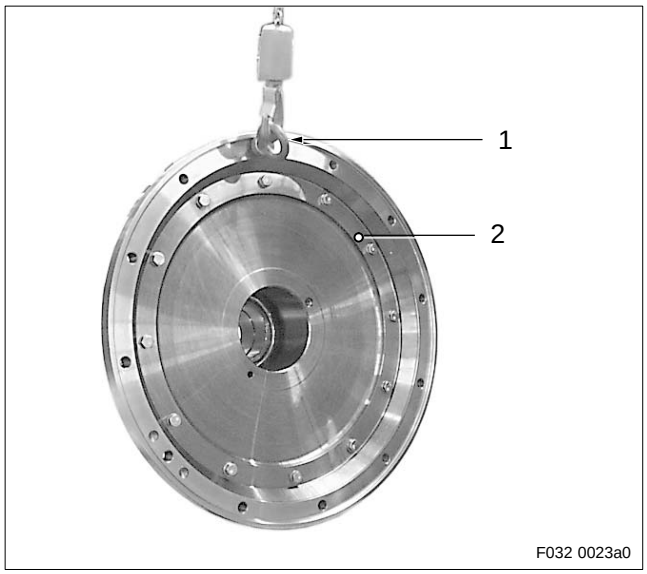
⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Turn flywheel on assembly bench by 180°.

Install hex screws (arrow) and washers and tighten in diagonally opposite sequence.

C 032.05.11 Installation



F032 0023a0

Pressing on flywheel

Clean and degrease taper surface on crankshaft and flywheel (2).

Coat running surface of crankshaft bearing and flywheel (for crankshaft bearing) with oil.

Coat running surface of flywheel for radial-lip shaft seal with thin-film lubricant.

Coat lip of radial-lip oil seal with petroleum jelly.

⚠ WARNING

Suspended load.
Risk of injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Insert eyebolt (1) into flywheel.

Attach flywheel with crane and ropes.

Push flywheel onto crankshaft taper.

Calculate push-on distance by measuring distance from end face of crankshaft to end face of flywheel with depth gauge. Make a note of this distance.

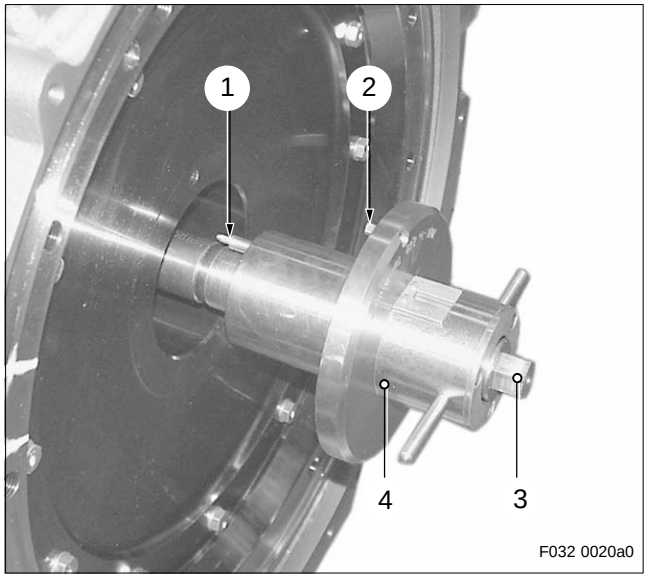
Calculate difference (=push-on distance) between measured dimension and dimension C.

Dimension C = distance from face of crankshaft to face of flywheel after hydraulic installation.

Dimension C, see overview drawing C 032.05.01 – Arrangement of hydraulic installation/removal tool

Push-on dimension “a” is stamped on flywheel.

If calculated distance is less than push-on distance a, check dimensional accuracy of taper.



⚠ WARNING

Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off and cause serious injury.
Risk of knocks or crushing!
Liquids emerging under high-pressure can lead to serious injury!
Hydraulic installation/removal must be carried out only by qualified personnel. Only use specified and tested equipment.
The specified expansion and push-on pressure must not be exceeded.
No-one is permitted to enter the danger zone behind the device while installation/removal is in progress. Do not attempt to bend or exert force on h.p. lines.
Always wear protective gloves and protective goggles/safety mask.

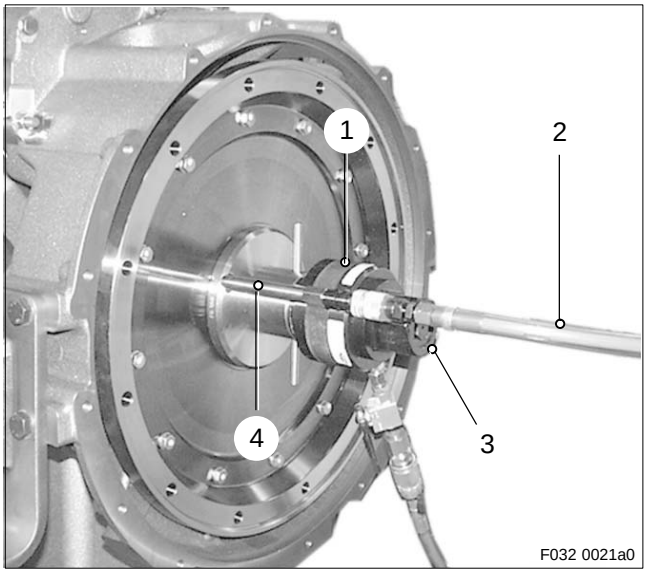
Screw draw spindle (3) into crankshaft.

Measure reference dimension (D) draw spindle mating faces to crankshaft mating faces.

Required dimension D = 345 mm

Dimension D, see overview drawing C 032.05.01 – Arrangement of hydraulic installation/removal tool.

Fit pressure bush (4) on draw spindle, ensuring correct fit of positioning pin (1) in crankshaft and dowel pin (2) in flywheel.



Screw reducer (4) into flywheel and tighten.

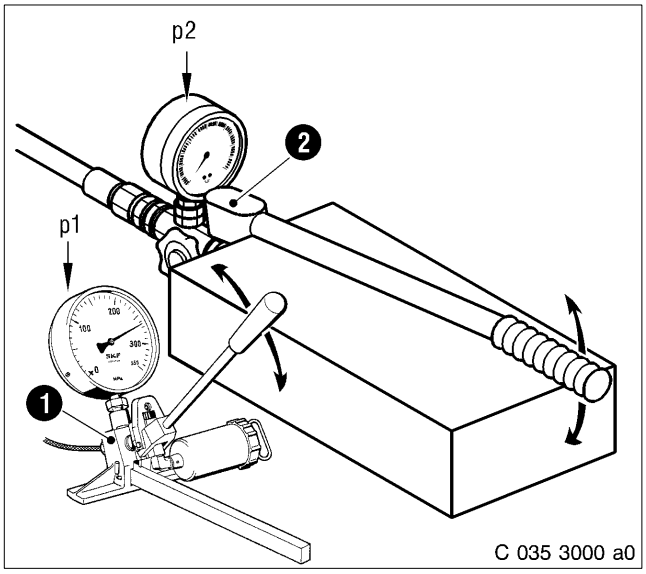
Fit hydraulic press (1) over draw spindle up to pressure bush.

Install nut (3) and hand-tighten.

Connect H.P. line (2) to reducer.

Connect H.P. line of Lukas hand pump to hydraulic press.

Note: Before tightening nut, make sure that hydraulic press is in initial position (0 stroke).



Fill hydraulic hand pumps with SAE 10 engine oil.

Vent pumps and pipework until bubble-free oil emerges.

Tighten high-pressure line.

Before press-fitting, coat taper faces with expansion fluid; operate hydraulic hand pump (1) until expansion fluid escapes at expansion taper.

Operate Lukas hand pump (2) for hydraulic press and, by exerting minimum pressure, seat hydraulic press on flywheel.

Operate pump for expansion fluid until no further increase in expansion pressure (p1) is possible, then operate force-on pump to increase force-on pressure (p2).

Repeat this process until crankshaft gear is seated on flywheel.

Select force-on pressure such as to seat shaft in approx. 5 steps.

When installing, make sure that expansion pressure never exceeds the maximum permissible expansion pressure p_{max}.

p_{max} see information stamped on flywheel.

Hydraulic installation is completed when pressure sleeve is seated against crankshaft.

Open valve screw in hydraulic oil pump to relieve expansion pressure.

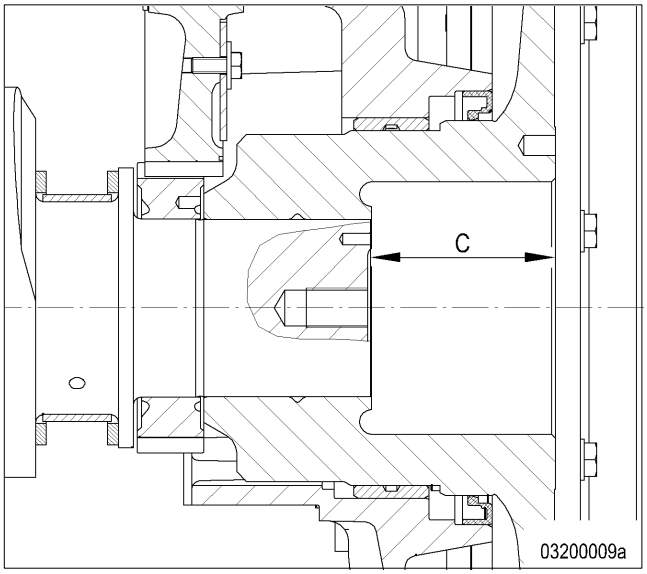
Maintain maximum force-on pressure for 60 minutes, to ensure that the expansion fluid is expelled from the joint and static friction can build up between the fixed components.

Disconnect high-pressure line.

Allow specified retention time to elapse and remove nut, hydraulic press, pressure sleeve, reducer and draw spindle.

Note: Do not subject press fitting to operating load for at least 8 hours.

After holding period, remove oil from the expansion bore in the hub, insert plug and tighten.



Check push-on dimension (C), crankshaft face to flywheel face.

Specified dimension C = 93.5 mm ± 0.5 mm.

C 032.05.12 After-Installation Operations

A distinction must be made as to whether:

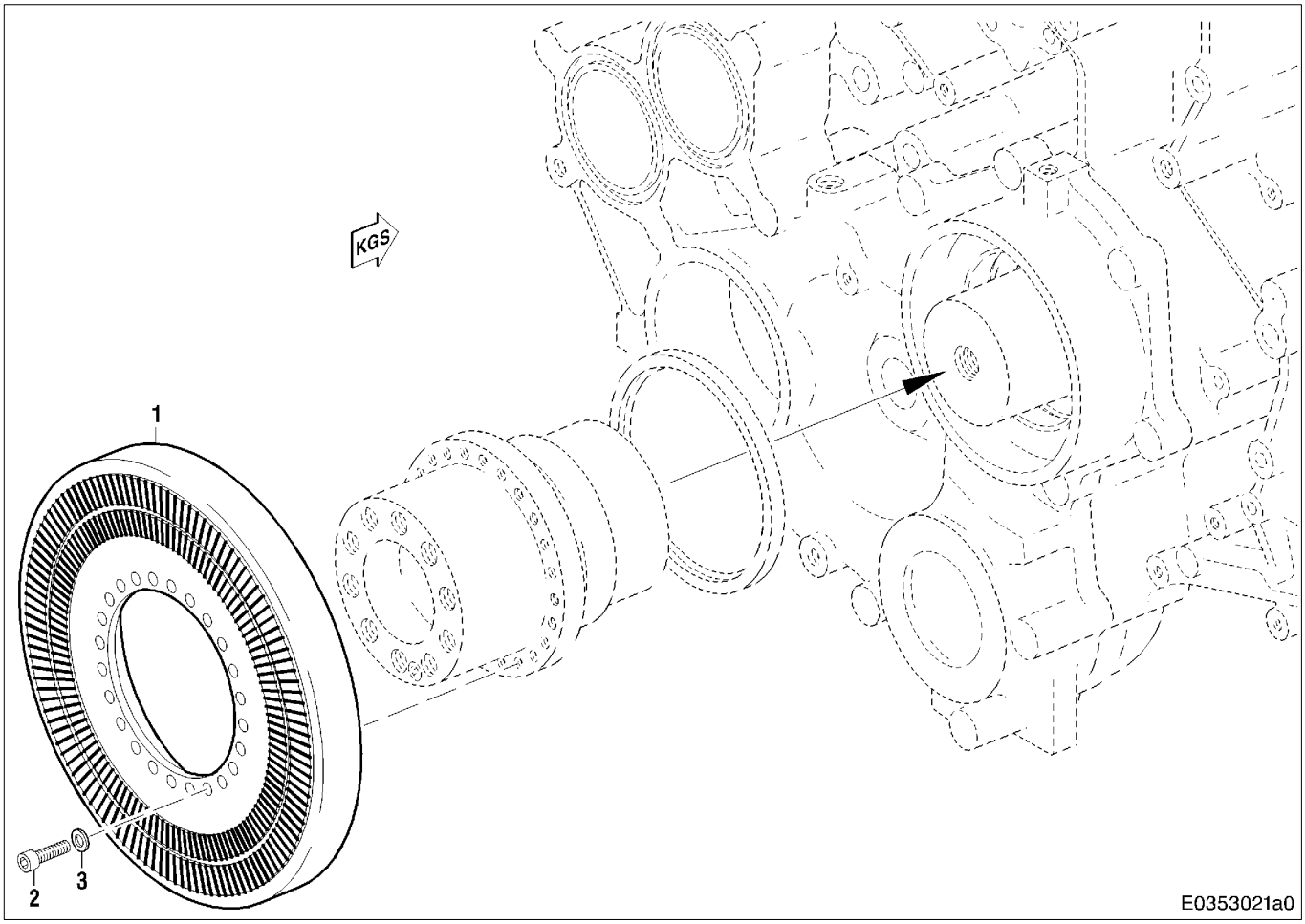
1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install coupling	Special Publication
–	–	x	Connect engine to alternator	–
–	–	x	Release engine start	Operating Instructions

C 035.05 PTO, Free End

C 035.05.01 Overview Drawing

Viscous vibration damper 12V

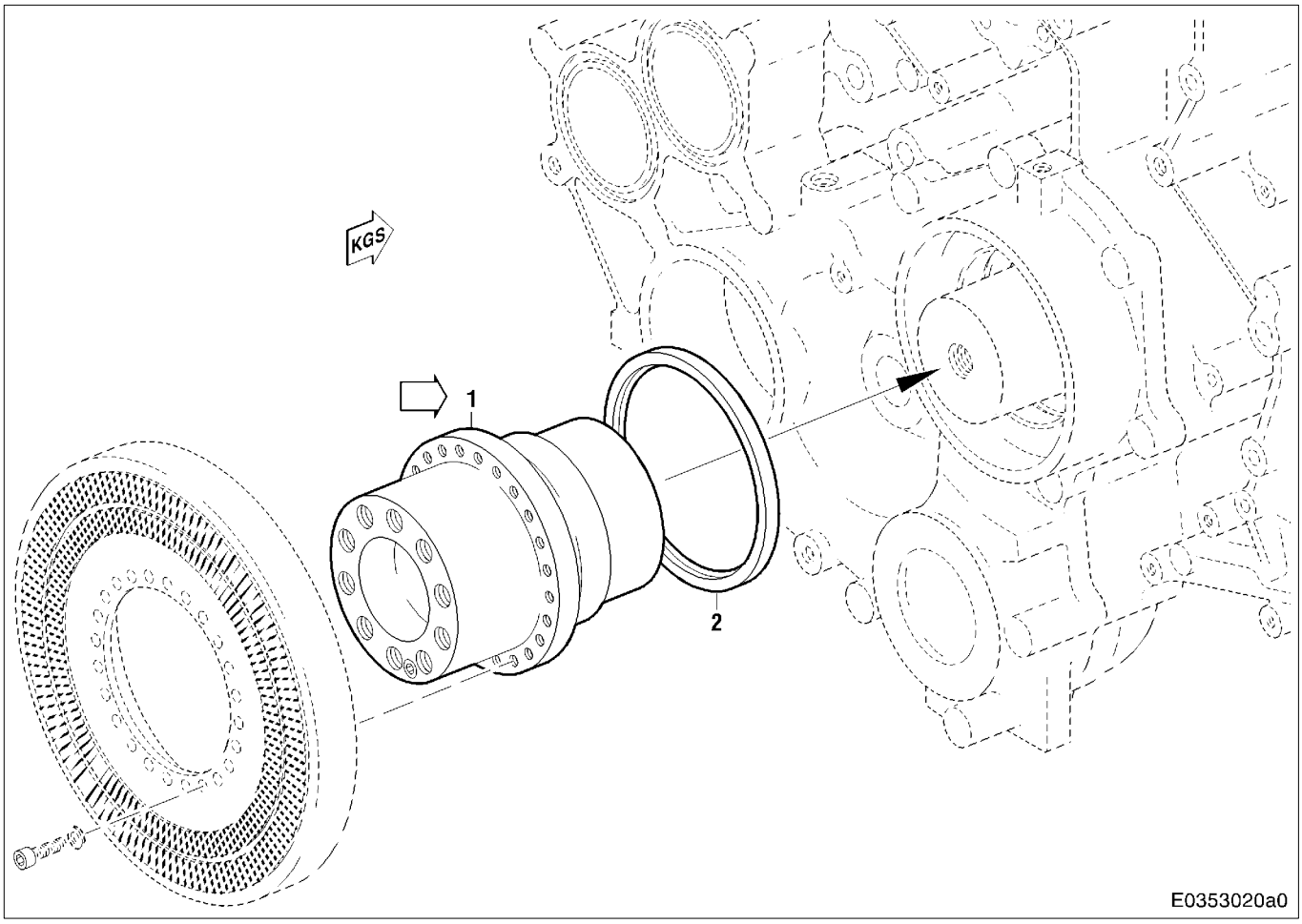


1 Vibration damper

2 Socket-head screw
Tightening torque: 31 Nm + 3 Nm
Lubricant: Engine oil

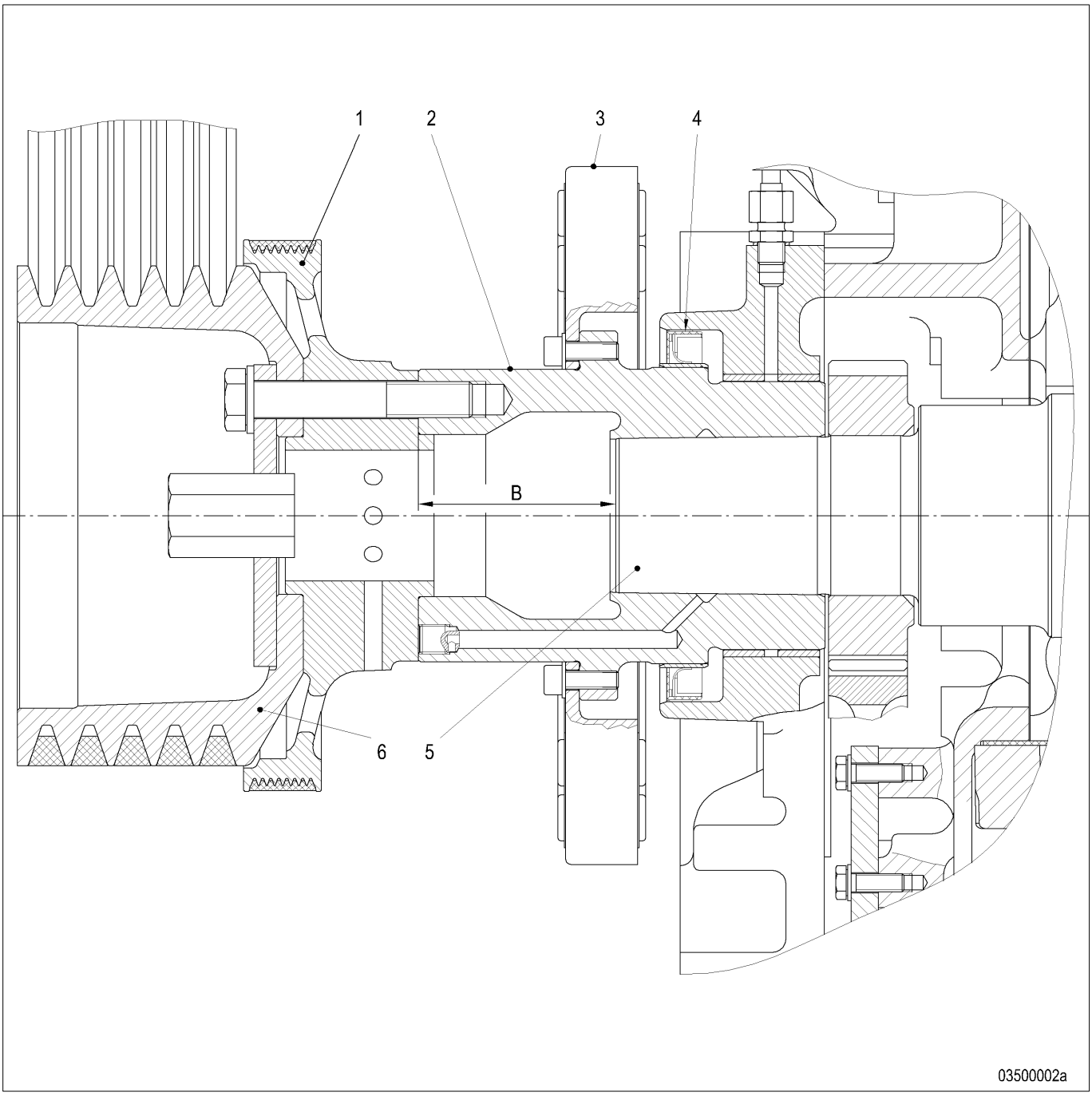
3 Washer

Drive flange, free end, 12V



1 Drive flange
2 Shaft seal

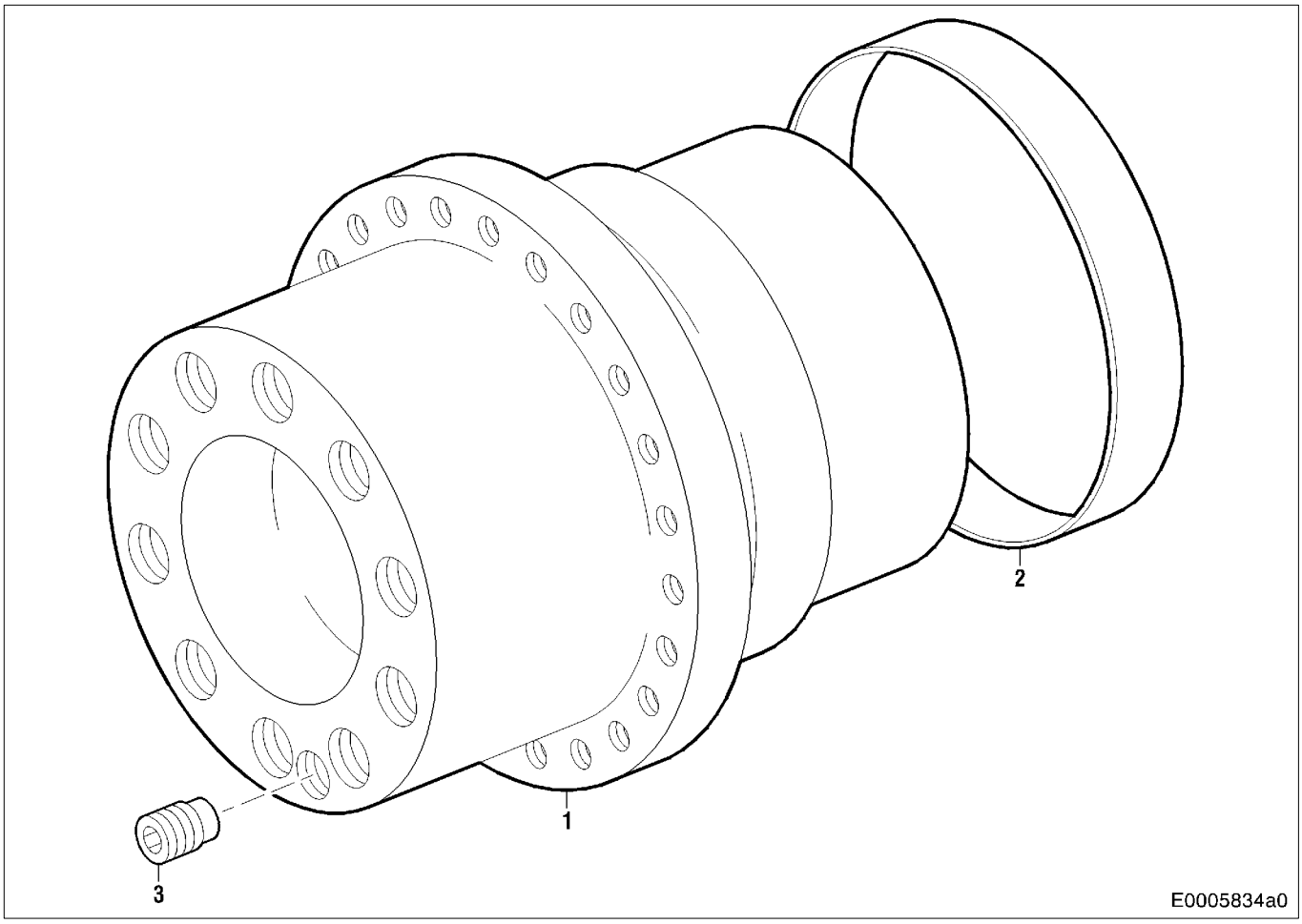
PTO, Free End, 12V



1 Belt pulley
2 Drive flange
3 Vibration damper
4 Shaft seal
5 Crankshaft
6 Belt pulley

Push-on dimension B = 87.7 mm ± 0.05 mm

Drive flange, free end, 12V

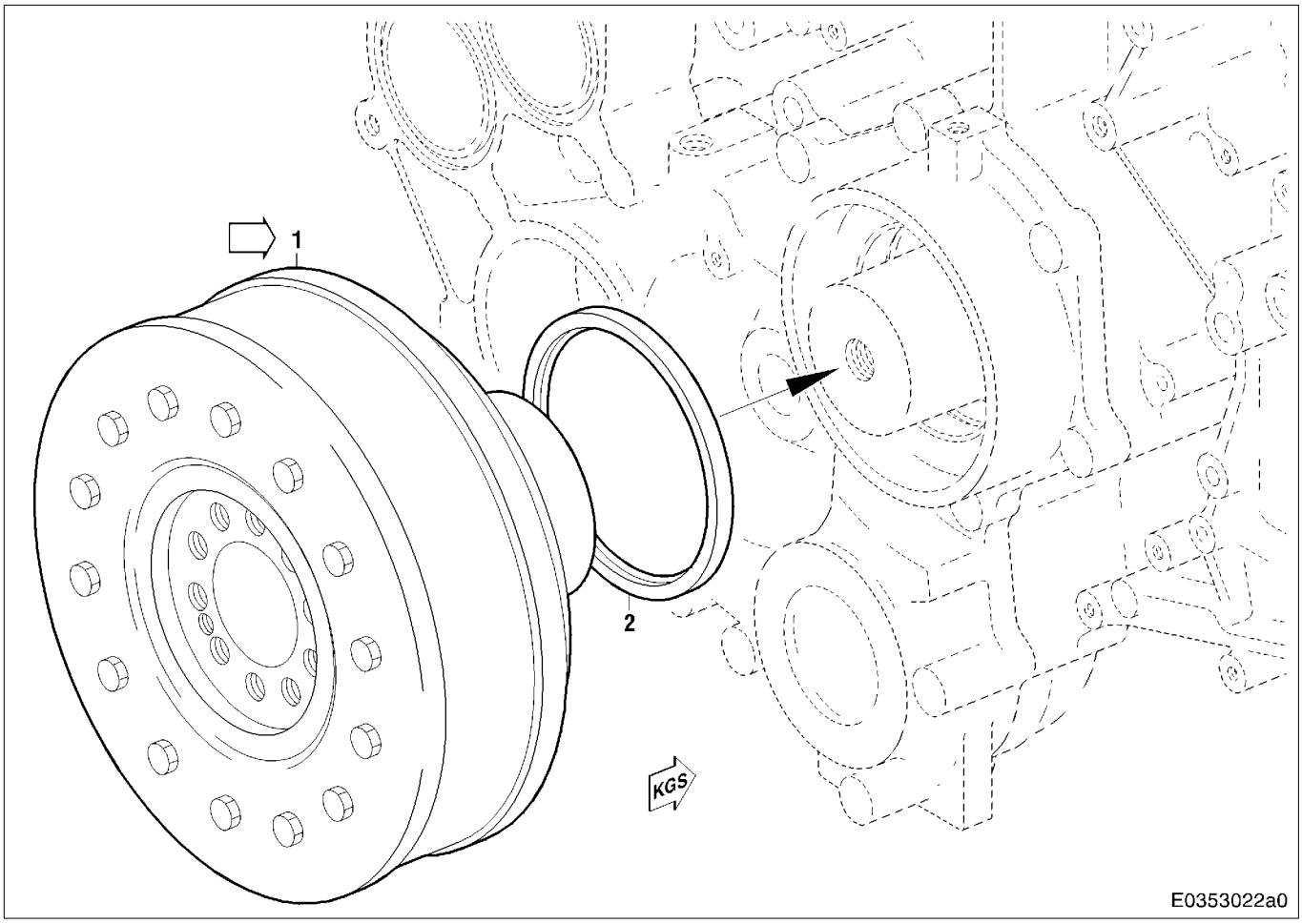


1 Drive flange

2 Track ring

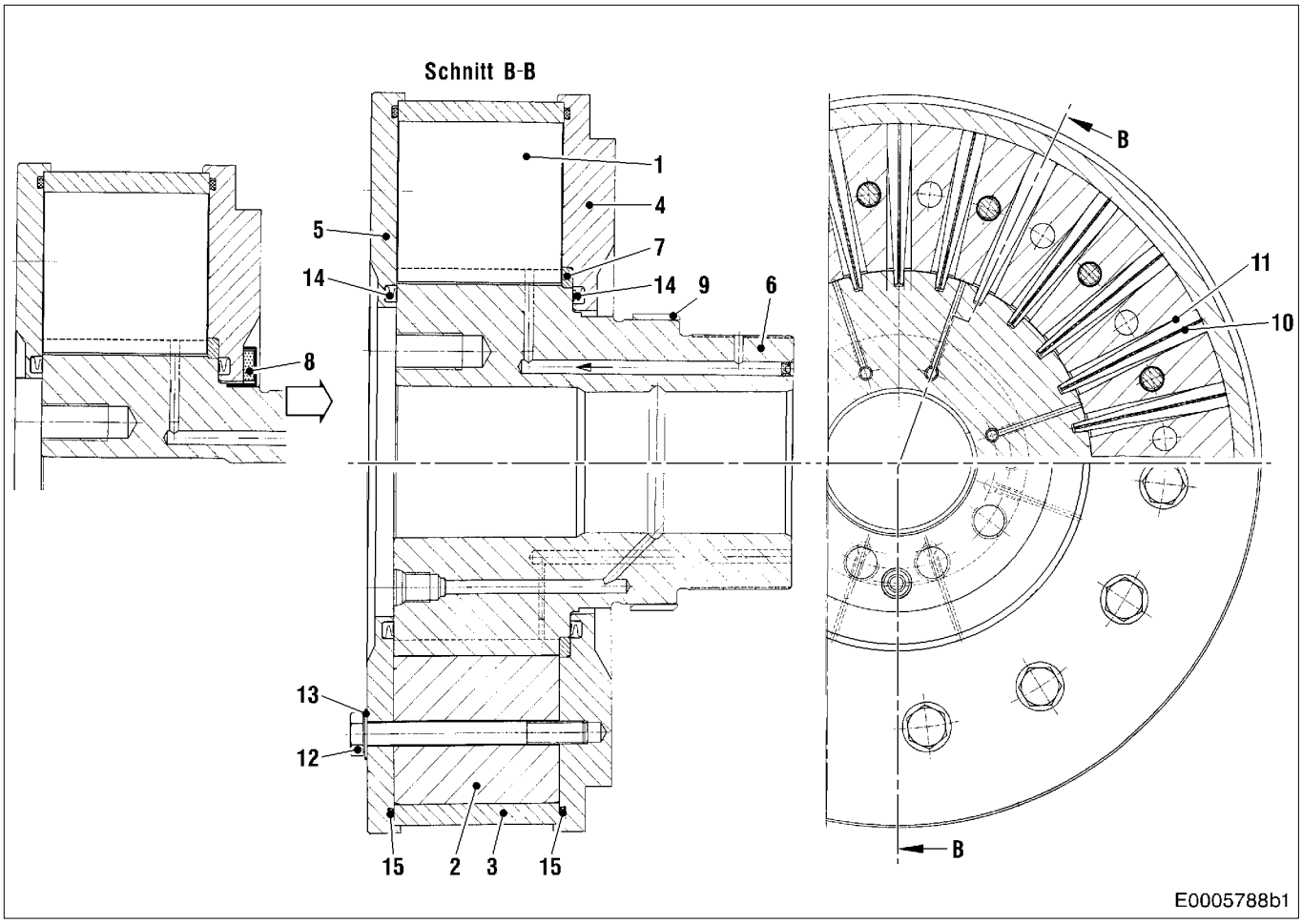
3 Threaded pin
Tightening torque: 21 Nm + 3 Nm
Lubricant: Engine oil

Vibration damper, 16V



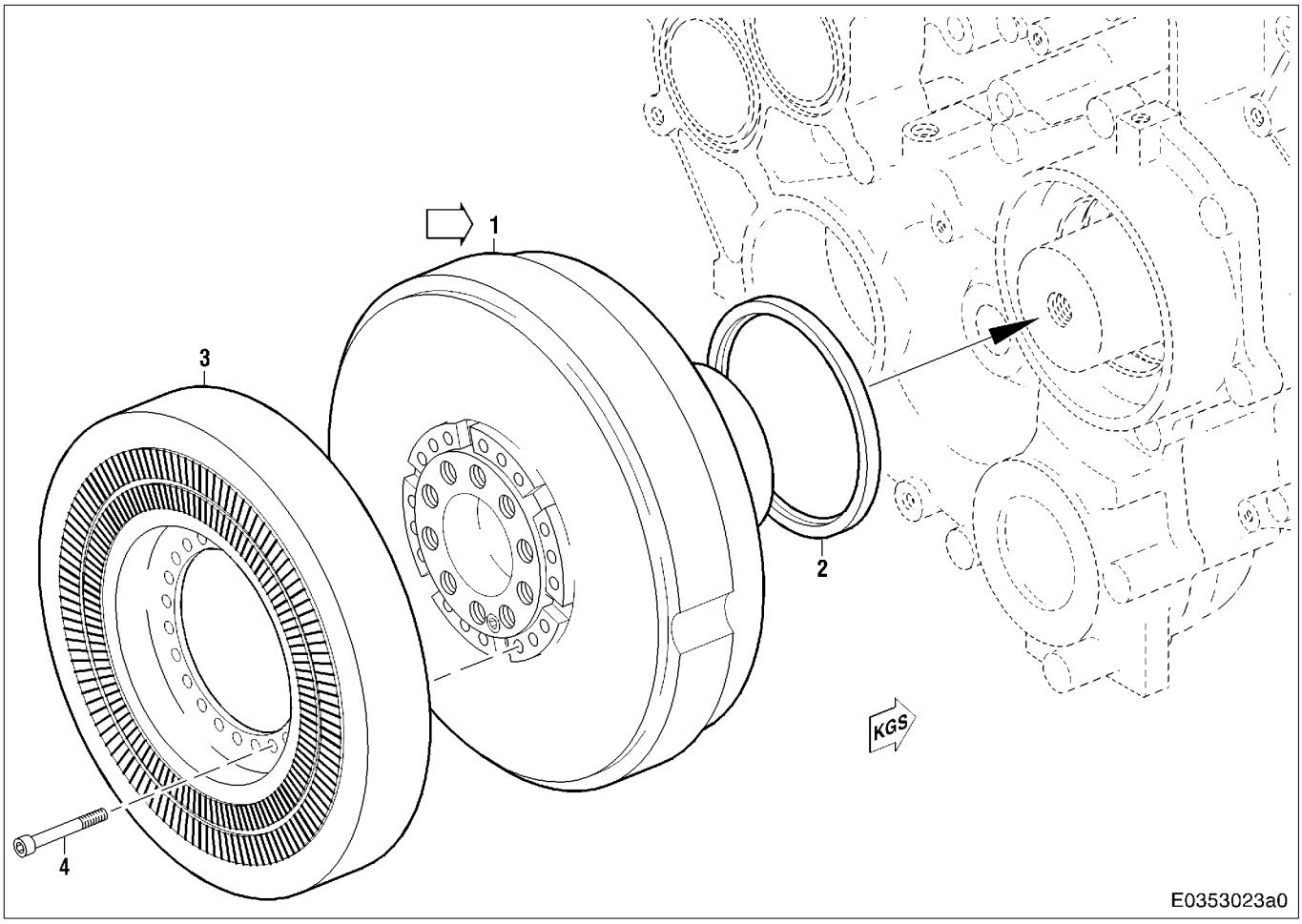
1 Vibration damper
2 Shaft seal

Vibration damper, 16V



1 Spring pack
2 Intermediate elements
3 Clamping ring
4 Flange
5 Side plate
6 Inner star
7 Bearing bush
8 Dust ring
9 Bush
10 Bronze gasket
11 Expansion gasket
12 Hex screw
Lubricant: Engine oil
Tightening torque: 52 Nm
13 Dished washer
14 Y-gasket
15 O-ring

Viscous vibration damper and centrifugal mass, 16V



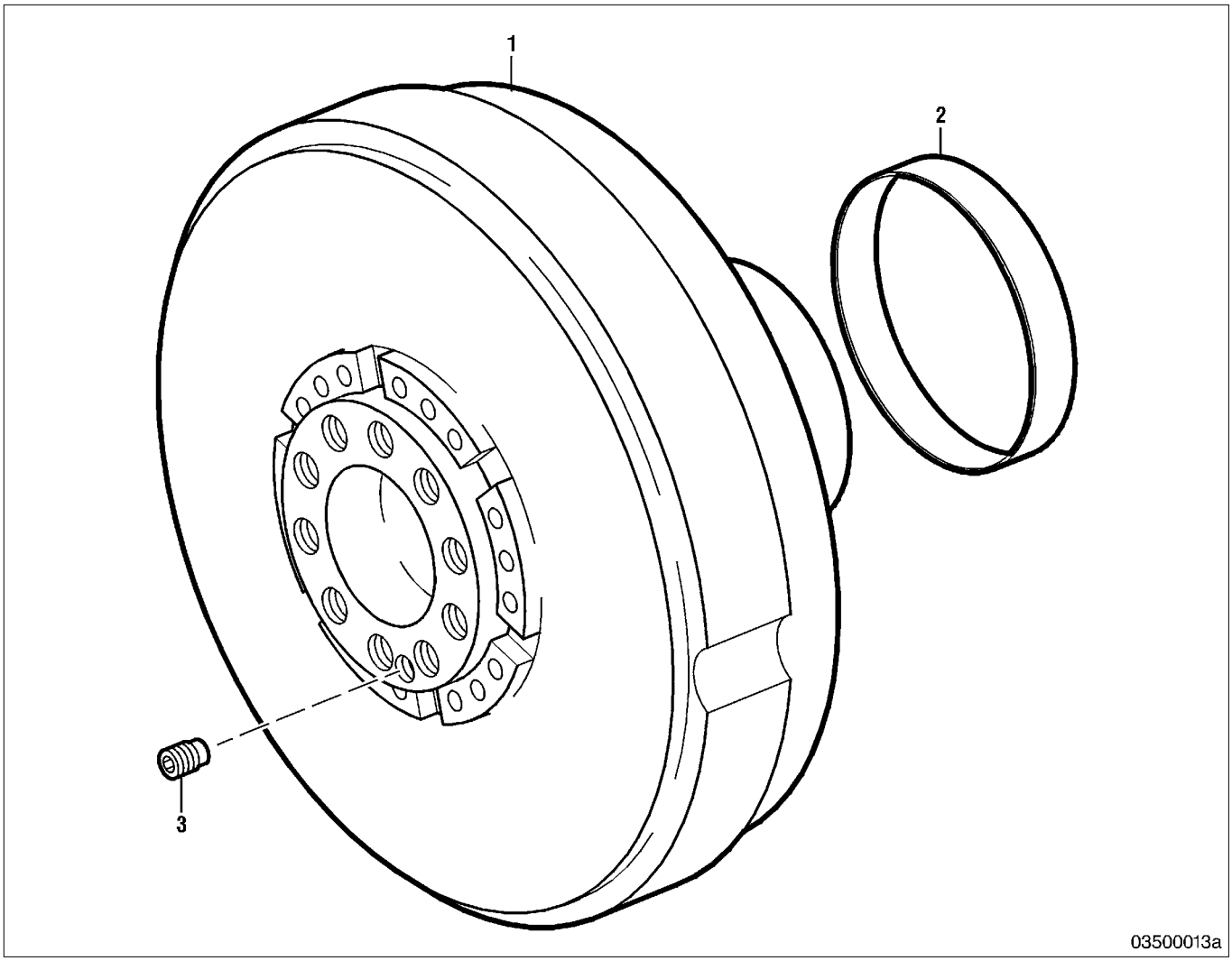
1 Drive flange

2 Shaft seal

3 Vibration damper

4 Socket-head screw
Tightening torque: 31 Nm + 3 Nm
Lubricant: Engine oil

Drive flange

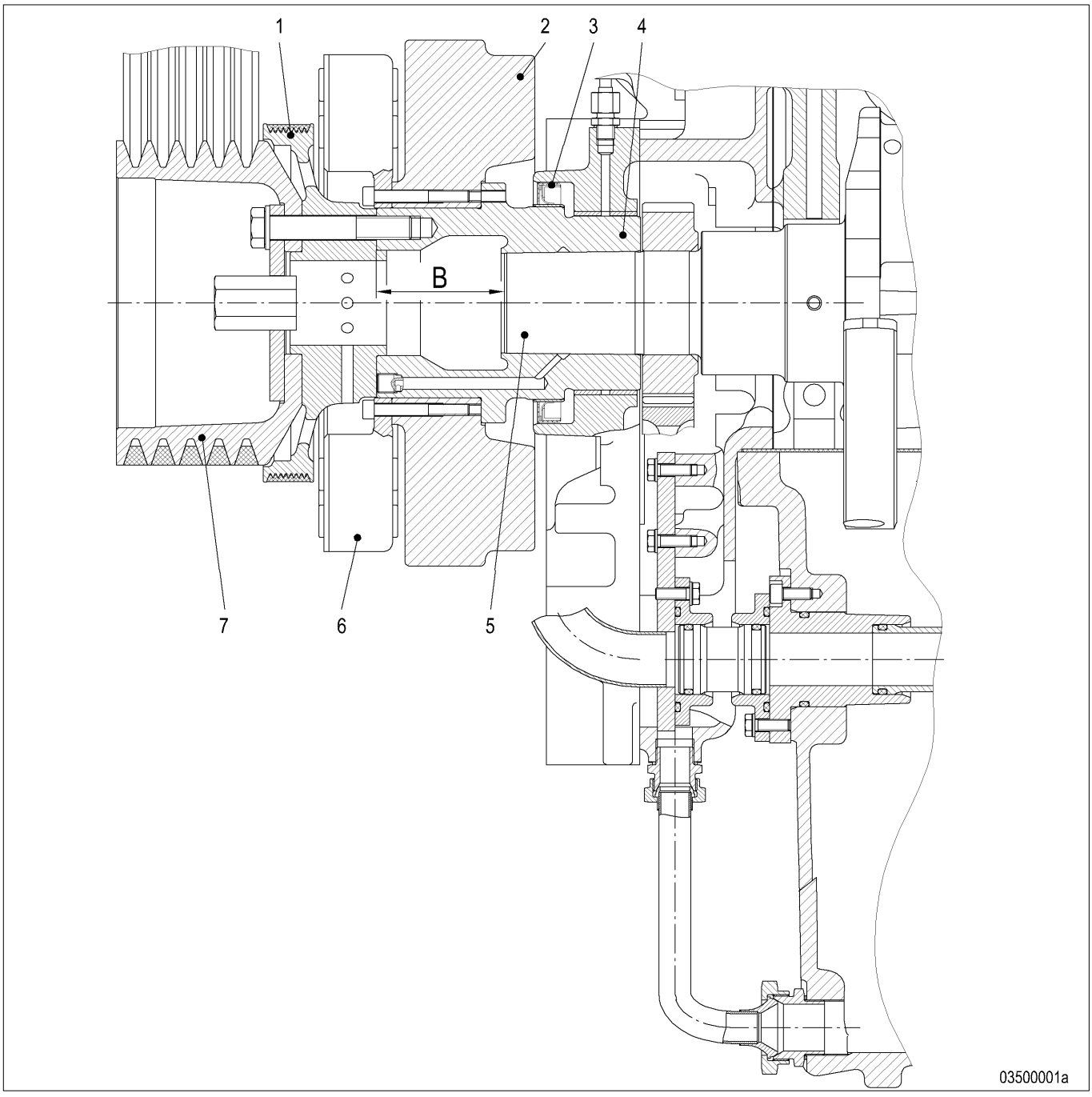


1 Drive flange

2 Track ring

3 Threaded pin
Tightening torque: 21 Nm + 3 Nm
Lubricant: Engine oil

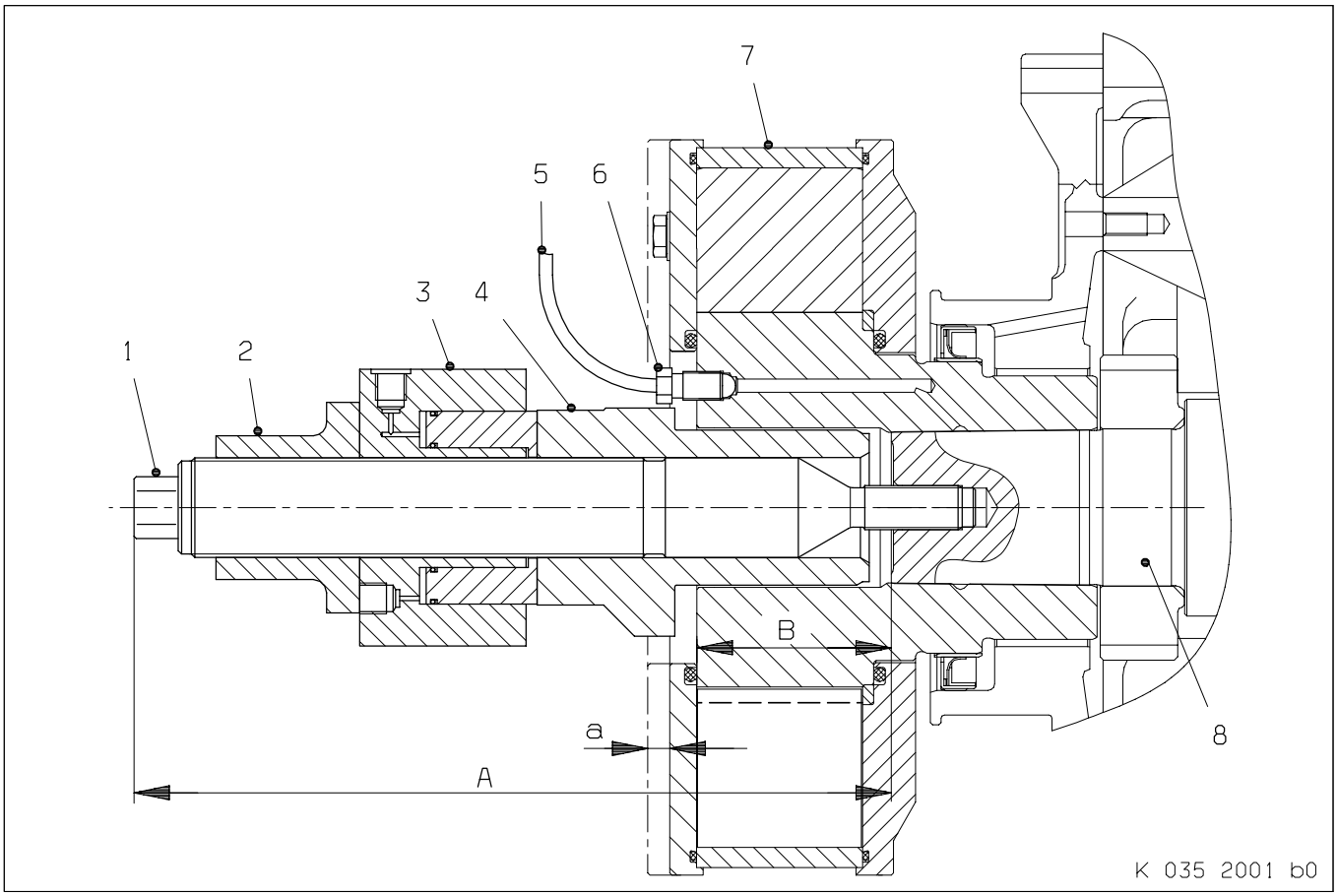
PTO, Free End, 16V



1 Belt pulley
2 Centrifugal mass
3 Shaft seal
4 Drive flange
5 Crankshaft
6 Vibration damper
7 Belt pulley

Push-on dimension B = 87.7 mm ± 0.05 mm

Layout for installation/removal tool for vibration damper



1 Draw spindle
2 Nut
3 Hydraulic press
4 Thrust bush
5 H.P. line
6 Reducer
7 Vibration damper
8 Crankshaft

Reference dimension	A = 345 mm
Push-on dimension	B = from 87.6 mm to 87.8 mm
Push-on distance	a

C 035.05.02 Special Tools

Designation – Application	Number
Installation/removal tool for vibration damper	1
Oil pressure hand pump 0–3500 bar	1
Lukas hand pump	1
Puller for vibration damper bush	1
Assembly device for bush on vibration damper	1

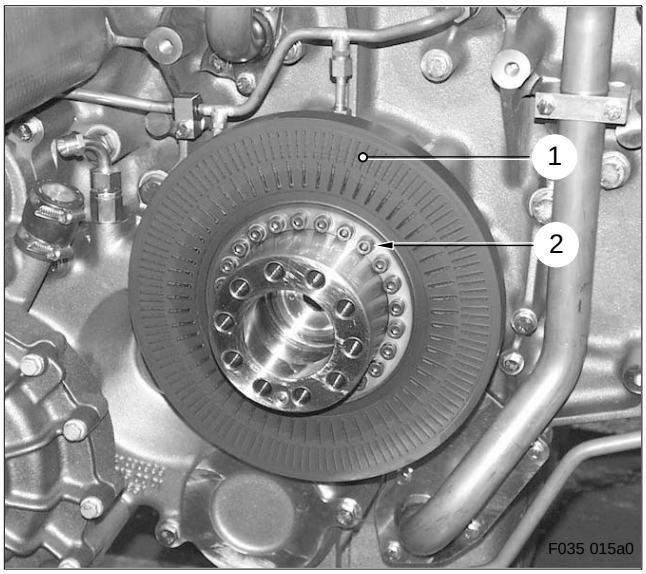
C 035.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 —— The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove V-belt	C 213.05/221.05
–	x	x	Remove belt pulley	C 213.05/221.05

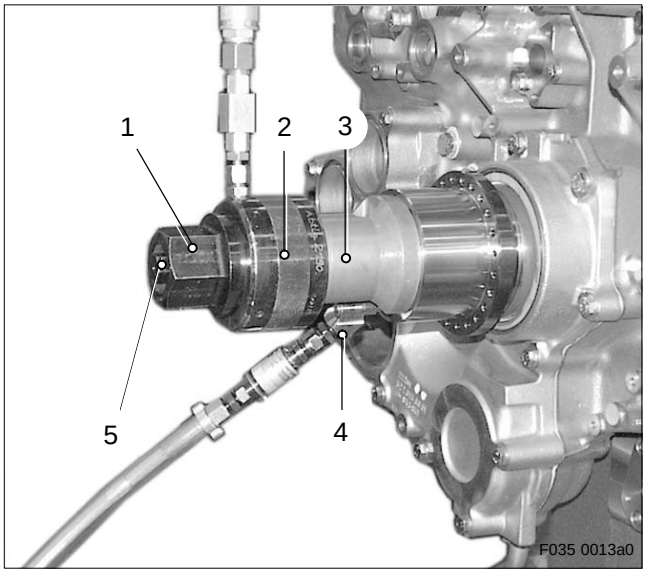
C 035.05.05 Removal



Removing viscous vibration damper (12V)

Remove securing screws (2) for vibration damper (1) as per overview drawing – see also C 035.05.01.

Remove vibration damper from drive flange.



Removing drive flange (12V)

⚠ WARNING

Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off and cause serious injury.
Risk of knocks or crushing!
Liquids emerging under high-pressure can lead to serious injury!
Hydraulic installation/removal must be carried out only by qualified personnel. Only use specified and tested equipment.
The specified expansion and push-on pressure must not be exceeded.
No-one is permitted to enter the danger zone while installation/removal is in progress. Do not attempt to bend or exert force on H.P. lines.
Always wear protective gloves and protective goggles/safety mask.

Remove threaded pin from expansion bore in drive flange.

Screw draw spindle (5) into crankshaft.

Check reference dimension A of draw spindle as per overview drawing C 035.05.01 – Arrangement of installation/removal tool for vibration damper.

A = 345 mm

Mount pressure sleeve (3) and hydraulic press (2) over spindle and install nut (1).

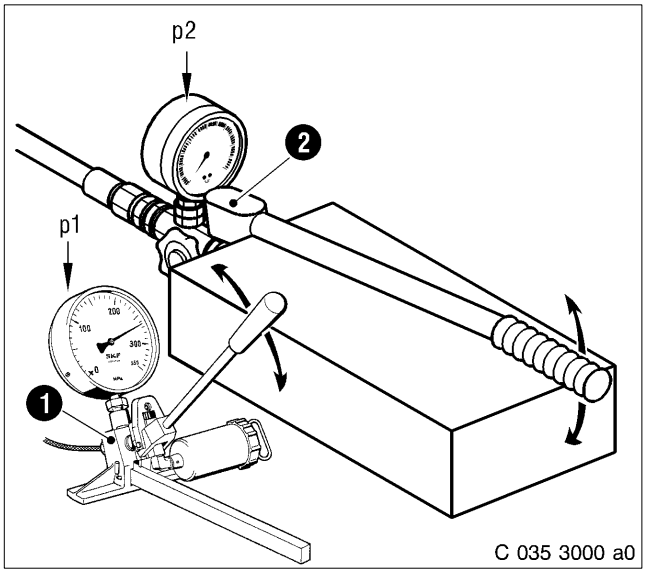
Screw reducer (4) into drive flange and connect H.P. line.

Connect H.P. line of Lukas hand pump to hydraulic press.

Fully tighten nut then back off nut distance equal to push-on dimension.

Force-on distance a is stamped on drive flange.

Note: Before tightening nut, make sure that hydraulic press is in initial position (0 stroke).



Fill hydraulic hand pumps with SAE 10 engine oil.

Vent pumps and pipework until bubble-free oil emerges.

Tighten high-pressure line.

Operate Lukas hand pump (2) for hydraulic press and, by applying minimum pressure (p2) (start of pressure increase), seat press against drive flange.

Note: The hydraulic press acts as a buffer, stopping the hub as it slips off its taper seat.

Operate hydraulic hand pump (1) for expanding the driver flange taper until expansion pressure is half the permitted maximum (p1).

Maintain this pressure for approx. 5 minutes.

Maximum expansion pressure p_{max} is stamped on vibration damper.

Increase expansion pressure in 0.1 · p_{max} stages at intervals of approx. 2 minutes until driver flange is released from crankshaft.

Do not exceed maximum permissible expansion pressure p_{max}.

Operate pump to maintain constant expansion pressure.

An increase in pressure (p2) in the hydraulic press indicates that drive flange is released from taper seat.

Gradually relieve pressure in hydraulic press while steadily operating pump for expansion fluid.

Relieve pressure in hydraulic hand pumps.

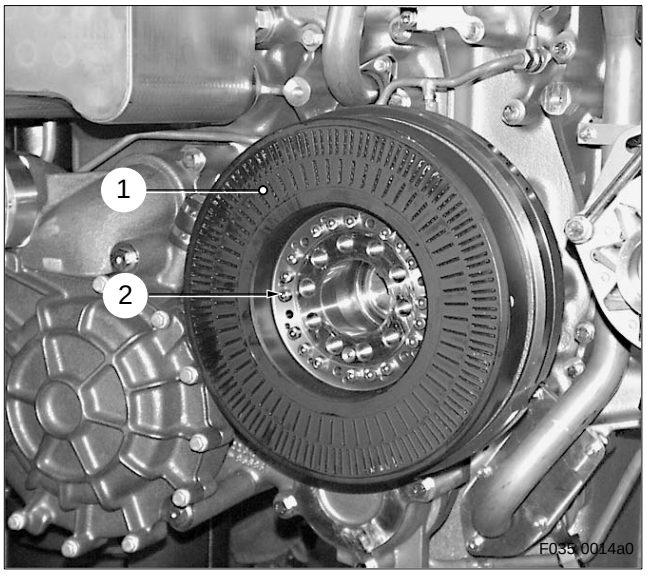
Disconnect high-pressure line.

Remove nut, hydraulic press, pressure sleeve, and draw spindle.

Unscrew reducer.

Important: Take care not to damage taper surfaces when removing.

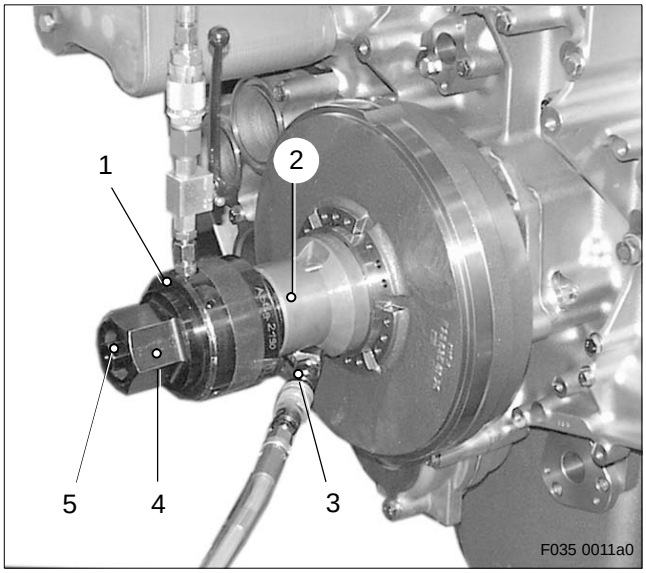
Remove drive flange from crankshaft.



Removing viscous vibration damper (16V)

Remove securing screws (2) for vibration damper (1) as per overview drawing – see also C 035.05.01.

Remove vibration damper from drive flange.



Removing drive flange (16V)

Remove threaded pin from expansion bore in drive flange.

Installation and removal of draw spindle (4), high-pressure line (1), pressure sleeve (6), hydraulic press (2), spacer (3) and nut (4) and remove gear – see Removing driver flange (12V).

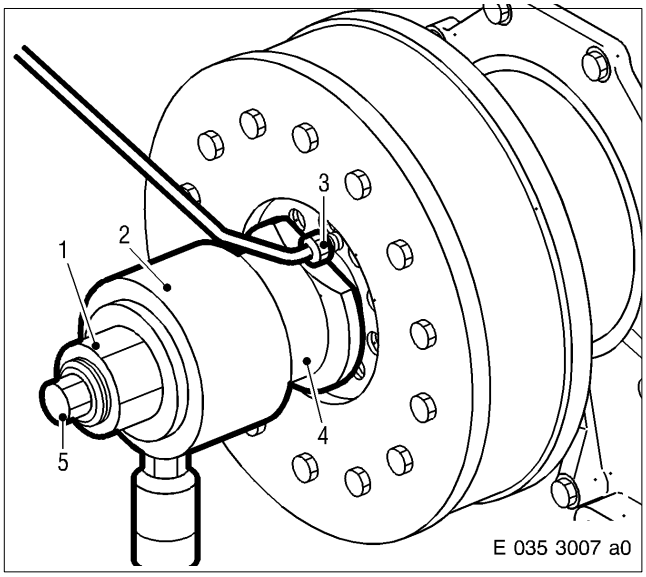
Force-on distance a and maximum expansion pressure p_{max} are stamped on drive flange.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

After removal, remove hydraulic equipment and remove drive flange gear from crankshaft.

Important: Take care not to damage taper surfaces when removing.



Removing Geislinger vibration damper (16V)

Installation and removal of draw spindle (5), high-pressure line (3), pressure sleeve (4), hydraulic press (2) and nut (1) – see Removing driver flange (12V).

Force-on distance a and maximum expansion pressure p_{max} are stamped on vibration damper.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

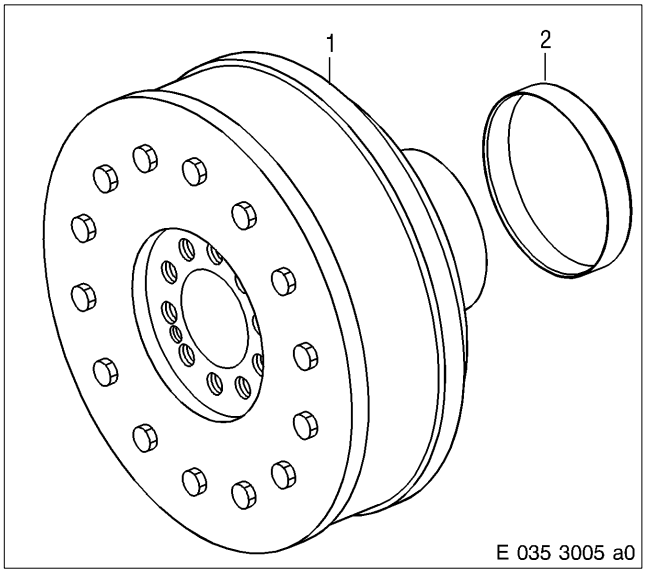
After removal, remove hydraulic equipment and remove vibration damper from crankshaft.

Important: Take care not to damage taper surfaces when removing.

C 035.05.06 Disassembly

Viscous vibration damper

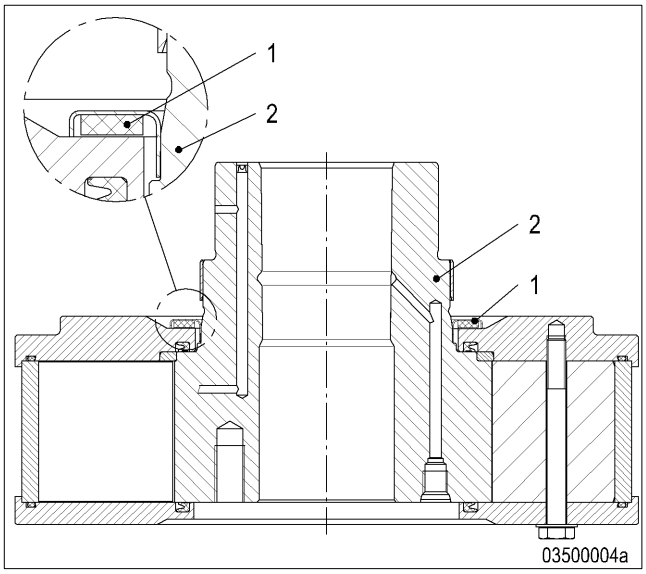
The viscous vibration damper cannot be disassembled.



Removing bush from Geislinger vibration damper

Note: If necessary (e.g. due to wear), remove bush (2).

Use puller to remove bush from vibration damper (1).



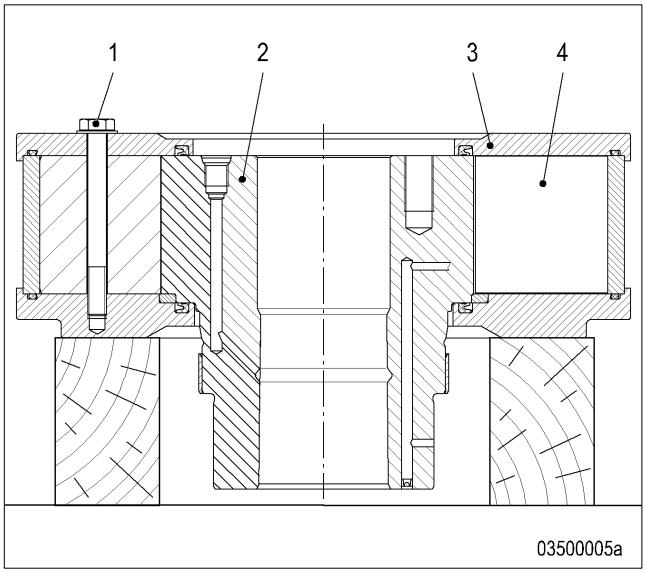
Disassembling Geislinger vibration damper

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Place vibration damper on workbench.

Withdraw dust ring (1) from inner star (2).



Place vibration damper on flange (damper axis is vertical).

Remove hex screws (1) and dished washers.

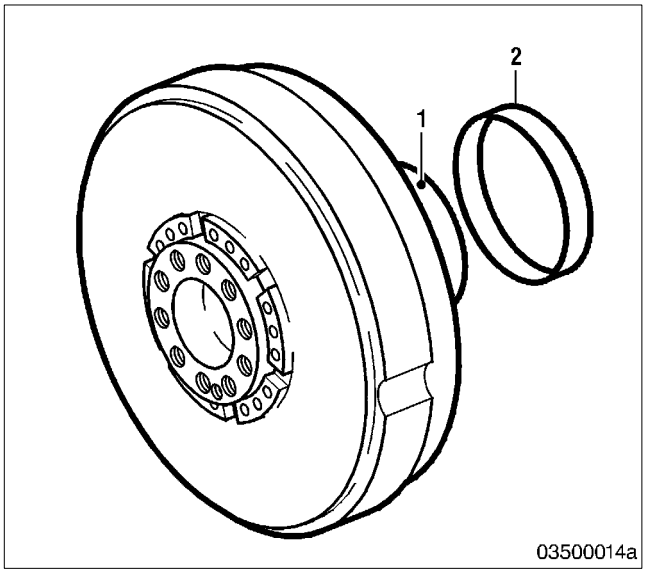
Remove side plate (3).

Remove coupling intermediate section (4).

Remove inner star (2).

Remove O-rings, Y-rings and felt insert.

Note: In this condition, a complete check of the damper can be carried out. Further disassembly of the outer section, e.g. in order to replace the spring packs, can only be carried out at the manufacturer's factory or by a Geislinger service point.



Removing track ring from drive flange

Note: Remove track ring only if necessary (e.g. due to wear).

Use a suitable puller to remove track ring (2) from drive flange (1).

C 035.05.08 Inspection and Repair

Clean all parts.

Make a visible inspection of all components, especially sealing, mating and sliding surfaces for wear and damage.

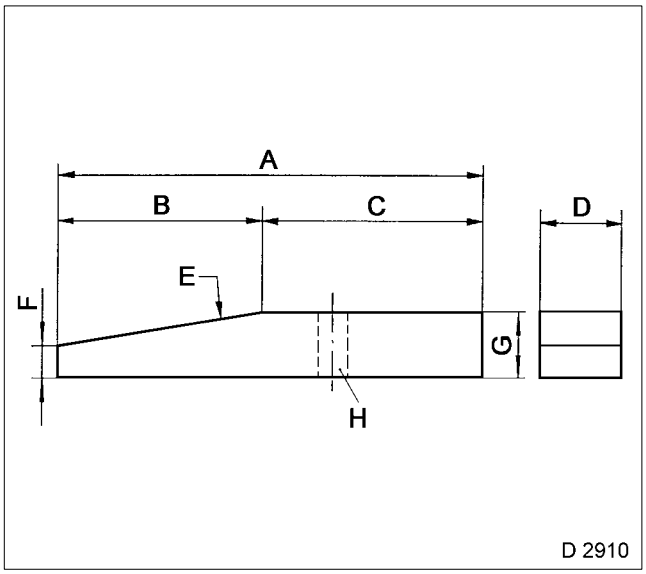
Remove minor wear and scoring by rubbing down with oilstone or emery cloth.

If there is excess wear or damage, replace component.

Replace vibration damper during W6 overhaul.

Visually inspect spring pack of vibration damper, inner teeth of inner star and side plate for damage and wear.

Replace vibration damper if there is excess wear or damage.



Measuring spring pack wear

Use a measuring wedge to measure spring pack wear.

Use the adjacent sketch to make the measuring wedge.

A = approx. 80 mm (measuring wedge length)

B = Go-end wedge length

C = No-go end

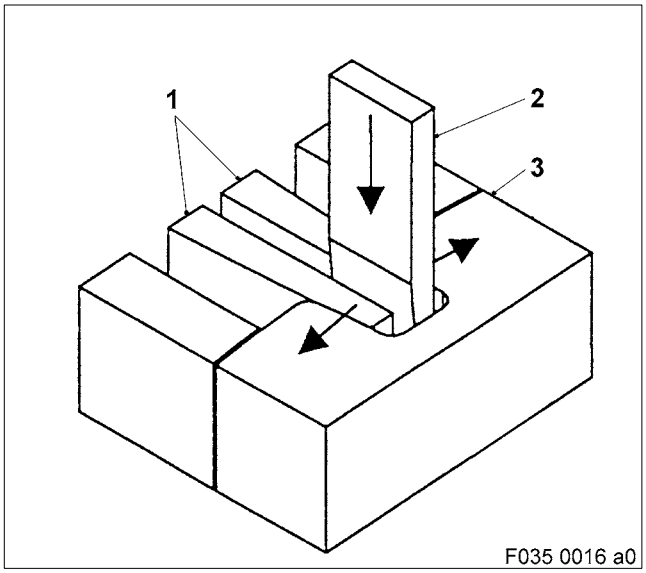
D = 7 mm (Wedge width)

E = 1:30 (gradient)

F = 0.8 mm $\pm$ 0.05 mm (wedge height)

G = 1.34 mm $\pm$ 0.02 mm (wedge height)

H = Auxiliary bore for removal



Measuring spring pack wear

Approx. every fourth spring pack (1) must be measured.

Position Geislinger measuring wedge (2) between spring leaf points at groove base.

Press measuring wedge down (by hand or with a rubber mallet) until spring leaf points contact groove flanks on both sides.

The further it is possible to press the measuring wedge down, the more the groove and spring are worn.

Note: Half wedge length means half wear, three-quarters wedge length means three-quarters wear, etc.

If it is possible to insert the measuring wedge up to the full length of the wedge (= max. mark) or further between the spring leaf ends, the inner star and springs must be replaced.

Max. permissible wear on sealing surfaces of inner star (wear of Y-gasket):
0.2 mm each side.

If there are signs of friction wear (fretting) on sleeve bearing contact surfaces, the entire vibration damper must be replaced with a new one.

Check thread in flange and driver star for ease of movement, recut as necessary.

Ensure that oilways are particularly clean.

Check taper bores of vibration damper and of drive flange with taper gauge 1:50.

If the tapered bore has expanded, replace component.

Check face of taper bore and bearing sliding surfaces for wear and scoring.

If there is excess wear or damage, replace component.

Check screws for damage and check condition of threads; replace screws if necessary.

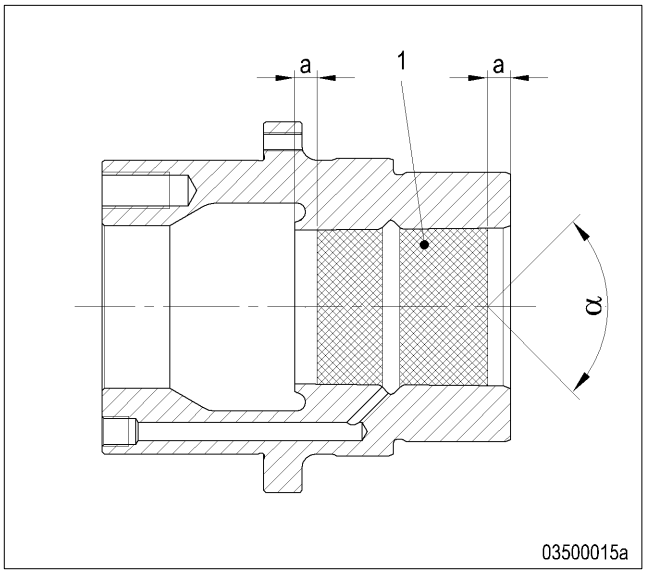
Check radial-lip shaft seal running surface on bush and track ring; replace part if necessary.

Check viscous vibration damper for leakages or fluid loss.

In event of leaks, replace the viscous vibration damper.

Replace viscous vibration damper at W6 overhaul or in the event of overspeed or crankshaft fracture.

Replace O-rings, Y-rings, felt insert, dished washers and sealing rings during each overhaul.



Roughen smooth areas on taper surface (1) of drive flange or inner star caused by installation etc. with emery cloth (granulation 60) until roughness corresponds to remaining fit surface.

Mean roughness height (R_z) of taper surface = from 10 μm to max. R 16 permissible.

Observe dimensions and angles as per illustration.

α = from 30° to 90°

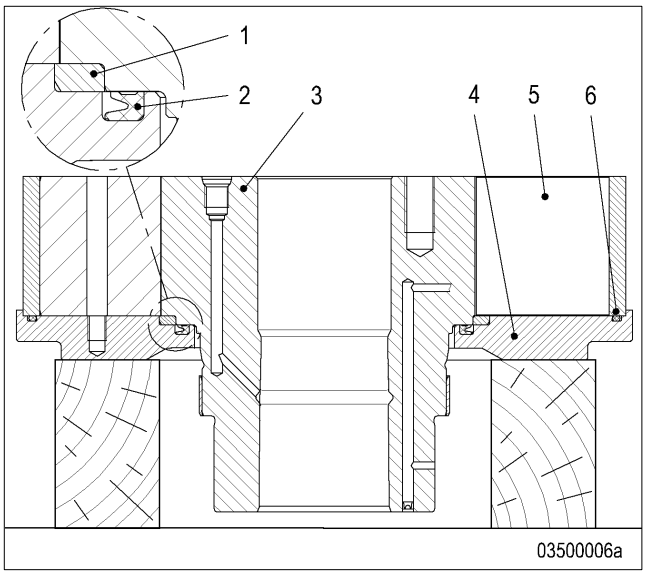
a = from 10 mm to 15 mm

After roughening, clean taper surface and oil bore and check for particular cleanness.

Check taper 1:50 with taper gauge.

If the tapered bore has expanded, replace component.

C 035.05.10 Assembly



Assembling Geislinger vibration damper

Note: Make sure parts are perfectly clean.

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

Blow through oil bores in vibration damper with compressed air and ensure that they are perfectly clean.

Place flange (4) on suitable base on assembly bench.

Coat O-ring (6) and Y-ring (2) with Molykote 111 and insert in respective grooves in flange.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Placing damper middle section (5) on flange

Note: If necessary, use a rubber mallet to install damper middle section in centering.

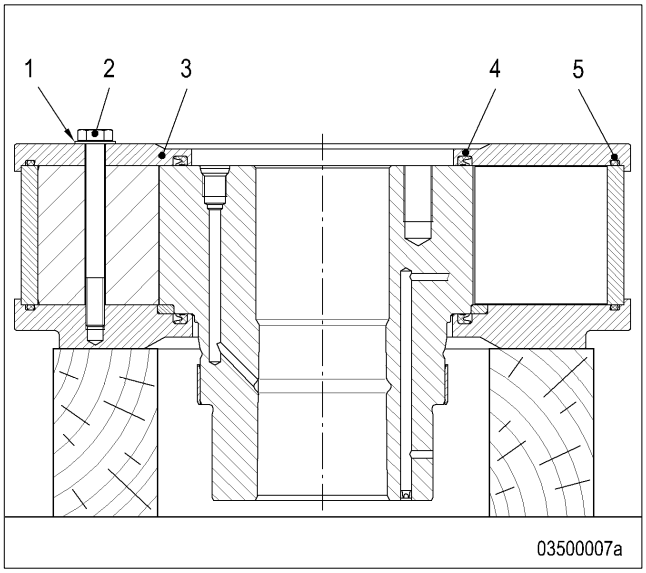
Coating inner star running surfaces of Y-gasket with Molykote D3484

Important: Before assembling the vibration damper, ensure that the running surfaces coated with Molykote D3484 are dry.

Treat the remaining surface of the inner star (3) with corrosion inhibitor.

Coat running surfaces of bearing (1) with engine oil.

Fit inner star, ensuring markings made before disassembly are correctly aligned.



Coat new O-ring (5) and Y-ring (4) with Molykote 111 and insert in respective grooves in side plate (3).

Place side plate on coupling intermediate section, ensuring it is correctly positioned.

Note: If necessary, use a rubber mallet to install side plate in centering.

Clean and degrease contact faces of dished washers (1).

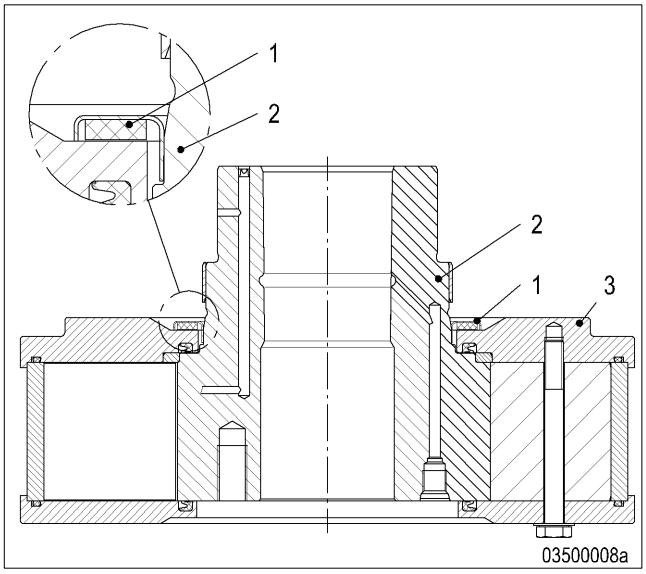
Coat dished washers on both sides with surface sealant and fit correctly on screws (2).

Convex end of dished washer must point to screw head!

Coat hex screw threads with engine oil.

Tighten hex screws in diagonally opposite sequence to specified torque – see C 035.05.01.

Note: Ensure correct final strength of surface sealant – see Table in C 030!



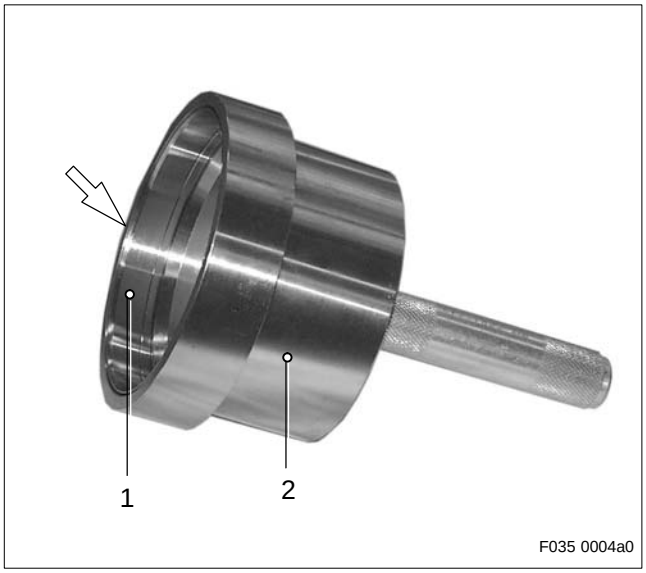
Place vibration damper on side plate (damper axis is vertical).

Coat felt insert in dust ring (1) and respective running surface on flange (3) with Molykote 111.

Important: Take care not to damage dust ring when installing.

Use a rubber mallet to carefully install dust ring on inner star (2) until inner diameter of dust ring contacts inner star.

Check that dust ring is uniformly in contact around entire circumference.



Installing bush from Geislinger vibration damper

Note: The bush can be press-fitted or installed by heating as described below.

Heat bush (1) to approx. 130 °C.

⚠ CAUTION

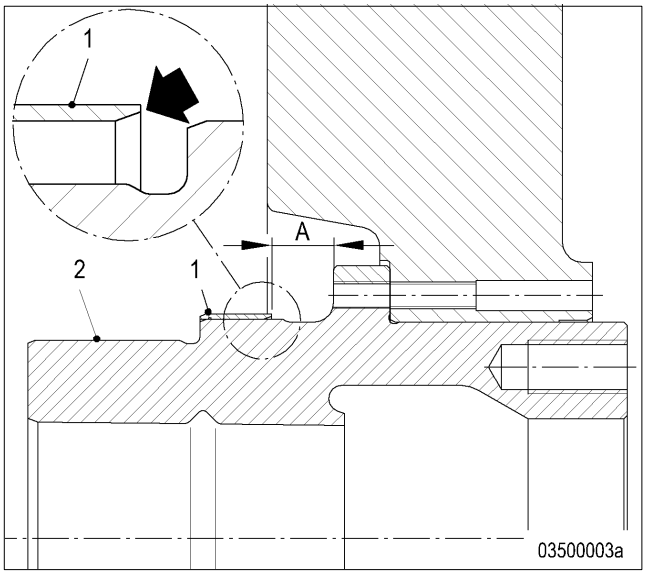
Component is hot.
Risk of injury!
Touch components only when wearing protective gloves.

Insert heated bush, with chamfer facing upward (arrow), into assembly device (2).

Fit heated bush flush on vibration damper.

Allow bush to cool to room temperature, then remove assembly device.

Check that bush is fitted flush around entire circumference.



Installing track ring on drive flange

Note: The track ring can be press-fitted or installed by heating as described below.

Heat track ring (1) to 150 °C + 30 °C.

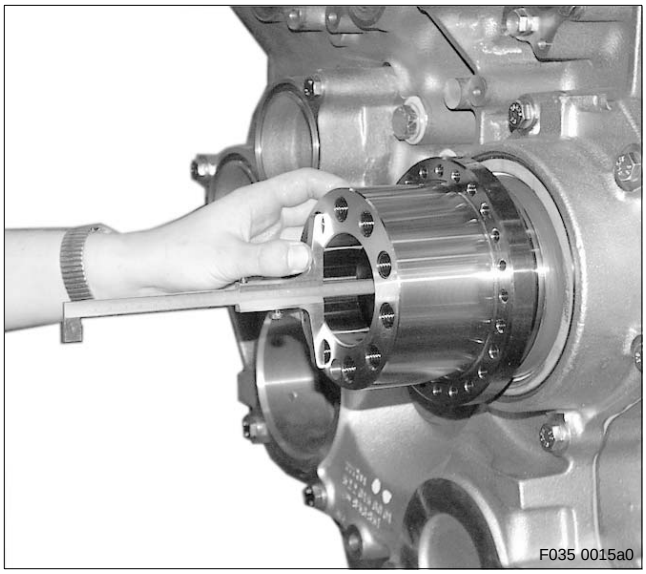
⚠ CAUTION

Component is hot.
Risk of injury!
Touch components only when wearing protective gloves.

Push the heated track ring flush onto the drive flange with the chamfer (arrow) facing the drive flange (2).

Allow track ring to cool to room temperature and check that the distance (A) is even along the entire circumference.

C 035.05.11 Installation



Installing drive flange (12V)

⚠ WARNING

Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off.
If lines are faulty, installation and expansion fluids may be discharged at high pressure.
Risk of injury!
Hydraulic installation/removal must be carried out only by qualified personnel.
Only use specified and tested equipment.
It is not permitted for personnel to remain within the danger area behind the equipment during the removal operations.
The max. permissible installation and expansion pressures must not be exceeded.
Do not attempt to bend or exert force on high-pressure hoses while they are under pressure.
Always wear protective gloves and protective goggles/safety mask.

Clean and degrease taper surface on crankshaft and drive flange.

Coat running surface of crankshaft bearing and drive flange with oil.

Coat lip of radial-lip oil seal with petroleum jelly.

Important: Take care not to damage taper surfaces when installing.

Mount driver flange on crankshaft taper.

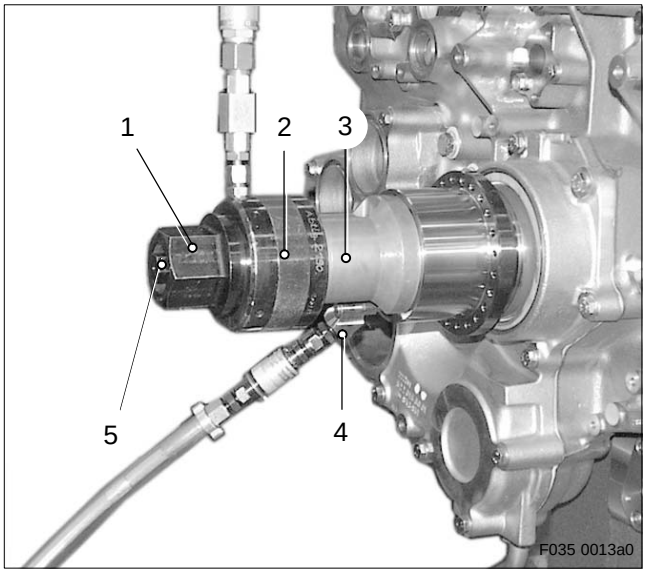
To calculate force-on distance, measure distance from end face of crankshaft to end face of drive flange using depth gauge. Make a note of this figure.

Calculate difference (=push-on distance) between measured dimension and push-on dimension (B), see C 035.05.01.

Push-on dimension (B) = distance from face of crankshaft to face of drive flange after hydraulic installation.

Force-on distance a is stamped on drive flange.

If calculated distance is less than push-on distance a; check dimensional accuracy of taper.



Screw draw spindle (5) into crankshaft.

Check reference dimension A of draw spindle as per overview drawing C 035.05.01 – Arrangement of installation/removal tool for vibration damper.

A = 345 mm

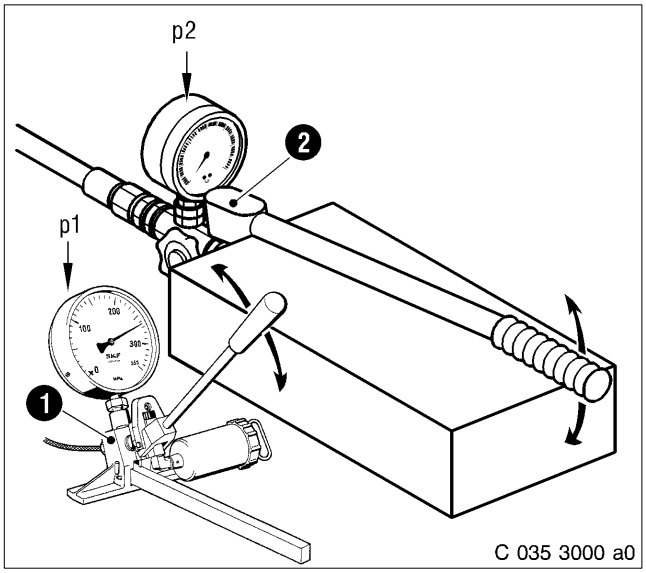
Mount pressure sleeve (3) and hydraulic press (2) over spindle.

Install nut (1) and hand-tighten.

Note: Before tightening nut, make sure that hydraulic press is in initial position (0 stroke).

Screw reducer (4) into drive flange and connect H.P. line.

Connect H.P. line of Lukas hand pump to hydraulic press.



Fill hydraulic hand pumps with SAE 10 engine oil.

Vent pumps and pipework until bubble-free oil emerges.

Tighten high-pressure line.

Before press-fitting, coat taper faces with expansion fluid; operate hydraulic hand pump (1) until expansion fluid escapes at drive flange ends.

Operate Lukas hand pump (2) for hydraulic press and, by applying minimum pressure, seat press against drive flange.

Operate pump for expansion fluid until no further increase in expansionpressure (p1) is possible, then operate force-on pump to increase force-on pressure (p2).

Repeat this process until drive flange is correctly seated.

Select force-on pressure such as to seat shaft in approx. 5 steps.

When installing, make sure that expansion pressure never exceeds the maximum permissible expansion pressure $p_{max.}$

p_{max} see specification on drive flange.

Hydraulic installation is completed when pressure sleeve is seated against crankshaft.

Open valve screw in hydraulic oil pump to relieve expansion pressure.

Maintain maximum force-on pressure for 60 minutes, to ensure that the expansion fluid is expelled from the joint and static friction can build up between the fixed components.

Disconnect high-pressure line.

Allow specified retention time to elapse and remove nut, hydraulic press, pressure sleeve and draw spindle.

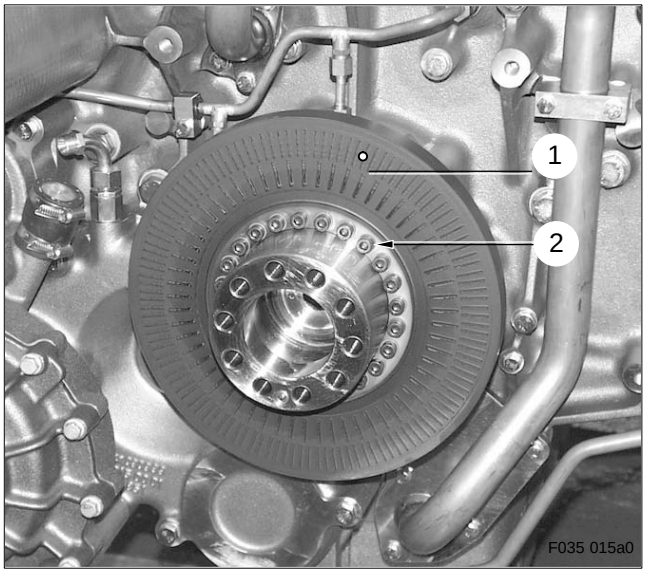
Note: The press-on connection must not be subjected to operational load for at least 8 hours.

Measure distance from face of crankshaft to face of drive flange (push-on dimension B) – see previous illustration.

Required distance = 87.7 mm $\pm$ 0.05 mm

If push-on dimension is not achieved, hydraulically remove drive flange and determine the cause.

After specified holding time, remove oil from expansion bore, screw in threaded pin and tighten to specified torque as per overview drawing C 035.05.01.

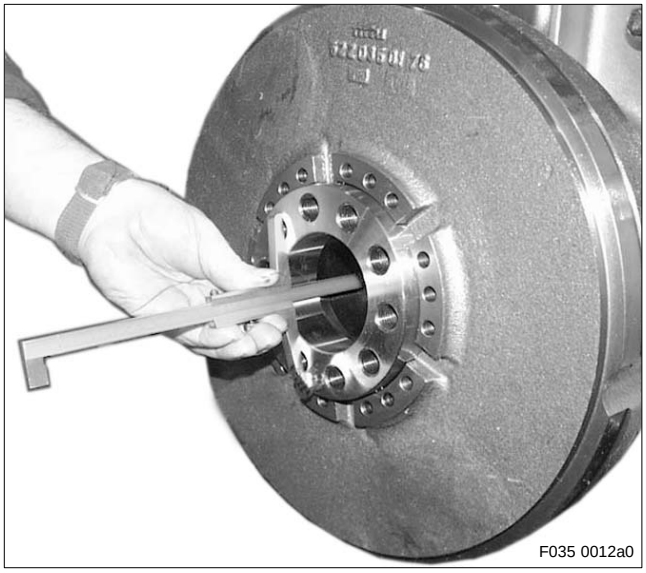


Installing viscous vibration damper (12V)

Check support surfaces, clean if necessary.

Install vibration damper (1) with socket-head screws (2) and washers on drive flange.

Note: Tighten socket-head screws diagonally to specified tightening torque – see overview drawing C 035.05.01!



Installing drive flange (16V)

Important: Take care not to damage taper surfaces when installing.

Clean and degrease taper surface on crankshaft and drive flange.

Coat running surface of crankshaft bearing and drive flange with oil.

Coat lip of radial-lip oil seal with petroleum jelly.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Mount driver flange on crankshaft taper.

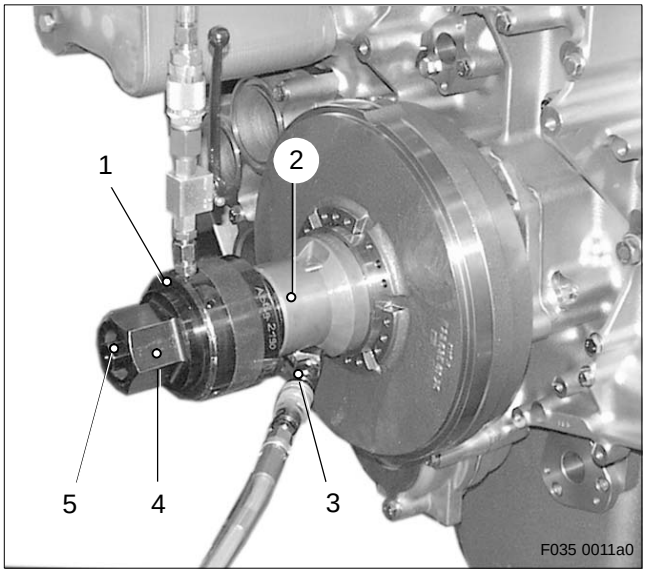
To calculate force-on distance, measure distance from end face of crankshaft to end face of drive flange using depth gauge. Make a note of this figure.

Calculate difference (=push-on distance) between measured dimension and push-on dimension (B), see C 035.05.01.

Push-on dimension (B) = distance from face of crankshaft to face of drive flange after hydraulic installation.

Force-on distance a is stamped on drive flange.

If calculated distance is less than push-on distance a; check dimensional accuracy of taper.



Installation and removal of draw spindle (5), high-pressure line (3), pressure sleeve (2), hydraulic press (1) and nut (4) – see Installing drive flange (12V).

Important: It is essential to observe the safety instructions for hydraulic removal and installation.

Maximum expansion pressure $p_{max,}$ is stamped on driver flange.

Note: After installation, allow appropriate times to elapse before relieving force-on pressure and subjecting press fit to operating load.

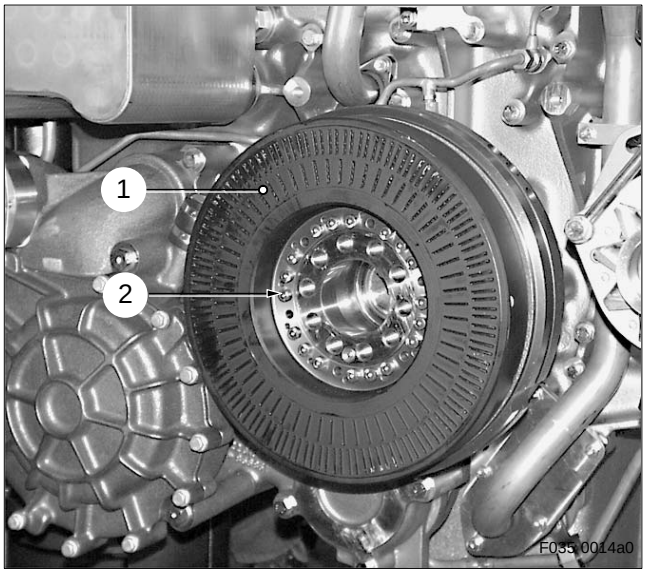
Remove hydraulic equipment.

Remove oil from expansion bore, screw in threaded pin and tighten to specified torque as per overview drawing C 035.05.01.

Measure distance from face of crankshaft to face of drive flange (push-on dimension B) – see previous illustration.

Required distance = 87.7 mm ±0.05 mm

If distance is not achieved, hydraulically remove drive flange and determine the cause.

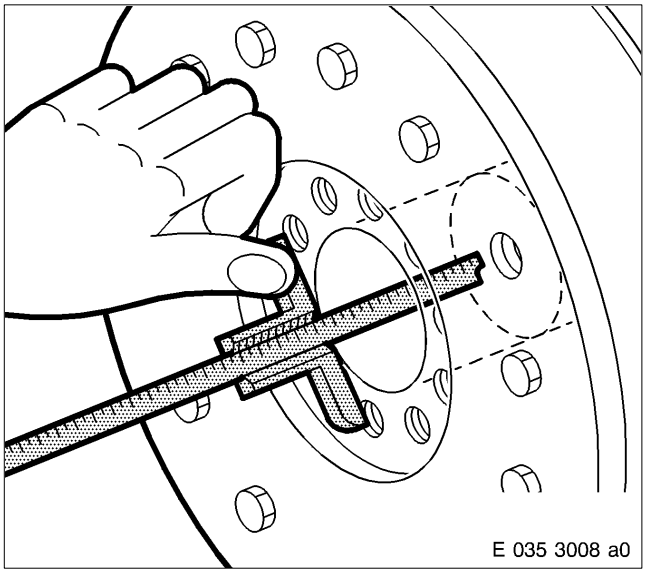


Installing viscous vibration damper (16V)

Check support surfaces, clean if necessary.

Install vibration damper (1) with socket-head screws (2) and washers on drive flange.

Note: Tighten socket-head screws diagonally to specified tightening torque – see overview drawing C 035.05.01!



Installing Geislinger vibration damper (16V)

Important: Take care not to damage taper surfaces when installing.

Clean and degrease tapers of crankshaft and vibration damper.

Coat running surface of crankshaft bearing and vibration damper with oil.

Coat lip of radial-lip oil seal with petroleum jelly.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Push vibration damper onto crankshaft taper.

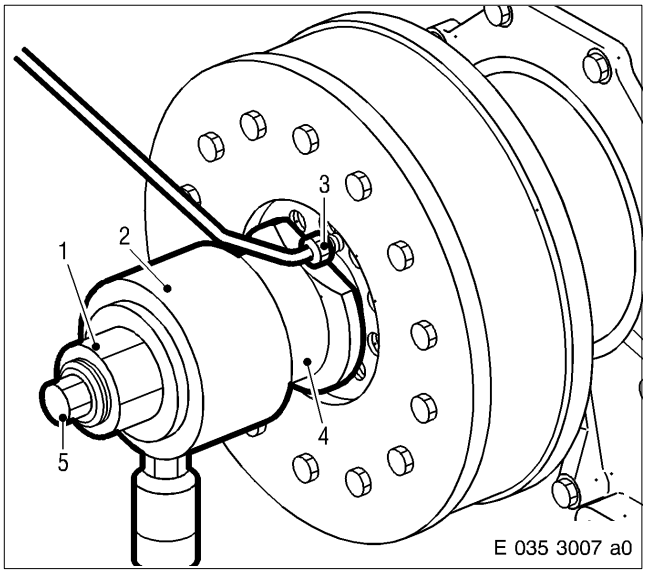
Calculate push-on distance by measuring distance from end face of crankshaft to end face of vibration damper with depth gauge. Make a note of this distance.

Calculate difference (=push-on distance) between measured dimension and push-on dimension (B), see C 035.05.01.

Push-on dimension (B) = distance from face of crankshaft to face of vibration damper after hydraulic installation.

Push-on dimension a is stamped on vibration damper.

If calculated distance is less than push-on distance a; check dimensional accuracy of taper.



Installation and removal of draw spindle (5), high-pressure line (3), pressure sleeve (4), hydraulic press (2) and nut (1) – see Installing drive flange (12V).

Important: It is essential to observe the safety instructions for hydraulic removal and installation.

Maximum expansion pressure p_{max} is stamped on vibration damper.

Note: After installation, allow appropriate times to elapse before relieving force-on pressure and subjecting press fit to operating load.

Remove hydraulic equipment.

Measure distance from face of crankshaft to face of vibration damper – see previous illustration.

Specified distance = from 87.6 mm to 87.8 mm.

If distance is not achieved, hydraulically remove vibration damper and determine the cause.

C 035.05.12 After-Installation Operations

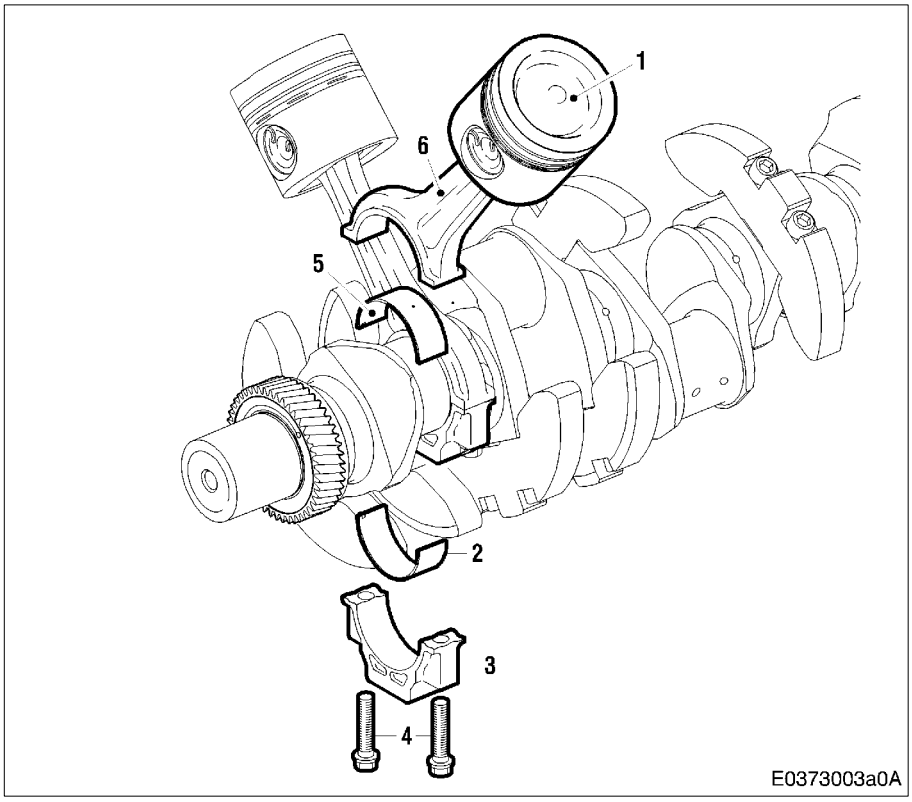
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install belt pulley	C 213.05/221.05
–	x	x	Install V-belt and set V-belt tension	C 213.05/221.05
–	–	x	Release engine start	Operating Instructions

C 037.05 Pistons and Conrods

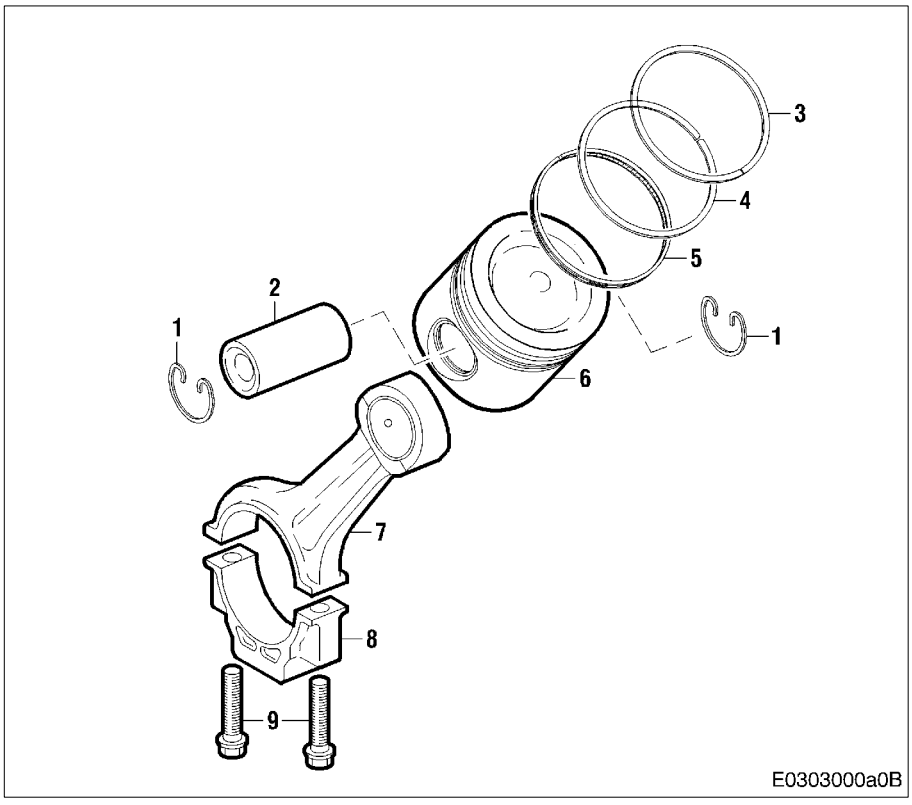
C 037.05.01 Overview Drawing



1 Piston
2 Conrod bearing, bottom
3 Conrod cap
4 Conrod screw

Max. shaft length:	68.5 mm
Lubricant:	Engine oil
Pretightening torque:	100 Nm + 15 Nm
Angle of further rotation :	90° + 10°

5 Conrod bearing, top
6 Conrod



1 Snap ring
2 Piston pin
3 Keystone-type compression ring
4 Taper-face compression ring
5 Oil scraper ring
6 Piston
7 Conrod
8 Conrod cap
9 Conrod screw*****

*** Only attach conrod bearing cover to conrod with bearing shells installed.**

C 037.05.02 Special Tools

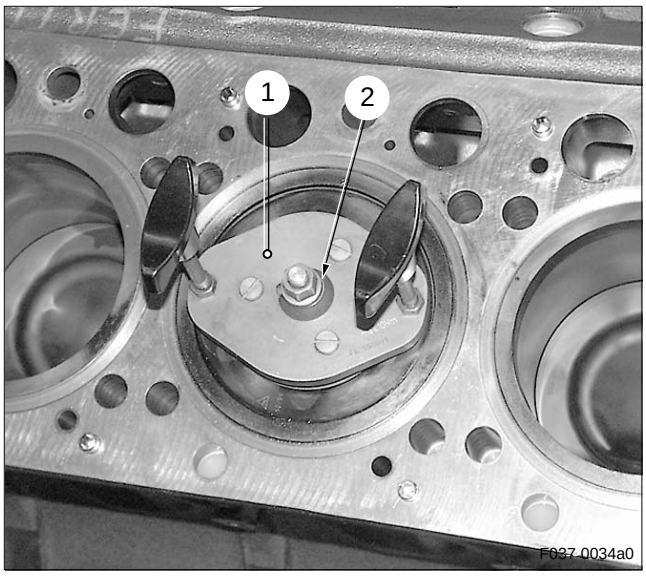
Designation – Application	Number
Socket for conrod screws	1
Removal tool for piston with connecting rod	1
Piston ring pliers	1
Barring tool for flywheel	1
Graduated disc	1
Pointer	1
Piston ring band clamp	1
Installation tool for conrod bearings	1
Ring gauge for piston ring end clearance measuring	1
Measuring device for determining TDC	1

C 037.05.04 Before-Removal Operations

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65
–	x	x	Remove air filter	C 121.05
–	x	x	Remove intake housing	C 123.05
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove cover	C 114.05
–	x	x	Release or remove charge air manifolds	C 124.05
–	x	x	Remove exhaust turbocharger	C 101.01
–	x	x	Remove exhaust manifold	C 142.05
–	x	x	Remove cylinder head cover	C 055.10
–	x	x	Remove H.P. fuel line	C 073.05
–	x	x	Disconnect leak-off fuel lines	C 086.05
–	x	x	Remove rocker arm assembly	C 055.05
–	x	x	Remove pushrods	C 054.05
–	x	x	Remove cylinder head	C 041.05
–	x	x	Lower or remove oil pan	C 014.05

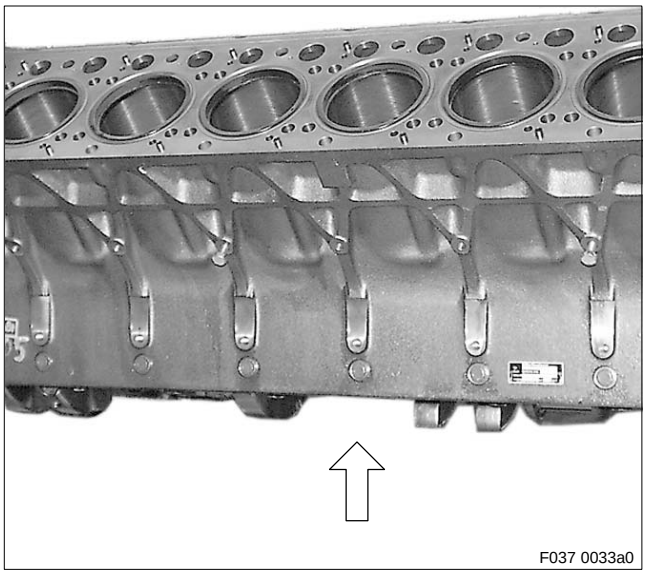
C 037.05.05 Removal



Removing piston with connecting rod with oil pan lowered

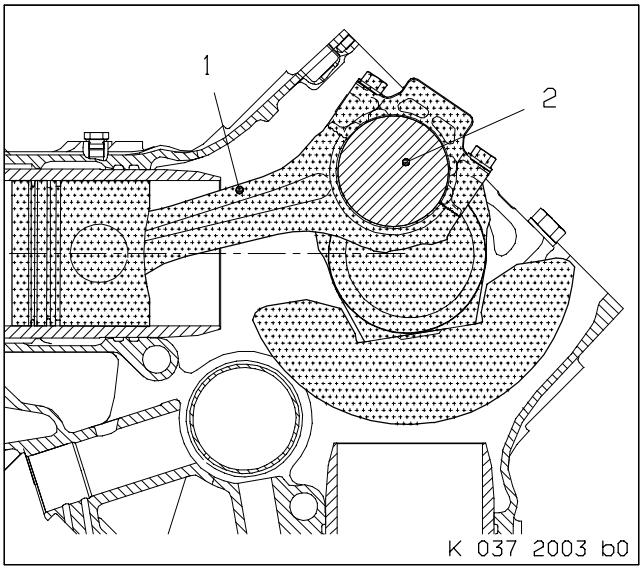
Install removal tool (1) in combustion bowl of piston to be removed.

Note: Hex nut (2) may be tightened to **max**. 10 Nm.



Release conrod screws with socket and large ratchet from beneath (arrow).

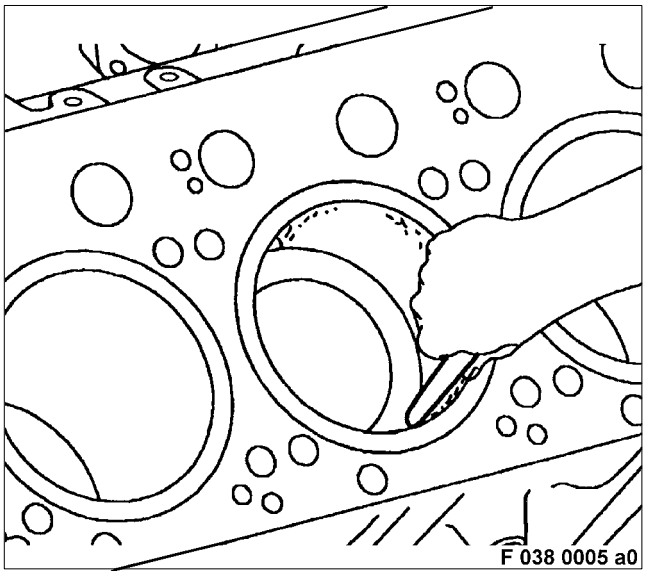
With the exception of the different position of the crankcase, rest of removal procedure is the same as for – Removing piston with conrod in assembly dolly –.



Removing piston with conrod in assembly dolly

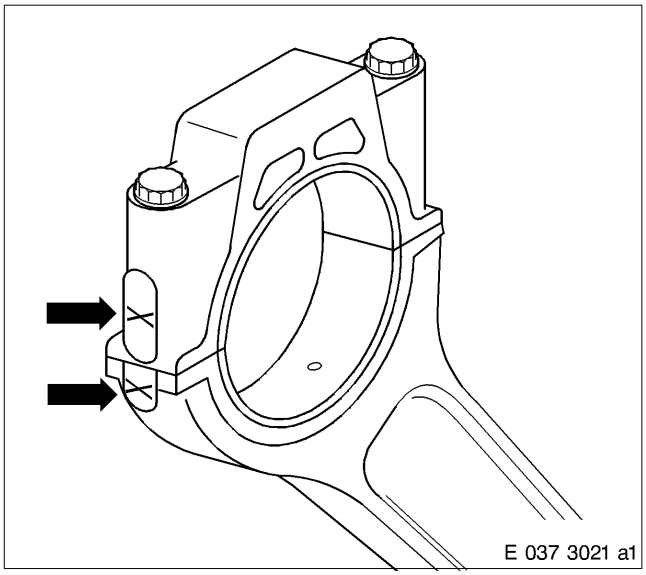
Rotate crankcase in assembly dolly until piston to be removed is horizontal.

Turn crankpin (2) of crankshaft of piston and connecting rod (1) to be removed according to sketch in disassembly position.



Carefully remove combustion residues over top lands in cylinder liner with a scraper. Take care not to damage running surface!

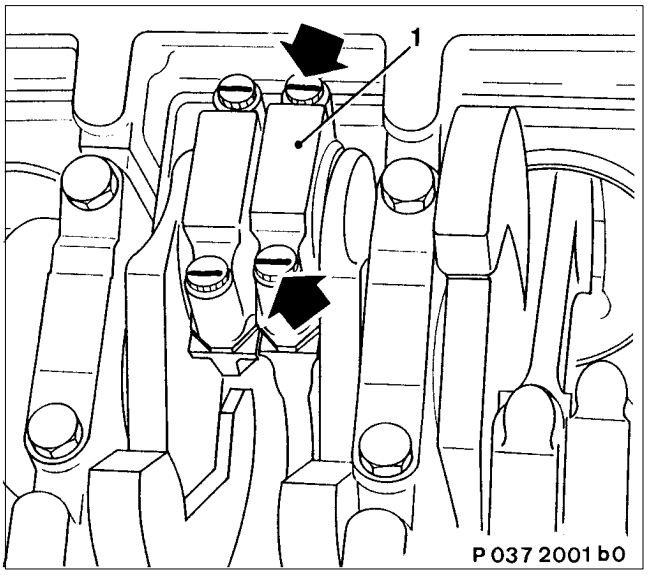
Note: This ensures that the piston rings are not damaged when the piston is being removed.



Check marking (arrows) of conrod cap to conrod.

Mark parts as necessary.

Note: Bearing cap and conrod are a single unit and must not be interchanged.



Remove conrod screws (arrows) with socket and ratchet and remove conrod cap (1).

Remove bearing shell from conrod cap and protect from damage.

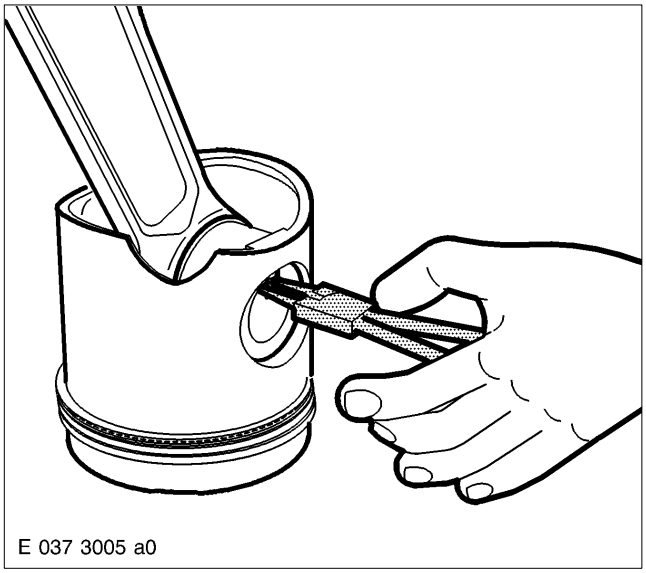
Check markings from bearing shell to conrod; reapply markings if necessary.

Important: When removing piston, do not damage or bend oil spray nozzle.

Press piston out of cylinder liner using a wedge of wood at edge of piston skirt.

Remove bearing shell from conrod and protect from damage.

C 037.05.06 Disassembly



E 037 3005 a0

Removing conrod from piston

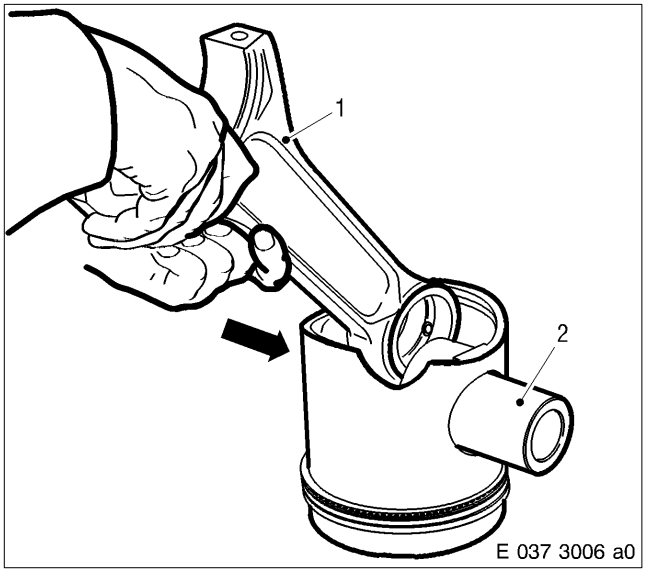
Place piston and conrod on workbench.

Check marking on conrod, piston and piston pin; correct markings if necessary.

⚠ CAUTION

Snap ring pretension.
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Using circlip pliers (1), remove circlips.



