Shop manual

MTU
Diesel Engine
12V 4000 Gx0/Gx1
16V 4000 Gx0/Gx1

Réf. constructeur : MR20108/01E

Réf. GPAO : 33525059201

Amendment Service!

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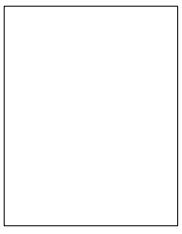

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MTU Friedrichshafen GmbH
Department SCT
88040 Friedrichshafen
GERMANY

MR20108/01E

Maintenance Manual

12V 4000 Gx0/1
16V 4000 Gx0/1

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Publication number:

MR20108/01E

Name

Manufacturer

Department

Fax Telephone

Street

Postal box number

(Postal code) City

Country

Contents – Repair Manual

A001 Important information

This manual is intended for use by technical personnel responsible for the maintenance and servicing of the MTU 4000 series **diesel engine**

This handbook contains descriptions of the following:

- scheduled service operations under maintenance echelons W6
- non-scheduled service operations on the individual assemblies

REMAN assemblies

The following assemblies are available only in the replacement procedure:

- Cylinder head
- High-pressure pump
- Injector
- Coolant pump
- MDEC
- Exhaust Turbocharger
- Intercooler
- Vibration damper
- Starter
- Alternator (generator)
- Fuel delivery pump

Only removal and installation is explained.

Structure of this handbook

This manual is divided 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.

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

- 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:

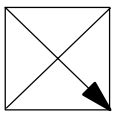
- The contents sheet, which cross-references the tables of contents of the individual groups.
- An alphabetical subject index in Section A provides direct access to the individual Groups.
- The Group Summary at the start of Section C lists the individual main function groups.

Requirements for maintenance tasks

If the maintenance work is carried out by the customer, the following must be ensured:

- All safety regulations are observed
- Use of trained and qualified personnel
- Suitable workshop equipment with general tools
- Suitable test equipment
- Approved special tools

General Assembly Instructions

- Component cleanness:
  Areas of all components that come into contact with oil, fuel, coolant and combustion air must be clean.
- Components requiring “special cleanness” (e.g. oil and fuel-carrying parts) 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 and similar) must not be washed with diesel fuel, solvent 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 SAE30 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 O-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 installing shaft seals
  – 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.
  In the case of an elastomer outer jacket or combined metal/elastomer outer jacket, 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 SAE30 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 SAE30 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 SAE30 engine oil.
- Components used in hot part areas (e.g. V-clamps, bellows, plug-in pipes) must be coated at the support and mating surfaces with assembly paste, unless otherwise specified.
- 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, engine oil (SAE 30) must be used as lubricant, and assembly paste in the area of hot parts.
- 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.
- 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 tolerance for tightening torque is stated, the tightening tolerance is +10% of 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/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).
  – Tightening to elongation
    Tightening must be carried out in accordance with tightening specifications taking the tightening tolerance into consideration.

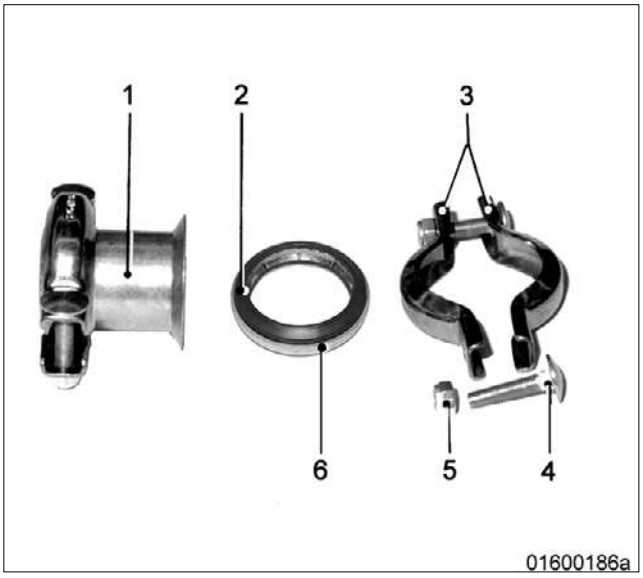
Information on installation of Flexmaster pipe connection

To improve adhesion between the sealing ring and pipe, as well as prevent loosening of the sealing ring, both pipe ends are to be thoroughly degreased to at least the insertion depth. Remove paint from the area near the sealing ring.

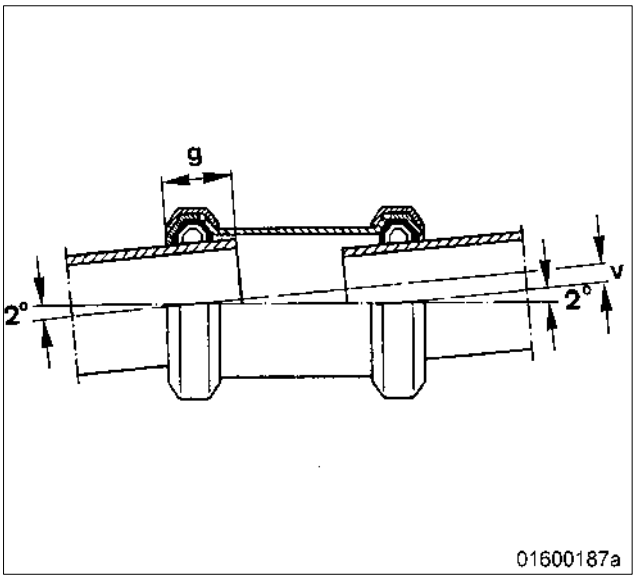
The cut edges on the pipe must be deburred.

Otherwise leaks may arise during installation or in operation.

Note: When installing sealing rings, no oil, grease, graphite or other lubricants must be used.



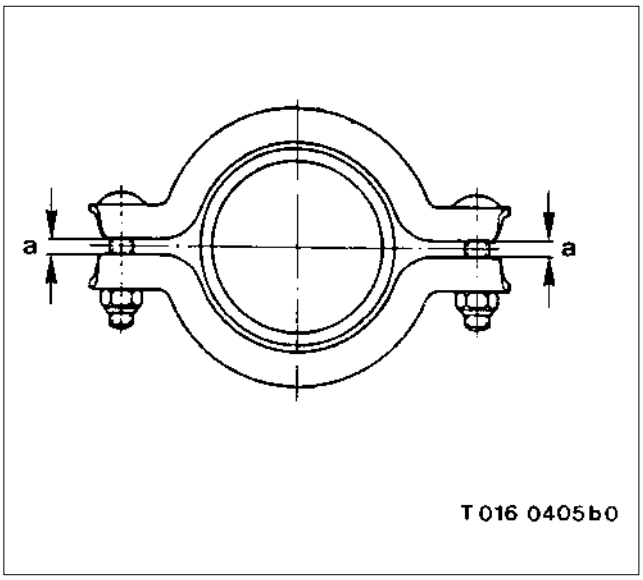
1 Sleeve
2 Sealing ring
3 Clamps
4 Screw
5 Self-locking nut
6 Seal carrier



In event of alignment offset (v) of pipes to be connected, pipe ends of the sleeve must not touch.

The permissible non-alignment is determined by the immersion depth of the pipe ends (g) and the permissible angle of $\pm$ 2°.

The depth of insertion (g) must be marked beforehand for a well centred fit.



The clamp halves are placed over seal carrier and sleeve and tightened with screws and self-locking nuts until dimension “a” is achieved.

Note: Replace deformed clamping-ring halves.
Clamps must not be fully tightened.
Replace self-locking nuts after loosening and retightening several times.

Dimension “a” for pipe outer diameters:

from 12 mm to 26.9 mm min. 2 mm max. 5 mm
from 28 mm to 60.3 mm min. 4 mm max. 8 mm
from 63.5 mm to 127 mm min. 8 mm max. 12 mm

A002 Hazards at the workplace

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

General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention must be observed.

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
- Operation, maintenance and repair carried out by untrained personnel
- Modifications or conversions
- Noncompliance with the Safety Instructions

Correct use

The engine is intended exclusively for the application specified in the contract or upon delivery. 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 and compliance with the maintenance specifications.

Personnel requirements

Work on the engine must only be carried out by properly qualified personnel.

The specified legal minimum age must be respected.

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.

MTU will accept no liability or warranty claims for any damage caused by unauthorised modifications or conversions.

Organisational measures

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

It must be kept at hand near the engine and accessible to all personnel involved in operation, maintenance, repair or transportation.

The personnel must be instructed on engine operation and repair by means of this publication, 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. Such personnel must be given instructions repeatedly.

Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. In event of any damaged caused by the use of other spare parts, no liability or warranty claims vis-à-vis the engine manufacturer will be accepted.

Working clothes and protective equipment

Wear proper work clothing for all work.

Depending on the kind of work, use additional protective equipment, e.g. protective goggles, protective gloves, protective helmet, apron.

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.).

Transport

Lift the engine only with the lifting eyes provided.

Use only the transportation and lifting equipment approved by MTU.

Take into consideration engine centre of gravity.

The engine must only be transported in installation position.

In the case of special packaging with aluminium foil, suspend the engine on the lifting eyes of the bearing pedestal or transport with equipment suitable for heavy loads (forklift truck).

Prior to transporting the engine, it is imperative to install transportation locking devices for crankshaft and engine mounts.

Secure the engine against tilting during transportation. The engine must be especially secured against slipping or tilting when going up inclines and ramps.

Setting the engine down after transportation

Place the engine only on an even, firm surface.

Ensure appropriate consistency and load-bearing capacity of the ground or support surface.

Never place an engine on the oil pan unless expressly authorised by MTU on a case-by-case basis to do so.

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles.

Laser equipment can generate extremely intensive, concentrated radiation by the effect of stimulated emission in the range of visible light or in the infrared or ultraviolet spectral range. The photochemical, thermal and optomechanical effects of the laser can cause damage. The main danger is irreparable damage to the eyes.

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A,
- Laser devices of class 3B, which have maximum output only in the visible wavelength range (400 to 700 Nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

Engine operation

When the engine is running, always wear ear protectors.

Ensure the engine room is well ventilated.

Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable bonding agent.

Exhaust gases from combustion engines are poisonous and injurious to health if inhaled. Inhalation of poisonous exhaust gases is a health hazard. The exhaust pipework must be leak-free and must discharge the gases to atmosphere.

Do not touch battery terminals, generator terminals or cables during engine operation.

Inadequate protection of electrical components can lead to electric shocks and serious injuries.

When the engine is running, never release coolant, oil, fuel, compressed air or hydraulic lines.

Maintenance and repair

Compliance with maintenance and repair 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, the battery disconnected and the “Do not operate” sign put up in the operating area or attached to the control equipment. Persons not involved must be kept clear.

Never attempt to rectify faults or carry out repairs if you do not have the necessary experience or special tools required. Maintenance and repair work must only be carried out by authorised, qualified personnel.

Use only the proper, calibrated tools.

Do not work on engines or components which are only held by lifting equipment or crane. Always support these components in accordance with regulations on suitable frames or stands before beginning any maintenance or repair work.

Before barring the engine, make sure that nobody is standing in the danger zone. 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 and repair work, take care not to damage the fuel lines. 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, except when necessary for design reasons during installation.

Elastomers (E.G. Viton sealing rings) are safe under normal working conditions. In event of fire or temperatures above 300 °C, the material disintegrates. Hydrogen fluoride vapours are then released. If it contacts the skin, serious burning results. If elastomer seals look carbonised or resinified, do not touch with unprotected hands. Wear protective gloves.

Take care with hot fluids in lines, pipes and chambers. ⇒ Risk of injury!

Note cooling period for components which are heated for installation or removal. ⇒ Risk of injury!

Take special care when removing ventilation or plugs from engine. In order to avoid the discharge of 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!

When draining, collect fluids in a suitable container, mop up any spilt fluids or wipe or soak them up with a suitable bonding agent.

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.

In order to prevent back injuries when lifting heavy components, adults should only lift weights between max. 10 kg and 30 kg, depending on age and sex.

- Use lifting gear or seek assistance.
- Ensure that all chains, hooks, slings, etc. are tested and authorised, are sufficiently strong and that hooks are correctly positioned. Lifting eyes must not be unevenly loaded.

Welding operations

Welding operations on the engine or mounted plants are not permitted.

Never use the engine as an earth connection. – (This prevents the welding current passing through the engine and causing scorching or burning at bearings, sliding surfaces and tooth flanks, which can lead to pitting or other material damage)

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.

It is not necessary to remove the connector and connections when carrying out welding operation on MTU electronics if the master switch for power supply is switched from “ON” to “OFF” and the wire is disconnected from the negative and positive poles on the battery.

Hydraulic installation and removal

Only the hydraulic installation and removal equipment specified in the work schedule and in the assembly instructions must be used.

The max. permissible push-on pressure specified for the equipment must not be exceeded.

The H.P. lines for hydraulic installation and removal are tested with 3800 bar.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the system to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with piston retracted.
- For hydraulic removal, screw on the tool with piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is achieved.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed. As long as the system is under pressure, there is the risk that the component to be installed/removed may be suddenly released from the pressure connection.

Before use, the tools must be checked at regular intervals (crack test).

Working on electrical/electronic assemblies

Before starting all maintenance or repair work, or before the necessary switching off of electronic components for this purpose, approval must be obtained from the manager responsible.

Before carrying out work on assemblies, the power supply must be switched off at the relevant areas and secured against unauthorised switching on. As soon as a certain measure requires power supply, notification to this effect is provided in the documentation.

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.

Do not secure wiring to fluid-carrying lines.

On completion of the maintenance and repair work, any cables which have become loose must be correctly connected and secured.

Always tighten connectors with connector pliers.

After all repair work, a function check of the unit or system must be carried out by means of suitable tests. A separate check of the repaired component without connection to the system is insufficient.

If wires are installed beside mechanical components and there is a risk of chafing, use cable clamps to properly support the wires.

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.

The spare parts must be correctly stored before replacement, i.e. in particular be protected against dampness. Defective electronic components and assemblies must be properly packaged for transport to the repair location, i.e. in particular protected against dampness, secured against jolts and if necessary wrapped in antistatic foil.

Operation of electrical equipment

When operating electrical equipment, certain components of this equipment are live.

Noncompliance with the warning instructions given for this equipment may result in serious injury or damage to property.

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 cloths soaked with fluids and lubricants lying around on the engine. Do not store combustible fluids near the engine.

Do not weld pipes and components carrying oil or fuel. Before welding, clean with a nonflammable fluid.

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 suitable fire-fighting equipment (fire extinguishers) at hand and familiarise yourself with their use.

Noise

Noise can lead to an increased risk of accident if acoustic signals, warning shouts or noises indicating danger are drowned.

At all workplaces with a sound pressure level over 85 dB(A), always wear ear protectors (protective wadding, plugs or capsules).

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.

Only fuels of the specified quality required to achieve emission limits must be used.

In Germany, the VAwS (=regulations governing the use of materials that may affect water quality) is applicable, which means work must only be carried out by authorised specialist companies (MTU is such a company).

Auxiliary materials

Use only fluids and lubricants that have been tested and approved by MTU.

Fluids and lubricants must be kept in suitable, properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions applicable to the product. Take care when handling hot, chilled or caustic materials. When using inflammable materials, avoid all sparks and do not smoke.

⇒ **Lead**

When working with lead or lead-containing pastes, avoid direct contact to the skin and do not inhale lead vapours.

Adopt suitable measures to avoid the formation of lead dust!

Switch on extraction system!

After coming into contact with lead or lead-containing materials, wash hands!

⇒ **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. Make sure that adjacent work areas are not affected.

It is absolutely essential to wear masks providing protection against paint and solvent fumes.

Observe all fire-prevention regulations!

No smoking!

No naked flame!

⇒ **Liquid oxygen**

Liquid oxygen is highly inflammable.

Liquid oxygen should only be stored in small quantities and in regulation containers (without fixed seals)! 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 combustible substances (e.g. oils and greases) within 5 m of the working area!

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 covers.

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 air which has been compressed at excess pressure and is stored in tanks from which it can then be extracted.

The prevailing pressure can be read off at the pressure indicators (pressure gauges) which are to be fitted on the pressure vessels and the compressed air lines.

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 injury to 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”!
- Do not blow dirty clothing with compressed air when being worn on the body.
- 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!

Wash hands after contact with used oil.

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.

Warning notices

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:

! DANGER !
For an imminent danger. **Consequences: Death or serious injuries**

! WARNING !
For a potentially hazardous situation. **Consequences: Death or serious injuries**

! CAUTION !
For a hazardous situation. **Consequences: Slight injuries or damage to property**

In such cases, special care is required.
Before operating or repairing the product, read and familiarise yourself with all warning instructions!
Forward all safety instructions also to the operating, maintenance, repair and transportation personnel.

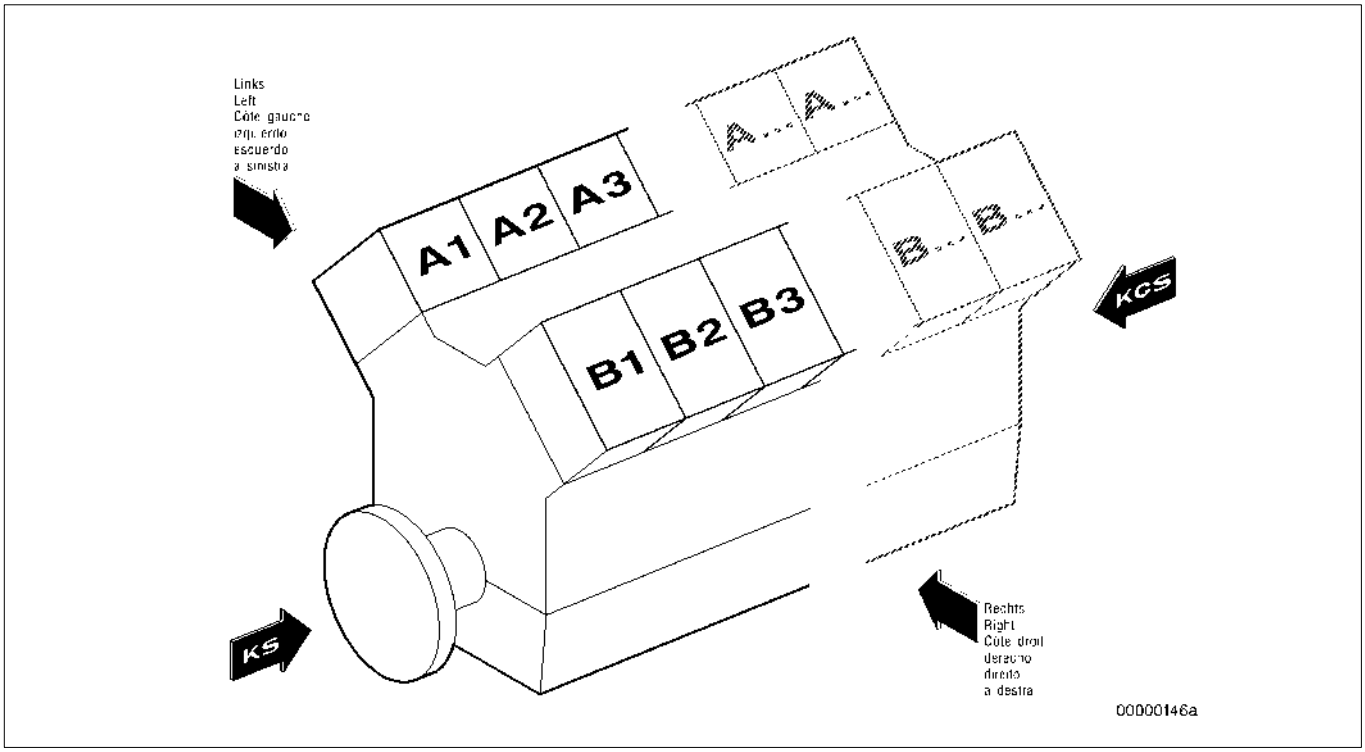
A003 Engine side and cylinder designations

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.

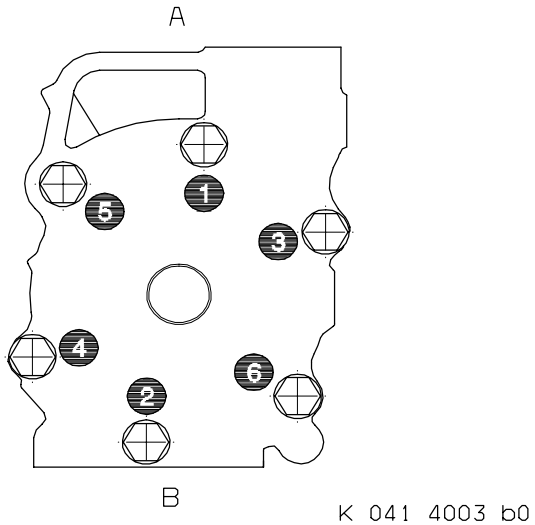


Designations and Abbreviations

- Driving end = KS
- Free end = KGS
- Left side
- Right side
- Top end
- Bottom end
- Exhaust turbocharger = ATL

A004 Tightening specifications for screws and nuts

Designation	Tightening Specification	Lubricant	See
Crankcase			
Stud for main bearing cap in crankcase (against bottom of blind hole) Stud Nominal length: 347.5 mm to 348.5 mm – Elongation, stud, crankshaft bearing cap – Remaining screw elongation Newly installed studs must be pre-stretched prior to initial tightening	80 Nm Δl 1.15 mm + 0.05 mm Δl 0.9 mm + 0.05 mm	Engine oil	C 031.05 C 011.05 C 031.05
Side socket-head screws – Starting driving end: Left side, all screws – Starting driving end: Right side, all screws – Final tightening torque – Final tightening torque	 80 Nm 80 Nm 280 Nm + 20 Nm 280 Nm + 20 Nm	Engine oil	C 031.05
Running gear			
– Screws for counterweight – Nominal length: 129.6 to 130 mm – Maximum length: 132 mm Pretightening torque: Additional angle of rotation: Checking torque:*	 320 Nm + 30 Nm 120° + 10° 800 Nm + 50 Nm	Engine oil	C 031.05
Hex screws on vibration damper flange	500 Nm + 50 Nm	Engine oil	C 035.05
Hex screws on side plate of vibration damper	400 Nm	Engine oil only on Thread	C 035.05
Conrod screws Nominal length: 102.6 mm to 103.2 mm Maximum elongation 104.5 mm Initial tightening Sequence: – Pretightening torque: Additional angle of rotation: Checking torque:* – Notch mark:	 1 short arm 2 long arm 240 Nm + 20 Nm 90° + 10° 450 Nm + 20 Nm	Engine oil	C 037.05
Hex screws on seal carrier, free end	74 Nm + 7 Nm	Engine oil	C 035.05
Hex screws on graduated disc	21 Nm + 2 Nm	Engine oil	C 032.20

Cylinder head			
Hex screws for cylinder head Nominal length: 283.3 mm Nominal length: 333.3 mm engine lifting eye Tightening sequence of screws: 1, 2, 3, 4 ,5 ,6 – Fit: Pretightening torque: Additional angle of rotation: Checking torque:*****	 approx. 25 Nm 180 Nm + 10 Nm 180°+ 10° 450 Nm	Engine oil	C 042.05
Cylinder head tightening diagram  			
Valve gear			
Hex screw for camshaft gear on camshaft	100 Nm + 10 Nm	Engine oil	C 052.05
Locknut (a/f 19) on adjusting screw for valve bridge	35 Nm + 5 Nm	Engine oil	C 055.05
Locknut on adjusting screw for rocker arm outlet	90 Nm + 9 Nm	Engine oil	C 055.05
Locknut on adjusting screw for rocker arm inlet	90 Nm + 9 Nm	Engine oil	C 055.05
Hex screws for rocker shaft support Max. shaft length: 180.8 mm – Tightening torque:	 250 Nm + 25 Nm	 Engine oil	 C 055.05
Hex screw: Cylinder head cover	42 Nm	Engine oil	C 055.10

Designation	Tightening Specification	Lubricant	See
Fuel System - High-Pressure			
Nuts for H.P. line on injector and on flow limiting valve	120 Nm + 12 Nm	Engine oil	C 077.05
Nuts for H.P. line on H.P. pump and on H.P. accumulator	100 Nm + 10 Nm	Engine oil	C 077.05
H.P. accumulator on crankcase	57 Nm + 6 Nm	Engine oil	C 077.05
H.P. sensor for H.P. pump	30 Nm to 40 Nm	Engine oil	C 073.05
Thrust screw for H.P. accumulator seal	550 Nm + 55 Nm	Engine oil	C 077.05
Socket-head screws for pressure relief valve in thrust screw	15 Nm + 2 Nm	Engine oil	C 077.05
Hex screw for hold-down clamp at injector	100 Nm + 10 Nm	Engine oil	C 075.05
Temperature transmitter on H.P. pump	30 Nm to 40 Nm	Engine oil	C 075.05
Exhaust System			
Hex screws, exhaust distribution housing/exhaust line M12 X 60	70 Nm + 7 Nm	Ultra-Therm MTU or Molykote P37	C 143.05
Lube oil system			
Nut for cooler insert	100 Nm	Engine oil	C 183.15
Lube oil pressure transmitter	24 to 27 Nm	Engine oil	C 183.05
Lube oil temperature transmitter	24 to 27 Nm	Engine oil	C 183.05
Crankcase pressure transmitter	24 to 27 Nm	Engine oil	C 183.05
Oil spray nozzle	21 Nm + 2 Nm	Engine oil	C 184.10
Generator			
Nut for belt pulley	360 to 400 Nm	Engine oil	C 213.05
Mounting/support			
Hex screws: Engine carrier on foundation	74 Nm + 7 Nm	Engine oil	C 231.10
Hex screw: Damping mount on engine carrier	190 Nm + 19 Nm	Engine oil	C 231.10
Hex screws: Engine carrier on crankcase	500 Nm + 50 Nm	Engine oil	C 231.10
Hex screws: Engine support on flywheel housing	180 Nm + 18 Nm	Engine oil	C 231.10
Hex screws for engine support on equipment carrier	74 Nm + 7 Nm	Engine oil	C 231.10

*** The screw must not turn at testing torque!**

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 tot = 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 %.

Thread	Manual-tightened		Machine-tightened	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M 6	9	12	8	11
M 8	21	31	20	28
M 8 x 1	23	32	21	30
M 10	42	60	40	57
M 10 x 1.25	45	63	42	60
M 12	74	100	70	92
M 12 x 1.25	80	110	75	105
M 12 x 1.5	76	105	72	100
M 14	115	160	110	150
M14 x 1.5	125	180	120	170
M 16	180	250	170	235
M16 x 1.5	190	270	180	255
M 18	250	350	240	330
M18 x 1.5	280	400	270	380
M 20	350	500	330	475
M 20 x 1.5	390	550	350	520
M 22	480	680	450	650
M 22 x 1.5	520	730	490	700
M 24	600	850	570	810
M 24 x 1.5	680	950	640	900
M 24 x 2	660	900	620	850
M 27	900	1250	850	1175
M 27 x 2	960	1350	900	1275
M 30	1200	1700	1100	1600
M 30 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).

When tightening, secure screw shafts against torsional stress.

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.

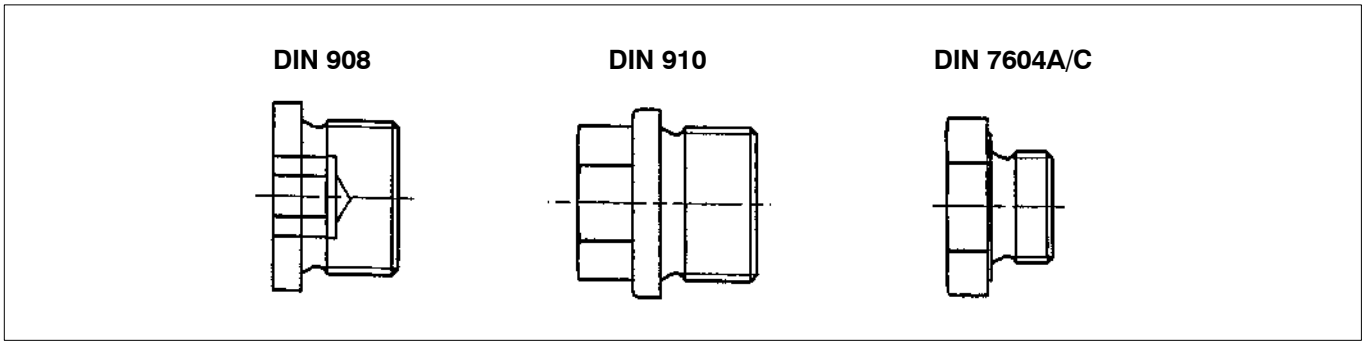
The values in the tables are for manual tightening with torque wrench.

Thread	Without torsion protection M_A (Nm)	With torsion protection* M_A (Nm)
M 6	9	12
M 8	21	28
M 8 x 1	24	30
M 10	42	55
M 10 x 1.25	46	60
M 12	75	93
M 12 x 1.5	78	99
M 14	120	150
M 14 x 1.5	135	160
M 16	180	225
M 16 x 1.5	200	245
M 18	250	315
M 18 x1.5	300	360
M 20	350	450
M 20 x 1.5	430	495
M 22	500	620
M 22 x 1.5	560	675
M 24	640	790
M 24 x 2	700	850
M 27	900	1170
M 27 x 2	1000	1230
M 30	1250	1575

Note: When tightening, secure screw shafts against torsional stress.

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).



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.

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 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)
M 10 x 1	15	15
M 12 x 1.5	35	25
M 14 x 1.5	35	25
M 16 x 1.5	40	30
M 18 x1.5	50	35
M 20 x 1.5	55	45
M 22 x 1.5	60	50
M 24x1.5	70	60
M 26 x 1.5	80	70
M 27 x 2	80	70
M 30 x 1.5	100	90
M 30 x 2	95	85
M 33 x 2	120	110
M 36 x 1.5	130	115
M 38 x 1.5	140	120
M 42 x 1.5	150	130
M 45 x 1.5	160	140
M 48 x 1.5	170	145
M 52 x 1.5	180	150
M 56 x 2	190	160
M 64 x 2	205	175

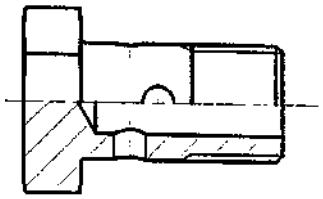
Tightening torques for plugs as per DIN 7604C (with long screwed plug)

Thread	inserted in	
	steel /gray cast iron M_A (Nm)	Al-alloy M_A (Nm)
M 8 x 1	10	10
M 22 x 1.5	80	65
M 26 x 1.5	105	90
M 30 x 1.5	130	130
M 38 x 1.5	140	120
M 45 x 1.5	160	140

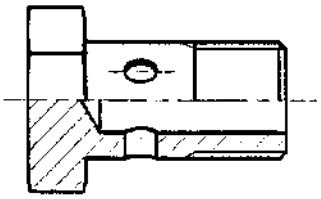
Tightening torques for banjo screws as per MTN 5183–2 standard

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.

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 for banjo screws made of steel

Thread	Installed in steel/grey cast iron/Al alloy M_A (Nm)
M 8 x 1	10
M 10 x 1	15
M 12 x 1.5	20
M 14 x 1.5	25
M 16 x 1.5	25
M 18 x1.5	30
M 22 x 1.5	60
M 26 x 1.5	90
M 30 x 1.5	130
M 38 x 1.5	140
M 45 x 1.5	160

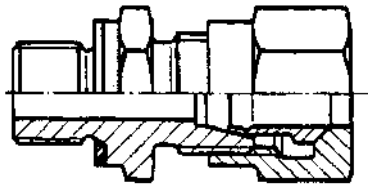
Tightening torques for banjo screws made of copper-alluminium alloys

Thread	Installed in steel/grey cast iron/Al alloy M_A (Nm)
M 10 x 1	15
M 16 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.

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.

Thread	Installed in steel/grey cast iron M_A (Nm)
M 10 x 1	10
M 12 x 1.5	20
M 14 x 1.5	40
M 16 x 1.5	50
M 18 x1.5	60
M 22 x 1.5	70
M 26 x 1.5	100
M 32 x 2	160
M 42 x 2	260
M 48 x 2	320

A005 Settings

Firing order

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

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

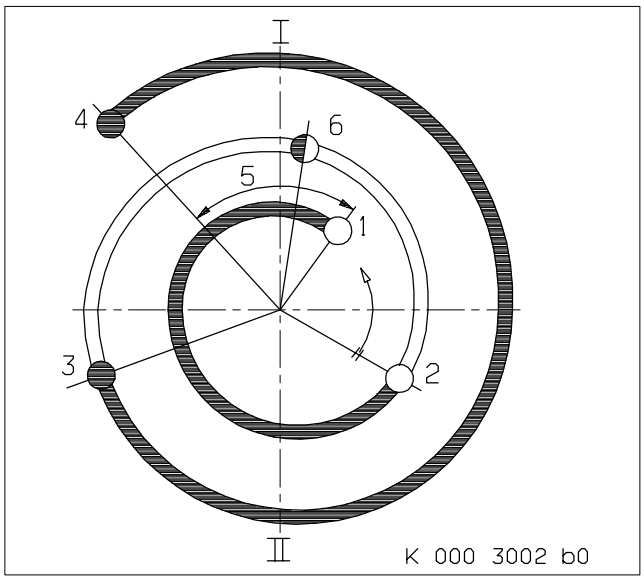
Direction of rotation as viewed from driving end

Crankshaft	counterclockwise
Camshaft	clockwise
H.P. fuel pump	counterclockwise
Oil pump	counterclockwise
Engine coolant pump	counterclockwise
Charge air coolant pump	counterclockwise
Air-conditioner compressor	counterclockwise

Valve clearance, engine cold (20 °C)

Inlet	0.20 mm
Exhaust	0.50 mm

Timing with valve clearance adjusted



Valve clearance adjusted	Crank angle°
1 Inlet valve opens	42.6 before TDC
2 Inlet valve closes	66.6 after BDC
3 Exhaust valve opens	57.6 before BDC
4 Exhaust valve closes	30.4° after TDC
5 Overlap	73
6 Start of delivery	Map based

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

Camshaft and valve lift for camshaft adjustment

	Inlet	Exhaust
Cam lift at TDC	1.43 mm	1.43 mm
Valve lift at TDC (zero valve clearance)	2.00 mm	2.00 mm

A007 Conversion tables

Length

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

Surface

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

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

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.)

Ground

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

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

Density

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

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

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

Pressure

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

Mass moment, 2nd degree

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

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

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

	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)

A008 Publication overview

The present documentation is supplemented by the following MTU publications:

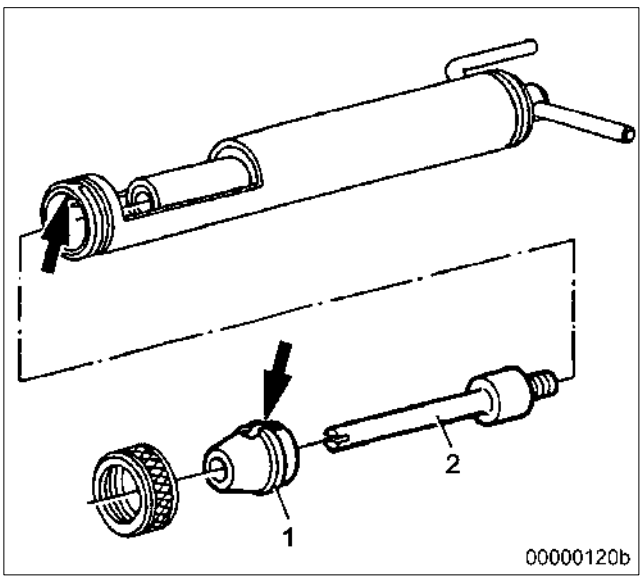
- Spare Parts Catalogue 12V 4000 G M031 390
- Spare Parts Catalogue 16V 4000 G M031 385
- Operating Instructions 12V 4000 G M015 403
- Operating Instructions 16V 4000 G M015 403
- Description 12V 4000 G M013 012
- Description 16V 4000 G M013 012
- Maintenance Schedule 12V 4000 G M050 xxx
- Maintenance Schedule 16V 4000 G M050 xxx
- Tools Catalogue BR 4000 M004 029
- Fluids and Lubricants Specification A001 061
- Tolerance and Wear Limits List M070 040
- Surface Crack-Testing Procedure, Instructions for Assembly and Auxiliary Materials A060643

Further data, in particular operational data, can be obtained from the MTU Engine Acceptance Test Record for the individual engine concerned.

A009 Repair of threaded bores through threaded inserts (Heli-Coil)

Data

Thread	Diameter of blind hole (max./min.)	Diameter of twist drill
M 6	6.31 6.04	6.1–6.2–6.25
M 8	8.35 8.04	8.1–8.2–8.25–8.3
M 8 x 1	8.32 8.04	8.1–8.2–8.25–8.3
M 10	10.40 10.05	10.25
M 12	12.50 12.05	12.25–12.5
M 12 x 1.5	12.43 12.05	12.25
M 14	14.53 14.06	14.25–14.5
M 14 x 1.5	14.43 14.05	14.25
M 15 x 2	15.30 15.20	15.25
M 16	16.53 16.06	16.25–16.5
M 16 x 1.5	16.43 16.05	16.25
M 24x1.5	24.43 24.05	24.25
M 26 x 1.5	26.43 26.05	26.25
M 30 x 1.5	30.43 30.05	30.25



Repairing

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

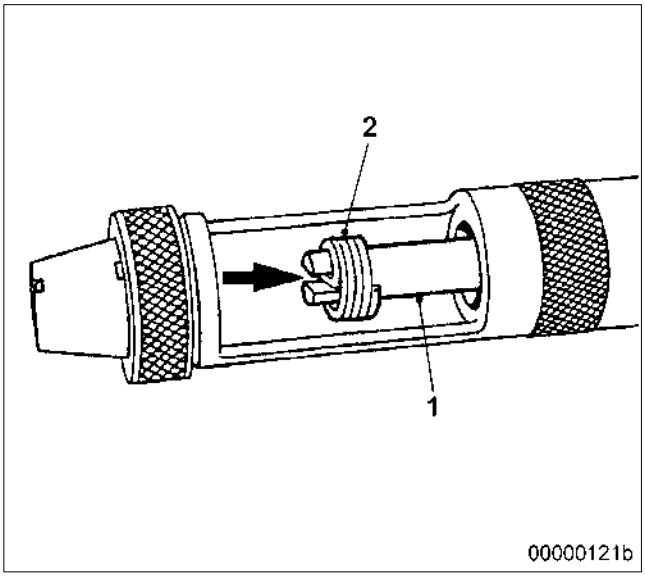
Bore core hole with suitable twist drill – see table.

Cut thread with special tapped bore.

Note: Do not countersink bore!

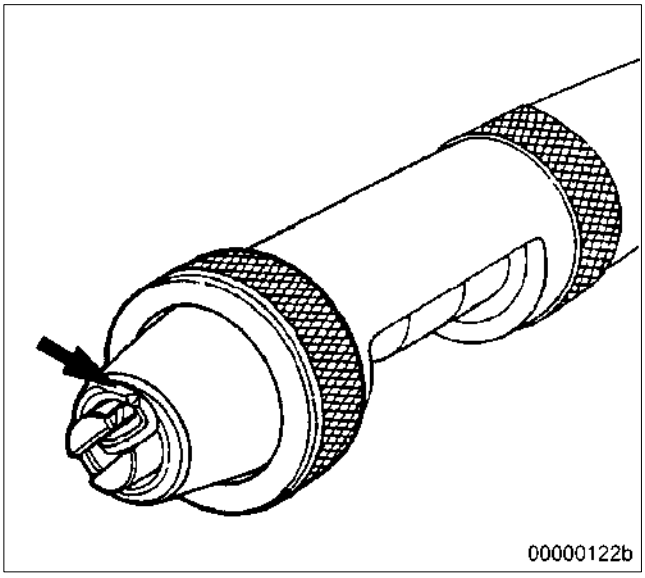
Mount spindle (2) and snout (1) corresponding with thread.

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

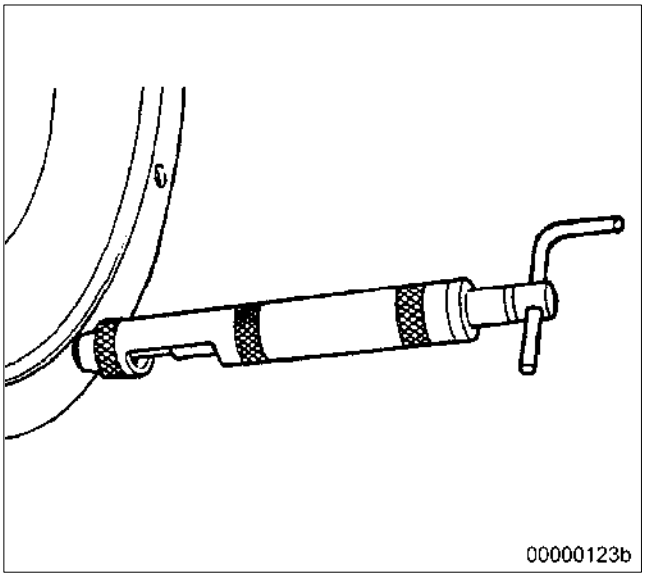


Insert thread insert (2) into spindle (1) in installation tool.

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 M 14.

In event of threaded inserts over M 14, move driver journal up and down with pointed pliers and remove.

A080 Abbreviations

°C	Grad Celsius
ATL	Abgasturbolader (Exhaust turbocharger)
ECS	Engine Control System, MTU-Motormanagementsystem
ECU	Engine Control Unit, MTU-Motorregler
ISO	International Organization for Standardisation
KGS	Freie Seite (Kraftgegenseite) (Free end)
KS	Antriebsseite (Kraftseite) (Driving end)
KW	Kurbelwelle (Crankshaft)
LLK	Ladeluftkühler (Intercooler)
M_A	Tightening torques
MDEC	MTU Diesel Engine Control
MTU	Motoren- und Turbinen-Union
NW	Nockenwelle (Camshaft)
UT	Unterer Totpunkt (Bottom dead centre)
OT	Obere Totpunkt (Top dead centre)

A090 Keyword Index

A

C

E

F

G

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I

L

M

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P

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T

V

W

B001 Engine condition check before 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
Perform operations preparatory to starting the engine	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 for water emerging from intercooler drain lines and check for obstructions	Operating Instructions
Check exhaust gas colour	Operating Instructions
Operate engine with adjustable zero-power speed	–
Connect fuel line connections for leaks	–
Remove cylinder head cover	C 055.10
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 coolant sample	Operating Instructions
Analyze coolant sample	MTU Test Kit
Check function of monitoring system and ECU.	Operating Instructions
Shut down engine	Operating Instructions
Only if installed: Reduce the coolant level in the expansion tank and check the level switch response (coolant level monitoring)	Operating Instructions
Drain coolant	Operating Instructions
Drain charge air coolant	Operating Instructions
Fill system with cleaning solution	Special Publication
Start engine	Operating Instructions
Flush cooling system	–
Flush charge air cooling system	–
Shut down engine	Operating Instructions
Check engine (endoscopic examination)	Operating Instructions

B002 W5 maintenance operations

Note: The following table is based on maintenance schedule MO...../.
When carrying out maintenance work, always use the valid maintenance schedule corresponding to the affected engine.

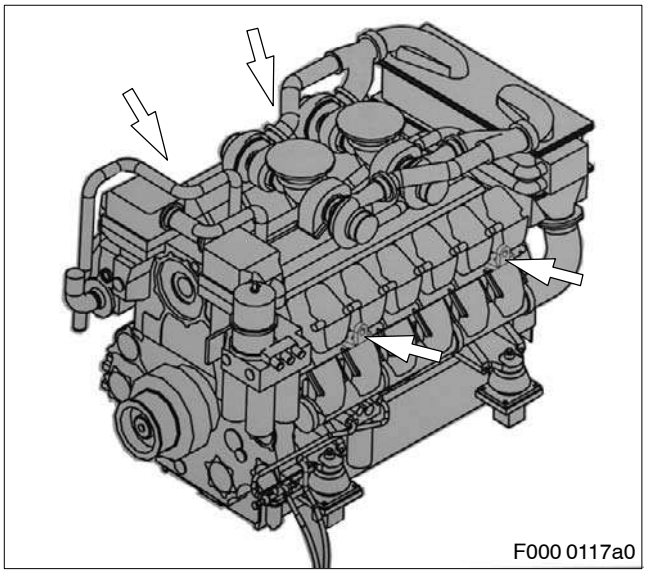
Operations to be performed	See
Disable engine start	Operating Instructions
Wash plant, without using chemical cleaning agents	Operating Instructions
Drain engine coolant and flush coolant systems	Operating Instructions
Drain engine oil Replace engine oil filter	Operating Instructions Operating Instructions
Replace fuel duplex filter easy-change filter Clean fuel prefilter or replace filter elements	Operating Instructions Operating Instructions
Clean air filter, replace if necessary. Check function of contamination indicator and reset if necessary	Operating Instructions Operating Instructions
Overhaul engine coolant preheating system	–
Replace exhaust turbocharger	C 101.01
Intake air system, remove lines, clean, replace gaskets	–
Drain exhaust system, check security of securing screws	Operating Instructions
Remove and replace intercooler (low-temperature circuit)	C 111.05
Engine coolant cooler (high-temperature circuit), clean and check for leaks	–
Clean charge air coolant cooler (low-temperature circuit), check for leaks	–
Check coolant thermostat (high-temperature circuit), replace if necessary	C 206.05.08
Check coolant thermostat (low-temperature circuit), replace if necessary	C 206.05.08
Replace engine coolant pump (high-temperature circuit)	C 202.05.06
Replace charge air coolant pump	C 203.05.08
Check condition of engine control system and wiring and check for security	–
Check starter, wiring and connections for corrosion and loose connections, check wiring	–
Replace H.P. fuel pump and H.P. sensor	C 073.05.05
Remove and check valve gear, rocker arms and valve bridges Check rocker arms, rollers, pushrod seat and rocker arm bearings for wear	C 055.05.05
Remove and replace cylinder heads	C 041.05.05
Valve gear, prelubricate	–
Remove and replace vibration damper	C 035.05.05
Clean centrifugal oil filter Check bearing, replace if necessary Replace sealing sleeve	Operating Instructions C 183.10.05 Operating Instructions
Remove oil heat exchanger, clean and check for leaks, replace O-rings	C 183.15.05
Crankcase breather, replace oil separator	C 018.10
Check starter	C 172.05.08
Engine mount, check security Check condition of resilient mounts Check buffer clearance	Operating Instructions Operating Instructions Operating Instructions
ECU, wiring, check security and condition	Operating Instructions

Operations to be performed	See
Check function of monitoring units	Operating Instructions
Check battery charge state, electrolyte specific gravity and level	Operating Instructions
Reinstall/mount parts that were removed after they have been assembled according to the engine assembly sequence	B 005
Fill oil system with engine oil Fill engine coolant, vent coolant system Carry out before-operation services	Operating Instructions Operating Instructions Operating Instructions
Switch on monitoring system	Operating Instructions
Carry out lamp test	–
Open fuel supply	Operating Instructions
Preheat engine	Operating Instructions
Start engine Perform checks with engine running as for initial operation	Operating Instructions Operating Instructions
Engine test run, check speed, pressures, and temperatures Check running noises	Operating Instructions
Check engine and external pipework for leaks	Operating Instructions
Check turbocharger and exhaust connections for leaks; check oil supply and return lines for leaks	Operating Instructions
Check exhaust gas colour	Operating Instructions
Check intake air system for leaks	Operating Instructions
Shut down engine	Operating Instructions
Check engine oil level	Operating Instructions
Check engine coolant level	Operating Instructions
Charge air coolant, check level	Operating Instructions

B003 Engine removal

Operations to be performed	See
Shut off fuel supply	Operating Instructions
Drain oil with engine warm if possible	Operating Instructions
Examine oil sludge for metallic residues	Operating Instructions
Drain engine coolant when temperature of coolant is below 60 °C	Operating Instructions
Drain charge air coolant	Operating Instructions
Wash plant, without using chemical cleaning agents	–
Disconnect all connections	–
Install non-fibrous plugs and blanking plates to seal all open connections	–
Release engine securing screws	–
Remove engine and place on stands	–
Using a lifting device, attach engine only on lifting eyes provided as shown in installation drawing, taking centre of gravity and transportation specifications into consideration.	–

Illustration also applies to 16V



Engine weight:
(with standard accessories installed without coupling)

- 12V 4000: approx. 5650 kg
- 16V 4000: approx. 6950 kg

Note: Raise engine only by means of the lifting eyes shown (arrows).

B004 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
Place engine in assembly dolly	–
Mark and disconnect electric cables	–
Remove crankcase vent line	C 018.10
Remove crankcase breather	C 018.10
Remove oil supply lines for turbochargers	C 185.10
Remove oil return lines for turbochargers	C 185.25
Remove intake air system from turbocharger to intercooler	C 125.05
Remove Y-pipe from exhaust outlet housing	C 141.10
Remove exhaust turbocharger	C 101.01
Remove coolant vent lines	C 202.65
Remove charge air coolant lines (low temperature)	C 203.25
Remove intercooler	C 111.05
Remove coolant lines (high temperature)	C 202.10
Remove exhaust manifolds	C 141.10
Remove coolant lines (high temperature)	C 202.10/C 202.20
Remove fan drive	C 221.05
Remove engine carrier, free end (gear case)	C 231.05
Remove vibration damper	C 035.05
Remove centrifugal filter	C 183.10
Remove oil heat exchanger	C 183.15
Remove coolant distribution housing and thermostat	C 206.05
Remove oil filter	C 183.05
Remove V-belt	C 213.05
Remove generator	C 213.05
Disconnect air supply to cylinders	C 124.05
Remove fuel filter	C 083.05
Remove fuel lines (low pressure)	C 083.05
Remove fuel pump (low pressure)	C 081.10
Remove leak-off fuel lines	C 086.05
Remove injection lines with H.P. accumulator	C 077.05
Remove H.P. pump	C 073.05
Remove wiring harness	C 507.10
Remove Engine Control Unit ECU	C 508.10
Remove cylinder head covers	C 055.10
Remove fuel injectors	C 075.05
Remove coupling	Special Publication

Operations to be performed	See
Remove drive flange, seal carrier and graduated disc	C 032.10
Remove flywheel housing	C 016.30
Remove drive flange (free end) from crankshaft	C 035.10
Remove graduated disc	C 032.10
Remove seal carrier (free end)	C 035.05
Remove charge air coolant pump (low temperature)	C 203.05
Remove coolant pump (high-temperature)	C 202.05
Remove starter	C 172.05
Remove valve gear	C 055.05
Remove pushrods	C 054.10
Remove cylinder heads	C 041.05
Remove auxiliary PTO	C 259.05
Remove oil dipstick and oil filler neck	C 011.05
Remove oil pan	C 014.05
Remove suction basket and oil drain valve from the oil pan	C 014.05
Remove lube oil pump and valves	C 181.05
Remove main oil gallery	C 011.05
Remove oil supply and oil spray nozzles	C 184.10
Remove crankcase from assembly dolly	C 011.05.11

B005 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
Install crankcase in assembly dolly	C 011.05.05
Install oil spray nozzle	C 184.10
Install flywheel housing	C 016.05
Install valve drive	C 055.05
Install flange on oil pan	C 014.05
Install suction basket in oil pan	C 014.05
Install oil pan	C 014.05
Remove crankcase from assembly dolly	C 011.05
Install oil dipstick and oil filler neck	C 011.05
Install cylinder heads	C 041.05
Install pushrods	C 054.10
Install valve gear	C 055.05
Install main oil gallery	C 011.05
Install starter	C 172.05
Install H.P. pump	C 073.05
Install fuel injector	C 075.05
Install fuel pump (low pressure)	C 081.05
Install injection lines with H.P. accumulator	C 077.05
Install wiring harness	C 507.10
Install Engine Control Unit ECU	C 508.10
Install fuel filter	C 083.05
Install intercooler	C 111.05
Install charge air manifolds	C 124.05
Install oil heat exchanger	C 183.15
Install centrifugal filter	C 183.10
Install oil filter	C 183.05
Install coolant pump (high-temperature)	C 202.10
Install coolant distribution housing and thermostat	C 206.05
Install coolant lines (high-temperature)	C 202.10
Install exhaust manifold	C 141.10
Install turbocharger	C 101.01
Install oil supply lines for turbochargers	C 185.10
Install oil return lines for turbochargers	C 185.25
Install Y-pipe at exhaust outlet housing	C 141.10
Install crankcase breather	C 018.25
Install crankcase vent line	C 018.10
Install coolant lines (high-temperature)	C 202.10/C 202.20
Install charge air coolant pump (low-temperature)	C 203.05

Operations to be performed	See
Install charge air coolant lines (low-temperature)	C 203.25
Install generator	C 213.05
Install V-belt	C 213.05
Install seal carrier (free end)	C 035.05
Install drive flange (free end) on crankshaft	C 035.05
Install vibration damper	C 035.05
Install engine mount, free end (gear case)	C 231.05
Install graduated disc, seal carrier (driving end) with drive flange	C 032.10
Install coupling	see Special Publication

B006 Engine run-in

After installing the replacement component “engine short block”, an engine run-in must be carried out in accordance with the respective run-in program.

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 brake by means of a resilient coupling.

Settings

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

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

Fuel temperature depends on the volume of the service tank insofar as there is no fuel-cooling device on the test stand.

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

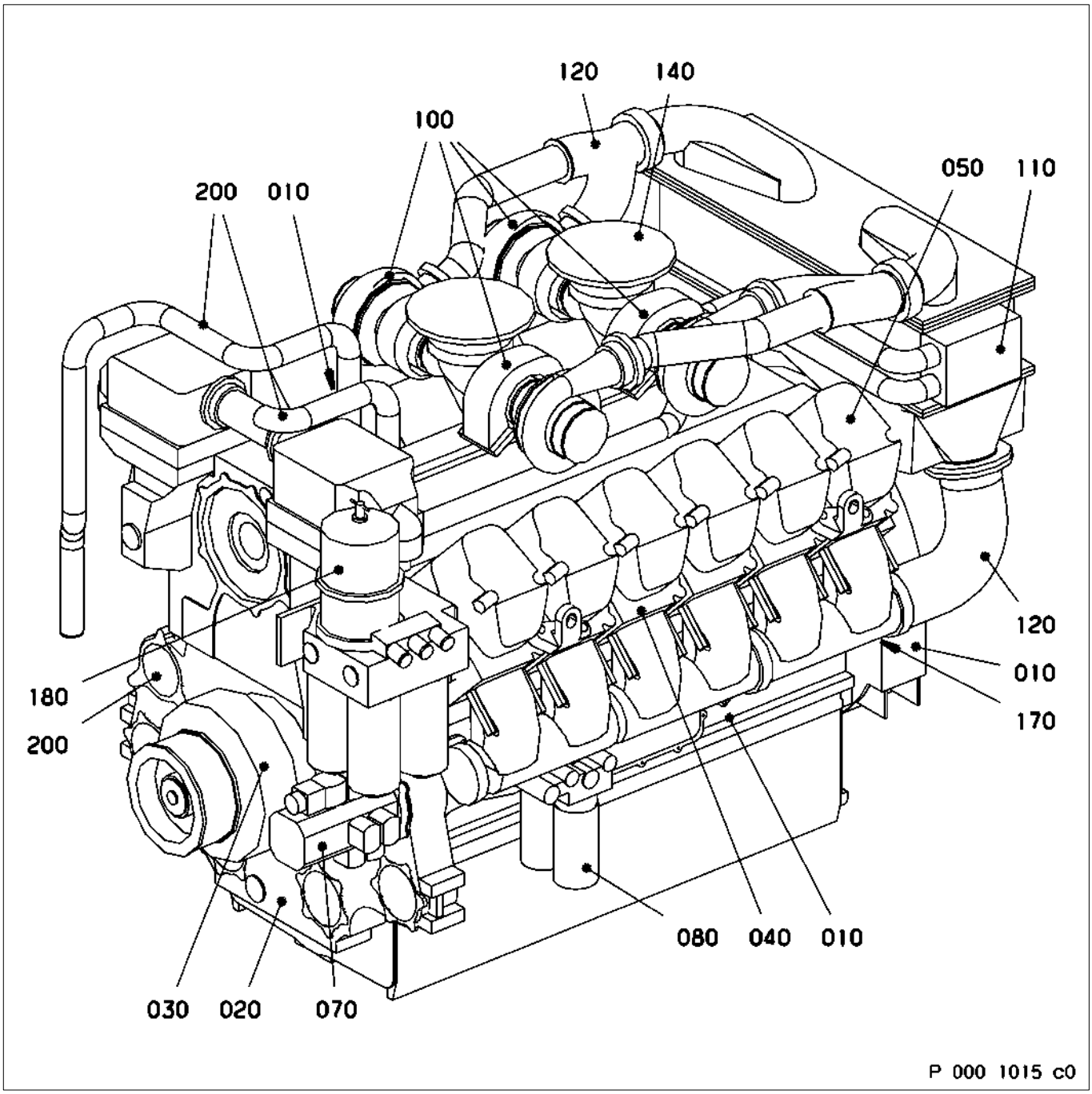
Operations to be performed	See
Install engine on test stand	–
Connect engine to brake or alternator	–
Connect air intake, exhaust, engine coolant and fuel lines	–
Connect measuring sensor and measuring lines to the corresponding measuring points to record the measured values for fuel, lube oil, engine coolant, supercharging and exhaust which were noted in the MTU Engine Acceptance Test Record.	MTU Engine Acceptance Test Record
Connect dialogue unit to ECU	–
Fill expansion tank with coolant and 2% corrosion inhibitor oil up to max. mark	Operating Instructions
Vent coolant lines until bubble-free coolant emerges	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
Prelubricate valve gear with oil	Operating Instructions
Check operation of emergency shutdown system	–
Preheat engine coolant	Operating Instructions
Prelubricate engine oil system (external pump)	–
Start engine via ECU	Operating Instructions
Shut down engine after approx. 1 min no-load operation and carry out following operations: – Check oil level, top up with oil if necessary. – Remove valve gear cover, check valve gear lubrication.	– Operating Instructions Operating Instructions
Start engine, check idling speed	–
Check engine running noises	Operating Instructions
Carry out engine warm-up procedure	Operating Instructions
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	B 006
Compare test data with those recorded in MTU Acceptance Test Record Check and make a note of fuel density	MTU Engine Acceptance Test Record
Check exhaust gas colour	–
Enter barometric reading and relative humidity in record	MTU Engine Acceptance Test Record

Operations to be performed	See
Check engine for abnormal noises and for leaks	–
Check function of monitoring units	–
After running in, run down engine and switch off	Operating Instructions
Oil filter – cut open one filter and check residues	Operating Instructions
Check oil level and prepare engine for oil-consumption measurement	–
Carry out acceptance test in accordance with MTU Engine Acceptance Test Record	B 006
Enter operational data in engine acceptance test record provided	MTU Engine Acceptance Test Record
Compare test data with those recorded in MTU Engine Acceptance Test Record	MTU Engine Acceptance Test Record
Carry out governor test	–
After completing acceptance test, run down engine and switch off	Operating Instructions
Carry out oil-consumption test	Operating Instructions
Start engine	–
Go through the governor curve (DBR) in accordance with the MTU Engine Acceptance Test Record	MTU Engine Acceptance Test Record
Set the specified service power rating as per MTU Engine Acceptance Test Record	MTU Engine Acceptance Test Record
Shut down engine and carry out six start attempts	–
Carry out engine preservation run	Operating Instructions
Shut down engine and disable engine start	–
Drain engine oil and coolant	Operating Instructions
Adopt suitable protective measures if engine is scheduled for marine transport	–
Disconnect exhaust, engine coolant and fuel lines Disconnect valve gear from MDEC	–
Remove measuring sensor and measuring lines from engine and seal measuring points	–
Remove engine from test stand	–
Prepare engine for paint spraying and spray with protective paint	–

B007 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.	–
Join connections for engine coolant, fuel, engine monitoring as appropriate	–
Fill engine coolant system	Operating Instructions
Fill charge air coolant system	Operating Instructions
Fill oil system with engine oil	Operating Instructions
Align engine	–
Prepare engine for operation	Operating Instructions
Preheat engine	Operating Instructions
Start engine	Operating Instructions
Perform checks while engine is running	Operating Instructions
Carry out test run	–
Measure intake air depression	Operating Instructions
Measure exhaust backpressure	Operating Instructions
Shut down engine	Operating Instructions
Perform after-shutdown services	Operating Instructions
If the plant is to be taken out of service for an extended period, carry out external preservation, disable engine start, seal air inlet and exhaust outlet. (Note: An engine preservation run was carried out after the test stand run.)	Operating Instructions

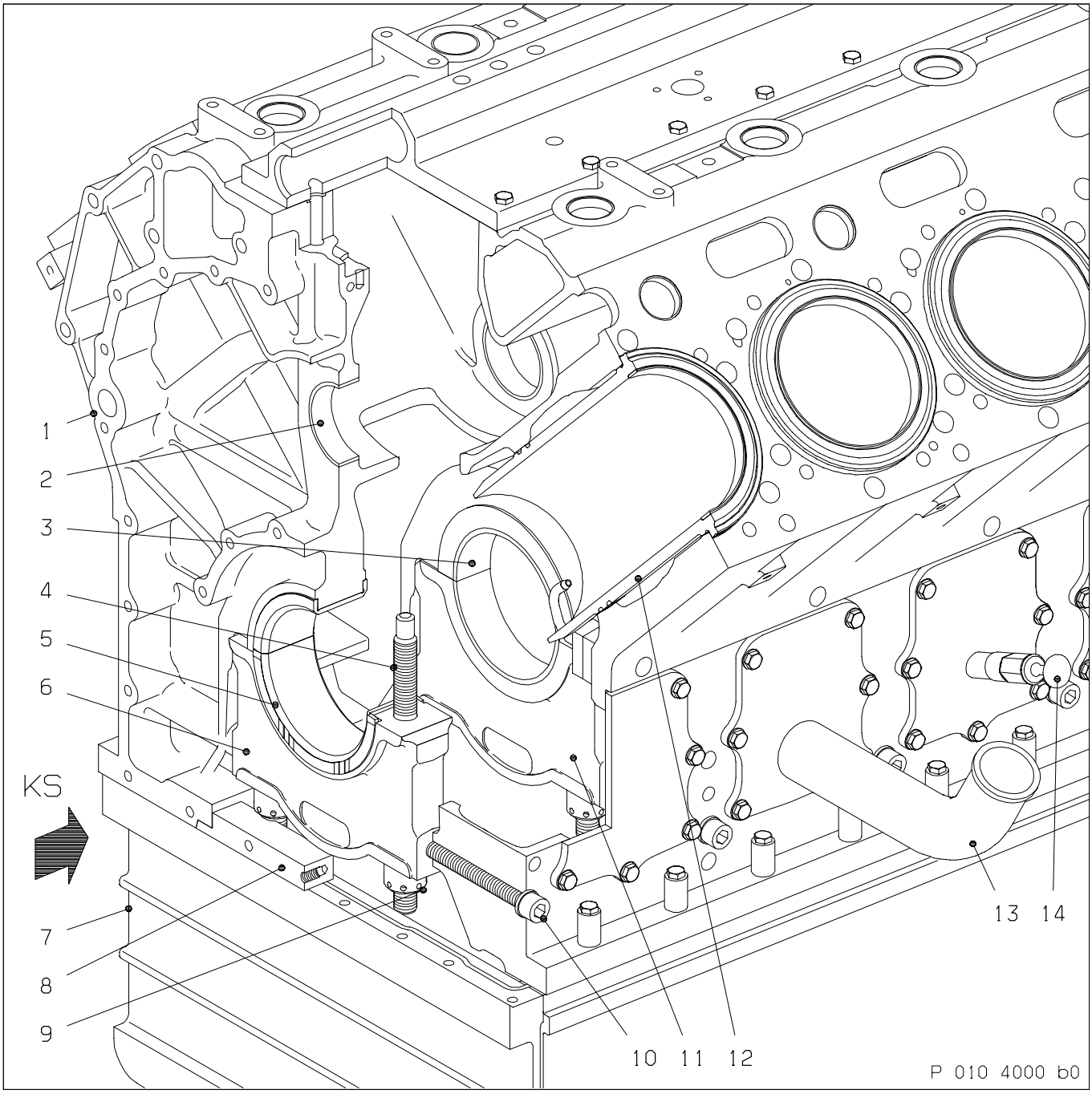
C000 Group Summary



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

*** not shown**

C010 Crankcase and attachments

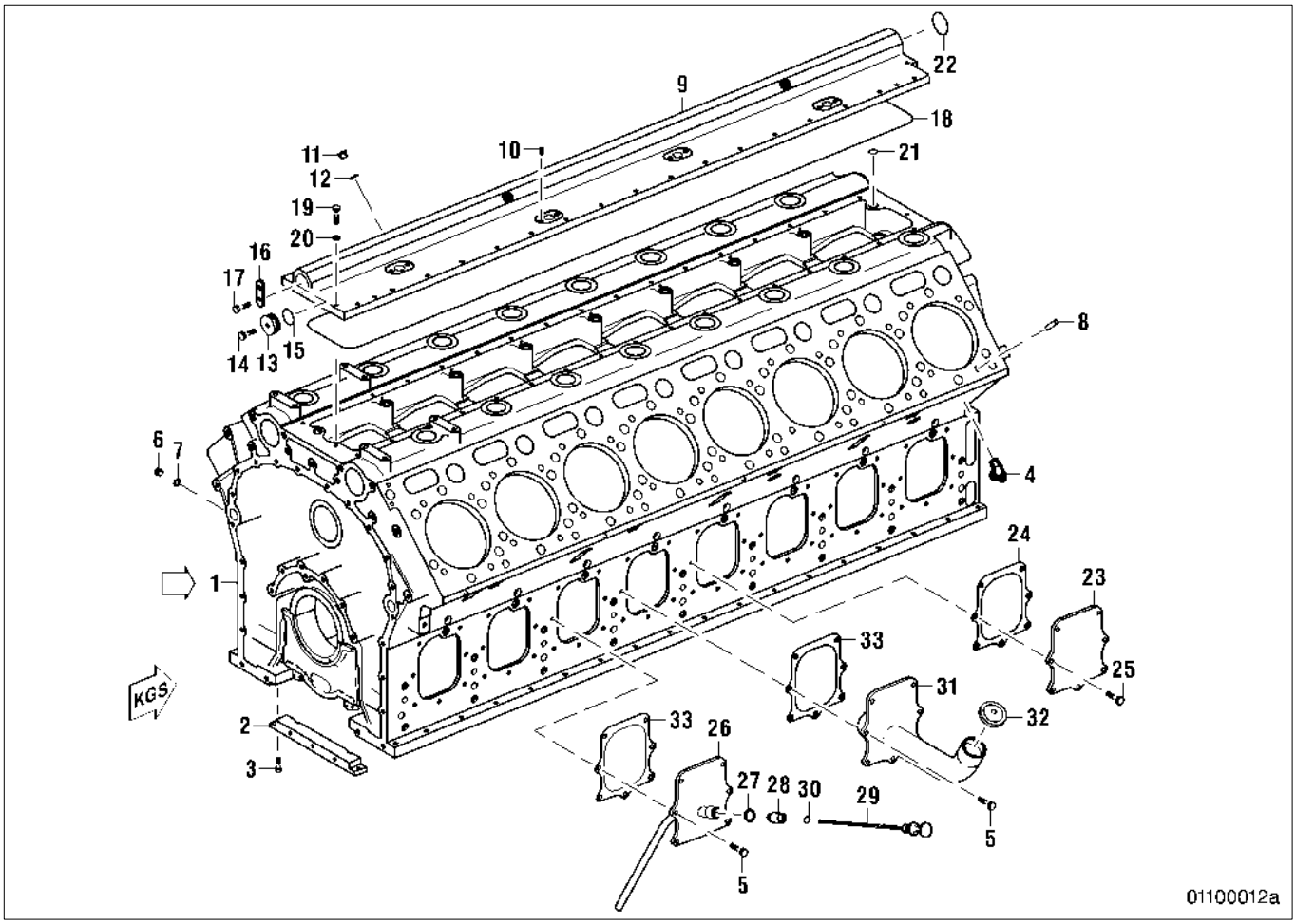


1 Crankcase
2 Camshaft bearing
3 Crankshaft bearing
4 Stud
5 Crankshaft alignment bearing
6 Crankshaft alignment bearing cover
7 Oil pan
8 Block
9 Nut for crankshaft bearing cap
10 Socket-head screws
11 Main bearing cap
12 Cylinder liner
13 Oil filler neck
14 Oil dipstick

C011.05 Crankcase

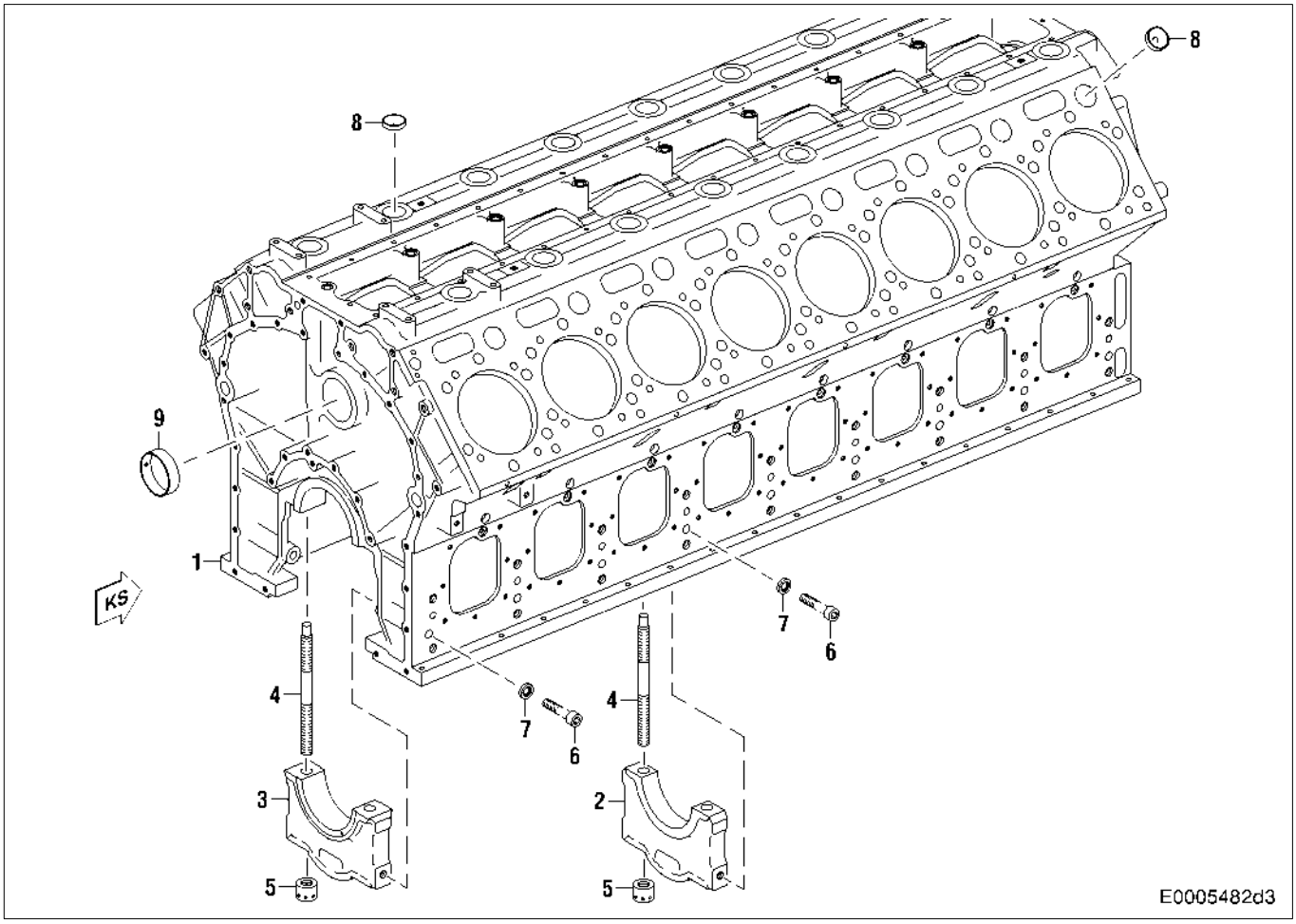
C011.05.01 Overview drawings, also applies to 12V

Cover (main oil gallery), guide tube, oil filler neck,



1 Crankcase
2 Block
3 Socket-head screw
4 Drain valve
5 Hex screw
6 Plug
7 Sealing ring
8 Dowel pin
9 Cover
10 Stud
11 Blanking plug
12 Sealing ring
13 Blanking plug
14 Hex screw
15 O-ring
16 Link
17 Hex screw
18 O-ring
19 Hex screw
20 Washer
21 O-ring
22 O-ring
23 Inspection port cover
24 Gasket
25 Hex screw
26 Guide tube
27 Sealing ring
28 Union
29 Oil dipstick
30 O-ring
31 Oil filler neck
32 Cover
33 Gasket

Crankcase



1 Crankcase

2 Main bearing cap

3 Main bearing cap

4 Stud **
Tightening torque: 80 Nm
(to blind hole)
Lubricant: Engine oil

5 Nut, main bearing cap
Screw elongation: Δl = 1.15 mm +0.05 mm
Remaining screw elongation: Δl = 0.9 mm +0.05 mm
Lubricant: Engine oil

6 Socket-head screw
* Pretightening torque: 80 Nm
* Tightening torque: 280 Nm + 20 Nm
Lubricant: Engine oil

7 Washer

8 End cover
Securing agent: Thread-locking compound

9 Camshaft bearing

* Tightening sequence, starting from driving end:
1. Pretighten all socket-head screws on left side and then on right side
2. Fully tighten all socket-head screws on left side and then on right side

** Newly installed studs must be pre-stretched prior to initial tightening

C011.05.02 Special tools

Designation	Use/dimension	Number
• Alignment plate	Crankcase block on driving end	1
• Stop plate	Aligning oil gallery with crankcase	1
• Assembly device	Installing camshaft bearing	1
– Bracket	Shrink-on tool	1
– Shrink-on tool	Camshaft bearing	1
– Guide bush	Fit camshaft bearing on shrink-on tool	1
• Removal pipe	Camshaft bearing stage 0–0 dia. 104.065 mm	3
– Removal tool	Camshaft bearing BR 4000	1
• Assembly mandrel	Crankcase plugs	1
• Installation/removal tool	Stud, crankshaft bearing	1
• Hydraulic set	Main bearing screws	1
• Hydraulic set	Main bearing screws (hydraulic pump)	1
• Swivel frame (assembly dolly)	Crankcase or engine	1
– Mounting bracket		1
– Support		1
• Base plate	Crankcase crankcase	4

C011.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Engine removal	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004

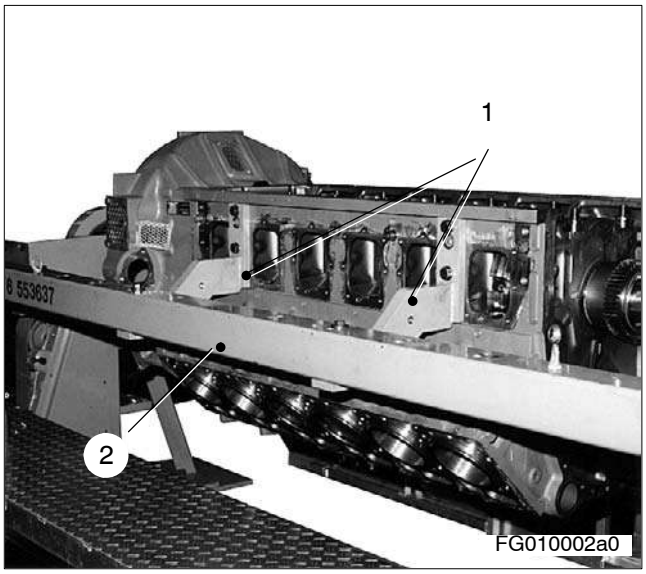
C011.05.05 Removal

Removing cover (main oil gallery), guide tube, oil filler neck, inspection port cover

Remove cover, guide tube, oil filler neck and inspection port cover as shown in the overview drawing, see C 011.05.01.

Remove blanking plugs, gaskets, sealing rings and O-rings.

Remove O-ring from blanking plug.



Installing crankcase in assembly dolly

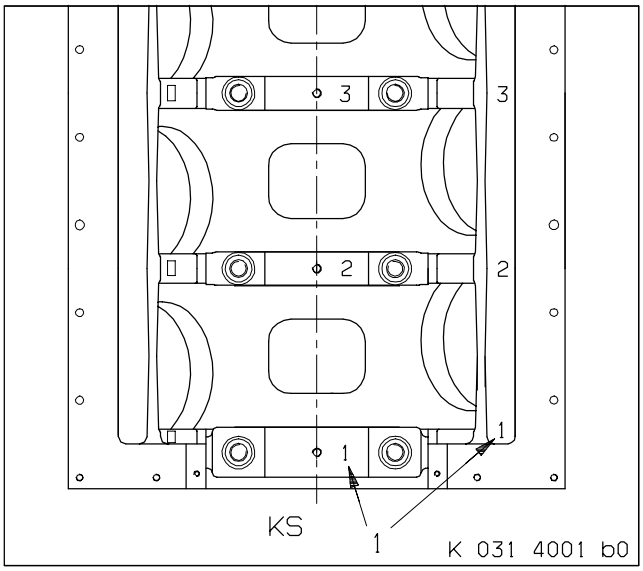
Install supports (1) for assembly dolly at left and right side of the crankcase.

⚠ WARNING

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

Raise crankcase with lifting appliance and lifting ropes, place in assembly dolly (2) and secure.

C011.05.06 Disassembly

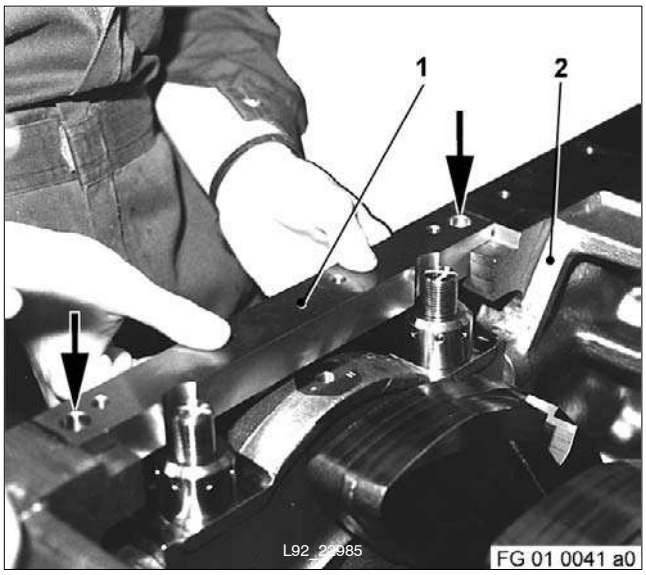


Checking marking on crankshaft bearing cap

Check marking on crankshaft bearing cap to crankshaft, and if necessary mark according to sequence.

To do this, punch the main bearing serial number on crankcase and crankshaft bearing cap on left side of engine (A side).
Numeral punch 6 mm high.
Number sequence: Beginning at driving end side with main bearing No. 1.

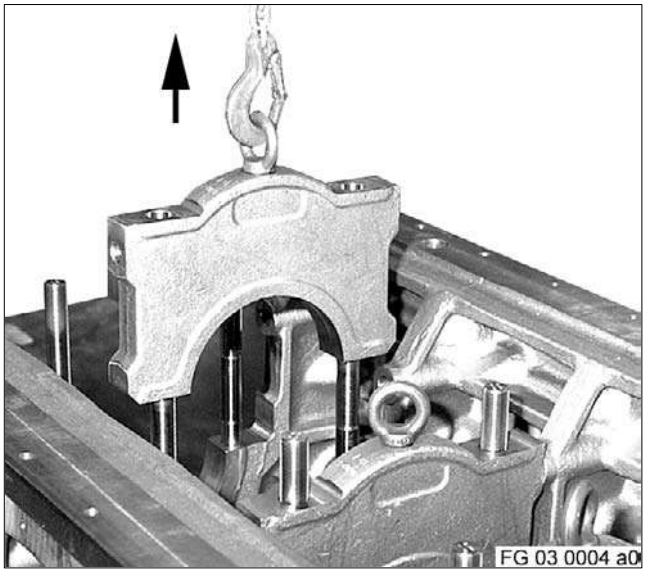
Note: In the diagram opposite, the crankcase is rotated 180°. Viewed from this angle the A side is on the right.



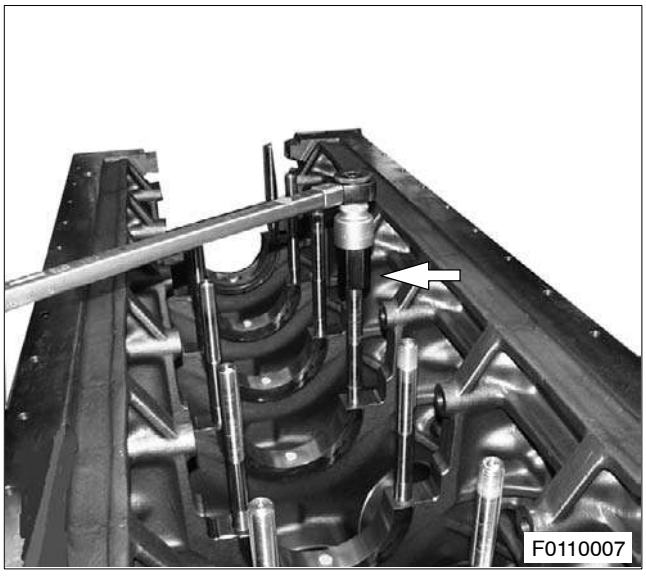
Removing main bearing caps

Remove socket head screws (arrows).

Remove block (1) from crankcase (2).



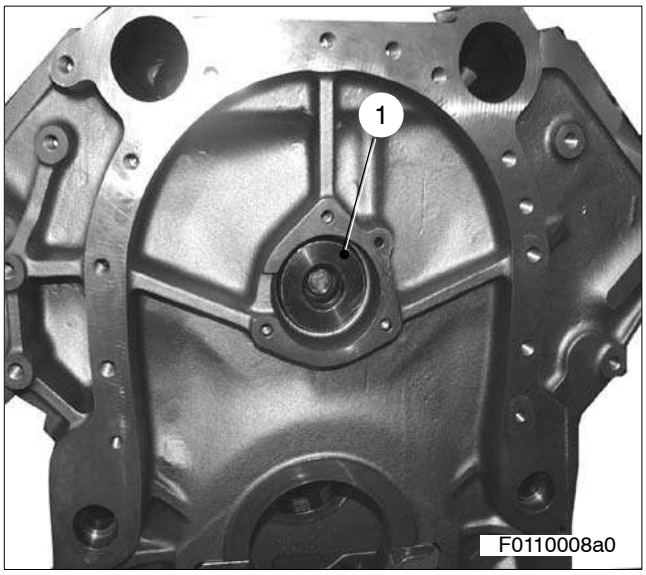
Remove main bearing cap – see Section C 031.05.05 Removal – Removing main bearing cap.



Removing stud(s) for main bearing cap

Important: Only remove studs if necessary.

Remove appropriate stud(s) using an installation/removal tool (arrow).



Removing camshaft bearing bush

Important: Remove camshaft bearing bushes only when wear limit is reached or if damaged – see C 011.05.08.

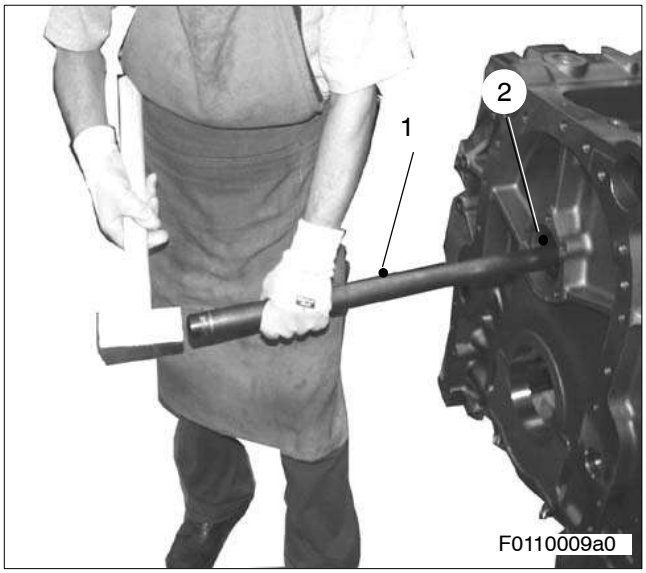
Remove first bearing bush, driving or free end.

I only one bearing is to be replaced, protect the following bearing against damage – see next illustration.

Note: Cover the bottom of the camshaft chamber so that no bearing bush falls into the running gear.

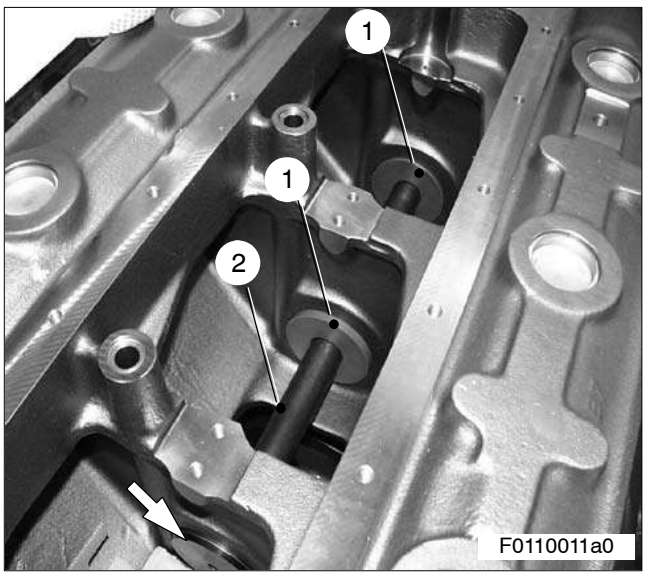
Insert thrust pad (1) into bearing to be removed.

Protect bearings not being removed against damage, e.g. by inserting a rag.



Place removal tool (1) in thrust pad (2) support.

Using a copper hammer, carefully drive camshaft bearing out of crankcase.



Removing next camshaft bearing bush

Insert thrust pad (arrow) into next bearing bush which is still installed.

Insert removal tool (2) with guide washers (1) into camshaft bearing bore on crankcase.

Drive out camshaft bearing bush.

Follow same procedure to remove other bearing bushes.

Removing end cover

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

Using a mandrel and hammer, carefully knock the edge of one side of the end cover inwards until it tilts in the bore.Then withdraw the cover with pliers.

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

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

C011.05.08 Inspection and repair

Clean all components.

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

Using the magnetic crack-testing method with fluorescent powder, check the crankshaft bearing cap and screws for main bearing cap for cracks; replace part if cracks are detected.

Check mating faces, upper and lower fits of the cylinder liners in the crankcase for wear, damage and cavitation, machine if necessary.

Check thread and shaft of main bearing studs for damage; replace studs if necessary.

Check that thread, shaft and screw head surface of the socket-head screws, which are used to secure crankshaft main bearing cap at the side, are in perfect condition; replace socket-head screw as required.

Check camshaft bearings and guide bushes on wear and damage; replace if necessary.

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

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.

Thoroughly blow clear all threads; check for ease of movement; machine if necessary.

Note: Any inquiries concerning machining work on the crankcase should be directed to MTU Service.

Oil filler neck

Clean oil filler neck with cold cleaner and blow clear with compressed air.

Visually inspect component for damage and defects; replace if necessary.

Check condition of threads; machine or replace components as necessary.

Replace sealing rings.

Oil dipstick

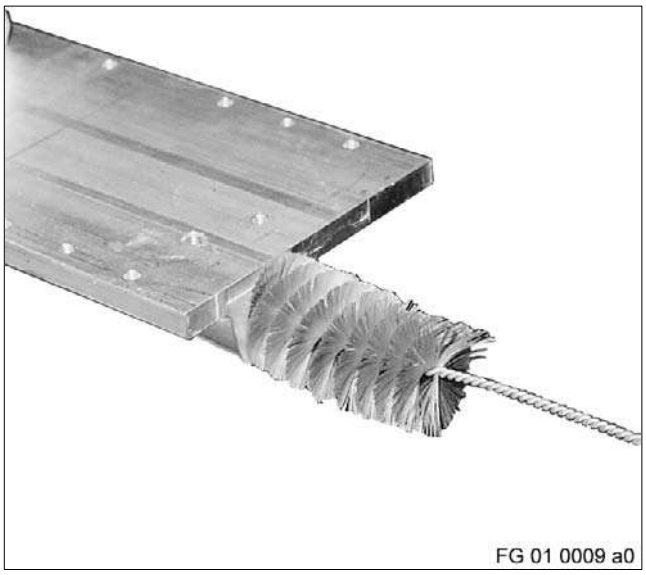
Visually inspect for damage and defects; replace if necessary.

Check that the oil dipstick is secure in the guide tube.

When replacing dipstick, make sure you use correct version. Part number is stamped on grip.

Replace O-ring.

Note: Make sure parts are perfectly clean.



Cover

Remove old sealant from mating surfaces and check for wear and damage; machine if necessary.

Thoroughly clean oil bores, use a bristle brush if necessary.

Attention: 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.

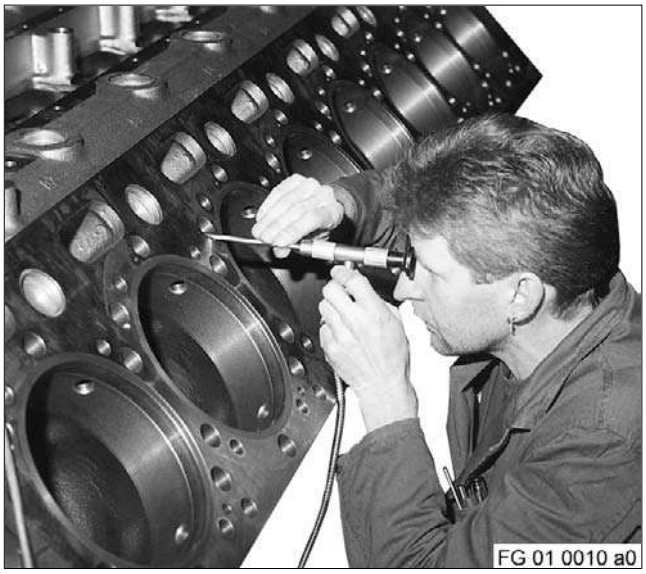
After cleaning, flush oilways (under pressure if possible) and blow clear with dry compressed air.

Use a plastic plug or suitable adhesive tape to prevent each bore from getting dirty until the crankcase has been assembled.

Check oil bores in crankcase

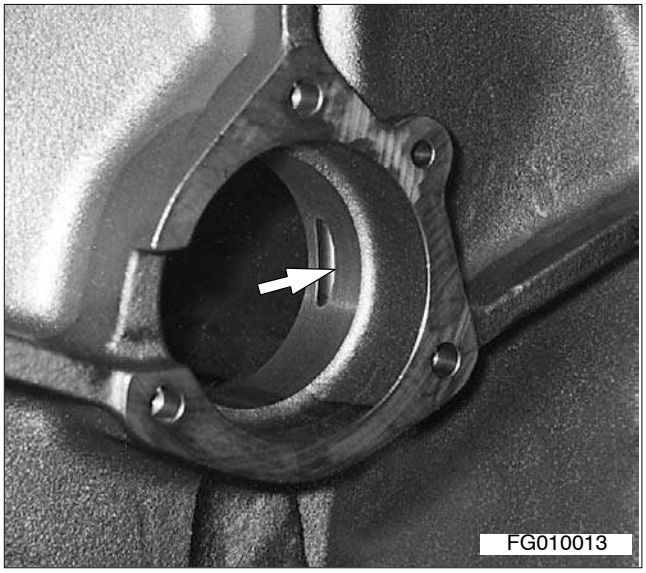
Note: During a major engine overhaul or when there are metal chips in the engine oil system, all oil bores must be thoroughly cleaned and checked for particular cleanness.

The oil bores in the following pictures should be lit up with an endoscope and cold light and checked for particular cleanness.