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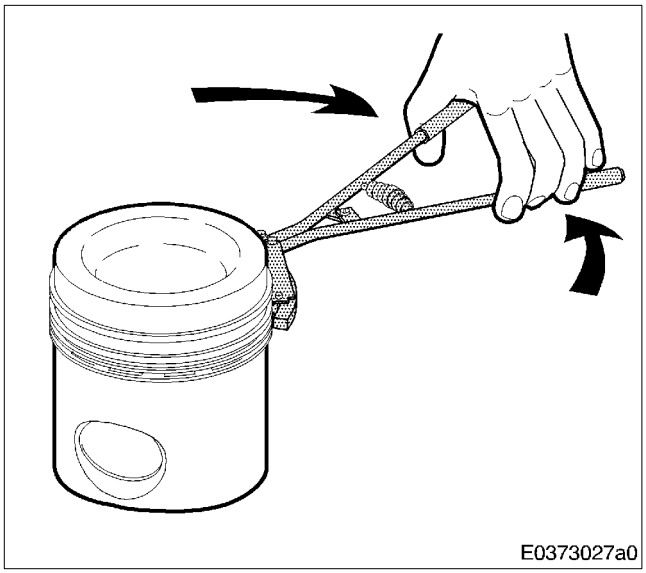
Use wooden rod to press out piston pin (2) (arrow).

Note: Do not use sharp-edged tool to force out piston pin.

Hold conrod (1) and remove piston pin.

Remove conrod from piston.



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Removing piston rings

Remove piston rings with piston ring pliers in sequence from top to bottom.

Note: Stretch piston rings (arrows) only until they can be removed from the piston. Do not overstretch piston rings, **as they may break.**

C 037.05.08 Inspection and Repair

Piston

Note: The graphite layer on the piston skirt must not be mechanically removed or treated with strong cleaners!

CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Treat carbon deposits on piston crown and piston ring grooves with decarbonizer.

Remove remaining residues from piston crown and piston ring grooves by brushing.

Note: Use only a soft brush (e.g. perlon brush) to avoid damaging piston surface.

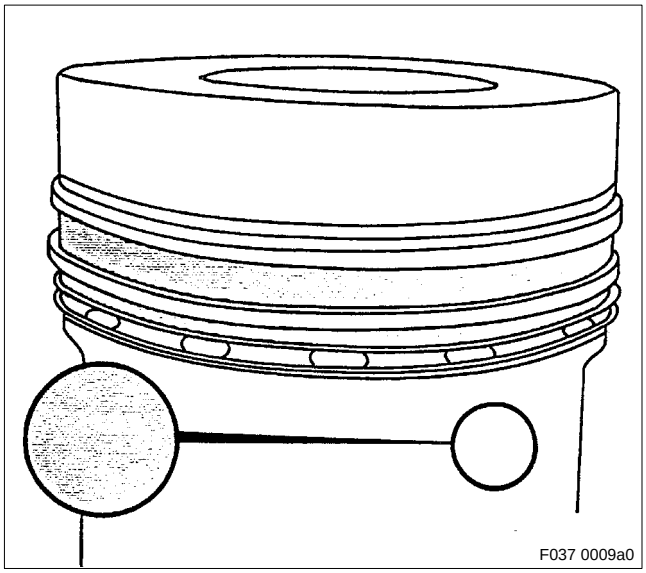
CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

After cleaning, blow out oil chamber and oil bores with compressed air and check for particular cleanness.

Using the surface crack-testing method with fluorescent penetrant dye, check piston for cracks; replace if necessary.

Carefully inspect piston ring grooves for cracks.

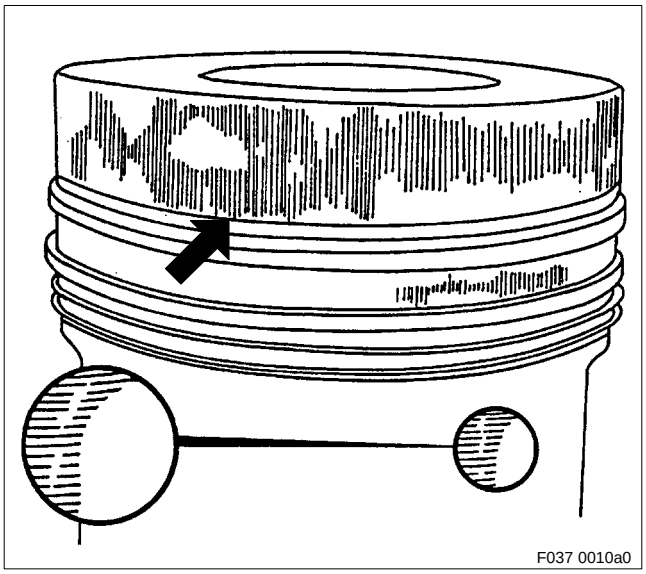


Checking piston skirt and top land

Check piston skirt surface condition for wear, pitting and scoring.

The piston skirt wear pattern must cover most of the surface as the friction scores must be easily identifiable in this area.

Note: The friction scores on the circumference are artificial depressions which are filled with oil and result in improved lubrication.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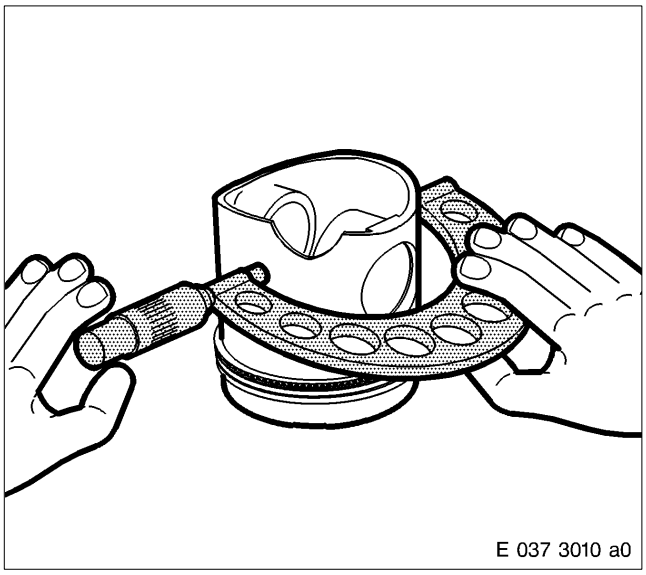
In the event of contact erosion on the piston edge, replace the complete piston.

Remove scoring or scuffing on top land of piston if local and not extending as far as first annular groove.

Replace piston if damage is more extensive, i.e. if scoring or pitting extends as far as the first annular groove (arrow).

In the event of extensive polishing wear on piston skirt (appears dull rather than shiny) and concentrated scoring, replace piston.

Replace pistons exhibiting even minor, localized scuffing on piston skirt.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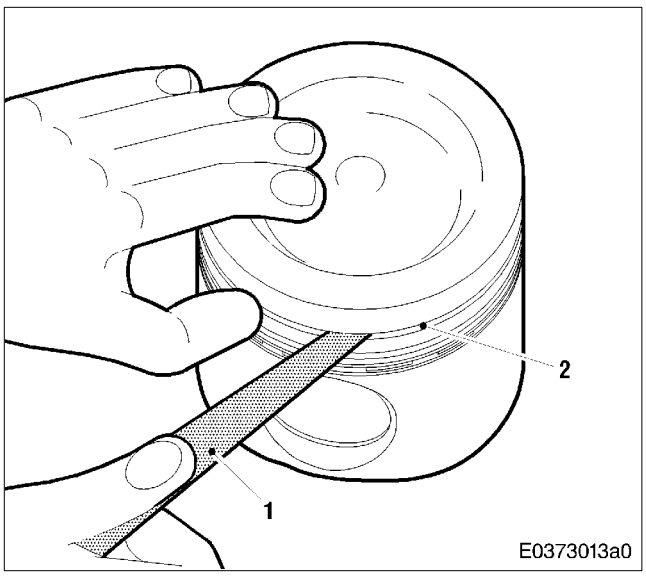
Measuring piston skirt diameter

Use an outside micrometer to measure outside diameter on points free from graphite.

If measurements are below limit values as per Tolerance and Wear Limits List, replace piston.



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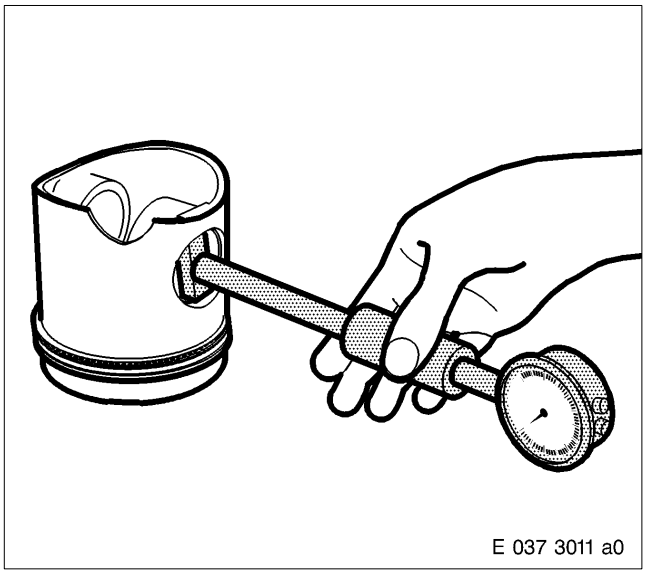
Inspecting piston ring grooves

Check groove width with final measurements.

Alternatively, a new piston ring (2) can be inserted into groove and axial clearance measured with feeler gauge (1).

If the limit values as per Tolerance and Wear Limits List are exceeded, or measurements are below limit values for groove for oil control ring, replace piston.

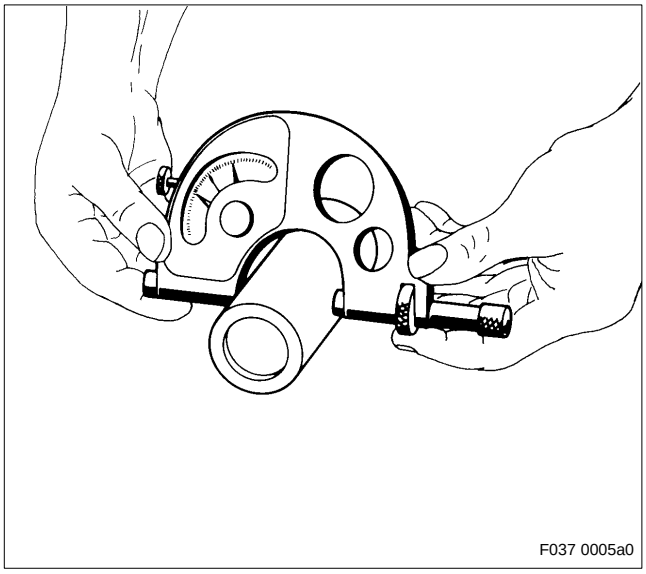

E 037 3011 a0

Inspecting piston pin boss

Adjust bore gauge and measure piston pin bore.

If limit values as per Tolerance and Wear Limits List are exceeded, replace pistons.

Check sliding surfaces of bronze bushing for wear and scoring; replace piston as necessary.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Inspecting piston pin

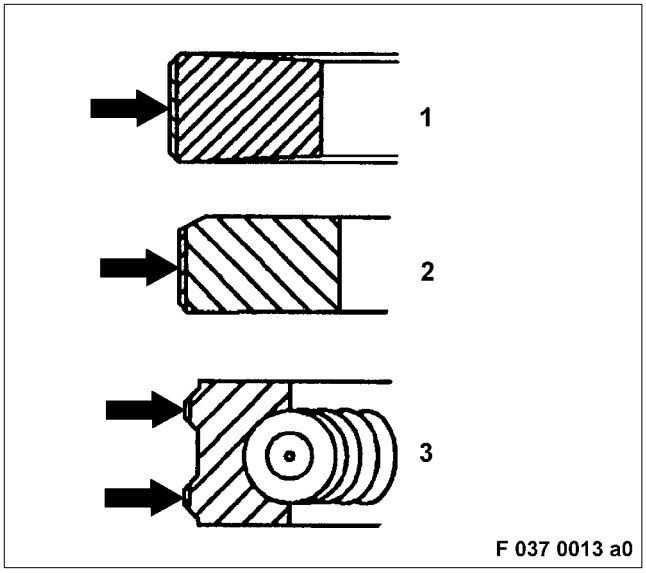
Using magnetic crack-testing method and fluorescent magnetic powder, check piston pin for cracks; if cracks are detected, replace piston pin.

Remove minor traces of wear and scoring by polishing.

Replace piston pins exhibiting scuffing, indentations and severe wear.

Measure outside diameter with outside micrometer and determine pin clearance – see Tolerance and Wear Limits List.

If limit value is exceeded, replace piston pin.



F 037 0013 a0

Inspecting piston rings

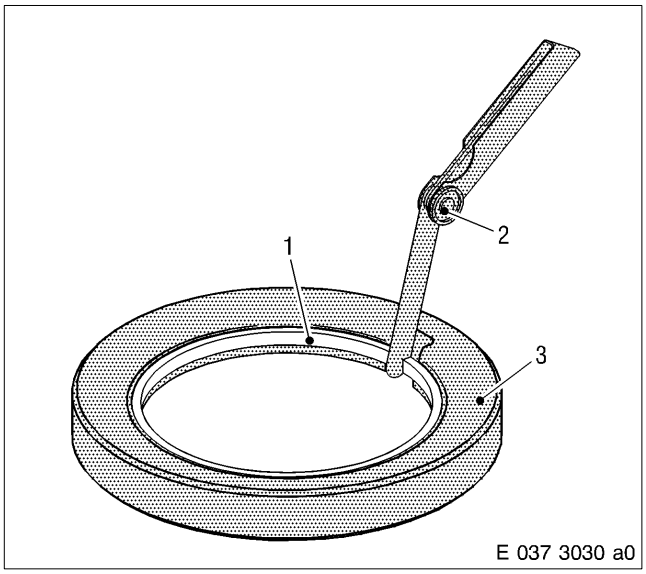
Replace piston rings during W6 overhaul.

Clean piston rings of combustion residue and check for damage; replace if necessary.

Condition or wear of chrome layer (arrow) is a deciding factor when reusing or replacing keystone-type compression ring (1), taper face compression ring (2) and oil scraper ring (3).

Chrome layer must not show signs of scoring, cracks or heat discoloration.

Replace sharp-edged piston rings.



Place piston ring (1) in ring gauge (3) to measure piston ring end clearance.

Ensure that piston ring is fitted evenly in ring gauge!

Check piston ring gap with feeler gauge (2).

If limit values as per Tolerance and Wear Limits List are exceeded, replace piston rings.

Note: Piston rings must only be replaced in sets. Hone cylinder liners if new piston rings are installed.

Connecting rod

Using magnetic crack-testing method with fluorescent magnetic powder, check conrod, conrod cap and conrod screws for cracks.

Replace cracked components.

Check conrod and conrod screw threads for ease of movement.

Polish out all traces of nicks in conrod; replace conrod if necessary.

Check conrod for blue colouring; if blue colouring is detected (due to bearing damage), replace connecting rod.

Check main bore for wear and scoring; replace conrod if necessary.

Check conrod bush for scoring, dirt, wear and hot runs; burnish minor scoring with emery cloth; replace conrod bush if necessary.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body.

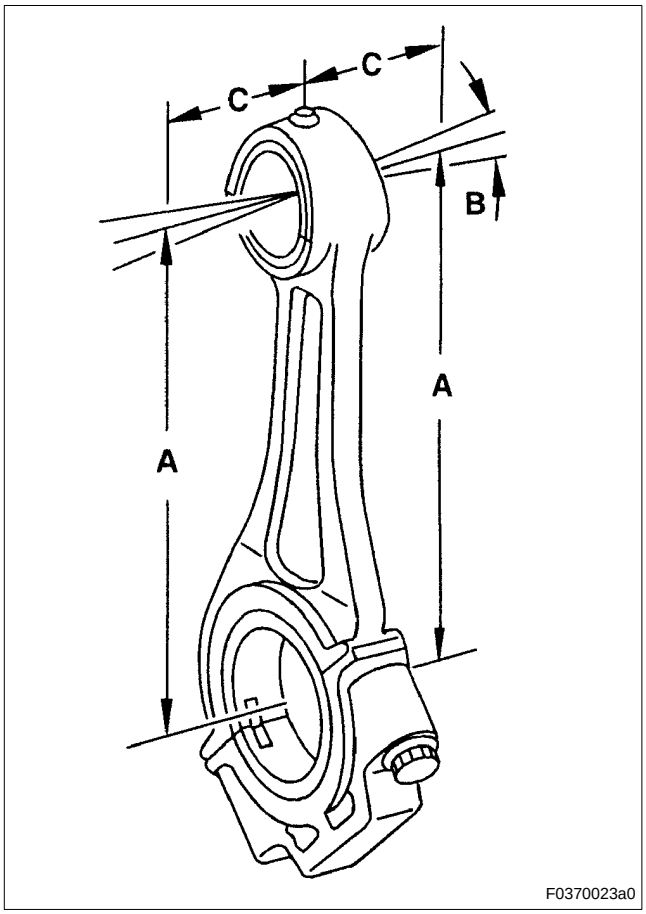
Use a brass brush to clean toothing on conrod and conrod cap mating faces and blow dry with compressed air.

Use oilstone to remove surface irregularities and traces of wear from serrations.

Apply engineer’s blue to check contact pattern.

Check that lube oil bore in connecting rod is perfectly clean; if necessary clean with bristle brush and blow with compressed air.

Note: Never use a wire brush!



Checking conrod twist

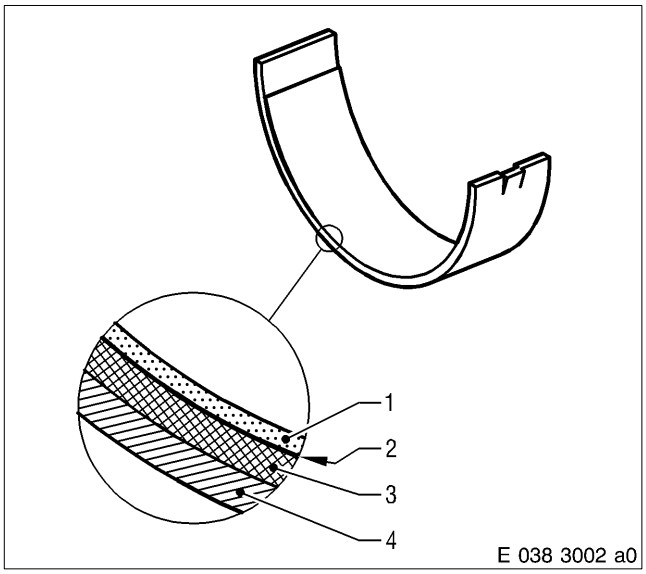
Measure permitted deviation (B) of bend between conrod bearing and conrod bushing bore to measuring distance (C).

Measure distance (A) from centre conrod bearing bore to centre conrod bushing bore.

For required measurements and limit values – see Tolerance and Wear Limits List.

If limit values are exceeded, replace conrod.

Note: Connecting rod must not be straightened!



Checking and assessing conrod bearing shells

Check surface condition of bearing shells and check shells for wear. Replace worn or chipped bearing shells.

Replace bearing shells as part of every W6 overhaul.

Bearing shell has the following material structure:

1 Sliding layer (from 12 µm to 20 µm)

2 Intermediate layer (nickel barrier)

3 Bearing metal

4 Steel support shell

An important indicator for assessing extent of wear on bearing shell is the shape and extent of the nickel barrier areas exposed.

Use of bearing shell is already restricted in friction area once the sliding layer is reduced to 70%!

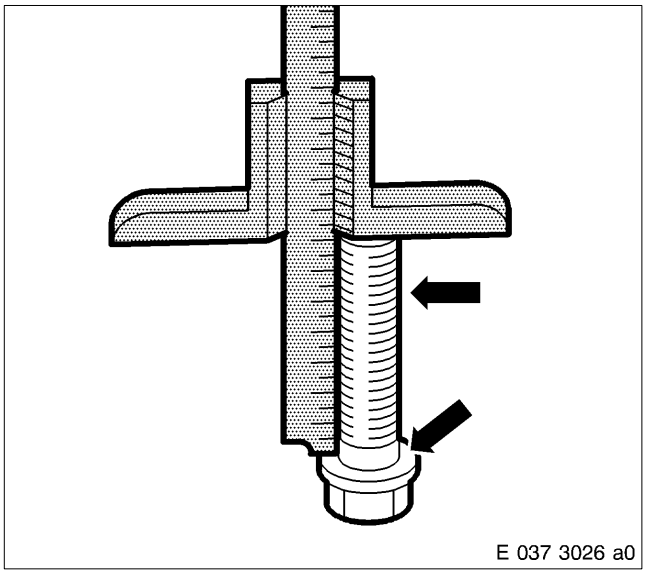
Note: It is often difficult to differentiate between the hard nickel barrier and softer sliding layer. If in doubt, consult a bearing specialist.

Check condition of bearing shell butt and bearing reverse side and check for friction corrosion (pitting); if there is evidence of friction corrosion, replace bearing shell and determine cause.

Possible causes: Screws not sufficiently pretensioned, assembly fault, bearing shell spread dimension is outside tolerance limit and defective bearing support bore.

Measure bearing shells spread dimension.

If spread dimension is too low (see Tolerance and Wear Limits List), replace bearing shells.

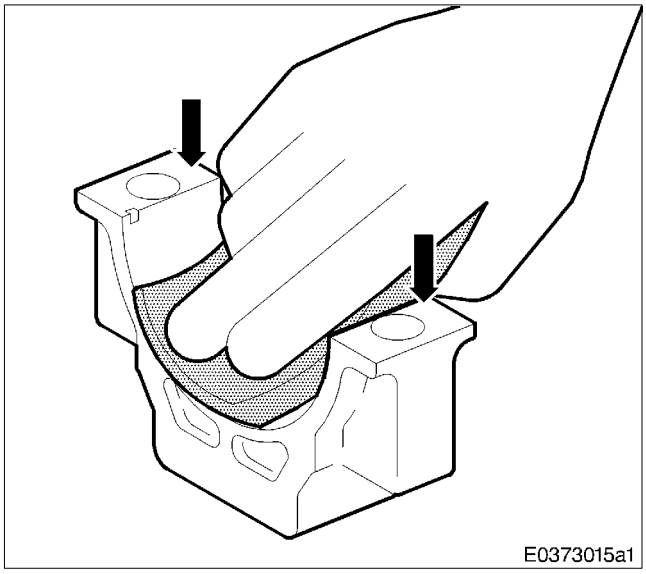


Checking conrod cap screw

Check screw head support and thread (arrows) for scoring or damage; replace screw if necessary.

Measure shaft length of conrod screw with depth gauge.

For max. permissible shaft length – see C 037.05.01.



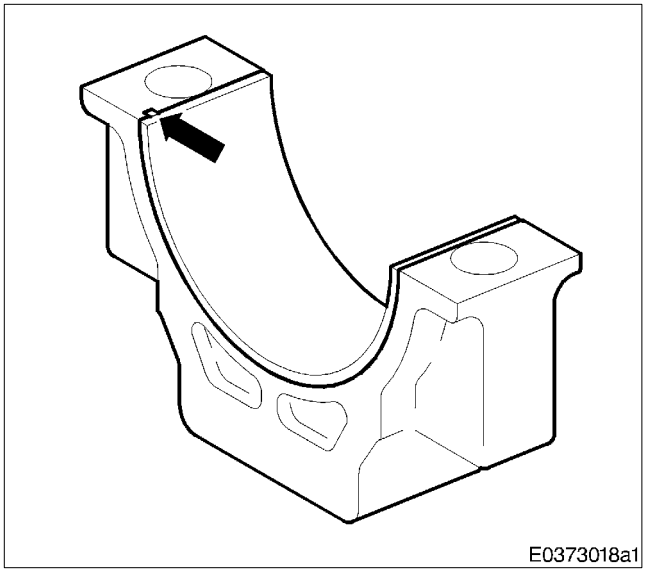
Storing conrod bearing shells

⚠ CAUTION

Compressed air is air which has been compressed under pressure. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out splines (arrows) on mating faces of connecting rod and conrod cap with compressed air and check that components are clean.

Wipe bearing shell mating faces on connecting rod and conrod cap.



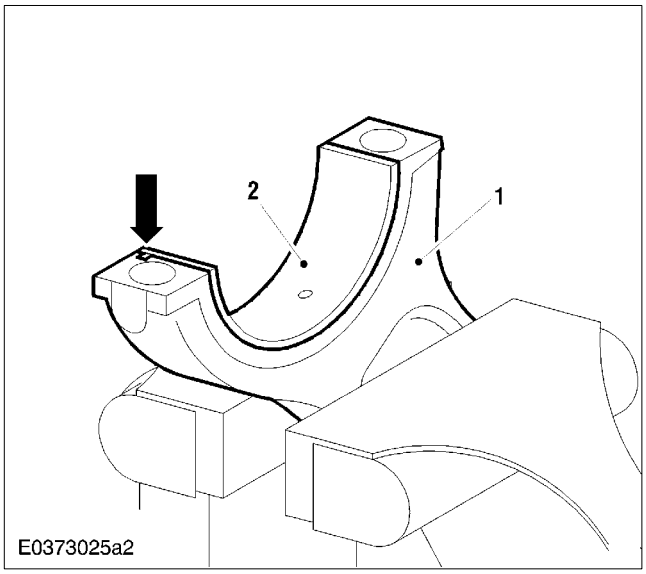
Note: New conrod bearing shells must be installed as part of every W6 overhaul.
Prior to installing conrod bearing shells, compare repair stage marking on connecting rod and in crankshaft data sheet.

Mark conrod bearing shells according to cylinder number on front face.

Note: Top and bottom bearing shells have different part numbers.

Wipe lower conrod bearing shell (bearing shell without oil bore) on both sides and fit in conrod cap.

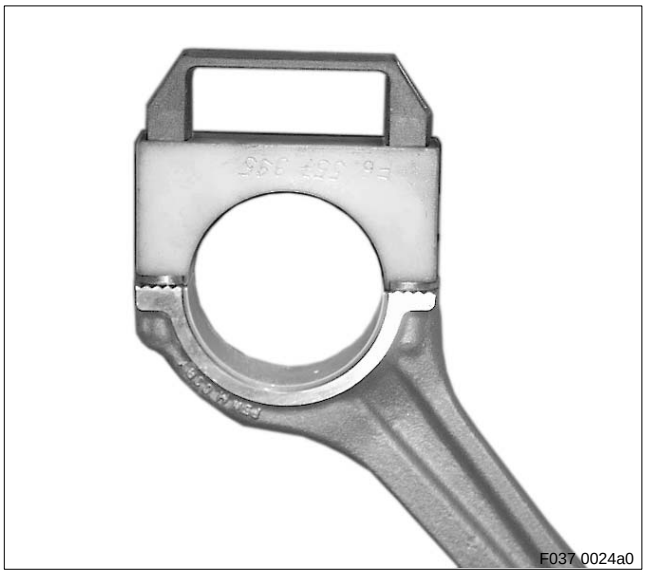
Securing lug (arrow) of conrod bearing shell must sit in groove in conrod bearing cover.



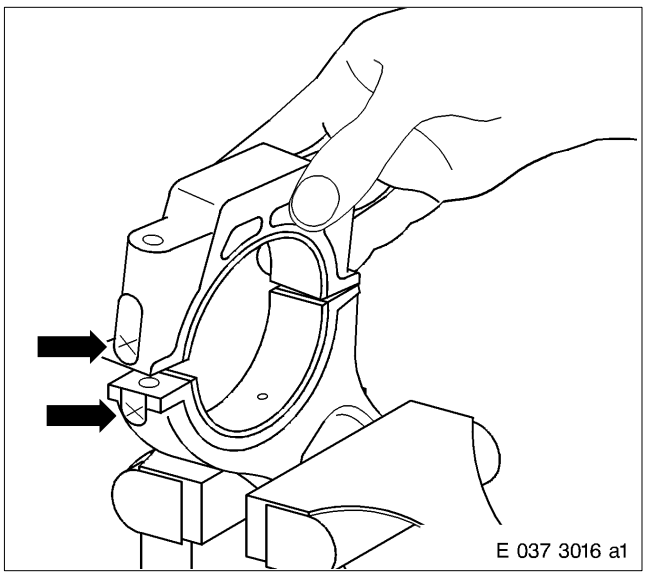
Clamp conrod (1) in vice with aluminium jaws.

Wipe upper conrod bearing shell (2) (bearing shell with oil bore) on both sides and fit in conrod.

Securing lug (arrow) of conrod bearing shell must sit in the groove of the connecting rod and the bore in the conrod bearing shell and conrod must match.



Align conrod bearing shell with assembly device.

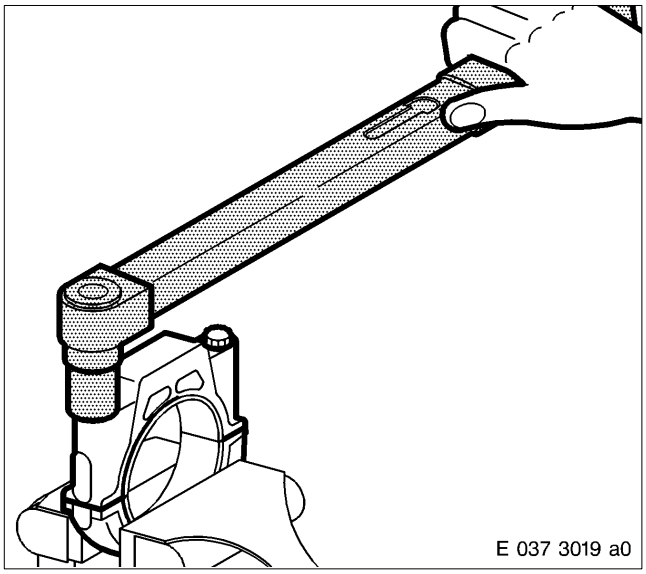


Place conrod cap in position on conrod, making sure that serial numbers (arrows) match.

Coat threads of screw head mating face and screw head seating surfaces with engine oil.

Fit conrod cap screws.

Note: Manually press conrod cap into place when installing conrod screws.

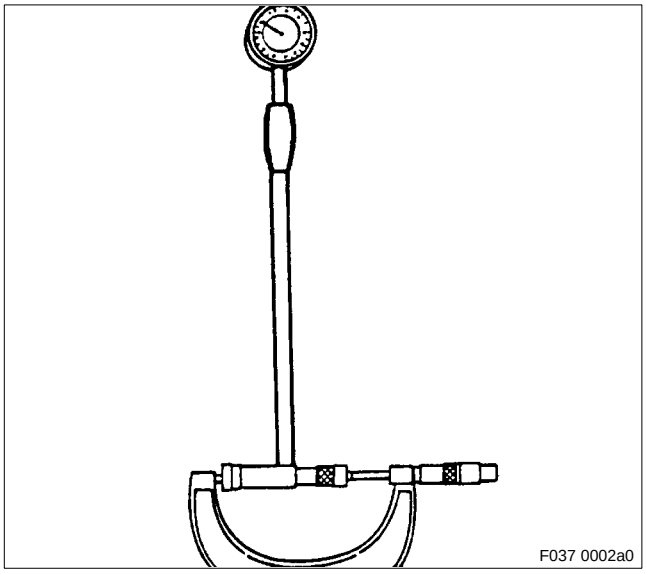


To avoid twisting the conrod, clamp conrod in vice according to diagram.

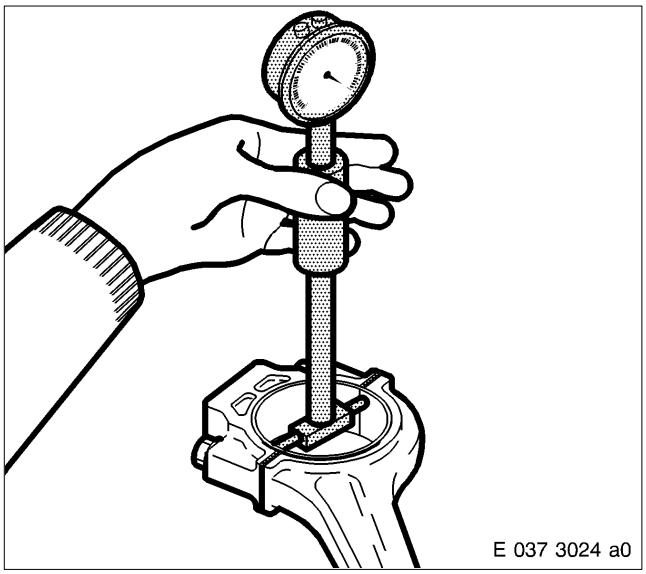
Pretighten conrod screws with torque wrench and socket to specified pretightening torque – see C 037.05.01.

Mark screw heads.

Tighten conrod screws through specified additional angle of rotation.



Adjust bore gauge and dial gauge with micrometer to basic size for conrod bearing bore as per Tolerance and Wear Limits List.



Coat sliding surfaces of bearing shells with engine oil.

Measure conrod bearing bore.

For limit values and measuring points, see Tolerance and Wear Limits List.

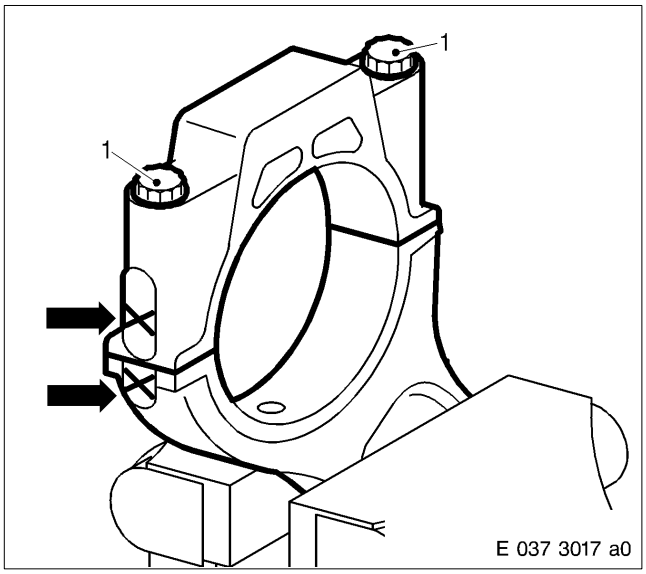
Enter measurement values in data sheet.

If limits values are exceeded or not achieved, replace bearing shells or machine conrod basic bore to repair size.

Note: Conrod bearing shells are ready for installation when supplied. No reconditioning must be carried out.

Remove conrod screws, conrod cap and bearing shells.

Protect bearing shells from damage!



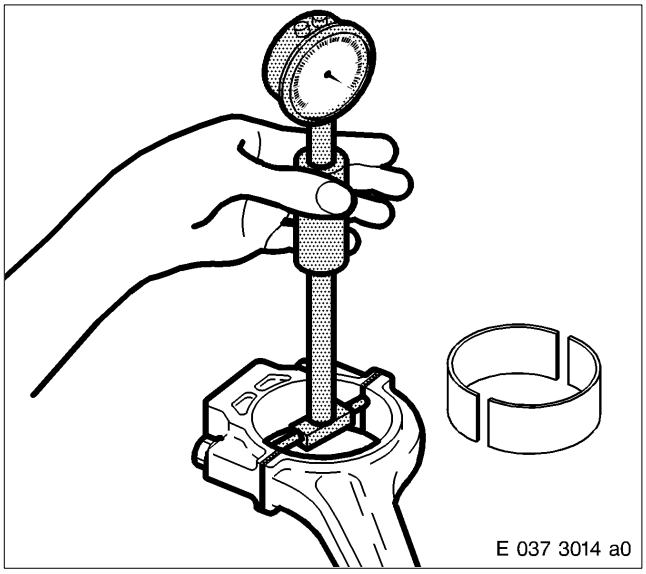
Measuring conrod main bore

Note: Conrod screws must only be loosely fitted without bearing shells installed (10 to 20 Nm) and **not** tightened to specified torque.

Correctly fit conrod cap on connecting rod.

Check that markings (arrows) for conrod cap to conrod are aligned.

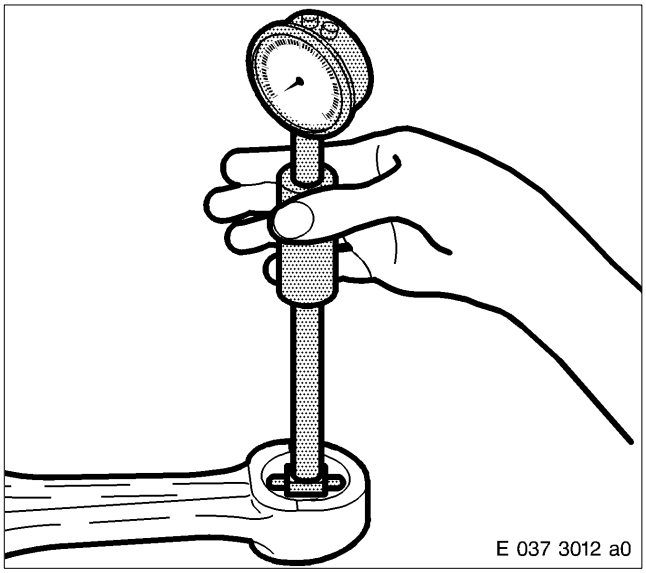
Manually press conrod cap into place, insert conrod screw (1) and tighten (10 to 20 Nm).



Adjust bore gauge to basic size conrod bearing bore and measure.

For basic size of conrod basic bore, limit values and measuring points – see Tolerance and Wear Limits List.

If limit values are exceeded, machine conrod main bore to repair size or replace conrod.



Measuring conrod bushing bore

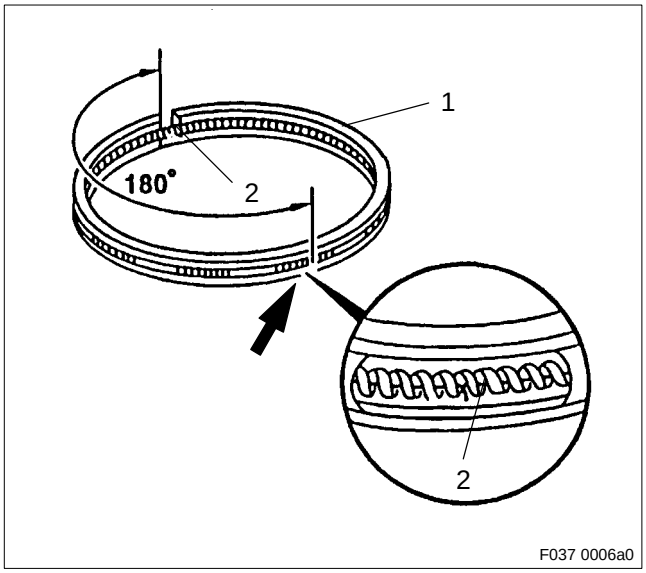
Adjust bore gauge to zero dimension for conrod bush bore as per Tolerance and Wear Limits List and measure bore of conrod bush.

If limit values are exceeded, replace conrod bush.

Consultation with MTU is required.

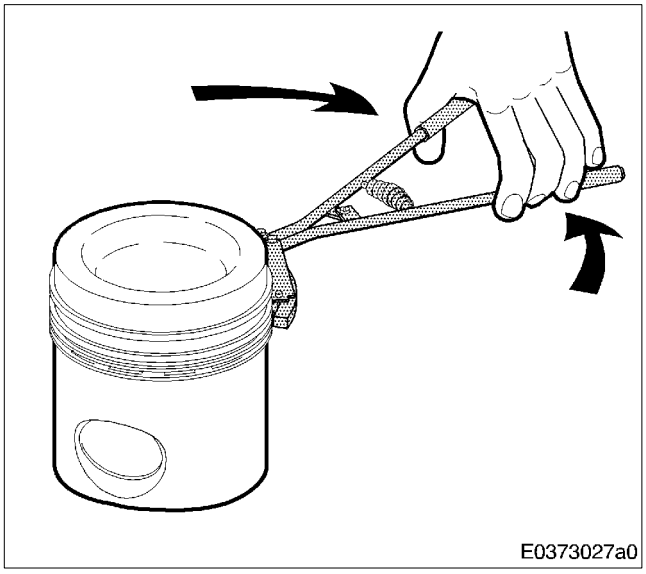
C 037.05.10 Assembly

Note: Always make sure that all components are perfectly clean.



Installing piston rings

Turn coiled spring expander (2) in oil scraper ring (1) to offset ring spring butting face (arrow) to oil scraper ring butt by 180°.



In sequence from bottom to top (oil scraper ring first), insert piston rings with piston ring pliers into annular grooves on piston.

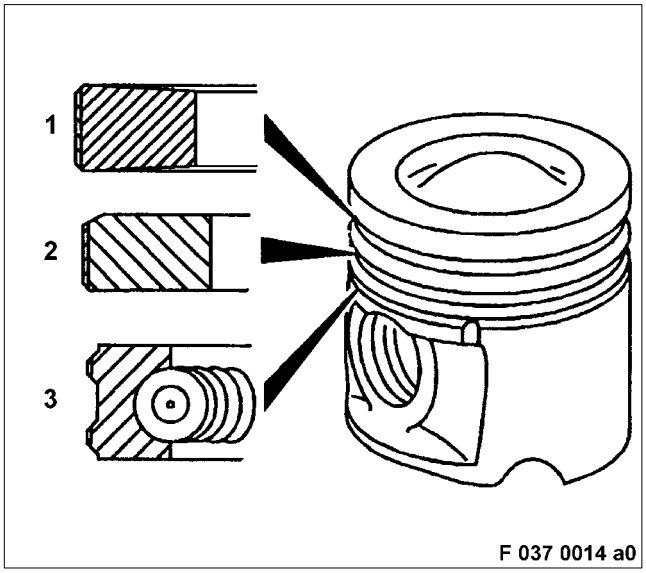
Note: Stretch piston rings (arrows) only until they can be fitted over the piston. Do not overstretch piston rings, **as they may break.**

Make sure piston rings are installed in correct sequence – see next illustration.

TOP marking on piston rings must point upwards.

Note: Oil scraper ring does not have a TOP marking, installation position as required.

Check that piston rings move freely in their grooves.



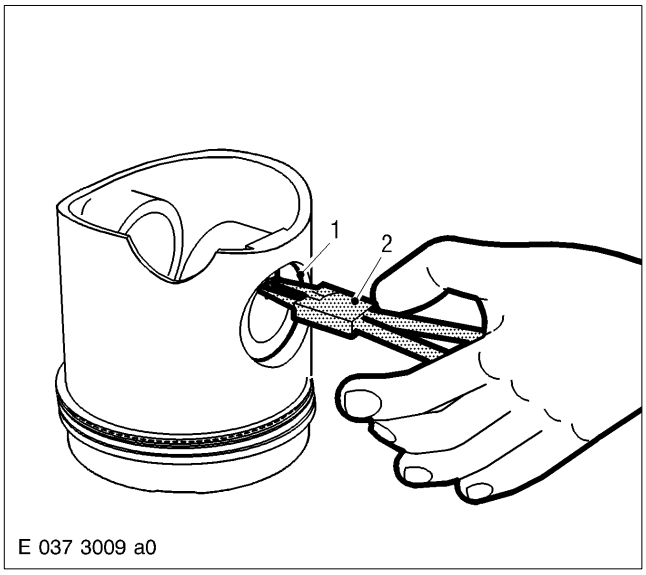
Sequence of piston rings:

1 – Keystone-type compression ring

2 – Taper-face compression ring

3 – Oil scraper ring

Note: Piston rings must only be replaced in sets. Hone cylinder liners if new piston rings are installed.



E 037 3009 a0

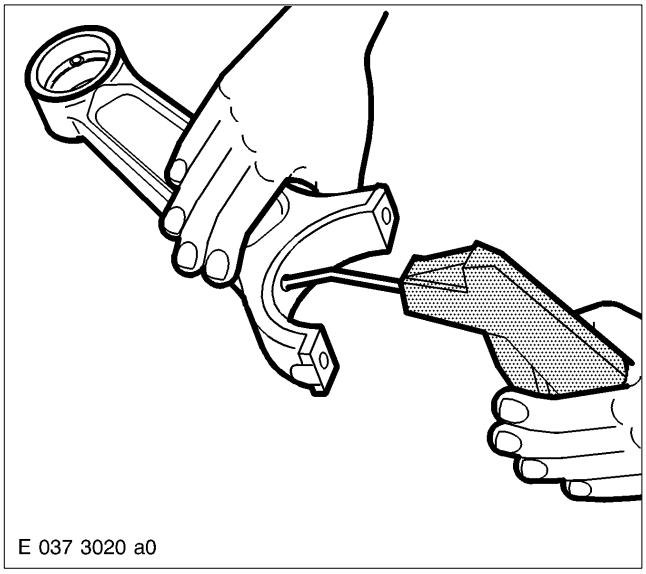
Installing conrod in piston

⚠ CAUTION

Snap ring pretension.
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Using snap ring pliers (2), insert snap ring (1) into piston boss.

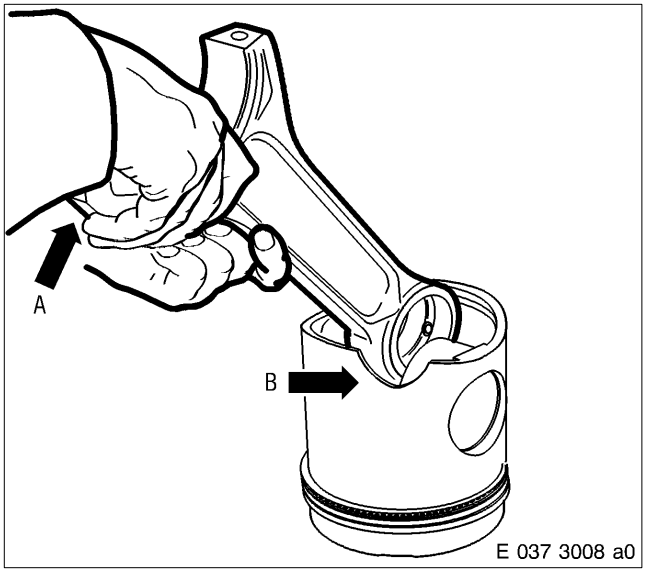
Note: Make sure snap ring is perfectly seated in groove. Snap ring must be seated securely in the groove.


E 037 3020 a0

⚠ CAUTION

Compressed air is air which has been compressed under pressure. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar (40 lb/in^2).

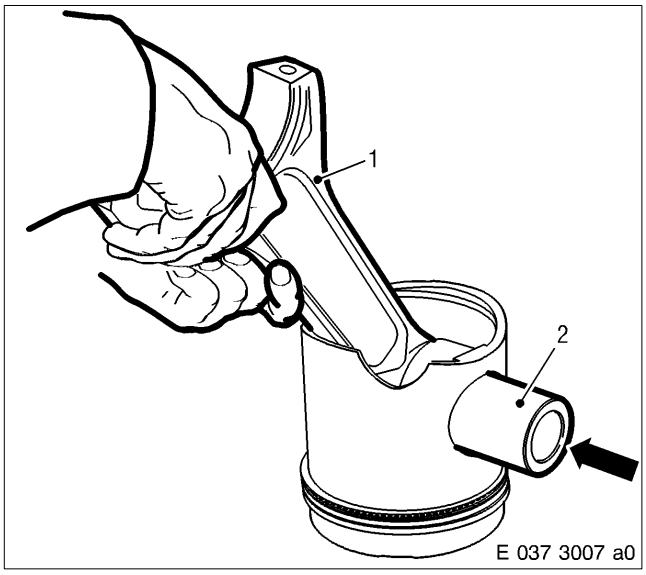
Blow through lube oil bores in conrod with compressed air and ensure that they are perfectly clean.



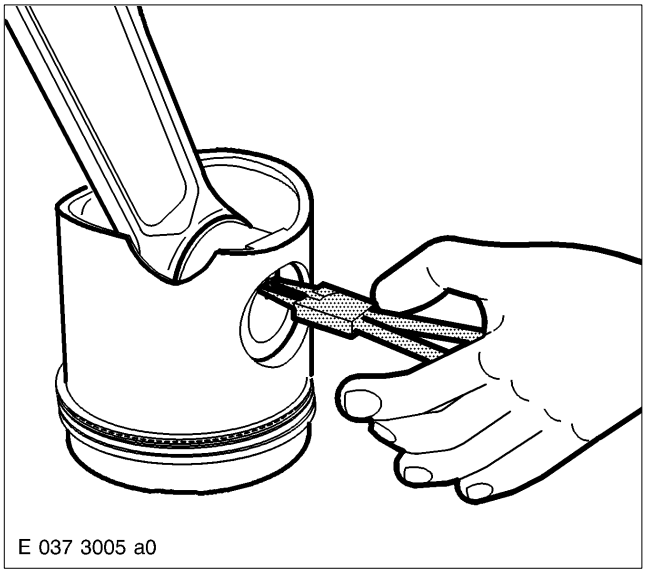
E 037 3008 a0

Wipe down piston pin, conrod bushing and piston pin bore with chamois leather and coat with engine oil.

Insert conrod according to markings into relevant piston in such a way that the longer end (A) of the angle-split conrod faces recess (B) for oil spray nozzle.



Push associated piston pin (2) into piston and conrod (1) until seated against snap ring installed beforehand (arrow).



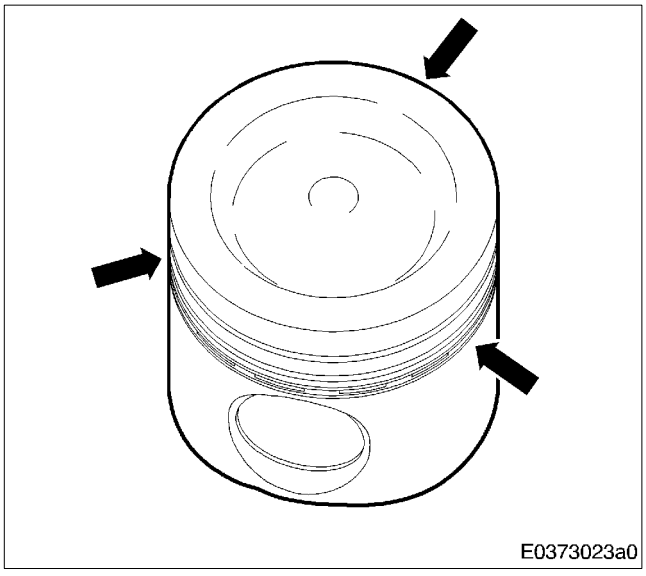
⚠ CAUTION

Snap ring pretension.
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Insert second snap ring with snap ring pliers.

Note: Make sure snap ring is perfectly seated in groove. Snap ring must be seated securely in the groove.

C 037.05.11 Installation

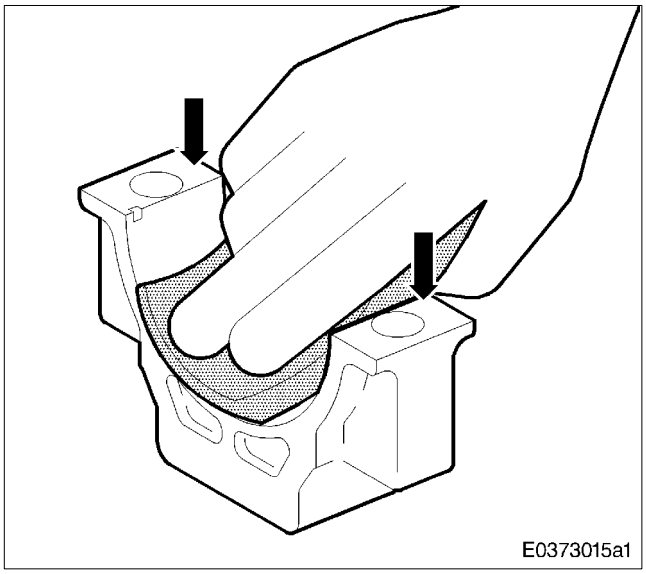


Installing piston with conrod in assembly dolly

Note: Always make sure that all components are perfectly clean.

Spray the piston and piston rings with engine oil.

Position piston ring butts (arrows) consecutively at 120° intervals.

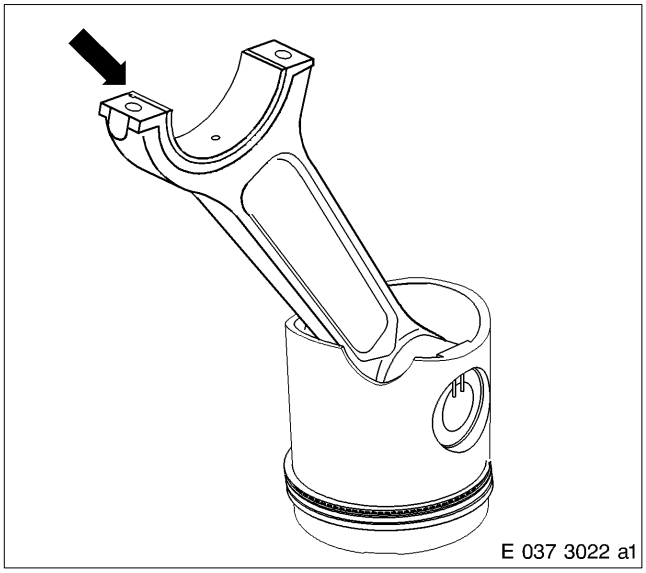


⚠ CAUTION

Compressed air is air which has been compressed under pressure. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out splines (arrows) on mating faces of connecting rod and conrod cap with compressed air and check that components are clean.

Wipe bearing shell mating faces on connecting rod and conrod cap.



Note: Top and bottom bearing shells have different part numbers.

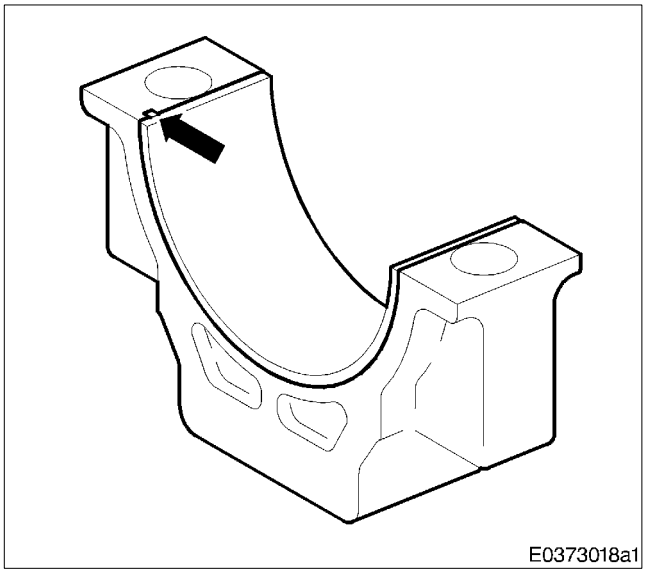
Wipe upper conrod bearing shell (bearing shell with oil bore) on both sides and insert into conrod in accordance with markings.

Note: Prior to installing bearing shell, note respective stage on connecting rod and crankshaft journal – see data sheets.

Securing lug (arrow) of conrod bearing shell must sit in groove in conrod.

Bore in the conrod bearing shell and conrod must be aligned.

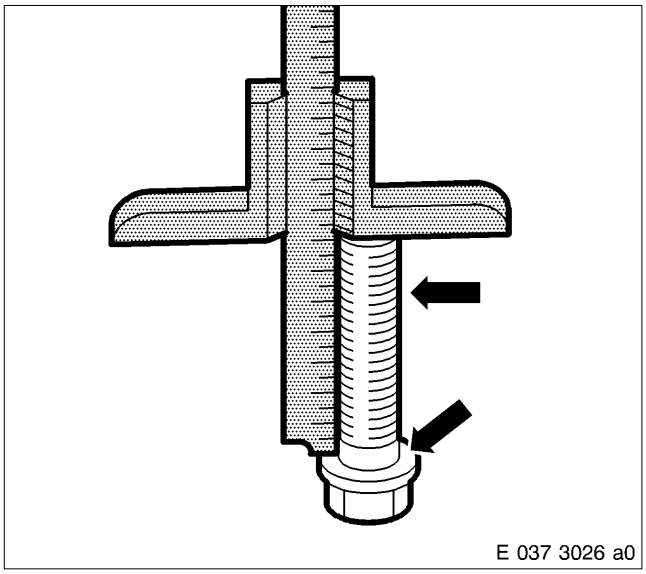
Coat friction face of conrod bearing shell with engine oil.



Wipe lower conrod bearing shell (bearing shell without oil bore) on both sides and insert into conrod cap in accordance with markings.

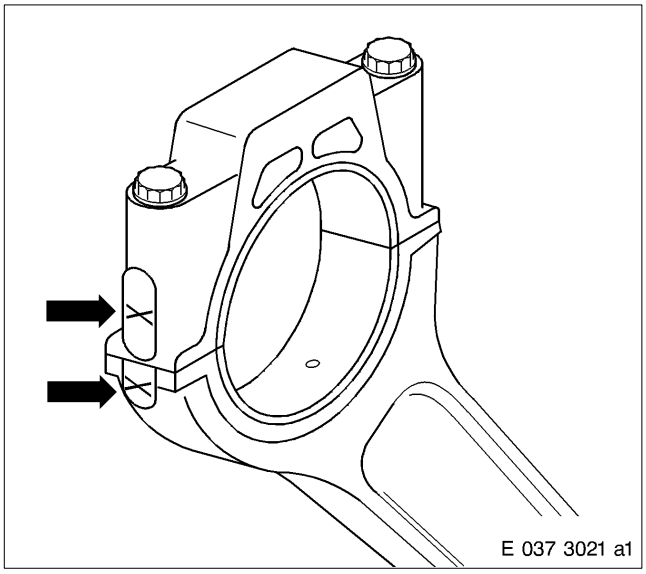
Securing lug (arrow) of conrod bearing shell must sit in groove in conrod cap.

Coat friction face of conrod bearing shell with engine oil.

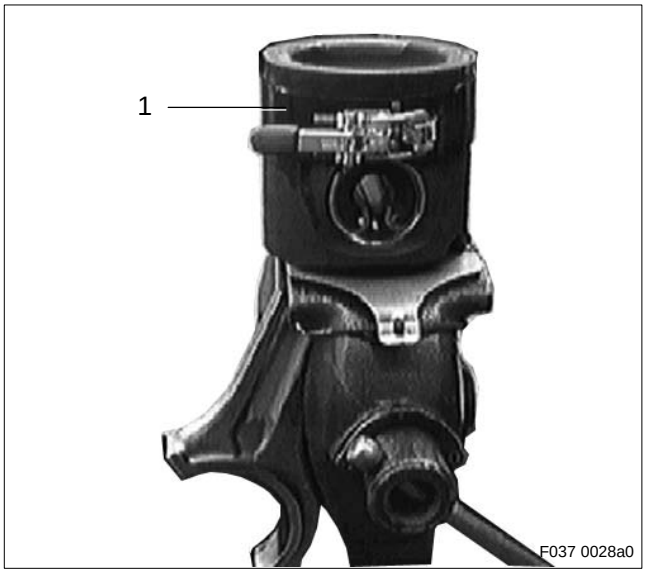


Measure shaft length of conrod screws; for max. shaft length – see C 037.05.01.

Coat threads and screw head seating surfaces (arrows) with engine oil.

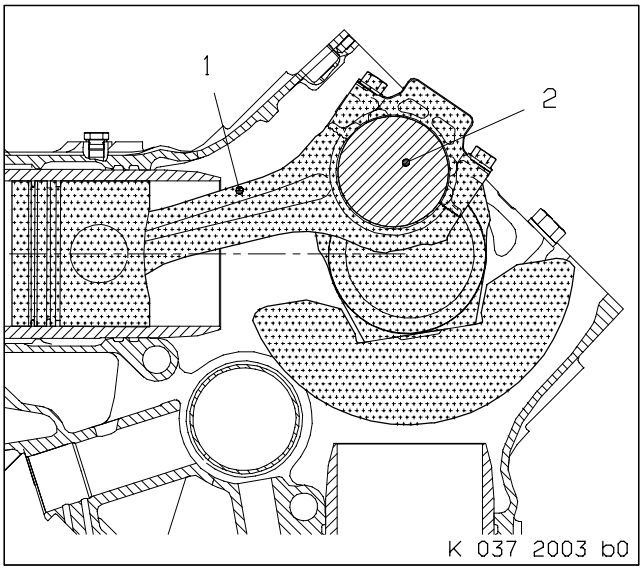


Check that markings (arrows) for conrod cap to conrod are aligned.



Guide piston ring band clamp (1) via piston rings and clamp.

Note: It must still not be possible to move the sleeve of the piston ring band clamp; retension gaiter if necessary.

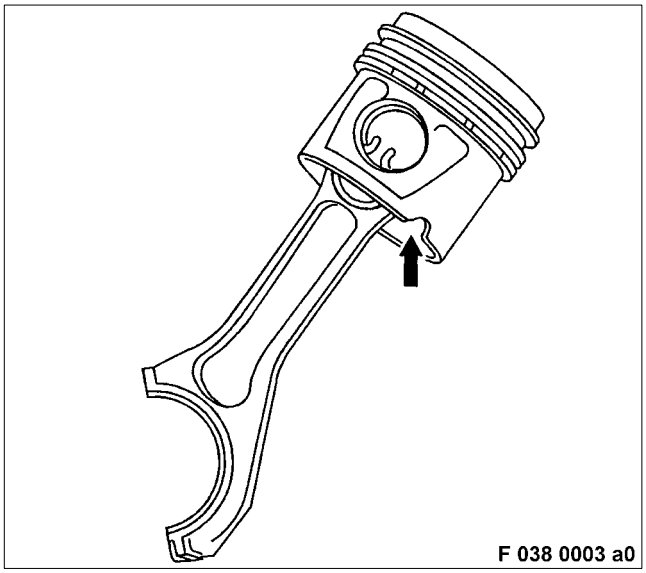


Rotate crankcase in assembly dolly until cylinder liners are horizontal.

Turn crankpin (2) of crankshaft of piston to be installed and connecting rod (1) according to sketch to assembly position.

Wipe crankpin and running surface of cylinder liner and spray with engine oil.

Insert piston according to markings in associated cylinder liner until the piston ring band clamp is in contact with the cylinder liner.



The recess (arrow) for the oil spray nozzle on the piston points inwards to the engine centre.

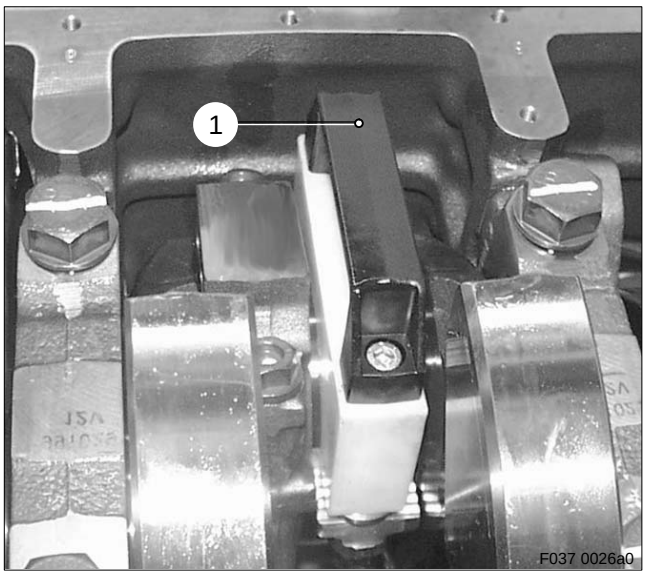
Note: In order to guide the conrod and avoid damage to the oil spray nozzle, piston installation must be carried out by two people.

Gently turn piston when inserting so that the oil spray nozzle is not damaged when the conrod is installed.

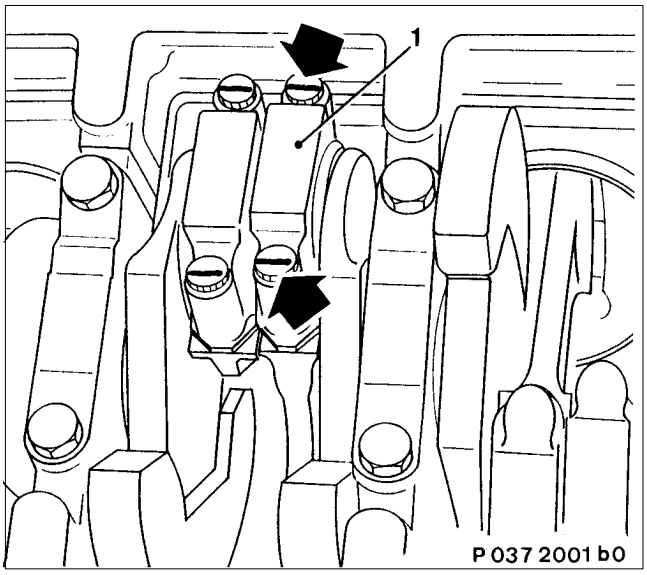
If the oil spray nozzle is damaged, remove spray nozzle and replace.

Press in piston until the conrod bearing shell fits exactly on crankpin of crankshaft, turn crankshaft if necessary.

Remove piston ring band clamp.



Align conrod bearing shell with assembly device (1), holding piston and connecting rod firmly in position to prevent displacement of conrod.



Fit conrod cap (1) correctly (marking must be on one side) and manually insert conrod screws.

Note: Manually press conrod cap into place when installing conrod screws.

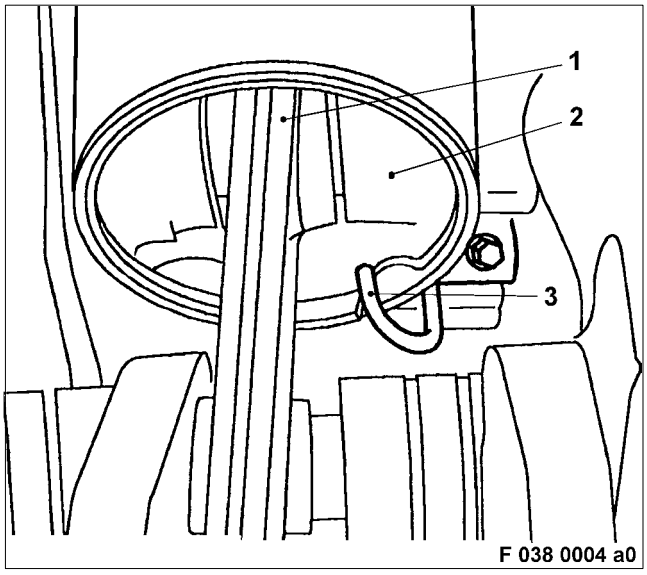
Pretighten conrod screws with torque wrench and socket to specified pretightening torque – see C 037.05.01.

Check that conrod has axial play.
If there is no axial clearance, remove conrod cap and replace damaged bearing shell.

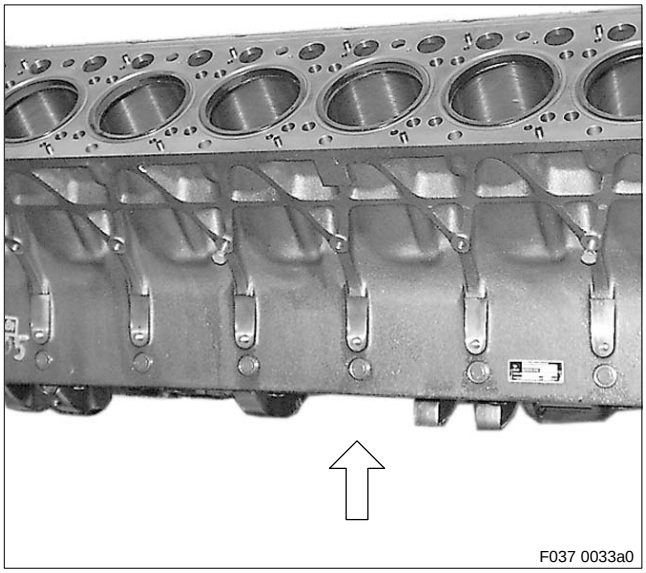
Mark screw heads (arrows).

Tighten conrod screws through specified additional angle of rotation.

Check that conrod has axial play.

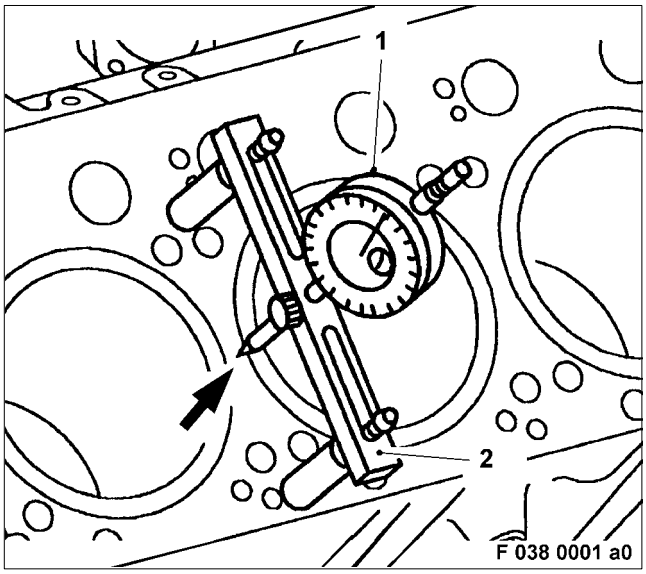


Bar crankshaft and ensure that there is ease of movement between oil spray nozzle (3), piston (2) and conrod (1).



Installing piston with connecting rod with oil pan lowered

During installation, the installation position of the crankcase remains unchanged and the conrod bearing, conrod cap and conrod screws are installed from beneath (arrow); the procedure is principally identical to that contained in – Installing piston with connecting rod in assembly dolly –.



Measuring piston protrusion

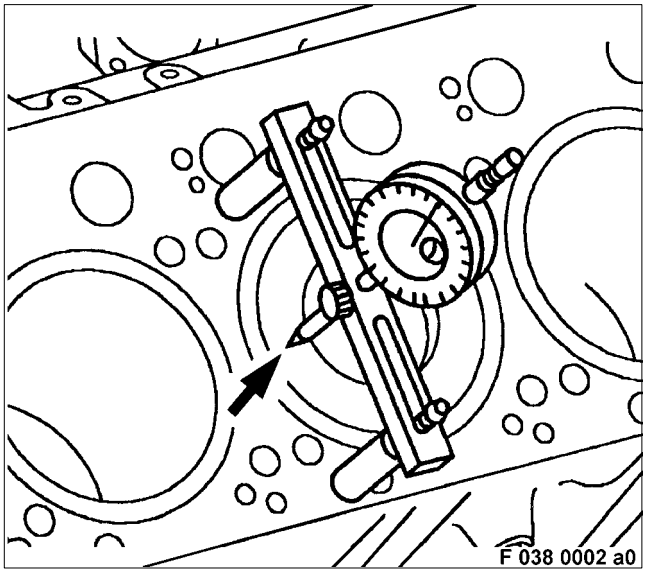
Note: Measure protrusion between piston crown crankcase partition without the cylinder head gasket in position.
To eliminate piston-tilt clearance, perform measurements in direction of piston pin.

Clean residues from piston and crankcase partition.

Turn the crankshaft slowly in engine direction of rotation until the piston being measured is approx. 1 cm before TDC.

Secure dial gauge (1) with pretension in the bridge meter (2).

Position bridge meter and dial gauge stylus (arrow) on crankcase partition and set dial gauge scale to zero.



Move bridge meter and feeler from the crankcase partition over the outer piston face (arrow); hold back the dial gauge stylus while doing this.

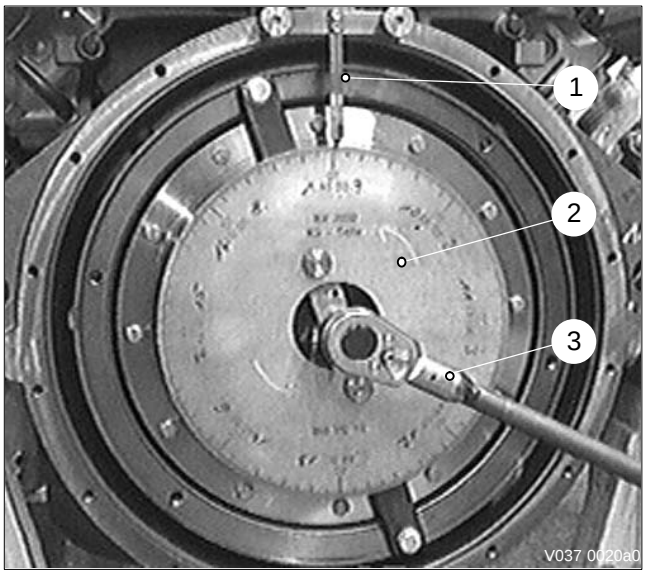
Turn the crankshaft slowly in engine direction of rotation until the dial gauge pointer no longer moves or the piston is precisely at TDC.

Read off and make a note of piston protrusion at dial gauge.

Measure piston protrusion of all pistons in the same way.

For specified values, see Tolerance and Wear Limits List.

If the tolerance deviation is impermissible, check the affected conrod and replace if necessary.



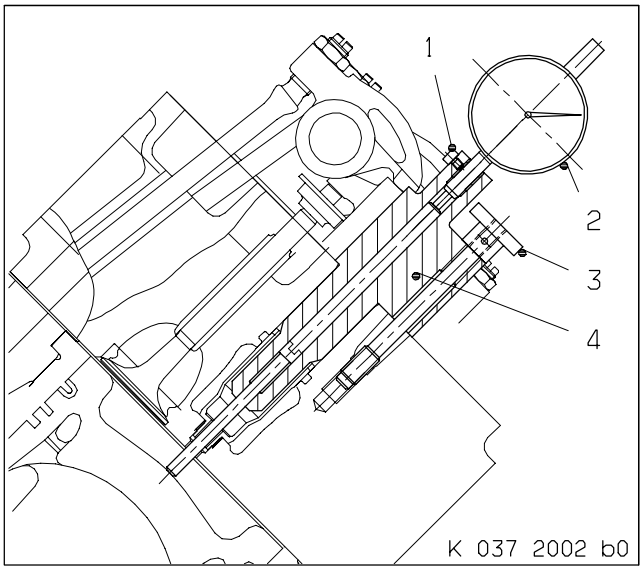
Defining piston TDC

Set piston cylinder A1 to TDC.

Install pointer (1) on flywheel housing.

Install index plate (2) with barring tool on flywheel, set to TDC marking of A1 and tighten.

Mount ratchet (3) on barring tool.



Install dial gauge (2) under preload in measuring unit (4) and clamp with screw (1).

Install measuring unit into cylinder head and secure with knurled-head screw (3).

Set dial gauge to zero.

Move piston several times up and down through TDC until needle of dial gauge registers its highest reading.

Set dial gauge to zero and readjust index plate accordingly.

Bar crankshaft in normal direction of rotation to 5° before TDC, read dial gauge and make a note of measured value.

Bar crankshaft past TDC to approx. 10° (to take up bearing play).

Bar crankshaft in direction opposite to normal direction of rotation to 5° after TDC, read dial gauge and make a note of measured value.

Example:

Piston to 5° before TDC	– 0.36 mm
Piston to 5° after TDC	– 0.32 mm
Total values	= 0.68 mm
Mean value	= 0.34 mm

Bar crankshaft to approx. 10° after TDC, then bar in direction opposite to normal direction of rotation until dial gauge reads mean value, i.e. = 0.34 mm.

Set pointer of index plate to 5° after TDC and tighten.

Inspection: Absolute TDC is reached when the dial gauge shows the same values before and after TDC at the same angle. To eliminate bearing clearance, the piston must always move in direction of TDC.

C 037.05.12 After-Installation Operations

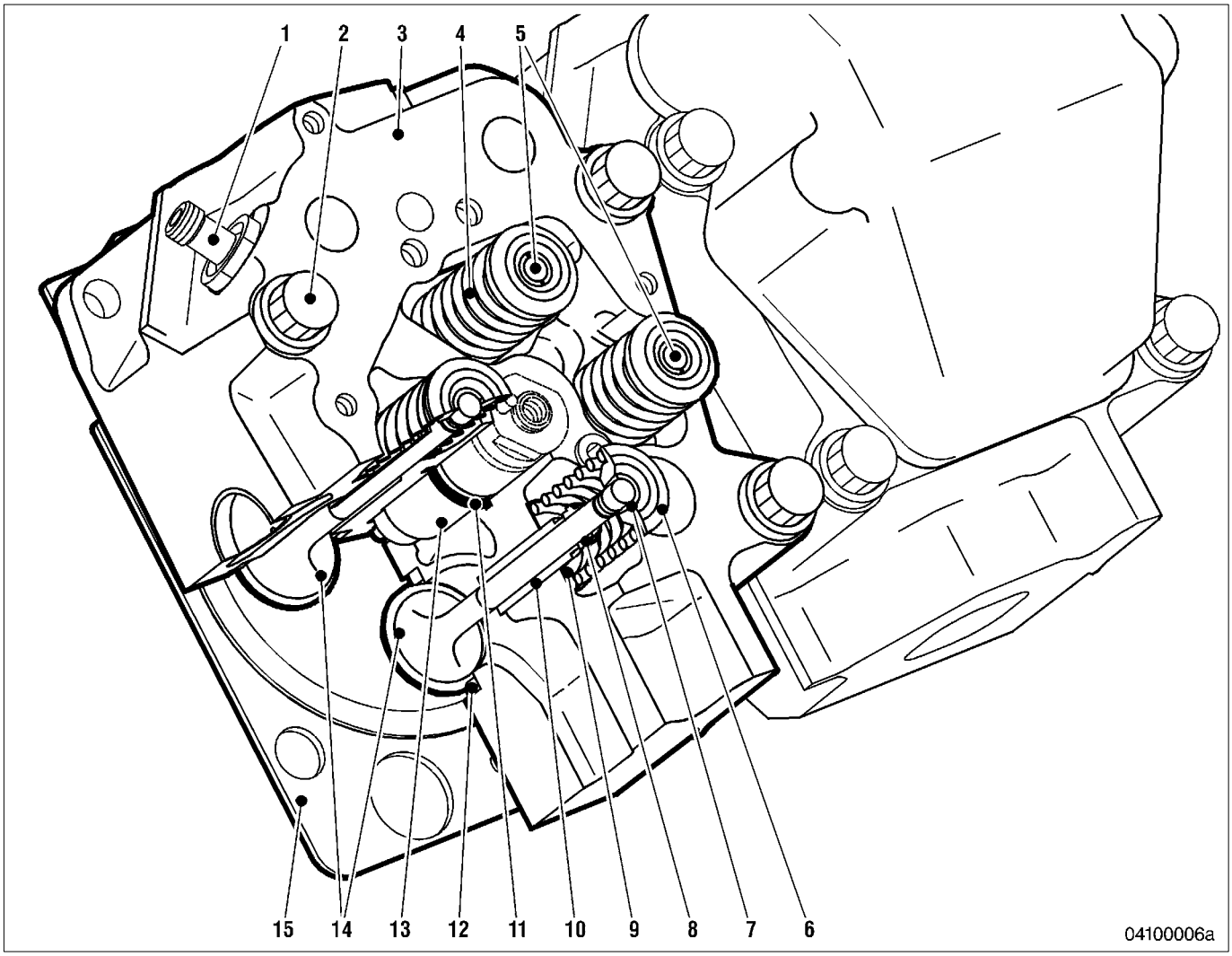
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install oil pan	C 014.05
–	x	x	Install cylinder head	C 041.05
–	x	x	Install pushrods	C 054.05
–	x	x	Install rocker arm assembly	C 055.05
–	x	x	Adjust valve clearance	C 055.05.11
–	x	x	Connect leak-off fuel lines	C 086.05
–	x	x	Install H.P. fuel line	C 073.05
–	x	x	Install cylinder head cover	C 055.10
–	x	x	Install exhaust manifold	C 142.05
–	x	x	Install turbocharger	C 101.01
–	x	x	Install charge air manifolds	C 124.05
–	x	x	Install cover	C 114.05
–	x	x	Install charge air lines	C 125.05
–	x	x	Connect vent lines	C 202.65
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Install crankcase breather	C 018.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

Contents

C 040 Cylinder Head with Fixtures



1 Pressure pipe joint
2 Double-hex screw
3 Cylinder head
4 Valve spring
5 Inlet valves
6 Valve spring retainer
7 Valve collet
8 Valve shaft gasket
9 Washer
10 Valve guide
11 O-ring
12 Valve seat insert
13 Protective sleeve
14 Exhaust valves
15 Cylinder head gasket

The following is a list of auxiliary equipment and materials needed for the assembly operations:

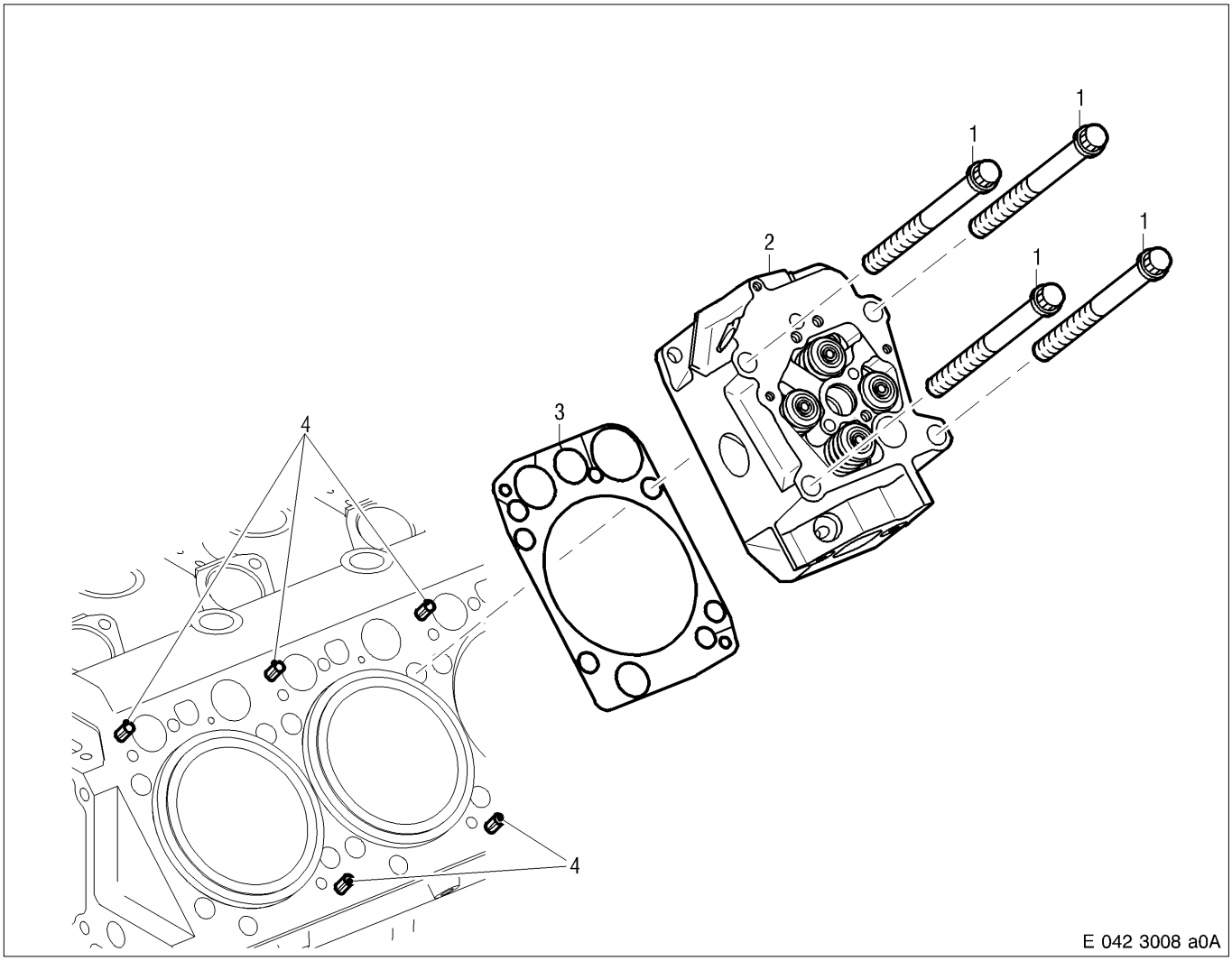
CAUTION

When using these miscellaneous materials, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	Order No.		Remarks
		MTU	DDC	
Polishing cloth				
Rotary wire brush				
Valve guide cleaning brush				
Magnifier				
Spray gun				
Inspection lamp				
Liquid nitrogen				
Activator	Loctite No. 7649	50548		
Vaseline	Petroleum jelly, white	40317		
Thread-locking compound	Loctite No. 270	40083		Final strength at 20 °C ≈ 12 h
Engine oil				
Cleaning agent (carbon-deposit remover)	Meister Proper	40377		
Cleaning agent	Solvclean KW	40022		
Corrosion inhibitor	Caramba Express	40008		
Kerosene or diesel fuel				
Denaturated ethanol		40250		
Multipurpose grease	Shell Retinax A	40333		
Dry compressed air				
Surface crack-testing equipment with red penetrant dye				
Surface crack-testing equipment with fluorescent penetrant dye				

C 041.05 Cylinder Head

C 041.05.01 Overview Drawing

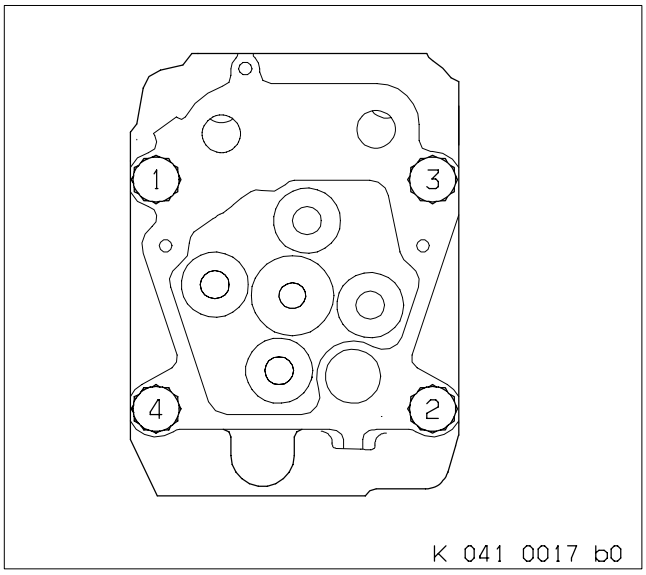


1 Double-hex screw
For tightening torque – see next illustration

2 Cylinder head

3 Cylinder head gasket

4 Spring pin



Cylinder head tightening diagram

Max. shaft length: 212 mm

Lubricant: Engine oil

Pretightening torque, in stages:

1st stage	10 Nm
2nd stage	50 Nm
3rd stage	100 Nm
4th stage	200 Nm

additional angle of rotation, in stages:

1st stage	90° + 10°
2nd stage	90° + 10°

C 041.05.02 Special Tools

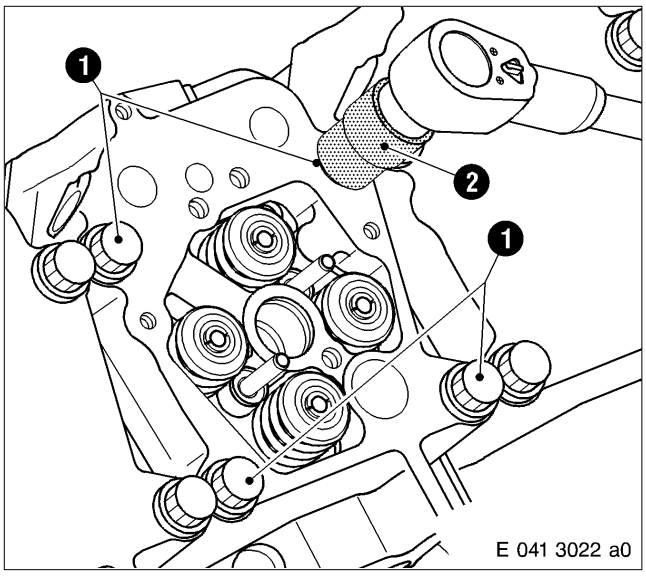
Designation – Application	Number
Socket for cylinder head screws	1

C 041.05.04 Before-Removal Operations

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

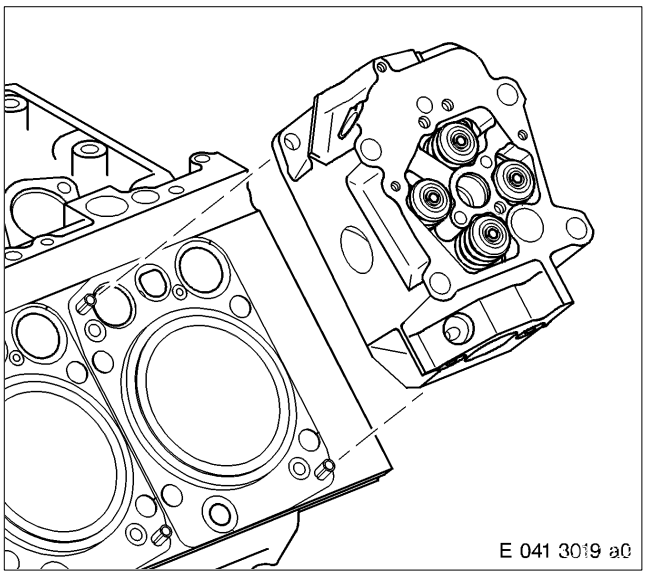
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65
–	x	x	Remove air filter	C 121.05
–	x	x	Remove intake housing	C 123.05
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove cover	C 114.05
–	x	x	Release or remove charge air manifolds	C 124.05
–	x	x	Remove exhaust turbocharger	C 101.01
–	x	x	Remove exhaust manifold	C 142.05
–	x	x	Remove cylinder head cover	C 055.10
–	x	x	Remove H.P. fuel line	C 073.05
–	x	x	Disconnect leak-off fuel lines	C 086.05
–	x	x	Remove rocker arm assembly	C 055.05
–	x	x	Remove pushrods	C 054.05

C 041.05.05 Removal



Removing cylinder head

Evenly remove double-hex screws (1) for cylinder head with large ratchet and socket (2).

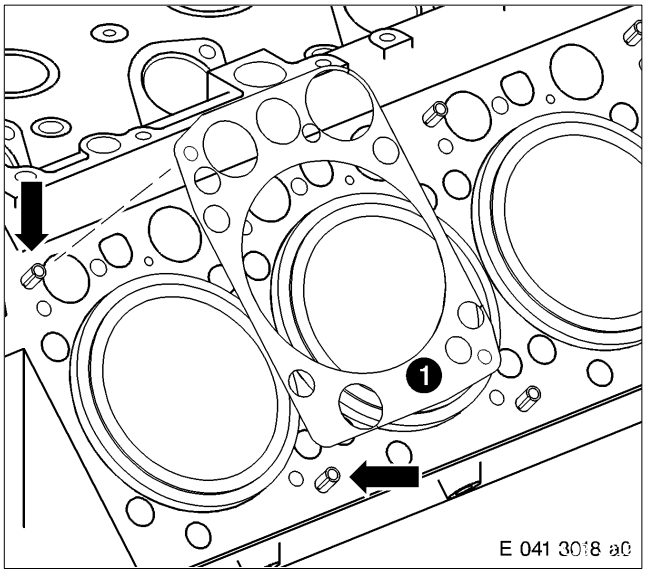


⚠ CAUTION

Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Lift cylinder head from crankcase and lower onto suitable support.

Note: With injector installed, place cylinder head to the side. Injector protrudes at bottom of cylinder head.



Remove cylinder head (1).

Using a suitable blanking plug, seal oil bores and coolant bores in crankcase.

If necessary (e.g. due to damage), remove spring pins (arrows) from crankcase.

C 041.05.06 Disassembly

Disassembly of the cylinder head is not planned.

The cylinder head is a replacement component and is available through the usual replacement procedure.

C 041.05.08 Inspection and Repair

Visually inspect outside of cylinder head for damage and condition.

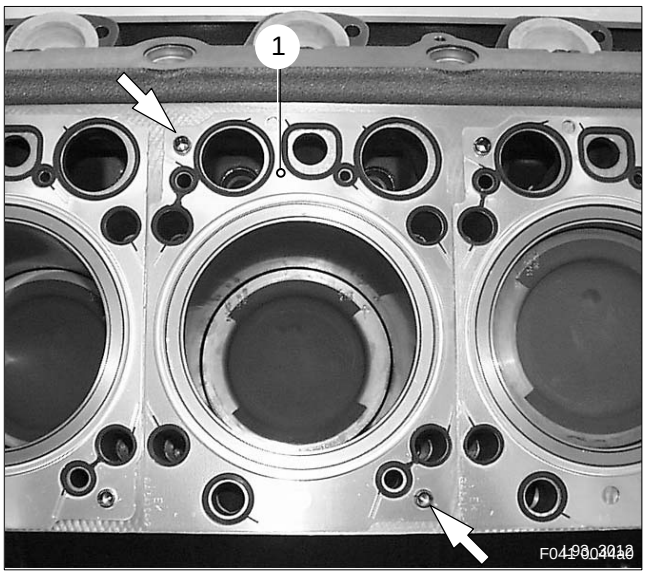
Check cylinder head interfaces (combustion chamber side) for evenness and damage; replace cylinder head if necessary.

Check that thread and screw head mating face of cylinder head screws are in perfect condition; replace screws if necessary.

Check all threads in cylinder head for ease of movement; rechase threads as necessary.

Replace cylinder head gaskets and O-rings at every assembly.

C 041.05.11 Installation



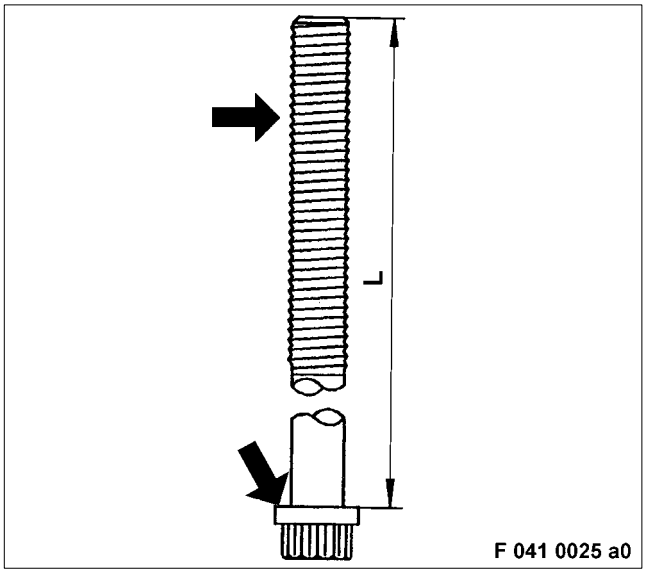
Installing cylinder head

Note: Prior to installation, remove all blanking plugs and check that oil bores are perfectly clean.

Wipe cylinder head and crankcase interface and check.

Insert new spring pins (arrows) into crankcase until they contact the stop.

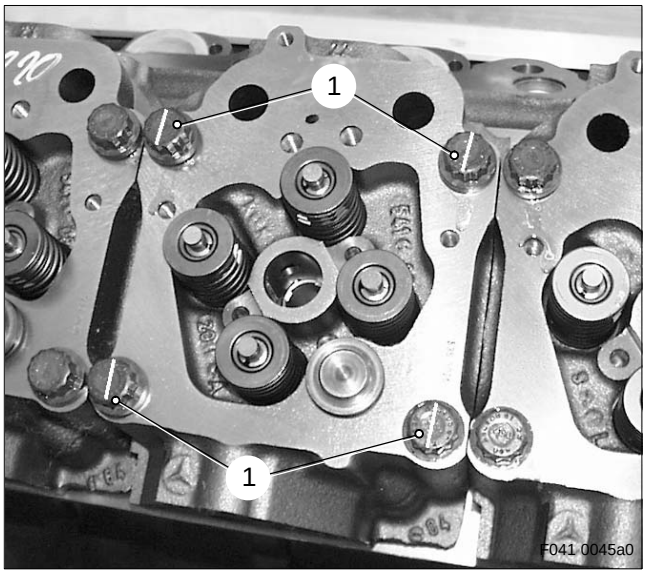
Mount new cylinder head gasket (1) via spring pins on end face of crankcase as shown in illustration.



Measure shaft length (L) of double-hex screws with depth gauge.

For max. permissible shaft length – see C 041.05.01.

Coat threads and screw head seating surfaces (arrows) with engine oil.



⚠ CAUTION

Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Mount cylinder head via spring pins on cylinder head gasket.

Note: To ensure that the cylinder head remains in correct position, all prescribed tightening torque stages and tightening sequence in accordance with cylinder head tightening diagram, see C 041.05.01, must be observed.

Tighten double-hex screws (1) for cylinder head with socket in stages to specified pretightening torque in prescribed sequence in accordance with cylinder head tightening diagram.

Mark screw heads.

Tighten double-hex screws in specified sequence to angle of rotation in accordance with tightening specifications.

If the tightening torque or angle of rotation is exceeded for a cylinder head screw, remove all cylinder head screws, check shaft (replace cylinder head screw if necessary) and retighten to tightening specification.

Note: Cylinder head screws are not retightened!

C 041.05.12 After-Installation Operations

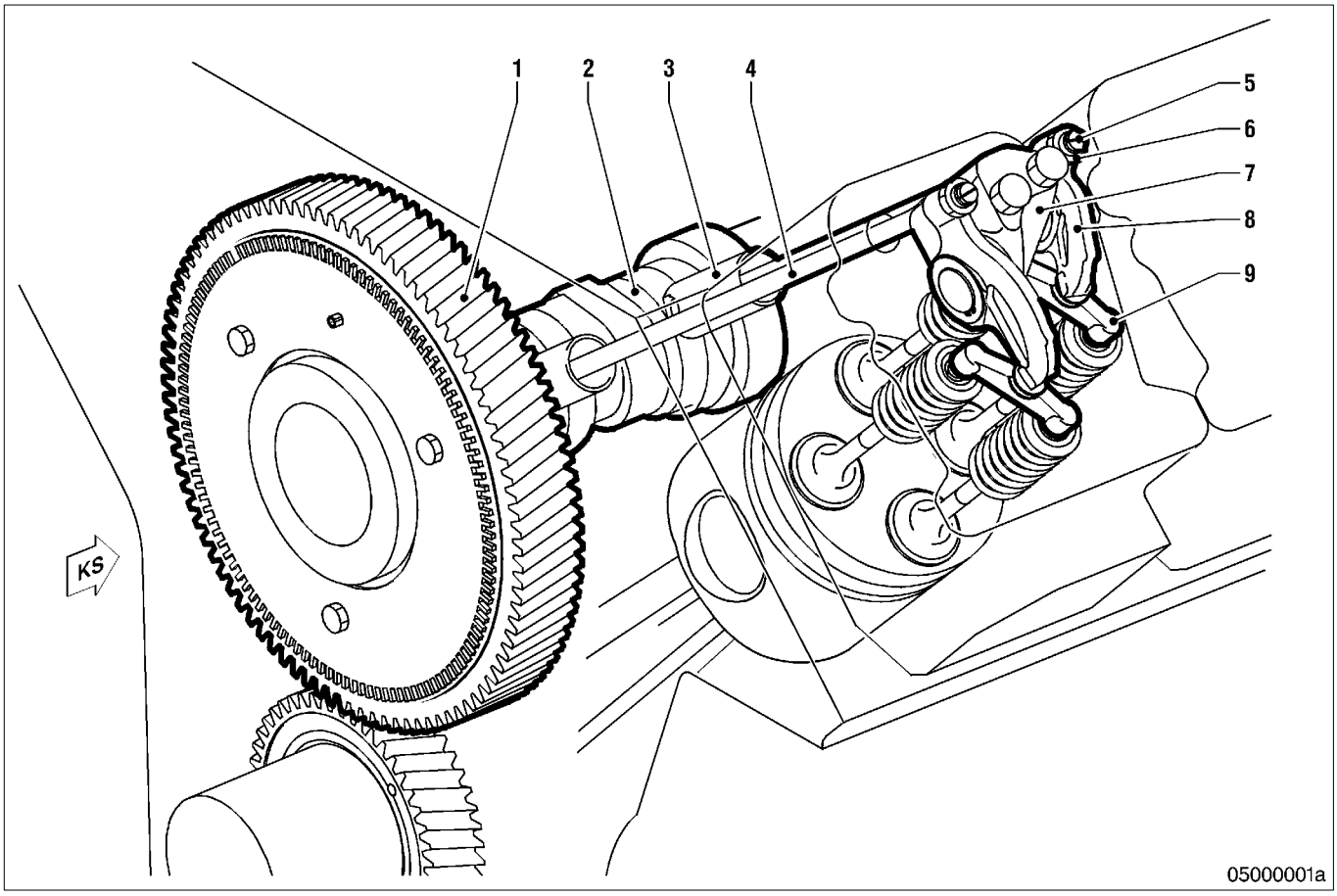
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install pushrods	C 054.05
–	x	x	Install rocker arm assembly	C 055.05
–	x	x	Adjust valve clearance	C 055.05.11
–	x	x	Connect leak-off fuel lines	C 086.05
–	x	x	Install H.P. fuel line	C 073.05
–	x	x	Install cylinder head cover	C 055.10
–	x	x	Install exhaust manifold	C 142.05
–	x	x	Install turbocharger	C 101.01
–	x	x	Install charge air manifolds	C 124.05
–	x	x	Install cover	C 114.05
–	x	x	Install charge air lines	C 125.05
–	x	x	Connect vent lines	C 202.65
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Install crankcase breather	C 018.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

Contents

C 050 Valve Gear



1 Camshaft gear
2 Camshaft
3 Roller tappet
4 Push rod
5 Adjusting screw
6 Nut
7 Rocker shaft support
8 Rocker arm, inlet
9 Valve bridge

The following is a list of auxiliary equipment and materials needed for the assembly operations:

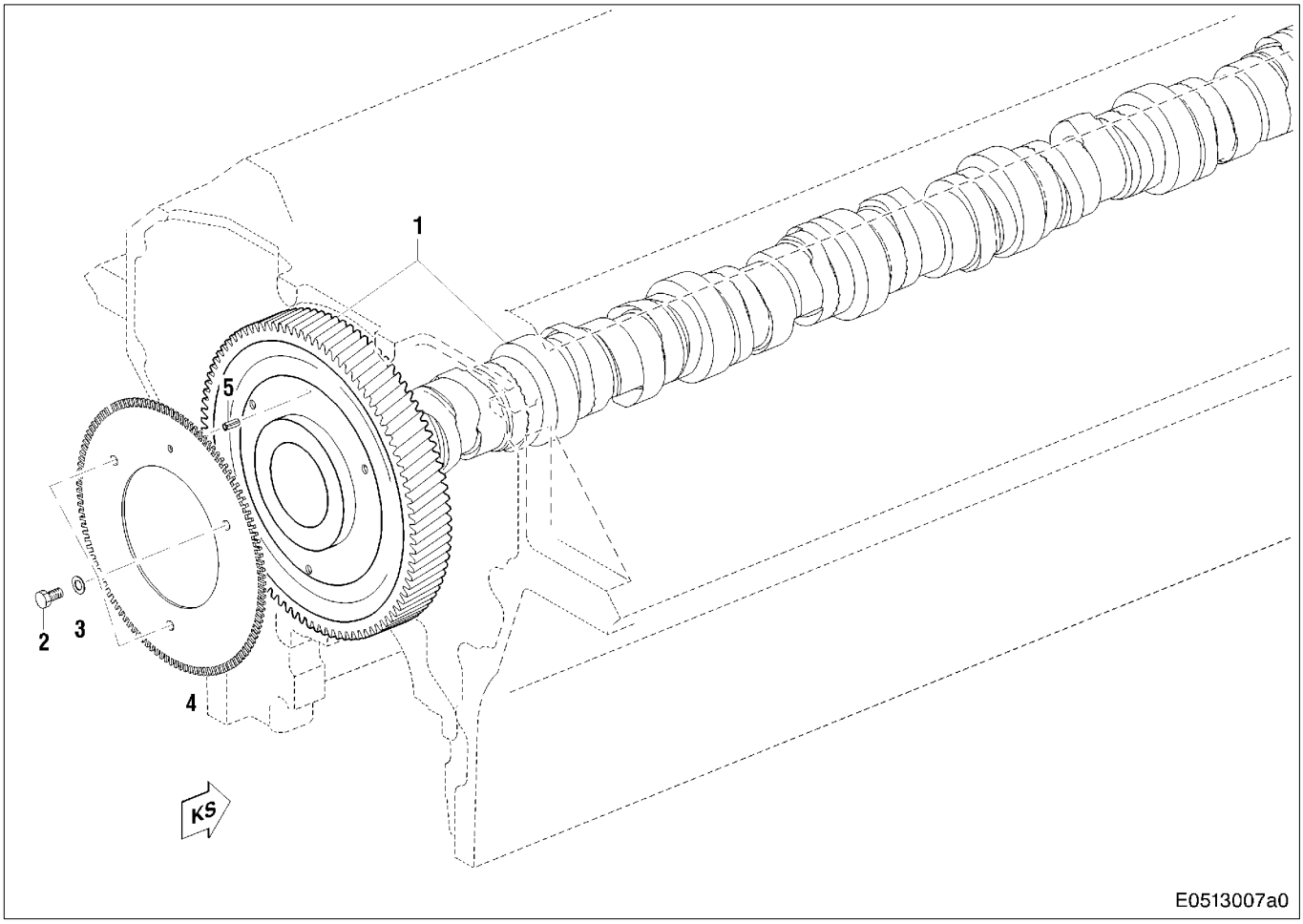
CAUTION

When using these miscellaneous materials, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Spray gun			
Inspection lamp			
Vaseline	Petroleum jelly, white	40317	
Liquid nitrogen			
Thread-locking compound	Loctite No. 270	40083	Final strength at 20 °C ≈ 12 h
Engine oil			
Kerosene or diesel fuel			
Cleaning agent	Solvclean KW	40022	
Corrosion inhibitor	Caramba Express	40008	
Denaturated ethanol		40250	
Engineer's blue	blue	40641	
Multipurpose grease	Shell Retinax A	40333	
Dry compressed air			
Magnetic crack-testing equipment with fluorescent magnetic powder			
Surface crack-testing equipment with red penetrant dye			

C 051.05 Camshaft

C 051.05.01 Overview Drawing



1 Camshaft with camshaft gear

2 Hex screw
Securing agent: Thread-locking liquid

3 Washer

4 Measuring wheel

5 Spring pin
Securing agent: Thread-locking liquid

C 051.05.02 Special Tools

Designation – Application	Number
Guide mandrel	1
Installation device	1
Measuring unit (TDC position)	1

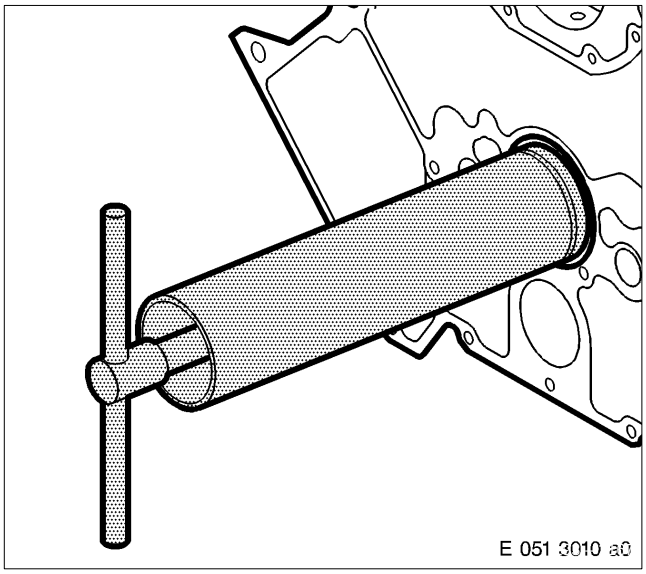
C 051.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

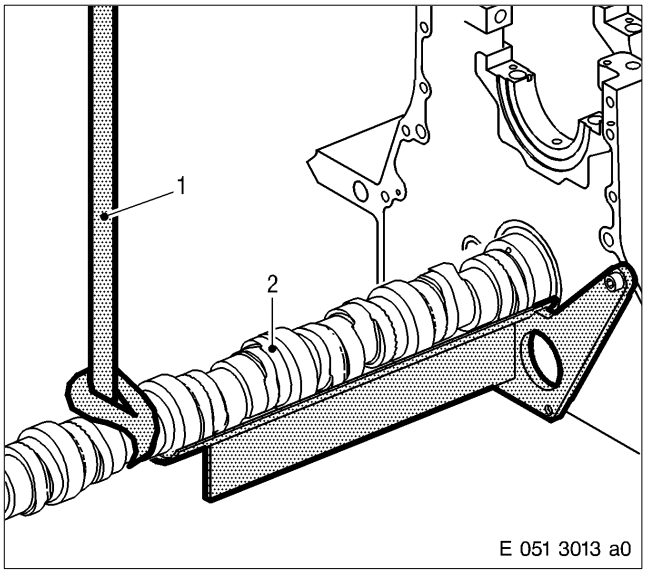
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	x	x	Removal not scheduled	–

C 051.05.05 Removal



Removing camshaft

Screw guide mandrel onto face of camshaft installed in crankcase.



Taking care not to damage bearing, carefully remove camshaft (2) from crankcase until installation unit – see C 051.05.11 can be installed.

Attach installation unit to front side of crankcase.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Attach rope (1) midway along camshaft.

Take up slack and continue carefully withdrawing camshaft from crankcase.

Remove insertion sleeve and installation unit.

C 051.05.08 Inspection and Repair

Clean camshaft.

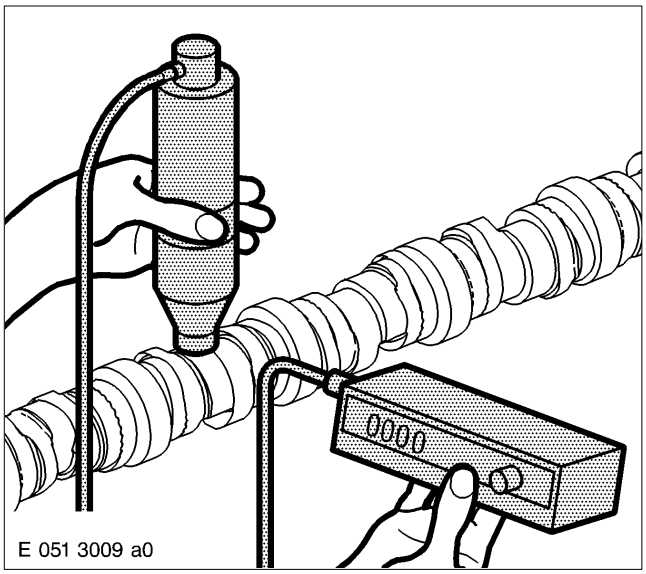
Pre-polish bearing journals and cams with emery cloth.

Using the magnetic crack-testing method with fluorescent magnetic powder, check camshaft for cracks; replace camshaft if necessary.

Check camshaft gear tooth flanks, axial sliding surface, bearing running surfaces and roller running track for scoring, wear and indentations.

Remove minor scoring, wear and indentations by polishing with emery cloth; if necessary, machine to MTU specifications or replace camshaft.

For limit values, see Tolerance and Wear Limits List.



Checking hardness of cams and journals

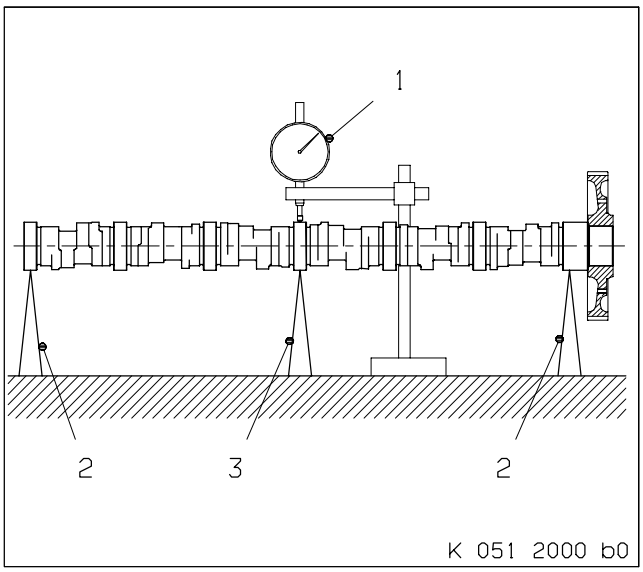
Check hardness of cam (inlet and exhaust valves, plug-in pump) and journal on camshaft using Microdur testing unit or another suitable hardness testing unit.

Test hardness of each journal at four points at 90° intervals around circumference.

For limit values, see Tolerance and Wear Limits List.

If limit values are not attained, machine camshaft or replace as necessary.

Required hardness = 60 HRC ± 2 HRC



Checking concentricity and cam lift

Set camshaft at outer journals on V-blocks (2) or roller stands.

Place supporting mount (3) at centre journal.

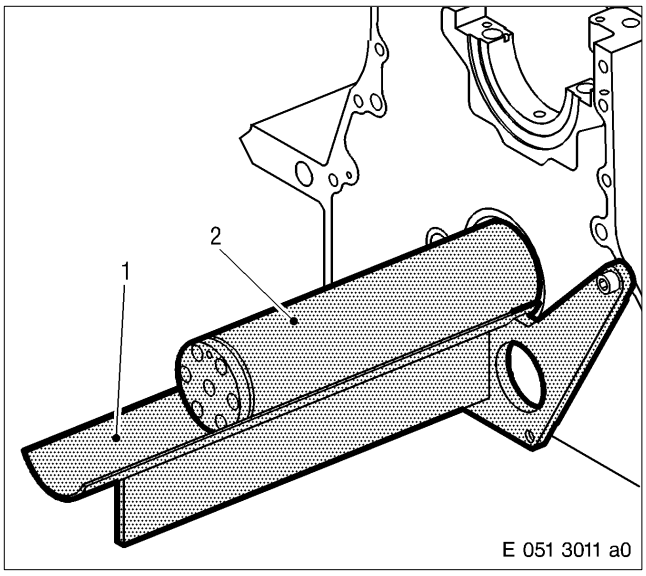
Measure radial runout of cam base circle and bearings with dial gauge (1).

Measure cam lift over base circle diameter of valve and plug-in pump cams with dial gauge.

For limit values, see Tolerance and Wear Limits List.

If limit values are not attained, machine camshaft or replace as necessary.

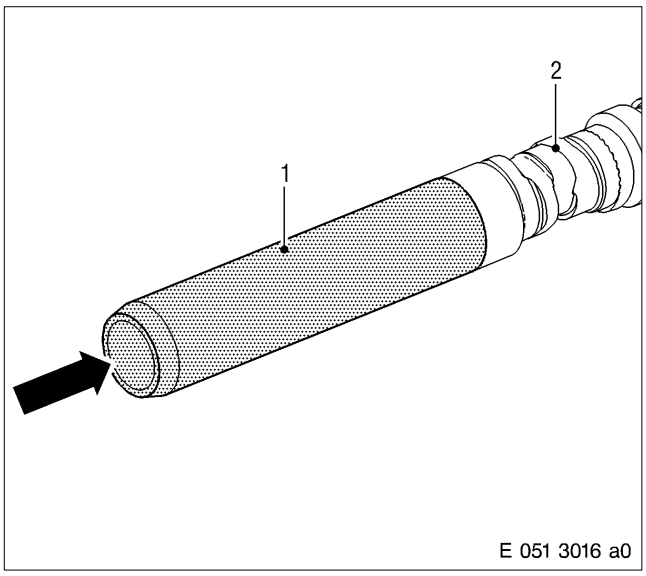
C 051.05.11 Installation



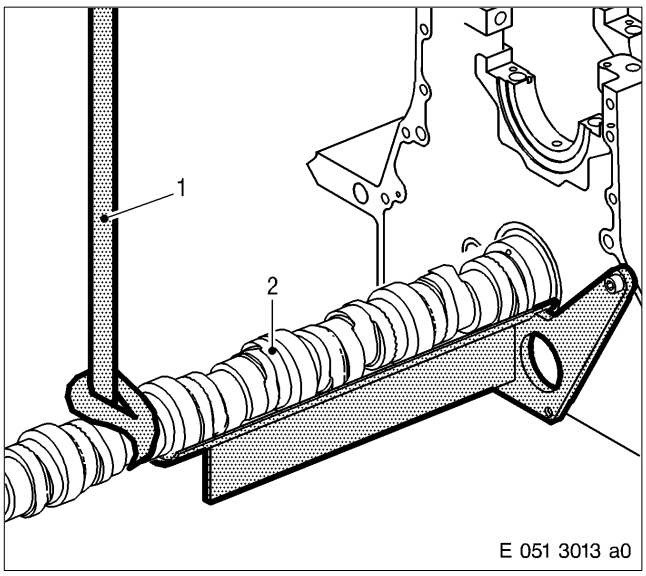
Installing camshaft

Note: Make sure all components are perfectly clean.

Attach installation unit (1) to front side of crankcase and centre to camshaft bearings with guide mandrel (2).



Screw guide mandrel (1) onto face of camshaft (2) (arrow).



⚠ WARNING

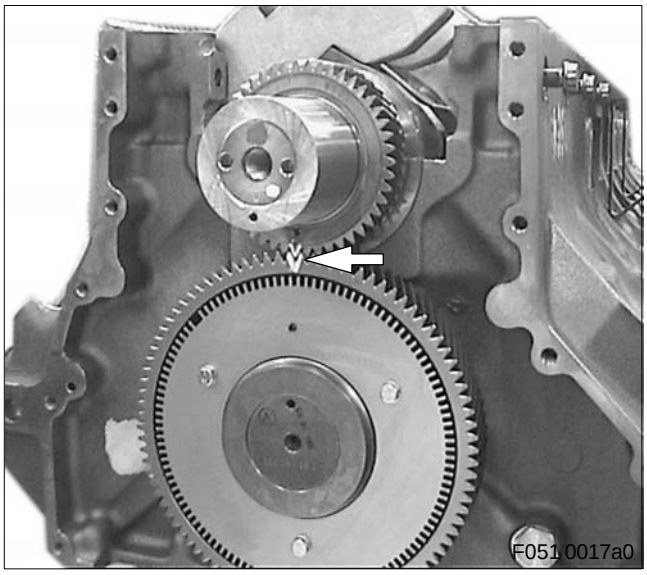
Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Attach camshaft (2) in centre with rope (1) and wipe.

Coat camshaft, camshaft bearings, installation unit and guide mandrel with engine oil.

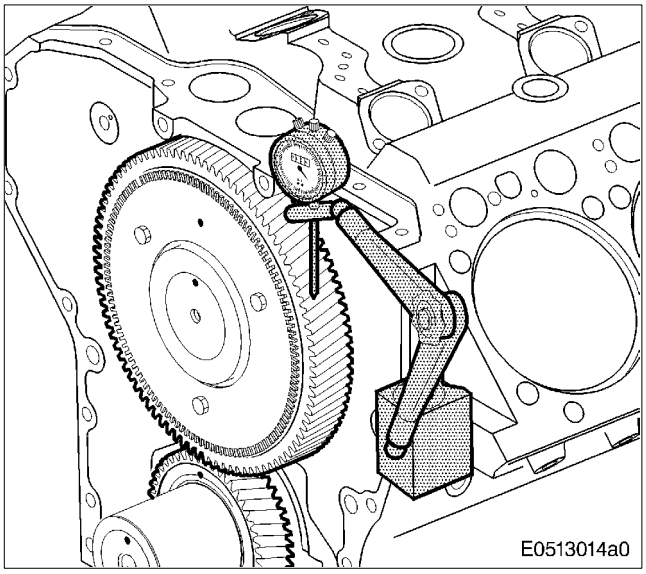
Taking care not to damage bearings, slowly introduce camshaft into crankcase up to last bearing.

Remove guide mandrel and installation unit.



When installing camshaft with crankshaft installed, ensure that markings (arrow) on crankshaft gear and camshaft gear are aligned.

Note: Locate camshaft axially and/or ensure that it cannot fall out until flywheel housing is installed.



Measuring backlash

Measure backlash of camshaft after crankshaft has been installed, See C 031.05.

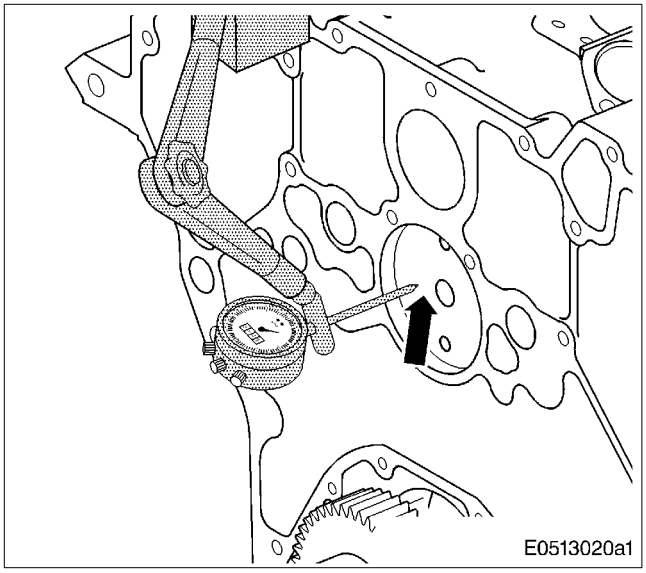
Mount magnetic dial gauge holder with dial gauge on crankcase.

Position dial gauge stylus with low preload on one tooth flank of camshaft gear.

Set dial gauge to zero.

Check backlash by moving camshaft gear back and forth.

For backlash, see C 020.



Measuring camshaft axial play

Measure camshaft axial play after flywheel housing has been installed – see C 021.05.

Mount magnetic dial gauge holder with dial gauge on crankcase, free end.

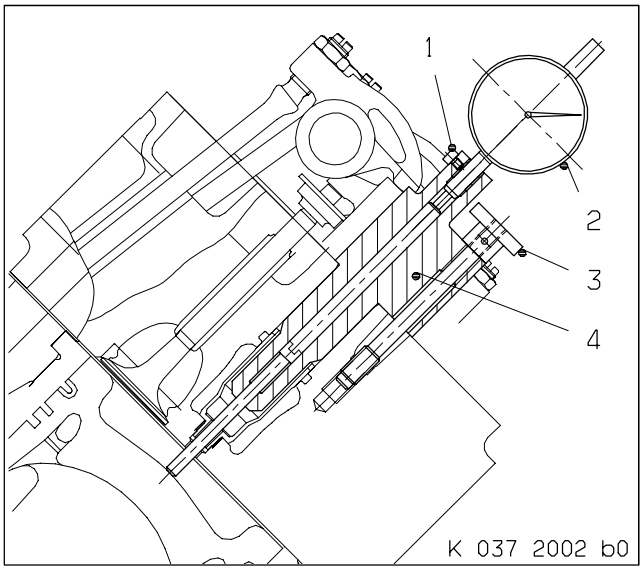
Position dial gauge stylus against front end of camshaft (arrow).

Press camshaft on camshaft gear axially as far as it will go.

Set dial gauge with preload to zero.

Move camshaft from stop to stop and record measured value (axial clearance).

For axial clearance– see C 020.



Check camshaft timing

Note: Check injection timing with cylinder head and valve drive in position.

Set piston A1 to firing TDC – see – Determining TDC position of piston –, C 037.05.11.

or

Fix TDC position of piston in the following way:

Install dial gauge (2) under preload in measuring unit (4) and clamp with screw (1).

Install measuring unit into cylinder head and secure with knurled-head screw (3).

Set dial gauge to zero.

Mount a suitable TDC indicator to the flywheel housing or on the crankcase (free end) in order to stamp the TDC mark on flywheel or vibration damper.

Using the barring tool, bar the engine until the piston of cylinder A1 is at firing TDC.

Note: If both rocker arms are relieved, i.e. have clearance, the piston is firing TDC.

Move piston several times up and down through TDC until needle of dial gauge registers its highest reading.
Set dial gauge to zero.

Back off crankshaft approx. 20° against direction of rotation.

Move the crankshaft in direction of rotation to 0.3 mm (dial gauge reading) before TDC and place a precise marking (e.g. with scriber) on flywheel or vibration damper opposite the tip of the TDC indicator.

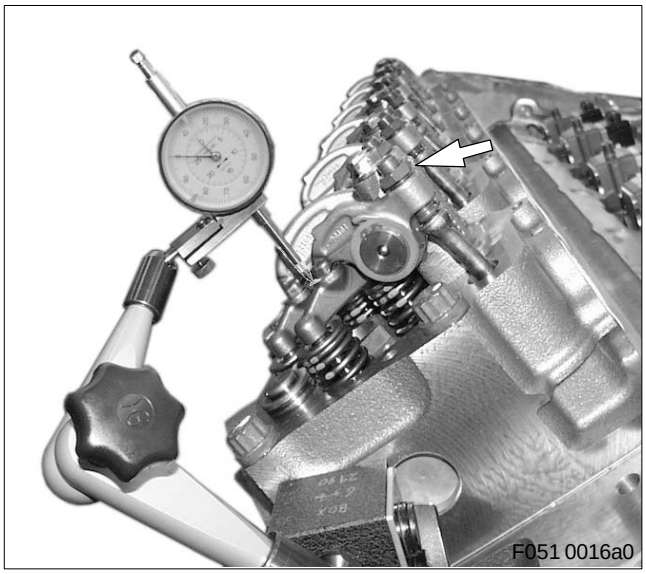
Bar crankshaft in direction of rotation past TDC to approx. 20° (to take up bearing play).

Bar crankshaft in direction opposite to normal direction of rotation to 0.3 mm after TDC and make a second mark.

Note: To eliminate bearing clearance, the piston must always move in direction of TDC.

Make the third alignment mark exactly in the middle of the other two marks. This is the TDC position of the piston.

Remove measuring device with dial gauge.



Measure valve stroke as follows:

Release locknuts (arrow) and insert adjusting screws until there is no more play and then slightly tighten locknuts.

Note: Ensure there is no valve play in order to obtain valid measurements!

Mount magnetic-base indicator holder with dial gauge on cylinder A1.

Position dial gauge stylus with low preload on valve bridge of inlet valve and set scale to zero.

Turn the crankshaft slowly in engine direction of rotation 360° and align exactly with the overlap TDC in accordance with existing alignment marks.

Read valve stroke from dial gauge and record readings in Data Sheet.

Position dial gauge stylus on valve bridge of exhaust valve and set scale to zero.

Further rotate crankshaft slowly in engine direction of rotation until pointer of dial gauge no longer moves.

Read valve stroke from dial gauge and record readings in Data Sheet.

For specified values, see A 004.

Check camshaft if tolerance deviation is above permitted level.

Set valve clearance on cylinder A1 – see C 055.05.11.

C 051.05.12 After-Installation Operations

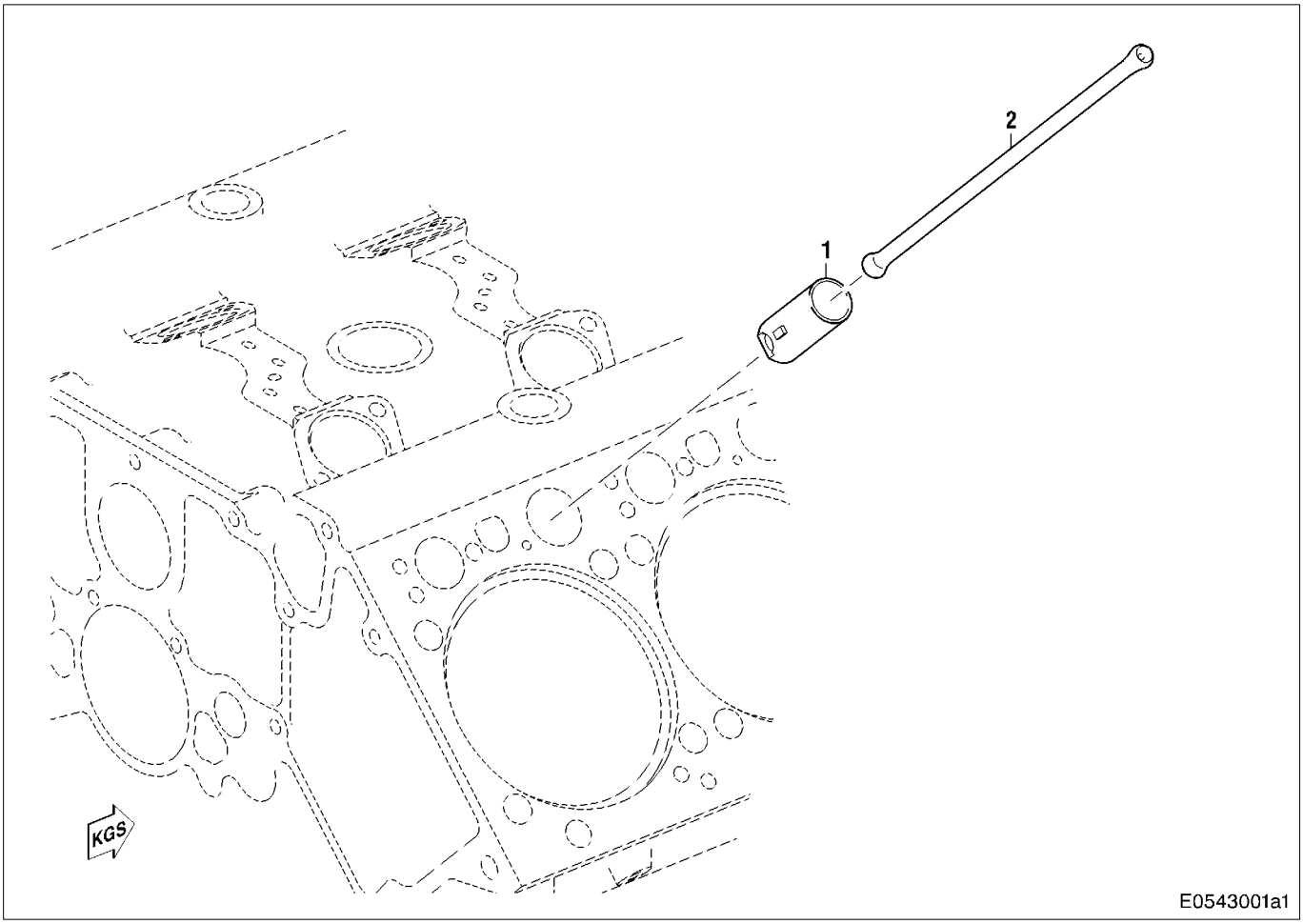
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007

C 054.05 Valve Roller Tappets, Pushrods

C 054.05.01 Overview Drawing



1 Roller tappet
2 Pushrod

C 054.05.02 Special Tools

Designation – Application	Number
Gripper pliers for roller tappet	1

C 054.05.04 Before-Removal Operations

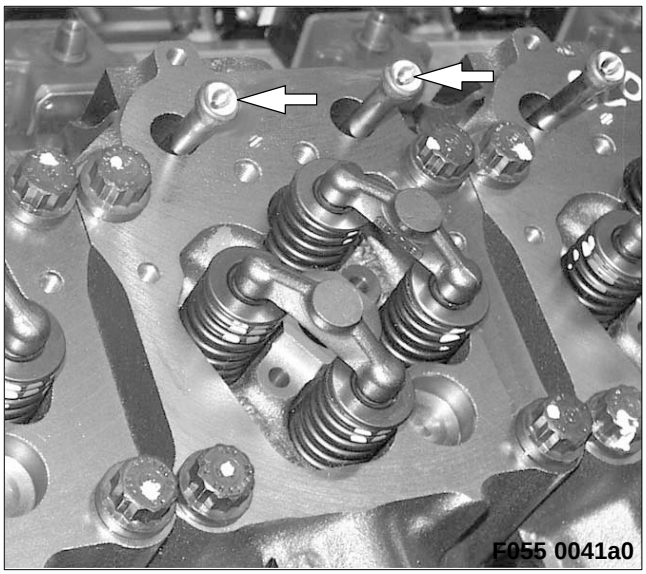
A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant*	Operating Instructions
–	x	x	Remove charge air lines*	C 125.05
–	x	x	Remove oil supply lines for turbochargers*	C 185.10
–	x	x	Disconnect vent lines*	C 202.65
–	x	x	Remove air filter (if necessary)*	C 121.05
–	x	x	Remove intake housing (if necessary)*	C 123.05
–	x	x	Remove crankcase ventilation (if necessary)	C 018.10
–	x	x	Disconnect or remove electrical cable (if necessary)*	C 507.10
–	x	x	Remove cove (as necessary)*	C 114.05
–	x	x	Release or remove charge air manifolds*	C 124.05
–	x	x	Remove ECU-housing and bracket (if necessary)*	C 508.10
–	x	x	Remove exhaust turbocharger*	C 101.01
–	x	x	Remove exhaust manifold*	C 142.05
–	x	x	Remove cylinder head cover	C 055.05
–	x	x	Remove H.P. fuel line*	C 073.05
–	x	x	Disconnect leak-off fuel lines*	C 086.05
–	x	x	Remove rocker arm assembly	C 055.10
–	x	x	Remove cylinder head *	C 041.05

* – only when removing valve roller tappets

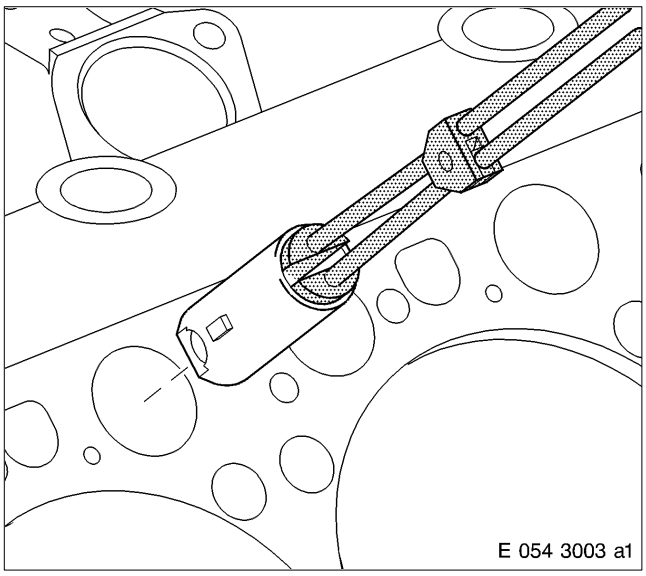
C 054.05.05 Removal



Removing pushrods

Remove push rods (arrows) from roller tappets.

When withdrawing the push rods, rotate them so that they are released from the roller tappet and the roller tappet is not pulled out of the crankcase.



Removing roller tappets

For instructions on removing cylinder head – see C 041.05.

Using gripping pliers, remove roller tappet from crankcase.

Mark roller tappets Attach coupling (1) with installed universal joint (4) to lifting gear in relation to crankcase.

C 054.05.08 Inspection and Repair

Clean all parts.

Using the magnetic crack-testing method with fluorescent powder, check roller tappet and pushrod for cracks; replace components if cracks are detected.

Check roller tappets for wear, scoring and indentations.

Remove minor wear, scoring and indentations by rubbing down with emery cloth; replace complete roller tappet if necessary.

Check roller tappet for ease-of-movement and excessive play.

Replace roller tappet if play is too great or tappet is sluggish.

Measure outside diameter of roller tappet with micrometer.

For limit values – see Tolerance and Wear Limits List.

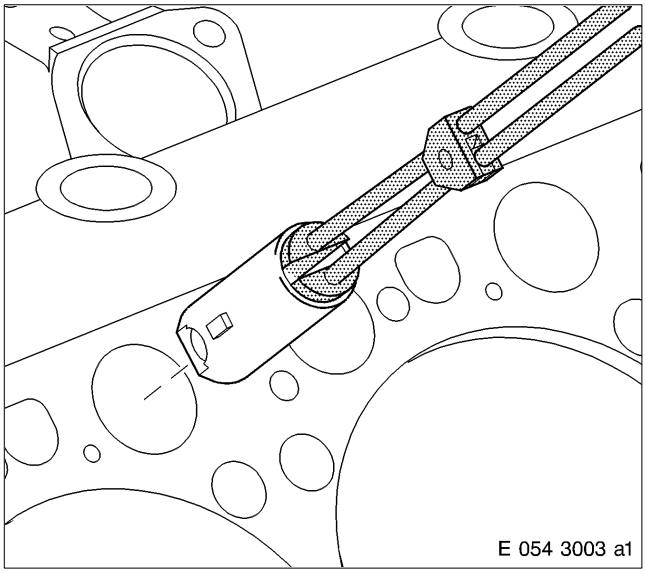
If measurements are below limit value, replace roller tappet.

Check pushrod seat and ball socket of push rod for wear; replace push rod if necessary.

Check concentricity of push rod; replace push rod if necessary.

C 054.05.11 Installation

Note: Make sure all components are perfectly clean.



Installing roller tappets

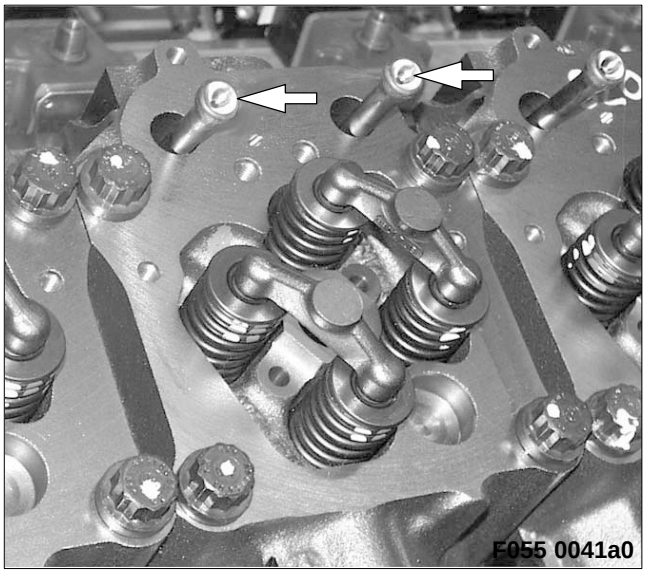
Coat roller tappet and bore in crankcase with engine oil.

Observe the roller tappet marking (installation point).

Using pliers, insert tappet into guide bore in crankcase, making sure that slot is correctly positioned.

Note: Do not drop roller tappet onto camshaft.

Check that roller tappet moves freely in guide bore.



Installing pushrods

For instructions on installing cylinder head, see C 041.05.

Coat ball sockets (arrows) and ball sockets of push-rods with engine oil.

Insert the push rod with the ball-head side through the cylinder head into the roller tappet making sure that it sits securely in the roller tappet.

C 054.05.12 After-Installation Operations

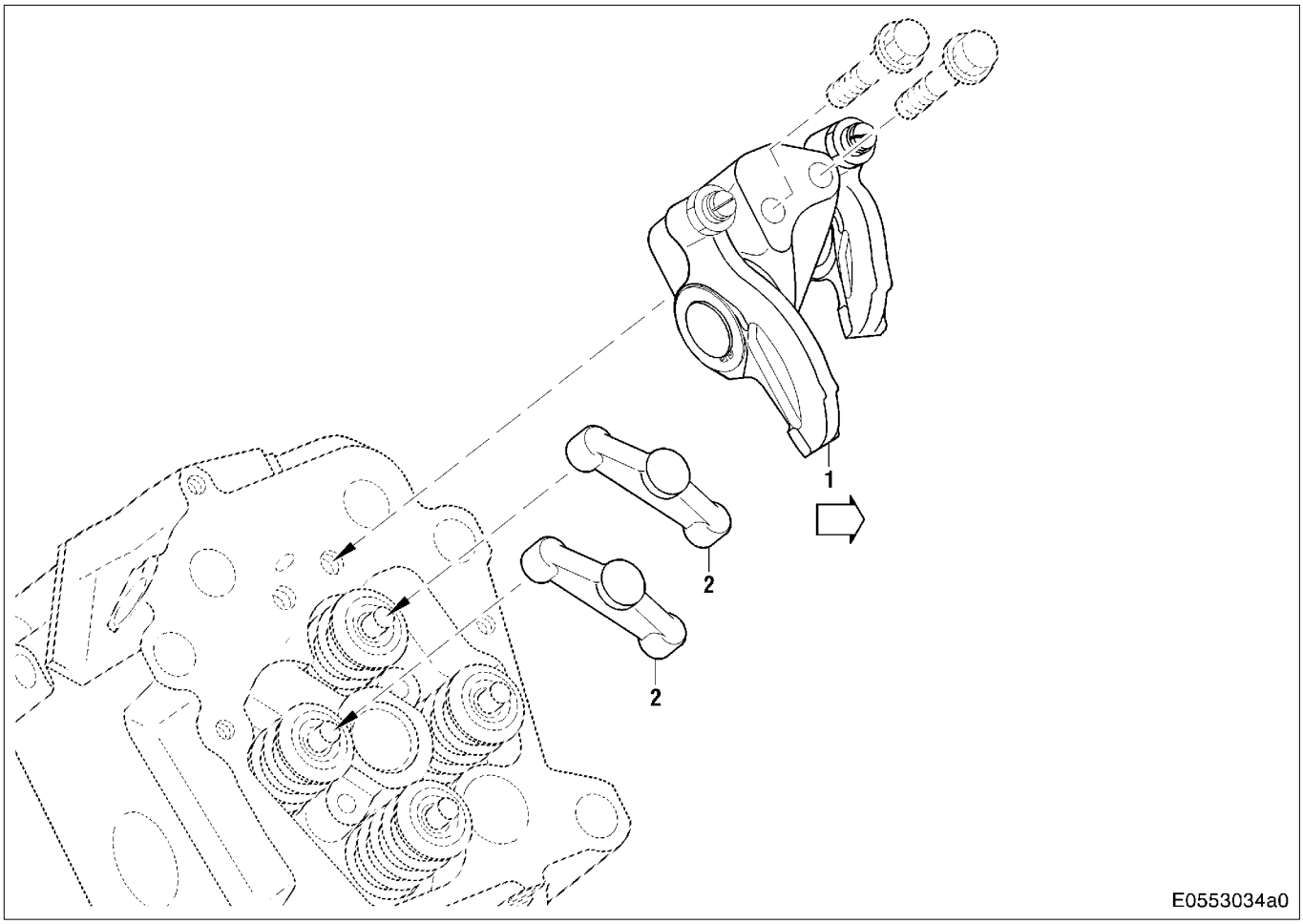
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install rocker arm assembly	C 055.10
–	x	x	Adjust valve clearance	C 055.05.11
–	x	x	Connect leak-off fuel lines	C 086.05
–	x	x	Install H.P. fuel line	C 073.05
–	x	x	Install cylinder head cover	C 055.05
–	x	x	Install exhaust manifold	C 142.05
–	x	x	Install turbocharger	C 101.01
–	x	x	Install charge air manifolds	C 124.05
–	x	x	Install cover	C 114.05
–	x	x	Install charge air lines	C 125.05
–	x	x	Connect vent lines	C 202.65
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Install crankcase breather	C 018.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

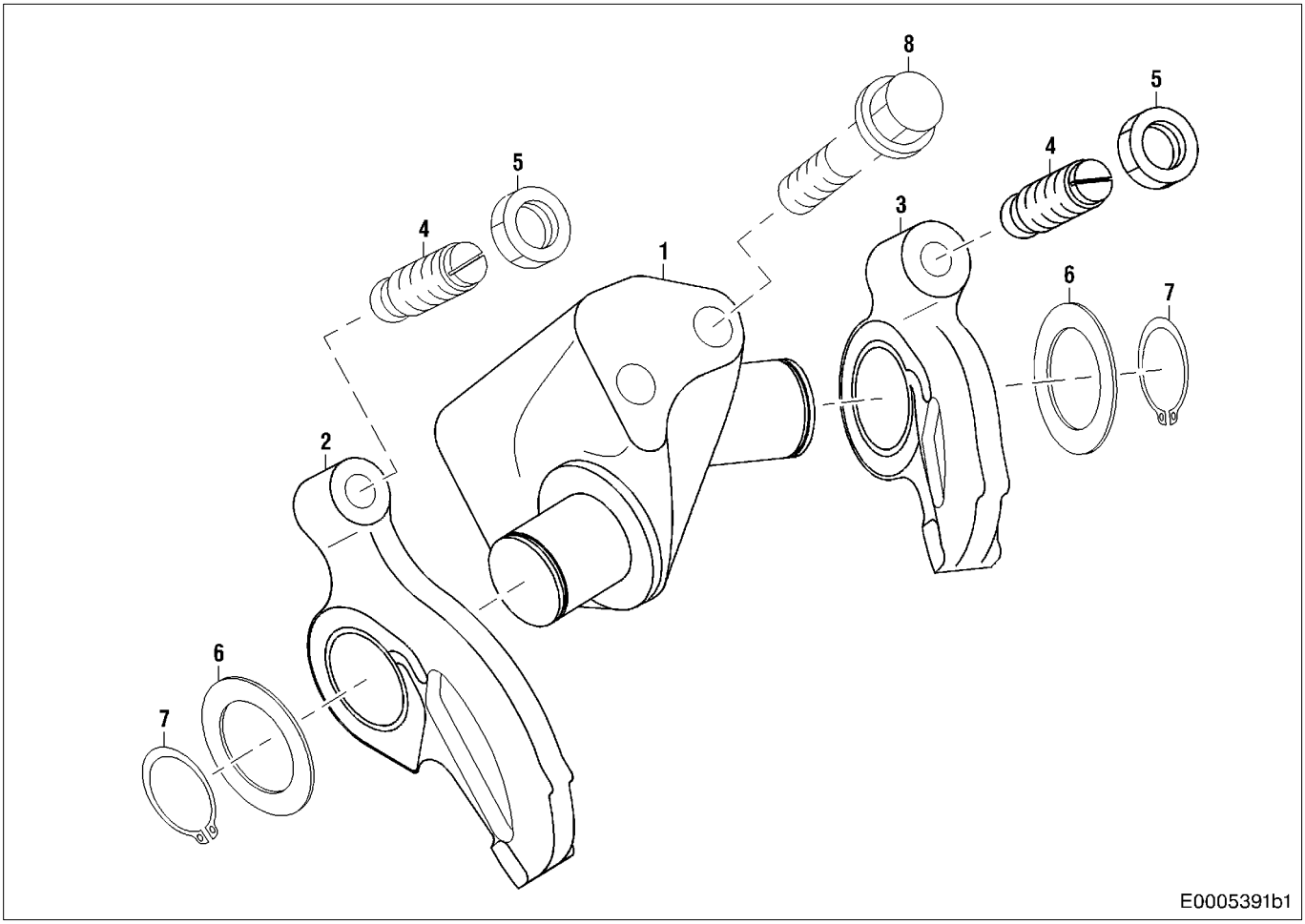
C 055.05 Valve Drive

C 055.05.01 Overview Drawing



1 Rocker shaft support
2 Valve bridge

Rocker shaft support



1 Rocker shaft support
2 Rocker arm, exhaust
3 Rocker arm, inlet
4 Adjusting screw
5 Nut
Lubricant: Engine oil
Tightening torque: 50 Nm
6 Washer
7 Snap ring
8 Hex screw
Max. shaft length: 91 mm
Lubricant: Engine oil
Pretightening torque: 60 Nm
Additional angle of rotation: 90°

C 055.05.02 Special Tools

Designation – Application	Number
Gauge 0.4 mm/0.6 mm, for setting valve clearance	1
Screwdriver, short, for setting valve clearance	1
Measuring unit (TDC position)	1

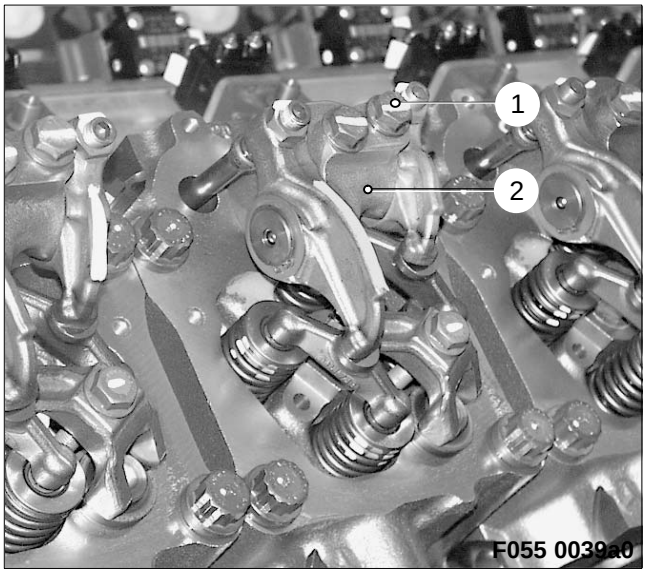
C 055.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

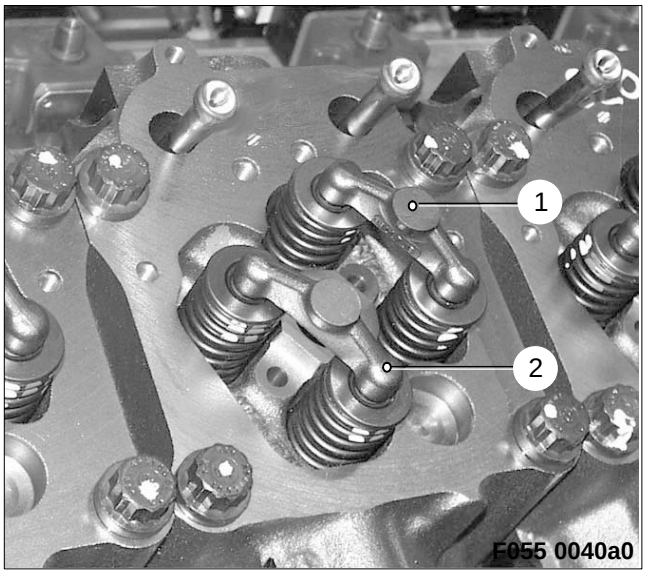
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Cylinder head cover removal	C 055.10

C 055.05.05 Removal



Removing rocker arm assembly

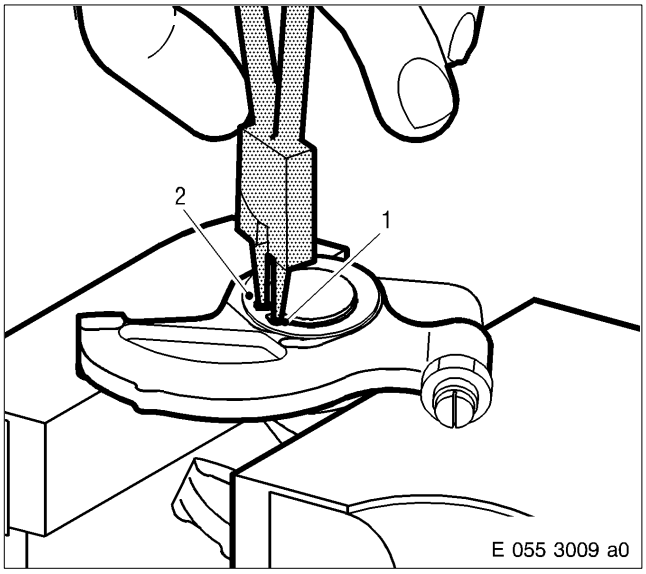
Remove hex screws (1) and remove rocker shaft support (2) from cylinder head.



Remove valve bridges.

Mark valve bridges (1) and (2) with respect to valves and remove.

C 055.05.06 Disassembly



Disassembling rocker arm assembly

Clamp rocker shaft support in vice with aluminium jaws.

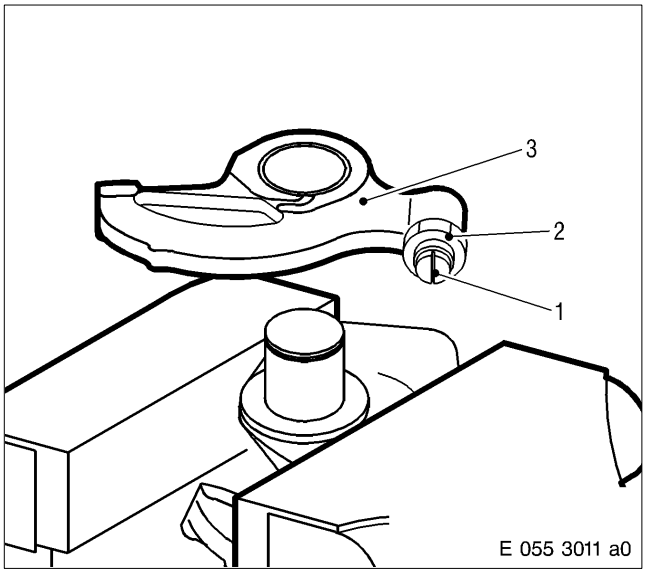
Release nuts of adjusting screws.

⚠ CAUTION

Snap ring pretension
Risk of injury!
Use suitable snap ring pliers. Always wear protective goggles/safety mask.

Using snap ring pliers, remove snap ring (1) from shaft.

Remove washer (2).



Remove rocker arm (3) from axle.

Remove nut (2) and adjusting screw (1).

C 055.05.08 Inspection and Repair

Clean all parts.

Using the magnetic crack-testing method with fluorescent magnetic powder, check rocker shaft support and axles, rocker arms and valve bridges for cracks.

Replace cracked components.

Check running surfaces of axles, valve bridges and rocker arms for wear, indentations and scoring.

Remove scoring and indentations by polishing with emery cloth; replace components as necessary.

Check snap rings and washers for damage and wear; replace components as necessary.

Check condition of mating faces on rocker shaft support; burnish with oilstone if necessary.

Check condition of axle snap ring grooves; replace rocker shaft support as necessary.

Check tapers and slot of adjusting screws for wear and damage; replace component if necessary.

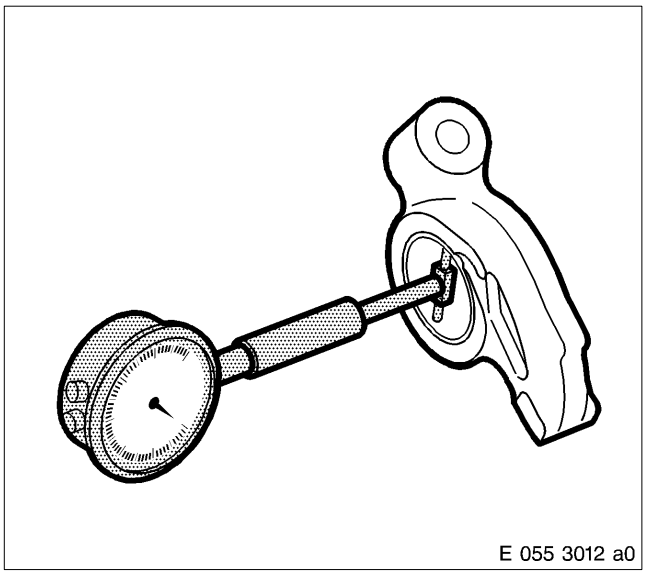
Check heads and seating faces of nuts for damage; replace adjusting screw as necessary.

Check threads of nuts and adjusting screws for ease of movement; replace component as necessary.

Check threaded bores in rocker arms for ease of movement; remachine if necessary.

Replace snap rings during W6 overhaul.

Make sure that all components are perfectly clean and that flow through lube oil bores is unobstructed.



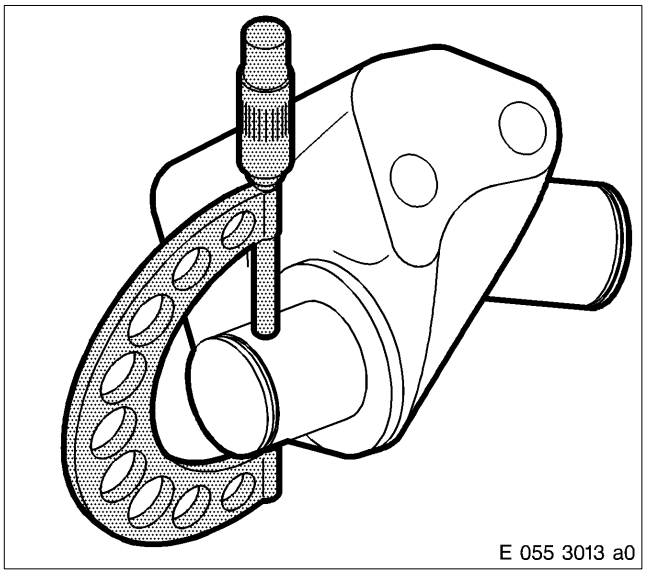
E 055 3012 a0

Measuring diameter of bush bore in rocker arm

Adjust bore gauge to basic size of bush bore and measure diameter of bore.

If limit values are exceeded, replace rocker arm.

For limit values, see Tolerance and Wear Limits List.

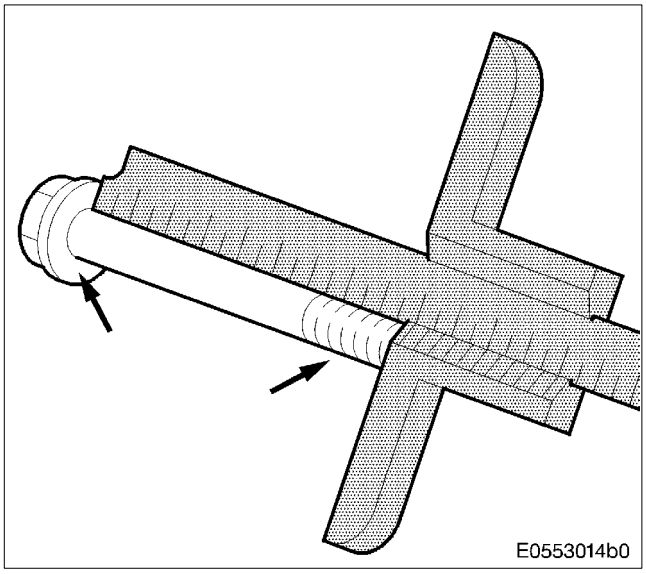


Measuring diameter of bearing pedestal axles

Using micrometer, measure outside diameters of bearings.

If measurements are below limit values, replace rocker shaft support.

For limit values, see Tolerance and Wear Limits List.



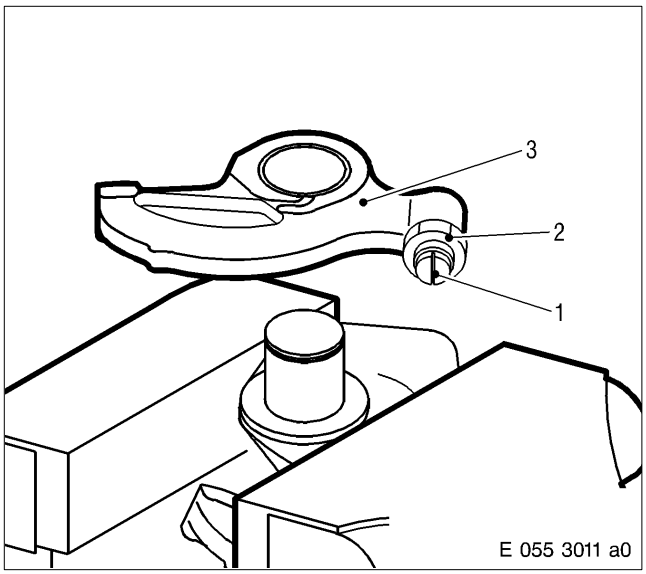
Checking hex screws for rocker shaft support

Measure shaft length of hex screw; for max. shaft length – see C 055.05.01.

Check that thread and screw head mating face (arrows) are in perfect condition; replace screw if necessary.

Check hexagon for damage; replace screw if necessary.

C 055.05.10 Assembly



Assembling rocker arm assembly

Note: Make sure parts are perfectly clean.

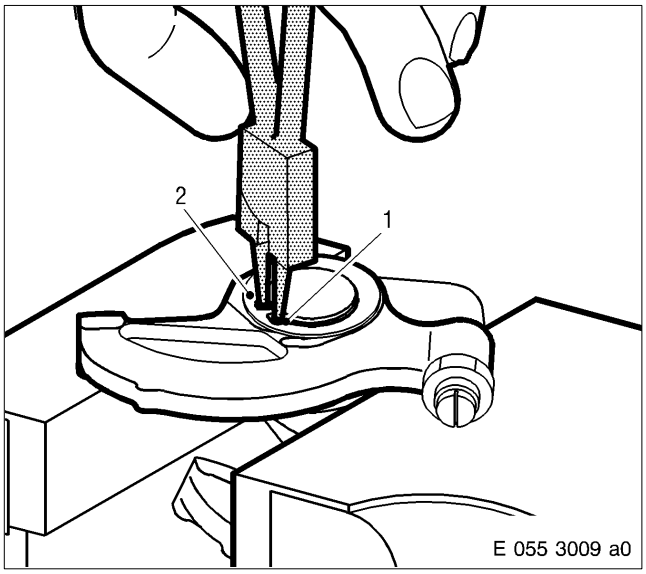
Insert adjusting screw (1) into rocker arm (3).

Attach nut (2) to adjusting screw; do not tighten!

Coat axles on rocker shaft support and bushes of rocker arm with engine oil.

Clamp rocker shaft support in vice with aluminium jaws.

Fit rocker arm on axle.



⚠ CAUTION

Snap ring pretension
Risk of injury!
Use suitable snap ring pliers. Always wear protective goggles/safety mask.

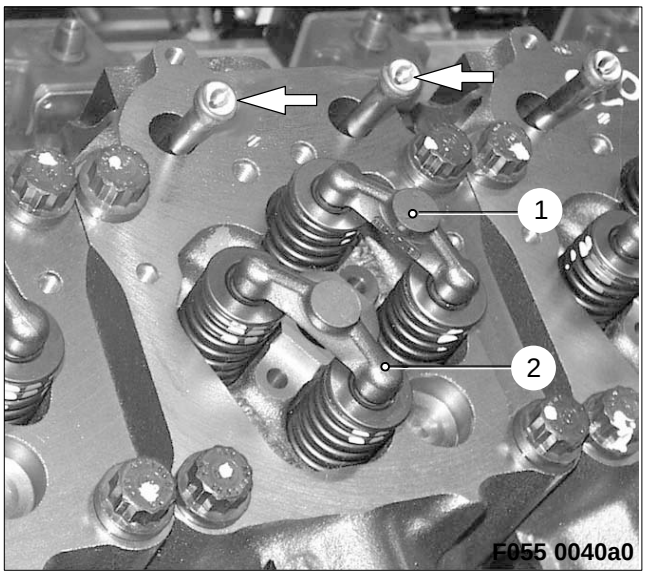
Fit washer (2) and secure with snap ring (1).

Make sure that snap ring is correctly seated.

Check minimum axial clearance of rocker arm.

Install second rocker arm similarly.

C 055.05.11 Installation

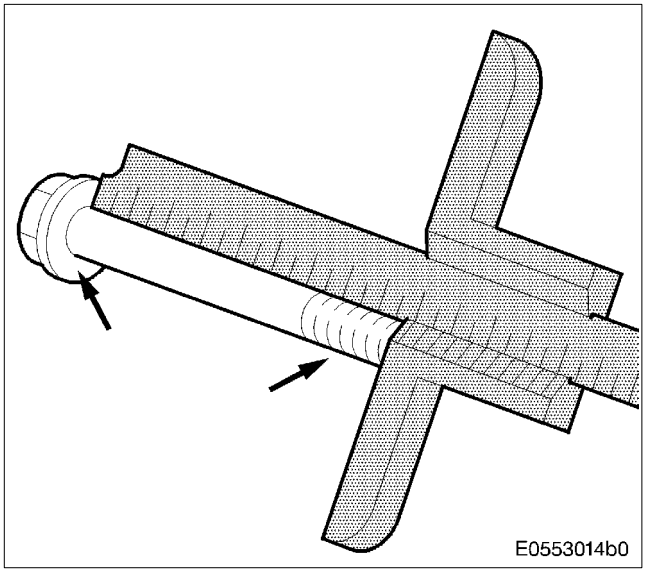


Installing valve bridges and rocker arms

Note: Make sure parts are perfectly clean.

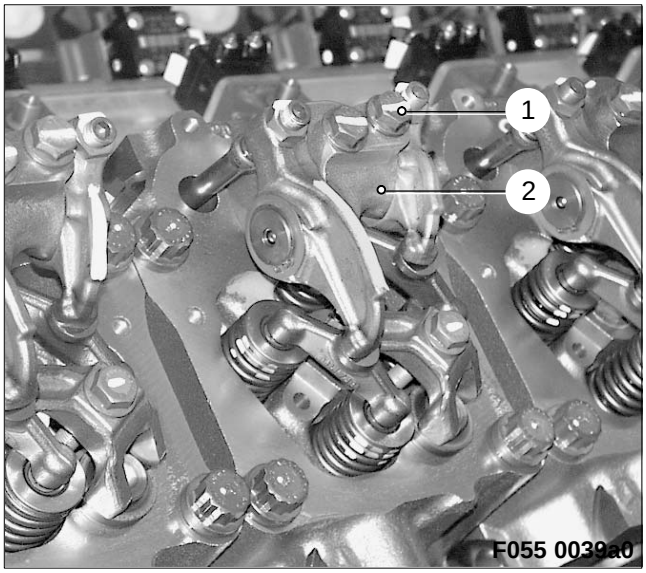
Mount valve bridges (1) and (2) according to markings (location) on valve in cylinder head.

Coat ball sockets (arrows) of pushrods with engine oil.



Measure shaft length of hex screw; for max. shaft length – see C 055.05.01.

Coat thread and mating face (arrows) of hex screws with engine oil.



Using the barring tool, set piston of cylinder to be checked to firing TDC.

Note: In firing TDC, both roller tappets of the cylinder to be checked are in the camshaft basic circle.

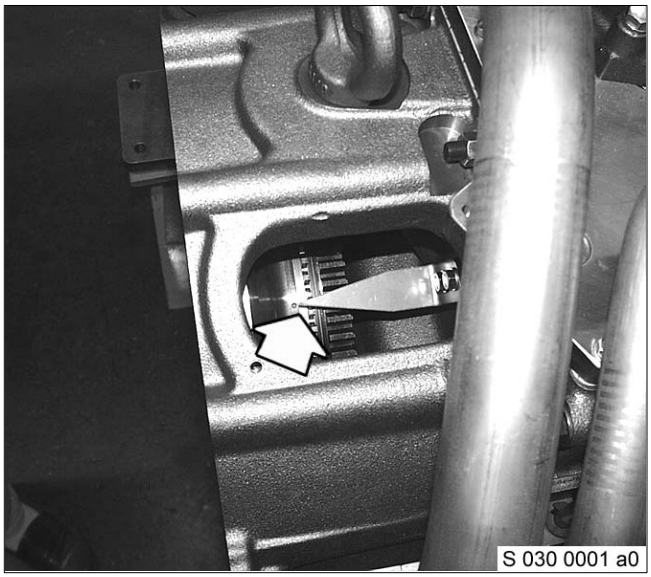
Release nuts of adjusting screws on rocker shaft support and back off adjusting screws.

Fit rocker shaft support (2) on cylinder head and check position of tapers in push rods.

Insert both hex screws (1) into cylinder head and tighten to specified tightening torque – see C 055.05.01.

Proceeding in engine firing sequence, set other pistons to firing TDC and install all rocker arm bearing pedestals in same manner.

Set valve clearance, see following Section.



Adjusting valve clearance with two crankshaft positions

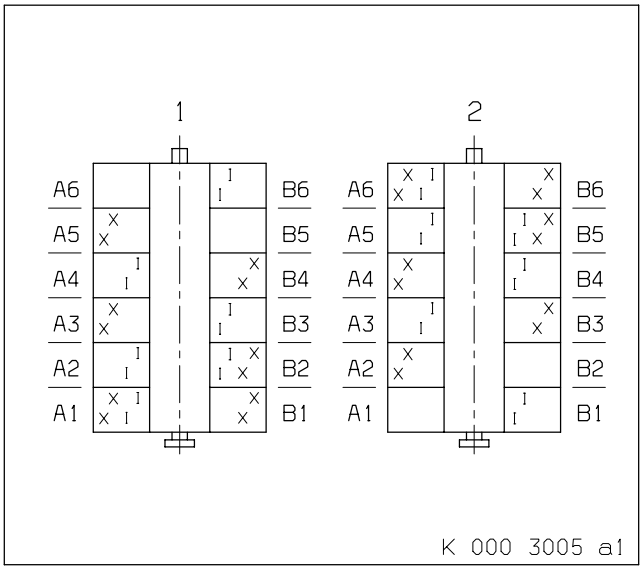
Turn crankshaft with barring tool in normal direction of engine rotation until TDC–A1 mark on flywheel (arrow) and pointer on flywheel housing are aligned.

If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.

If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.

Set valve clearances at this TDC crankshaft position in accordance with following valve clearance setting diagrams.

Rotate crankshaft a further 360° (to next TDC crankshaft position) and set remaining valve clearances in accordance with valve clearance setting diagram.



Valve clearance setting diagram 12V

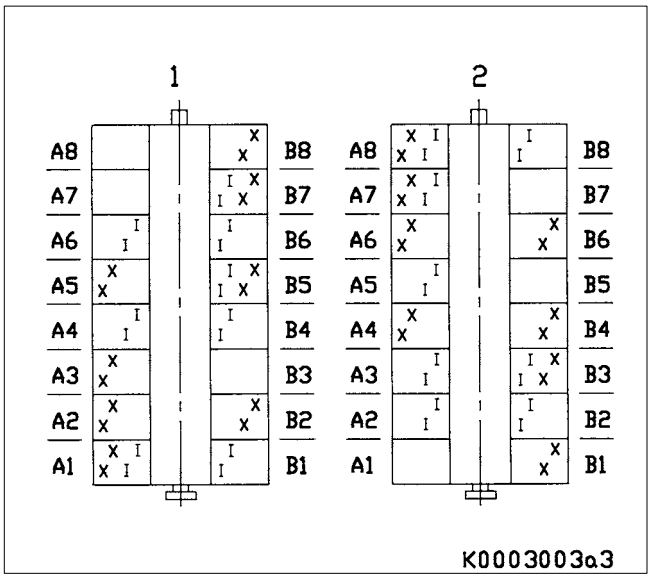
1 = Firing TDC at cylinder A1

2 = Overlap TDC at cylinder A1

X = Exhaust valve

I = Inlet valve

Procedure for setting – see following illustrations.



Valve clearance setting diagram 16V

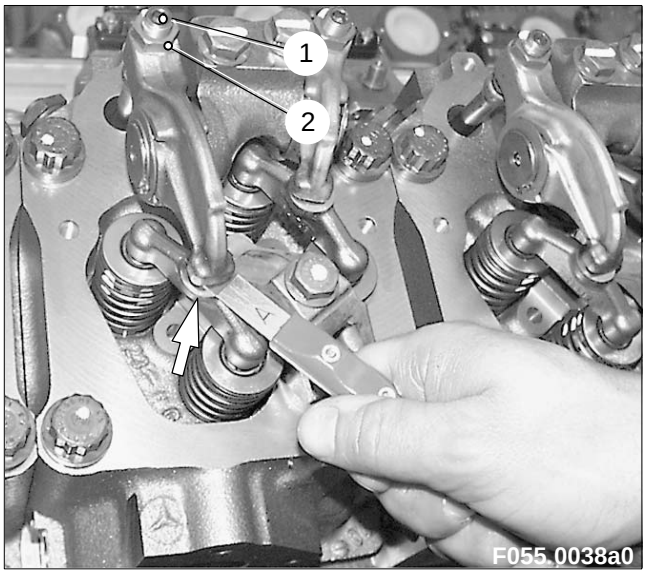
1 = Firing TDC at cylinder A1

2 = Overlap TDC at cylinder A1

X = Exhaust valve

I = Inlet valve

Procedure for setting – see next illustration.



Release locknut (2) and slightly unscrew adjusting screw (1).

Insert feeler gauge between valve bridge and rocker arm (arrows).

For specified valve clearance – see A 004.

Set adjusting screw so that the feeler gauge can just be pulled through when locknut is tightened.

Tighten locknut to specified tightening torque – see C 055.05.01; when doing this, hold adjusting screw in position with a screwdriver.

Recheck valve clearance after locking nut.

C 055.05.12 After-Installation Operations

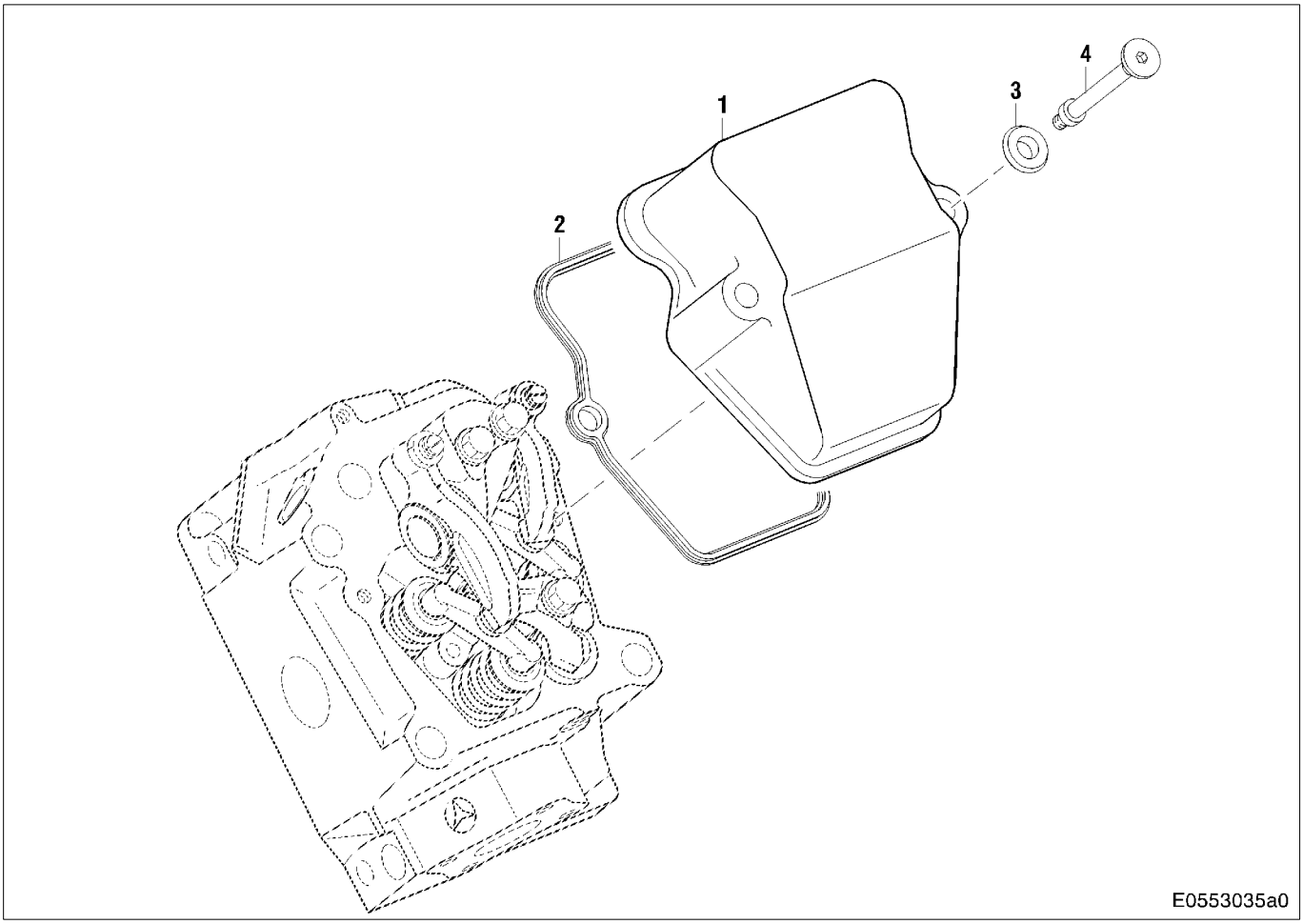
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install cylinder head cover	C 055.10
–	–	x	Release engine start	Operating Instructions

C 055.10 Cylinder Head Cover

C 055.10.01 Overview Drawing



1 Cylinder head cover
2 Gasket
3 Sealing washer
4 Collar screw
Lubricant: Engine oil
Tightening torque: 20 Nm

C 055.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 055.10.05 Removal

Removing cylinder head cover

Remove both collar screws.

Remove cylinder head cover and gasket.

C 055.10.08 Inspection and Repair

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Clean cylinder head cover with cleaner, blow out with compressed air and make sure it is perfectly clean.

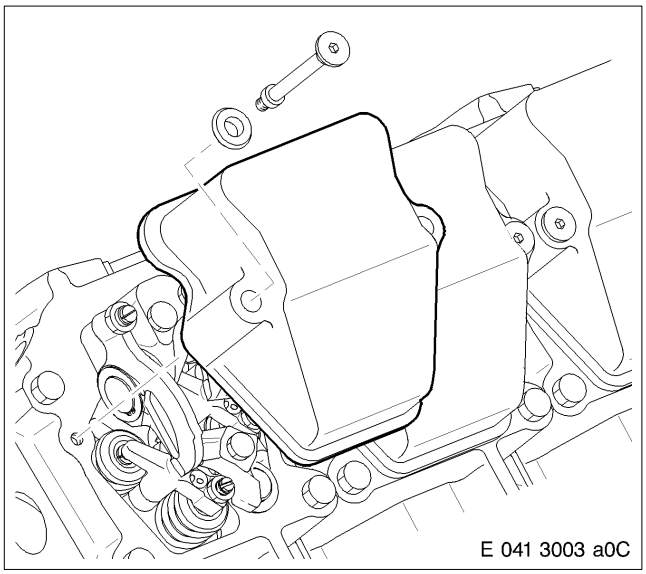
Make visible inspection of cylinder head cover for wear and damage paying particular attention to the mating and sealing surfaces; rub down with emery cloth or an oilstone or replace component as necessary.

Clean collar screws and check for wear and damage; replace if necessary.

Check thread of collar screws for ease of movement; replace collar screw if necessary.

Replace gaskets and sealing washers during W5 overhaul.

C 055.10.11 Installation



Installing cylinder head cover

Note: Make sure parts are perfectly clean.

Check mounting surface, clean if necessary.

Insert gasket in groove in cylinder head cover and press firmly into position.

Fit cylinder head cover on cylinder head.

Install screws with sealing washers and tighten to specified tightening torque – see C 055.10.01.

C 055.10.12 After-Installation Operations

A distinction must be made as to whether:

1 ——— The engine was completely disassembled

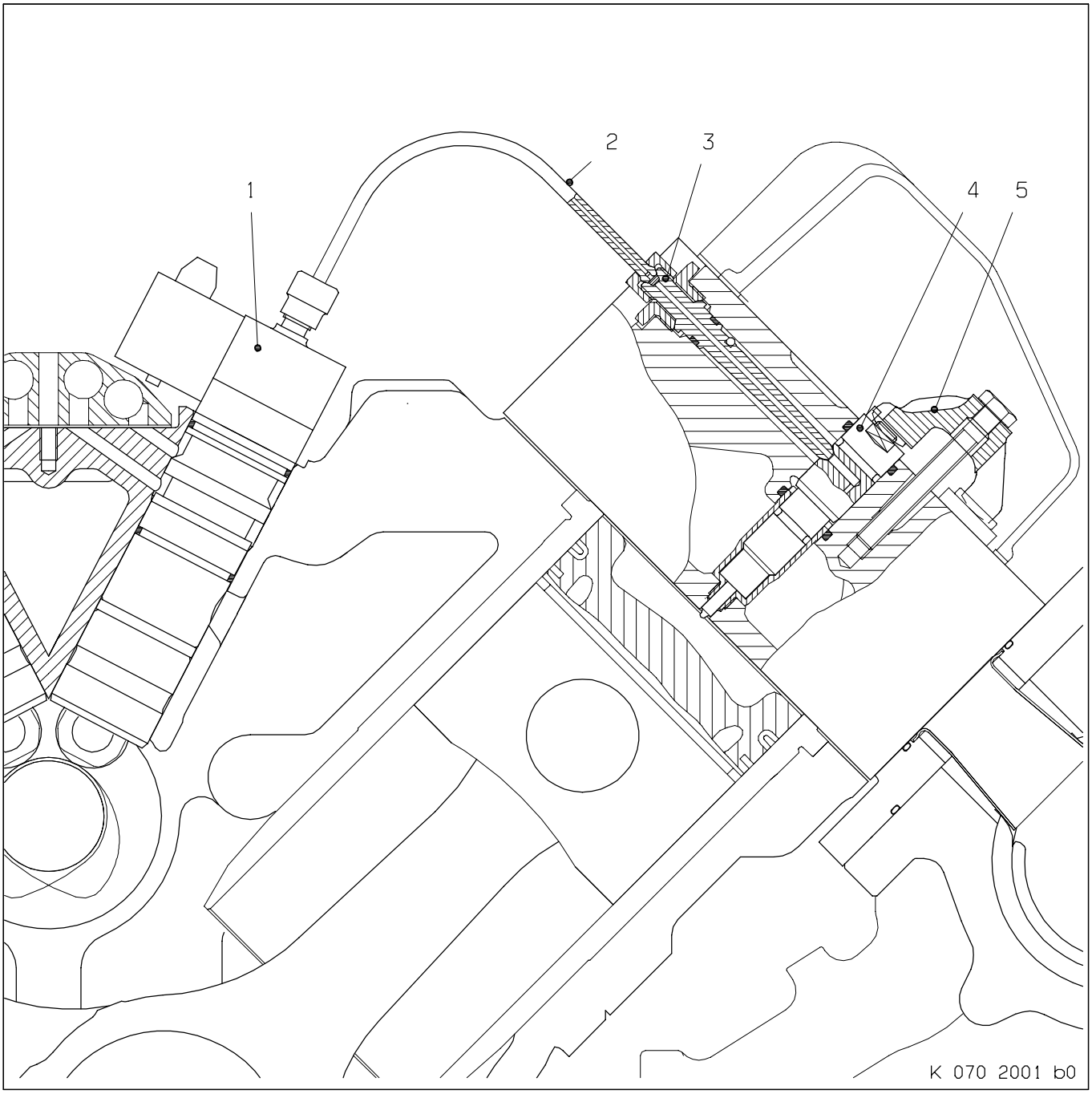
2 ——— The engine is removed but was not disassembled

3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 070 Fuel System – High-Pressure



1 Plug-in pump
2 Injection line
3 Pressure pipe connection
4 Injector
5 Clamping element

The following is a list of auxiliary equipment and materials needed for the assembly operations:

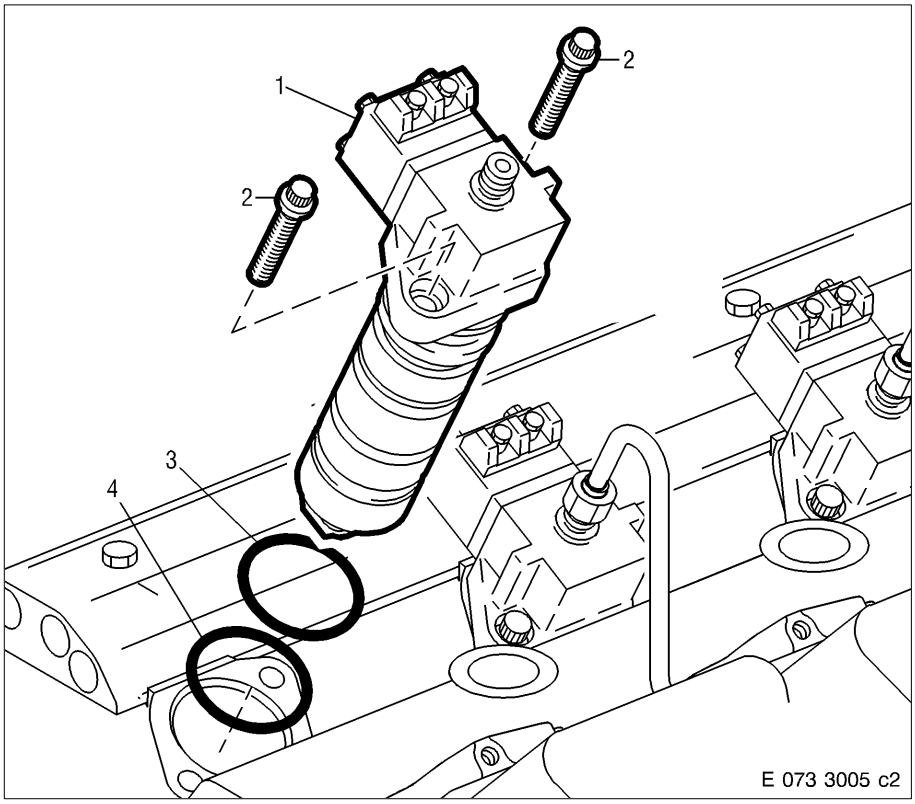
CAUTION

When using these miscellaneous materials, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Bottle brush			
Magnifier			
Vaseline	Petroleum jelly, white	40317	
Engine oil			
Multipurpose grease	Shell Retinax A	40333	
Kerosene or diesel fuel			
Cleaning agent	Solvclean KW	40022	
Corrosion inhibitor	Caramba Express	40008	
Engineer's blue	Blue	40641	
Dry compressed air			
Magnetic crack-testing equipment with fluorescent magnetic powder			

C 073.05 Fuel Injection Pump

C 073.05.01 Overview Drawing



1 Plug-in pump
2 Double-hex screw
Lubricant: Engine oil
Tightening torque: 60 Nm + 12 Nm
3 Sealing ring
4 Sealing ring

C 073.05.02 Special Tools

Designation – Application	Number
Socket for double-hex screw	1

C 073.05.04 Before-Removal Operations

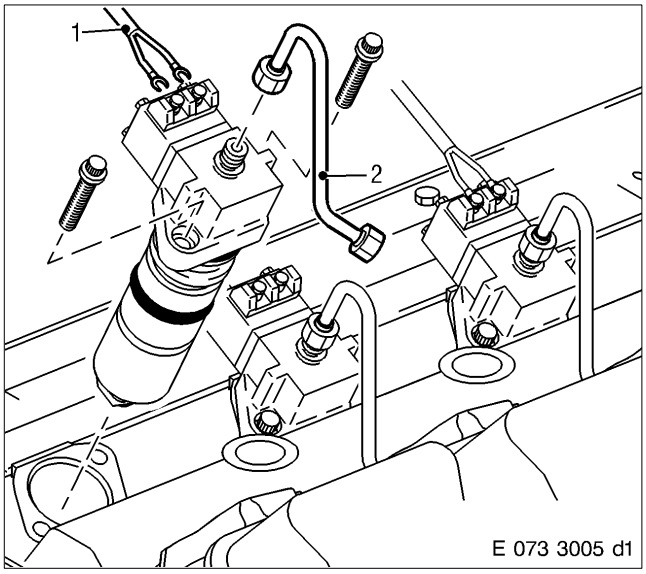
A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Drain fuel from fuel guide rail, driving end (blow out if necessary)	Operating Instructions
–	x	x	Remove or disconnect electric wiring*****	C 507.10
–	x	x	Remove ECU housing and bracket*****	C 508.10
–	x	x	Remove charge air manifold (free end)*****	C 124.05

***** only for 16V

C 073.05.05 Removal



⚠ WARNING

Fuels are combustible.
Risk of fire!
When working on the fuel system:
– do not use naked flame
– no electric sparks
– do not smoke
– do not spill fuel.

Release screws for wiring (1) on solenoid valve and separate both plug-in clips.

Remove injection line (2) – see also C 077.05.

Mark injection pump in accordance with installation location.

Using socket and extension, remove double-hex screws of injection pump approx. 6 mm.

If the injection pump is not already pressed out of the crankcase by means of the preloaded compression spring, bar the engine with the engine barring tool until the injection pump is lifted by the pump cams.

Note: A firmly-seated injection pump must not be pressed out at the solenoid valve or intermediate plate!

If necessary, carefully press out injection pump at recess in injection pump head.

Remove double-hex screws and injection pump.

Remove sealing rings from injection pump.

Seal installation bore if necessary.

C 073.05.06 Disassembly

Injection pump must not be disassembled.

The injection pump is a replacement component and is available through the usual replacement procedure.

C 073.05.08 Inspection and Repair

Replace injection pump in accordance with maintenance schedule during appropriate maintenance echelon.

! CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

When re-using injection pump, clean with cleaning agent, blow out with compressed air and make sure it is perfectly clean.

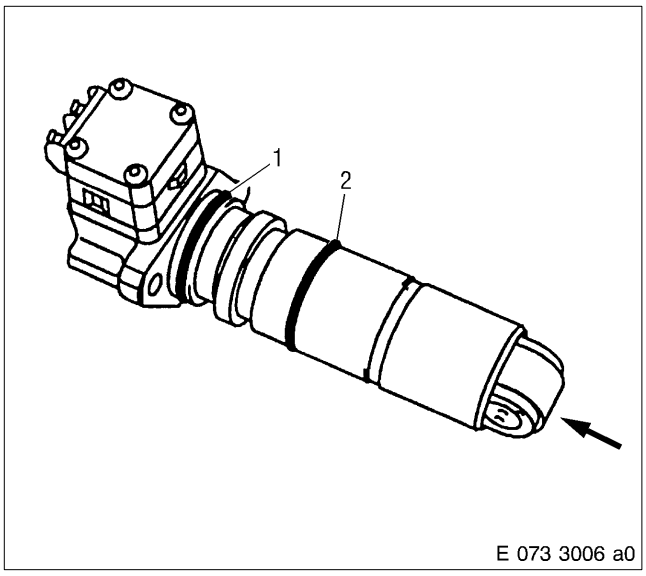
Make visible inspection of injection pump for wear and damage paying particular attention to the running surface of the roller; replace injection pump if it is worn or damaged.

Clean double-hex screws and check condition of screws.

Make sure threads are in perfect condition; replace double hex screws as necessary.

Replace sealing rings as part of every assembly.

C 073.05.11 Installation



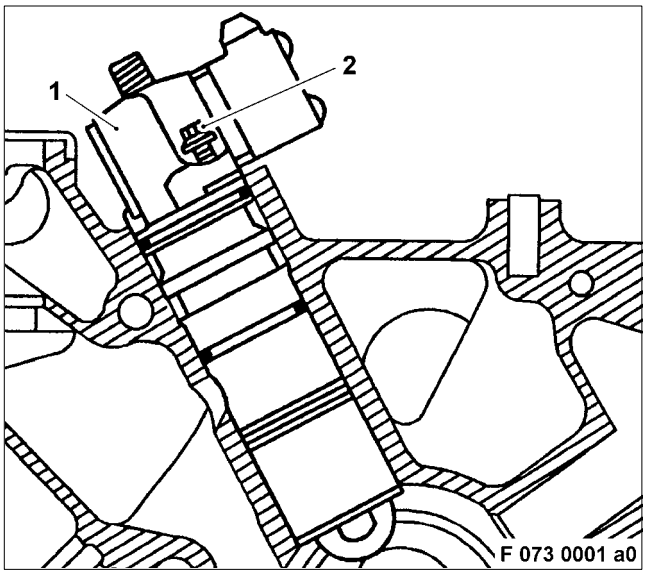
Installing injection pump

Note: Make sure parts are perfectly clean.

Coat both sealing rings (1) and (2) with petroleum jelly and fit on injection pump.

Note: Sealing rings have different item numbers. Pay attention to installation location – see Spare Parts Catalogue!

Coat roller (arrow) of injection pump with engine oil.



Note: Before installing, remove all blanking plugs and covers.

Check that sealing surfaces and fuel bores in the crankcase are perfectly clean; clean if necessary.

Using the engine barring tool, set pump cams of camshaft to base circle.

Arrange injection pump (1) with respect to installation location and manually press into crankcase against spring power (distance approx. 4 mm).

Insert both double-hex screws (2) with socket and extension uniformly and tighten to specified tightening torque – see C 073.05.01.

Attach plug-in clip of wiring to solenoid valve and tighten screws to specified tightening torque – see A 003.

C 073.05.12 After-Installation Operations

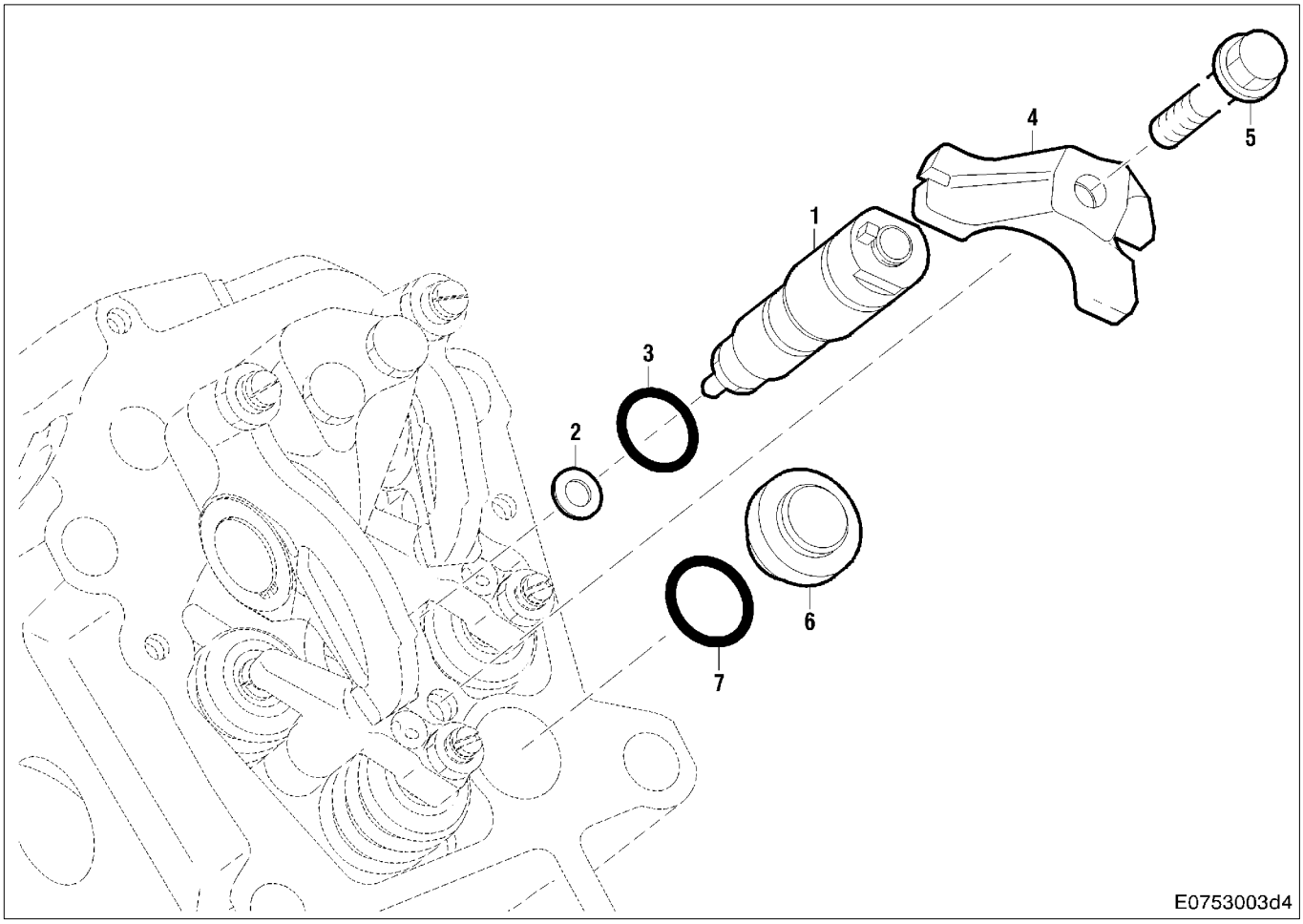
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install H.P. fuel line	C 077.05
–	x	x	Install charge air manifold	C 124.05
–	x	x	Install bracket and ECU housing	C 508.10
–	x	x	Connect electric cables	C 507.10
–	–	x	Vent fuel system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 075.05 Injector

C 075.05.01 Overview Drawing



1 Injector
2 Sealing ring
3 Sealing ring
4 Clamping element
5 Hex screw
Lubricant: Engine oil
Tightening torque: 50 Nm
6 End cover
7 Sealing ring

C 075.05.02 Special Tools

Designation – Application	Number
Ring wrench insert for thrust screw	1
Removal tool for injector	1

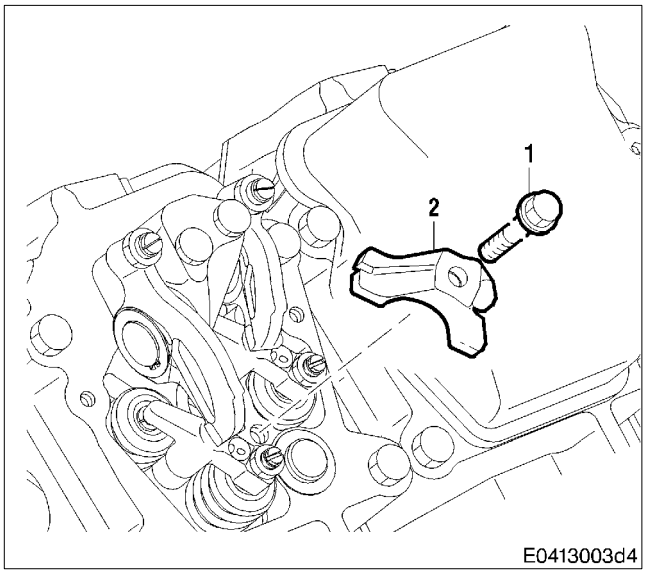
C 075.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove air filter (if necessary)	C 121.05
–	x	x	Remove intake housing (if necessary)	C 123.05
–	x	x	Remove cylinder head cover	C 055.10
–	x	x	Remove H.P. line and pressure pipe connection	C 077.05

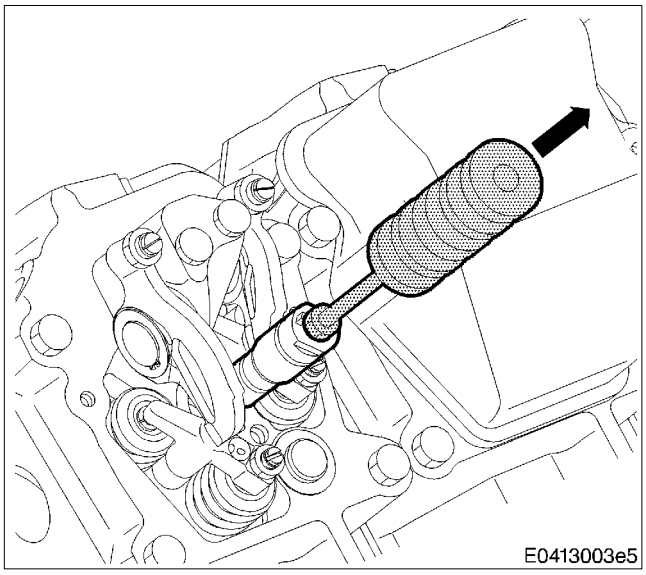
C 075.05.05 Removal



Removing fuel injector

Important: H.P. line and pressure pipe connection must be removed.

Remove hex screw (1) and remove clamping element (2).

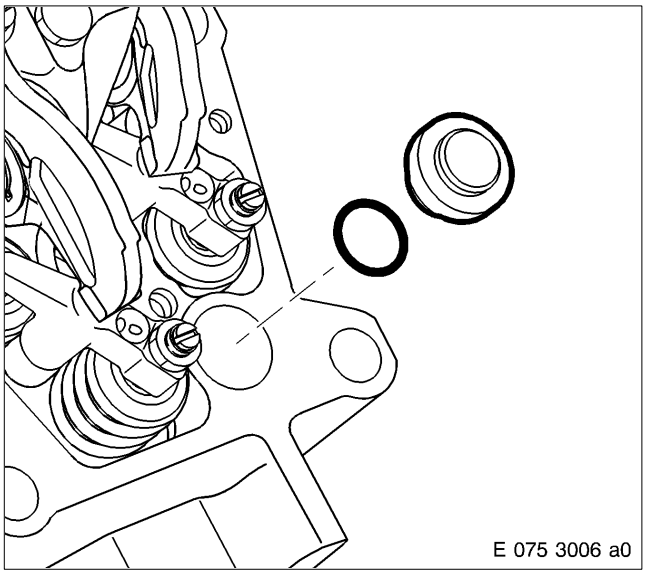


Screw removal tool into injector.

Use removal tool to remove injector.

Remove copper sealing ring with a wire hook.

Remove sealing ring from injector.



Removing end cover for clamping element in cylinder head

Using a screwdriver, carefully remove end cover from cylinder head.

Remove sealing ring.

C 075.05.06 Disassembly

Injector must not be disassembled.

The injector is a replacement component and is available through the usual replacement procedure.

C 075.05.08 Inspection and Repair

Replace injector in accordance with maintenance schedule during appropriate maintenance echelon.

Clean all parts.

When reusing injector, check it externally for damage and replace if necessary.

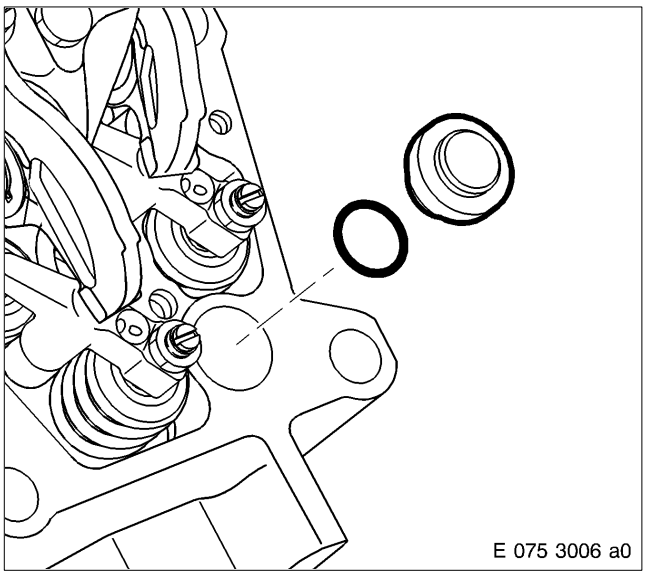
Using the magnetic crack-testing method with fluorescent magnetic powder, check hex screw and clamping element for cracks; replace components as necessary.

Check seating faces of clamping element and end cover; if necessary rub down with an oilstone or emery cloth. Replace components as necessary.

Check hex screws for damage and check threads for ease of movement; replace hex screw if necessary.

Replace sealing rings as part of every assembly.

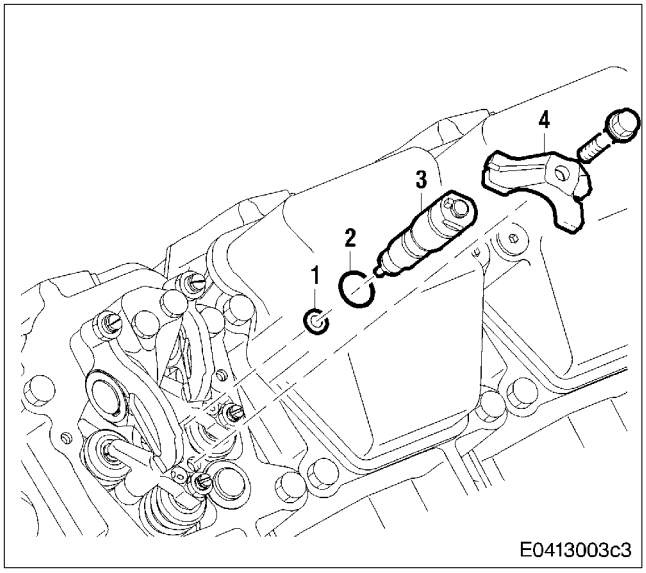
C 075.05.11 Installation



Installing end cover for clamping element in cylinder head

Coat sealing ring with petroleum jelly and insert in groove on end cover.

Insert end cover into bore in cylinder head.



Installing fuel injector

Note: Make sure fuel-carrying components are perfectly clean. Before installing, remove all blanking plugs and covers.

⚠ WARNING

Fuels are combustible.
Risk of fire!
When working on the fuel system:
– do not use naked flame
– no electric sparks
– do not smoke
– do not spill fuel.

Bar engine several times to blow out any remaining fuel.

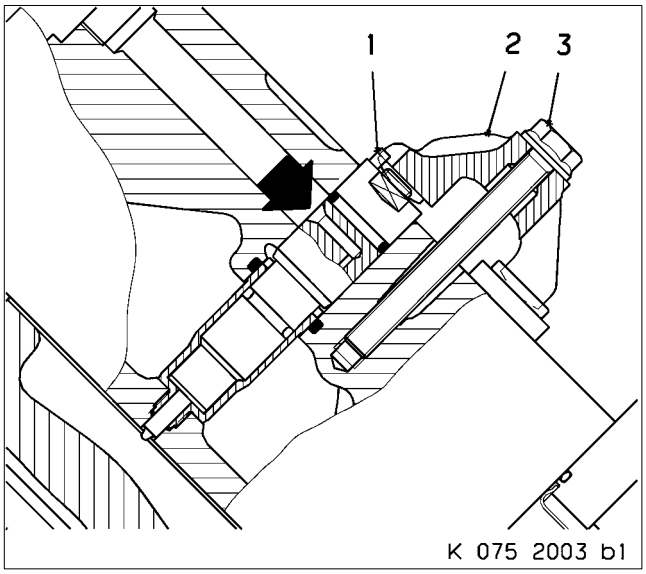
Check sealing surface on cylinder head and nozzle holder; clean if necessary.

Coat new sealing ring (2) with petroleum jelly and fit on injector (3).

Attach new copper sealing ring (1) with grease to injector.

Press injector into cylinder head by hand. Ensure that pin in injector is at 11 o'clock position with regard to engine longitudinal axis. Installation direction – see next illustration.

Install clamping element (4) with hex screw, ensuring that it is positioned correctly and that it is perfectly seated on injector and end cover.



The injector supply bore must point in the installation direction (arrow) of the pressure pipe connection.

Pin (1) in injector must be located in clamping element (2) recess.

The fork on the clamping element must engage in the end cover.

Tighten hex screw (3) to specified tightening torque – see C 075.05.01.

C 075.05.12 After-Installation Operations

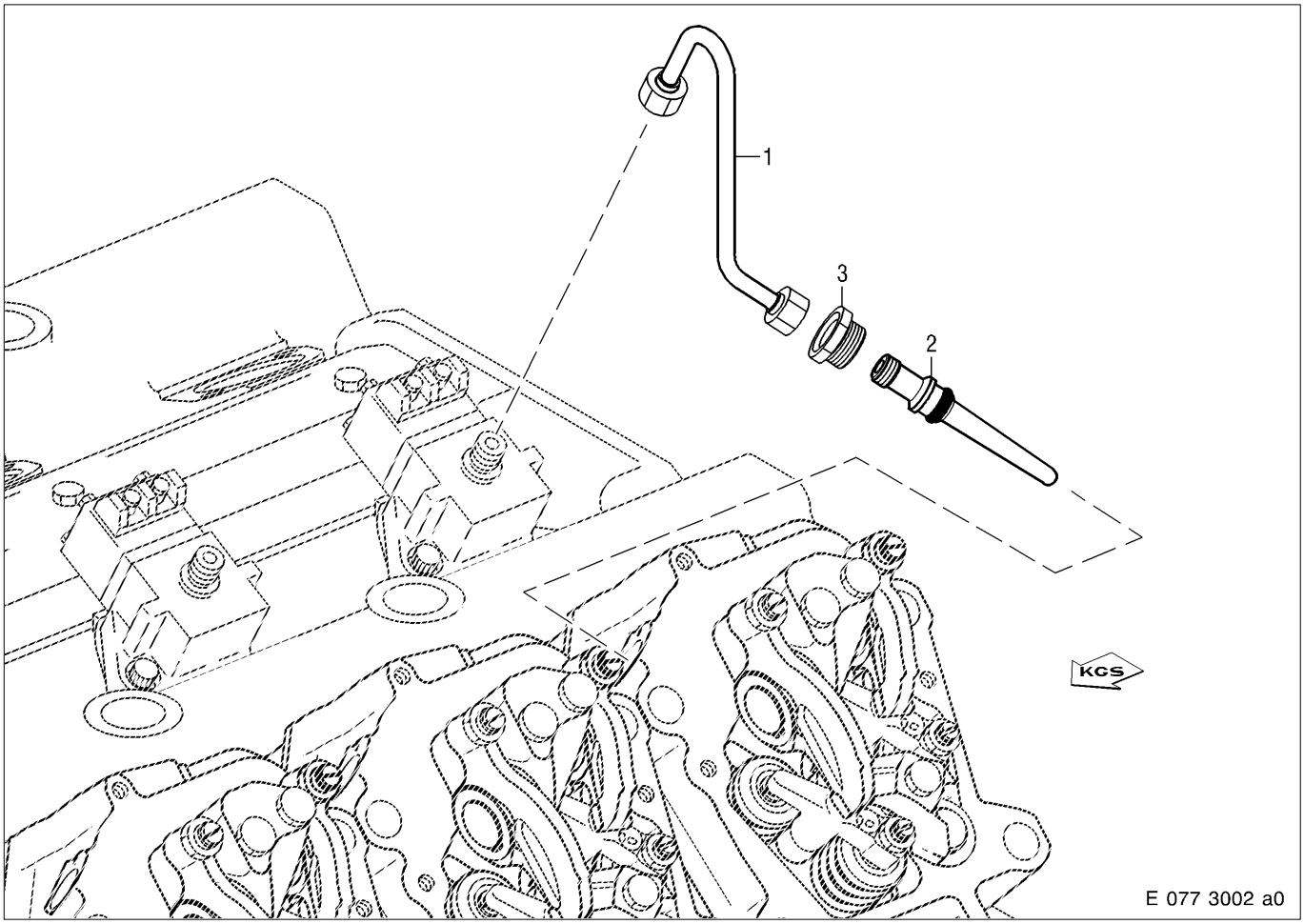
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install pressure pipe connection and H.P. line	C 077.05
–	x	x	Install cylinder head cover	C 055.10
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 077.05 Injection Line / High-Pressure Line

C 077.05.01 Overview Drawing



1 Injection line
Lubricant: Engine oil
Tightening torque:
Union nut on injection nozzle: 20 Nm + 5 Nm
Union nut on high-pressure pump: 30 Nm + 5 Nm

2 Pressure pipe joint

3 Thrust screw
Lubricant: Engine oil
Tightening torque: 40 Nm + 5 Nm

C 075.05.02 Special Tools

Designation – Application	Number
Fuel suction lift	1
Ring wrench insert for union nuts	1

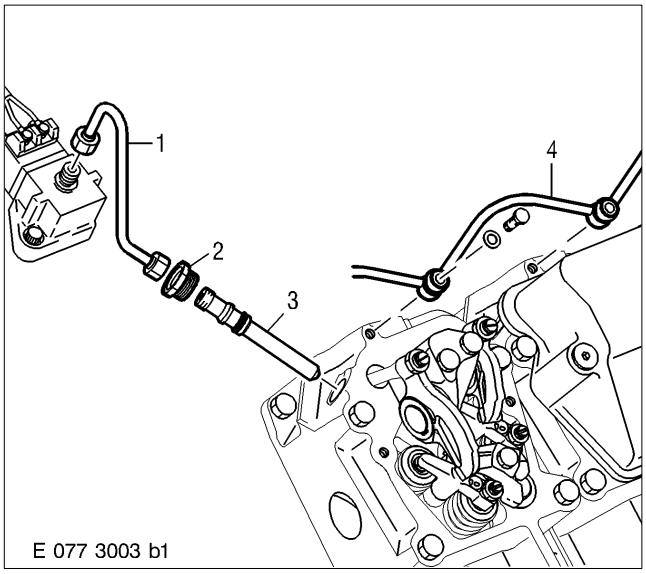
C 077.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 077.05.05 Removal



Removing H.P. line and pressure pipe connection

⚠ WARNING

Fuels are combustible.
Risk of fire!
When working on the fuel system:
– do not use naked flame
– no electric sparks
– do not smoke
– do not spill fuel.

Remove leak-off fuel line (4) – see C 086.05.

Remove H.P. line (1).

Remove thrust screw (2).

Remove pressure pipe connection (3).

Using a sprayer and rubber hose, drain fuel in the two free bores.

Note: Ensure that no fuel enters the cylinder chamber.

Cover all connections with suitable plugs.

Remove sealing ring from pressure pipe connection.

C 077.05.08 Inspection and Repair

Clean all components with cleaner; visually inspect for damage and check condition; replace component as necessary.

! CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow H.P. line and pressure pipe connection clear with compressed air and make sure that they are completely clean.

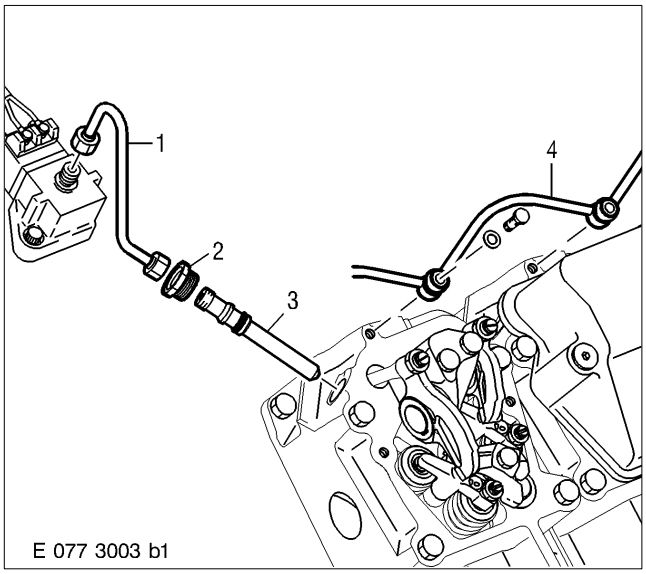
Check threads of union nuts and single-ended unions for ease of movement; recondition or replace part as required.

Replace sealing ring as part of every assembly.

C 077.05.11 Installation

Install pressure pipe connection and H.P. line

Important: Injector must be installed and hex screw on clamping element tightened to specified tightening torque.



Note: Make sure fuel-carrying components are perfectly clean. Prior to installation, remove all blanking plug and/or covers.

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar.

Blow H.P. line (1) and pressure pipe connection (3) clear with compressed air and check that they are particularly clean.

Coat new sealing ring with petroleum jelly and fit on pressure pipe connection.

Moisten sealing cone of pressure pipe connection (on injector) with engine oil.

Insert pressure pipe connection until it contacts sealing ring, but do not yet press firmly into position.

When pressing pressure pipe connection into cylinder head, screw thrust screw (2) into cylinder head by a few turns of the thread.

Press pressure pipe connection into cylinder head by hand.

Tighten thrust screw (2) to specified tightening torque – see C 077.05.01.

Note: Do not bend the H.P. line! Make sure that installation position is correct.

Install H.P. line and tighten union nuts to respective specified tightening torque.

Install leak-off fuel line (4) – see C 086.05.

Note: After engine start, visually inspect fuel lines for leaks.

C 077.05.12 After-Installation Operations

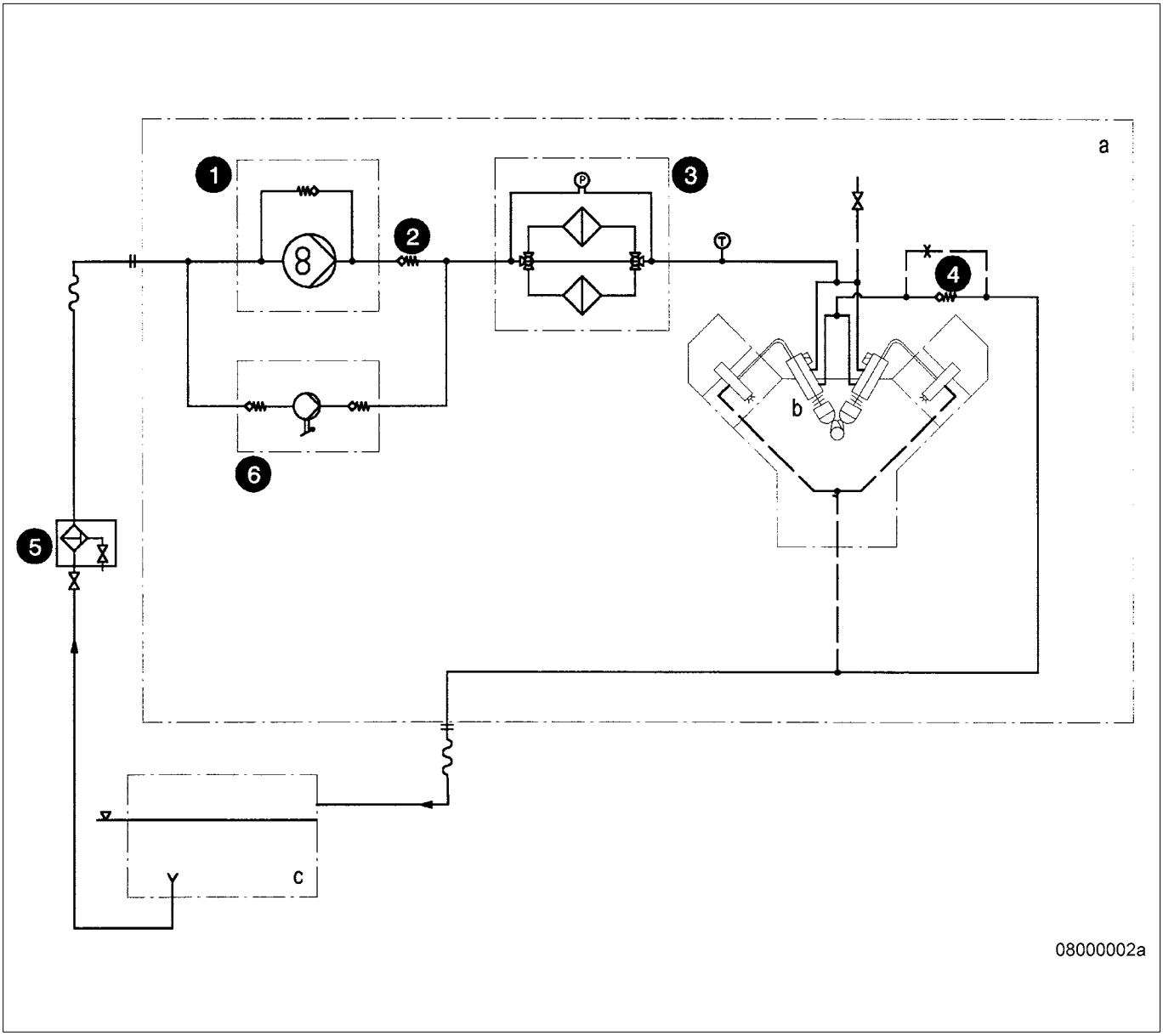
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

Contents

C 080 Fuel System (Low-Pressure)



1 Fuel pump
2 Non-return valve
3 Fuel duplex filter
4 Non-return valve 8.5 bar
5 Fuel prefilter
6 Fuel hand pump

a Engine
b Fuel system (high pressure)
c Fuel supply tank
P Fuel pressure sensor
T Fuel temperature sensor

——— = Fuel line (low pressure)
═══ = Fuel line (high pressure)
— — — — = Vent or leak-off fuel line
—— · —— = System limits (assemblies)

The following is a list of auxiliary equipment and materials needed for the assembly operations:

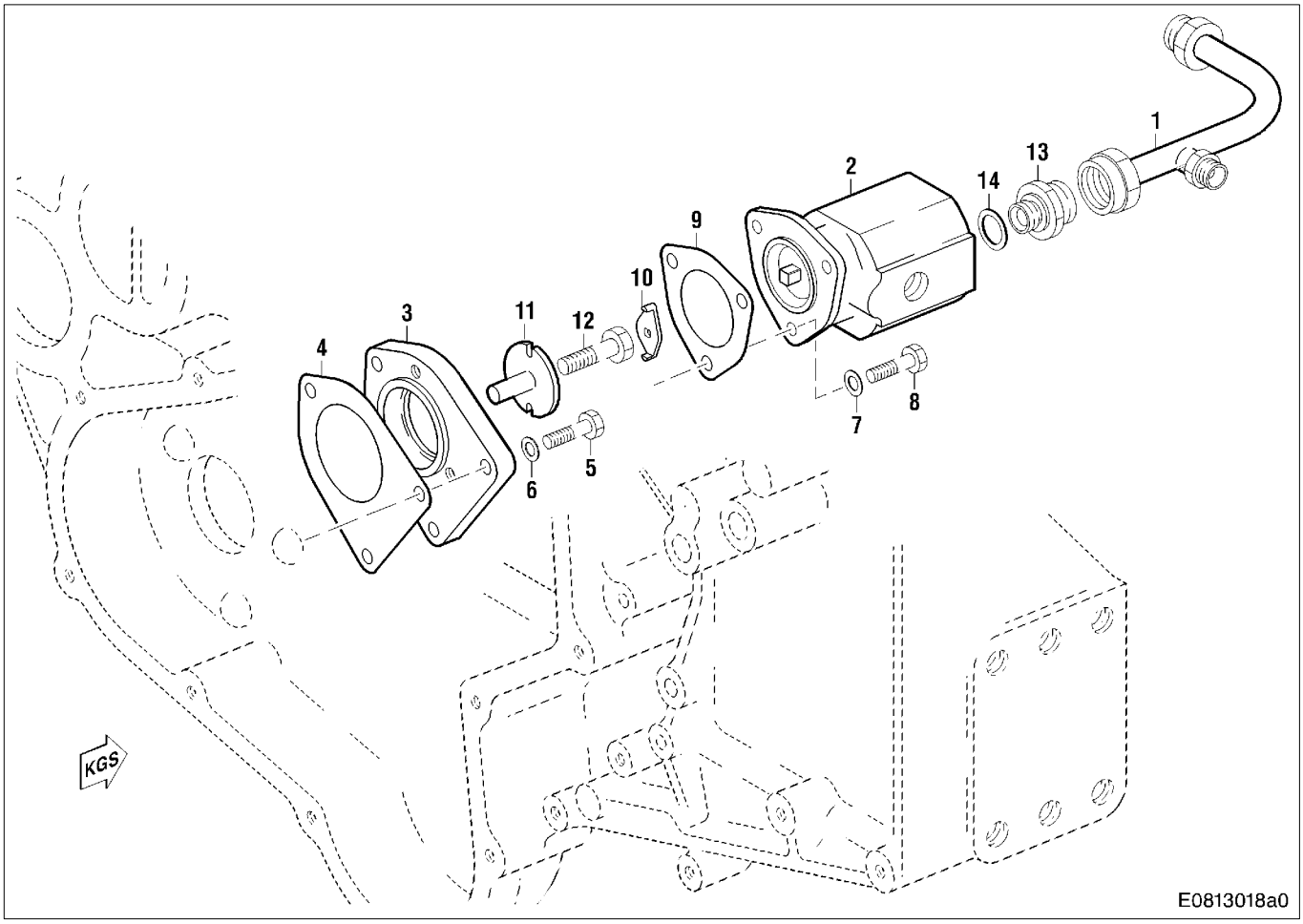
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Magnifier			
Sealing paste	Elastosil N 189	50545	
Vaseline	Petroleum jelly, white	40317	
Surface sealant	Loctite No. 573	40031	
Engine oil			
Multipurpose grease	Shell Retinax A	40333	
Cleaning agent	Solvclean KW	40022	
Hydrochloric acid			
Corrosion inhibitor	Pfinder AP 11 F	40355	
Kerosene or diesel fuel			
Thread-locking compound	Loctite No. 270	40083	Final strength at 20 °C ≈ 12 h
Thread-sealing compound	Loctite No. 586	40033	Final strength at 20 °C – 12 h
Activator	Loctite No. 7649	50548	
Ethanol, denaturated		40250	
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Surface crack-testing equipment with red penetrant dye			

C081.05 Fuel Lines before Fuel Pump, Fuel Pump

C 081.05.01 Overview Drawing



1 Fuel line
2 Fuel delivery pump
3 Intermediate flange
4 Gasket
5 Hex screw
6 Washer
7 Washer
8 Hex screw
9 Gasket
10 Driver, PPE side
11 Driver
12 Hex screw
13 Reduction union
14 Sealing ring

C 081.05.02 Special Tools

Designation – Application	Number
Starter key, 13x17, for fuel pump	1
Crowfoot wrench 3/8” A/F	1
Extension, bent, 3/8”, 150 mm	1

C 081.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 081.05.05 Removal

Removing fuel line

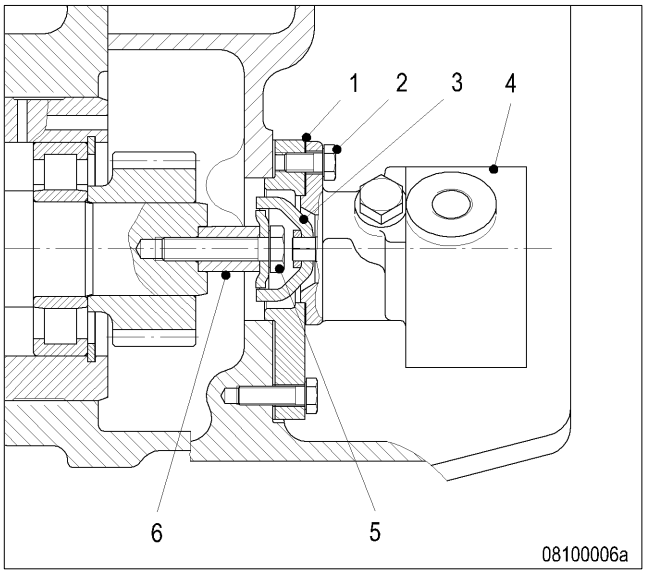
WARNING

Fuels and fuel vapours are flammable and poisonous. Risk of fire, explosions and poisoning! When using fuel: – do not use naked flame, – no electric sparks, – do not smoke, – do not spill fuel. Do not inhale. Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Release fuel line threaded connection and catch fuel emerging in a suitable container.

Remove fuel line in accordance with overview drawing – see C 082.05.01.

After removing the fuel line, cover all connections with suitable plugs.



Removing fuel delivery pump

Remove hex screws (2) and washers for fuel delivery pump (4).

Release fuel delivery pump from its seat and remove.

Remove driver (3) from drive shaft of fuel delivery pump.

Remove gasket (1).

Remove screw (5) from coolant pump shaft and remove driver (6).

Remove intermediate flange as per overview drawing – see C 081.05.01.

Remove gasket.

C 081.05.08 Inspection and Repair

Note: Make sure fuel-carrying components are perfectly clean.

Fuel line

Clean fuel line with cleaner and visually inspect for condition and damage; replace if necessary.

If necessary, pressure-test fuel line with air in water bath for leaks.

WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Check condition of threads of union nut and adapter.

Fuel delivery pump

Check fuel delivery pump in a specialist workshop or at Manufacturer's; have repaired if necessary.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Clean fuel delivery pump with cleaner, blow out with compressed air and make sure it is perfectly clean.

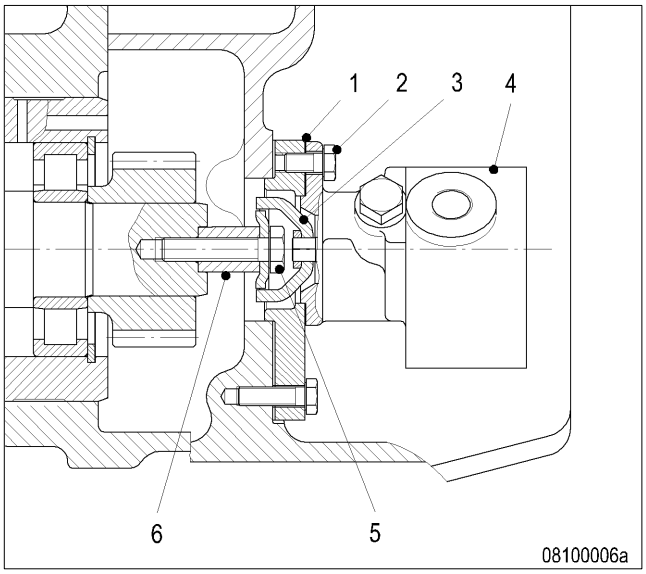
Perform external visual inspection of fuel delivery pump for damage and wear; replace as necessary.

Check securing screws for damage and check threads for ease of movement; replace screws if necessary.

Replace gasket and sealing rings ring at every assembly.

C 081.05.11 Installation

Note: Make sure fuel-carrying components are perfectly clean.



Installing fuel delivery pump

Install intermediate flange as per overview drawing – see C 081.05.01.

Install driver (6) with screw (5) on coolant pump shaft and tighten.

Fit gasket (1) on intermediate flange.

Fit driver (3) on drive shaft of fuel delivery pump (4).

Align driver dog to driver of coolant pump shaft.

Install fuel delivery pump in equipment carrier, making sure driver dog is correctly positioned.

Uniformly tighten fuel delivery pump with hex screws (2) and washers.

Installing fuel lines

Note: Before installation, remove blanking plugs.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow fuel line clear with compressed air.

Make sure fuel-carrying components are perfectly clean.

Install fuel line in accordance with overview drawing, ensuring it is free from tension – see C 081.05.01.

Note: After engine start, visually inspect fuel system for leaks.

C 081.05.12 After-Installation Operations

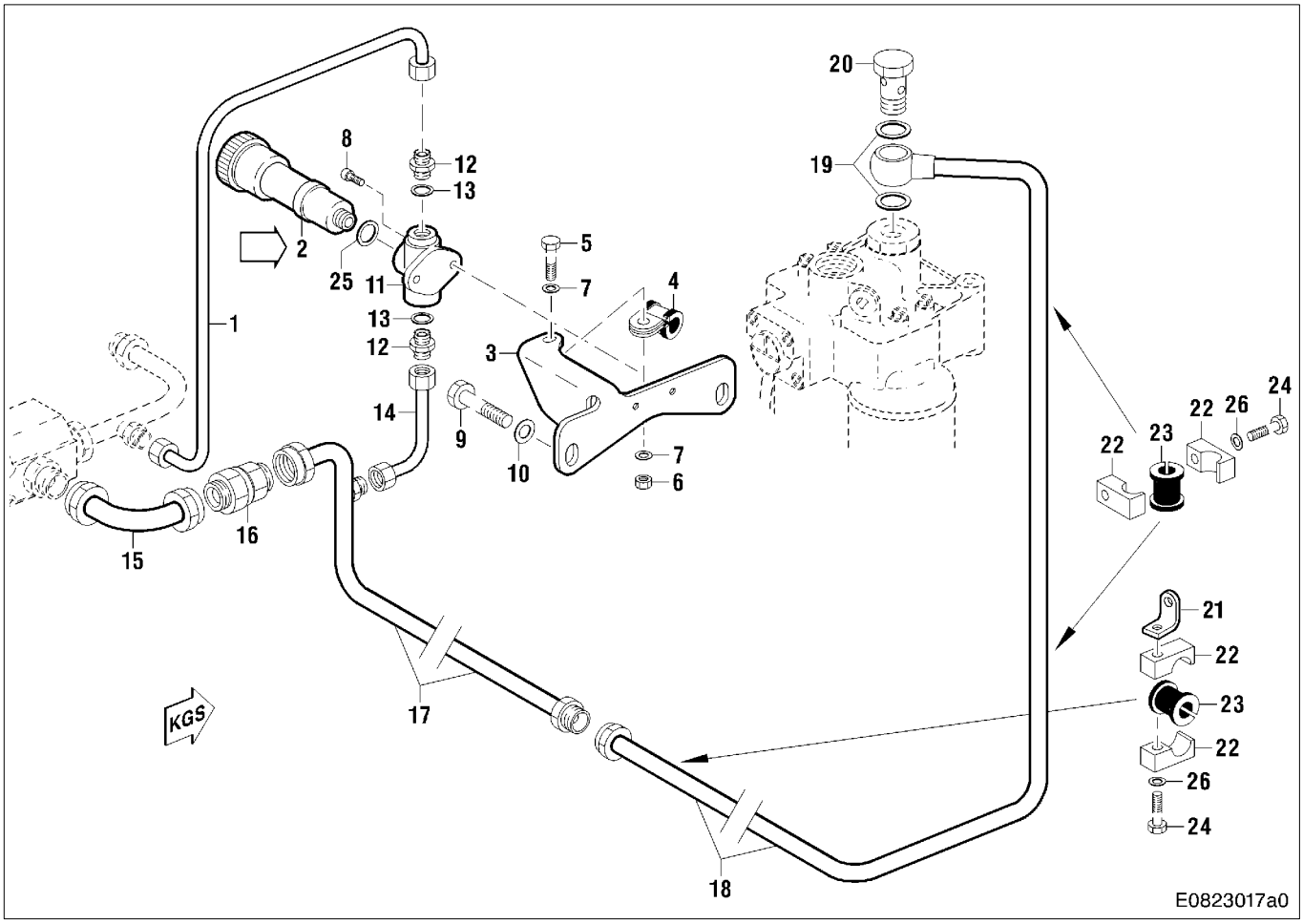
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

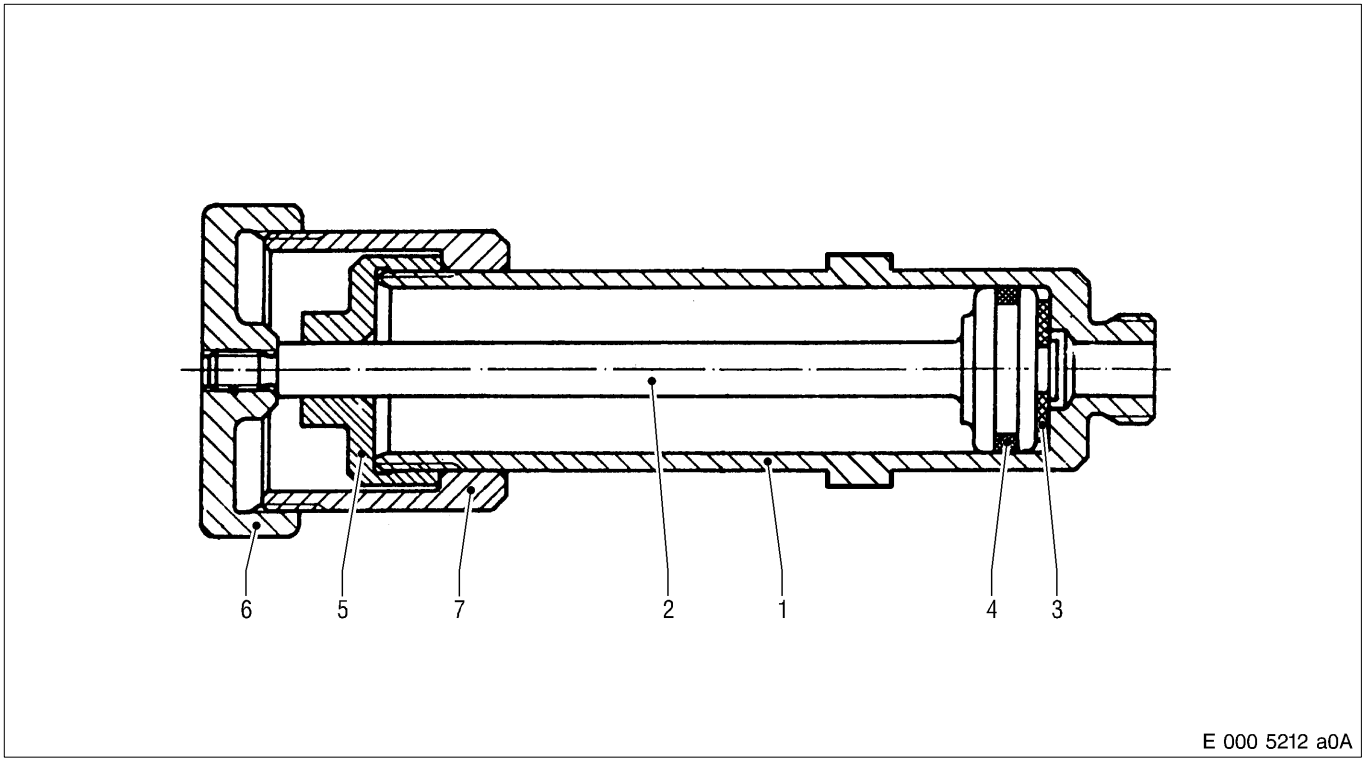
C 082.05 Fuel Line from Pump to Filter

C 082.05.01 Overview Drawing



1 Fuel line
2 Fuel hand pump
3 Bracket
4 Clamp
5 Hex screw
6 Hex nut
7 Washer
8 Socket-head screw
9 Hex screw
10 Washer
11 Pump housing
12 Union
13 Sealing ring
14 Fuel line
15 Fuel line
16 Non-return valve
17 Fuel line
18 Fuel line
19 Sealing ring
20 Banjo screw
21 Bracket
22 Pipe clamp half
23 Grommet
24 Hex screw
25 Sealing ring
26 Washer

Hand pump



1 Housing
2 Piston rod
3 Gasket
4 O-ring
5 Cover
6 Handle
7 Sleeve

C 082.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 082.05.05 Removal

Removing fuel lines and hand pump

Note: Before removing fuel lines, it is advisable to photograph the engine from all sides or attach metal tags to the fuel lines so that they can be reinstalled in their original positions.