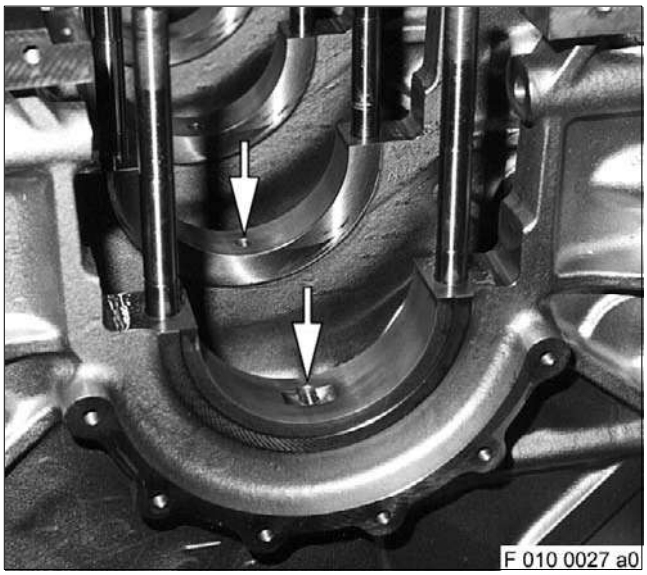


Oil supply bores to valve gear at crankcase, sides A and B.

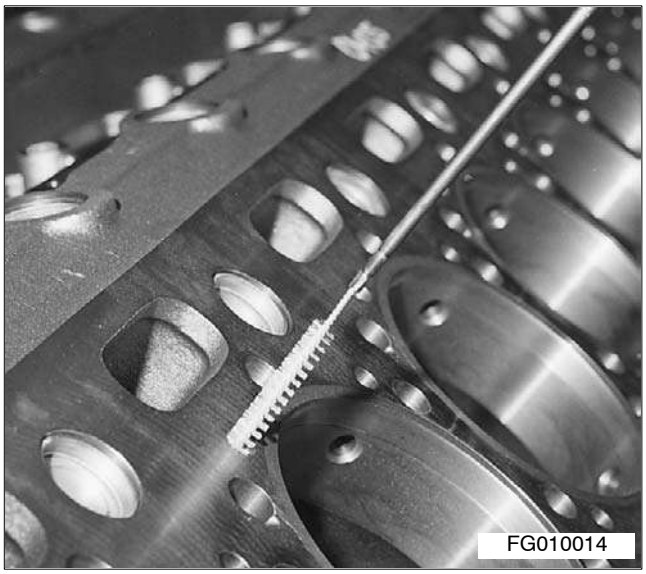
Main oil supply bores to camshaft and main bearing in crankcase V.



Oil bores (arrow) in camshaft chamber



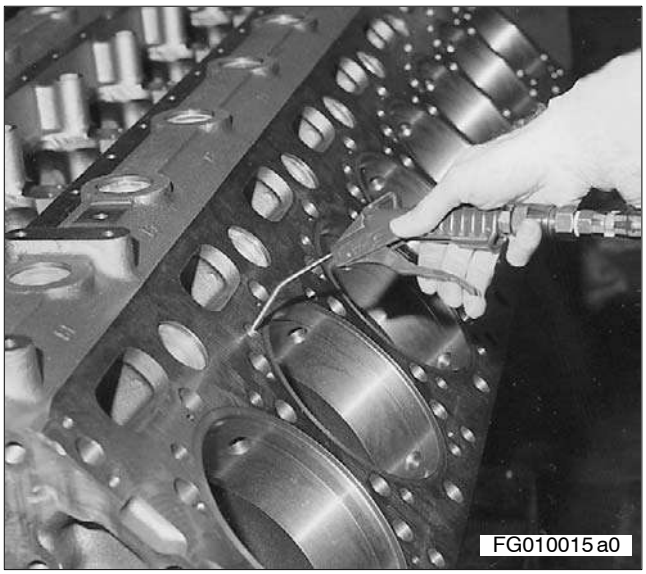
Oil bores (arrows) to main bearings



Check all other coolant and oil bores in same way for contamination.

If necessary, clean bores with bristle brush (1).

Attention: Never use a wire brush!

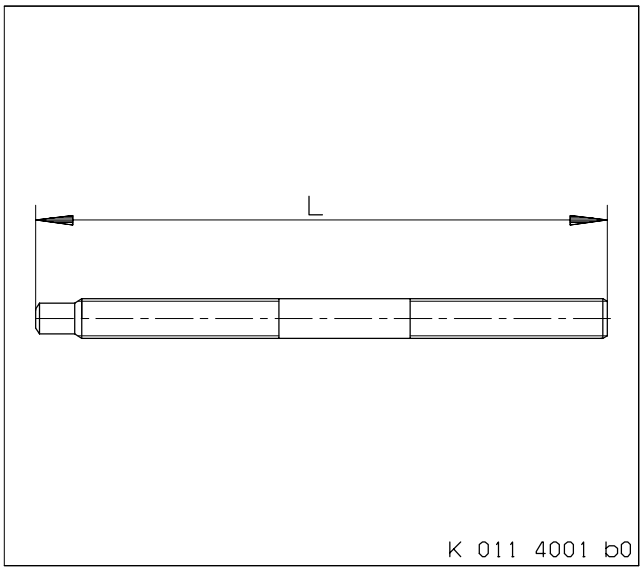


⚠ CAUTION

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 bores (under pressure if possible) and blow clear with compressed air.

Note: If the crankcase is not assembled or put into operation immediately, dry oil bores, preserve and seal air-tight with suitable plugs.



Checking stud for main bearing cap

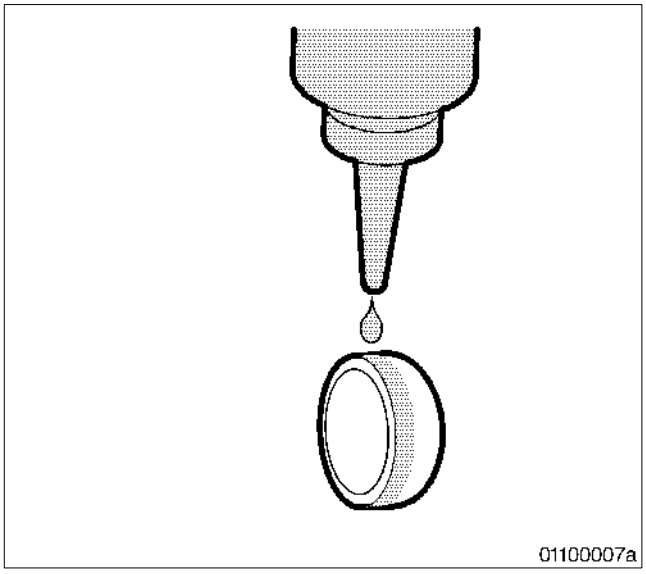
Note: Remove stud only if necessary (e.g. if damaged).

Check that thread and shaft are in perfect condition; replace stud if necessary.

Measure length of stud.

Specified length – see Tolerance and Wear Limits List.

C011.05.10 Assembly



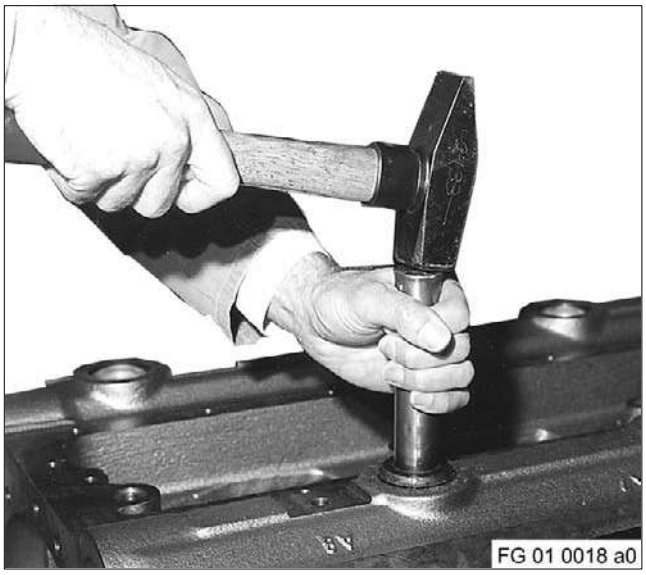
⚠ CAUTION

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

Installing end cover

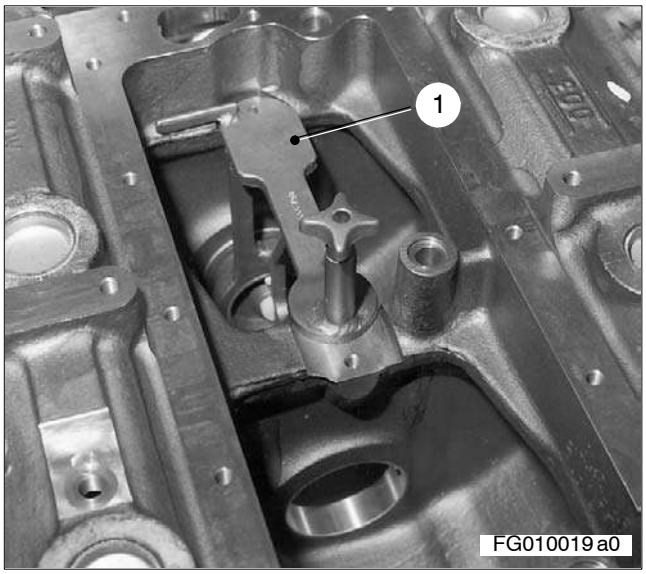
Clean and degrease seating face on end cover and bore in crankcase.

Coat seating surface of cap with high-strength thread-locking liquid Loctite 270.



Using a mandrel, knock end cover into the crankcase bore.

Note: If necessary (leaks, sealing surface damage), the cover can be swaged in after it has been knocked with a mandrel. Final strength of thread-locking agent at 20 °C after ≈ 12 h!



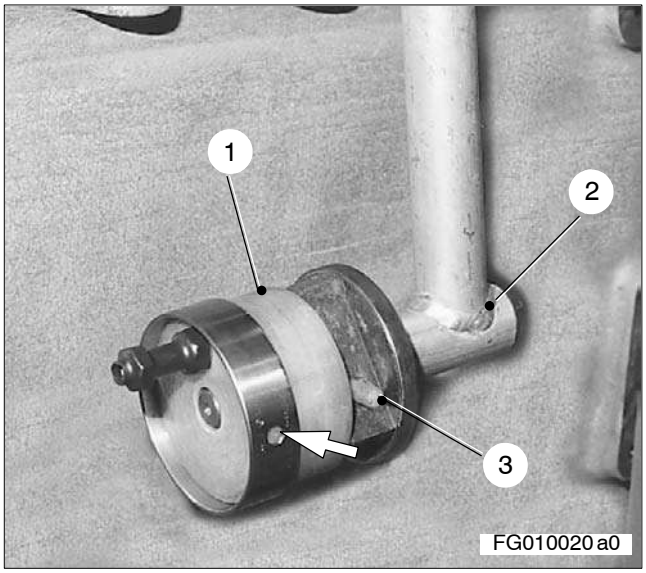
Installing camshaft bearing

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

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

Check lube oil bores and ensure they are perfectly clean and unobstructed, clean if necessary.

Beginning with the first camshaft bearing, screw the stop and camshaft bearing alignment device (1) onto the locating bore of the rocker shafts.

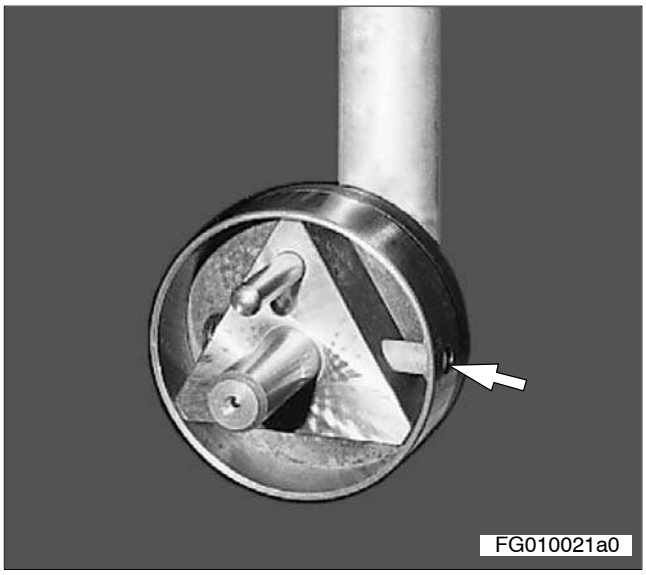


Fit plastic mandrel (1) on installation tool (2).

⚠ CAUTION

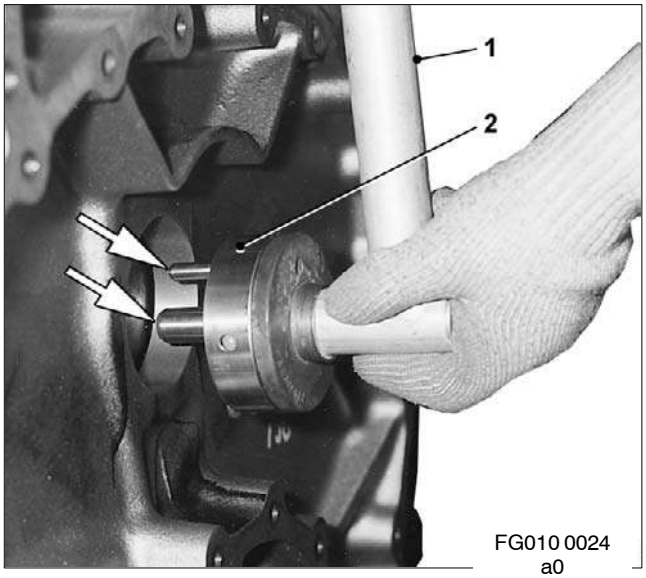
Nitrogen is liquid at – 200 °C)
Danger of freezing and suffocation!
Do not allow liquid nitrogen to come into contact with parts of body (eyes, hands).
Wear protective clothing (including gloves and closed shoes) and goggles. Ventilate working area well.

Fit chilled camshaft bearing bush so that spring-loaded locating mandrel (3) of installation tool engages in oil bore (arrow) of camshaft bearing bush.



Remove insertion mandrel from assembly tool.

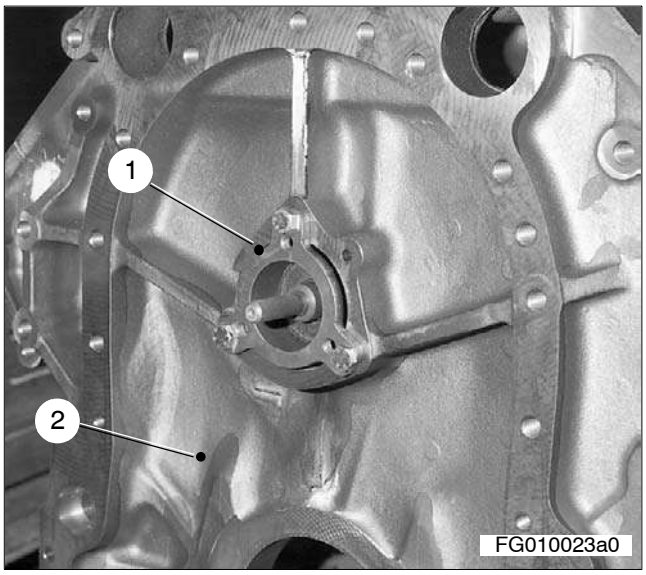
Check position of crankshaft bearing oil bore in assembly tool (arrow).



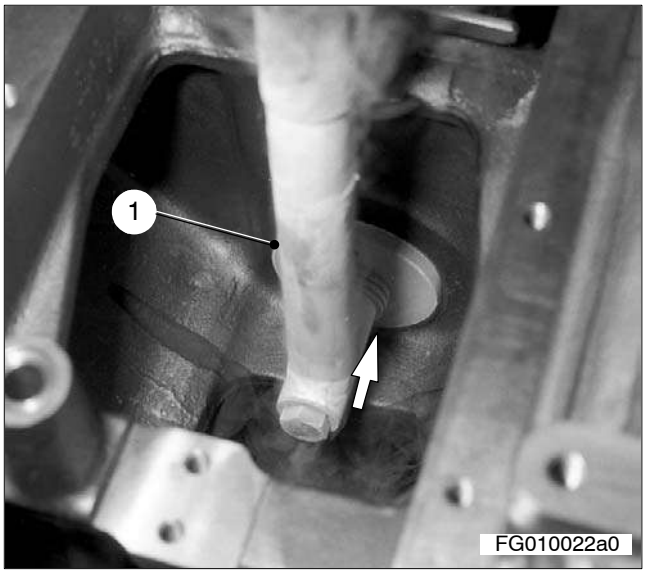
Using the assembly tool (1), insert camshaft bearing bush (2) from the outside into the camshaft basic bore as far as it will go.

At the same time, the assembly tool is positioned by the centring and positioning mandrel which are inserted as the camshaft bearing bush is fitted in the stop (arrow).

Check that lube-oil bores in bearing bush and crankcase are aligned.



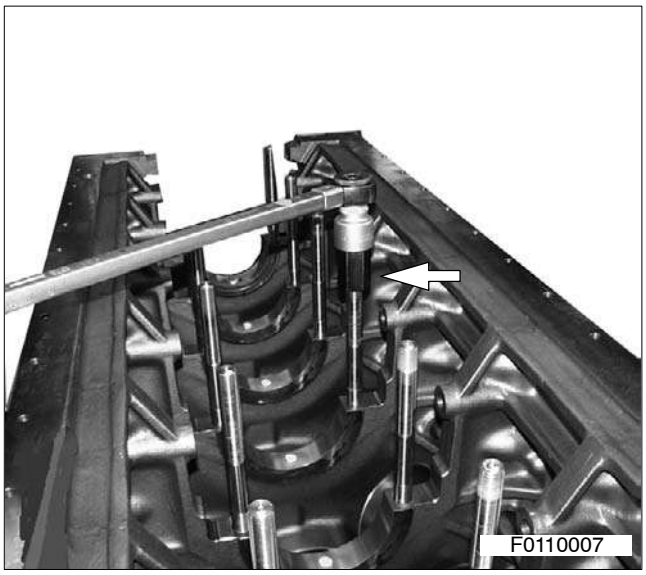
To install the last camshaft bearing (free end), install stop and alignment device (1) from the outside on the free end of the crankcase (2).



Using the assembly tool (1), insert camshaft bearing bush in the camshaft locating bore as far as it will go.

At the same time, the assembly tool is positioned by the centring and positioning mandrel which are inserted as the camshaft bearing bush is inserted in the stop.

Check that lube-oil bores in bearing bush and crankcase are aligned.



Installing studs for crankshaft bearing cap

⚠ WARNING

Compressed air is highly pressurized.
Risk of injury!
Do not direct compressed air jet at personnel.
Always wear protective goggles/safety mask and ear protection.

Clean threaded bore in crankcase and blow clear with compressed air.

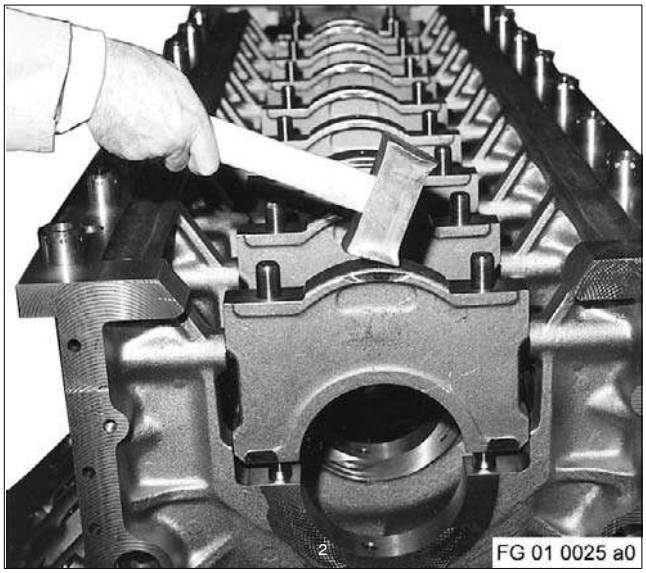
Check threaded bore with a new stud for ease of movement up to the thread end in the crankcase.

Coat stud thread on the journal side with engine oil.

Insert stud with the journal side in the threaded bore.

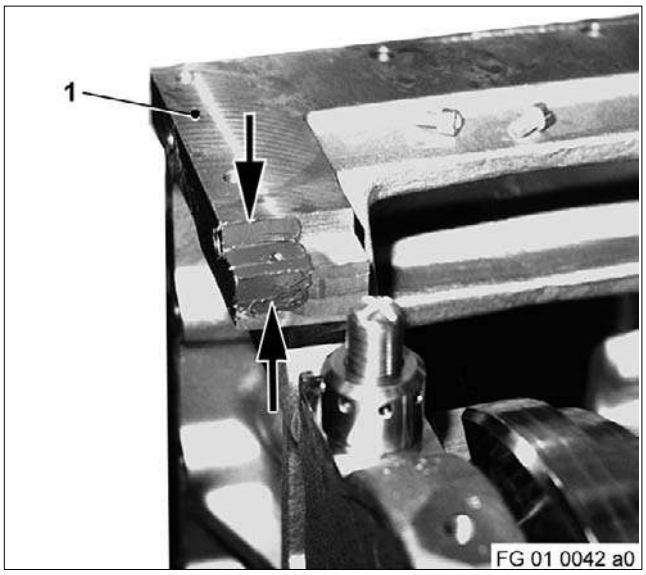
Using the installation/removal tool (arrow), screw stud in until it is in position and then tighten to specified torque, see C 011.05.01.

Note: Newly installed studs must be prestretched before initial tightening – see C 031.05.



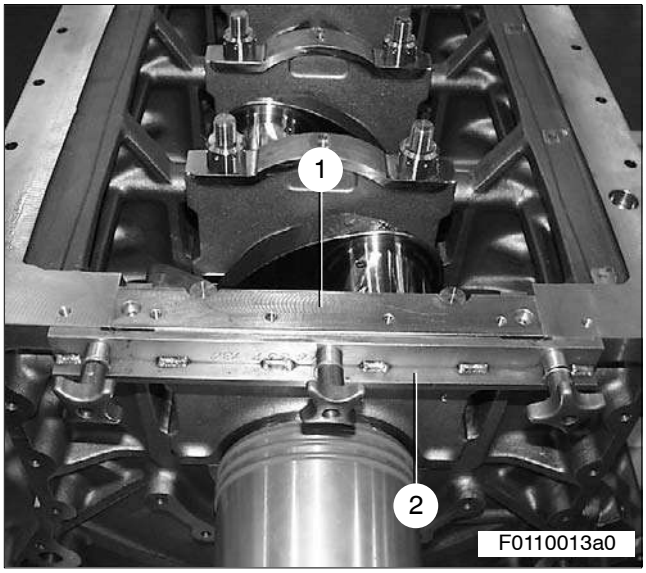
Installing main bearing cap

Install main bearing cap and tighten lateral socket-head screws – see C 031.05.11 Installation – installing main bearing cap –.

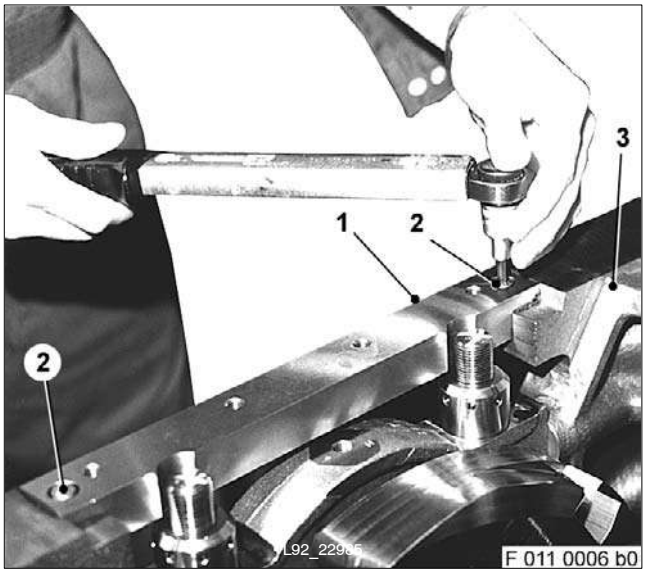


Clean and degrease crankcase mating face (1) for block (driving end).

Coat mating face with Loctite 5910 surface sealant (arrows), ensuring that the faces are also coated.



Insert block (1) into crankcase and align with alignment plate (2).



Using socket-head screws (2), secure the block (1) to the crankcase (3).

Using a straightedge, check the alignment of the block to the crankcase.

The block surface must form a single plane with the crankcase parting line so that the oil pan sits perfectly.

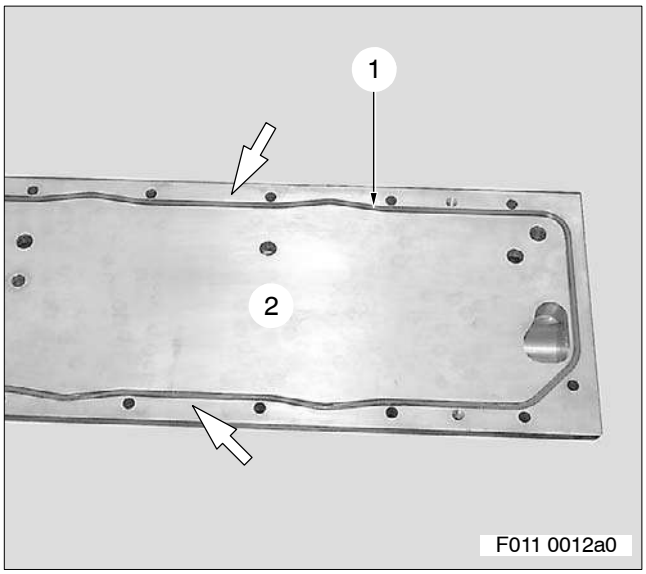
C011.05.11 Installation

Note: Prior to installation, remove all blanking plugs and covers. Make sure parts are perfectly clean.

Installing inspection port cover, inspection port cover with oil filler neck and oil dipstick

Install and tighten inspection port cover as per overview drawing – see C 011.05.01.

Note: Use new gaskets!



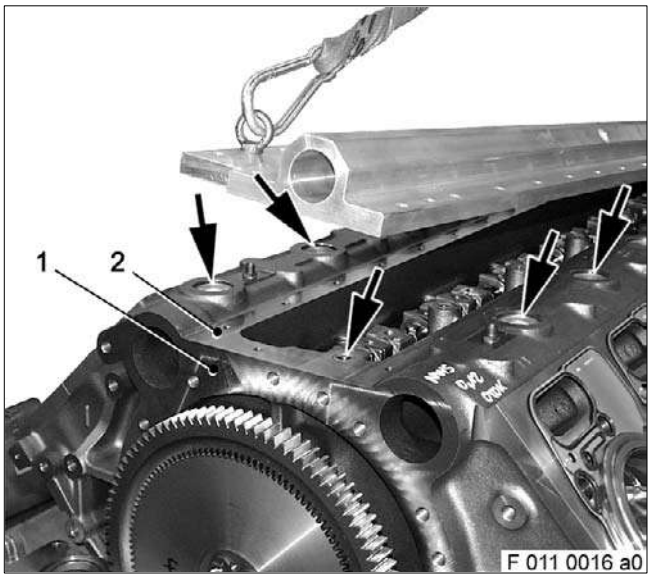
Installing cover (main oil gallery)

Make sure that oil chambers and oilways are perfectly clean.

Complete cover as per overview drawing – see C 011.05.01.

Clean and degrease mating faces on crankcase and cover (2) (arrows).

Insert new O-ring (1) into groove in cover.



Coat mating face (2) on crankcase with surface sealant (Loctite 5910).

Insert new O-rings (arrows) in oil transfer bores on crankcase.

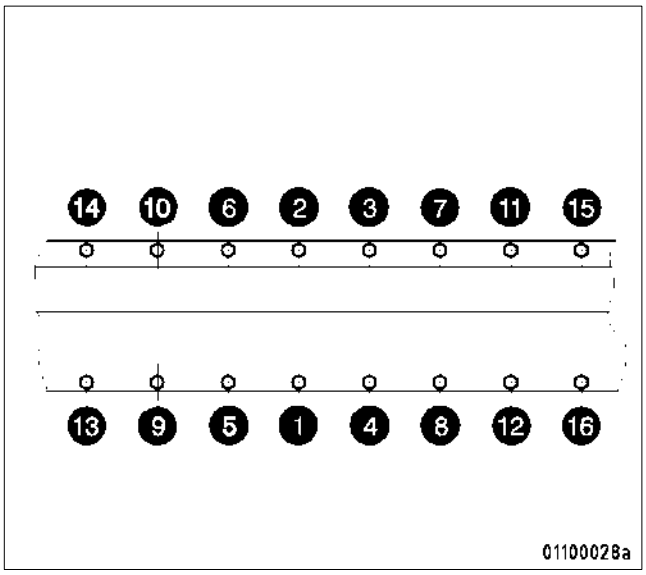
Insert assembly pins in the crankcase at two diagonally opposite corner points.

Screw in suitable lifting eyes.

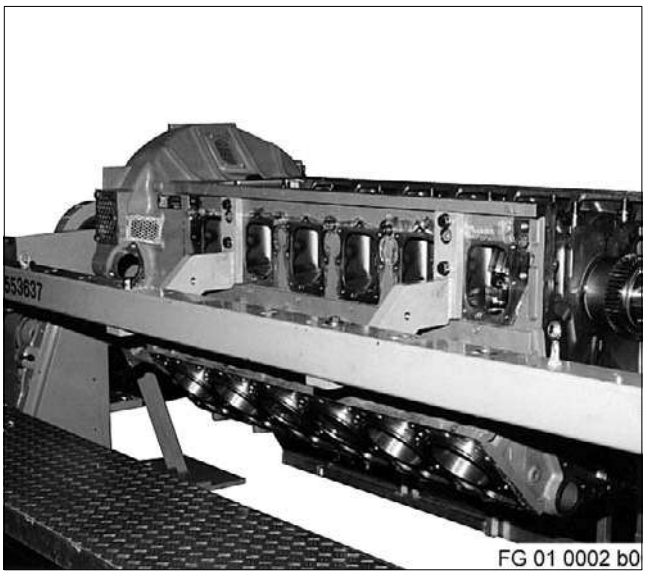
Using the lifting appliance, fit the cap onto the assembly pins and slowly lower onto the crankcase support surface.

Install stop plate on face (1) of crankcase.

Align cover with stop plate.



Tighten hex screws as per adjacent tightening diagram.



Removing crankcase from assembly dolly

Move lifting appliance and lifting ropes into position at the crankcase. Ensure lifting ropes are equally tensioned.

⚠ WARNING

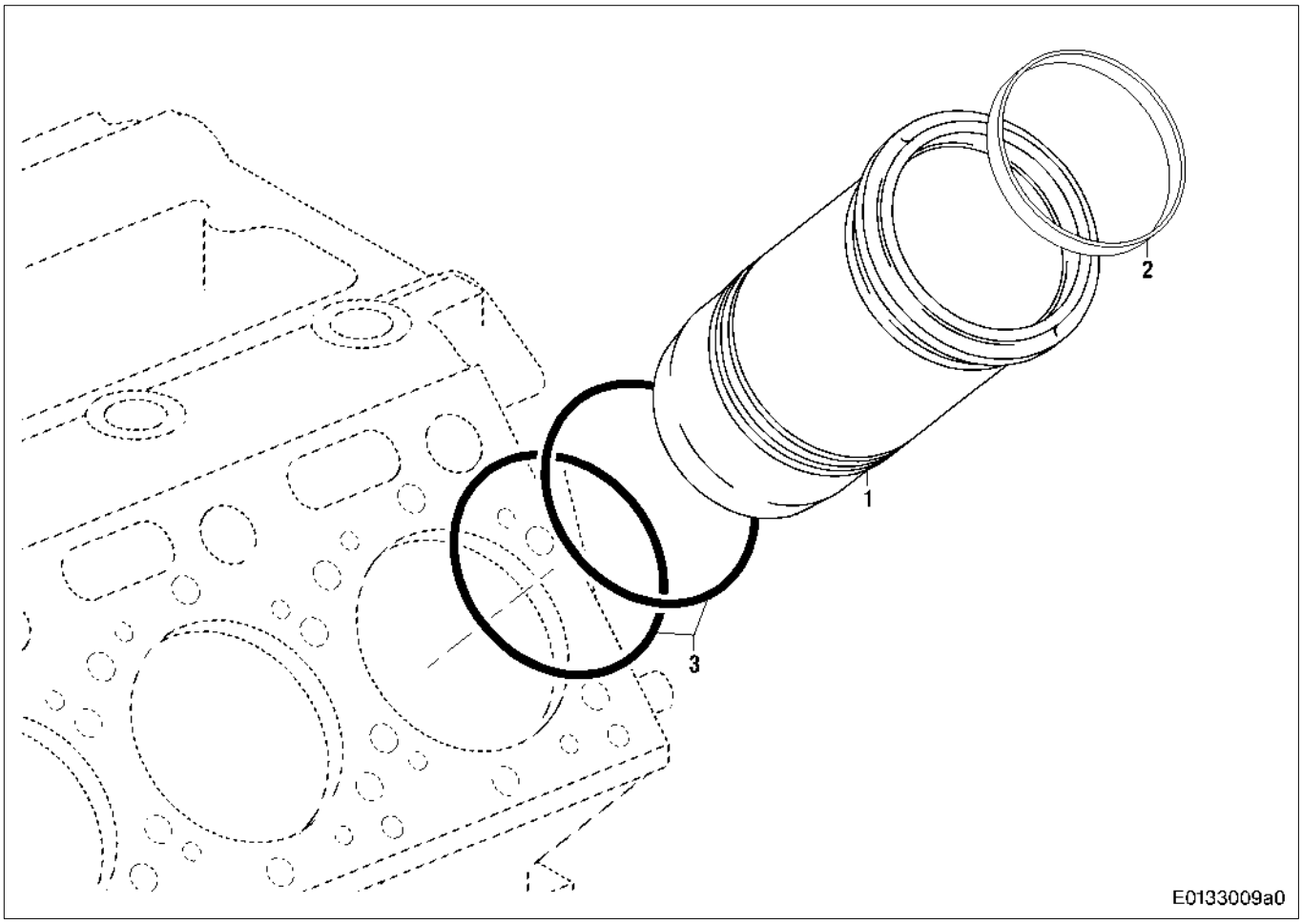
Suspended load.
Risk of injury!
Only use lifting device provided by manufacturer and observe lifting instructions.
Never stand beneath a suspended load.

Release crankcase from assembly dolly and raise it out.

C011.05.12 After-Removal Operations

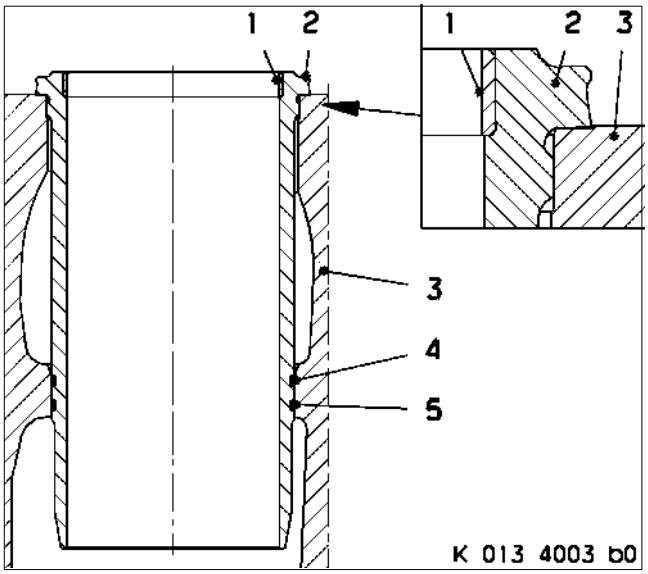
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007

C013.05 Cylinder liner



1 Cylinder liner
2 Scraper ring
3 Sealing ring (2), black

Cylinder liner in crankcase



1 Scraper ring
2 Cylinder liner
3 Crankcase
4 Sealing ring
5 Sealing ring

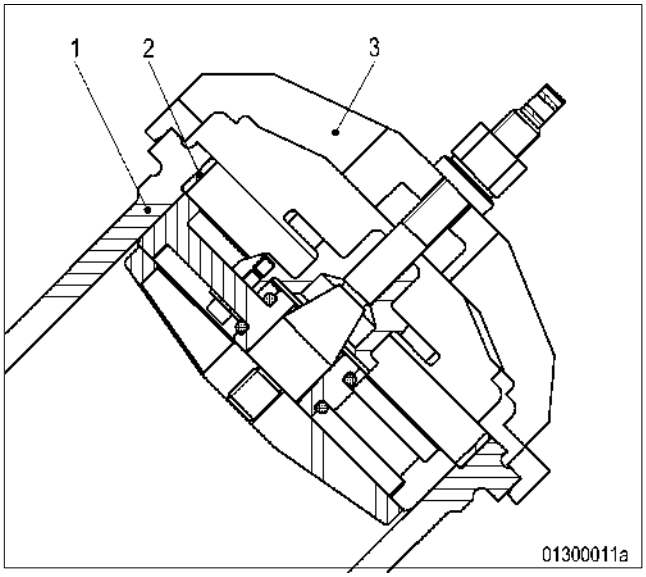
C013.05.02 Special tools

Designation	Use/dimension	Number
• Removal tool	Cylinder Liner	1
• Press-fitting tool	Cylinder Liner	1
• Removal tool	Carbon-deposit scraper ring	1

C013.05.04 Before-removal operations

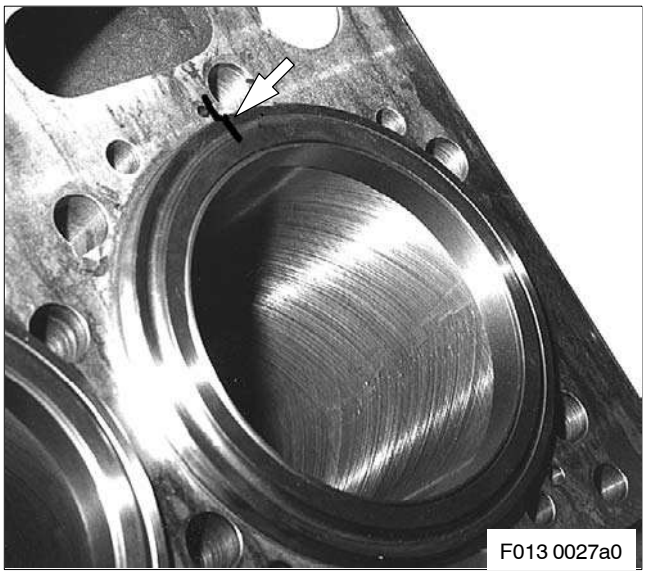
For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Drain engine coolant	→ Operating Instructions
–	–	x	Drain charge air coolant	→ Operating Instructions
–	–	x	Drain or draw off engine oil	→ Operating Instructions
–	x	x	Remove air filter (if necessary)	→ Operating Instructions
–	x	x	Remove exhaust pipework after cylinder head	→ C 141.05.05
–	x	x	Remove exhaust turbocharger	→ C 101.01.05
–	x	x	Remove charge air manifold	→ C 124.05.05
–	x	x	Remove charge air coolant lines (if required)	→ C 203.25.05
–	x	x	Disconnect fuel return lines	→ C 086.05.05
–	x	x	Remove crankcase ventilation (if necessary)	→ C 018.12.05
–	x	x	Remove exhaust pipework after cylinder head	→ C 141.10.05
–	x	x	Remove valve drive	→ C 055.05.05
–	x	x	Remove pushrods	→ C 054.05.05
–	x	x	Remove H.P. line	→ C 077.05.05
–	x	x	Remove fuel injector	→ C 075.05.05
–	x	x	Remove cylinder head	→ C 041.05.05
–	x	x	Remove cylinder head gasket	→ C 041.05.05
–	x	x	Open inspection port cover, lower or remove oil pan as required	→ C 014.05.05
–	x	x	Remove piston and conrod	→ C 037.05.05

C013.05.05 Removal



Removing carbon scraper ring

Remove carbon scraper ring (2) with removal tool (3) from cylinder liner fit (1).

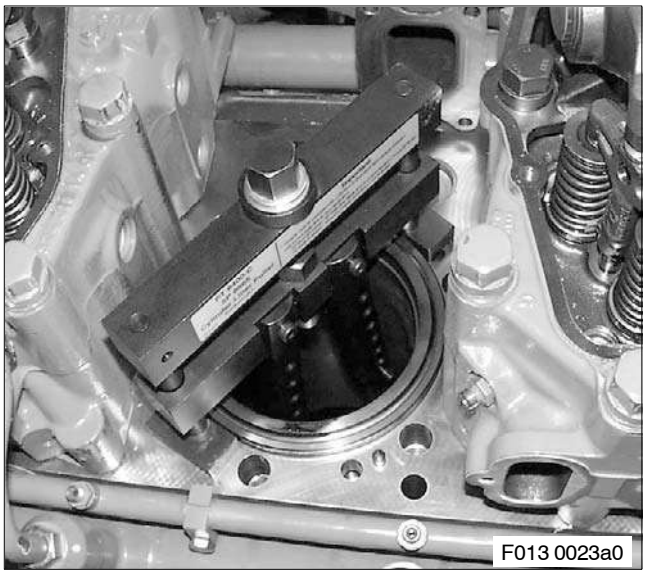


Removing cylinder liner

⚠ WARNING

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

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



Insert removal tool into cylinder liner and fit on bottom collar of cylinder liner.

Take care that the oil spray nozzle is not damaged.

Position the fork of the removal tool only lightly so that the liner is not displaced.

Rotate the removal tool spindle until the cylinder liner is released from the crankcase bore.

Remove removal tool.

Remove cylinder liner from crankcase.

Remove sealing rings from cylinder liner.

C013.05.08 Inspection and repair

Clean cylinder liner and, using the magnetic crack-testing method with fluorescent magnetic powder, check for cracks; replace component as necessary.

Check outer wall for pitting; replace cylinder liner if necessary.

If minor pitting is found, install cylinder liner rotated by 90°.

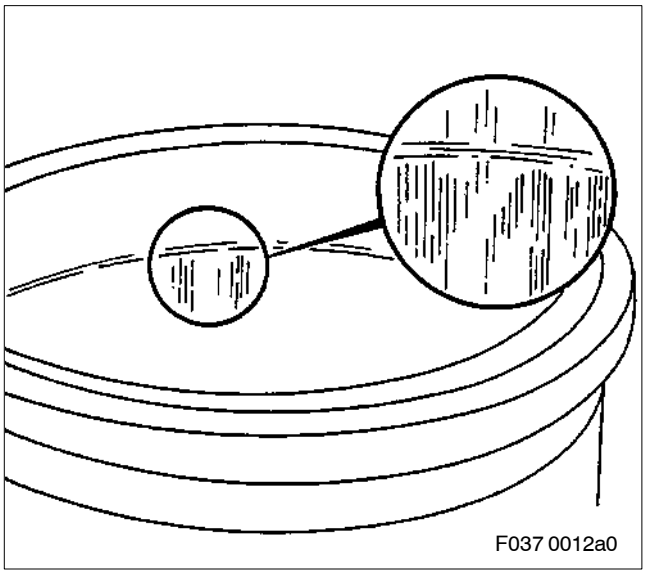
If cylinder liner has to be turned for reinstallation, rehone liner bore.

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

Check sealing and mating faces for wear and damage; replace cylinder liner if necessary.

Replace sealing rings.

With cylinder liners with carbon scraper ring: Check carbon scraper ring for scores and pitting, replace if necessary. Check floating mount of the carbon scraper ring in the cylinder liner. If the carbon scraper ring appears to jam, measure the fit in the cylinder liner, replace carbon scraper ring if necessary.

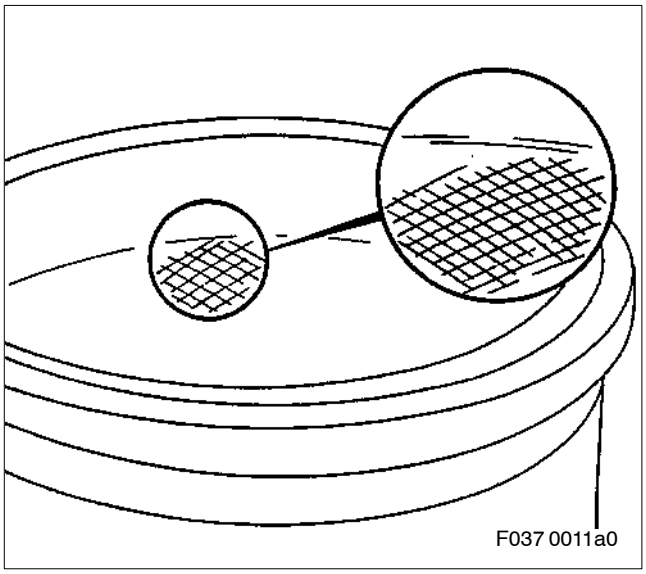

F037 0012a0

Checking wear pattern of cylinder liners

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

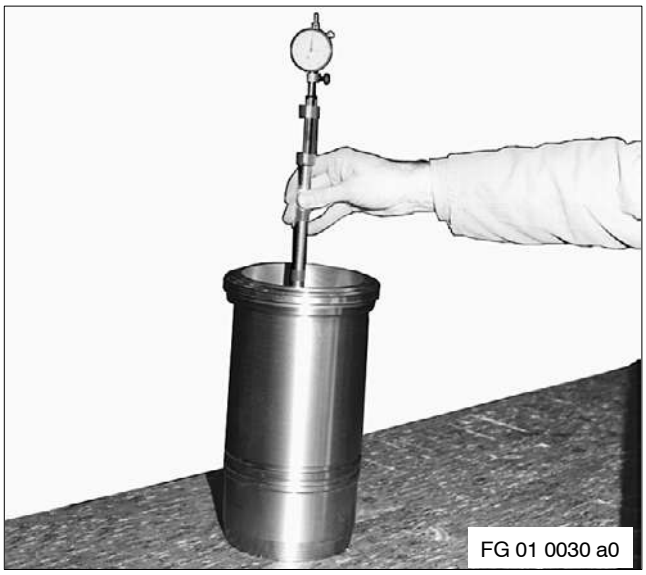
Check the reversing point of the first piston ring for wear, replace cylinder liner if necessary.

Note: When cylinder liners have scraper rings, honing is carried out with the scraper ring removed. After honing, carefully clean the transition from the honing pattern to the mating face of the scraper ring.


F037 0011a0

When reusing cylinder liners which have not been re-honed, the honing must be more or less clearly recognizable over entire running surface.

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



Measuring cylinder liner I.D.

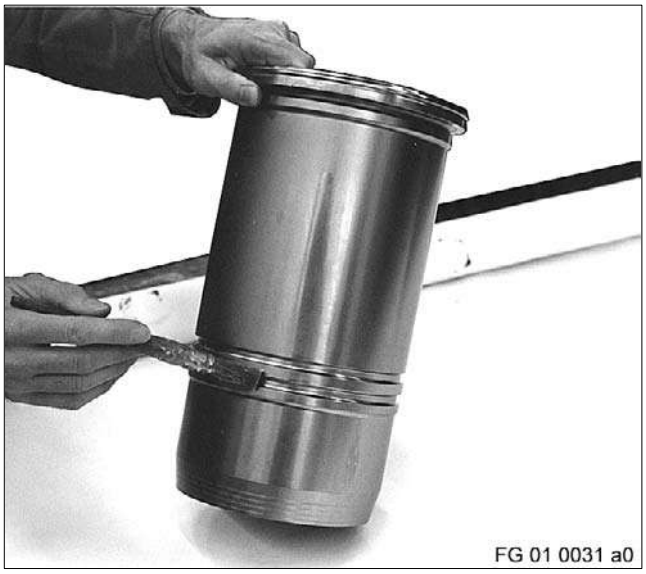
Adjust bore gauge and dial gauge with micrometer or gauge ring to basic size for cylinder liner as per Tolerance and Wear Limits List.

Measure cylinder liner I.D. with bore gauge.

Refer to the Tolerance and Wear Limits List for measuring levels and limit values.

If specified dimensions are exceeded, replace cylinder liner.

C013.05.11 Installation



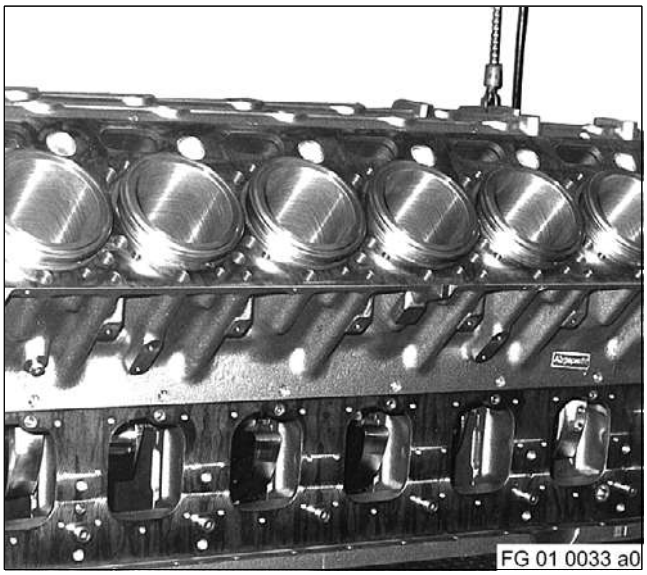
Installing cylinder liner

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

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

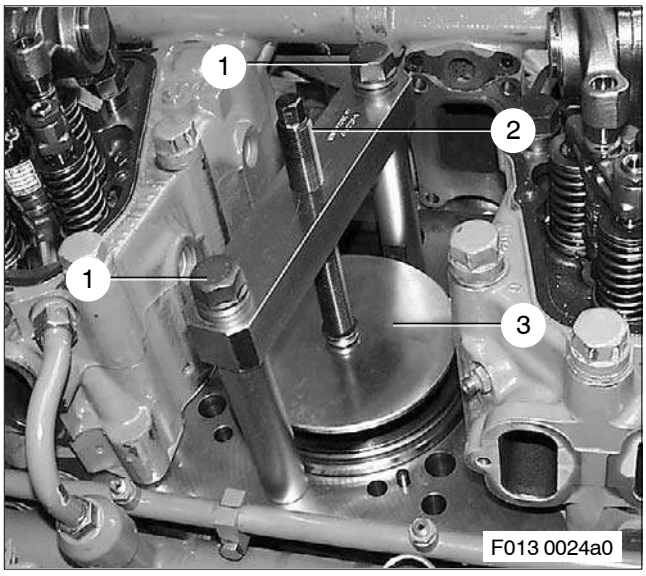
Fit sealing rings (2), bottom, on grooves on cylinder liner (1).

Note: Fit the sealing rings so that the flat side lies against the cylinder liner and the rounded side lies against the crankcase.



Insert cylinder liner in the crankcase

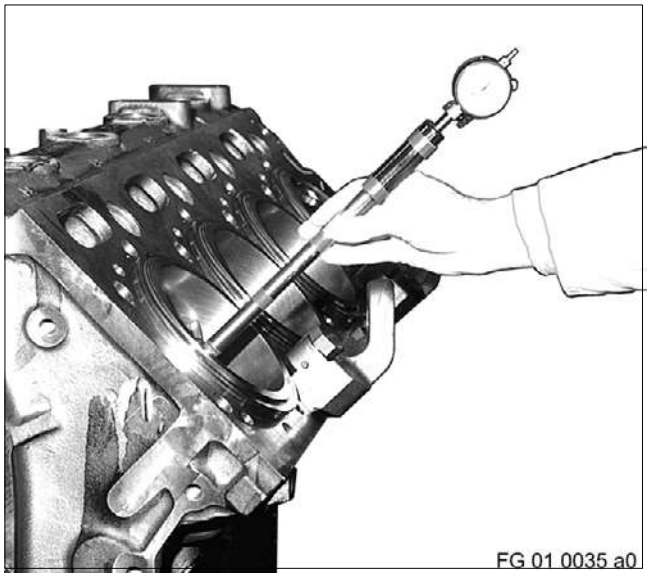
Note: In event of slight cavitation on the outer wall of cylinder liner, install liner offset by 90° with regard to previous installation position.



On the opposite side, insert screws (1) of insertion tool into threaded bores for cylinder head screws.

Fit pressure plate (3) on cylinder liner.

Turn spindle (2) in clockwise direction to press cylinder liner into crankcase bore.



Measuring cylinder liner I.D.

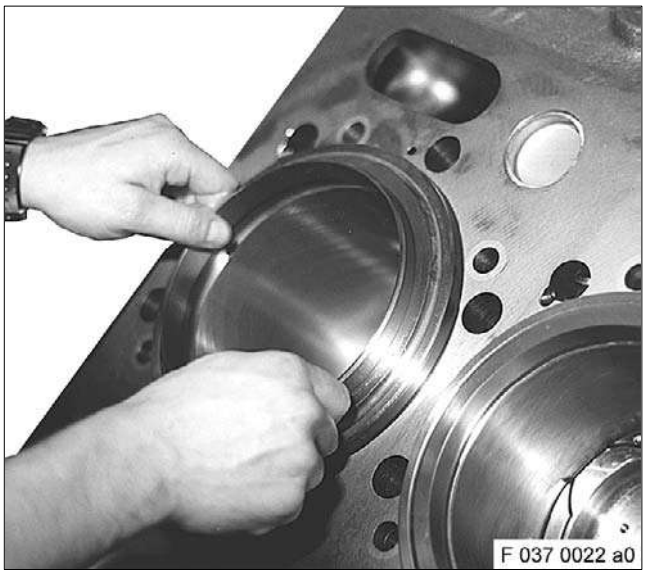
Adjust bore gauge and dial gauge with micrometer or gauge ring to basic size for cylinder liner as per Tolerance and Wear Limits List.

Using a bore gauge, measure cylinder liner I.D. at 4 points offset at 90° with respect to each other.

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

Record measured values in data sheet.

If an out-of-round is measured, remove cylinder liner and measure cylinder liner I.D. and O.D.



Note: The carbon scraper ring is not inserted in the cylinder liner until the piston has been installed.

Spray cylinder liner and carbon scraper ring with engine oil.

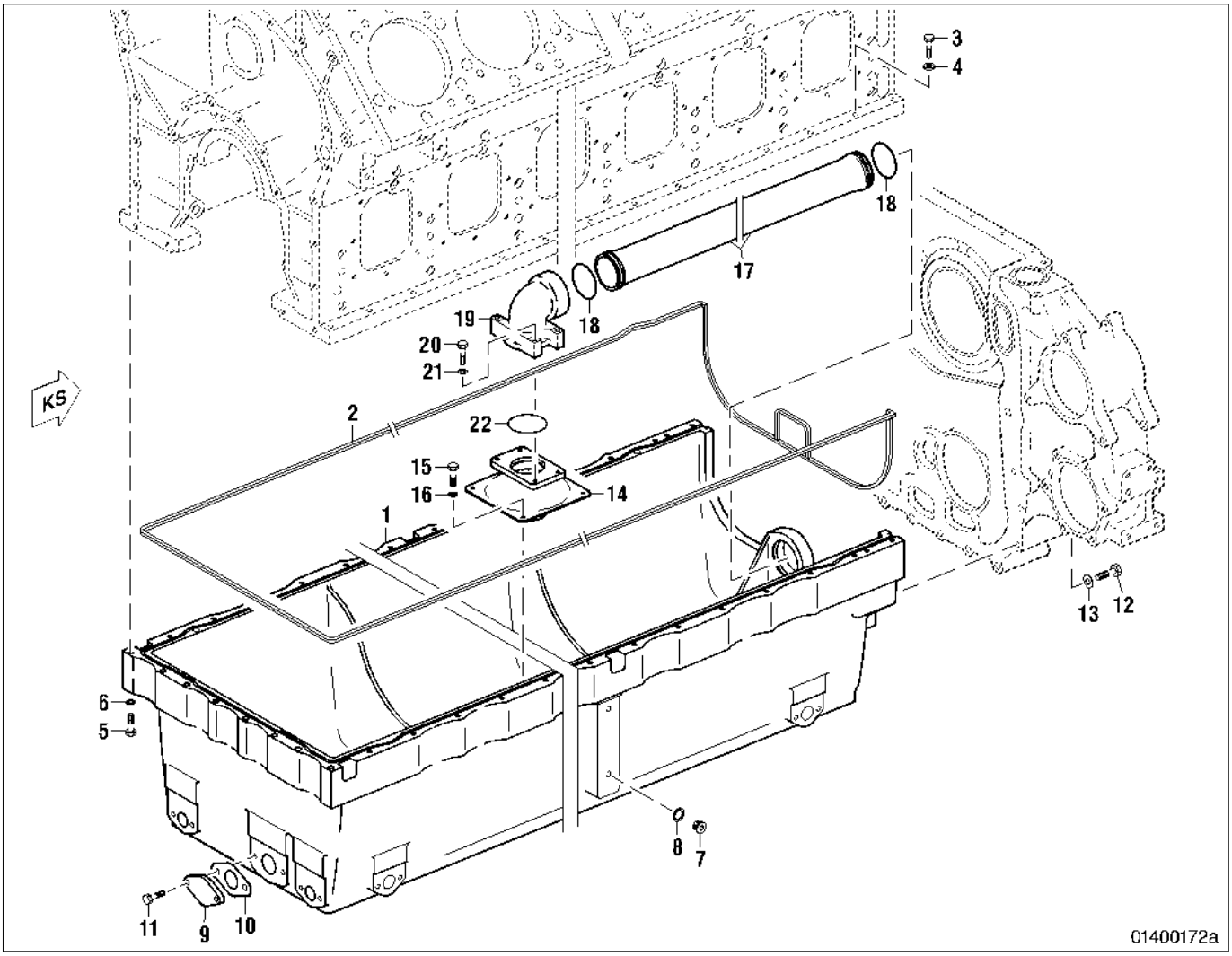
Insert carbon scraper ring into fit of cylinder liner.

C013.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 013.05.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions

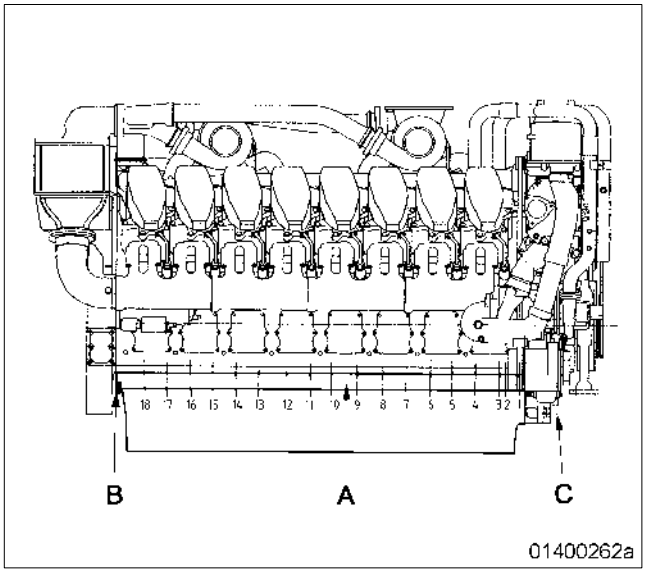
C014.05 Oil pan

C014.05.01 Overview drawing, grey cast iron



1 Oil pan
2 Rubber profile
3 Hex screw
4 Washer
5 Hex screw
6 Washer
7 Plug
8 Sealing ring
9 Flange
10 Gasket
11 Hex screw
12 Hex screw
13 Washer
14 Suction basket
15 Hex screw
16 Washer
17 Plug-in pipe (intake pipe)
18 O-rIng
19 Connector
20 Hex screw
21 Washer

Tightening diagram, oil pan (cast steel)

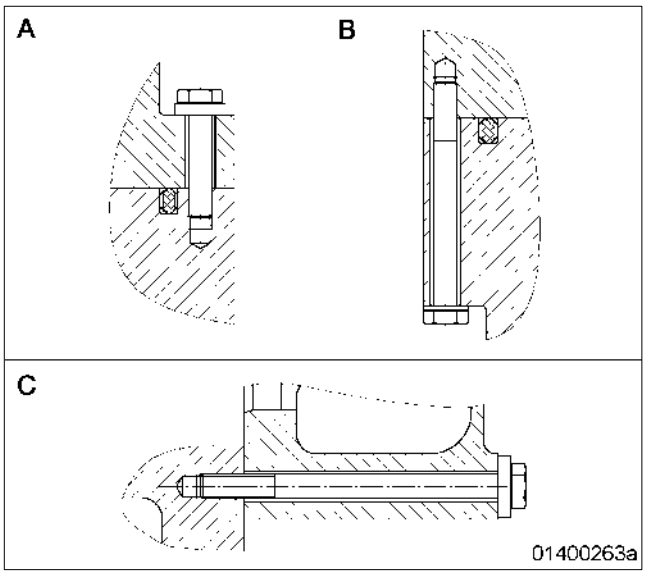


A – Longitudinal side: . . . . . 42 + 4 Nm*
- 12V: Items 1...14
- 16V: Items 1...18

B – Face side: . . . . . 27 +3 Nm*

C – Equipment carrier on oil pan: . . . . . 74 +7 Nm*

* – Lubricant: Engine oil



Oil pan installation

⚠ CAUTION

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

Clean and degrease mating faces of oil pan, crankshaft and equipment carrier.

Coat equipment carrier on crankcase with surface sealant Loctite 518 red. Wipe excess surface sealant from the free flange areas with a cloth sprayed with Loctite cleaner.

Fit rubber profile carefully in oil pan groove.

Note: For oil pan installation, use a new rubber profile.

Coat rubber profile on contact surface to crankcase and equipment carrier with assembly fluid MTH 5108 (petroleum jelly).

Immediately before installing oil pan, apply elastic black sealant Loctite 5910:

- in fillet, equipment carrier / crankcase, bead 5 mm thick.
- on flange surface, driving end, on strip joints.

Important: Black sealant must not dry, otherwise it will form a skin.

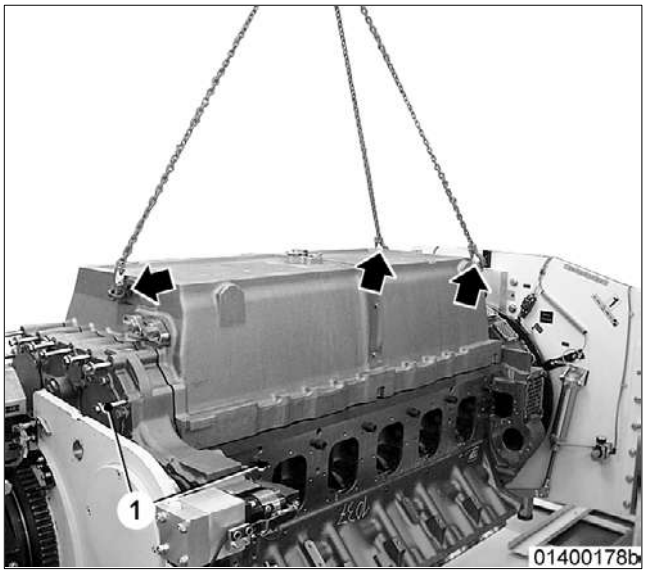
Screw oil pan to crankcase and equipment carrier, alternately in several steps.

Note: Washers for screws A, B and C are different.

C014.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 (as required)	→ Operating Instructions
–	–	x	Drain or draw off engine oil	→ Operating Instructions
–	x	x	Remove gear case	→ C 024.05.05
–	x	x	Remove fuel delivery pump (as required)	→ C 081.05.05
–	x	x	Release or remove oil filler neck	→ C 011.05.05
–	x	x	Remove engine mounts, free and driving ends	→ C 231.05.05

C014.05.05 Removal



Removing oil pan

Install engine in assembly dolly and turn by 180°.

Remove all hex screws for oil pan (1).

Unscrew plugs at the drain points of the oil pan and insert three suitable eyebolts (arrow) in the oil pan.

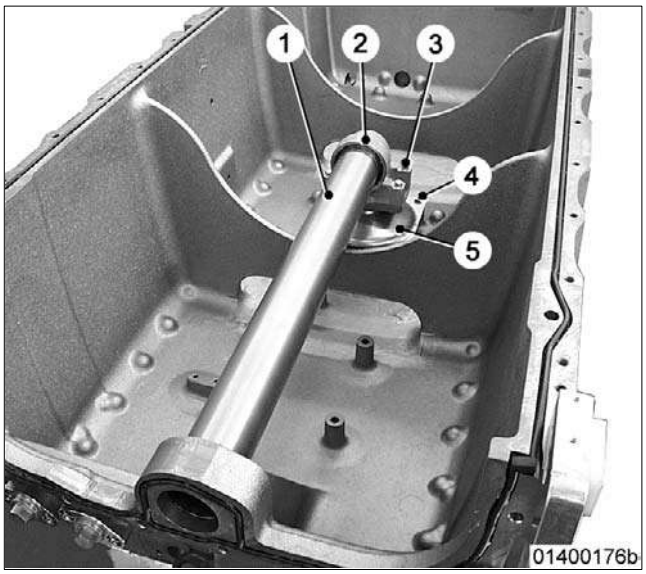
⚠ WARNING

Suspended load.
Risk of 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 and crane and lower onto suitable support.

Remove eyebolts and remove flange from the front face.

Remove rubber profile.



Removing suction basket

Unscrew and remove hex screws (3) and (4) with washers, remove suction basket (5) with connector (2) and intake pipe (1) from oil pan.

Remove O-rings.

C014.05.08 Inspection and repair

Note: Make sure parts are perfectly clean.

Clean oil pan and carefully remove any remaining detergent.

Check oil pan and attachments for cracks using surface crack-testing method with red penetrant dye and repair as necessary.

Replace component if cracks are found.

If oil pan must be reconditioned, contact MTU.

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

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

Check all mating and sealing faces and the rubber profile support groove; rub down with emery cloth or an oilstone as necessary.

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

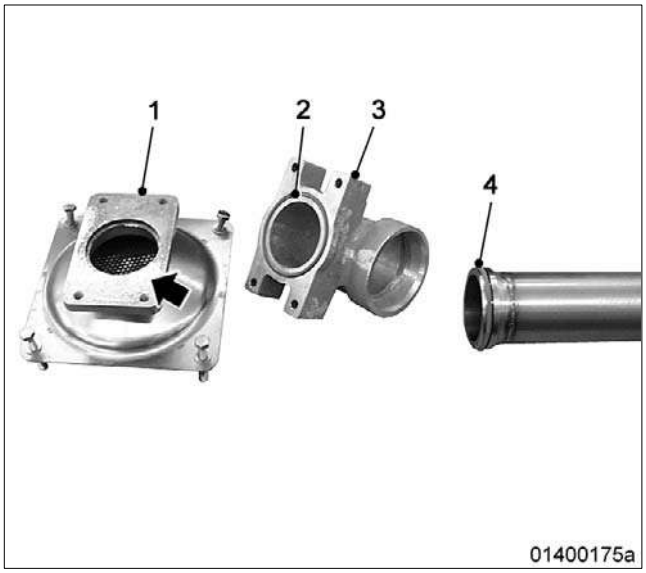
Check condition of threads in tapped bores; replace threaded inserts if necessary.

Check suction basket for contamination and damage; replace the suction basket if the mesh grill is found to be damaged (pierced).

Replace gaskets, sealing rings and rubber profile.

C014.05.11 Installation

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

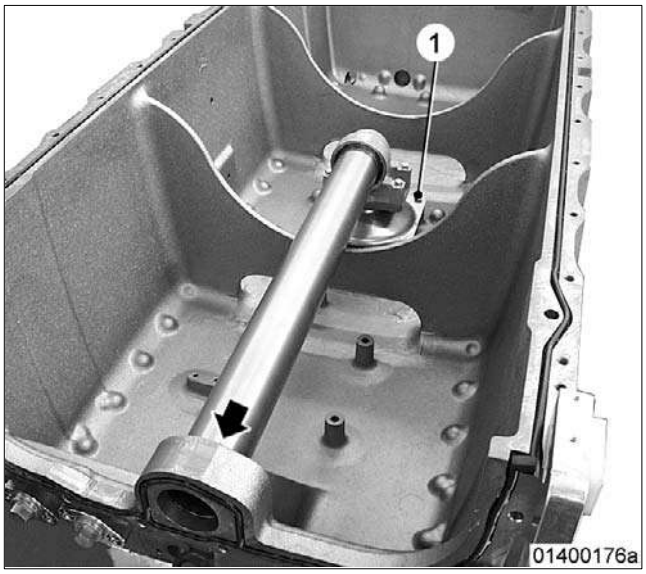


Installing suction basket

Insert O-rings (2) and (4) into groove on connector (3) or fit on intake pipe and coat with petroleum jelly.

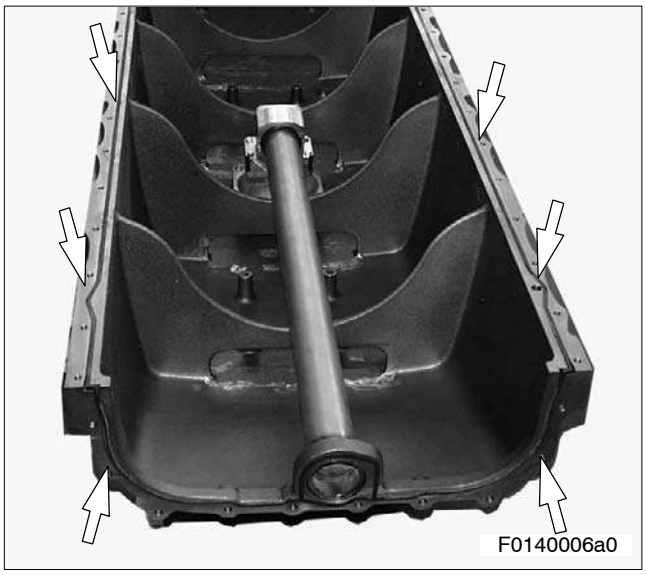
Clean mating face (arrow) on suction basket (1) and install connector on suction basket – see also Overview drawing C014.05.01.

Fit intake pipe in connector.



Press suction basket with connector and intake pipe into oil pan (arrow).

Install hex screws (1) with washers and tighten.

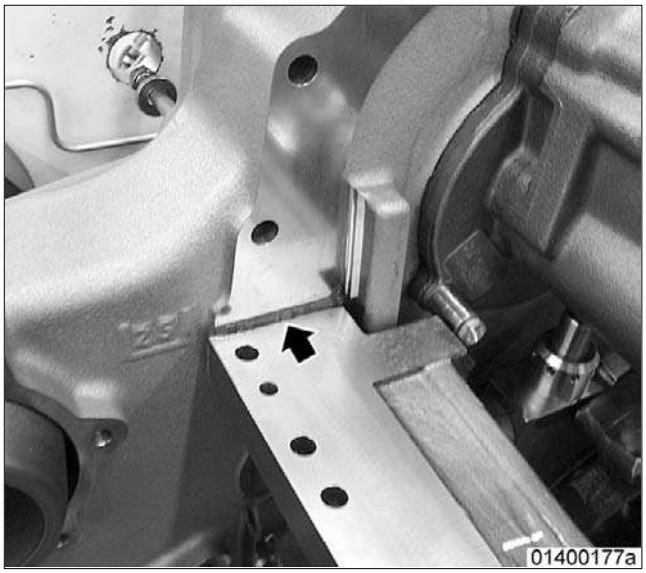


Installing oil pan

Note: Make sure parts are perfectly clean.

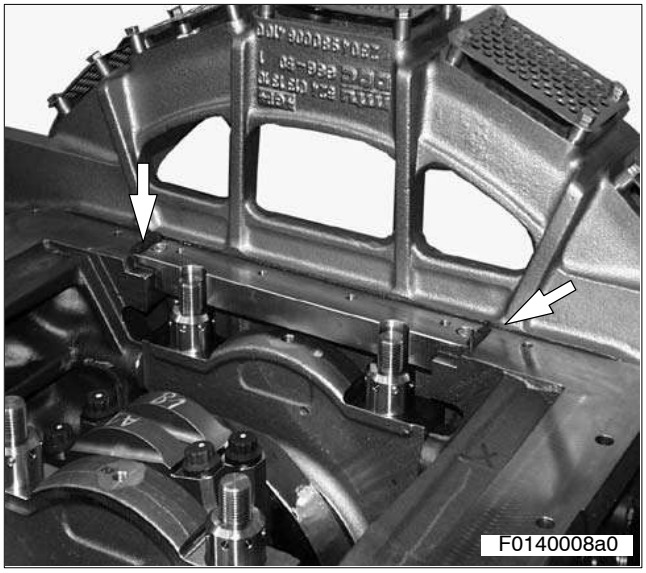
Clean and degrease mating faces on oil pan, on crankcase and on equipment carrier with Loctite cleaning agent.

Insert rubber profile carefully in oil pan groove (see arrow) and coat with petroleum jelly.



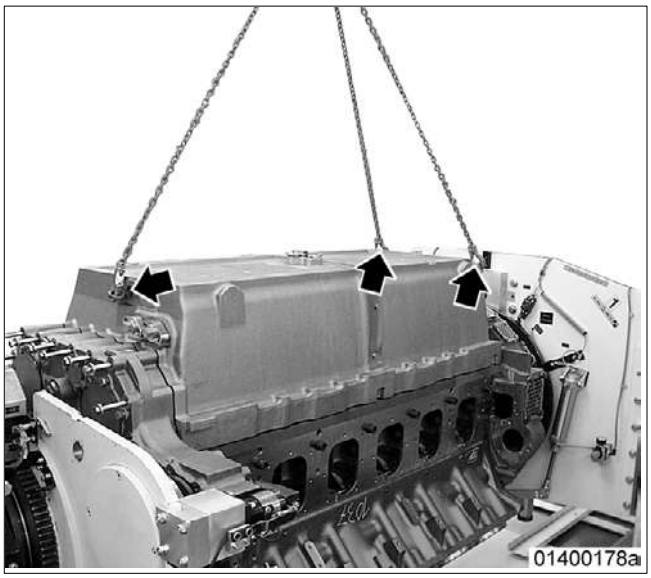
Coat equipment carrier/crankcase butting face with surface sealant (Loctite 5910) on both sides of equipment carrier (arrow), applying a bead of approx. 5 mm.

Attention: Apply surface sealant immediately before installing oil pan.
Surface sealant must not start to dry.



Coat parting line/crankcase with surface sealant 5910 (arrow); apply a bead of approx. 5 mm.

Note: Apply surface sealant 5910 (black) directly before assembly to the oilpan. Surface sealant must not be allowed to dry.



Coat flange surface on equipment carrier with Loctite 518 (red).

Wipe off excess Loctite (red) from free flange surfaces with lint-free cloth, or clean with Loctite cleaner.

⚠ WARNING

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

Insert three suitable eyebolts into oil pan bores for blanking plugs.

Using the lifting ropes and crane, lift the oil pan and carefully place on the mating face of the crankcase. (Align oil pan bores with crankcase bores).

Screw in eyebolts as per tightening diagram (see C 014.05.01) and tighten.

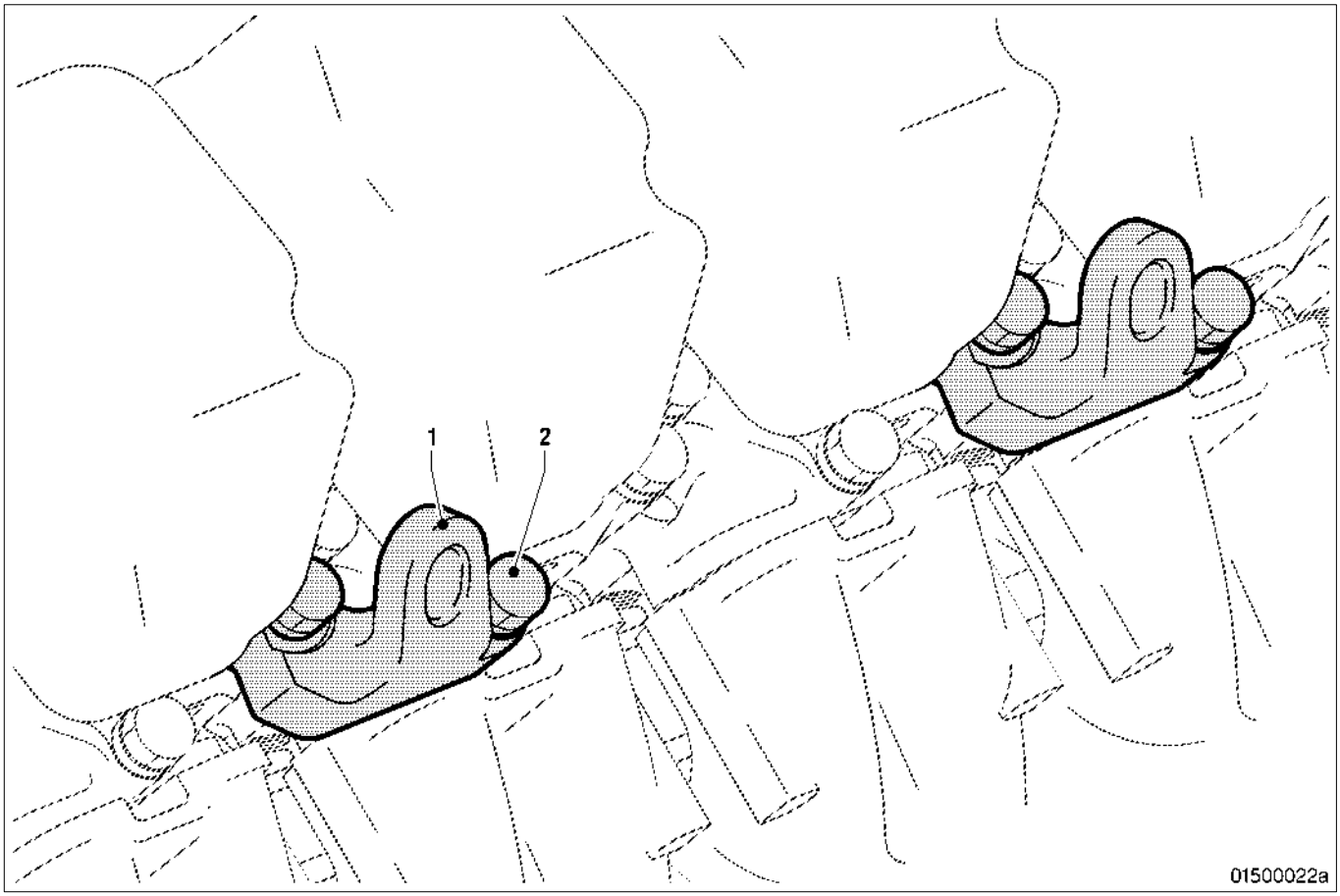
Screw on cover as per Overview drawing – see C 014.05.01.

C014.05.12 After-installation operations

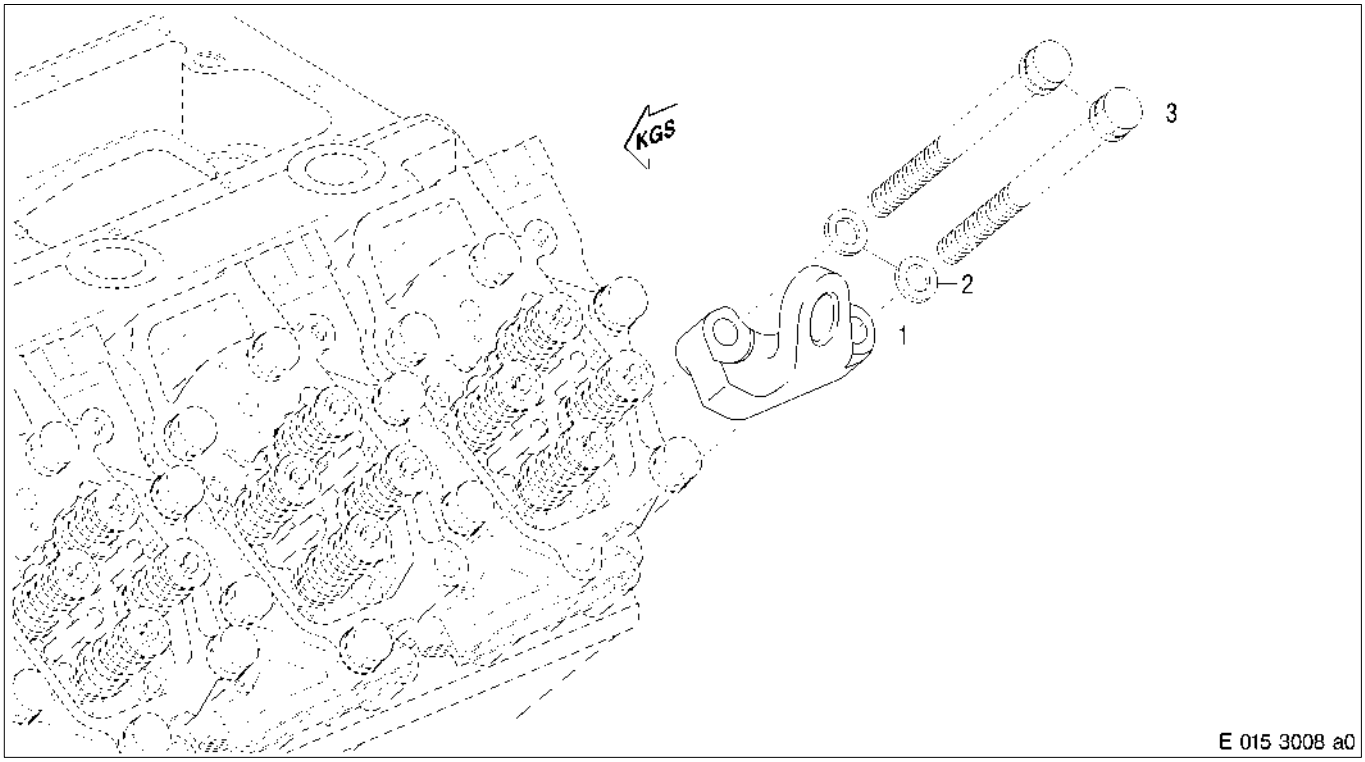
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 014.05.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C015.05 Engine, running gear suspension

C015.05.01 Overview drawing



Engine lifting device



1 Lifting eye
2 Thrust washer
3 Cylinder head screw

C015.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C015.05.05 Removal

Removing engine lifting attachments

Remove cylinder head screws for lifting eye – see overview drawing C 015.05.01.

Remove cylinder head screws, thrust washer and lifting eye.

C015.05.08 Inspection and repair

Clean all components and visually inspect for damage and defects; repair as necessary.

Using the magnetic crack-testing method with fluorescent powder, check lifting eye for cracks; replace with original spare part if cracks are detected.

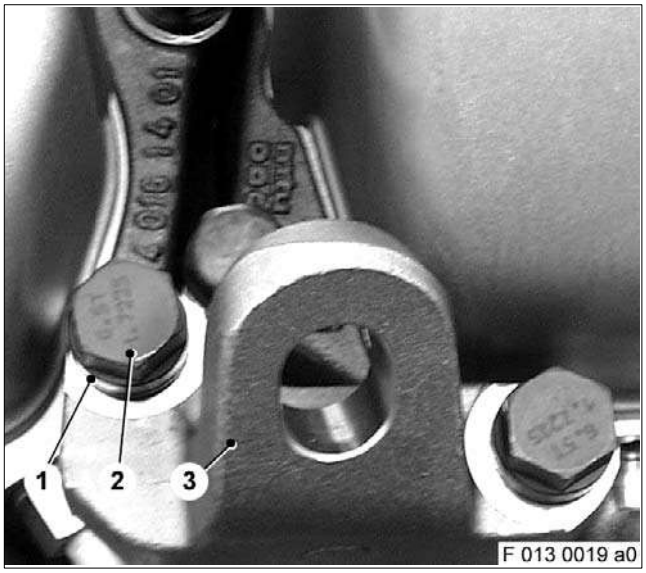
Note: Alignment work or repair welding is not permitted at the lifting eye!

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

Check thread in cylinder head for ease of movement; rechase as necessary.

Check thread and screw head mating face of cylinder head screws, replace if necessary.

C015.05.11 Installation



Installing engine lifting attachment

Place lifting eye (3) on cylinder head edges and align to the bores for the cylinder head screws.

Screw in cylinder head screw (2) with thrust washer (1) and tighten as per tightening specifications – see C 041.05.01.

Note: If only the cylinder head screws at the lifting eye were released, then it is sufficient to tighten **both** of these cylinder head screws to torque / additional angle of rotation in accordance with C 41.05.01.

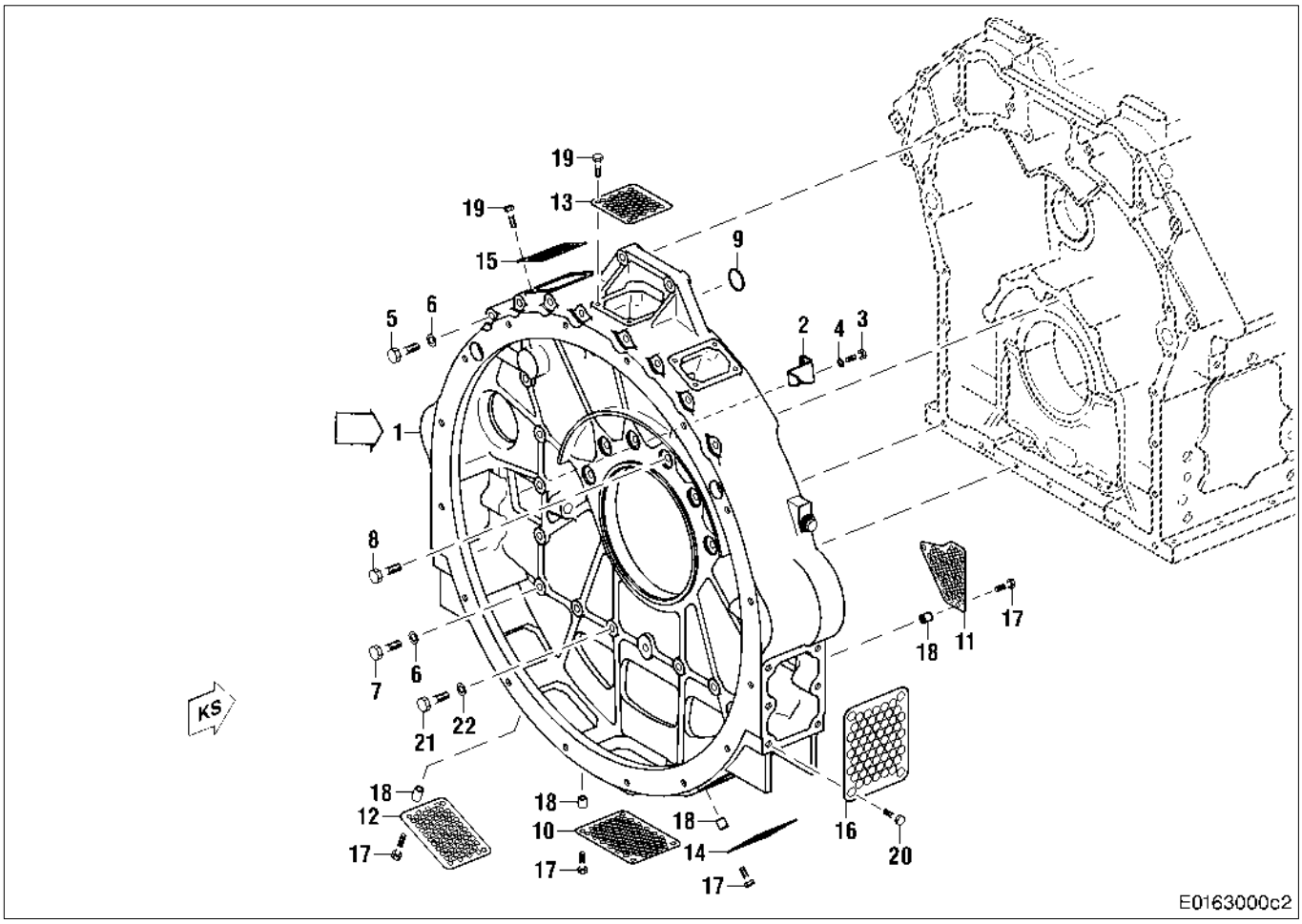
C015.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C016.30 End housing, driving end and free end

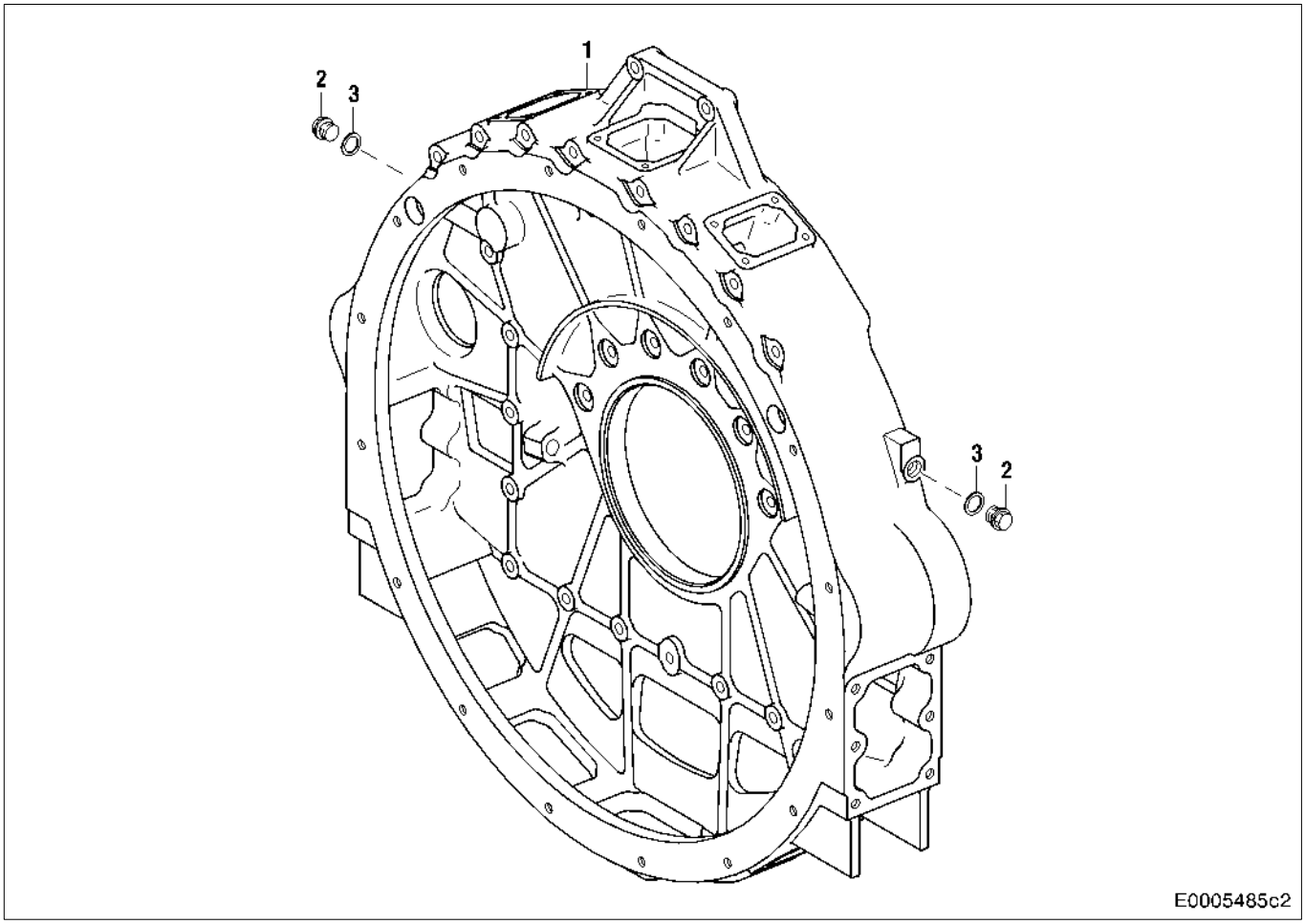
C016.30.01 Overview drawing

Flywheel housing with attachments



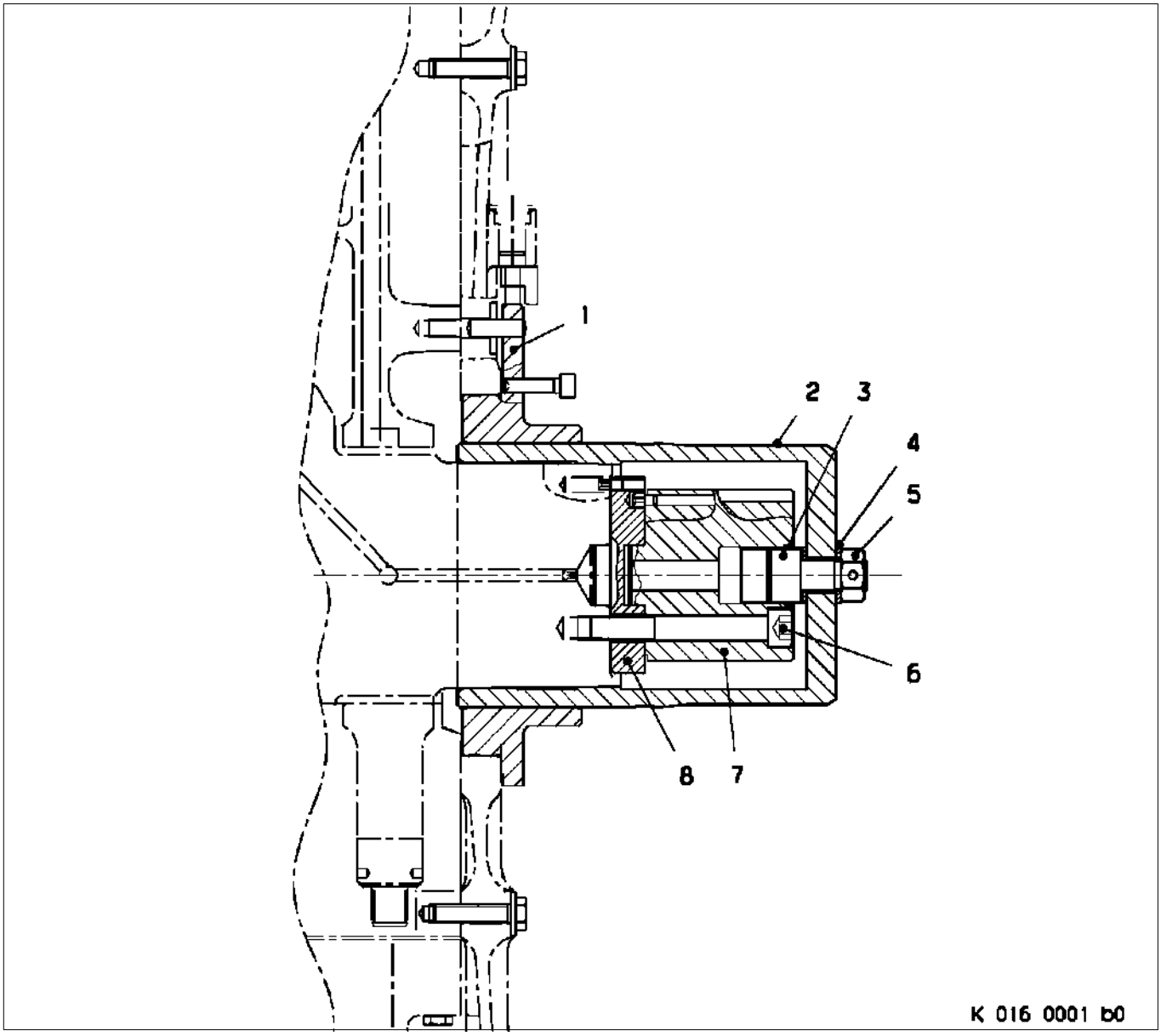
1 Flywheel housing
2 Dead-centre indicator
3 Hex screw
4 Washer
5 Plug
6 Spring washer
7 Hex screw
8 Hex screw
9 O-ring
10 End cover
11 Protective plate
12 Protective plate
13 Protective plate
14 Protective plate
15 End cover
16 Protective plate
17 Hex screw
18 Spacer bush
19 Hex screw
20 Hex screw
21 Hex screw
22 Spring washer

Flywheel Housing



1 Flywheel housing
2 Plug
3 Sealing ring

Guide bush layout for installation / removal of flywheel housing



1 Support
2 Guide bush
3 Guide
4 Washer
5 Nut
6 Socket-head screw
7 Flange
8 Flange

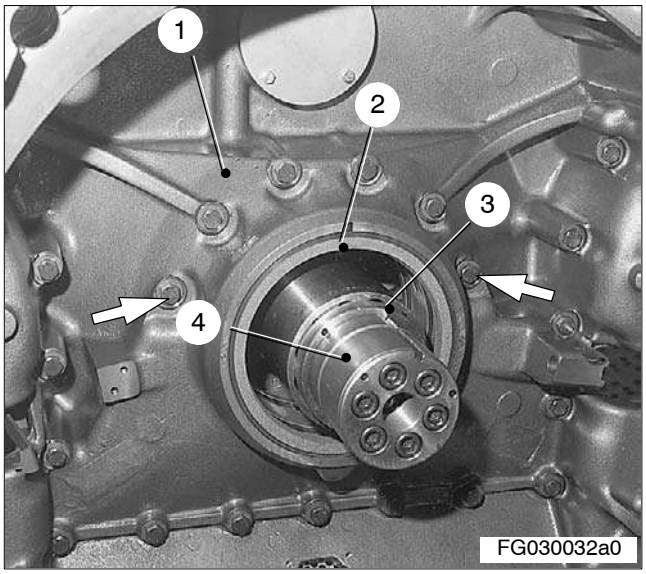
C016.30.02 Special tools

Designation	Use/dimension	Number
• Guide bush	for flywheel housing (short)	1
– Support		1
– Flange		1
– Flange		1
– Socket-head screw	M 16 x 120	6
• Support bracket	for flywheel housing, short and long	1

C016.30.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 (high temperature)	→ Operating Instructions
–	–	x	Drain charge air coolant (low temperature)	→ Operating Instructions
–	–	x	Install appropriate charge air manifold	→ C 124.05.05
x	x	x	Remove starter, right side	→ C 172.05.05
x	x	x	Remove intercooler	→ C 111.05.05
x	x	x	Remove flywheel with graduated disc	→ C 032.20.05

C016.30.05 Removal



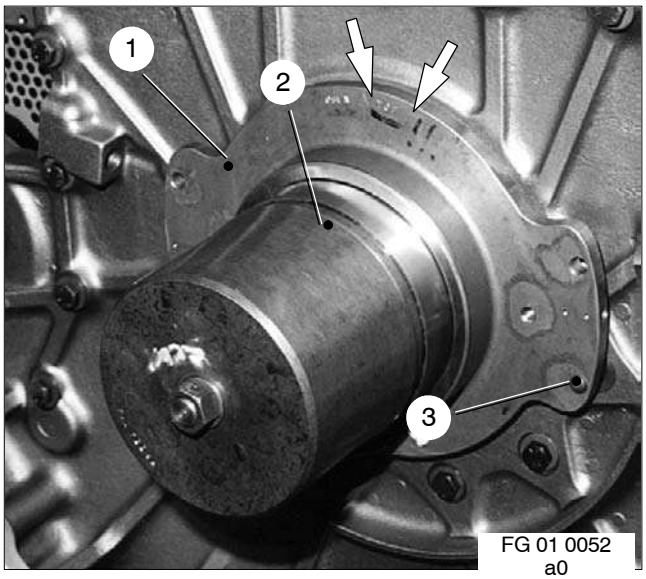
Removing flywheel housing

Note: The engine is turned 180°, i.e. oil pan side is at the top.
Do not damage flywheel housing and crankshaft.

Use a suitable extractor to withdraw radial-lip shaft seal (2) out of flywheel housing (1).

Mount flanges (3 and 4) on crankshaft end.

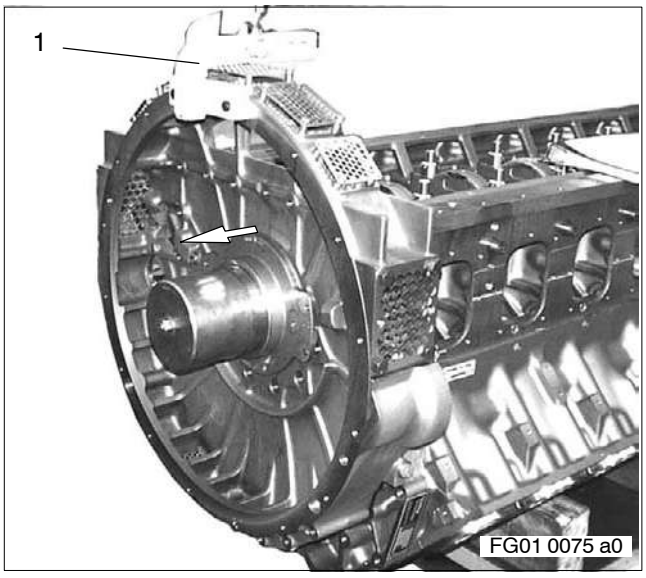
Unscrew the two hex screws marked with an arrow in the flywheel housing inner circle.



Push support (1) onto guide bush (2).

Insert the positioning mandrels (3) of the support in the bores of the hex screws that were previously released and press the support against the flywheel housing as far as it will go.

Note: The marking “TOP – Oben” (arrows) on the front of the guide bush must always face up, independently of the crankcase position.



⚠ WARNING

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

Screw lifting appliance (1) to flywheel housing and, using a lightly tensioned rope, hang onto crane.

Unscrew all of the hex screws that secure the flywheel housing to the crankcase (see overview drawing C 016.30.01).

Remove flywheel housing (in direction of arrow) from crankcase.

C016.30.06 Disassembly

Removing dead-centre indicator, end cover and guard plates

Remove dead-centre indicator, end cover and guard plates as per overview drawing – see C 021.05.01.

C016.30.08 Inspection and repair

Clean all components and visually inspect damage and defects; repair as necessary.

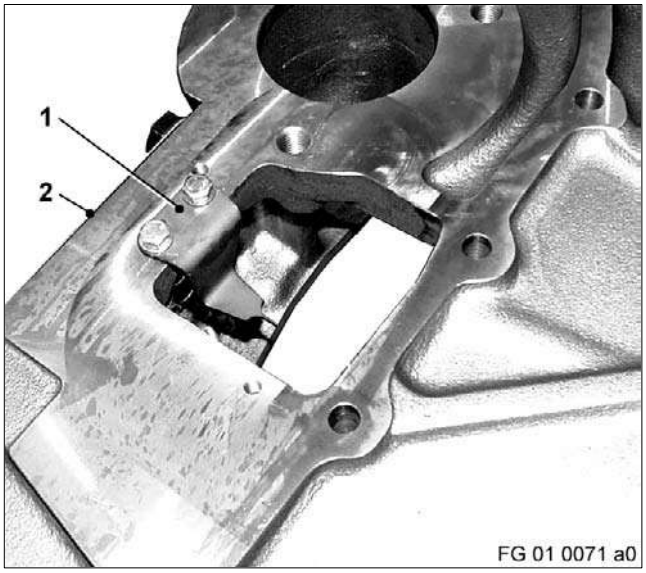
Check dead-centre indicator for damage. Do not straighten dead-centre indicator if it is damaged or bent but replace with a new part.

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.

Replace O-rings and sealing rings at every assembly.

C016.30.10 Assembly

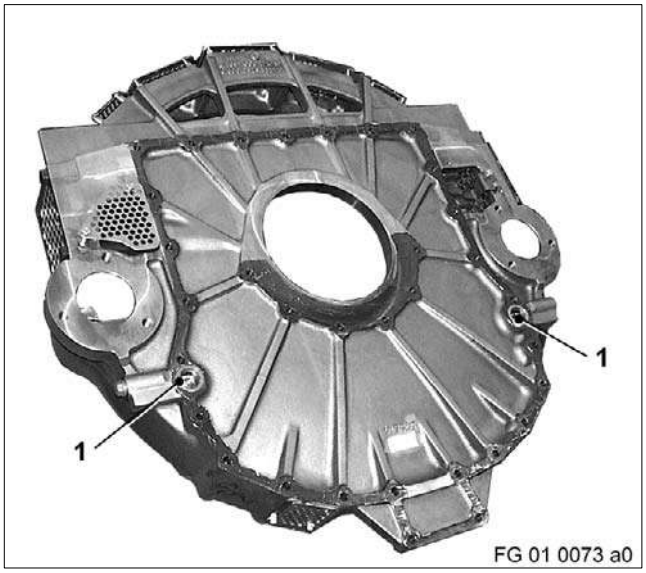


Installing dead-centre indicator, end cover and guard plates

Fit dead-centre indicator (1) to flywheel housing (2).

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

C016.30.11 Installation

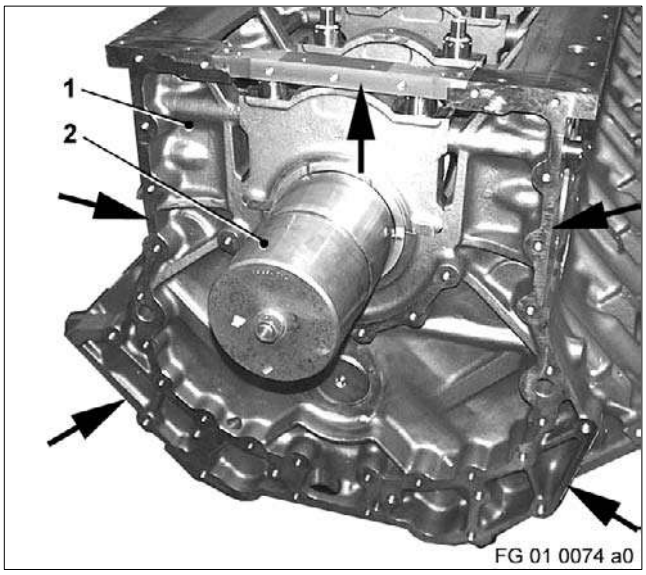


Installing flywheel housing

Clean and degrease sealing surfaces between flywheel housing and crankcase.

Apply surface sealant (Loctite 518) on sealing surface and smoothen.

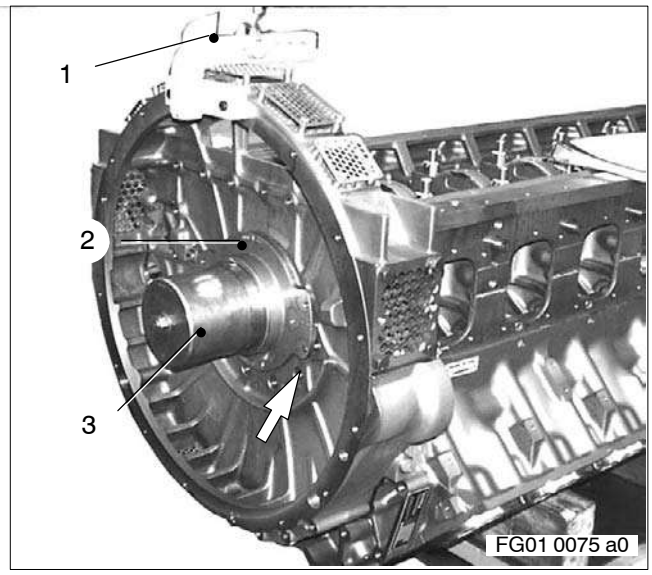
Coat O-rings (1) with petroleum jelly and insert into bores.



Note: In the picture, the engine is turned 180°, i.e. oil pan side is at the top.

Clean and degrease sealing surfaces (arrows) on crankcase.

Screw guide bush (2) onto flange at crankshaft end.



⚠ WARNING

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

Install support (2) on the flywheel housing.

Suspend flywheel housing from crane with lifting gear (1).

Install flywheel housing with support on guide bush (3) and push in direction of crankcase up to stop.

Attention: Note that screws differ in length.

Screw in hex screws for flywheel housing hand-tight (see overview drawing, C 016.30.01).

Tighten two opposing hex screws in the inner circle (arrow) of the flywheel housing to specified torque.

Remove support from flywheel housing.

Fit remaining hex screws.

Tighten all hex screws for securing flywheel housing and crankcase (see overview drawing, C 016.30.01) to specified torque.

Note: First tighten hex screws in inner circle of flywheel, then tighten screws in outer circle of flywheel housing.
Proceed clockwise.

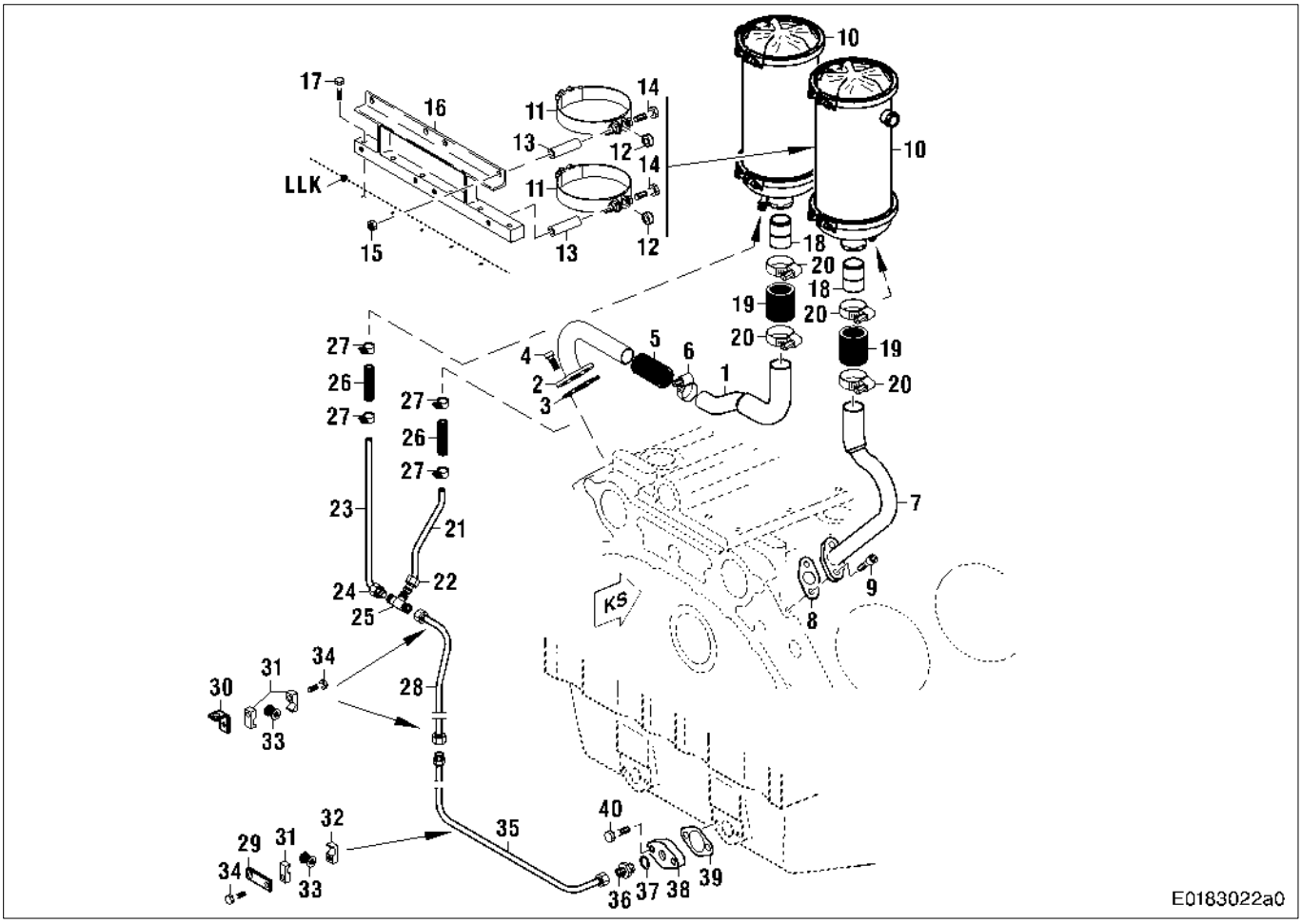
Install radial-lip shaft seal in flywheel housing – see C 032.05.10.

C016.30.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 016.30.04
–	–	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C018.10 Crankcase ventilation

C018.10.01 Overview drawing, driving end

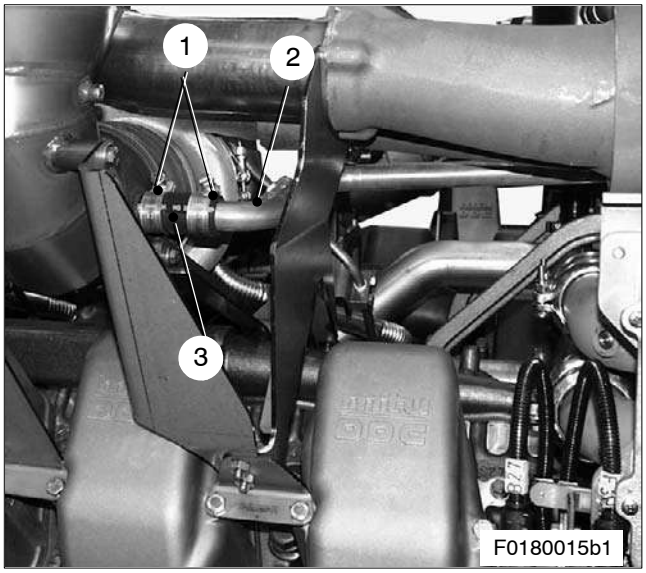


1 Pipeline
2 Pipeline
3 Gasket
4 Socket-head screw
5 Rubber sleeve
6 Clamp
7 Pipeline
8 Gasket
9 Hexagon socket screw
10 Oil separator
11 Clamp
12 Washer
13 Spacer bushing
14 Hex screw
Tightening torque: 20 Nm + 2 Nm
15 Hex nut
16 Bracket
17 Hex screw
18 Guide sleeve
19 Rubber sleeve
20 Clamp
21 Pipeline
22 Nut
23 Pipeline
24 Nut
25 T-piece
26 Rubber sleeve
27 Clamp
28 Pipeline
29 Bracket
30 Bracket
31 Pipe clamp half
32 Pipe clamp half
33 Grommet
34 Hex screw
35 Pipeline
36 Reduction union
37 Sealing ring
38 Flange
39 Gasket
40 Hex screw

C018.10.04 Before-removal operations

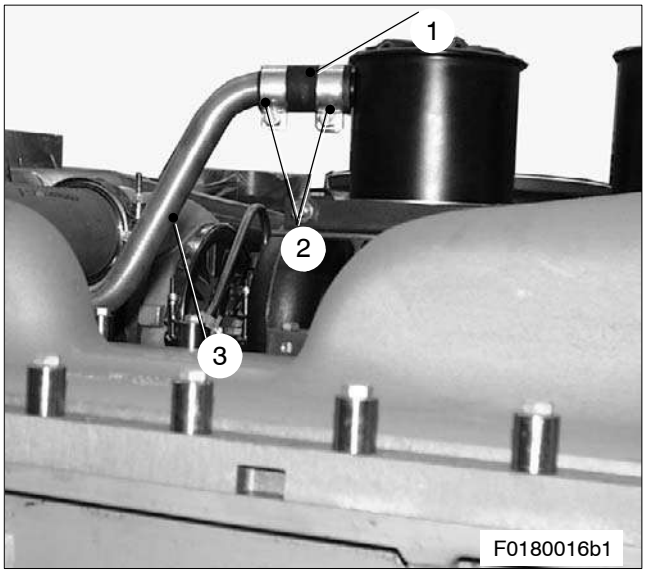
For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C018.10.05 Removal



Release clamps (1) and fit rubber sleeve (3) over remaining pipe end (2).

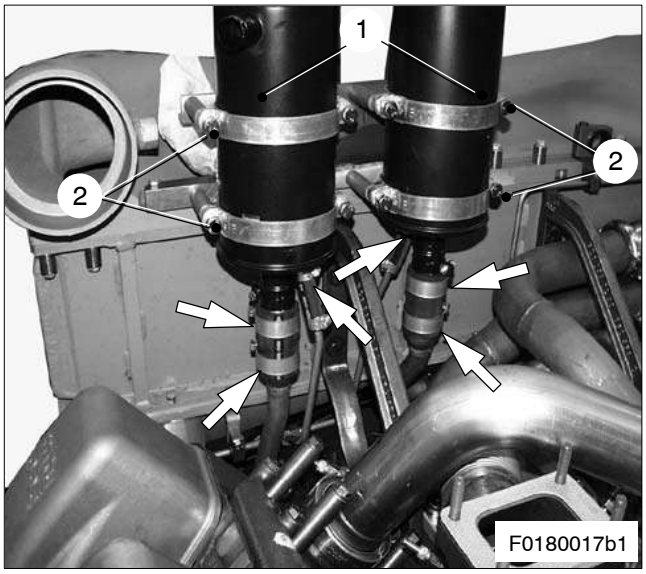
Note: Dismantling refers to engine side, left and right.



Release clamps (2) and fit rubber sleeve (1) over remaining pipe end (3).

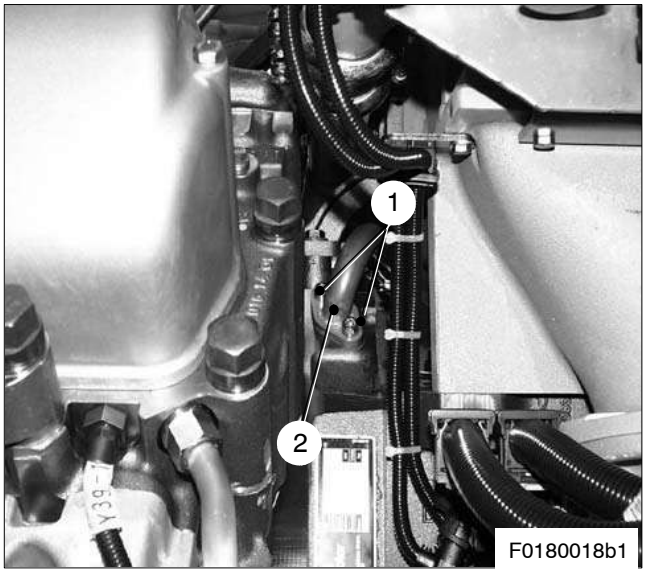
Remove piping system.

Note: Dismantling refers to engine side, left and right.

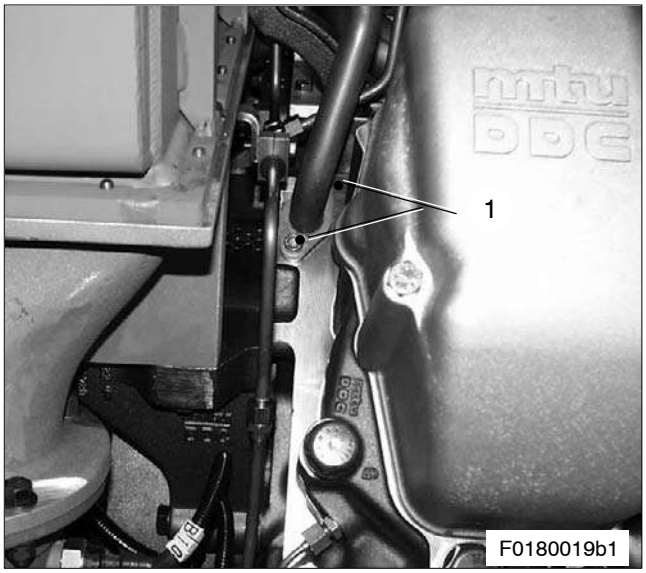


Release clamps (arrow) and fit rubber sleeves over remaining pipe.

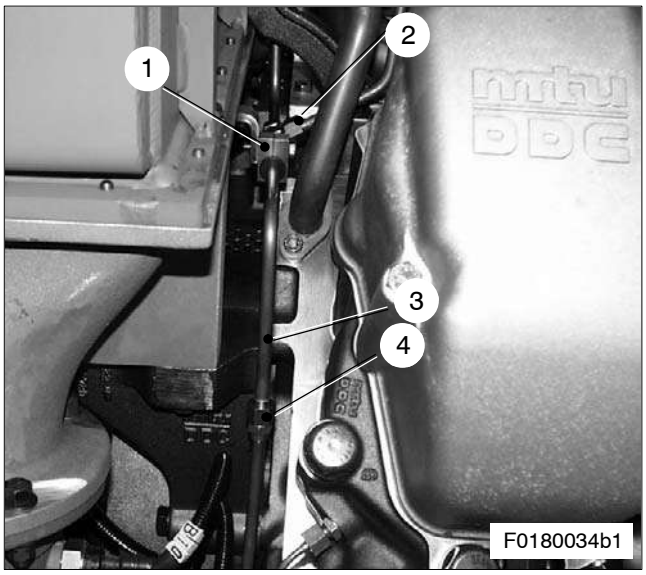
Unscrew hex screws (2), remove clamps with oil separator (1) and spacer sleeves.



Unscrew hex sockets (1) and remove piping system (2), left engine side.

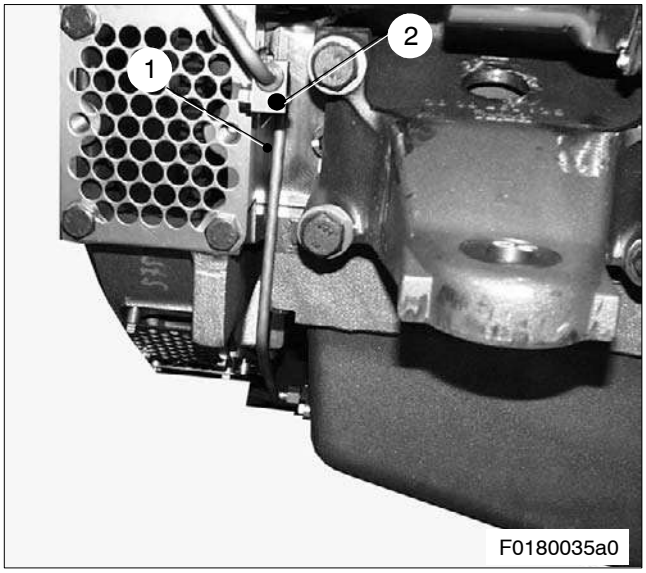


Unscrew hex sockets (1) and remove piping system, right engine side.

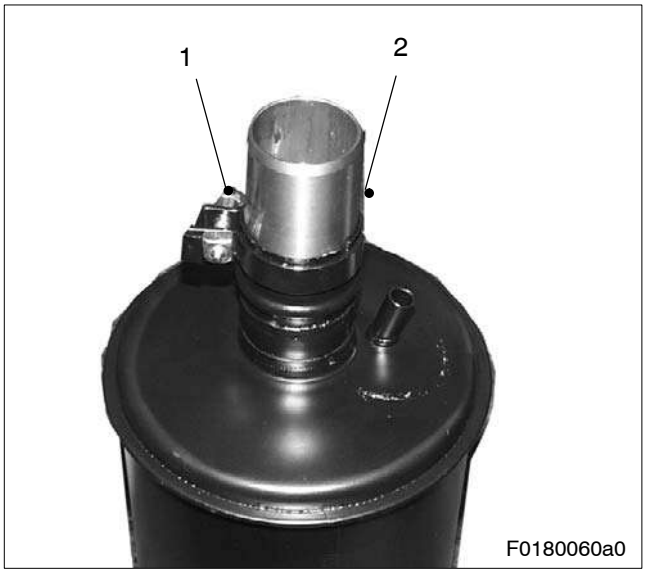


Disconnect piping system (2) at T-piece.

Remove pipe clamp halves (1), disconnect line (3) at partition area (4) and remove.



Remove pipe clamp halves (2), disconnect line (1) at partition area to oil pan and remove.



Unscrew hex screw (1), withdraw sleeve (2) from oil separator and remove.

Note: Sleeve is not included in scope of delivery of new oil separator.

Note: After removal, seal all connections with suitable plugs.

C018.10.08 Inspection and repair

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

Clean all components.

Replace oil separator.

Dispose of parts in accordance with local regulations.

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

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

Check pipes for damage, repair if necessary. Check for leaks in water bath, using compressed air which contains 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.

WARNING

Hydrochloric acid is extremely caustic. Risk of injury and suffocation!
Do not allow hydrochloric acid to come into contact with eyes, clothing or skin. Do not inhale.
Always wear protective clothing, protective gloves and protective goggles/safety mask.
Ventilate working area well.

After welding or hot-bending pipework, allow pipework to cool slowly and then pickle with a hydrochloric acid solution (9 parts water and 1 part hydrochloric) .

Pickling period up to 2 hours depending on layer of scale or rust.

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 pickling, wash lines with hot water and blow dry with compressed air.

Preserve lines in oil bath and allow to drip dry.

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

Replace gaskets and O-rings.

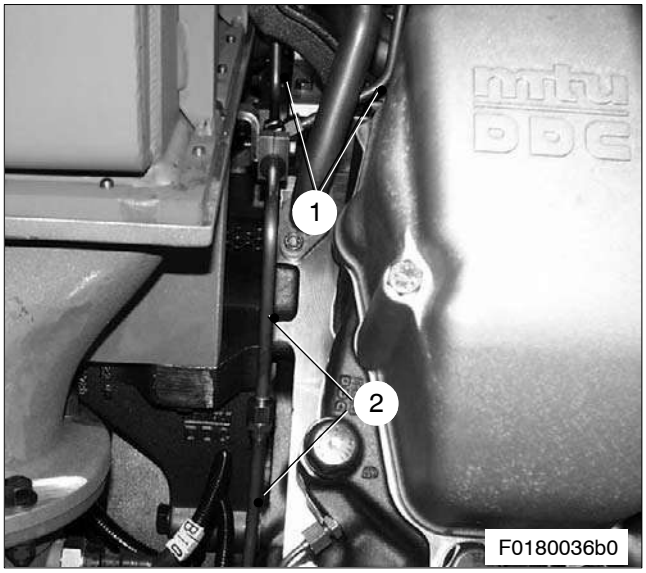
C018.10.11 Installation

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

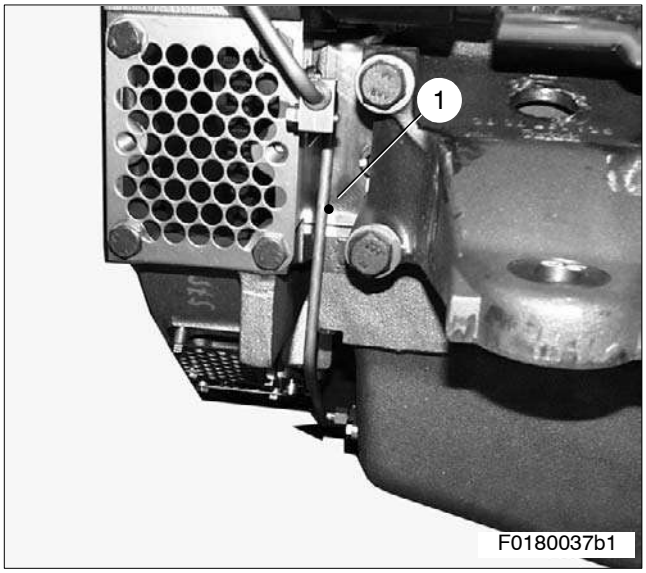
Engine side, right

Fit pipe (arrow) with new gasket, see overview drawing C 018.05.01.

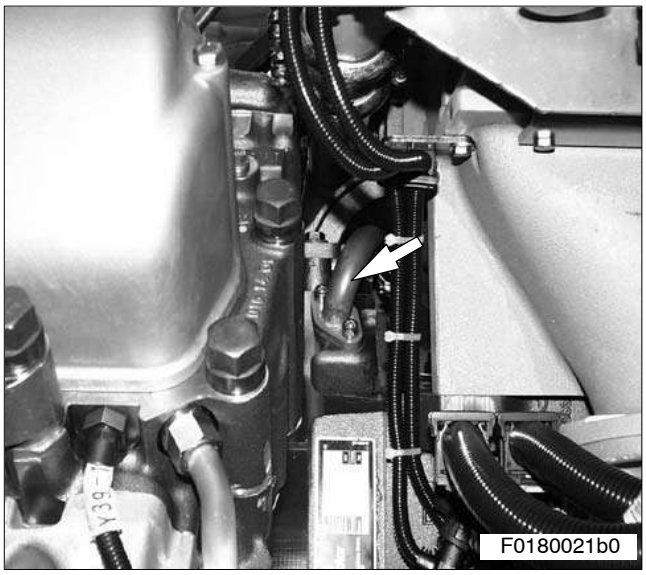
Slide rubber sleeves over pipe end and loosely fit clamps over rubber sleeve.



Ensure pipes (1) and (2) are free of tension when installed. Mount pipe clamp halves with rubber grommet and hex screw.
Tighten nuts on piping system.



Ensure pipework (1) is free of tension when installed. Mount pipe clamp halves with rubber grommet and hex screw. Tighten nuts on piping system.
Hold reduction union firmly in position.



Engine side, left

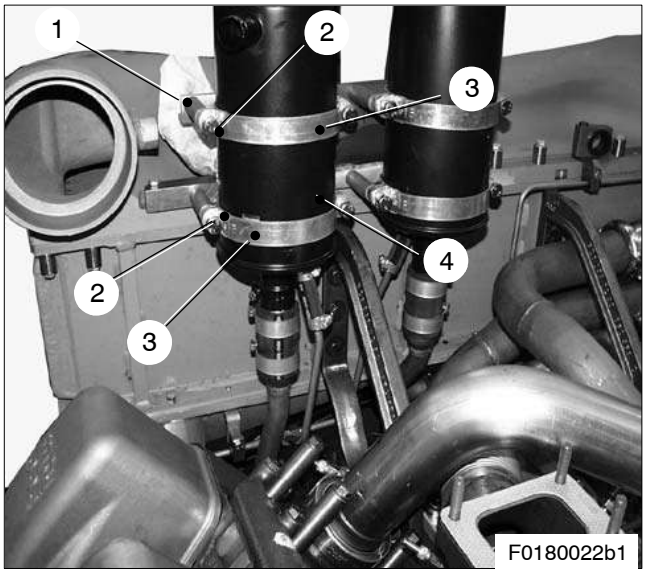
Fit pipe (arrow) with new gasket, see overview drawing C 018.05.01.

Slide rubber sleeves over pipe end and loosely fit clamps over rubber sleeve.

Coat O-ring (arrow) with denaturated ethanol. Insert sleeve, see next illustration.

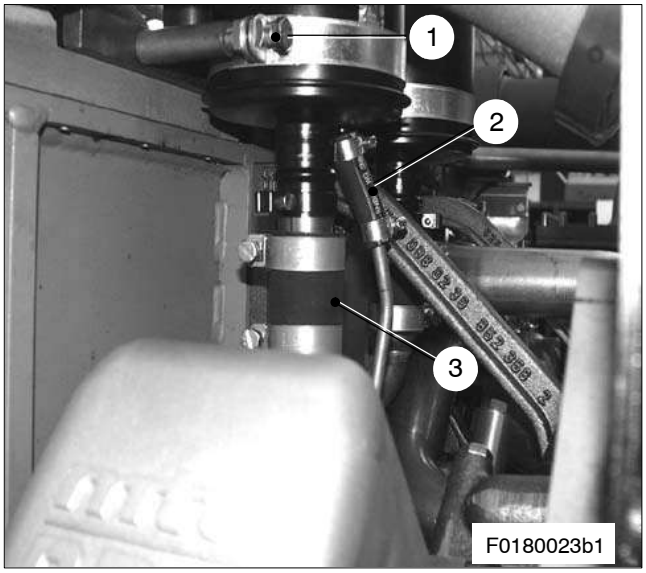
Note: Denaturated ethanol acts as an anti-friction coating during fitting.

Insert sleeve (1) and tighten with hex screw (2).



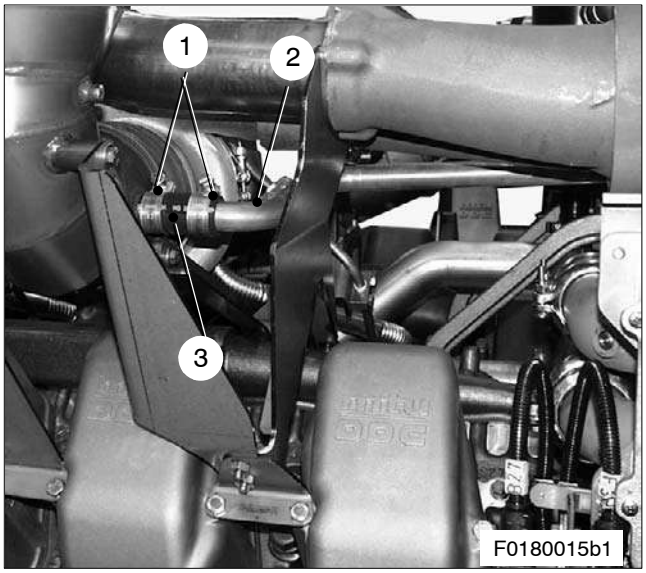
Mount clamps (3) with spacer sleeves (1) and hex screws (2) on intercooler retainer but do not fully tighten.

Mount oil separator (4) and align, see overview drawing C 018.05.01.



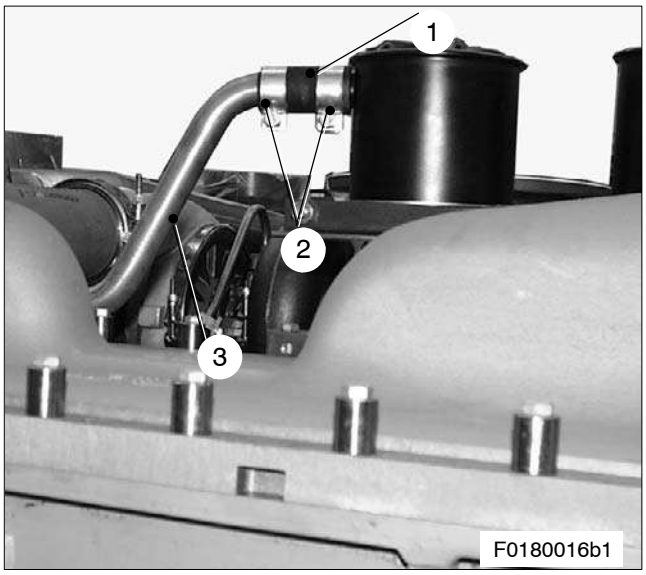
Fit rubber sleeves (2) and (3) over the pipe ends and tighten using suitable pipe clamps, see overview drawing C 018.05.01.

Tighten hex screws (1) as shown in overview drawing C 018.05.01 to specified tightening torque.



Mount rubber sleeve (3) with clamps (1).

Note: Installation refers to engine side, left and right.
Ensure that pipe (2) is installed free of tension.



Mount rubber sleeve (1) with clamps (2).

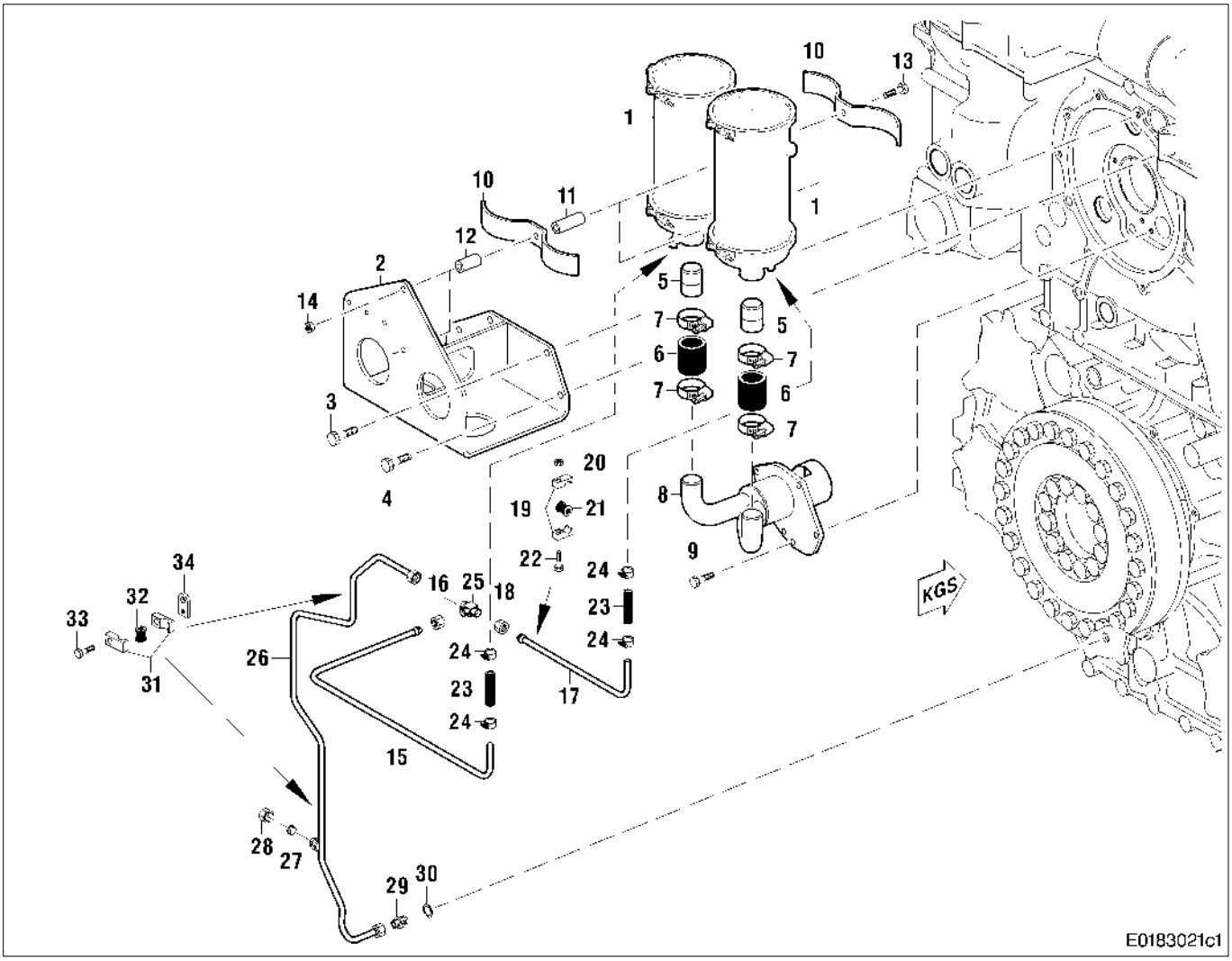
Note: Installation refers to engine side, left and right.
Ensure that pipe (3) is installed free of tension.

C018.10.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C018.10a Crankcase ventilation

C018.10.01a Overview drawing, free end

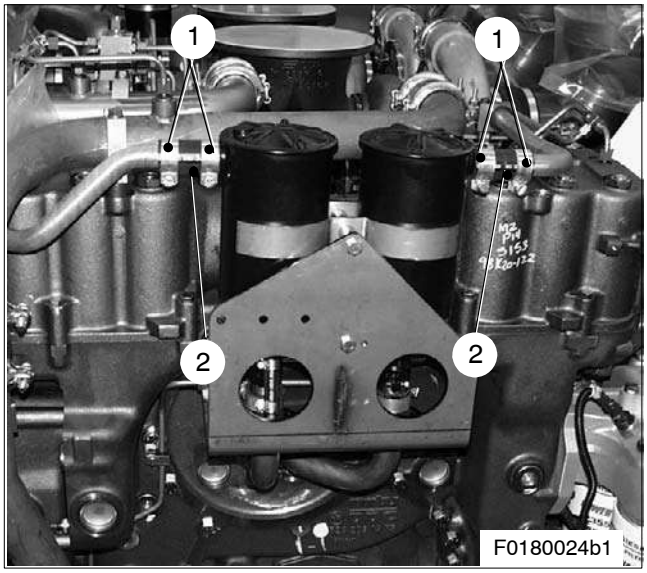


1 Oil separator
2 Bracket
3 Hex screw
4 Hex screw
5 Guide sleeve
6 Rubber sleeve
7 Clamp
8 Pipe
9 Hex screw
10 Clamp
11 Spacer sleeve
12 Spacer sleeve
13 Hex screw
14 Hex nut
15 Oil line
16 Nut
17 Oil line
18 Nut
19 Pipe clamp half
20 Hex nut
21 Grommet
22 Hex screw
23 Rubber sleeve
24 Clamp
25 T-piece
26 Oil line
27 Sealing cone
28 Nut
29 Reduction union
30 Sealing ring
31 Pipe clamp half
32 Grommet
33 Hex screw
34 Bracket

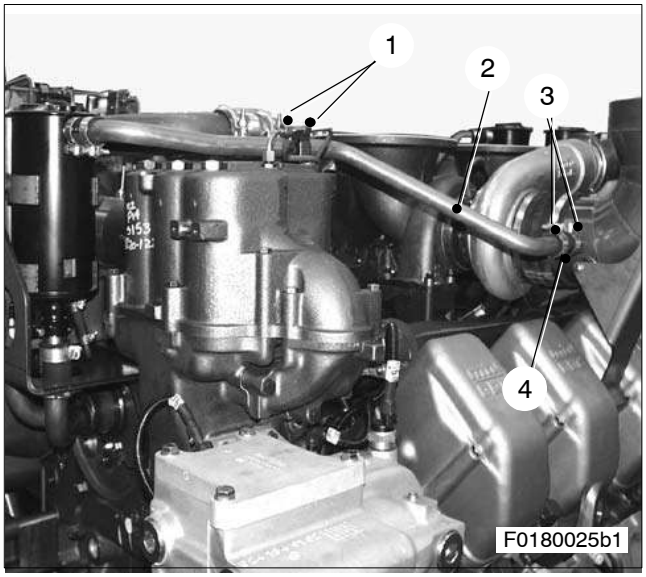
C018.10.04a Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C018.10.05a Removal

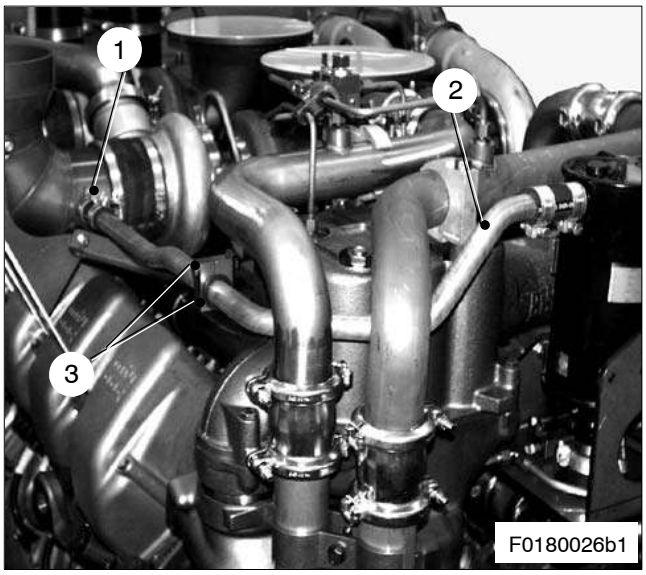


Release clamps (1) and fit rubber sleeves (2) over remaining pipe end.



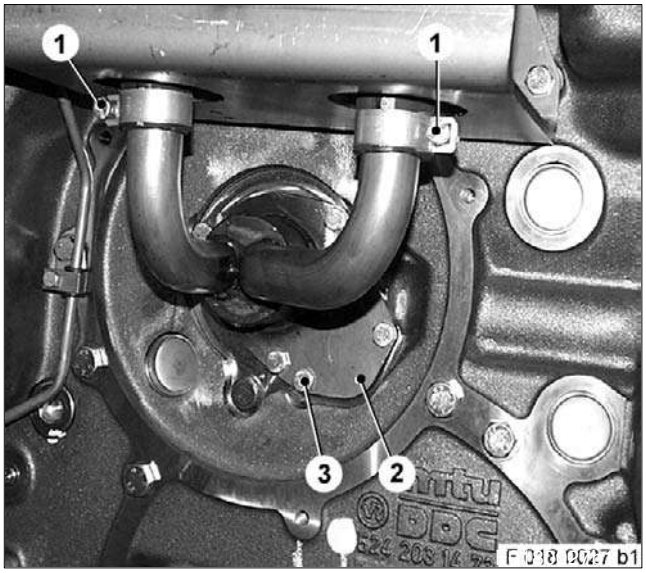
Unscrew hex screws (1), remove pipe clamp halves, release clamps (3) and fit rubber sleeve (4) over the remaining pipe end.

Remove pipe (2) from left engine side.



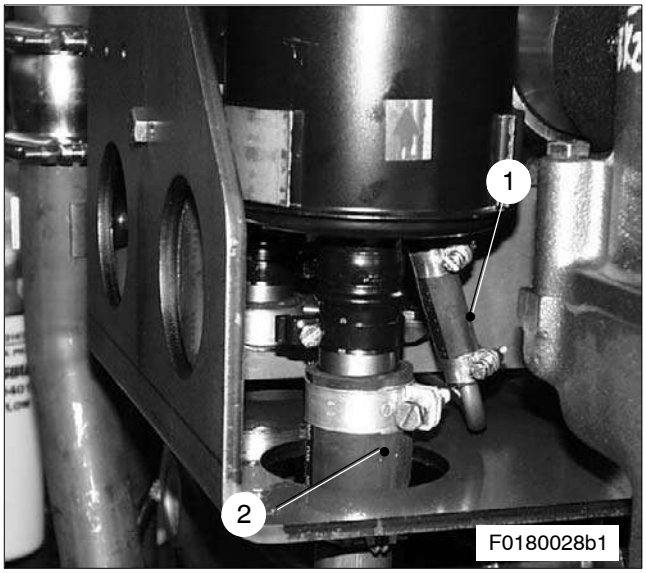
Unscrew hex screws (3), remove pipe clamp halves, release two clamps (1) and fit rubber sleeve over the remaining pipe end.

Remove pipe (2) from right engine side.

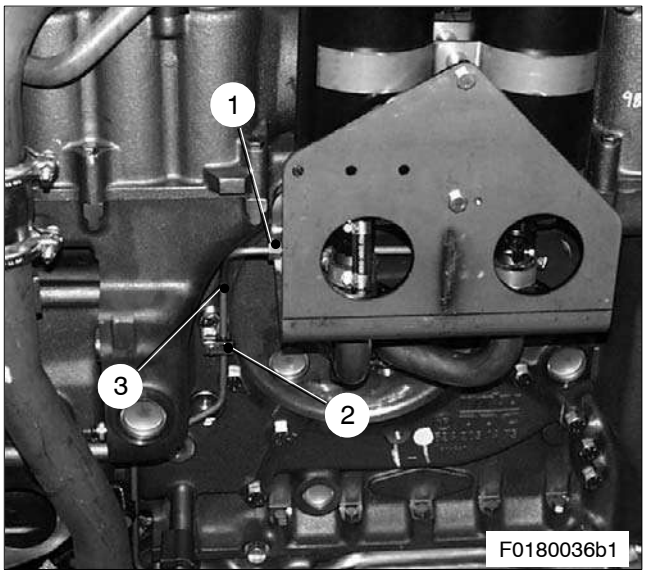


Release hex screws (1) from clamps.

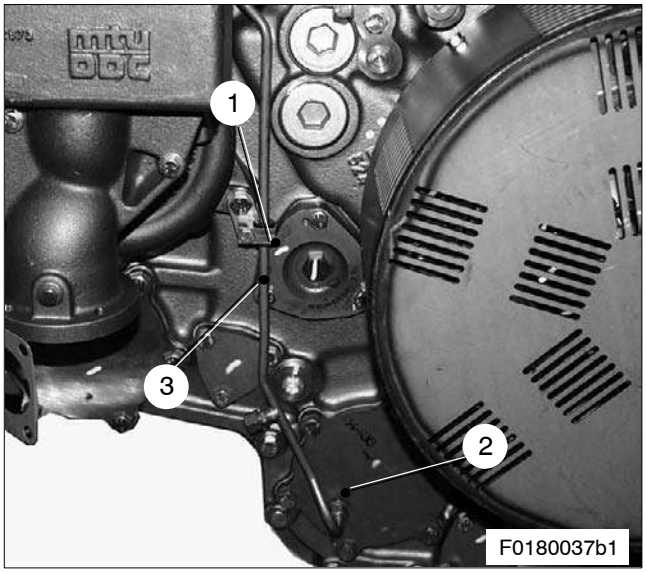
Unscrew hex screws (3) from pipe retainer (2), press off pipe retainer to remove.



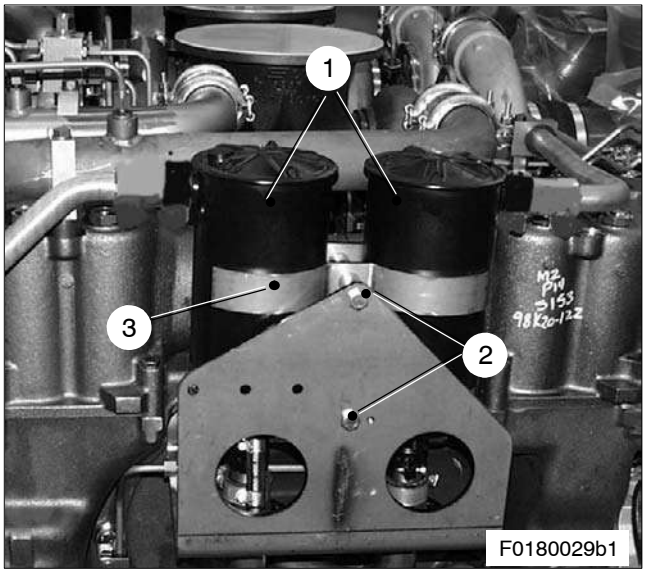
Release clamp(s) from rubber sleeve(s) (1) and (2). Fit rubber sleeve(s) over remaining pipe(s).



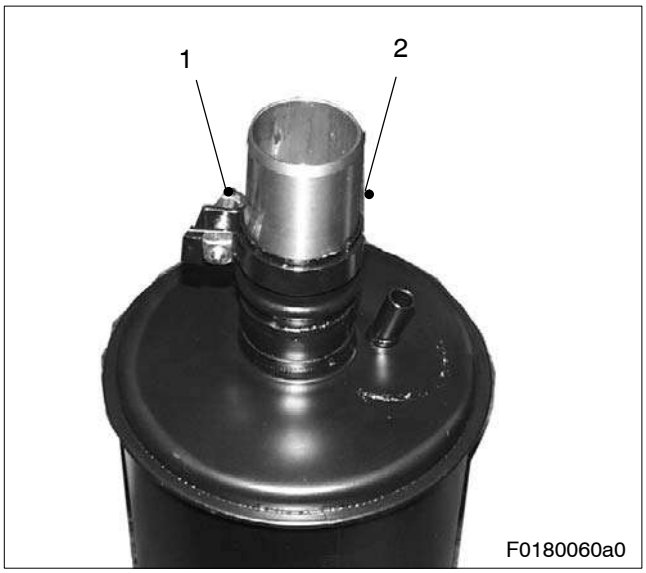
Remove pipe clamp halves (2) and separate pipe (3) from nut (1).



Remove pipe clamp halves (1) and separate pipe (3) from nut (1).



Unscrew hex screws (2), remove clamps (3) with oil separator (1) and spacer sleeves.



Unscrew hex screw (1), withdraw sleeve (2) from oil separator and remove.

Note: Sleeve is not included in scope of delivery of new oil separator.

Note: After removing lines, seal all open connections by installing suitable plugs.

C018.10.08 a Inspection and repair

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

Clean all components.

Replace oil separator.

Dispose of parts in accordance with local regulations.

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

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

Check pipes for damage, repair if necessary. Check for leaks in water bath, using compressed air which contains 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.

WARNING

Hydrochloric acid is extremely caustic. Risk of injury and suffocation!
Do not allow hydrochloric acid to come into contact with eyes, clothing or skin. Do not inhale.
Always wear protective clothing, protective gloves and protective goggles/safety mask.
Ventilate working area well.

After welding or hot-bending pipework, allow pipework to cool slowly and then pickle with a hydrochloric acid solution (9 parts water and 1 part hydrochloric).

Pickling period up to 2 hours depending on layer of scale or rust.

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 pickling, wash lines with hot water and blow dry with compressed air.

Preserve lines in oil bath and allow to drip dry.

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

Replace gaskets and O-rings.

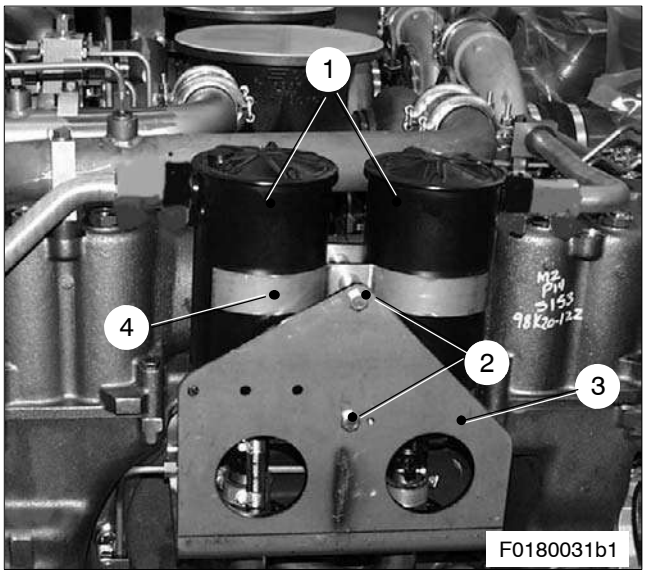
C018.10.11a Installation

Note: Prior to installation, remove all plugs and ensure they are perfectly clean.
Install all pipes tension-free.

Coat O-ring (arrow) with denaturated ethanol. Insert sleeve, see next illustration.

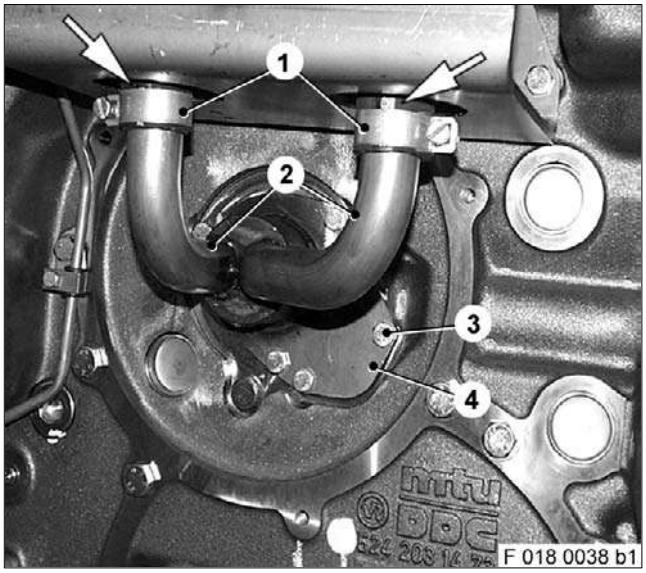
Note: Denaturated ethanol acts as an anti-friction coating during fitting.

Insert sleeve (1) and tighten with hex screw (2).



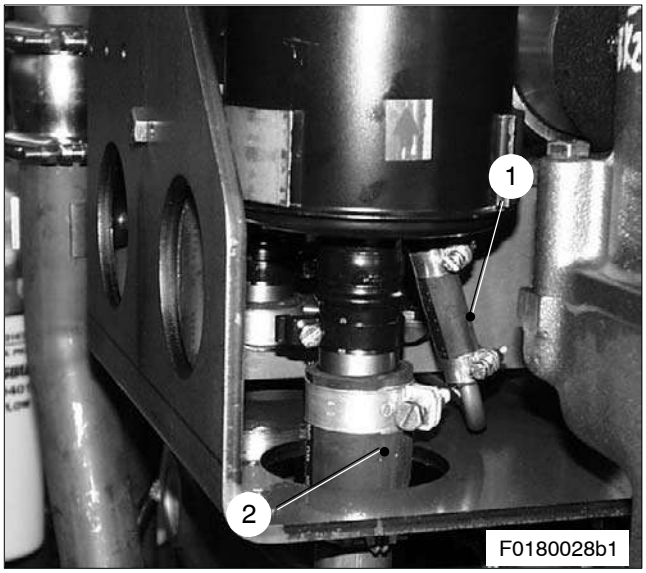
Mount clamps (4) with spacer sleeves (arrow) and hex screws (2) on retainer (3) do not fully tighten.

Mount oil separator (1) and align, see overview drawing C 018.05.01.a.

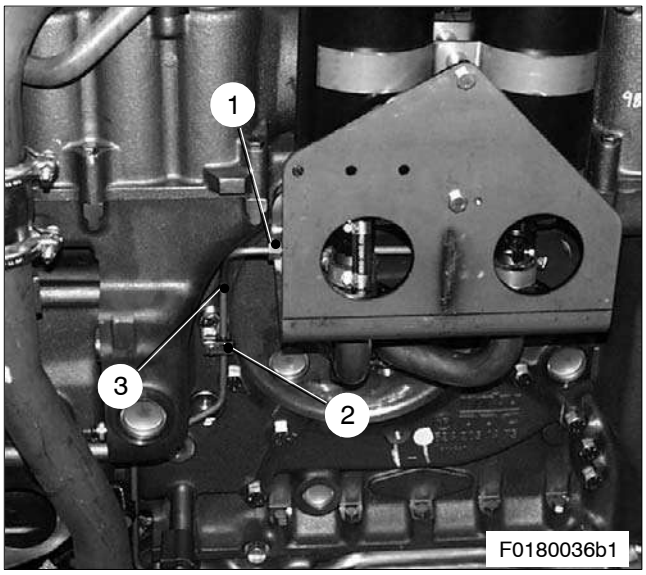


Check mounting surface, clean if necessary.

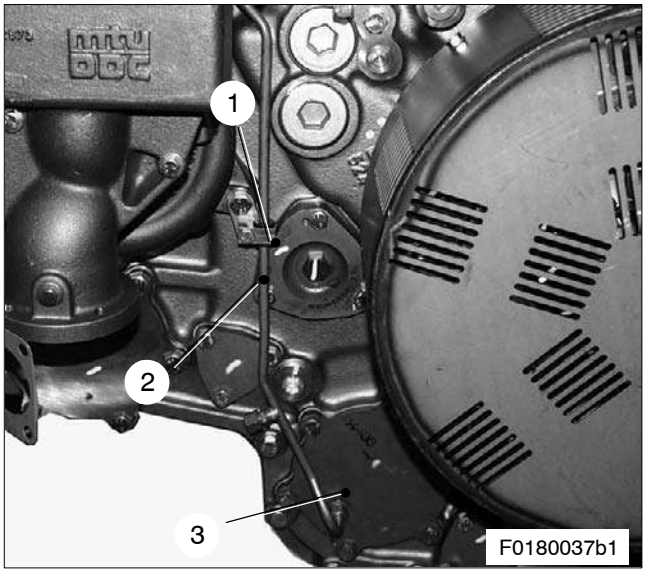
Coat mounting surface of pipe retainer (4) with Loctite 5910 and fit pipe retainer with hex screws (3) on coolant distribution housing. Fit rubber sleeve(s) (arrow) over the pipe(s) (2) and mount with clamp(s) (1).



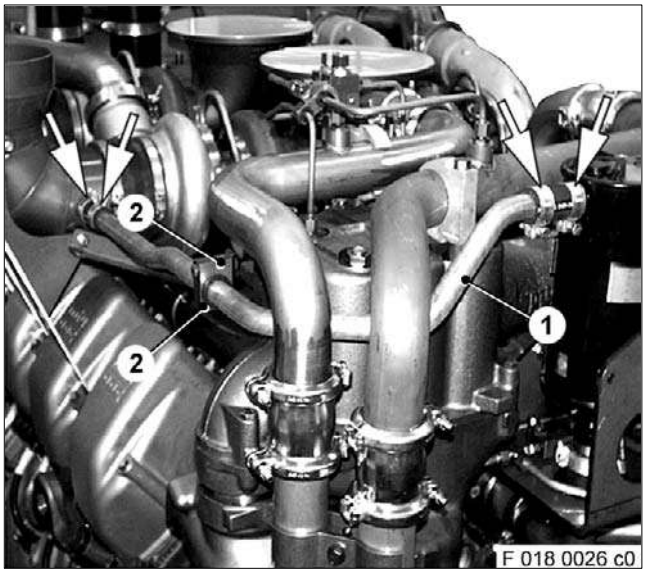
Fit rubber sleeves (1) and (2) over the respective joining sockets and secure with clamps, see overview drawing C 018.05.01 a.



Mount pipe (3) with pipe clamp halves (2) and pipe loosely at the partition area (1).



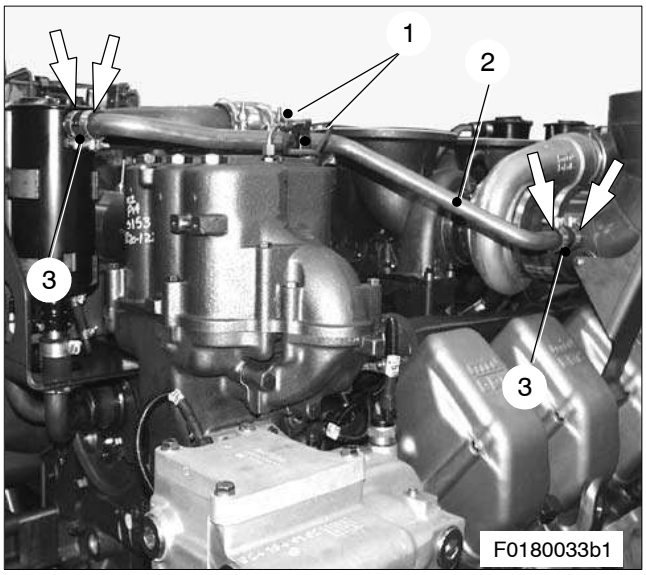
Mount pipe (2) with pipe clamp halves (1) on equipment carrier.
Tighten nut (3), hold reduction union firmly in position – see overview drawing C 018.10.01a.
Tighten nut and pipe clamp halves, pipe (2) at separations.



Engine side, right

Align pipe (1) and mount pipe clamp halves (2) but do not yet tighten.
Fit rubber sleeves over the pipe ends.

Mount clamps (arrow) and tighten pipe clamp halves with hex screws on heat exchanger housing.



Engine side, left

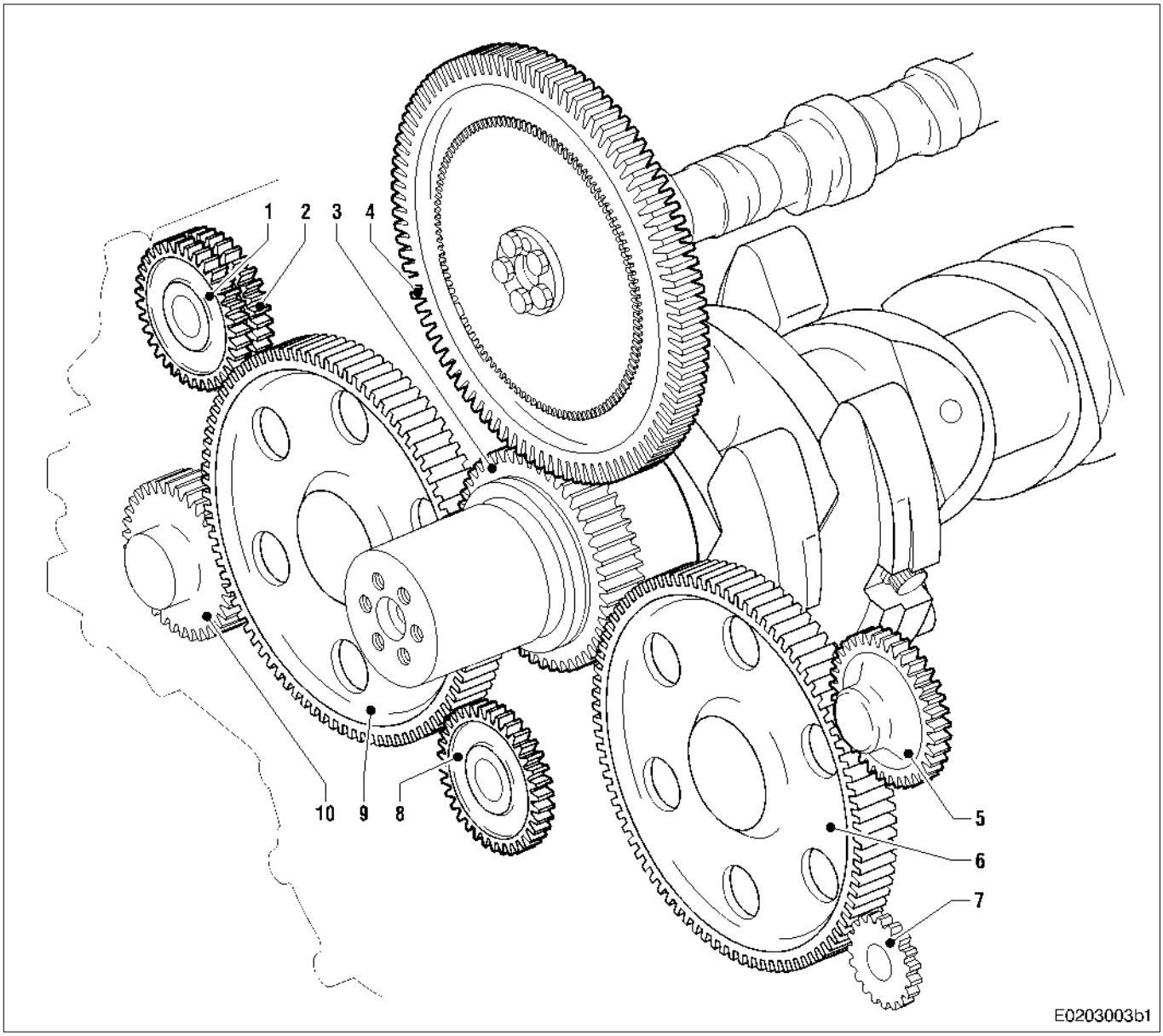
Align pipe (2) and mount pipe clamp halves (1).
Fit rubber sleeves over the pipe ends.

Mount clamps (arrow) and tighten pipe clamp halves with hex screws on heat exchanger housing.

C018.10.12 a After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

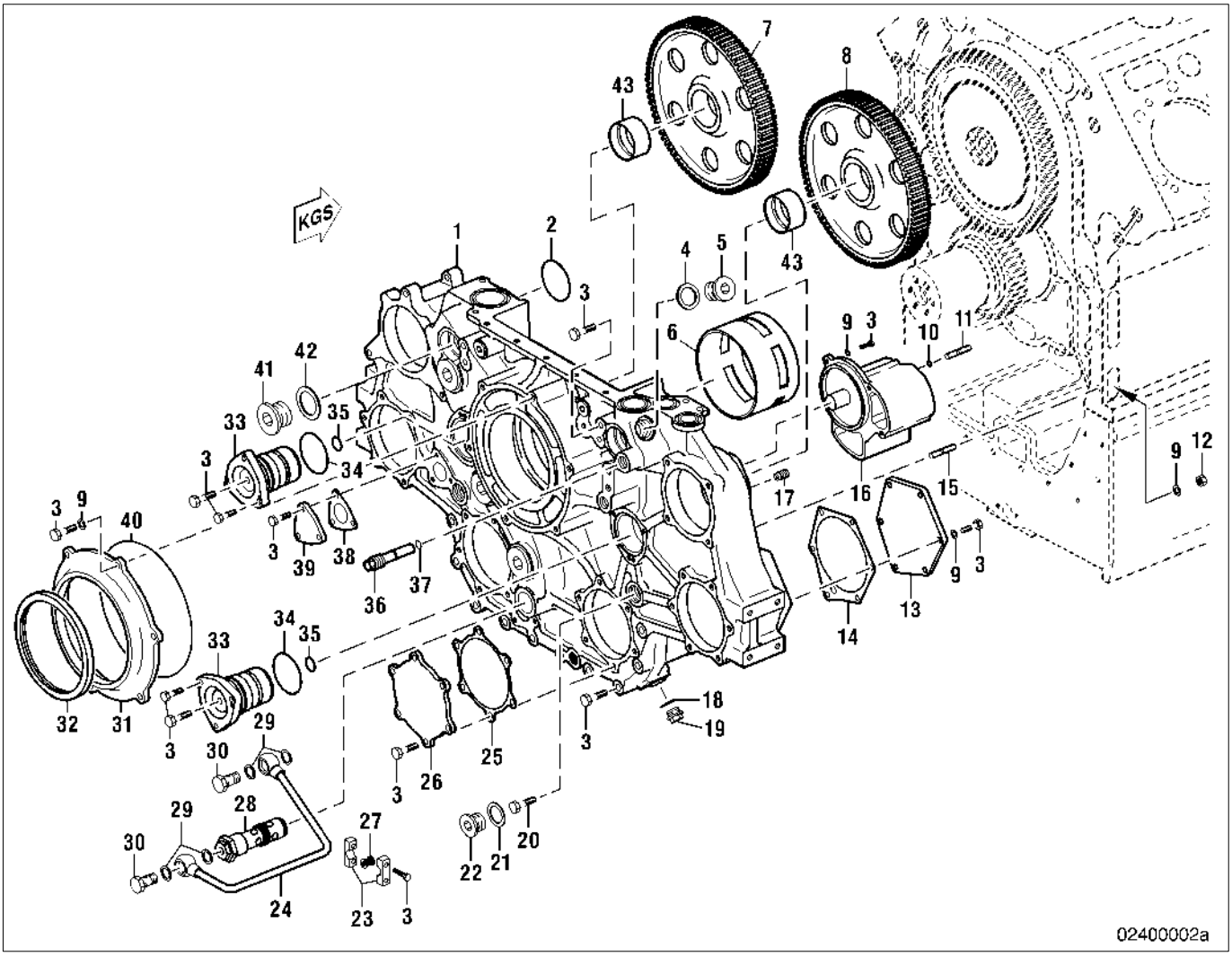
C020 Gear train



		Number of teeth	Tooth backlash (mm)	Axial clearance (mm)
1	Gear, coolant pump, low-temperature circuit	32	0,201 ± 0,065	–
2	Gear, coolant pump, high-temperature circuit	32	0,201 ± 0,065	–
3	Crankshaft gear	48	–	–
4	Camshaft gear	96	0,286 ± 0,081	0.1 to 0.18
5	Gear, H.P. fuel pump	32	0,201 ± 0,065	–
6	Idler gear	89	0,285 ± 0,080	0.2 to 0.6
7	–	–	–	–
8	Gear, oil pump	34	0,279 ± 0,077	–
9	Idler gear	89	0,285 ± 0,080	0.2 to 0.6
10	Gear, generator	19	0,222 ± 0,128	–

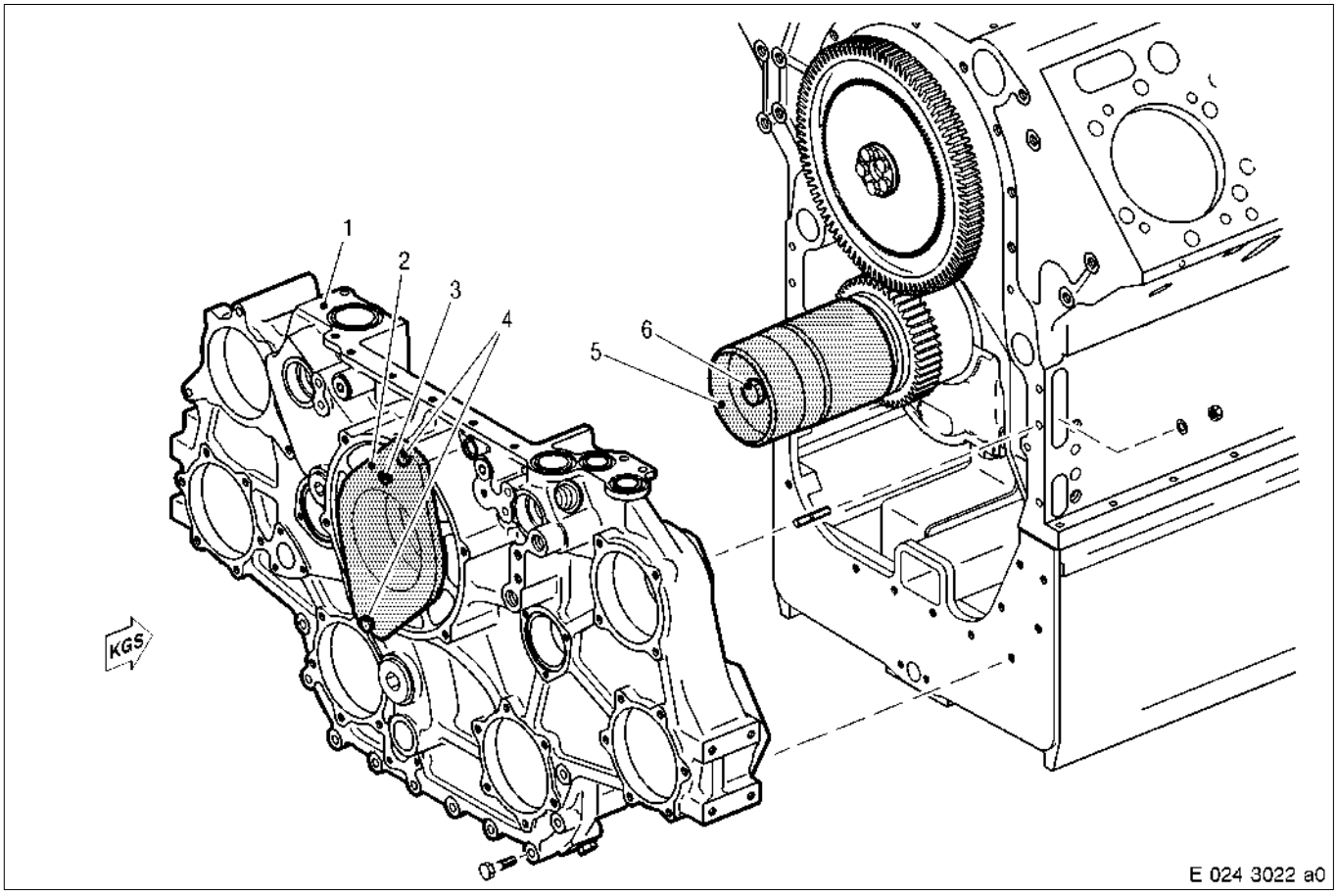
C024.05 Gear case (equipment carrier), free end

C024.05.01 Overview drawing



1	Equipment carrier	12	Hex nut	23	Pipe clamp half/halves	34	O-rIng
2	O-rIng	13	Cover	24	Oil line	35	O-rIng
3	Hex screw	14	Gasket	25	Gasket	36	Drain plug
4	Sealing ring	15	Stud	26	Cover	37	O-rIng
5	Plug	16	Oil pump	27	Grommet	38	Gasket
6	Main bearing, free end	17	Threaded bush	28	Pressure reduction valve	39	Cover
7	Idler gear, right side	18	Sealing ring	29	Sealing ring(s)	40	O-rIng
8	Idler gear, left side	19	Plug	30	Banjo screw	41	Plug
9	Washer	20	Hex screw	31	Seal carrier (free end)	42	Sealing ring
10	Washer	21	Sealing ring	32	Radial-lip shaft seal	43	Bearing bush
11	Stud	22	Plug	33	Axle, intermediate gear		

Arrangement of alignment jig for equipment carrier and equipment carrier cover



1 Equipment carrier
2 Alignment tool
3 Marking, top
4 Hex screw
5 Guide bush
6 Hex screw

C024.05.02 Special tools

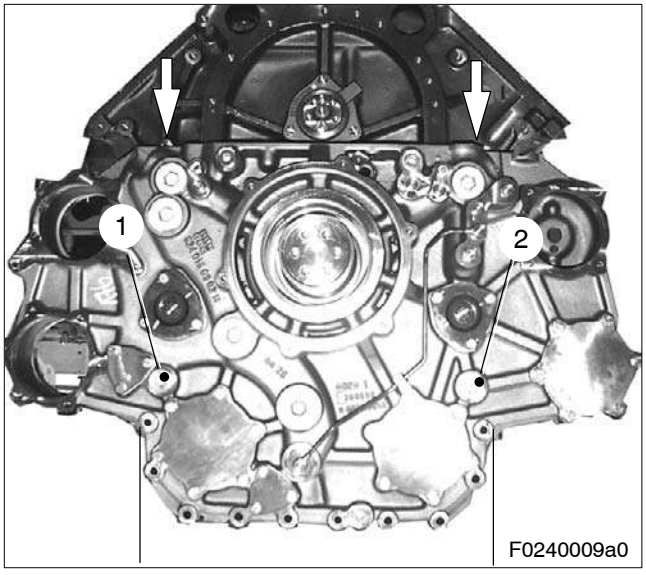
Designation	Use/dimension	Number
• Alignment tool	Gear case (free end)	1
– Guide bush		2
• Press-in tool	for radial-lip shaft seal in DR holder, free end	1
• Installation tool	Crankshaft bearing, equipment carrier	1
– Locating device	Crankshaft bearing	1
• Lifting gear	for gear case	1
• Puller	Fitting bearing on equipment carrier (free end)	1
– Lukas cylinder		1
– Adapter	Connection, Lukas cyl. on SKF hand pump	1
– SKF hand pump		1

C024.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	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 (high temperature)	→ Operating Instructions
–	–	x	Drain charge air coolant (low temperature)	→ Operating Instructions
–	–	x	Drain or draw off engine oil	→ Operating Instructions
–	x	x	Remove vibration damper	→ C 035.05.05
–	x	x	Remove charge air coolant pump	→ C 203.05.05
–	x	x	Remove coolant pump	→ C 202.05.05
–	x	x	Remove charge air coolant lines	→ C 203.25.05
–	x	x	Remove coolant vent lines	→ C 202.65.05
–	x	x	Remove charge air coolant vent lines	→ C 203.55.05
–	x	x	Remove coolant housing with thermostat	→ C 206.05.05
–	x	x	Remove generator	→ C 213.05.05
–	x	x	Remove H.P. pump	→ C 073.05.05
–	x	x	Remove centrifugal filter	→ C 183.10.05
–	x	x	Remove engine mount, free end	→ C 231.10.05
–	x	x	Remove oil filter	→ C 183.05.05
–	x	x	Remove driver flange	→ C 035.05.05

C024.05.05 Removal



Removing equipment carrier

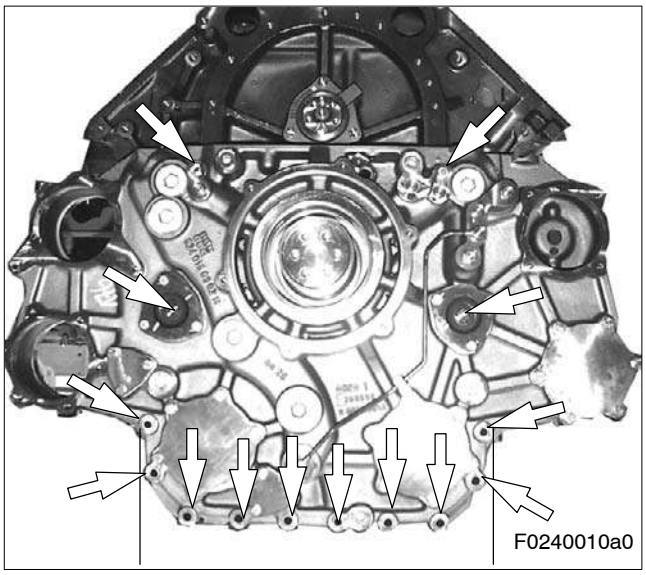
Screw two eyebolts (arrows) into equipment carrier.

Attach equipment carrier to crane with ropes and tension ropes equally.

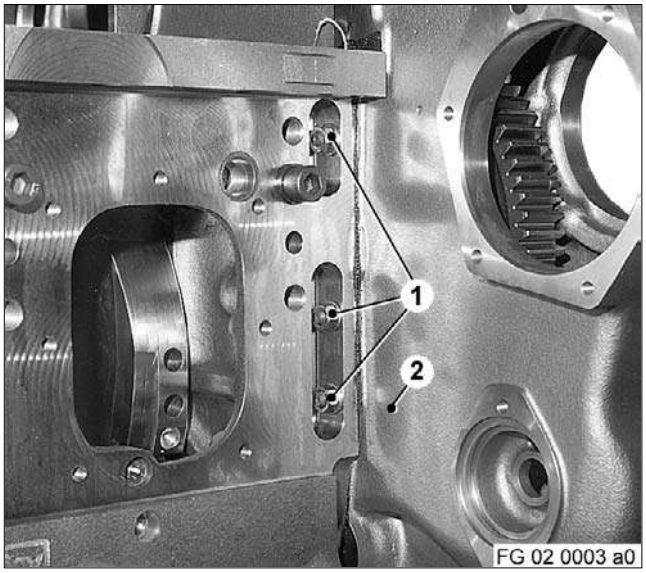
Remove plugs (1) and (2).

Remove hex screws through idler gear bores.

If the screws are inaccessible, rotate crankshaft accordingly.



Mark all screws on equipment carrier circumference (arrows) (differing lengths) and remove.



⚠ WARNING

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

Release nuts (1), left and right sides of crankcase and remove with washers.

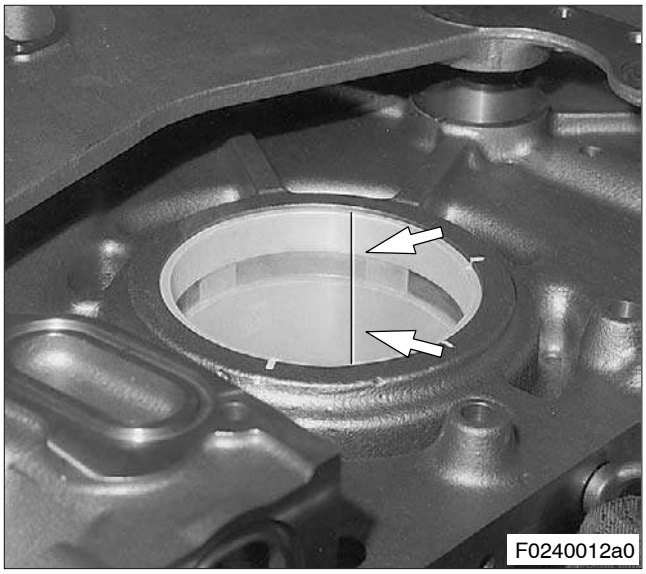
Carefully push equipment carrier (2), with the ropes pretensioned, in direction of free end until it is freed from crankcase.

Remove O-rings.

C024.05.06 Disassembly

Removing radial-lip shaft seal from seal carrier, free end

Using suitable mandrel and hammer, drive radial-lip shaft seal out of seal carrier.



Removing crankshaft bearing from equipment carrier

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

Before removing, release main bearing by making an axial cut with a saw to leave a remaining wall thickness of approx. 1 mm.

⚠ WARNING

Tools may be released suddenly.
Fluid is highly pressurised.
Risk of injury!
Only use specified and tested equipment.
Personnel must stay clear of the danger area.
Always wear protective gloves and protective goggles/safety mask.

Using removal tool, press crankshaft bearing, Lukas cylinder and SKF hand pump out of equipment carrier.

C024.05.08 Inspection and repair

Clean gear case.

Thoroughly clean oilways and chambers in equipment carrier and check that they are perfectly clean.

Using magnetic crack-testing method and fluorescent magnetic powder, check equipment carrier for cracks; if cracks are detected, replace equipment carrier.

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

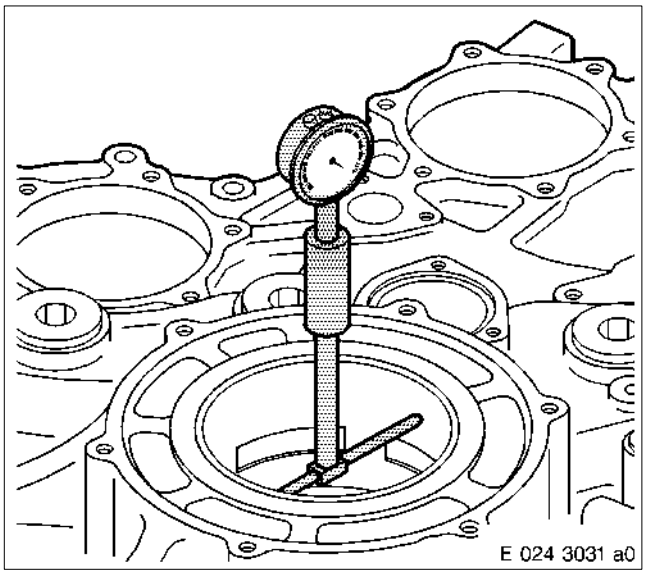
Check condition of threads in equipment carrier; rechase threads as necessary.

Check thread and shaft of hex screws and studs for damage; replace screws if necessary.