WARNING

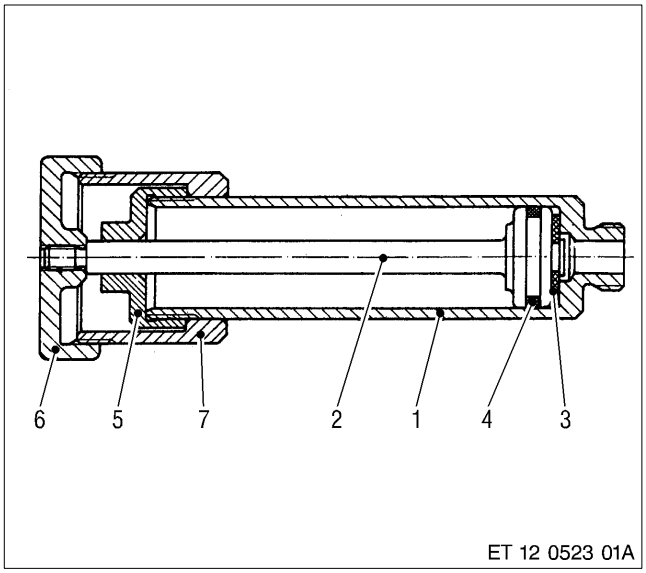
Fuels and fuel vapours are flammable and poisonous. Risk of fire, explosion and poisoning! When using fuel: – do not use naked flame, – no electric sparks, – do not smoke, – do not spill fuel. Do not inhale. Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Release fuel line threaded connection and catch fuel emerging in a suitable container.

Remove fuel lines, hand pump, non-return valve and fixtures as per overview drawing – see C 082.05.01.

After removing fuel lines, seal all connections with suitable plugs.

C 082.05.06 Disassembly



Disassembling hand pump

Disconnect handle (6) from sleeve (7).

Note: Handle is secured with thread-locking liquid.

Heat handle to approx. 130 °C.

CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.

Remove handle from piston rod (2).

Unscrew cover (5) from housing (1).

Remove sleeve from housing.

Withdraw piston rod from housing.

Remove O-ring (4) and gasket (3).

C 082.05.08 Inspection and Repair

Note: Make sure fuel-carrying components are perfectly clean.

Fuel lines, non-return valve and fixtures

Clean fuel lines and non-return valve with cleaner, check for damage (visual inspection) and replace if necessary.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow lines through with compressed air and make sure they are perfectly clean.

Check fuel lines with air under water for leakages; replace if leaks are found.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Check non-return valve for leaks and correct opening pressure; if leaks are found or opening pressure is incorrect, replace non-return valve.

Note: The opening pressure (in bar) and flow direction (arrow) are indicated on the non-return valve housing.

Check threads of union nuts and single-ended unions for ease of movement; recondition or replace part as required.

Check fuel line fixtures for damage and wear; replace components as necessary.

Replace clamps and grommets as part of every W6 overhaul.

Replace sealing rings as part of every assembly.

Hand pump and pump housing

Clean all parts.

Visually inspect components for damage and wear; replace components as necessary.

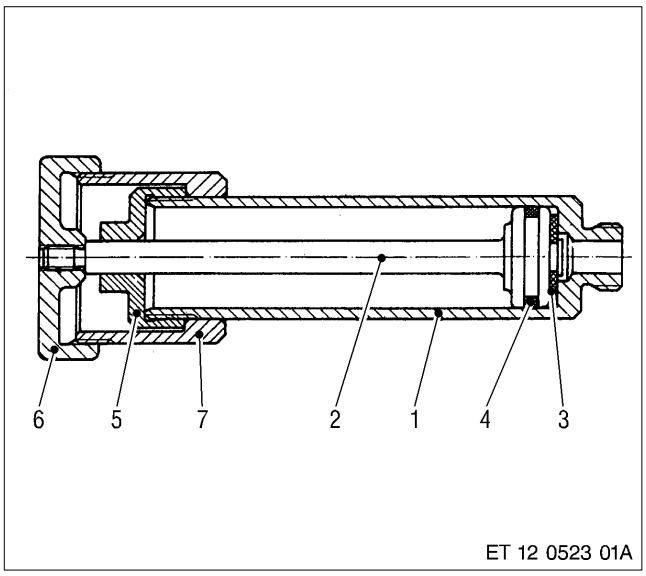
Check all mating, sealing and sliding surfaces for wear; rub down or smooth with emery cloth or replace components as necessary.

Check condition of threads; rechase as necessary.

Replace gasket, sealing rings and O-ring at every assembly.

C 082.05.10 Assembly

Note: Make sure fuel-carrying components are perfectly clean.



Assembling hand pump

Fit O-ring (4) and gasket (3) on plunger rod (2).

Coat O-ring with petroleum jelly.

Install piston rod in housing (1).

Push sleeve (7) over housing.

Screw cover (5) to housing.

Clean and degrease thread of piston rod and handle (6).

Coat thread of plunger rod with thread-locking liquid and screw on handle hand-tight.

Note: Ensure correct final strength of thread-locking agent – see C 080!

Check operation of hand pump.

Assemble handle and sleeve.

C 082.05.11 Installation

Installing fuel lines and hand pump

Note: Prior to installation, remove all blanking plugs.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow fuel lines clear with compressed air.

Make sure fuel-carrying components are perfectly clean.

Install fuel lines, hand pump, non-return valve and fixtures tension-free as per overview drawing (see C 082.05.01), or as shown in photo or in accordance with markings.

Note flow direction of non-return valve (arrow on housing).

Note: After engine start, visually inspect fuel system for leaks.

C 082.05.12 After-Installation Operations

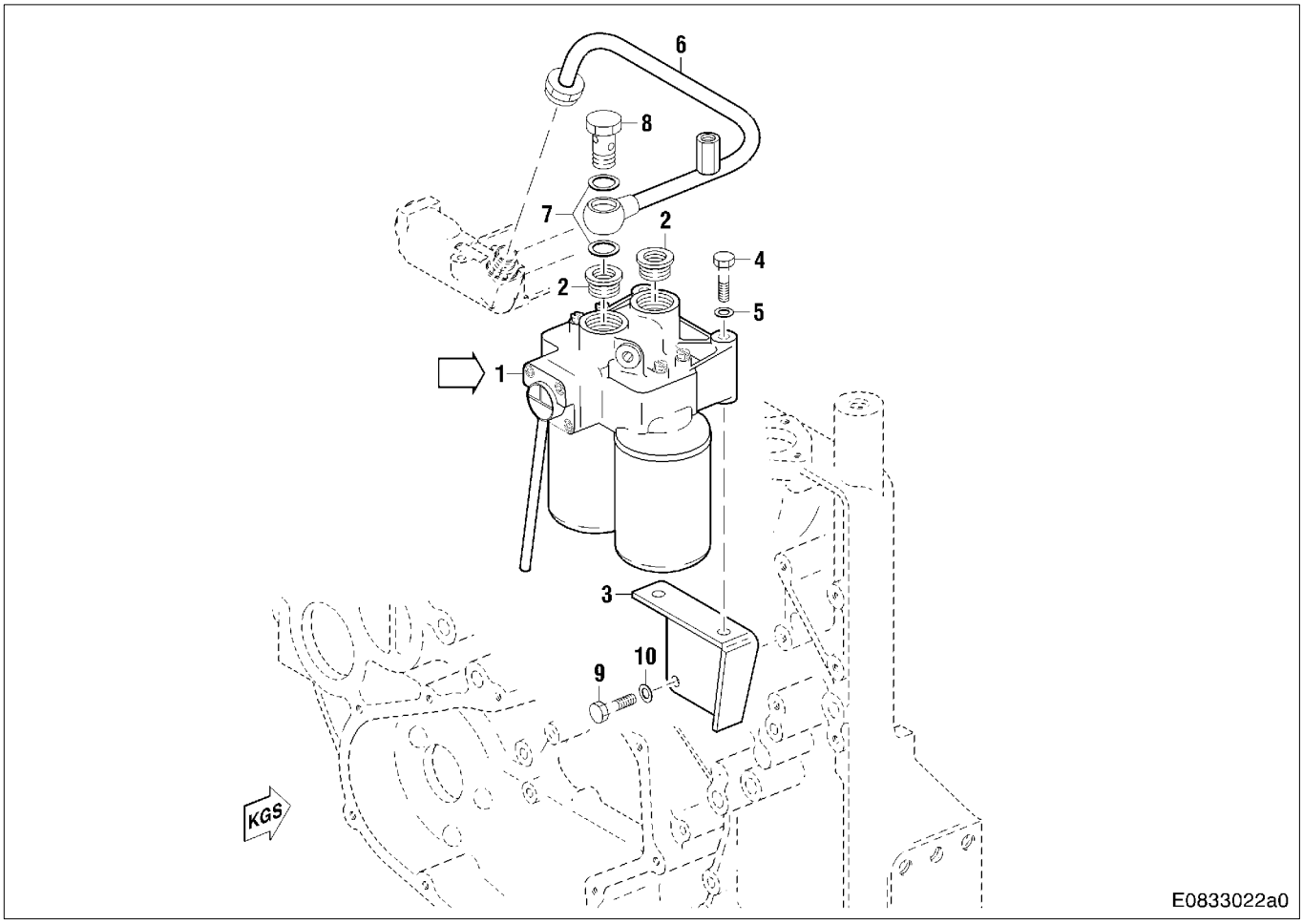
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

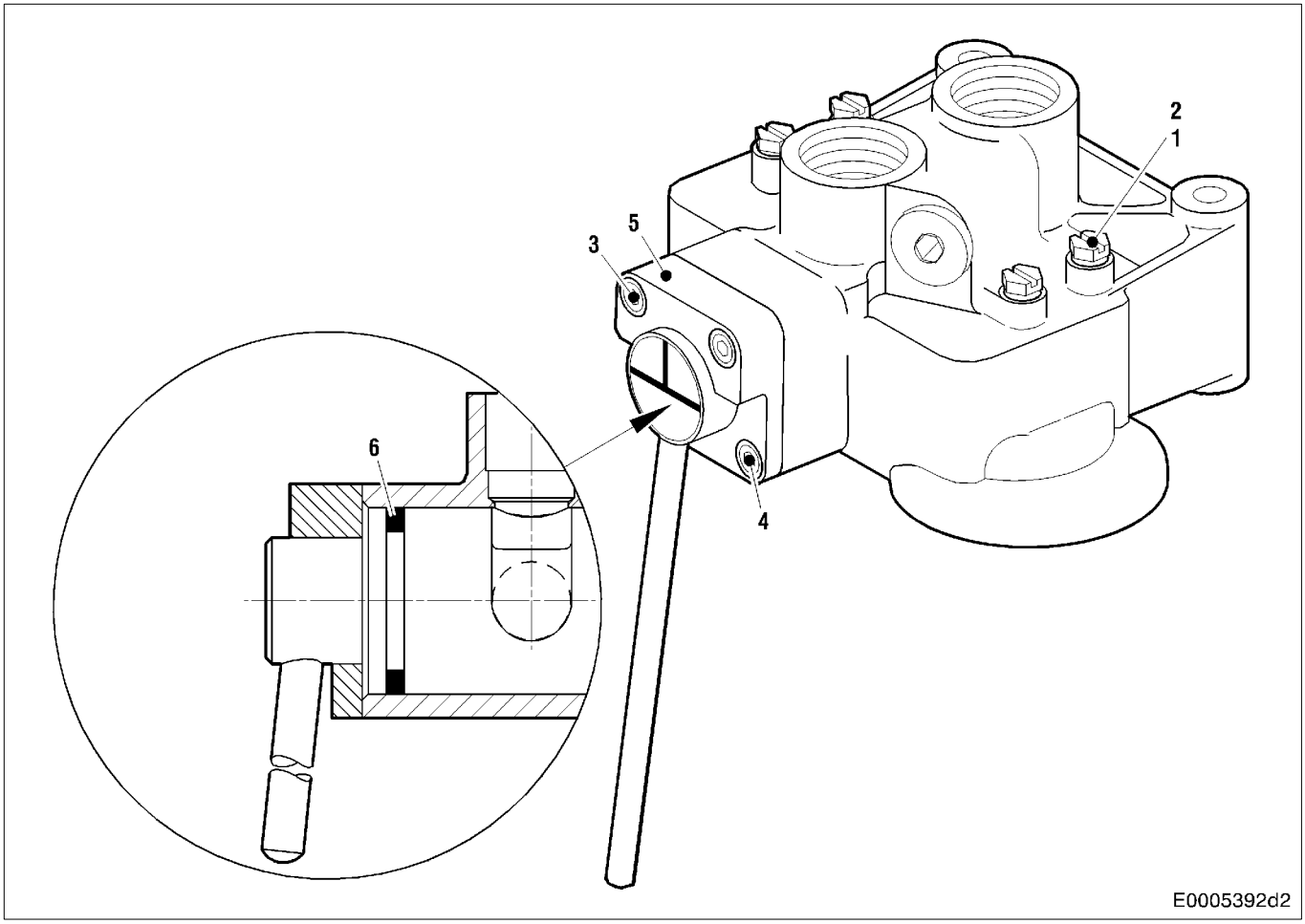
C 083.05 Fuel Filter

C 083.05.01 Overview Drawing



1 Fuel filter
2 Threaded bush
3 Bracket
4 Hex screw
5 Washer
6 Fuel line
7 Sealing ring
8 Banjo screw
9 Hex screw
10 Washer

Fuel filter head



1 Vent plug
2 Sealing ring
3 Screw
4 Screw
5 Cover
6 Sealing ring

C 083.05.02 Special Tools

Designation – Application	Number
Strap wrench for fuel filter	1

C 083.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Disconnect fuel lines	C 082.05

C 083.05.05 Removal

Removing fuel duplex filter

⚠ WARNING

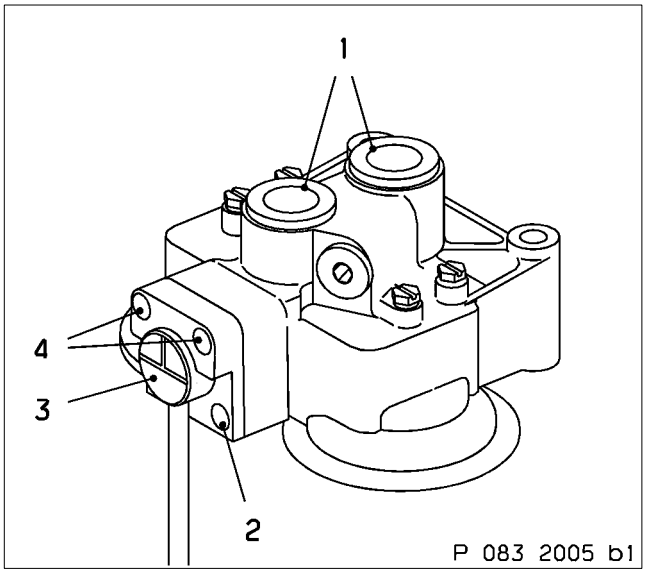
Fuels and fuel mists are flammable and poisonous. Risk of fire, explosions and poisoning! When using fuel:
– do not use naked flame
– no electric sparks
– do not smoke
– do not spill fuel Do not inhale.
Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Remove filter inserts using a strap wrench (arrow) and dispose of in accordance with local regulations.

Note: Collect run-off fuel!

Remove filter head and carrier as per overview drawing – see C 083.05.01.

C 083.05.06 Disassembly



Disassembling filter head

Remove all vent plugs.

Remove sealing rings.

Remove short socket-head screws (2) and long socket-head screws (4).

Remove changeover valve (3) with cover from filter head.

Remove O-rings from changeover valve.

Note: Remove threaded bushes (1) only if necessary (e.g. damaged).
Threaded bush is inserted with pipe-thread sealant and must be heated to approx. 200 °C before removal.

C 083.05.08 Inspection and Repair

Note: Make sure fuel-carrying components are perfectly clean.

Replace filter inserts.

Clean all components with cleaner; visually inspect for damage and check condition; replace component as necessary.

Brush off corrosion stains or water stains in filter head and changeover valve.

Check bore for changeover valve in filter head for wear and pitting.

Remove minor wear and pitting by polishing with emery cloth; replace filter head if necessary.

CAUTION

Compressed air is air pressurised by overpressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out filter head with compressed air and make sure they are perfectly clean.

If necessary, pressure-test fuel duplex filter with air in water bath for leaks.

Note: Install filter inserts before carrying out leak check.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

WARNING

Compressed air is air pressurised by overpressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Test pressure: 0.5 bar

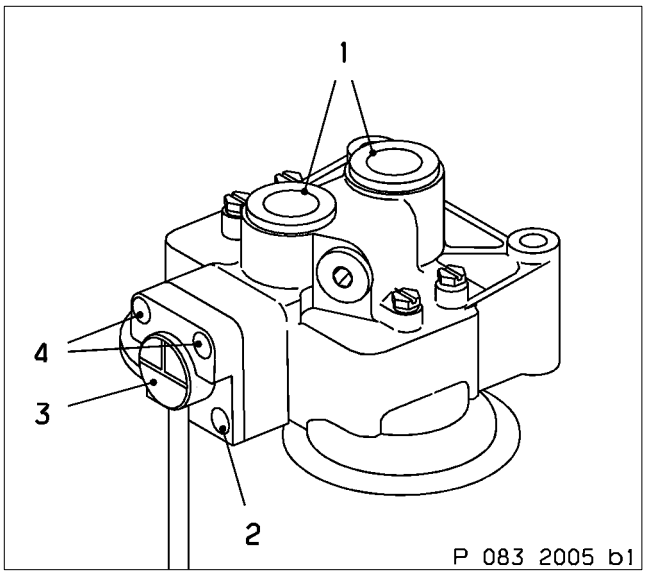
In event of leaks, replace blanking plug or replace filter head.

Check sealing and mating faces for damage and defects; rub down with an oilstone or replace parts if necessary.

Check condition of threads; machine or replace components as necessary.

Replace O-rings and sealing rings at every assembly.

C 083.05.10 Assembly



Assembling filter head

Note: Make sure all fuel-carrying components are perfectly clean.

Clean and degrease thread in filter head and male thread of threaded bushes (1).

Coat male thread of threaded bushes with pipe-thread sealant.

Insert and tighten threaded bushes in filter head.

Note: Ensure correct final strength of pipe-thread sealant – see C 080!

Coat O-rings with engine oil and insert into grooves on changeover valve (3).

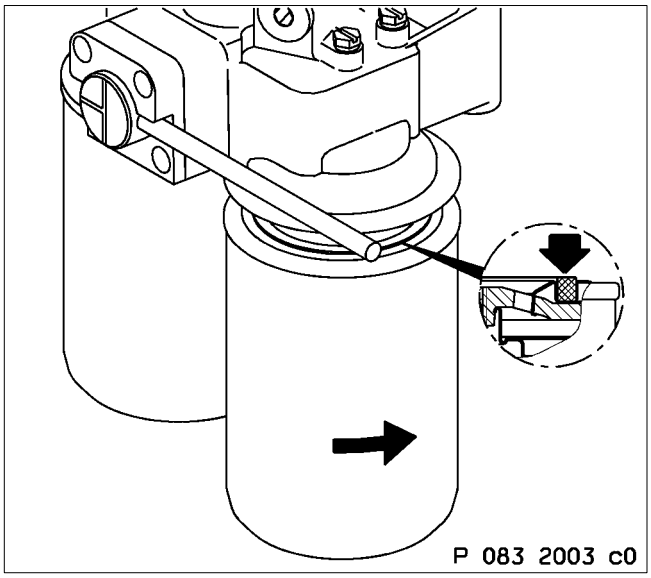
Insert changeover valve with cover into filter head.

Check condition of changeover valve in filter head.

Insert short socket-head screws (2) and long socket-head screws (4) and tighten in diagonally opposite sequence.

Insert all vent plugs and sealing rings.

C 083.05.11 Installation



Installing fuel duplex filter

Note: Make sure all fuel-carrying components are perfectly clean.

Install filter head and carrier as per overview drawing – see C 083.05.01.

⚠ WARNING

Fuels and fuel mists are flammable and poisonous. Risk of fire, explosions and poisoning!
When using fuel:
– do not use naked flame
– no electric sparks
– do not smoke
– do not spill fuel Do not inhale.
Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Fill filter elements with clean fuel.

Coat sealing ring of filter elements with fuel.

Note: Do not use any tool to attach filter element!

Attach filter elements and tighten manually.

Note: After test run, check fuel filter for leaks; re-tighten as necessary.

C 083.05.12 After-Installation Operations

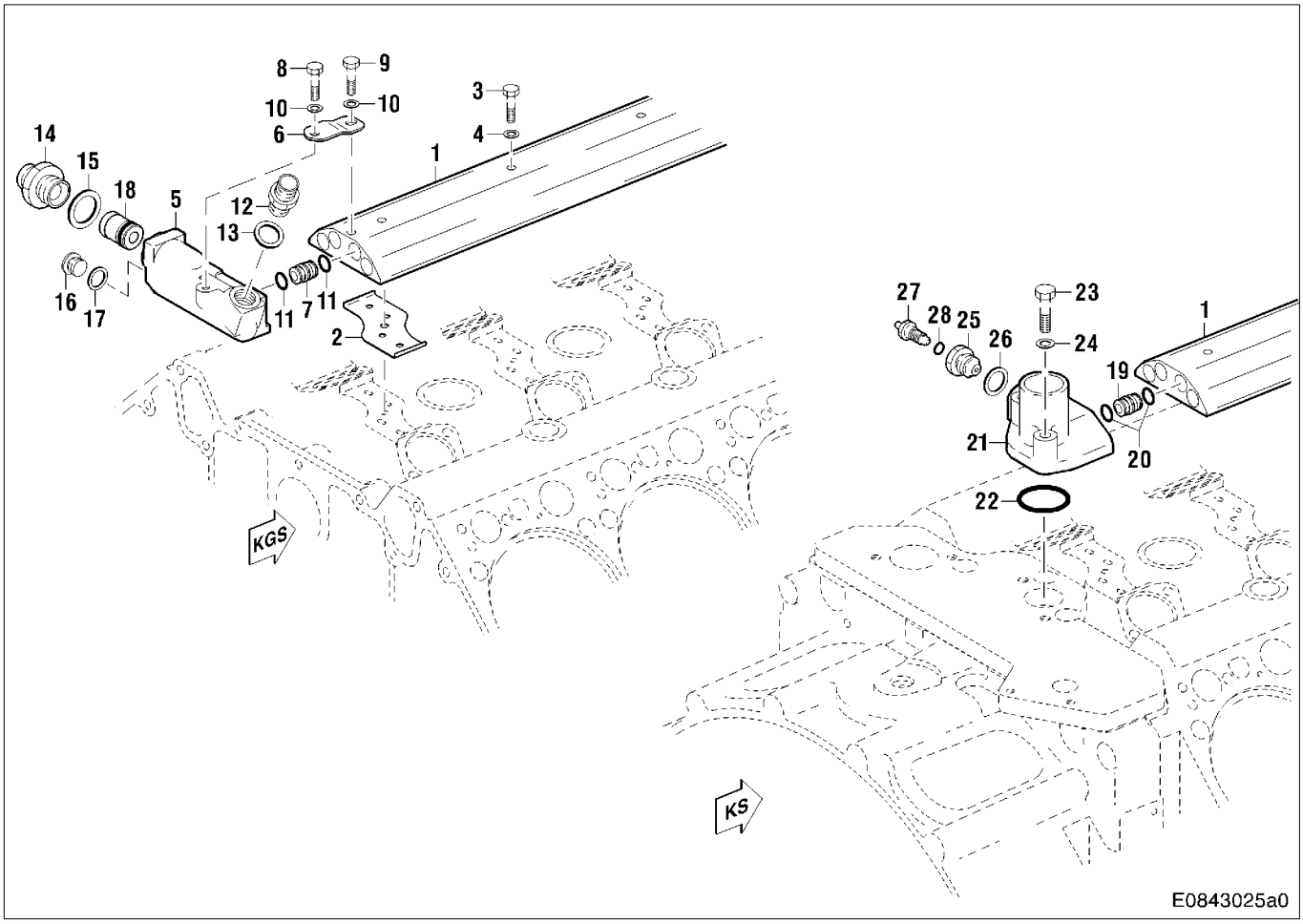
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install fuel lines	C 082.05
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 084.05 Fuel Line from Filter to Injection Pump

C 084.05.01 Overview Drawing



1 Fuel line
2 Gasket
3 Hex screw
4 Washer
5 Connector
6 Bracket
7 Plug-in pipe
8 Hex screw
9 Hex screw
10 Washer
11 O-rIng
12 Adapter
13 Sealing ring
14 Reduction union
15 Sealing ring
16 Plug
17 Sealing ring
18 Pressure relief valve
19 Plug-in pipe
20 O-rIng
21 End piece
22 O-rIng
23 Hex screw
24 Washer
25 Threaded bush
26 Sealing ring
27 Nipple
28 O-rIng

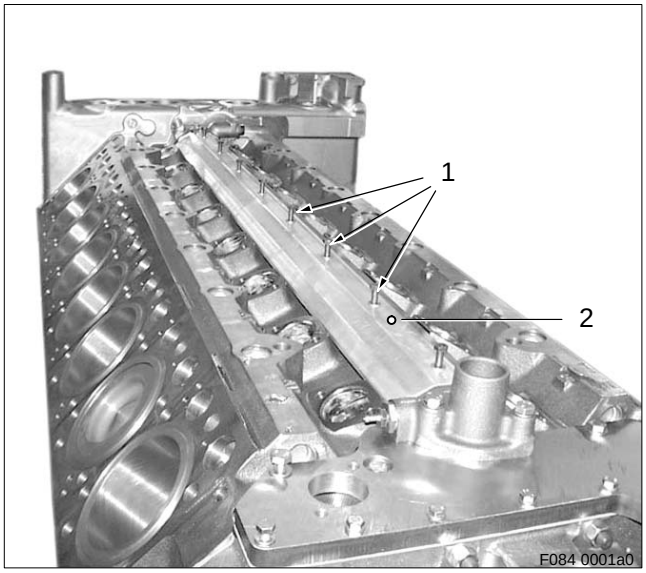
084.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Drain fuel from fuel guide rail, driving end (blow out if necessary)	Operating Instructions
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Remove fuel line	C 083.05
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove cover	C 114.05
–	x	x	Remove charge air manifolds	C 124.05
–	x	x	Remove injection pumps on engine side	C 073.05

C 084.05.05 Removal



Removing fuel line (fuel guide rail) and connector

⚠ CAUTION

Fuels and fuel vapours are inflammable and poisonous.
Risk of fire, explosions and poisoning!
When handling fuel:
– No open flame
– No electric sparks
– Do not smoke
– Do not spill fuel
– Do not inhale
Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Release fuel line threaded connection and catch fuel emerging in a suitable container.

Remove hex screws (1) and remove fuel distribution rail (2) from crankcase.

Remove connector, plug-in pipes, end piece and blanking plug from fuel line rail – see overview drawing C 084.05.01.

Remove all sealing ring, gaskets and O-rings.

Cover all connections with suitable plugs.

C 084.05.08 Inspection and Repair

Note: Make sure fuel-carrying components are perfectly clean.

Clean all components with cleaner and visually inspect for condition and damage; replace component as necessary.

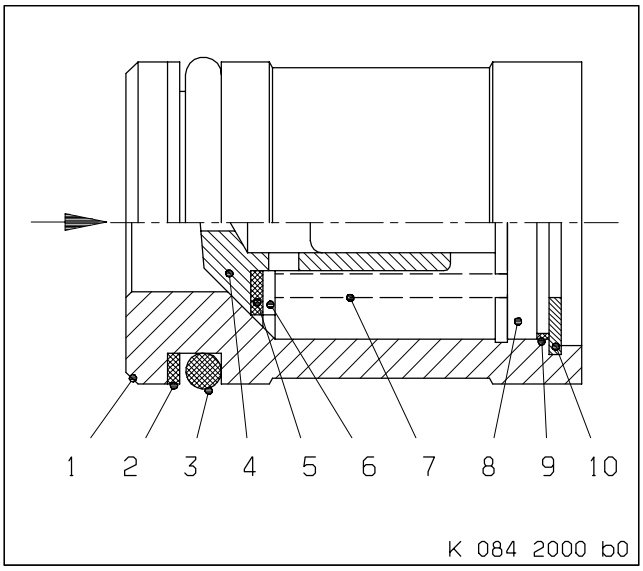
Check condition of threads of union nut and adapter.

Check that sealing cone on nipple is in perfect condition; replace component if necessary.

Replace unions, threaded bushes and blanking plugs as required.

Check sealing and bolt-on faces for wear and damage; smooth with oilstone or emery cloth.

Replace all sealing rings, gaskets and O-rings.



Checking pressure relief valve

1 Housing
2 Support ring
3 O-rIng
4 Valve
5 Sealing washer
6 Washer
7 Compression spring
8 Valve guide
9 Ring
10 Circlip

Make visible inspection of pressure relief valve for wear and damage; replace if necessary.

Check opening pressure of pressure relief valve, observe flow direction (arrow).

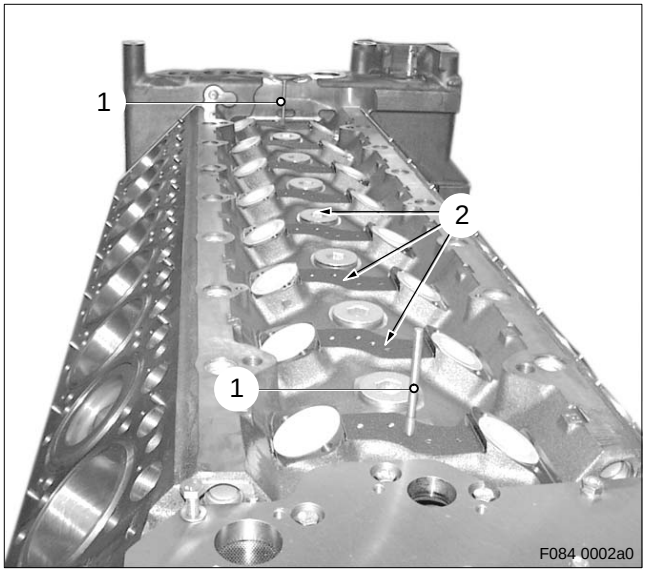
⚠ CAUTION

**Compressed air is highly pressurized.
Risk of injury!
Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.**

Opening pressure: 8.5 bar ± 1 bar

If opening pressure cannot be reached, replace pressure relief valve.

C 084.05.11 Installation



Completing and installing fuel line (fuel guide rail)

Note: Remove all blanking plugs before installation. Make sure fuel-carrying components are perfectly clean.

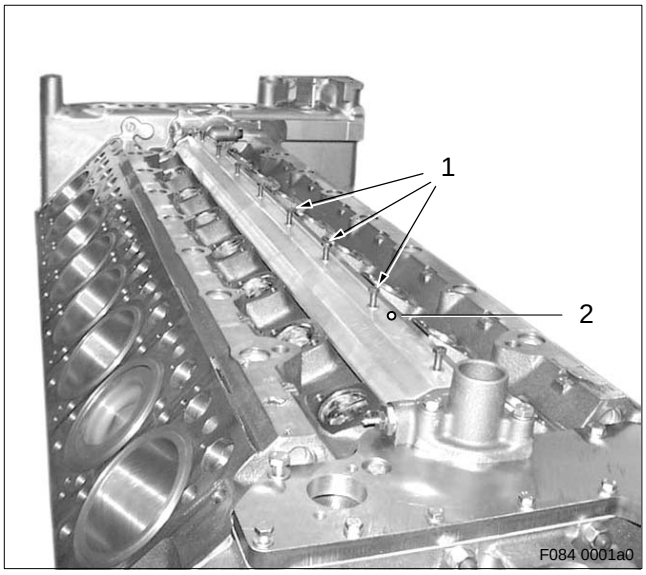
⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
Pressure must not exceed 3.0 bar.

Blow out fuel bores in crankcase and in fuel distribution rail with compressed air, ensure they are perfectly clean and not obstructed.

Fit gaskets (2) on crankcase.

Insert two suitable guide pins (1) into crankcase.



Positioning correctly, insert pressure relief valve with O-ring as shown in overview drawing (see C 084.05.01) into connector.

Coat new O-rings with petroleum jelly and fit onto plug-in pipes and into end piece as shown in overview drawing – see C 084.05.01.

Complete fuel guide rail with plug-in pipes, connector and end piece as shown in overview drawing.

Fit fuel distribution rail (2) via guide pins on gaskets and tighten evenly with hex screws (1) and washers.

Note: After engine start, visually inspect fuel system for leaks.

C 084.05.12 After-Installation Operations

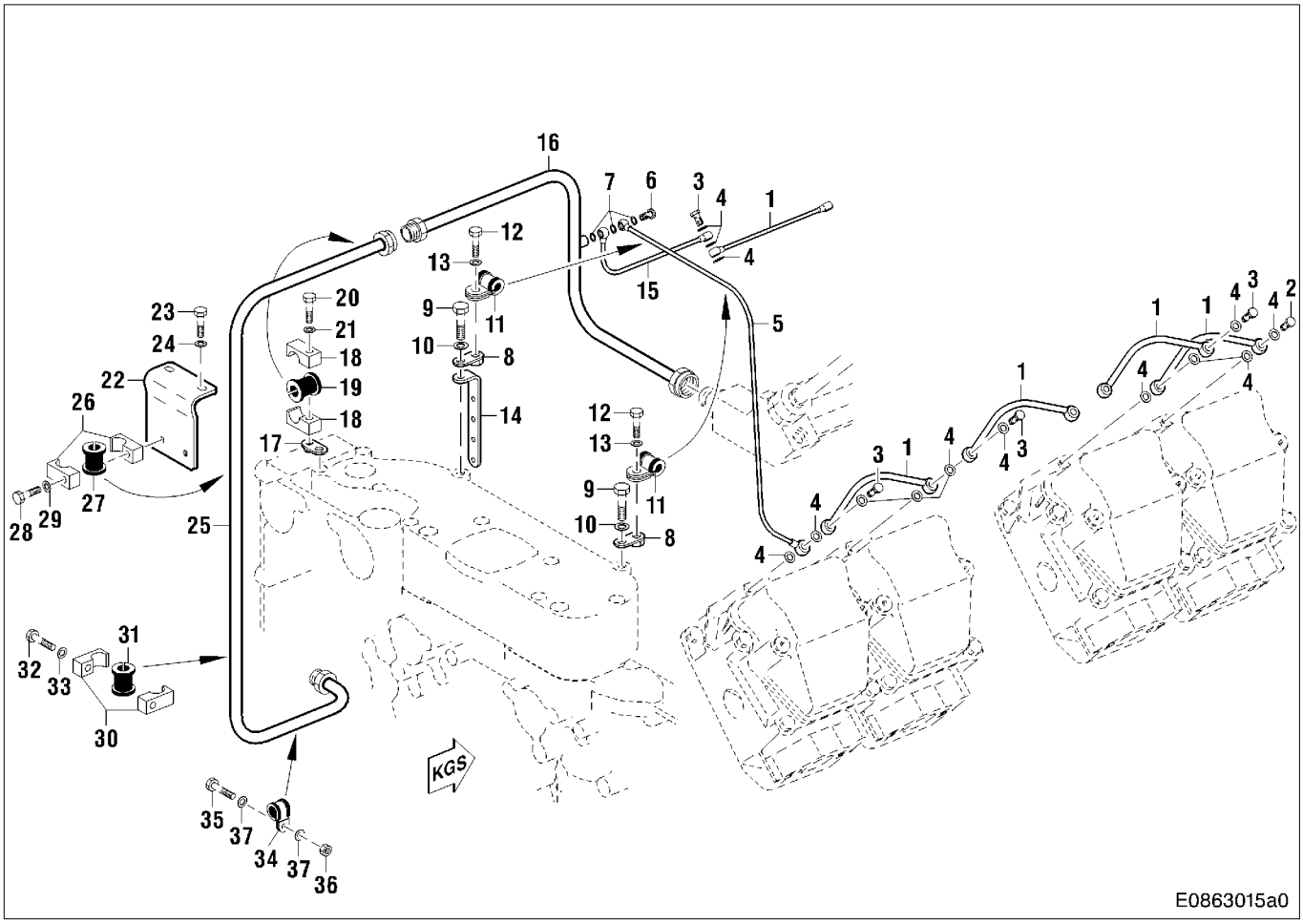
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install fuel injection pump	C 073.05
–	x	x	Install fuel line	C 083.05
–	x	x	Install charge air manifolds	C 124.05
–	x	x	Install cover	C 114.05
–	x	x	Install crankcase breather	C 018.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Connect vent lines	C 202.65
–	x	x	Install charge air lines	C 125.05
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 086.05 Leak-off Fuel Line

C 086.05.01 Overview Drawing



1	Fuel line	11	Clamp	20	Hex screw	29	Washer
2	Banjo screw	12	Hex screw	21	Washer	30	Pipe clamp half
3	Banjo screw	13	Washer	22	Bracket	31	Grommet
4	Sealing ring	14	Bracket	23	Hex screw	32	Hex screw
5	Fuel line	15	Fuel line	24	Washer	33	Washer
6	Banjo screw	16	Fuel line	25	Fuel line	34	Clamp
7	Sealing ring	17	Bracket	26	Pipe clamp half	35	Hex screw
8	Bracket	18	Pipe clamp half	27	Grommet	36	Hex nut
9	Hex screw	19	Grommet	28	Hex screw	37	Washer
10	Washer						

C 086.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 086.05.05 Removal

Disconnecting leak-off fuel lines

Note: Before removing fuel lines, it is advisable to take photographs of the lines on the engine or to mark the fuel lines with metal tabs to facilitate reinstallation.

WARNING

Fuels and fuel mists are flammable and poisonous. Risk of fire, explosions and poisoning! When using fuel: – do not use naked flame, – no electric sparks, – do not smoke, – do not spill fuel, – do not inhale. Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

Release banjo screws on fuel lines and catch fuel emerging.

Remove fuel line in accordance with Overview Drawing– see C 086.05.01.

Remove sealing rings.

After removing lines, seal all open connections by installing suitable plugs.

C 086.05.08 Inspection and Repair

Note: Make sure fuel-carrying components are perfectly clean.

Clean all components with “cleaner”; visually inspect for damage and check condition; replace component as necessary.

If necessary, pressure-test fuel lines in air in water bath for leaks; replace if necessary.

WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Check condition of sealing surfaces of connecting elements and of banjo screws; check thread for ease of movement; replace components as necessary.

Replace sealing rings as part of every assembly.

Replace clamps and grommets as part of every W6 overhaul.

C 086.05.11 Installation

Connecting leak-off fuel lines

Note: Prior to installation, remove all blanking plugs.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out leak-off fuel lines with compressed air and make sure they are perfectly clean.

Ensure fuel bores and sealing surfaces on cylinder heads are perfectly clean; clean if necessary.

Install leak-off fuel lines tension-free with banjo screws, new sealing rings and fixtures as per overview drawing (see C 086.05.01), or photos or markings.

Note: After engine start, visually inspect fuel system for leaks.

C 086.05.12 After-Installation Operations

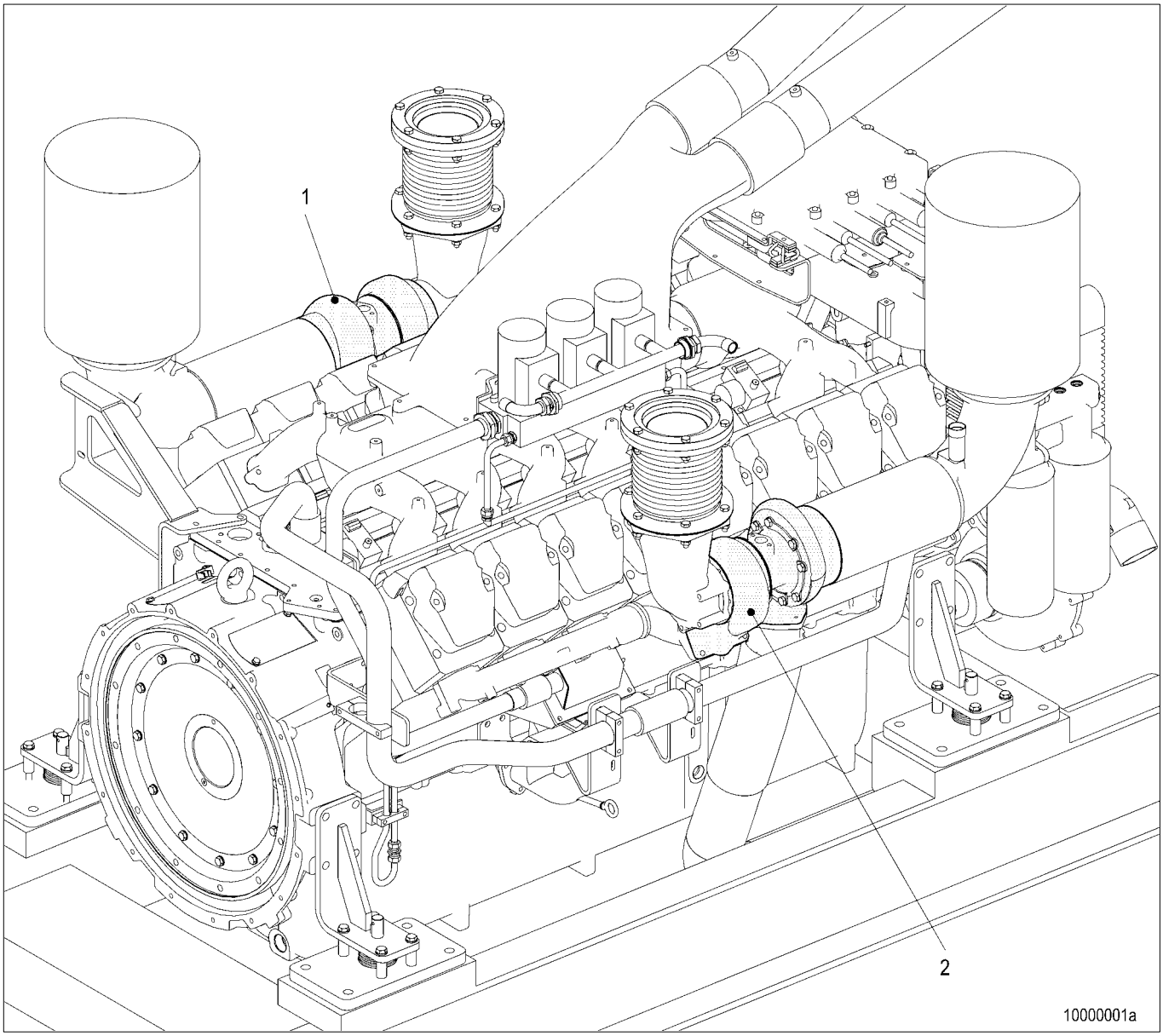
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	see
x	–	–	Perform operations as per Assembly Plan	B 005
x	x	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 100 Exhaust Turbocharger



1 Exhaust turbocharger
2 Exhaust turbocharger

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

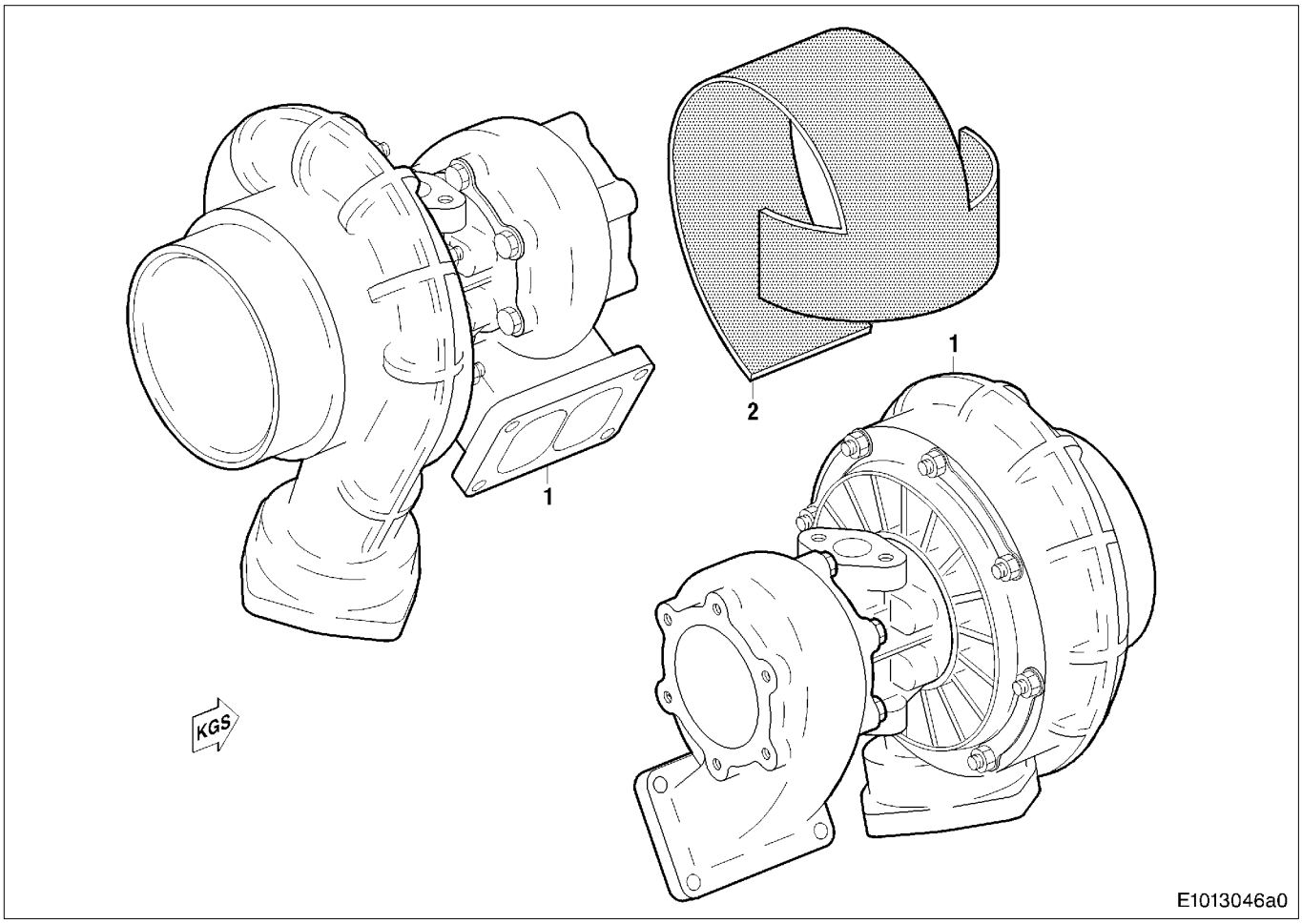
When using these chemical substances, it is essential to observe the Manufacturer's Instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Cleaning agent (carbon-deposit remover)	Meister Proper	40377	
Cleaning agent	Solvclean KW	40022	
Denaturated ethanol		40250	
Sealing paste	Elastosil N 189	50545	
Joints 40	Loctite 640	40105	Final strength at 20 °C ≈ 24 h
Screw locking varnish	RAL 4001 red/purple	40664	
Assembly paste	Ultra-Therm	50547	
Vaseline	Petroleum jelly, white	40317	
Corrosion inhibitor	Caramba Express	40008	
Engine oil			
Kerosene or diesel fuel			
Dry compressed air			
Synthetic shot-blasting pellets	Dry Strip Type 216/20	20098	
Engineer's blue	blue	40641	
Surface crack-testing equipment with red penetrant dye			

C 101.01 Exhaust Turbocharger

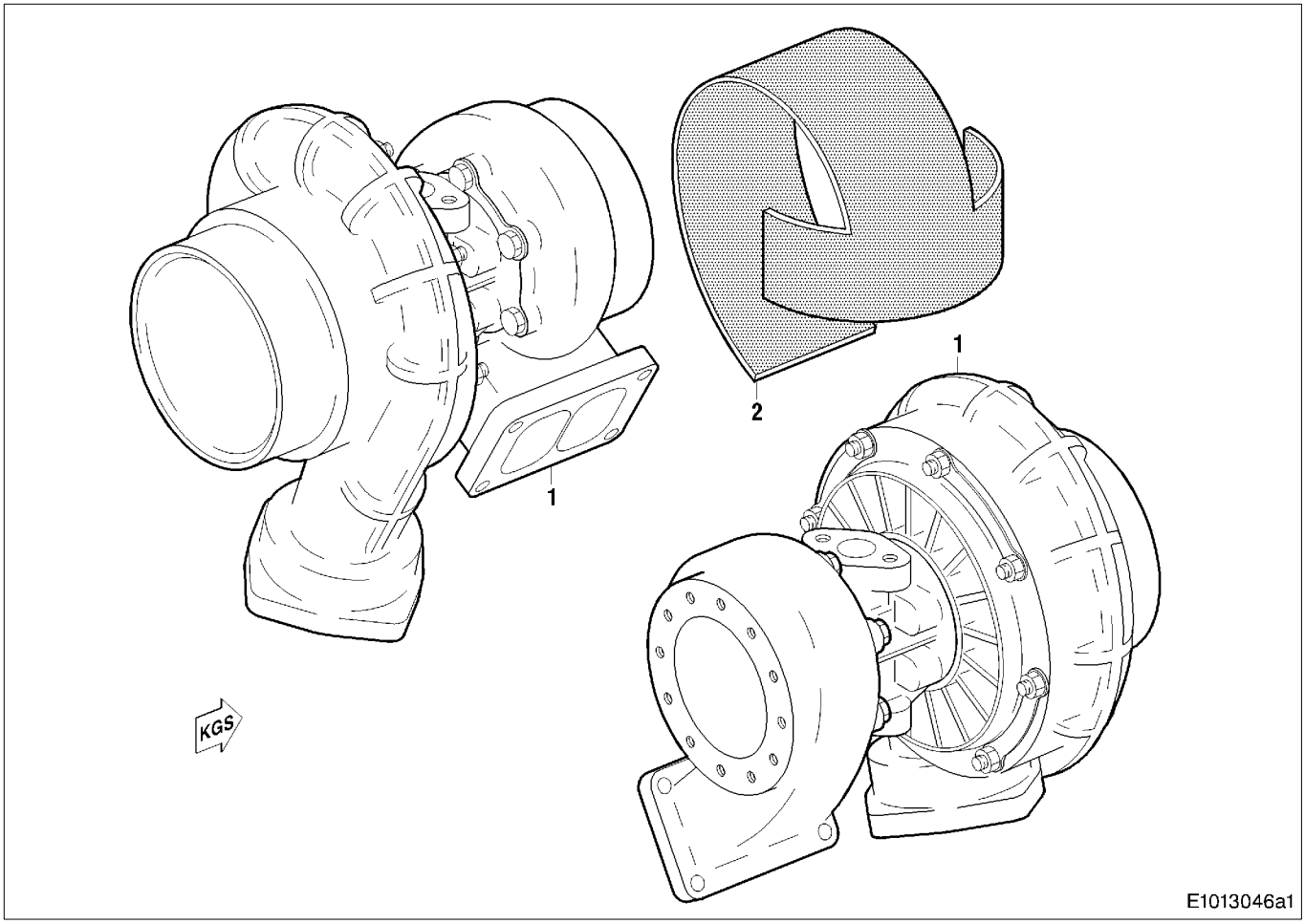
C 101.01.01 Overview Drawing

Exhaust turbocharger, 12V

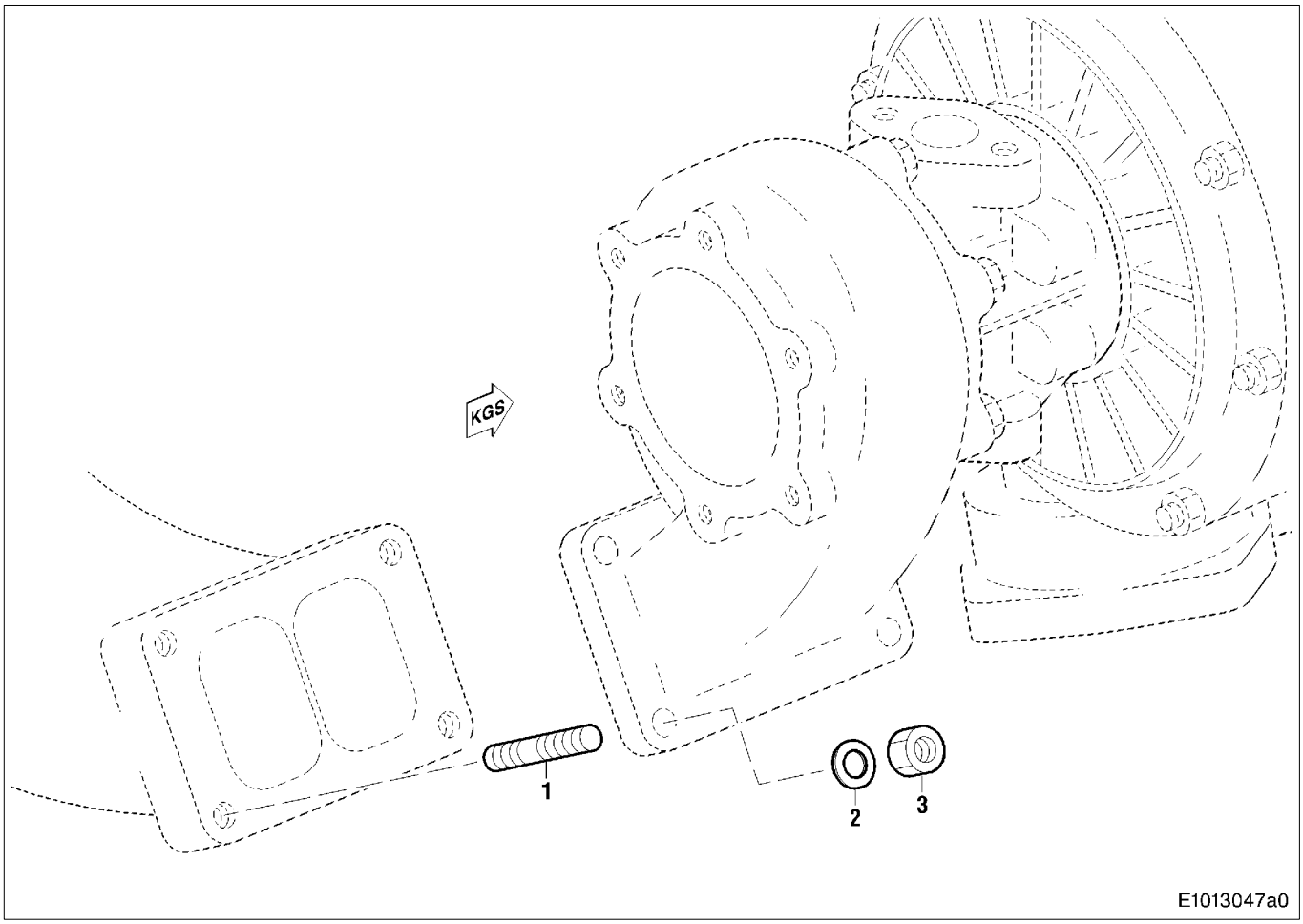


1 Exhaust turbocharger K36
2 Insulation

Exhaust turbocharger, 16V

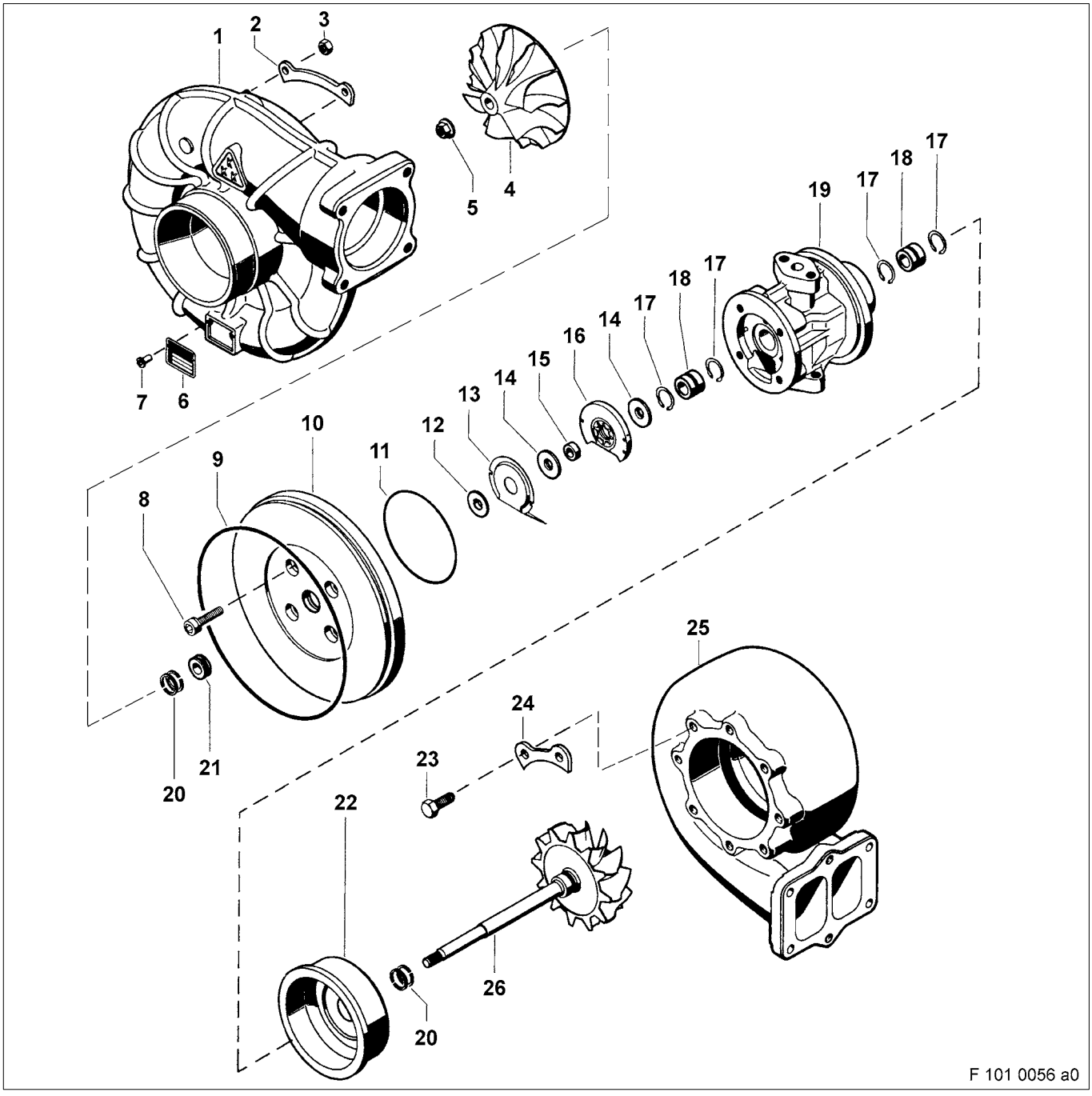


1 Exhaust turbocharger K37
2 Insulation



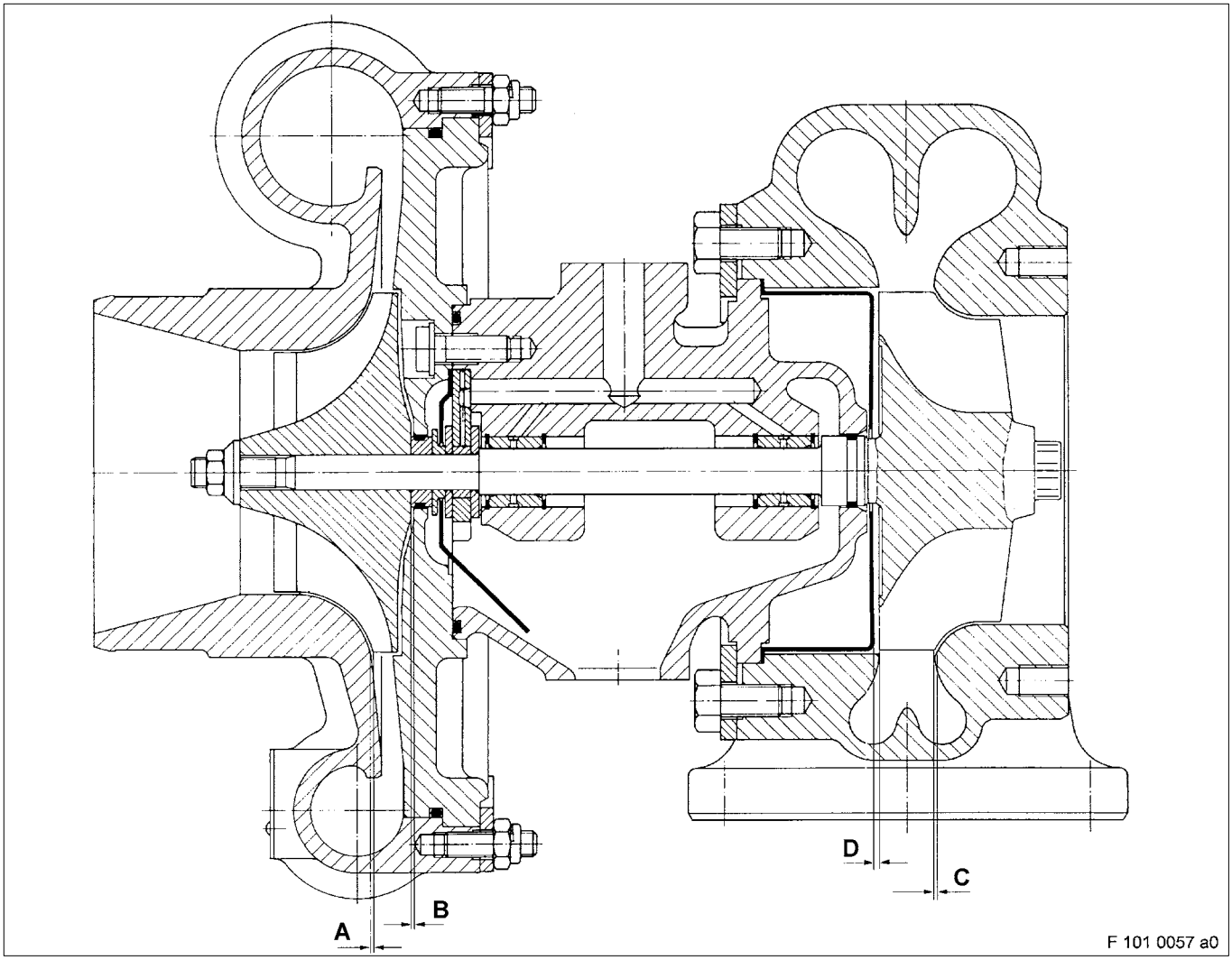
1 Stud
2 Washer
3 Hex nut

Exhaust turbocharger K36, K37



1 Compressor housing
2 Compressor housing clamping segment
3 Hex nut, self-locking
Tightening torque: 15 Nm
4 Compressor wheel
5 Shaft nut
Tightening torque: 10 Nm
Angle of further rotation: 70° – 5°
6 Nameplate
7 Blind rivet
8 Socket-head screw and washer
Securing agent: Loctite 640
Tightening torque: 28 Nm
9 O-ring
10 Rear wall
11 O-ring
12 Oil deflector
13 Oil deflector
14 Bearing collar
15 Bush
16 Thrust bearing disc
17 Snap ring
18 Bearing bush
19 Bearing housing
20 Piston rings
21 Sealing bush
22 Heat shield
23 Hex screw
Lubricant: Assembly paste
Tightening torque: 40 Nm
24 Turbine housing clamping segment
25 Turbine housing
26 Rotor

Exhaust turbocharger K36, K37



Permissible contour gap for K36

Gap dimensions (in mm)		**min.**	**max.**
A	Compressor wheel contour	0.35	0.8
B	Compressor wheel back	–	–
C	Turbine wheel contour	0.62	1.06
D	Turbine wheel back	0.8	1.2
–	Axial clearance	0.08	0.135

Permissible contour gap for K37

Gap dimensions (in mm)		**min.**	**max.**
A	Compressor wheel contour	0.35	0.8
B	Compressor wheel back	0.8	1.1
C	Turbine wheel contour	0.55	1.13
D	Turbine wheel back	0.9	1.3
–	Axial clearance	0.08	0.135

C 101.01.02 Special Tools

Designation – Application	Number
Assembly jaws for vice	2
Circlip pliers	1
Torque wrench, double-arm	1
Angle-of-rotation measuring tool	1
Screwdriver bit, M8 Ribe	1

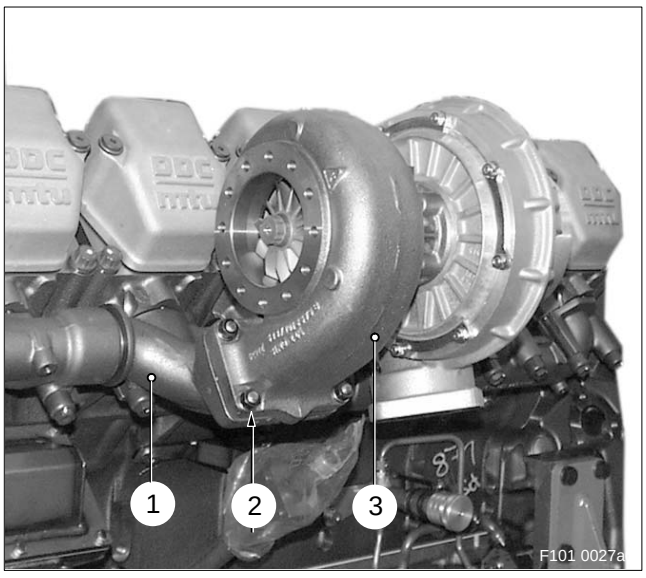
C 101.01.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove air system before exhaust turbocharger	C 123.05
–	x	x	Remove air system after exhaust turbocharger	C125.05
–	x	x	Remove exhaust system after exhaust turbocharger	–
–	x	x	Remove oil supply lines	C 185.10
–	x	x	Remove oil return lines	C 185.25

C 101.01.05 Removal



Removing exhaust turbocharger

Remove nuts (2) and washers for exhaust turbocharger from exhaust elbow (1).

Remove exhaust turbocharger from exhaust elbow.

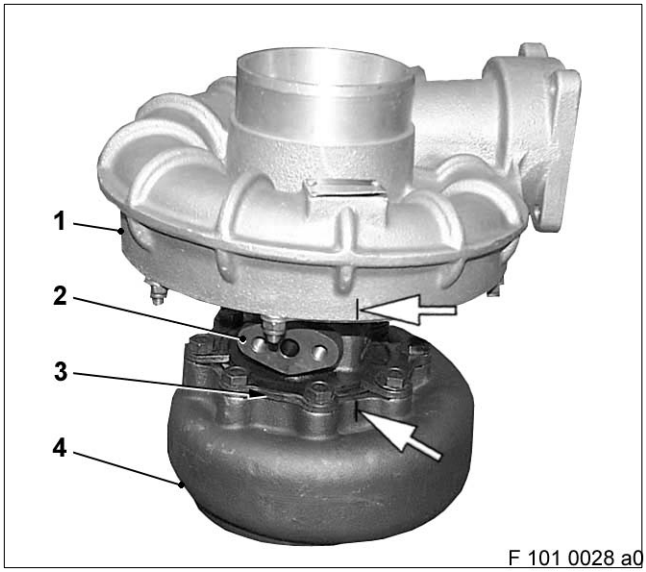
Seal openings (air, exhaust, oil supply, oil return) on turbocharger and exhaust elbow with suitable plugs or covers.

Note: Replace studs each time turbocharger is removed.

To remove studs, fit two nuts on stud to be removed and lock.

Unscrew stud with open-end wrench.

C 101.01.06 Disassembly



Disassembling exhaust turbocharger

Mark position of compressor housing (1), turbine housing (4) and compressor rear wall with regard to bearing housing (2) (arrows).

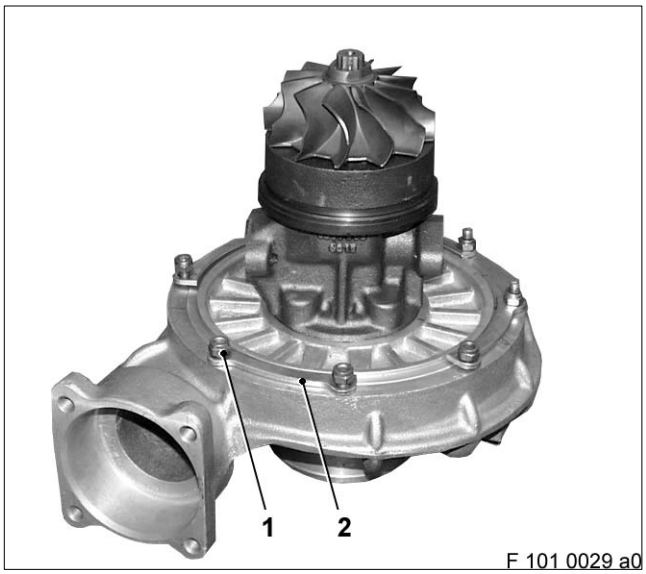
Clamp turbine housing at gas inlet flange (use protective jaws).

Remove clamping segments (3) from turbine housing.

Important: When removing turbine housing, hold level to avoid risk of damaging the blades.

Carefully remove turbine housing from bearing housing.

Note: If turbine housing cannot be released, use derusting agent and, if necessary, use a copper hammer.

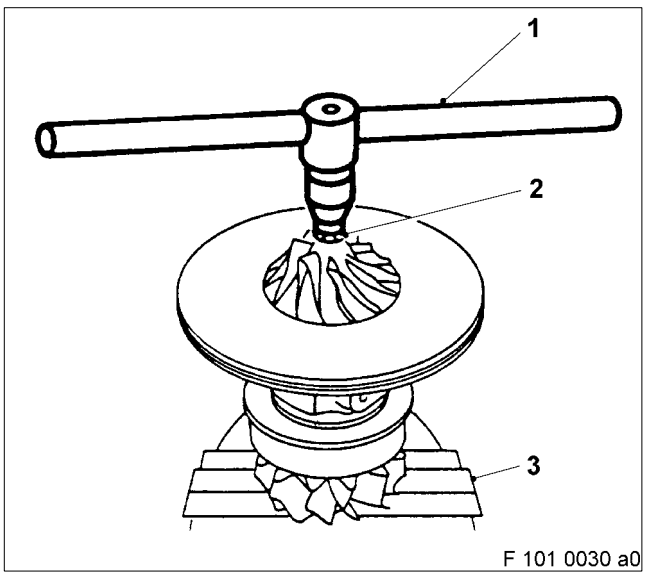


Unscrew hex nuts (1) and remove clamping segments (2) from compressor housing.

Important: When removing compressor housing, hold level to avoid risk of damaging the blades.

Carefully remove compressor housing from bearing housing.

Note: If housing won't move, use rubber mallet.

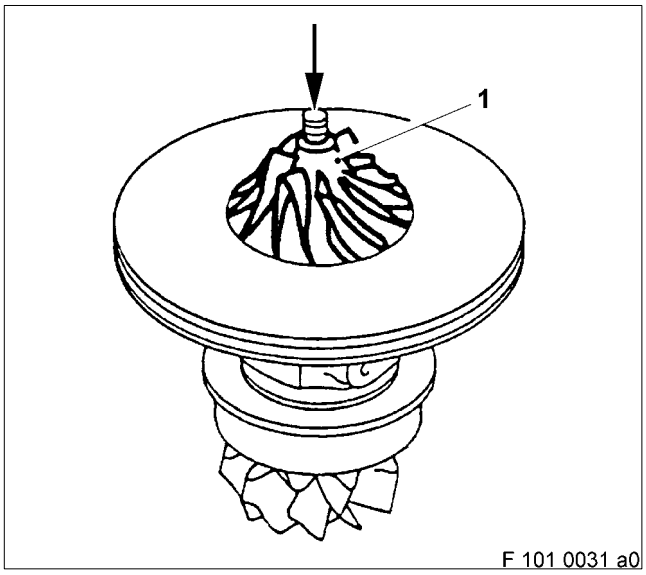


Clamp rotor at hub in special vice jaws (3).

Important: Left-hand thread!

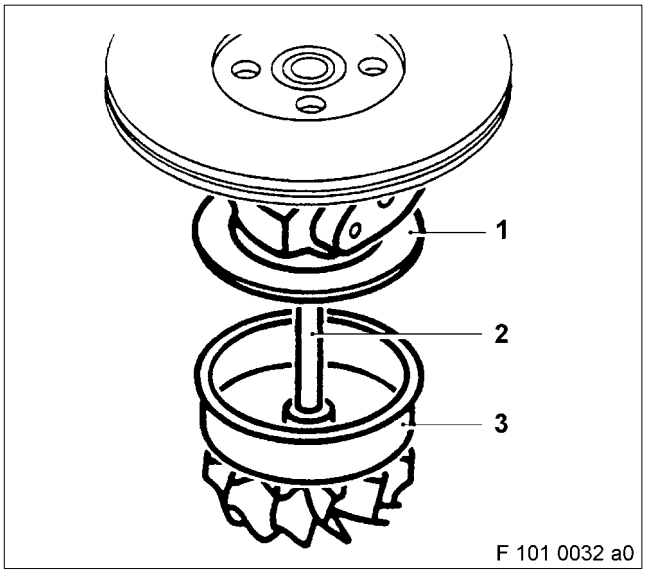
Unscrew self-locking nut (2) with two-armed wrench (1).

Note: In order not to deform the rotor shaft, release nut only with two-armed wrench.



Withdraw compressor wheel (1) from compressor shaft, if necessary press out rotor with a manual press (arrow).

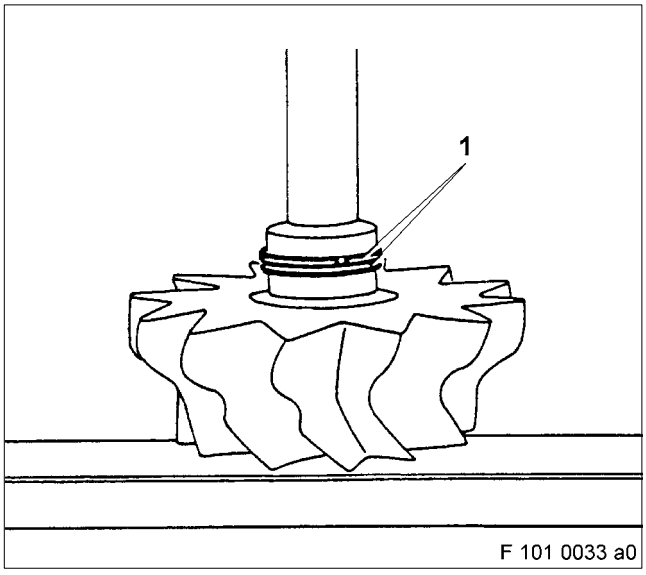
Note: Protect thread of shaft with brass bush.



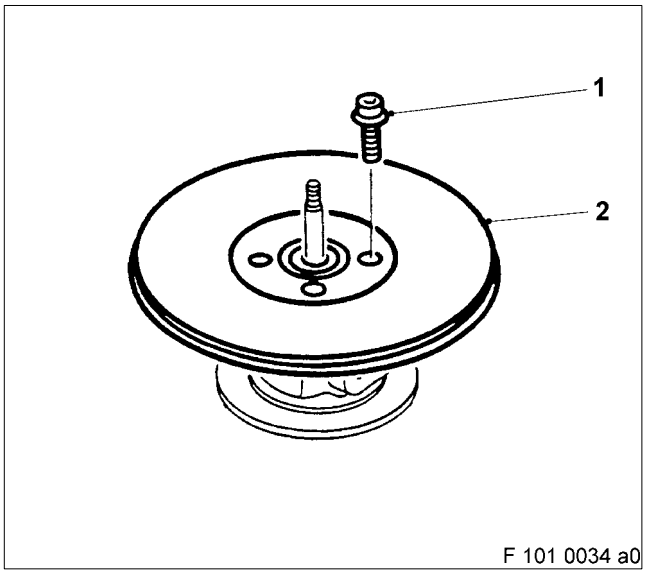
Carefully withdraw rotor shaft (2) out of bearing housing (1).

Centre heat shield (3) and remove from rotor shaft.

Note: Take care not to damage piston rings on rotor shaft.



Use pliers to remove piston rings (1) from rotor shaft.

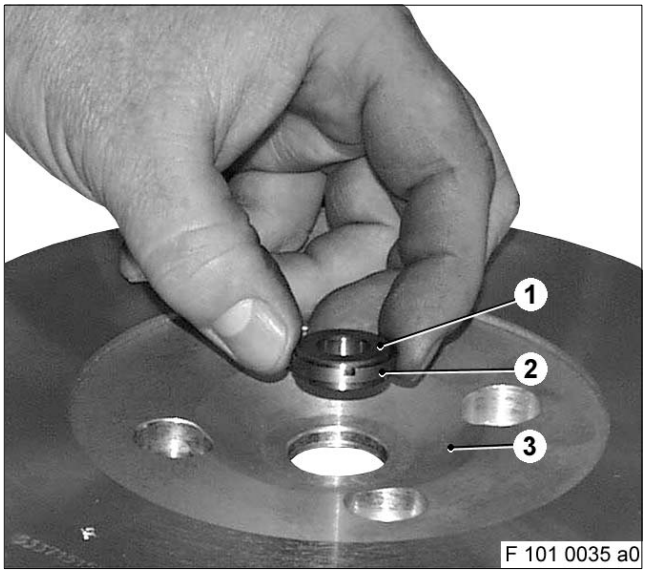


Clamp bearing housing between oil supply flange and oil drain flange in vice (use protective jaws).

Remove hexagon socket screws (1).

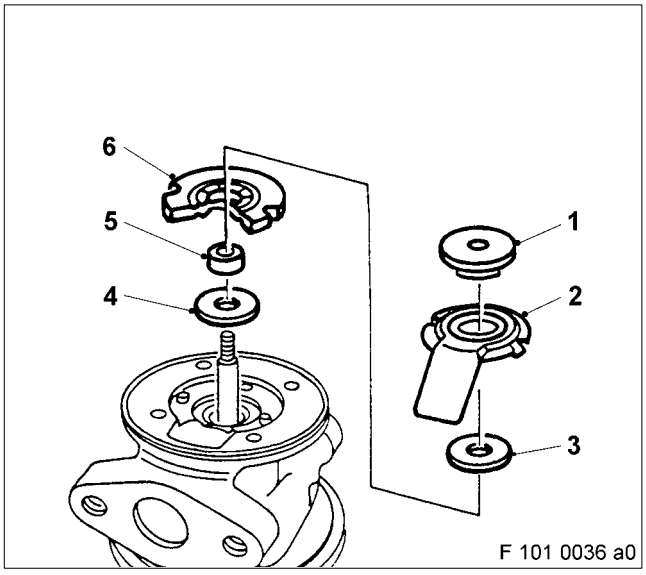
Remove rear wall (2) from bearing housing.

Remove O-rings.

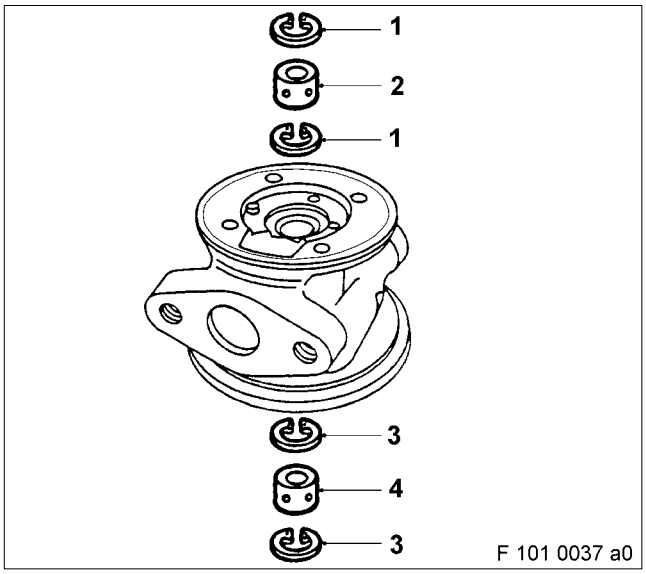


Press sealing bush (1) from rear wall (3).

Remove piston rings (2) with pliers from sealing bush.



Remove oil deflector ring (1), oil deflector (2), bearing collar (3), thrust bearing disc (6), bush (5) and bearing collar (4) from bearing housing.



Remove snap rings (1) and bearing bushes (2) from compressor side and then snap rings (3) and bearing bushes (4) from turbine side.

C 101.01.08 Inspection and Repair

Note: Ensure that all components are perfectly clean.

Carefully clean all components:

Wet-sand-blast housing, rotor, compressor wheel, rear wall and heat shield.

Important: When sand-blasting, protect bearing bores and piston ring sealing surfaces on bearing housing, rotor shaft and piston ring sealing surfaces on rear wall from sand-blasting medium.

Check components as follows (visual inspection):

– Check housing, guide ring, heat shield and impellers for cracks, foreign bodies and wear.
  Check oil supply bores in bearing housing for foreign bodies.
  Check piston ring sealing surfaces and bearings for damage.
– Check turbine housing for scaling. Check gas inlet flange and gas outlet flange for evenness.
– Examine impellers for bent or broken blades, and rotor shaft for scored bearings.
– Check piston ring seats in rear wall and in bearing housing for scoring and damage.

Limits of reusability

Note: Wear components and rotating parts showing cracks must be replaced.
Replace hex nuts (self-locking) and O-rings during each assembly.
During overhaul, replace clamping segments, hex nut, shaft nut, piston rings, socket-head screws and washers, O-rings, oil deflector, thrust bearing disc, snap rings, bearing bushes and hex screws.

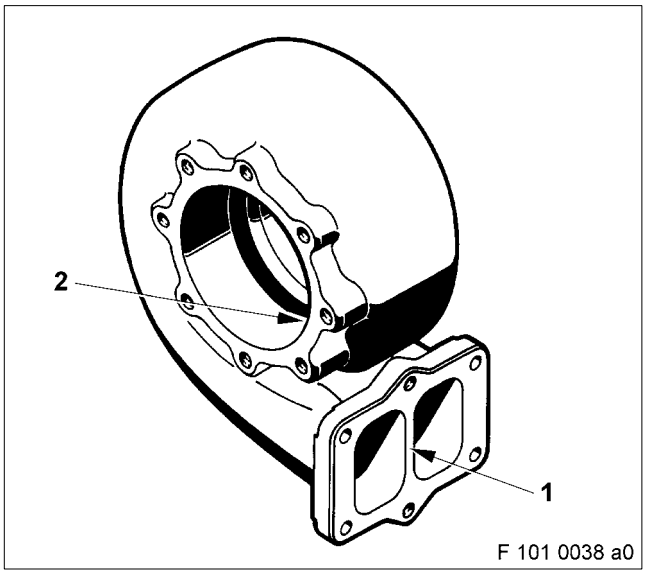
Bearing housing:

Heavy corrosion of the segment support surfaces is not permissible.

Use a bore gauge to measure bore inner diameter at bearings.

Max. bore inner diameter = 22.272 mm

Replace bearing housing if limit value is exceeded.



Turbine housing:

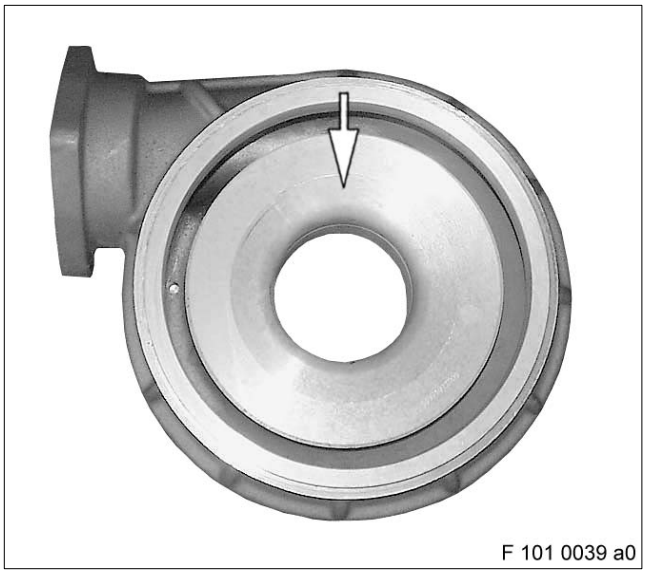
Radial cracks up to 10 mm in length in area of tongue (2) and partition (1) are permissible.

Continuous cracks are not permissible.

Slight scraping in area of contour are permissible.

In event of scaling on land at gas inlet and contour, replace component.

If gas inlet flange or outlet flange is deformed, replace part.

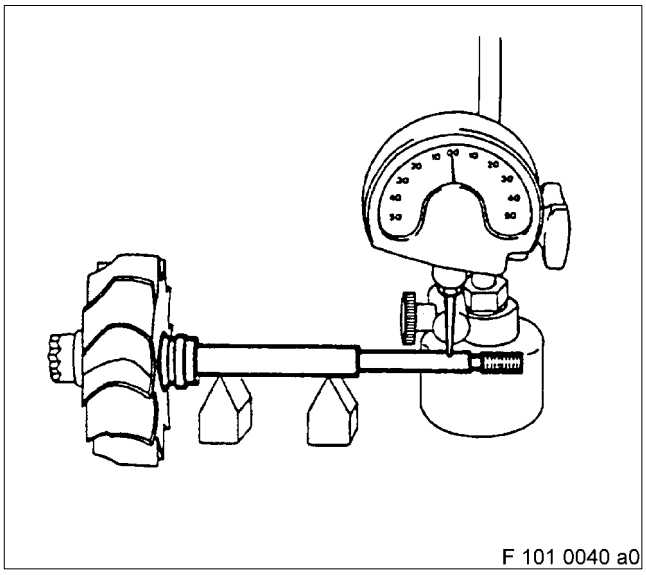


Compressor housing:

Check for scraping in contour area (arrow) and deformation.

Scraping up to 0.2 mm is permissible.

Replace compressor housing if deformed.


F 101 0040 a0

Rotor:

Do not straighten bent impeller blades. If impeller blades are bent, replace rotor.

Replace turbine wheels and compressor wheels showing traces of scraping and rotors with scored bearings.

Check rotor shaft for concentricity; for this purpose, mount rotor shaft on two prisms at height of bearings.

Place measuring sensor on shaft 5 mm before end of compressor wheel seat.

During test, press rotor shaft firmly onto prisms.

Permissible radial runout < 0.008 mm.

If permissible radial runout is exceeded, replace rotor.

Measure diameter of shaft at bearings and width of piston ring groove.

Min. diameter = 14.25 mm

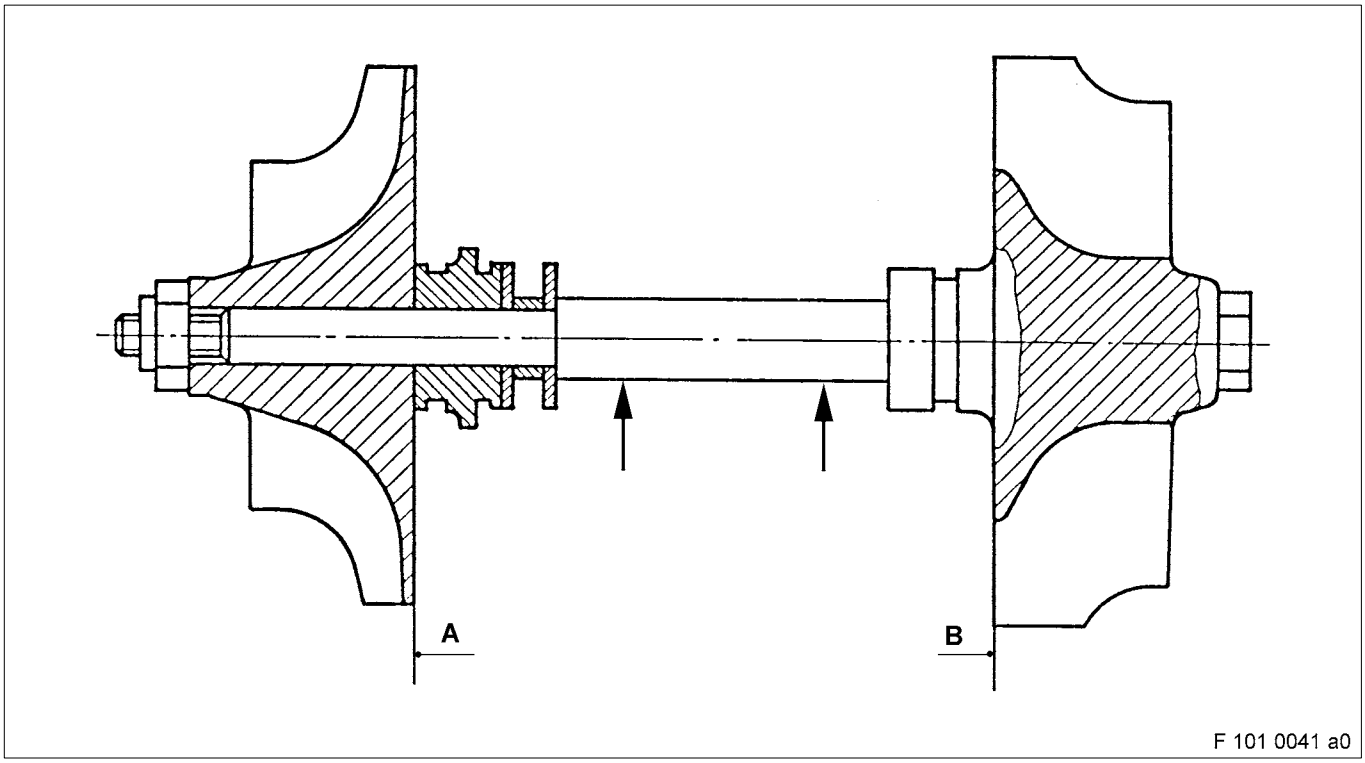
Max. groove width = 3.23 mm

If limits are exceeded or not reached, replace shaft.

Rotor assembly dynamic balancing

Note: During manufacture, all compressor wheels and rotors are dynamically balanced individually. During operation, additional imbalance may occur as a result of deposits and impurities on compressor wheels and turbine wheels. During every repair, the dynamic balancing of the complete rotor assembly must be checked (except for installation of a new rotor assembly).

All rotor assembly components (rotor, bearing collar, sealing bush (oil deflector), bush, compressor wheel, shaft nut) must be cleaned before dynamic balancing. The position of the components with respect to each other must be marked.



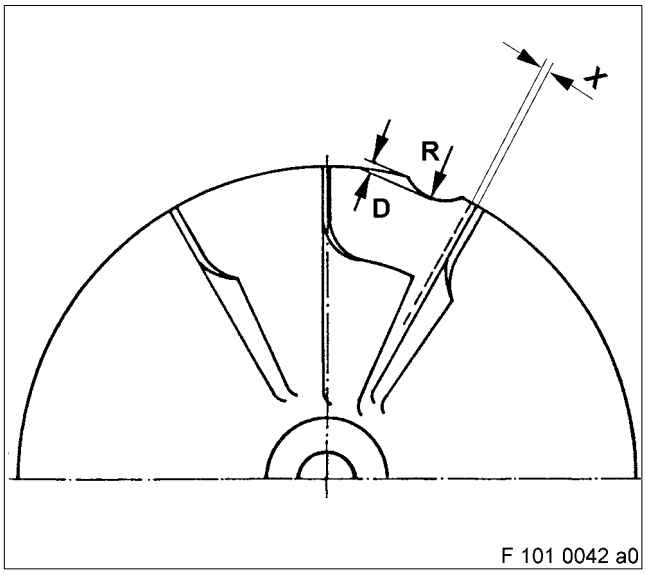
Place complete rotor assembly on bearings (arrows) in dynamic balancing machine.

The rotor assembly must only be balance at balancing levels A + B!

Impermissible residual imbalance in rotor assembly must be reduced by removing material (see following section) in balancing levels A and B to max permissible balancing qualities specified in table.

Max. permissible residual imbalance

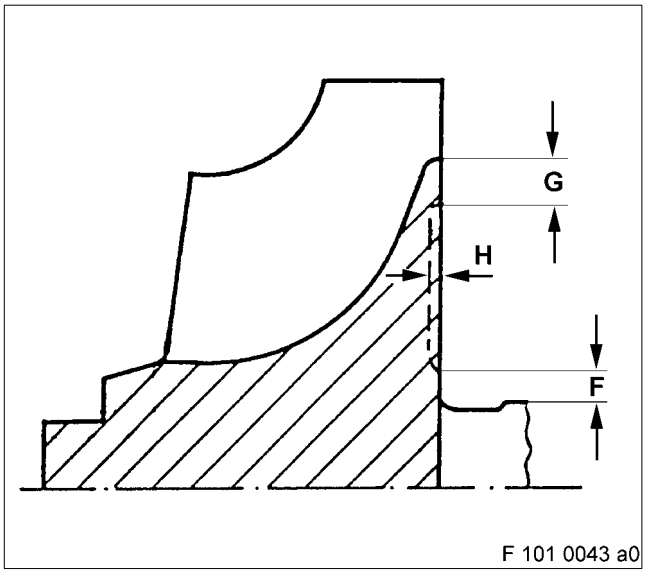
Turbocharger model	**Balancing level A (VS)** in mmg	**Balancing level T (TS)** in mmg
K 36	4.0	3.1
K 37	4.6	3.6



Material removal at compressor wheel

In event of material removal in area of blade connections, a minimum distance (X) of 3 mm must be observed.

All impressions must merge smoothly with surrounding surfaces.



Material removal on turbine wheel

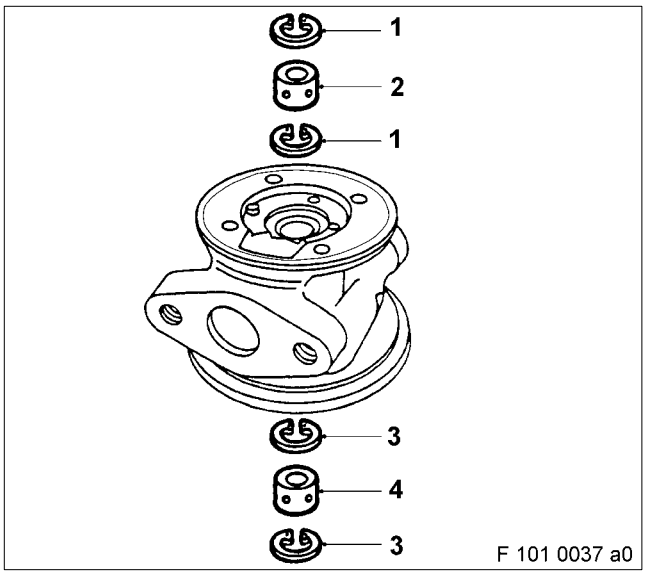
Material removal during dynamic balancing in arch of max. 150°.

All impressions must merge smoothly with surrounding surfaces.

Max. permissible material removal

Turbocharger model	Compressor wheel		Turbine wheel		
	D (mm)	**R** (mm)	**F** (mm)	**G** (mm)	**H** (mm)
K 36	4	4	2,5	4,0	1,5
K 37	4	4	2.5	4.0	1.5

C 101.01.10 Assembly



Assembling exhaust turbocharger

Check that components are particularly clean and clean if necessary.

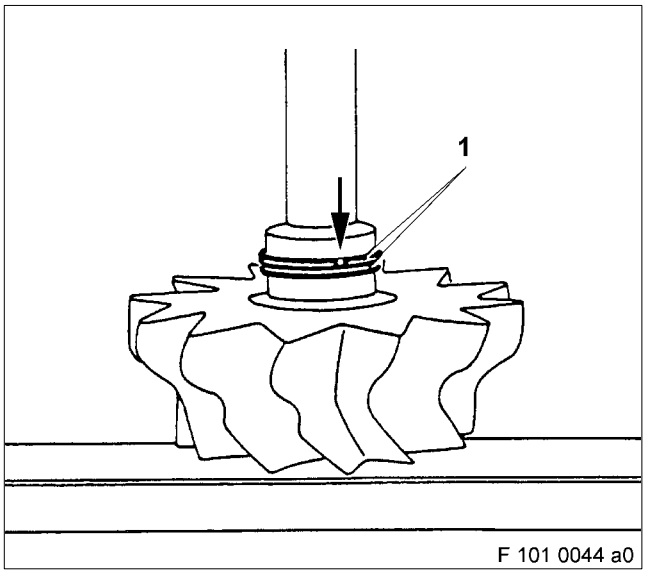
Lubricate following bearing components before installation:

- Rotor bearings
- Bearing bushes
- Thrust bearing disc
- Sealing bush
- Oil deflector
- Bearing collar
- Piston rings
- Bush

Important: When installing bearings, ensure absolute cleanness.

Install snap rings (1) and bearing bushes (2) into bearing housing from compressor side and then snap rings (3) and bearing bushes (4) from turbine side.

Note: Fit snap rings so that the rounded side is facing the bearing bush.
Make sure snap ring is perfectly seated in groove!

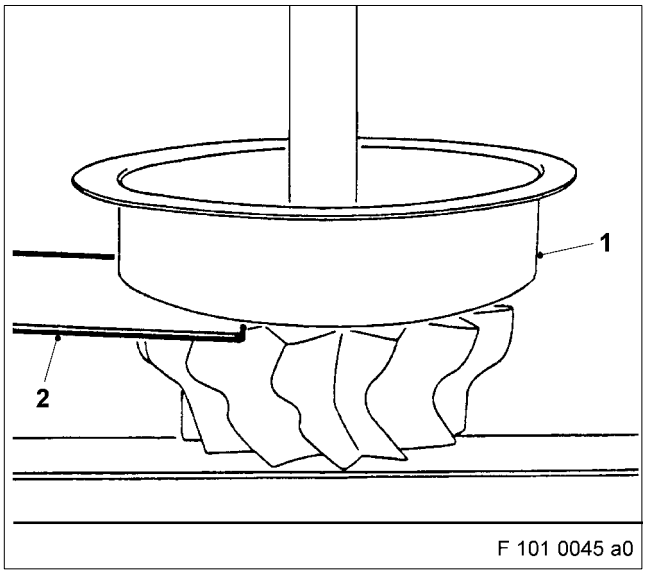


Clamp rotor shaft in vice (use protective jaws).

Carefully fit piston rings (1) onto shaft.

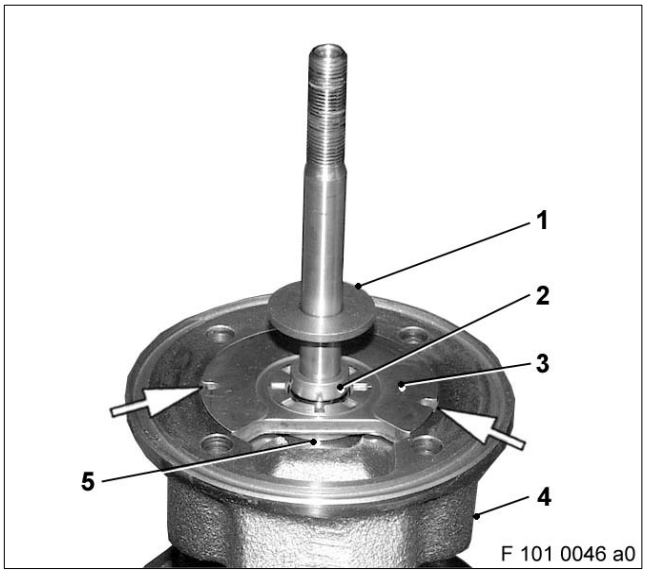
Position ring butts (arrow) at 180° intervals.

Centre piston rings on rotor shaft.



Fit heat shield (1) carefully over piston rings on turbine wheel.

Place a metal strip of 1 mm thickness between heat shield and turbine wheel rear side (to ensure correct guidance of piston rings in bearing housing bore).



Note: If the rotor assembly has been rebalanced, pay attention to respective position markings.

Fit sleeve over rotor shaft to protect thread.

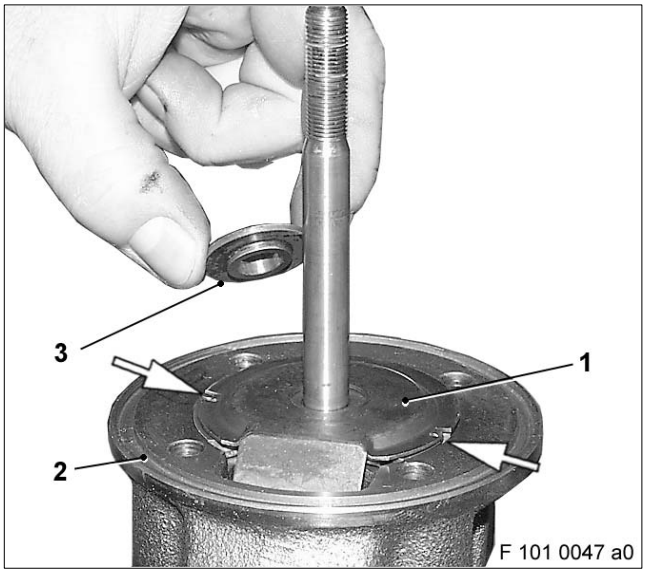
Carefully fit bearing housing (4) over rotor shaft, ensuring that oil supply bore of bearing housing is offset by 90° with respect to piston ring butt.

Note: The piston rings are correctly seated when heat shield and bearing housing can be rotated easily.

Fit first bearing collar (5) and bush (2) over rotor shaft.

Fit thrust bearing disc (3) in bearing housing, paying attention to fit of centering pins (arrows).

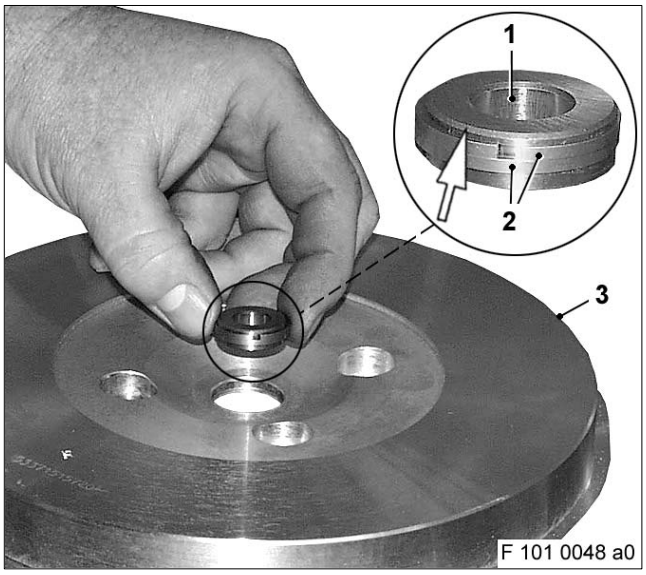
Fit second bearing collar (1) on rotor shaft.



Place oil deflector (1) on thrust bearing disc, paying attention to fit of oil deflector (arrows).

Fit oil deflector (3) with small collar facing down on rotor shaft.

Coat new O-ring (2) with petroleum jelly and insert into groove (arrow) in bearing housing.



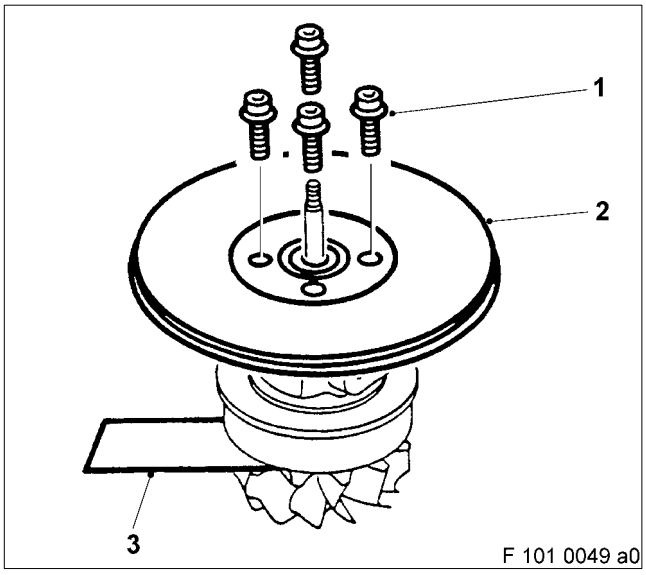
Carefully fit two piston rings (2) on sealing bush (1)

Position ring butts at 180° intervals.

Install sealing bush with piston rings, with chamfer (arrow) in direction of compressor wheel back (upwards) into rear wall (3).

Position sealing bush so that oil supply bore of bearing housing is offset by 90° with regard to piston ring butt.

Note: If necessary, compress piston ring with a screwdriver.



Clean and degrease thread of socket-head screws (1) and thread in bearing housing.

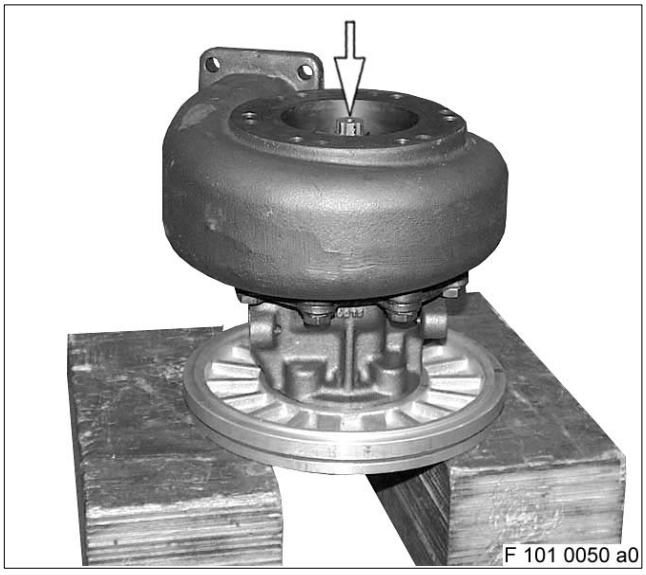
Coat thread of socket-head screw with Loctite 640.

Place rear wall (2) on bearing housing in position as shown.

Fit socket-head screws and washers and tighten to specified tightening torque – see C 101.01.01.

Note: Joints achieve final strength (Loctite 640) after approx. 24 hours.

Withdraw metal strips (3) between heat shield and turbine wheel rear side.



Measure turbine-side contour gap:

Place core group, without compressor wheel and shaft nut, in turbine housing and secure with hex screws.

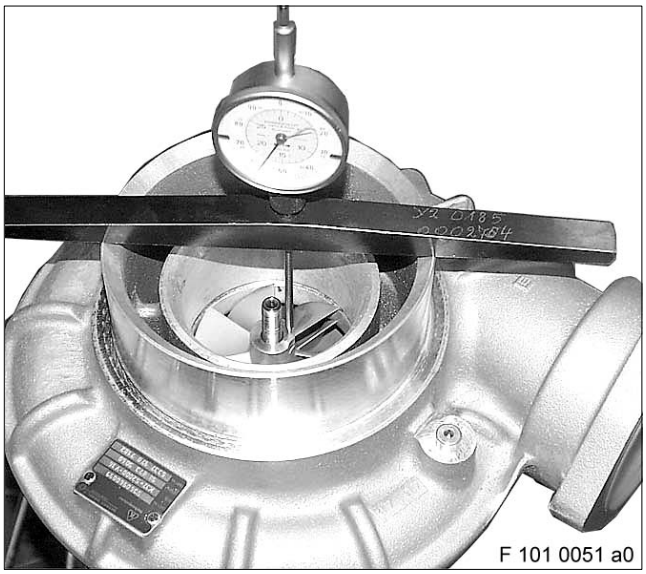
Place dial gauge stylus on turbine wheel hub.

Press rotor down and set dial gauge to “0”.

Press rotor against dial gauge stylus and note value.

Required contour gap – see overview drawing C 101.01.01.

After measurement, remove turbine housing.


F 101 0051 a0

Measure compressor-side contour gap:

Fit compressor wheel on shaft.

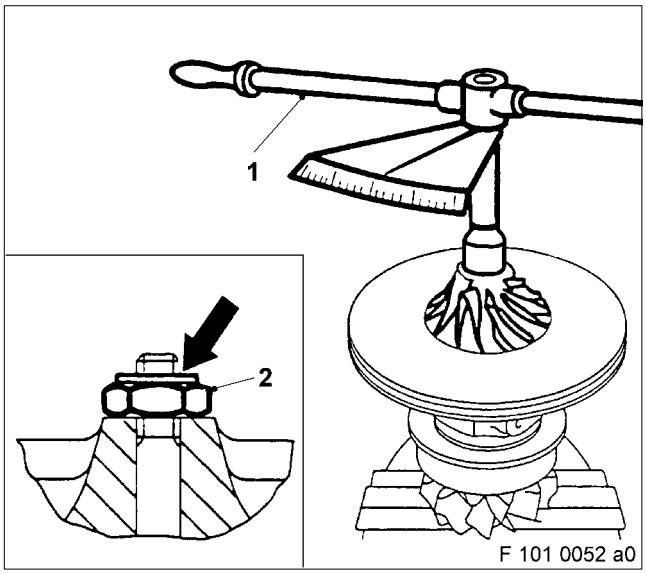
Place core group, without shaft nut, in compressor housing and secure with hex nuts.

Place dial gauge stylus on compressor wheel hub and set dial gauge to “0”.

Raise compressor wheel to max. possible position and record value.

Required contour gap – see overview drawing C 101.01.01.

After measurement, remove compressor housing.



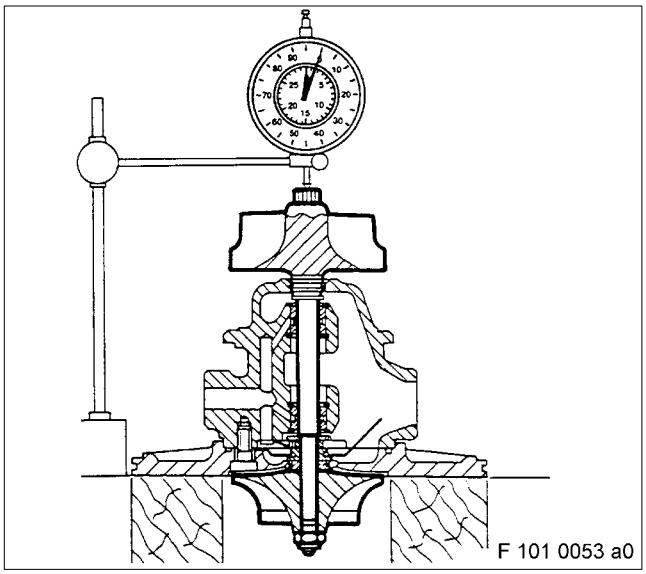
F 101 0052 a0

Note: To prevent the rotor shaft from being bent, tighten shaft nut (2) with a T-torque wrench (1).

Tighten new shaft nut to specified pretightening torque and then to angle of rotation – see overview drawing C 101.01.01.

Note: Turbine-side piston rings are correctly seated if heat shield and bearing housing can be rotated easily after installation of compressor wheel.

Seal shaft nut and threaded stem of rotor with thread-locking varnish (arrow).


F 101 0053 a0

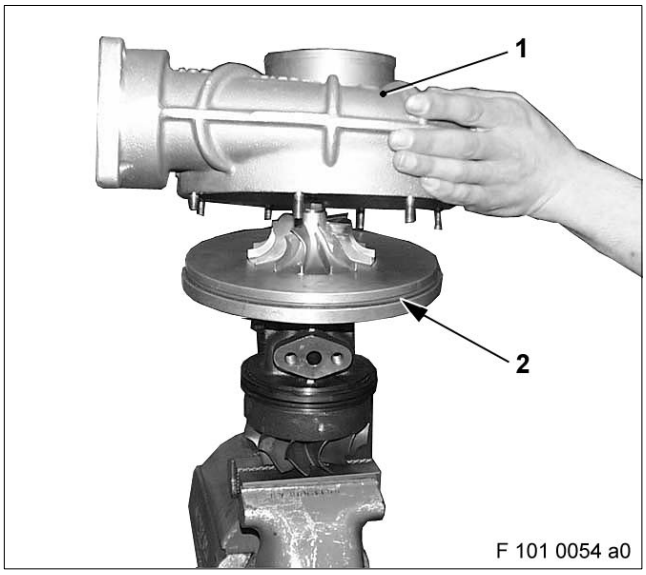
Measure axial clearance of rotor shaft:

Place dial gauge stylus with preload on turbine wheel hub.

Press rotor down and set dial gauge to “0”.

Press rotor against dial gauge stylus and note value.

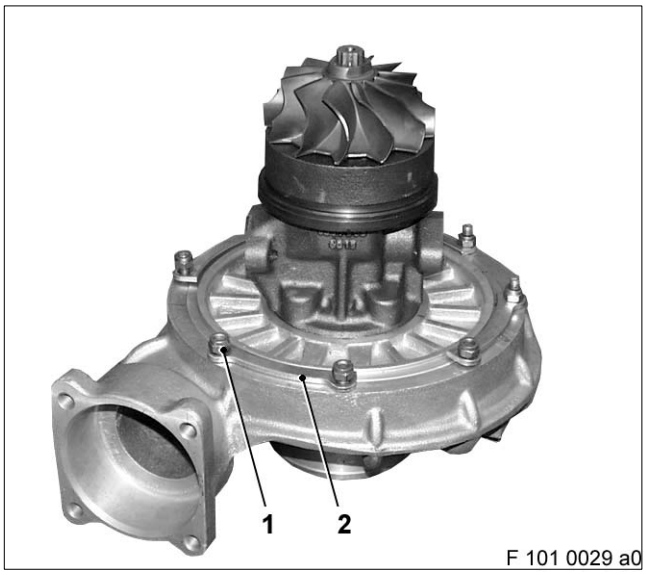
Max. permissible axial clearance = 0.10 mm



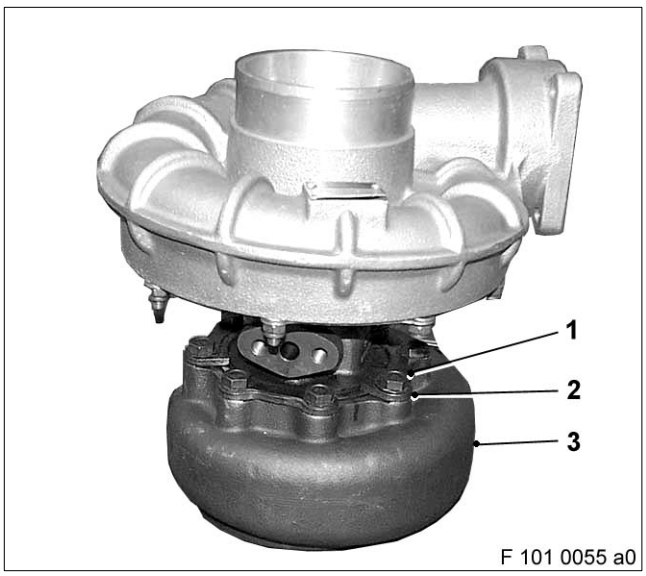
Coat new O-ring (2) with petroleum jelly and insert into groove (arrow) in rear wall.

Important: When fitting compressor housing (1), ensure it is held in correct position.

Position compressor housing on rear wall in accordance with markings applied before removal.



Mount clamping segments (2) and secure with new hex nuts (1).



Important: When fitting turbine housing (3), ensure it is held in correct position.