Note: Studs are secured with thread-locking compound and must be heated to approx. 130°C before removal.

Check all mating and sealing faces and fits: If necessary, smooth by polishing with an oilstone or emery cloth.

Replace O-rings.



Measuring main bearing bore in equipment carrier

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

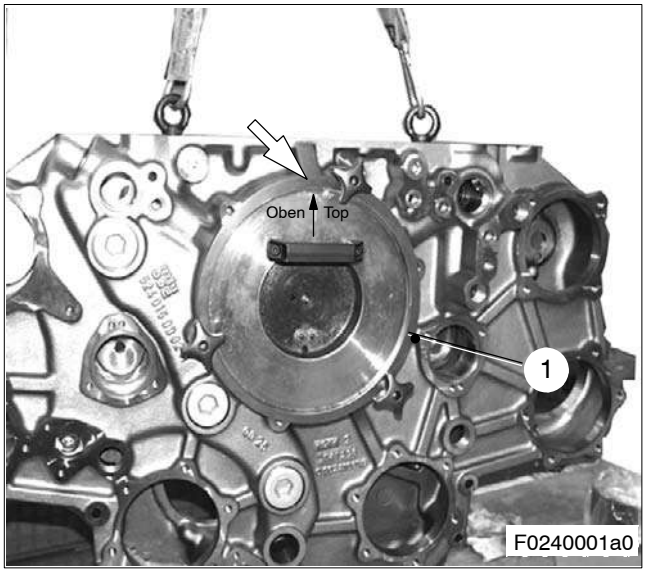
Measure diameter of crankshaft bearing bore with bore gauge.

Record measured values in data sheet.

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

Replace equipment carrier if limit values are exceeded.

C024.05.10 Assembly



Installing main bearing in equipment carrier

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

⚠ WARNING

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

Install eyebolts in equipment carrier.

Attach equipment carrier with rope and crane.

⚠ CAUTION

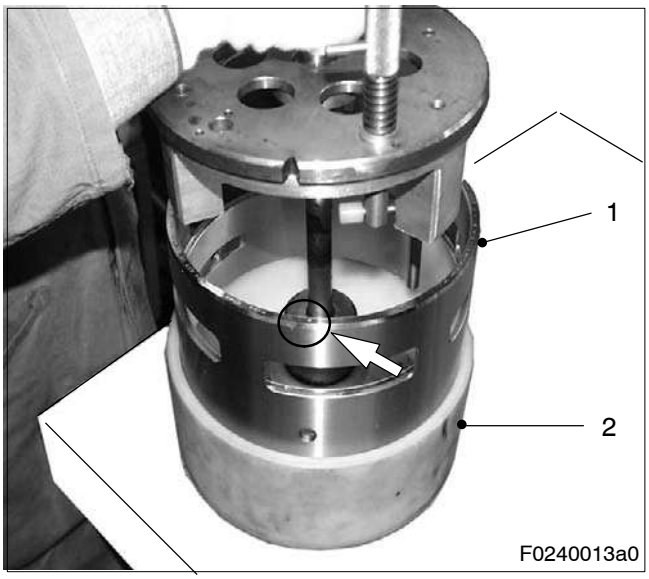
Component is hot.
Risk of injury!
Handle components only when wearing protective gloves.

Heat equipment carrier to 80 °C.

Clean and degrease main bearing bore.

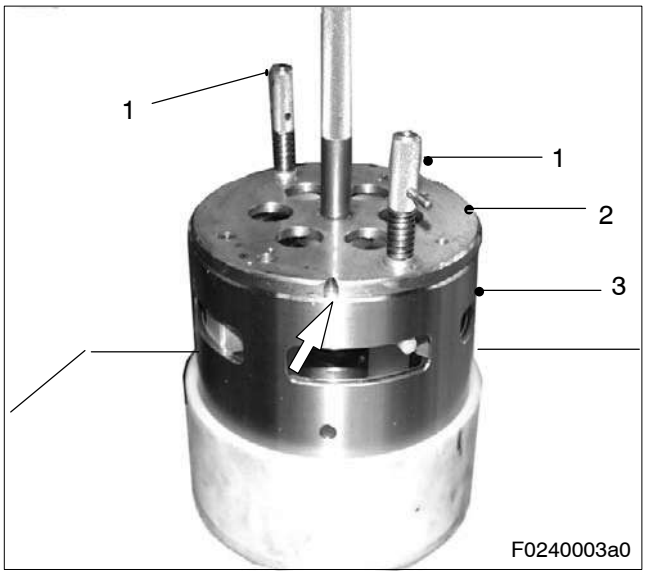
Install locating device and spacer (1).

Note: Pay attention to arrow and marking “Oben und Top” (arrow).



Clean and degrease crankshaft bearing (1) and insert in locating device (2).

Ensure correct positioning of the bearing marking (arrow) with regard to the main bearing installation position.



Insert installation tool (2).

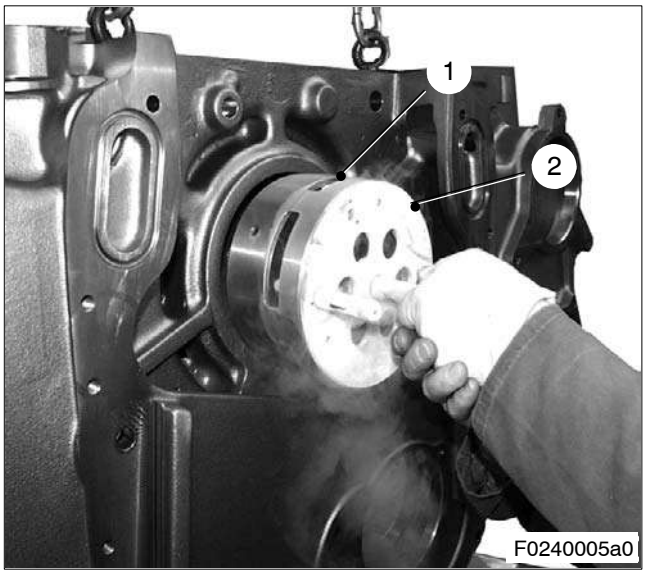
Note: Insert main bearing (3) and installation tool, ensuring they are correctly positioned with regard to each other (position mark/notch mark).

Lock installation tool with sliding bar handles (1).

⚠ 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.

Using installation tool, chill crankshaft bearing in liquid nitrogen.



Use installation tool (2) to introduce chilled main bearing (1) into locating device until contact is felt.

Note: Location is by means of an asymmetrical pin guide.

After a brief dwell period, release and remove the installation tool.

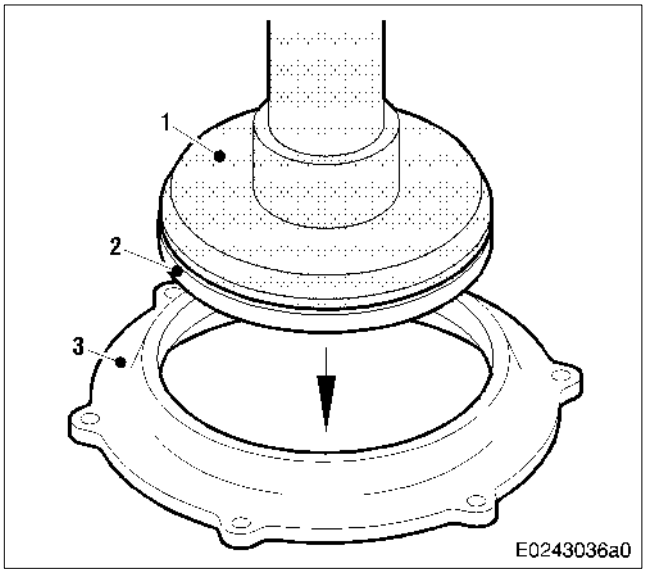
Check that main bearing/equipment carrier oil bores are aligned.

Coat friction face of crankshaft bearing with engine oil.

Measure diameter of crankshaft bearing bore with bore gauge.

Record measured values in data sheet.

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



Installing radial-lip oil seal in seal carrier

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

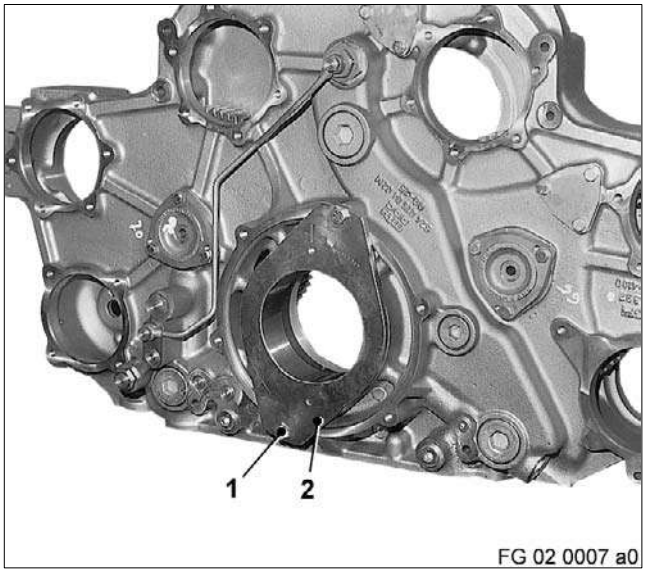
Coat sealing face of radial-lip oil seal with denaturated ethanol.

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

Clean and degrease sealing face for radial-lip oil seal in seal carrier (3).

Install radial-lip shaft seal with installation tool in seal carrier.

C024.05.11 Installation



Install equipment carrier

Note: Ensure that components and tools are particularly clean.

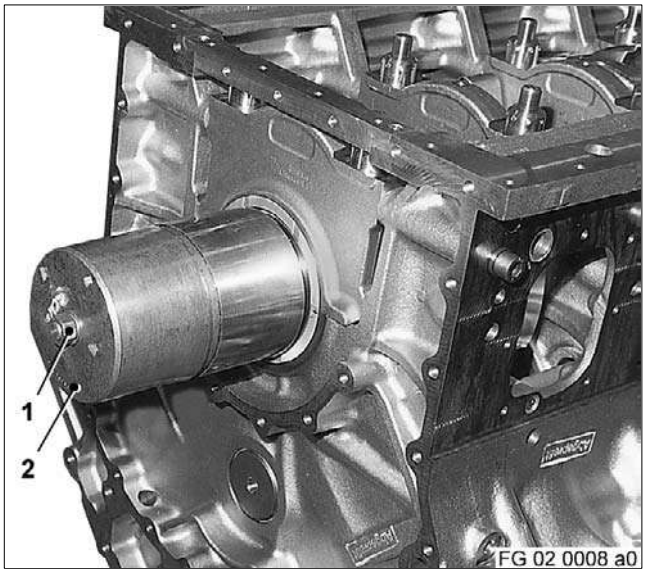
Install intermediate gears and axles, see C 025.05.11.

Install delivery valve (see C 184.10.11) and pressure reduction valve (see C 181.05.11).

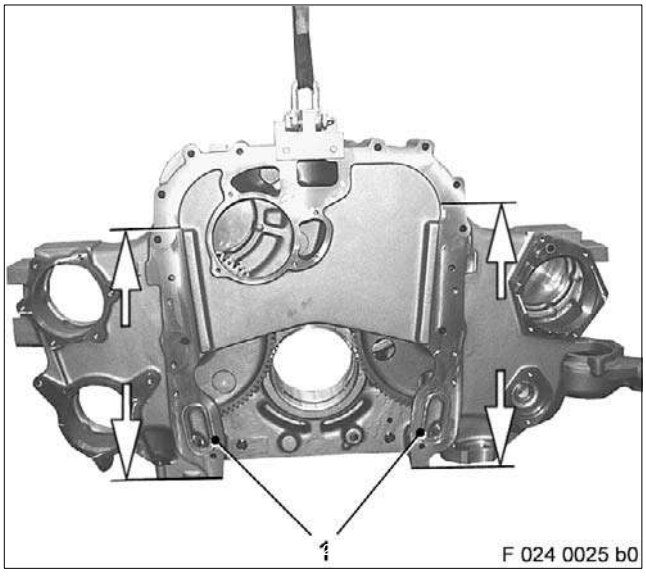
Coat alignment jig (2) and guide bush with engine oil and install with hex screws (1) on equipment carrier.

Note: Pay attention to “TOP/OBEN” marking, which must always face up, independently of the crankcase position.

Remove guide bush after installing alignment jig.



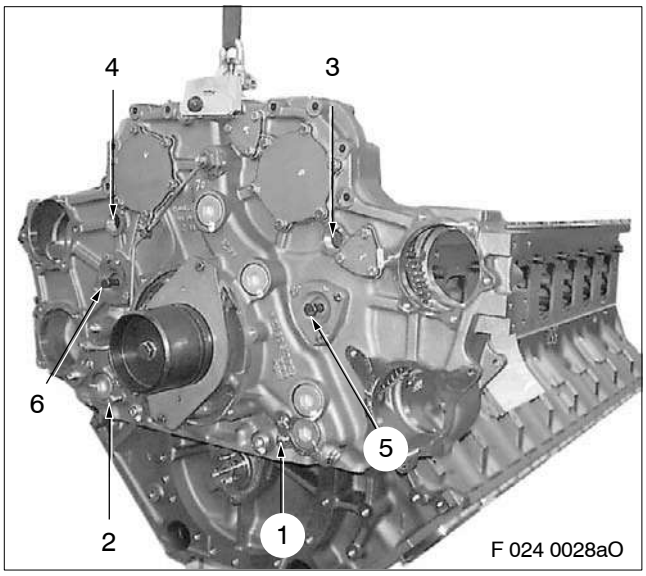
First install flange (see page 2) and then guide bush (2) with hex screw (1) on crankshaft stump.



Degrease mating face between arrows with Loctite 7063 cleaner and dry clean.

Using a spatula/roller, coat sealing surface of equipment carrier with surface sealant Loctite 518.

Insert O-rings (1) in groove on equipment carrier.



⚠ WARNING

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

Using lifting gear and rope, attach equipment carrier to crane.

Carefully move equipment carrier over crankshaft guide bush.

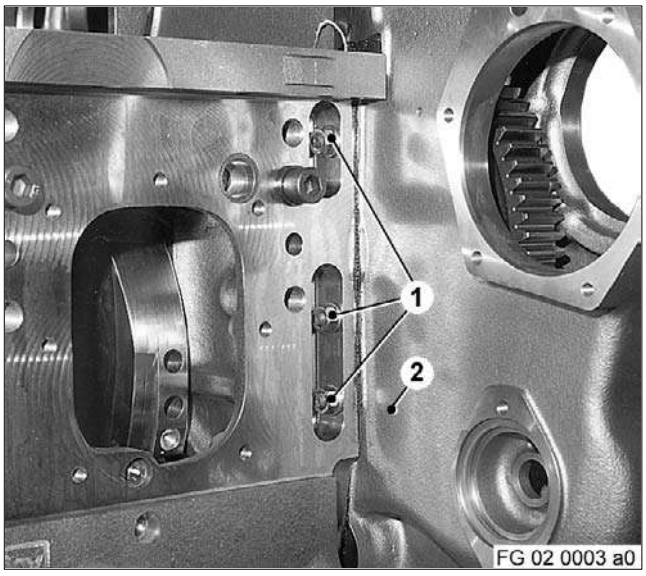
Check fit of studs and gear meshing in crankshaft gear.

Note: Make sure components are reinstalled in accordance with markings, and note that screws differ in length.

If necessary, rotate idler gears to be able to screw in screws behind the gears.

Attention: Relieve load on crane before tightening the screws.

Tighten screws in sequence 1 – 6 until final torque is reached.



Fit and tighten nuts (1) and washers for equipment carrier (2), left and right sides, remaining securing screws and plugs with new sealing rings.

Remove alignment jig, taking care not to affect the ease of movement.

Remove guide bush, flange, attachment ropes and eyebolts.

Attention: Final strength of surface sealant, after ≈ 72 h!

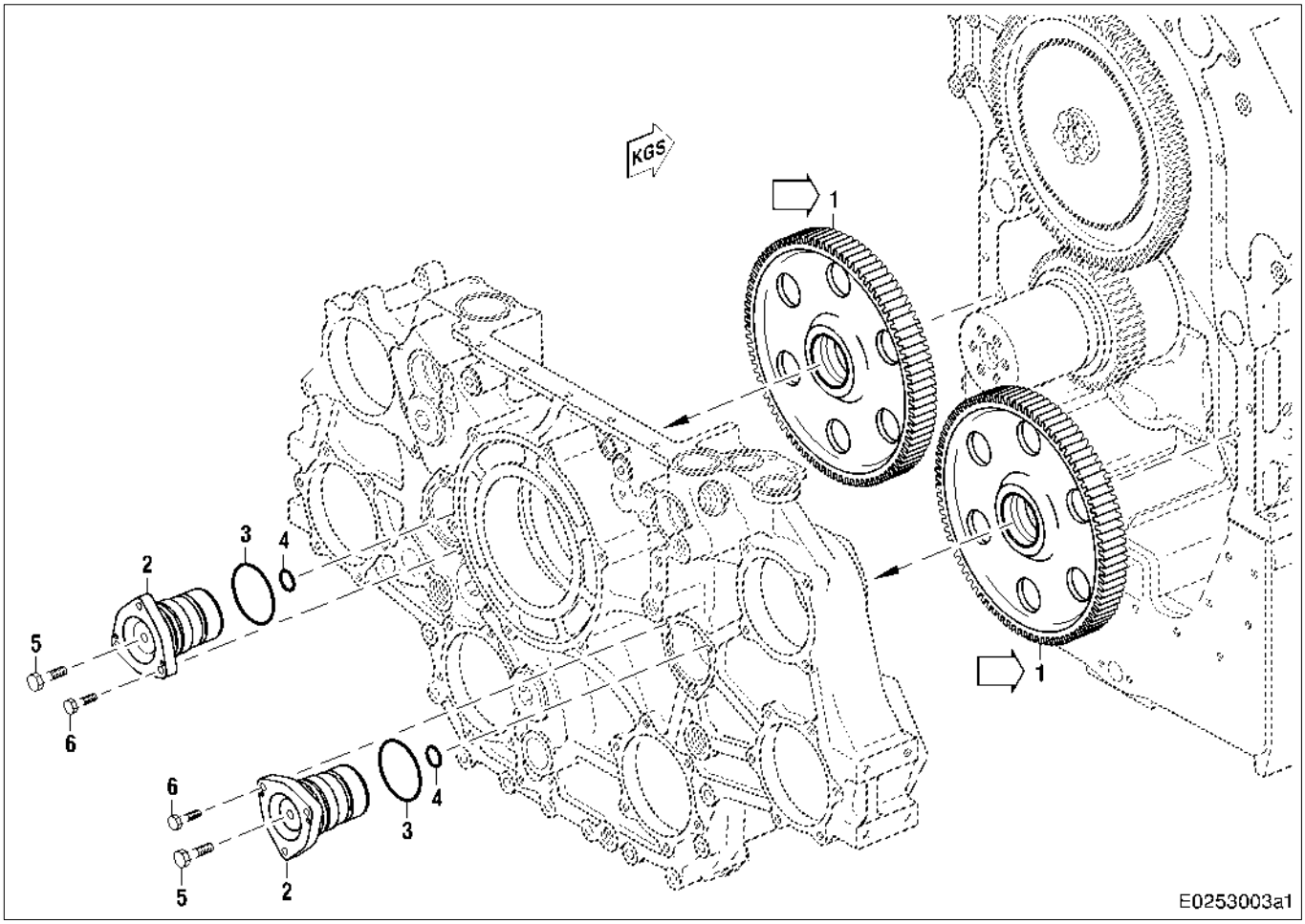
C024.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 024.05.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill fuel system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

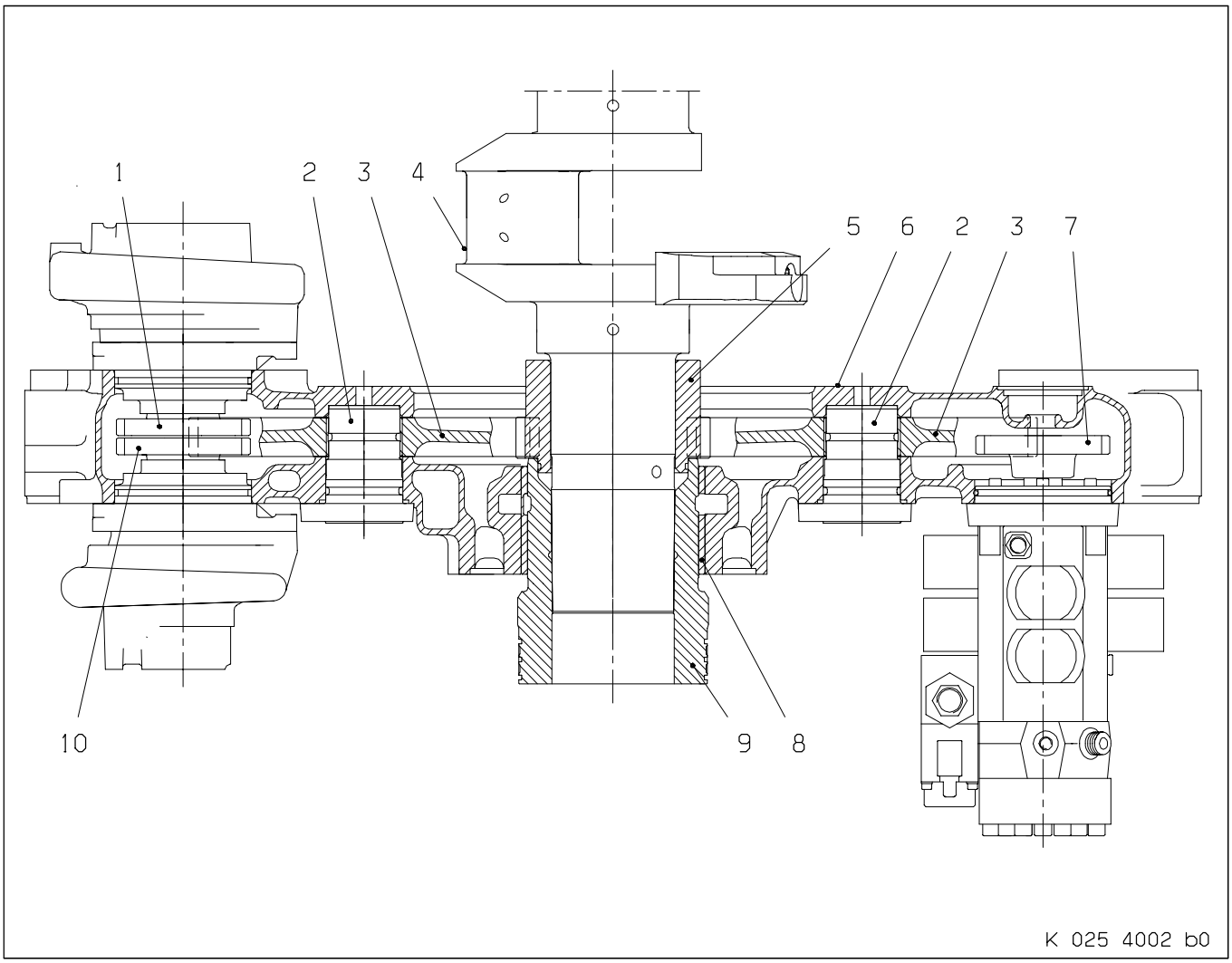
C025.05 Gear train, free end

C025.05.01 Overview drawing



1 Idler gear
2 Axle
3 O-ring
4 O-ring
5 Hex screw
6 Hex screw

Gear train, free end



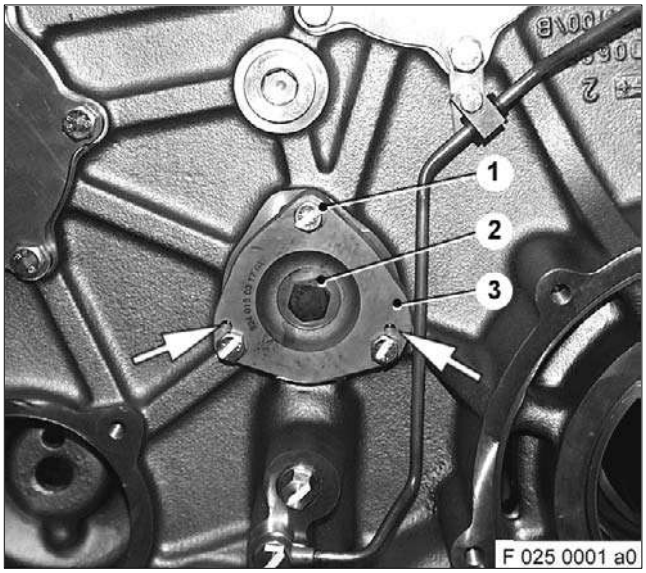
1 Engine coolant pump drive gear
2 Axle
3 Idler gear
4 Crankshaft
5 Crankshaft gear
6 Engine carrier, free end (equipment carrier)
7 H.P. fuel pump drive gear
8 Main bearing, free end
9 Driver flange, free end

C025.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	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 equipment carrier	→ C 024.05

C025.05.05 Removal



Removing idler gears from equipment carrier

⚠ WARNING

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

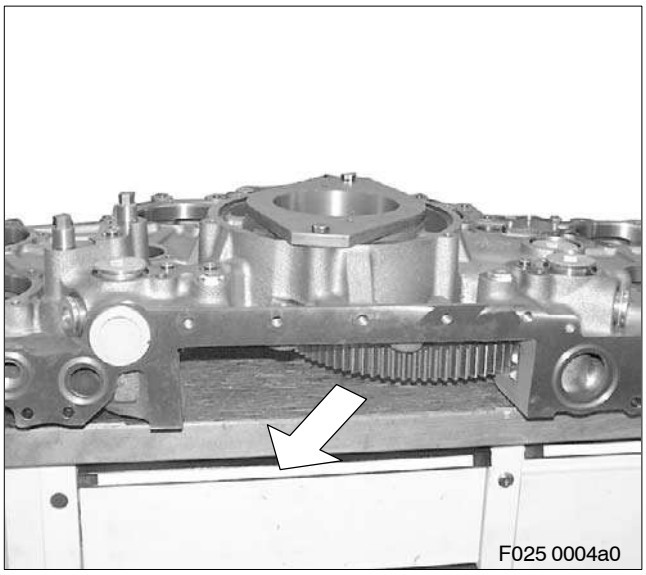
Place equipment carrier on assembly bench (see next illustrations).

Remove hex screws (1) and (2).

Screw jackscrews into thread (arrows) of axle (3) and press out axle.

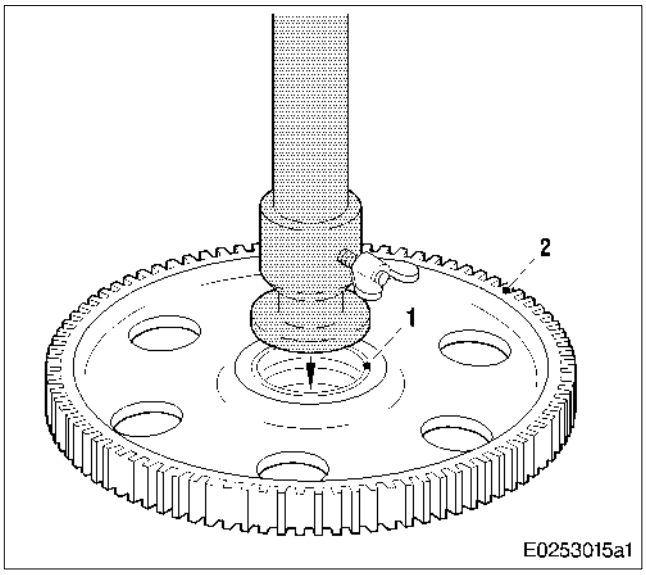
Mark axle according to installation position and remove from equipment carrier.

Remove idler gears from fit.



Remove idler gears from fit (arrow).

C025.05.06 Disassembly



Removing bearing bush from idler gear

Important: Remove bearing bushes only when wear limits are reached or when they are damaged, see C 025.05.08.

Using a suitable sleeve and manual press, remove bearing bush (1) from idler gear (2).

C025.05.08 Inspection and repair

Clean all components.

Using magnetic crack-testing method and fluorescent magnetic powder, check idler gears for cracks; if cracks are detected, replace idler gear.

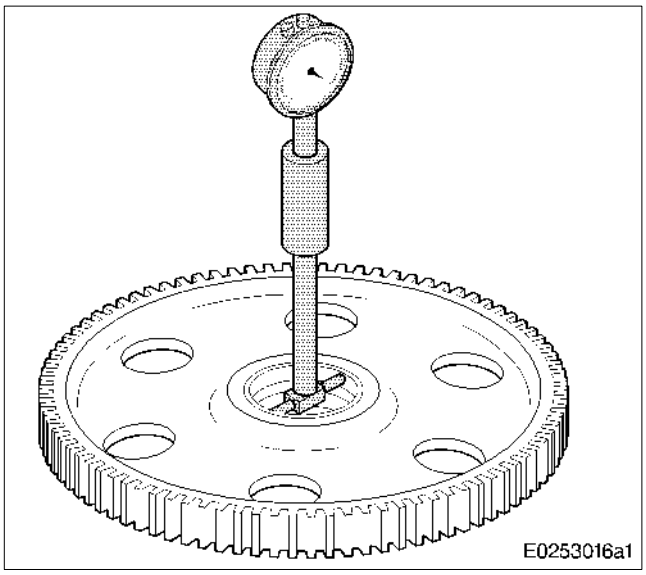
Check surface condition of idler gear with magnifying glass; replace idler gear if necessary.

Check running surface of axles, bearing bushes in idler gears and axial friction faces of gears for wear and scores.

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

Check taper seat and screw-on surface of axles for scoring and wear.

Check screws for damage and check condition of threads; replace screws if necessary. Thoroughly clean all axle oilways (arrow); make sure oilways are perfectly clean.



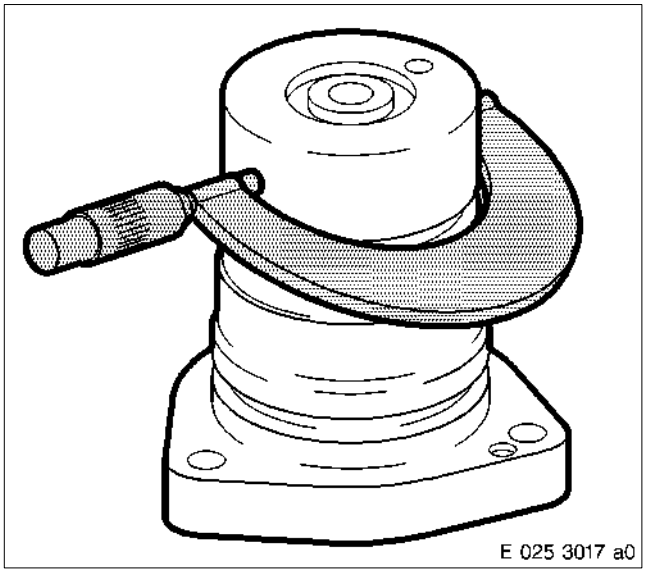
Measuring bearing bush bore in idler gear

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

Measure diameter of bore.

For permissible values, see Tolerance and Wear Limits List.

If limit values are exceeded, replace idler gear.



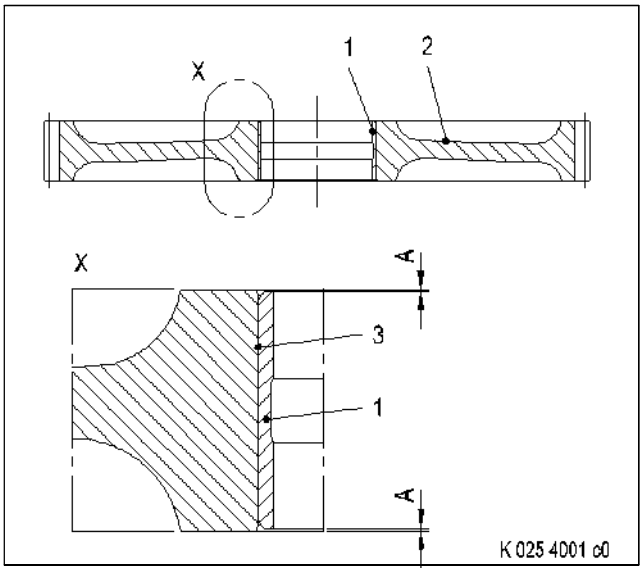
Measuring bearing diameter on axles

Using micrometer, measure outside diameter of axles at running surface.

For permissible values, see Tolerance and Wear Limits List.

If limit values are exceeded, replace axle.

C025.05.10 Assembly



Installing bearing bush for idler gear

Measure basic bore (3) in idler gear (2) – see C 025.05.08.

Place idler gear on suitable rest to ensure that when bush (1) is installed there is no side projection.

⚠ 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.

Cool bush in liquid nitrogen and heat idler gear to 80 °C.

⚠ CAUTION

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

Insert chilled bush into idler gear, observing distance (A).

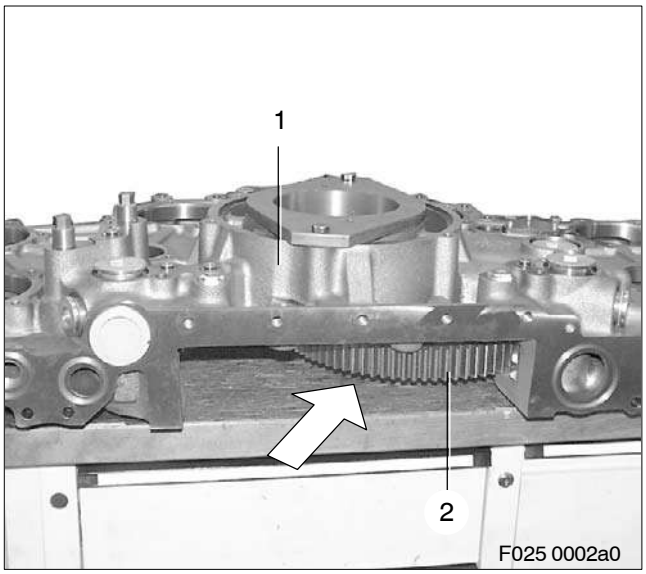
A = 0.35 mm ±0.15 mm

Measure diameter of bearing bore with bore gauge.

For permissible values, see Tolerance and Wear Limits List.

C025.05.11 Installation

Note: Make sure all components are perfectly clean.



Installing idler gears in equipment carrier

⚠ WARNING

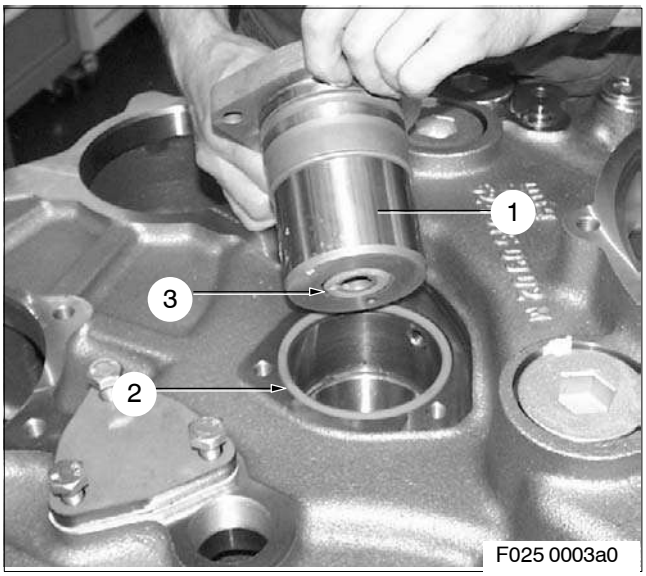
Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Place equipment carrier (1) on assembly bench.

Note: Insert idler gear (2) for coolant H.P. pump first, and then second idler gear, in equipment carrier, then fit axles.

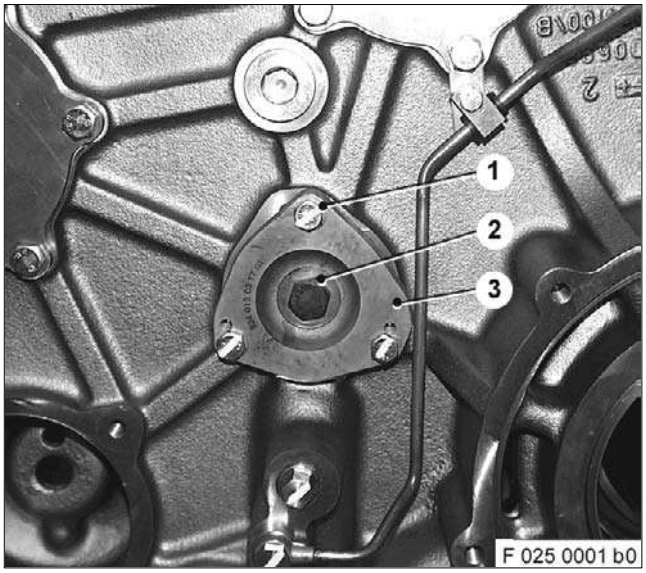
Coat bearing bush in idler gear with engine oil.

Insert idler gears through opening (arrow) into equipment carrier, ensuring it is correctly positioned.



Note: Ensure oil bores of axle (1) are perfectly clean.

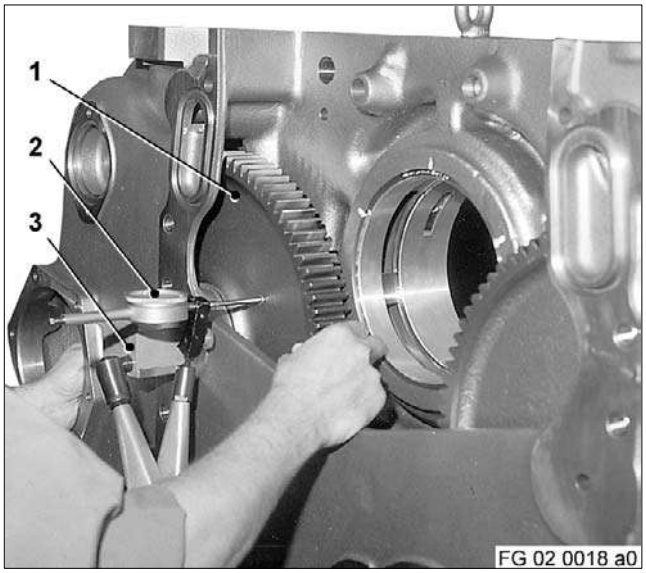
Coat O-rings (2) and (3) with petroleum jelly and insert in equipment carrier and axle.



Insert axle (3) in equipment carrier, paying attention to fit of idler gear.

Install hex screws (1) and tighten evenly.

Fit hex screw (2) to secure equipment carrier.



Checking axial clearance and backlash

Mount magnetic dial-gauge holder (3) with dial gauge (2) in equipment carrier.

Place dial gauge stylus with preload on lateral collar of idler gear (1).

Set dial gauge to zero.

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

To measure backlash, place switch of Puppi gauge with preload on o tooth flank of idler gear.

Set dial gauge with preload to zero.

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

For axial clearance and backlash, see C 020.

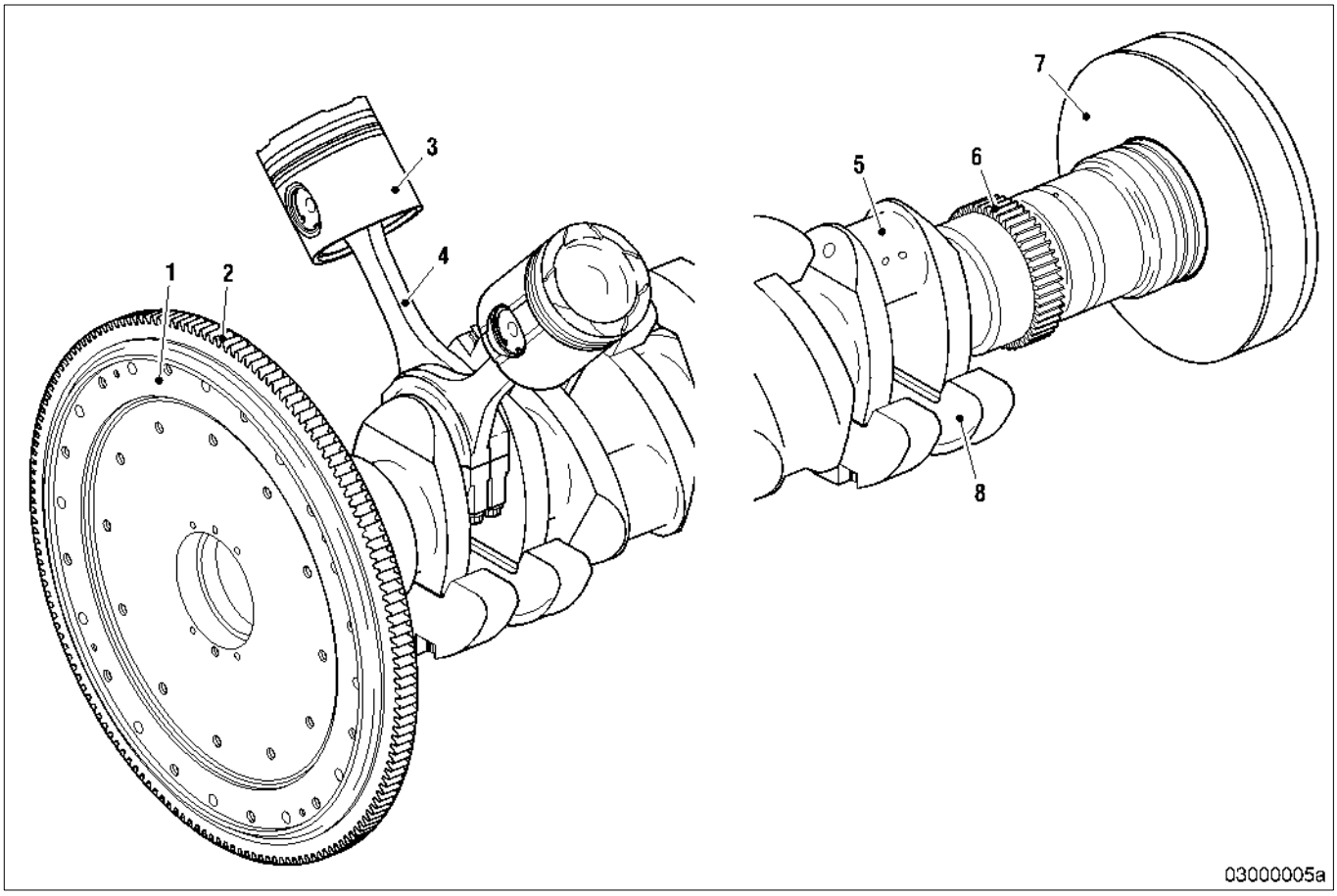
If limit values are exceeded, replace idler gears.

C025.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 025.05.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill fuel system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

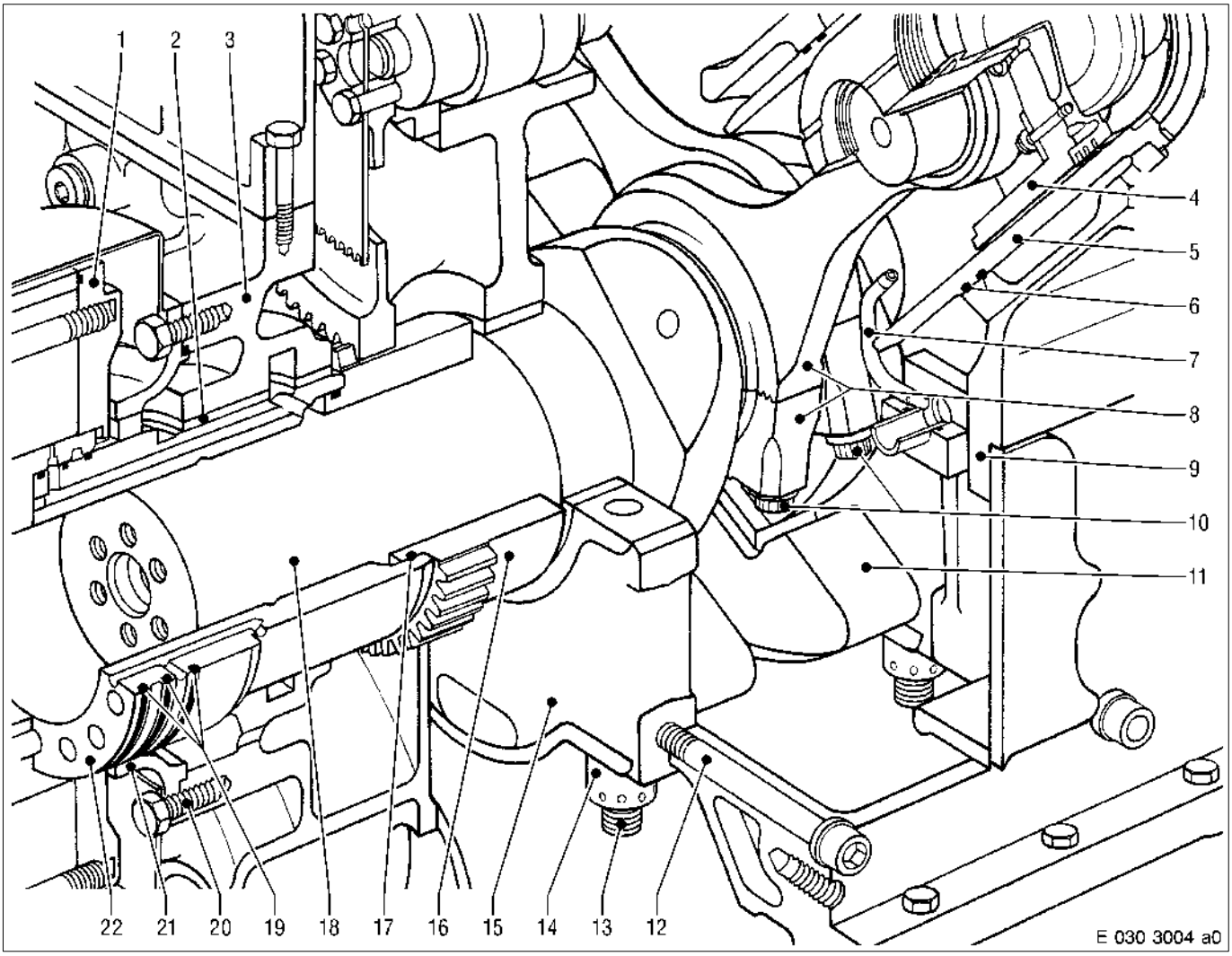
C030 Running gear



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

C031.05 Crankshaft

C031.05.01 Overview drawing

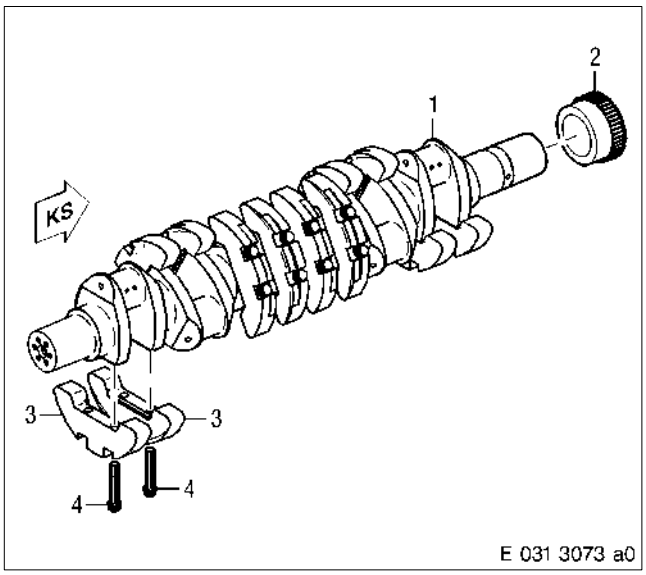


1 Vibration damper
2 Main bearing, free end
3 Equipment carrier
4 Piston
5 Cylinder liner
6 O-ring
7 Oil spray nozzle
8 Conrod
9 Crankcase
10 Conrod screw
11 Crankshaft counterweight
12 Socket-head screw
Lubricant: Engine oil
* Pretightening torque: 80 Nm
* Tightening torque: 280 Nm+ 20 Nm
13 Stud **
Lubricant: Engine oil
Screw elongation:
Δl = 1.15 mm +0.05 mm
Remaining screw elongation:
Δl = 0.9 mm +0.05 mm
14 Nut
15 Main bearing cap
16 Crankshaft gear
17 O-ring
18 Crankshaft
19 O-ring
20 Hex screw
21 Seal carrier
22 Driver flange

* Tightening sequence starting from driving end:
1. Pretighten all socket-head screws on left side and then on right side
2. Fully tighten all socket-head screws on left side and then on right side

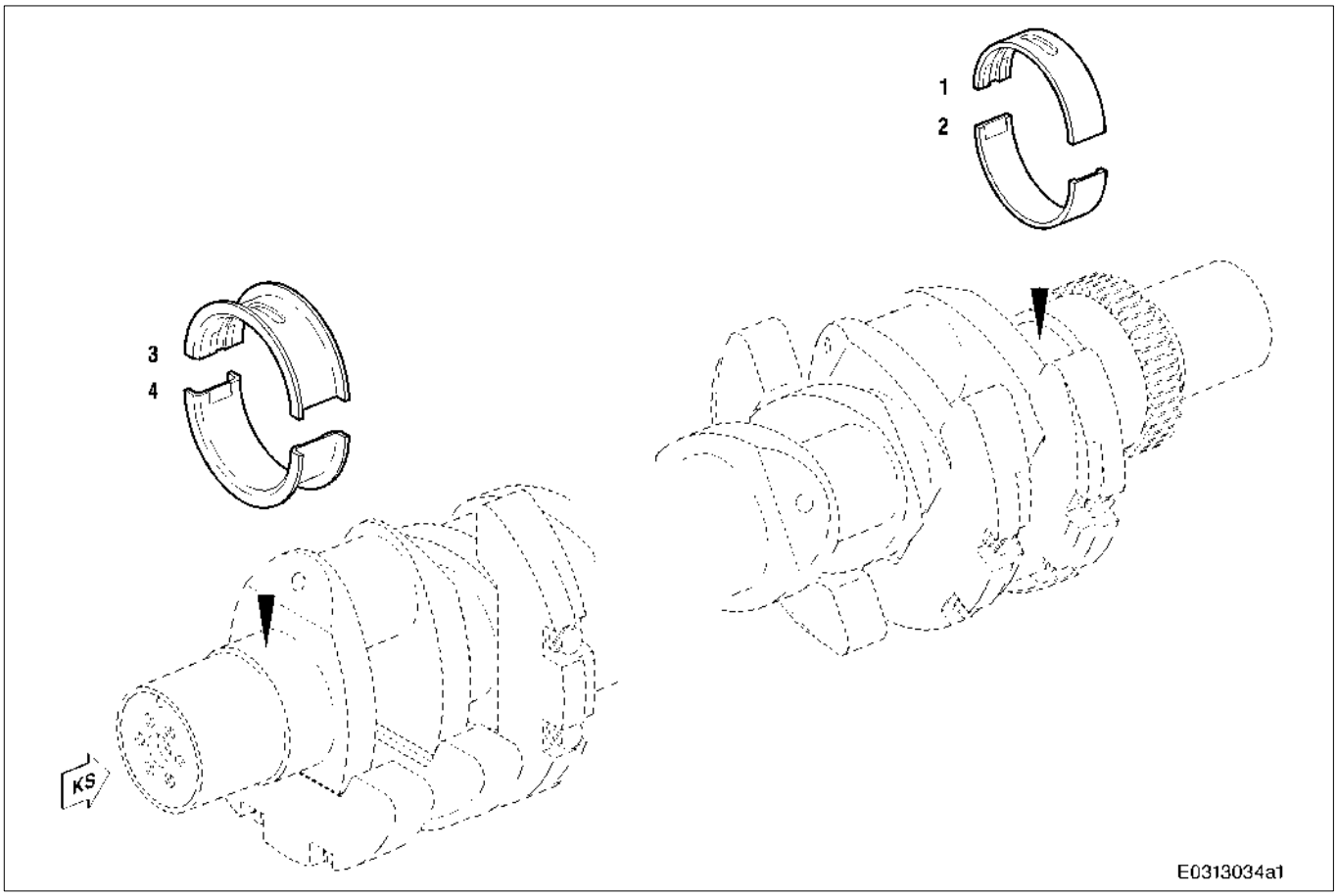
** Newly fitted studs must be elongated before initial tightening.

Crankshaft



1 Crankshaft
2 Crankshaft gear, free end
3 Counterweight
4 Stress bolt
– Max. length: 132 mm
– Lubricant: Engine oil
– Pretightening torque: 320 Nm + 30 Nm
– Additional angle of rotation: 120° + 10°
– Test moment: 800 Nm + 50 Nm

Crankshaft with bearing



1 Crankshaft bearing, top
2 Crankshaft bearing, bottom
3 Alignment bearing, top
4 Alignment bearing, bottom

C031.05.02 Special tools

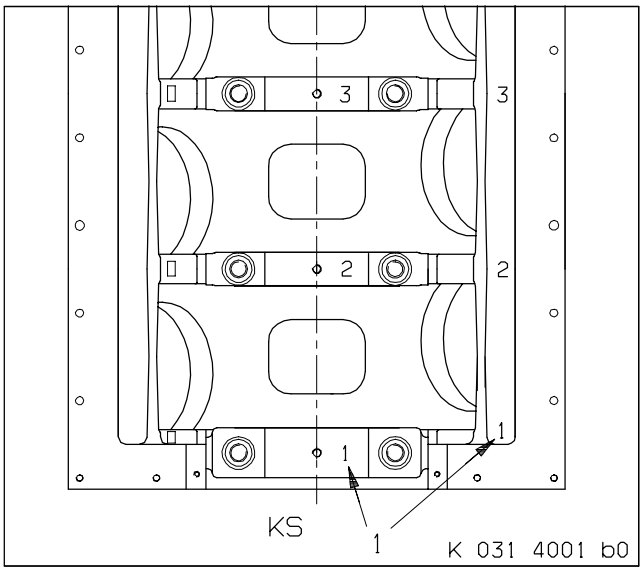
Designation	Use/dimension	Number
• Hydraulic set	for main bearing screws	1
• Hydraulic set	for main bearing screws (hydraulic pump)	1
• Locating device	Locating crankshaft axially	1
• Press-fitting tool	for main bearing shell	1
• Slip protection	Crankshaft	2
• Locating device	Crankshaft	2
• Installation/removal tool	for main bearing shell	1
• Removal pliers	for main bearing shell	1
• Installation aid	for main bearing shell	1
• Barring tool	Free end	1
• Magnetic stand with dial gauge		1

C031.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	x	x	Removal of crankshaft not scheduled	→ –

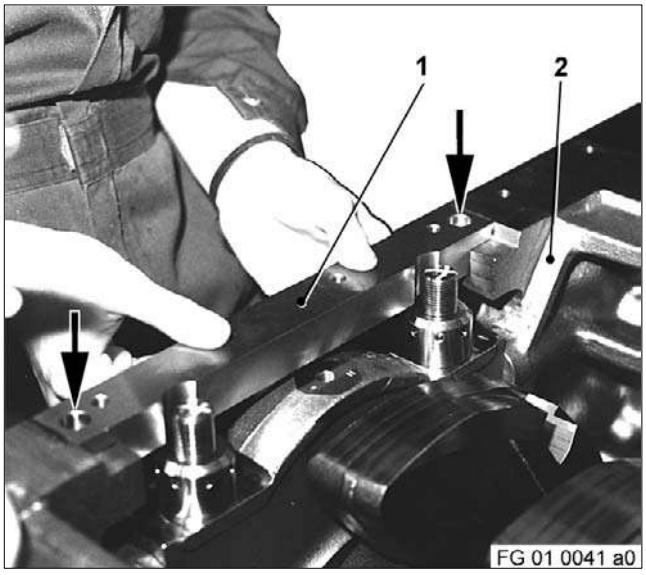
C031.05.05 Removal



Checking marking on crankshaft bearing cap

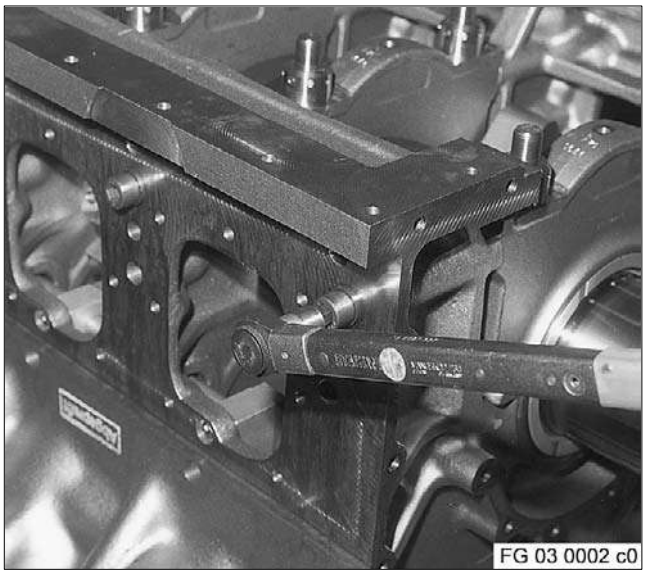
Check marking on crankshaft bearing cap to crankshaft, and if necessary mark according to sequence.

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



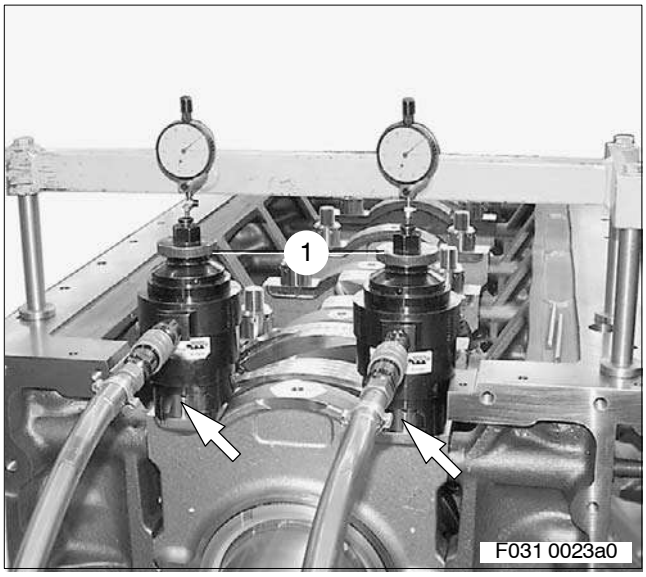
Removing main bearing caps

Remove socket-head screw (arrows), remove block (1) from crankcase (2).



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

Remove all lateral hex socket screws for main bearing cap.



⚠ WARNING

Tools may be released suddenly.
Fluid is highly pressurised.
Risk of injury!
Only use specified and tested equipment.
Personnel must stay clear of the danger area.
Always wear protective gloves and protective goggles/safety mask.

Beginning with the 1st bearing cap (driving end), mount hydraulic preloading device on studs of crankshaft bearing cap.

Insert jacking nuts (1) by hand as far as stop and then back off one revolution.

Connect hydraulic hand pump to hydraulic preloading device.

Position magnetic-base indicator holder with dial gauges on the crankcase support surface for extension measurement of the studs.

Place dial gauge stylus centrally on respective measuring point on face of nut.

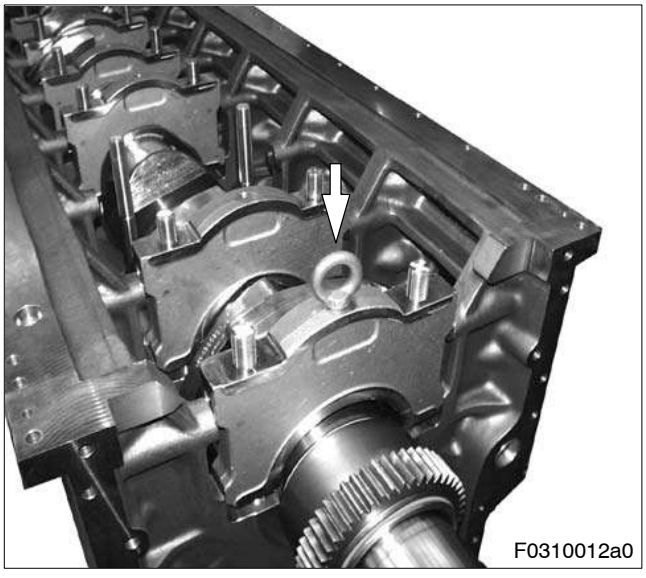
Set dial gauges with preload to zero.

Operate hydraulic hand pumps and elongate both studs at same time (max. 0.25 mm) until nuts of main bearing caps can be released with the aid of a tommy bar.

Release nuts with tommy bar.

Relieve tension on studs, mount dial gauges with magnetic holders and hydraulic preloading devices on studs of next adjacent main bearing cap and follow the same procedure to release all remaining nuts.

Remove loose nuts from studs.

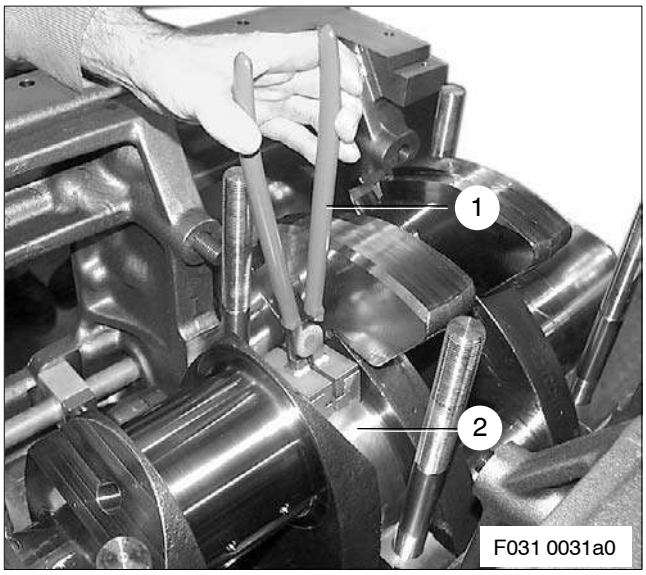


Screw eyebolt (arrow) into bearing cap.

Using ropes and crane, carefully raise bearing cap vertically until clear of crankcase.

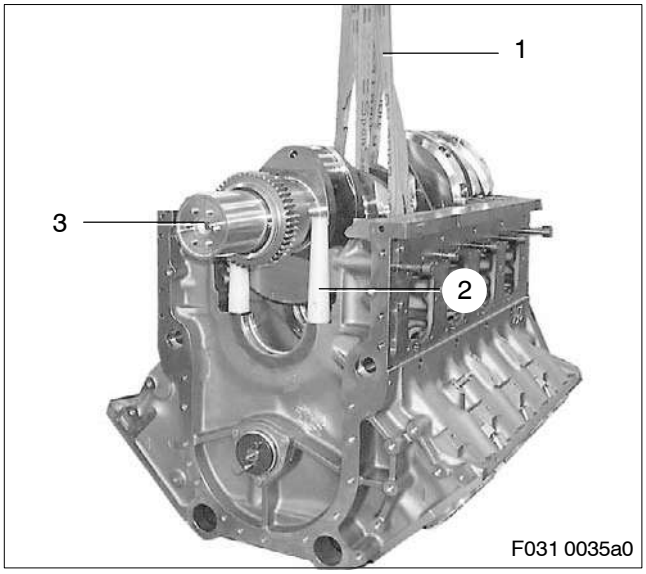
⚠ CAUTION

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



Remove bearing shell (2) with removal pliers (1) and mark according to respective bearing cap.

Note: Protect bearing shells from damage!



Removing crankshaft

To protect the crankshaft (3), fit protective sleeves (2) on the pins of the last bearing and locating device at the first bearing.

⚠ WARNING

Suspended load.
Risk of 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 clear of crankcase.

Take care to keep crankshaft horizontal.

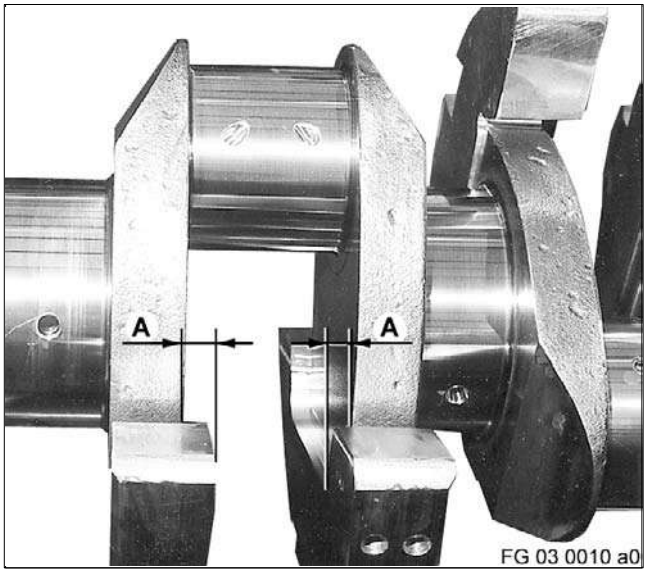
Lower crankshaft onto a sturdy base.

Using installation/removal tool, remove bearing shells from bearing pedestals.

Mark bearing shells laterally and facing direction of driving end with number of respective main bearing.

Make markings (arrow) by etching or with a non-wipe felt marker pen.

C031.05.06 Disassembly



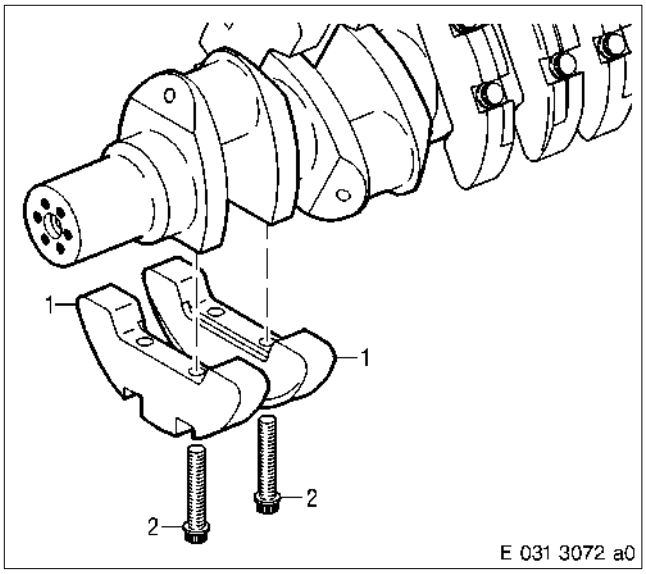
Removing counterweight

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

Make position marking (line) for counterweight to crankshaft.

Determine and record distance A (web to counterweight).

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



Note: Remove counterweights with crankshaft in a sturdy stand.

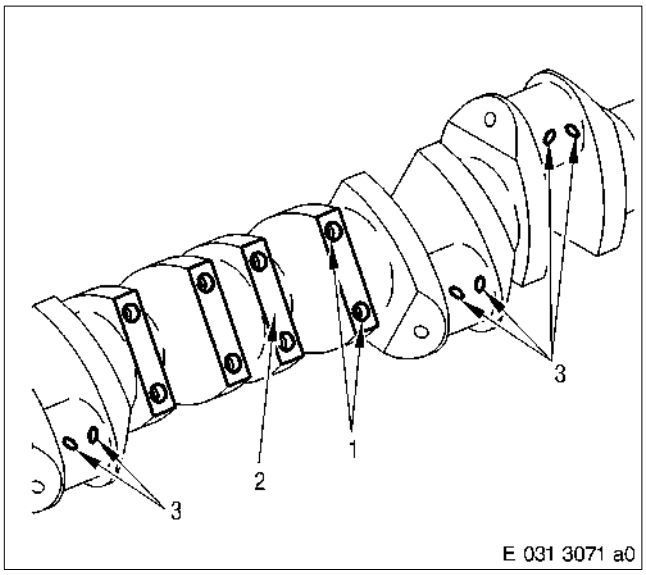
Remove screws (2) and counterweight (1).

C031.05.08 Inspection and repair

Cleaning and checking crankshaft

Cleaning and checking crankshaft

Clean and repair crankshaft only after consulting MTU.



Checking crankshaft for cracks

Check counterweight mating faces (2) for wear; machine-grind if necessary.

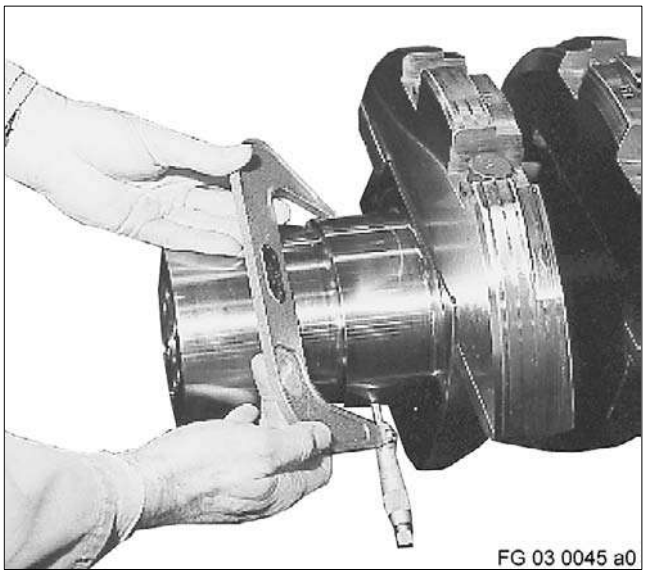
Request information from MTU Service.

Using the magnetic crack-testing method with fluorescent magnetic powder, check crankshaft for longitudinal and transverse cracks. Include oil bores and journal bores (3), counterweight mating faces and tapped 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.

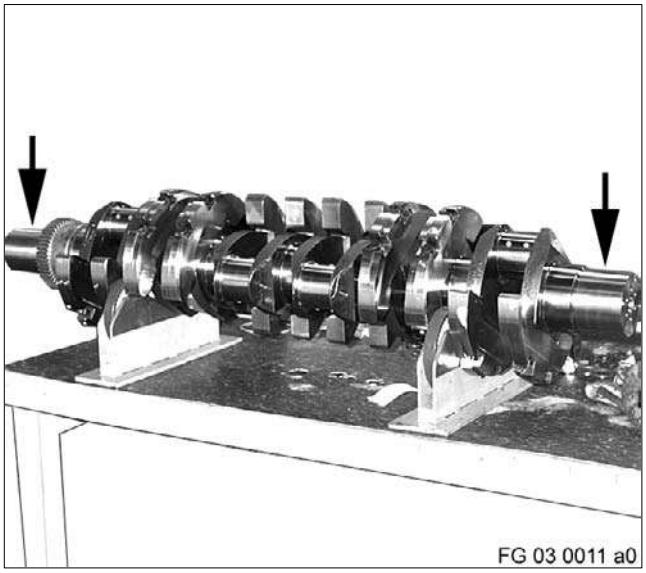


Measuring crankshaft journal

Using micrometer, measure main bearings and crankpins 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.



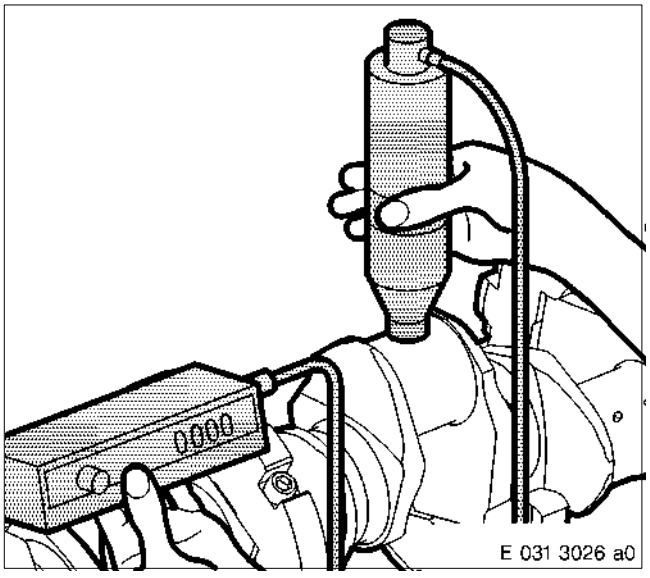
Checking crankshaft taper

Check taper surfaces (arrows) for scoring and damage.

Remove minor scoring and damage by polishing with emery cloth.

Check tapers 1:50 with taper gauge.

If necessary, recondition taper; request information from MTU Service.



Checking hardness of journals

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

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

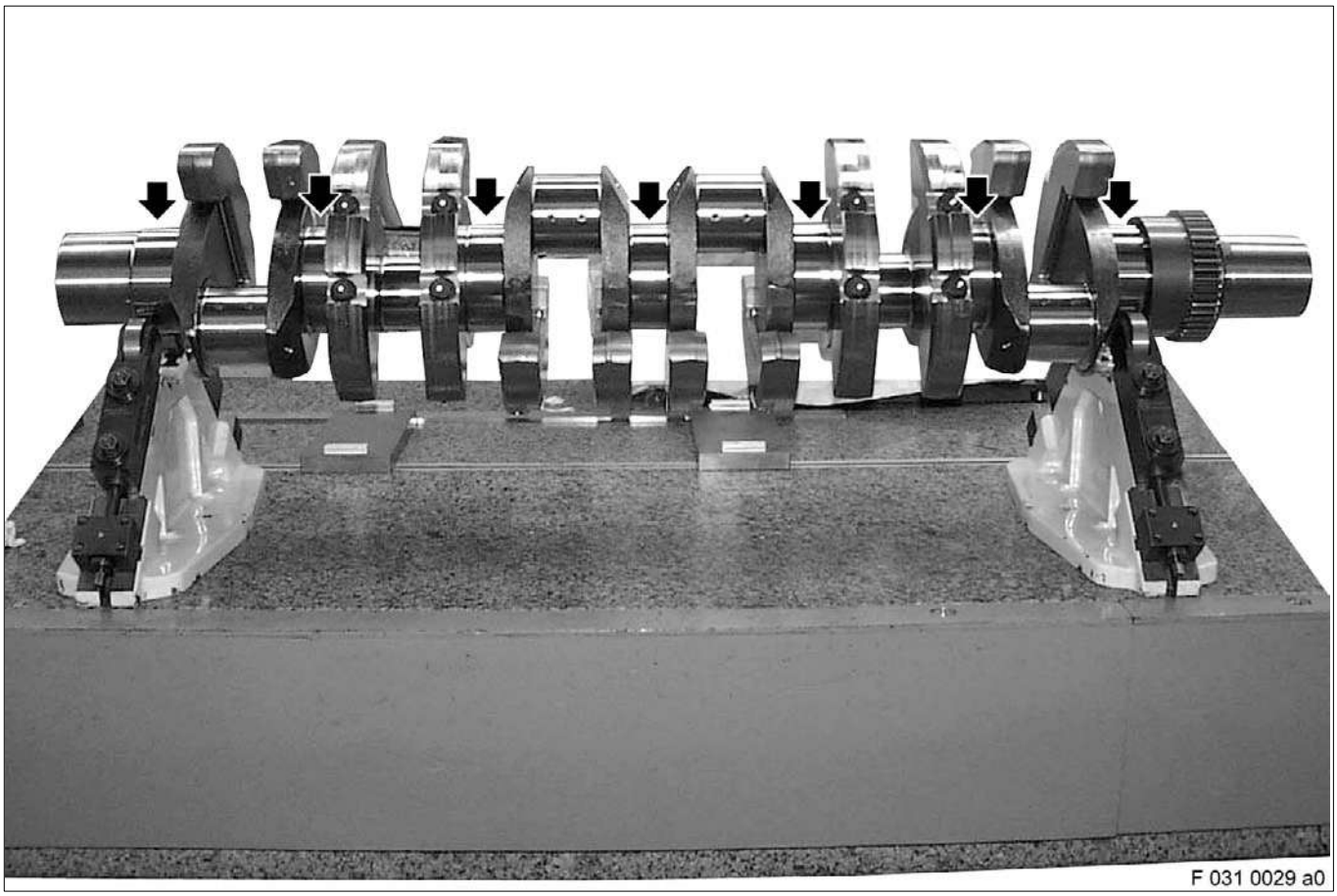
Test hardness of each journal at four points at 90° intervals around circumference.

Specified hardness = from 49 HRC to 53 HRC

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

Checking crankshaft concentricity

Illustration showing 12V crankshaft



With 12 V engine, support crankshaft in main bearings 1 and 7

With 16 V engine, support crankshaft in main bearings 1 and 9

Using adjustable dial gauge support and dial gauge, check main bearing journal (arrows) concentricity.

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

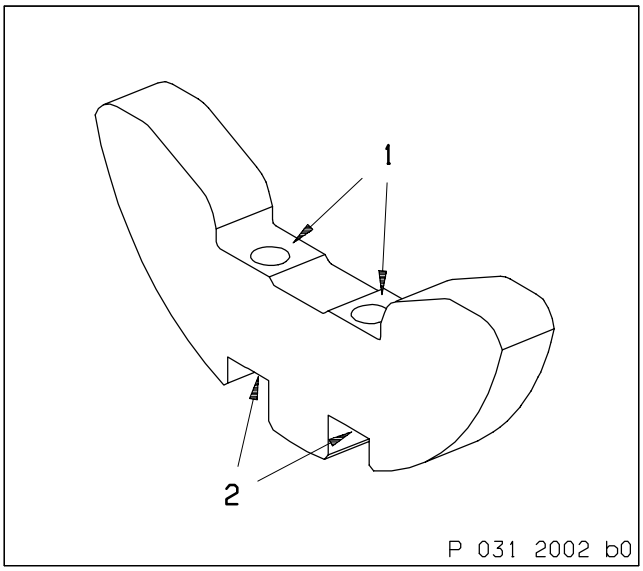
For limit values, see Tolerance and Wear Limits List.

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

Consult MTU service for further information.

Note: Do not straighten crankshaft after hardening!

Always consult DDC or MTU before grinding crankshaft journals.



Checking counterweights

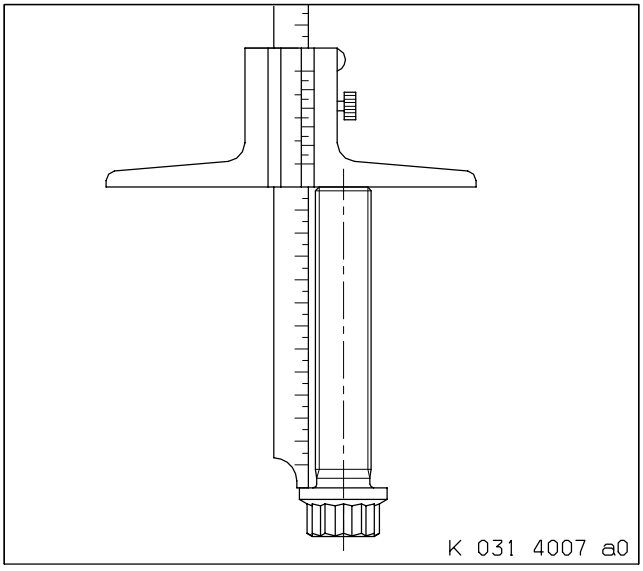
Using the magnetic crack-testing method with fluorescent magnetic powder, check counterweight for cracks.

If cracks are detected, replace counterweight.

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

Consult MTU service for further information.

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.

Dynamic balancing

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

Support 12 V crankshaft in main bearings 2 and 6.

- Max. operating speed: . . . . . 2100 rpm
- Mass of balancing group: . . . . . 525 kg
- Balancing speed: . . . . . 150 rpm
- Permissible residual imbalance per balancing plane for initial balancing: . . . . . 200 gcm
- Permissible Residual imbalance per compensation level in other clamp or balancing machine: . . . . . 600 gcm

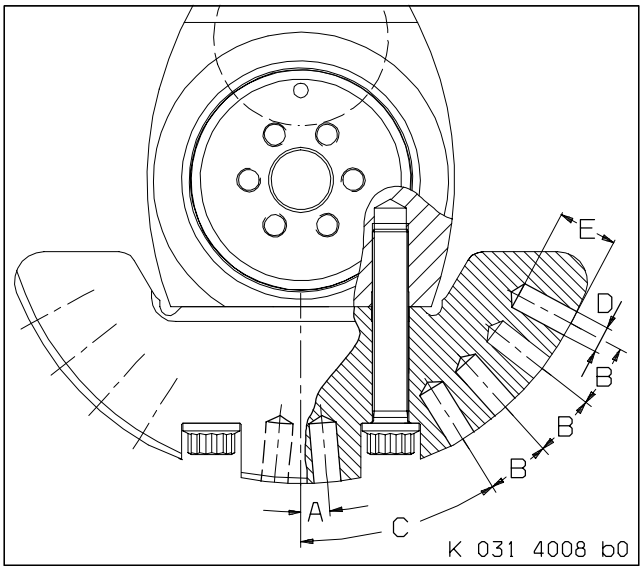
Support 16 V crankshaft in main bearings 2 and 8.

- Max. operating speed: . . . . . 1800 rpm
- Mass of balancing group: . . . . . 710 kg
- Balancing speed: . . . . . 150 rpm
- Permissible residual imbalance per balancing plane for initial balancing: . . . . . 200 gcm
- Permissible Residual imbalance per compensation level in other clamp or balancing machine: . . . . . 300 gcm

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

For specified bore values, see following illustration.

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



Bore values for counterweights

A = 5° (max.)

B = 10°

C = 32° (min.)

D = 18 mm (max. bore diameter)

E = 39 mm (max. bore depth)

Minimum wall strength around balancing bores: 5 mm

Checking and assessing crankshaft bearing shells

Replace bearing shells as part of every W6 overhaul.

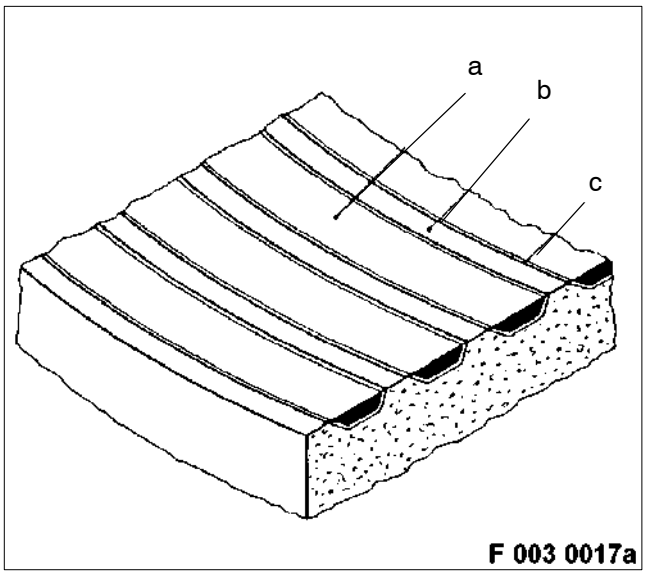
In event of reuse (e.g. unscheduled removal), check bearing shells for surface wear, scoring, cracking, corrosion, erosion and damage; replace if necessary.

Check condition 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.



Crankshaft bearing shell (grooved bearing) (upper half)

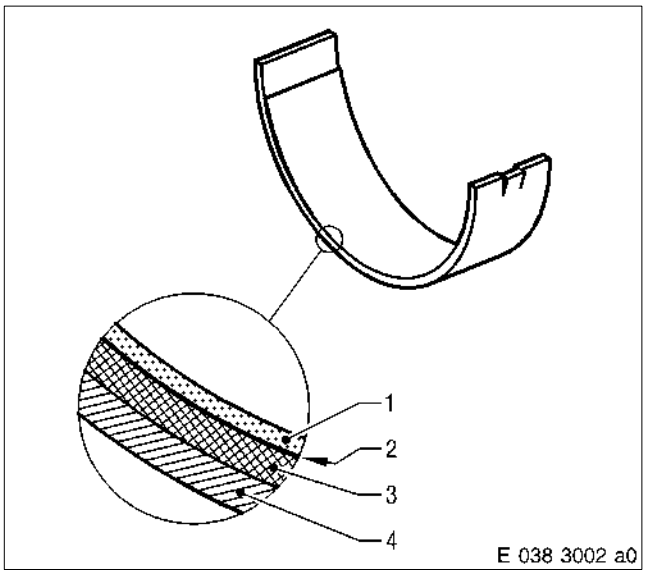
Bearing shell has the following material structure:

a Sliding layer (thickness 16 µm, central axle distance 0.2 mm)

b Intermediate layer (nickel barrier)

c Barrier layer (from 1 µm to 3 µm sputtered)

In new condition, the running surface has approx. 75% sliding layer, approx. 20% intermediate layer and max. 5% barrier layer.



Crankshaft bearing shell (sputtered bearing) (lower half)

Bearing shell has the following material structure:

1 Wear layer (from 22 µm to 28 µm sputtered)

2 Barrier layer (nickel barrier, from 1 µm to 3 µm sputtered)

3 Intermediate layer corresponds to approx. 10% of bearing thickness.

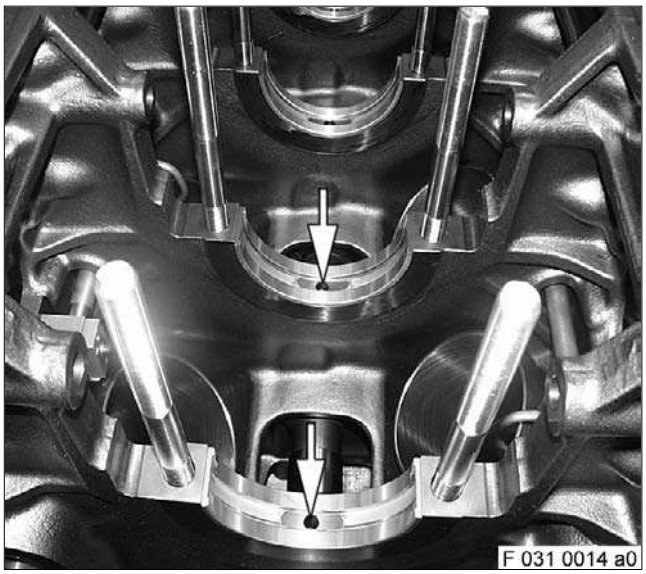
4 Protective steel shell corresponds to approx. 88% of bearing thickness.

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

Use of bearing shell is already restricted in friction area once the sliding layer is reduced to 70%!

Checking main bearing shell bore

Note: The crankshaft bearing bore must first be tested without installed main bearings and then with installed main bearings. The following describes the test with installed main bearings. The procedure is the same for testing the crankshaft bearing bore without installed main bearings.



Installing bearing shells

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

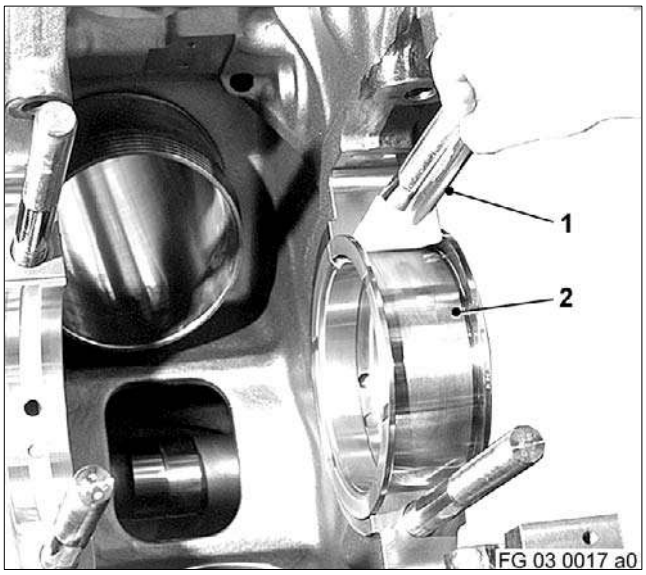
Turn crankcase upside down in assembly dolly with oil pan mating face horizontal.

Wipe bores 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 size and journal diameter of new shells and bearing number of used shells. These markings must be on sides facing toward driving end. First main bearing is designed as an alignment bearing – see next illustration.

Using installation/removal tool, insert bearing shells on housing side in accordance with bearing number into housing bore to form a positive connection and align with press-fitting tool.

Oil bores (arrow) in bearing shells and in crankcase must be aligned.



Wipe bearing shell on both sides and insert into crankshaft bearing cap according to markings or bearing number.

Bearing numbers on shells must be aligned and all numbers must be toward driving end.

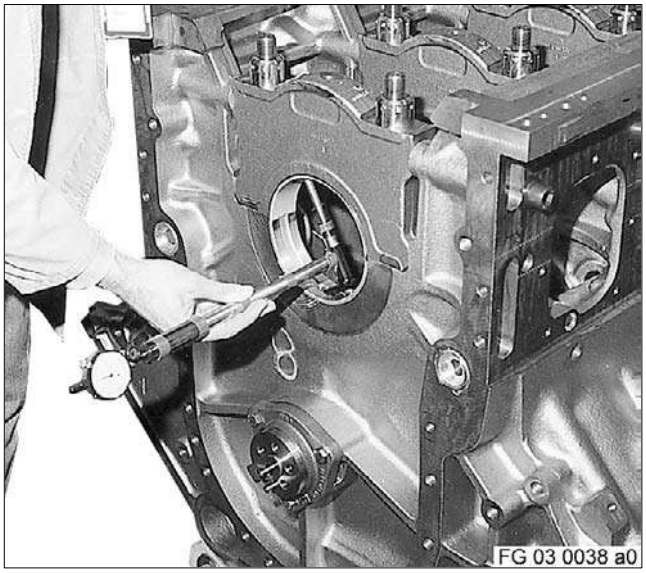
Position jig (1) between bearing cap stud and rear face of shell on side where butting joint is.

Compress main bearing cap shell (2) until free end can be pressed down onto butting face of crankcase shell.

Butting joint must be closed.

Axially align bearing shells.

Install main bearing cap and tighten lateral socket-head screws – see Section C 031.05.11 Installation – Installing main bearing cap –.



Measuring crankshaft bearing I.D.

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

Coat wear faces of main bearing shells with engine oil.

Measure I.D. of main bearing bore with shells installed.

Record measured values in data sheet.

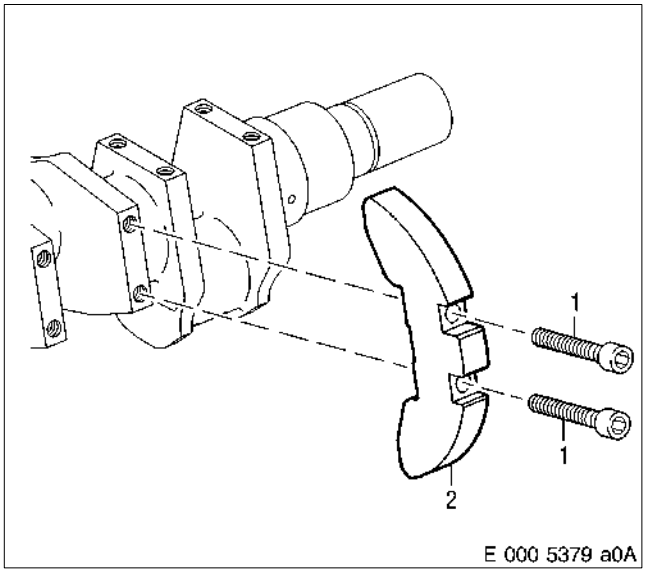
For measuring points and limit values, see Tolerance and Wear Limits List.

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

After measuring main bearing bore I.D., if necessary mark bearing shell according to bearing shell number.

Remove main bearing cap – see C 031.05.05.

C031.05.10 Assembly



Installing counterweights

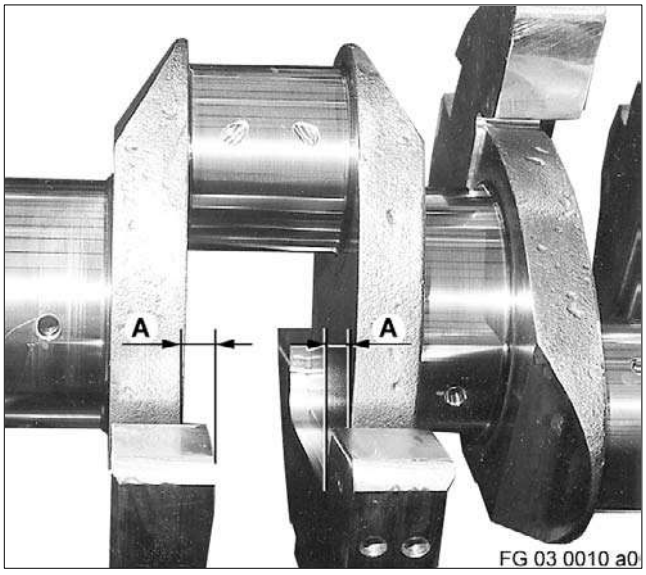
Measure shaft length of screws for counterweights; for max. shaft length, see C 031.05.01.

Clean and degrease mating face on crankshaft and counterweight (2).

Coat threads and screw head mating face of screws (1) with engine oil.

Note: Install counterweights in accordance with markings.

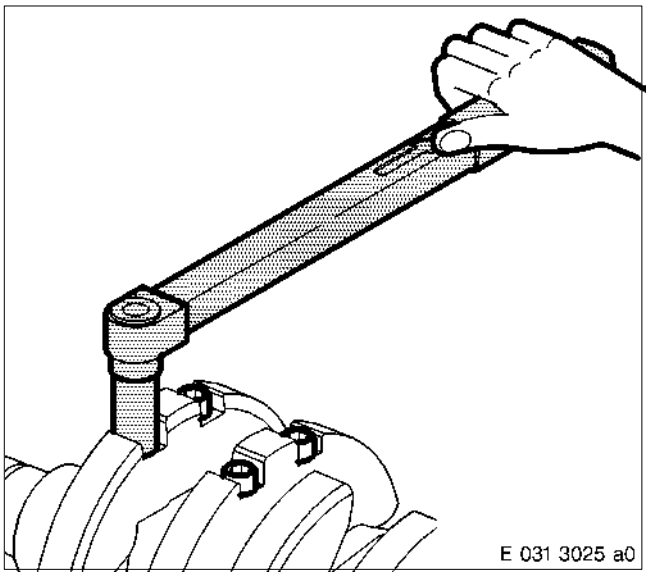
Fit counterweight on crankshaft and tighten slightly with screws.



Align counterweight to mark applied before removal and dimension A.

Pretighten screws to specified pretightening torque – see C 031.05.01

Check that marking and measured distances are correct.



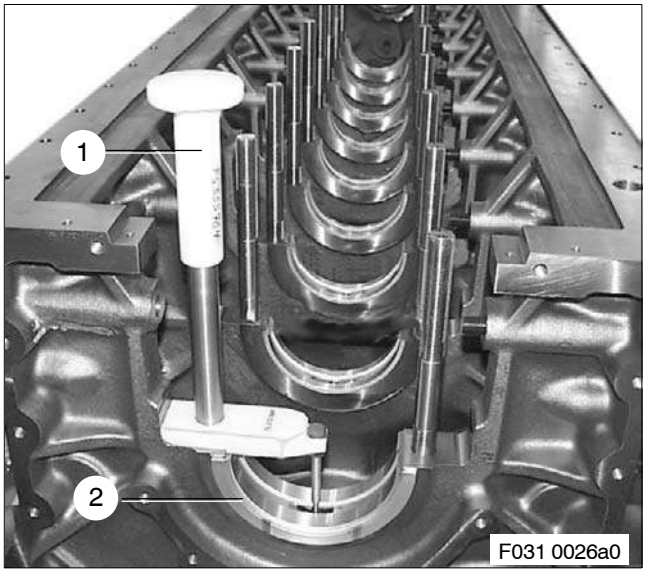
Mark screw heads.

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.

C031.05.11 Installation



Installing crankshaft

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.

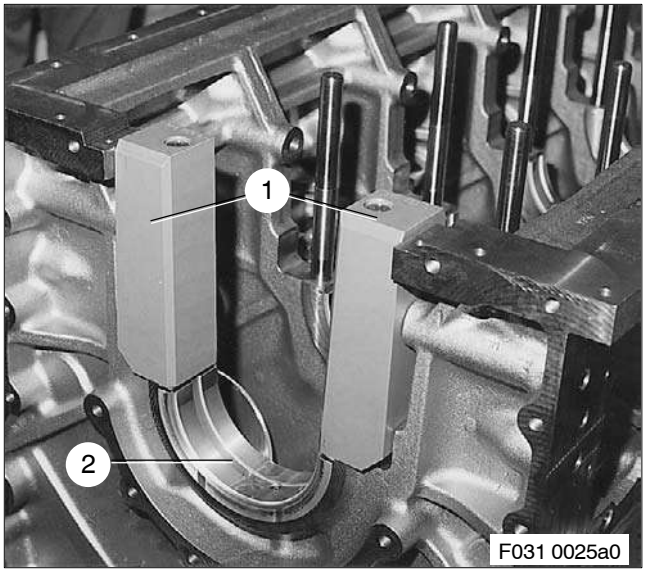
Light up oil bores to main bearings in crankcase with cold light and check that they are perfectly clean.

Note: Top and bottom bearing shells have different part numbers.
First main bearing (2), driving end, is designed as an alignment bearing.

Using installation/removal tool, manually insert bearing shells on housing side in accordance with bearing number into housing bore to form a positive connection.

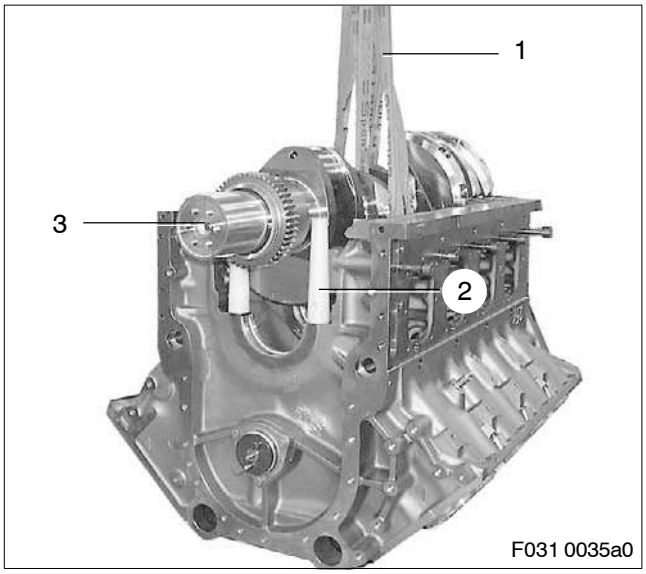
Note: Check repair stage of crankshaft main bearing bore and repair stage of bearing shells – see crankcase data sheet and crankshaft characteristics record.

Align alignment bearing shell (2) and remaining bearing shells with press-fitting tool (1) into housing bore.



Spray running faces of crankcase bearing shells with engine oil.

To protect crankshaft, slip locating device (1) over main bearing cap studs of first bearing (2).



Fit protective sleeves (2) over studs of last bearing.

Wipe crankshaft bearing surfaces (3).

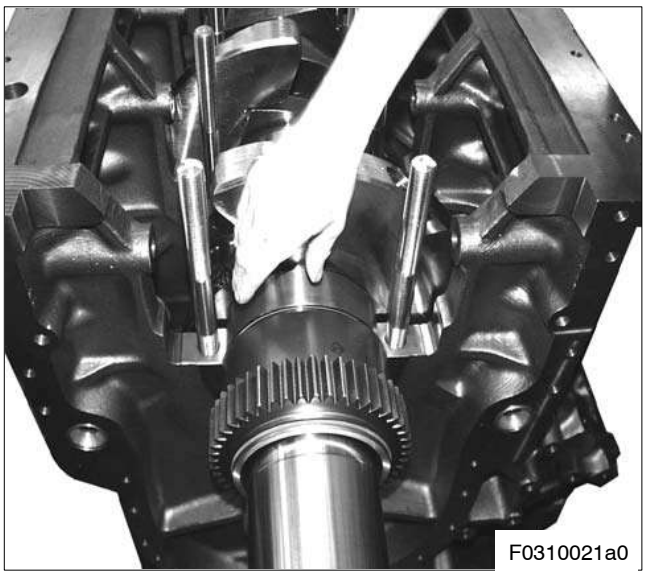
Inspect oil bores with lamp and ensure they are perfectly clean.

⚠ WARNING

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

Lift crankshaft using rope slings (1) and crane.

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

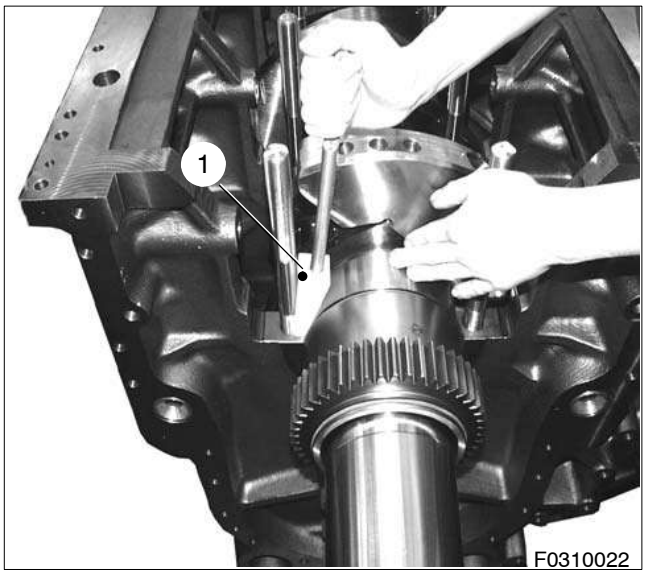


Remove protective sleeves and locating device.

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

Wipe bearing shell and crankshaft bearing cap with chamois leather, spray running surface with engine oil and install.

Note: Bearing numbers on shells must be aligned and all numbers must be toward driving end. Check alignment of upper and lower bearing shells.



Position jig (1) between bearing cap stud and rear face of shell on side where butting joint is.

Compress main bearing cap shell until free end can be pressed down onto butting face of crankcase shell.

Note: Butting joint must be closed.

Axially align bearing shells.

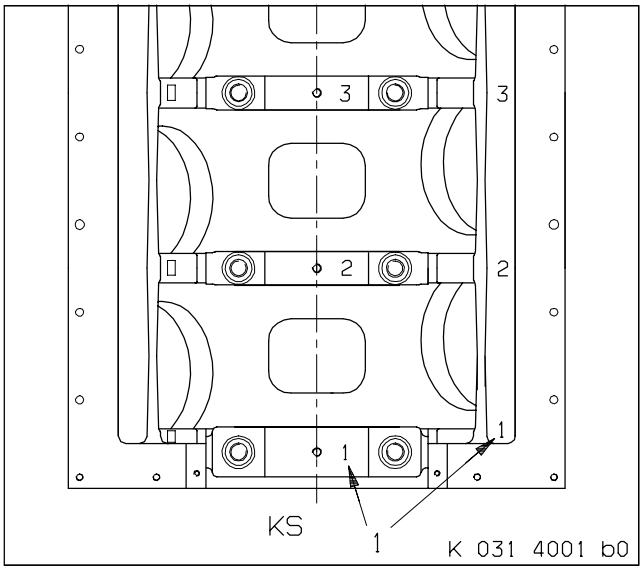
Installing main bearing cap

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.

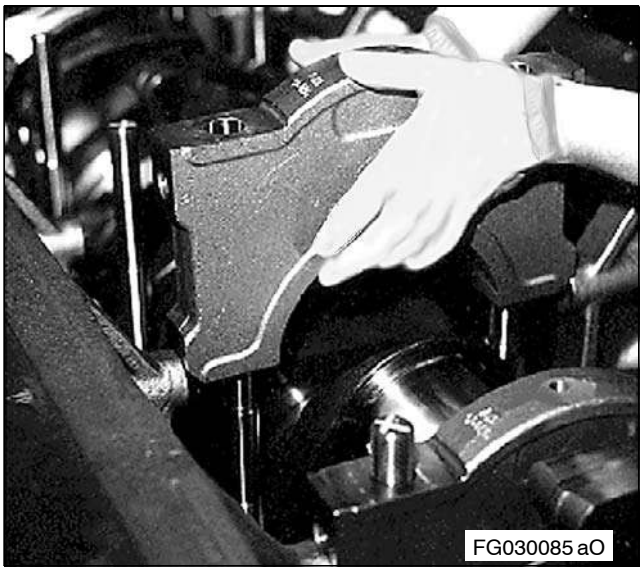
Check mating faces on crankshaft bearing cap and bores for cleanness and blow out with compressed air.



Note: Crankshaft bearing caps must not be interchanged!

1 – Stamp number of main bearing, starting from driving end, ensuring it is legible.

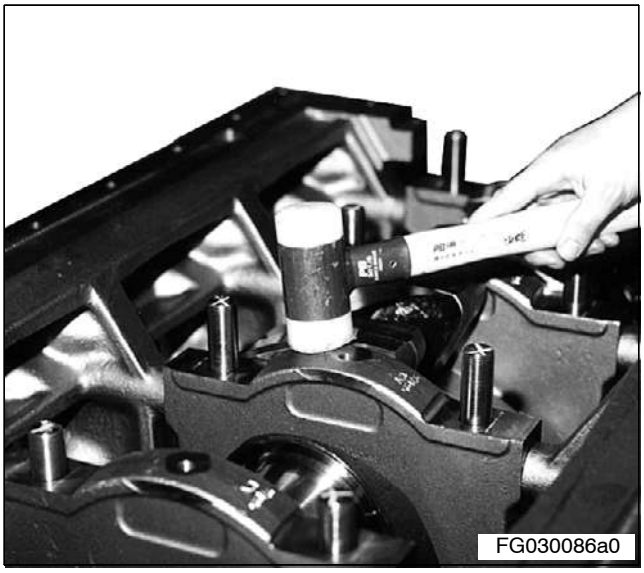
Allocate bearing cap according to crankcase marking to respective bearing.



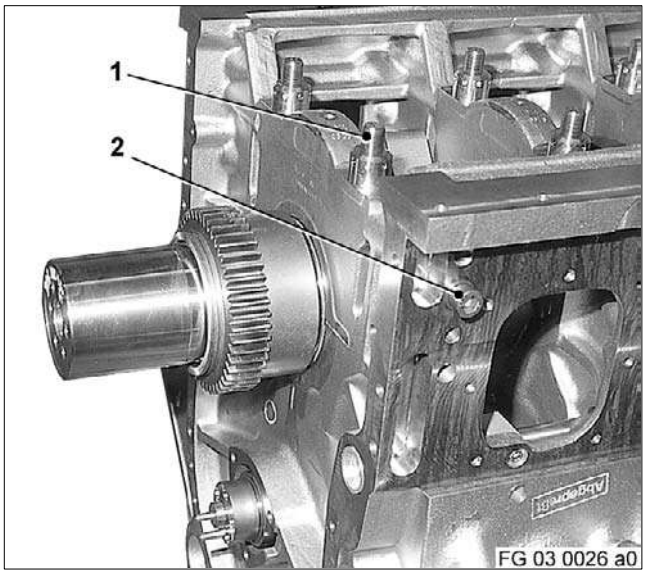
⚠ CAUTION

Narrow gap.
Risk of crushing!
Keep fingers clear of the danger zone.

Position allocated bearing cap on respective bearing.



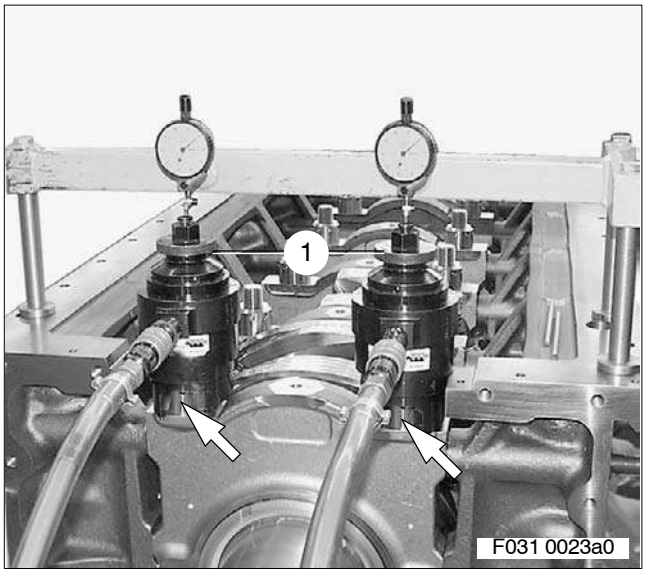
Hit the crankshaft bearing cap lightly to settle in final position.



Coat thread and mating face of side hex socket screws (2) and studs (1) with engine oil.

Turn nuts for bearing cap to mating face of bearing caps.

Install hex socket screws but do not tighten.



⚠ WARNING

Tools may be released suddenly.
Fluid is highly pressurised.
Risk of injury!
Only use specified and tested equipment.
Personnel must stay clear of the danger area.
Always wear protective gloves and protective goggles/safety mask.

Beginning with the 1st bearing cap (driving end), mount hydraulic preloading device on studs of crankshaft bearing cap.

Fit nuts (1) by hand till they contact.

Connect hydraulic hand pump to hydraulic preloading device.

Warning: Newly fitted studs must be elongated as follows before initial tightening:

1. Elongation of studs with 1500 bar (309 kN, valid for device with effective piston area A_K= 20.6 cm^2)
2. Release
3. Elongation as in Point 1.
4. Release

Position magnetic-base indicator holder with dial gauges on the crankcase support surface for extension measurement of the studs.

Position a dial gauge stylus against end of each sleeve measuring stud.

Set dial gauges with preload to zero.

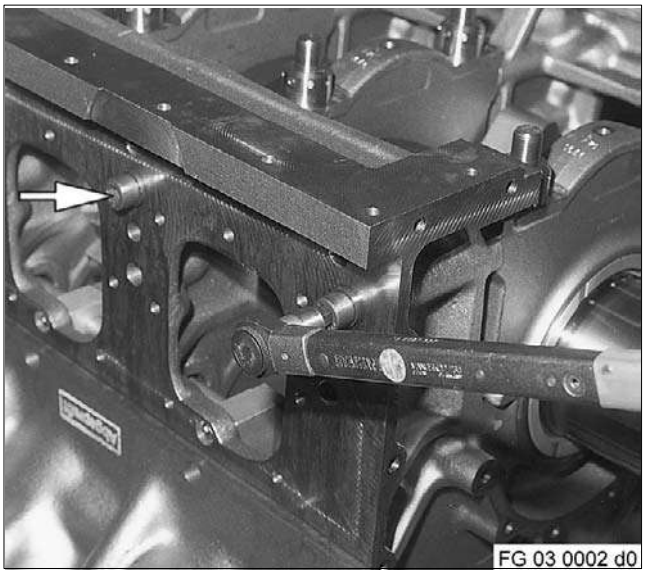
Operate the hydraulic hand pump and, at the same time, elongate studs (max. 1.15 mm + 0.05 mm).

Tighten nuts on crankshaft bearing cap with a pin (arrow).

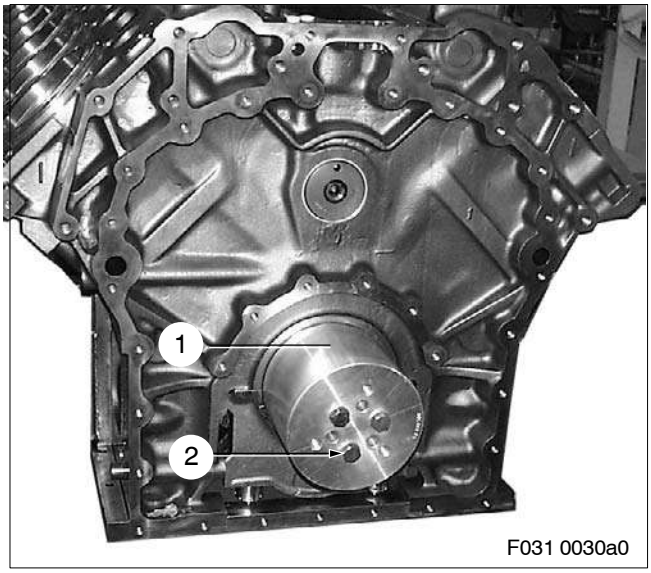
Relieve tension on studs, mount dial gauges with magnetic holders and hydraulic pretensioner on studs of next adjacent main bearing cap and install all nuts in same order.

Note: Remaining elongation of studs after release: 0.9 mm + 0.05 mm.

If remaining elongation of studs is outside tolerance, release nuts, see C 031.05 .05 and repeat nut tightening procedure; if necessary, replace studs.



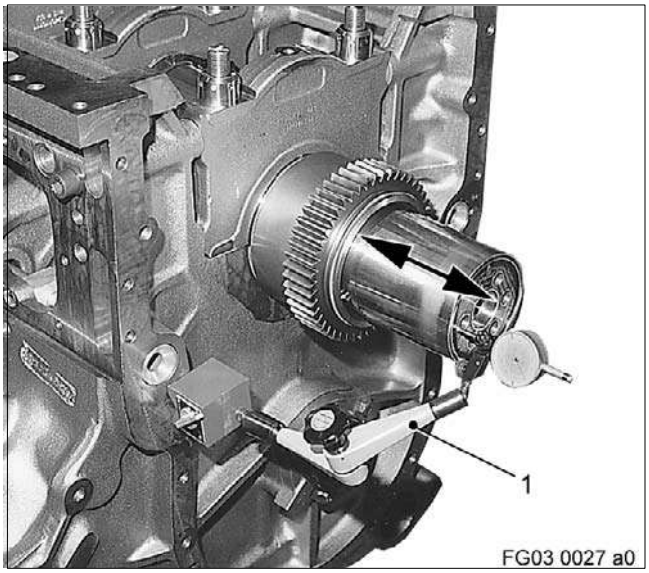
Tighten hex socket screws (arrow) to specified tightening torque – see overview drawing C 031.05.01.



To rotate crankshaft without flywheel, install locating device (1) with hex screws (2) on crankshaft, driving end.

Bar crankshaft manually and check for ease of movement.

Install block with two socket-head screws – see C 011.05.10.



Measuring crankshaft axial play

Note: Measure axial clearance only with drive flange or flywheel mounted.

Mount magnetic stand with dial gauge (1) on crankcase.

Position dial gauge stylus against front face of crankshaft.

Using pry bar, 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.

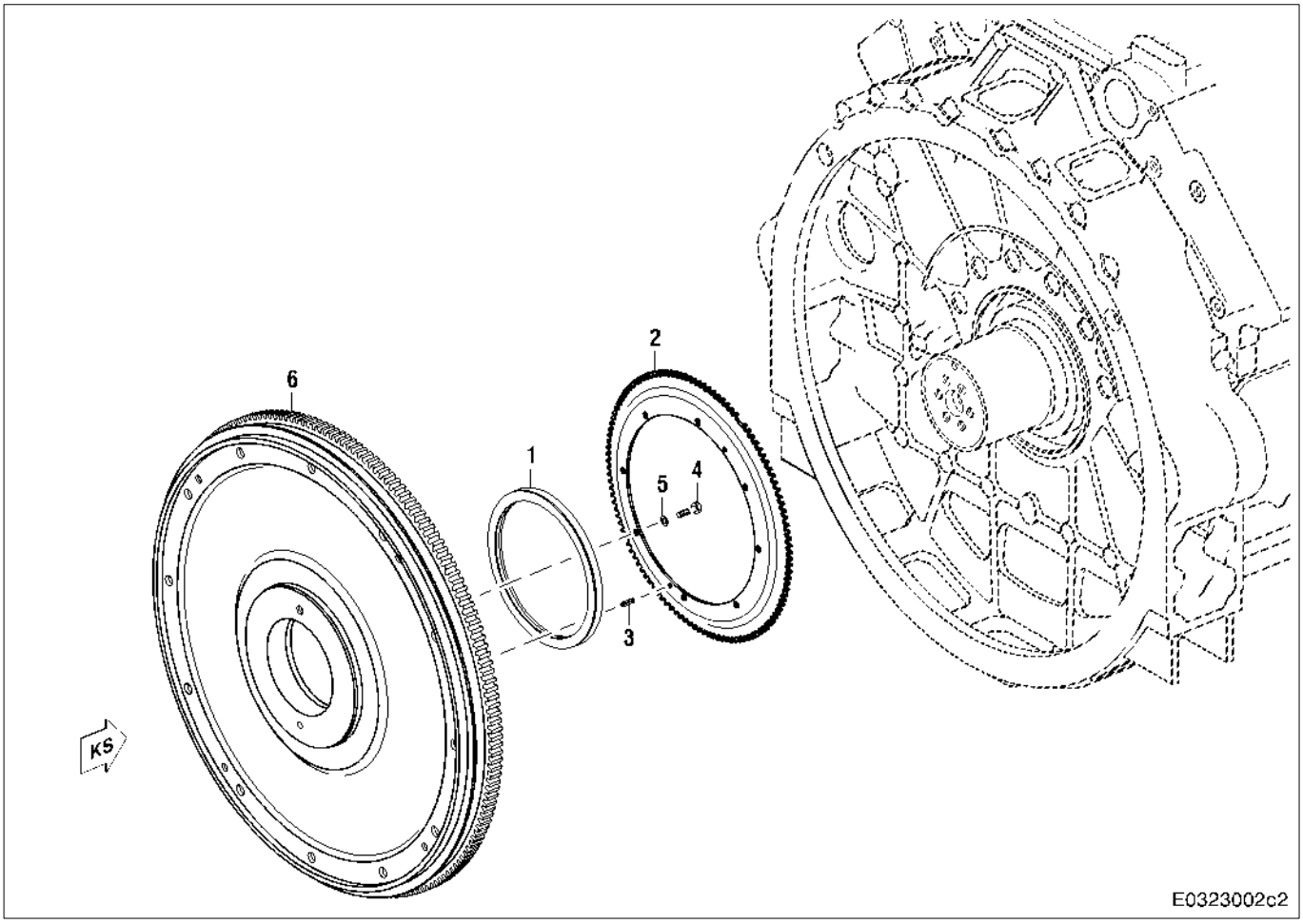
C031.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007

C032.05 PTO, driving end

C032.05.01 Overview drawing

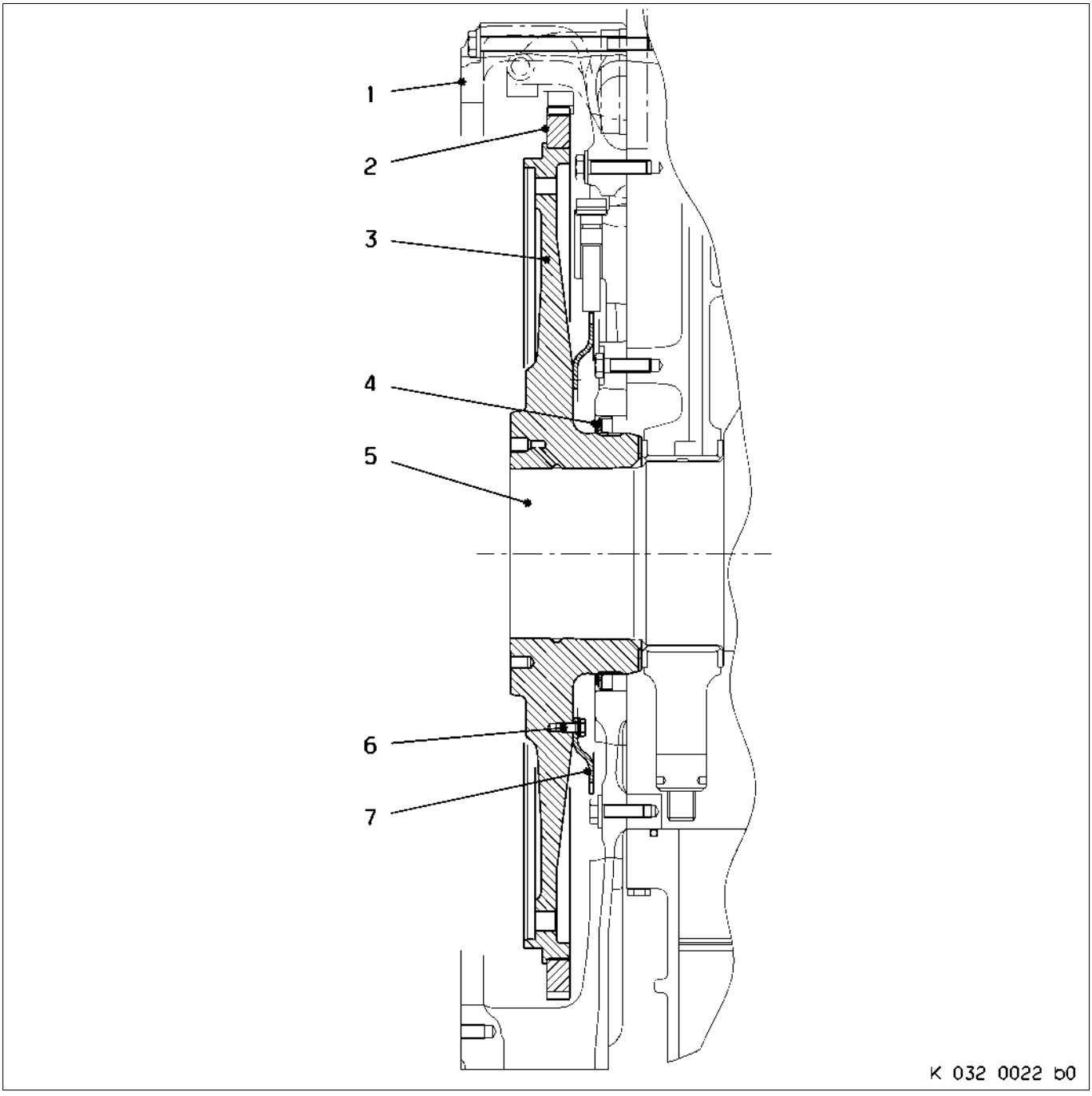


1 Radial-lip shaft seal
2 Graduated disc
3 Spring pin
4 Hex screw

Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

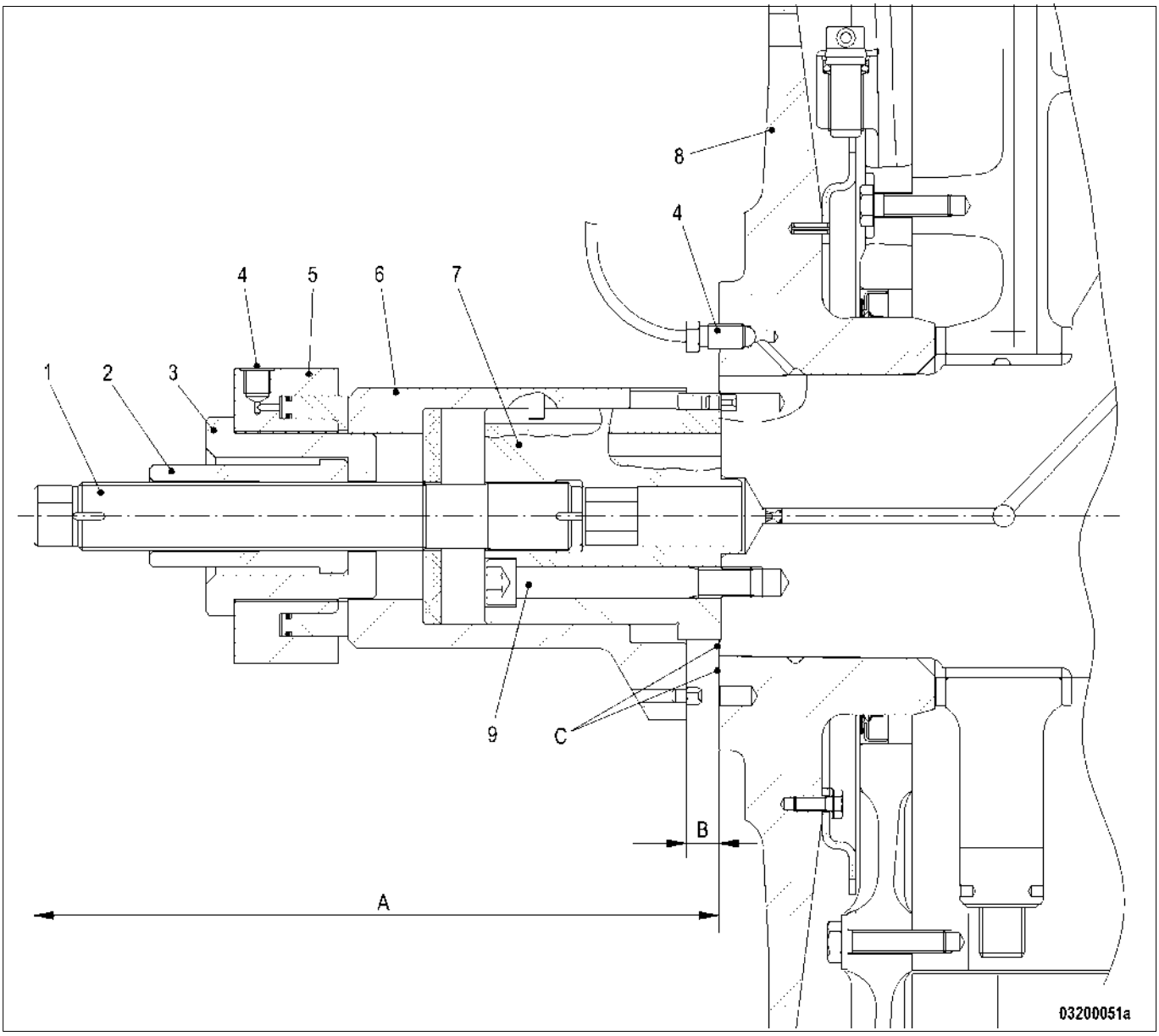
5 Washer
6 Flywheel

PTO with flywheel



1 Flywheel housing
2 Flywheel ring gear
3 Flywheel
4 Radial-lip shaft seal
5 Crankshaft
6 Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm
7 Graduated disc

Layout for installation/removal tool for flywheel



1 Draw spindle
2 Hex nut M36
3 Support
4 Connection for H.P. fuel line
5 Hydraulic nut (press)
6 Pressure bush
7 Flange
8 Flywheel
9 Screw

Reference dimension	A = 362 mm
Push-on dimension	B = 17 mm to 13.7 mm
Reference surface	C = press-fitted flush

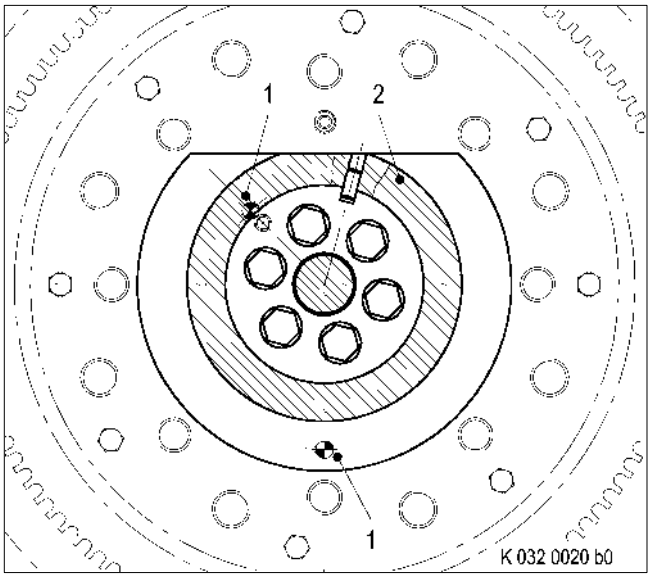
C032.05.02 Special tools

Designation	Use/dimension	Number
• Installation/removal tool	for flywheel	1
• Tool kit (hydraulic hand pump)	for 0 – 3500 bar	1
• SKF hand pump	for 0 – 1000 bar	1
• Press-fitting tool	for radial-lip shaft seal	1
• Assembly sleeve	for flywheel	1

C032.05.04 Before-removal operations

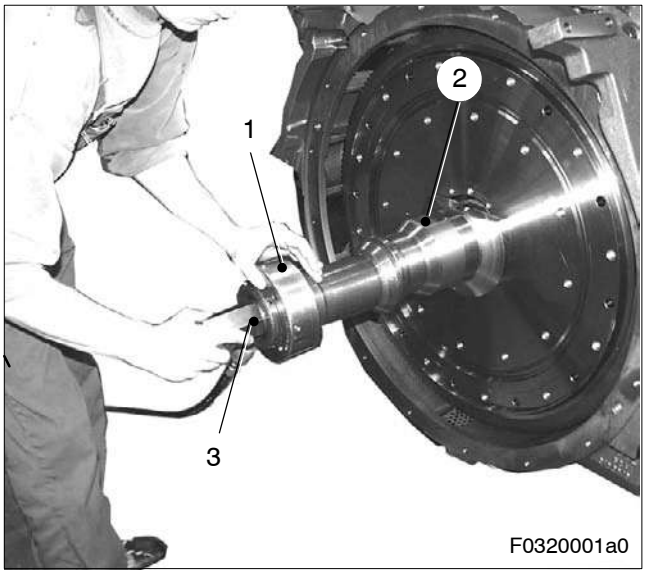
For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Separate engine from gearbox or alternator	→ –

C032.05.05 Removal



Install flange with hex screws – see overview drawing C 032.05 Arrangement, hydraulic installation and removal – on crankshaft journal, driving end.

Rotate crankshaft so that locating element (1) of pressure bush (2) engages in flywheel.



⚠ WARNING

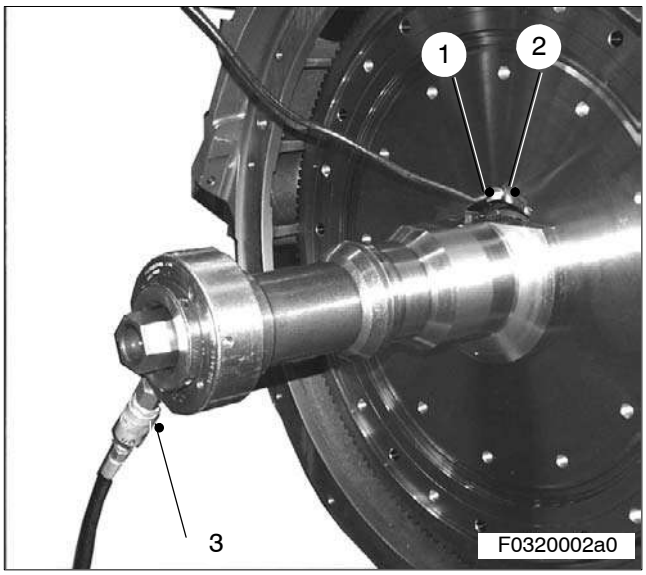
Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off and cause serious injury.
Risk of knocks or crushing!
Liquids emerging under high-pressure can lead to serious injury!
Hydraulic installation/removal must be carried out only by qualified personnel. Only use specified and tested equipment.
The specified expansion and push-on pressure must not be exceeded.
During the installation/removal procedure, make sure that nobody is standing in the danger area. 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.

For arrangement of installation/removal tool, see overview drawing C 032.05.01.

Screw draw spindle into crankshaft.

For reference dimension (A), see overview drawing C 032.05.01, Measuring end face of draw spindle to end face of spacer.

Mount pressure sleeve (2) and hydraulic nut (press) (1) over draw spindle and install nut (3).



Remove plug from expansion bore in flywheel.

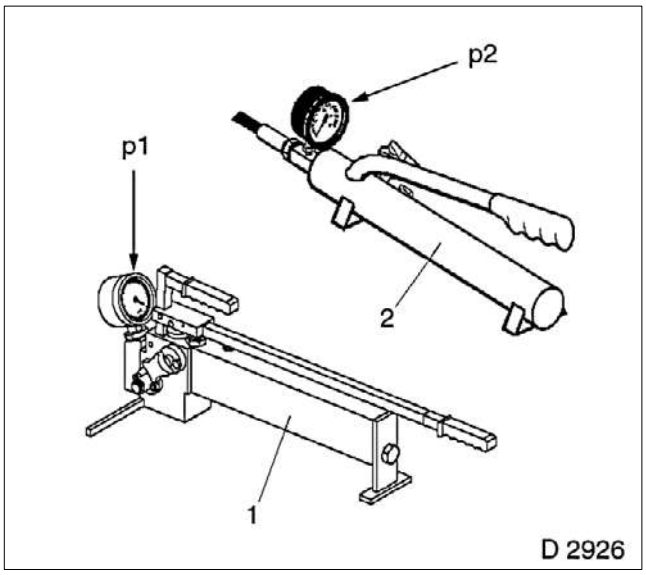
Screw connector (2) into flywheel and connect H.P. line (1).

Connect H.P. line (3) of Lukas hand pump to hydraulic press.

Fully tighten nut then back off nut distance equal to push-on dimension.

Push-on dimension – see overview drawing 032.05.01.

Note: When fitting the nut up to the stop, the hydraulic press must be at its initial position (0 stroke).



Fill hydraulic hand pumps with SAE10 engine oil.

Prime pumps and lines until oil escaping is free of bubbles.

Tighten high-pressure line.

Actuate SKF hand pump (2) for hydraulic press and move press with minimum pressure (p2) (pressure starts to rise) until it contacts with hub.

Note: The hydraulic nut (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 drive flange.

Increase expansion pressure in stages of 0.1 x 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.

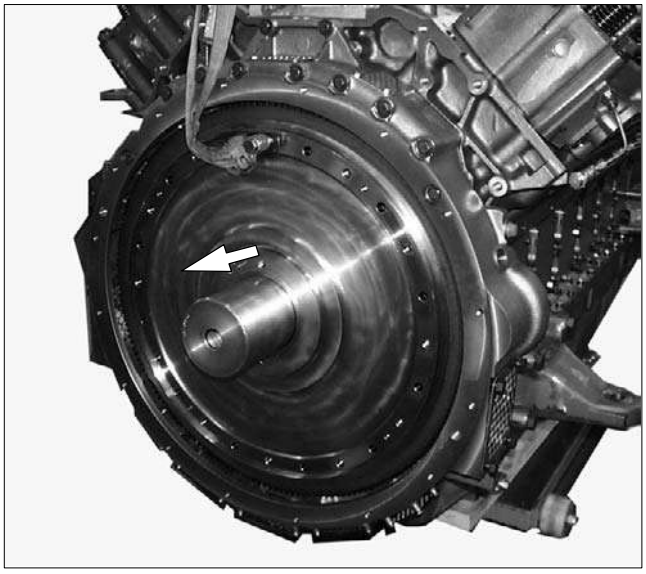
Gradually relieve pressure in hydraulic press while steadily operating pump for expansion fluid.

Relieve pressure in hydraulic hand pumps.

Insert eyebolt into flywheel and attach to rope and crane.

Remove high-pressure line and reducer.

Remove nut, hydraulic press and pressure sleeve.



⚠ WARNING

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

Remove flywheel via forcing thread.

Slightly tension flywheel with crane and rope sling. Using crane and rope sling, lift flywheel via the pressure bush out of flywheel housing.

C032.05.06 Disassembly

Removing radial-lip shaft seal from flywheel housing

Use a suitable extractor to withdraw radial-lip shaft seal out of flywheel housing.

Note: Do not damage flywheel housing and crankshaft.

Removing graduated disc

Note: Remove measuring wheel only if necessary (e.g. if damaged).

Remove graduated disc as per overview drawing – see C 032.05.01.

Withdraw spring pin from flywheel.

C032.05.08 Inspection and repair

Clean all components.

Using the magnetic crack-testing method with fluorescent magnetic powder, check flywheel with ring gear 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 taper surfaces of flywheel for scoring and damage.

Remove minor scoring and damage by polishing with emery cloth.

Check taper 1:50 with taper gauge.

Replace flywheel if taper bore is oversized.

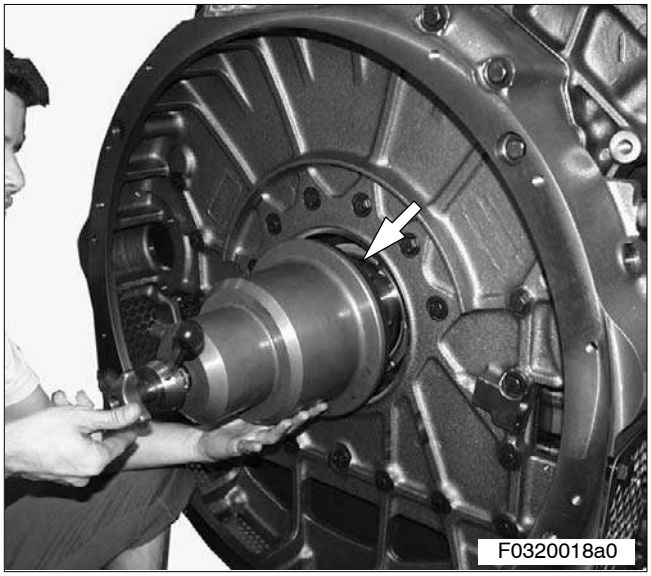
Check thread of expansion bore; rechase if necessary.

Check ring gear for wear, replace if necessary.

Remove slight burrs and chipping from teeth by grinding or filing.

Replace spring pin and O-rings at every installation.

C032.05.10 Assembly



Installing radial-lip shaft seal into flywheel housing

⚠ WARNING

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

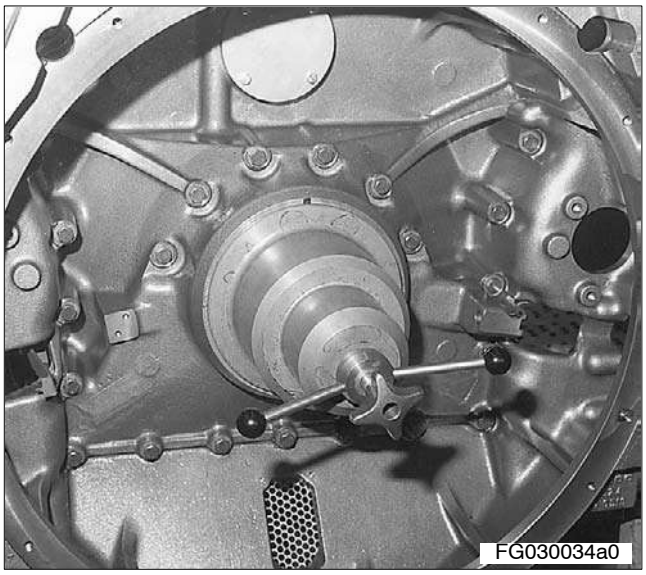
Note: The press-fitting tool for the radial-lip shaft can only be used when the flywheel housing is installed. Installation of flywheel housing – see Section C 016.30.

Install flange with spacer on face of crankshaft – see overview drawing C 032.05.01.

Fit radial-lip shaft seal, with sealing lip facing outwards, on press-fitting tool.

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

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



Clean and degrease support bore for radial-lip oil seal in flywheel housing.

Use pressure spindle to install radial-lip shaft seal flush in flywheel housing.

Remove pressure spindle with flange from crankshaft.

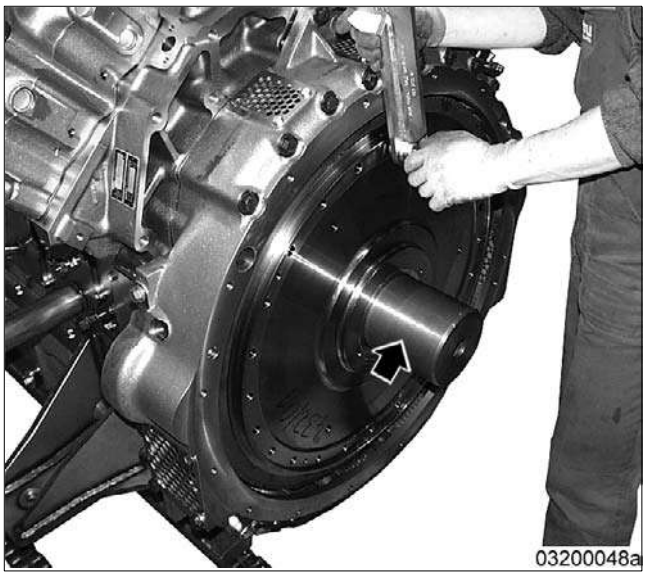
C032.05.11 Installation

Completing flywheel

Install graduated disc (2) with hex screws (1) on flywheel, but do not tighten.

Drive spring pins (arrow) into flywheel.

Tighten hex screws in diagonally opposite sequence to specified torque – see C 032.05.01.



⚠ WARNING

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

Clean and degrease taper surface on crankshaft and flywheel (2).

Coat running surface of flywheel for radial-lip shaft seal with thin-film lubricant.

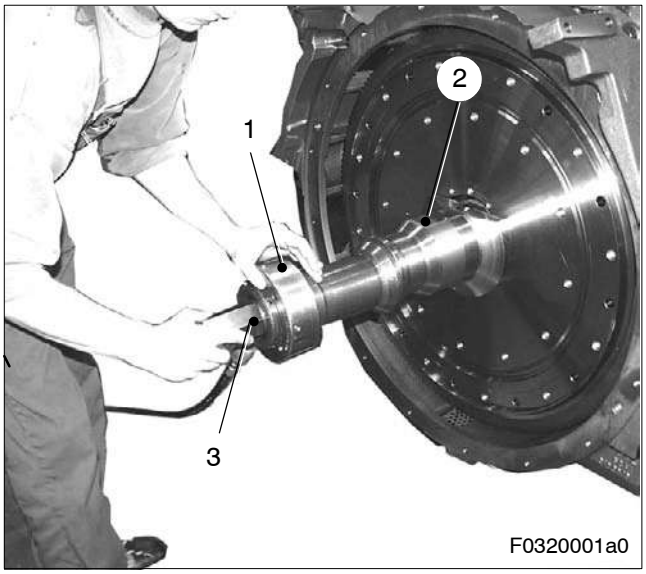
Coat lip of radial-lip oil seal with petroleum jelly.

Install guide sleeve (arrow).

Using the crane and ropes, insert the flywheel over the guide sleeve into the flywheel housing.

Note: Take care not to damage radial seal lip.

Remove guide sleeve (arrow).



⚠ WARNING

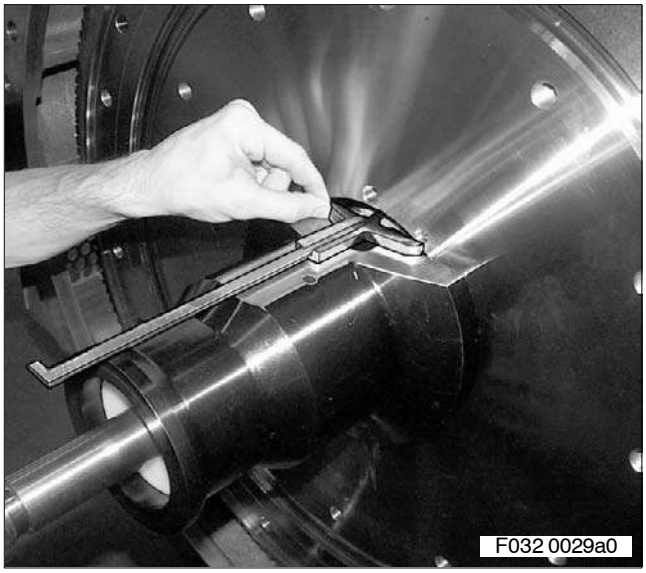
Equipment which is faulty, installed incorrectly or not in accordance with specifications may become loose or drop off and cause serious injury.
Risk of knocks or crushing!
Liquids emerging under high-pressure can lead to serious injury!
Hydraulic installation/removal must be carried out only by qualified personnel. Only use specified and tested equipment.
The specified expansion and push-on pressure must not be exceeded.
During the installation/removal procedure, make sure that nobody is standing in the danger area. 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.

For arrangement of installation/removal tool, see overview drawing C 032.05.01.

Screw draw spindle into crankshaft.

For reference dimension (A), see overview drawing C 032.05.01, measuring end face of draw spindle to end face of spacer.

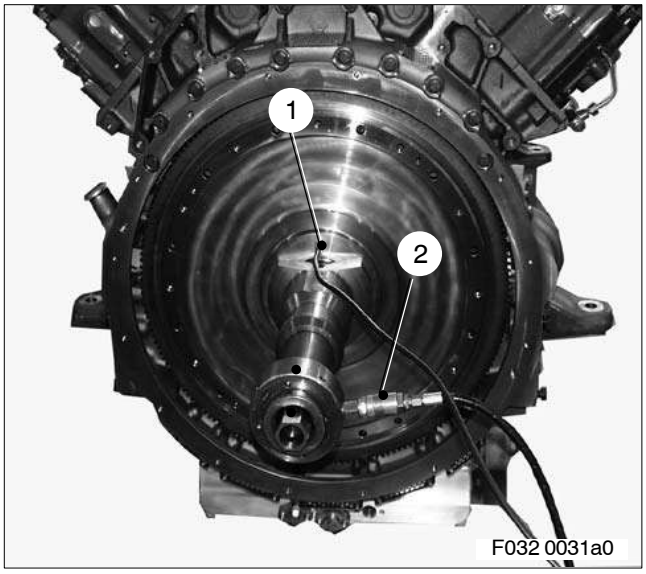
Mount pressure sleeve (2) and hydraulic nut (press) (1) over draw spindle and install nut (3).



Calculate push-on distance by measuring distance from end face of spacer to end face of flywheel with depth gauge.

If calculated distance is less than push-on distance a, check dimensional accuracy of taper.

Push-on dimension “a” is stamped on 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.
During the installation/removal procedure, make sure that nobody is standing in the danger area. 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.

Note: Pressure bush with centring pin (see overview drawing C 032.05.01) centres drive flange and specifies installation position.

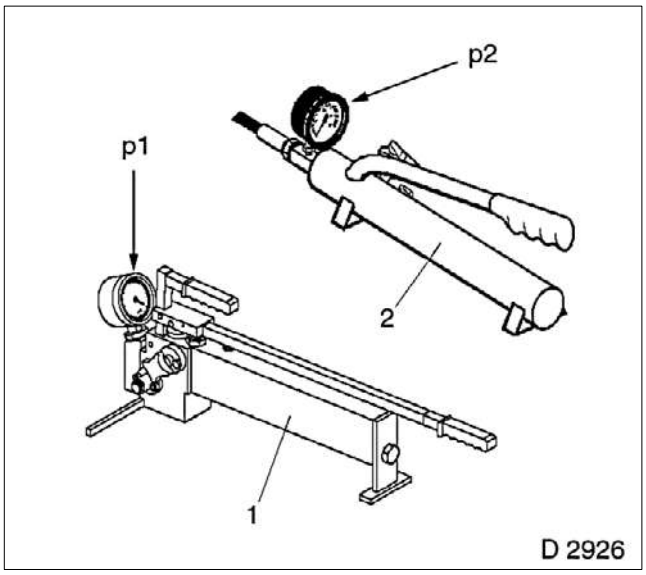
Connect H.P. line (1).

Connect H.P. line (2) of Lukas hand pump to hydraulic nut (press).

Fully tighten nut then back off nut distance equal to push-on dimension.

For push-on dimension B and expansion pressure, see information on face of flywheel.

Note: Before tightening nut (press), make sure that hydraulic press is in initial position (0 stroke).



Fill hydraulic hand pumps with SAE 10 engine oil.

Prime pumps and lines until oil escaping is free of bubbles.

Tighten high-pressure line.

Before installing, coat taper faces with expansion fluid by operating hydraulic hand pump (1) until expansion fluid emerges at both sides of hub.

Operate Lukas hand pump (2) for hydraulic nut (press) and, by applying minimum pressure, seat press against flywheel.

Operate pump for expansion fluid until no further increase in expansion pressure (p1) is possible, then increase force-on pressure (p2) by operating force-on pump.

Repeat this process until crankshaft gear is seated on flywheel.

Select force-on pressure such as to seat shaft in approx. 5 steps.

During installation, do not allow the expansion pressure to exceed the maximum permissible expansion pressure p_{max}.

p_{max} see information stamped on flywheel.

The installation procedure has concluded when the pressure bush is at the stop on the crankshaft.

Note: Rapid pressure rise (P2)

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.

Unscrew H.P. lines.

Allow specified retention time to elapse and remove nut, hydraulic nut (press), pressure sleeve and draw spindle.

Note: Do not subject press fitting to operating load for at least 8 hours.

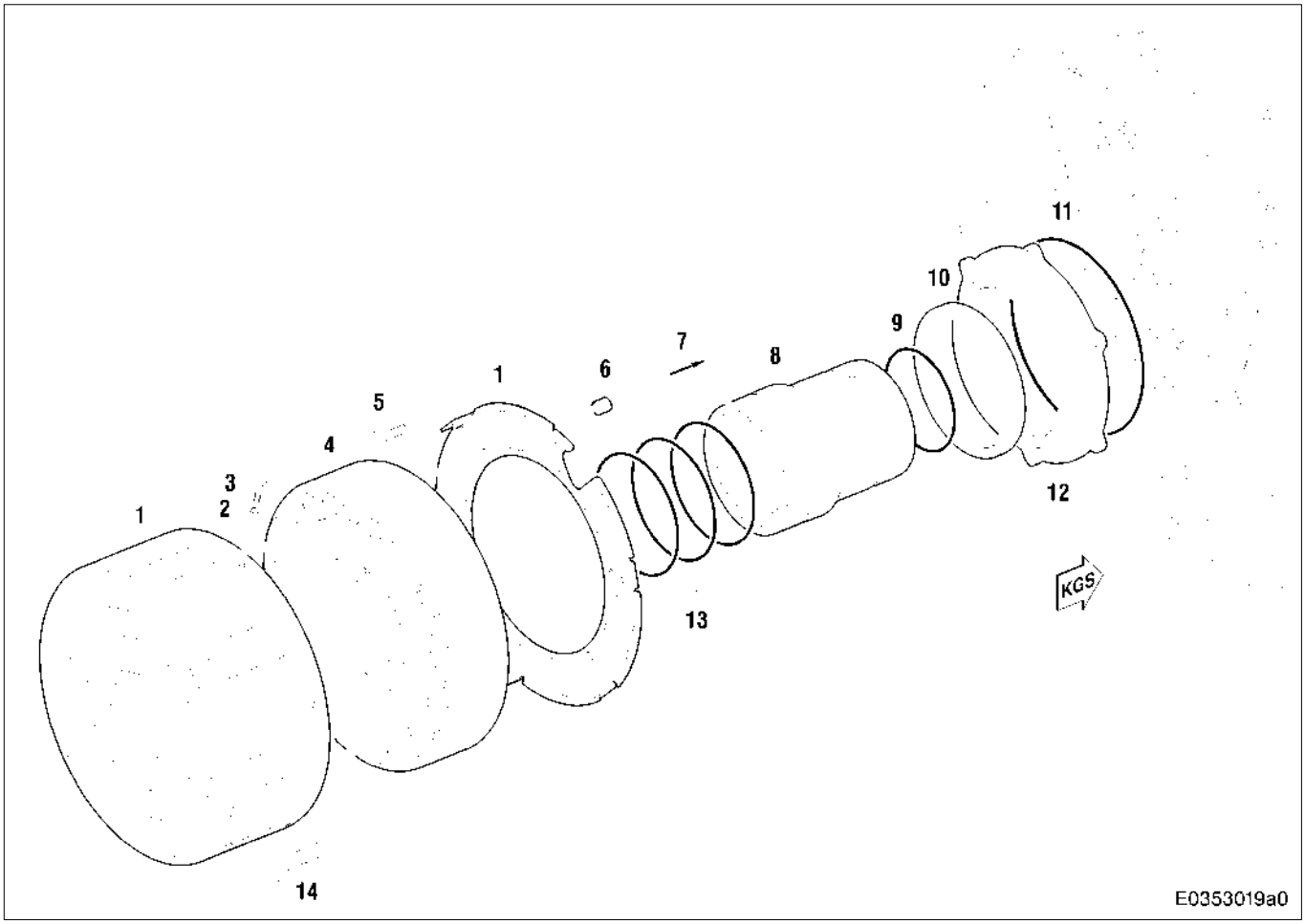
After the retention time, remove oil from the expansion bore, screw in threaded pin and tighten to specified torque – see overview drawing C 032.05.01.

C032.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Connect engine with gearbox/alternator	→ –
–	–	x	Release engine start	→ Operating Instructions

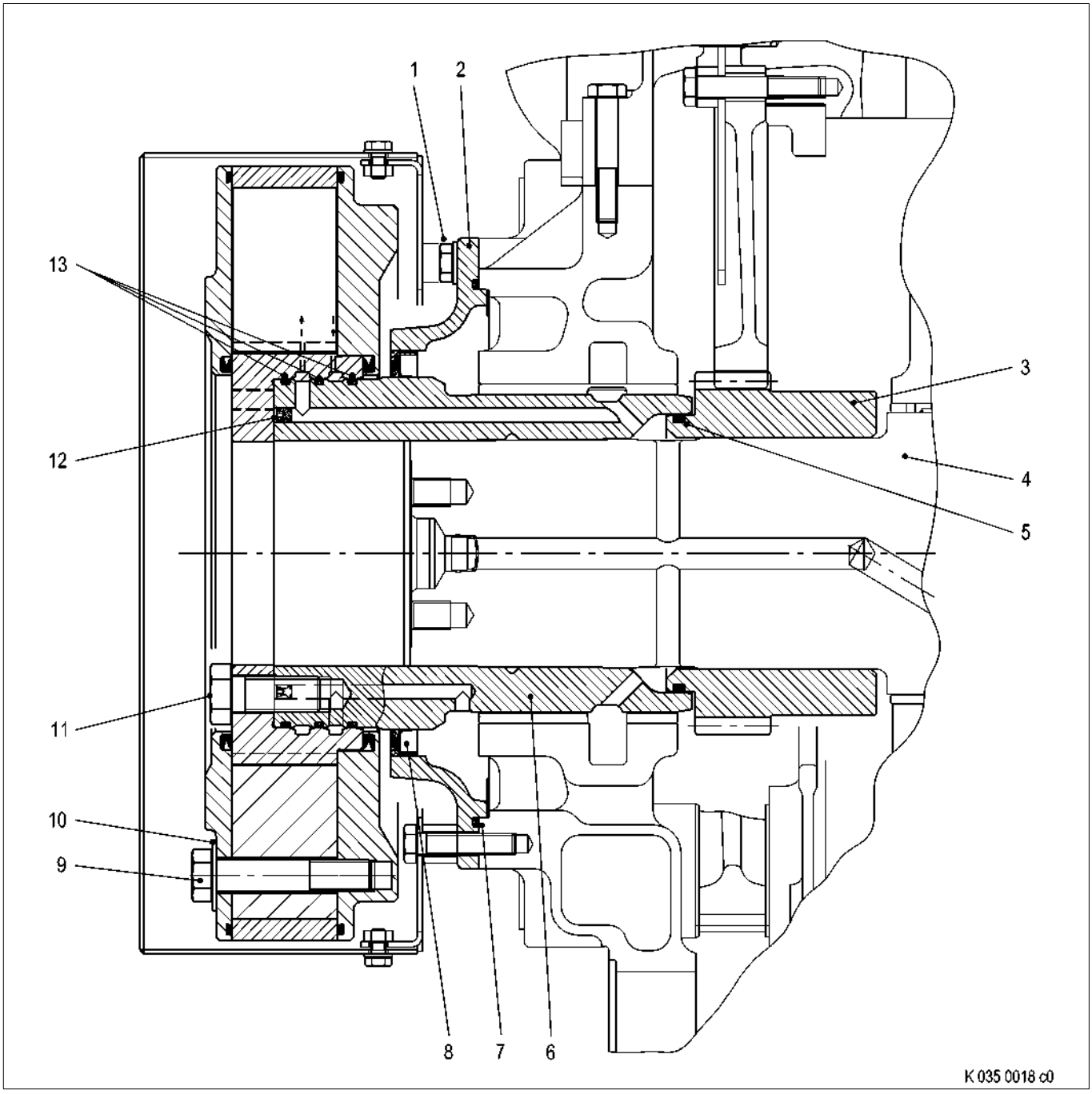
C035.05 PTO, free end

C035.05.01 Overview drawing



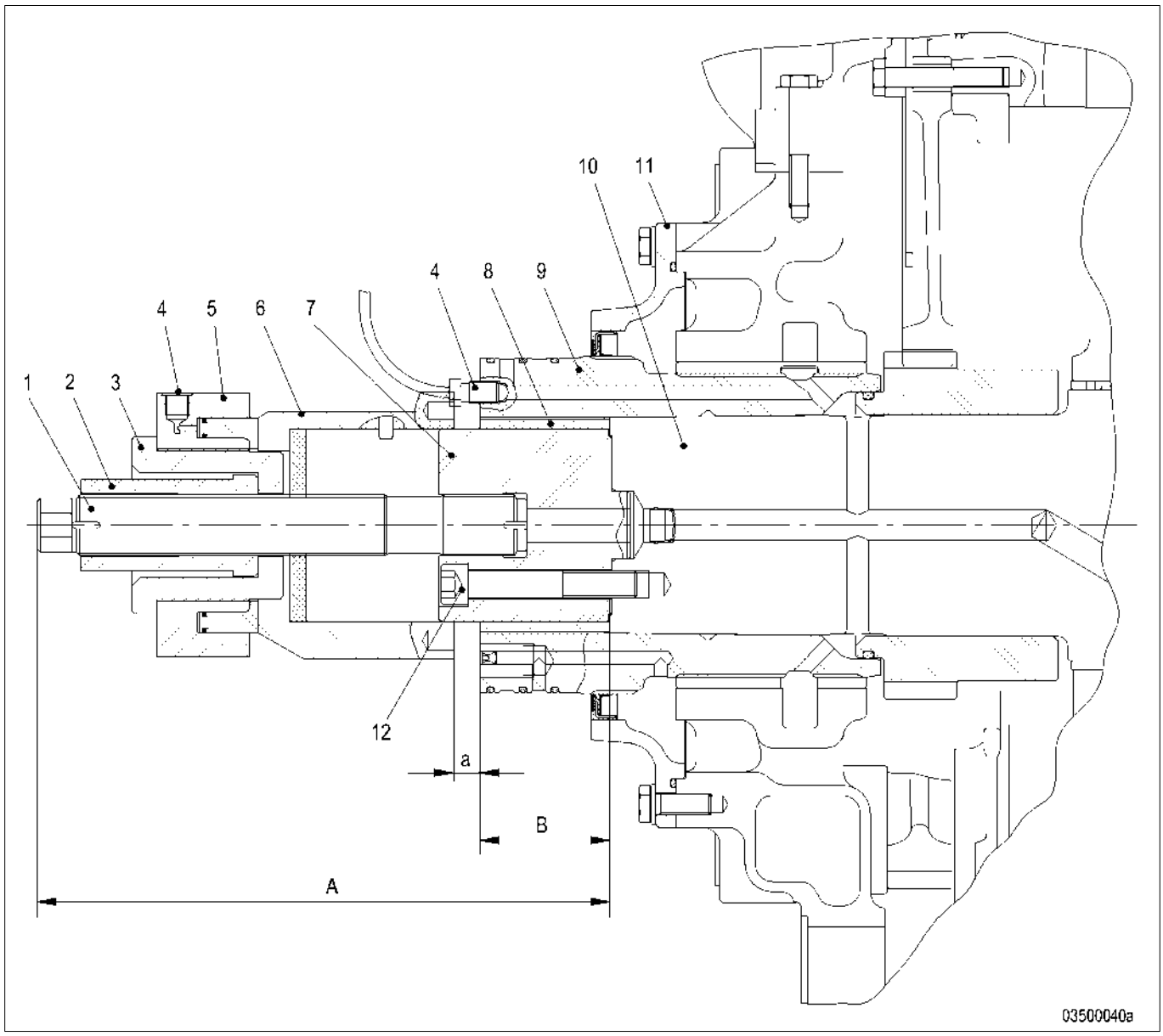
1 Protective plate
2 Washer
3 Hex screw
4 Vibration damper
5 Hex screw
Lubricant: Engine oil
Tightening torque: 74 Nm + 7 Nm
6 Spacer sleeve
7 Sealing plug
8 Drive flange
9 O-ring
10 Radial-lip shaft seal
11 O-ring
12 Seal carrier, free end
13 O-rings
14 Hex screw
Lubricant: Engine oil
Tightening torque: 500 Nm + 50 Nm

PTO with vibration damper



1 Hex screws
Lubricant: Engine oil
Tightening torque: 74 Nm + 7 Nm
2 Seal carrier
3 Crankshaft gear
4 Crankshaft
5 O-ring
6 Drive flange
7 O-ring
8 Radial-lip shaft seal
9 Hex screw
10 Washer
11 Hex screw
Lubricant: Engine oil
Tightening torque: 500 Nm + 50 Nm
12 Sealing plug
13 O-rings

Arrangement of drive flange installation/removal tool



1 Draw spindle
2 Hex nut
3 Support
4 Connection for H.P. fuel line
5 Hydraulic nut (press)
6 Pressure bush
7 Flange
8 Spacer bush
9 Drive flange
10 Crankshaft
11 Seal carrier
12 Socket-head screw

Reference dimension	A = 339 mm
Push-on dimension	B = from 76.95 mm to 77.05 mm
Push-on distance	a = 15.5 mm

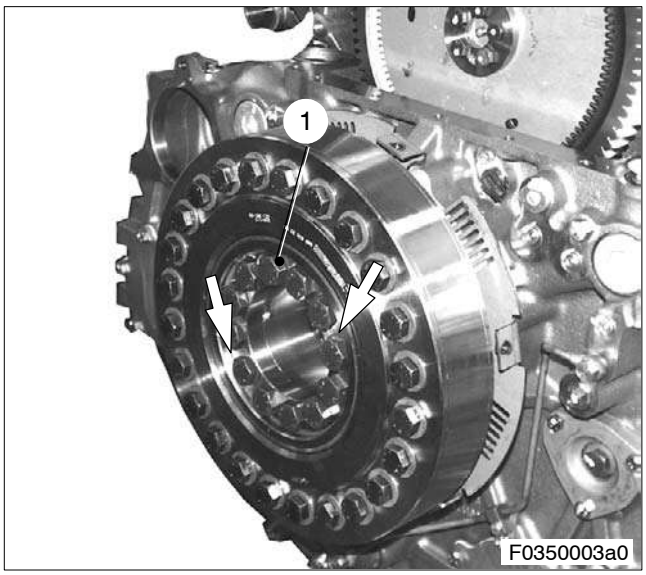
C035.05.02 Special tools

Designation	Use/dimension	Number
• Installation/removal tool	for drive flange	1
• Hydraulic set	for main bearing screws	1
– Hand pump 3000 HT		1
• Adjusting mandrel	for vibration damper	2
• Support bracket	for vibration damper	1
• Retaining device	for flywheel	1

C035.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C035.05.05 Removal



Removing vibration damper

Remove guard plate – see overview drawing C 035.05.01.

Lock flywheel on flywheel housing with positioning fixture.

Remove hex screws (1), one screw is left for securing purposes.

Screw in two adjusting mandrels in opposite threaded bores of drive flange.

Remove remaining hex screw.

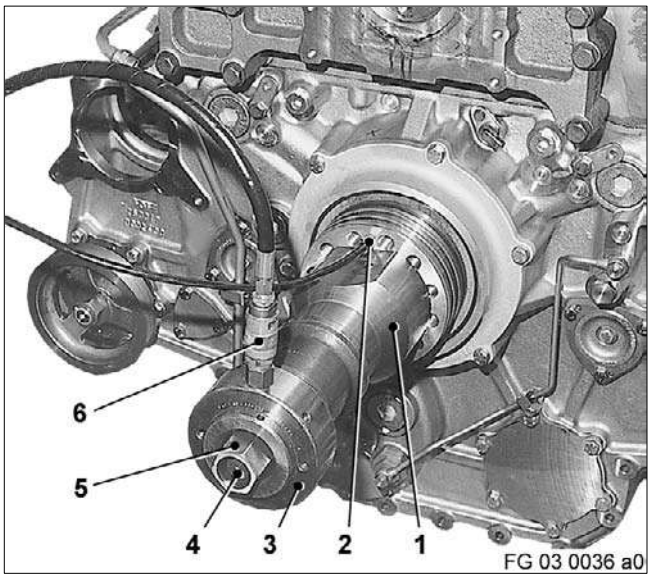
Remove vibration damper with two jackscrews (arrows).

⚠ WARNING

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

Attach vibration damper with support bracket to rope and crane and remove.

Unscrew adjusting mandrels and remove.



Removing drive flange

⚠ 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.
During the installation/removal procedure, make sure that nobody is standing in the danger area. Do not attempt to bend or exert force on H.P. lines.
Always wear protective gloves and protective goggles/safety mask.

Remove seals from expansion bore in driver flange.

Screw draw spindle (4) into crankshaft.

Check reference dimension A of draw spindle – see overview drawing C 035.05.01.

Mount pressure sleeve (1) and hydraulic press (3) over spindle and install nut (5).

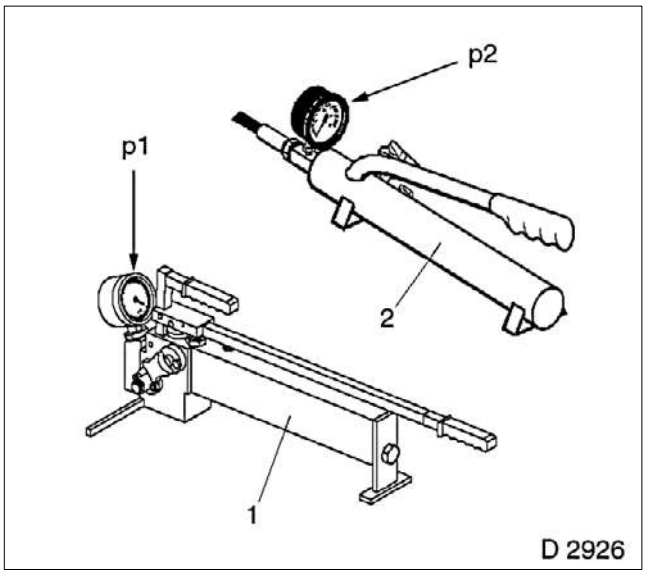
Screw connector (2) into drive flange and connect H.P. line.

Connect H.P. line (6) 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 driver flange.

Note: When fitting the nut up to the stop, the hydraulic press must be at its initial position (0 stroke).



Fill hydraulic hand pumps with SAE 10 engine oil.

Prime pumps and lines until oil escaping is free of bubbles.

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 driver flange.

Note: The hydraulic press acts as a buffer, stopping the driver flange as it slips off its tapered seat, and ensures safety when the driver flange is released.

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 driver flange.

Increase expansion pressure in stages by $0.1 \cdot p_{max}$, holding for approx. 2 minutes between each stage, until drive 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 driver 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.

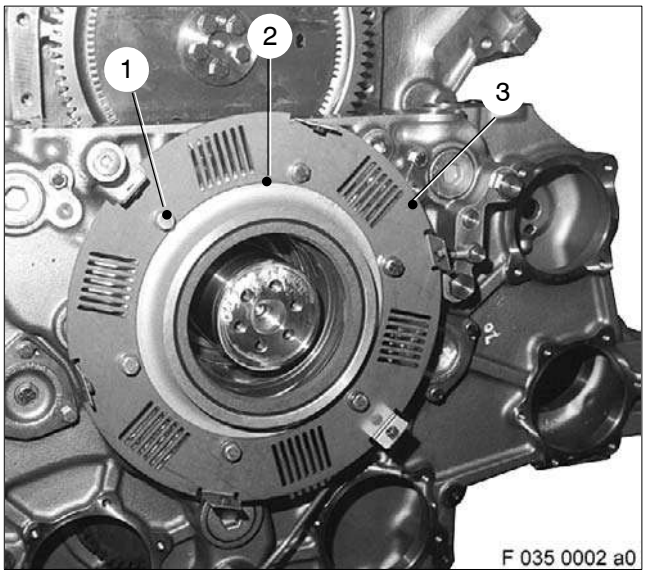
Remove nut, hydraulic press, pressure sleeve, and draw spindle.

Unscrew reducer.

⚠ WARNING

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

Remove driver flange from crankshaft.



Removing seal carrier

Remove hex screws (1) together with washers.

Remove guard plate (3).

Press seal carrier (2) from fit and remove.

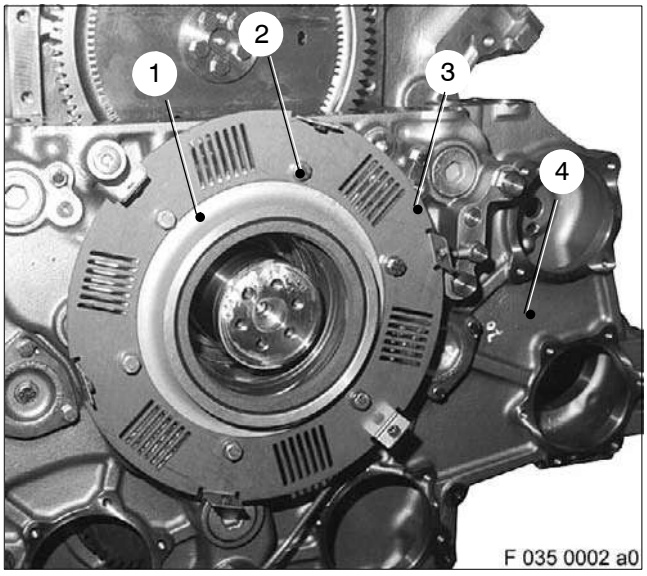
Note: The radial-lip shaft seal can only be replaced after removal of the driver flange. If the assembly sequence is not followed, the sealing ring will be damaged or destroyed.

C035.05.06 Disassembly

Disassembly of the vibration damper is not planned.

The vibration damper is an exchangeable component and can be obtained in the exchange procedure.

C035.05.11 Installation



Installing seal carrier

Coat O-ring with petroleum jelly and insert in groove in seal carrier (1).

Press-fit seal carrier in equipment carrier (4), ensuring it is exactly flush.

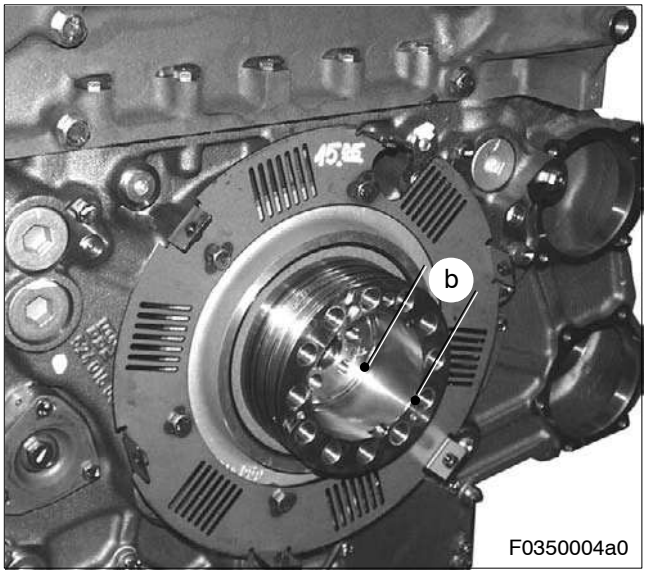
Install guard plate (3) and tighten hex screws (2) with washers diagonally to specified tightening torque – see overview drawing C 035.05.01.

Installing drive flange

⚠ 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.
During the installation/removal procedure, make sure that nobody is standing in the danger area. Do not attempt to bend or exert force on H.P. lines.
Always wear protective gloves and protective goggles/safety mask.

Coat O-ring with petroleum jelly and fit on crankshaft gear (arrow) – see also overview drawing C 035.05.01



Clean and degrease tapers of crankshaft and vibration damper.

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.

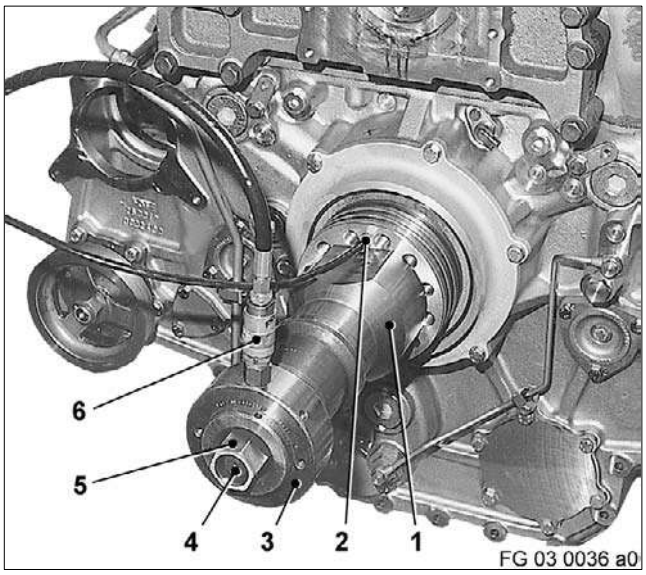
To calculate force-on distance, measure distance from end face of crankshaft to end face of drive flange using depth gauge. Make a note of this figure.

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.



Screw draw spindle (4) into crankshaft.

Check reference dimension A – see C 035.05.01.

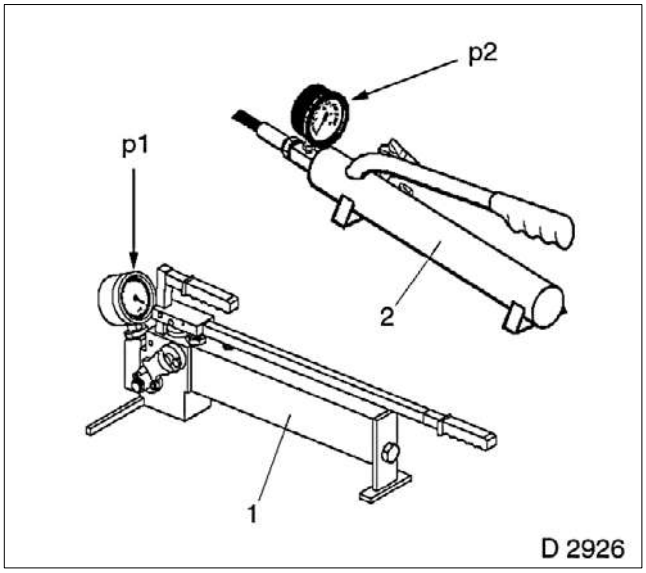
Mount pressure sleeve (1) and hydraulic press (3) over spindle.

Install nut (5) and hand-tighten.

Note: When fitting the nut up to the stop, the hydraulic press must be at its initial position (0 stroke).

Screw connector (2) into drive flange and connect H.P. line.

Connect H.P. line (6) of Lukas hand pump to hydraulic press.



Fill hydraulic hand pumps with SAE 10 engine oil.

Prime pumps and lines until oil escaping is free of bubbles.

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 end.

Operate Lukas hand pump (2) for hydraulic press and, by applying minimum pressure, seat press against driver flange.

Operate pump for expansion fluid until no further increase in expansion pressure (p1) is possible, then increase force-on pressure (p2) by operating force-on pump.

Repeat this process until driver flange is correctly seated.

Select force-on pressure such as to seat shaft in approx. 5 steps.

During installation, do not allow the expansion pressure to exceed the maximum permissible expansion pressure p_{max}.

p_{max} see specification on drive flange.

The installation procedure has concluded when the pressure bush is at the stop on the crankshaft.

Note: Rapid pressure rise (P2)

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.

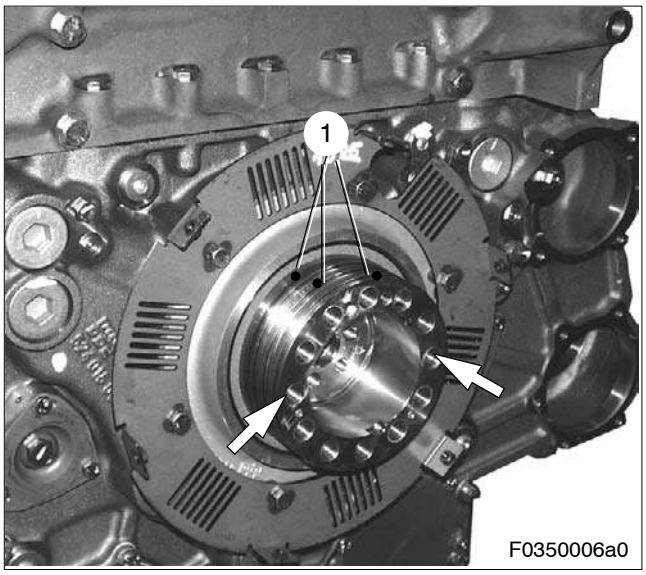
Allow specified retention time to elapse and remove nut, hydraulic press, pressure sleeve and draw spindle.

Note: Do not subject press fitting to operating load for at least 8 hours.

Check push-on dimension B – see C 035.05.01, crankshaft end face to driver flange end face.

If push-on dimension is not achieved, hydraulically remove drive flange and determine the cause

Remove oil from expansion bore in driver flange, screw in and tighten plug.

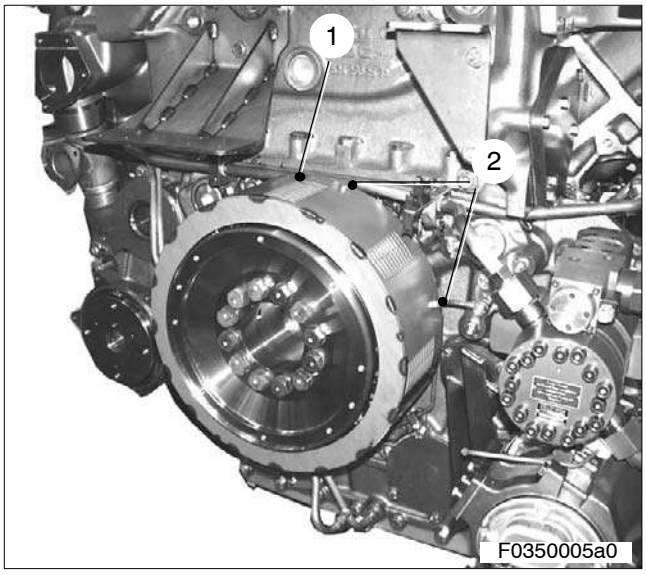


Install vibration damper

Note: Make sure parts are perfectly clean.

Screw in two adjusting mandrels in opposite threaded bores (arrows) of drive flange.

Coat O-rings (1) with petroleum jelly and fit on driver flange.



Coat vibration damper felt with Molykote 111.

⚠ WARNING

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

Attach vibration damper with support bracket to rope and crane and install over adjusting mandrels.

Fit hex screws and tighten diagonally and evenly.

Remove adjusting mandrels and lifting device.

Lock flywheel on flywheel housing with positioning fixture.

Tighten hex screws in diagonally opposite sequence to specified torque – see C 035.05.01.

Attention: Remove positioning fixture.

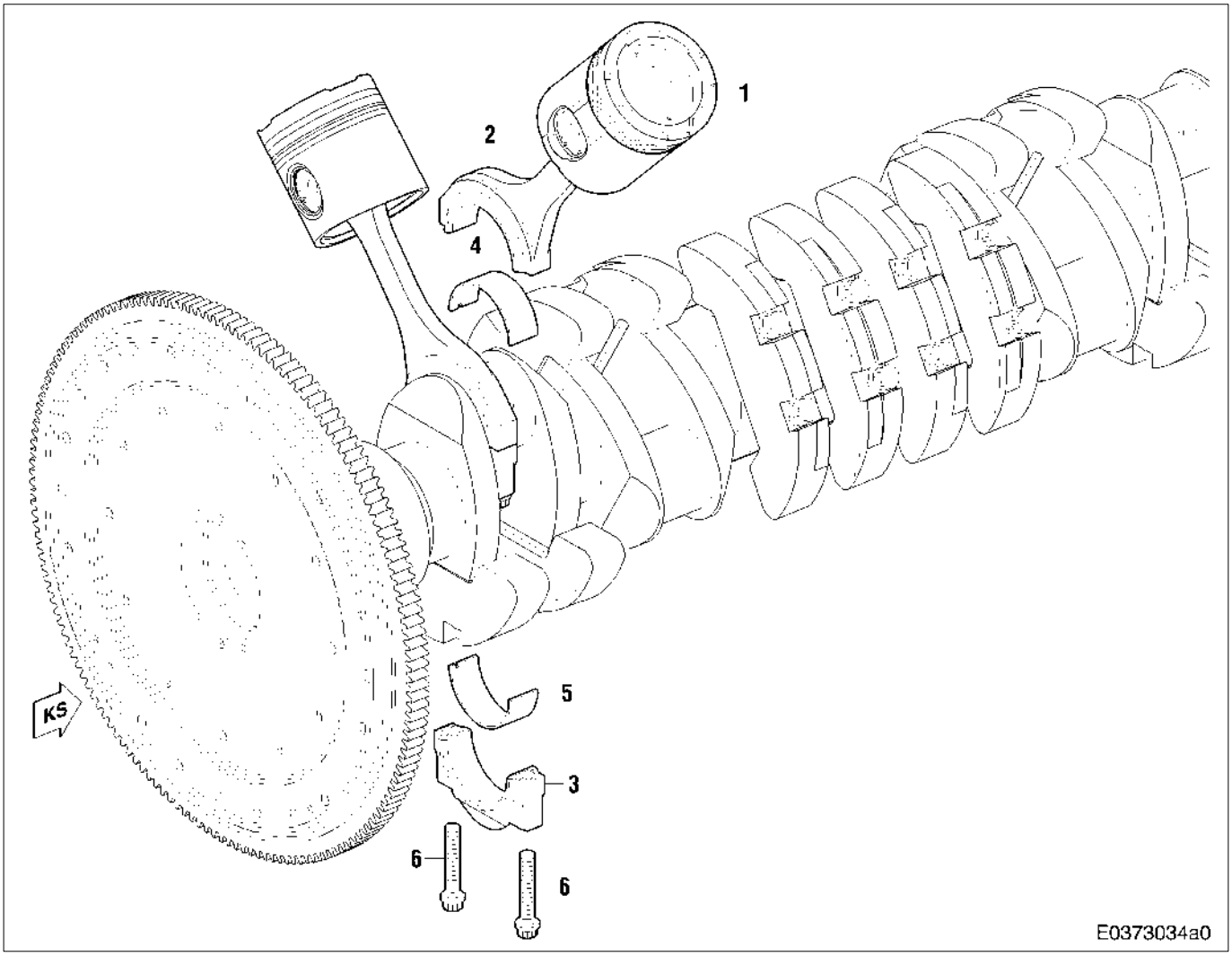
Install guard plate (1) with hex screws (2) and washers as per overview drawing.