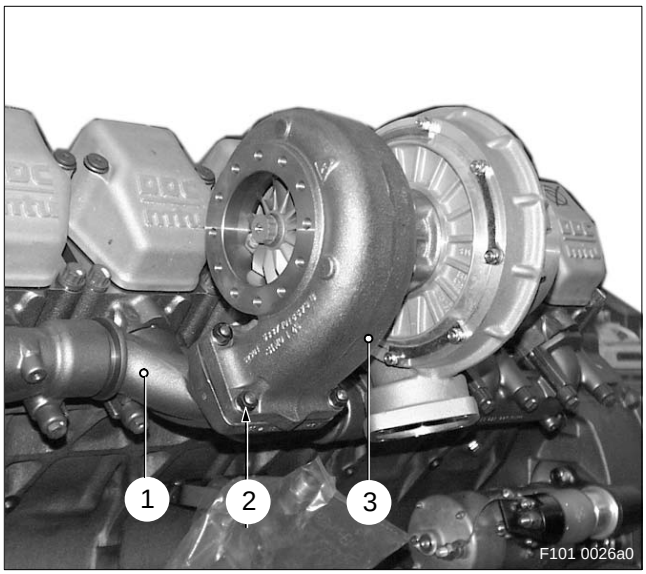
Position turbine housing on bearing housing in accordance with markings applied before removal.

Coat thread of hex screws (1) with assembly paste.

Mount clamping segments (2) and tighten hex screws to specified tightening torque – see overview drawing C 101.01.01.

Check rotor shaft for free movement.

C 101.01.11 Installation



Installing turbocharger

Note: Installation applies also to 12V and 16V turbochargers.
Make sure that air-carrying and oil-carrying components are perfectly clean.

Remove covers from compressor housing, turbine housing and exhaust elbow (1).

Check mating face on exhaust turbocharger (3) and on exhaust elbow; clean as necessary.

Coat thread of new studs with assembly paste.

Using an installation tool or two nuts, screw studs into exhaust elbow and tighten.

By means of studs, lower exhaust turbocharger onto exhaust elbow.

Install new nuts (2) and washers on studs and tighten diagonally and evenly.

Note: Before installing oil supply line, the turbocharger bearing housing must be filled with engine oil via the oil inlet bore. At the same time, turn the turbocharger shaft by hand so that the bearings are covered in an oil film.

C 101.01.12 After-Installation Operations

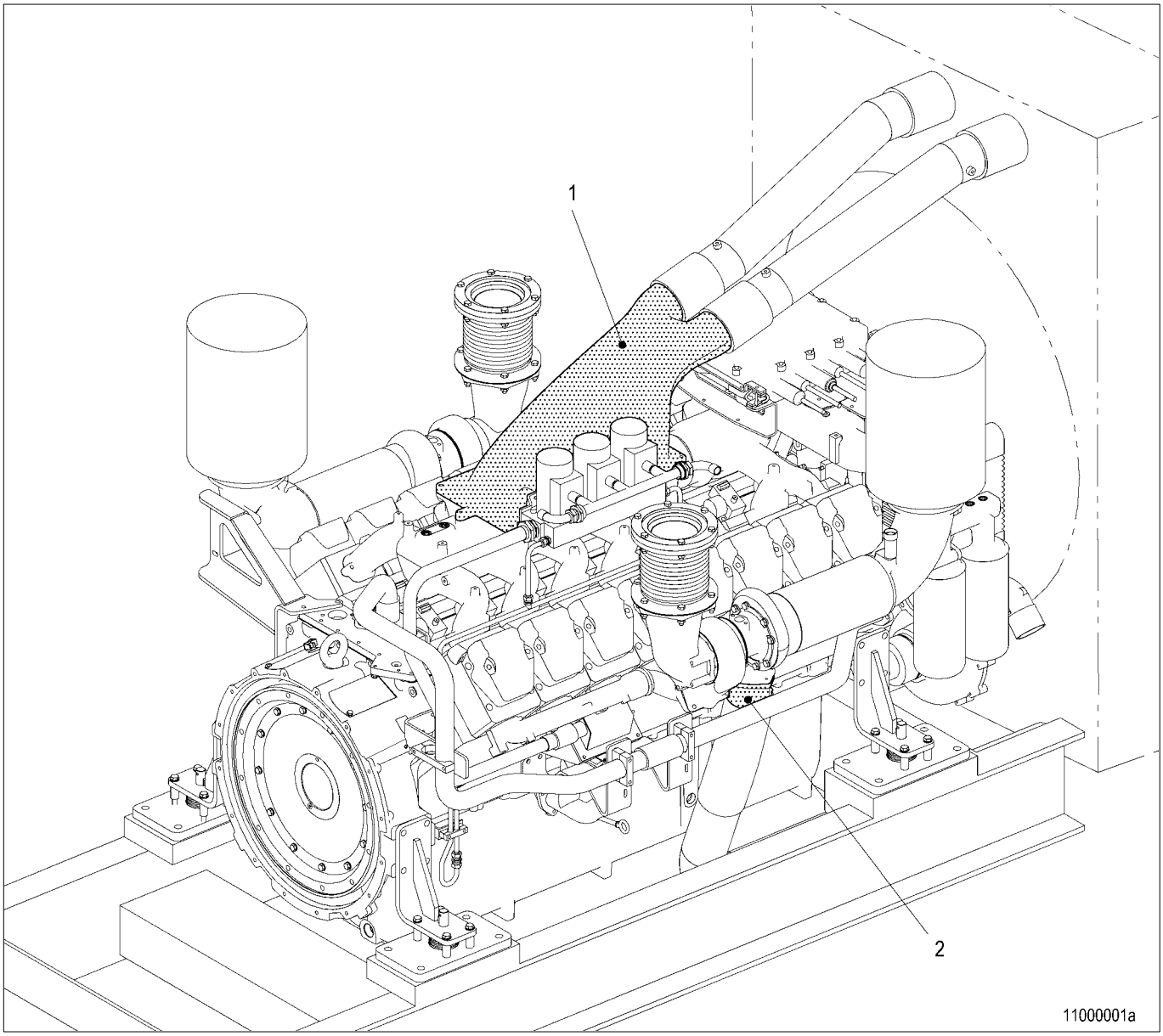
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install oil supply lines	C 185.10
–	x	x	Mount oil return lines	C 185.25
–	x	x	Install exhaust system after exhaust turbocharger	–
–	x	x	Install air system before exhaust turbocharger	C 123.05
–	x	x	Install air system after exhaust turbocharger	C125.05
–	–	x	Release engine start	Operating Instructions

Contents

C 110 Charge Air Cooling



1 Cover
2 Flange

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

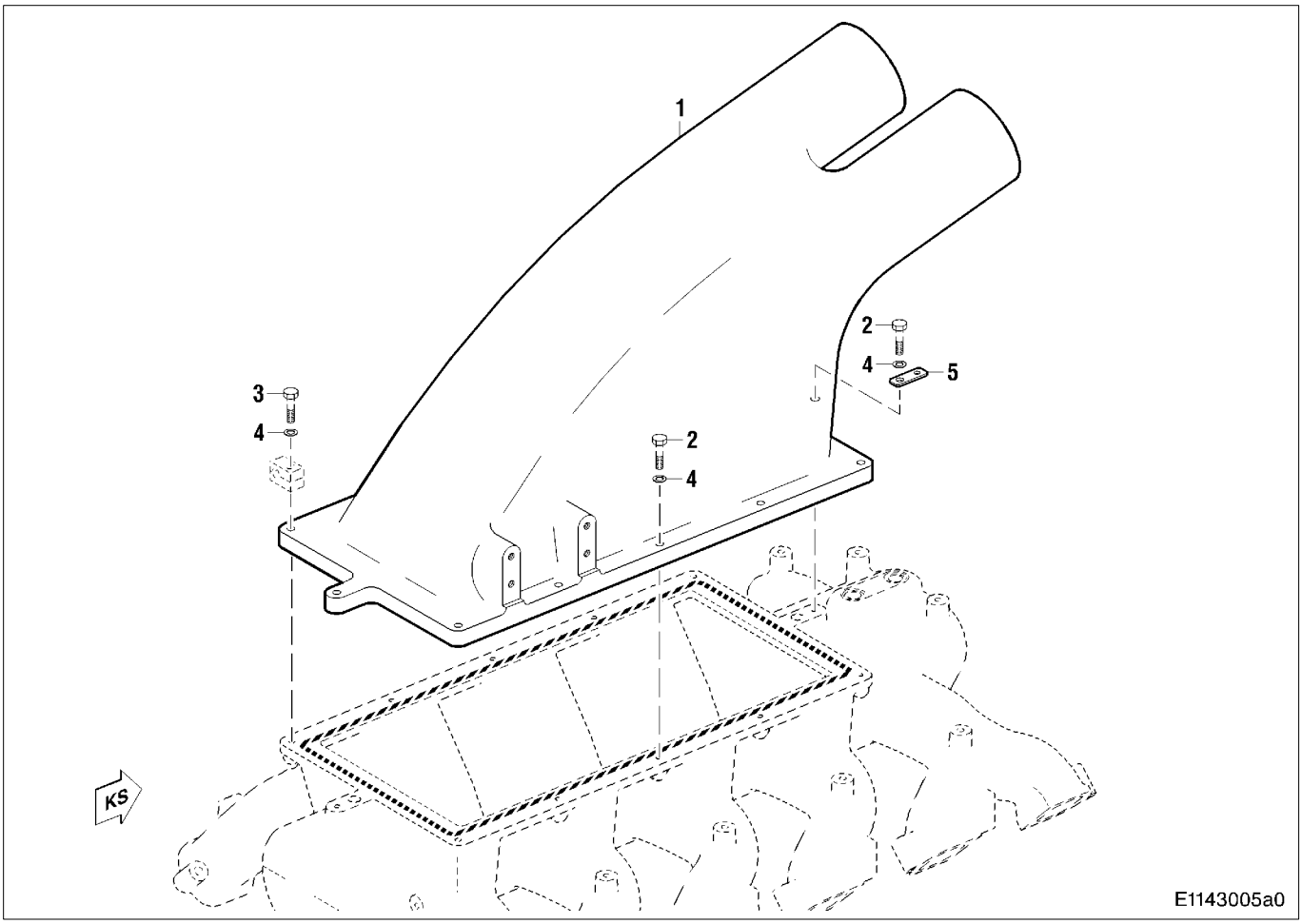
When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Spray gun			
Inspection lamp			
Vaseline	Petroleum jelly, white	40317	
Cleansing agent	Solvclean KW	40022	
Thin-film lubricant	Molycote g-N plus	40041	
Engine oil			
Sealing paste	Elastosil N 189	50545	
Multipurpose grease	Shell Retinax A	40333	
Corrosion inhibitor	Caramba Express	40008	
Engineer's blue	blue	40641	
Dry compressed air			
Surface crack-testing equipment with red penetrant dye			

C 114.05 Connecting Housing

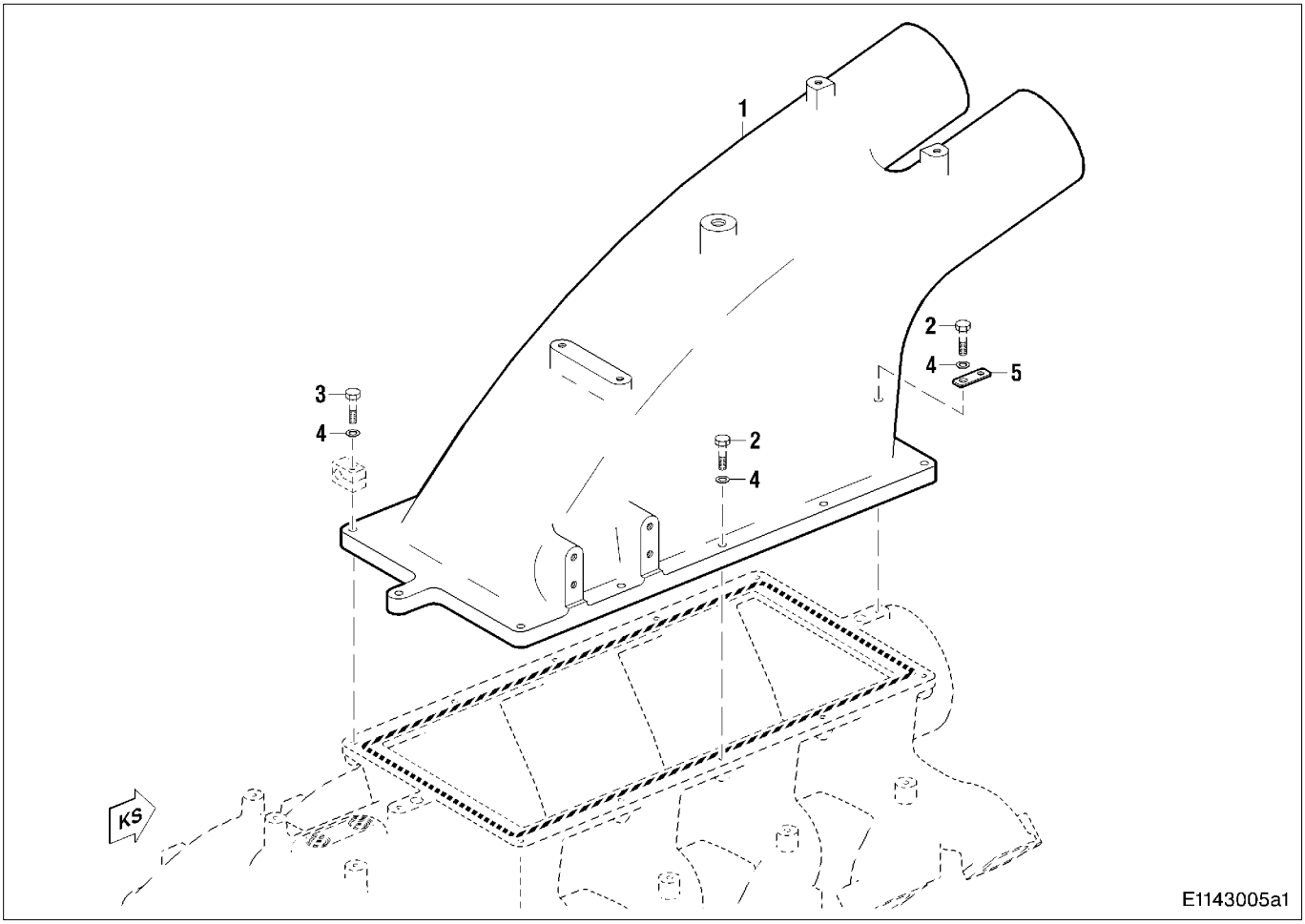
C 114.05.01 Overview Drawing

Cover, 12V



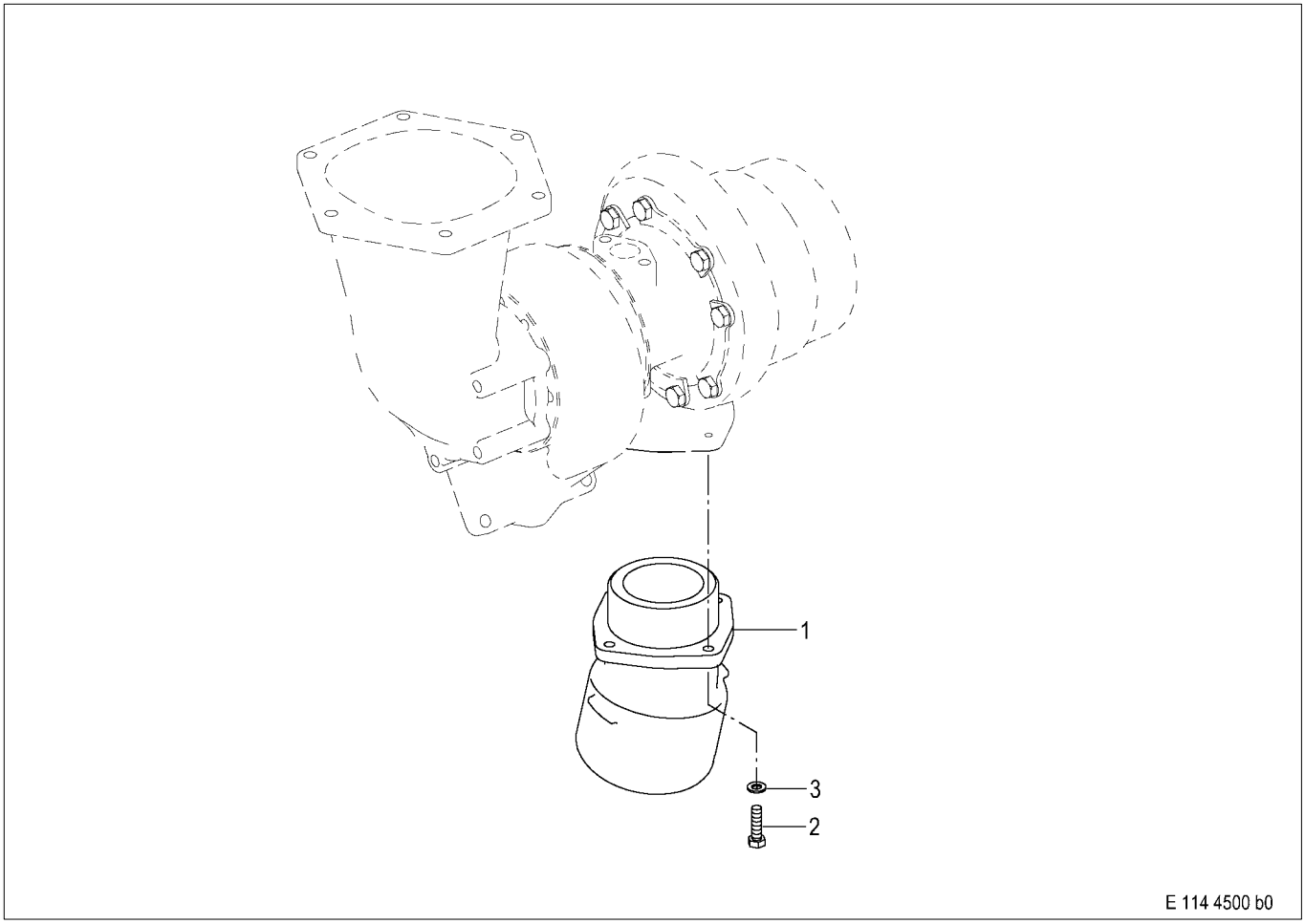
1 Cover
2 Hex screw
3 Hex screw
4 Washer
5 Bracket

Cover, 16V



1 Cover
2 Hex screw
3 Hex screw
4 Washer
5 Bracket

Connecting line for intercooler/exhaust turbocharger



1 Flange
2 Hex screw
3 Washer

C 114.05.04 Before-Removal Operations

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65

C 114.05.05 Removal

Removing cover and flange

WARNING

Heavy object. Risk of injury!
Use suitable tools and lifting equipment.

Remove cover and flange as shown in overview drawing – see C 111.05.01.
After removal, seal all connections with suitable plugs.

C 114.05.08 Inspection and Repair

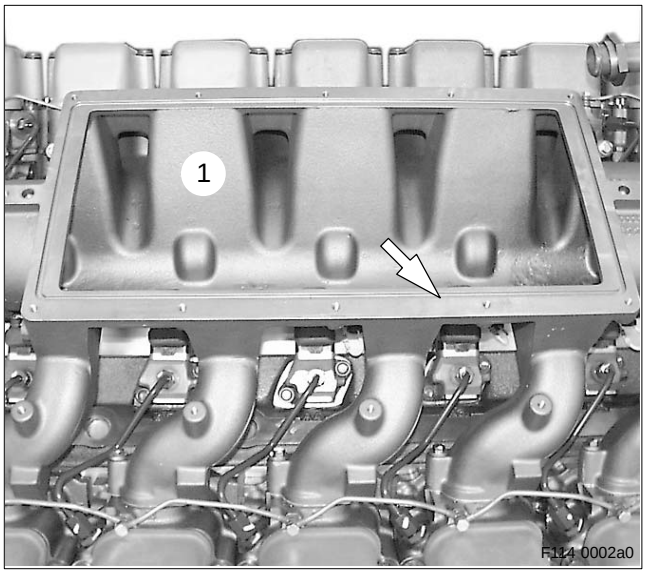
Clean all components and visually inspect for damage and defects; replace as necessary.
Check sealing and mating faces for surface irregularities and damage; rub down with an oilstone if necessary.
Pressure-test cover with air in water bath.

WARNING

Compressed air is highly pressurized.
Risk of injury!Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Air pressure = 0.5 bar
Check cover for cracks using surface crack-testing method with red penetrant dye as necessary.
Replace cover in event of leaks or cracks.
Check hex screws for damage and wear; replace as necessary.
Replace O-ring at every assembly.

C 114.05.11 Installation

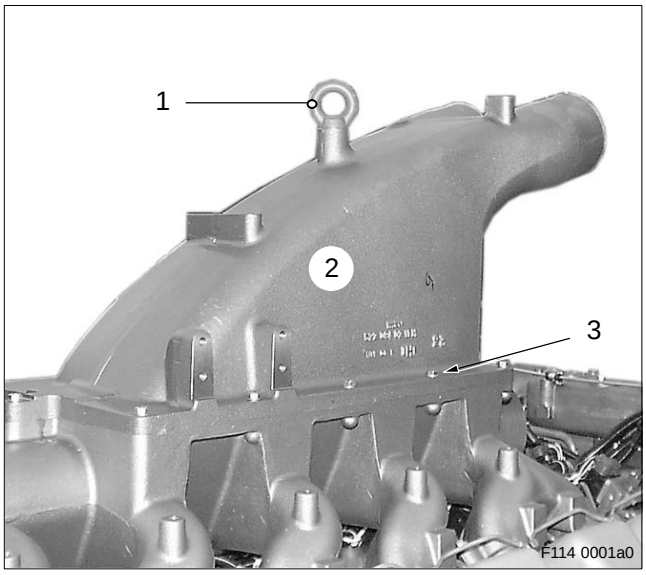


Installing cover

Note: Prior to installation, remove all blanking plugs and seals and ensure air-carrying lines are perfectly clean.

Check mating faces on cover and charge air manifold (1) and clean if necessary.

Coat new O-ring with thin-film lubricant and fit in groove (arrow) in charge air manifold.



⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Insert eyebolt (1) into cover (2).

Attach cover to crane and ropes and carefully lower onto charge air manifold.

Install cover with hex screws (3) and washers as per illustration.

Installing flange

Note: Prior to installation, remove covers and ensure air-carrying lines are perfectly clean.

Check mating faces on exhaust turbocharger and on flange; clean as necessary.
Install flange on turbocharger compressor housing as shown in overview drawing – see C 101.01.

C 114.05.12 After-Installation Operations

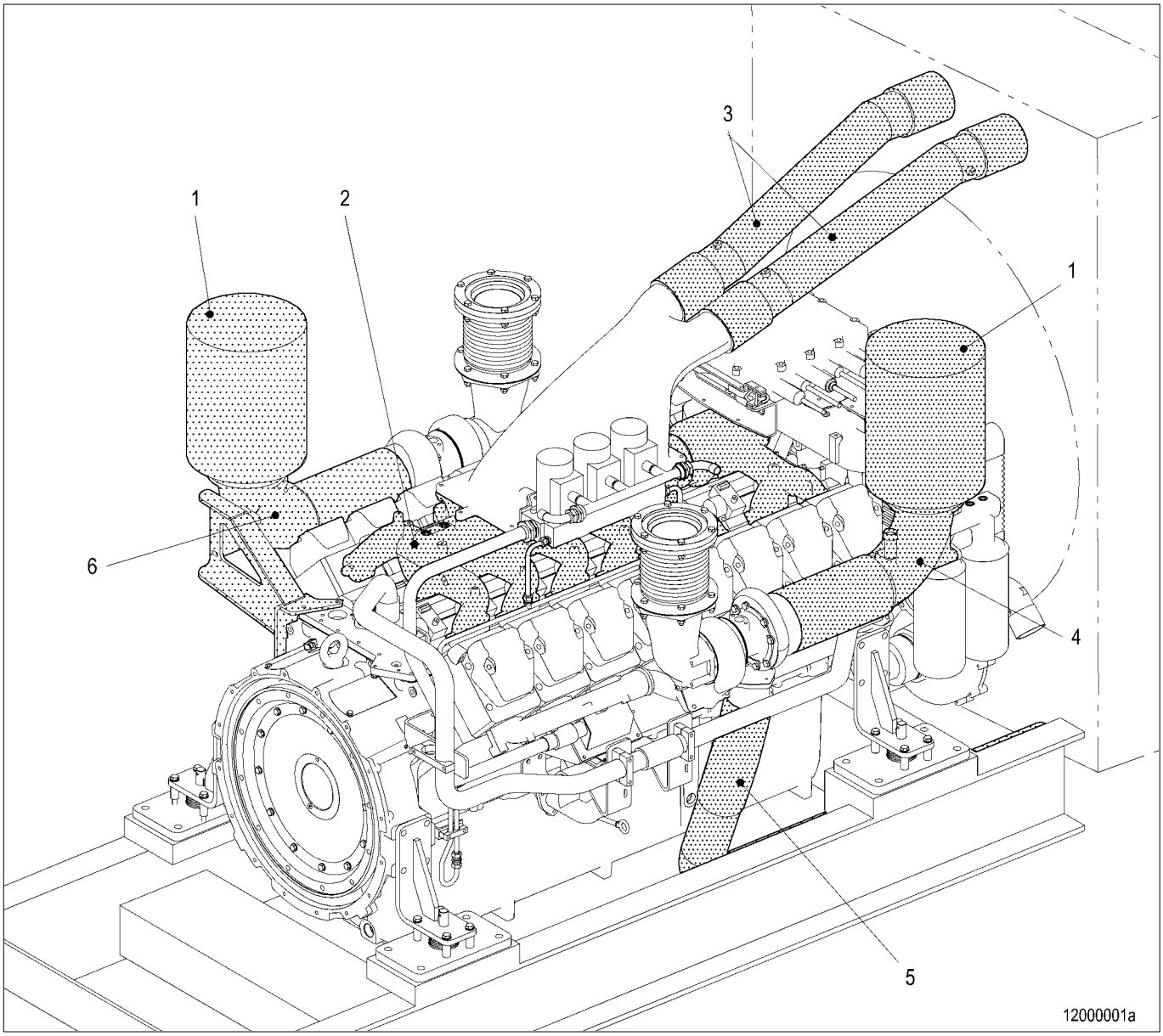
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install charge air lines	C 125.05
–	x	x	Connect vent lines	C 202.65
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Install crankcase breather	C 018.10
–	–	x	Fill engine cooling system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

Contents

C 120 Air Intake/Air Supply



1 Air filter
2 Charge air manifold
3 Charge air line
4 Elbow, right
5 Charge air line
6 Elbow, left

The following is a list of auxiliary equipment and materials needed for the assembly operations:

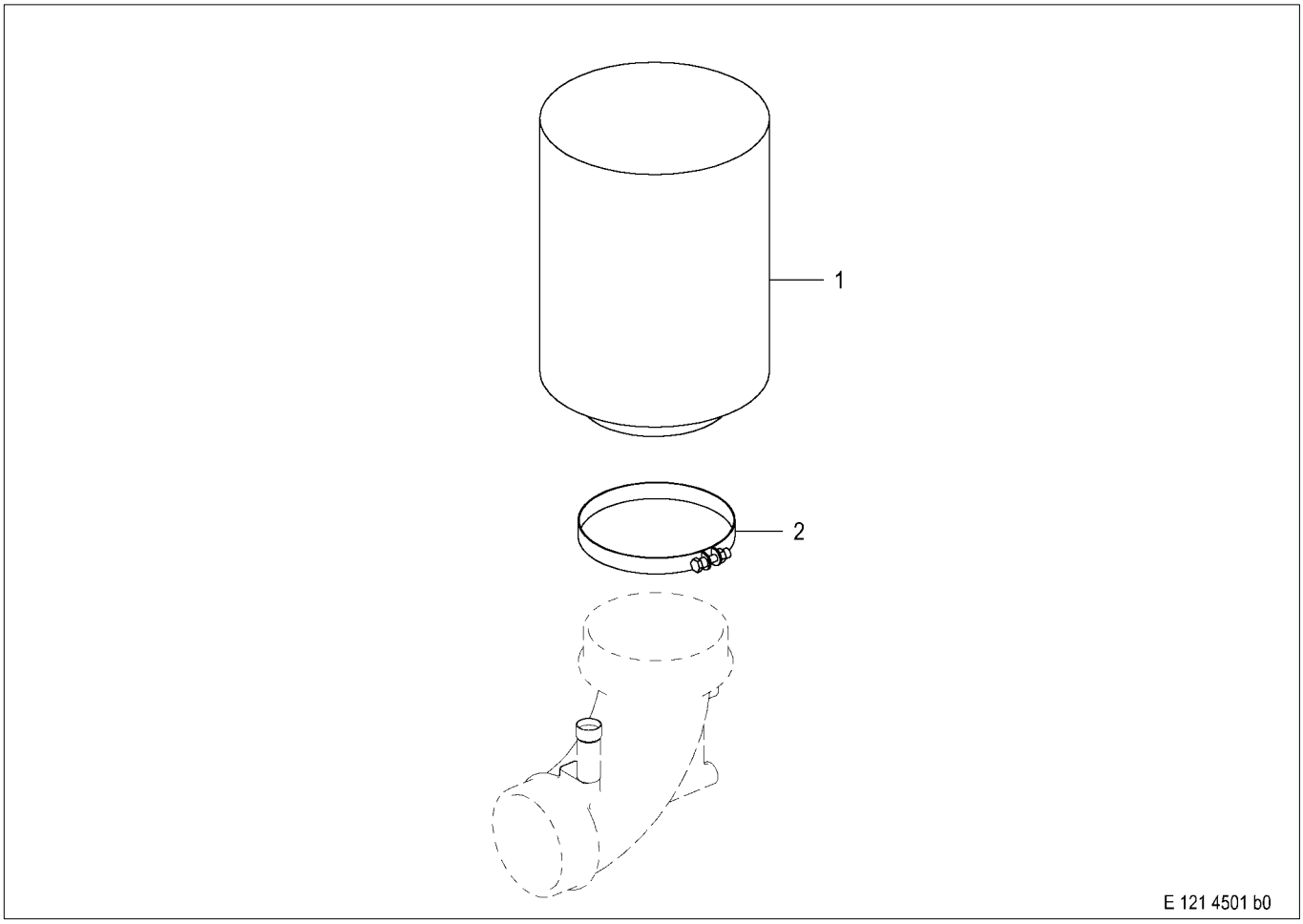
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Spray gun			
Inspection lamp			
Vaseline	Petroleum jelly, white	40317	
Corrosion inhibitor	Pfinder AP 11 F	40355	
Engine oil			
Assembly paste	Ultra Therm MTU	50547	
Cleaning agent	Solvclean KW	40022	
Cleaner (decarbonizer)	Meister Proper	40377	
Engineer's blue	blue	40641	
Kerosene or diesel fuel			
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Surface crack-testing equipment with red penetrant dye			
Surface crack-testing equipment with fluorescent penetrant dye			

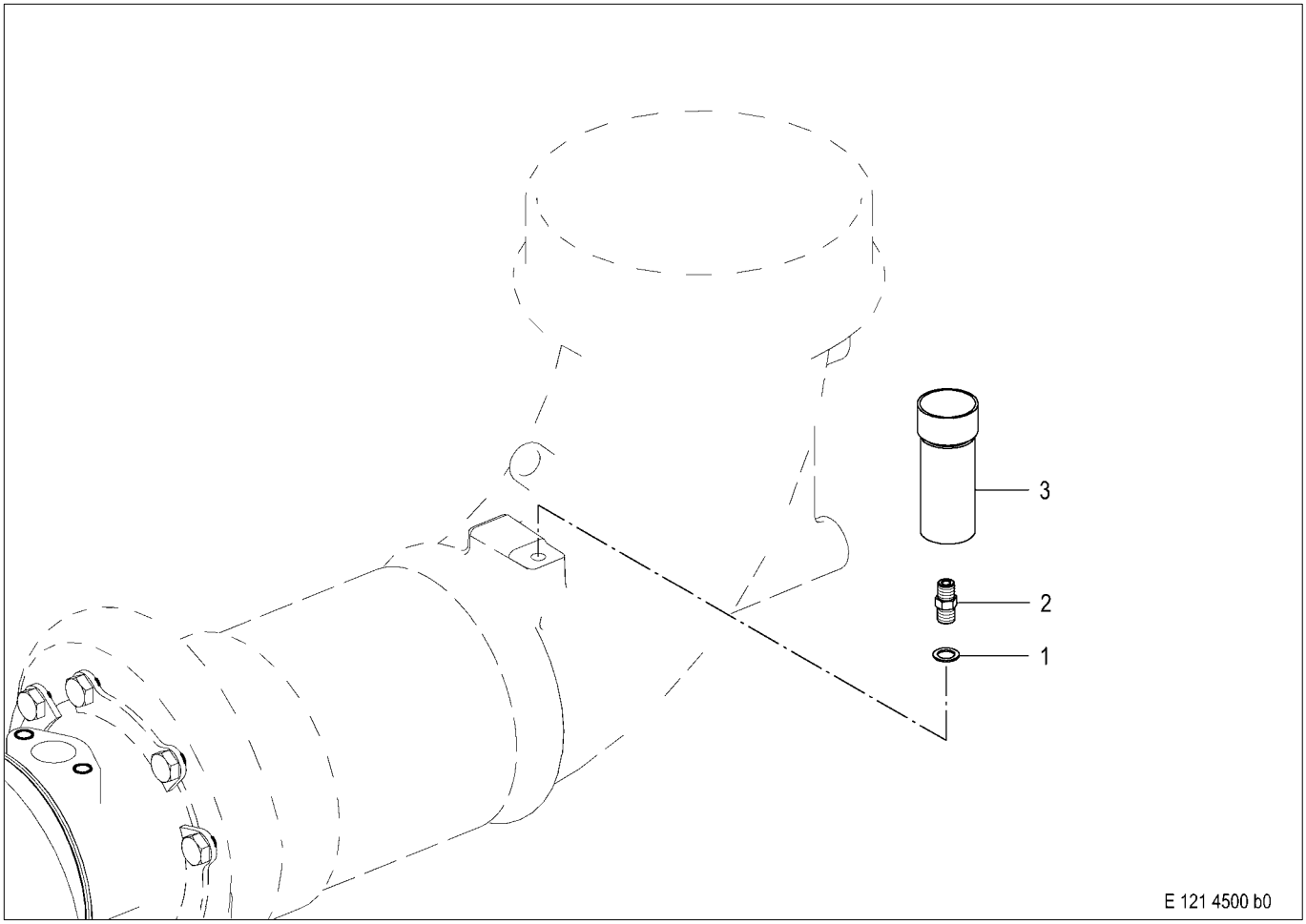
C 121.05 Air Filter

C 121.05.01 Overview Drawing



1 Air filter
2 Clamp

Filter contamination indicator



1 Sealing ring
2 Nipple
3 Contamination indicator

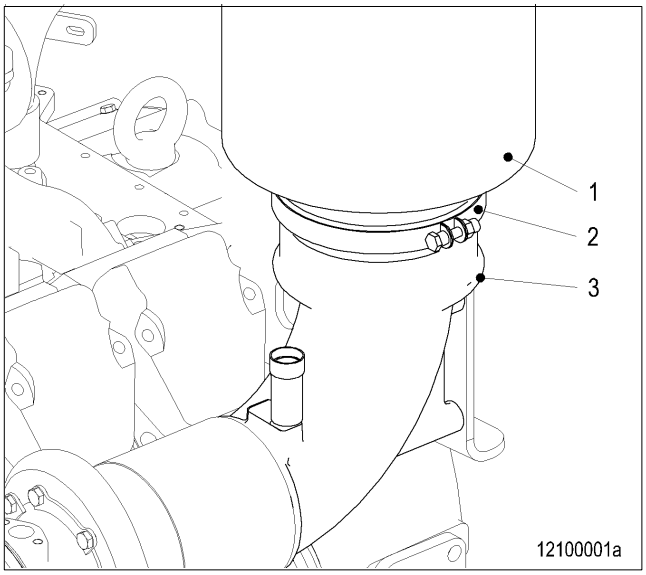
C 121.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 121.05.05 Removal



Removing air filter

Release clamp (2).

Remove air filter (1) from intake housing (3).

Cover installation opening if necessary.

Removing contamination indicator

Unscrew contamination indicator from nipple – see also overview drawing C 121.05.01.

Remove nipple and sealing ring from intake housing.

Seal installation bore with plug if necessary.

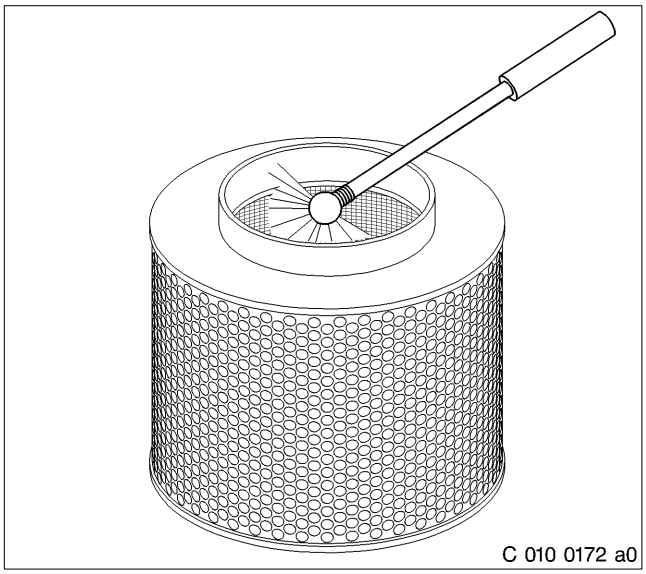
C 121.05.08 Inspection and Repair

Replace air filter in event of contamination or at appropriate maintenance echelon – See Operating Instructions.

Replace clamps as part of every W6 overhaul.

When re-using the clamps, clean them first.

Check clamps for condition and screws for ease of movement; replace clamp if necessary.

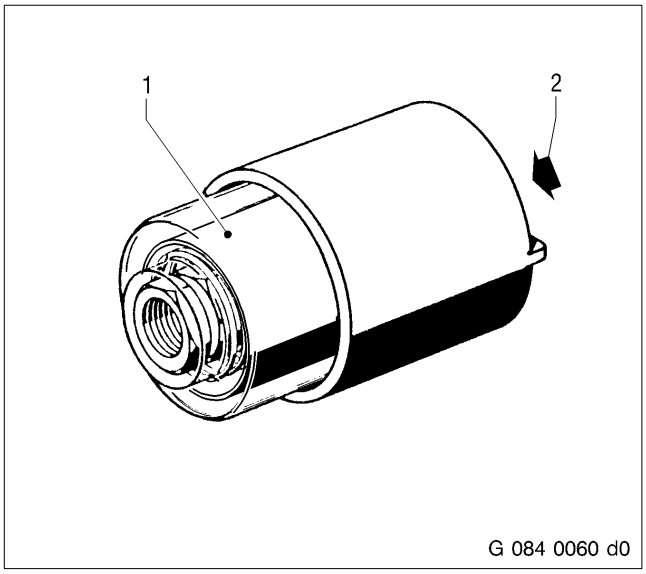

C 010 0172 a0

Checking air filter

When re-using the air filter, check for damage and particular cleanness.

For this purpose, illuminate air filter with an inspection lamp.

Replace air filter if damaged.



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Checking contamination indicator

Visually inspect contamination indicator; replace if necessary.

Check function of pressure indicator.

Depression indicator area of signal ring (1):
from 25 mbar to 50 mbar.

To generate necessary depression, suction must occur at contamination indicator connection.

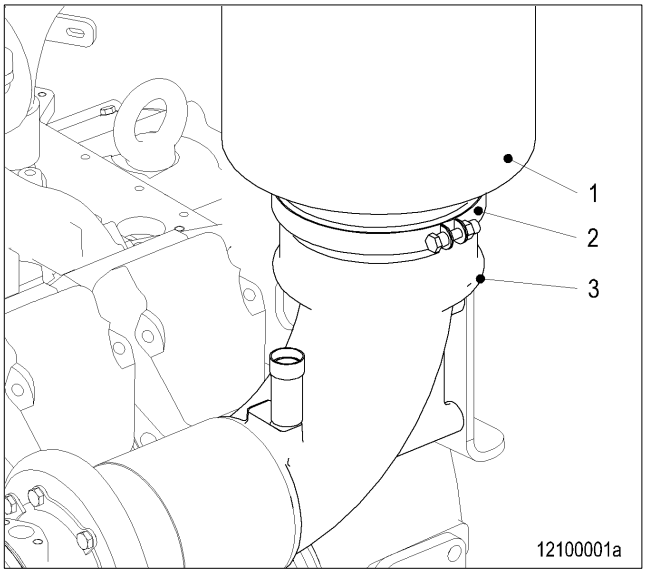
The easiest method of creating a suction is by mouth or using a simple hand pump.

The suction process must continue until maximum underpressure for contamination indicator has been reached.

The signal ring must be engaged after the suction process.

Disengage engaged signal ring with reset button (2).

C 121.05.11 Installation



Installing air filter

Note: Prior to installation, remove all covers and ensure air-carrying lines are perfectly clean.

Install air filter (1) with clamp (2) on intake housing (3).

Installing contamination indicator

Note: Before installation, remove blanking plugs.

Check that sealing surface and installation bore in intake housing are perfectly clean; clean if necessary.
Screw nipple and new sealing ring into intake housing – see overview drawing C 121.05.01.
Screw contamination indicator onto nipple.

C 121.05.12 After-Installation Operations

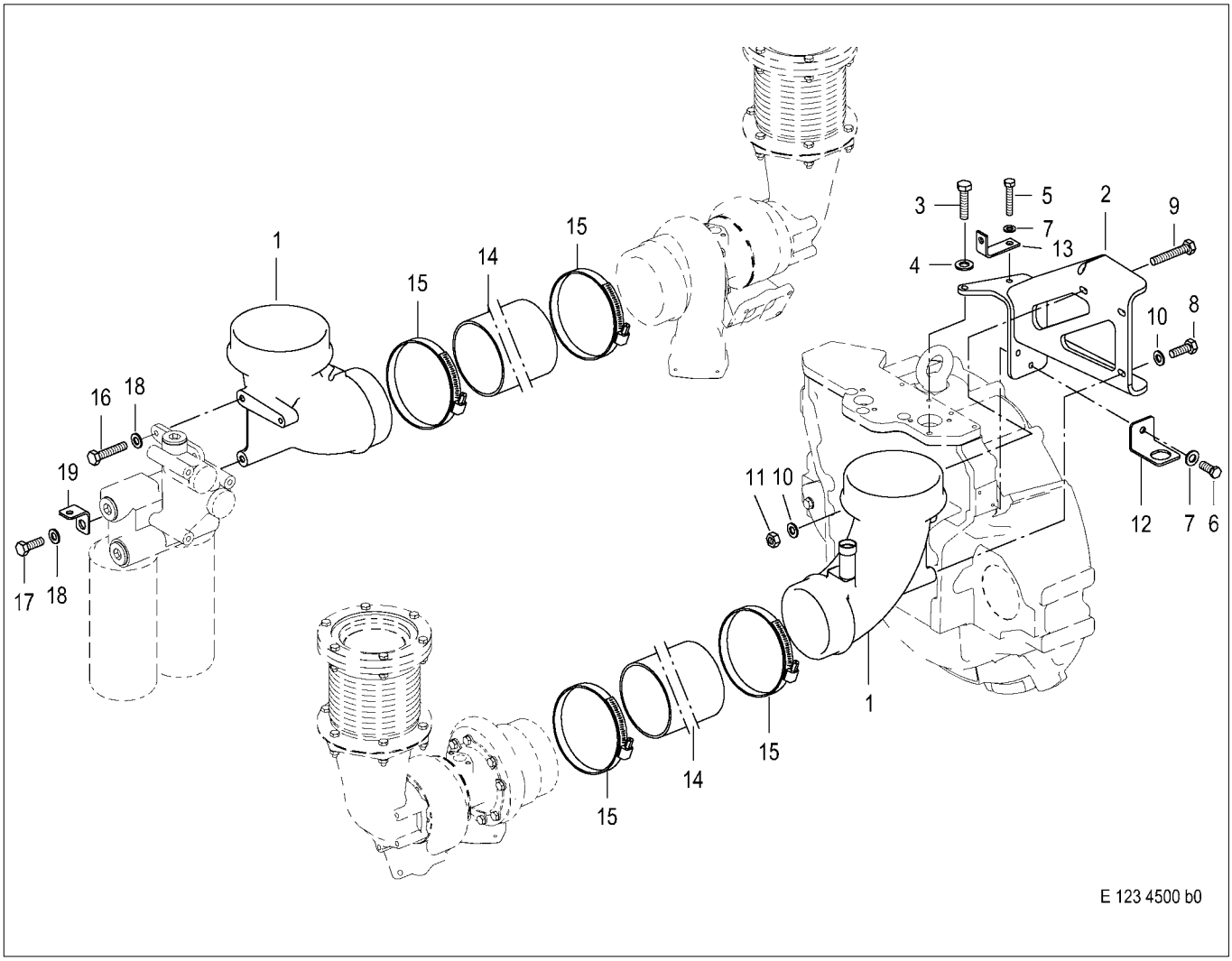
A distinction must be made as to whether:

1 —— The engine was completely disassembled
2 —— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

C 123.05 Intake Housing

C 123.05.01 Overview Drawing



1 Elbow
2 Bracket
3 Hex screw
4 Washer
5 Hex screw
6 Hex screw
7 Washer
8 Hex screw
9 Hex screw
10 Washer
11 Hex nut
12 Bracket
13 Bracket
14 Rubber sleeve
15 Clamp
16 Hex screw
17 Hex screw
18 Washer
19 Bracket

C 123.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove air filter	C 121.05
–	x	x	Remove fuel filter	C 083.05
–	x	x	Disconnect electric wiring	–
–	x	x	Remove intake hose of crankcase ventilation	C 018.10

C 123.05.05 Removal

Removing elbow

Remove bracket, elbow and rubber sleeves as per overview drawing C 123.05.

After removal, seal opening on turbocharger compressor housing with a suitable cover.

C 123.05.08 Inspection and Repair

Note: Make sure that air-carrying components are perfectly clean.

Clean all parts.

Using the surface crack-testing method with fluorescent penetrant dye, check elbow for cracks.

If cracks are detected, replace part.

Check bracket for wear, cracks and damage; recondition or replace as necessary.

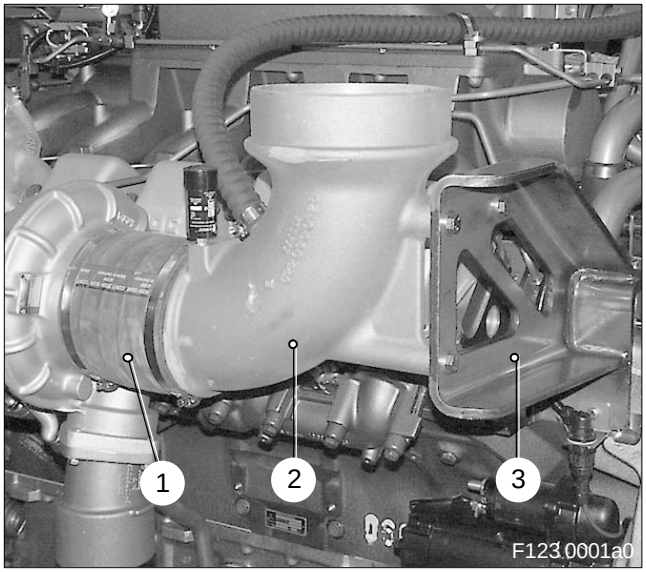
Check sealing, mating and seating faces on elbow for damage and surface irregularities; rub down with an oilstone as necessary.

Check condition of threaded inserts; replace if necessary.

Check clamps for condition and screws for ease of movement; replace clamp if necessary.

Replace clamps and rubber sleeves as part of W6 overhaul.

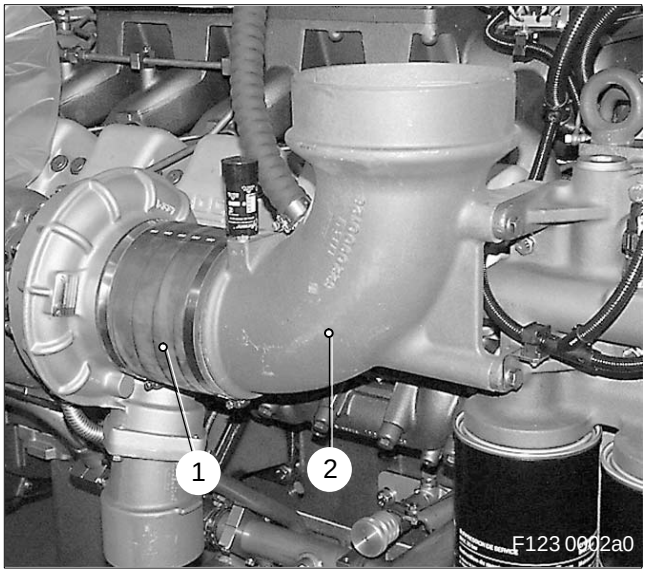
C 123.05.11 Installation



Install elbow, left engine side

Note: Prior to installation, remove cover and ensure air-carrying lines are perfectly clean.

Install elbow (2), rubber sleeve (1) and bracket (3), ensuring they are tension-free – see also overview drawing C 123.05.



Install elbow, right engine side

Note: Prior to installation, remove cover and ensure air-carrying lines are perfectly clean.

Install elbow (2) and rubber sleeve (1), ensuring they are tension-free – see also overview drawing C 123.05.

C 123.05.12 After-Removal Operations

A distinction must be made as to whether:

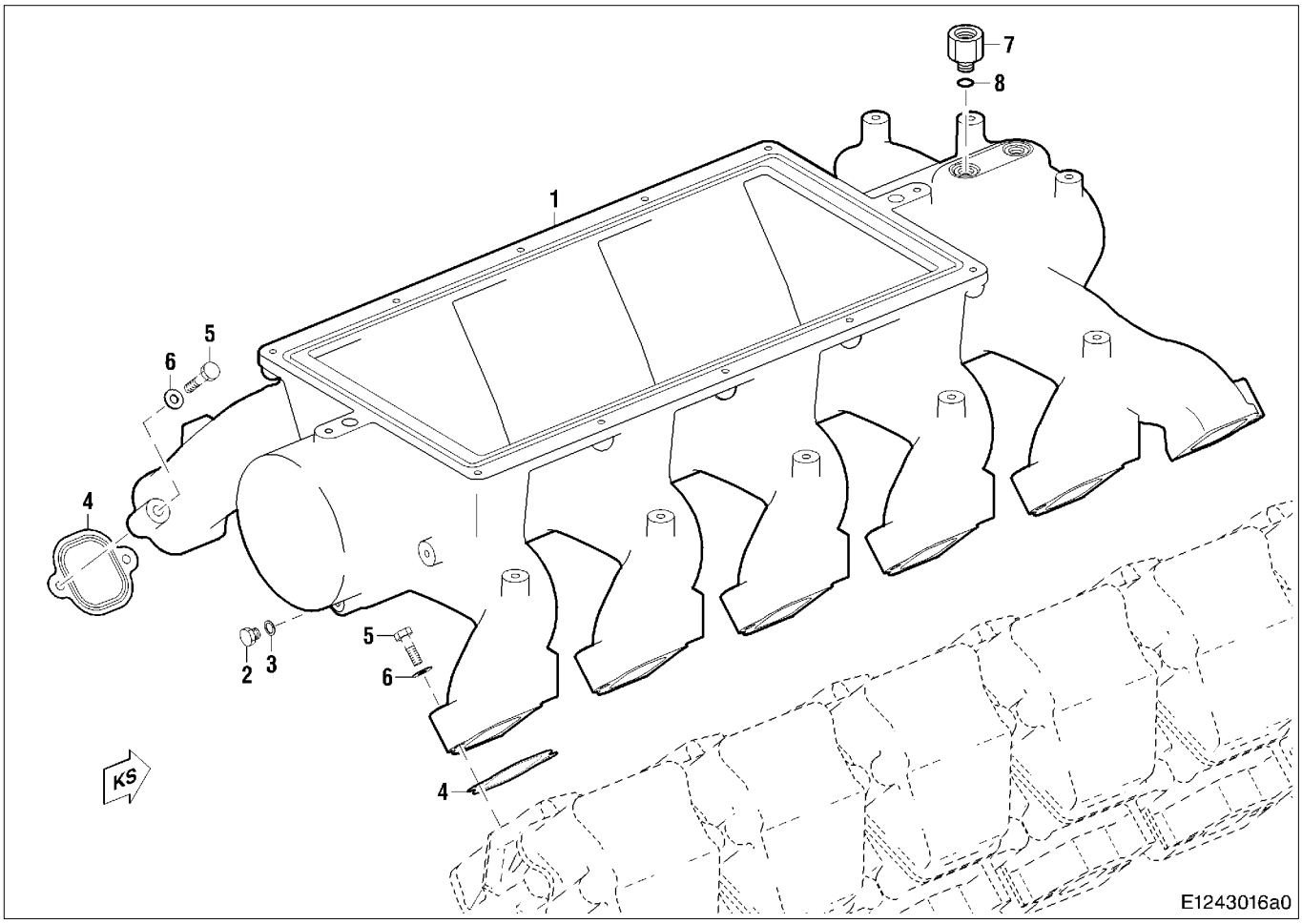
1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	x	–	Install engine	B 007
–	x	x	Install fuel filter	C 083.05
–	x	x	Connect electric cables	–
–	x	x	Install intake hose of crankcase ventilation	C 018.10
–	x	x	Install air filter	C 121.05
–	–	x	Release engine start	Operating Instructions

C 124.05 Air Supply to Cylinders

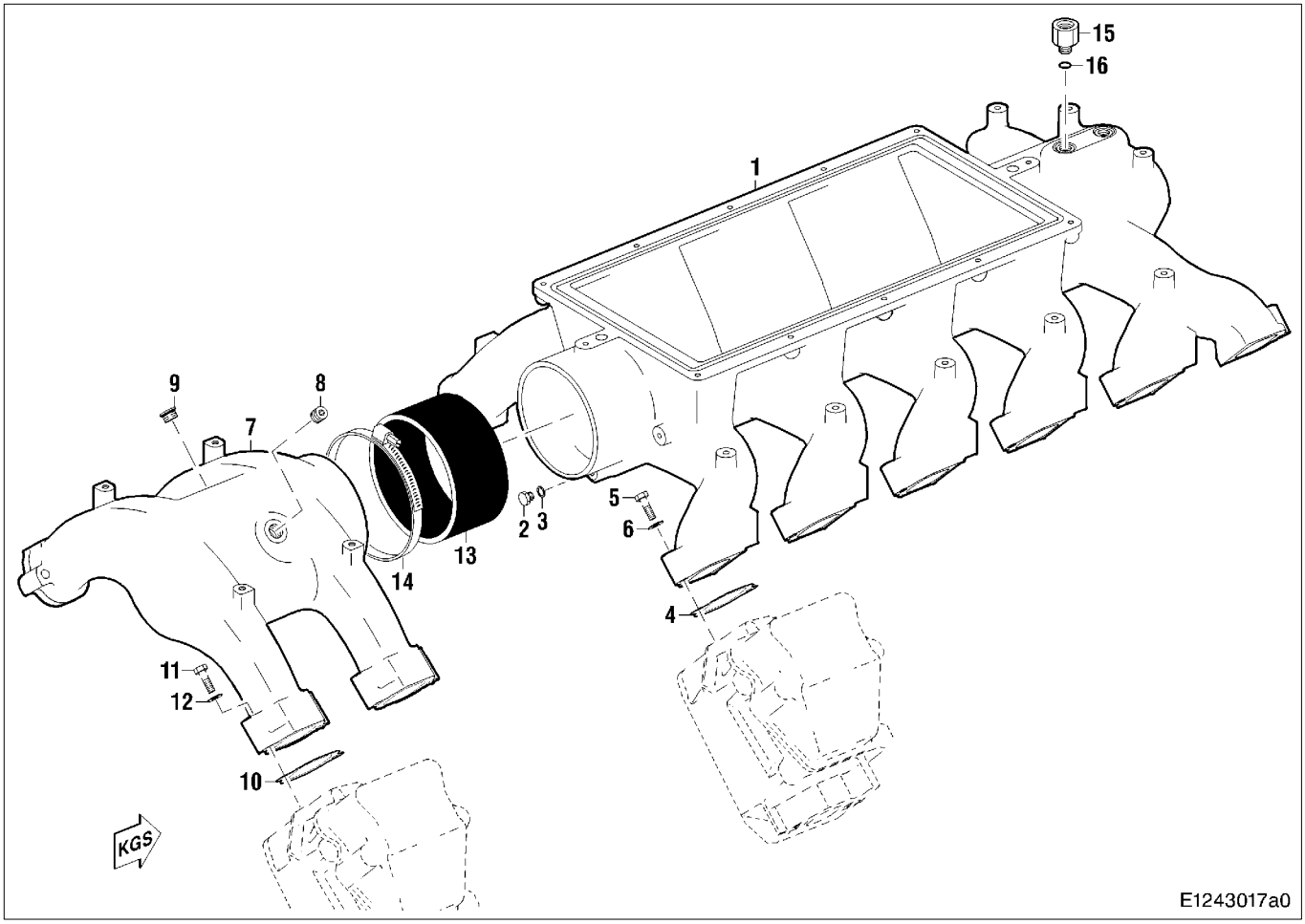
C 124.05.01 Overview Drawing

Charge air manifold, 12V



1 Charge air manifold
2 Plug
3 Sealing ring
4 Gasket
5 Hex screw
6 Washer
7 Union
8 O-ring

Charge air manifolds, 16V



1 Charge air manifold
2 Plug
3 Sealing ring
4 Gasket
5 Hex screw
6 Washer
7 Charge air manifold
8 Blanking plug
9 Plug
10 Gasket
11 Hex screw
12 Washer
13 Rubber sleeve
14 Clamp
15 Union
16 O-ring

C 124.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Remove oil supply lines for turbochargers	C 185.10
–	x	x	Disconnect vent lines	C 202.65
–	x	x	Remove crankcase breather	C 018.10
–	x	x	Disconnect electric wiring	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove charge air lines	C 125.05
–	x	x	Remove cover	C 114.05

C 124.05.05 Removal

Remove charge air manifold

Release clamps (16V) as per overview drawing – see C 124.05.01.

Remove hex screws and washers for charge air manifold.

WARNING

Heavy object. Risk of injury!
Use suitable tools and lifting equipment.

Remove charge air manifold (12V) or charge air manifold and charge air pipe (16V) and gaskets.

Remove unions, screws and blanking plugs.

Remove sealing rings and O-rings.

C 124.05.08 Inspection and Repair

Clean all air-carrying components with cleaning agent.

Check charge air manifold and charge air manifold for leaks with air under water.

WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Air pressure = 0.5 bar

Check charge air manifold for cracks using surface crack-testing method with red penetrant dye as necessary.

In event of leaks or cracks, replace charge air manifold.

Check sealing and mating faces for surface irregularities and damage; rub down with an oilstone if necessary.

Check condition of threads; rechase threads if necessary or replace threaded inserts if necessary.

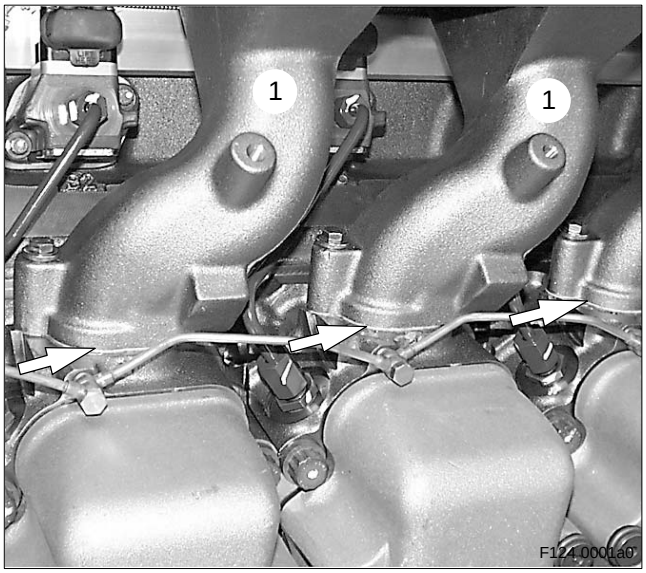
Check clamps for condition and screws for ease of movement; replace clamp if necessary.

Check hex screws for damage and wear; replace as necessary.

Replace O-ring, sealing ring and gaskets.

Replace clamps and rubber sleeves as part of W6 overhaul.

C 124.05.11 Installation



Install charge air manifold

Note: Make sure that air-carrying components are perfectly clean.

Before installation, coat O-ring with assembly paste.

WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Complete charge air manifold (12V) or charge air manifold and charge air pipe (16V) as per overview drawing – see C 124.05.01.

Check sealing surfaces on cylinder head and charge air manifold (1) or charge air pipe, clean as necessary.

Fit gaskets (arrows) on cylinder heads.

Install charge air manifold (12V) or charge air manifold and charge air pipe (16V) with connections as per overview drawing.

C 124.05.12 After-Installation Operations

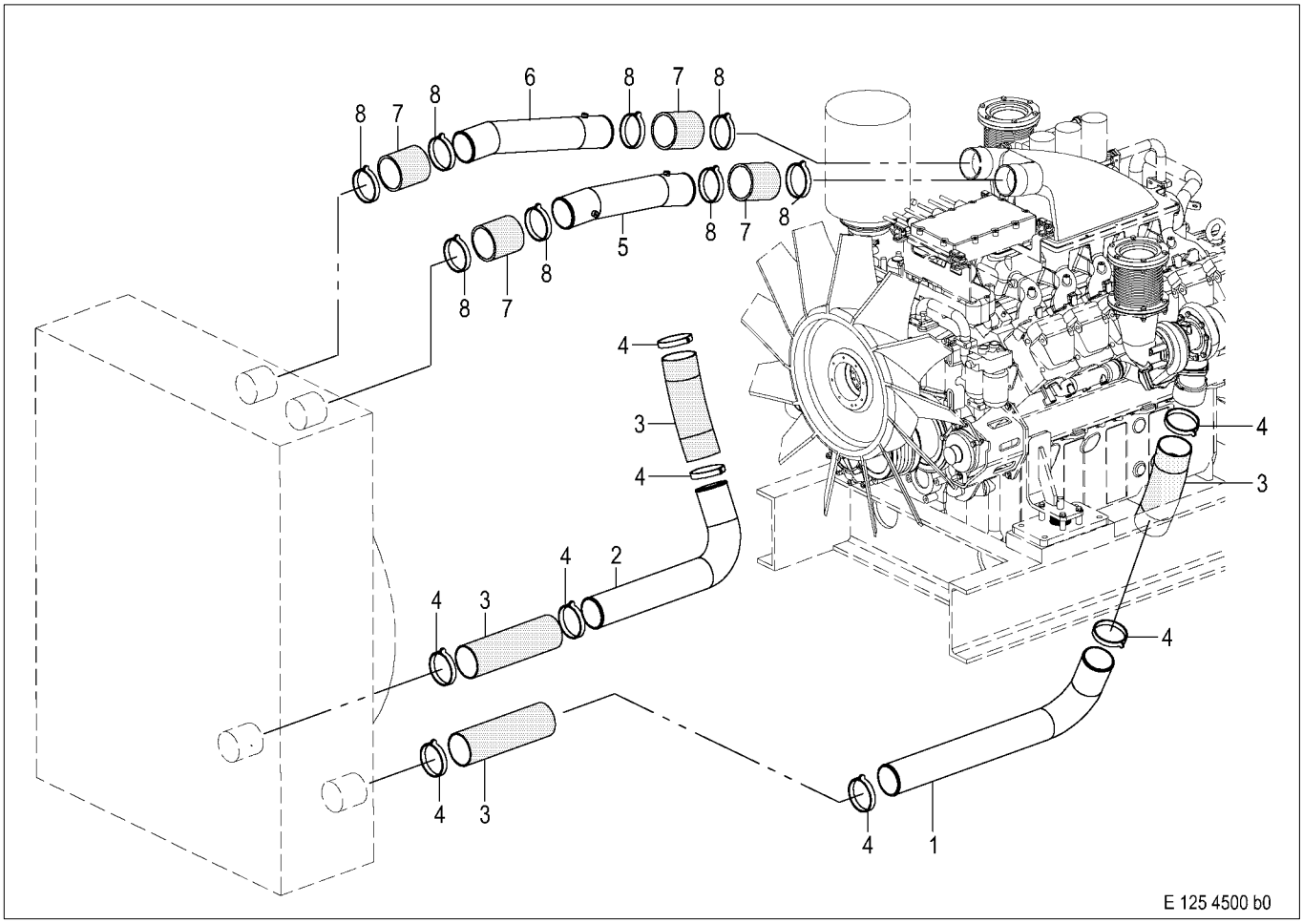
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install cover	C 114.05
–	x	x	Install charge air lines	C 125.05
–	x	x	Install crankcase breather	C 018.10
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect electric cables	C 507.10
–	x	x	Install oil supply lines for turbochargers	C 185.10
–	x	x	Connect vent lines	C 202.65
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 125.05 Air Supply System from Turbocharger to Intercooler

C 125.05.01 Overview Drawing



1 Charge air line, left
2 Charge air line, right
3 Spiral hose
4 Clamp
5 Charge air line, left
6 Charge air line, right
7 Rubber sleeve
8 Clamp

C 125.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 125.05.05 Removal

Removing charge air lines

Note: Before removing lines, it is advisable to photograph the engine from all sides or attach metal tags to the lines and fixtures so that they can be reinstalled in their original positions.

Remove lines, connecting components and fixtures as per overview drawing – see C 125.05.01.

After removing lines, seal all connections with suitable covers.

C 125.05.08 Inspection and Repair

Clean lines with cold cleaner and brush.

Visually inspect lines, especially sealing and mating faces, for wear and damage; rub down with emery cloth or an oilstone or replace component.

If necessary, repair pipelines. If necessary, check for leaks with corrosion inhibitor with air in water bath.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Check clamps, spiral hoses and rubber sleeves for damage; replace component as necessary.

Replace clamps, spiral hoses and rubber sleeves during W6 maintenance.

C 125.05.11 Installation

Installing charge air lines

Note: Prior to installation, remove all plugs and seals and ensure air-carrying lines are perfectly clean.

Install lines with connectors and securing components free of tension as shown in overview drawing – see C 125.05.01.

C 125.05.12 After-Installation Operations

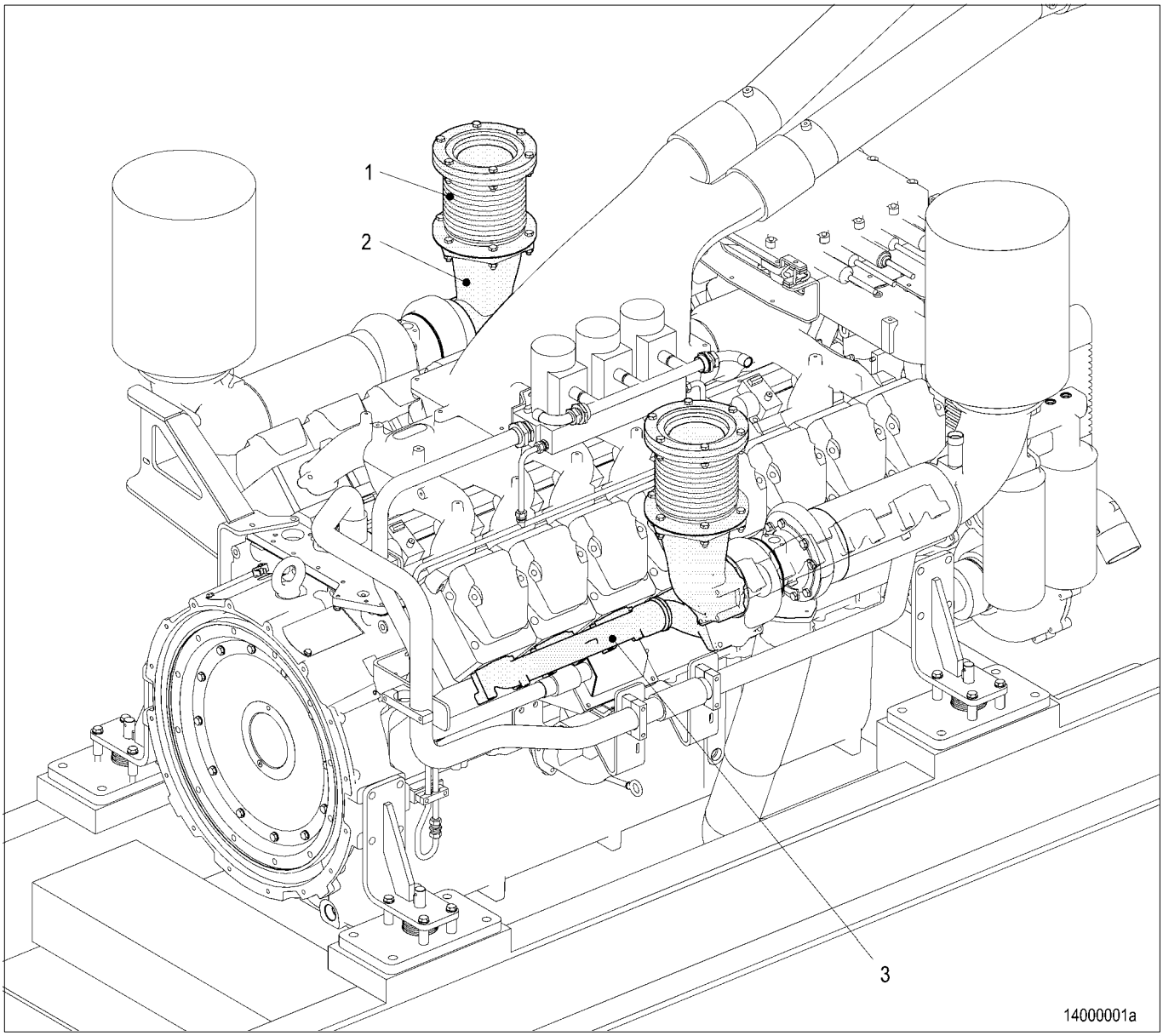
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007

Contents

C 140 Exhaust System



1 Bellows
2 Exhaust elbow
3 Exhaust manifold

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

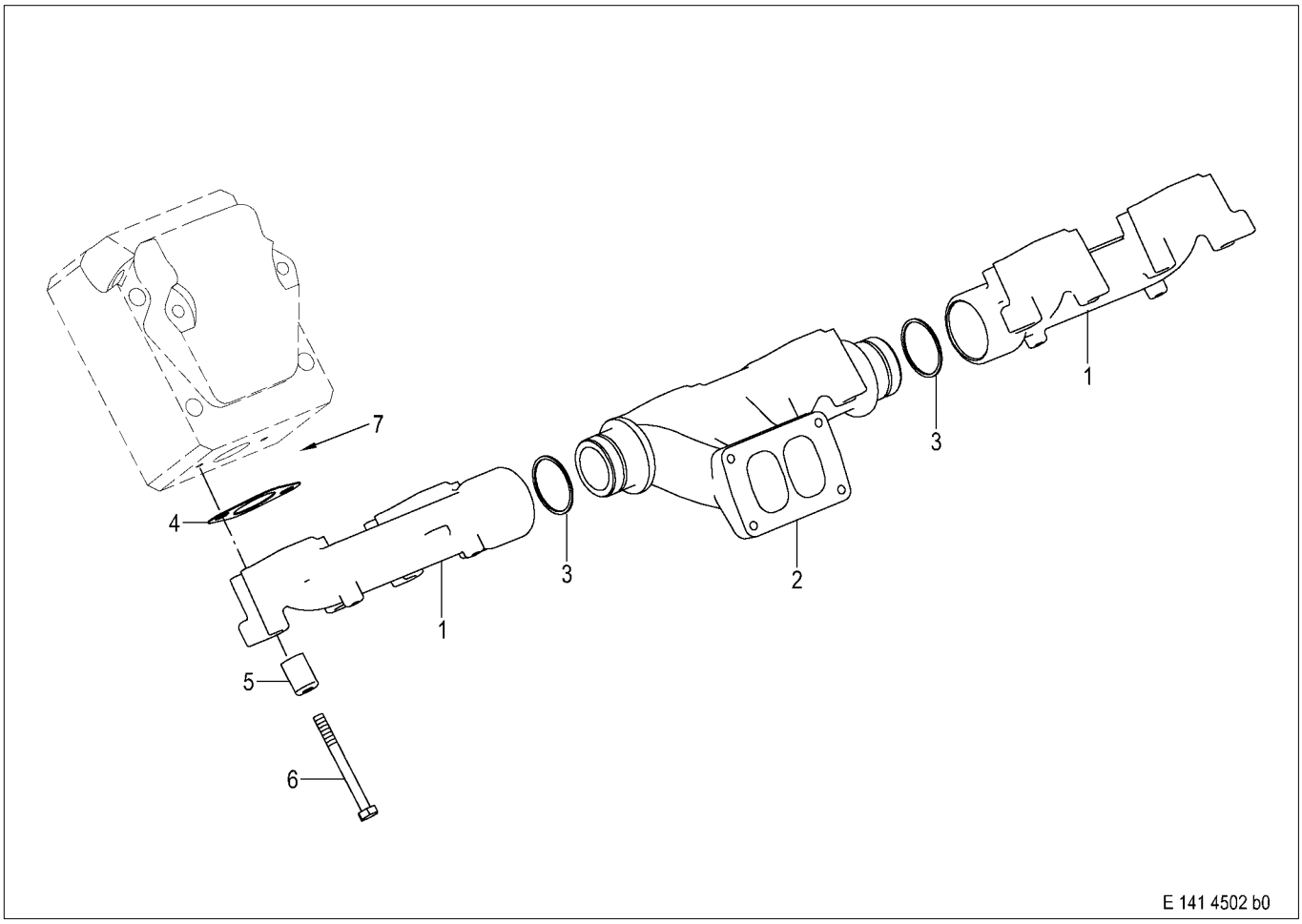
When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Magnifier			
Polishing cloth			
Liquid nitrogen			
Activator	Loctite No. 7649	50548	
Hydrochloric acid			
Corrosion inhibitor	Pfinder AP 11 F	40355	
Vaseline	Petroleum jelly, white	40317	
Assembly paste	Ultra-Therm	50547	
Cleaning agent (carbon-deposit remover)	Meister Proper	40377	
Engine oil			
Cleaning agent	Solvclean KW	40022	
Engineer's blue	blue	40641	
Synthetic shot-blasting pellets	Dry Strip Type 216/20	20098	
Kerosene or diesel fuel			
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Magnetic crack-testing equipment with fluorescent magnetic powder			
Surface crack-testing equipment with red penetrant dye			

C 141.10 Exhaust Pipework after Cylinder Head

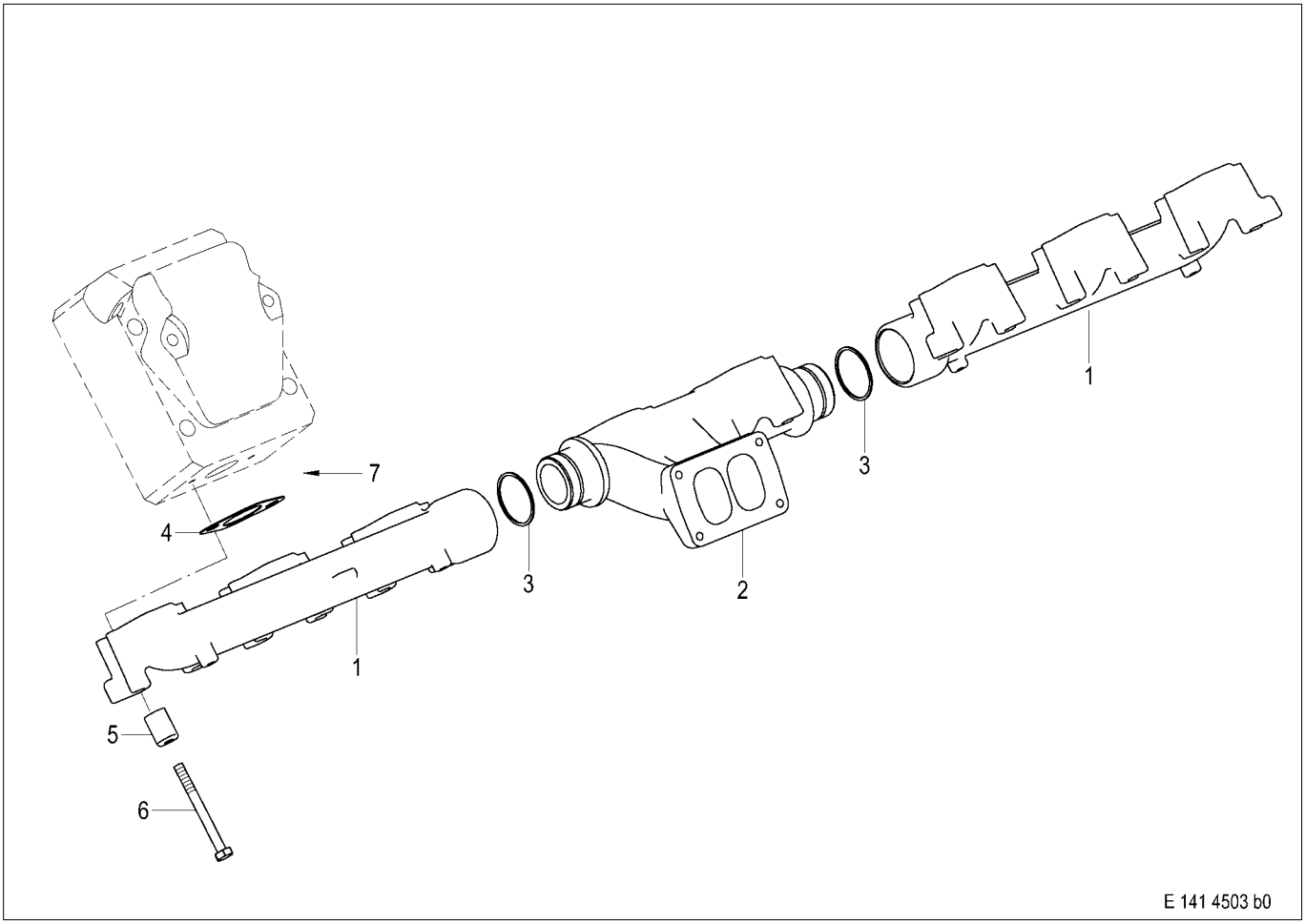
C 141.10.01 Overview Drawing

Exhaust line, 12V



1 Exhaust elbow
2 Exhaust elbow
3 Sealing ring
4 Exhaust elbow
5 Screw
Lubricant: Assembly paste
Tightening torque: 30 Nm

Exhaust line, 16V



1 Exhaust elbow
2 Exhaust elbow
3 Sealing ring
4 Exhaust elbow
5 Screw
Lubricant: Assembly paste
Tightening torque: 30 Nm

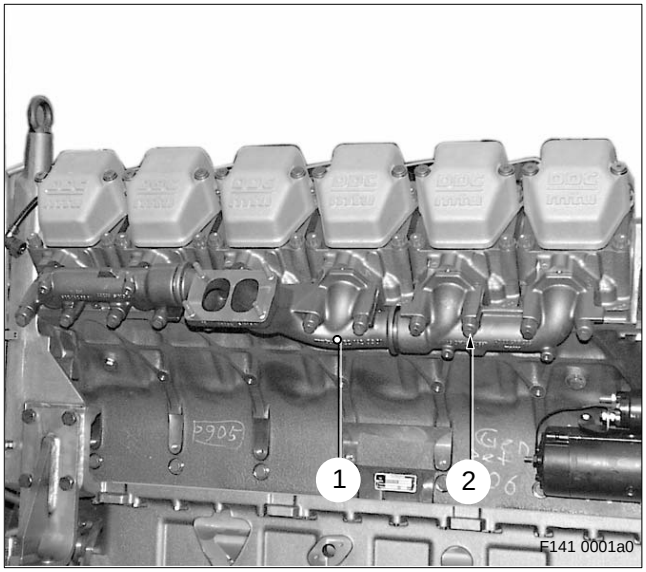
C 141.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove air filter	C 121.05
–	x	x	Remove intake housing	C 123.05
–	x	x	Remove exhaust system after exhaust turbocharger	C 145.05
–	x	x	Remove exhaust turbocharger	C 101.01

C 141.10.05 Removal



Removing exhaust line, 12V

Remove screws (2) for exhaust line (1) and remove complete exhaust line.

Remove gaskets.

Withdraw exhaust elbow and remove sealing rings.

Removing exhaust line, 16V

Removal is the same as for –Removing exhaust line, 12V.

C 141.10.08 Inspection and Repair

Clean all components and visually inspect for damage and defects; replace as necessary.

CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Place exhaust elbow in a tank filled with decarbonizer.

Dwell time depends on thickness of deposits.

After cleaning with carbon-deposit remover, rinse components in water until no further residues are washed off.

If deposits are stubborn, use synthetic shot-blasting pellets (nominal size 16 to 20) to help cleaning.

Using the surface crack-testing method with red penetrant dye, check exhaust elbow for cracks; replace component if cracks are found.

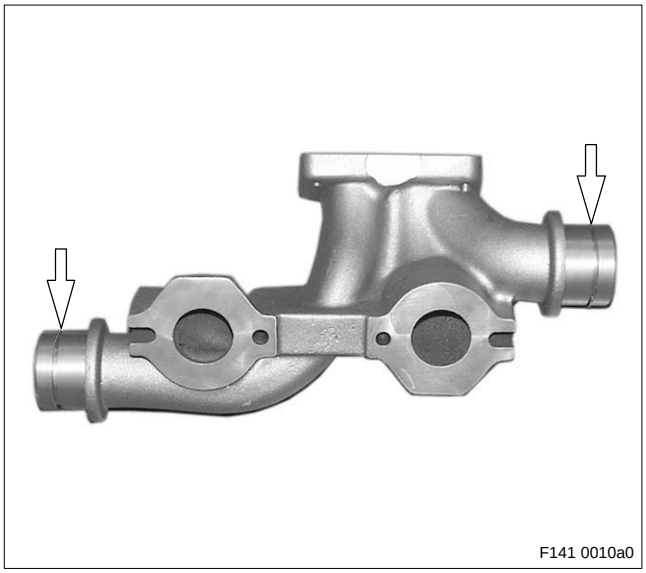
Check exhaust elbow for warping; replace elbow in event of warping.

Check sealing and mating faces; rub down with emery cloth or an oilstone or replace components as necessary.

Check condition of threads in exhaust elbow; rechase threads as necessary.

Replace gaskets, sealing rings and studs.

C 141.10.11 Installation



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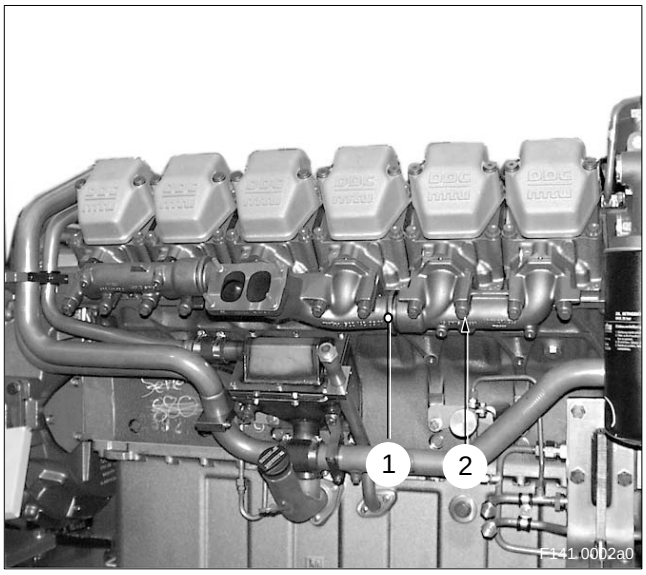
Installing exhaust line, 12V

Check sealing surfaces on exhaust elbow and cylinder heads; clean as necessary.

Coat sealing rings with assembly paste and insert in grooves (arrows) on exhaust elbow.



Install exhaust elbow (1), ensuring it is tension-free, with new gaskets, with spacers and hex screws (2) as per overview drawing – see C 141.10.01.

Tighten hex screws to specified tightening torque.

Installing exhaust line, 16V

Installation is the same as for –Installing exhaust line, 12V–.

C 141.10.12 After-Installation Operations

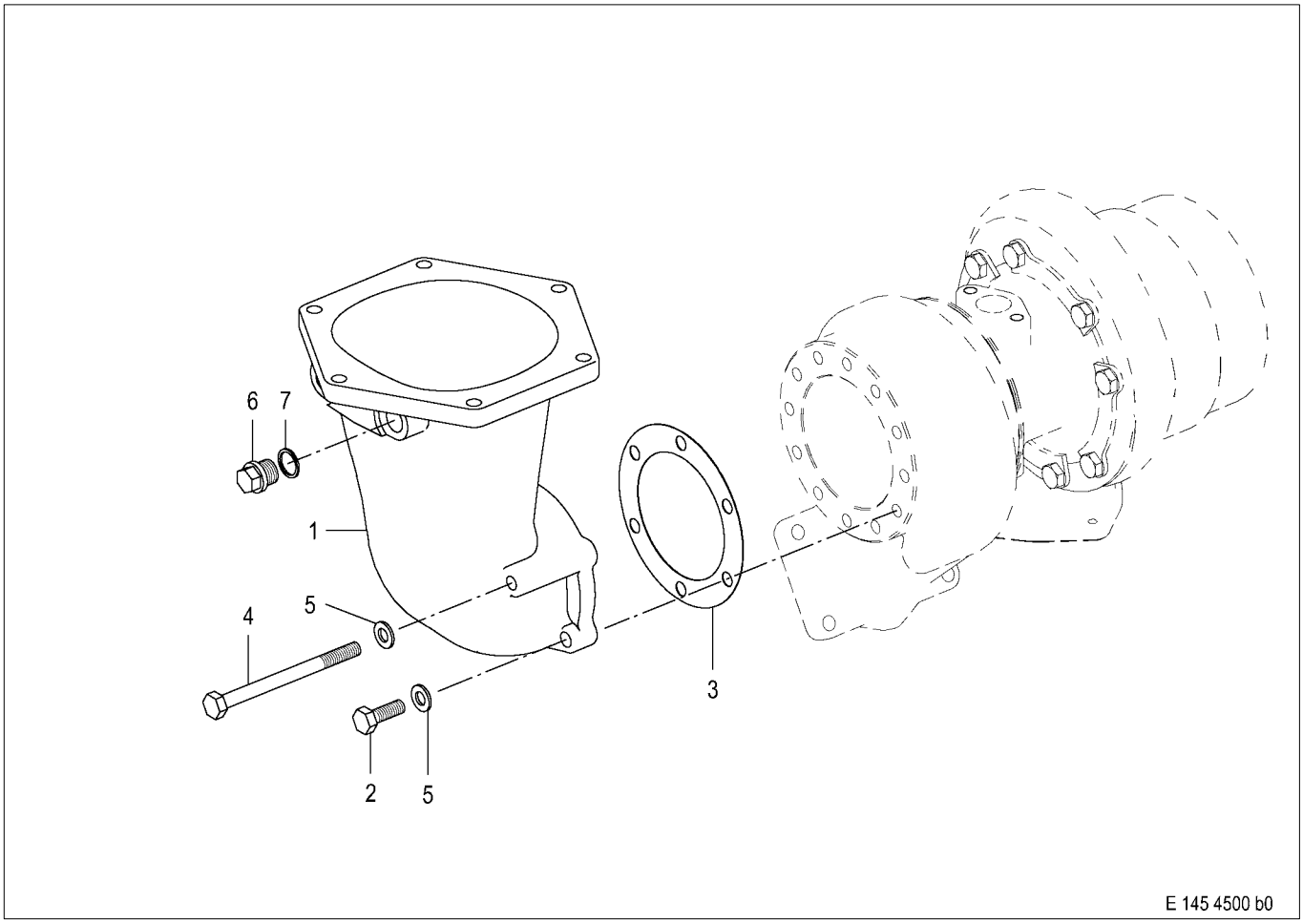
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

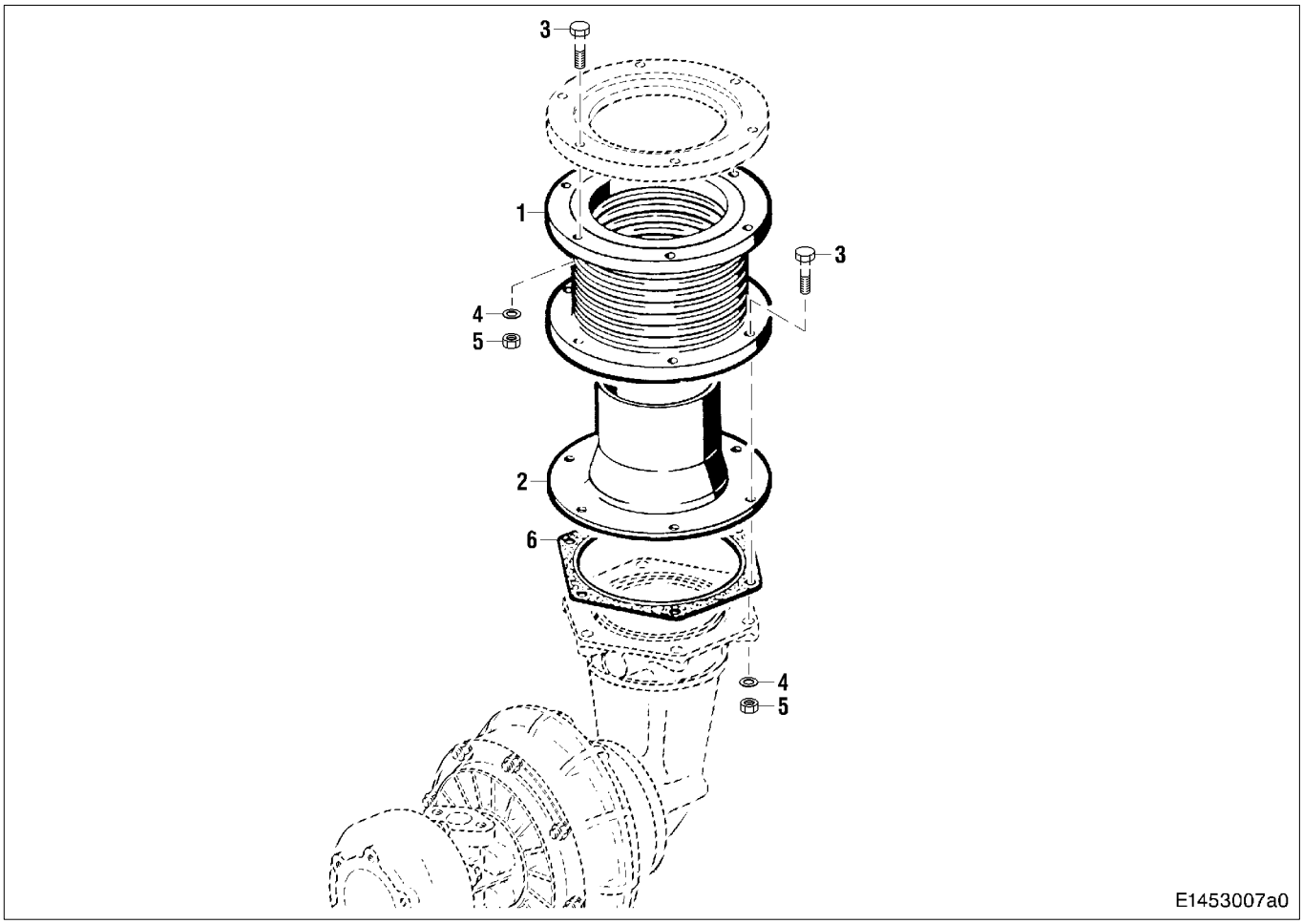
1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install turbocharger	C 101.01
–	x	x	Install intake housing	C 123.05
–	x	x	Install air filter	C 121.05
–	x	x	Install exhaust system after exhaust turbocharger	C 145.05
–	–	x	Release engine start	Operating Instructions

C 145.05 Exhaust System after Turbocharger

C 145.05.01 Overview Drawing



1 Exhaust elbow
2 Hex screw
3 Gasket
4 Hex screw
5 Washer
6 Plug
7 Sealing ring



1 Bellows
2 Protective tube
3 Hex screw
4 Washer
5 Nut
6 Gasket

C 145.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 145.05.05 Removal

Remove compensator, protective plate and exhaust elbow as per overview drawing – see C 145.05.01.

Remove sealing rings and gaskets.

C 145.05.08 Inspection and Repair

Clean all parts.

CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Place parts displaying soot deposits in a bath containing carbon-deposit remover. Dwell time depends on thickness of deposits.

After cleaning with carbon-deposit remover, rinse components in water until no further residues are washed off.

If deposits are stubborn, use synthetic shot-blasting pellets (nominal size 16 to 20) to help cleaning.

If necessary, use the surface crack-testing method with red penetrant dye to check exhaust elbow, compensator and protective pipe for cracks.

If cracks are detected, replace part.

Check parts for wear and warping; replace component if necessary.

Check sealing or mating faces for evenness and damage; rub down with oilstone or replace part.

Check condition of plugs, hex screws and hex nuts and check thread for ease of movement; replace part as necessary.

Replace sealing rings and gaskets.

C 145.05.11 Installation

Prior to assembly, coat plugs, hex nuts and hex screws with assembly paste.

Install exhaust elbow, protective plate and compensator with new sealing rings and gaskets as shown in overview drawing – see C 145.05.01.

C 145.05.12 After-Installation Operations

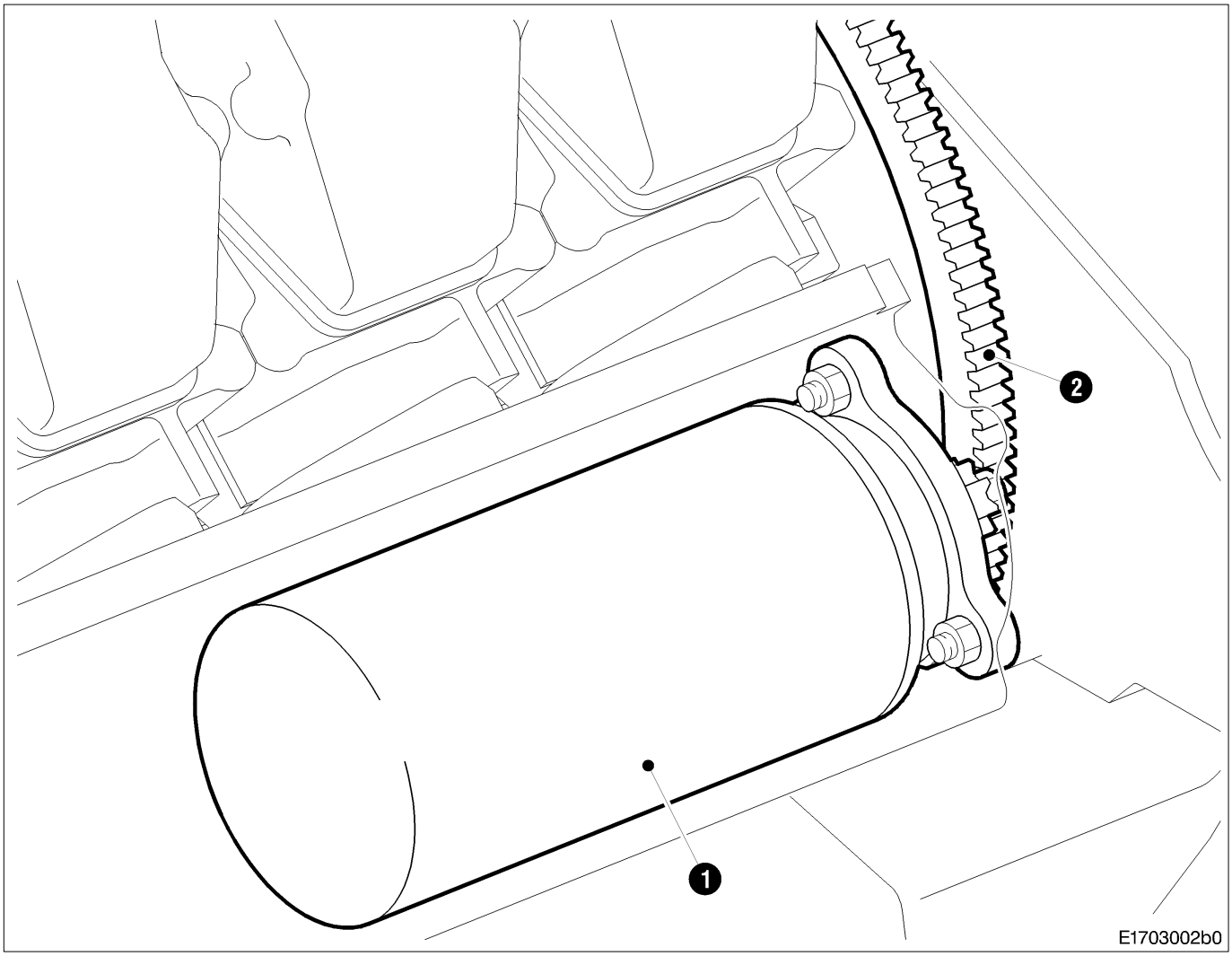
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 170 Starting System



1 Electric starter
2 Ring gear

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

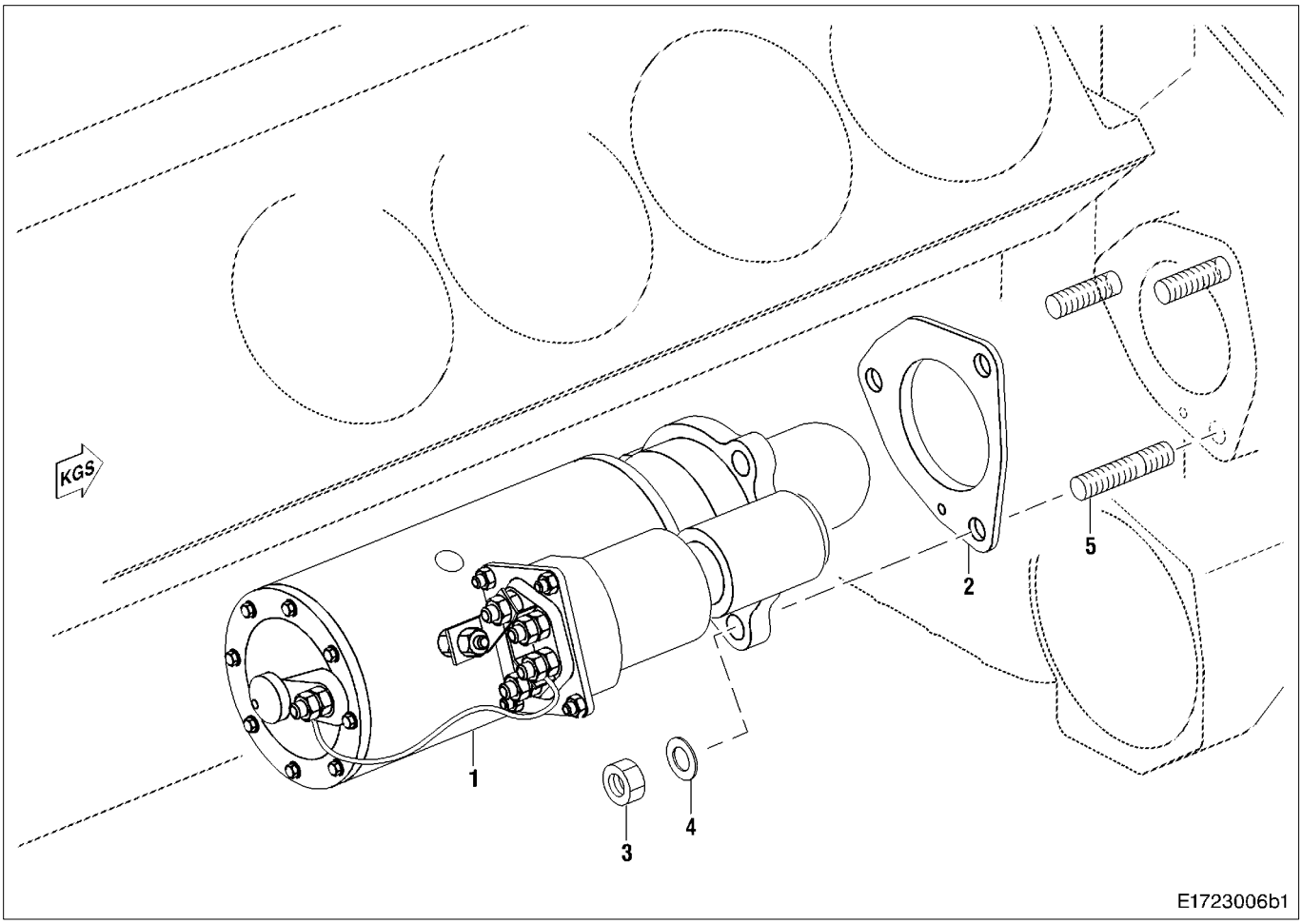
When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Vaseline	Vaseline grease, white	40317	
Multipurpose grease	Shell Retinax A	40333	
Engine oil			
Cleaning agent	Solvclean KW	40022	
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Kerosene or diesel fuel			

C 172.05 Starter

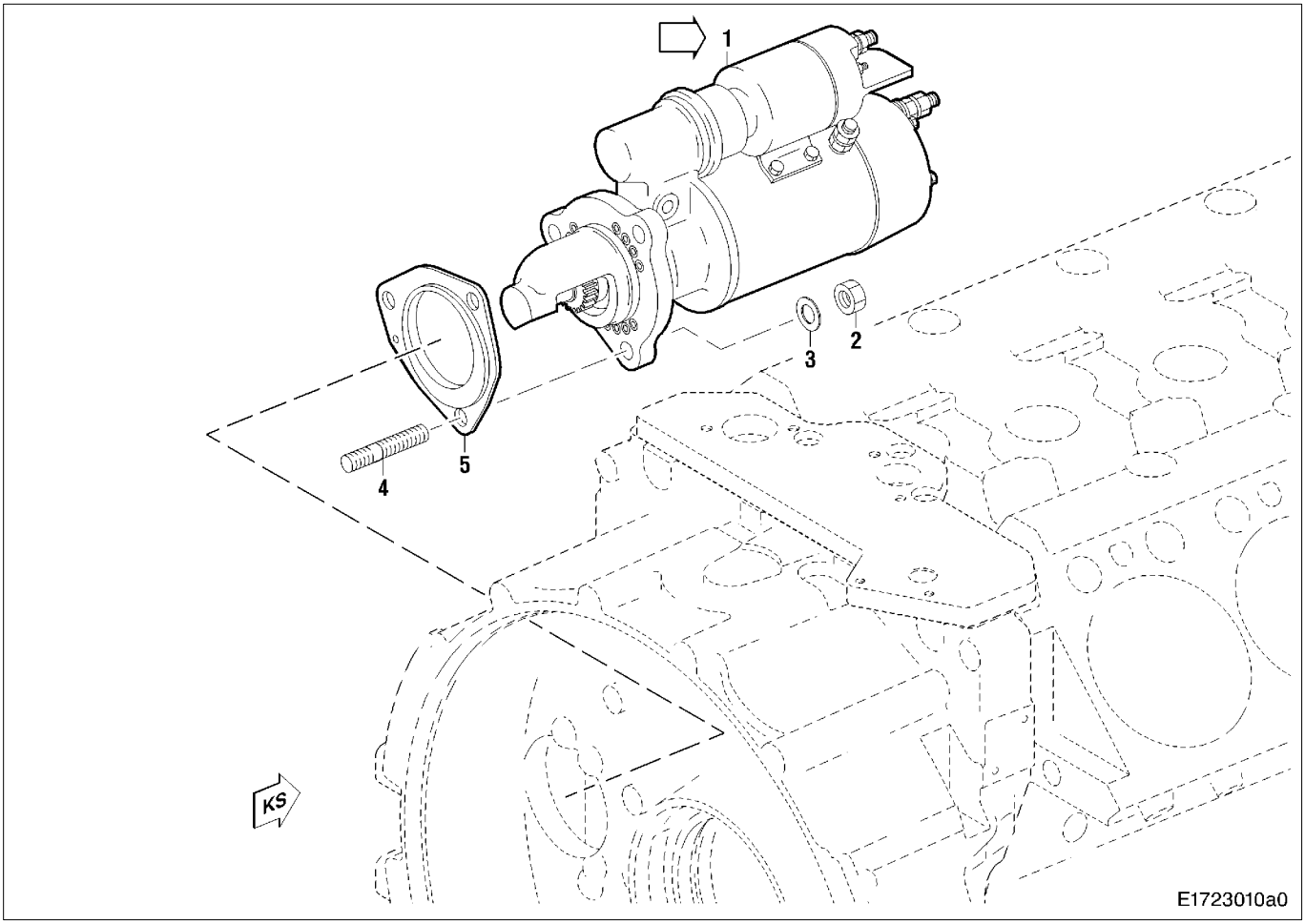
C 172.05.01 Overview Drawing

Starter, 12V



1 Starter
2 Flange
3 Hex nut
4 Washer
5 Stud

Starter, 16V



1 Starter
2 Hex nut
3 Washer
4 Stud
5 Flange

C 172.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 172.05.05 Removal

Removing starter

Note: Before removal, ensure that the negative battery pole is disconnected!

Mark cable at starter if necessary and remove.

Remove nuts for starter as per overview drawing – see C 172.05.01.

Pull starter from its seat and remove.

Remove flange from bore in flywheel housing.

Remove studs if necessary (e.g. if damaged).

C 172.05.06 Disassembly

See Manufacturer's Documentation.

C 172.05.08 Inspection and Repair

Inspect and repair individual parts of starter in accordance with Manufacturer's documentation.

Clean starter externally and check for damage and check condition.

Note: During cleaning operations, ensure that no moisture can penetrate inner parts of solenoid switch. If moistures penetrates solenoid switch it results in corrosion and circuit breaks.

Check tooth flanks of pinion for wear, indentations and chipping; if necessary recondition or replace starter.

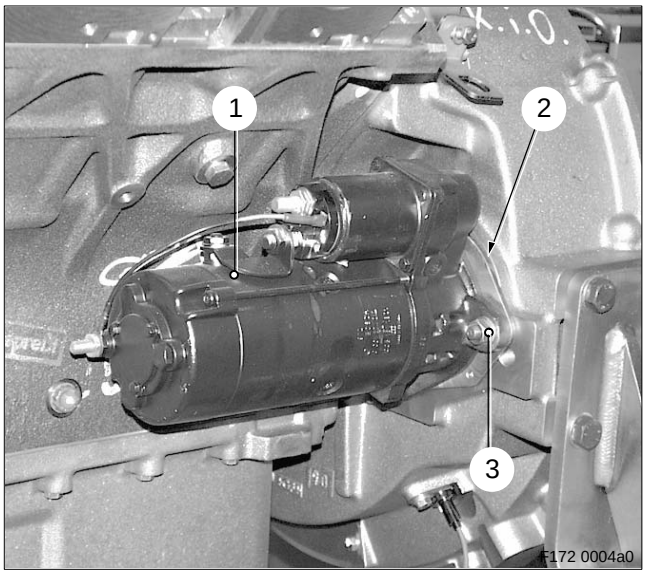
Check condition of flange and recondition or replace as necessary.

Check condition of studs, nuts and washers and thread for ease of movement; replace components as necessary.

C 172.05.10 Assembly

See Manufacturer's Documentation.

C 172.05.11 Installation



Installing starter, 12V

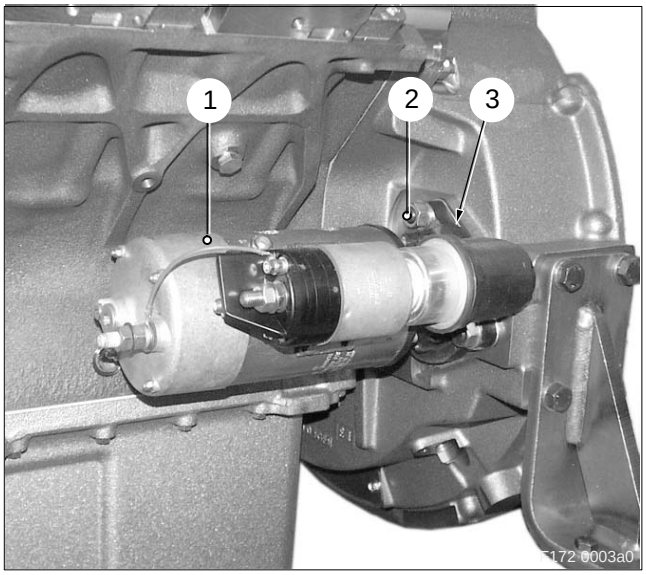
Prior to installing starter, coat starter pinion with long-lasting lubricant grease.

Insert flange (2) (see also overview drawing C 172.05.01) via studs into bore in flywheel housing.

Install starter (1) in flange and tighten with nuts (3) and washers.

Connect lines to starter, ensuring that lines to starter are correctly laid!

Connect battery ground strap.



Installing starter, 16V

Installation is the same as for –Installing starter, 12V–.

For installation position, see illustration.