C035.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C037.05 Pistons and Conrods

C037.05.01 Overview drawing



1 Piston

2 Conrod

3 Conrod cap

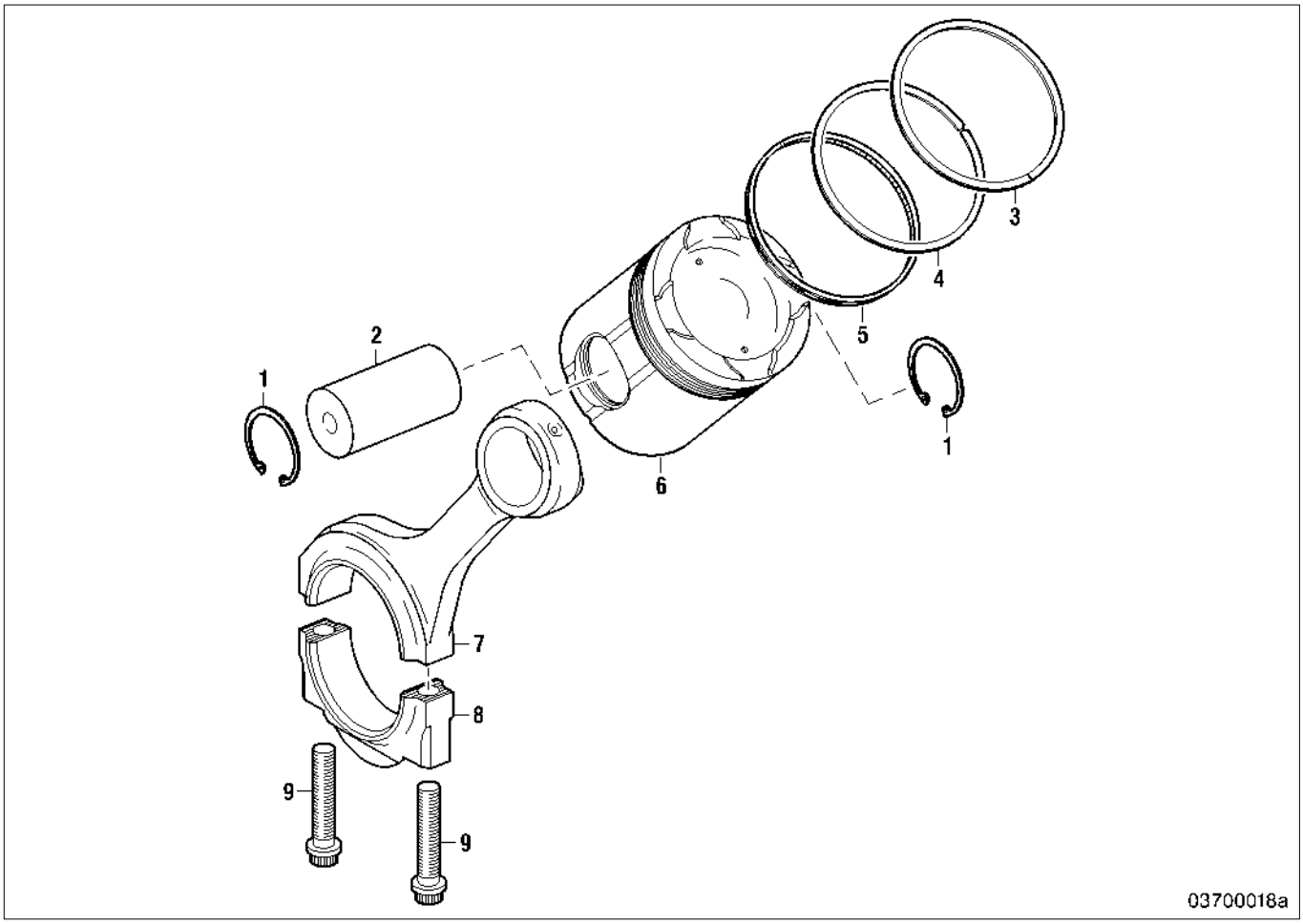
4 Conrod bearing, top

5 Conrod bearing, bottom

6 Conrod screw *

Max. shaft length:	104.5 mm
Lubricant:	Engine oil
Pretightening torque:	240 Nm + 20 Nm
Angle of further rotation:	90° + 10°
Checking torque:	450 Nm + 20 Nm

* Sequence: short connecting rod arm – long connecting rod arm



1 Snap ring
2 Piston pin
3 Rectangular-section ring
4 Taper-face compression ring
5 DSF ring
6 Piston
7 Conrod
8 Conrod cap
9 Conrod screw *****

Max. shaft length:	104.5 mm
Lubricant:	Engine oil
Pretightening torque:	240 Nm + 20 Nm
Angle of further rotation:	90° + 10°
Checking torque:	450 Nm + 20 Nm

***** Sequence: short connecting rod arm – long connecting rod arm

C037.05.02 Special tools

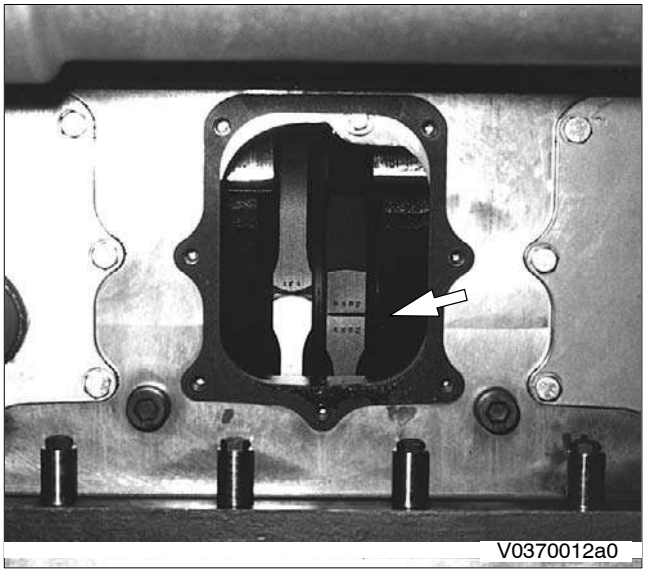
Designation	Use/dimension	Number
• Assembly device	Mounting connecting rod	1
– Adjusting mandrel	for conrod	1
• Barring tool	Free end	1
– Pointer	for barring tool	1
– Timing disc, free end	Setting TDC-A1	1
• Assembly sleeve	Installing piston/connecting rod	2
• Lifting device	Piston removal	1
• Socket insert	Conrod screws A/F 22	1
• Piston ring pliers		1
• Ring gauge	for piston gap clearance	1
• Sliding block	for conrod	1
• Test device	Checking conrod parallelism and twist	1
– Insert checking mandrel		2

C037.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	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/draw off charge air coolant	→ Operating Instructions
–	–	x	Drain or draw off engine oil	→ Operating Instructions
–	x	x	Remove left or right exhaust line	→ C 141.10.05
–	x	x	Remove cylinder head cover (as required)	→ C 055.05.05
–	x	x	Remove charge air manifold (as required)	→ C 124.05.05
–	x	x	Remove air filter	→ –
–	x	x	Disconnect or remove electrical cable (as required)	→ C 507.10.05
–	x	x	Remove coolant lines (as required)	→ C 202.20.05
–	x	x	Remove injection line (high-pressure)	→ C 077.05.05
–	x	x	Remove leak-off fuel lines (low-pressure)	→ C 086.05.05
–	x	x	Remove fuel injector	→ C 075.05.05
–	x	x	Remove valve drive	→ C 055.05.05
–	x	x	Remove pushrods	→ C 055.05.05
–	x	x	Remove cylinder head	→ C 041.05.05
–	x	x	Remove starter (as required)	→ C 172.05.05
–	x	x	Remove ECU housing with bracket (as required)	→ C 507.10.05
–	x	x	Remove oil dipstick and oil filler neck	→ C 011.05.05
–	x	x	Lower or remove oil pan	→ C 014.05.05

C037.05.05 Removal



Removing piston with connecting rod with oil pan installed (via access port)

Remove carbon scraper ring – see C 013.05.

Install barring tool.

Remove inspection port covers, left and right sides, from respective cylinders.

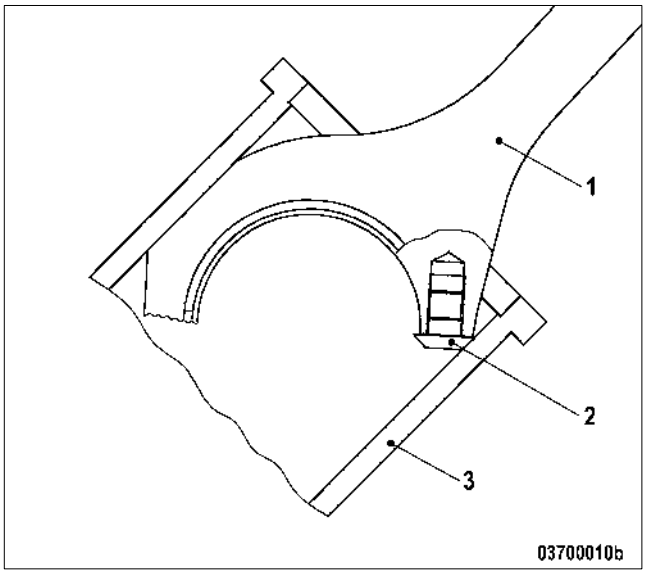
Note: Crankshaft must be turned only with flywheel installed or when axially located, see C 031.05.11.

Turn crankpin of respective cylinder on right side 40° before TDC and left side 40° after TDC.

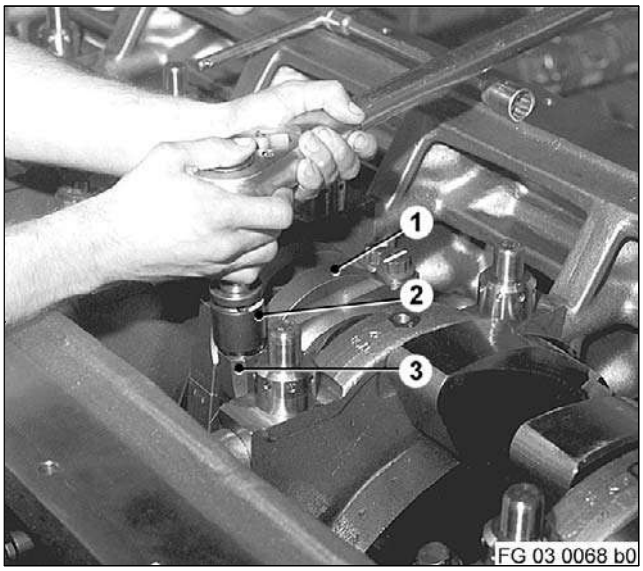
Release conrod screws with socket and large ratchet through inspection port (arrow).

With the exception of the unchanged position of the crankcase (engine in normal position), rest of removal procedure is the same as for *Removing piston with conrod in assembly dolly*.

Before removal, mount the sliding block on the conrod to be removed – see next illustration.



1 Connecting rod
2 Sliding block
3 Cylinder liner



Removing piston with conrod in assembly dolly

Turn crankcase in assembly dolly so that conrod bearing cap (1) of piston to be removed is horizontal.

Note: Crankshaft must be turned only with flywheel installed or when axially located, see C 031.05.11.

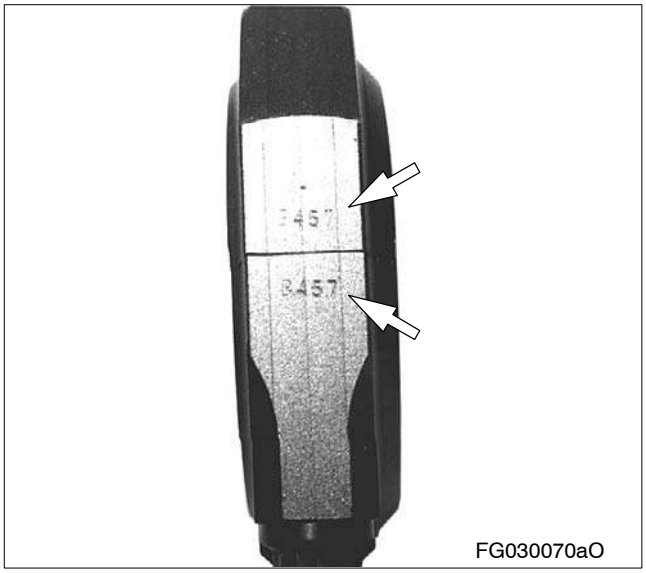
Turn crankpin of respective cylinder on right side 40° before TDC and left side 40° after TDC.

Remove combustion residues in cylinder liner.

Note: This is not required for cylinder liners with carbon scraper ring.

Remove carbon scraper ring – see C 013.05.

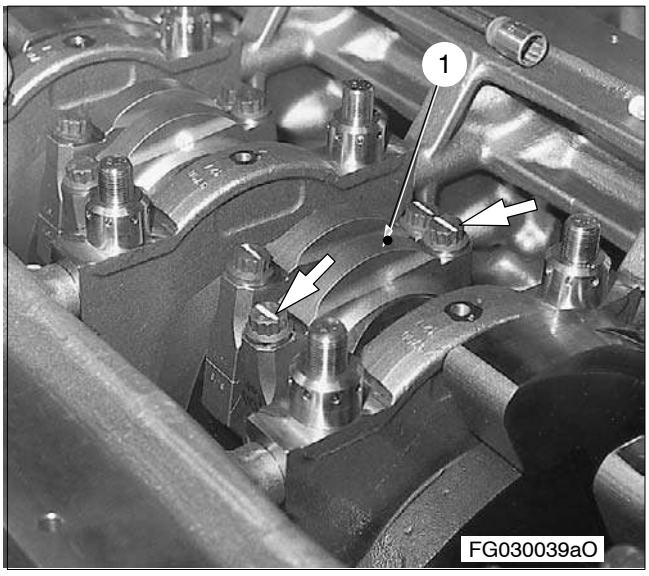
Release conrod screw (3) with socket (2), extension and ratchet.



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.

Note: The toothing on the conrod and conrod cap mating faces must not be damaged. If necessary, replace conrod.

Check markings from bearing shell to conrod; reapply markings if necessary.

Turn crankcase in assembly dolly so that piston to be removed with conrod is vertical.

Note: When removing piston do not damage or warp oil spray nozzle.

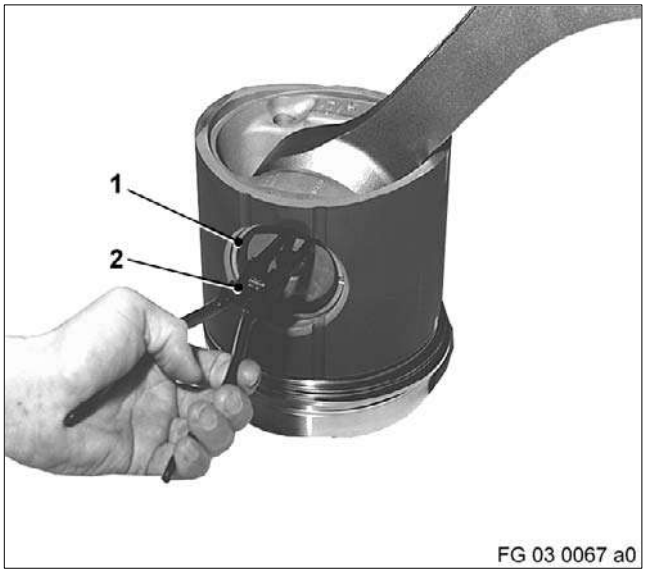
Remove bearing shell from conrod and protect from damage.

Secure lifting device (1) on piston crown (2).

Withdraw piston and connecting rod with rope and crane from cylinder liner fit.

Remove lifting device from piston crown.

C037.05.06 Disassembly

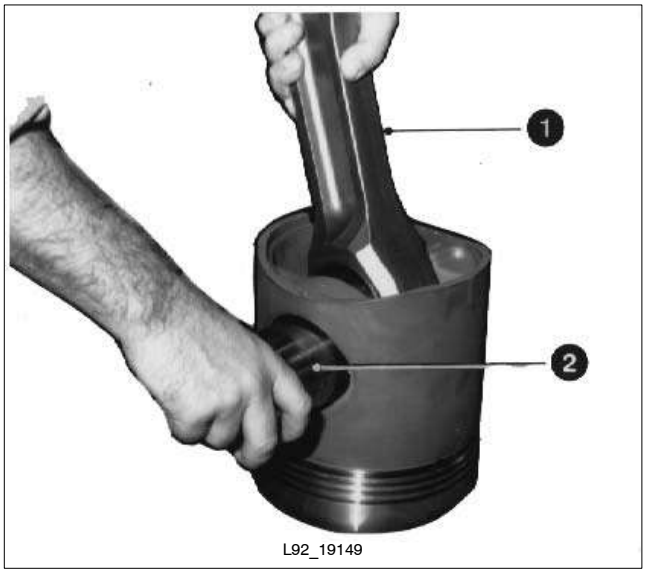


Removing conrod from piston

Place piston and conrod on workbench.

Check marking on conrod, piston and piston pin; correct markings if necessary.

Using snap ring pliers (1), remove snap ring (2).



Use wooden rod to press out piston pin (2).

Note: Do not use sharp-edged tool to force out piston pin.

Hold conrod (1) and remove piston pin.

Remove conrod from piston.

Removing piston rings

Remove piston rings with piston ring pliers in sequence from top to bottom.

Warning: Stretch piston rings only until they can be removed from the piston.
Do not overstretch piston rings, **as they may break.**

C037.05.08 Inspection and repair

Piston

Note: The graphite layer on the piston skirt must not be mechanically removed or treated with strong cleaners!

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.

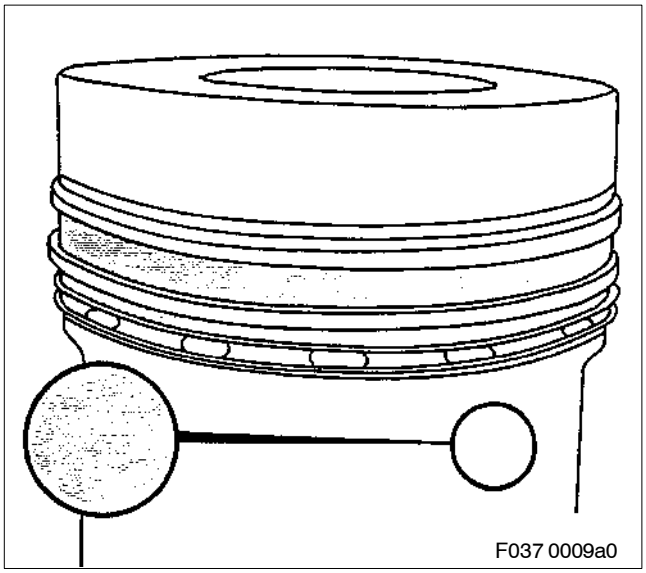
WARNING

Compressed air is highly pressurized. Risk of injury!
Do not direct compressed air jet personnel.
Always wear protective goggles/safety mask and ear protection.

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.

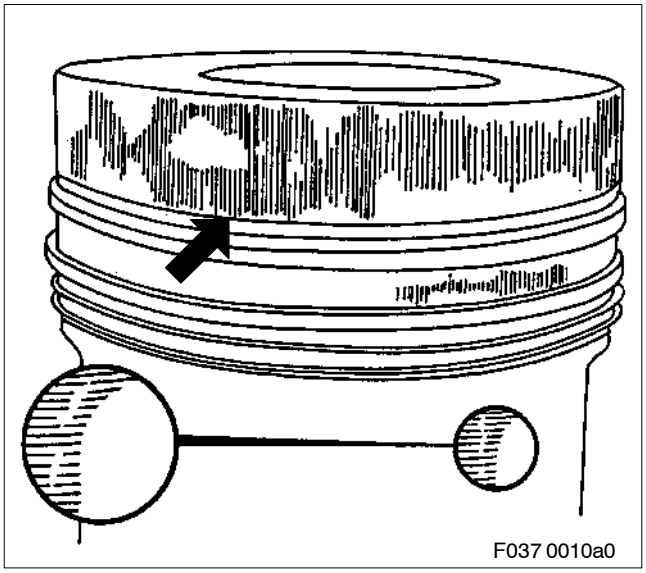

F037 0009a0

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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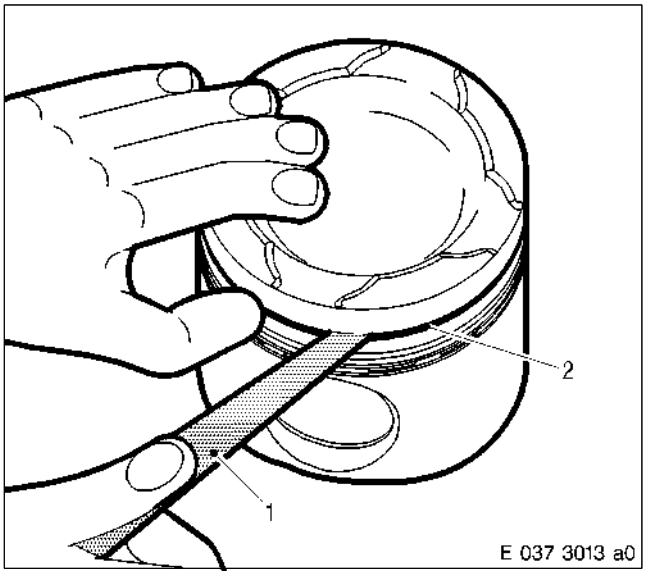
In the event of contact erosion on the piston edge, replace the complete piston.

Remove scoring or scuffing on top land of piston if local and not extending as far as first ring 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 and concentrated scoring, replace piston.

Replace pistons exhibiting even minor, localized scuffing on piston skirt.



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Inspecting piston ring grooves

Check groove width with final measurements.

Note: Alternatively, a new piston ring (2) can be inserted into groove and axial clearance measured with feeler gauge (1).

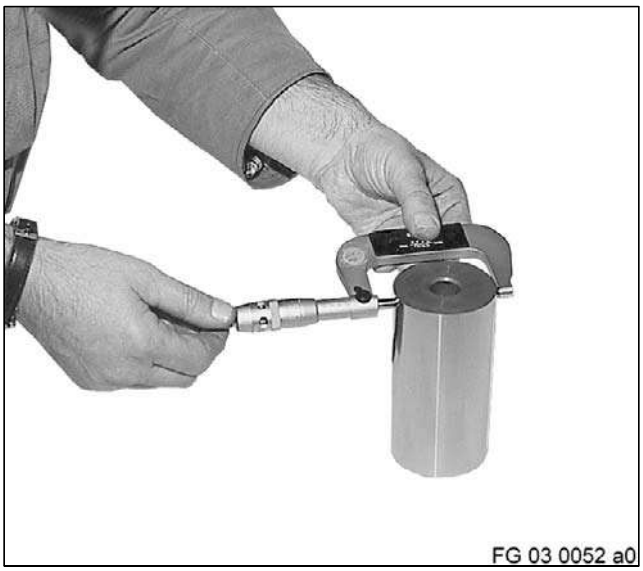
If the limit values as per Tolerance and Wear Limits List are exceeded, or measurements are below limit values for groove for oil control ring, replace piston.

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.



Inspecting piston pin

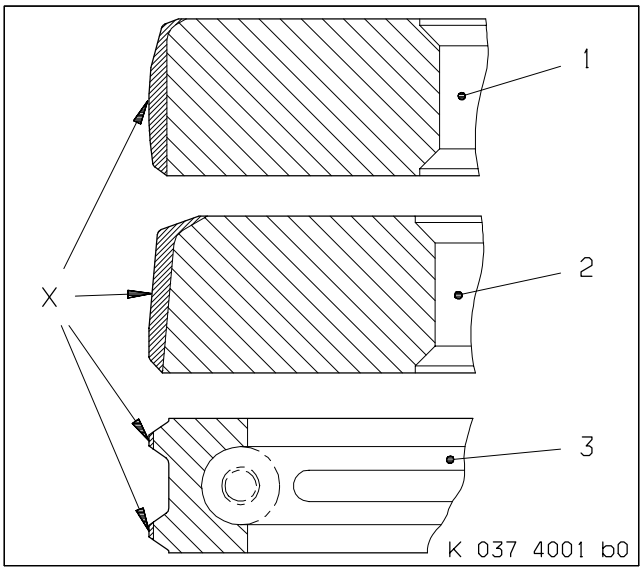
Using magnetic crack-testing method and fluorescent magnetic powder, check piston pin for cracks; if cracks are detected, replace piston pin.

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.



Inspecting piston rings

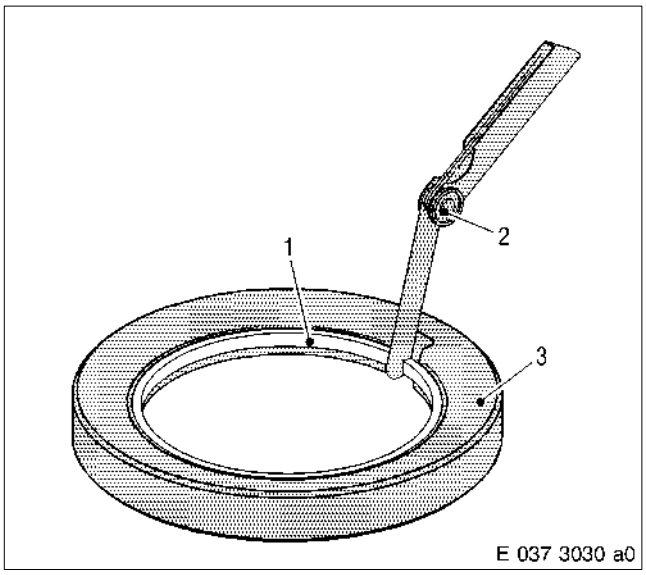
Replace piston rings during W6 overhaul.

Clean piston rings of combustion residue if necessary.

Replace sharp-edged piston rings, piston rings with burring and chipping and piston rings with axial ring wear on ring lower edge.

Condition or wear of chrome layer (x) is a deciding factor when reusing or replacing rectangular ring (1), taper-face compression ring (2) and DSF ring (3).

Chrome layer must not show signs of scoring, cracks or heat discoloration.



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

Check conrod for blue colouring; if blue colouring is detected (due to bearing damage), replace connecting rod.

Check conrod bush for scoring, dirt, wear and hot runs; burnish minor scoring with emery cloth; replace conrod if necessary.

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.

Use a brass brush to clean toothing on conrod and conrod cap mating faces and blow dry with compressed air.

Smooth wear on toothing with oilstone, check bedding pattern by ink-check method.

Check main bore for wear and scoring; if necessary machine bore to repair size or replace conrod.

Smooth conrod main bore with emery cloth.

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.

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 and assessing conrod bearing shells

Replace bearing shells as part of every W6 overhaul.

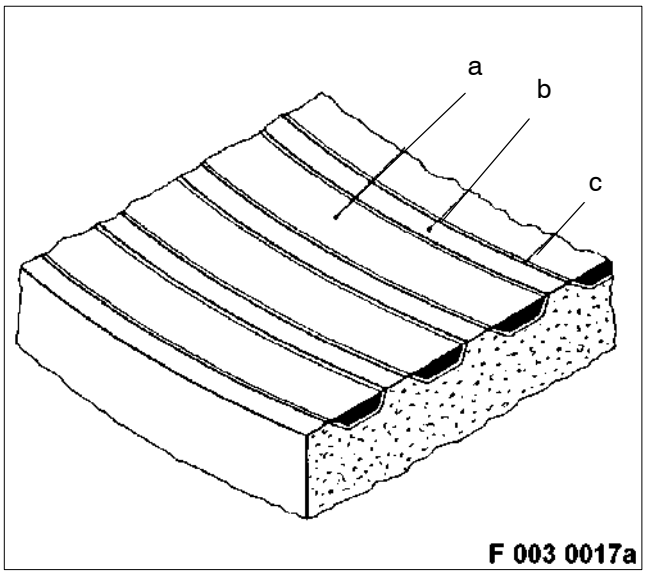
In event of reuse (e.g. unscheduled removal), check bearing shells for surface wear, scoring, cracking, corrosion, erosion and damage; replace if necessary.

Check bearing shell butting face and rear side of bearing for friction corrosion and pitting. If friction corrosion is found, 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.



Conrod bearing shell (grooved bearing lower half)

Bearing shell has the following material structure:

a Sliding layer
(Thickness 16 µm, central axle distance 0.2 mm)

b Intermediate layer (nickel barrier)

c Barrier layer (from 1 µm to 3 µm sputtered)

In new condition, the running surface has approx. 75% wear layer, approx. 20% intermediate layer and max. 5% barrier layer.

A magnifying glass is required for a more accurate assessment of the wear condition of the running surface (magnification min. 5x).

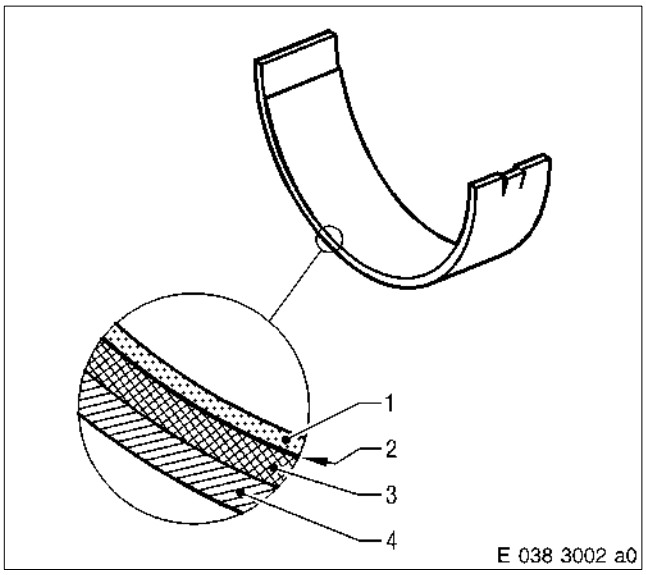
In doing so, the sliding layer is seen as the dark zone and the intermediate layer as the light zone.

The relationship between the width of the intermediate layer and the width of the groove and the extent of the worn area are decisive factors when evaluating the wear condition of the grooved bearings.

The grooved bearing is still functional if the sliding layer is partially missing in the grooves.

Practice has shown that the grooved bearing with partially empty grooves can continue in use without negatively affecting the function of the bearing.

During each assessment of the condition of the grooves, the running surface in the area subject to least load (groove mostly new) should be used for comparison.



Conrod bearing shell (sputtered bearing, upper half)

Bearing shell has the following material structure:

1 Sliding layer (from 12 µm to 18 µm sputtered)

2 Barrier layer (nickel barrier, from 1 µm to 3 µm sputtered)

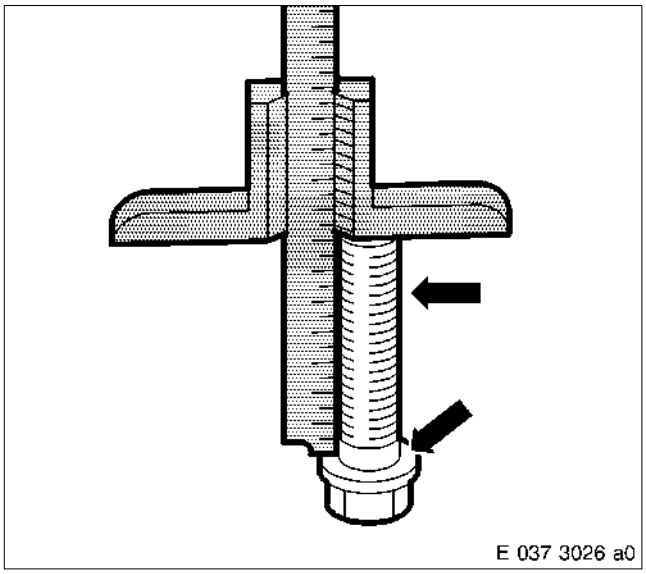
3 Intermediate layer corresponds to approx. 10% of bearing thickness.

4 Protective steel shell corresponds to approx. 88% of bearing thickness.

An important indicator for assessing extent of wear on bearing shell is the shape and extent of the nickel barrier (running-in layer) 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.

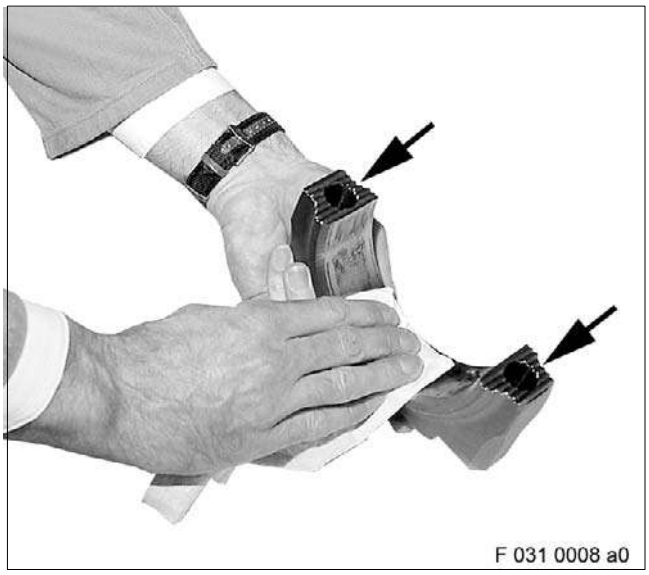


Checking conrod cap screw

Check screw head support and thread (arrows) for scoring or damage; replace screw if necessary.

Measure shaft length of conrod screw with depth gauge.

Max. permissible shaft length – see overview drawing C 037.05.01.



Storing conrod

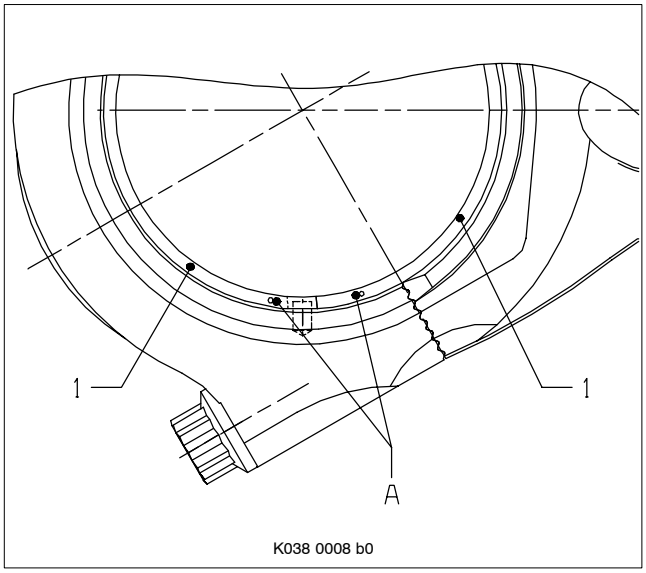
⚠ CAUTION

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 interfaces (arrows) on connecting rod and conrod cap with compressed air and check that they are clean.

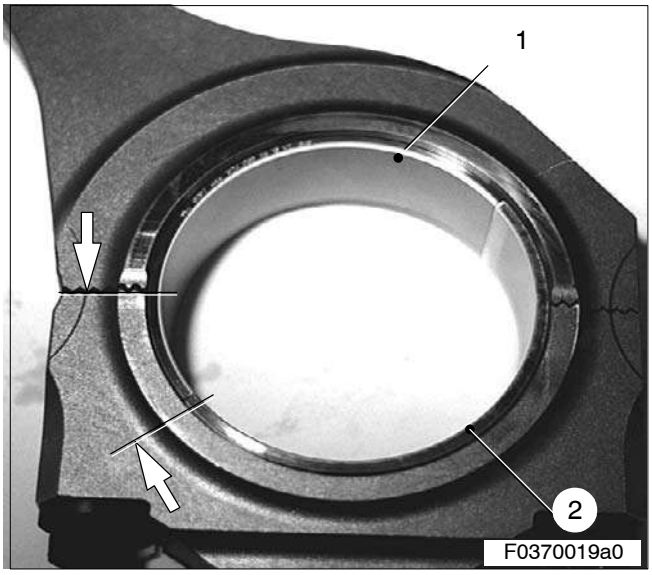
The toothing on the conrod and conrod cap mating faces must not be damaged. If necessary, replace conrod.

Wipe bearing shell mating faces on connecting rod and conrod cap.



Note: New conrod bearing shells (1) 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 (A).



Secure conrod in assembly trolley or in vice with aluminium jaws with mating face horizontal.

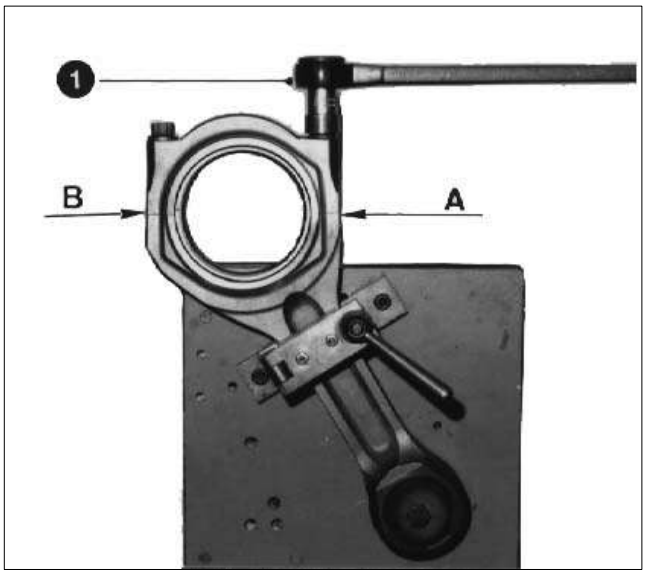
Place conrod bearing “groove” (2) (bottom), (identifying feature, running surface shiny), in conrod cap so that bearing shell recess engages in locating pin.

Place conrod bearing “sputter” (1) (TOP), (identifying feature, running surface mat) in connecting rod so that conrod bearing projects approx. 40° (arrows) over short conrod arm.

Carefully press conrod cap by hand onto conrod.

Pay attention to locating pin and correct location of bearing shell.

Coat threads of screw head mating face and screw head seating surfaces with engine oil.



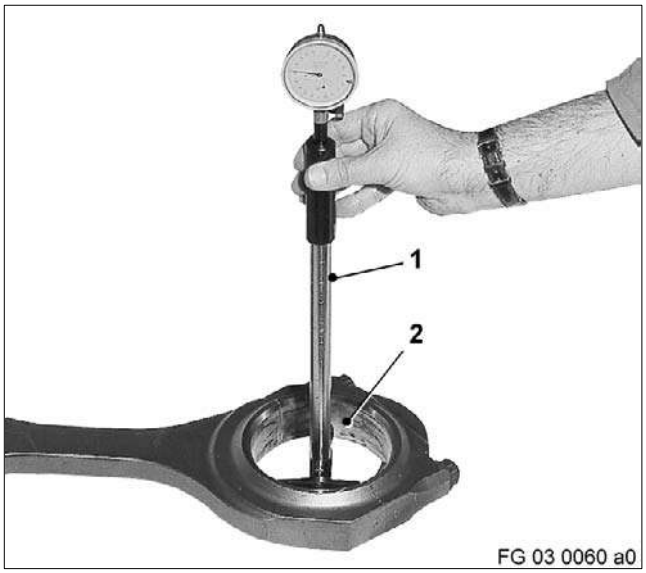
Carefully insert conrod screw into bearing cap bore by hand to first contact with thread flanks, then turn first three rotations without a tool.

Note: Do not drop screws into conrod cap bore. Thread must not be recut.

Install conrod cap screws until screw heads make contact and use socket wrench to tighten firmly by hand.

Conrod and conrod cap serrations on short and long conrod arms must be closed.

Using torque wrench (1), first tighten conrod cap screw at short conrod arm (A) and then on long conrod arm (B) to specified torque – see overview drawing C 037.05.01.



Measuring conrod basic bore

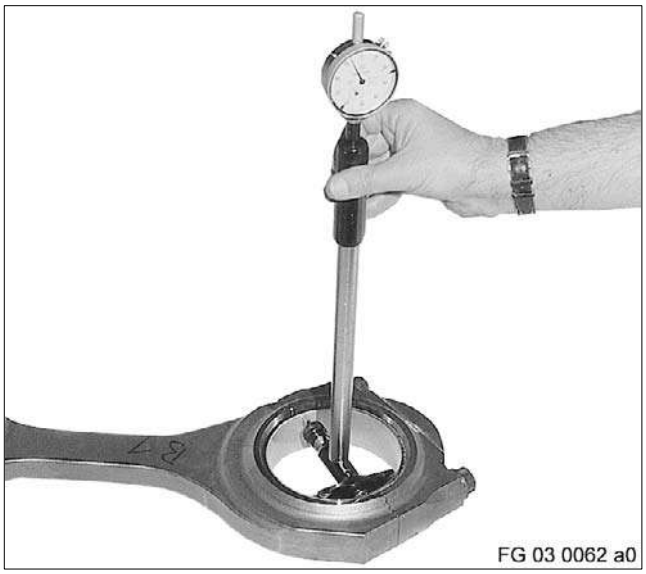
Check conrod bore for wear and scoring; if necessary machine bore to repair size or replace conrod.

Before measuring, smooth main bore (2) with emery cloth.

Adjust bore gauge (1) and measure conrod main bore.

For basic size of conrod basic bore, permissible limits and measuring points – see Tolerance and Wear Limits List.

If measurements are above permissible limit values as per Tolerance and Wear Limits List, replace conrod.



Measuring conrod bore with bearing shells

Coat sliding surfaces of bearing shells with engine oil.

Measure conrod bearing bore.

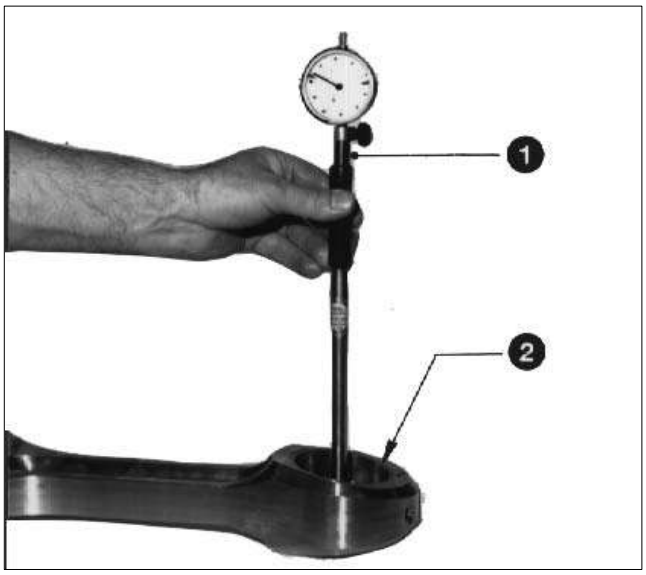
For permissible limits and measuring points, see Tolerance and Wear Limits List.

Record measured values in data sheet.

If permissible values are exceeded or not achieved, replace bearing shells.

Remove conrod screws, conrod cap and bearing shells.

Note: Protect bearing shells from damage!

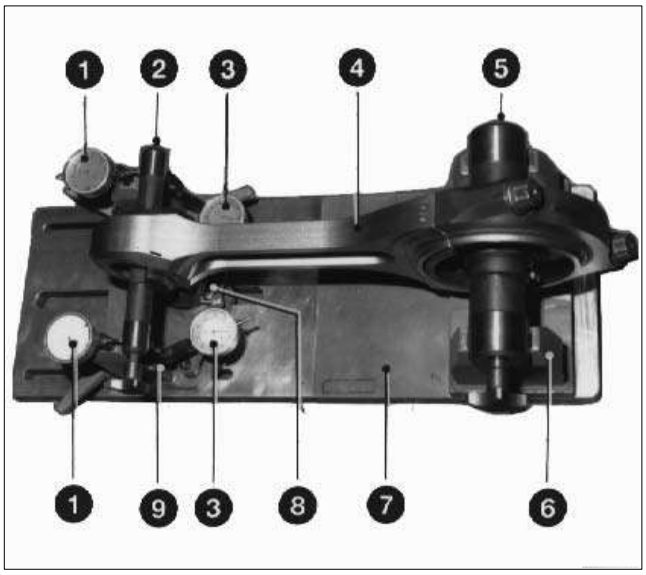


Measuring conrod bush bore or main bore

Set bore gauge (1) to zero dimension of conrod bush bore and measure conrod bush bore (2).

For permissible values, see Tolerance and Wear Limits List.

If values are not achieved, the conrod is a replacement component and is available through the usual replacement procedure.

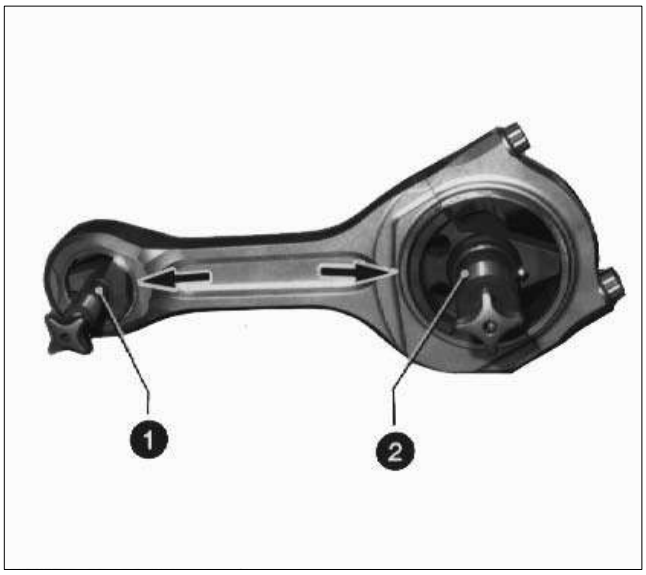


Checking conrod bore axial parallelism and twist

Arrangement of testing device

1 Dial gauge for axial parallelism
2 Test mandrel, small conrod eye
3 Dial gauge for conrod twist
4 Conrod
5 Test mandrel, large conrod eye
6 V-Block
7 Base plate
8 Resilient stop
9 Adjustable dial gauge holder

Note: For checking axial parallelism and twist of conrod bores, conrod cap is installed and conrod screws tightened as per tightening specifications.



Clean large and small conrod bore.

Insert test mandrel (2) in large conrod bore.

Make sure that installation position is correct.

Wide fit end of test mandrel (arrow) must point to conrod shaft, narrow fit side to conrod cap.

Lightly secure test mandrel with securing screw.

Take care test mandrel is properly inserted.

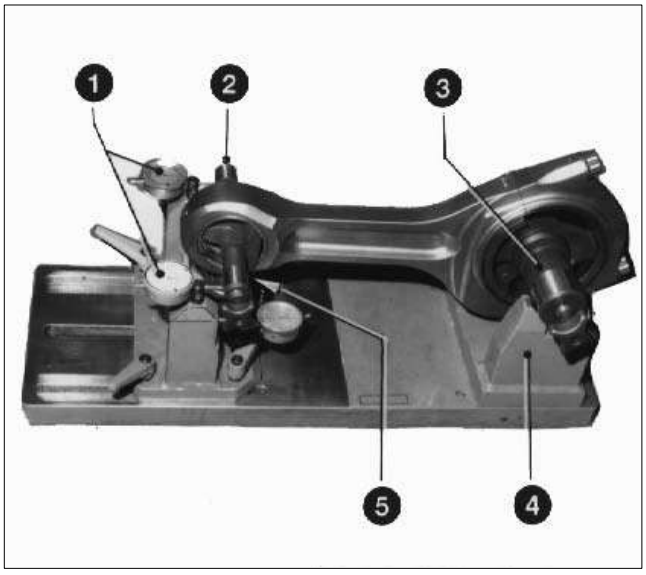
Insert test mandrel (1) in small conrod bore.

Make sure that installation position is correct.

The wide fit of test mandrel (arrow) must point toward conrod shaft, narrow fit to oil bores of small conrod bore.

Lightly secure test mandrel with securing screw.

Note: Insert test mandrels so that tension pins of narrow fit of test mandrels are in a single plane.



Checking axial parallelism

Insert conrod with test mandrel (3) in large conrod bore into prisms (4) of testing device.

Place small conrod eye on adjustable stop (5).

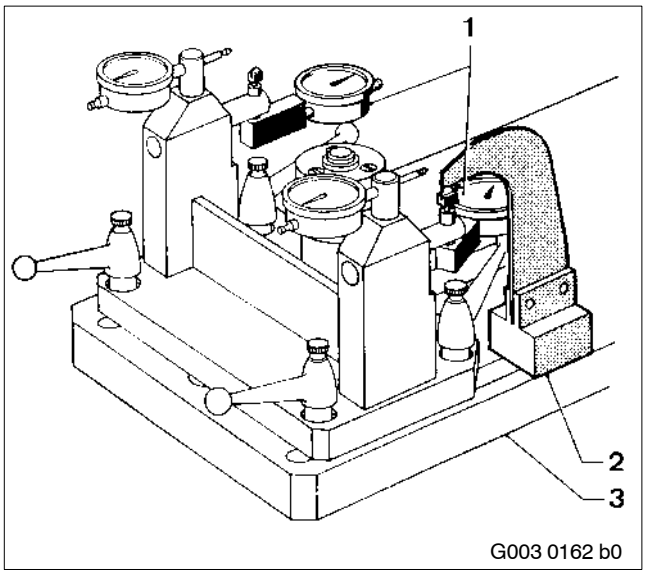
Adjust the rigid stop of adjustable stop so that axle of test mandrel (2) is approx. 2.0 mm below dial gauge stylus (1).

Adjust dial gauges so that their readings indicate approx. 2 mm preload at highest point on small-end mandrel, and set to zero.

Rotate conrod through 180° and carefully place in testing device.

Move small-end mandrel through dial gauge styluses at highest point on mandrel.

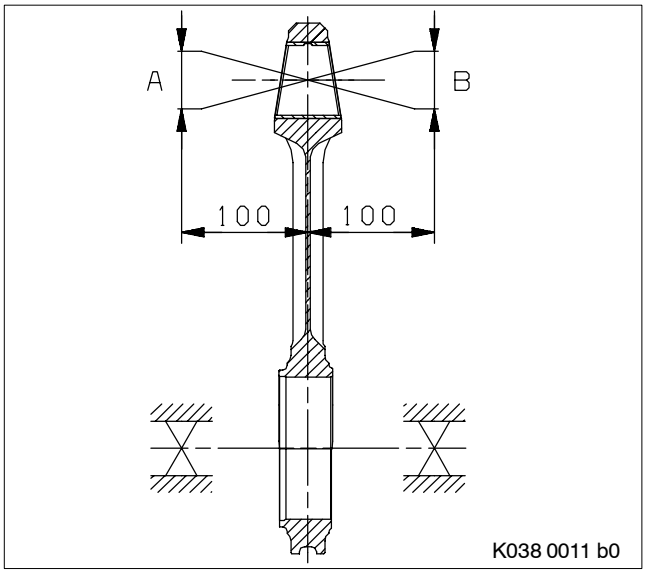
Determine and record deviations from zero on dial gauges.



Checking axial twist

Set both dial gauges (1) for axial twist with setting gauge (2) via dial gauge stylus to zero.

Remove setting gauge from testing device (3).



Calculating axial parallelism

The testing device is set for measuring axial parallelism at 200 mm intervals.

In order to achieve correct value at 100 mm intervals as per Tolerance and Wear Limits List, calculate values read off at dial gauges as in the example.

Example:

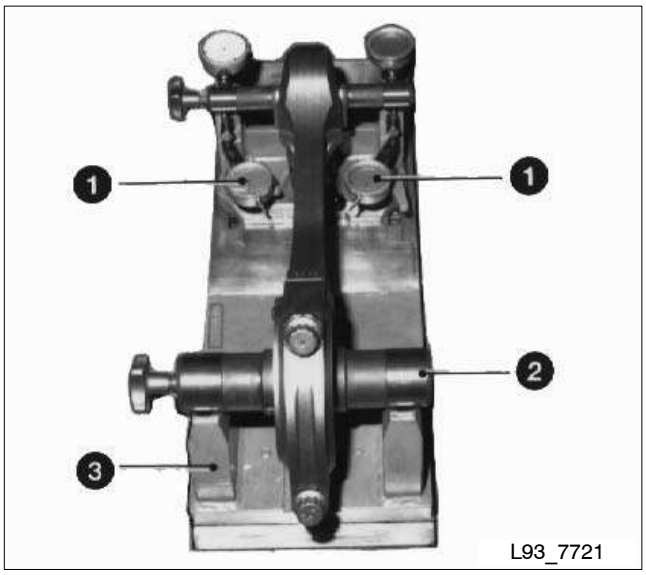
Left dial gauge	A = – 0.05 mm
Right dial gauge	B = + 0.03 mm
Difference	0.08 mm

Axial parallelism as per example:

0.08 mm: 4 = 0.02 mm

For specified limit, see Tolerance and Wear Limits List.

If limit value is exceeded, replace conrod.

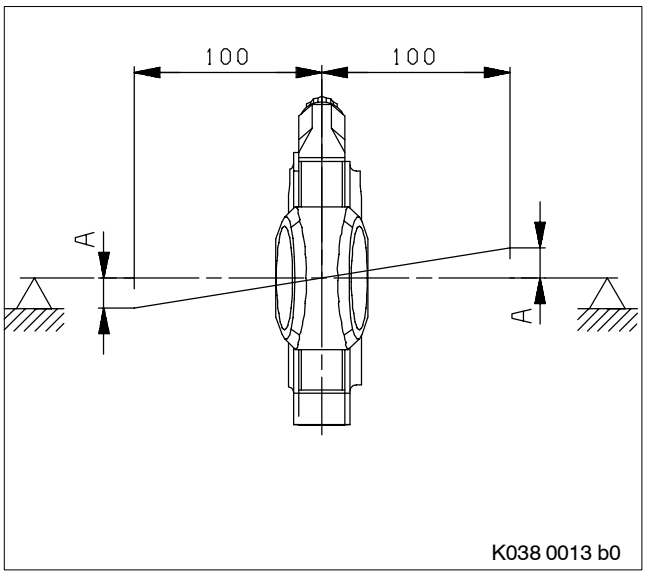


Insert conrod with test mandrel (2) into prisms of testing device (3).

Fixed support of adjustable stop is set so that dial gauge stylus travel is approx. 2 mm.

Press conrod at small conrod eye on fixed support.

Read and record values on dial gauges (1).



Calculating axial twist

To determine conrod bore axial twist, calculate value measured at 100 mm intervals as shown in example.

Example:

Left dial gauge A = –0.06 mm

Right dial gauge A = +0.04 mm

Difference 0.10 mm

Axial twist A as per example

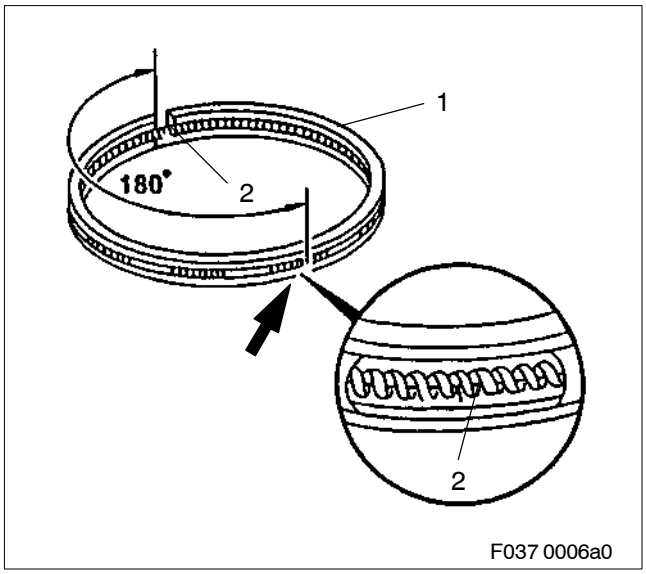
A = 0.10 mm : 2 = 0.05 mm

For specified limit, see Tolerance and Wear Limits List.

If limit value is exceeded, replace conrod.

C037.05.10 Assembly

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



Installing piston rings

Turn coiled spring expander (2) in DSF-ring (1) to offset ring spring butting face (arrow) to DSF-ring butt by 180°.

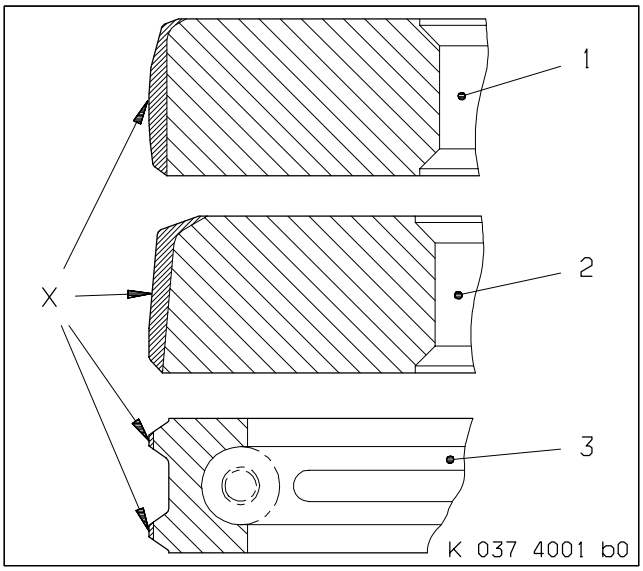
In sequence from bottom to top (DSF-ring first), insert piston rings with piston ring pliers into annular grooves on piston.

Warning: Stretch piston rings 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.

Note: TOP marking on piston rings must point upwards.

Check that piston rings move freely in their grooves.



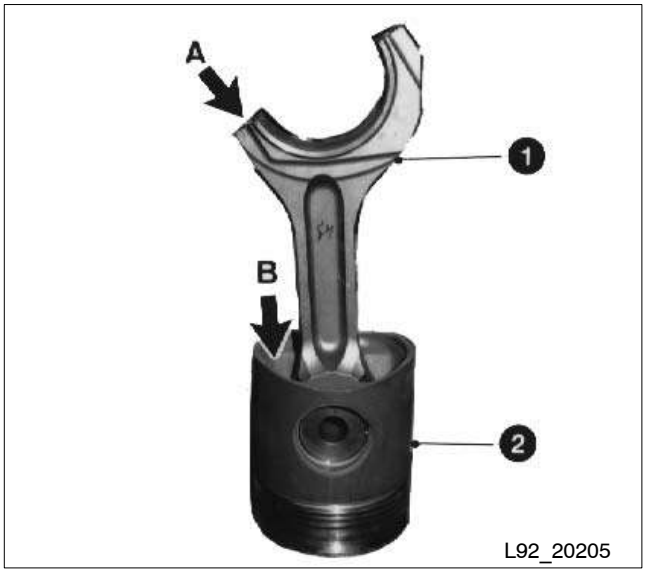
Sequence of piston rings:

1 – Rectangular-section ring

2 – Taper-face compression ring

3 – DSF ring

Note: Piston rings must only be replaced in sets. Hone cylinder liners if new piston rings are installed.

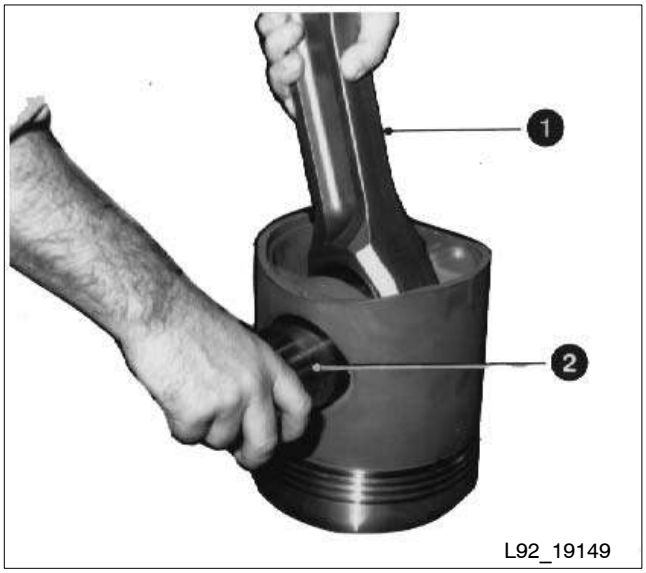


Wipe down piston pin, conrod bushing and piston pin bore with chamois leather and coat with engine oil.

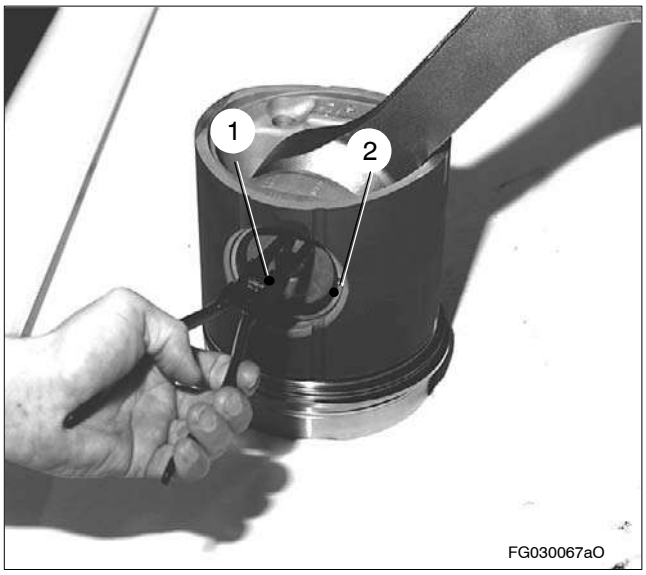
Using snap ring pliers, insert first snap ring into piston pin bore.

Note: Make sure snap ring is perfectly seated in groove.

Insert conrod (1) according to markings into relevant piston (2) in such a way that the shorter end (A) of the angle-split conrod faces piston cooling oil bore (B).



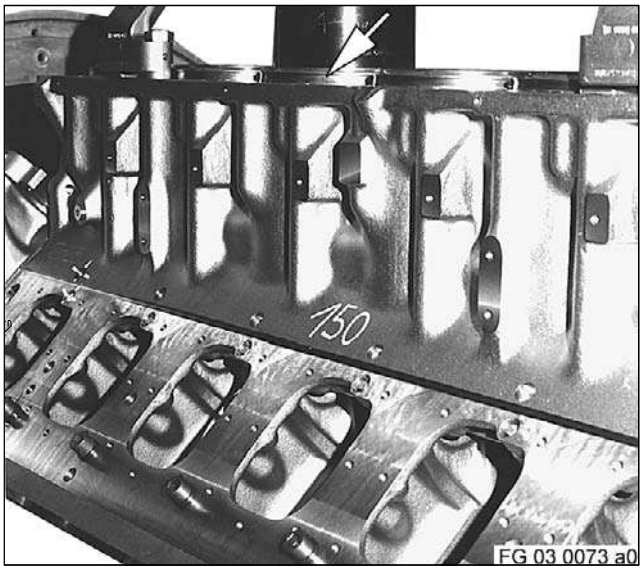
Push associated piston pin (2) into piston and conrod (1) until seated against snap ring installed beforehand.



Insert second snap ring (2) with snap ring pliers (1).

Note: Make sure snap ring is perfectly seated in groove.

C037.05.11 Installation



Installing piston with conrod in assembly dolly

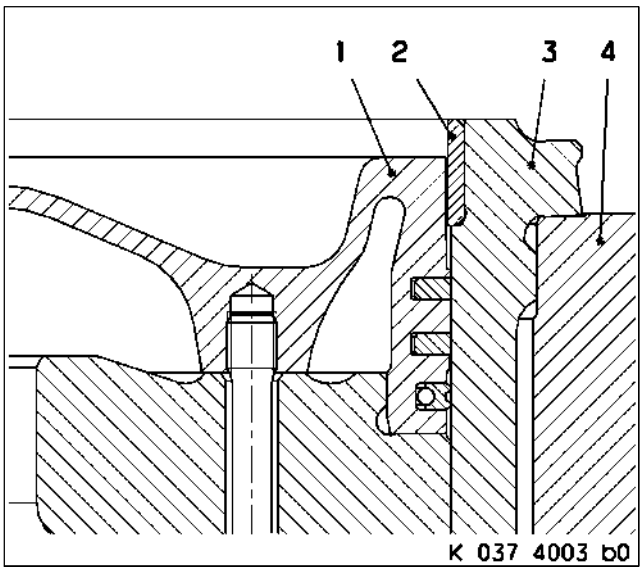
Note: Always make sure that all components are perfectly clean.

Rotate crankcase in assembly dolly until cylinder liner (arrow) is vertical.

Note: Crankshaft must be turned only with flywheel installed or when axially located, see C 031.05.11.

Turn crankpin of crankshaft of piston to be installed and connecting rod to assembly position.

Wipe crankpin and running surface of cylinder liner and spray with engine oil.



Cylinder liner with carbon scraper ring

Running surface of piston crown is machined according to carbon scraper ring.

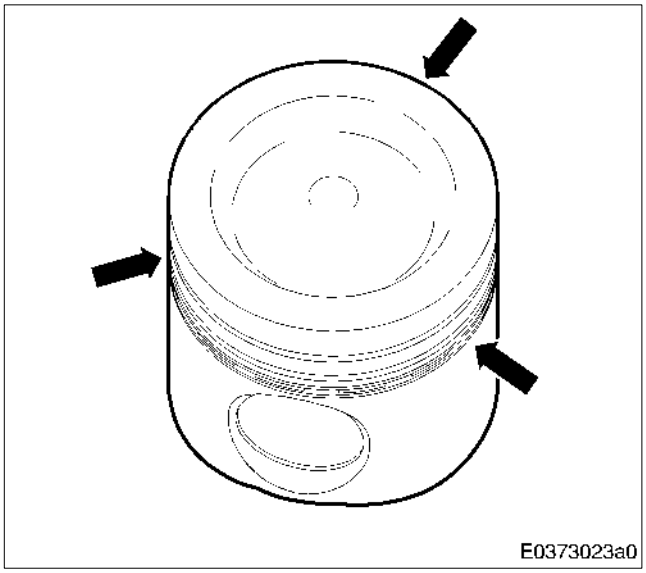
1 – Piston

2 – Carbon scraper ring

3 – Cylinder liner

4 – Crankcase

Attention: Install piston without carbon scraper ring.

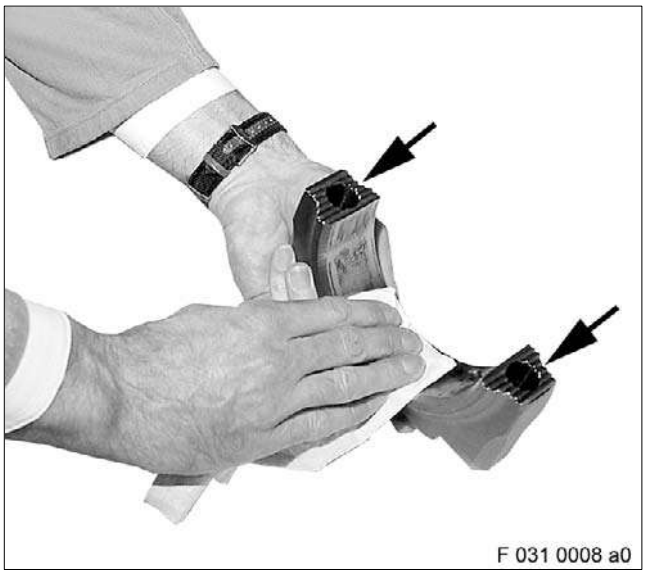


Spray the piston and piston rings with engine oil.

Ensure that piston rings (arrow) are evenly fitted around piston circumference.

Centre rings in grooves.

In particular, the DSF ring with coiled spring expander must be centred carefully in order to avoid damage.



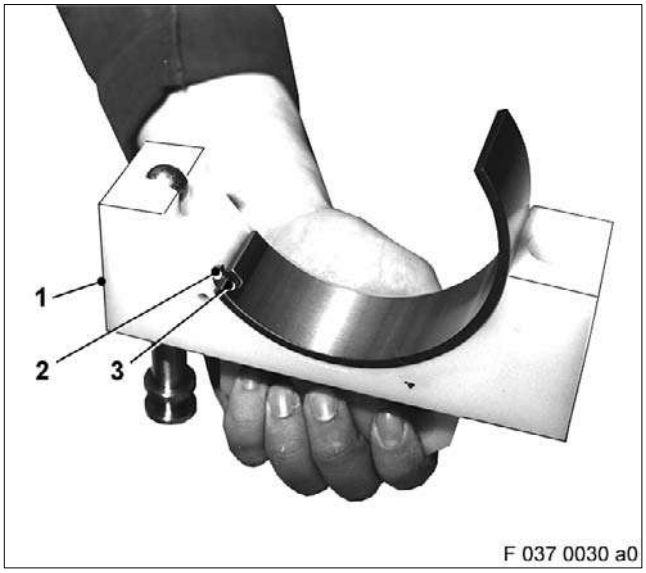
⚠ CAUTION

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 interfaces (arrows) on connecting rod and conrod cap with compressed air and check that they are clean.

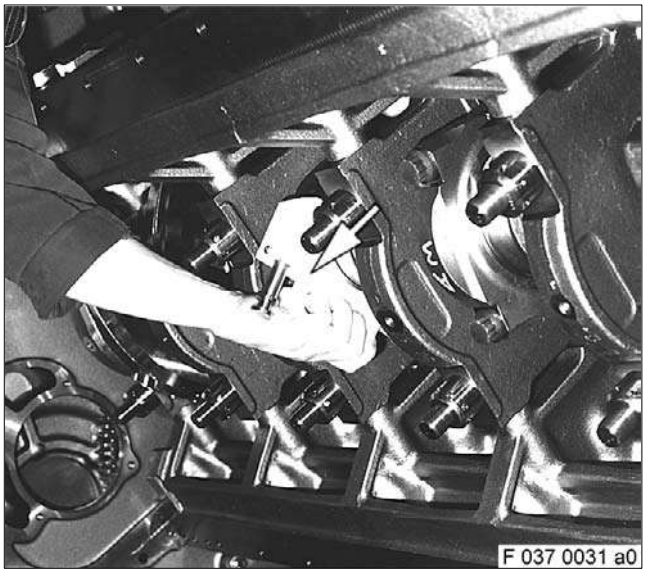
Toothing on mating faces must not be damaged. Replace conrod as necessary.

Wipe bearing shell mating faces on connecting rod and conrod cap.

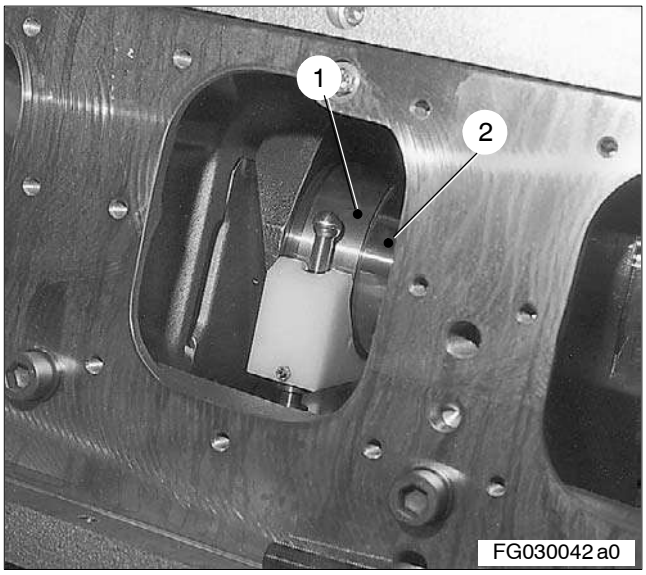


Place conrod bearing “groove” (bottom) in assembly device (1) so that conrod bearing recess (3) engages in locating pin (2).

Coat friction face of bearing shell with engine oil.

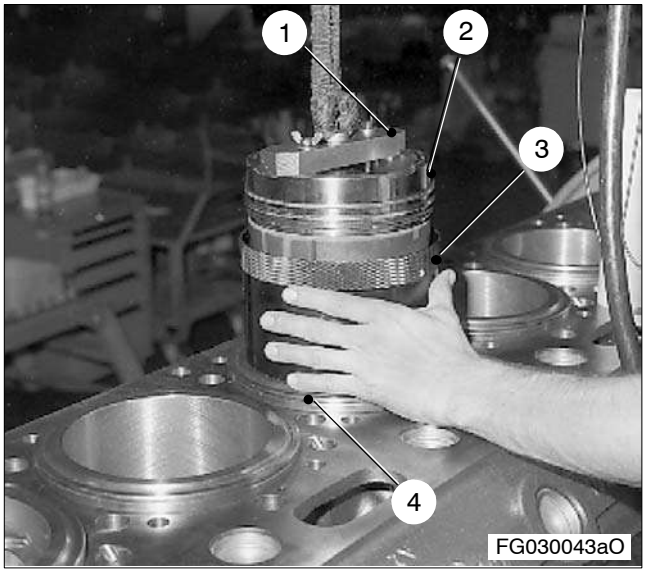


Press assembly device (arrow) with bearing shell half by hand on crankshaft crankpin.



Coat “sputter” (top) running surface of bearing shell with engine oil.

Position second bearing shell half (1) with recess for locating pin on crankpin (2) so that the two recesses are aligned.



Note: In order to guide the conrod and avoid damage to the oil spray nozzle, piston installation must be carried out by two people.

Attach lifting appliance (1) for piston (2).

Lubricate running surface of piston assembly sleeve (3) with oil.

Place piston assembly sleeve on appropriate cylinder liner (4).

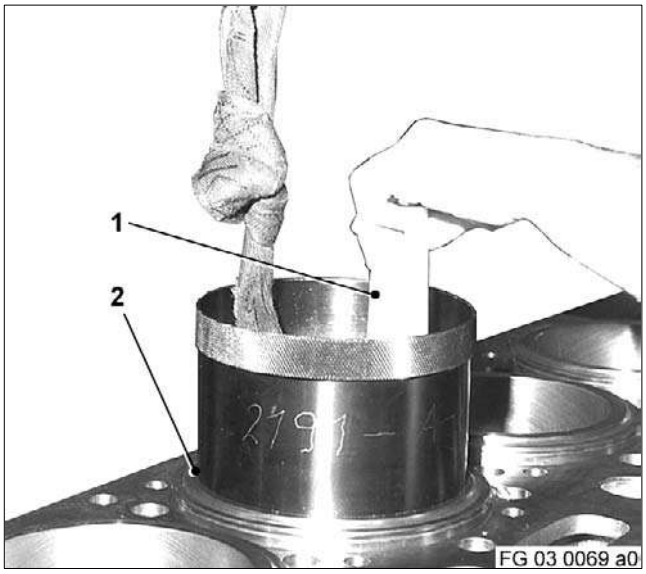
Note: For cylinder liner with carbon-deposit scraper ring, use an appropriate assembly sleeve with collar.

Suspend piston with ropes and pass through assembly sleeve into cylinder liner.

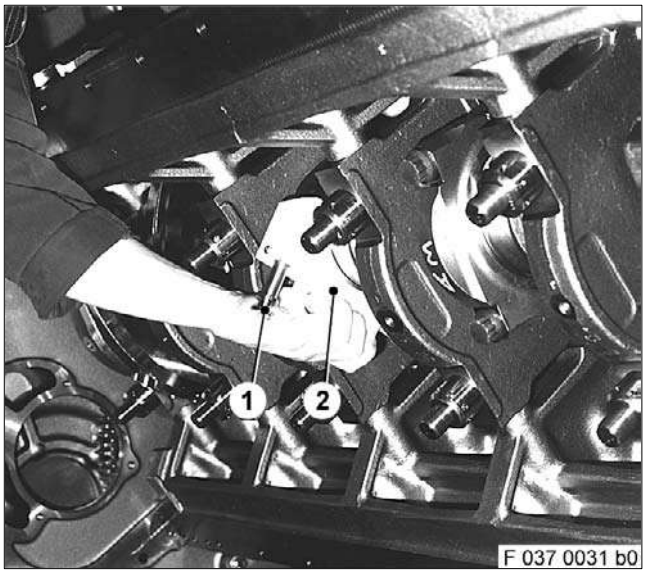
Install piston into cylinder liner so that short arm of conrod points outwards to air intake side.

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.



Use mandrel (1) to press piston into cylinder liner (2).

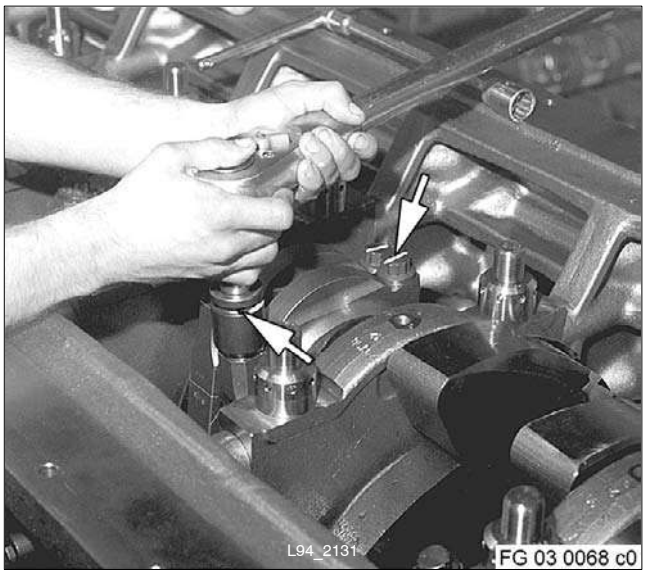


Place conrod on assembly device (2) for conrod bearing.

At same time, position assembly device with guide pin (1).

Remove assembly device and press conrod cap by hand onto conrod and position with adjusting mandrel.

Pay attention to fit of locating pin in recess in conrod cap.



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.

Carefully insert conrod screw into bearing cap bore by hand to first contact with thread flanks, then turn first three rotations without a tool.

Install conrod cap screws (arrow) until screw heads make contact and use socket wrench to tighten by hand.

Conrod and conrod cap serrations must be closed.

First tighten conrod cap screw at short conrod arm and then on long conrod arm to specified torque – see overview drawing C 037.05.01.

Checking axial clearance of connecting rod – see next section.

Mark screw heads (arrows).

Tighten conrod screws through specified angle of further rotation.

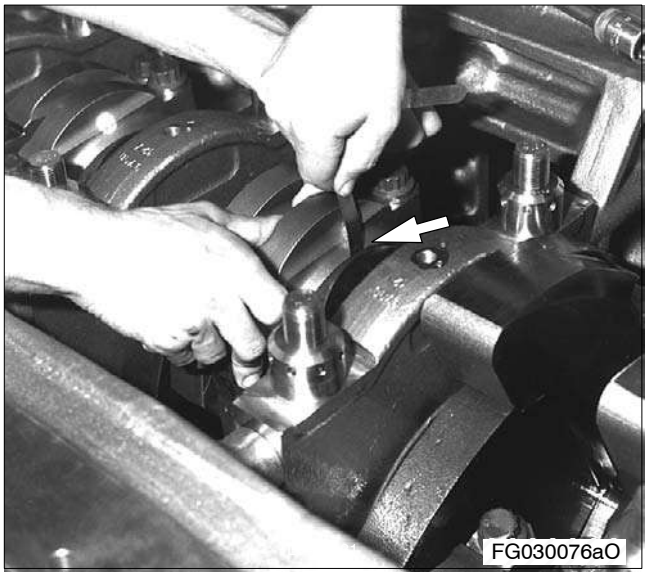
Check checking torque in tightening direction as per tightening specifications.

Again check axial clearance.

Note: Remove lifting device and assembly sleeve for piston with connecting rod.

Bar crankshaft and ensure that there is ease of movement between oil spray nozzle, piston and conrod.

Installing carbon scraper ring – see C 013.05.



Check axial clearance of connecting rod

Check distance between crankshaft web and conrod or between conrod and conrod, pressed towards each other.

The above-stated components must not touch each other.

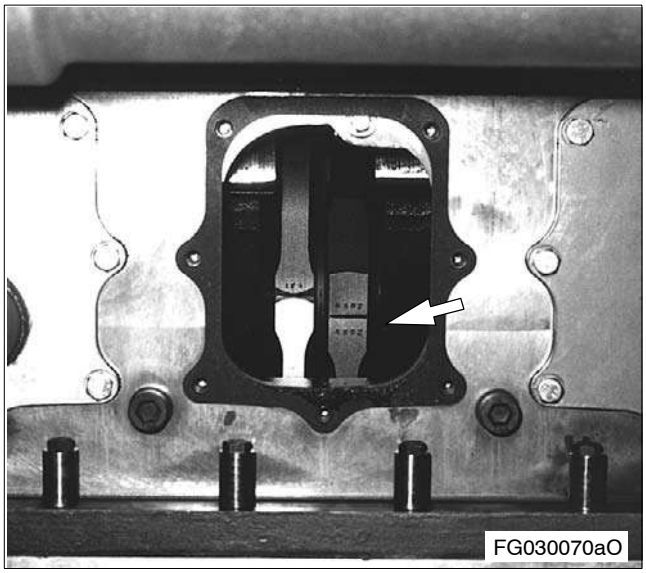
Use feeler gauge (arrow) to measure ring end clearance, pressing on three levels.

Min. clearance = 0.20 mm

Max. clearance = 0.60 mm

If the specified clearance is exceeded or undershot, adjustment is necessary.

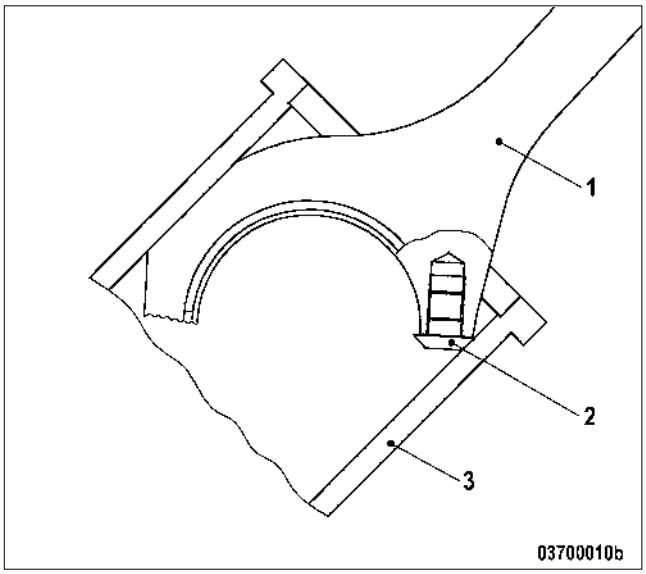
Release conrod cap screws, compensate clearance in axial area and again tighten as per tightening specifications.



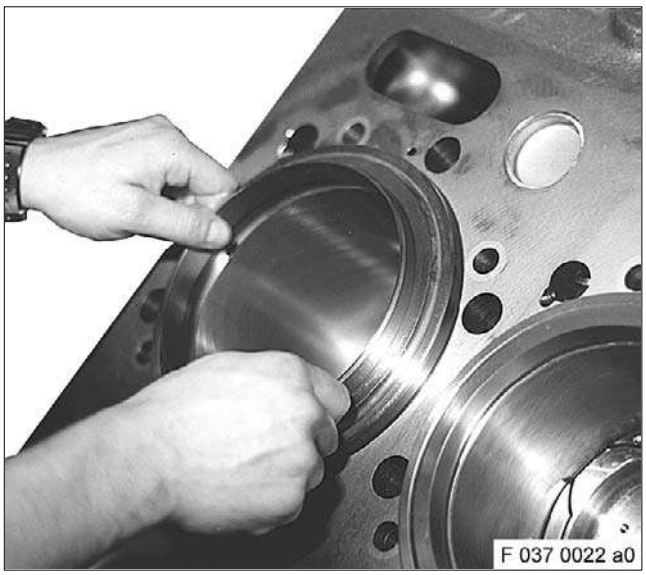
Install piston with connecting rod with oil pan installed (via access port)

Apart from the unaltered installation position of the crankcase (engine in normal position), installation of the conrod bearings, conrod caps and conrod screws through the access port (arrow), is in principal the same as for – *Installing piston with connecting rod in assembly dolly.*

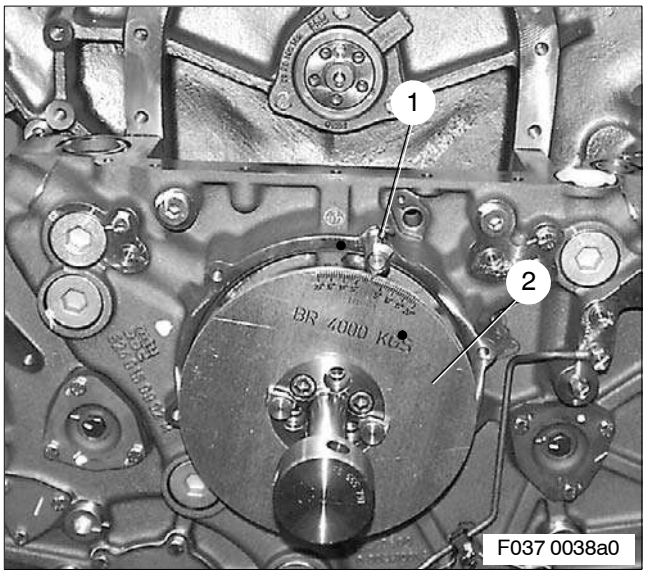
Before installing, mount the sliding block on the connecting rod to be installed, see next illustration.



1 Connecting rod
2 Sliding block
3 Cylinder liner



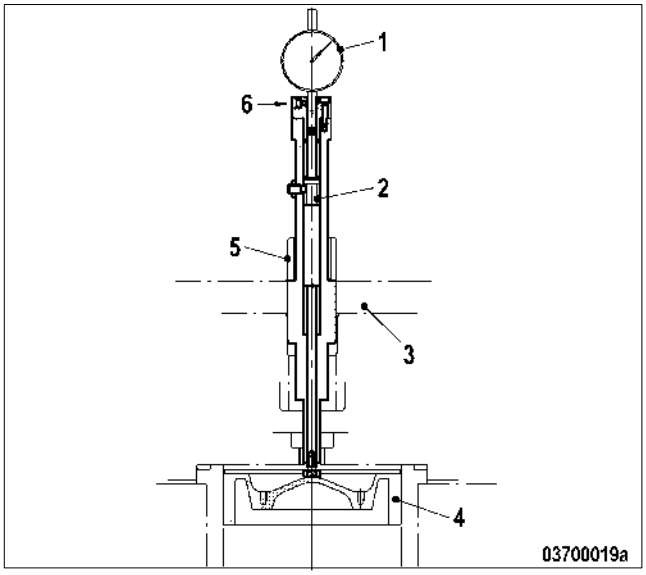
Inserting carbon scraper ring.
Before installing, spray cylinder liner and carbon scraper ring with engine oil.
Insert carbon scraper ring.



Defining piston TDC

Install pointer (1) on equipment carrier.

Install graduated disc (2) with barring tool on crankshaft, free end.



Install dial gauge (1) under preload in measuring unit (2) and clamp with screw (6).

Install measuring unit in cylinder head (3) and secure with hold-down clamp (5).

Set dial gauge to zero.

Move piston (4) up and down several times until pointer on dial gauge shows its maximum 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.

C037.05.12 After-installation operations

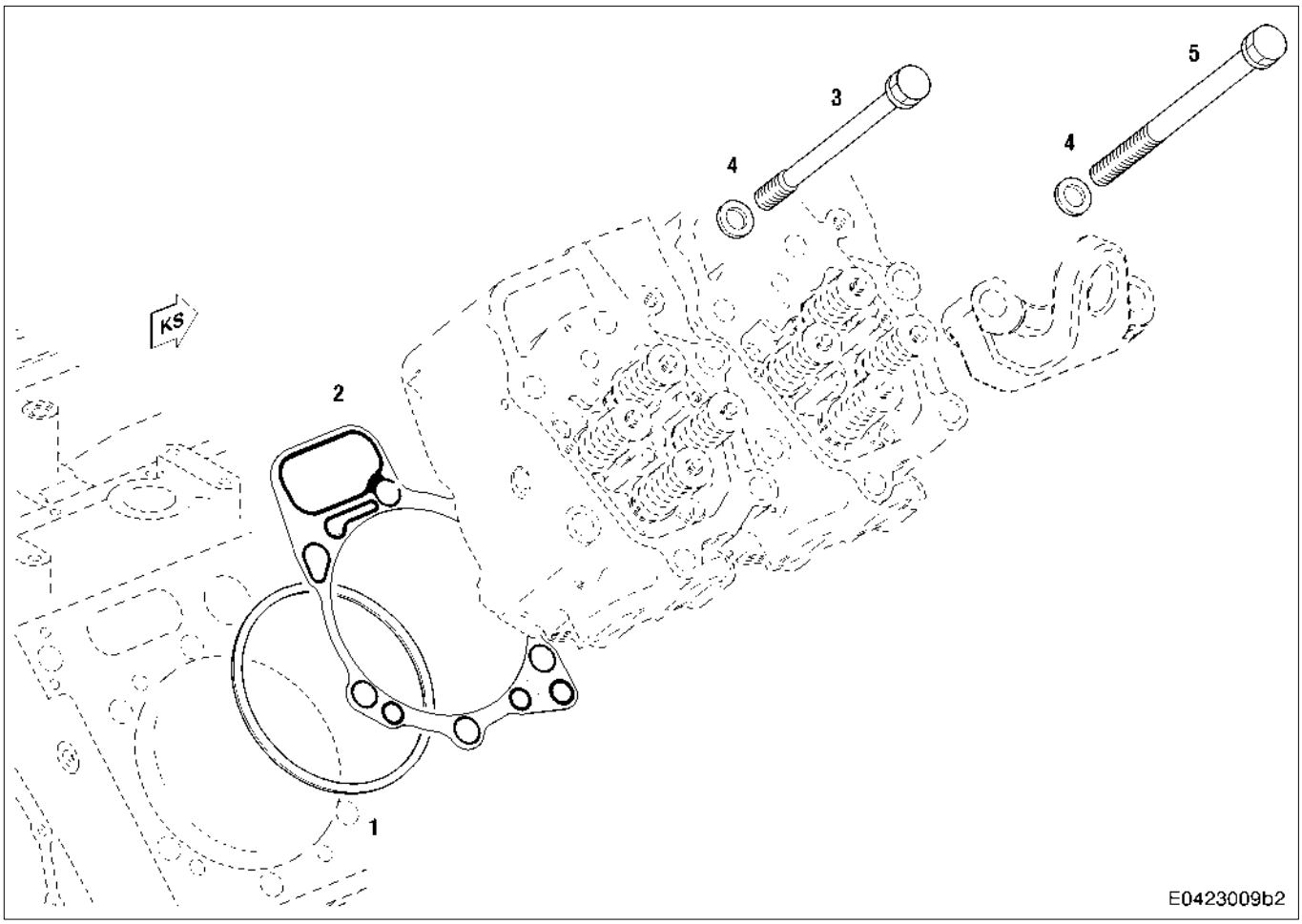
For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
–	–	x	Release engine start	→ Operating Instructions
–	x	x	Assembly in reverse sequence to disassembly	→ C 037.05.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

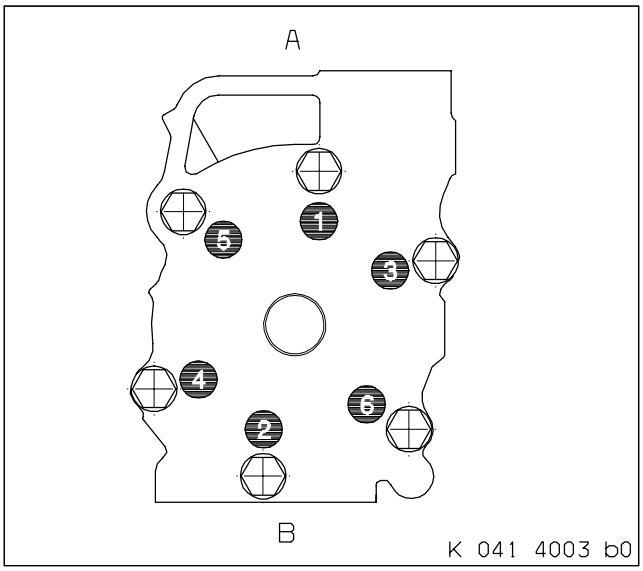
C040 Cylinder head with attachments

C041.05 Cylinder head

C041.05.01 Overview drawing



1 Sealing ring
2 Gasket
3 Cylinder head screw
4 Thrust washer
5 Cylinder head screw



Cylinder head tightening diagram

Lubricant: Engine oil

1. Fitting screws:	approx. 25 Nm
2. Tightening screws:	180 Nm + 10 Nm
3. Additional angle of rotation:	180° + 10°
4. Checking torque:	450 Nm

Tighten screws at every respective stage in the following sequence: 1, 2 ,3 ,4 ,5 , 6

A = Exhaust side

B = Inlet side

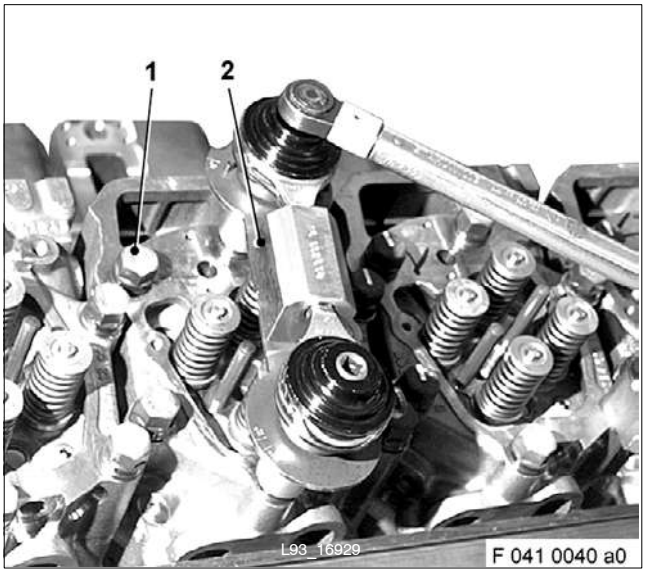
C041.05.02 Special tools

Designation	Use/dimension	Number
• Blanking plug	for oil duct at cylinder head screw bore	1
– Installation/removal tool.	for blanking plug	1
• Support bracket	for cylinder head in installation position	1
• Angle of rot. tightening tool (power amplifier)	Tighten for cylinder head screws	1
• Alignment tool	for cylinder heads, 8V/12V/16V engine	1
• Adjusting mandrel	for cylinder head	2

C041.05.04 Before-removal operations

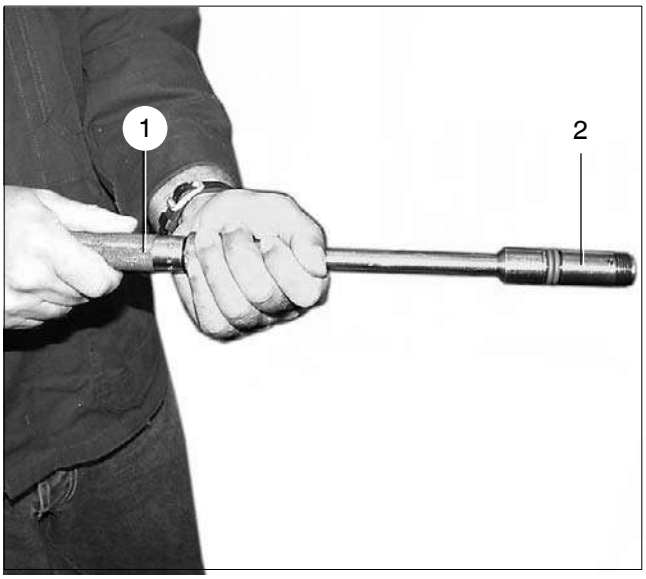
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Drain engine coolant	→ Operating Instructions
–	x	x	Remove air filter (if necessary)	→ –
–	x	x	Remove Y-pipe from exhaust	→ C 141.10.05
–	x	x	Remove exhaust turbocharger	→ C 101.01.05
–	x	x	Remove exhaust manifolds	→ C 141.10.05
–	x	x	Remove rocker arm brackets	→ C 055.05.05
–	x	x	Remove push rods	→ C 055.05.05
–	x	x	Remove valve bridges	→ C 055.05.05
–	x	x	Disconnect and remove electric cable at injector	→ C 507.10.05
–	x	x	Remove fuel injector	→ C 075.05.05
–	x	x	Remove charge air manifolds	→ C 124.05.05
–	x	x	Remove H.P. line between cylinder head and H.P. accumulator	→ C 077.05.05
–	x	x	Disconnect fuel return lines	→ C 086.05.05

C041.05.05 Removal



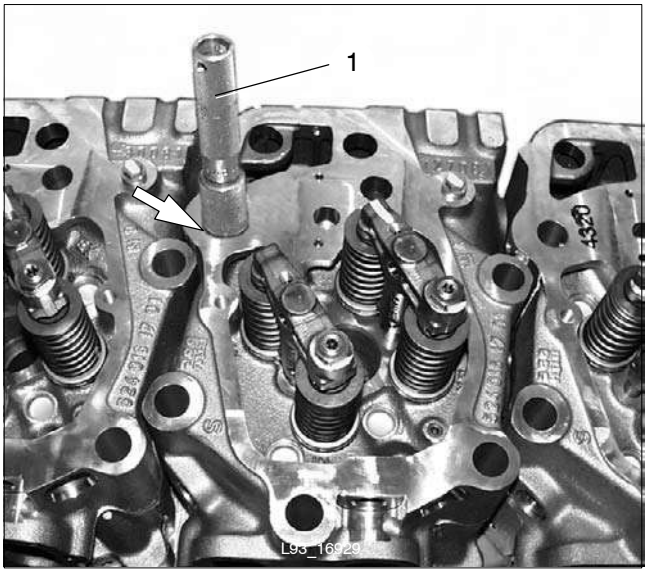
Removing cylinder head

Using a large ratchet or power assist (2), remove hex screws (1) evenly.