C 172.05.12 After-Installation Operations

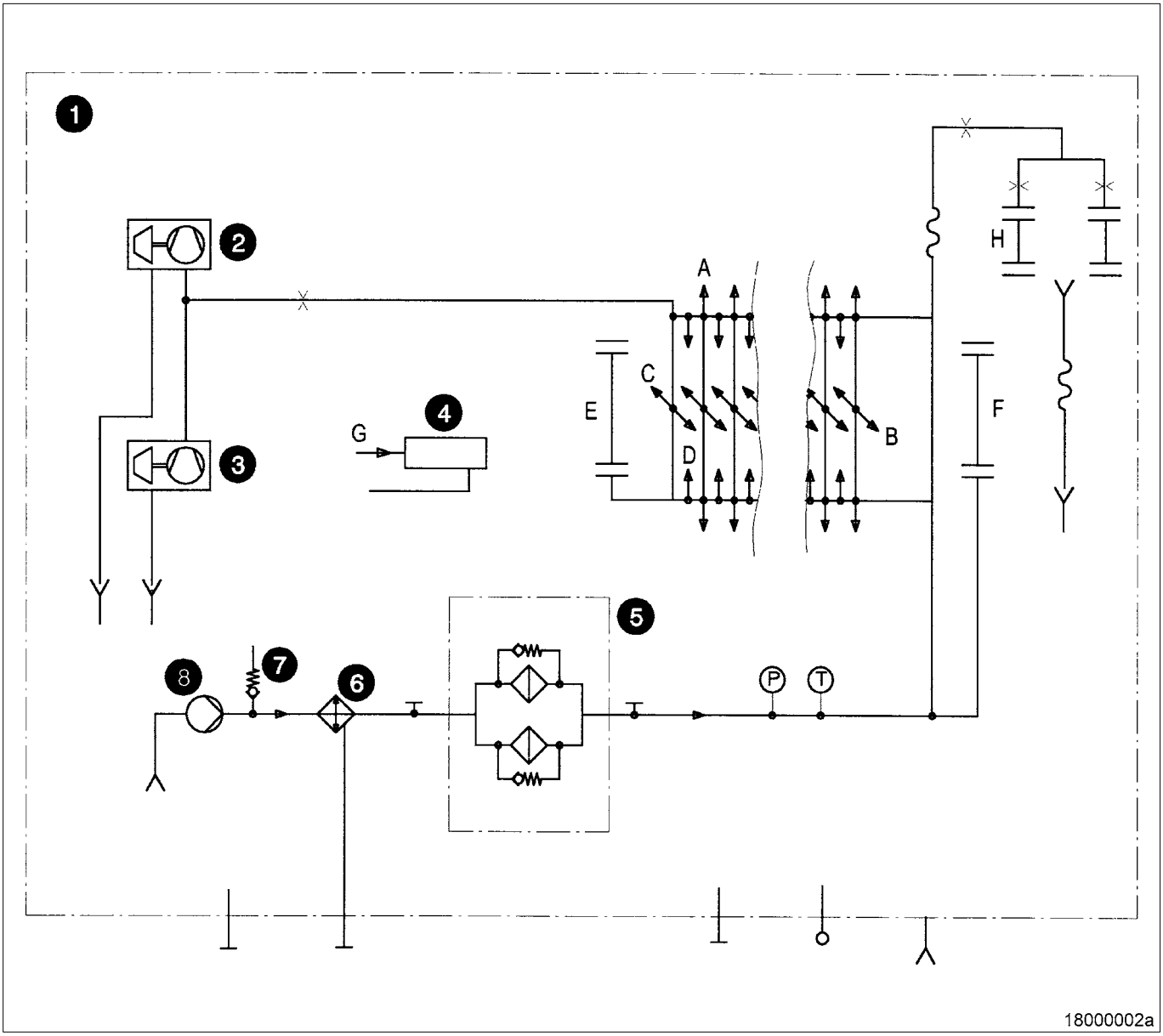
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 180 Lube Oil System



1 Engine
2 Exhaust turbocharger, left side
3 Exhaust turbocharger, right side
4 Plug-in pump
5 Lube oil filter
6 Oil heat exchanger
7 Lube oil pressure relief valve, 8.5 bar
8 Lube oil pump

A To rocker arms
B To main bearings
C To camshaft
D To piston cooling
E Crankshaft support bearing, driving end
F Gear case (free end) + crankshaft support bearing (free end)
G From camshaft
H Fan gear mounting
P Lube oil pressure sensor
T Lube oil temperature sensor

The following is a list of auxiliary equipment and materials needed for the assembly operations:

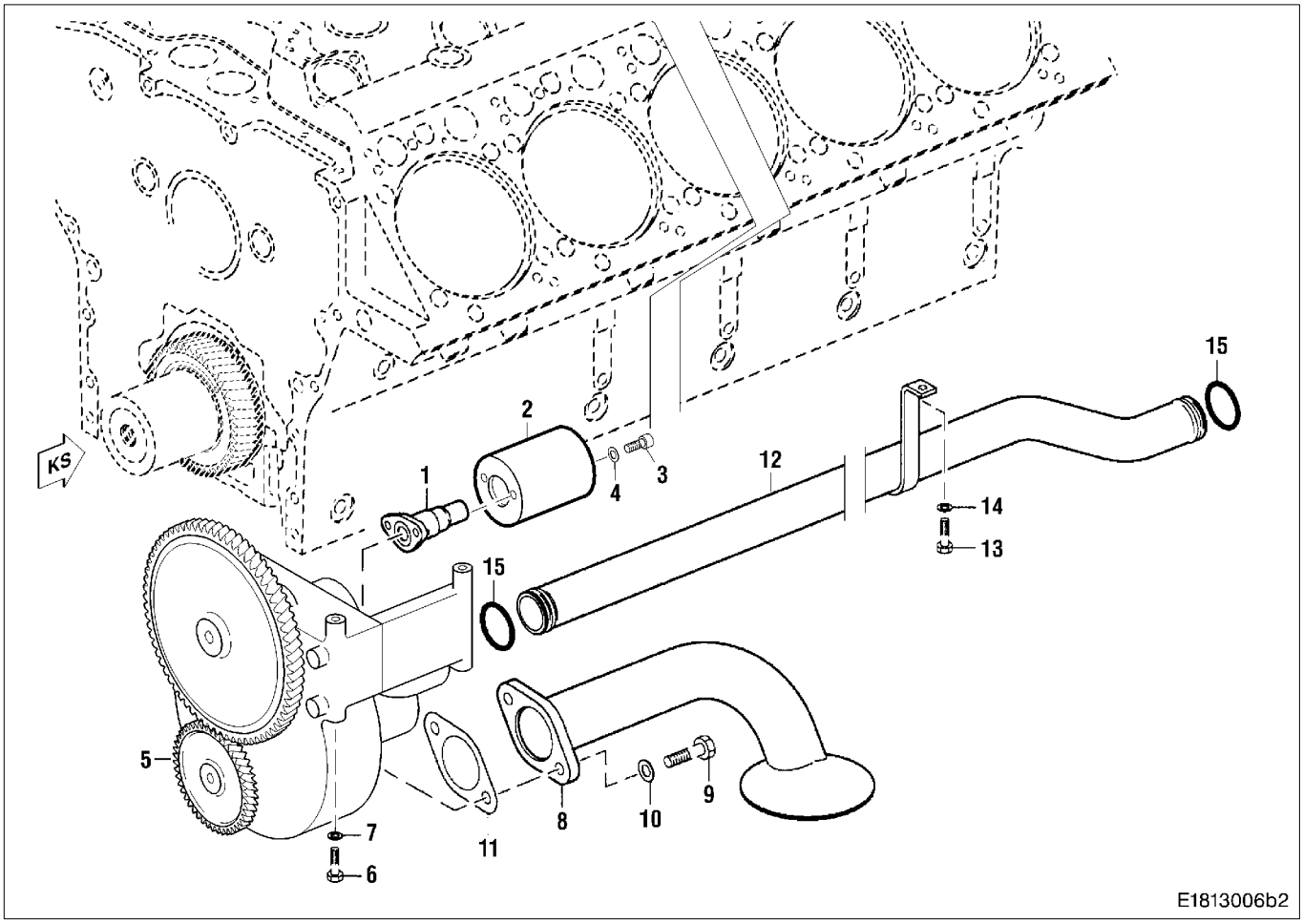
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Spray gun			
Inspection lamp			
Vaseline	Petroleum jelly, white	40317	
Engine oil			
Activator	Loctite No. 7649	50548	
Thread-sealing compound	Loctite No. 586	40033	Final strength at 20 °C – 12 hrs
Kerosene or diesel fuel			
Decalcifying agent	Porodox or Porozink		
Cooler cleaning agent (oil side)	P3 FD solution		
Hydrochloric acid			
Corrosion inhibitor	Pfinder AP 11 F	40355	
Preservation agent	Branol 32/10		
Cleaning agent	Solvclean KW	40022	
Engineer's blue	blue	40641	
Antifriction bearing grease	Texando F020	50107	
Denaturated ethanol		40250	
Sealing paste	Elastosil	50545	
Multipurpose grease	Shell Retinax A	40333	
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Surface crack-testing equipment with red penetrant dye			

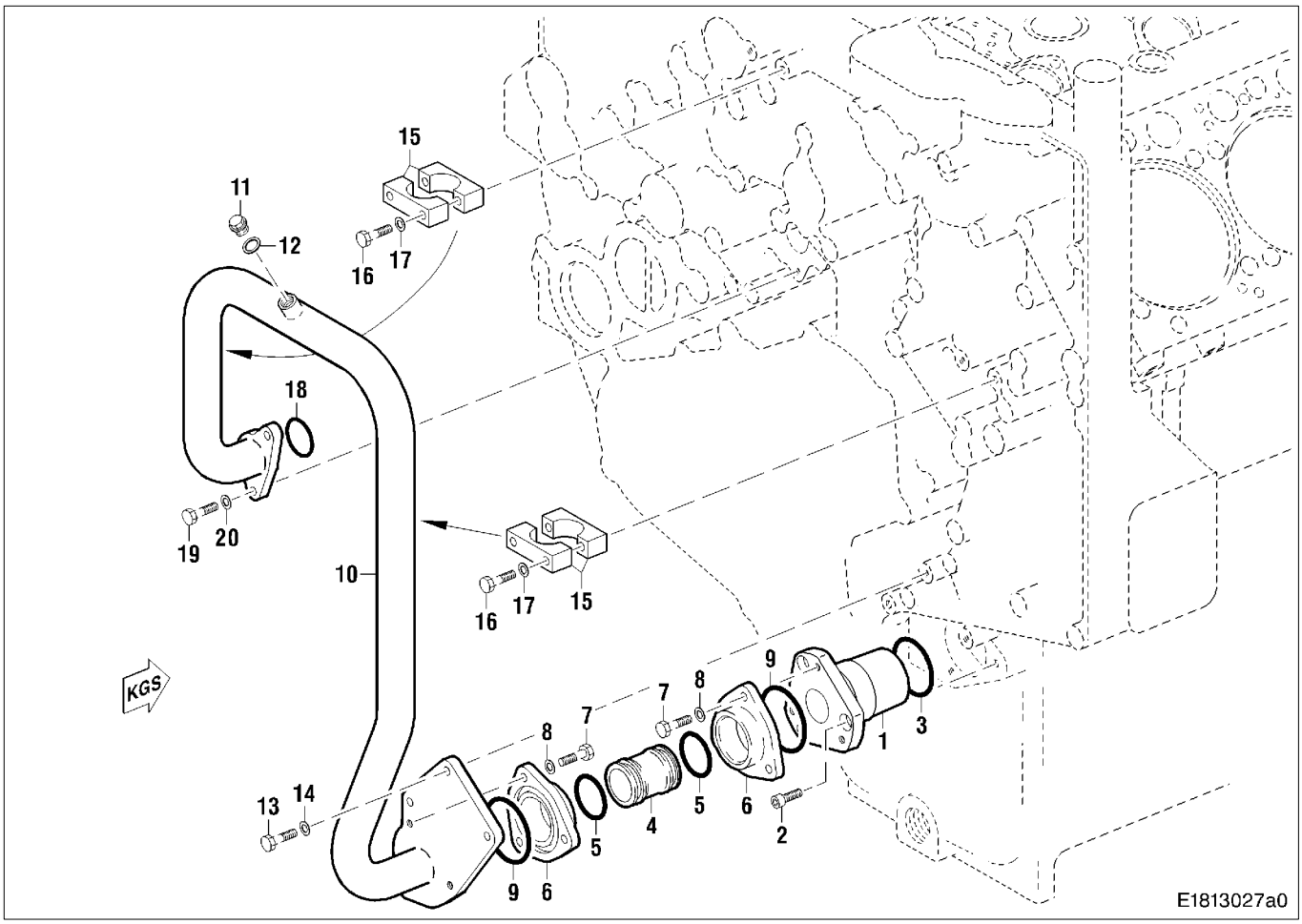
C 181.05 Lube Oil Pump with Drive

C 181.05.01 Overview Drawing



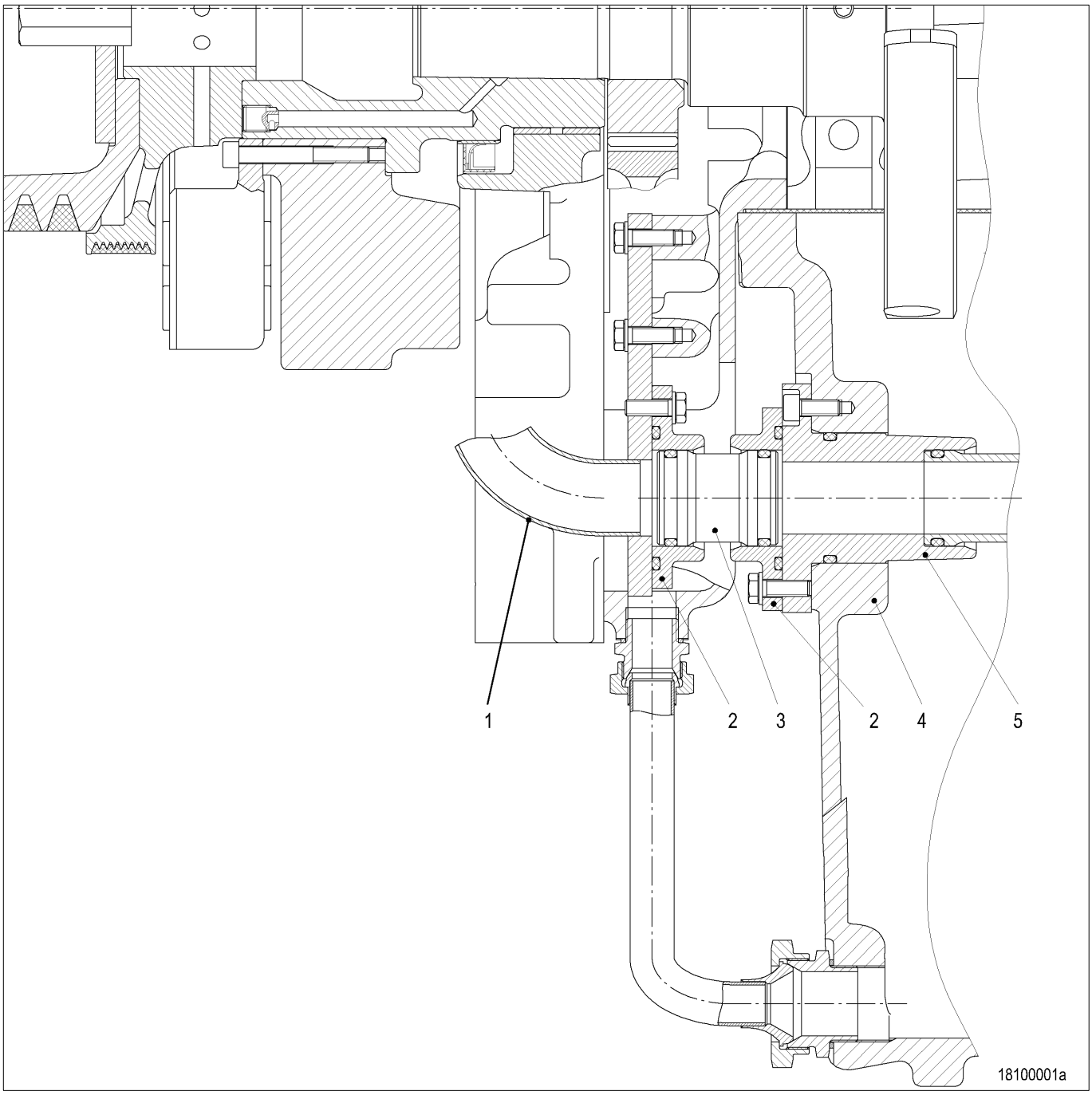
1 Oil pressure relief valve
2 Housing
3 Socket-head screw
4 Washer
5 Oil pump
6 Hex screw
7 Washer
8 Oil suction line
9 Hex screw
10 Washer
11 Gasket
12 Plug-in pipe
13 Hex screw
14 Washer
15 O-ring

Oil pump connections



1	Flange	6	Flange	11	Plug	16	Hex screw
2	Socket-head screw	7	Hex screw	12	Sealing ring	17	Washer
3	O-ring	8	Washer	13	Hex screw	18	O-ring
4	Plug-in pipe	9	O-ring	14	Washer	19	Hex screw
5	O-ring	10	Oil line	15	Pipe clamp half	20	Washer

Oil pump connections, 16V (also applies to 12V)



1 Oil line
2 Flange
3 Plug-in pipe
4 Oil pan
5 Flange

C 181.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Remove oil return line oil pan-gear case (free end)*	C 024.05
–	x	x	Remove oil pump connections (free end)*	C 181.05
–	x	x	Release or remove oil return lines for exhaust turbocharger*	C 185.25
–	x	x	Release or remove oil filler neck*	C 182.10
–	x	x	Remove or lower oil pan*	C 014.05

* Only for removal of intake pipe, pressure pipe and lube oil pump

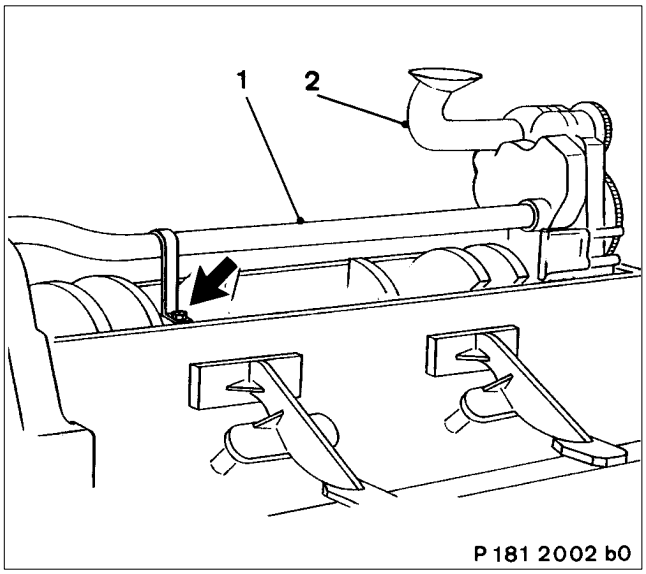
C 181.05.05 Removal

Removing oil line and connections

Remove oil line and connections as per overview drawing – see C 181.05.01.

Remove O-rings and sealing ring.

After removal, seal bores with suitable plugs.



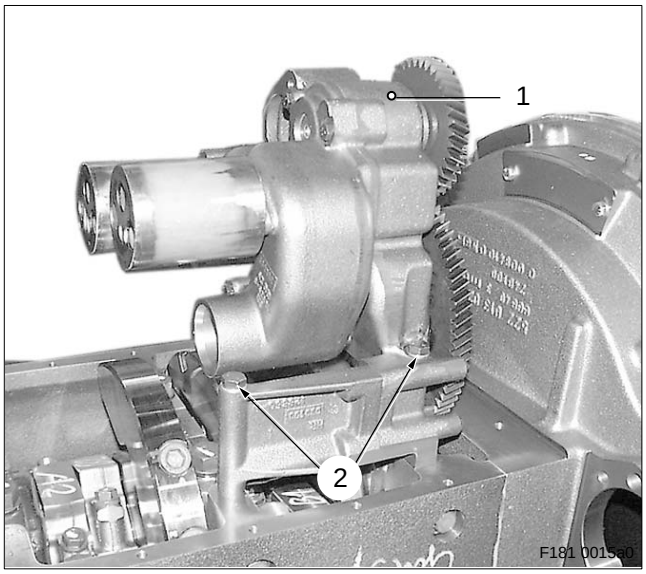
Removing suction and pressure pipe

Remove hex screw (arrow) and washer on bracket for pressure pipe (1).

Remove pressure pipe from lube oil pump.

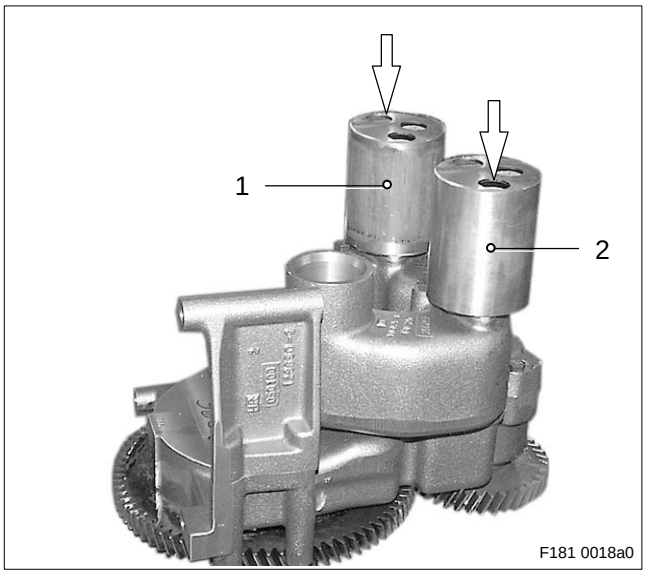
Remove hex screws and washers for suction pipe (2) and remove suction pipe.

Remove gasket and O-rings.



Removing lube oil pump

Remove all three hex screws (2) and washers for lube oil pump (1) and remove lube oil pump from crankcase.



Removing oil pressure relief valves

Unscrew socket-head screws (arrows) and washers for oil pressure relief valves and housings (1), (2) and remove components.

C 181.05.06 Disassembly

Disassembling lube oil pump

The lube oil pump must not be disassembled.

C 181.05.08 Inspection and Repair

Intake and pressure pipe, oil line and connections

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

Clean oil line and pipes with cold cleaner and blow clear with compressed air.
Visually inspect for damage and defects; if necessary recondition or replace.
Machine defective sealing face and check for surface irregularities with ink-check plate.
If necessary, pressure-test oil line, suction and pressure pipe with air in water bath. Replace if necessary.

WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

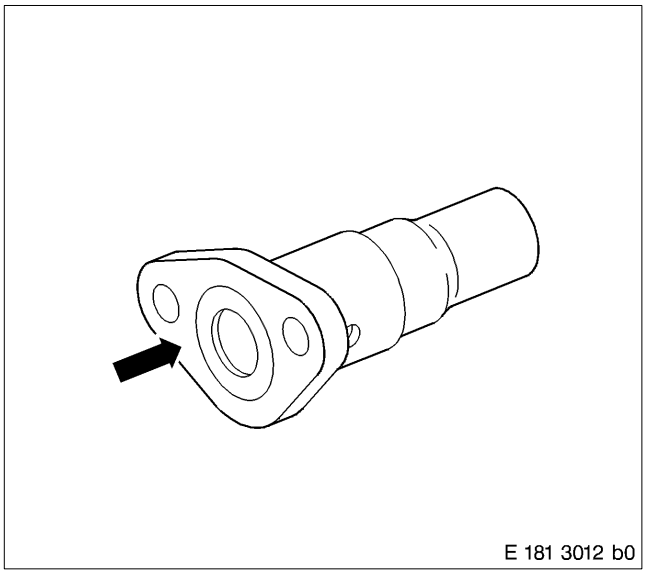
Test pressure: 0.5 bar, water temperature: min. 30 °C
Check connecting components and fixtures of oil line for damage and wear; replace components as necessary.
Check condition of threads; machine or replace componentsas necessary.
Replace sealing rings, gaskets and O-rings at every assembly.

Note: Make sure that oil lines and connections are perfectly clean.

Lube oil pump

Have lube oil pump checked and, if necessary, repaired by manufacturer.
Visually inspect outside of lube oil pump for damage and defects.
Check tooth flanks of gears for wear, indentations and chipping; if necessary recondition or replace lube oil pump.
Check securing screws for condition and thread for ease of movement; replace screws if necessary.

Note: Ensure that all components are perfectly clean.



Oil pressure relief valve and housing

Note: Do not disassemble oil pressure relief valve!

Check oil pressure relief valve and housing (visual inspection) for damage; replace component if necessary.

Check sealing surface (arrow) for evenness; recondition if necessary.

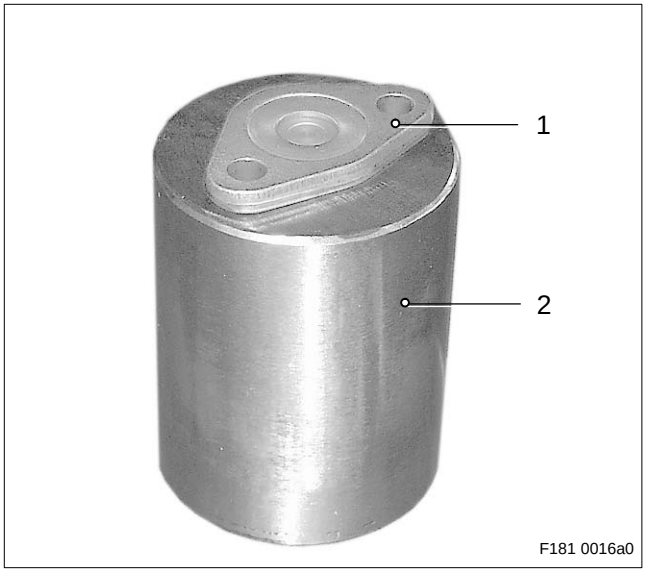
Max. permissible irregularity = 0.2 mm

⚠ WARNING

Test fluid is highly pressurised.
Risk of injury!
Liquids emerging under high pressure can lead to serious injury!
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Check pressure relief valve for opening pressure of 8.5 bar $\pm$ 0.7 bar. If values are above or below opening pressure, replace pressure relief valve.

C 181.05.11 Installation

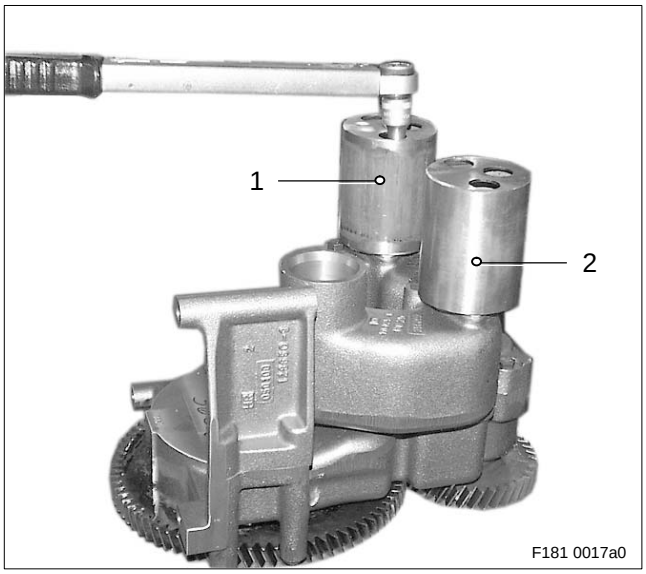


Installing oil pressure relief valves

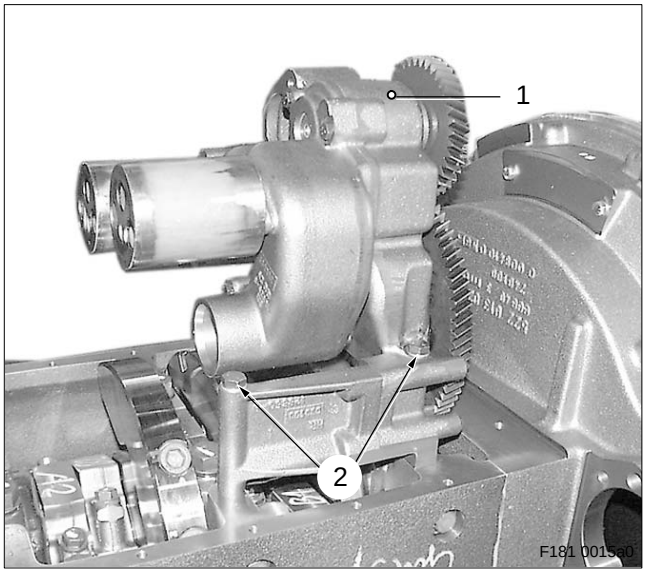
Note: Make sure parts are perfectly clean.

Check sealing surfaces on oil pressure relief valve (1) and on lube oil pump; clean if necessary.

Insert oil pressure relief valve in housing (2).



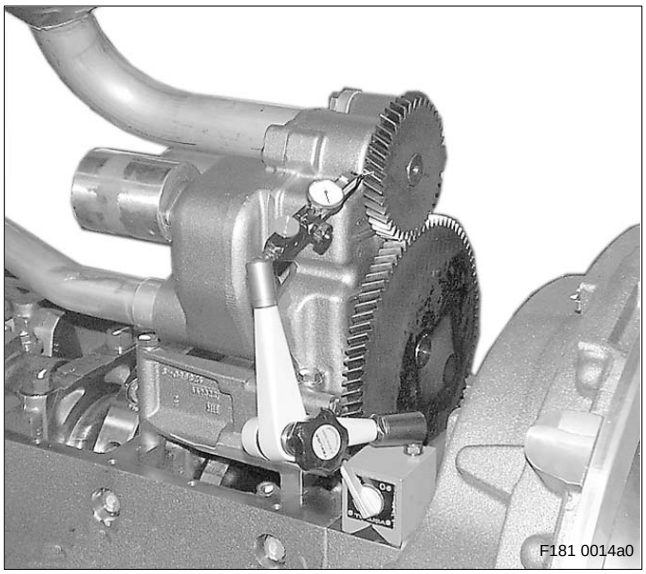
Install oil pressure relief valves and housings (1), (2) with socket-head screws and washers on lube oil pump.



Installing lube oil pump

Mount lube oil pump (1) on crankcase, ensuring gears engage correctly.

Centre the lube oil pump within screw bores and tighten with three hex screws (2) and washers.



Measuring backlash

Mount magnetic dial gauge holder with Puppi dial gauge on crankcase.

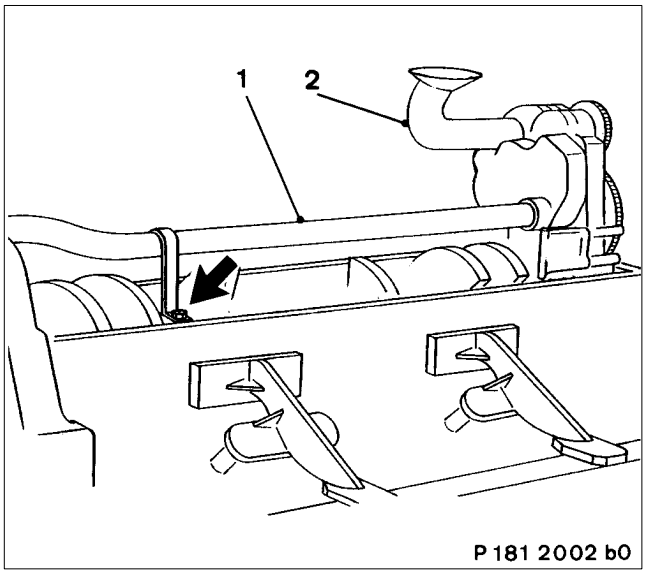
Vertically fit dial gauge stylus with small preload on a tooth flank of lube oil pump gear.

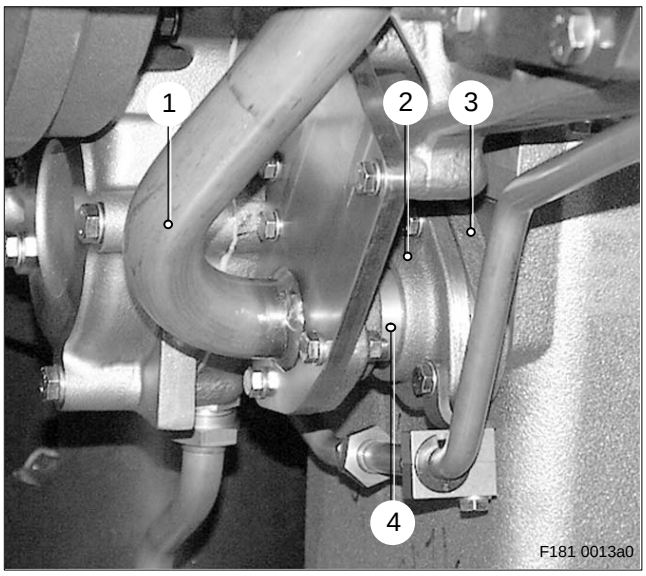
Set dial gauge to zero.

Measure backlash by moving lube oil pump gear back and forth.

Check backlash of second lube oil pump gear in same manner.

For backlash, see C 020.





Installing suction and pressure pipe

⚠ CAUTION

Compressed air is highly pressurized.
Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Pressure must not exceed 3.0 bar.

Blow intake pipe (2) and pressure pipe (1) through with compressed air and ensure pipes are perfectly clean.

Coat O-rings with petroleum jelly and insert into grooves, see C 181.05.01, on pressure pipe.

Insert pressure pipe into lube oil pump and secure to bracket with hex screw (arrow) and washer.

Fit new gasket and mount intake pipe with hex screws and washers on lube oil pump.

Installing connections and oil line

Install oil pan – see C 014.01.

Note: Before installing oil line and connections, remove all plugs and check that components are particularly clean.

Before installing, coat O-rings with petroleum jelly.

Insert flange (3) with new O-ring as per overview drawing (see C 181.15.01) into oil pan and secure with socket-head screws.

Install and tighten flanges (2), plug-in pipe (4) and oil line (1) with new O-rings and fixtures tension-free as per overview drawing.

Install plug and new sealing ring on oil line.

Note: After starting engine, check oil line and connections for leaks (visual inspection).

C 181.05.12 After-Installation Operations

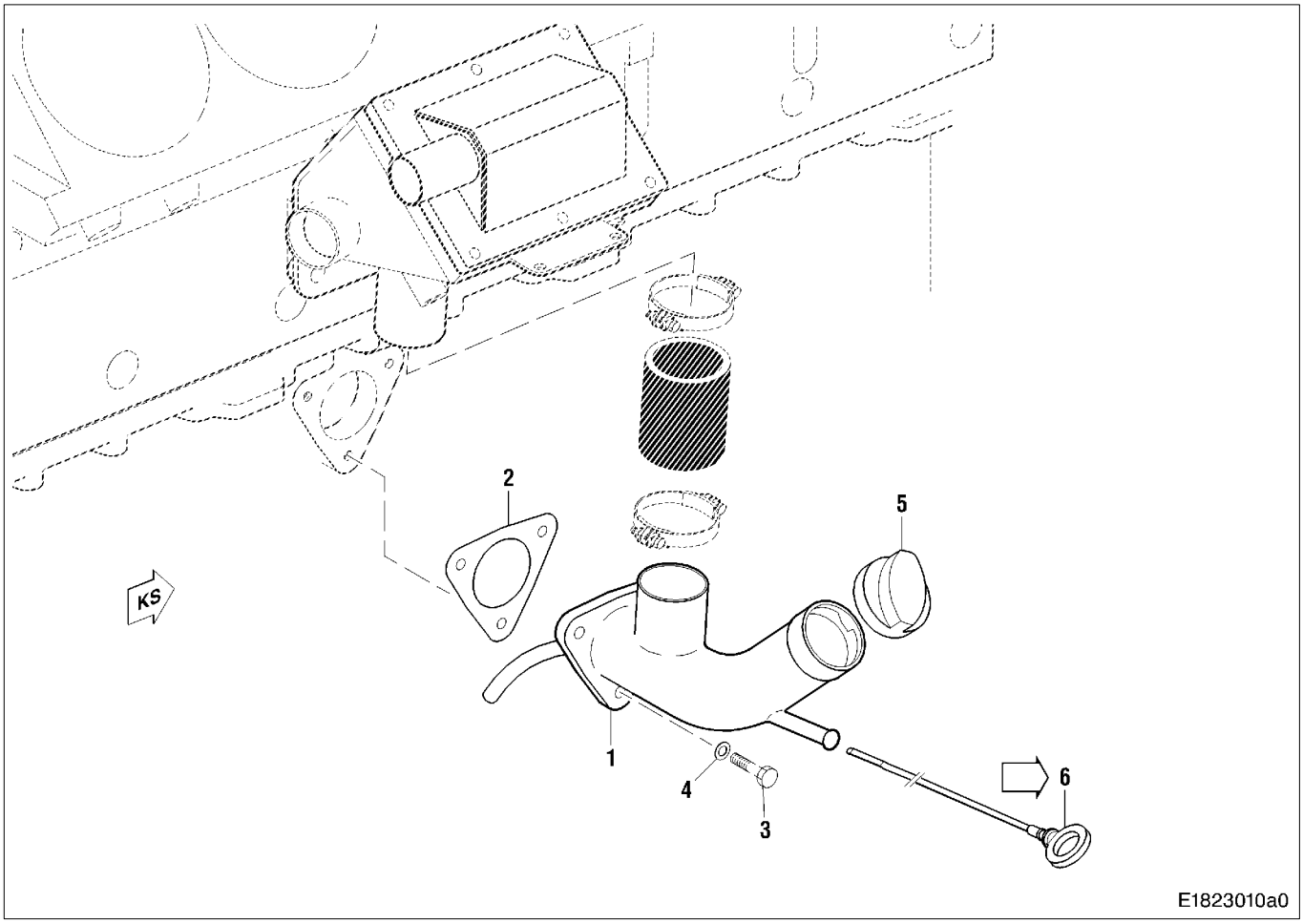
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install oil return line oil pan-gear case (free end)	C 024.05
–	x	x	Install oil pump connections (free end)	C 181.05
–	x	x	Install oil return lines for turbochargers	C 185.25
–	x	x	Install oil pan	C 014.05
–	x	x	Install oil filler neck	C 182.10
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Release engine start	Operating Instructions

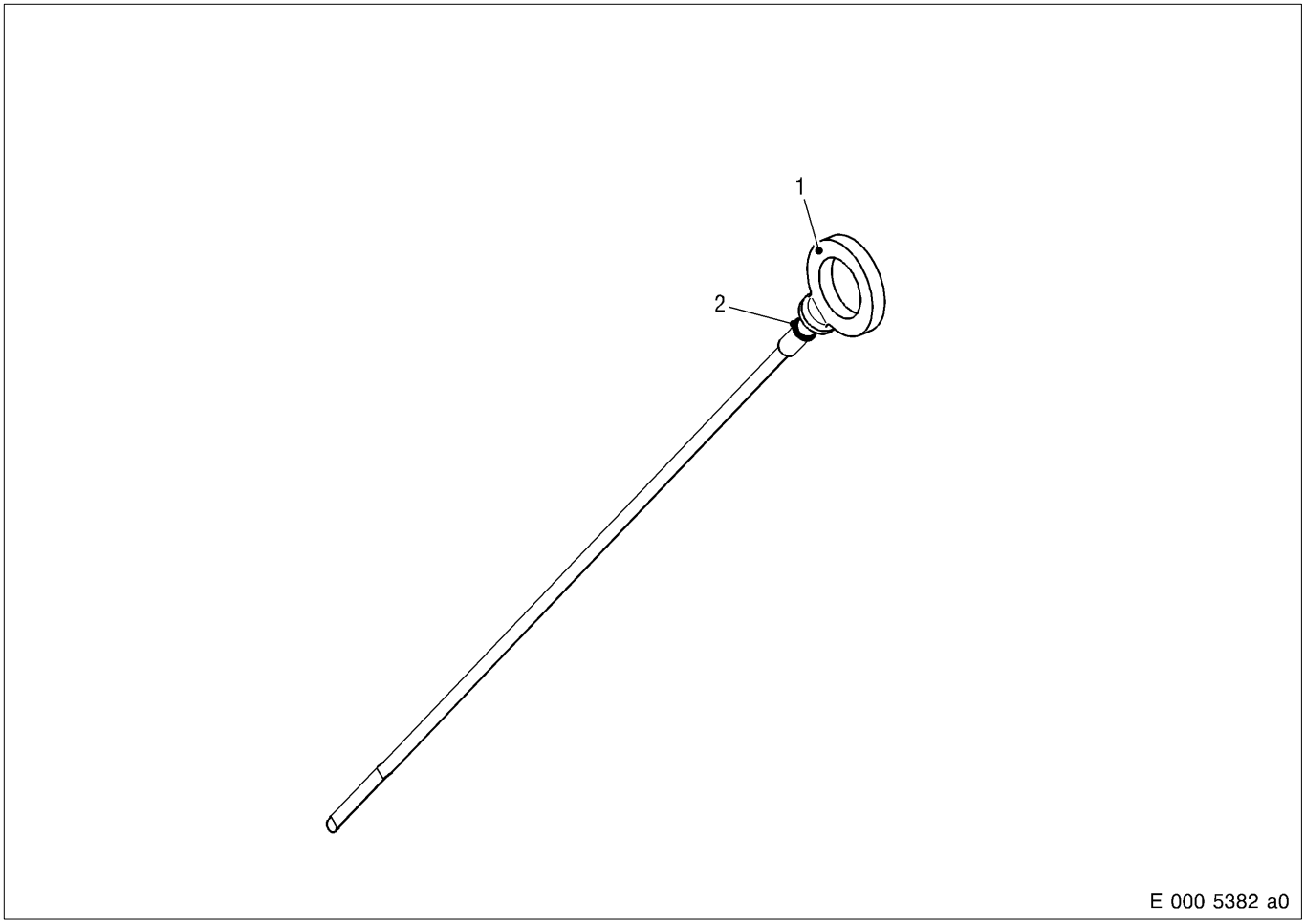
C 182.10 Oil Dipstick, Oil Filler Neck

C 182.10.01 Overview Drawing



1 Oil filler neck
2 Gasket
3 Hex screw
4 Washer
5 Cover
6 Oil dipstick

Oil dipstick



1 Oil dipstick
2 Sealing ring

C 182.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 182.10.05 Removal

Removing oil filler neck and oil dipstick

Remove oil filler neck as per overview drawing – see C 182.10.01.

Remove gasket.

If necessary, seal bore in the oil pan with suitable blanking plug.

C 182.10.08 Inspection and Repair

Oil filler neck

Clean all parts.

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

Clean oil filler neck with cold cleaner and blow clear with compressed air.

Visually inspect component for damage and defects; replace if necessary.

Replace gasket as part of every assembly.

Note: Ensure oil filler neck is perfectly clean!

Oil dipstick

Visually inspect for damage and defects; replace if necessary.

Replace sealing ring during W6 maintenance.

C 182.10.11 Installation

Installing oil filler neck and oil dipstick

Note: Prior to installation, remove all blanking plugs and ensure oil filler neck and dipstick are perfectly clean.

Install oil filler neck with new gasket with hex screws and washers and tighten as per overview drawing – see C 182.10.01.

C 182.10.12 After-Installation Operations

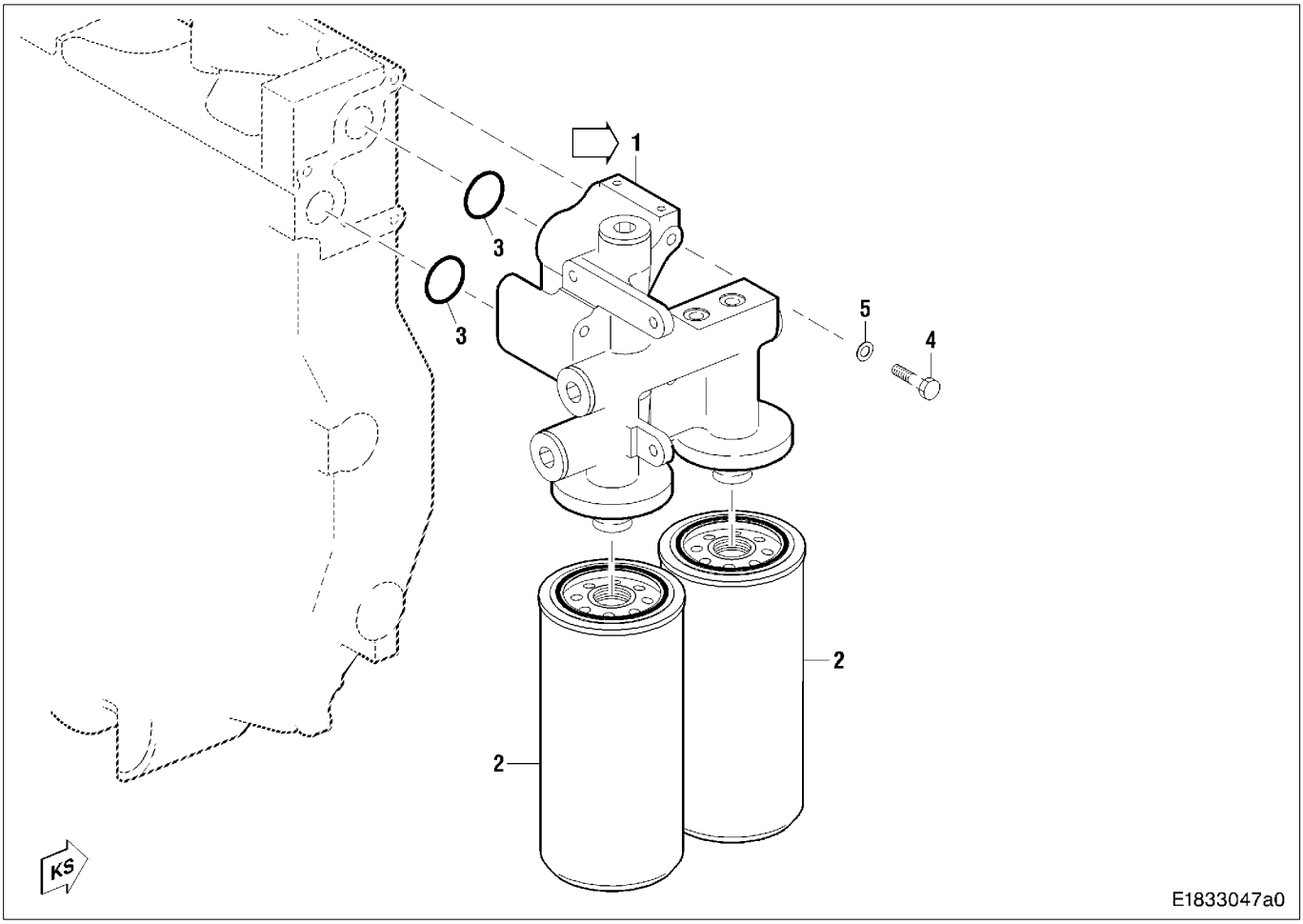
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

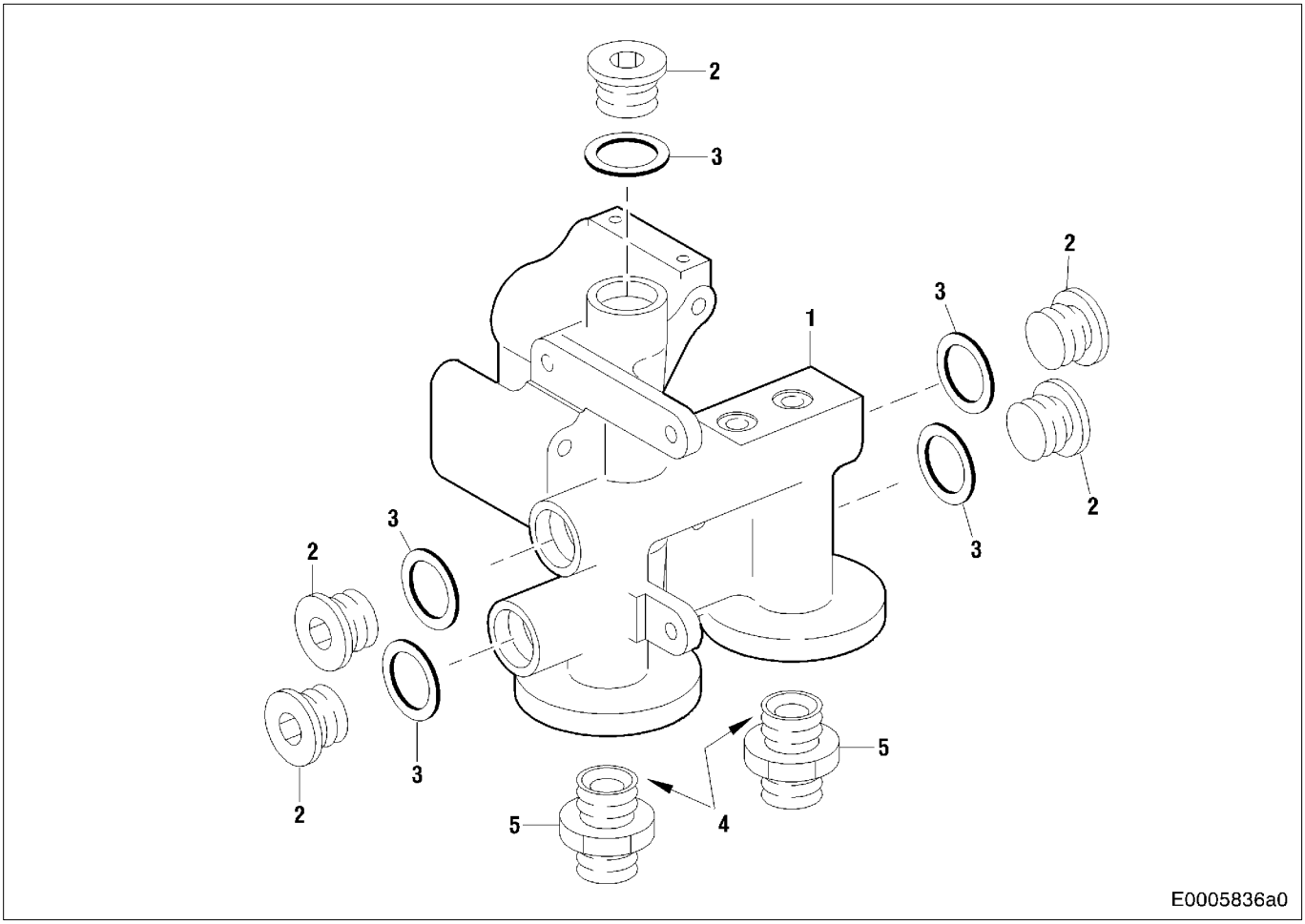
C 183.05 Oil Filter

C 183.05.01 Overview Drawing



1 Filter head
2 Oil filter
3 O-ring
4 Hex screw
5 Washer

Filter head



1 Filter head
2 Plug
3 Sealing ring
4 Pipe-thread sealant
5 Double nipple

C 183.05.02 Special Tools

Designation – Application	Number
Strap wrench for oil filter	1

C 183.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove pressure transmitter and temperature transmitter	C 507.10

C 183.05.05 Removal

Removing oil filter

Remove oil filter with strap wrench and dispose of in accordance with local specifications.

Drain oil residue from engine oil filter into a container.

Remove oil filter housing as shown in overview drawing – see C 183.05.01.

Seal connections with suitable plugs.

C 183.05.06 Disassembly

Disassembling filter head

Remove plugs as shown in overview drawing – see C 183.05.01.

Note: Remove double nipple only if necessary (e.g. in event of leakages). Double nipple is inserted with pipe-thread sealant and must be heated to approx. 200 °C before removal.

C 183.05.08 Inspection and Repair

Oil filter (easy-change filter)

Replace easy-change filter.

Filter head

Clean all components with cleaner and visually inspect for condition and damage; replace component as necessary.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out filter head with compressed air and make sure it is perfectly clean.

If necessary, pressure-test filter head with air in water bath for leaks.

Note: Install filter inserts before carrying out leak check.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Test pressure: 0.5 bar

In event of leaks, replace blanking plug or replace filter head.

Check sealing and bolt-on surfaces for damage.

Remove minor wear, scoring and indentations by rubbing down with oilstone or emery paper; replace components as necessary.

Check condition of threads; machine or replace components as necessary.

Replace O-rings and sealing rings at every assembly.

Note: Make sure parts are perfectly clean.

C 183.05.10 Assembly

Assembling filter head

Note: Make sure that oil-carrying components are perfectly clean.

Clean and degrease thread in filter head and male thread of double nipples (1).

Coat male thread of double nipples with pipe-thread sealant.

Insert and tighten threaded bushes in filter head.

Note: Ensure correct final strength of pipe-thread sealant – see C 080!

Install all plugs and sealing rings and tighten.

C 183.05.11 Installation

Installing oil filter

Note: Prior to installation, remove all blanking plugs.

Make sure sealing surfaces, oil chambers and oil-ways are particularly clean, clean as required.

Coat O-rings with petroleum jelly before installing.

Mount oil filter housing as shown in overview drawing – see C 183.05.01.

Check sealing ring of new engine oil filter and moisten with oil.

Note: Do not use any tool to attach oil filter!

Install new oil filter (arrows) and tighten manually.

Note: After engine start, visually inspect oil filters for leaks.

C 183.05.12 After-Installation Operations

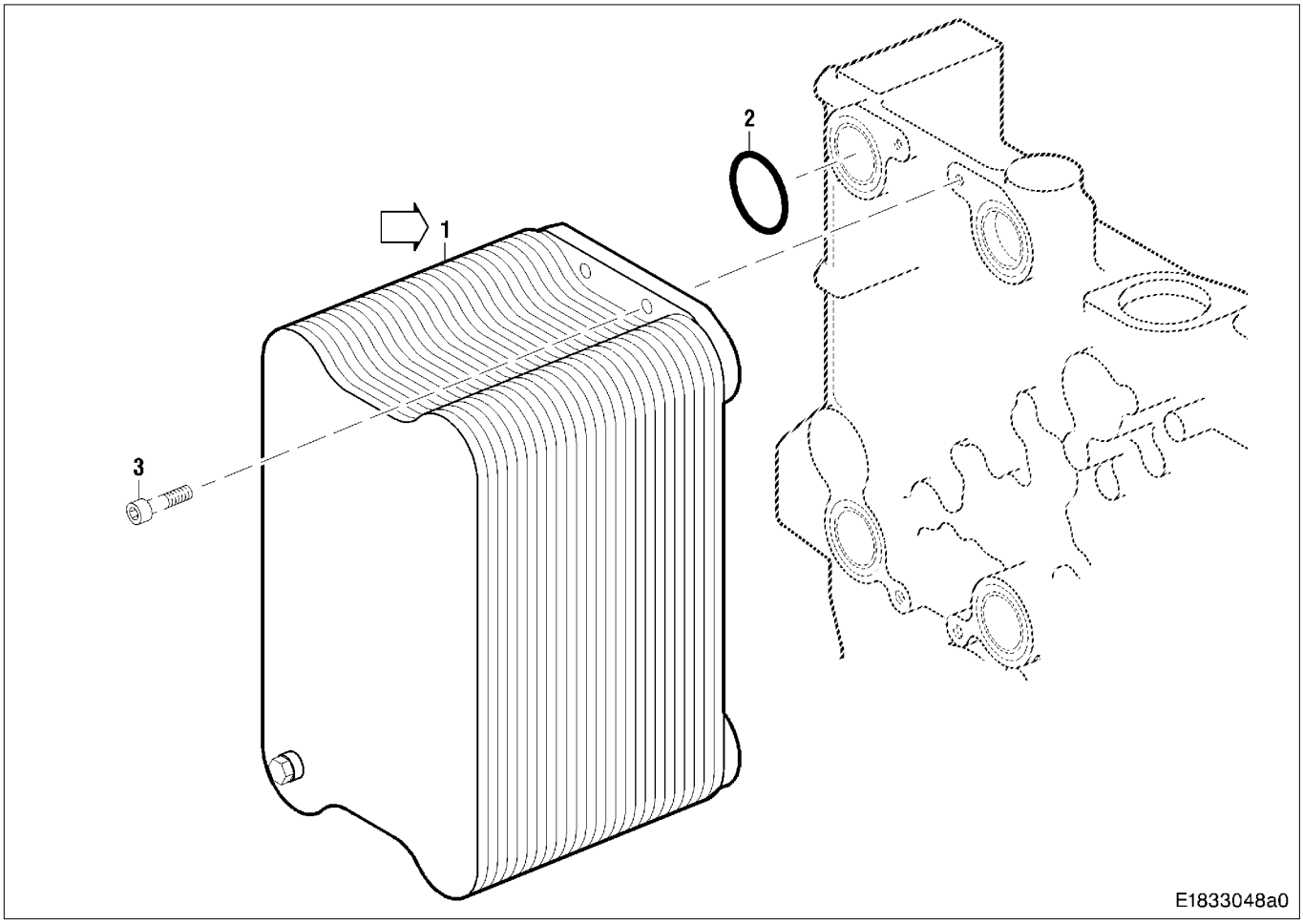
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Remove pressure transmitter and temperature transmitter	C 507.10
–	–	x	Release engine start	Operating Instructions

C 183.15 Oil Heat Exchanger

C 183.15.01 Overview Drawing



1 Oil heat exchanger
2 O-ring
3 Socket-head screw with washer

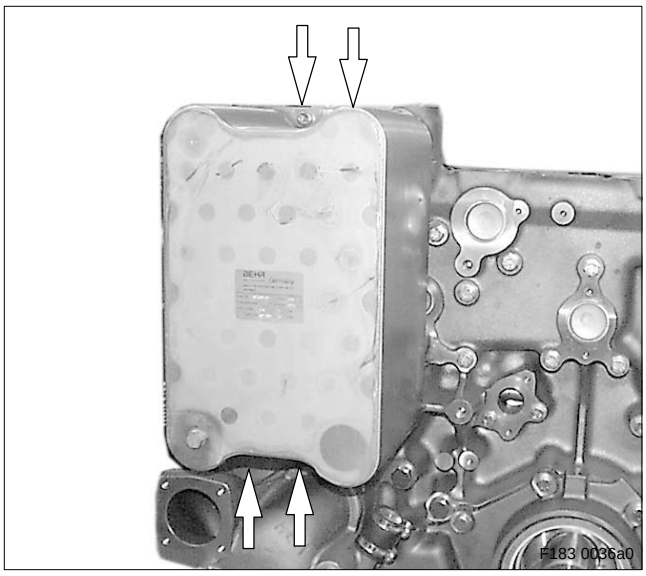
C 183.15.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Drain engine oil from oil heat exchanger	Operating Instructions

C 183.15.05 Removal



Removing oil heat exchanger

⚠ CAUTION

Heat exchanger ribs are sharp-edged.
Risk of injury!
Always wear protective gloves when handling heat exchanger.

Unscrew socket-head screws (arrows) and washers and remove oil heat exchanger.

Remove O-rings.

C 183.15.08 Inspection and Repair

Clean oil heat exchanger on coolant and oil side.

Cleaning coolant side:

It is essential to examine extent of contamination of coolant side prior to cleaning.

The water side must be cleaned if there is visible encrustation on the water side (inlet area) due to crustations, contamination and oil deposits.

Fill cooler with descaling agent.

⚠ CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

An agent which is not aggressive to metal surfaces (e.g. Porodox from Henkel or Porozink from Parobe-Chemie, Basel) must be used to remove deposited material.

Follow the manufacturer's instructions to the letter when preparing the descaling solution.

Dwell time depends on the condition and temperature of the solution and the nature and stubbornness of the deposits.

After cleaning, flush the cooler with water until pH values of clean water and rinsing water are approximately the same (difference 1 pH).

Normal coolant can be used for flushing purposes.

If the required level of cleanness is not achieved, repeat the above procedure.

If the cooler is not put into operation immediately after this cleaning or flushing of the oil side (see next section) has been cleaned the coolant and oil sides must be dried and then preserved.

Dry in a drying oven between 110 °C and 120 °C. Oven drying time: approx. 3 hours.

Spray preservation agent (Branol 32/10 from Brangs and Heinrich) into cooler. The preservation agent vaporises and condenses to form a protective layer over the inner surfaces.
Make sure dosages are correct! 2 ml Branorol 32/10 per litre of coolant.

After preservation, seal all openings air-tight with suitable plugs.

Cleaning/flushing oil side:

Note: The oil heat exchanger must be replaced if chippings have penetrated the engine oil system e.g. in event of piston scuffing or damage to bearings.

Connect oil side to sealed, forced-circulation flushing system.

Forced-circulation flushing system must be equipped with a filter (0.05 mm mesh).

Flush with cleaning agent in opposite direction of oil flow in normal operation.

CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Suitable descaling agents are buffered alkaline agents such as a 3 to 5% solution of P3 FD from Henkel.

Cleaning can be improved by using ultrasonic equipment.

After cleaning, oil side must be flushed with water until pH values of fresh water and flushing water are roughly equal (permissible difference 1pH).

This releases contaminants, particularly particles from wear parts, from swirl plates, so that they are flushed out with water.

Continue cleaning process until flushing medium leaving cooler is same as that entering.

WARNING

Test fluid is highly pressurized. Risk of injury!
Liquids emerging under high-pressure can lead to serious injury!
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Flushing pressure 3 to 4 bar at 150 to 300 litres/minute.

Note: If the cooler is not put into operation immediately, dry oil side, preserve and seal the openings (see – Cleaning coolant side:

Checking oil heat exchanger

Visually inspect oil heat exchanger for damage and defects; replace if necessary.

Check oil and coolant chambers of the oil heat exchanger for security and leaks.

WARNING

Test fluid is highly pressurized. Risk of injury!
Liquids emerging under high-pressure can lead to serious injury!
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Oil chamber: Fluid test pressure: 25 bar

Coolant chamber: Fluid test pressure: 8 bar

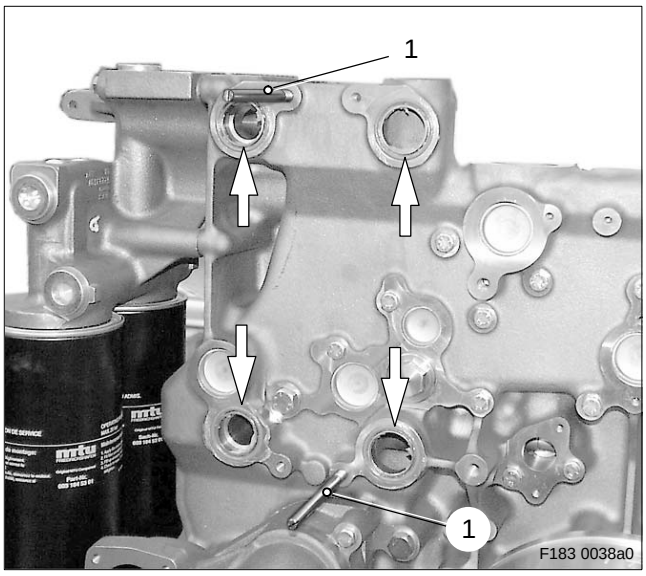
Test medium: Engine oil

Check all mating and sealing faces for wear and damage; rub down with emery cloth or an oilstone as necessary.

Replace O-rings.

Make sure that oil chambers and oilways are perfectly clean.

C 183.15.11 Installation



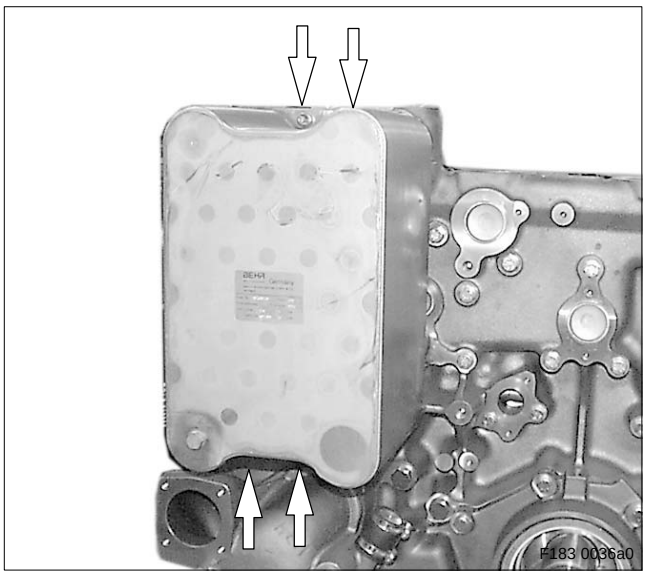
Installing oil heat exchanger

Note: Prior to installation, remove all blanking plugs.

Make sure that oil chambers and oilways are perfectly clean.

Coat O-rings (arrows) with petroleum jelly and insert into grooves in coolant distribution housing.

Insert two suitable guide pins (1).



⚠ CAUTION

Heat exchanger ribs are sharp-edged.
Risk of injury!
Always wear protective gloves when handling heat exchanger.

Mount oil heat exchanger via guide pins on coolant distribution housing.

Insert socket-head screws (arrows) and washers and tighten diagonally.

Note: After engine start, visually inspect oil heat exchanger for leaks.

C 183.15.12 After-Installation Operations

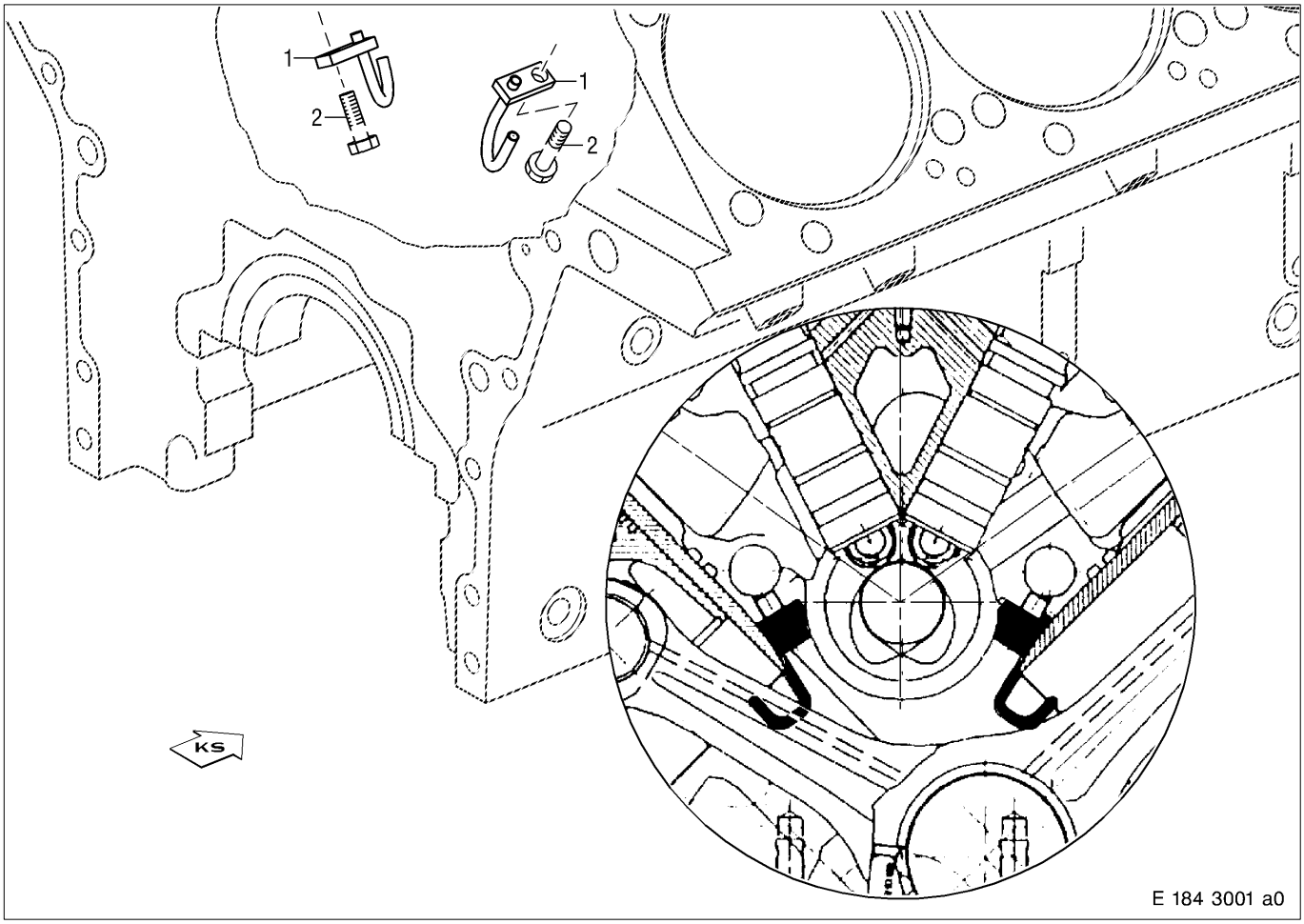
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Fill engine cooling system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 184.10 Oil Spray Nozzle

C 184.10.01 Overview Drawing



1 Oil spray nozzle

2 Hex screw
Lubricant: Engine oil
Tightening torque: 25 Nm

C 184.10.02 Special Tools

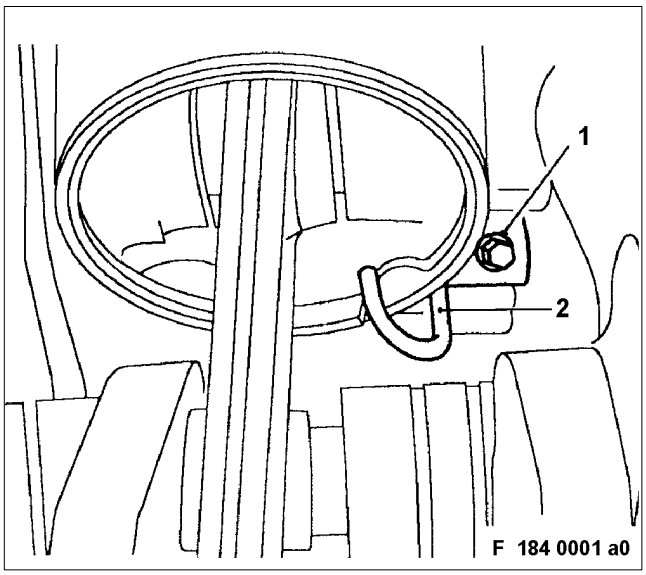
Designation – Application	Number
Testing unit for oil spray nozzle	1

C 184.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	x	x	Remove oil return line oil pan-gear case (free end)	C 024.05
–	x	x	Remove oil pump connections (free end)	C 181.05
–	x	x	Release or remove oil return lines for exhaust turbocharger	C 185.25
–	x	x	Release or remove oil filler neck	C 182.10
–	x	x	Lower oil pan	C 014.05



Removing piston cooling oil spray nozzle

Turn crankshaft until oil spray nozzle (2) to be removed is accessible.

Remove screw (1) and remove oil spray nozzle (2) from crankcase.

C 184.10.08 Inspection and Repair

Note: Make sure parts are perfectly clean.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

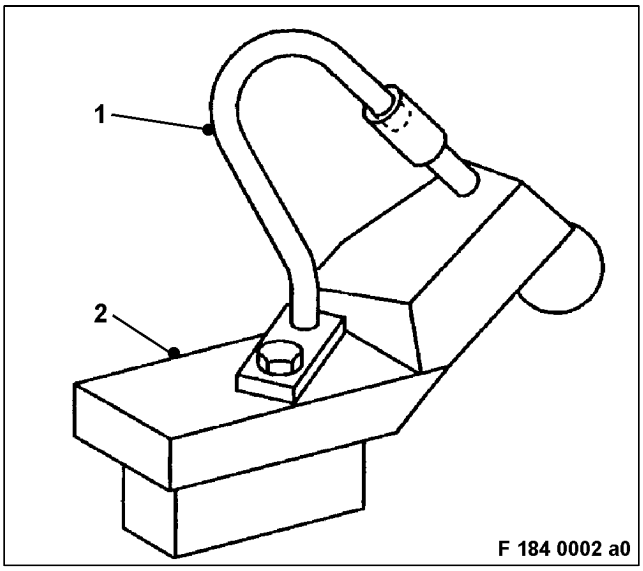
Clean piston cooling oil spray nozzle with cleaner and carefully blow clear with dry air.

Visually inspect condition of oil spray nozzle and check for damage. Replace if necessary.

Check sealing and mating faces; rub down with emery cloth or an oilstone or replace oil spray nozzle as necessary.

Check hex screws for damage and check threads for ease of movement; replace hex screw if necessary.

Check oil bores of oil spray nozzle (especially secondary bore 1 mm dia.) for obstructions and ensure they are perfectly clean!



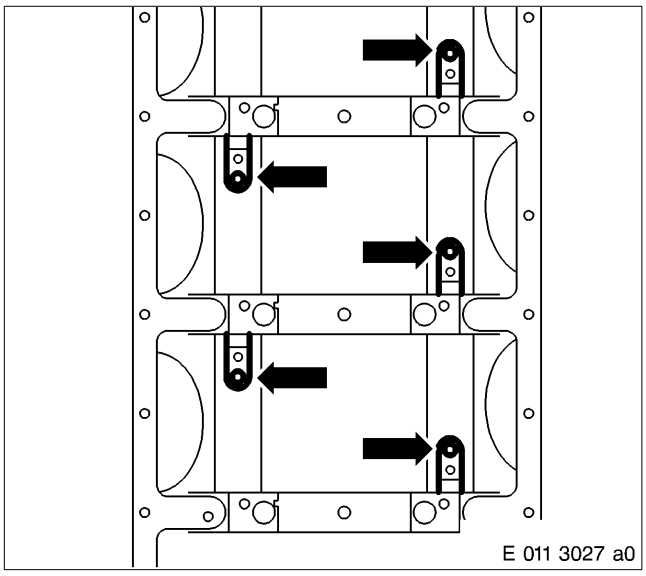
Checking spraying direction of oil spray nozzle

Attach oil spray nozzle (1) to gauge (2).

Use gauge to check oil injection pipe for plastic deformation.

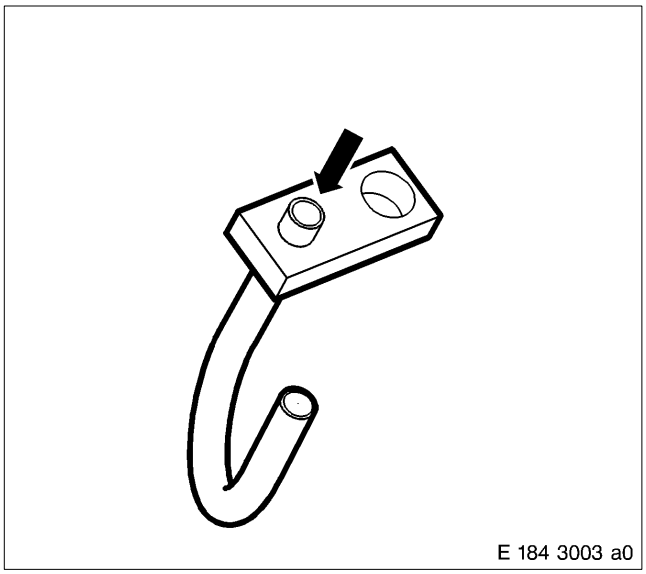
In event of plastic deformation, correct oil spray pipe or replace oil spray nozzle.

C 184.10.11 Installation



Installing piston cooling oil spray nozzle

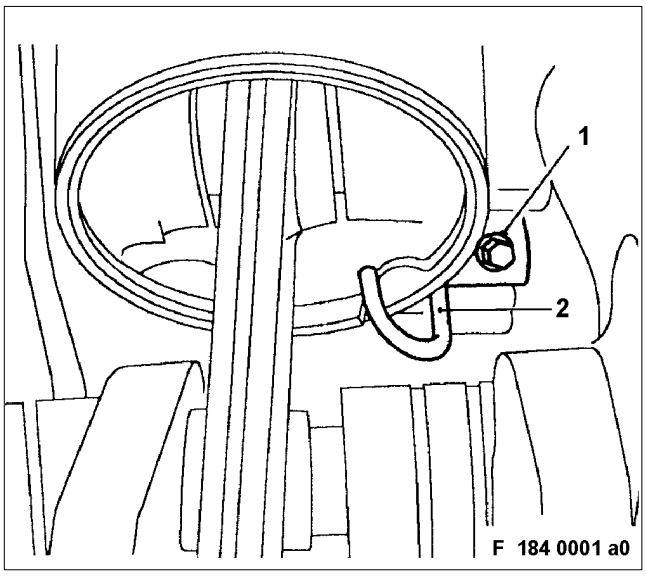
Ensure oil bores (arrows) for oil spray nozzles in crankcase are perfectly clean and not obstructed.



⚠ CAUTION

Compressed air is air which has been compressed under pressure. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask.
Compressed air must not be directed at the body.
The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out oil bore (arrow) of oil spray nozzle with compressed air and ensure it is perfectly clean and not obstructed (especially secondary bore 1 mm dia.).



Fit oil spray nozzle (2) on crankcase; when doing so, guide on oil spray nozzle must engage in bore in crankcase.

Tighten screw (1) to specified tightening torque – see C 184.01.01.

After installing piston, bar engine and ensure there is clearance between oil spray nozzle and piston.

C 184.10.12 After-Installation Operations

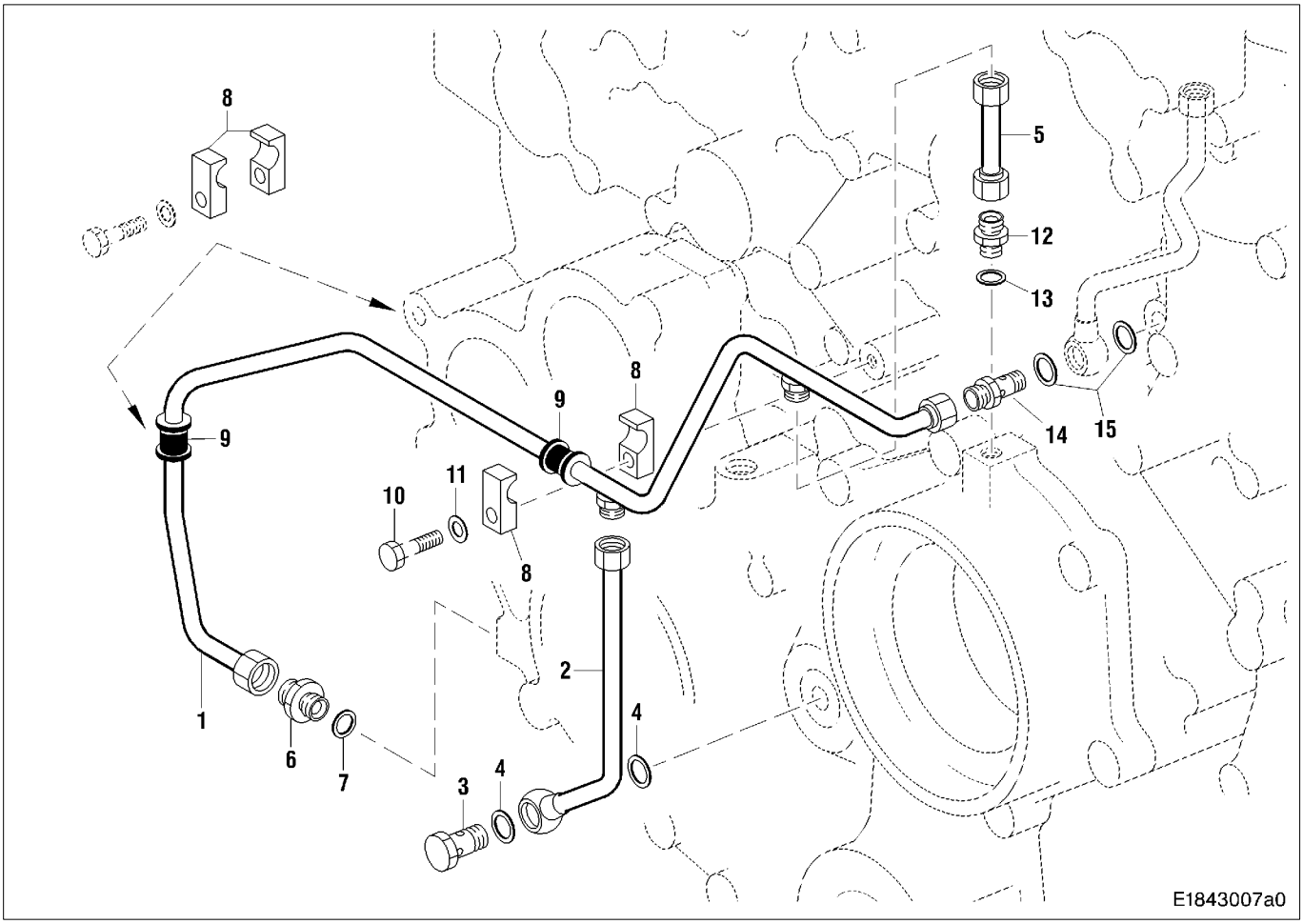
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install oil pan	C 014.05
–	x	x	Install oil filler neck	C 182.10
–	x	x	Install oil return line oil pan-gear case	C 024.05
–	x	x	Install oil pump connections	C 181.05
–	x	x	Install oil return lines for turbochargers	C 185.25
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 184.20 Oil Supply Lines for Gear Train

C 184.20.01 Overview Drawing



1 Oil line
2 Oil line
3 Banjo screw
4 Sealing ring
5 Oil line, short
6 Reduction union
7 Sealing ring
8 Pipe clamp half
9 Grommet
10 Hex screw
11 Washer
12 Union
13 Sealing ring
14 Union
15 Sealing ring

C 184.20.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 184.20.05 Removal

Removing oil supply lines

Remove oil lines, connection components and securing attachments from engine as shown in overview drawing – see C 184.20.01.

Remove sealing rings.

After removal, seal all connections with suitable plugs.

Protect oil lines from damage.

C 184.20.08 Inspection and Repair

Note: Make sure parts are perfectly clean.

Clean oil lines with cleaner. Check condition of lines and inspect for damage; replace lines if necessary.

Pressure-test oil lines with air in water bath for leaks as necessary.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

If leaks are found, replace oil line.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Then blow dry lines with compressed air.

Check connecting components and fixtures of oil lines for damage and wear; replace components as necessary.

Check condition of threads; machine or replace components as necessary.

Replace grommets as part of every W6 overhaul.

Replace sealing rings as part of every assembly.

C 184.20.11 Installation

Installing oil supply lines

Note: Prior to installation, remove all blanking plugs.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out oil lines with compressed air and ensure that it is perfectly clean.

Install oil lines with new sealing rings, gaskets with connecting and fixture elements, tension-free, as per overview drawing – see C 184.20.01.

Note: After engine start, visually inspect oil lines for leaks.

C 184.20.12 After-Installation Operations

A distinction must be made as to whether:

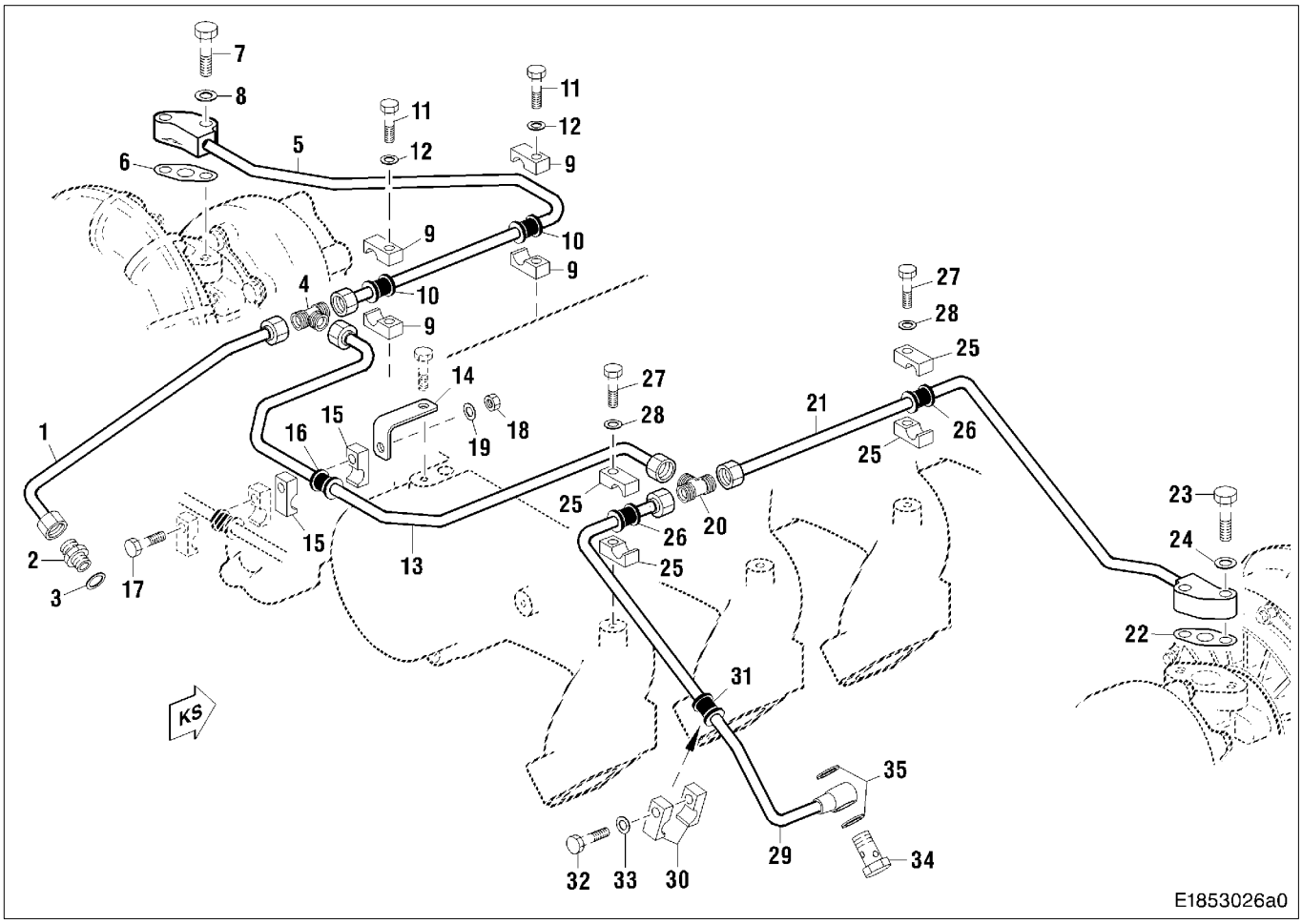
1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

C 185.10 Oil Supply Lines for Exhaust Turbocharger

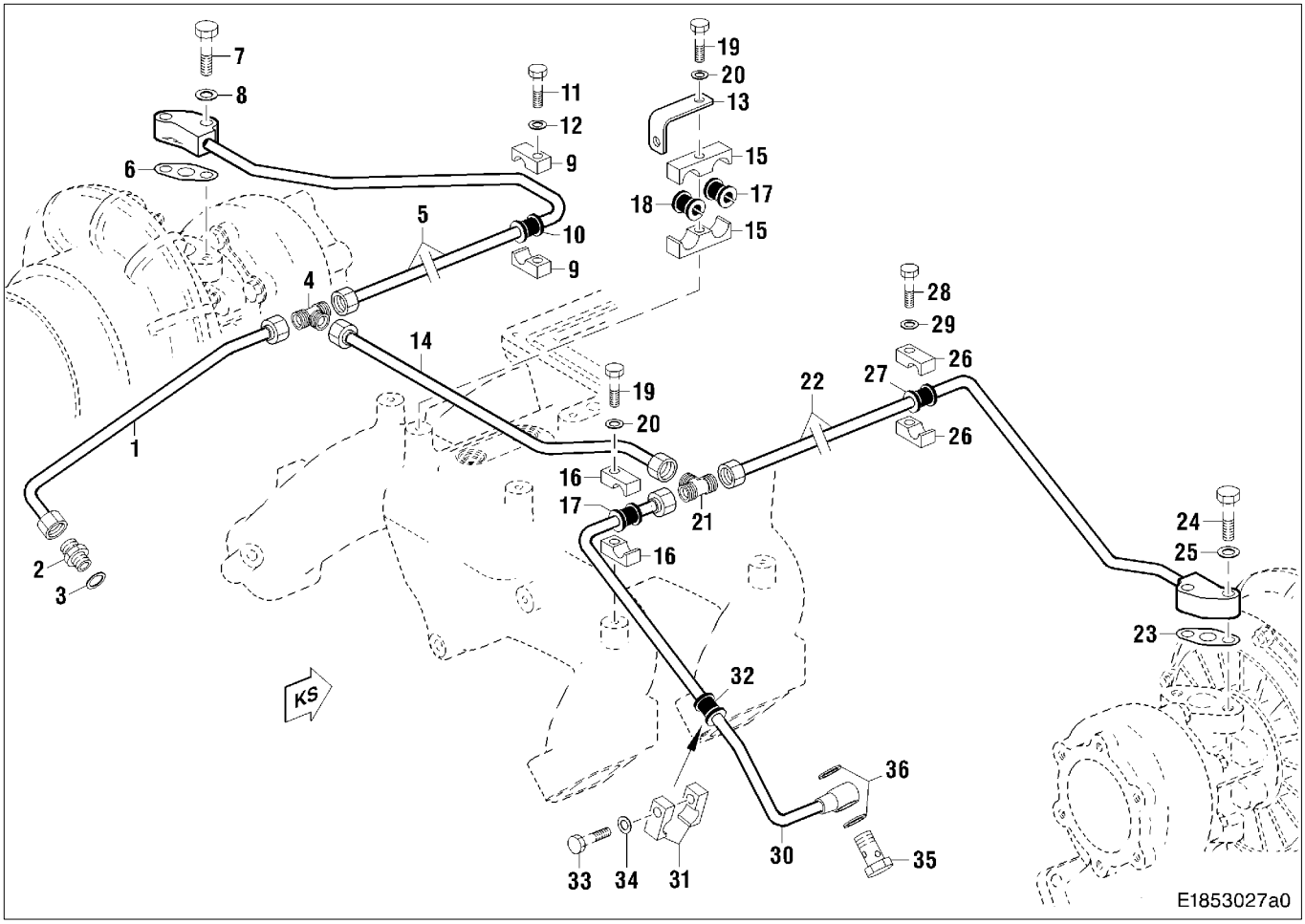
C 185.10.01 Overview Drawing

Oil supply lines, 12V



1 Oil line
2 Union
3 Sealing ring
4 T-piece
5 Oil line
6 Gasket
7 Hex screw
8 Washer
9 Pipe clamp half
10 Grommet
11 Hex screw
12 Washer
13 Oil line
14 Bracket
15 Pipe clamp half
16 Grommet
17 Hex screw
18 Hex nut
19 Washer
20 T-piece
21 Oil line
22 Gasket
23 Hex screw
24 Washer
25 Pipe clamp half
26 Grommet
27 Hex screw
28 Washer
29 Oil line
30 Pipe clamp half
31 Grommet
32 Hex screw
33 Washer
34 Banjo screw
35 Sealing ring

Oil supply lines, 16V



1 Oil line
2 Union
3 Sealing ring
4 T-piece
5 Oil line
6 Gasket
7 Hex screw
8 Washer
9 Pipe clamp half
10 Grommet
11 Hex screw
12 Washer
13 Bracket
14 Oil line
15 Pipe clamp half
16 Pipe clamp half
17 Grommet
18 Grommet
19 Hex screw
20 Washer
21 T-piece
22 Oil line
23 Gasket
24 Hex screw
25 Washer
26 Pipe clamp half
27 Grommet
28 Hex screw
29 Washer
30 Oil line
31 Pipe clamp half
32 Grommet
33 Hex screw
34 Washer
35 Banjo screw
36 Sealing ring

C 185.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 185.10.05 Removal

Removing oil supply lines

Remove oil lines, connection components and securing attachments from engine as shown in Overview Drawing – see C 185.10.01.

Remove sealing rings and gaskets.

After removal, seal all connections with suitable plugs.

Protect oil lines from damage.

C 185.10.08 Inspection and Repair

Note: Make sure parts are perfectly clean.

Clean oil lines with cleaner. Check condition of lines and inspect for damage; replace lines if necessary.

Pressure-test oil lines for leaks with air in water bath as necessary.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

If leaks are found, replace oil line.

CAUTION

Compressed air is air compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Then blow dry lines with compressed air.

Check connecting components and fixtures for damage and wear; replace components as necessary.

Check sealing and mating faces, smooth with oilstone or emery cloth if necessary.

Check condition of threads; machine or replace components as necessary.

Replace grommets as part of every W6 overhaul.

Replace gaskets and sealing rings as part of every assembly.

C 185.10.11 Installation

Installing oil supply lines

Note: Prior to installation, remove all blanking plugs.

CAUTION

Compressed air is air compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Blow out oil lines with compressed air and ensure that they are perfectly clean.

Install oil lines with new sealing rings, gaskets with connecting components and fixtures as shown in overview drawing (see C 185.10.01), making sure lines are free from tension.

Note: After engine start, visually inspect oil lines for leaks.

C 185.10.12 After-Installation Operations

A distinction must be made as to whether:

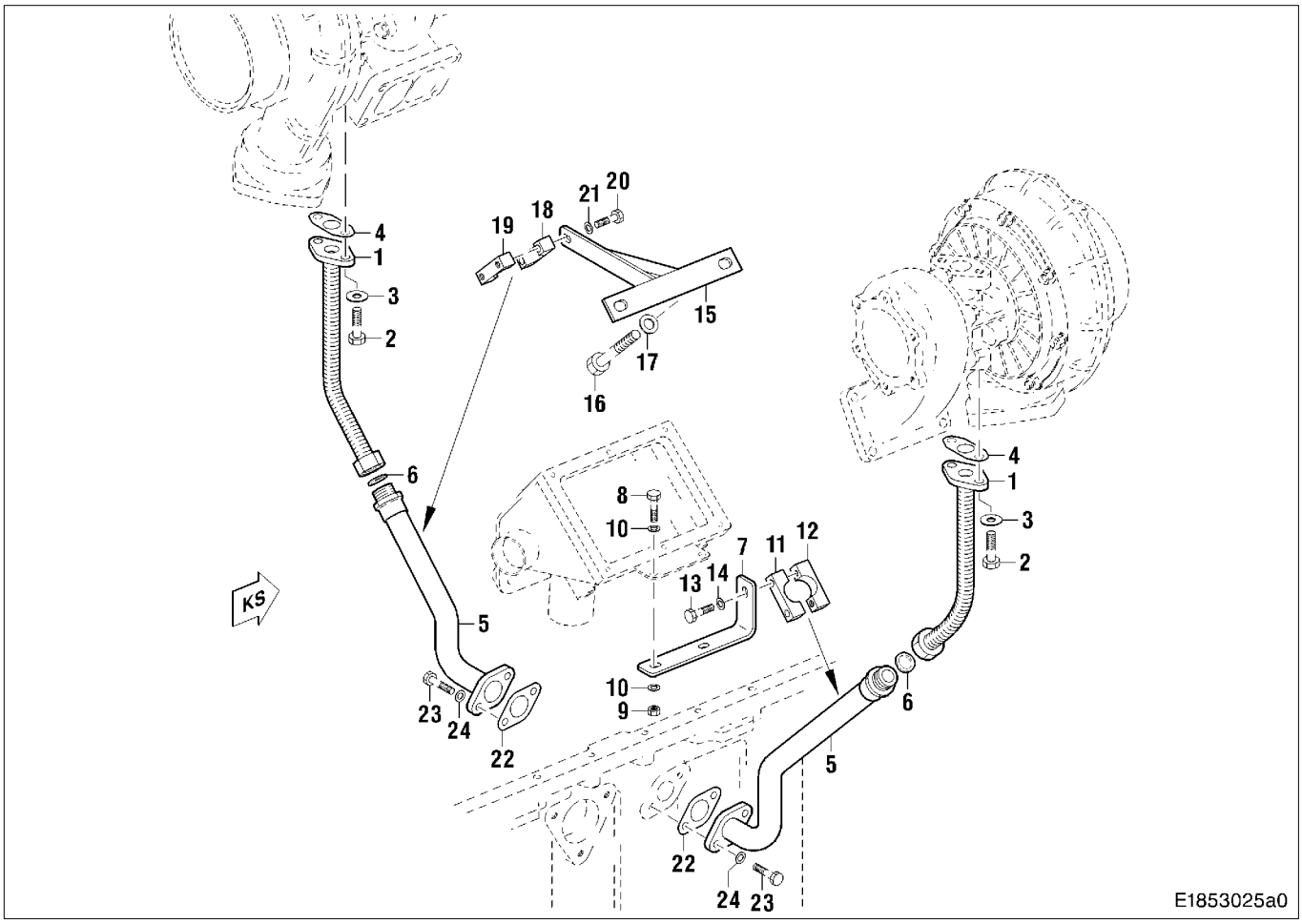
1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

C 185.25 Oil Return Lines for Exhaust Turbocharger

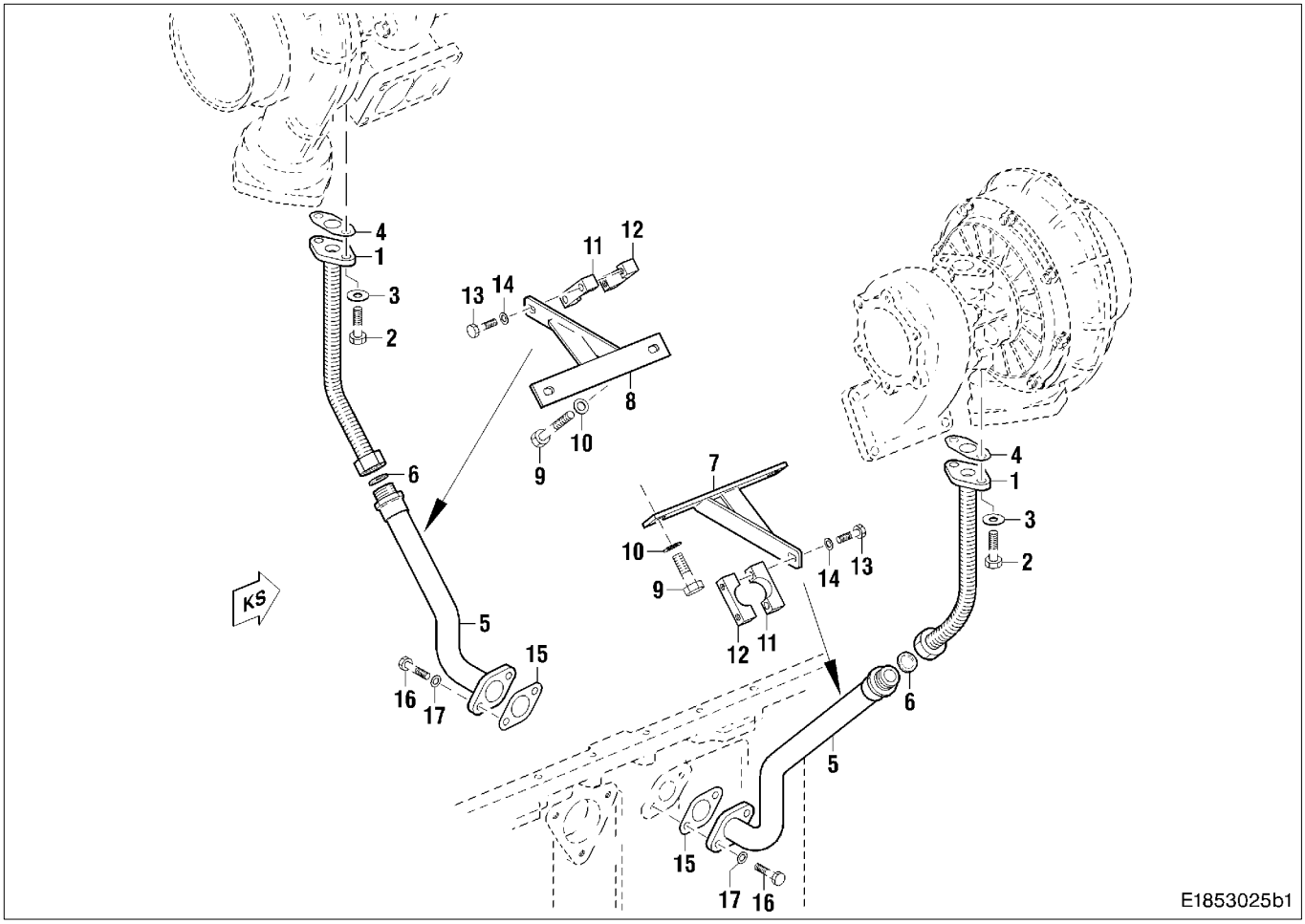
C 185.25.01 Overview Drawing

Oil return lines, 12V



1 Oil return line
2 Hex screw
3 Washer
4 Gasket
5 Oil return line
6 Sealing ring
7 Bracket
8 Hex screw
9 Hex nut
10 Washer
11 Pipe clamp half
12 Pipe clamp half
13 Hex screw
14 Washer
15 Bracket
16 Hex screw
17 Washer
18 Pipe clamp half
19 Pipe clamp half
20 Hex screw
21 Washer
22 Gasket
23 Hex screw
24 Washer

Oil return lines, 16V



1 Oil return line
2 Hex screw
3 Washer
4 Gasket
5 Oil return line
6 Sealing ring
7 Bracket
8 Bracket
9 Hex screw
10 Washer
11 Pipe clamp half
12 Pipe clamp half
13 Hex screw
14 Washer
15 Gasket
16 Hex screw
17 Washer

C 185.25.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 185.25.05 Removal

Removing oil return lines

Remove oil return lines, connection components and securing attachments as shown in overview drawing, see C 185.25.01.

Remove sealing rings and gaskets.

After removal, seal all connections with suitable plugs.

C 185.25.08 Inspection and Repair

Note: Make sure parts are perfectly clean.

Clean oil lines with cleaner. Visibly check condition of lines and inspect for damage; repair or replace lines if necessary.

Pressure-test oil lines with air in water bath for leaks as necessary.

WARNING

Compressed air is highly pressurized.
Risk of injury. Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Check connecting components and fixtures of oil lines for damage and wear; replace components as necessary.

Check sealing and mating faces, smooth with oilstone or emery cloth if necessary.

Replace gaskets and sealing rings as part of every assembly.

C 185.25.11 Installation

Note: Prior to installation, remove all blanking plugs.

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

Blow out oil lines with compressed air and ensure that they are perfectly clean.

Install oil lines with new gaskets and sealing rings, with connecting components and fixtures as shown in overview drawing (see C 185.25.01), making sure lines are free from tension.

Note: After engine start, visually inspect oil lines for leaks.

C 185.25.12 After-Installation Operations

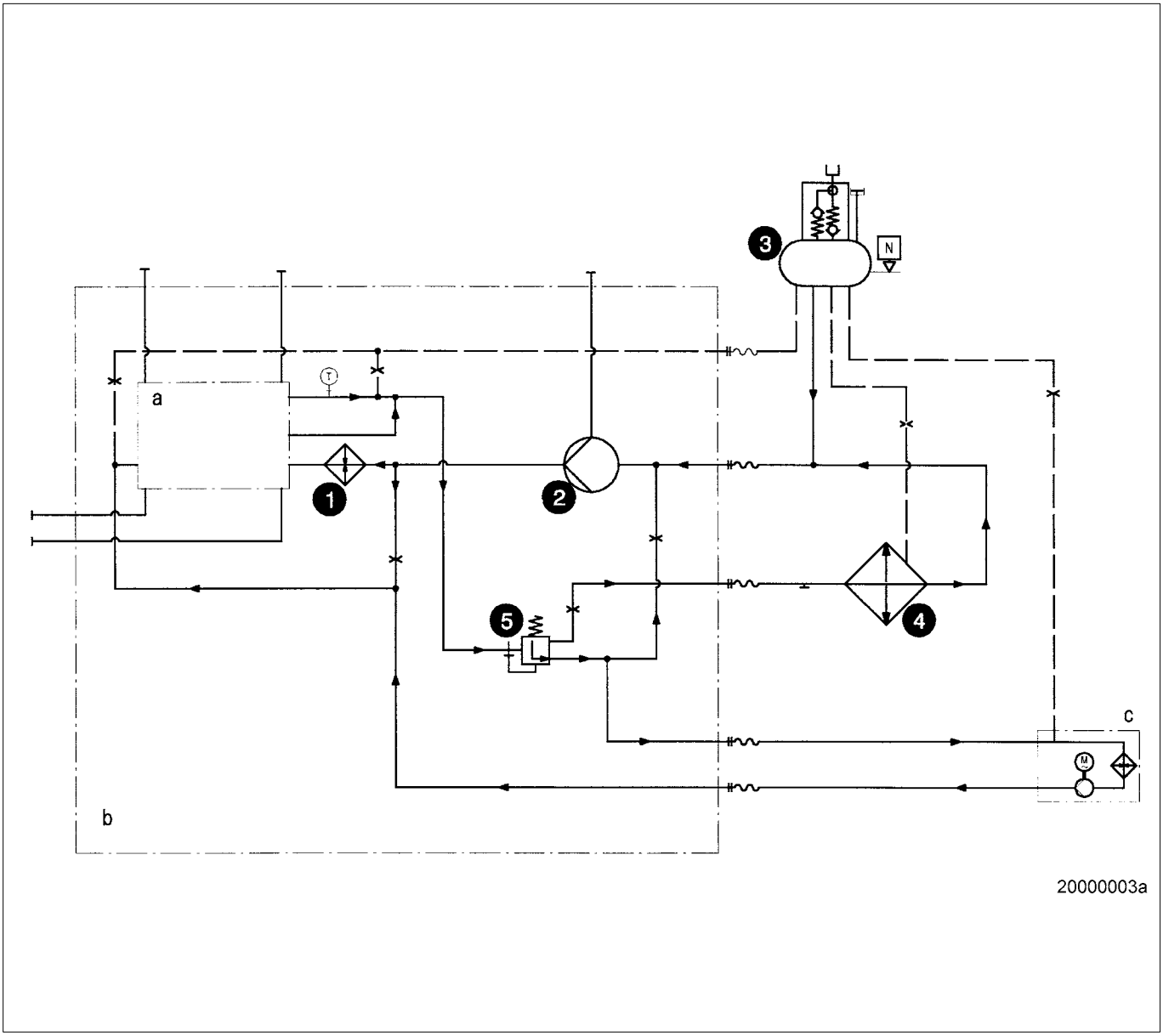
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Release engine start	Operating Instructions

Contents

C 200 Cooling System



1 Lube oil heat exchanger
2 Engine coolant pump
3 Engine coolant expansion tank
4 Air/engine coolant heat exchanger
5 Engine coolant thermostat

a Crankcase
b Engine
c Coolant preheating unit

——— = Fresh coolant line
— — — — = Vent line
—— · —— = System limits (assemblies)

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

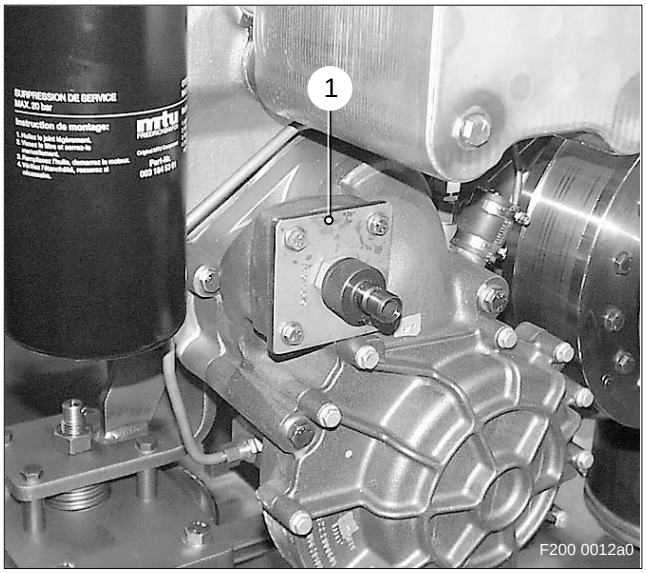
Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Magnifier			
Inspection lamp			
Polishing cloth			
Activator	Loctite No. 7649	50548	
Vaseline	Petroleum jelly, white	40317	
Surface sealant	Loctite No. 573	40031	Final strength ≈ 48 h
Engine oil			
Cleaning agent	Solvclean KW	40022	
Decalcifying agent	Porodox or Euron 1308		
Corrosion inhibitor	Pfinder AP 11 F	40355	
Denaturated ethanol		40250	
Multipurpose grease	Shell Retinax A	40333	
Kerosene or diesel fuel			
Sealing paste	Elastosil N 189	50545	
Engineer's blue	blue	40641	
Corrosion inhibitor	Caramba Express	40008	
Dry compressed air			
Surface crack-testing equipment with red penetrant dye			

C 200.08 Pressure-Testing Coolant Chambers

Note: After assembling engine, pressure-test coolant jackets with treated coolant and check for leaks.

WARNING

Only use hydraulic pressure testing device specified by Manufacturer.
Observe specified safety and accident prevention regulations!



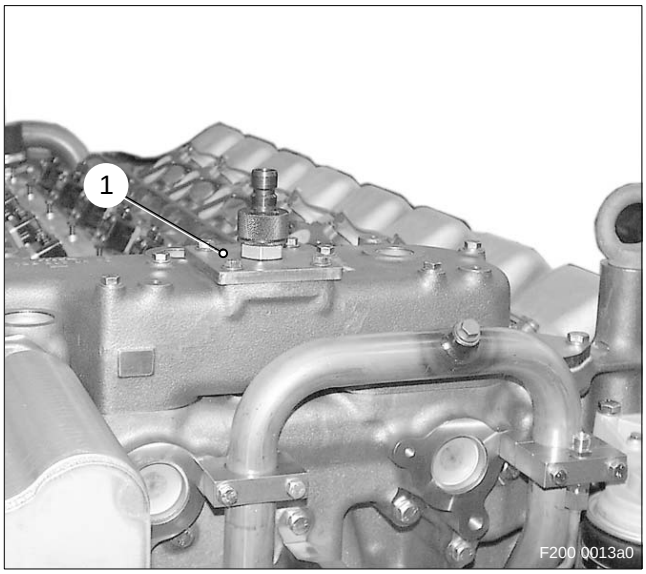
To facilitate checking of internal components, remove plugs from following components:

– Oil pan

– Oil heat exchanger (oil side)

Install connection (1) for supply hose line of hydraulic pressure testing device to coolant pump.

Connect supply hose line of hydraulic pressure testing device.



Install connection (1) for return hose line of hydraulic pressure testing device to thermostat housing.

Connect return hose line.

WARNING

Test liquid is hot and highly pressurised. Risk of injury!
Liquids emerging under high-pressure can lead to serious injury!
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Connect pressure unit and fill engine coolant chambers with treated coolant.

Vent piping system.

Pressure-test coolant chambers with water at 80 °C for one hour.

Test pressure = 7 bar

Check all coolant-carrying components for leaks.

If pressure loss is detected, determine cause and rectify.

After completion of pressure testing, relieve test pressure.

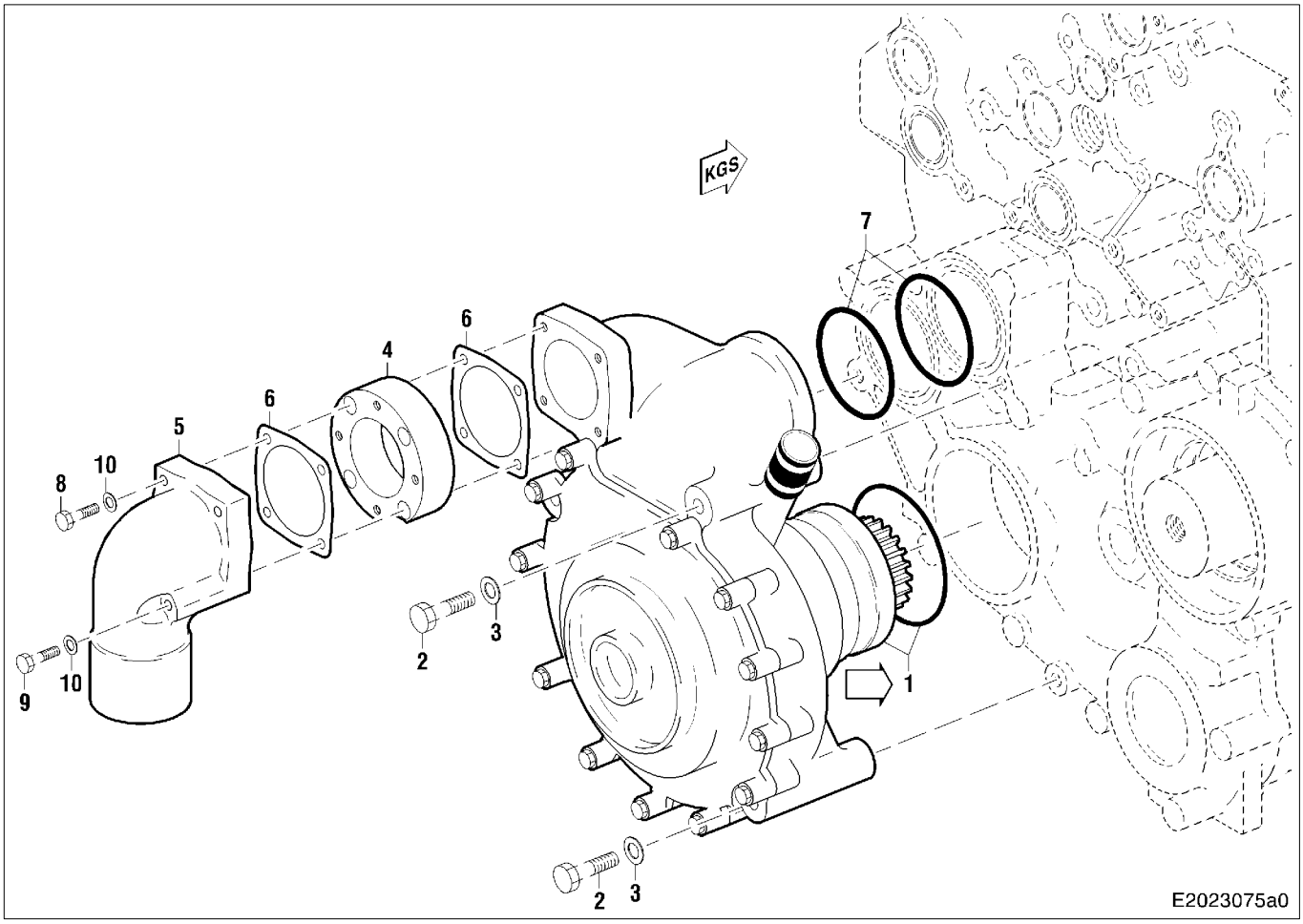
Drain system.

Remove pressure testing device.

Reinstall plugs.

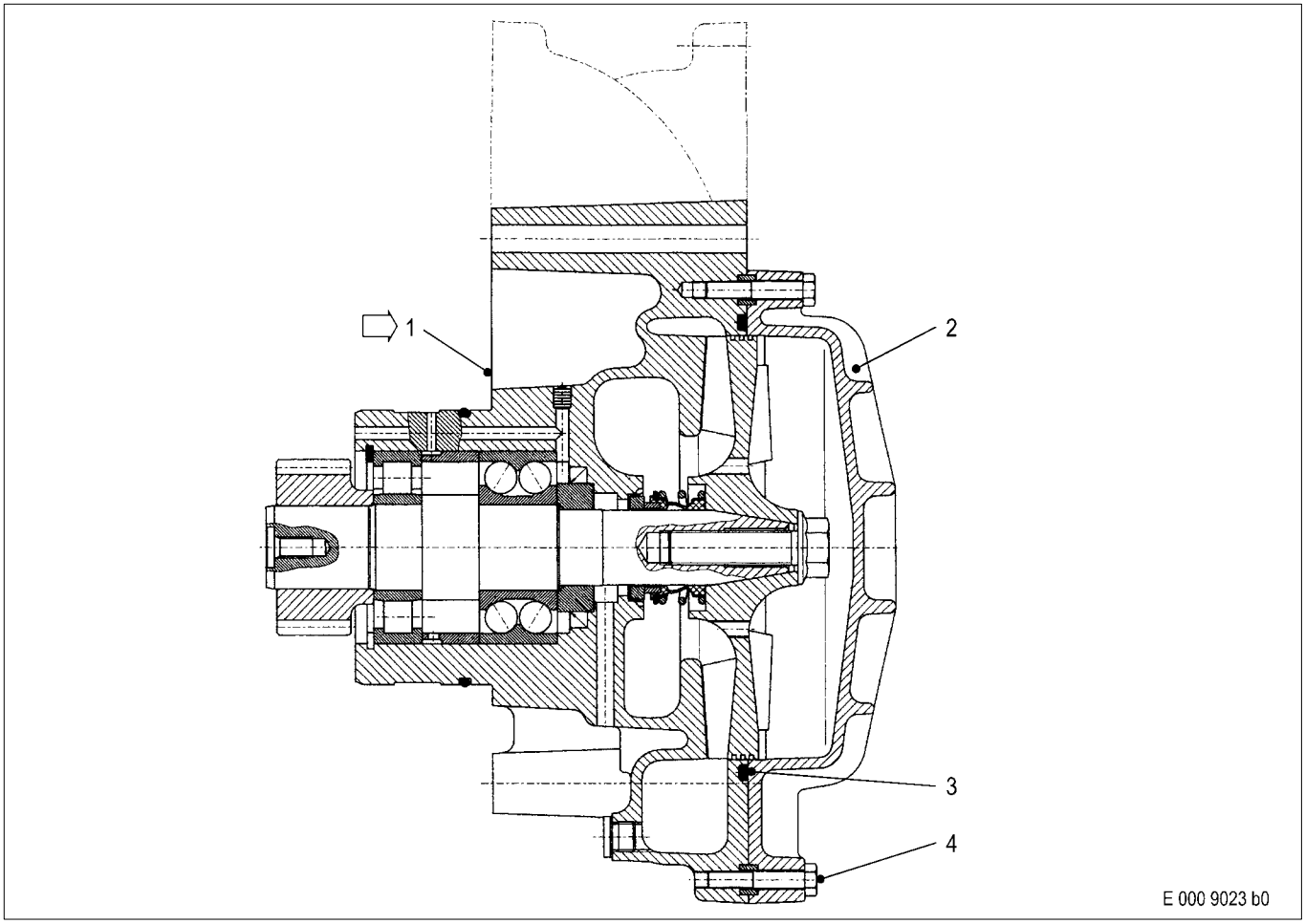
C 202.05 Engine Coolant Pump

C 202.05.01 Overview Drawing



1 Coolant pump
2 Hex screw
3 Washer
4 Flange
5 Elbow
6 Gasket
7 O-ring
8 Hex screw
9 Hex screw
10 Washer

Engine Coolant Pump



1 Housing lower section
2 Cover
3 O-ring
4 Hex screw

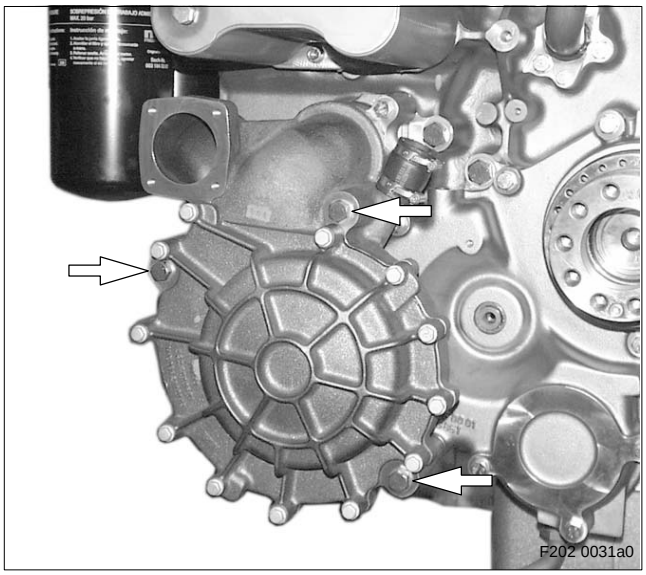
C 202.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
	x	x	Remove fuel pump	C 081.05

C 202.05.05 Removal



Removing engine coolant pump

Remove elbow and flange as shown in overview drawing – see C 202.05.01.

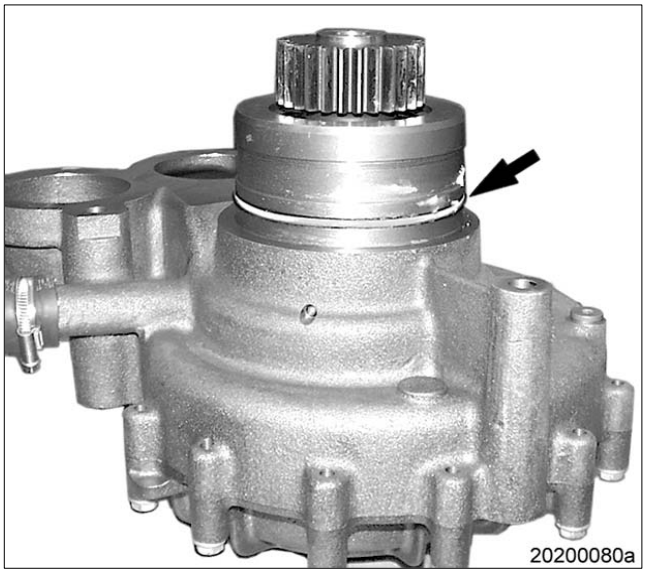
Remove hex screws (arrows) and washers.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Release engine coolant pump with lifting iron from gear case cover and remove.

Remove O-rings from gear case cover.



Remove driver for fuel pump – see also C 081.05.

O-ring (arrow) from engine coolant pump.

C 202.05.06 Disassembly

The coolant pump must not be disassembled.

The engine coolant pump is a replacement component and is available through the usual replacement procedure.

C 202.05.08 Inspection and Repair

Replace coolant pump in accordance with maintenance schedule during appropriate maintenance echelon.

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

When re-using coolant pump, check it externally for damage and replace if necessary.

Check cover and impeller for cavitation. In event of pitting, replace coolant pump.

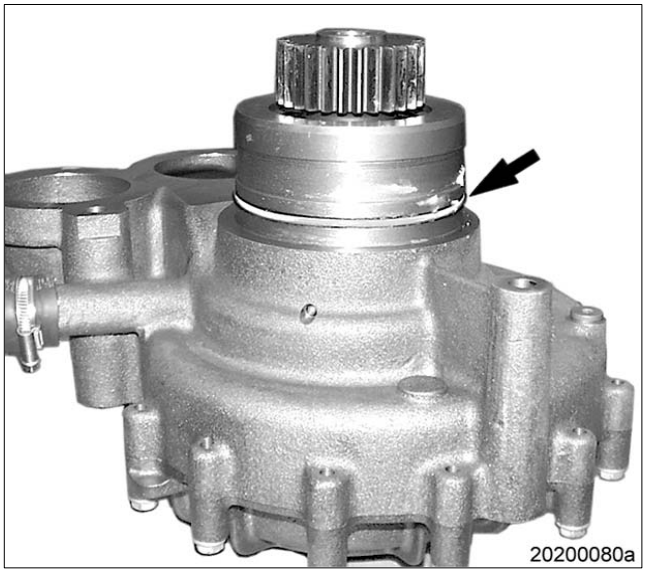
Visually inspect sealing surfaces for wear, pitting and cavitation; rub down with emery cloth or an oilstone or replace component.

Turn pump shaft to check freedom of rotation.

Check gear for impressions, wear and damage and smooth slight wear and damage with emery cloth or oilstone; replace engine coolant pump if necessary.

Replace gaskets and O-rings at every assembly.

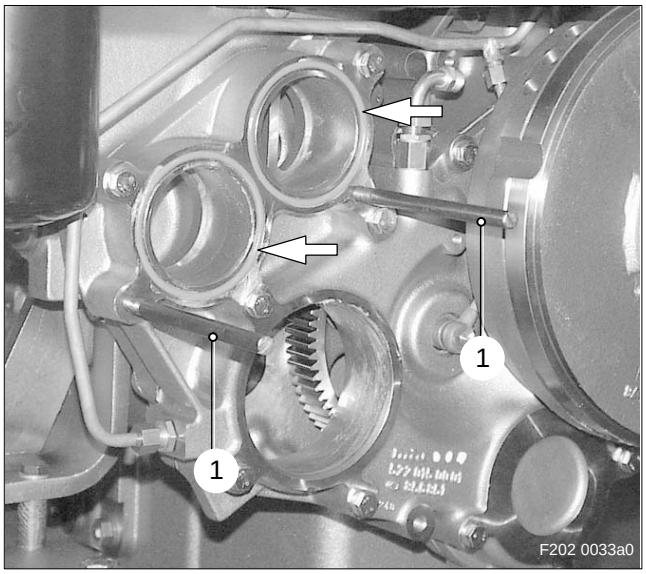
C 202.05.11 Installation



Installing engine coolant pump

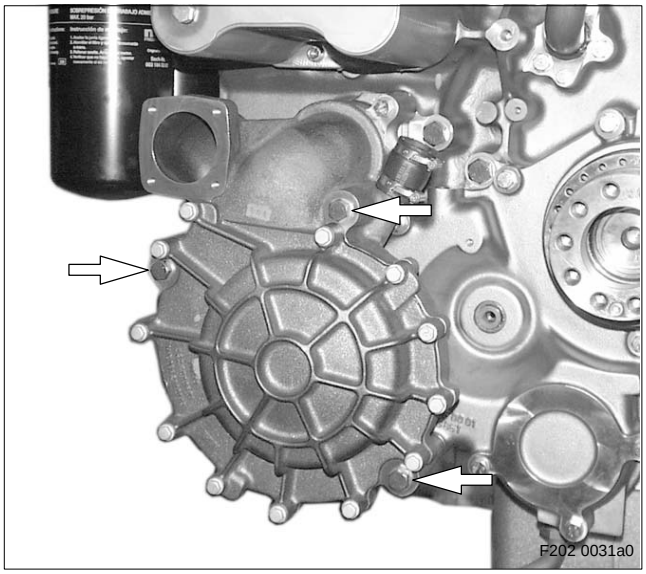
Install driver for fuel pump on pump shaft, see C 081.05.

Coat O-ring (arrow) with petroleum jelly and insert into groove on housing.



Insert two suitable guide pins (1) into gear case.

Coat O-rings (arrows) with petroleum jelly and insert in grooves in gear case cover.



⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Insert coolant pump into bore in gear case cover, ensuring it is correctly positioned. Pay attention to fit of driver and gear engagement, and if necessary rotate gear.

Install hex screws (arrows) and washers and tighten uniformly.

Install elbow and flange as shown in overview drawing – see C 202.05.01.

C 202.05.12 After-Installation Operations

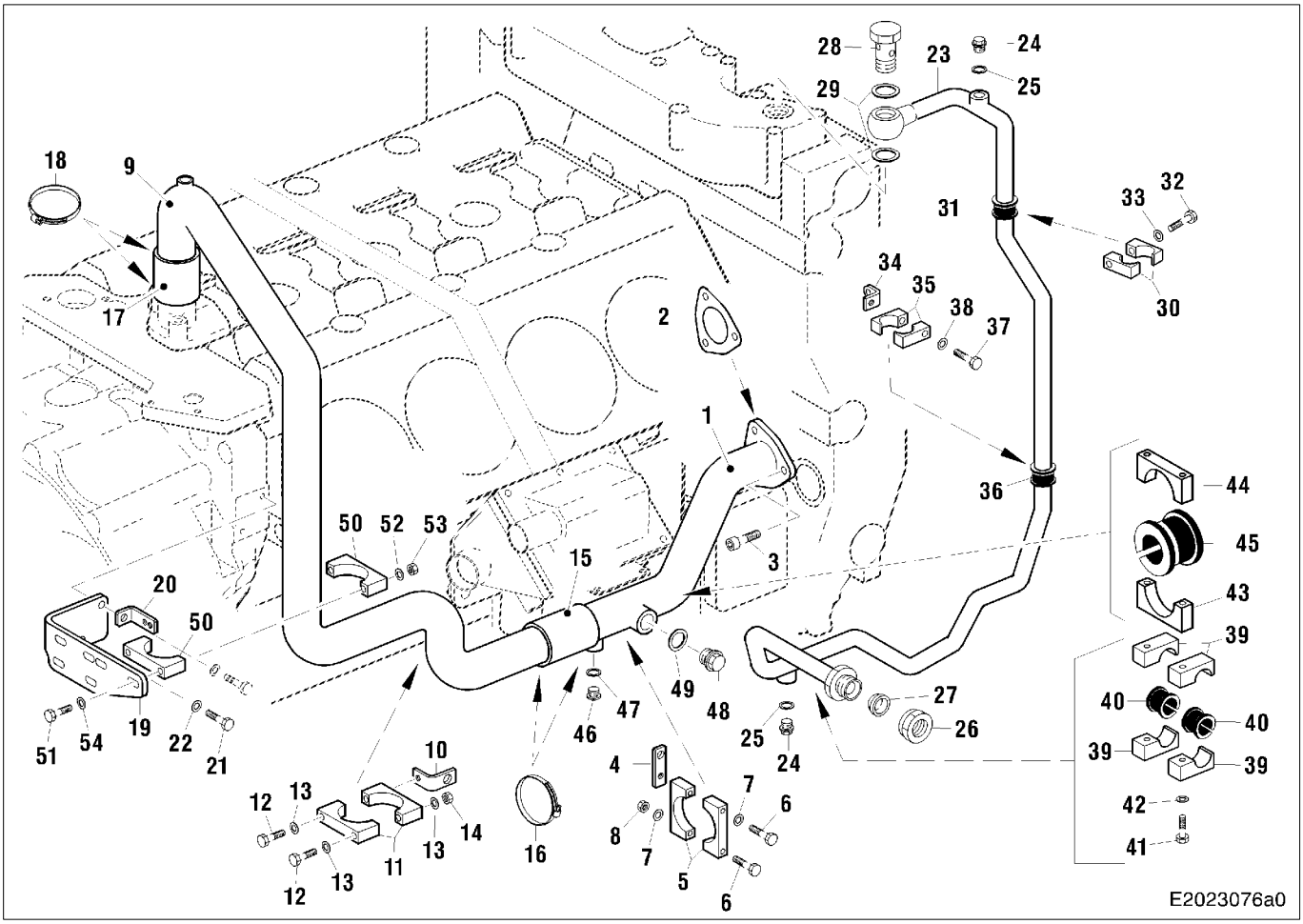
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install fuel pump	C 081.05
–	–	x	Fill engine cooling system	Operating Instructions
–	–	x	Release engine start	Operating Instructions
–	–	x	Vent fuel system	Operating Instructions

C 202.15 Engine Coolant Lines

C 202.15.01 Overview Drawing



1	Coolant line	19	Bracket	37	Hex screw
2	Gasket	20	Retaining element	38	Washer
3	Socket-head screw	21	Hex screw	39	Pipe clamp half
4	Bracket	22	Washer	40	Grommet
5	Pipe clamp half	23	Coolant line	41	Hex screw
6	Hex screw	24	Plug	42	Washer
7	Washer	25	Sealing ring	43	Pipe clamp half
8	Hex nut	26	Nut	44	Pipe clamp half
9	Coolant line	27	Sealing cone	45	Grommet
10	Bracket	28	Banjo screw	46	Plug
11	Pipe clamp half	29	Sealing ring	47	Sealing ring
12	Hex screw	30	Pipe clamp half	48	Plug
13	Washer	31	Grommet	49	Sealing ring
14	Hex nut	32	Hex screw	50	Pipe clamp half
15	Rubber sleeve	33	Washer	51	Hex screw
16	Clamp	34	Bracket	52	Washer
17	Rubber sleeve	35	Pipe clamp half	53	Hex nut
18	Clamp	36	Grommet	54	Washer

C 202.15.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ———— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Disconnect monitoring units and remove	C 507.10

C 202.15.05 Removal

Disconnecting engine coolant lines

Note: Before removing lines, it is advisable to photograph the engine from all sides or attach metal tags to the lines and fixtures so that they can be reinstalled in their original positions.

Remove lines in accordance with overview drawing – see C 202.15.01.

After removing lines, seal all open connections by installing suitable plugs.

C 202.15.08 Inspection and Repair

Clean lines with cold cleaner and brush.

Visually inspect all components, especially sealing and mating faces, for wear, pitting and cavitation; rub down with emery cloth or an oilstone or replace component.

If necessary, repair pipelines. If necessary, check for leaks with corrosion inhibitor with air in water bath.

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

Replace rubber sleeves, clamps and grommets during W6 maintenance.

Replace sealing rings and gasket ring at every assembly.

C 202.15.11 Installation

Connecting engine coolant lines

CAUTION

Compressed air is air which has been compressed under pressure. If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Compressed air must not be directed at the body. The pressure must not exceed 3.0 bar (40 lb/in^2).

Prior to installing, remove all blanking plugs and blow lines clear with compressed air.

Install lines with new sealing rings and gaskets with fixtures free of tension as shown in overview drawing (see C 202.15.01)

Note: After engine start, visually inspect lines for leaks.

C 202.15.12 After-Installation Operations

A distinction must be made as to whether:

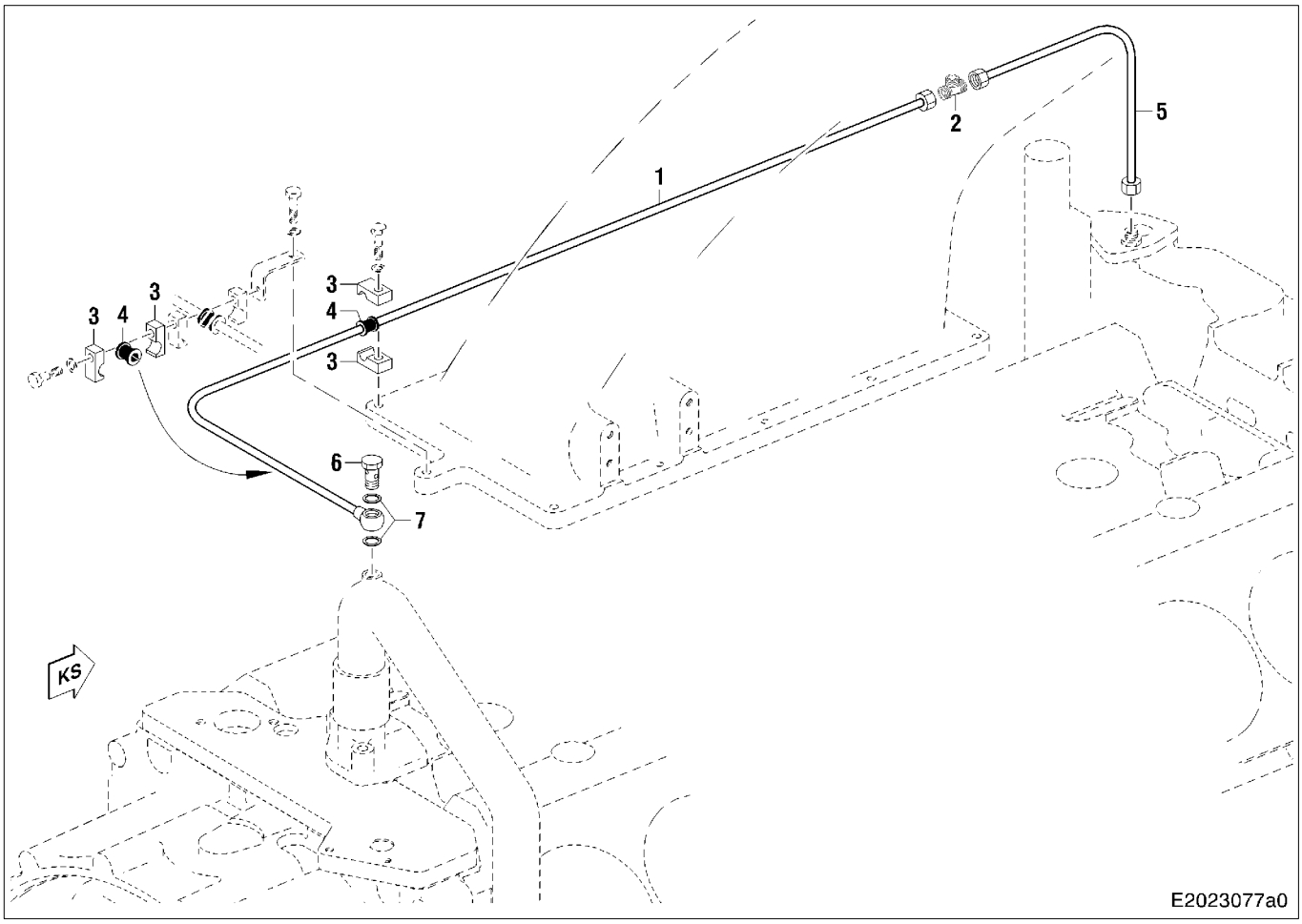
1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install monitoring units and connect	C 507.10
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 202.65 Vent Lines

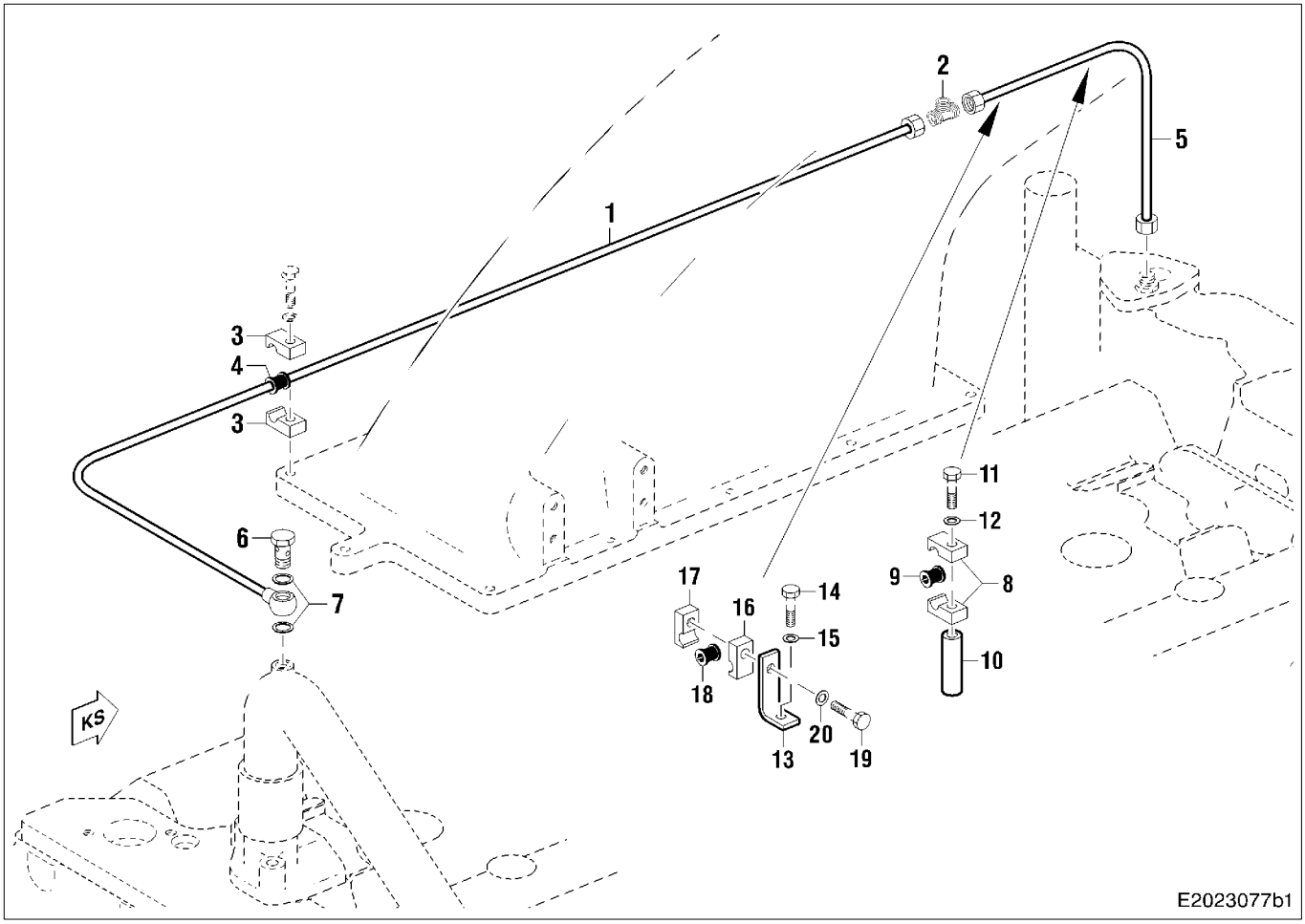
C 202.65.01 Overview Drawing

Vent line, 12V



1 Vent line
2 T-piece
3 Pipe clamp half
4 Grommet
5 Vent line
6 Banjo screw
7 Sealing ring

Vent line, 16V



1 Vent line
2 T-piece
3 Pipe clamp half
4 Grommet
5 Vent line
6 Banjo screw
7 Sealing ring
8 Pipe clamp half
9 Grommet
10 Spacer bush
11 Hex screw
12 Washer
13 Bracket
14 Hex screw
15 Washer
16 Pipe clamp half
17 Pipe clamp half
18 Grommet
19 Hex screw
20 Washer

C 202.65.04 Before-Removal

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions

C 202.65.05 Removal

Disconnect vent lines

Note: Before removing lines, it is advisable to photograph the engine from all sides or attach metal tags to the lines and fixtures so that they can be reinstalled in their original positions.

Remove vent lines with fixtures as per Overview Drawing – see C 202.65.01.

After removal, seal all connections with suitable plugs.

C 203.55.08 Inspection and Repair

Clean lines with cold cleaner and brush.

Check lines for damage and condition; if necessary, check under water with air using corrosion inhibitor for leaks.

WARNING

Compressed air is highly pressurized.
Risk of injury! Pressure must not exceed 0.5 bar.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Test pressure: 0.5 bar

Water temperature min. 30 °C, max. 40 °C.

If leaks are detected, replace line.

Replace grommets as part of every W6 overhaul.

Replace sealing rings as part of every assembly.

C 202.65.11 Installation

Connecting vent lines

CAUTION

Compressed air is highly pressurized. Risk of injury!
If compressed air is used for blowing out or blow-drying components, always wear protective goggles or safety mask. Pressure must not exceed 3.0 bar.

Prior to installing, remove all blanking plugs and blow lines clear with compressed air.

Install lines with new sealing rings and securing components free of tension as shown in overview drawing, see C 202.65.01.

C 202.65.12 After-Installation Operations

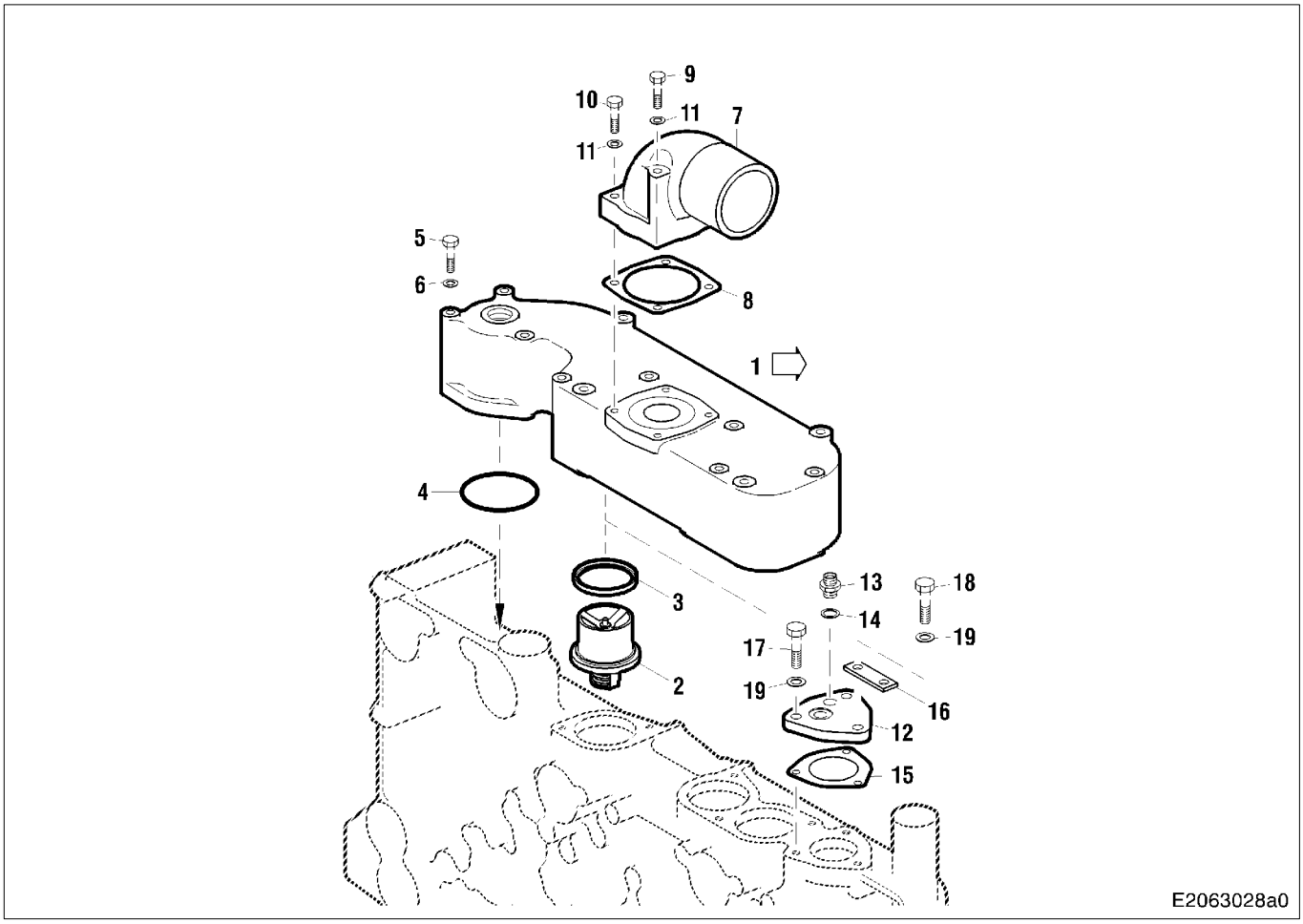
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 206.05 Coolant Distribution Housing and Thermostat

C 206.05.01 Overview Drawing



1 Thermostat housing
2 Thermostat insert
3 Sealing ring (Teflon)
4 O-ring
5 Hex screw
6 Washer
7 Elbow
8 Gasket
9 Hex screw
10 Hex screw
11 Washer
12 Flange
13 Union
14 Sealing ring
15 Gasket
16 Bracket
17 Hex screw
18 Hex screw
19 Washer

C 206.05.02 Special Tools

Designation – Application	Number
Press-in mandrel for sealing ring (Teflon)	1

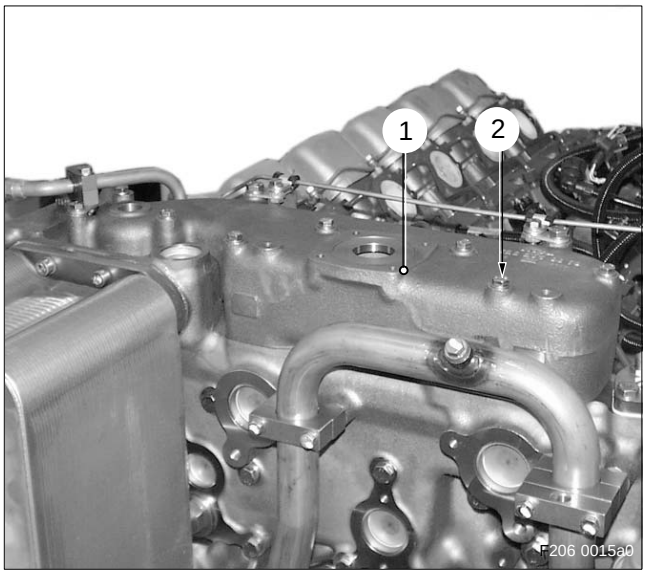
C 206.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant	Operating Instructions
–	x	x	Disconnect electric cables	C 507.10
–	x	x	Remove ECU housing and bracket	C 508.10
–	x	x	Remove coolant lines	C 202.15

C 206.05.05 Removal

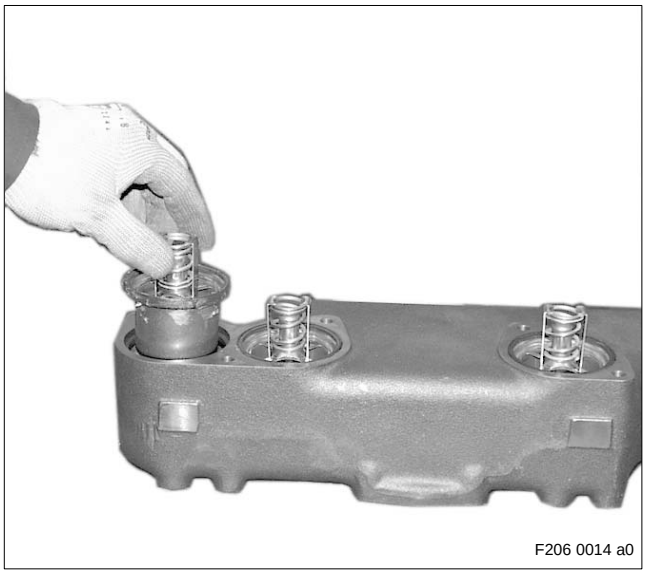


Remove thermostat housing

Unscrew securing screws (2) and washers securing thermostat housing (1).

Remove thermostat housing from gear case.

Remove O-ring.


F206 0014 a0

Removing thermostat elements

Remove thermostat elements from thermostat housing.

Remove sealing rings (Teflon) – see overview drawing – C 206.05.01 with suitable extractor from thermostat housing.

C 206.05.08 Inspection and Repair

Clean all parts with cold cleaner.

Check components for damage and defects; replace components as necessary.

Check thermostat housing for leaks with air in water bath (with corrosion inhibitor).

WARNING

Compressed air is air which has been compressed under pressure. Risk of injury! Pressure must not exceed 0.5 bar (7.25 lb/in^2). Always wear protective clothing, protective gloves and protective goggles/safety mask.

Coolant temperature min. 30 °C – components must also be at this temperature; max. 40 °C, if component must be held in hands.

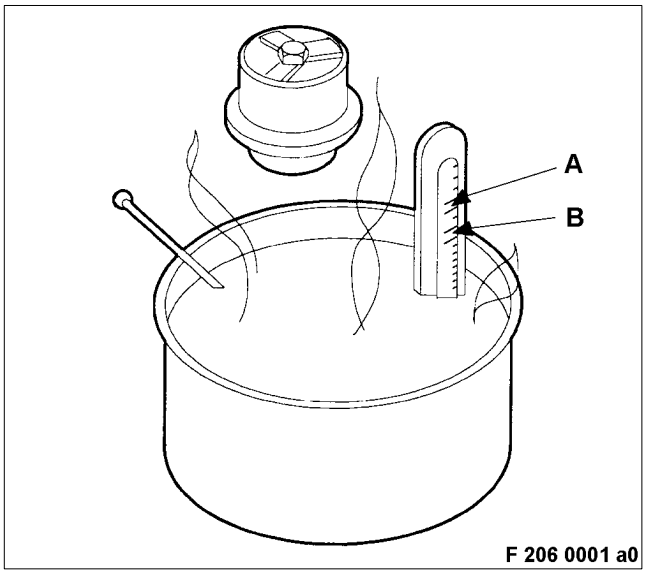
Test pressure: 0.5 bar

If leaks are found, replace component.

Check all mating and sealing faces for wear and damage; rub down with emery cloth or an oilstone as necessary.

Replace sealing rings (Teflon) as part of every W6 maintenance.

Replace O-rings, gaskets and sealing rings at every disassembly.



Checking thermostat insert

Hang thermostat insert on a wire in a container filled with water; thermostat insert must not contact container.

Heat water with suitable heat source.

As of approx. 10 °C under start-of-opening temperature (B), the heating speed must not exceed 1 °C per minute.

Start-of-opening temperature is stamped on thermostat insert.

Note: Never use welding torch or blow torch to heat thermostat insert!

⚠ CAUTION

Component is hot.
Risk of injury!
Touch components only when wearing protective gloves.

Check thermostat insert for start of opening with heat supply uniform and water constantly circulated.

Replace thermostat insert if results of check are negative.

Continue to heat coolant to full-opening temperature (A).

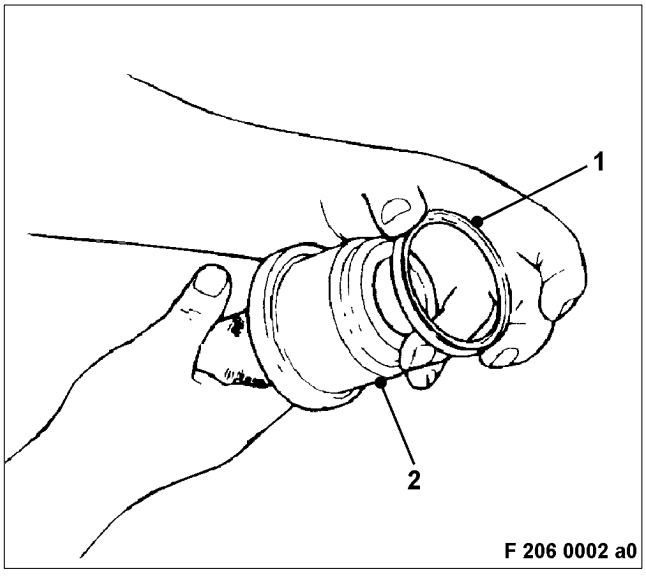
Full-opening temperature = 88 °C ± 2 °C

Thermostat insert must be completely open after 6 to 8 minutes.

Measure stroke travel of thermostat insert.

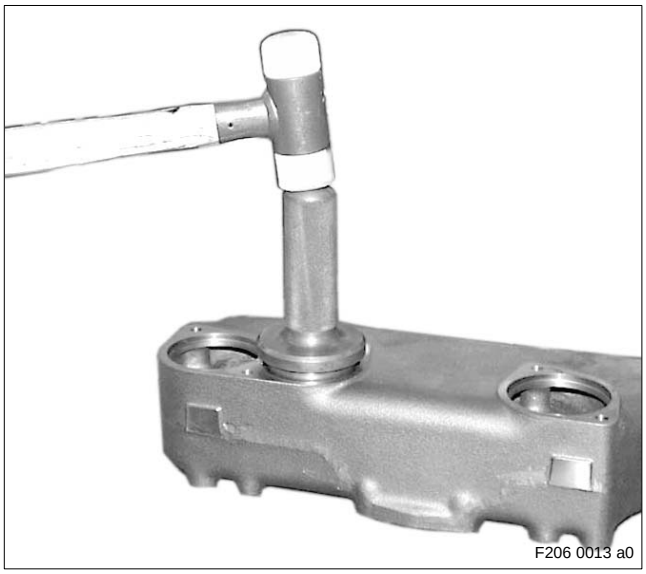
Stroke must be min. 9.5 mm; if not, replace thermostat element.

C 206.05.11 Installation



Installing sealing ring (Teflon) into thermostat housing

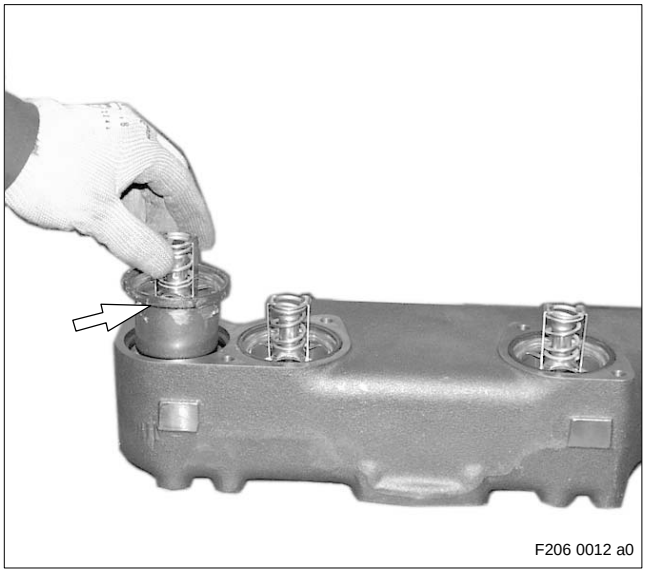
Fit sealing ring (1) on press-in mandrel, with flat end facing press-in mandrel (2).


F206 0013 a0

Check sealing and mating faces in thermostat housing, clean as necessary.

Use an installation mandrel to install sealing rings into thermostat housing.

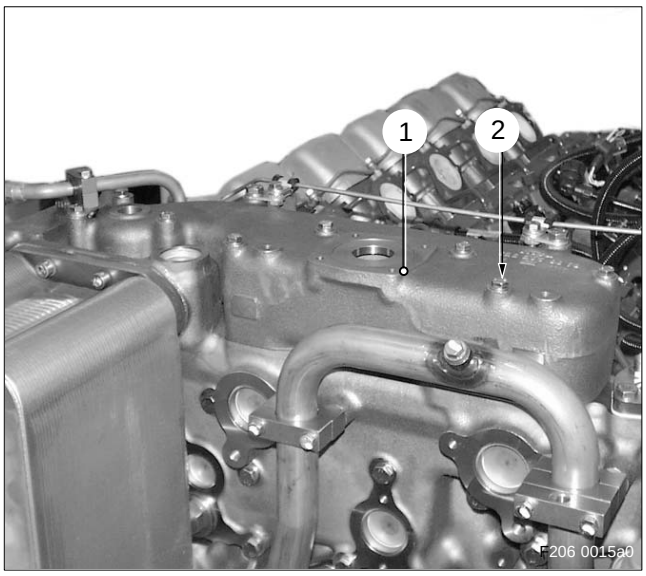
Note: When driving in sealing rings, turn press-in mandrel so that sealing rings in thermostat housing are at same height.


F206 0012 a0

Installing thermostat elements

Coat sealing ring (arrow) on thermostat element with petroleum jelly.

Press thermostat elements into thermostat housing by hand.



F206 0015a0

Installing thermostat housing

Check sealing and mating faces and clean if necessary.

Coat O-ring (see overview drawing C 206.05) with petroleum jelly and insert into groove in thermostat housing.

Install thermostat housing with screws (2) and washers on gear case and tighten evenly.

C 206.05.12 After-Installation Operations

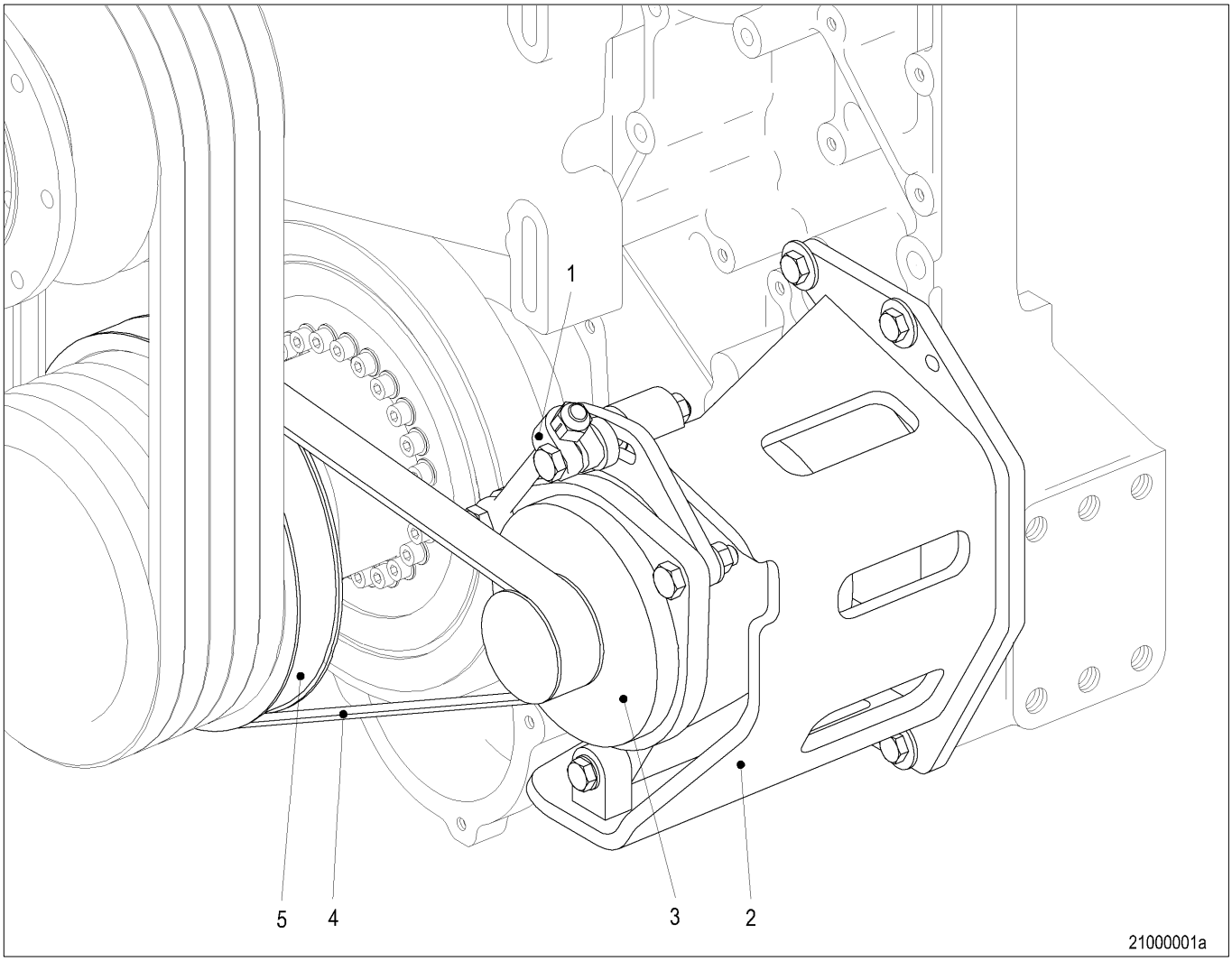
A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install ECU housing and bracket	C 508.10
–	x	x	Connect coolant lines	C 202.15
–	x	x	Connect electric cables	C 507.10
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

Contents

C 210 Power Supply, Engine Side



1 Belt tensioning device
2 Carrier
3 Alternator
4 V-belt
5 Belt pulley

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

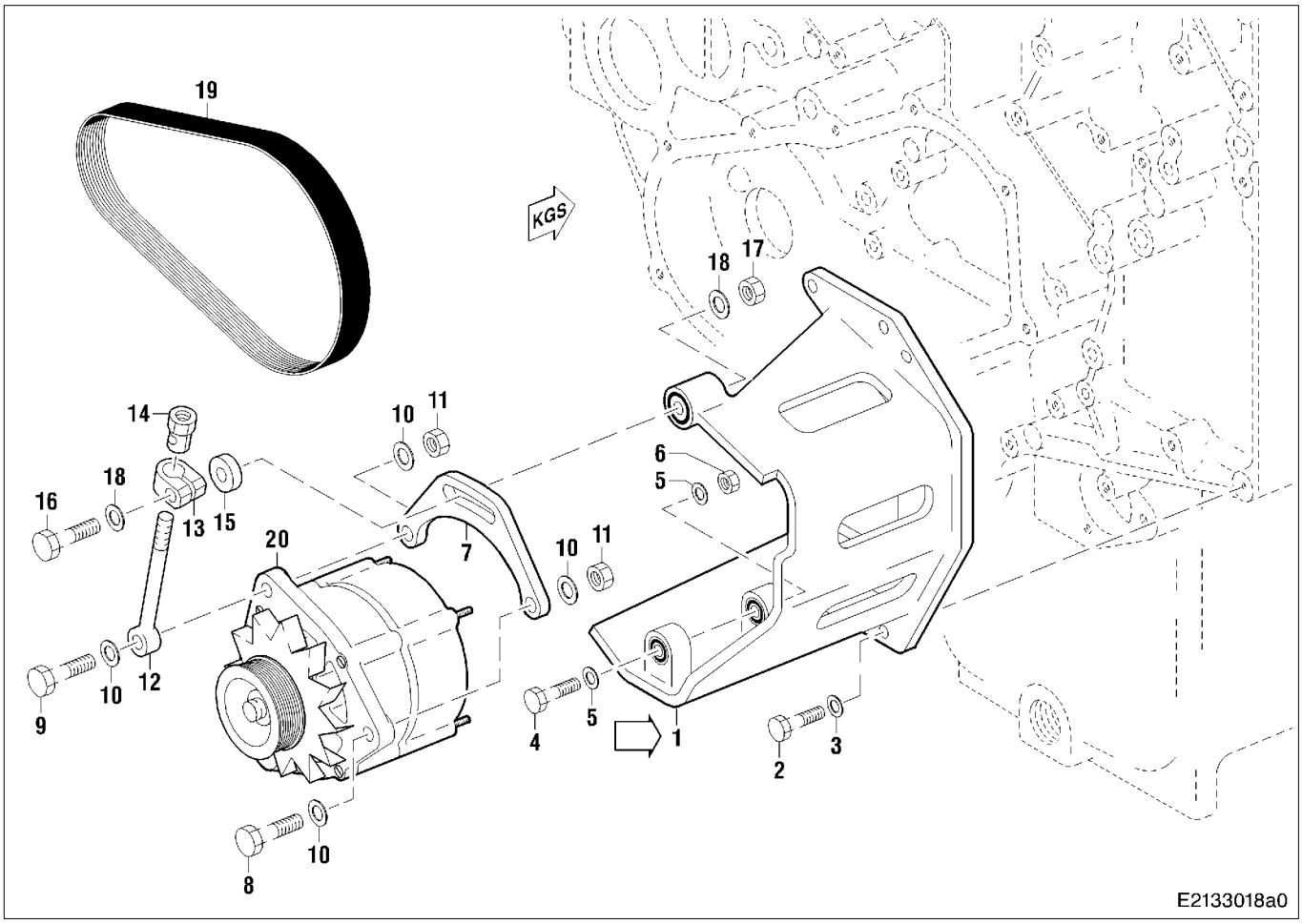
When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Polishing cloth			
Magnifier			
Engine oil			
Cleaning agent	Solvclean KW	40022	
Corrosion inhibitor	Caramba Express	40008	
Kerosene or diesel fuel			
Dry compressed air			

C 213.05 Generator

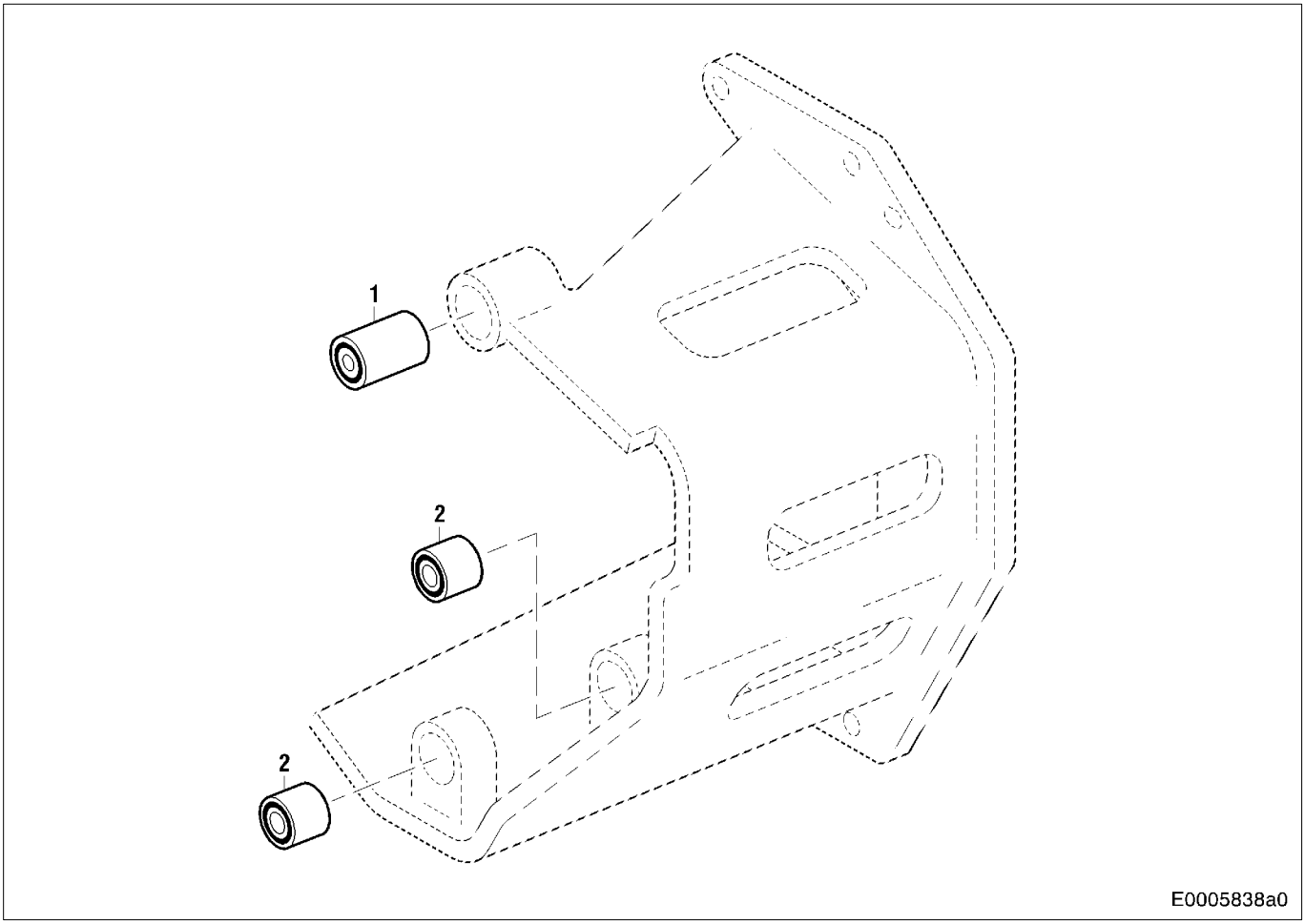
C 213.05.01 Overview Drawing

Three-phase alternator

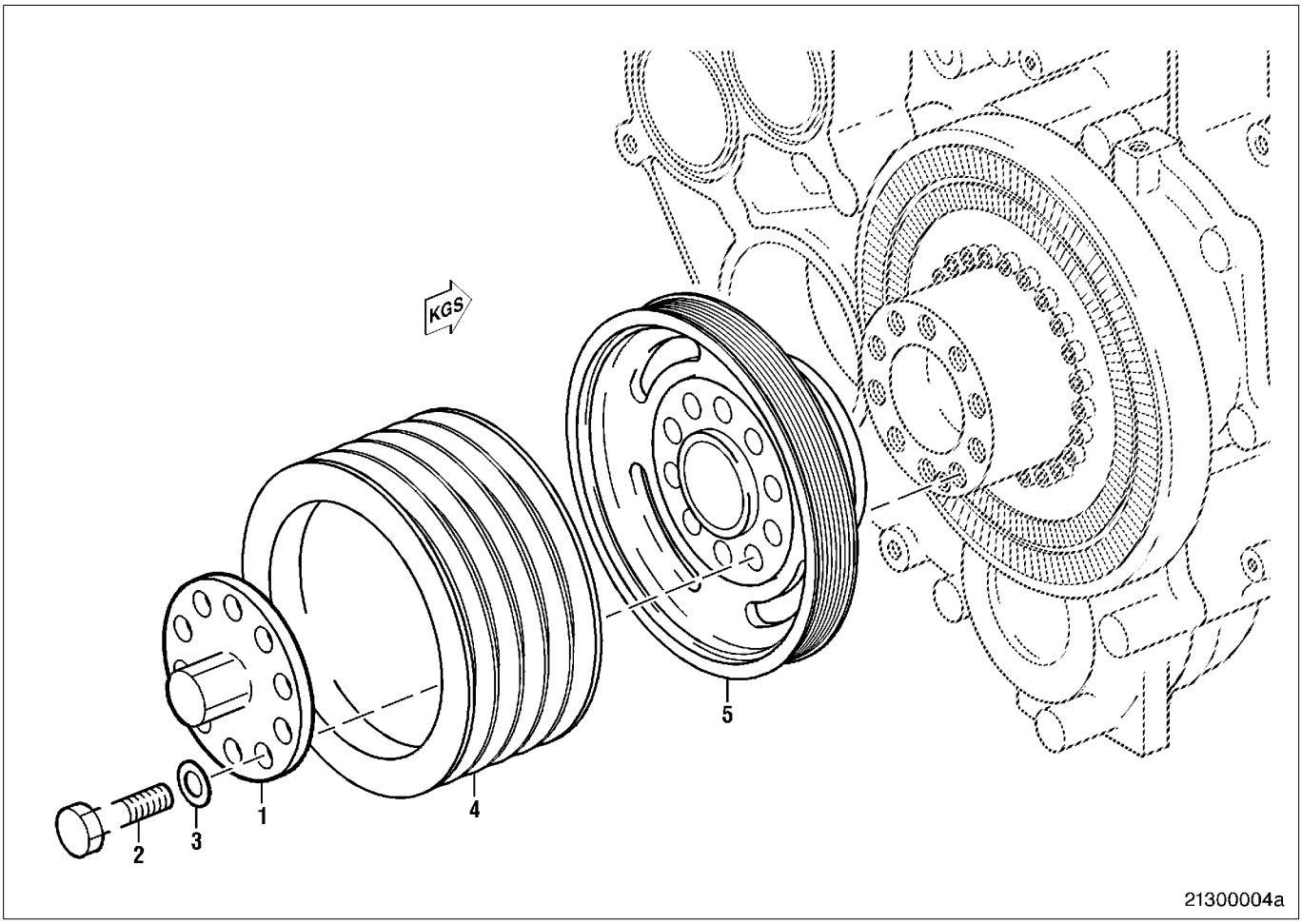


1 Carrier
2 Hex screw
3 Washer
4 Hex screw
5 Washer
6 Hex nut
7 Bracket
8 Hex screw
9 Hex screw
10 Washer
11 Hex nut
12 Eyebolt
13 Clamping element
14 Clamping nut
15 Washer
16 Hex screw
17 Hex nut
18 Washer
19 V-belt
20 Alternator

Bracket



1 Bush (rubber shock mount)
2 Rubber shock mount



1 Flange
2 Hex screw
3 Washer
4 Belt pulley
5 Belt pulley

C 213.05.02 Special Tools

Designation – Application	Number
V-belt tension gauge	1

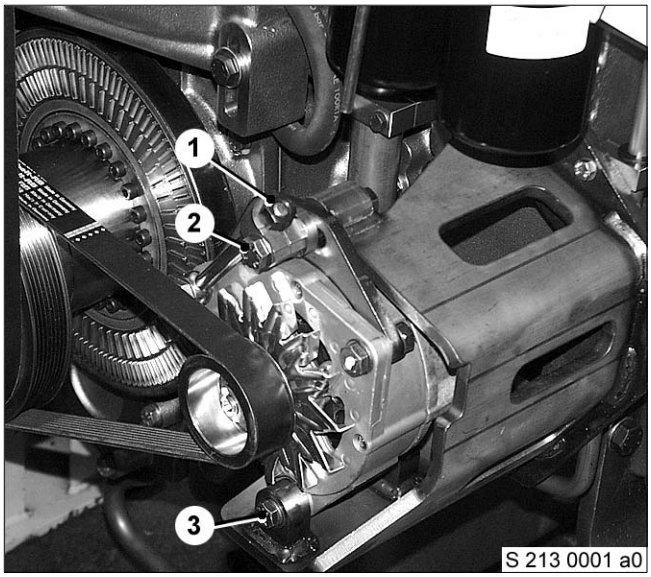
C 213.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Disconnect electric cables	C 507.10
–	x	x	Release cable brackets	–
–	x	x	Remove V-belt guard	C 028.05
–	x	x	Remove V-belt for fan drive	C 221.05

C 213.05.05 Removal



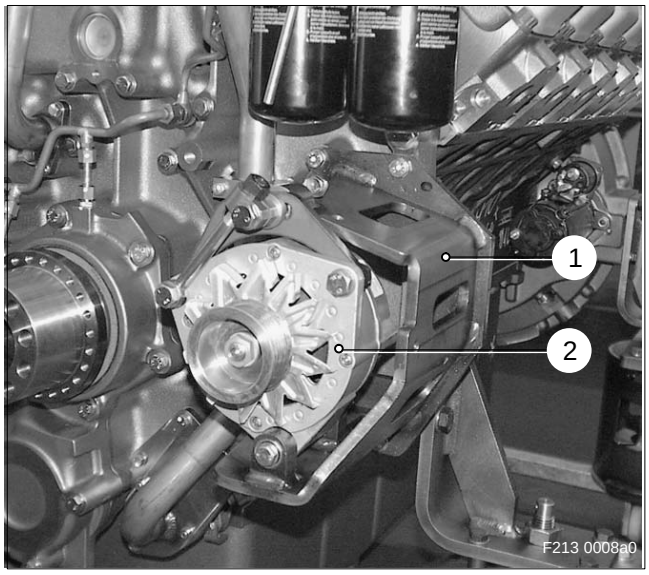
Removing V-ribbed belt

Release securing screws (2) and (3).

Release clamping nut (1) until V-ribbed belt can be removed.

Remove V-ribbed belt from belt pulleys.

Important: When removing V-ribbed belt, take care it is not bent or damaged.



Removing alternator

Remove securing screws, hex nuts and washers for alternator (2) and remove alternator from carrier (1).

Remove securing screws and washers for carrier from gear case and remove carrier.

Remove bracket from alternator.

Removing belt pulley from crankshaft drive flange

Remove belt pulley as per overview drawing C 213.05.01 from drive flange – see also C 231.05 –Removing belt pulley–.

C 213.05.06 Disassembly

Alternator disassembly, see Special Publication.

C 213.05.08 Inspection and Repair

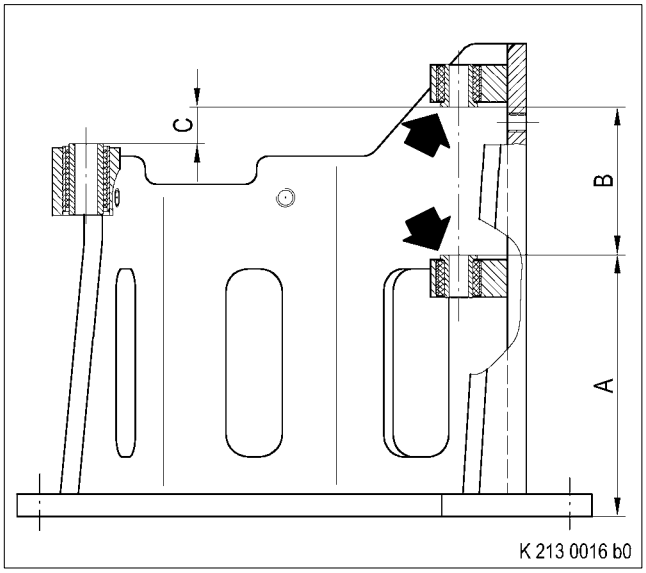
Inspect and repair individual parts of alternator in accordance with Manufacturer's documentation.

Visually inspect outside of alternator for damage and defects.

Clean carrier and securing components; visually inspect for damage and check condition; replace component as necessary.

Check condition of threads; replace components as necessary.

Replace bushes in carrier and V-ribbed belt during every W6 maintenance.



Replacing bushes (rubber shock mount)

Using manual press and suitable mandrel, press bushes out of carrier.

Clean fitted bore in carrier.

Use a manual press and mandrel to install new bushes to specified dimensions in carrier.

A = 138.8 mm ± 0.8 mm

B = 80.2 mm + 0.2 mm

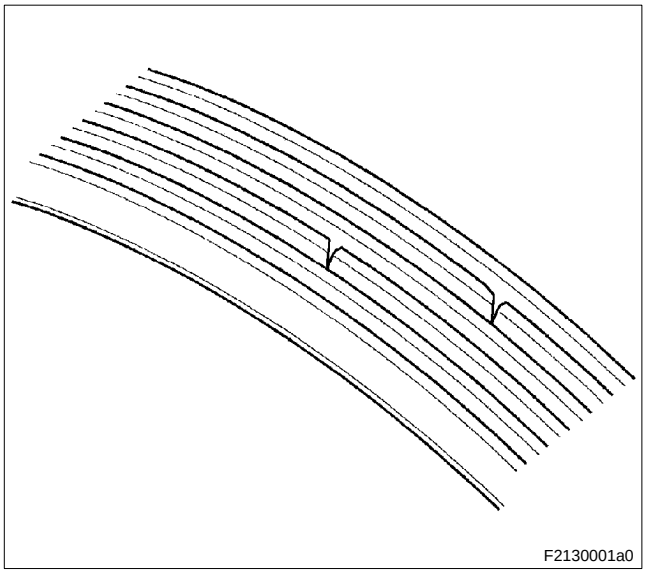
C = 21 mm + 0.2 mm

Note: Apply pressure to bush outer ring only. The bush collar (arrow) faces centre of carrier.

Checking V-ribbed belt

When re-using V-ribbed belts, check for cracks, oiling, overheating and wear. Clean or replace as necessary.

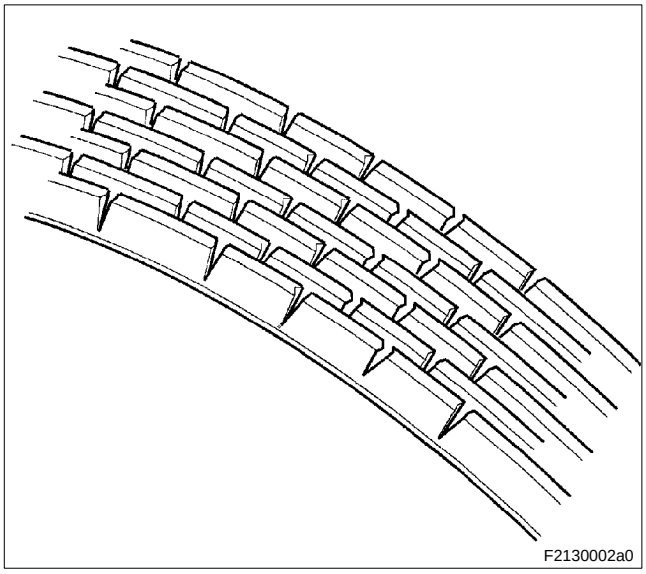
Note: Solvents such as benzene and benzol and sharp-edged objects must not be used.



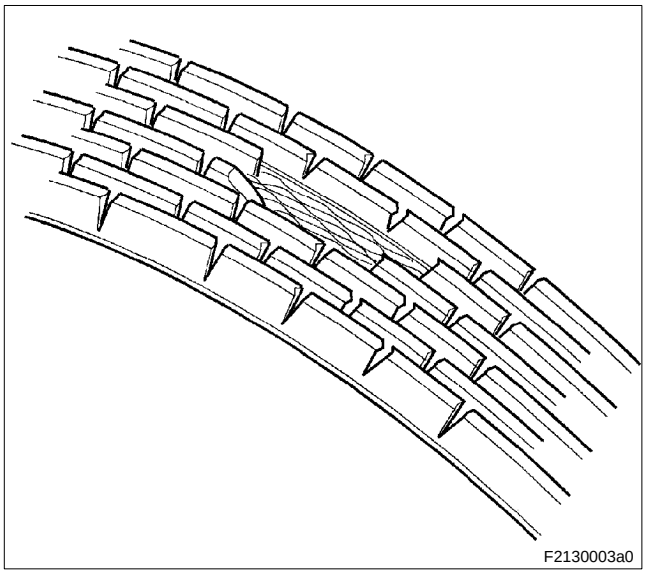
Damage characteristics of V-ribbed belt:

Normal wear.

One or two rib fractures of about 25 mm after long use can be regarded as normal; the V-ribbed belt can still be used.



The V-ribbed belt must be replaced since the ribs are broken round the entire circumference.



The V-ribbed belt must be replaced immediately since the rib material is broken and the ribs are broken round the entire circumference.

C 213.05.10 Assembly

Alternator assembly – see Special Publication.

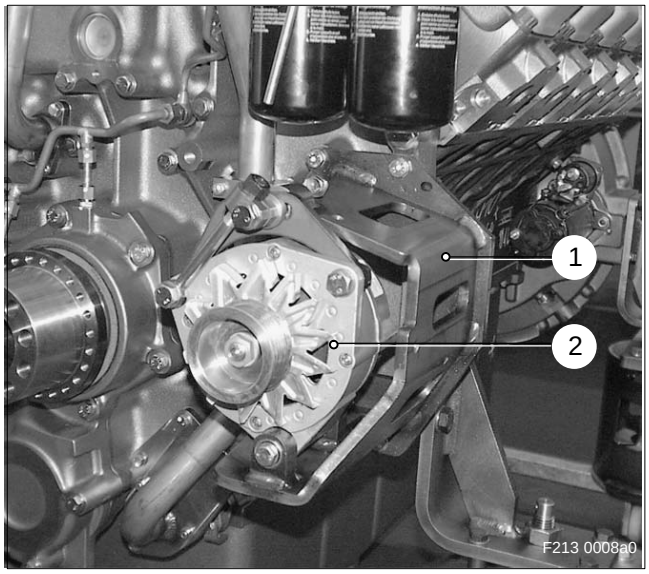
C 213.05.11 Installation

Installing belt pulley on crankshaft drive flange

Check mating faces before installation and clean if necessary.

Install belt pulley for alternator drive with hex screws (1) and washers as per overview drawing C 213.05.01 on drive flange. See also C 231.05 –Installing belt pulley–.

Note: Tighten hex screws in diagonally opposite sequence.

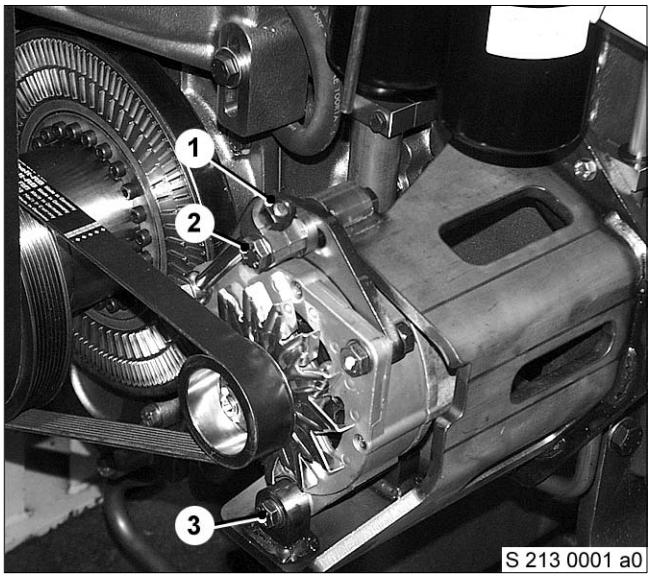


Installing alternator

Install carrier (1) as per overview drawing (see C 213.05.01) on gear case.

Install alternator (2) and bracket with hex screws, hex nuts and washers on carrier; do not yet fully tighten securing screws for alternator.

Note: Tighten securing screws for alternator only after V-belt is installed and tension adjusted.



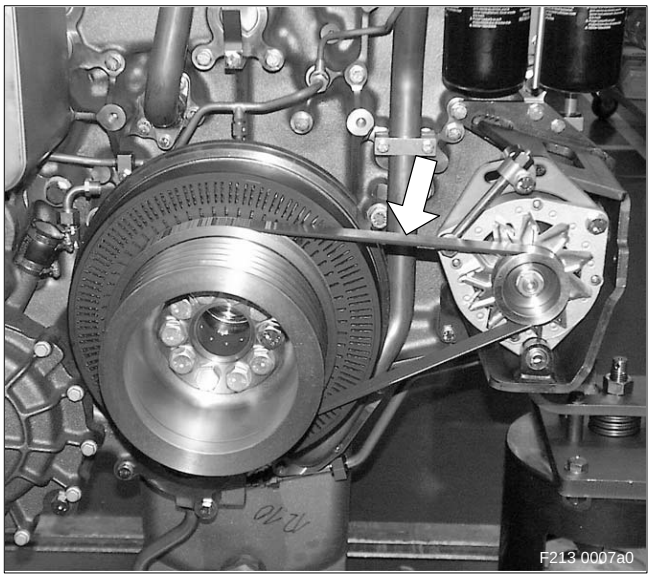
Installing V-belt and setting V-belt tension

Fit V-ribbed belt on belt pulley.

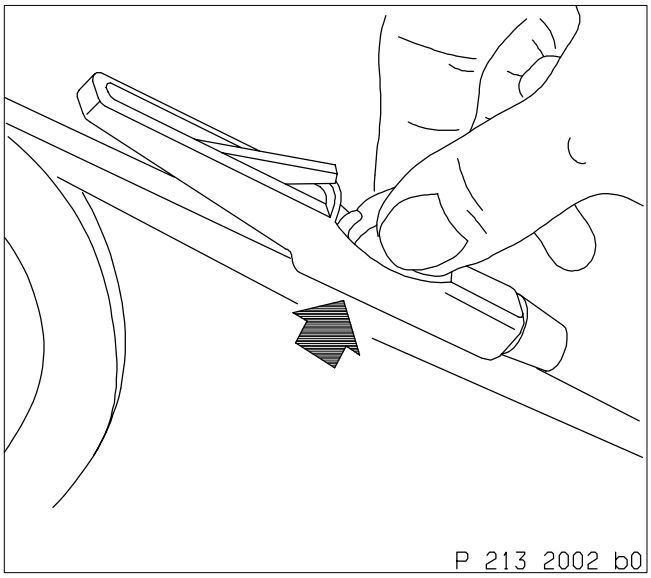
Note: Ensure that V-ribbed belt is correctly on belt pulleys.

Tension V-ribbed belt using clamping nut (1) and adjust V-ribbed belt tension – see following section.

After adjustment, tighten securing screws (2) and (3) of alternator.



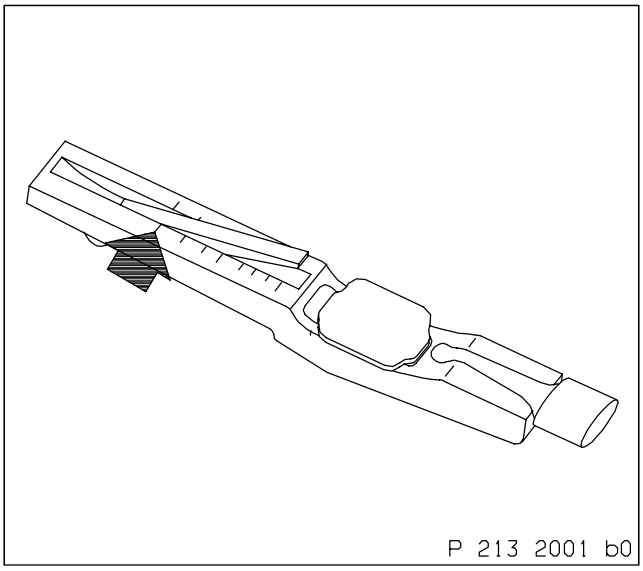
Place V-belt tension gauge on V-ribbed belt in centre (arrow) between belt pulleys.



Note: Contact (arrow) of measuring instrument must be located at side of V-belt and indicator arm must be lowered in measuring instrument.

With pushbutton, press down evenly on V-belt upper side until click spring can be heard or felt to disengage.

To avoid incorrect measuring, only apply pressure to pushbutton and release pressure when click spring disengages.



Carefully lift V-belt tension gauge without changing position of indicator arm.

Read off measured value at point of intersection of indicator arm and “crankcase” scale.

Settings

New V-ribbed belt:

60 N with impression depth of 7 mm

Run-in V-ribbed belt:

60 N with impression depth of 12 mm

If measured value does not correspond to prescribed set value, correct V-belt tension with tightening device and then tighten the alternator securing screws.

C 213.05.12 After-Installation Operations

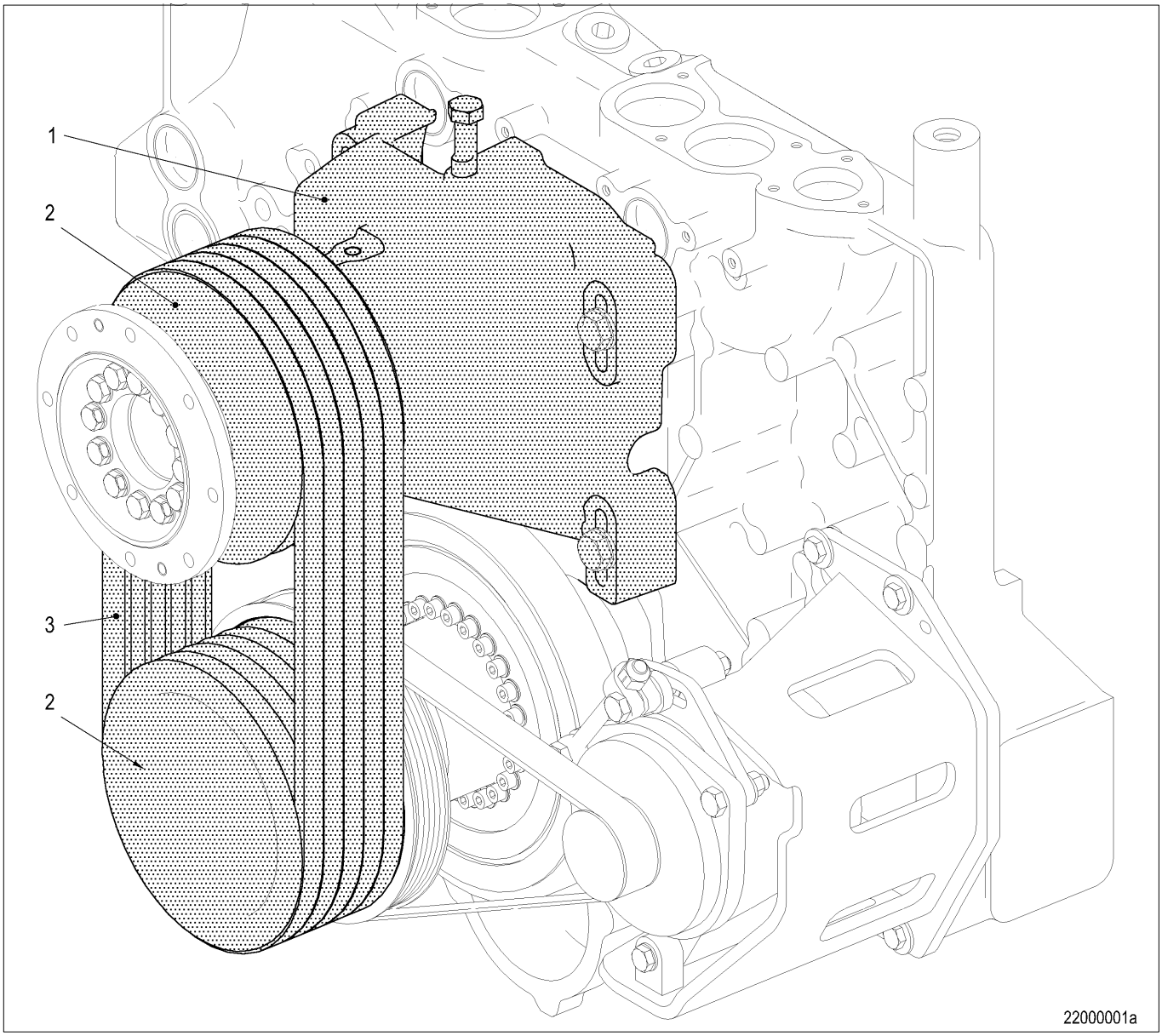
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
–	x	x	Installing V-belt for fan drive	C 221.05
–	x	x	Install V-belt guard	C 028.05
–	x	x	Install cable fixtures	–
–	x	x	Connect electric cable	C 507.10
–	–	x	Release engine start	Operating Instructions

Contents

C 220 Cooling Air System



1 Fan drive
2 Belt pulley
3 V-belt
4 Belt pulley

The following is a list of auxiliary equipment and materials needed for the assembly operations:

CAUTION

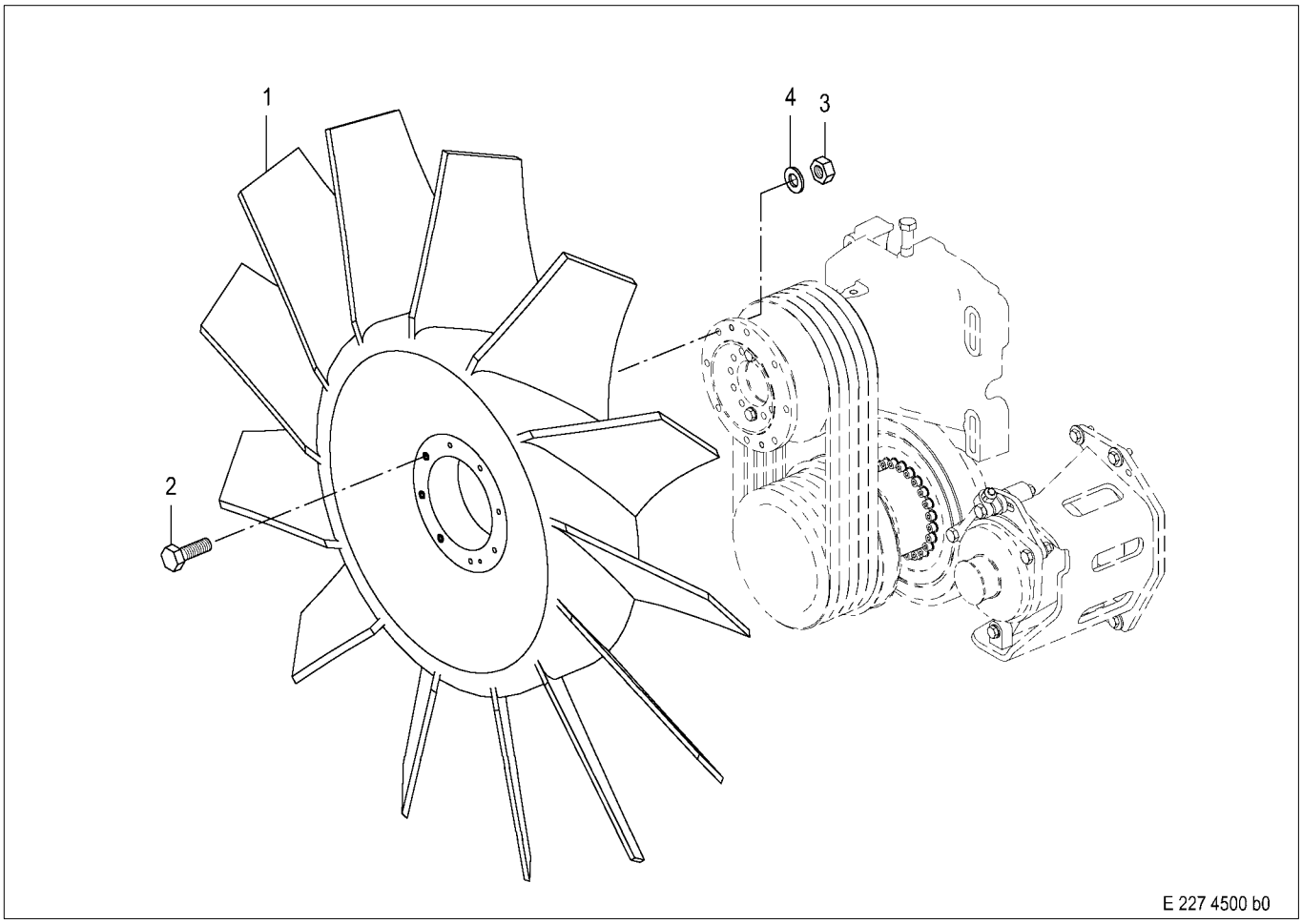
When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	Order No.		Remarks
		MTU	DDC	
Polishing cloth				
Magnifier				
Engine oil				
Cleaning agent	Solvclean KW	40022		
Multipurpose grease	Texaco Premium RB			
Corrosion inhibitor	Caramba Express	40008		
Kerosene or diesel fuel				
Dry compressed air				
Surface crack-testing equipment with red penetrant dye				
Surface crack-testing equipment with fluorescent penetrant dye				

C 221.05 Mechanical Fan Drive

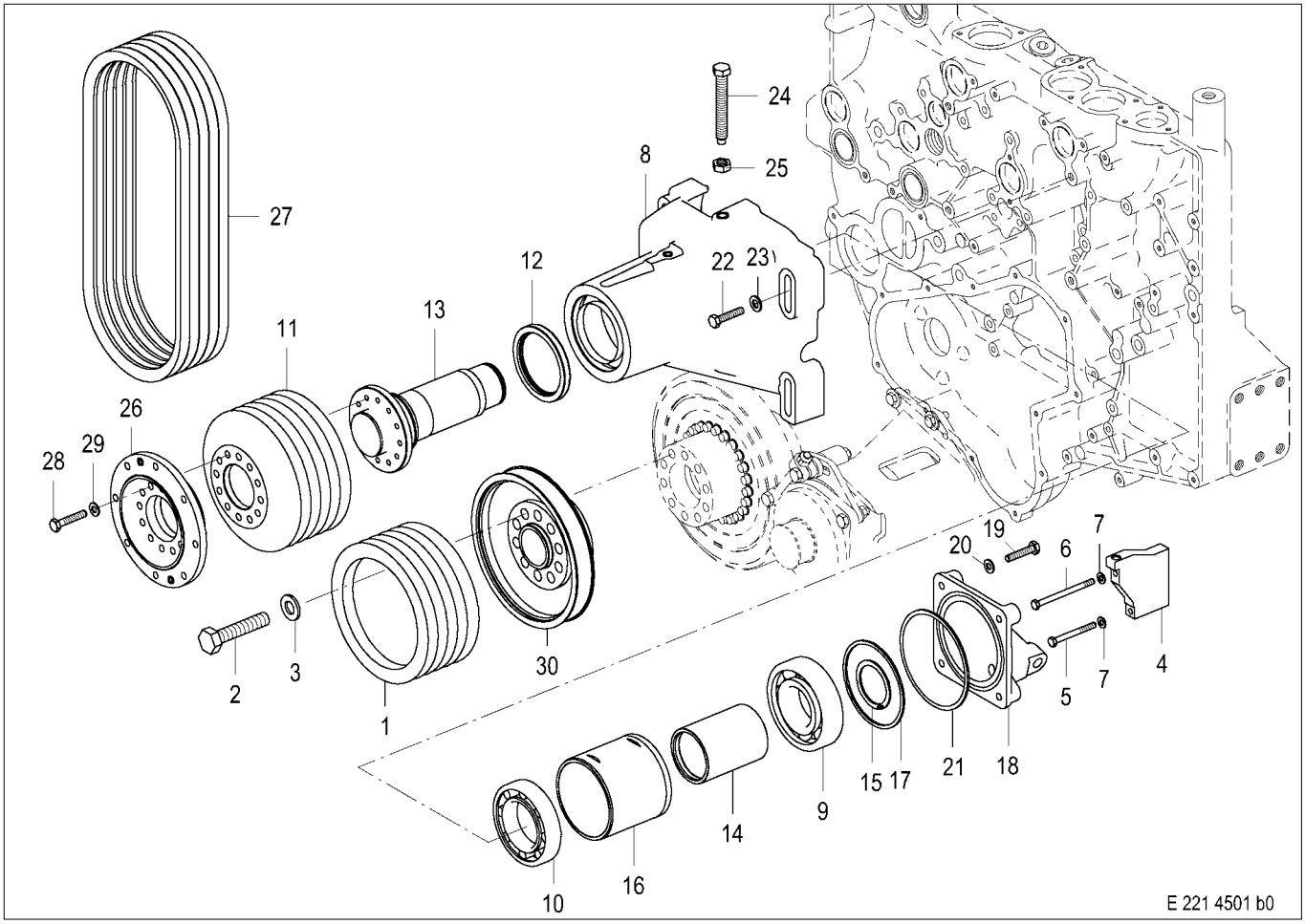
C 221.05.01 Overview Drawing

Fan wheel



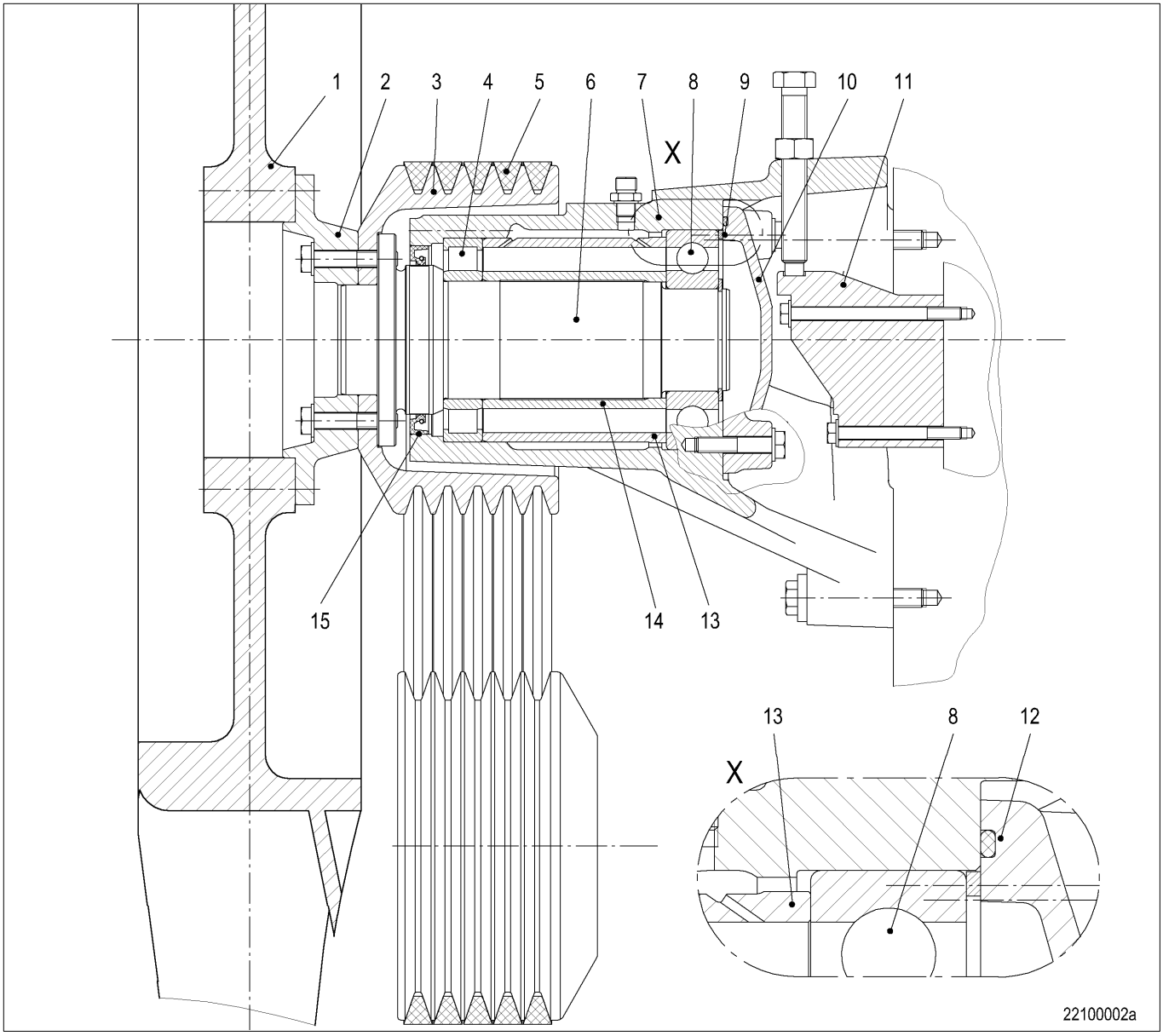
1 Fan wheel
2 Hex screw
3 Hex nut
4 Spring washer

Belt drive



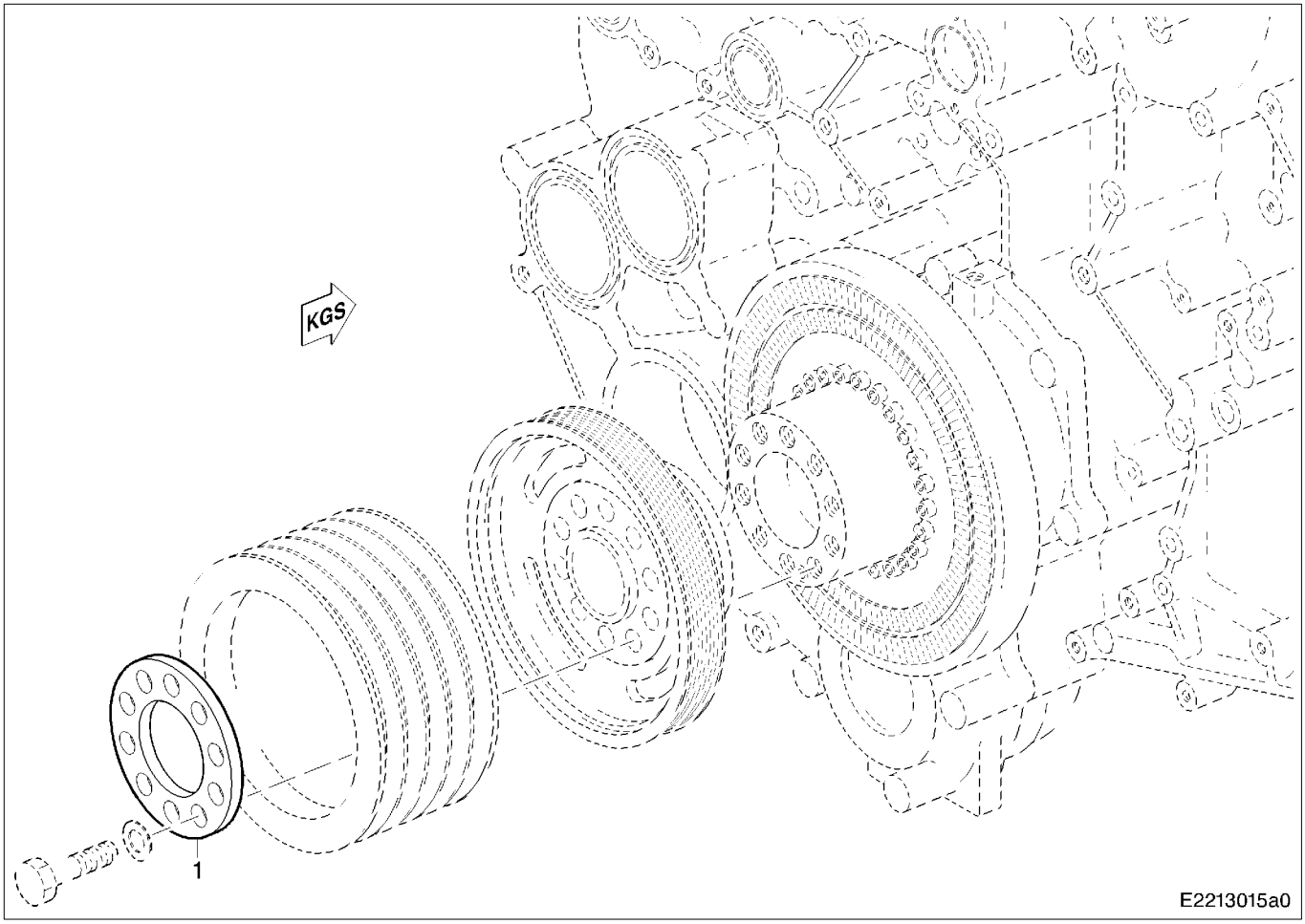
1 Belt pulley
2 Hex screw
3 Washer
4 Bracket
5 Hex screw
6 Hex screw
7 Washer
8 Bearing pedestal
9 Grooved ball bearing
10 Cylindrical roller bearing
11 Belt pulley
12 Shaft seal
13 Shaft
14 Spacer sleeve
15 Snap ring
16 Spacer sleeve
17 Spacer
18 Cover
19 Hex screw
20 Washer
21 O-ring
22 Hex screw
Tightening torque: 100 Nm
Lubricant: Engine oil
23 Washer
24 Hex screw
25 Hex nut
26 Flange
27 V-belt set
28 Hex screw
29 Washer
30 Belt pulley

Belt drive



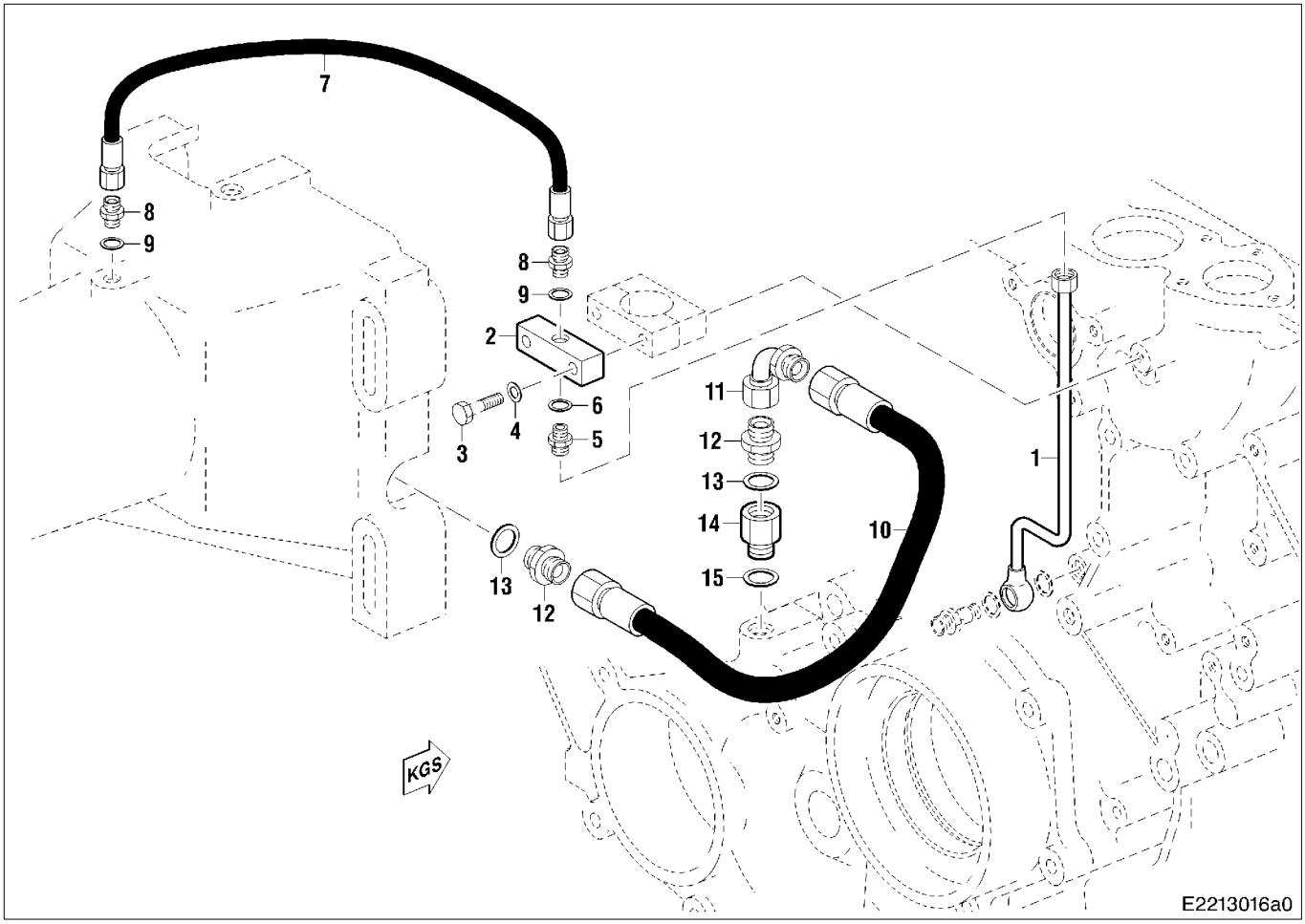
1 Fan wheel
2 Flange
3 Belt pulley
4 Cylindrical roller bearing
5 V-belt set
6 Shaft
7 Bearing pedestal
8 Grooved ball bearing
9 Spacer
10 Cover
11 Bracket
12 O-ring
13 Spacer sleeve
14 Spacer sleeve
15 Shaft seal

Belt drive



1 Spacer ring

Oil lines



1 Oil line
2 Link
3 Hex screw
4 Washer
5 Union
6 Sealing ring
7 Hose line
8 Union
9 Sealing ring
10 Hose line
11 Elbow
12 Union
13 Sealing ring
14 Union
15 Sealing ring

C 221.05.02 Special Tools

Designation – Application	Number
Removal tool for shaft	1
Removal tool for bearing	1
Press-in sleeve for antifriction bearing	1
Press-in tool for shaft seal	1

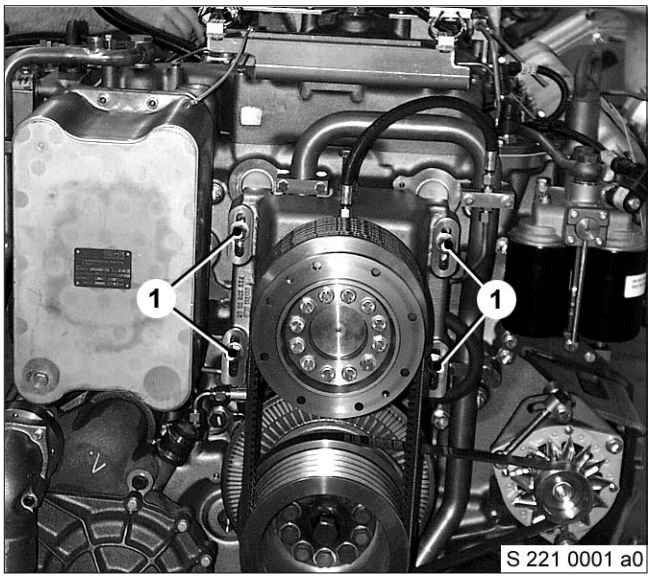
C 221.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

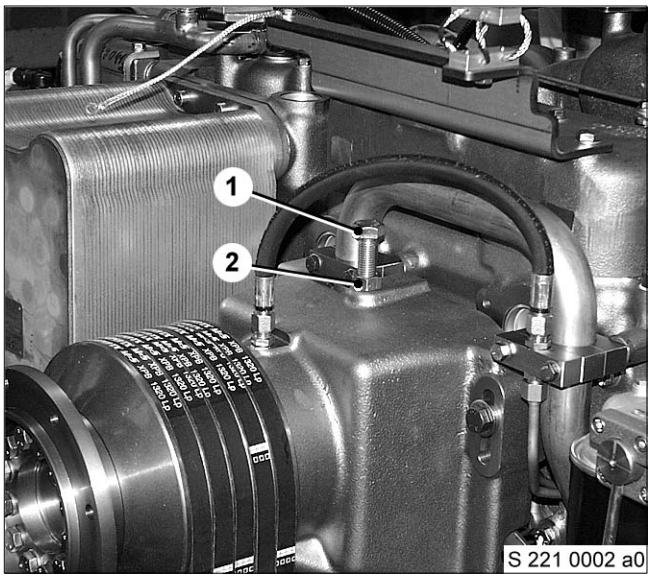
1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	x	x	Remove protective guard	–
–	x	x	Remove fan wheel	–

C 221.05.05 Removal



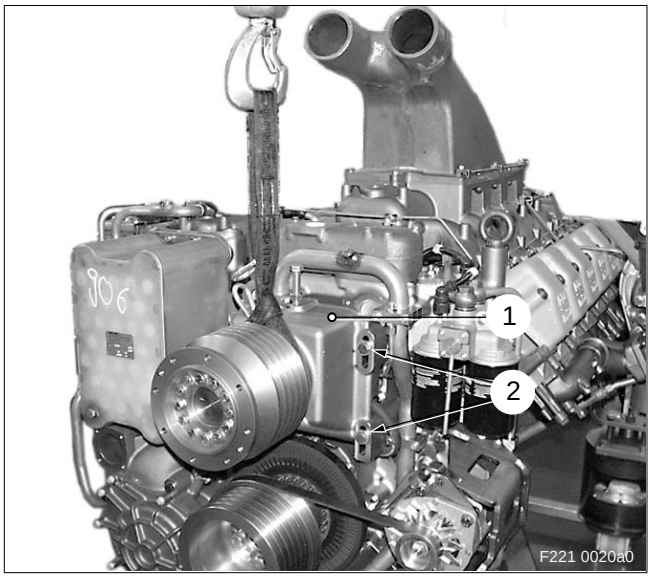
Removing V-belt for fan drive

Release securing screws (1).



Release locknut (2).

Unscrew clamping screw (1) until the V-belt can be removed.



Remove fan drive

Remove oil line and connections as per overview drawing – see C 221.05.01.

Remove sealing rings.

After removing oil line and connections, seal bores by installing suitable plugs.

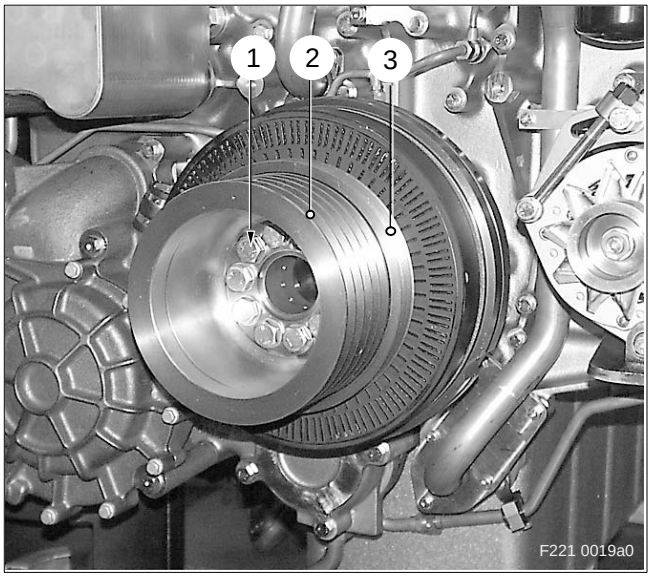
⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Attach fan drive (1) to rope and crane.

Remove hex screws (1) and washers, remove fan drive from gear case.

Place fan drive on suitable rest.

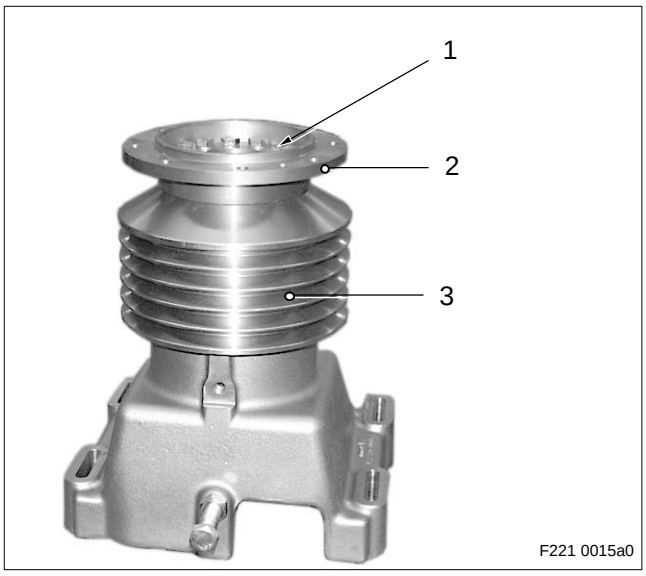


Removing belt pulley from drive flange

Remove hex screws (1) and washers.

Remove belt pulleys (2) and (3) from drive flange.

C 221.05.06 Disassembly



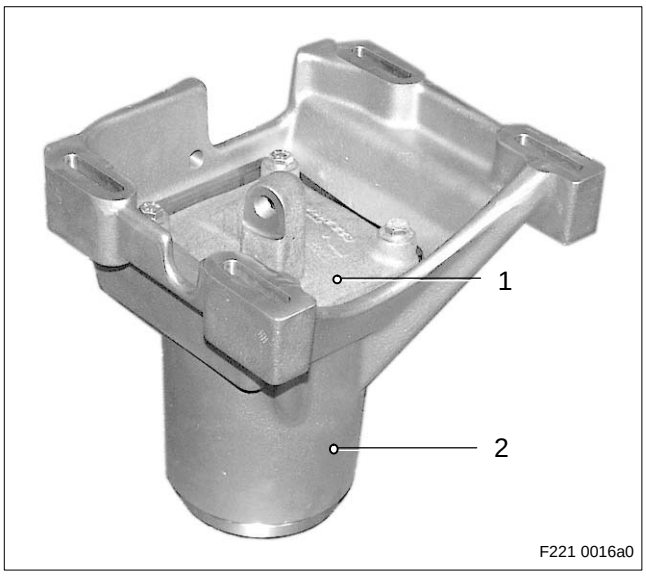
Disassembling fan drive

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Remove hex screws (1) and washers.

Remove flange (2) and belt pulley (3) from shaft.



Remove cover (1) from bearing pedestal (2).

Remove O-ring.

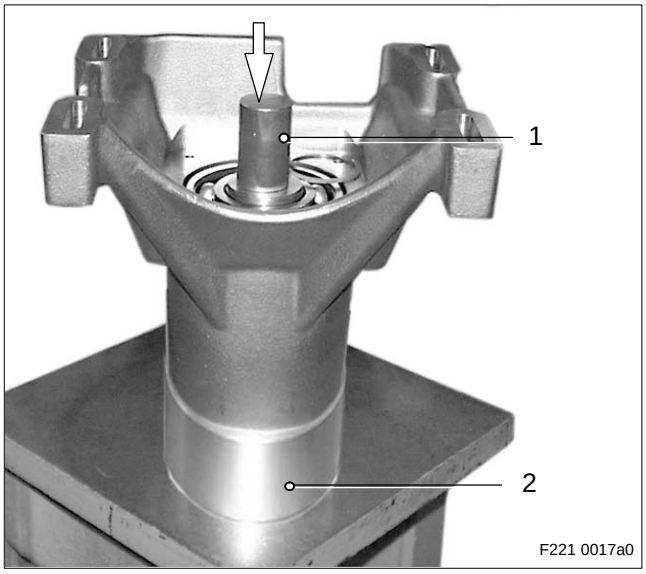
Remove gasket from outer race of grooved ball bearing.


F221 0012a0

⚠ CAUTION

Snap ring pretension.
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Remove snap ring from shaft.



F221 0017a0

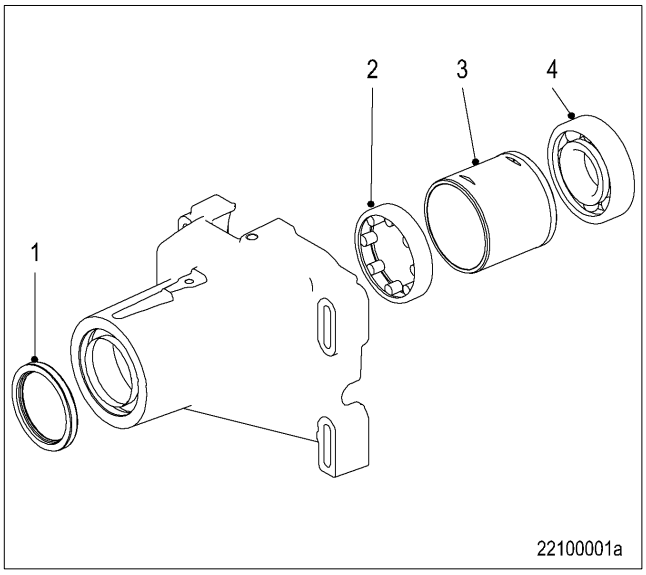
Place bearing pedestal on sleeve (2).

Note: When reusing bearings, take extra special care during removal operations. If possible, the forces should not be applied beyond the roller body, otherwise there is the risk that there may be indentations on the running surfaces of the bearing.
Bearing inner race and bearing outer race are seen as a single unit and must not be interchanged.

Use a manual press and extractor mandrel (1) to remove shaft from bearing pedestal (arrow).


F221 0018a0

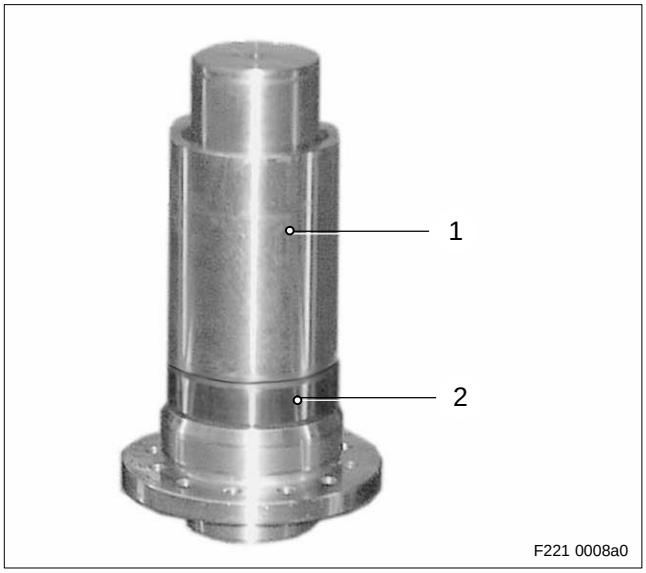
Use a crane and ropes to remove bearing pedestal from shaft.



Use a suitable extractor to withdraw shaft seal (1) from bearing pedestal.

Note: If bearings are to be reused, use pressure only on bearing outer race, not on roller body.

Use manual press and extractor tool to remove cylindrical roller bearing (2), spacer sleeve (3) and grooved ball bearing (4) from bearing pedestal.



⚠ CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.

Rapidly heat spacer sleeve (2) and inner race (1) of cylindrical roller bearing to max. 180 °C and remove from shaft.

C 221.05.08 Inspection and Repair

Clean all parts.

Note: Solvents, such as benzene or benzole, and sharp-edged objects, must not be used to clean V-belts.

Check V-belt for cracks, fouling by oil, overheating and wear; clean or replace V-belt if necessary.
If, for any reason, one or more V-belts come loose, a new V-belt set must be fitted.

WARNING

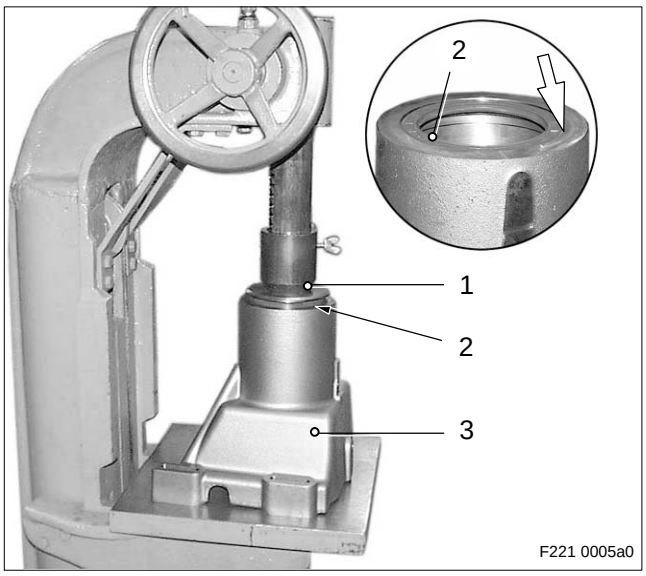
Fuels and fuel vapours are flammable and poisonous. Risk of fire, explosions and poisoning! When using fuel: – do not use naked flame, – no electric sparks, – do not smoke, – do not spill fuel. Do not inhale. Always wear protective gloves and protective goggles/safety mask. Ventilate working area well.

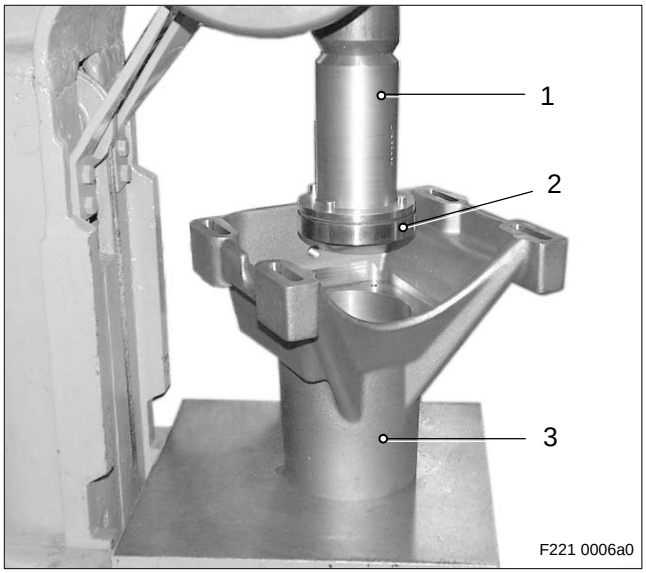
If the bearings are to be reused, clean them with fuel.
Visually inspect components, especially bearing roller element, for damage, wear and cracks.
Using the magnetic crack-testing method and fluorescent magnetic powder, check the shaft for cracks.
Using the surface crack-testing method, check bearing pedestal, belt pulley and fan flange for cracks.
In event of damage, wear or cracks, replace component.

Note: Bearing inner race and bearing outer race are seen as a single unit and must be replaced in pairs.

Check all mating faces and fits. Rub down with oilstone or emery cloth as necessary.
Adjust bore gauge and measure bearing bores in bearing pedestal.
If limit values are exceeded (see Tolerance and Wear Limits List) replace components.
Check condition of threads; rechase threads if necessary.
Replace O-ring and sealing rings at every disassembly.
Replace hose lines, V-belt, bearing, snap ring and shaft seal during W6 maintenance.

C 221.05.10 Assembly





Assembling fan drive

Note: Make sure parts are perfectly clean.

⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Check oil bores in bearing pedestal (3) for obstruction and make sure that they are particularly clean.

Coat seat surface (arrow) on radial-lip shaft seal (2) and in bearing pedestal wit denaturated ethanol.

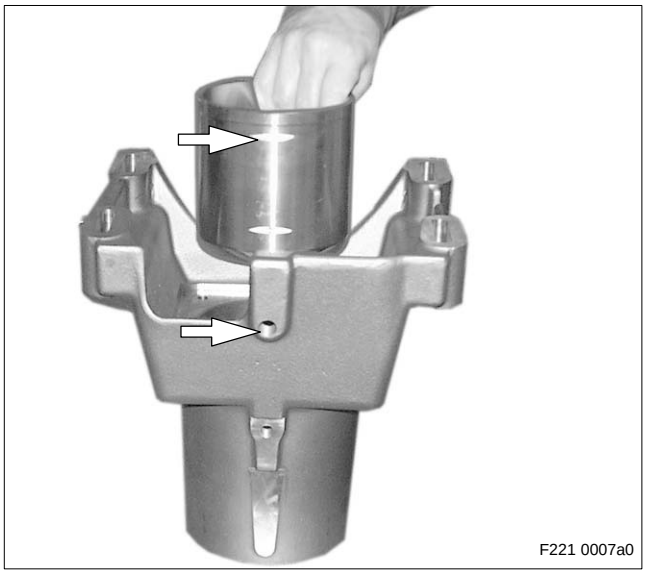
Use a manual press to install new radial-lip shaft seal, with sealing lip facing installation tool (1), in bearing pedestal.

Note: Shaft seal is inserted flush with outer edge. If shaft is worn, offset shaft seal by 2 mm axially.

Check register bores in bearing pedestal (3); clean as necessary and apply a thin film of lubricant to bearing seat points.

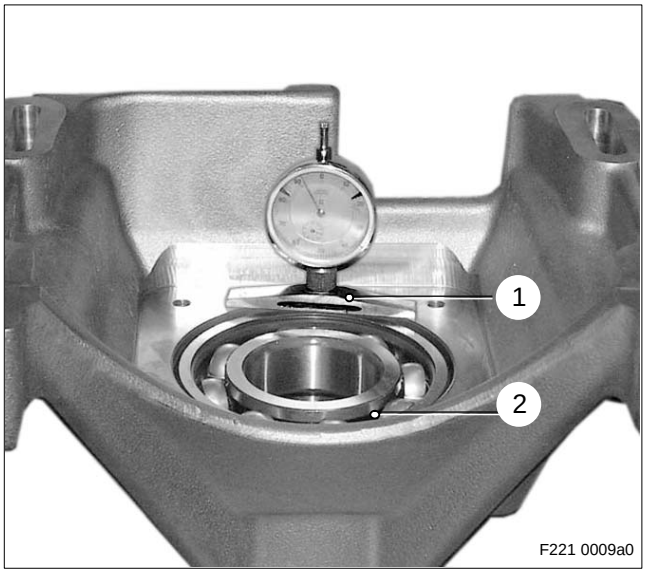
Note: Only apply installation pressure to bearing outer ring, not to rolling elements!

Using manual press and mandrel, press cylindrical roller bearing (2) as far as it will go into bearing pedestal.


F221 0007a0

Insert spacer sleeve in bearing pedestal, ensuring it is correctly positioned.

Oil bores (arrow) of spacer sleeve and of bearing pedestal must be aligned.



F221 0009a0

Note: Only apply installation pressure to bearing outer ring, not to rolling elements!

Using manual press and mandrel (1), press grooved ball bearing (2) as far as it will go into bearing pedestal.

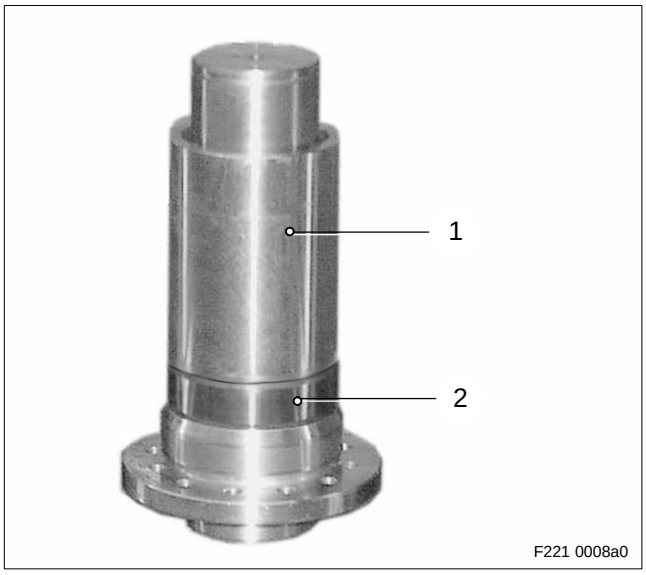
To determine packing plate thickness, measure depth of cover installation surface to bearing outer race:

Set dial gauge in bridge meter (1) to zero.

Measure depth to face of bearing outer race and record dimension.

Select packing plate as per table.

Packing plate table	
Applicable for depth (mm)	**Packing plate thickness** (mm)
2.80 – 3.00	2.85
3.01 – 3.20	3.05
3.21 – 3.40	3.25



Heat inner race (2) of cylindrical roller bearing to 150 °C.

⚠ CAUTION

Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.

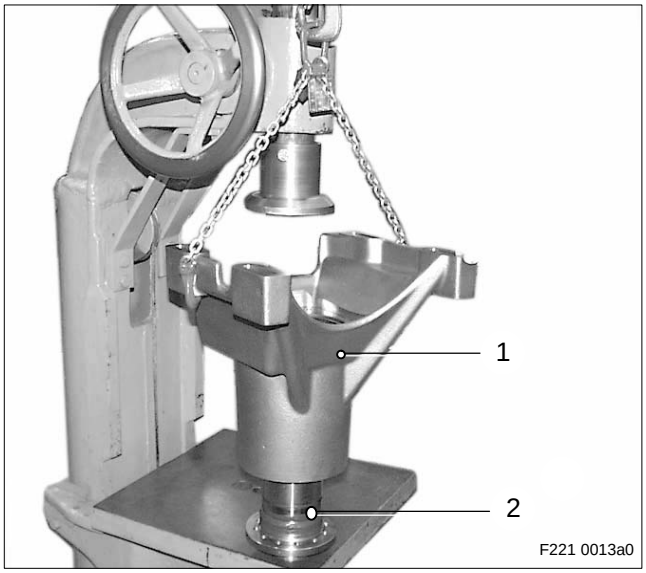
Fit inner race on shaft so that it is correctly seated.

Note: Bearing inner race and bearing outer race are seen as a single unit and must not be interchanged.

Heat spacer sleeve (2) to 180 °C.

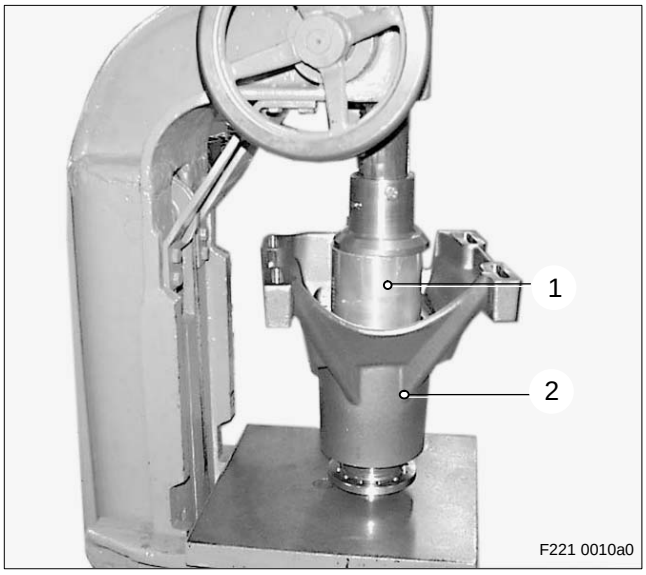
Fit spacer sleeve on cylindrical roller bearing inner race, ensuring it is correctly seated.

Check that spacer sleeve is fitted clearance-free on cylindrical roller bearing inner race; if necessary, press spacer sleeve again with manual press.



Coat sealing lip of radial-lip shaft seal in bearing pedestal (1) with petroleum jelly and coat running surface on shaft (2) with thin-film lubricant.

Carefully place bearing pedestal with ropes and crane on shaft.



Use a manual press and press-in sleeve (1) to press-fit bearing pedestal (2) via grooved ball bearing on shaft.


F221 0012a0

⚠ CAUTION

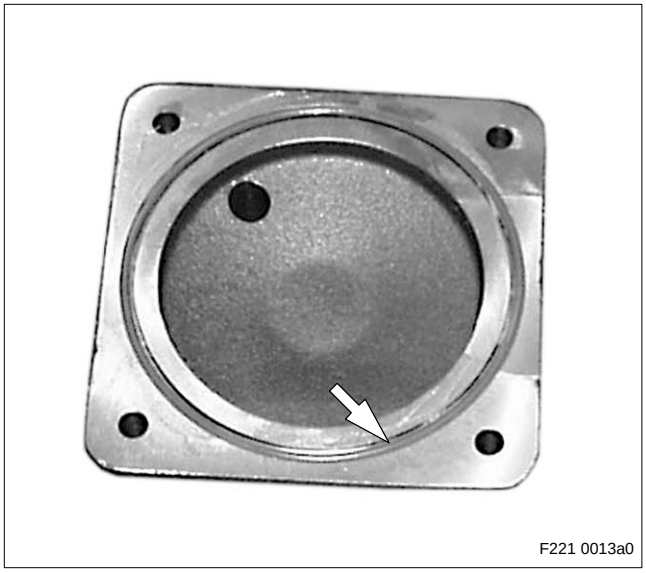
Snap ring pretension.
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Secure grooved ball bearing with snap ring.