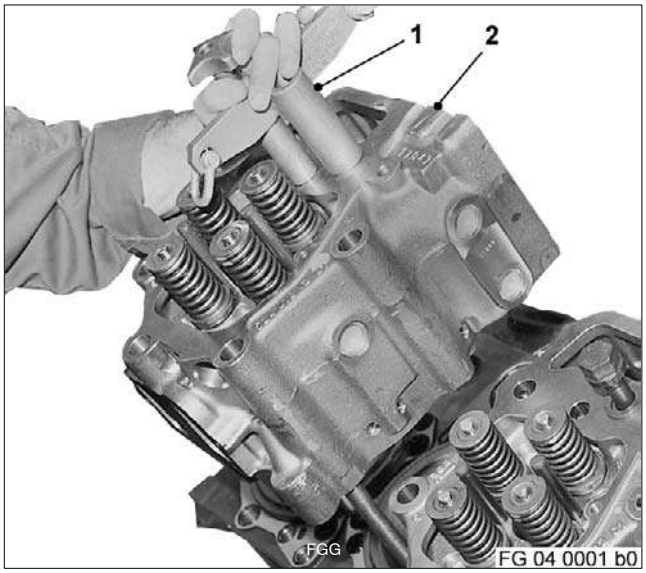
Before removing cylinder head, seal oil supply line to valve gear in crankcase as follows:

Fit blanking plugs (2) on installation/removal tool and lock slightly in position with the retaining grip (1).



Screw blanking plugs with installation/removal tool (1) into oil supply line (arrow) in crankcase (10 o'clock position) and spread.

Unscrew installation/removal tool from blanking plug and remove.



⚠ CAUTION

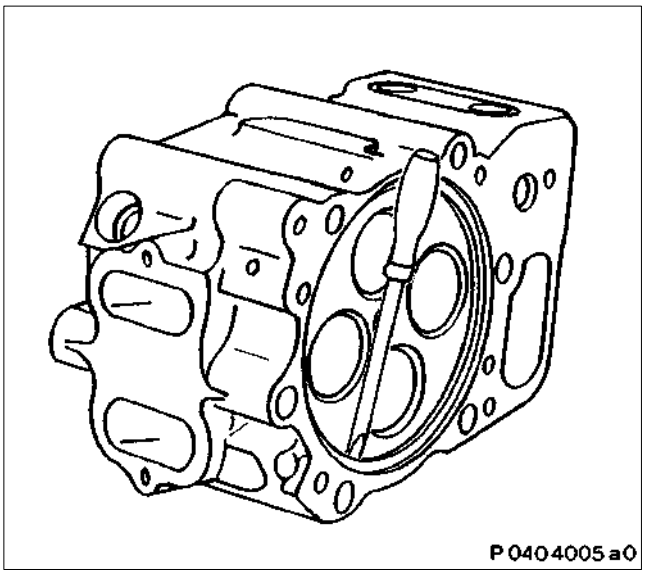
Components have sharp edges.
Risk of injury!
Handle components only when wearing protective gloves.

Using the lifting device (1), lift the cylinder head (2) out of the crankcase and place it on a suitable base.

Note: With injector installed, place cylinder head to the side. Injector protrudes at bottom of cylinder head.

Remove cylinder head gasket from crankcase mating face.

Remove blanking plug from oil supply bore for valve gear.



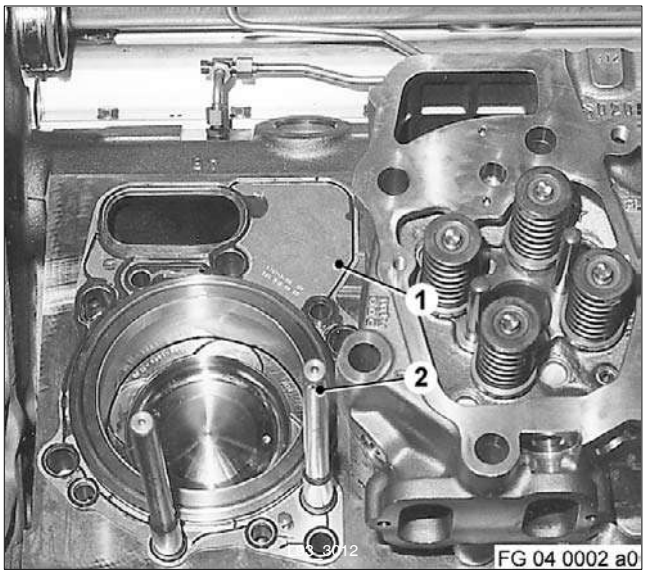
Using a screwdriver, carefully lever sealing ring (1) out of cylinder head lower section.

C041.05.06 Disassembly

Disassembly of cylinder head is not envisaged.

The cylinder head is a replacement part and available in the replacement programme.

C041.05.11 Installation



Install cylinder head

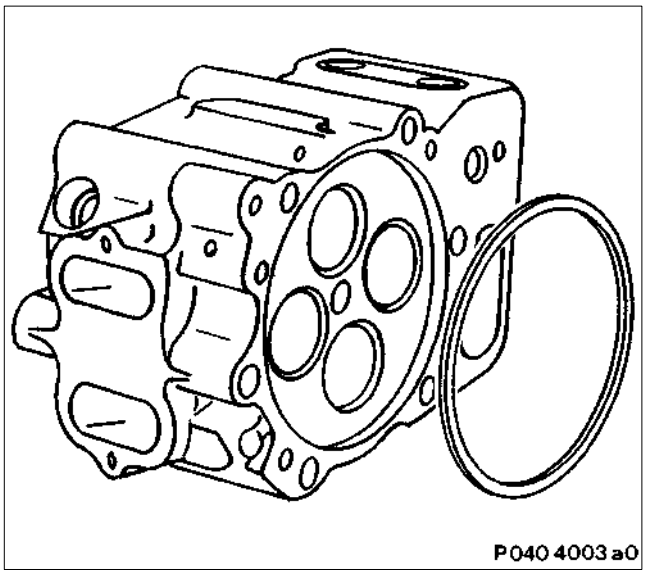
Note: Prior to installation, remove all plugs and ensure oil bores are perfectly clean.

Check that cylinder head mating face and crankcase partition surface are in perfect condition. Wipe and clean as necessary.

Note: Always use new cylinder head gaskets.

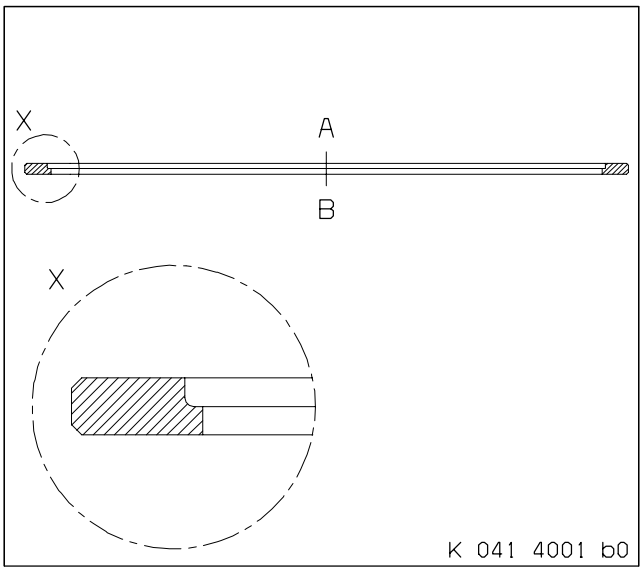
Fit cylinder head gasket (1).

Install adjusting mandrel (2) for positioning cylinder head gasket and cylinder head in crankcase.



To improve clamping effect of sealing ring in cylinder head, tap sealing ring with a plastic mallet to produce a slight oval shape.

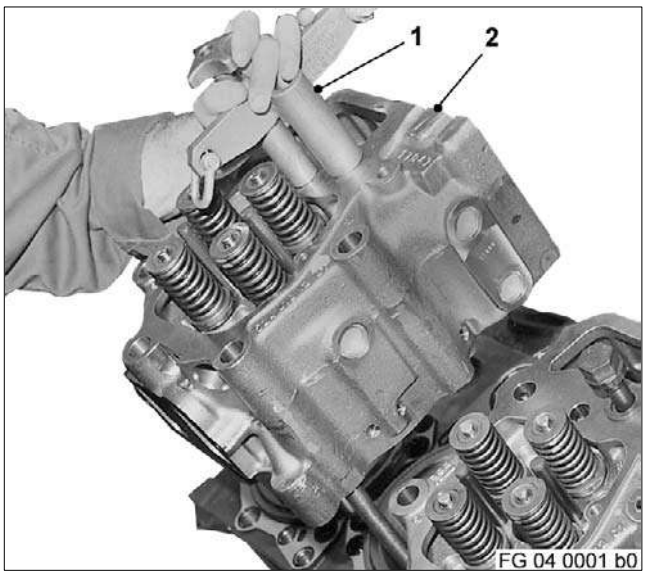
Insert sealing ring in groove on combustion chamber side of cylinder head.



Ensure that sealing ring is fitted correctly:

A = Cylinder head side

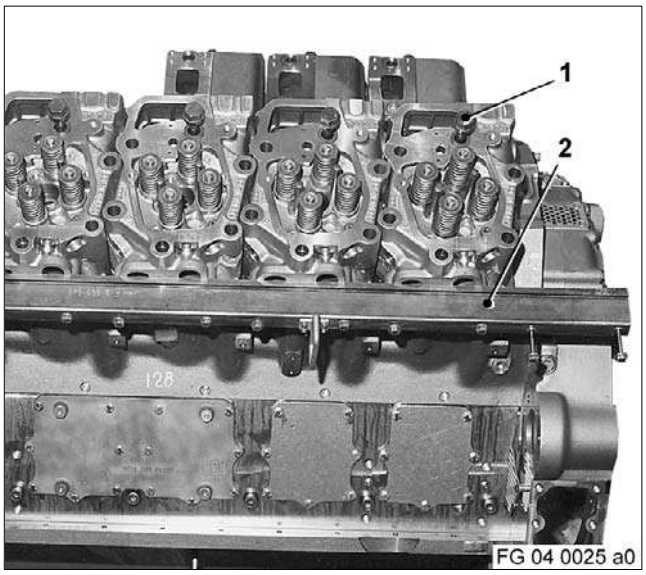
B = Piston side



⚠ CAUTION

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

Using lifting equipment (1), install cylinder head (2) on crankcase.



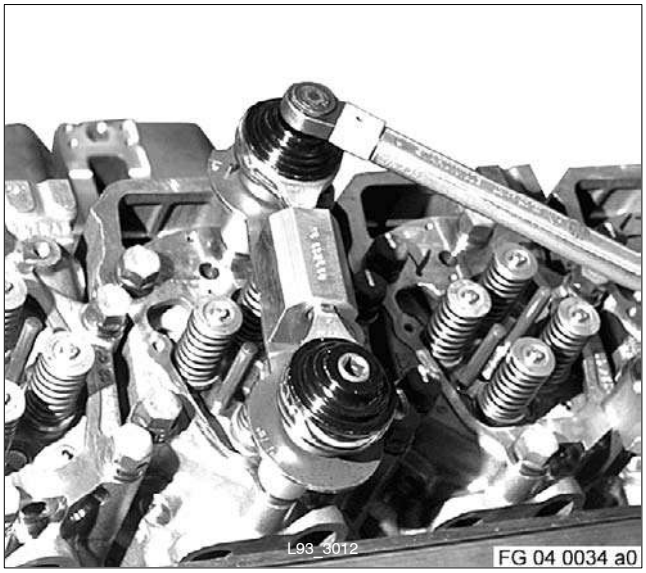
Coat thread, head and shaft of cylinder head screws (1) with engine oil.

Ensure correct allocation of cylinder head screws (engine lifting eye), see overview drawing C 041.05.01.

Install cylinder head screws with thrust washers manually in crankcase.

Fit alignment tool (2) on inlets of cylinder heads and tighten.

Attention: Carry out cylinder head alignment carefully, otherwise deformation and cracks may result in exhaust and intake pipework.



Tighten cylinder head screws in steps to specified pretightening torque in accordance with the tightening sequence, see overview drawing C 041.05.01.

Mark screw heads.

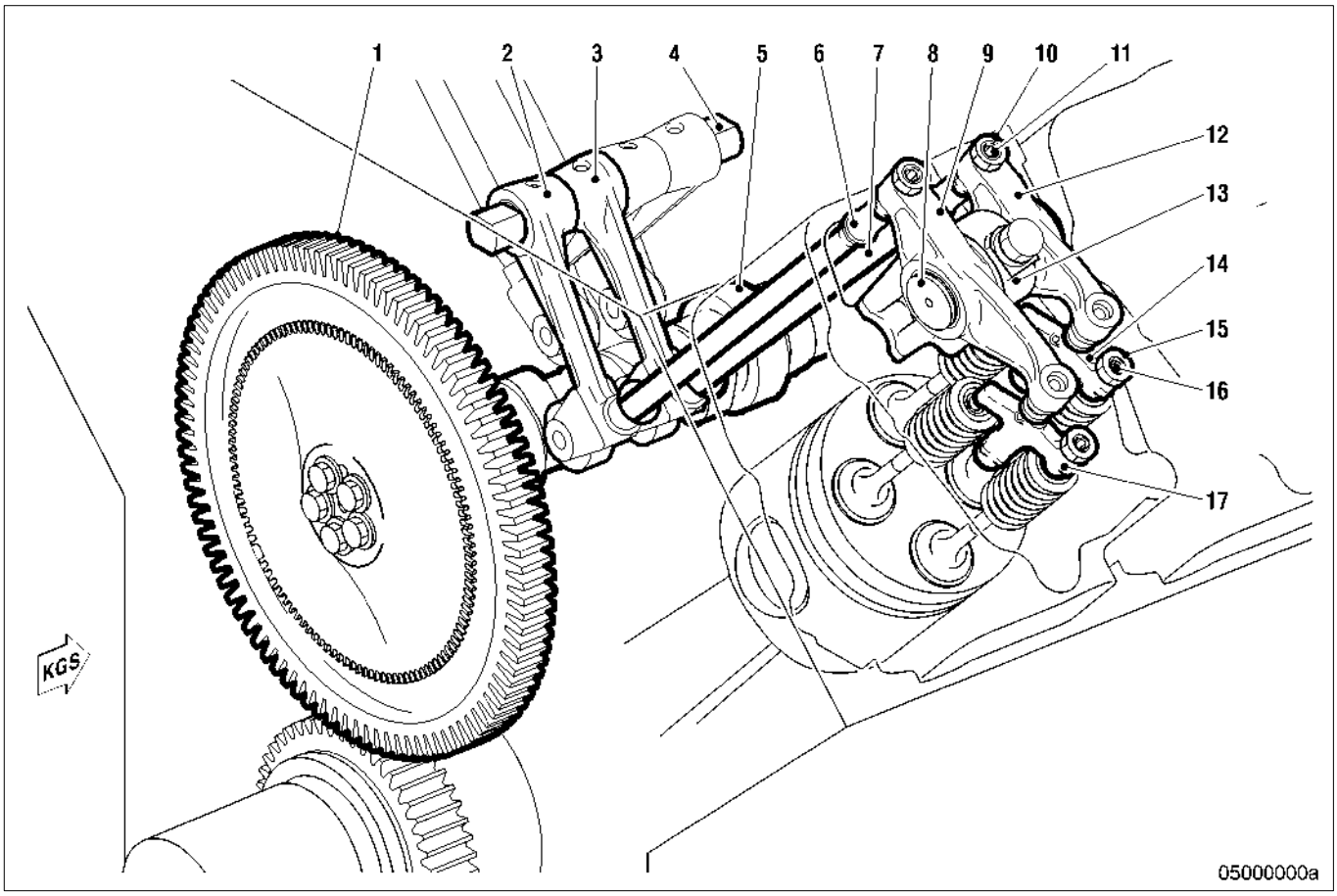
Using a large ratchet or power amplifier, tighten cylinder head screws to angle of rotation in specified sequence as per tightening specifications.

Remove alignment tool.

C041.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 041.05.04
–	x	x	Adjust valve clearance	→ C 055.05.11
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions
–	–	x	Fill fuel system	→ Operating Instructions

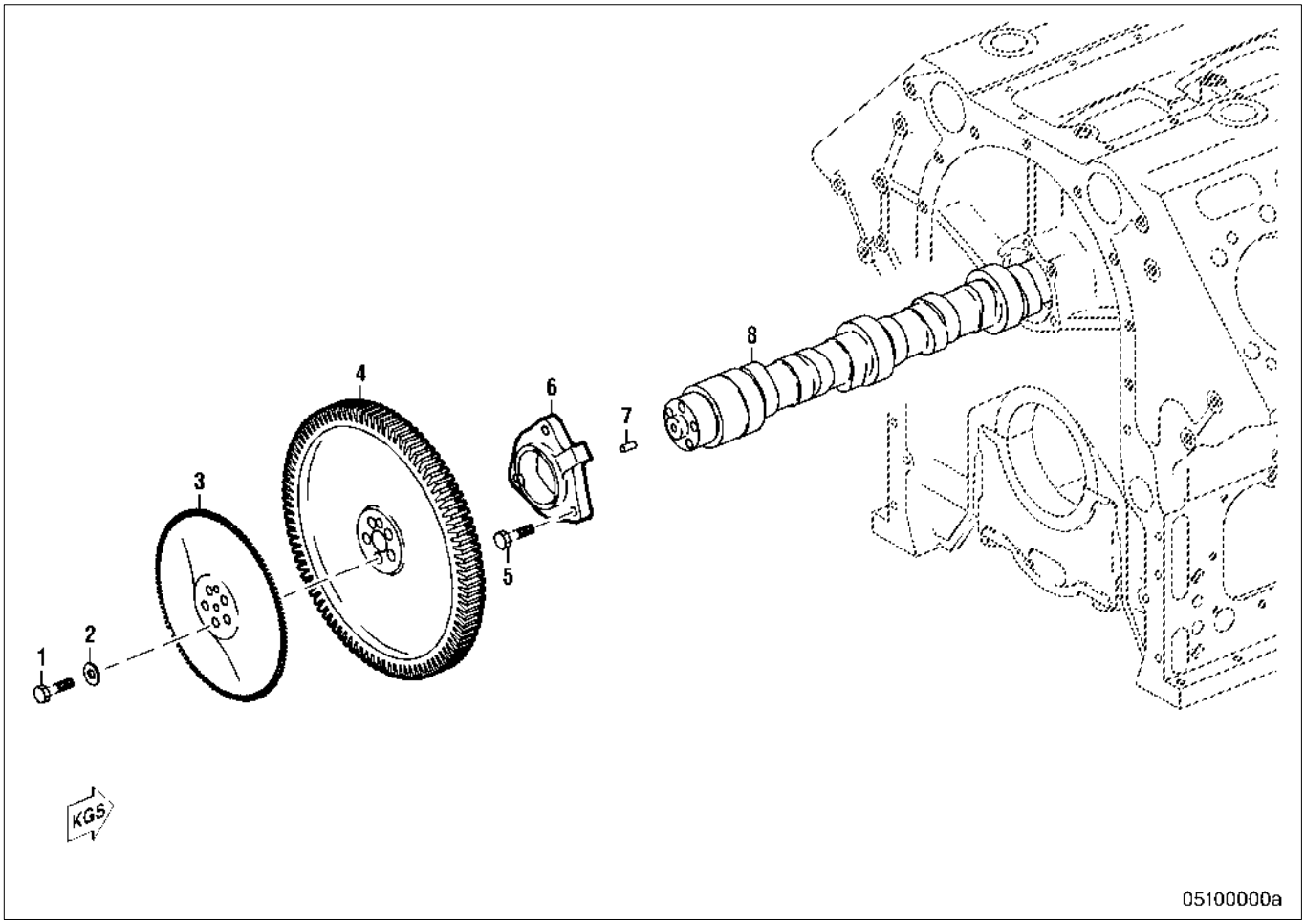
C050 Valve gear



1 Camshaft gear
2 Rocker arm, inlet
3 Rocker arm, exhaust
4 Rocker shaft
5 Camshaft
6 Pushrod, inlet
7 Pushrod, exhaust
8 Axle
9 Rocker arm, inlet
10 Hex nut
11 Adjusting screw
12 Rocker arm, exhaust
13 Bearing pedestal
14 Valve bridge, exhaust
15 Hex nut
16 Adjusting screw
17 Valve bridge, inlet

C051.05 Camshaft

C051.05.01 Overview drawing



1 Hex screw
Lubricant: Engine oil
Tightening torque: 100 Nm + 10 Nm
2 Spring washer
3 Graduated disc
4 Camshaft gear
5 Hex screw
6 Thrust bearing flange
7 Dowel pin
8 Camshaft

C051.05.02 Special tools

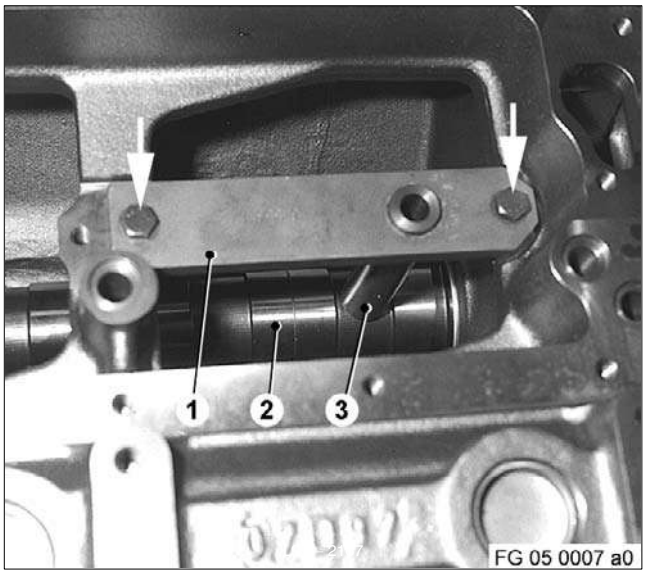
Designation	Use/dimension	Number
• Locating device	for camshaft	1
• Guide sleeve	for camshaft	1
• Installation/removal shoe	for camshaft	1
• Measuring device	(TDC position)	1
• Barring tool	Free end	1
– Pointer for barring tool	for barring tool	1
– Timing disc, free end	Set TDC-A1	1
• Magnetic stand with dial gauge		1

C051.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	x	x	Removal not scheduled	→ –

C051.05.05 Removal

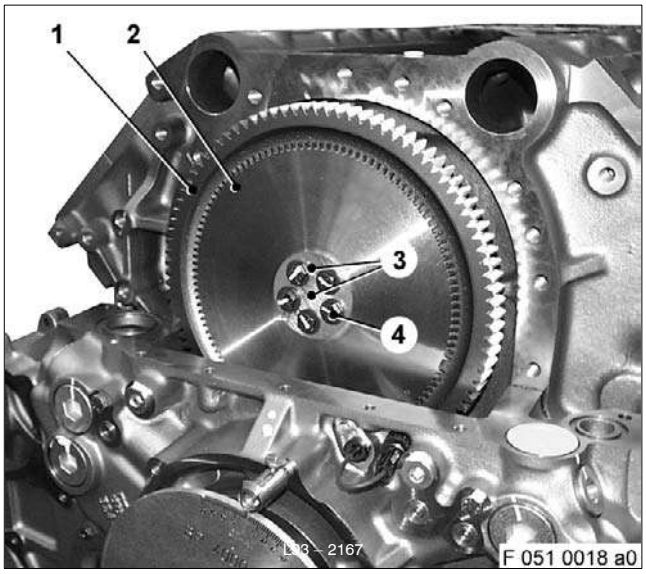


Removing camshaft gear and graduated disc

Position locating device (1) on securing plane of rocker shaft, driving end.

Insert dowel pin of guide tube (3) into camshaft bore (2) – see next illustration - and screw locating device into place (arrow).

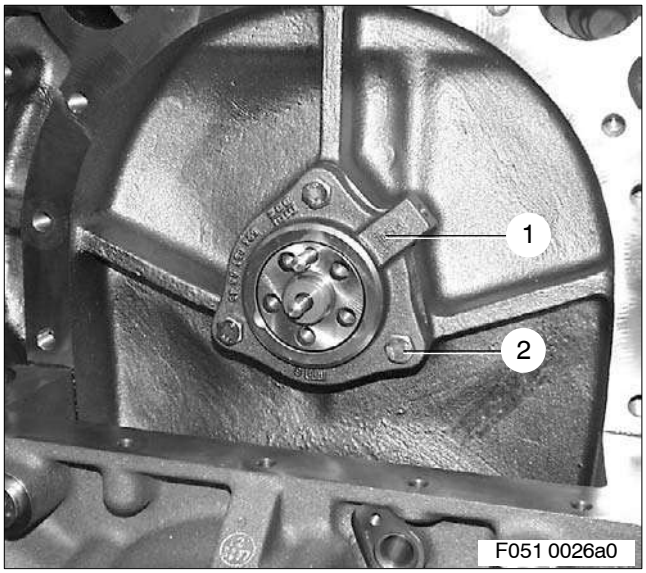
Locating bore (arrow) for locating device dowel pin.



Note: Cover bottom of equipment carrier so that no objects can fall into housing.

Remove hex screws (4).

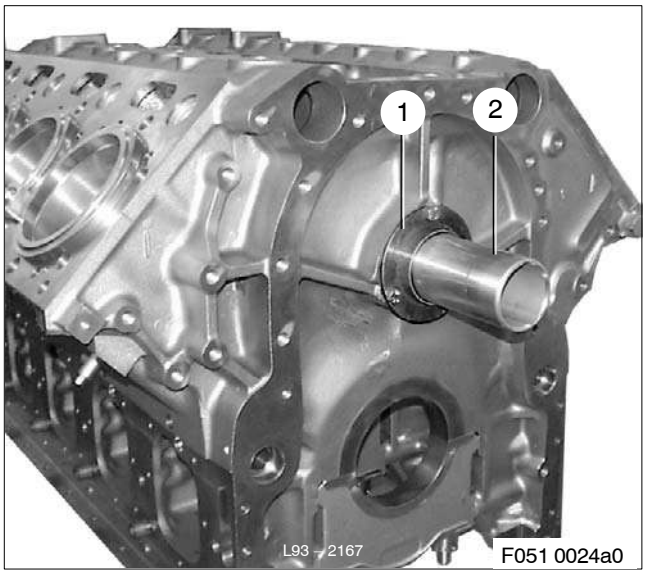
Remove graduated disc (2) and camshaft gear (1) from camshaft, paying attention to fit of dowel pins (3).



Removing camshaft axial alignment bearing

Remove hex screws (2) and remove axial alignment bearing flange (1).

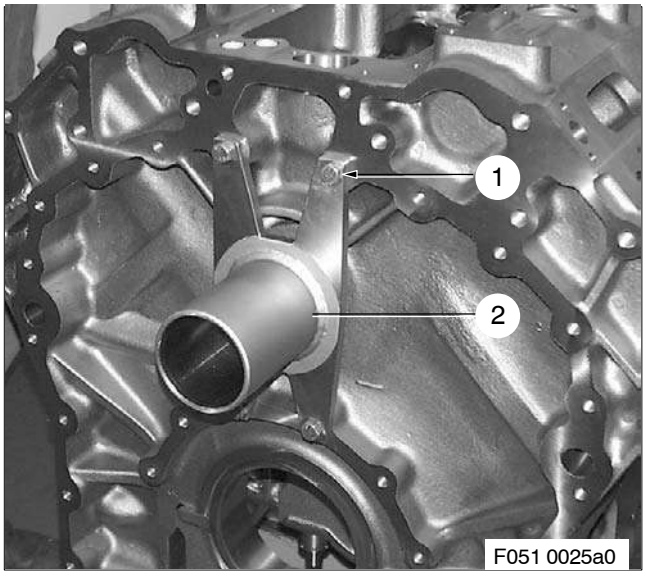
Remove locating device.



Removing camshaft

Screw inner guide sleeve (2) to face of camshaft, free end.

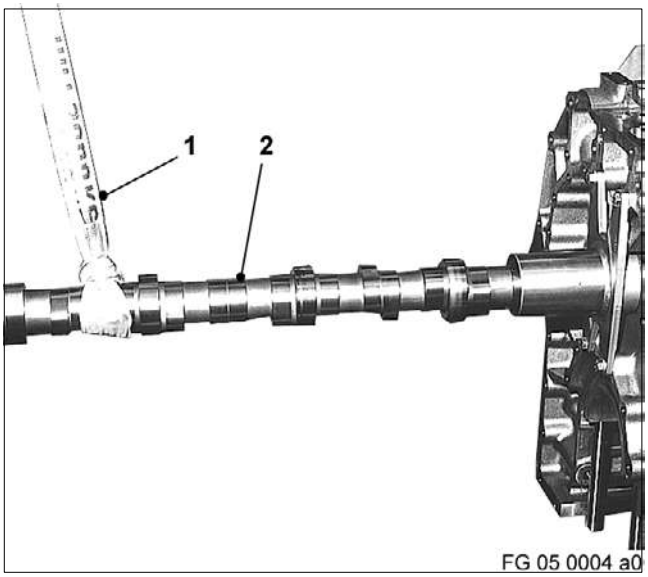
Secure guide flange (1) to crankcase.



Secure outer insertion sleeve (2) to crankcase, driving end, but do not yet tighten hex screws (1).

Carefully withdraw camshaft in direction of driving end only far enough so that the insertion sleeve can be centred with regard to the camshaft.

Tighten hex screws.



Fit installation/removal tool between bearing 3 and 4 on camshaft (2).

Carefully withdraw camshaft from crankcase so that bearings are not damaged.

⚠ 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.

C051.05.08 Inspection and repair

Clean parts.

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 axial sliding surface, journal faces and roller tracks of cams for scoring, wear and indentations.

Using the surface crack-testing method with red penetrant dye, check thrust bearing flange for cracks; replace component if cracks are found.

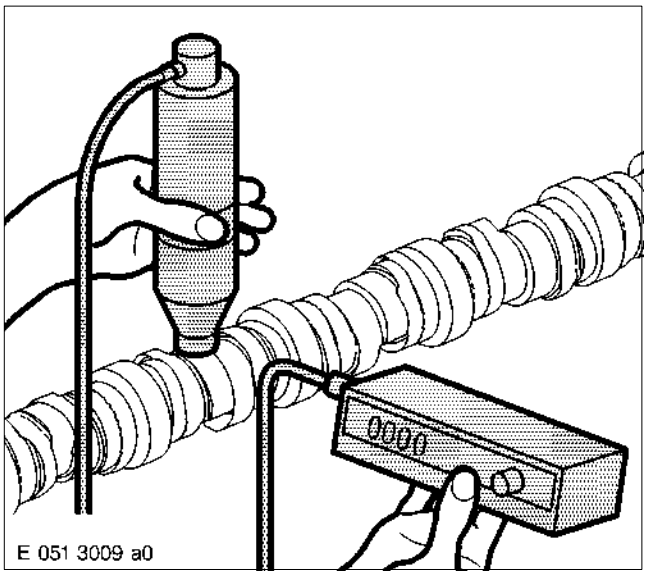
Check gear mating face and rub down with oilstone or emery cloth if necessary.

Check surface condition of camshaft gear teeth with magnifying glass; replace gear if necessary.

Check all components for damage or excessive wear; replace components as necessary.

Remove minor wear, indentations and scoring by rubbing down with polishing cloth; replace components as necessary.

Check screws for condition and thread for ease of movement; replace if necessary.



Checking hardness of cam and journal

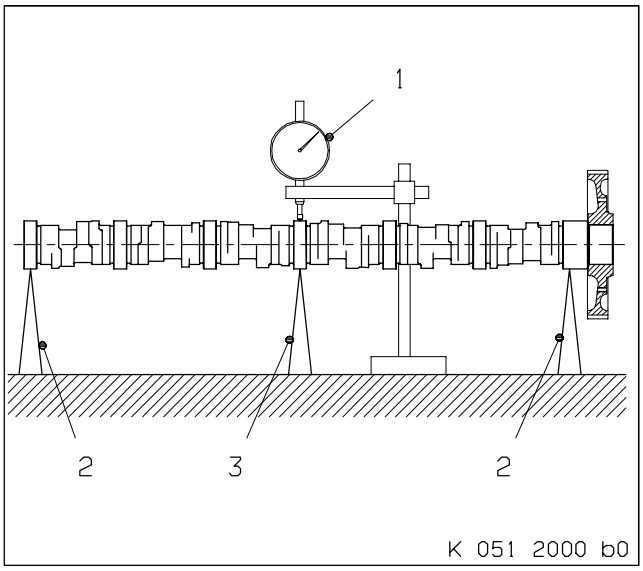
Check hardness of cam and journal on camshaft using Microdur testing unit or another suitable hardness testing unit.

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

Required hardness = 61 HRC ± 2 HRC

If limit values are not achieved, machine camshaft to MTU specifications or replace as necessary.

Note: Smoothen traces of wear with emery cloth.



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 roller track with dial gauge.

For permissible values, see Tolerance and Wear Limits List.

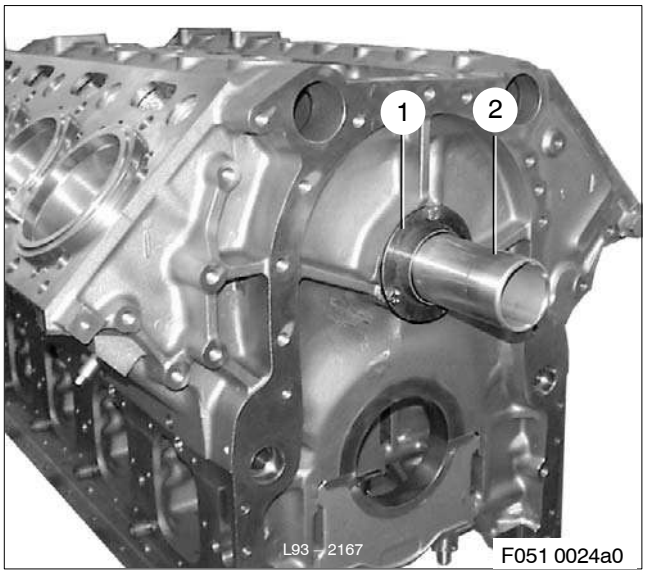
If limit values are not achieved, machine camshaft to MTU or DDC specifications or replace as necessary.

C051.05.11 Installation

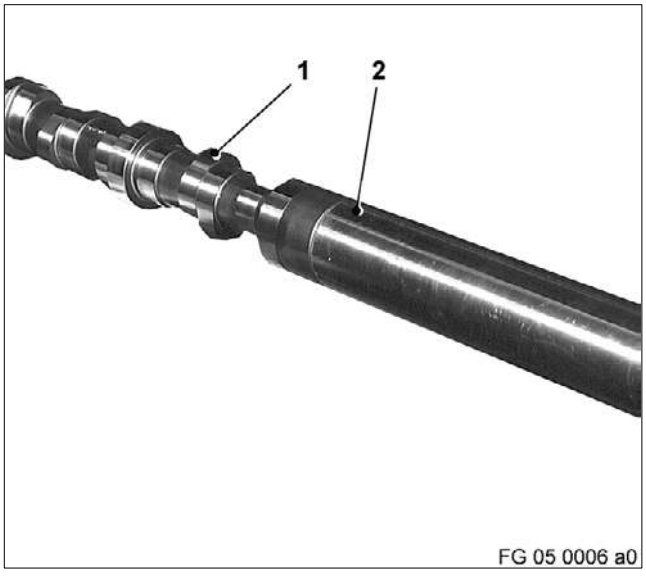
Installing camshaft

Note: Make sure all components are perfectly clean.

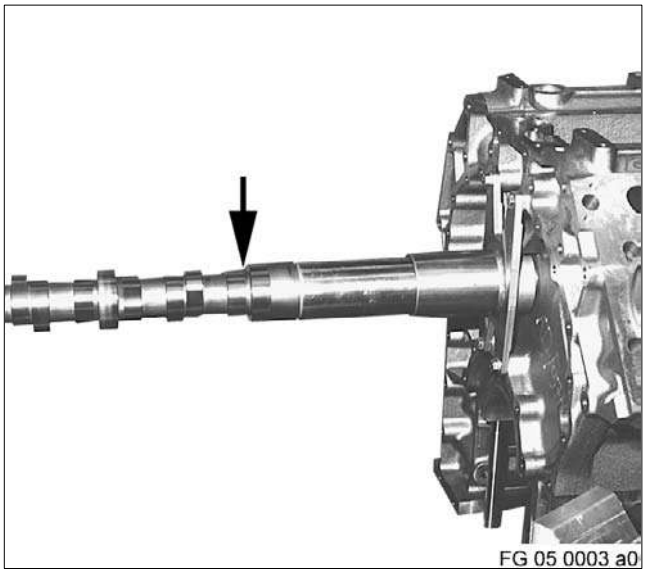
Attach outer guide sleeve (1) to driving end of crankcase and carefully centre with regard to camshaft bearings with inner guide sleeve (2).



Centre guide flange (1) with guide sleeve (2) on crankcase (free end) with regard to camshaft bearings and secure.



Position inner guide sleeve (2) on front of camshaft (1) and tighten.



⚠ WARNING

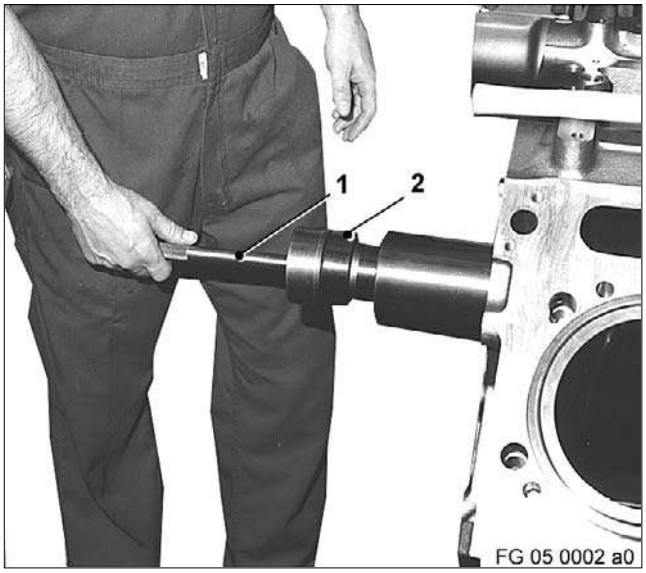
Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Attach camshaft (arrow) in centre with rope and wipe.

Spray camshaft, camshaft bearing, and guide sleeve with engine oil.

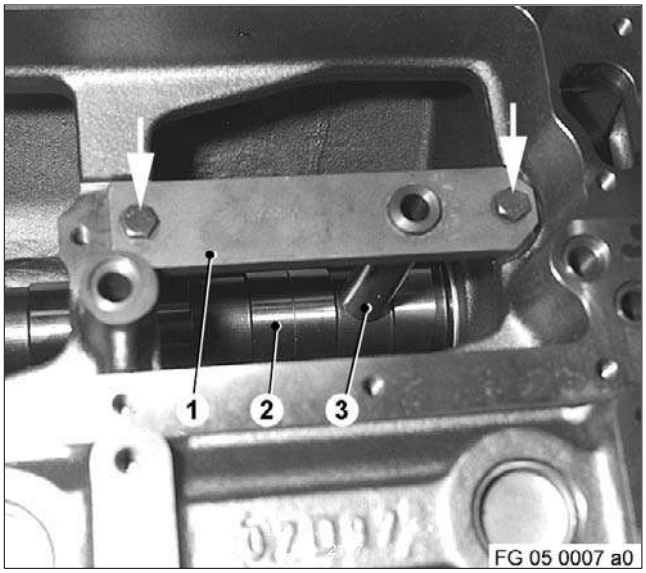
Install installation/removal shoe at outermost cam on camshaft.

Taking care not to damage bearings, slowly introduce camshaft into crankcase up to second-last bearing.



Position assembly extension (1) on camshaft (2) and insert camshaft up to last bearing.

Note: Locate camshaft axially and/or ensure that it cannot fall out until axial alignment bearing and camshaft gear are installed.

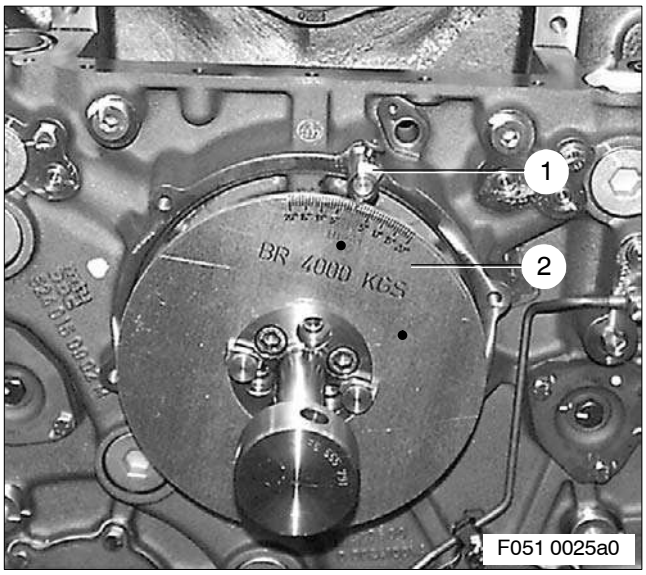


Installing camshaft axial alignment bearing

Turn camshaft (2) until locating bore in camshaft, driving end, is facing upward.

Position locating device (1) on securing plane of rocker shaft, driving end.

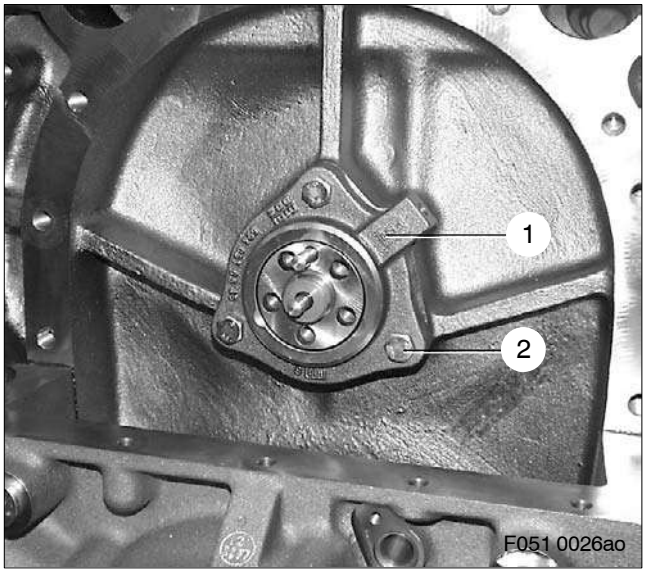
Insert dowel pin of guide tube (3) into camshaft bore and screw locating device into place (arrows).



Install pointer (1) on equipment carrier.

Install index plate (2) with barring tool on crankshaft, set to TDC marking of A1 and tighten.

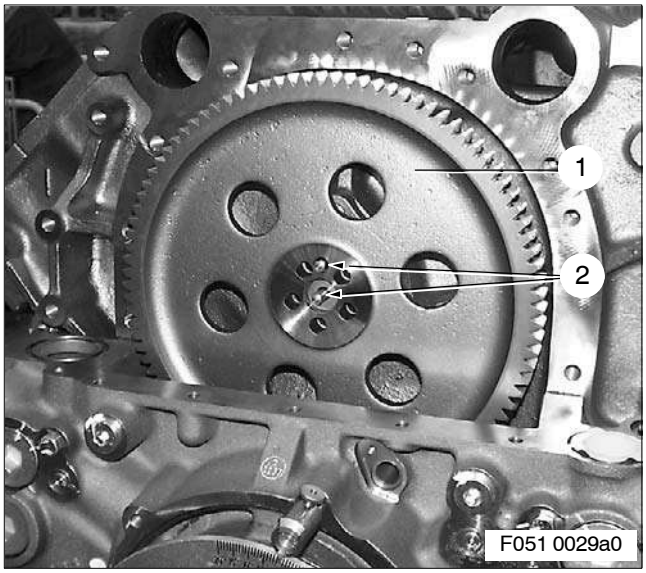
Position piston A1 to firing TDC – see Section C 37.05.11.



Note: Cover bottom of equipment carrier so that no objects can fall into housing.

Coat axial sliding surfaces with engine oil.

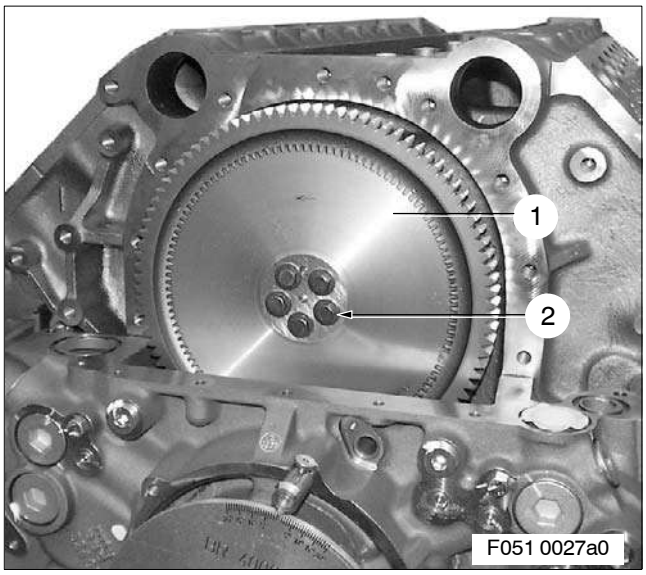
Tighten axial alignment bearing flange (1) with hex screws (2).



Install camshaft gear and graduated disc

Note: Camshaft locating device is installed.

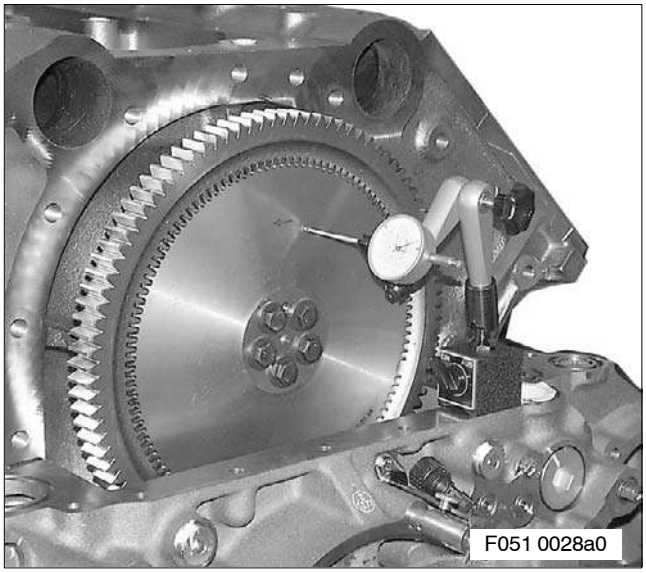
Fit camshaft gear (1) on camshaft so that dowel pins (2) engage in camshaft gear bore in a vertical line.



Install graduated disc (1) via dowel pins.

Tighten hex screws (2) diagonally and evenly to specified tightening torque, see overview drawing C 032.05.01.

Remove camshaft locating device.



Measuring camshaft axial play

Mount magnetic dial gauge holder with dial gauge on crankcase.

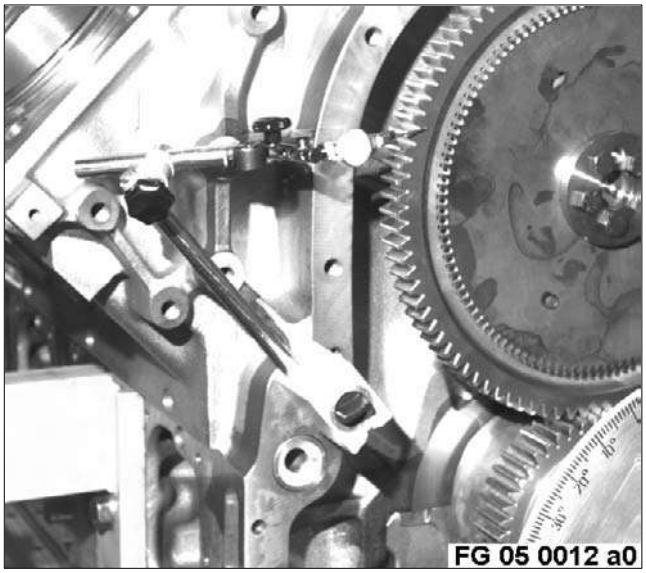
Fit dial gauge stylus on graduated disc.

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 measurement value (axial clearance).

For specified axial clearances, see Tolerance and Wear Limits List.



Measuring backlash

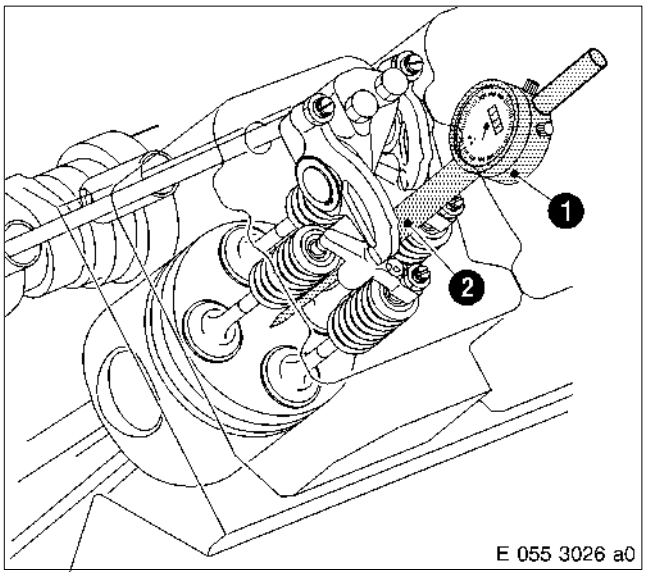
Mount magnetic dial gauge holder with dial gauge on crankcase, free end.

Mount 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 specified backlash, see C 020.



Checking 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 measuring device (2) with dial gauge (1).

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 in the firing TDC.

Note: If both rocker arms are relieved, i.e. have clearance, the piston is at 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.

Rotate crankshaft against normal direction of rotation to approx. 20°.

Rotate crankshaft in direction of rotation to 0.3 mm (dial gauge) before TDC and apply exact mark (e.g. with scriber) to flywheel or vibration damper opposite TDC pointer.

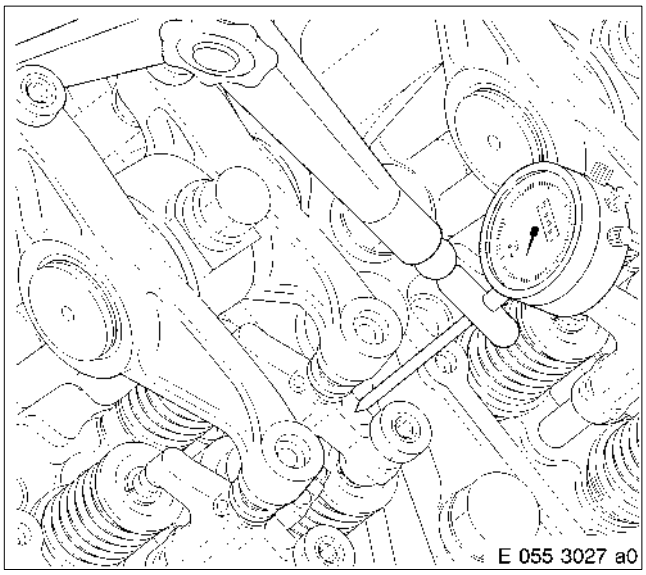
Bar crankshaft in direction of rotation past TDC to approx. 20° (to take up bearing play).

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.

Apply third mark at exact centre between marks.

Remove measuring device with dial gauge.



Measure valve stroke as follows:

Release locknuts (arrows) 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.

Slowly turn crankshaft further in engine direction of rotation 360° exactly to overlap TDC, in accordance with applied mark.

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.

C051.05.12 After-installation operations

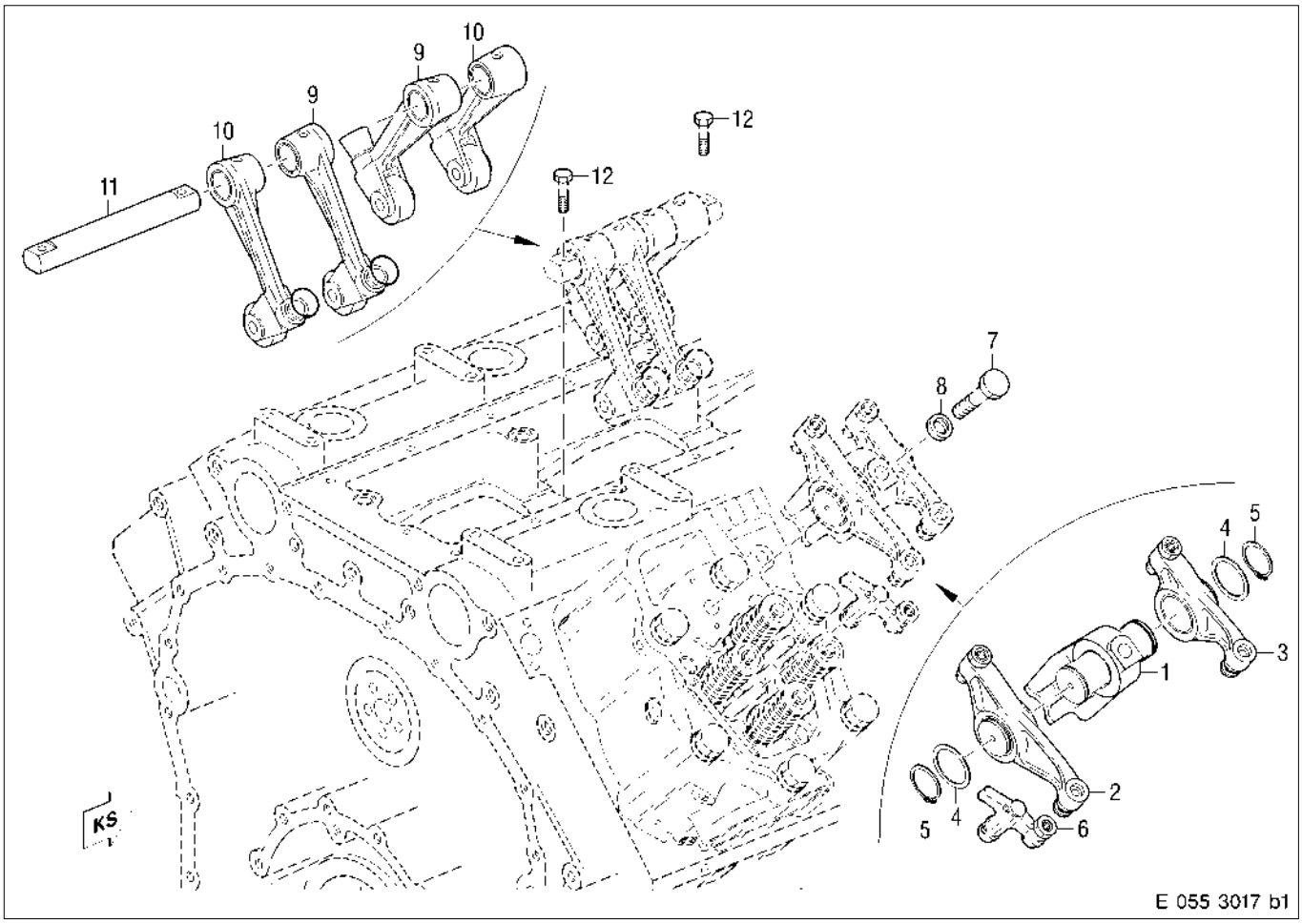
For the following tasks, a distinction must be made as to whether:
The engine is to be completely disassembled
The engine is to be removed but not disassembled
The engine is to remain installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007

C055.05 Valve drive

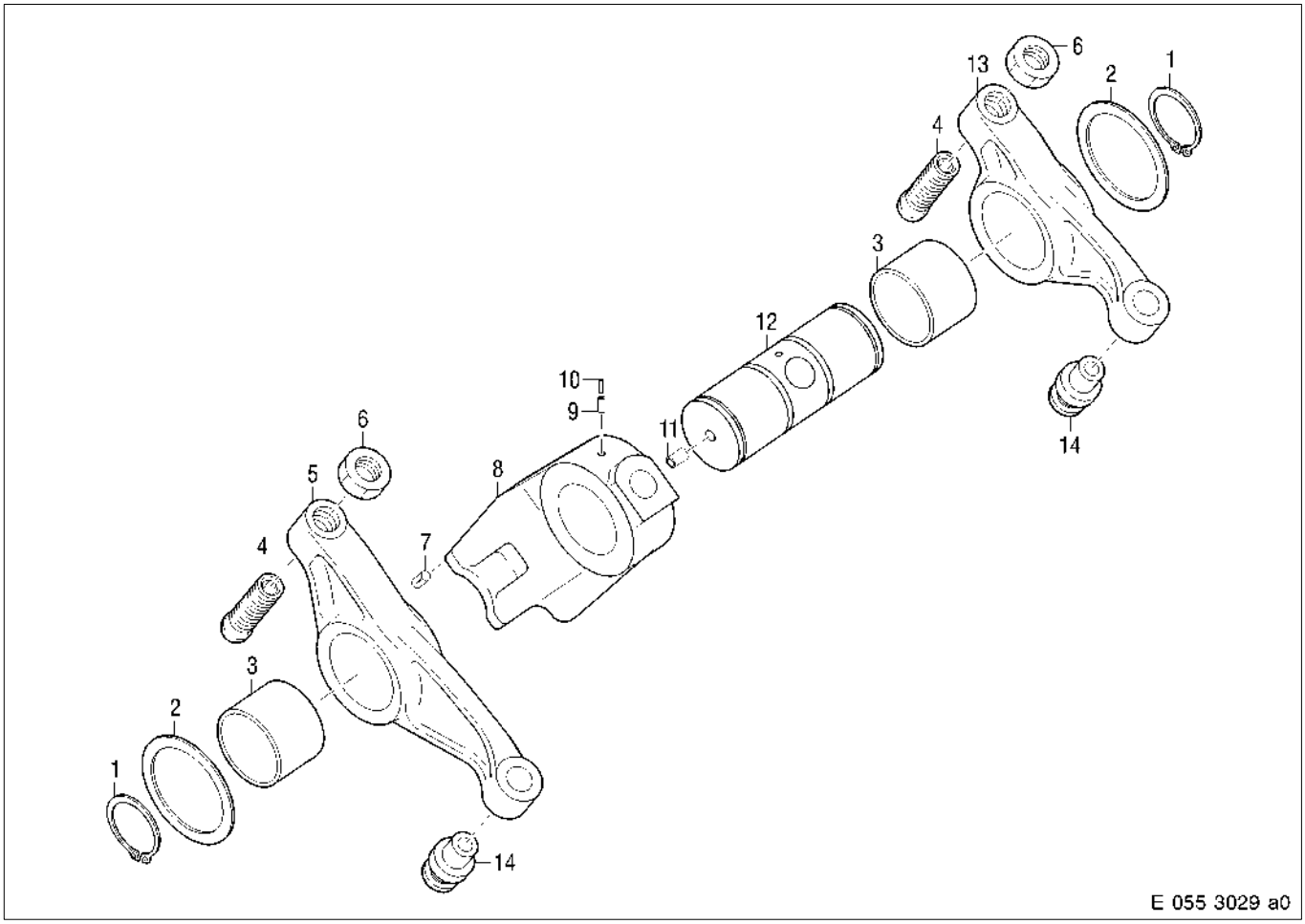
C055.05.01 Overview drawing

Rocker arm assembly



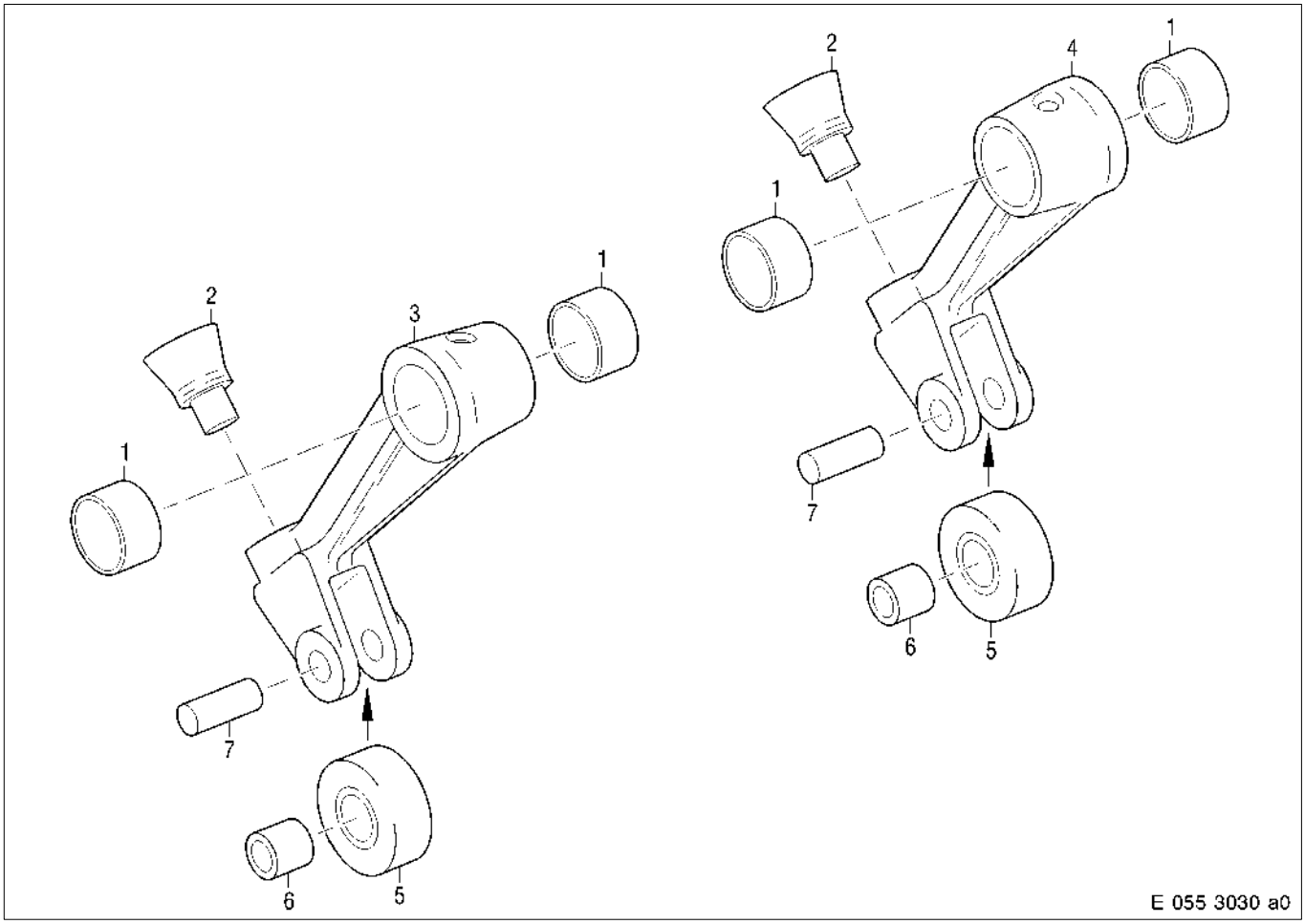
1 Bearing pedestal
2 Rocker arm, inlet
3 Rocker arm, exhaust
4 Adjusting shim
5 Snap ring
6 Valve bridge
7 Hex screw
Lubricant: Engine oil
Tightening torque: 250 Nm + 25 Nm
8 Washer
9 Rocker arm, exhaust
10 Rocker arm, inlet
11 Rocker shaft
12 Hex screw

Rocker shaft support



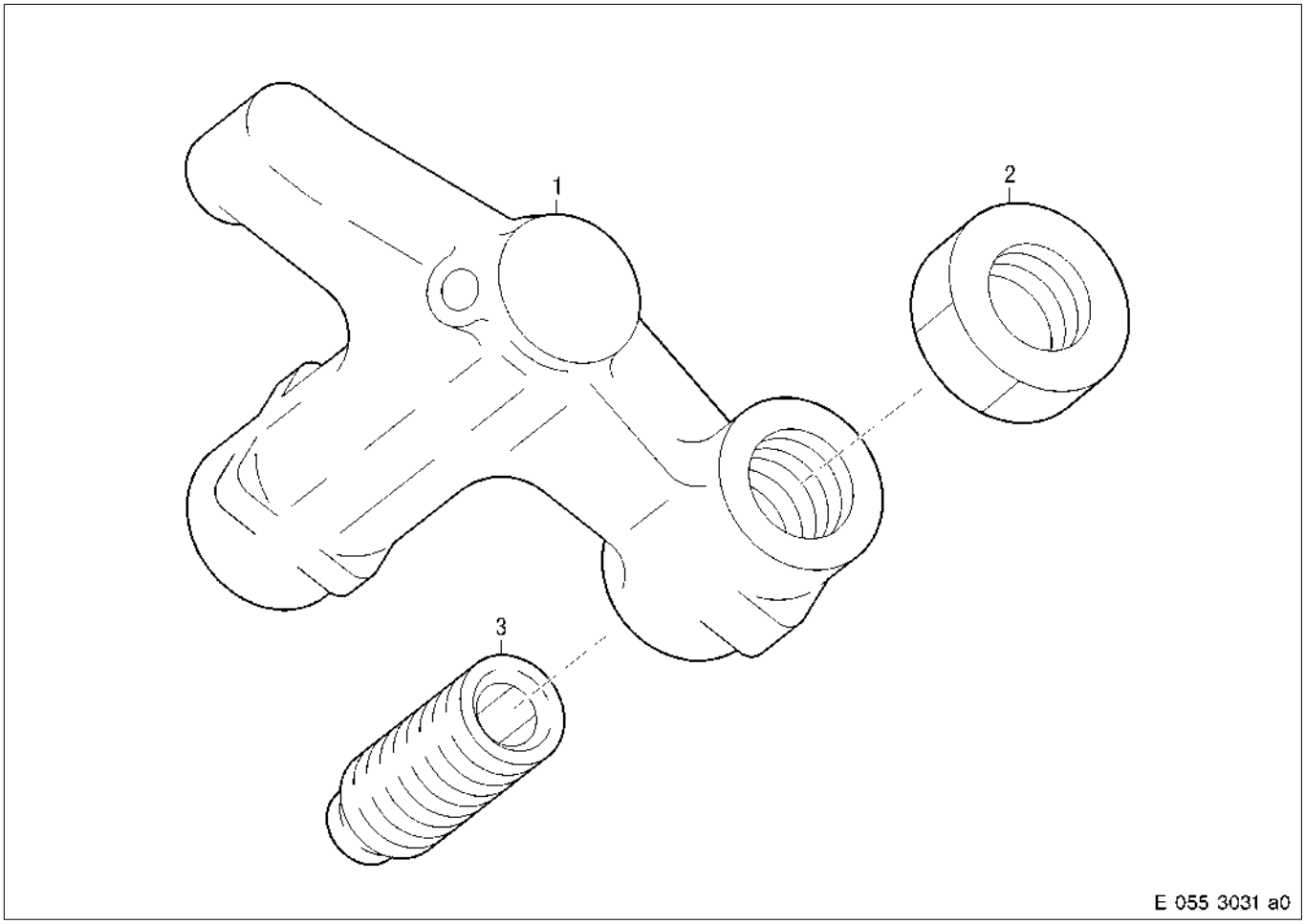
1 Snap ring
2 Adjusting shim
3 Bush
4 Adjusting screw
5 Rocker arm, inlet
6 Nut
Lubricant: Engine oil
Tightening torque: 90 Nm + 9 Nm
7 Grooved pin
8 Bearing pedestal
9 Spring pin
10 Spring pin
11 Sealing plug
12 Axle
13 Rocker arm, exhaust
14 Thrust pad

Rocker arm



1 Bush
2 Ball socket
3 Rocker arm, exhaust
4 Rocker arm, inlet
5 Roller
6 Bush
7 Pin

Valve bridge



1 Valve bridge

2 Nut, 19 A/F
Lubricant: Engine oil
Tightening torque: 35 Nm + 5 Nm

3 Adjusting screw M 12

C055.05.02 Special tools

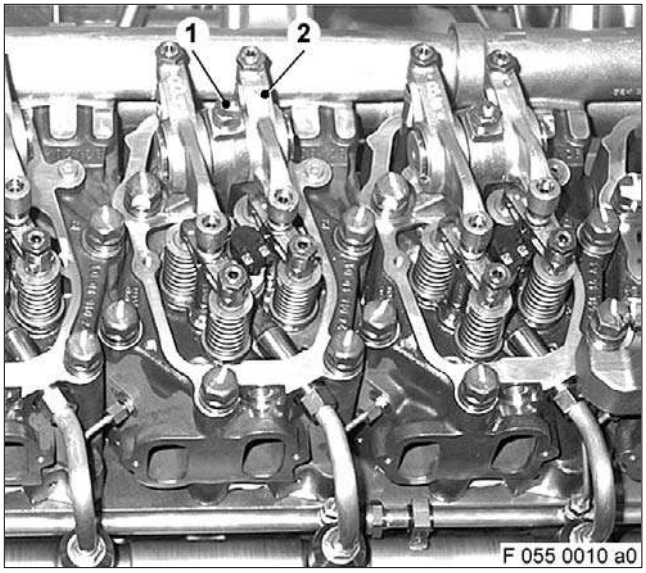
Designation	Use/dimension	Number
• Feeler gauge	0.5 – 1.0 mm	1
• Barring tool	Free end	1
– Pointer for barring tool	for barring tool	1
– Timing disc, free end	Set TDC-A1	1

C055.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 (high-temperature)	→ Operating Instructions
–	–	x	Drain charge air coolant (low-temperature)	→ Operating Instructions
–	x	x	Remove Y-pipe from exhaust outlet housing	→ C 141.10.05
–	x	x	Remove oil supply lines for turbochargers	→ C 185.10.05
–	x	x	Remove oil return lines for turbochargers	→ C 185.25.05
–	x	x	Remove air pipework from exhaust turbocharger to intercooler*	→ C 125.05.05
–	x	x	Remove coolant lines (high temperature)*	→ C 202.10.05
–	x	x	Remove exhaust turbocharger*	→ C 101.01.05
–	x	x	Remove charge air coolant vent lines (low temperature)	→ C 202.55.05
–	x	x	Remove engine coolant vent lines (high temperature)	→ C 202.65.05
–	x	x	Remove crankcase ventilation*	→ C 018.10.05
–	x	x	Remove charge air coolant line (low temperature)*	→ C 203.25.05
–	x	x	Remove main oil gallery*	→ C 011.05.05
–	x	x	Remove cylinder head cover(s)	→ C 055.10.05

* – in addition only when removing rocker arms

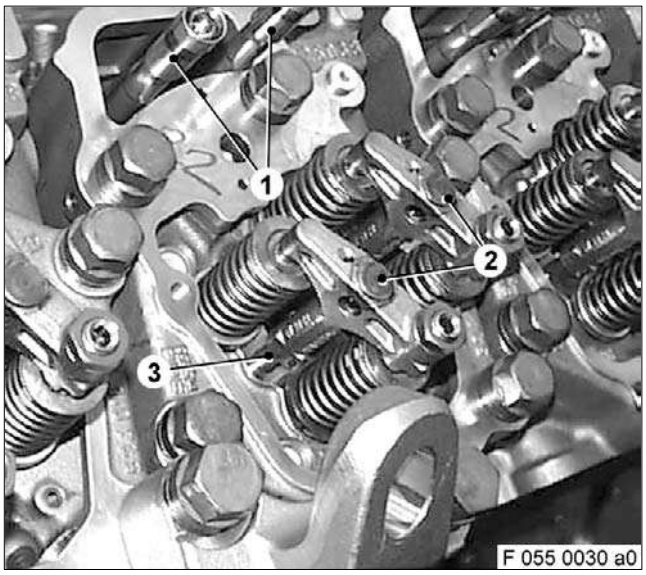
C055.05.05 Removal



Removing rocker arm assembly

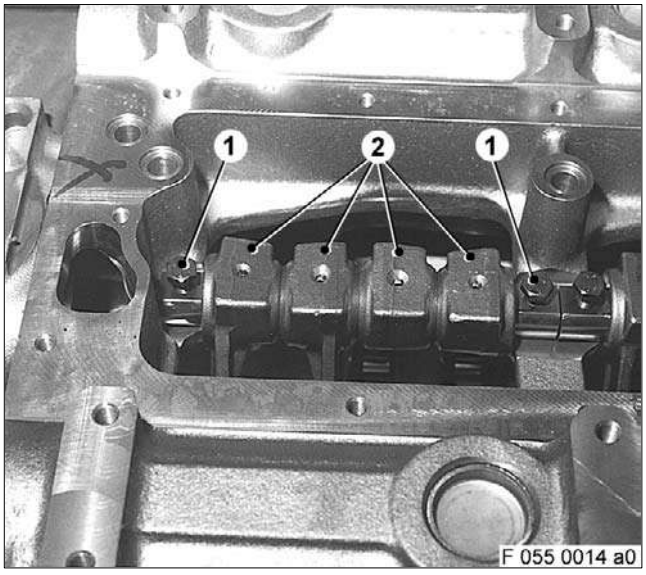
Remove hex screw (1) and remove rocker shaft support (2) from cylinder head, paying attention to grooved pin fit.

When raising rocker shaft support, ensure that a pushrod (suction effect, pushrod seat) is not lifted as well.



Mark valve bridges (2) and remove from sliding pins (3).

Mark pushrods (1) and remove.

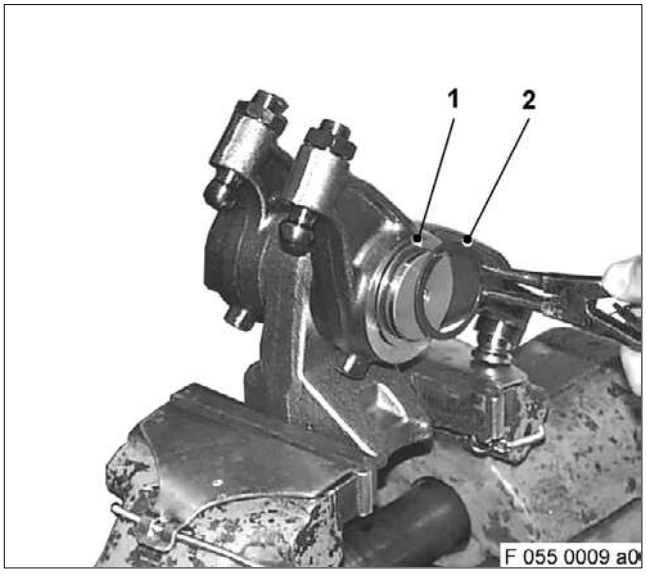


Removing rocker arm

Remove hex screws (1).

Remove rocker shaft with rocker arm (2) from crankcase.

C055.05.06 Disassembly



Disassembling rocker arm assembly

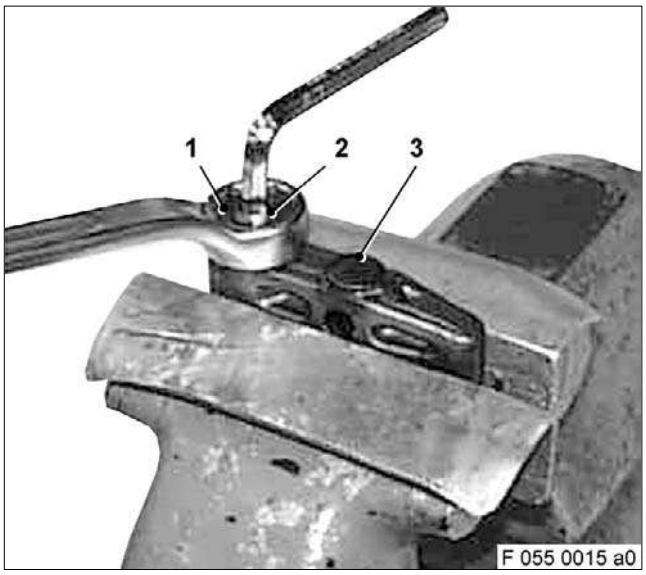
Clamp shaft support in vice with aluminium jaws.

Using snap ring pliers, remove snap ring (2) from shaft.

Remove washer (1).

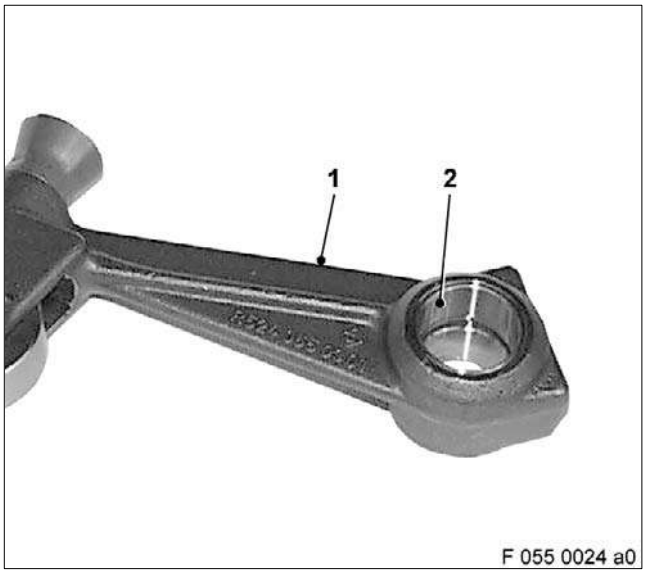
Remove rocker arm from axle.

Remove nut and adjusting screw.



Clamp valve bridge (3) in vice with aluminium jaws.

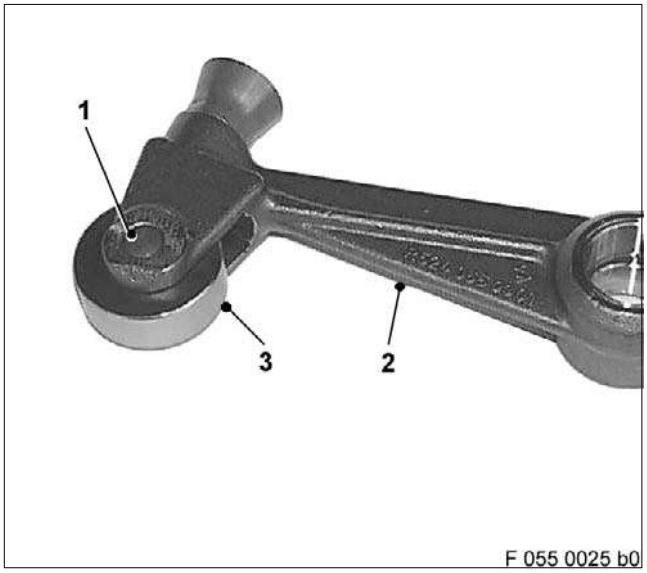
Release nut (1) and remove adjusting screw (2).



Removing rocker arm bush

Note: Remove rocker arm bush only if necessary (e.g. wear) – see C 055.05.08.

Use mandrel and hydraulic press to remove rocker arm bush (2) from rocker arm (1).



Removing pin and roller

Note: Remove pin and roller only if necessary – see C 055.05.08.

To remove pin, place rocker arm between two prisms so that both sides of pin bore have sufficient support.

Use mandrel to remove pin (1) from rocker arm (2).

Remove roller (3) from fit.

C055.05.08 Inspection and repair

Clean all components.

Using the magnetic crack-testing method with fluorescent magnetic powder, check rocker shaft support and axles, rocker arms, valve bridges, rocker shafts, pushrod, hex screws and adjusting screws for cracks.

Replace cracked parts.

Check condition of mating faces on rocker shaft support; burnish with oilstone if necessary.

The ball element within the swivel angle, at least 10°, must not jam and must move freely.

Check screws, nuts and adjusting screws for wear and damage; replace component if necessary.

Replace gaskets and sealing washers during W6 overhaul.


F 055 0018 a0

Measuring diameter of bush bore in rocker arm

Adjust bore gauge to basic size of bush bore and measure diameter of bore.

For specified dimensions, see Tolerance and Wear Limits List.

If permissible values are exceeded, replace bearing bush.


F 055 0019 a0

Measuring diameter of bearing pedestal axles

Using micrometer, measure outside diameters of bearings.

For permissible values, see Tolerance and Wear Limits List.

If measurements are below limit values, replace rocker shaft support.

Measuring diameter of bush bore in rocker arm

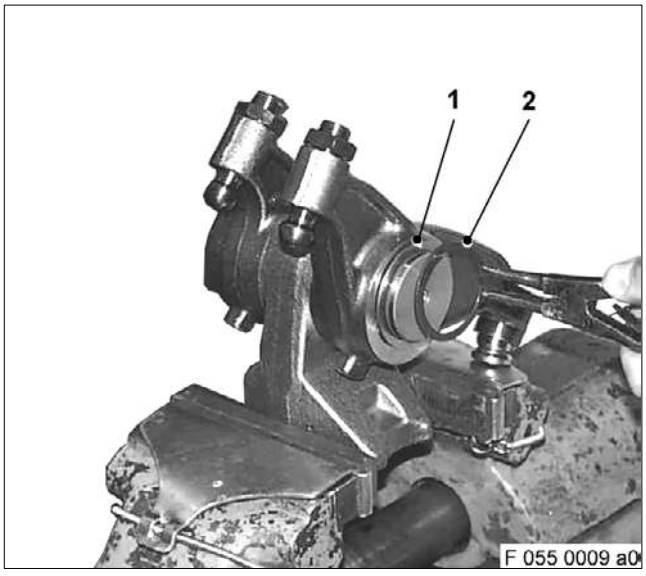
Adjust bore gauge to basic size of bush bore and measure diameter of bore.

For permissible values, see Tolerance and Wear Limits List.

If permissible values are exceeded, replace rocker arms.

C055.05.10 Assembly

Note: Make sure parts are perfectly clean.



Assembling rocker arm assembly

Clamp rocker shaft support in vice with aluminium jaws.

Fit adjusting screw and nut in rocker arm, but do not tighten!

Coat axles on rocker shaft support and bushes of rocker arm with engine oil.

Fit rocker arm on axle.

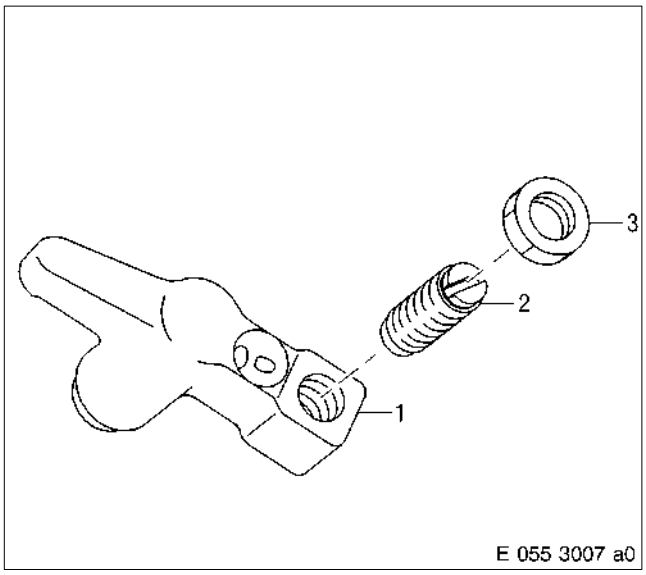
⚠ CAUTION

Snap ring pretension
Risk of injury!
Use suitable circlip pliers. Always wear protective goggles/safety mask.

Fit washer (1) and secure with snap ring (2).

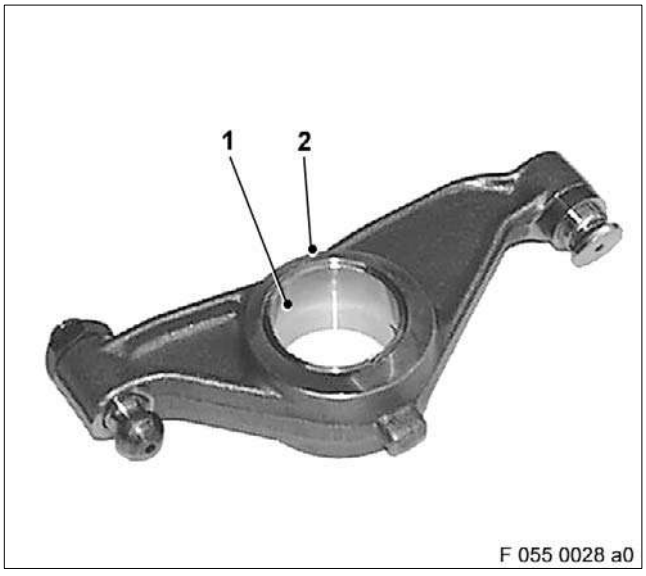
Make sure that snap ring is correctly seated.

Check minimum axial clearance of rocker arm.



Insert adjusting screw (2) into valve bridge (1).

Attach nut (3) to adjusting screw; do not tighten!



Assembling rocker arm

Chill bush (1) in liquid nitrogen.

⚠ 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.

Heat rocker arm to max. 150° C.

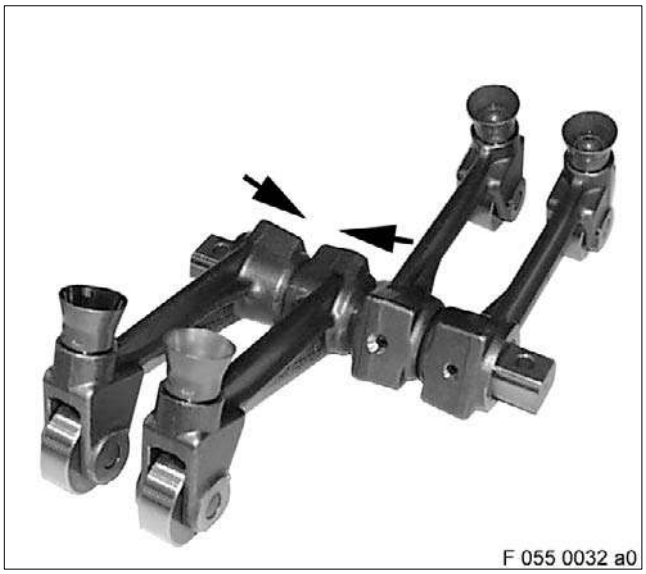
⚠ CAUTION

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

Insert bush (2) so that it is flush.

Projection is not permissible on both sides.

C055.05.11 Installation

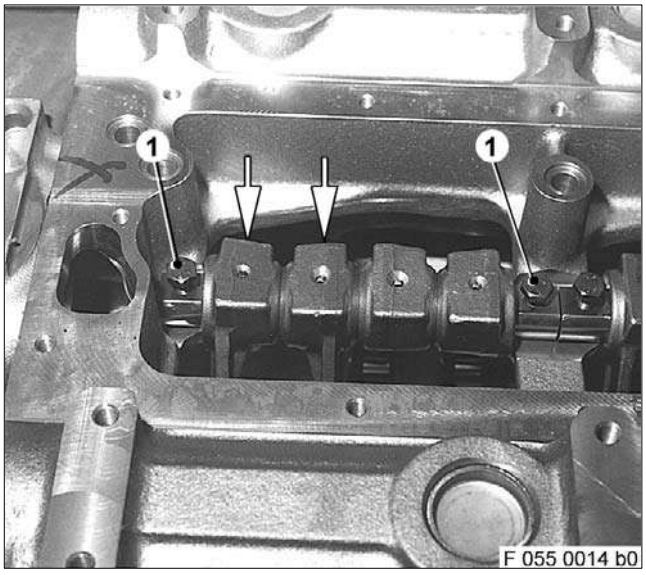


Installing rocker arm

Note: Make sure parts are perfectly clean.

Coat axle and bushes of rocker arm with engine oil.

Fit exhaust and inlet rocker arms on rocker shaft, ensuring they are correctly positioned (arrows).

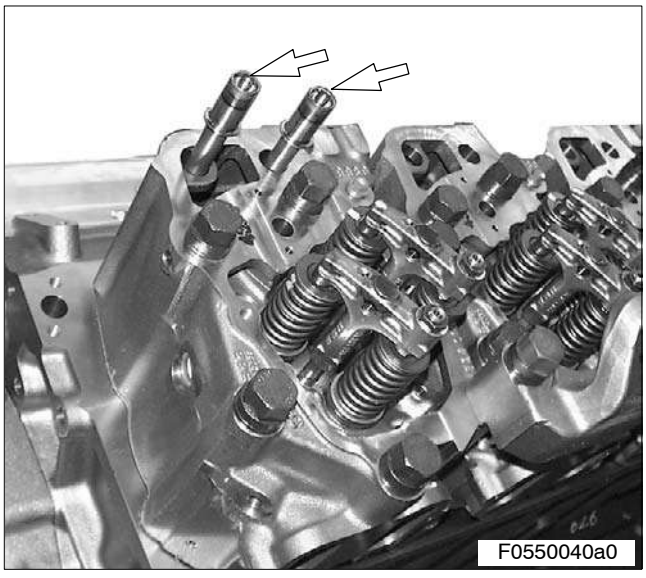


Coat rollers and camshaft bushings with engine oil.

Match rocker arms to left and right cylinder banks and carefully insert into camshaft chamber.

Note: Correct installation position (arrow) can be seen in this illustration.