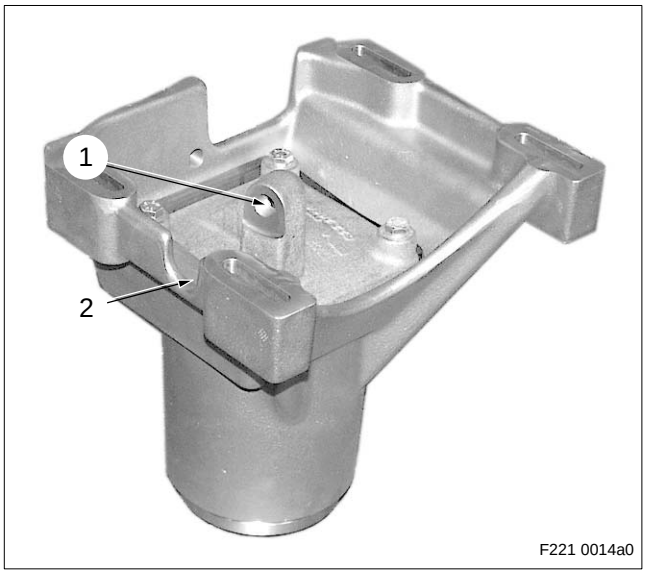
Note: Make sure snap ring is perfectly seated in shaft groove!


F221 0011a0

Fit selected gasket on outer race of grooved ball bearing.

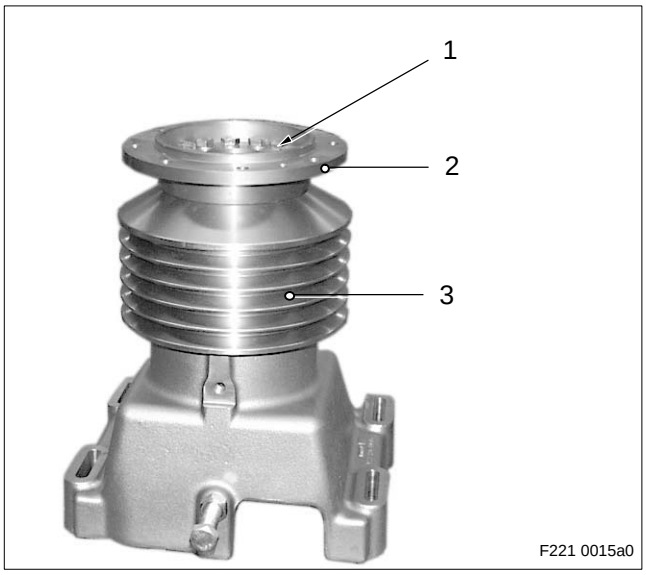

F221 0013a0

Coat O-ring (arrow) with petroleum jelly and insert in groove in cover.



Install cover with hex screws and washers on bearing pedestal, ensuring it is correctly positioned.

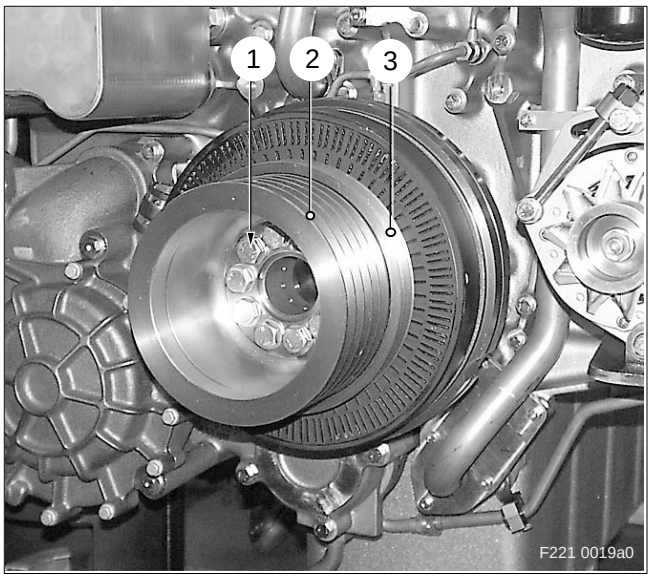
Oil bore (1) in cover faces recess (2) in bearing pedestal.



Mount belt pulley (3) and flange (2) with hex screws (1) and washers on shaft.

Note: Tighten hex screws in diagonally opposite sequence.

C 221.05.11 Installation

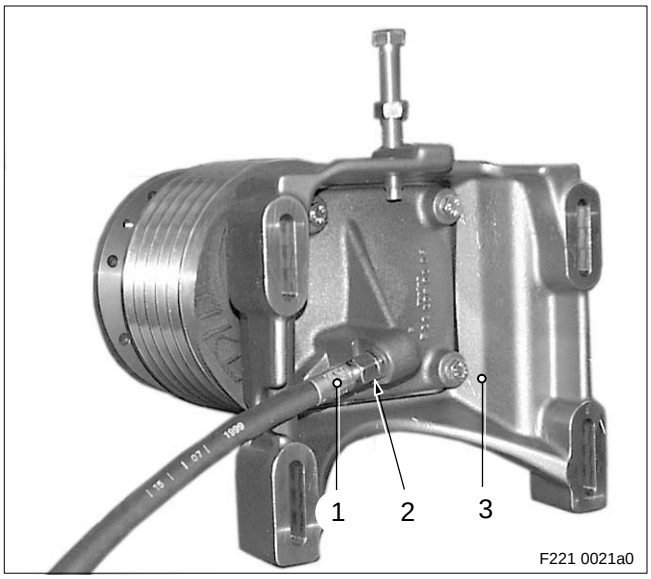


Installing belt pulley on drive flange

Check support surfaces, clean if necessary.

Install belt pulley (3) for alternator drive and belt pulley (2) for fan drive with hex screws (1) and washers on drive flange.

Note: Tighten hex screws in diagonally opposite sequence.

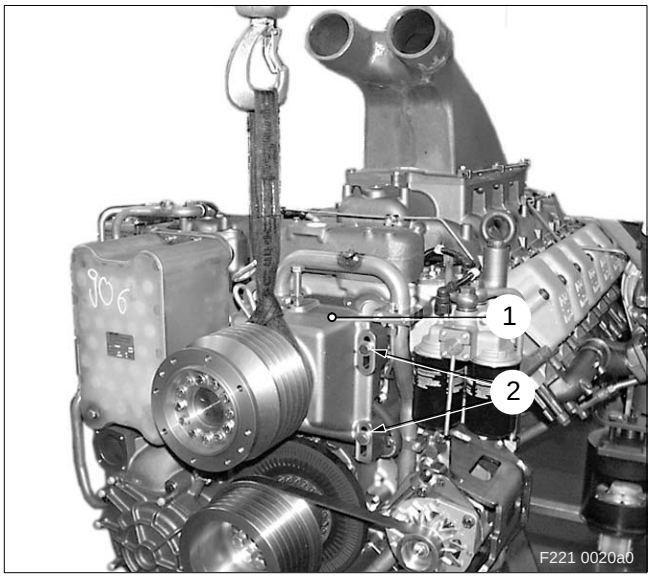


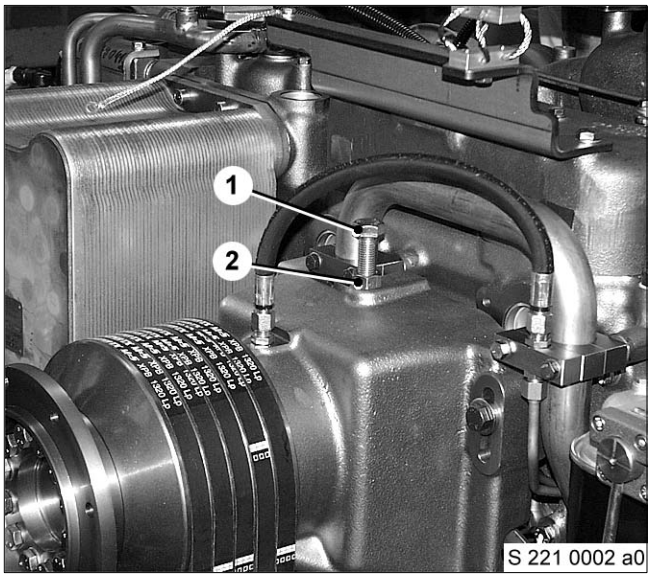
Installing fan drive

Note: Fit hose line (1) before installing fan drive (3), as it will subsequently be accessible only with difficulty.

Prior to installing oil lines and connections, remove all blanking plugs and check that oil lines and connections are perfectly clean.

Install and tighten union (2) with new sealing ring and hose line – see also overview drawing C 181.20.01.





⚠ WARNING

Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Mount fan drive (1) with hex screws (2) and washers on gear case, but do not yet tighten screws.

Note: Tighten securing screws for fan drive to specified torque only after installing V-belt and adjusting tension.

Install and tighten oil lines and connections with new sealing rings, ensuring they are free of tension (see also overview drawing C 181.20.01).

Note: In order to prevent hose line (oil return) coming into contact with rotating component, place hose line behind oil supply line.
After starting engine, check oil lines and connections for leaks (visual check).

Installing V-belt and setting tension

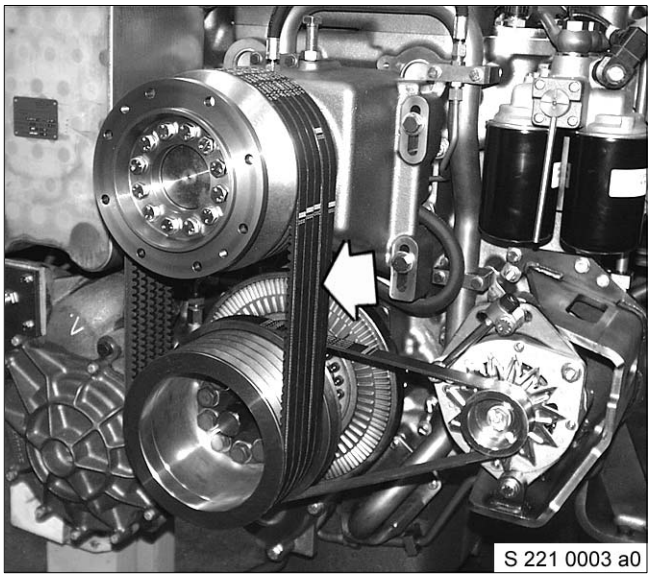
Fit new V-belt set.

V-belts must be fitted into the grooves without force.

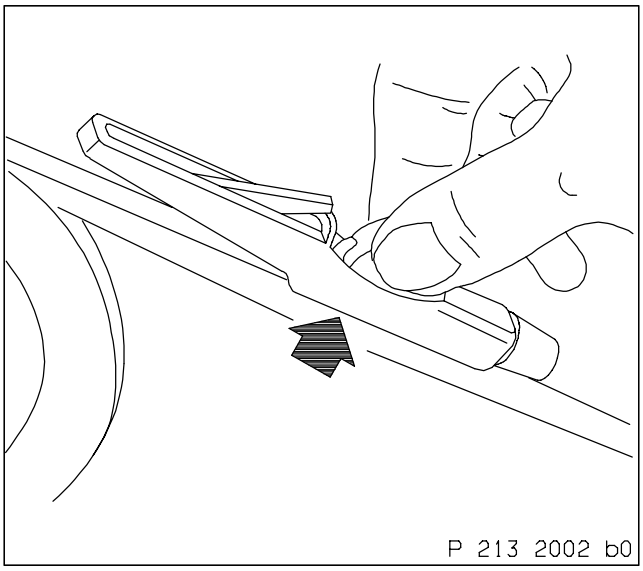
For V-belt tensioning, the fan bearing pedestal must be against the gear case.

Release locknut (2).

Pretension V-belt with screw (1).



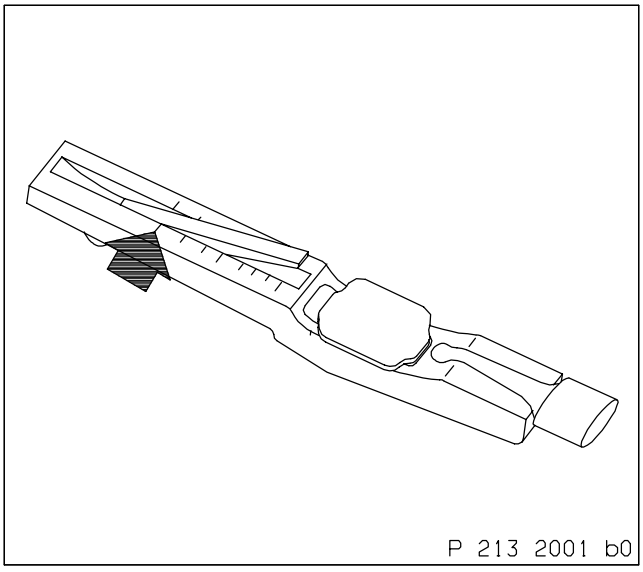
Place V-belt tension gauge (arrow) on V-belt in centre between belt pulleys and read off value.



Note: Contact (arrow) of measuring instrument must be located at side of V-belt and indicator arm must be lowered in measuring instrument.

With pushbutton, press down evenly on V-belt upper side until click spring can be heard or felt to disengage.

To avoid incorrect measuring, only apply pressure to pushbutton and release pressure when click spring disengages.



Carefully lift V-belt tension gauge without changing position of indicator arm.

Read off measured value at point of intersection of indicator arm and “crankcase” scale.

Settings

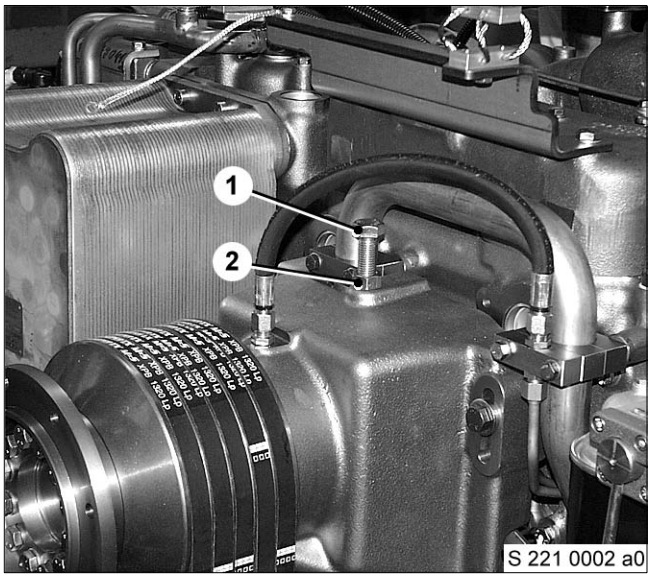
Measurement with pretension measuring device

New V-belt: 75 N with press-in depth of 7 mm.

Run-in V-belt: 75 N with press-in depth of 9 mm.

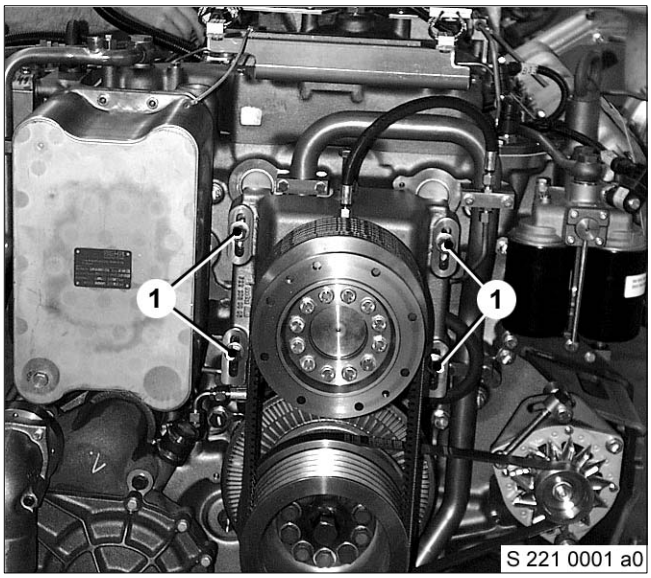
If measured value does not correspond to specified value, V-belt tension must be corrected.

Note: In event of multiple belt drive, check all V-belts.



Tension V-belts with tensioning screw (1).

Note: Turn the screw clockwise V-belt tension. After adjustment, tighten locknut (2).



Tighten hex screws (1) to specified tightening torque – see overview drawing C 221.05.01.

Check V-belt tension.

Note: After approx. 30 minutes engine operation at low load, again check V-belt tension and re-adjust if necessary. After approx. 8 hours engine operation under load, again check V-belt tension and retension as necessary.

C 221.05.12 After-Installation Operations

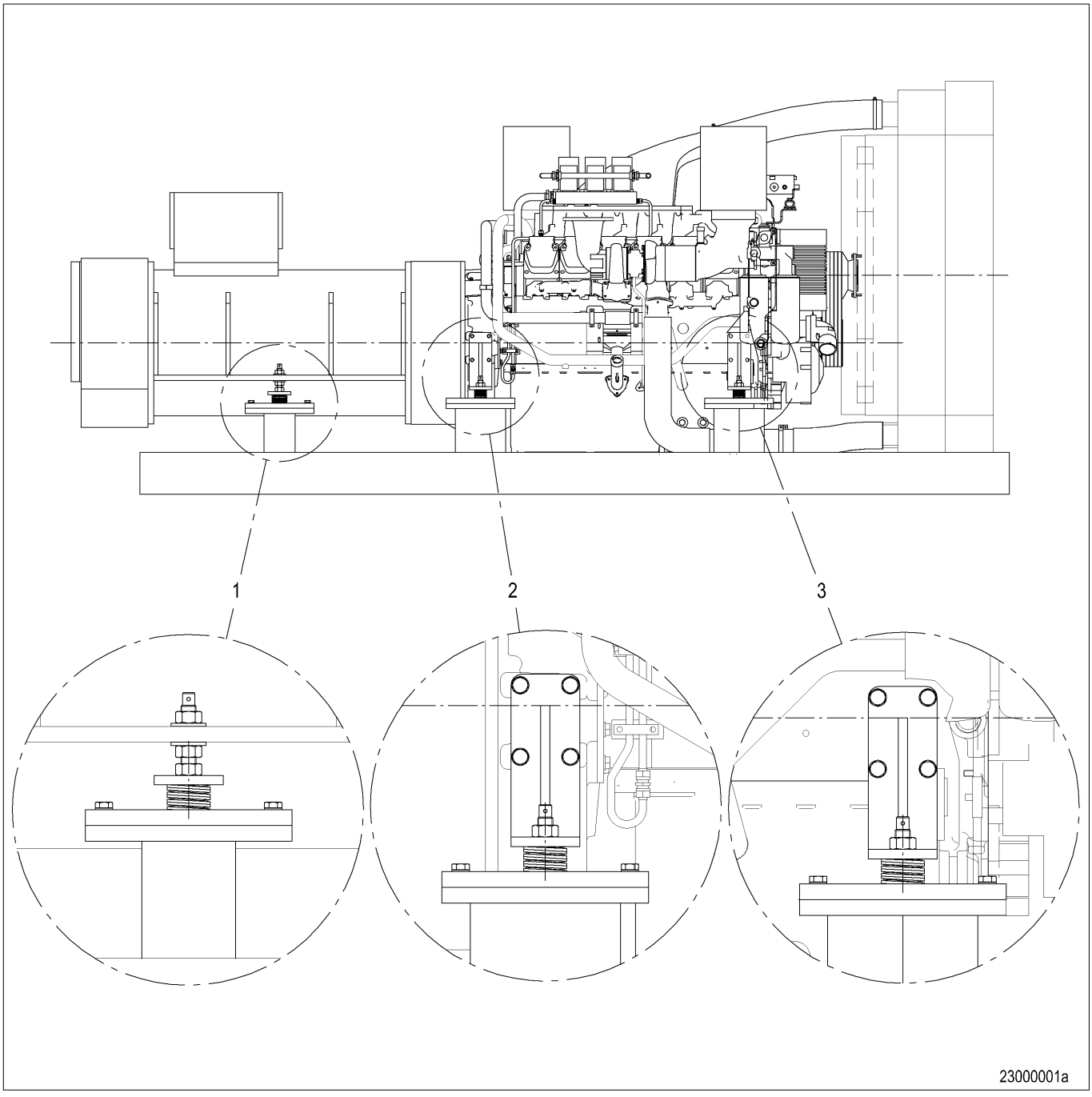
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install fan wheel	–
–	x	x	Mount protective guard	–
–	–	x	Release engine start	Operating Instructions

Contents

C 230 Engine Mounts



1 Alternator mount
2 Engine mount, driving end
3 Engine mount, free end

The following is a list of auxiliary equipment and materials needed for the assembly operations:

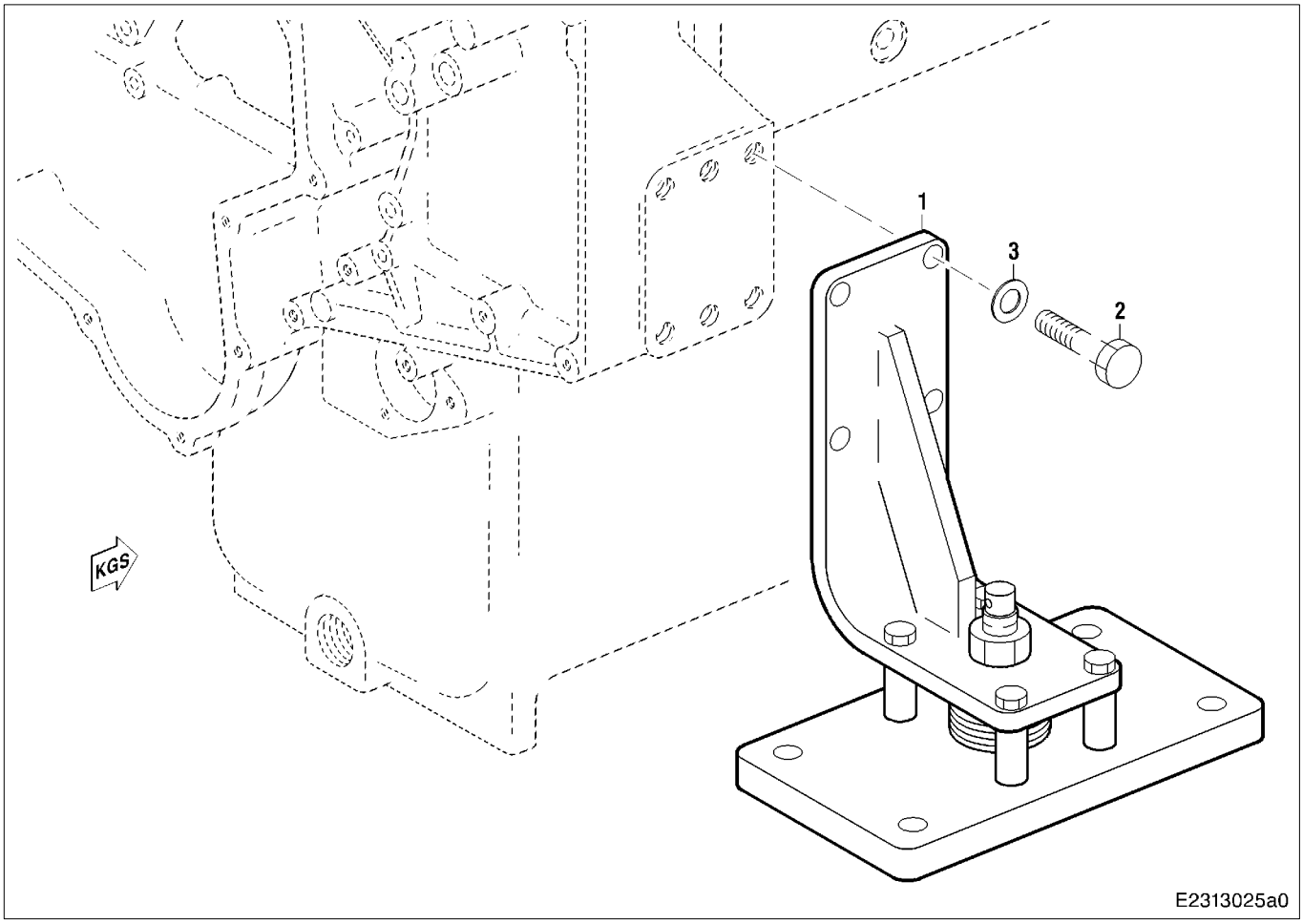
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	MTU Order No.	Remarks
Cleaning agent	Solvclean KW	40022	
Corrosion inhibitor	Caramba Express	40008	
Engine oil			
Dry compressed air			

C 231.05 Engine Mount

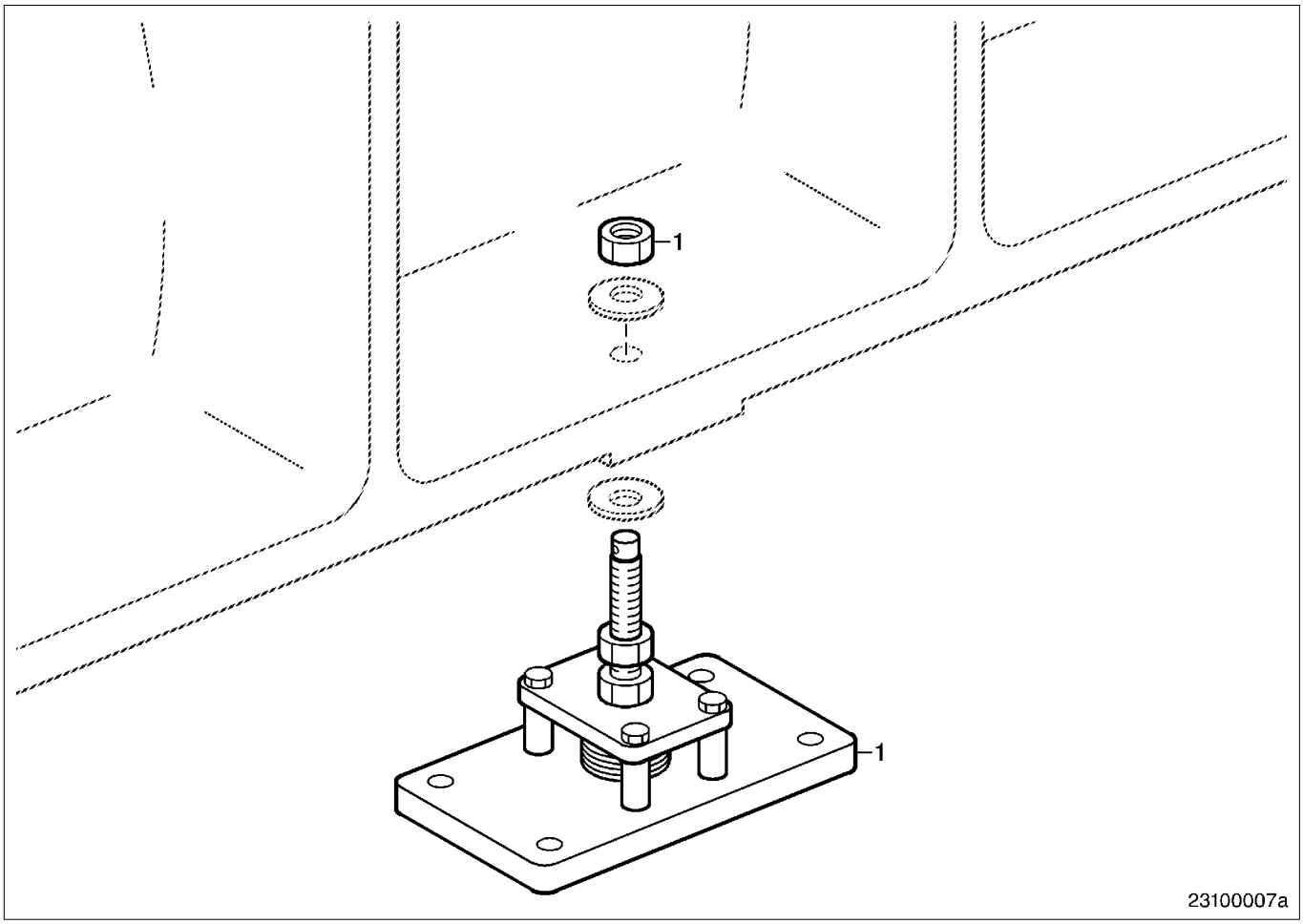
C 231.05.01 Overview Drawing



1 Engine mount with transportation locking device

2 Hex screw
Lubricant: Engine oil
Tightening torque: 250 Nm + 25 Nm

3 Washer



1 Alternator mount with transportation locking device
Height-adjusting nut (M24)
Lubricant: Engine oil
Tightening torque: 180 Nm + 18 Nm

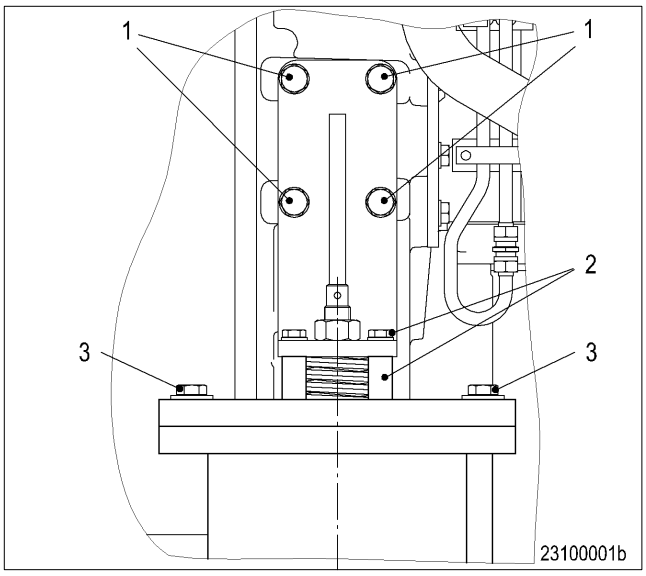
C 231.05.04 Before-Removal Operations

A distinction must be made as to whether:

1 ——— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain coolant	Operating Instructions
–	–	x	Disconnect coolant lines from cooler	–
–	–	x	Disconnect charge air lines from cooler	–

C 231.05.05 Removal



Removing engine mounts

⚠ WARNING

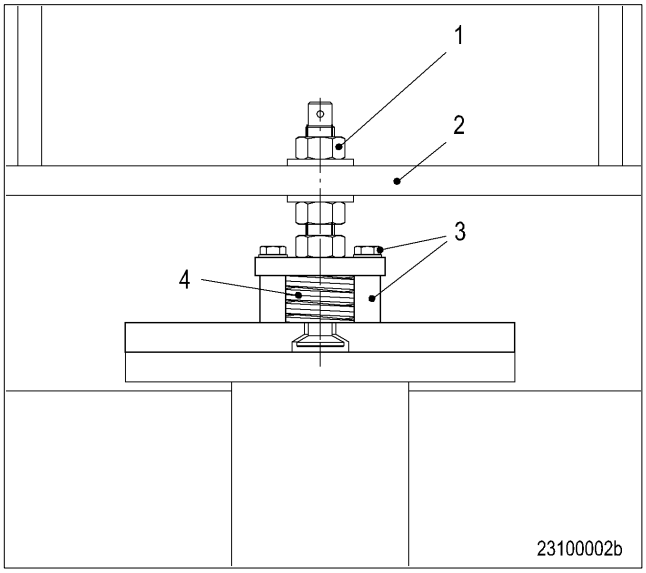
Engine may tilt.
Risk of fatal injury!
Before removing engine mounts or alternator mounts, ensure engine or alternator is properly supported.
Only use lifting device provided by manufacturer and observe lifting instructions.

Lock damping mounts with hex screws, washers and sleeves (2).

Release foundation screws (3) on damping mount to be released.

Attach engine to lifting device.

Remove securing screws (1) for damping mount on flywheel housing or gear case and remove damping mount.



Removing alternator mounts

Lock all damping mounts (engine + alternator) with hex screws, washers and sleeves (3).

Release foundation screws on all damping mounts (engine + alternator).

Remove height-adjusting nuts (1) on both alternator mounts.

⚠ WARNING

Engine may tilt.
Risk of fatal injury!
Before removing engine mounts or alternator mounts, ensure engine or alternator is properly supported.
Only use lifting device provided by manufacturer and observe lifting instructions.

Raise plant with lifting device until damping mount (4) can be removed from alternator base (2).

C 231.05.08 Inspection and Repair

Important: Do not release locking device and central buffer.

Clean damping mount with cleaner.

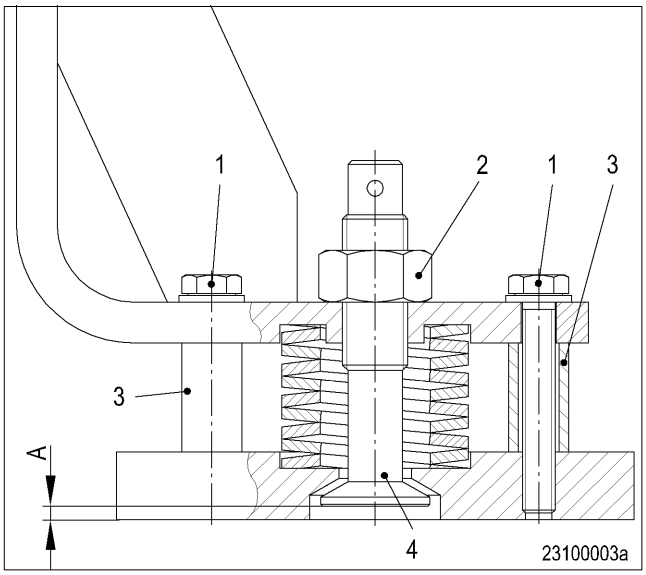
Visually inspect damping mounts for damage and wear; replace as necessary.

After cleaning and inspection, lubricate spring pack by spraying with engine oil or penetrating oil.

Check bolt-on surface on damping mount for evenness; rub down with an oilstone or emery cloth as necessary.

Check screws and nuts for condition and thread for ease of movement; replace if necessary.

C 231.05.11 Installation



Installing engine mounts and alternator mounts

Note: New damping mounts are delivered lubricated and must not be cleaned.

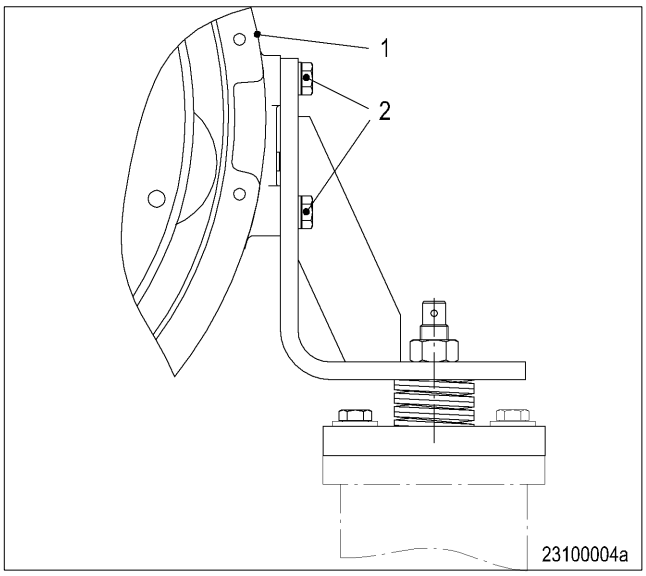
Before installation, check clearance (A) of central screw (4) on damping mounts, with locking devices installed (1) and (3).

Measure clearance with depth gauge and, if necessary, readjust by releasing hex nut (2) and turning central screw accordingly.

Required clearance A = 5 mm

Note: One rotation = 3 mm.

After adjusting, tighten hex nut.



⚠ WARNING

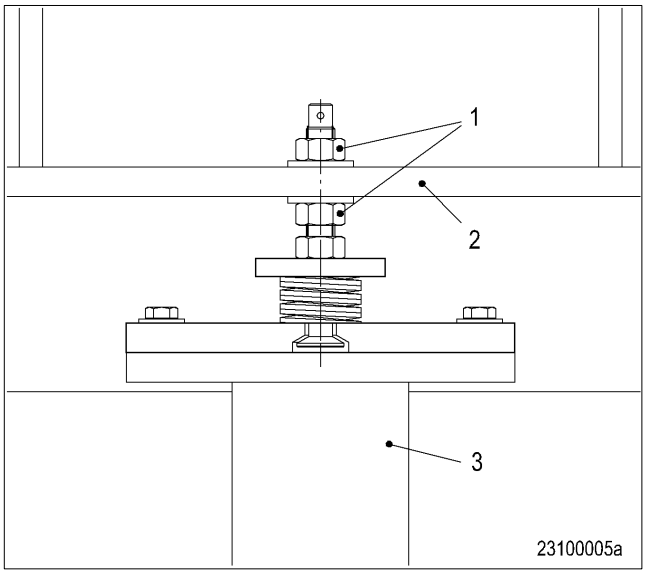
Engine may tilt.
Risk of fatal injury!
Before installing engine mounts or alternator mounts, ensure engine or alternator is properly supported.
Only use lifting device provided by manufacturer and observe lifting instructions.

Note: Damping mounts are installed with locking devices in place.

Install damping mounts with hex screws (2) and washers on flywheel housing (1) or gear case.

Tighten securing screws to specified tightening torque – see C 231.05.01.

Important: Remove locking devices only after mounts have been aligned.



Raise plant with lifting device if necessary.

Install locked damping mounts with height-adjusting nuts (1) and washers on alternator (2).

Note: The plant height is aligned by means of height-adjusting nuts, which are tightened after plant alignment.

Clean and check plant mating faces – see also engine/alternator mounting drawing.

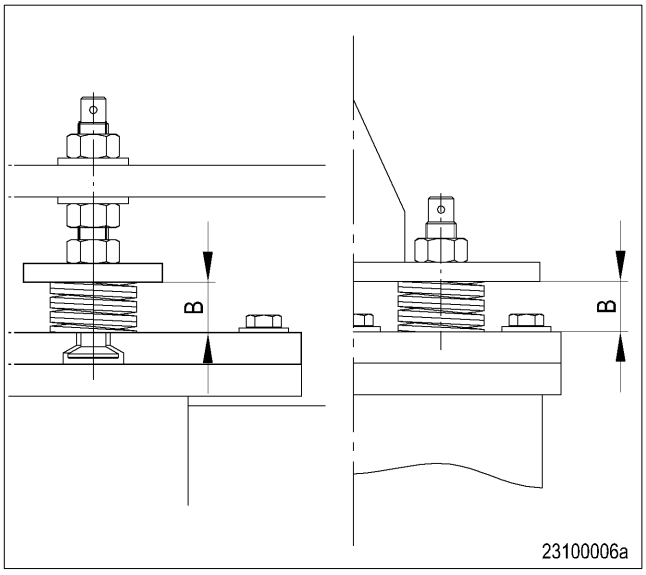
Lower plant on foundation (3).

Carry out plant alignment in accordance with regulations.

Tighten height-adjusting nuts to specified tightening torque – see C 231.05.01.

Bolt damping mounts to foundation.

Remove locking devices from all damping mounts.



During installation, measure **new** damping mounts, reference dimension (B).

Required reference dimension B = 40 mm ± 0.5 mm

C 231.05.12 After-Removal Operations

A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
–	–	x	Connect charge air lines	–
–	–	x	Connect coolant lines	–
–	–	x	Fill with charge air coolant	Operating Instructions
–	–	x	Release engine start	Operating Instructions

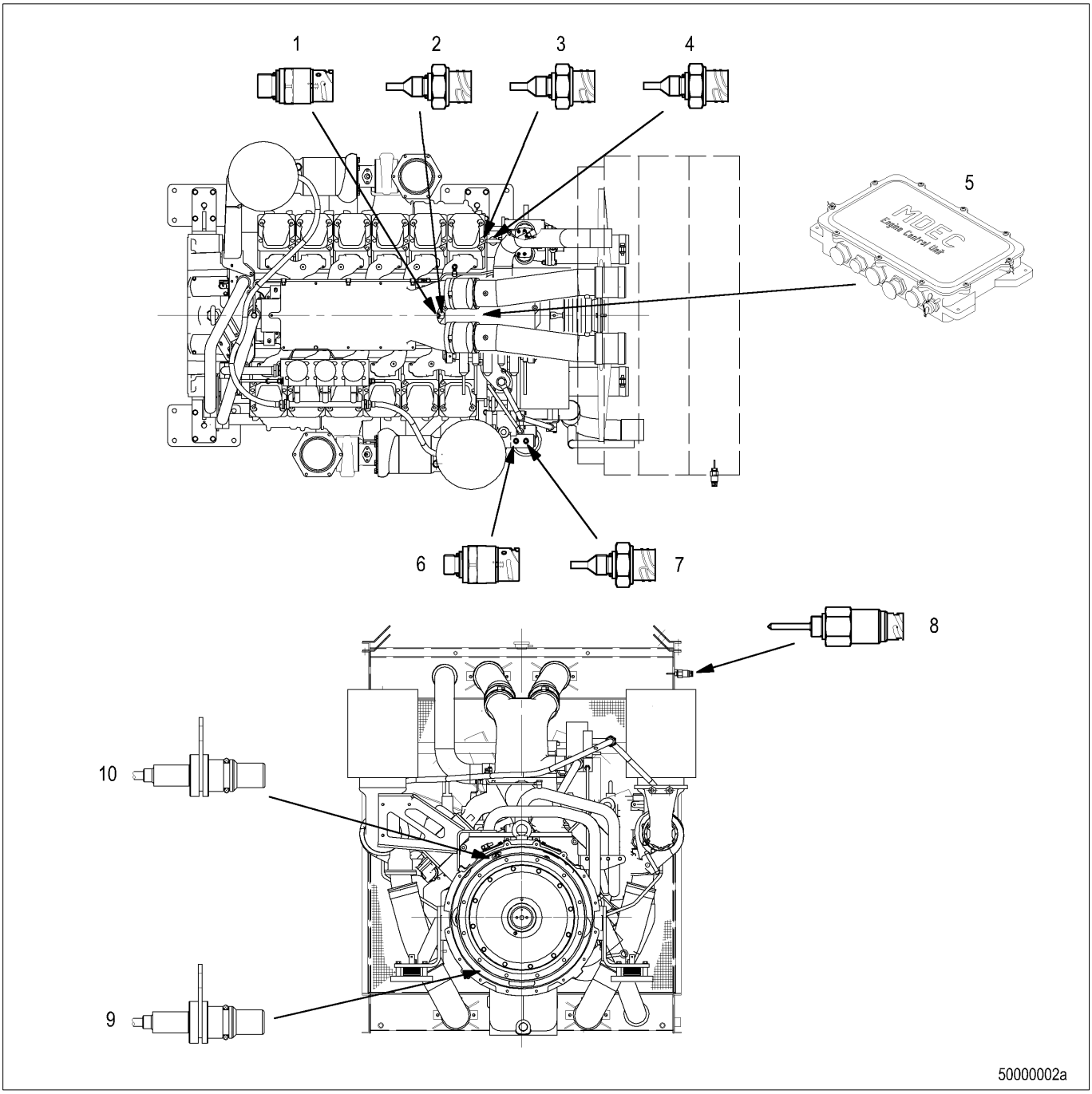
C 250 PTO Systems, Driving and Free Ends (Coupling)

See special publication.

Contents

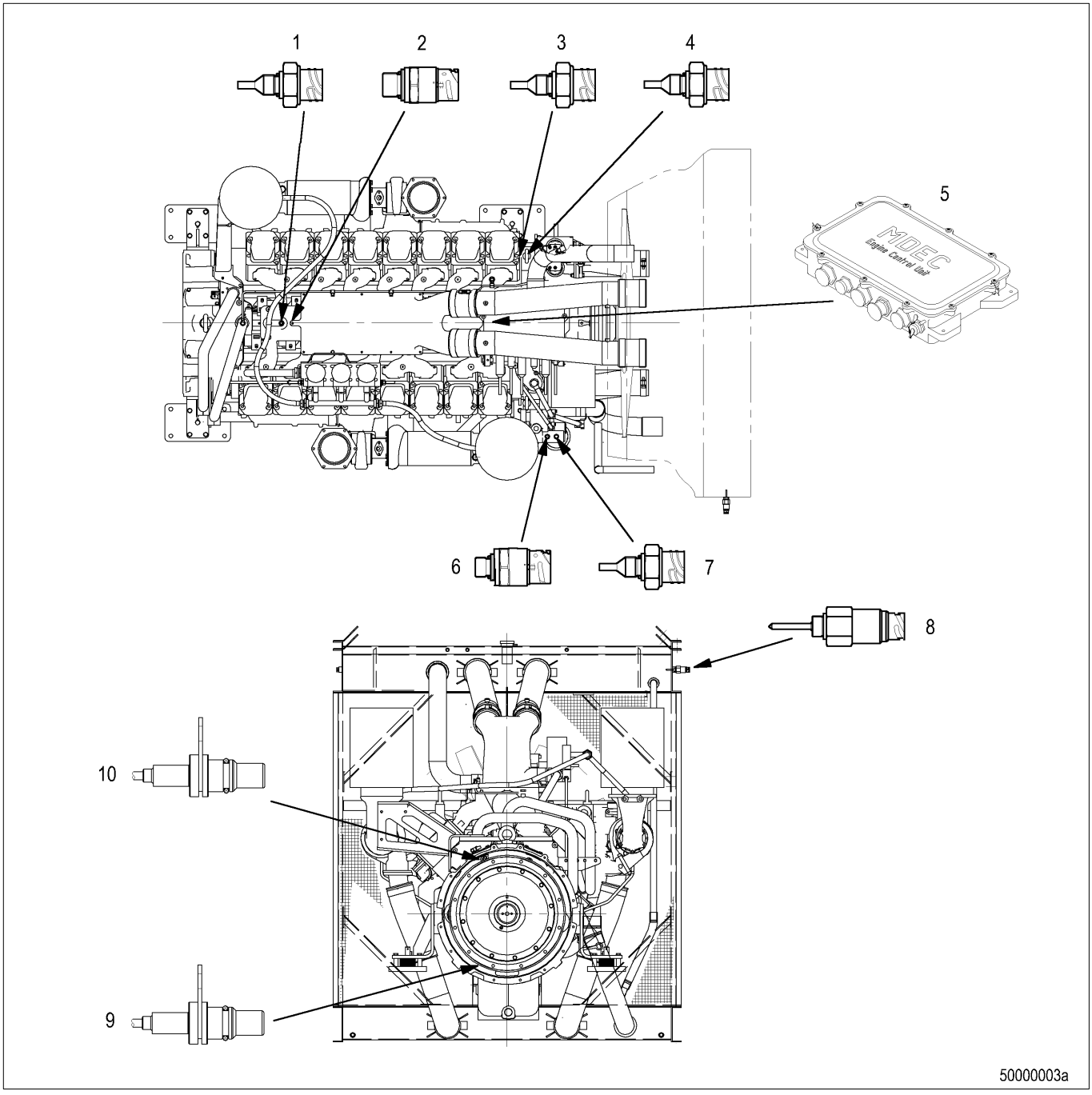
C 500 Monitoring, Control and Regulation Devices

12V



1 Charge air pressure sensor
2 Charge air temperature sensor
3 Fuel temperature sensor
4 Coolant temperature sensor
5 Housing ECU 4–03
6 Lube oil pressure sensor
7 Lube oil temperature sensor
8 Coolant level sensor
9 Speed sensor (crankshaft)
10 Speed sensor (camshaft)

16V



1 Charge air pressure sensor
2 Charge air temperature sensor
3 Fuel temperature sensor
4 Coolant temperature sensor
5 Housing ECU 4–03
6 Lube oil pressure sensor
7 Lube oil temperature sensor
8 Coolant level sensor
9 Speed sensor (crankshaft)
10 Speed sensor (camshaft)

The following is a list of auxiliary equipment and materials needed for the assembly operations:

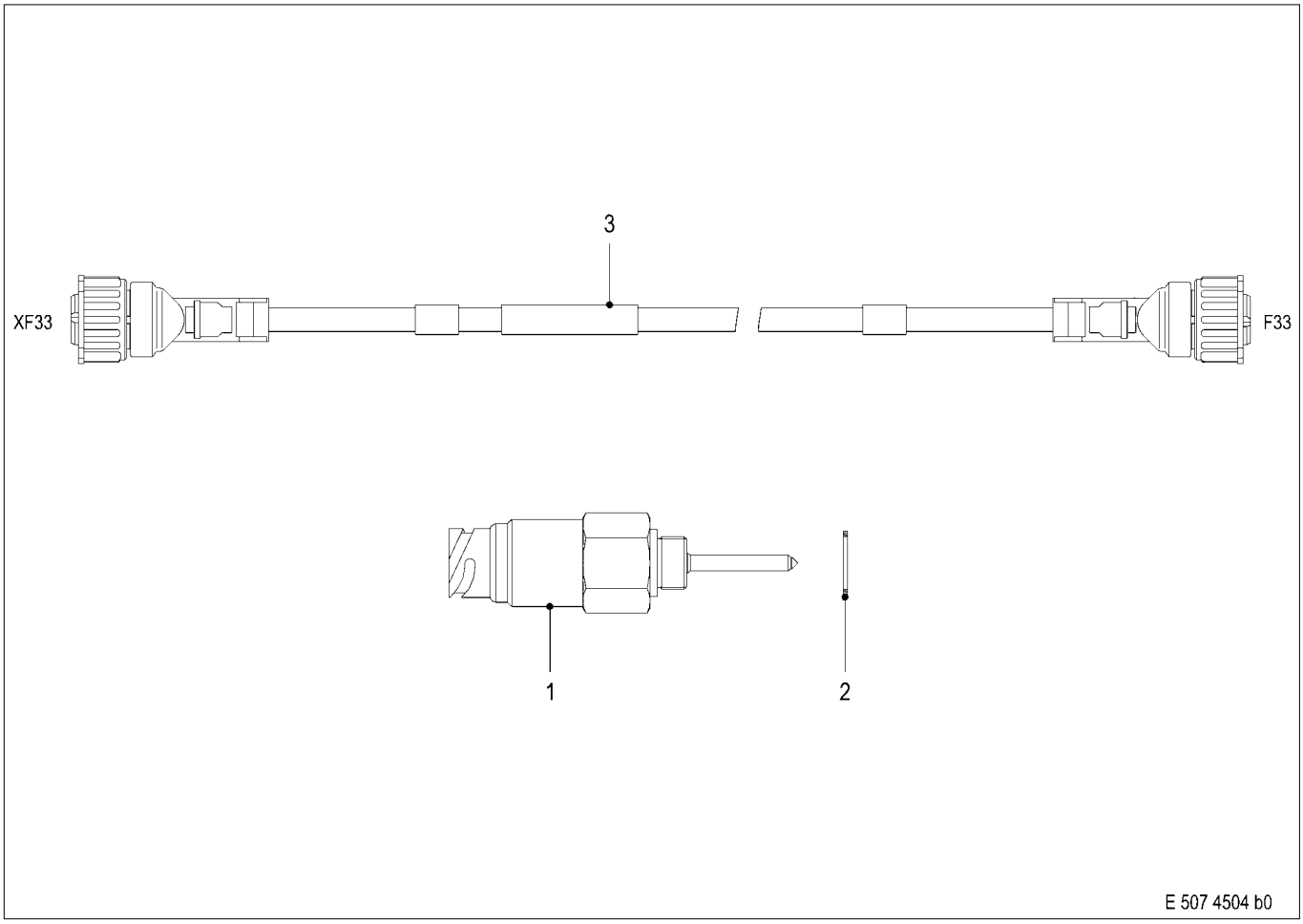
CAUTION

When using chemical substances, it is essential to observe the manufacturer's instructions for use, safety instructions and waste disposal specifications.

Auxiliary Equipment and Materials	Designation	Order No.		Remarks
		MTU	DDC	
Vaseline	Petroleum jelly, white	40317		
Cleaning agent	Solvclean KW	40022		
Assembly paste	Ultra Therm MTU	50547		
Corrosion inhibitor	Caramba Express	40008		
Isoprophyl alcohol		46181		
Dry compressed air				
Engine oil				

C 507.10 Wiring

C 507.10.01 Overview Drawing

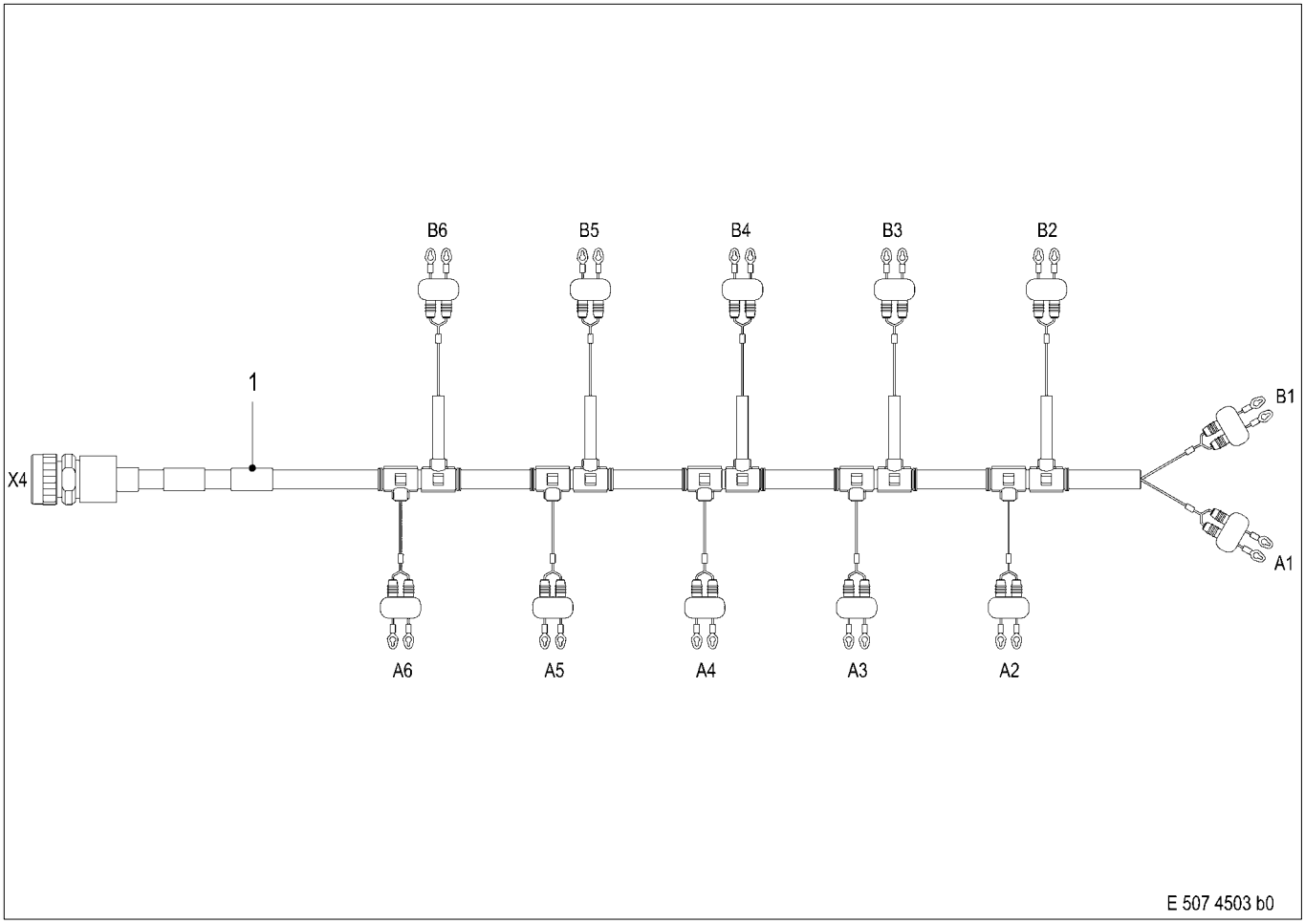


1 Coolant level sensor
Tightening torque: max. 30 Nm
Lubricant: Engine oil

2 Sealing ring

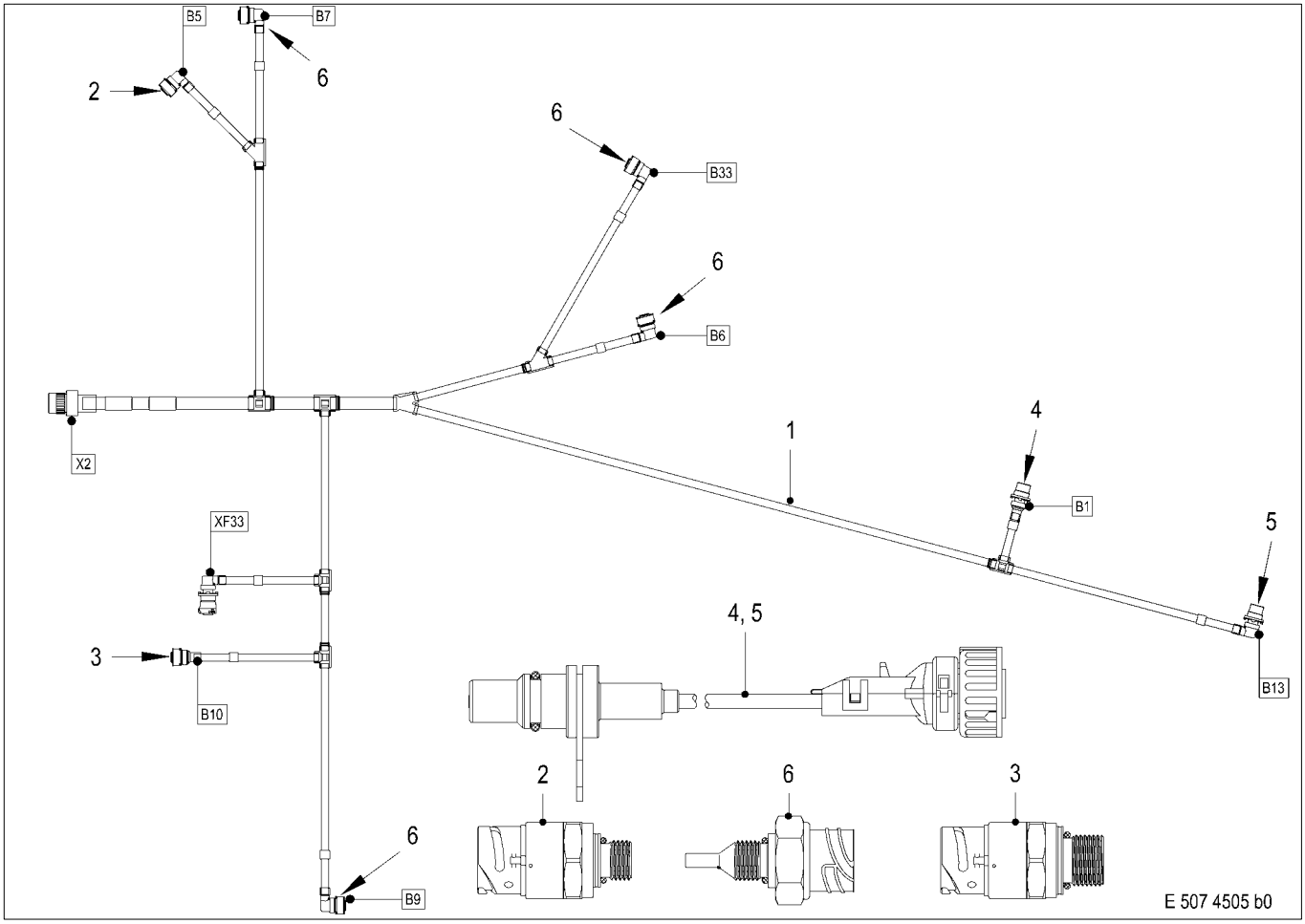
3 Connecting cable

Wiring, 12V



1 Wiring harness injector

Wiring, 12V



1 Wiring harness X2

2 Pressure sensor, 10 bar
Tightening torque: min. 20 Nm
max. 45 Nm
Lubricant: Engine oil

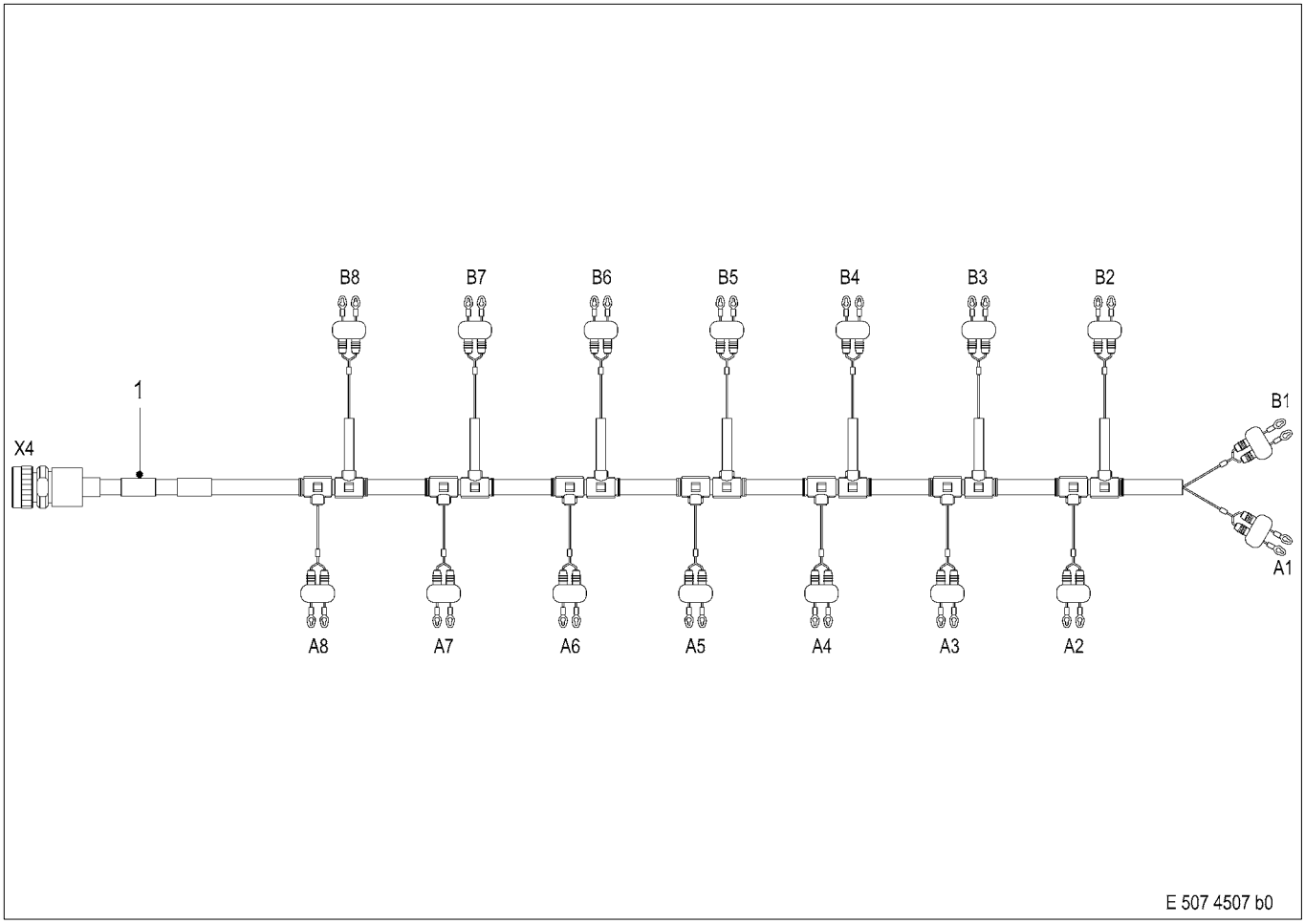
3 Pressure sensor, 4.5 bar
Tightening torque: min. 20 Nm
max. 70 Nm
Lubricant: Engine oil

4 Speed sensor

5 Speed sensor

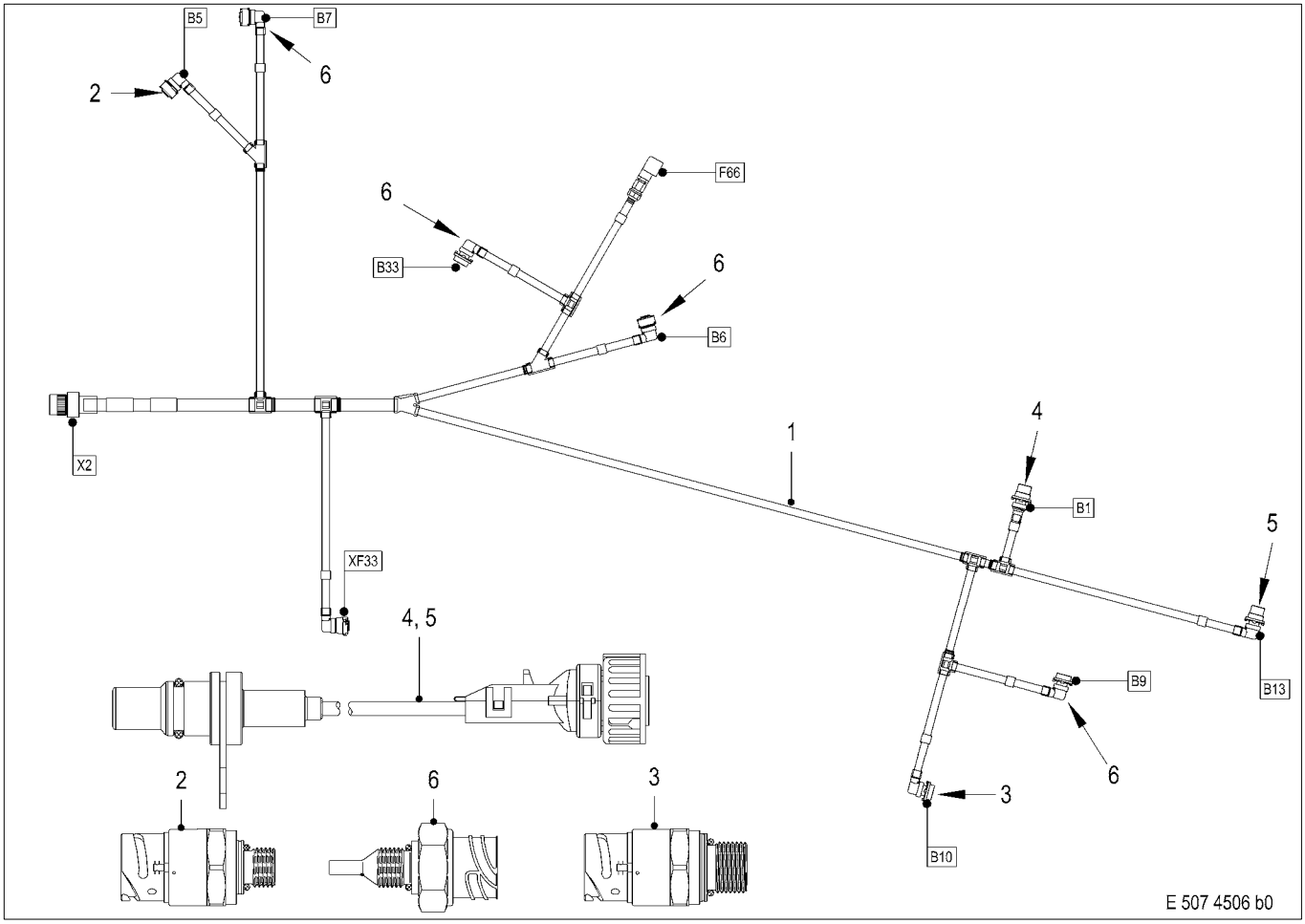
6 Temperature sensor, PT 1000
Tightening torque: min. 15 Nm
max. 30 Nm
Lubricant: Engine oil

Wiring, 16V



1 Wiring harness injector

Wiring, 16V



1 Wiring harness X2

2 Pressure sensor, 10 bar
Tightening torque: min. 20 Nm
max. 45 Nm
Lubricant: Engine oil

3 Pressure sensor, 4.5 bar
Tightening torque: min. 20 Nm
max. 70 Nm
Lubricant: Engine oil

4 Speed sensor

5 Speed sensor

6 Temperature sensor, PT 1000
Tightening torque: min. 15 Nm
max. 30 Nm
Lubricant: Engine oil

C 507.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain engine coolant*	Operating Instructions

* – Only for removal of coolant sensors

C 507.10.05 Removal

Removing electric cables

Note: Before removing lines, it is advisable to photograph the engine from all sides or attach metal tags to the lines and fixtures so that they can be reinstalled in their original positions.

Separate electrical plug-in connections from appropriate assemblies.

Turn bayonet nut of connector counterclockwise and remove connector.

Remove electric cables as per overview drawing, see C 508.10.01.

Seal plug-in connections with suitable dust caps and store lines safely away from oil and dirt.

Mark securing material of electrical installation and store separately from other securing material.

Removing temperature sensor, pressure sensor and coolant level probe

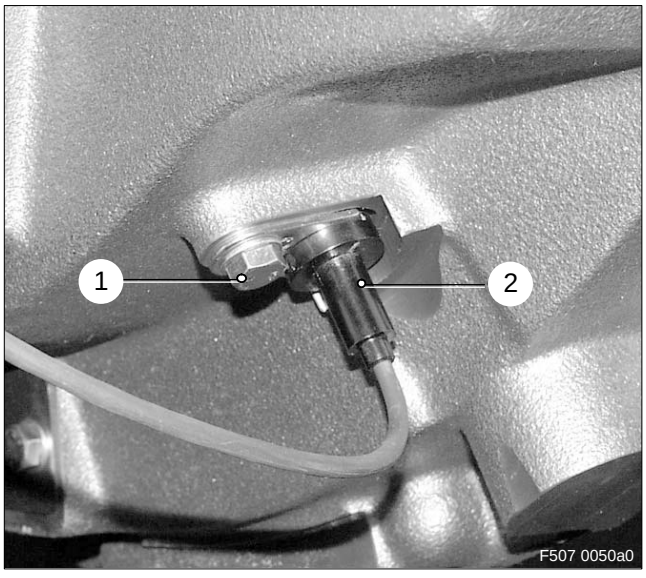
Note: Sensor and probe are electronic components. Take due care when removing.

Unscrew sensor or probe with open-end wrench.

Fit suitable dust caps on pressure sensor insertion threads.

Store sensor and probe and protect from dirt and mechanical damage.

Seal bores with suitable plugs as necessary.



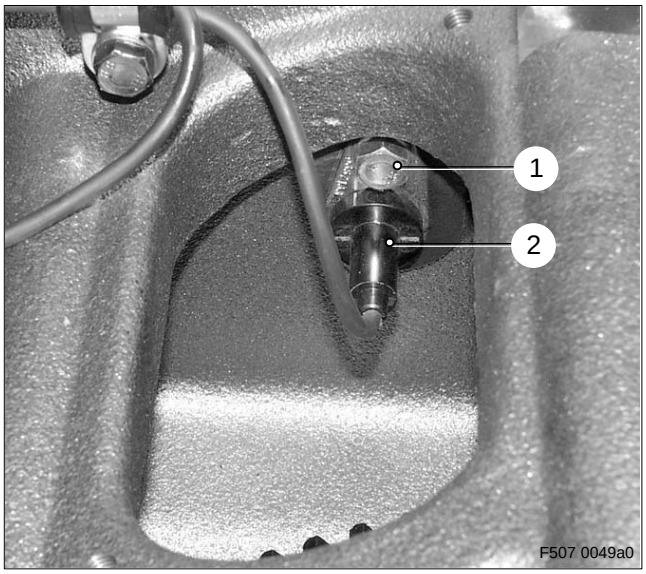
Removing speed sensor (crankshaft)

Note: The speed sensor is an electronic component. Take due care when removing.

Separate electrical plug-in connection for speed sensor (2).

Remove securing screws (1).

Remove speed sensor from flywheel housing.



Removing speed sensor (camshaft)

Note: The speed sensor is an electronic component. Take due care when removing.

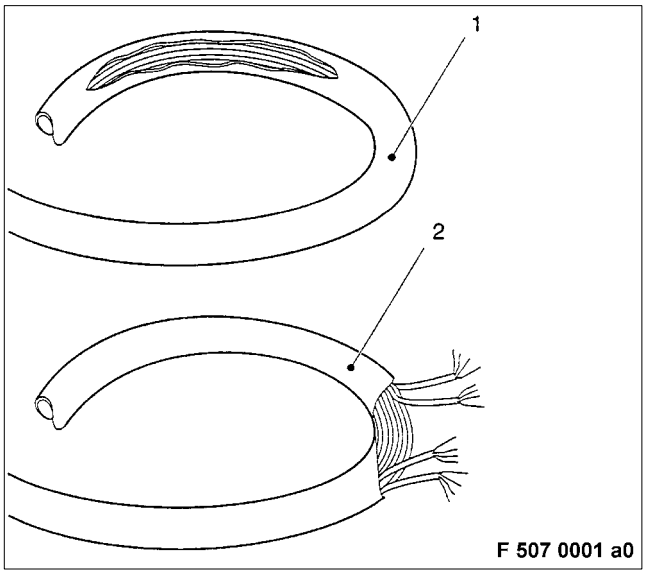
Remove end cover from flywheel housing – see C 016.30.

Separate electrical plug-in connection for speed sensor (2).

Remove securing screws (1).

Remove speed sensor from flywheel housing.

C 507.10.08 Inspection and Repair



Checking cable for damage

Clean connector housing and contacts thoroughly with isoprophyl alcohol as necessary.

Check wording (marking grommets) on cable for legibility; make legible or replace as necessary.

Check lines and connections for damage (visual inspection).

If damage is found on outer insulation of cable, proceed as follows:

- Individual cores are visible, but none of the individual cores are damaged – see example (1): Wrap insulating tape around cable.
- Individual cores are damaged – see example (2): Replace wiring harness.

Check plug-in contacts for burning, wear and vibration damage.

Check components for damage and defects.

Replace faulty components.

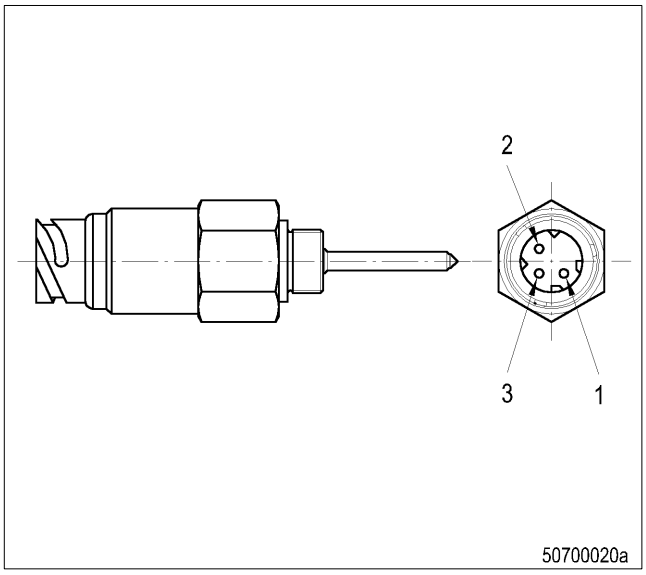
Replace clamps as part of every W6 overhaul.

Checking monitoring units

Note: Monitoring units are maintenance-free and are replaced as a single unit. Adjustment is not possible.

Check monitoring units for damage (visual inspection), replace as necessary.

Replace sealing rings.



Checking coolant level sensor (minimum sensor)

Important: With minus-switching sensors, there is the danger of destruction if negative potential is connected to the signal connection and positive potential to the negative connection.

When coolant level drops, check operation of probe by measuring trip point between connector contacts 2 and 3 with a voltmeter.

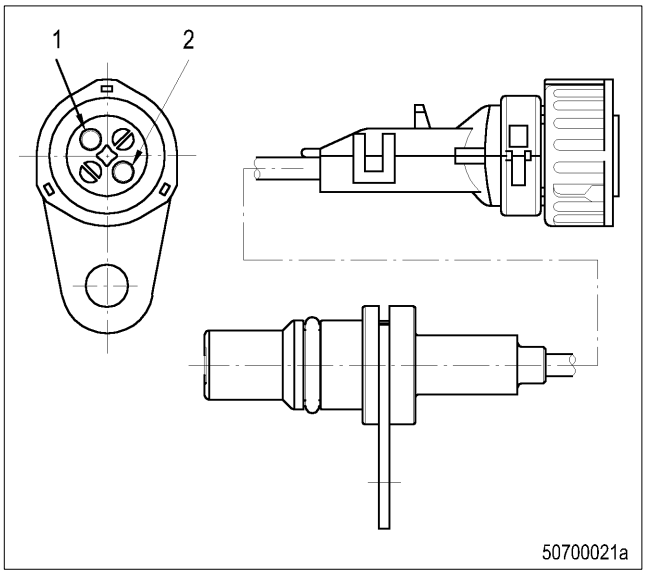
Rated voltage: 24 VDC

Contact designations:

1 = plus ($+U_B$)

2 = minus ($\perp$)

3 = signal (U_{out})



Checking speed sensor

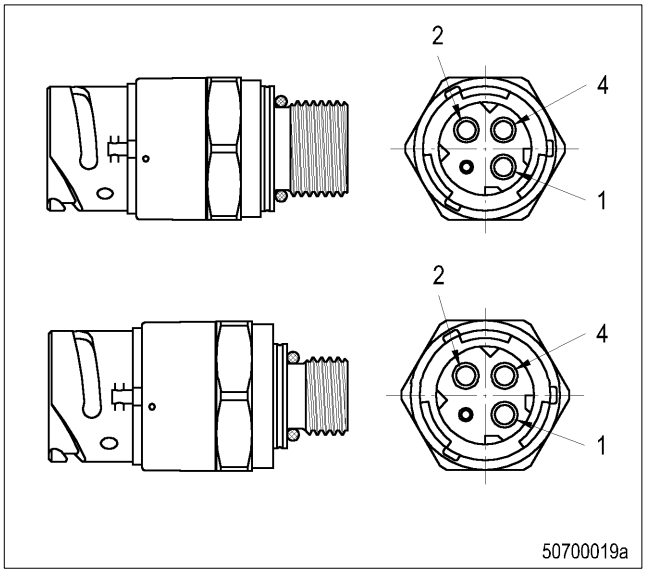
Measure resistance between pin 1 and pin 2 with an ohmmeter.

Required resistance = 136 ohms ± 20 ohms

In event of deviation from specified value, replace sensor.

Check magnetic pull as follows:

Position metal screwdriver at front of speed sensor; screwdriver should be clearly attracted, otherwise replace speed sensor.



Checking pressure sensor

Carry out D.C. voltage test on sensor.

Pin 1 = Voltage input

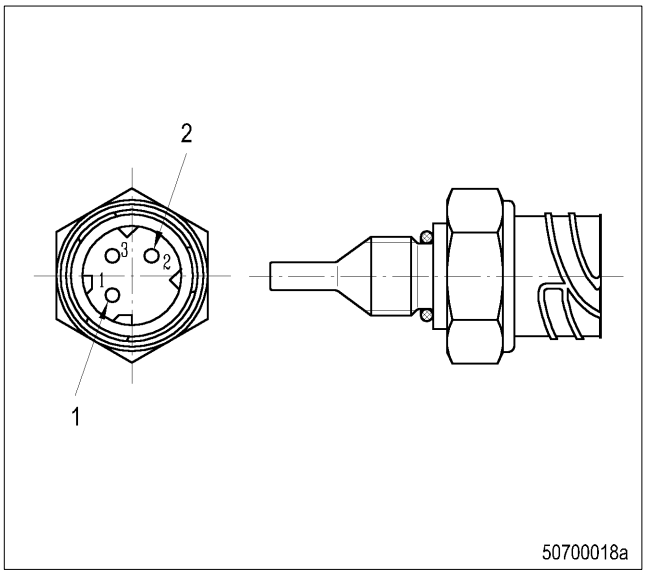
Pin 2 = Voltage output

Pin 4 = Ground

Input voltage at 25 °C = 5 VDC

Specified output voltage = 0.5 VDC

In event of deviation from specified value, replace sensor.



Checking temperature sensor

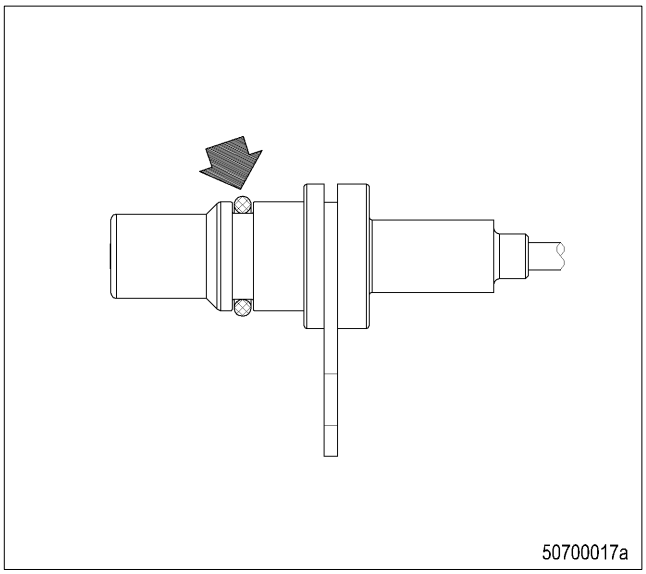
Measure resistance between pin 1 and pin 2 with an ohmmeter at different bath temperatures.

Specified resistance at 0 °C = 1000 ohms

Specified resistance at 100 °C = 1385 ohms

In event of deviation from specified values, replace sensor.

C 507.10.11 Installation

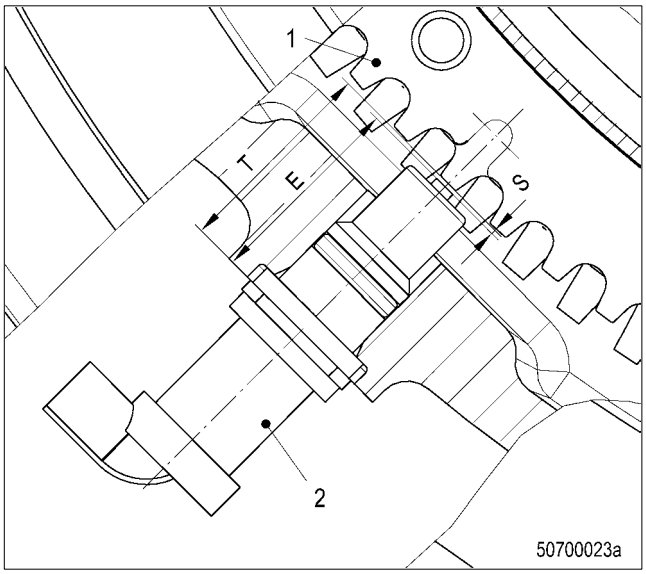


Installing speed sensor (crankshaft)

Note: The speed sensor is an electronic component. Take due care when installing.

Check fit in flywheel housing (see overview drawing C 512.10.01) and clean as necessary.

Coat O-ring (arrow) with petroleum jelly.

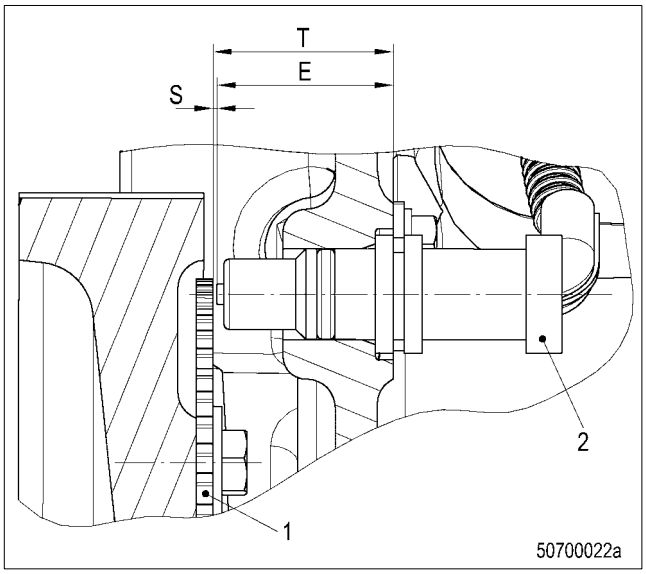


Check gap clearance “S” between graduated disc (2) and speed sensor (1):

S = from 0.45 mm to 1.45 mm

For this purpose, measure installation length “E” of speed sensor and compare with depth of support bore. Installation length “E” must be smaller by dimension “S” than installation depth “T”.

Install speed sensor in respective fitted bore in flywheel housing and tighten securing screw.

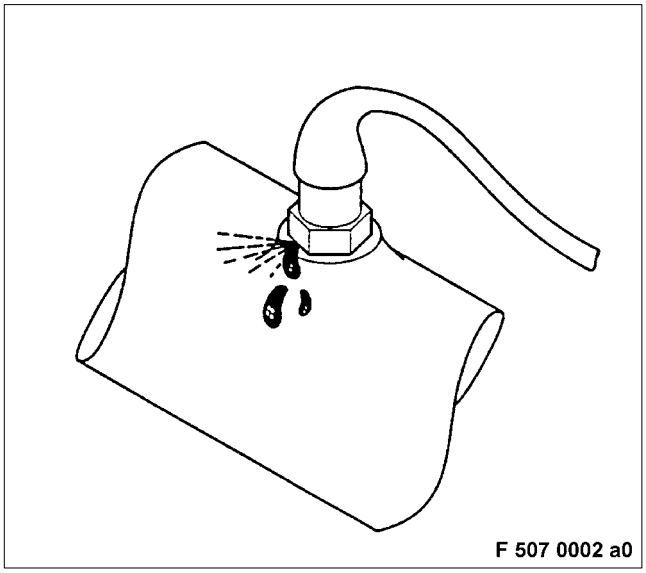


Installing speed sensor (camshaft)

Installation is in principle the same as –Installing speed sensor (crankshaft)–.

Gap clearance “S” between graduated disc (1) and speed sensor (2):

S = from 0.1 mm to 1.6 mm



Installing temperature sensor, pressure sensor and coolant level probe

Note: Sensor and probe are electronic components. Take due care when installing. Ensure that lube oil sensor and charge air sensor are particularly clean.

Remove blanking plug.

Check that sealing ring, sealing surfaces and installation bore (thread) are perfectly clean; clean if necessary.

Screw in temperature sensor, pressure sensor and coolant level probe as per overview drawing (see C 500), and tighten to specified torque – see C 507.10.01.

Note: After starting engine, visually check threaded connections of sensors and probe for leaks.

If leaks are found, tighten threaded connection slightly.

If the connection cannot be sealed by tightening, remove sensor or probe and replace sealing ring.

Installing electric cables

Install electric cables in accordance with overview drawing (see C 507.10.01) in original position on engine, ensuring they are tension-free.

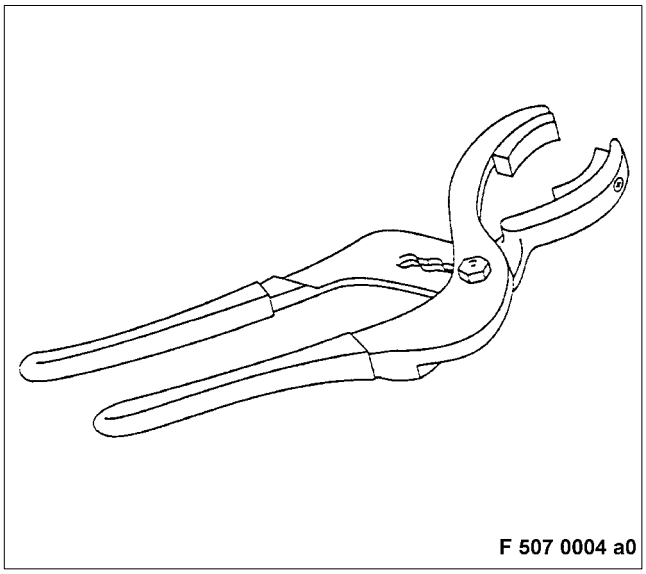
In order to prevent vibration damage to the lines, secure the lines with appropriate securing fixtures.

Remove dust caps.

Note: Before joining plug-in connections, ensure that connector and bush are dry.

Connect all plug-in connections according to markings (marking grommets) with respective assemblies.

The bayonet union nut must engage firmly in place.



Installing plug-in connections on Engine Control Unit ECU

Note: Before joining plug-in connections, ensure that connector and bush are dry.

Connect plug-in connections as per markings to Engine Control Unit ECU.

Use pliers to turn bayonet union nut clockwise until union nut engages firmly in place.

Note: The pliers must be used to tighten the bayonet union nut. Otherwise there is the risk that the connector may come loose during engine operation.

C 507.10.12 After-Installation Operations

A distinction must be made as to whether:

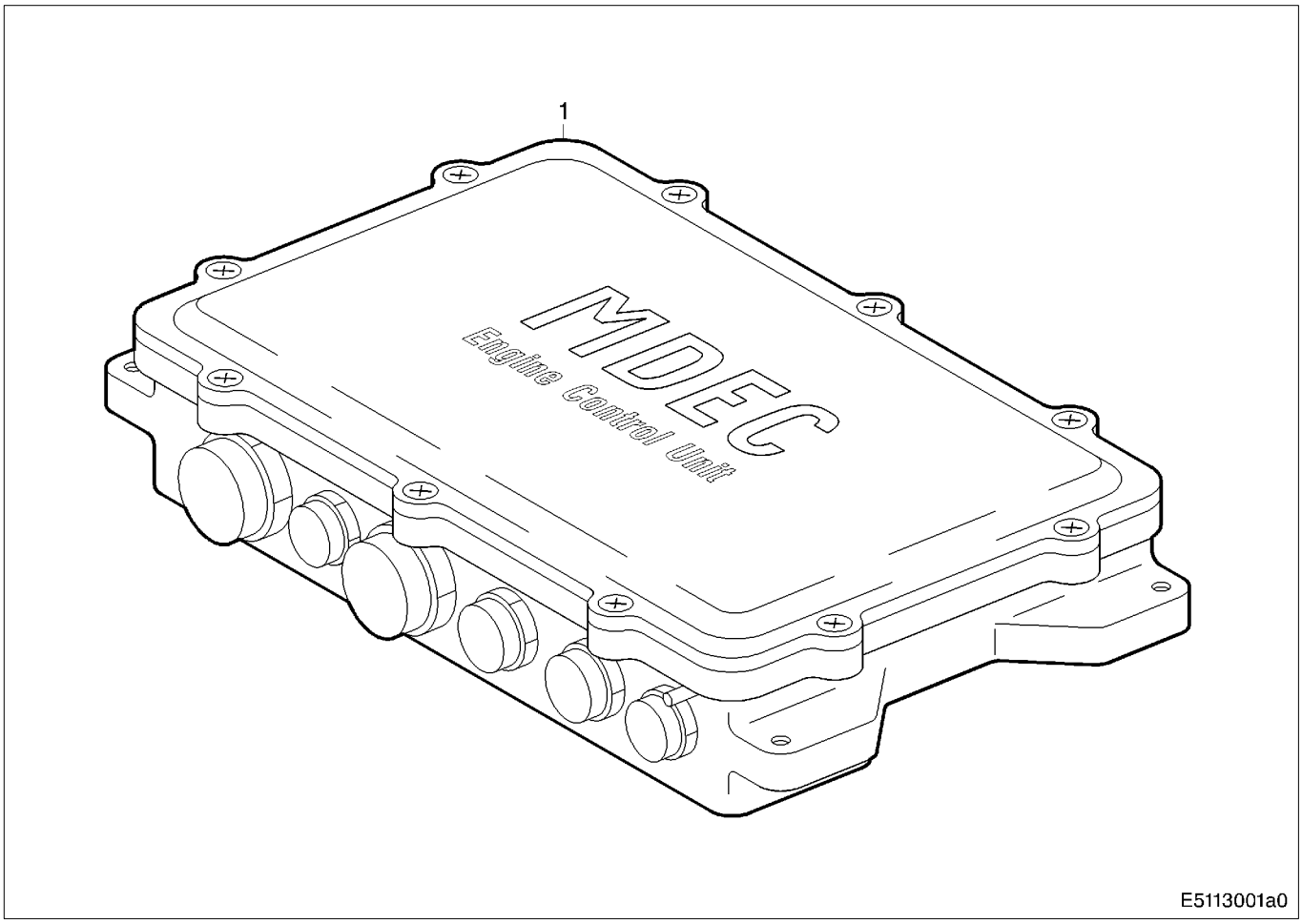
1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Release engine start	Operating Instructions

C 508.10 Accessories for Engine Governor/Controls System

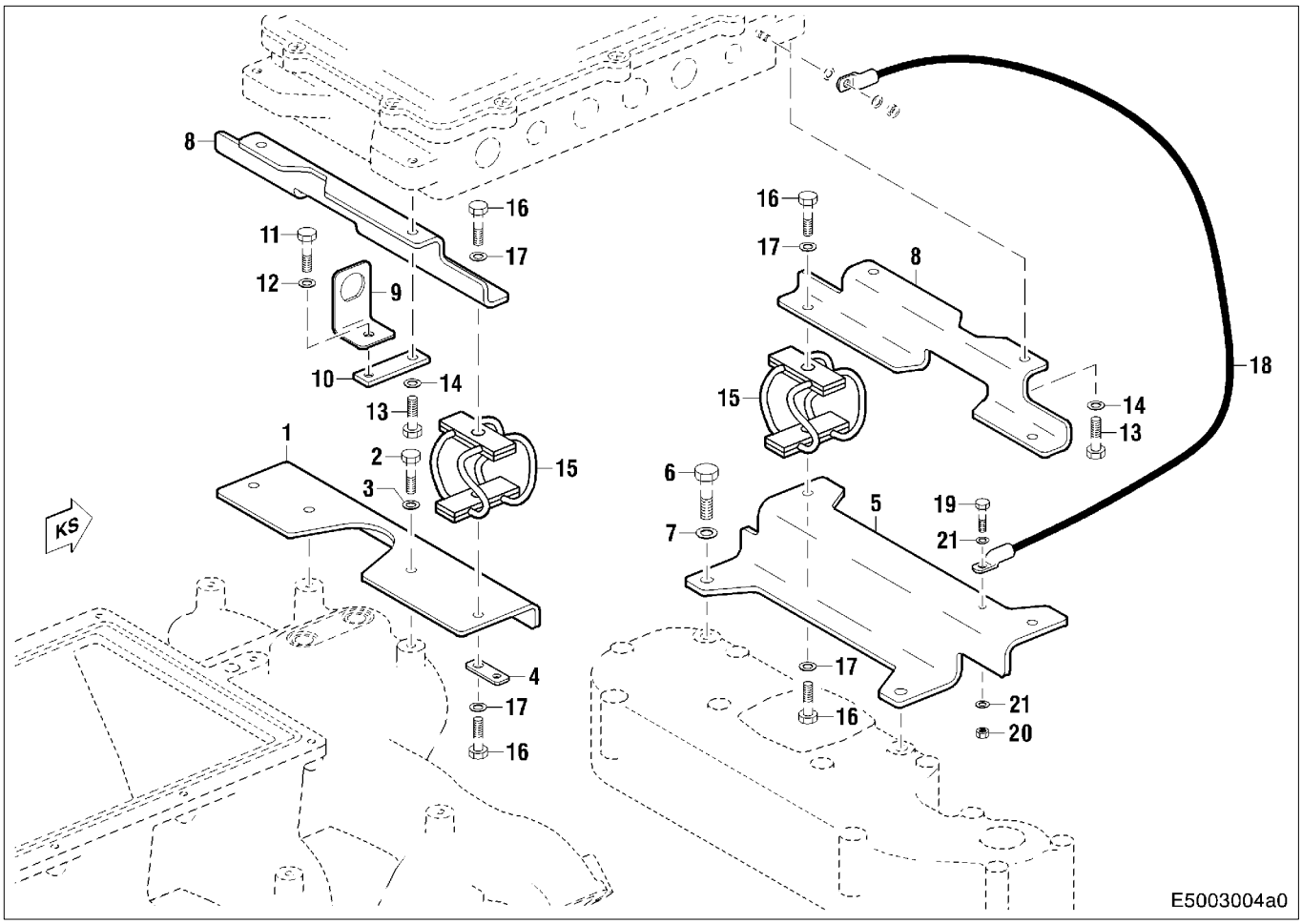
C 508.10.01 Overview Drawing

ECU 4–03



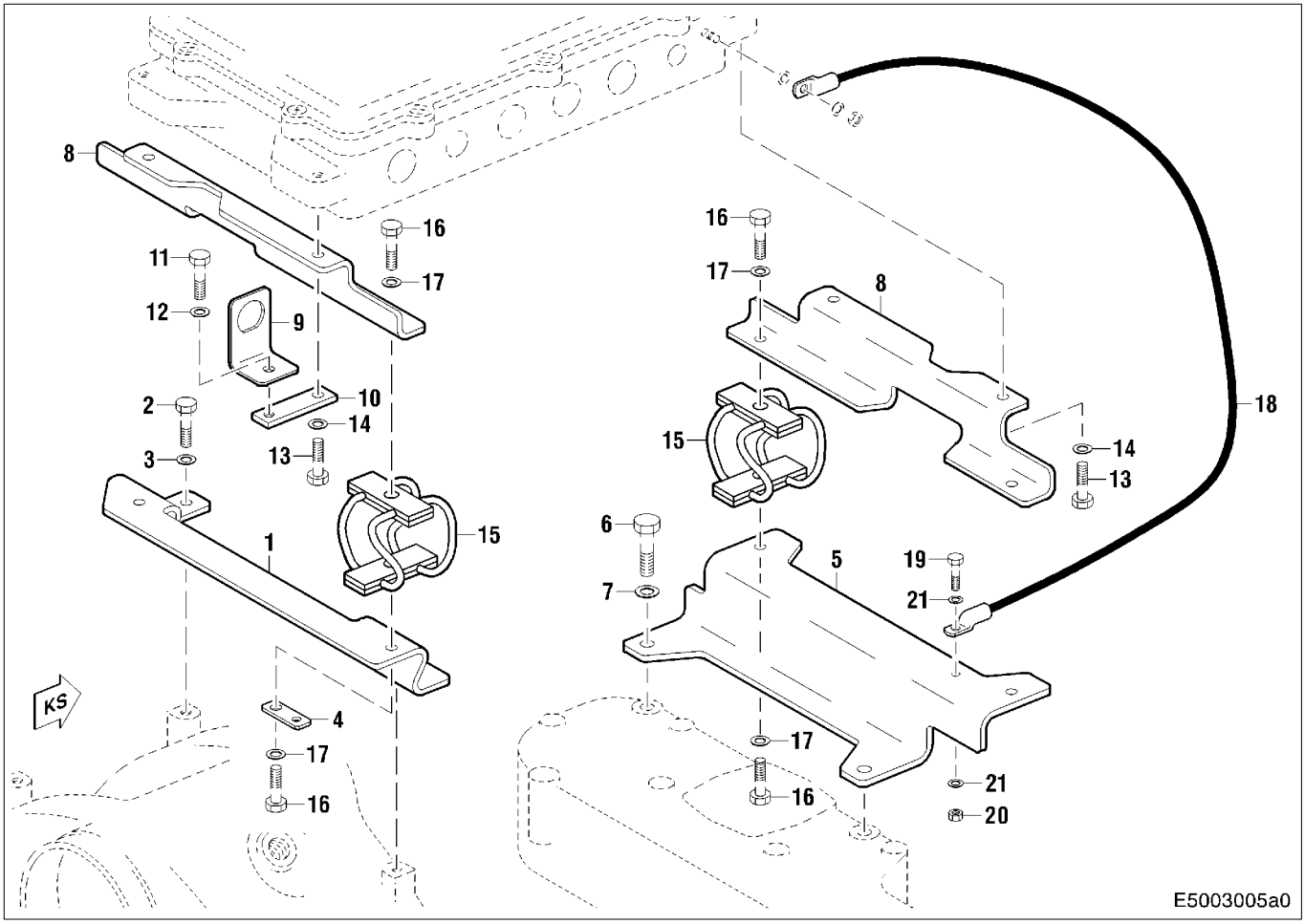
1 Electronic governor ECU 4–03

Bracket, 12V



1 Bracket
2 Hex screw
3 Washer
4 Bracket
5 Bracket
6 Hex screw
7 Washer
8 Bracket
9 Bracket
10 Bracket
11 Hex screw
12 Washer
13 Hex screw
14 Washer
15 Metal-cable damper
16 Hex screw
17 Washer
18 Earthing strip
19 Hex screw
20 Hex nut
21 Washer

Bracket, 16V



1 Bracket
2 Hex screw
3 Washer
4 Bracket
5 Bracket
6 Hex screw
7 Washer
8 Bracket
9 Bracket
10 Bracket
11 Hex screw
12 Washer
13 Hex screw
14 Washer
15 Metal-cable damper
16 Hex screw
17 Washer
18 Earthing strip
19 Hex screw
20 Hex nut
21 Washer

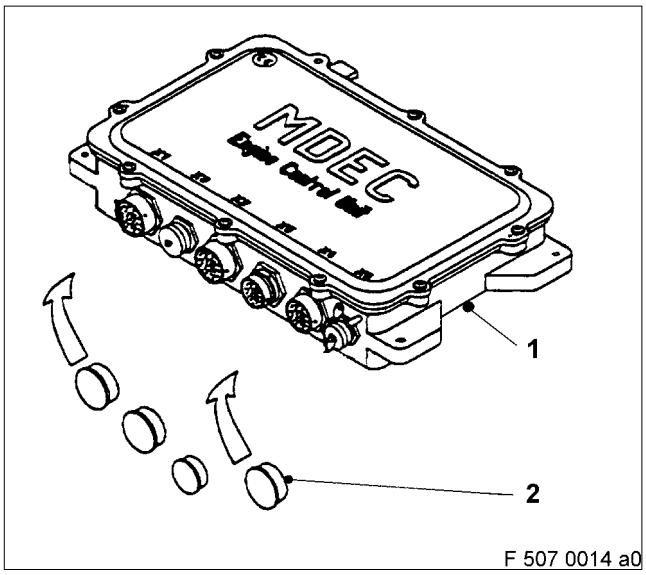
C 508.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ——— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions

C 508.10.05 Removal



Removing electronic governor

Note: Before removing lines, it is advisable to photograph the engine from all sides or attach metal tags to the lines and fixtures so that they can be reinstalled in their original positions.

Disconnect electric plug-in connections on electronic governor (1).

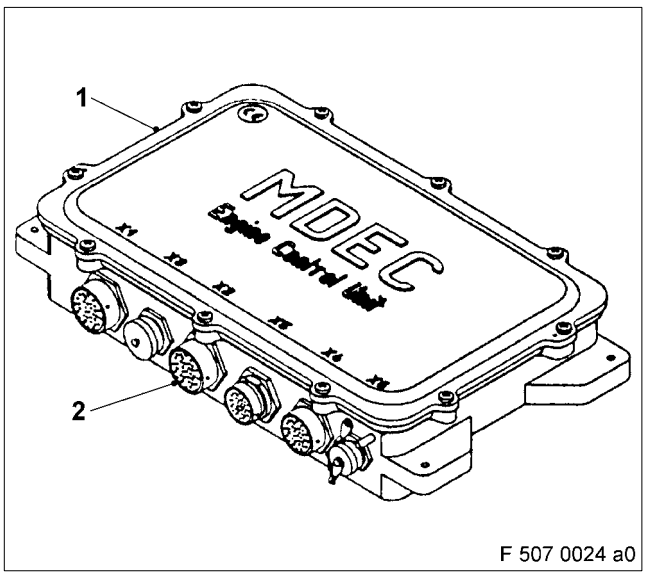
Remove electronic governor as per overview drawing – see C 508.10.01.

Seal all connections with suitable dust caps (2).

Store ECU housing safely away from oil and dirt.

Mark securing material for electronic governor and store separately from other securing material.

C 508.10.08 Inspection and Repair



Cleaning and checking Engine Control Unit ECU

Note: The Engine Control Unit ECU consists of a fully encapsulated housing in which all associated assemblies are integrated.
Owing to the encapsulation, it is not necessary to clean these assemblies.

Clean housing (1) and connector surface (2) with a cloth soaked in isoprophyl alcohol.

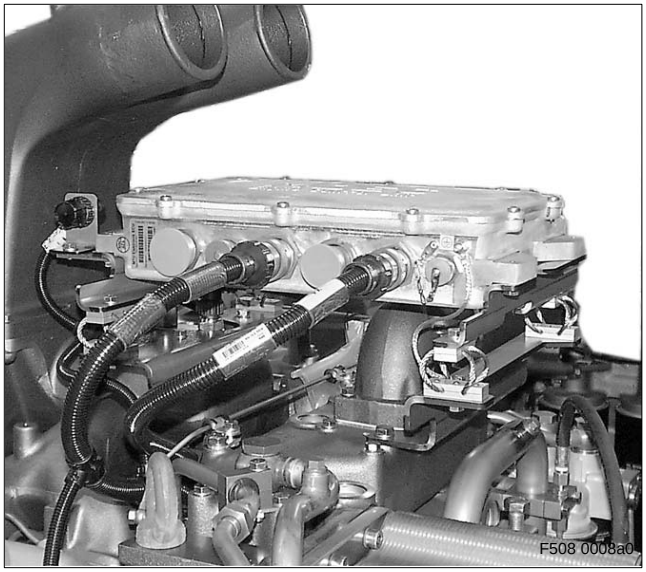
Clean connector housing, contacts and connector bushes with isoprophyl alcohol as necessary.

Visually inspect outside of housing for damage and defects.

Visually inspect fixtures for damage and defects; replace if necessary.

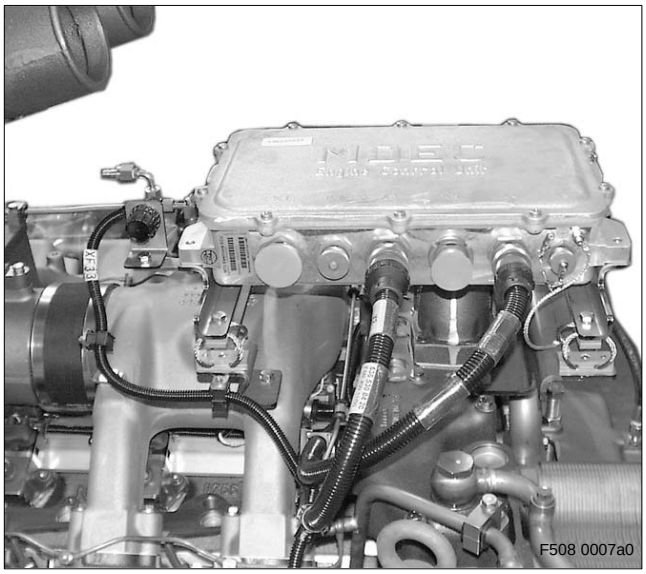
Check electronic governor in accordance with Special Publication.

C 508.10.11 Installation



Installing electronic governor, 12V

Install electronic governor on engine as per illustration – see also overview drawing C 507.10.01.



Installing electronic governor, 16V

Install electronic governor on engine as per illustration – see also overview drawing C 507.10.01.

C 508.10.12 After-Installation Operations

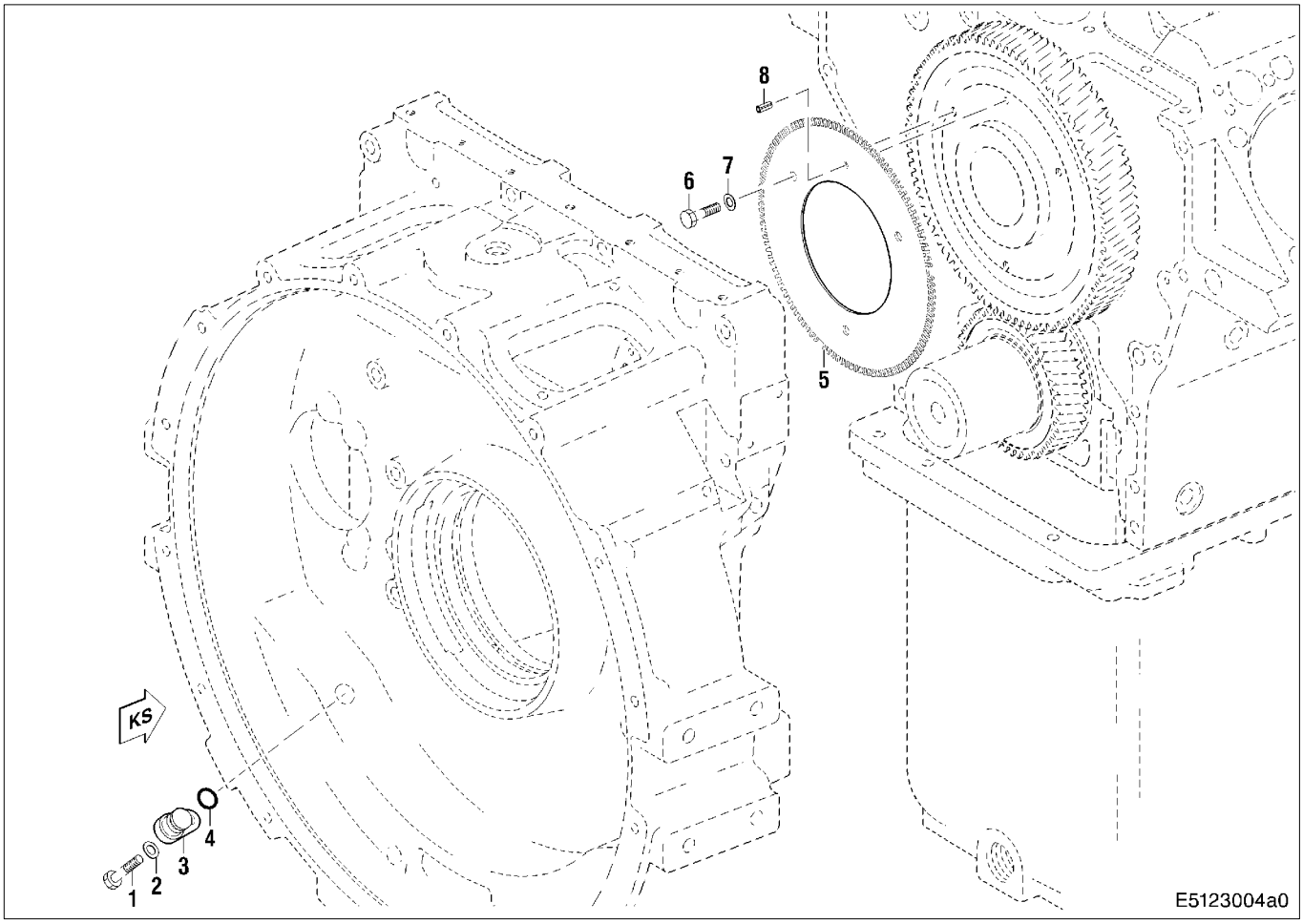
A distinction must be made as to whether:

1 ——— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	–	x	Connect electric plug-in connections on electronic governor.	C 507.10
–	–	x	Release engine start	Operating Instructions

C 512.10 Speed Monitoring System

C 512.10.01 Overview Drawing



1 Hex screw
2 Washer
3 Plug
4 O-ring
5 Graduated disc, camshaft
6 Hex screw
7 Washer
8 Spring pin

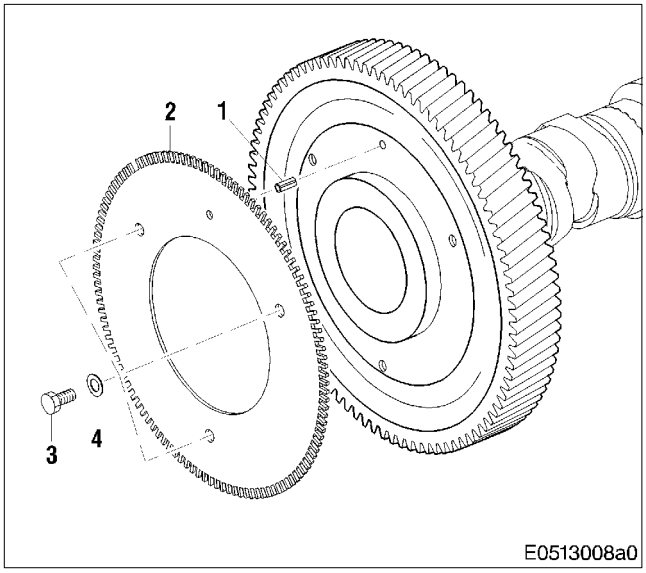
C 512.10.04 Before-Removal Operations

A distinction must be made as to whether:

1 ———— The engine is to be completely disassembled
2 ———— The engine is to be removed but not disassembled
3 — The engine is to remain installed

1	2	3	Operations	See
x	–	–	Remove engine	B 003
x	–	–	Perform operations as per Disassembly Plan	B 004
–	–	x	Disable engine start	Operating Instructions
–	–	x	Drain or draw off engine oil	Operating Instructions
–	–	x	Separate engine from alternator	–
–	x	x	Remove coolant lines	C 202.15
–	x	x	Remove coupling	Special Publication
–	x	x	Remove flywheel	C 032.05
–	x	x	Lower or remove oil pan	C 014.05
–	x	x	Remove air filter	C 121.05
–	x	x	Remove elbow, left engine side	C 123.05
–	x	x	Remove starter	C 172.05
–	x	x	Remove speed sensor	C 507.10
–	x	x	Attach engine to lifting device	B 003
–	x	x	Remove engine mount, driving end	C 231.05
–	x	x	Remove flywheel housing	C 016.30

C 512.10.05 Removal



Removing measuring wheel (camshaft)

Note: Remove measuring wheel only if necessary (e.g. if damaged). Securing screws and spring pin are secured with thread-locking agent and must be heated to approx. 200 °C before removal.

Unscrew hex screws (3) and washers (4) and remove graduated disc (2).

Remove spring pin (1) from camshaft gear.

C 512.10.08 Inspection and Repair

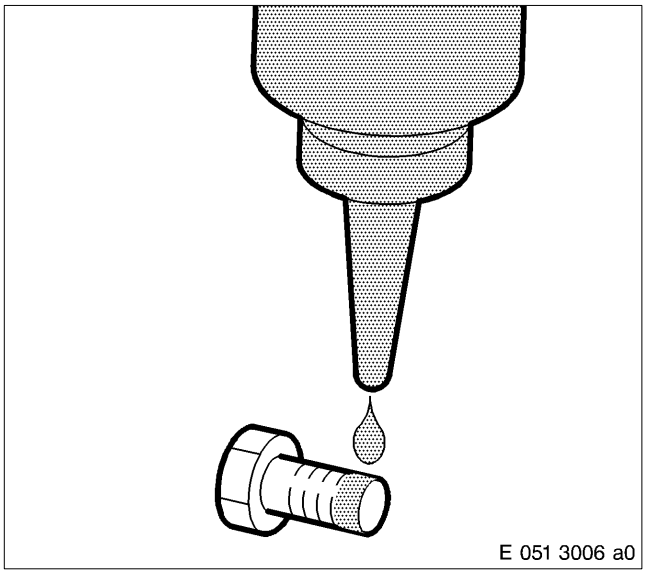
Clean all parts.

Check securing screw for condition and thread for ease of movement; replace screw if necessary.

Check graduated disc for wear, replace if necessary.

Replace spring pin and O-ring at every installation.

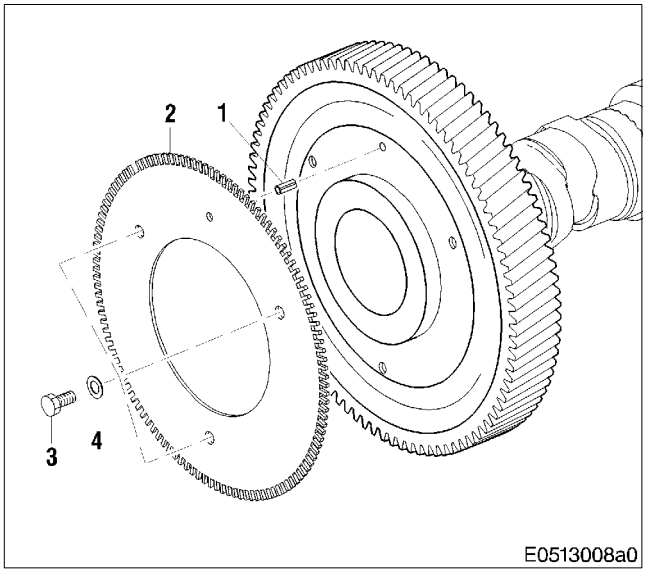
C 512.10.11 Installation



Installing graduated disc (camshaft)

Clean and degrease thread in camshaft gear and hex screws and spring pin and spring pin bore in camshaft gear.

Coat thread of hex screws and spring pin bore with thread-locking agent.



Drive spring pin (1) into camshaft gear to a protrusion of 5 mm.

Position graduated disc (2) on camshaft gear, taking care not to damage fit of spring pin.

Screw in hex screws (3) and washers (4) and tighten.

Note: Ensure correct final strength of thread-locking agent – see C 050.

C 512.10.12 After-Installation Operations

A distinction must be made as to whether:

1 ———— The engine was completely disassembled
2 ——— The engine is removed but was not disassembled
3 — The engine is installed

1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x	Install flywheel housing	C 016.30
–	x	x	Install engine mount, driving end	C 231.05
–	x	x	Connect coolant lines	C 202.15
–	x	x	Install elbow, left engine side	C 123.05
–	x	x	Install air filter	C 121.05
–	x	x	Press on flywheel	C 032.05
–	x	x	Install oil pan	C 014.05
–	x	x	Install starter	C 172.05
–	x	x	Install speed sensor	C 507.10
–	x	x	Install coupling	Special Publication
–	–	x	Fill oil system with engine oil	Operating Instructions
–	–	x	Fill engine coolant system	Operating Instructions
–	–	x	Connect engine to alternator	–
–	–	x	Release engine start	Operating Instructions