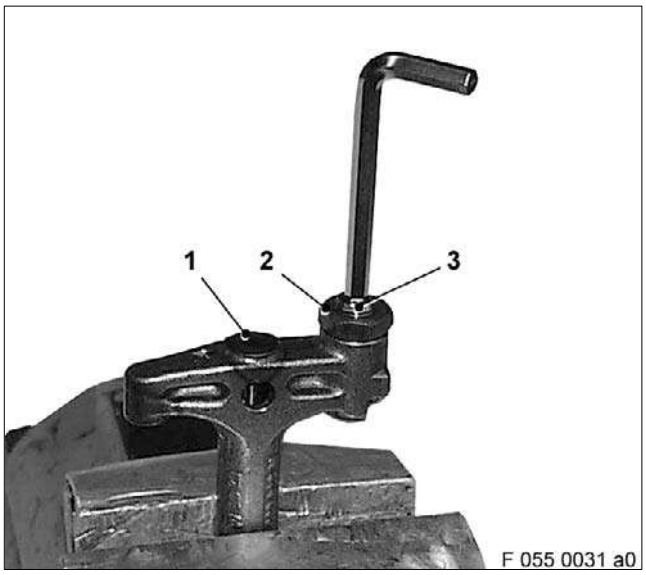
Insert hex screws (1) and tighten.



Install pushrods

Coat pushrod seats and ball sockets (arrows) of pushrods with engine oil.

Insert pushrods through cylinder head into pushrod seats of rocker arms.

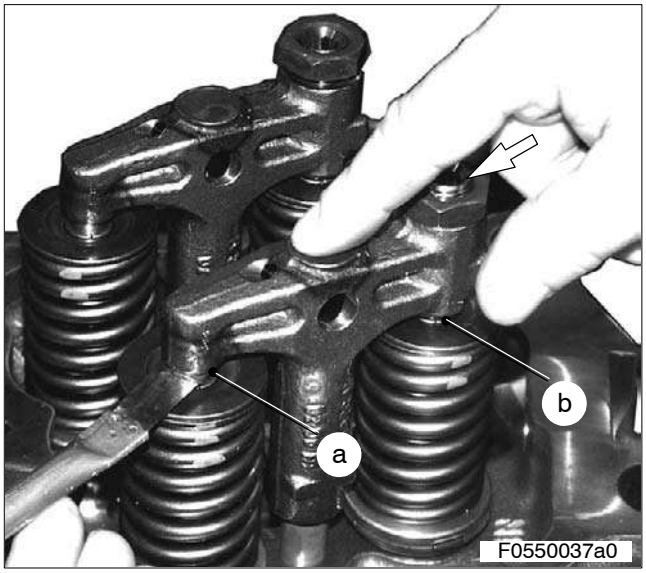


Adjusting and installing valve bridges

Measure projection of sliding pins with respect to cylinder head – see C 041.05.08.

Coat register bore of valve bridge with engine oil.

Secure valve bridge (1) in vice with aluminium jaws, release locknut (2) and back off adjusting screw (3) by approx. 3 revolutions.



Fit valve bridge(s) in accordance with marking (installation location) on sliding pin in cylinder head.

Adjusting screw (arrow) faces charge air manifold.

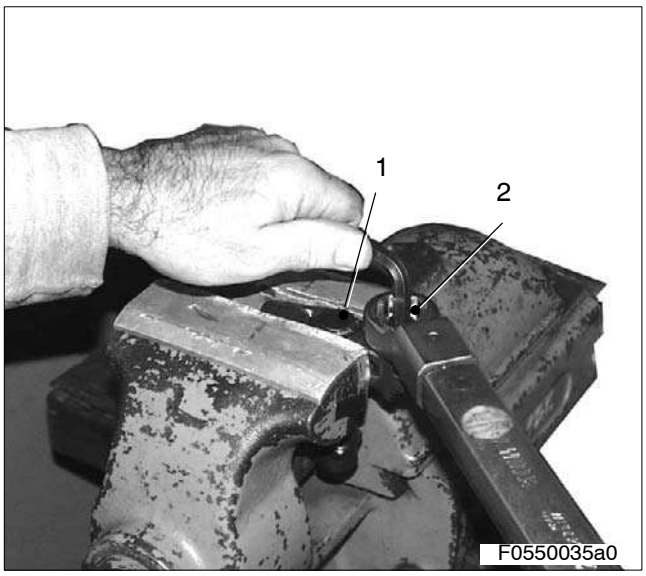
Press valve bridge downwards and hold.

The valve bridge must be in contact with the valve shaft (A), if necessary back off adjusting screw.

Use Allen key to insert adjusting screw with valve bridge pressed until adjusting screw just contacts valve stem (B); valve bridge must not move upwards.

Hold adjusting screw firmly with Allen key and tighten locknut by hand.

Remove valve bridge from cylinder head.



Clamp valve bridge (1) in vice with aluminium jaws.

Tighten locknut to specified tightening torque – see C 055.05.01.

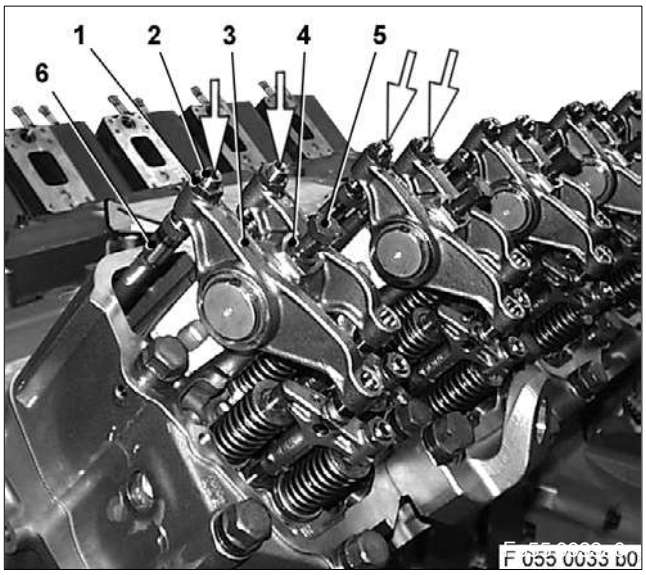
Fit valve bridge in accordance with marking (installation location) on corresponding sliding pin in cylinder head.

Check valve bridge adjustment as follows:

1. Insert feeler gauge (0.05 mm) between valve bridge and valve stem (see illustration above); when the valve bridge is pressed, the feeler gauge must jam or be drawn through with resistance.

2. Insert feeler gauge (0.05 mm) between valve bridge and opposing valve stem and check resistance.

The valve bridge is correctly adjusted if the feeler gauge jams when the valve bridge is pressed or can be drawn through with resistance.



Installing rocker arm assembly

Bar crankshaft to bring appropriate piston of cylinder to firing TDC.

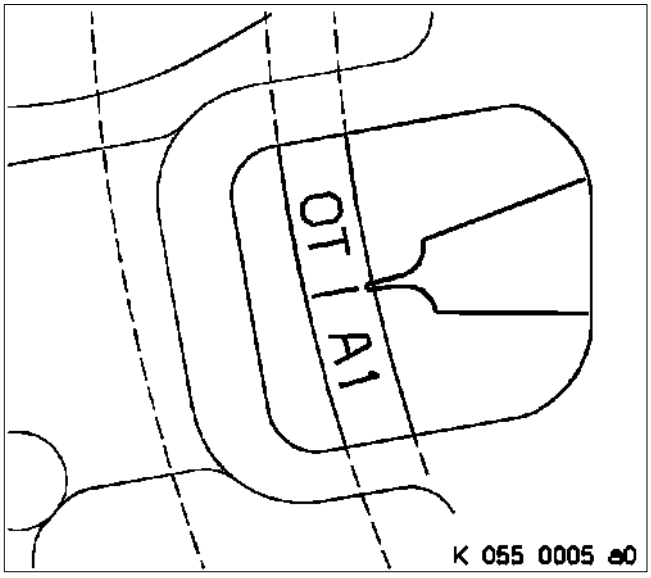
Release nuts (1) of adjusting screws (2) on rocker arm (3) and back off adjusting screw.

Fit rocker shaft support on cylinder head and check fit of grooved pins.

Check position of ball joints in pushrods (6).

Install hex screw (5) with washer (4) in cylinder head and tighten to specified tightening torque – see overview drawing C 055.55.01.

Note: Fill adjusting screws (arrow) with engine oil.



Adjusting valve clearance with two crankshaft positions

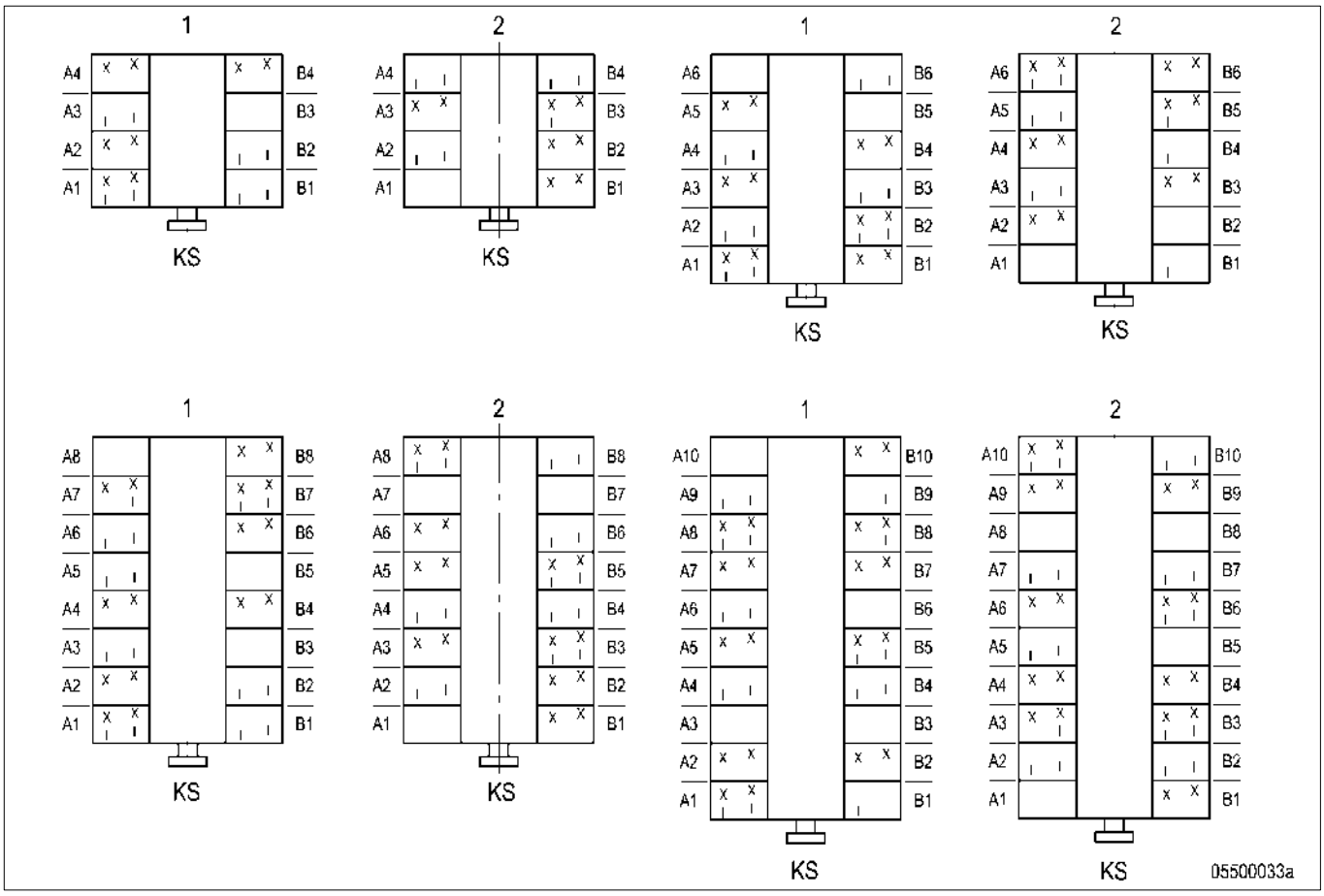
Note: Valve bridges are adjusted!

Turn crankshaft with barring tool in normal direction of engine rotation until OT-A1 mark on starter ring gear and dead-centre indicator 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 initial TDC crankshaft position in accordance with the adjacent valve clearance setting diagrams.



Procedure for setting – see next illustration.

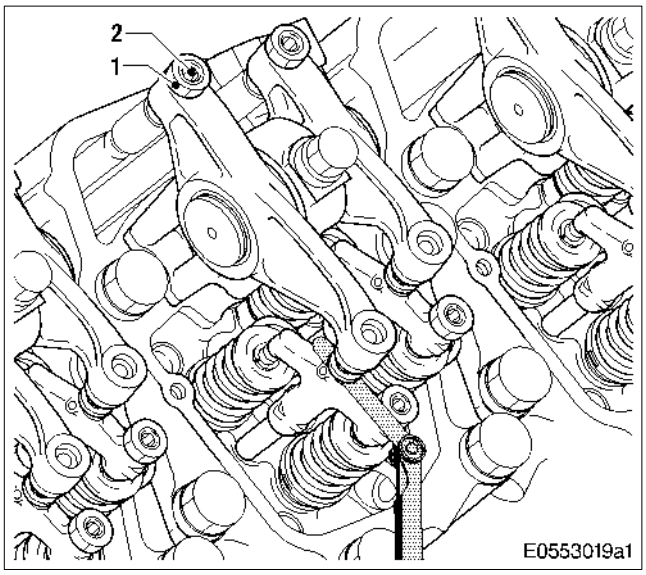
Rotate crankshaft a further 360° (to second TDC crankshaft position) and set remaining valve clearances in accordance with valve clearance setting diagram.

1 = Firing TDC at cylinder A1

2 = Overlap TDC at cylinder A1

X = Exhaust valve.

O = Inlet valve.



Note: Inlet valves: Long rocker arm exhaust valves: Short rocker arm

Release locknut (1) and back off adjusting screw (2) slightly with Allen key.

For specified valve clearance – see A 004.

Insert feeler gauge between valve bridge and rocker arm.

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 an Allen key.

Recheck valve clearance after locking nut.

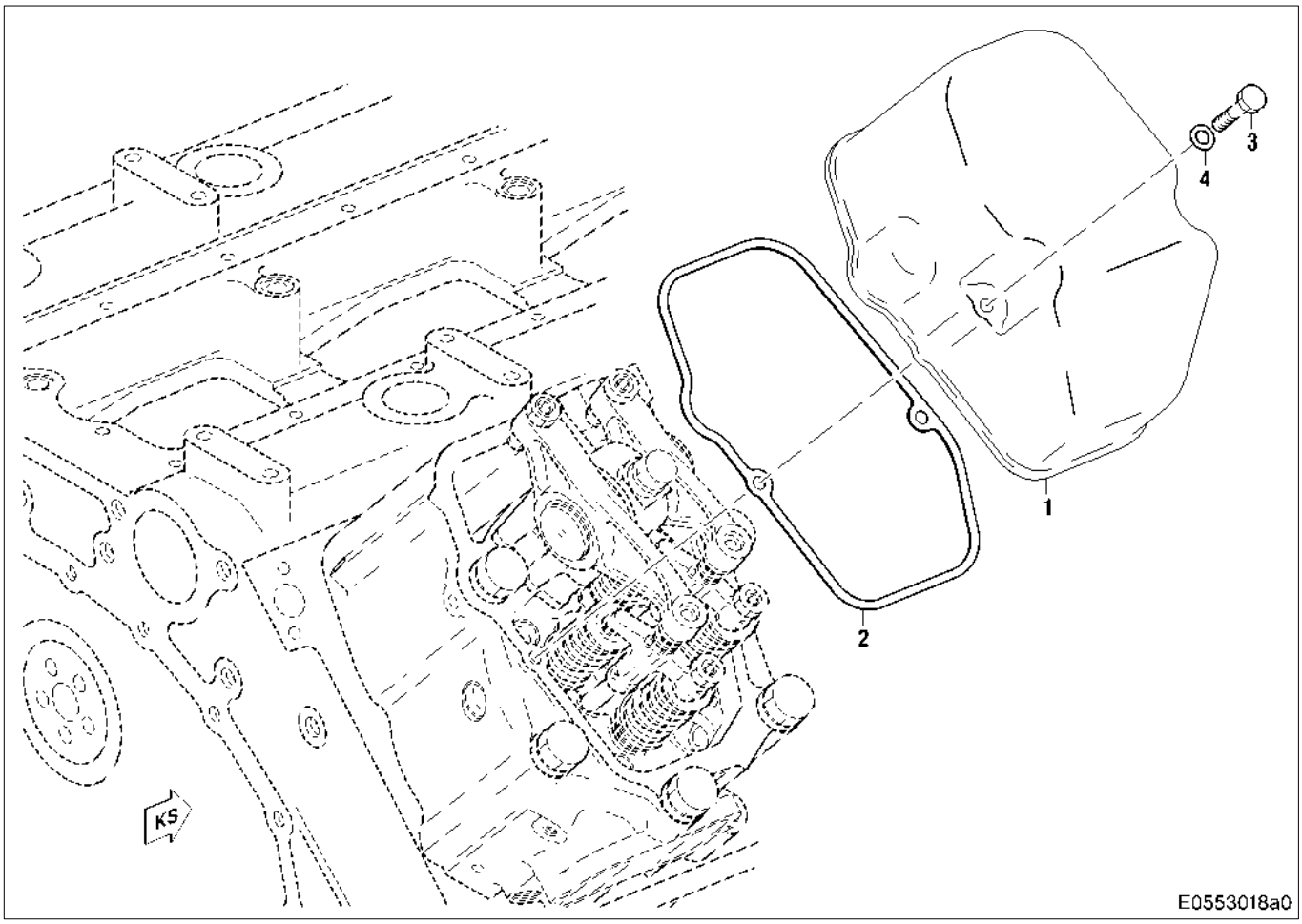
Remove engine barring tool.

C055.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Assembly in reverse sequence to disassembly	→ C 055.05.04
–	–	x	Release engine start	→ Operating Instructions

C055.10 Cylinder head cover

C055.10.01 Overview drawing

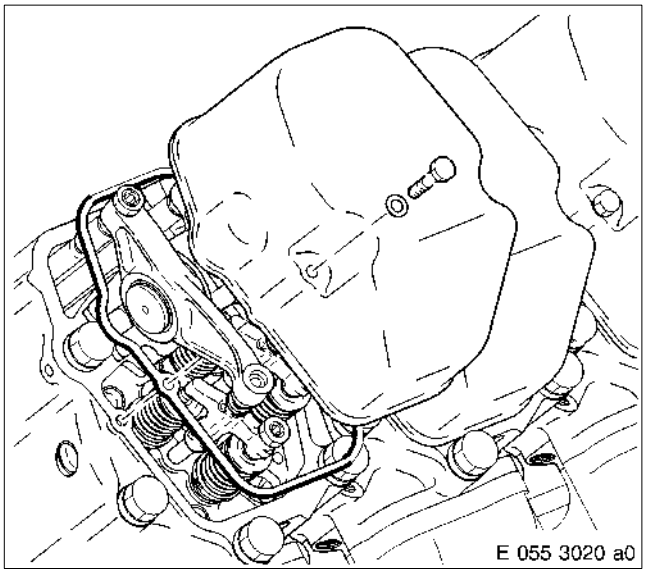


1 Cylinder head cover
2 Gasket
3 Hex screw
Lubricant: Engine oil
Tightening torque: 42 Nm
4 Washer

C055.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C055.10.05 Removal



Removing cylinder head cover

Remove hex screws.

Remove cylinder head cover and gasket.

C055.10.08 Inspection and repair

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).

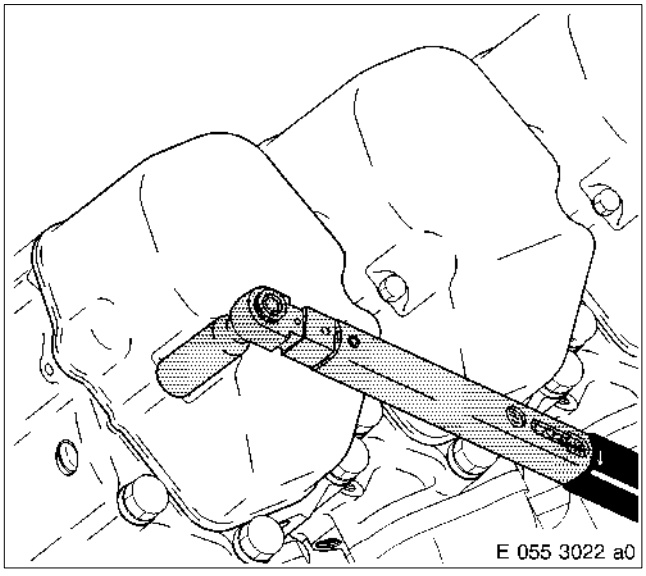
Clean cylinder head cover with cleaner, blow out with compressed air and make sure it is perfectly clean.

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 cylinder head cover as necessary.

Clean hex screws and check condition, check thread for ease of movement; replace hex screw if necessary.

Replace gasket during W6 maintenance.

C055.10.11 Installation



Installing cylinder head cover

Note: Make sure parts are perfectly clean.

Check mounting surface, clean if necessary.

Insert gasket into cylinder head cover.

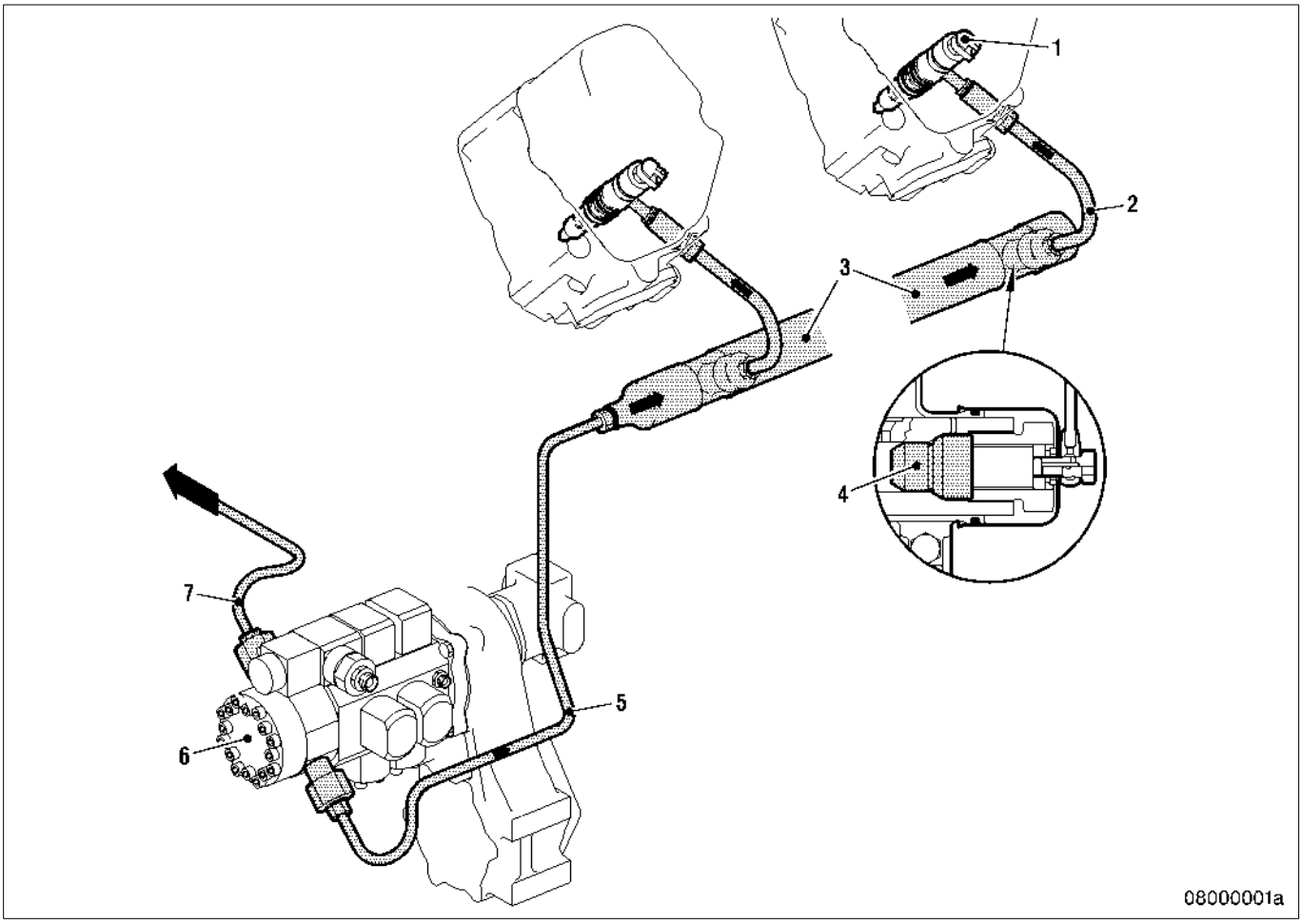
Place cylinder head cover on cylinder head as per overview drawing – Arrangement of cylinder head covers.

Tighten hex screws and washers to specified tightening torque – see overview drawing C 055.10.01.

C055.10.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

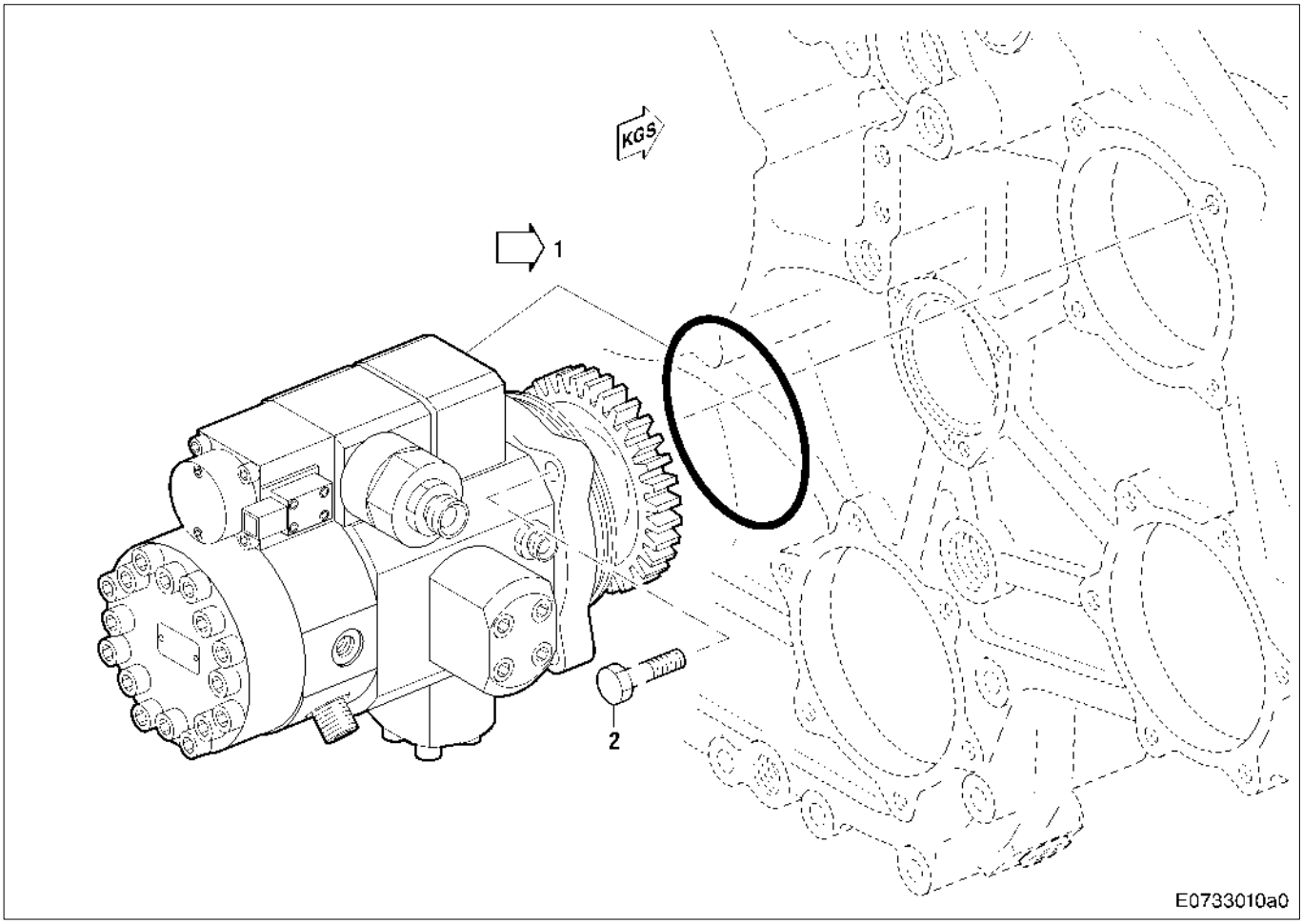
C070 H.P. fuel system



1 Injector
2 H.P. line
3 H.P. accumulator
4 Pressure relief valve
5 H.P. line, left engine side
6 High-pressure pump
7 H.P. line, right engine side

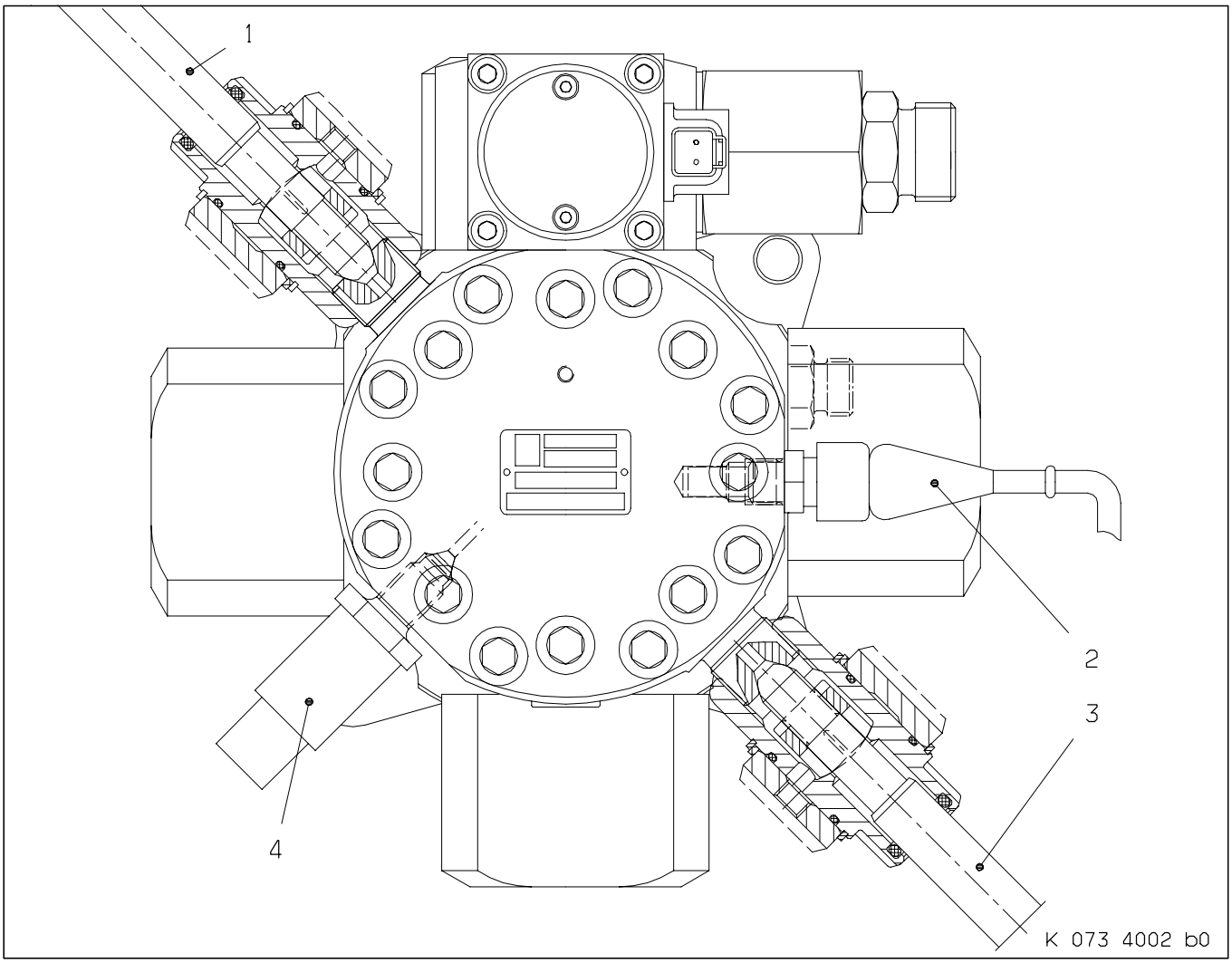
C073.05 High-pressure pump

C073.05.01 Overview drawing



1 High-pressure pump
2 Hex screw

High-pressure pump



1 H.P. line to right engine side
2 Temperature sensor
3 H.P. line to left engine side
4 High-pressure sensor

C073.05.02 Special tools

Designation	Use/dimension	Number
• Support bracket	for high-pressure pump	1
• Hydraulic filling unit	for H.P. and L.P. fuel system	1

C073.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove low-pressure fuel pump	→ C 081.10
–	x	x	Remove fuel lines (low-pressure)	→ C 086.05
–	x	x	Remove fuel lines (high-pressure)	→ C 077.05
–	x	x	Remove high-pressure sensor	→ C 500
–	x	x	Remove temperature transmitter	→ C 500

C073.05.05 Removal

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.

Removing H.P. pump

WARNING

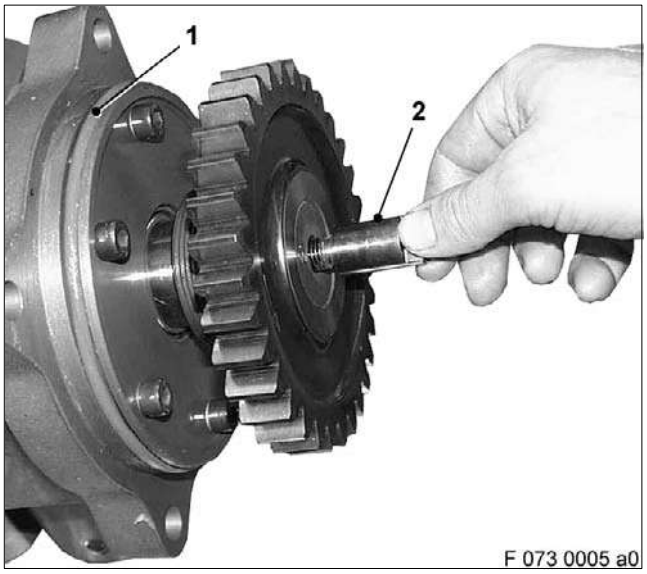
Heavy object. Risk of injury!
Use suitable tools and lifting equipment.

Attach H.P. pump with support bracket to crane.

Remove hex screws for high-pressure pump.

Release high-pressure raw water pump from equipment carrier and remove.

Cover opening in gear case.



Remove O-ring (1).

Note: Remove intermediate element only if necessary (e.g. if damaged). Intermediate element has been installed with thread-locking agent and must be heated to approx. 130°C before removal.

Remove intermediate element (2)

Note: Replacement high-pressure pumps are delivered without intermediate element.

C073.05.06 Disassembly

No provision is made for disassembling the high-pressure pump.

The H.P. pump is a replacement part and available in the replacement programme.

C073.05.08 Inspection and repair

Check high-pressure pump in a specialist workshop or at Manufacturer's; have repaired if necessary.

Clean hex screws and check condition.

Make sure threads are in perfect condition; replace hex screw as necessary.

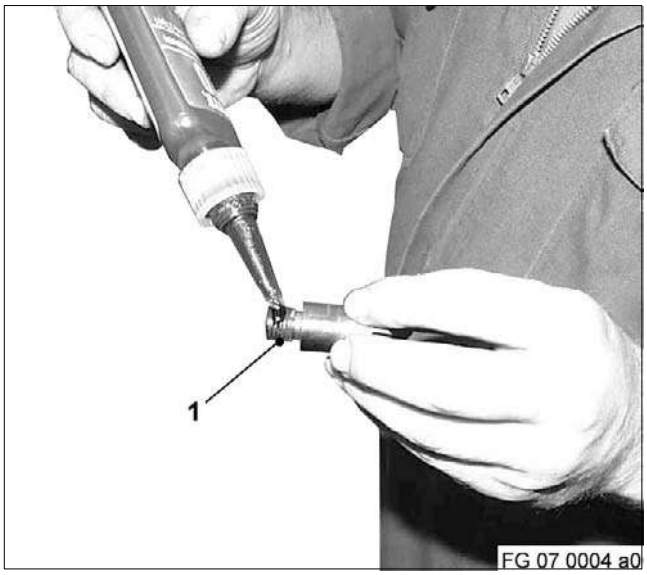
Check connection thread on high-pressure pump for perfect condition and ease of movement.

Check drive gear.

Check condition of wiring; replace if necessary.

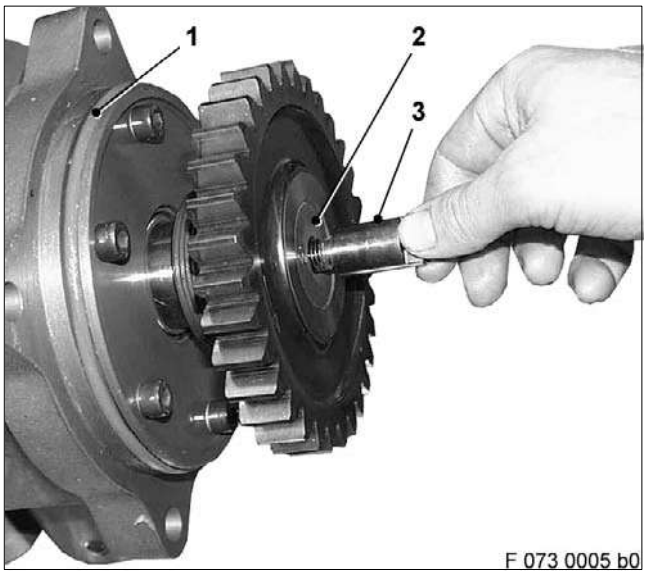
Replace O-ring after each removal.

C073.05.11 Installation



Installing H.P. pump

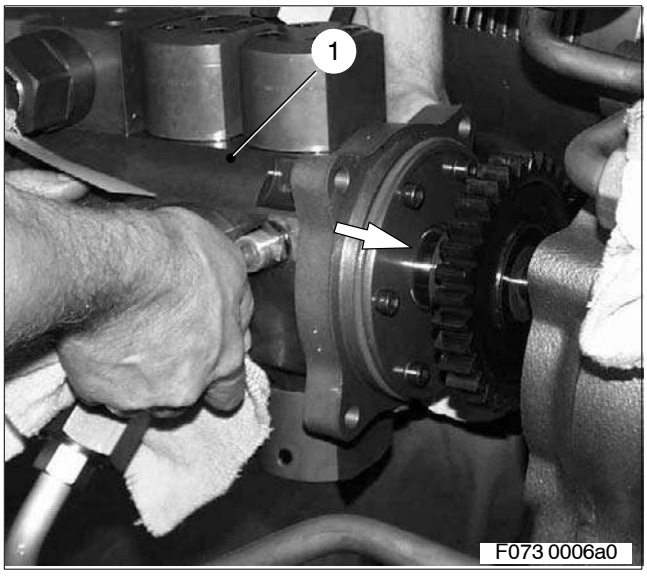
Coat thread of driver (1) with Loctite 270 thread-locking agent.



Screw driver (3) into pump shaft (2).

Note: Final strength of thread-locking agent at 20 °C after 12 hours.

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



Clean and check sealing surface in support bore of equipment carrier.

Note: Before installing the high-pressure pump, the low-pressure pump with plug-in coupling must first be removed, as perfect insertion of the driver (high-pressure pump) in the plug-in coupling is not guaranteed.

⚠ WARNING

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

Attach H.P. pump (1) with support bracket to crane and carefully move into assembly bore.

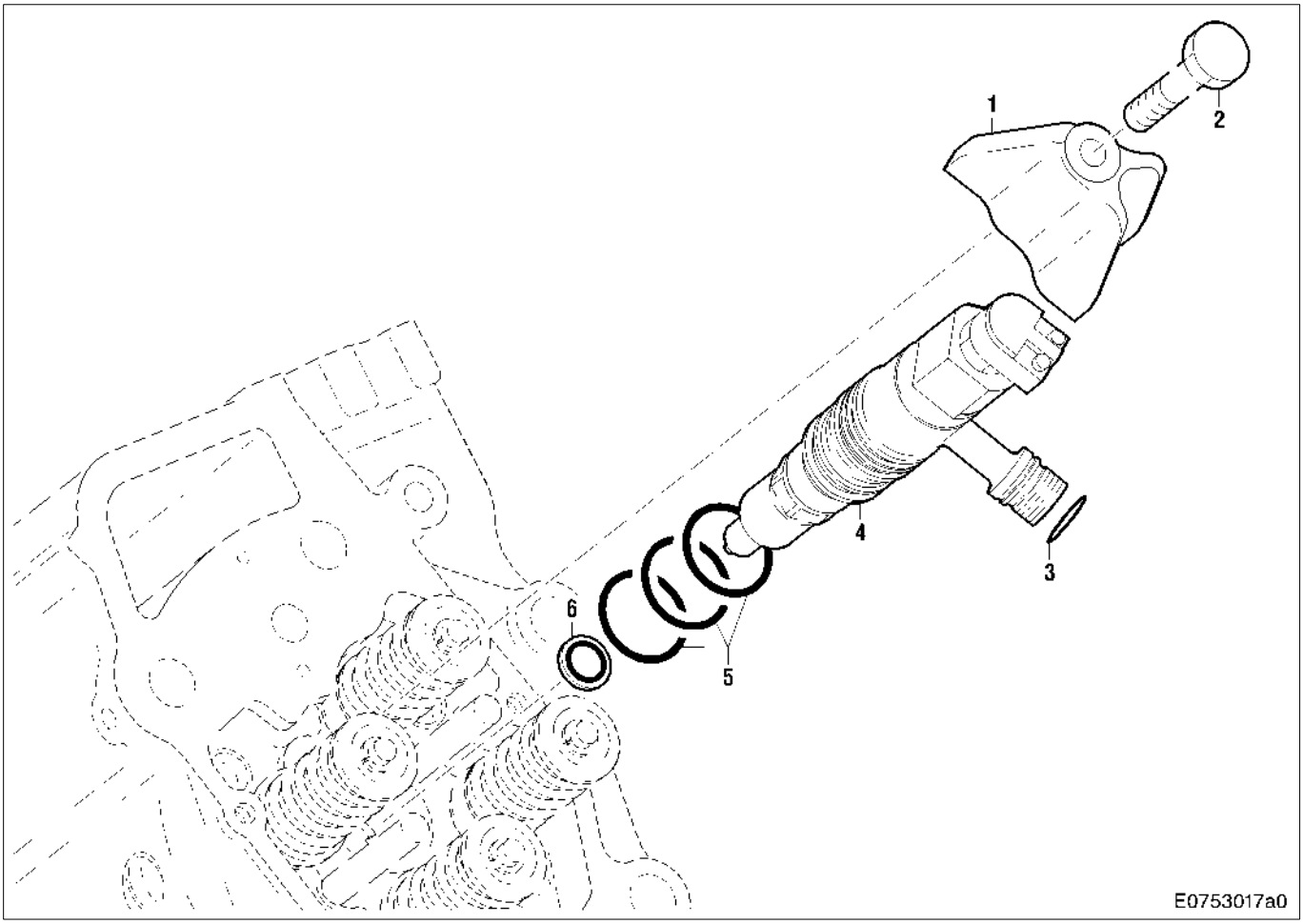
Install hex screws for high-pressure pump and tighten uniformly.

C073.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 073.05.04
–	x	x	Fill fuel system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C075.05 Injector

C075.05.01 Overview drawing



1 Hold-down clamp

2 Hex screw
Lubricant: Engine oil
Pretightening torque: 5 Nm + 5 Nm
Tightening torque: 100 Nm + 10 Nm

3 O-ring

4 Injector

5 O-ring

6 Sealing ring

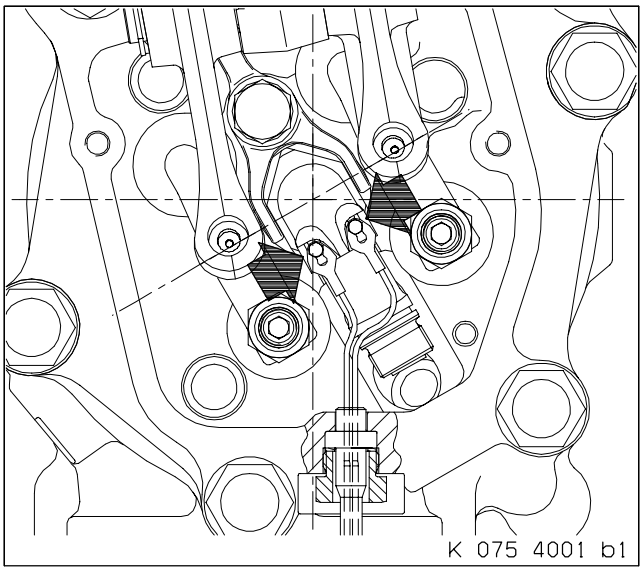
C075.05.02 Special tools

Designation	Use/dimension	Number
• Tools from the W4 tool kit		1
• Torque wrench	M3 screws for cable connection	1

C075.05.04 Before-removal operations

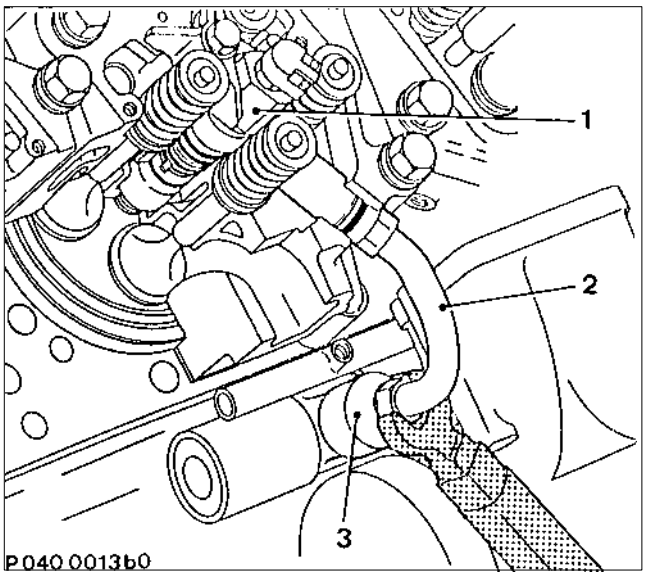
For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove cylinder head cover	→ C 055.10

C075.05.05 Removal

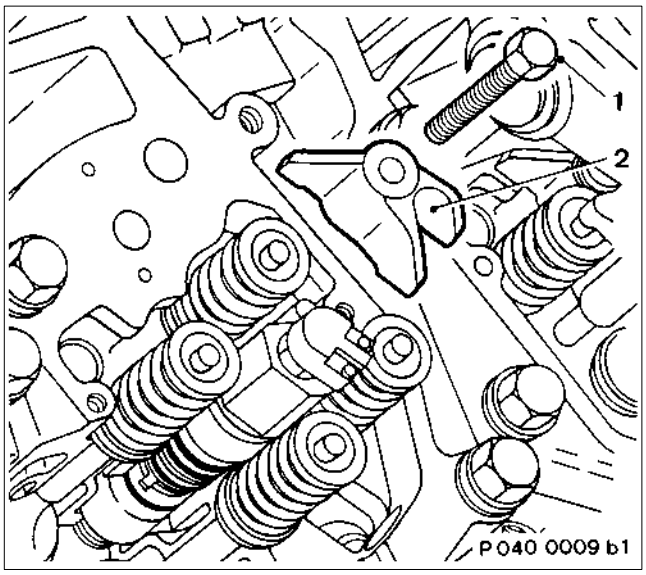


Removing fuel injector

Release cable terminal union on injector and remove cable terminals.



Unscrew H.P. line (2) from injector (1) and limiting valve (3) – see also C 077.05.

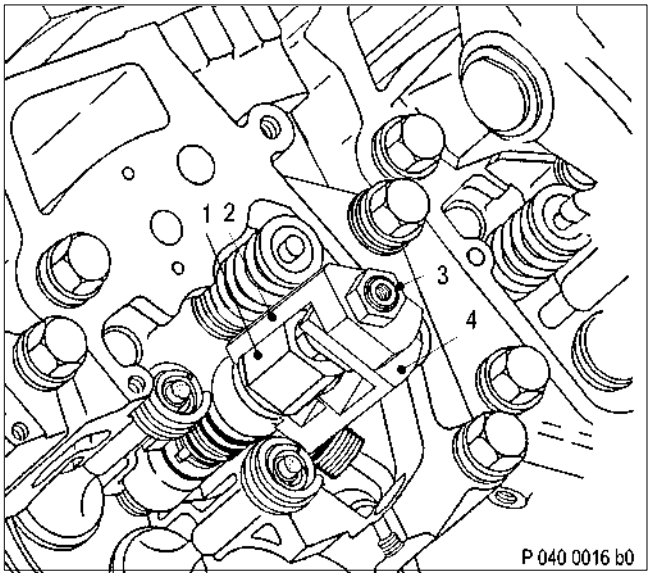


⚠ WARNING

Fuels and fuel mists 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.

Note: Ensure that no fuel enters the cylinder chamber.

Remove screw (1) on hold-down clamp (2) and remove hold-down clamp.

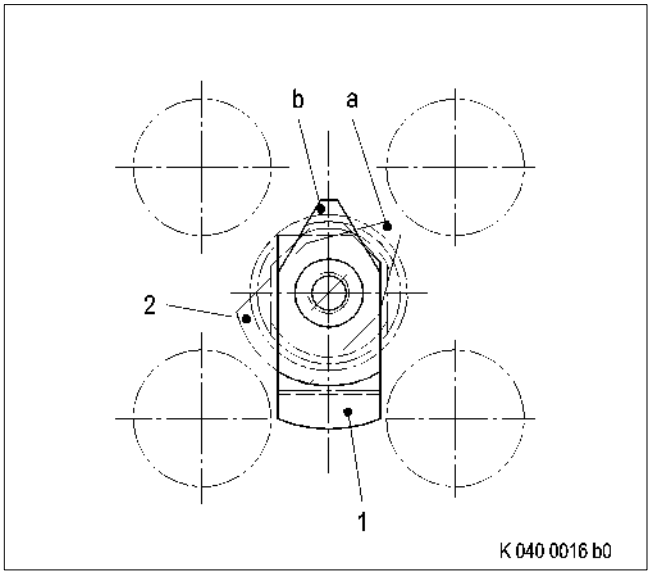


Note: The removal tool for the injector consists of two components.

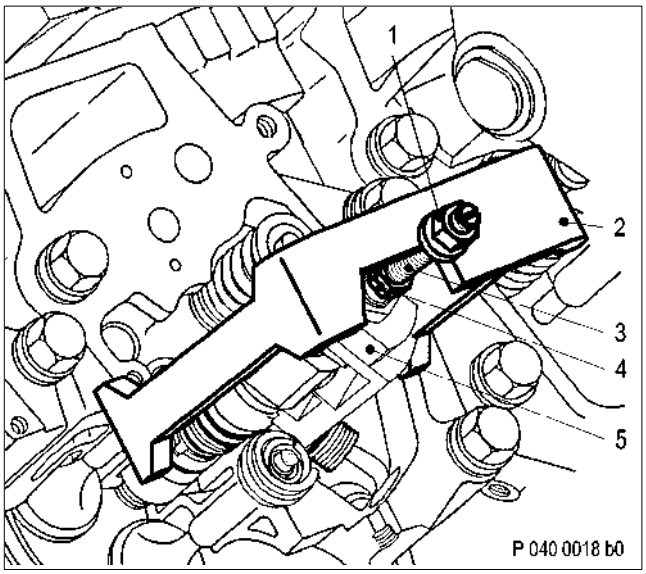
Place removal sleeve (4) on injector (1).

Fit locking sleeve (2) over removal sleeve and rotate to correct position – see next illustration.

Secure locking sleeve with hex nut (3).



Rotate locking sleeve (2) from position “a” to position “b” over the removal sleeve (1).



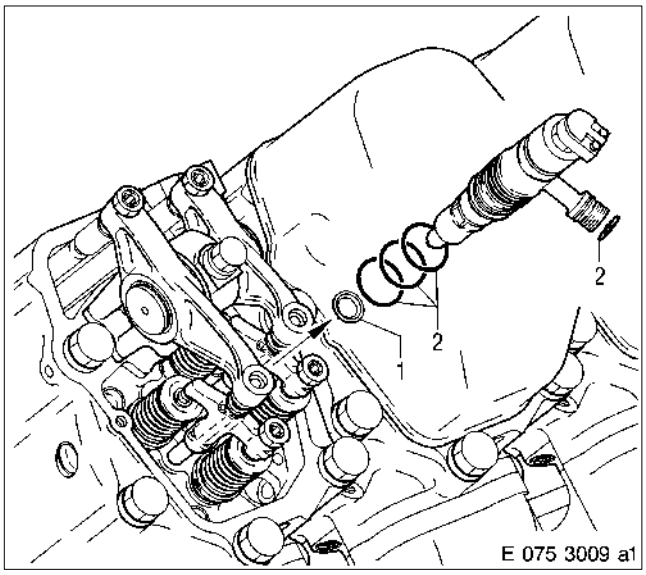
Mount removal bracket (2) on cylinder head.

Insert threaded rod (3) in extractor sleeve (5) and lock with hex nut (4).

Remove injector by turning nut (1) to the right.

Remove special tool.

Remove injector manually.



Remove O-ring (2) from injector.

Remove sealing ring (CE-ring) (1) from injector or use wire hook to remove from cylinder head.

Note: After removing injector, make sure no CE support ring remains in bore for injector in cylinder head.

Cover all connections and installation bores or seal with suitable plugs.

C075.05.06 Disassembly

Injector must not be disassembled.

The injector is a replacement part and available in the replacement programme.

C075.05.07 Inspection and repair

Clean all components.

Check injector visually on outside for damage and defects.

In event of wear or other defects, the injector must be replaced.

Using the magnetic crack-testing method with fluorescent magnetic powder, check hex screw and clamping element for cracks; replace components as necessary.

Check mating faces of hold-down clamp; rub down with emery cloth or an oilstone or replace components as necessary.

Check mating face of injector (in cylinder head), replace component if necessary.

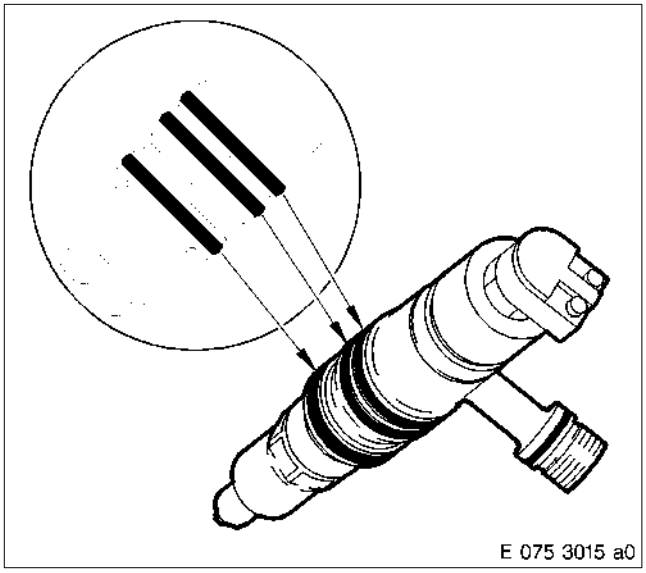
Check cable connections for damage.

Check sealing cone of injector for damage and wear; replace component if necessary.

Check thread on hex screw and injector for ease of movement. Replace part if necessary.

Replace CE rings and O-rings at every assembly.

C075.05.11 Installation



Installing fuel injector

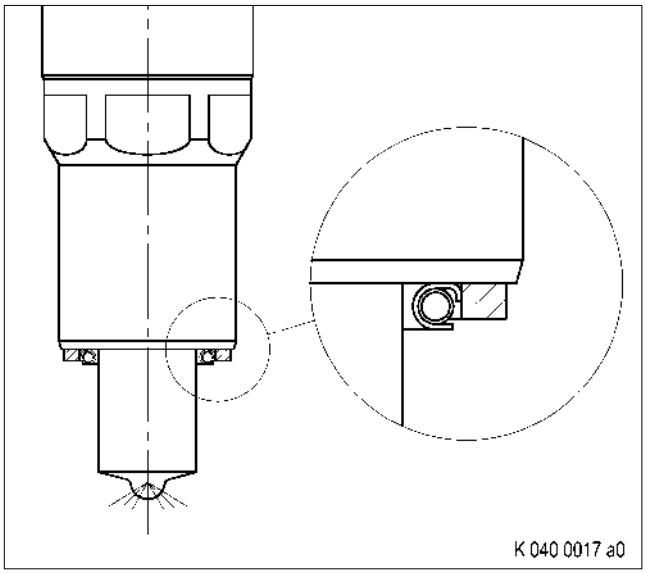
Note: Make sure fuel-carrying components are perfectly clean. Prior to installation, remove all blanking plug and/or covers.

Coat O-rings with petroleum jelly and fit on injector.

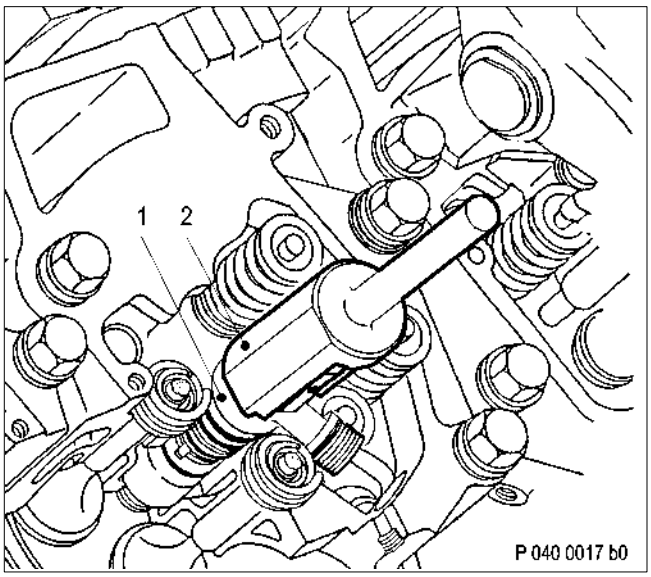
Affix sealing ring with grease on mating face of injector.

Attention: Ensure that sealing ring is correctly fitted, see next illustration.

Check sealing surface on cylinder head and nozzle holder; clean if necessary.

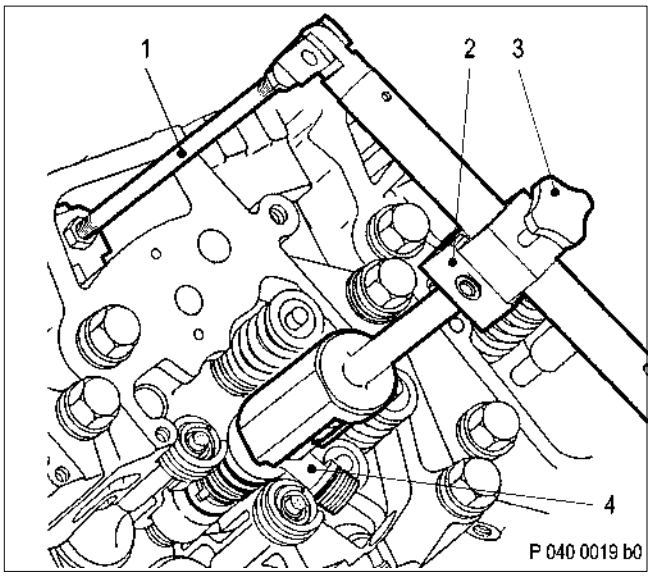


Fit sealing ring on injector so that level contact surface faces injector.



Insert injector (1) into cylinder head, ensuring that H.P. line connection is correctly aligned.

Fit installation sleeve (2).

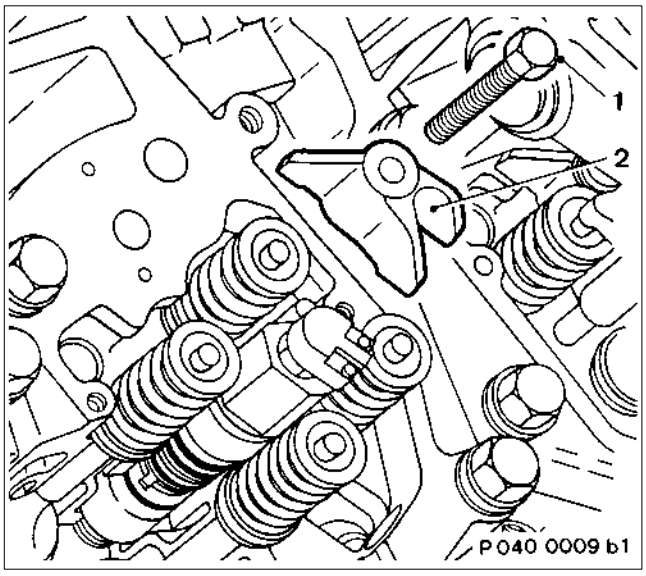


Lock retaining device (1) of press-fitting tool between pushrods.

Release palm grip (3) and move pressure section (2) to correct position for installation sleeve.

Lock palm grip and press injector (4) with press-fitting tool into cylinder head.

Remove installation tool.



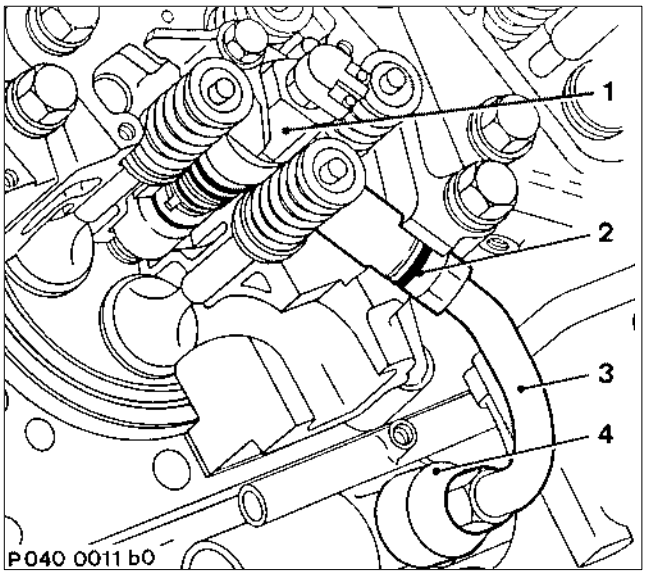
Mount hold-down clamp (2), ensuring it is correctly positioned, and pretighten hex screw (1) (see overview drawing C 075.05.01); injector must still be rotatable.

To ensure smooth assembly on injector, the following procedure should be used for **Reman cylinder heads** in conjunction with **new CE rings**:

1 Tighten hex screws (1) to 100 Nm +10 Nm and then release.

2 Pretighten hex screw, see overview drawing C 075.05.01; injector must still be rotatable.

Note: Hex screw of hold-down clamp is not fully tightened until H.P. line is fitted.



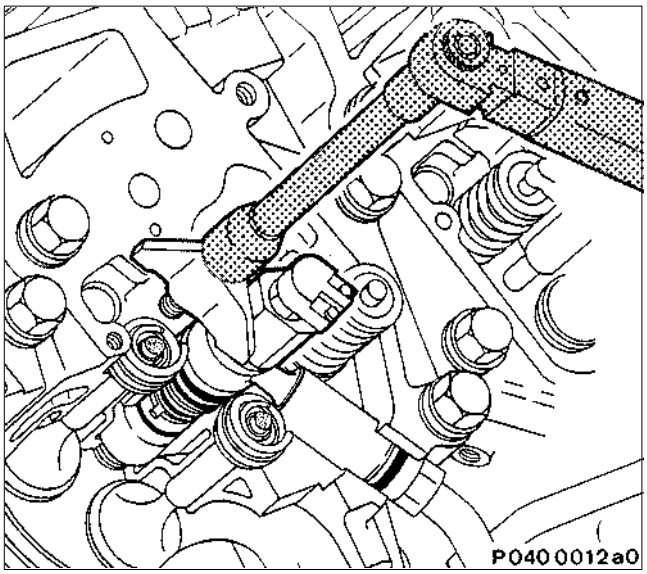
Note: Do not bend the H.P. line and pay attention to installation position.

Retighten thrust rings at both ends of line with face spanner – see C 077.05.10.

Coat O-rings with petroleum jelly and insert in grooves on union nuts (2) and (4).

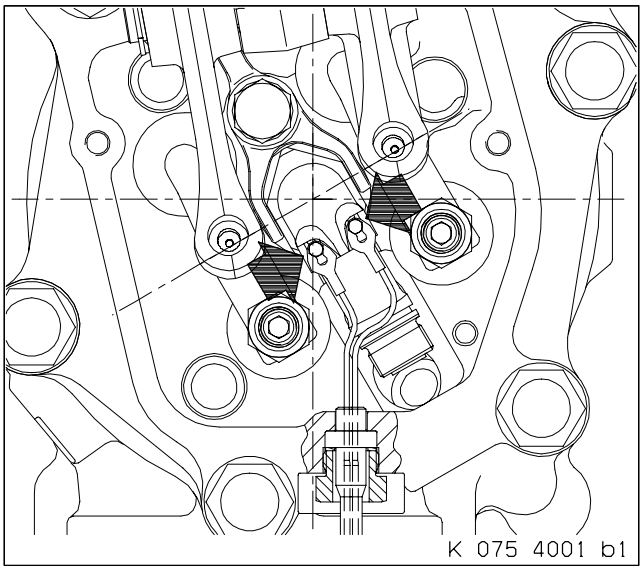
Install H.P. line on injector (1) and on limiting valve.

Fit H.P. by hand and pretighten to 10 Nm.



Tighten hex screw of hold-down clamp to tightening torque – see overview drawing C 075.05.01.

Install threaded union of H.P. line on injector (1) and on connector for limiting valve (2) – for tightening torque, see overview drawing C 077.05.01.



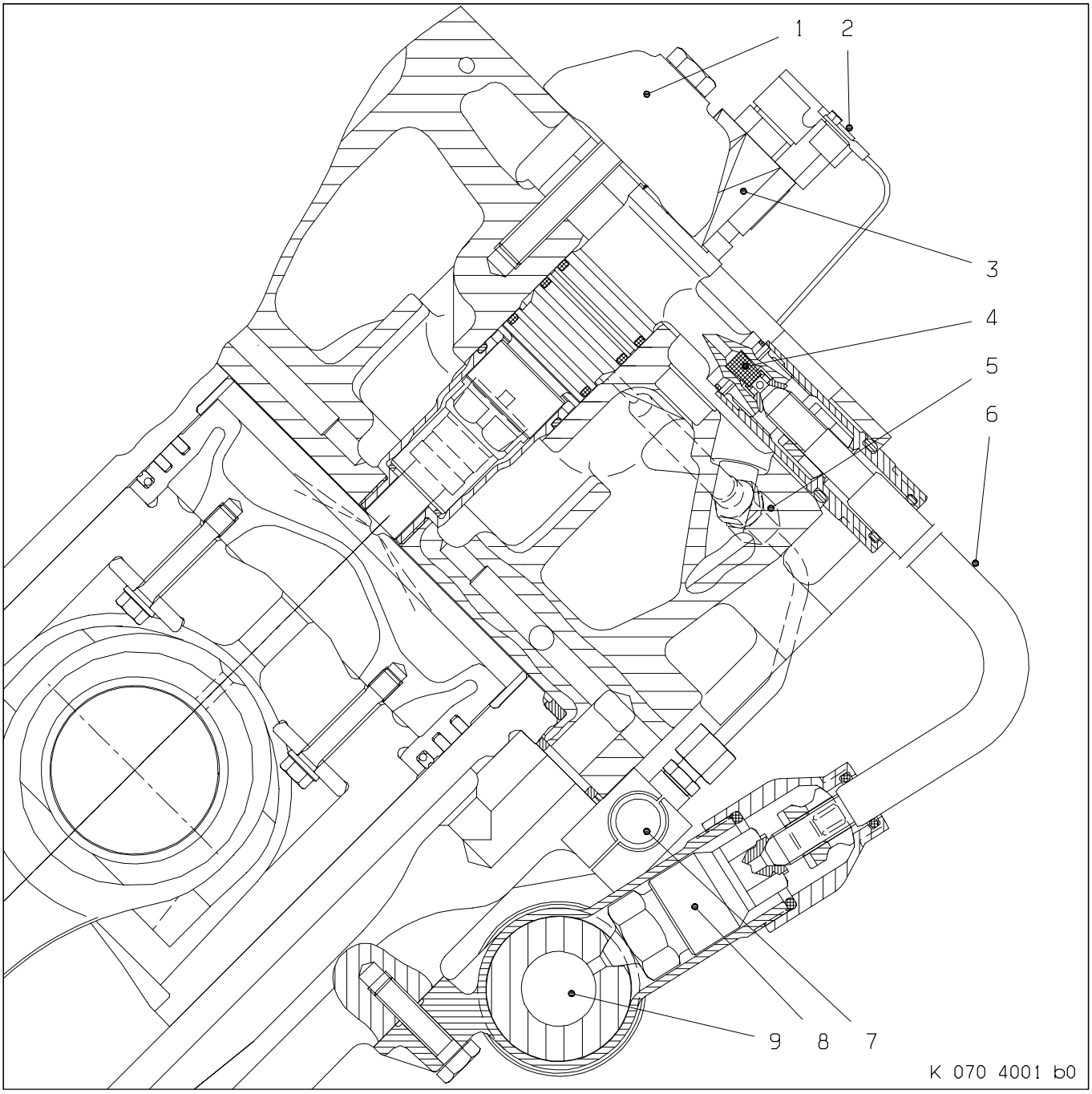
Push cable terminals under screws on injector and tighten to specified tightening torque, see overview drawing C 077.05.01.

C075.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ 075.05.04
–	–	x	Release engine start	→ Operating Instructions

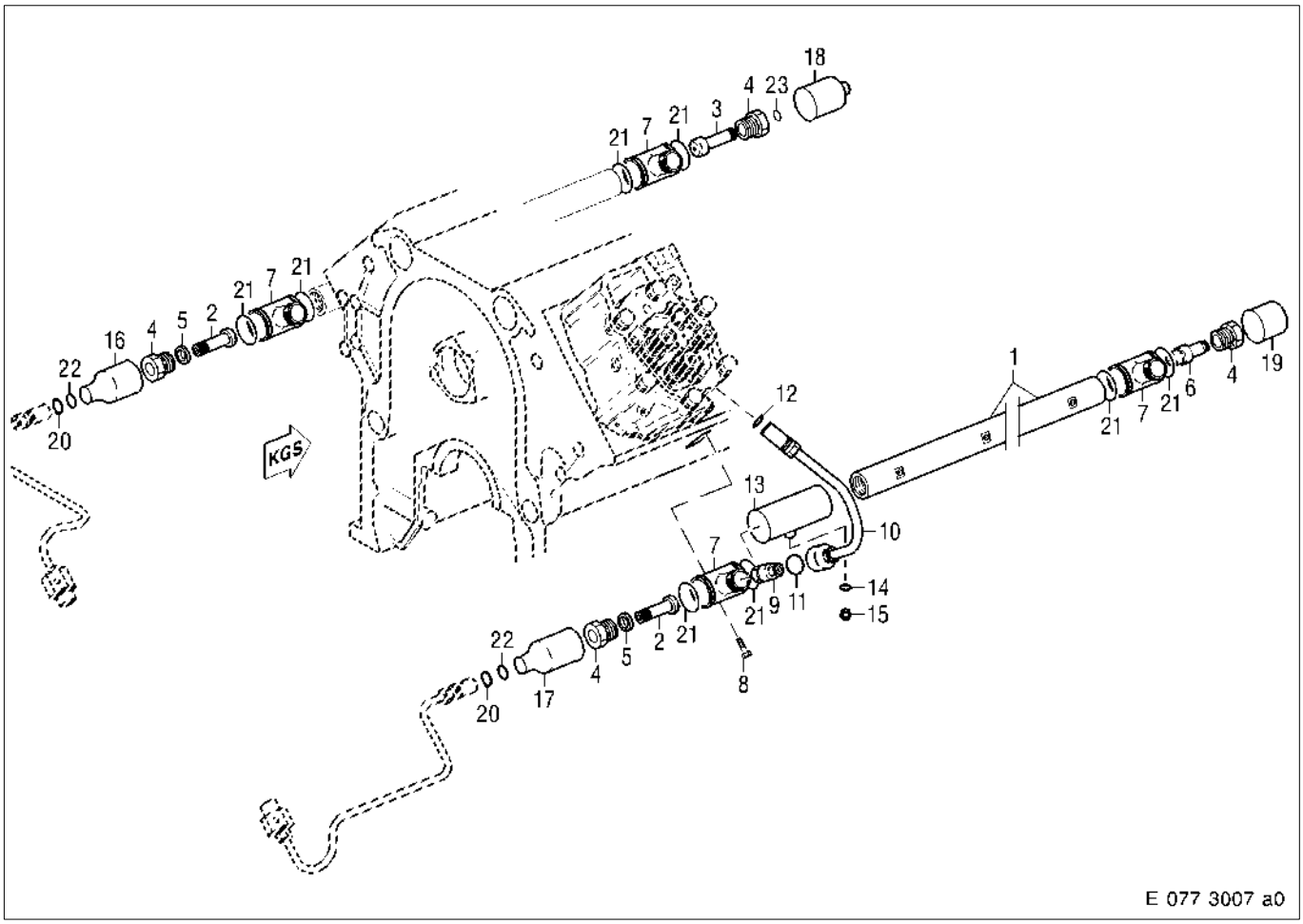
C077.05 Injection line / H.P. line

C077.05.01 Overview drawing



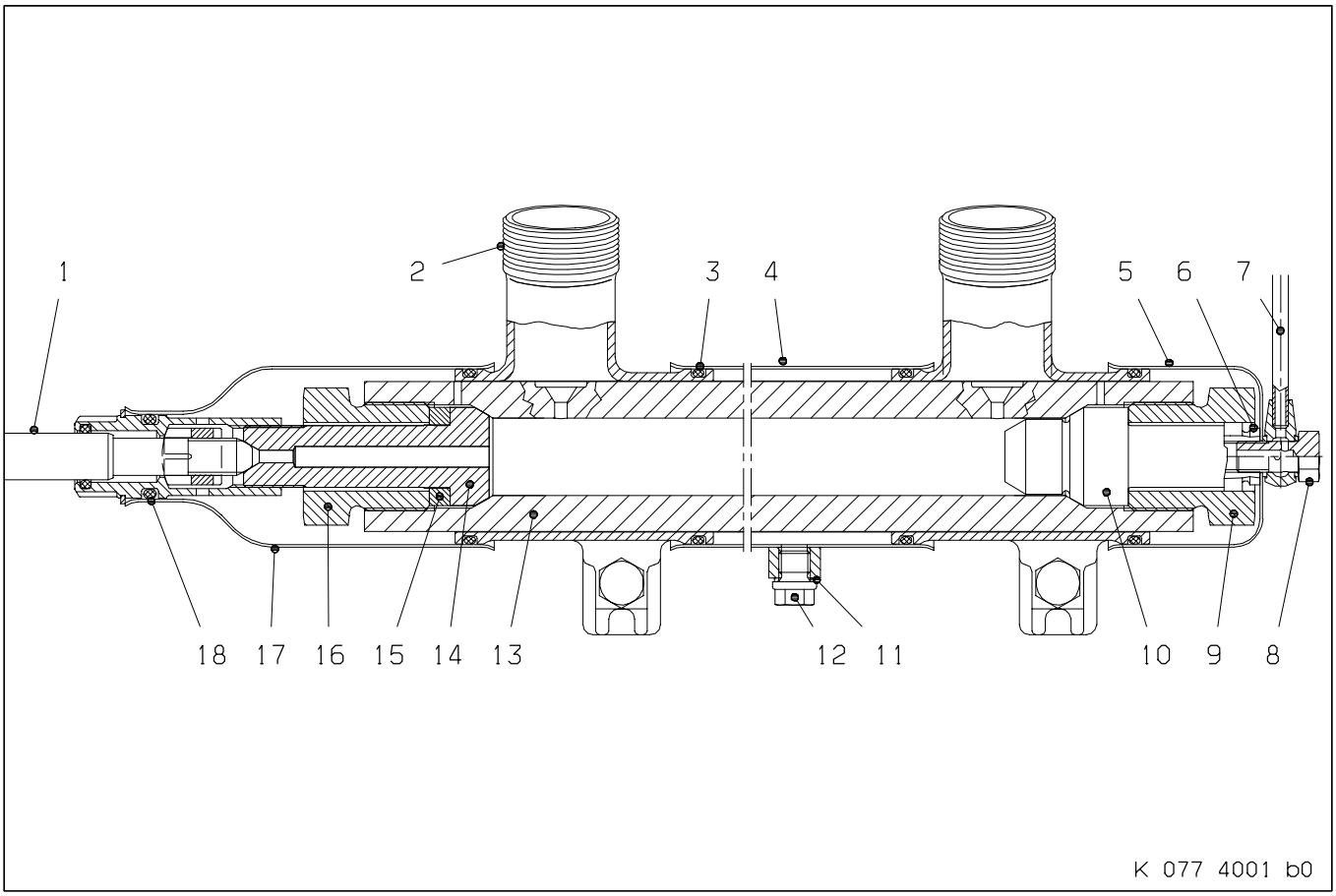
1 Hold-down clamp
2 Cable connection
Tightening torque: 1 Nm
3 Injector
4 Filter head
5 Fuel return line
6 H.P. line
7 Fuel collecting line
8 Limiting valve
9 H.P. accumulator

H.P. accumulator (version with pressure relief valve 1300 bar)



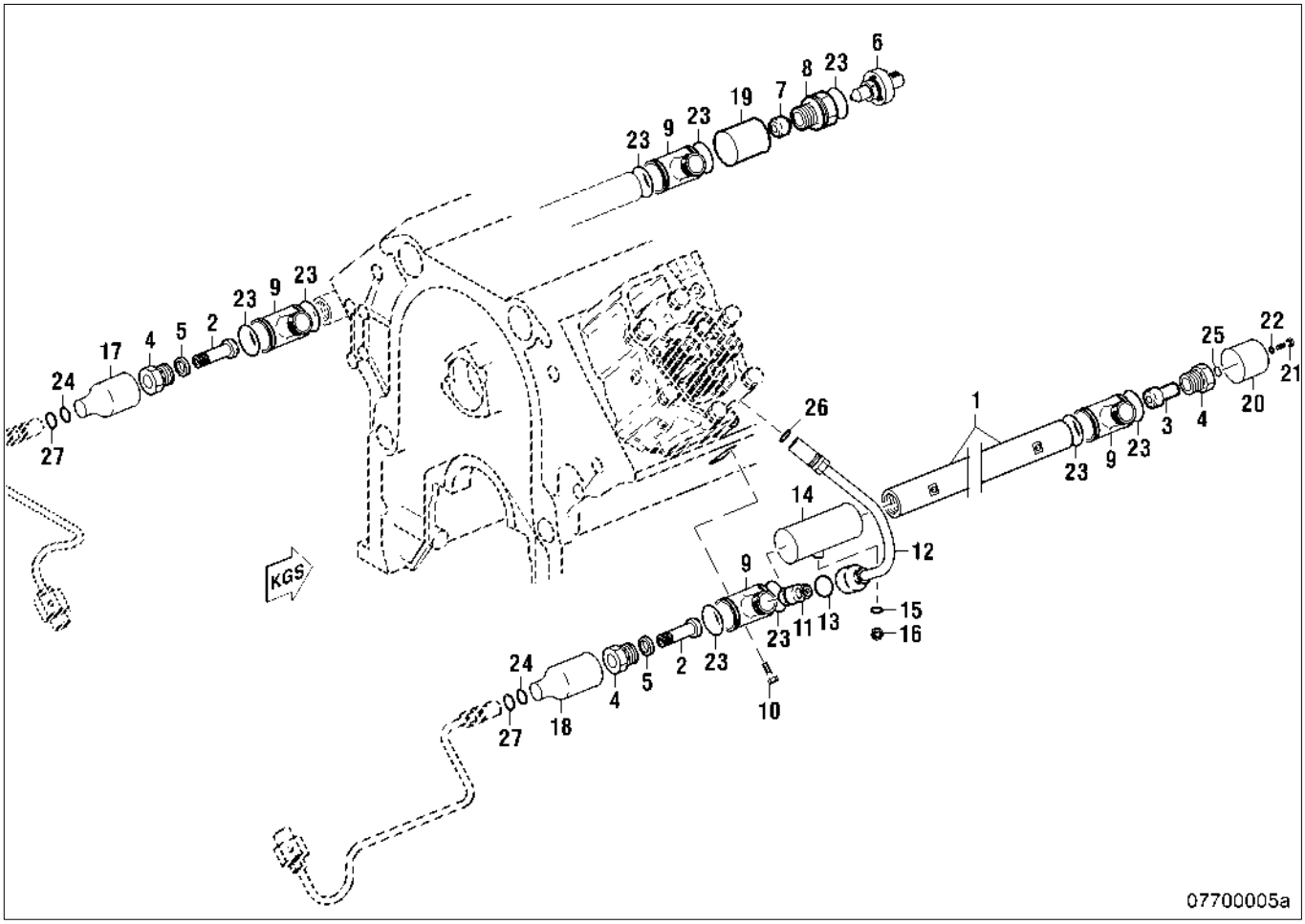
1 H.P. accumulator
2 Thrust pad
3 Thrust pad
4 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm
5 Washer
6 Pressure relief valve
7 Connector
8 Hex screw
Lubricant: Engine oil
Tightening torque: 57 Nm + 6 Nm
9 Limiting valve
10 H.P. line
Lubricant: Engine oil
Tightening torque: 120 Nm + 12 Nm
11 O-ring
12 O-ring
13 Plug-in pipe
14 Sealing ring
15 Plug
16 Plug-in pipe
17 Plug-in pipe
18 Plug-in pipe
19 Plug-in pipe
20 Plug-in pipe securing ring
21 O-ring
22 O-ring
23 O-ring

H.P. accumulator, left engine side (version with pressure relief valve 1300 bar)



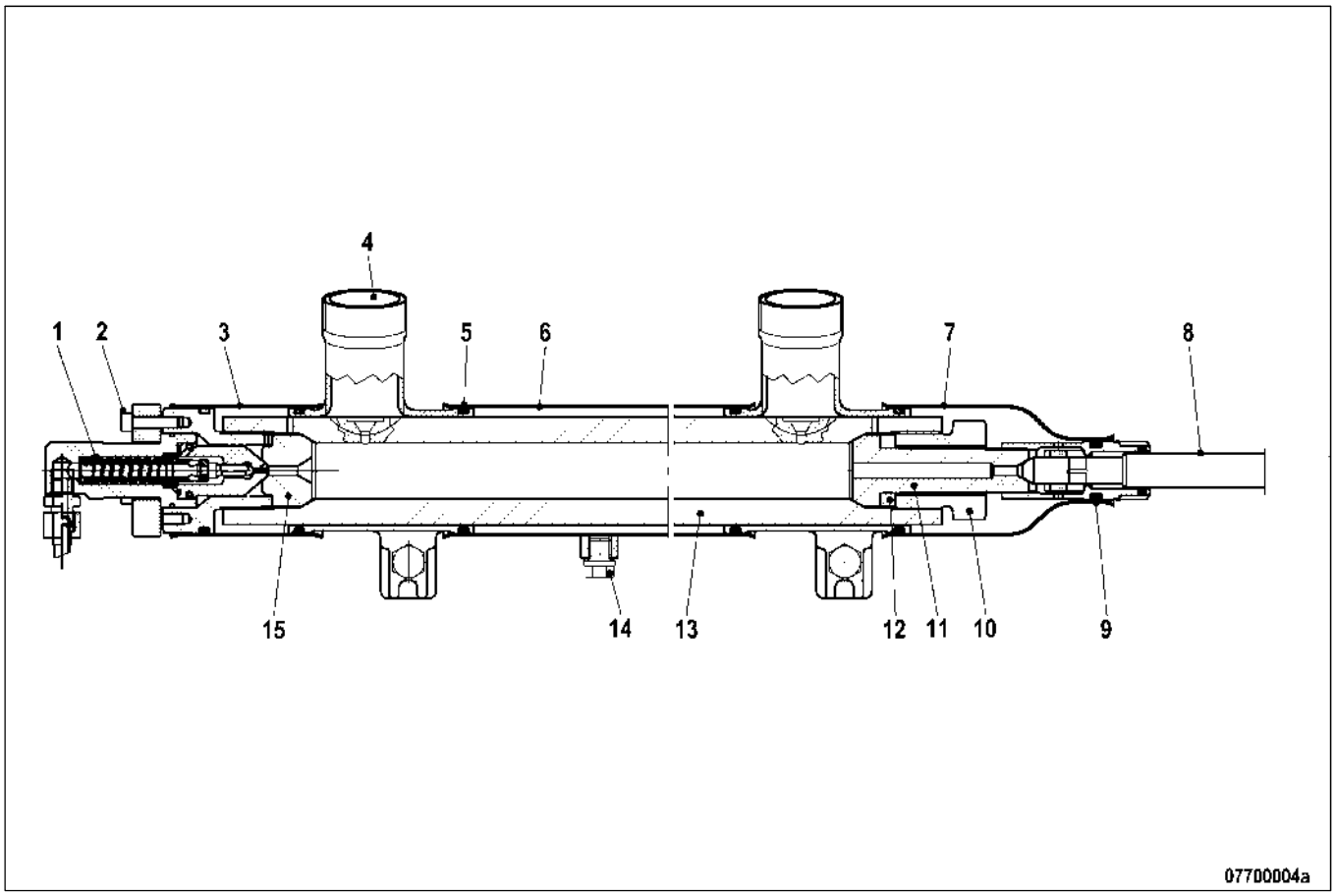
1 H.P. line
2 Connector for H.P. line
3 O-ring
4 Plug-in pipe
5 Plug-in pipe
6 Sealing ring
7 Return line for emergency operation
8 Banjo screw
9 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm
10 Pressure relief valve
11 Washer
12 Plug
13 H.P. accumulator
14 Thrust pad
15 Washer
16 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm
17 Plug-in pipe
18 O-ring

H.P. accumulator (version with pressure relief valve 1550 bar)



1 H.P. accumulator
2 Thrust pad
3 Thrust pad
4 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm
5 Washer
6 Pressure relief valve
7 Adapter
8 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm
9 Connector
10 Hex screw
Lubricant: Engine oil
Tightening torque: 57 Nm + 6 Nm
11 Limiting valve
12 H.P. line
Lubricant: Engine oil
Tightening torque: 120 Nm + 10 Nm
13 O-ring
14 Plug-in pipe
15 Sealing ring
16 Plug
17 Plug-in pipe
18 Plug-in pipe
19 Plug-in pipe
20 Plug-in pipe
21 Hex screw
22 Washer
23 O-ring
24 O-ring
25 O-ring
26 O-ring
27 Snap ring

H.P. accumulator, right engine side (version with pressure relief valve 1550 bar)



1 Pressure relief valve

2 Socket-head screw
Lubricant: Engine oil
Tightening torque: 15 Nm + 2 Nm

3 Plug-in pipe

4 Connector for H.P. line

5 O-ring

6 Plug-in pipe

7 Plug-in pipe

8 H.P. line

9 O-ring

10 Thrust screw
Lubricant: Engine oil
Tightening torque: 550 Nm + 50 Nm

11 Thrust pad

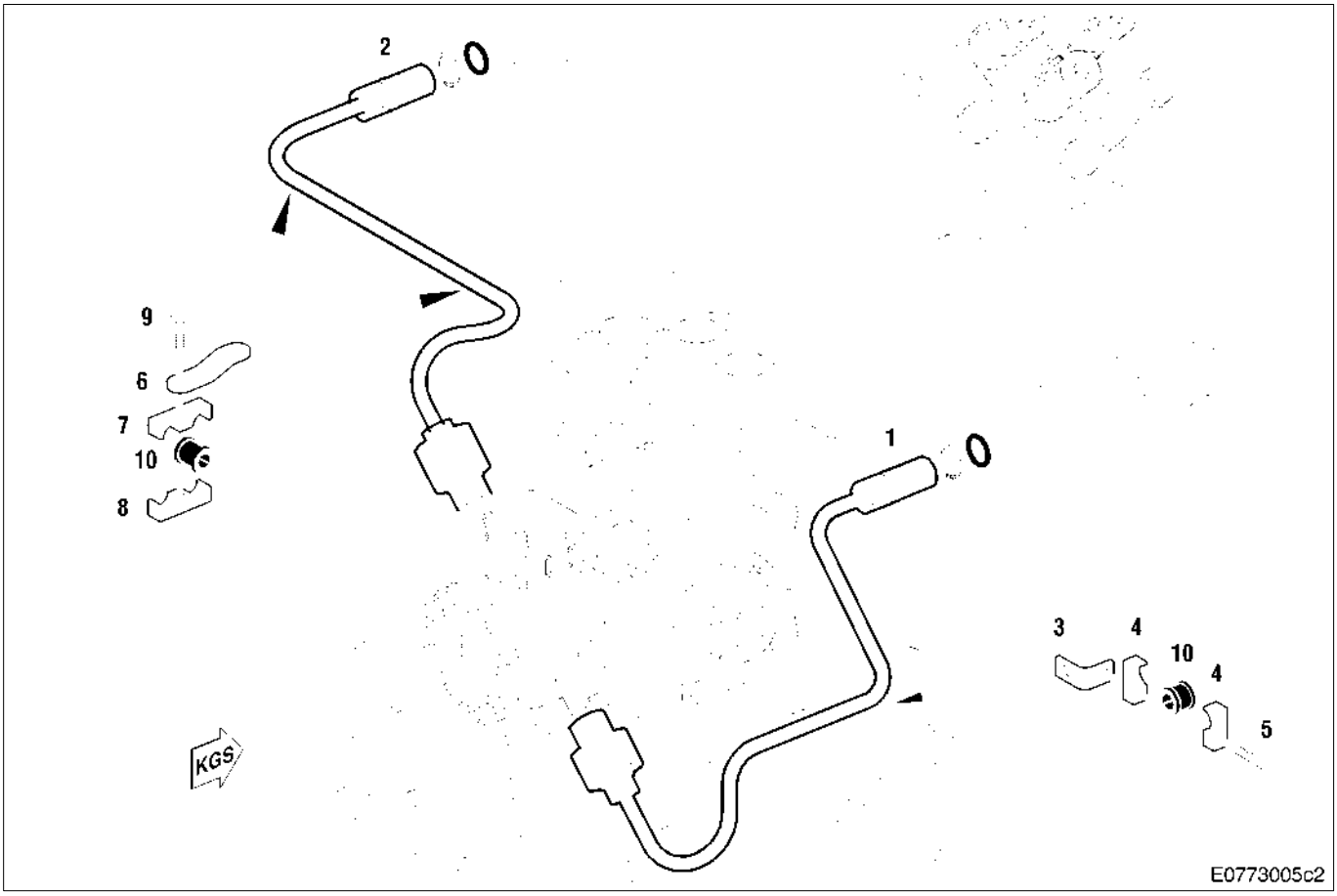
12 Washer

13 H.P. accumulator

14 Plug

15 Thrust pad

H.P. line



1 H.P. line, left side
Lubricant: Engine oil
Tightening torque: 100 Nm + 10 Nm
2 H.P. line, right side
Lubricant: Engine oil
Tightening torque: 100 Nm + 10 Nm
3 Bracket
4 Pipe clamp half
5 Hex screw
6 Bracket
7 Pipe clamp half
8 Pipe clamp half
9 Hex screw
10 Grommet

C077.05.02 Special tools

Designation	Use/dimension	Number
• Mount retaining device	for H.P. accumulator	1
• Alignment tool	for H.P. accumulator	2
• Tools from the W4 tool kit		1
• Hydraulic filling unit	for H.P. and L.P. fuel system	1

C077.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled / The engine is to be removed but not disassembled / The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove charge air manifolds	→ C 123.05

C075.05.05 Removal

Removing H.P. lines between H.P. pump and H.P. accumulator

Note: Before removing H.P. lines, it is advisable to photograph the mounted lines or attach metal tags to the lines so that they can be reinstalled in their original positions.

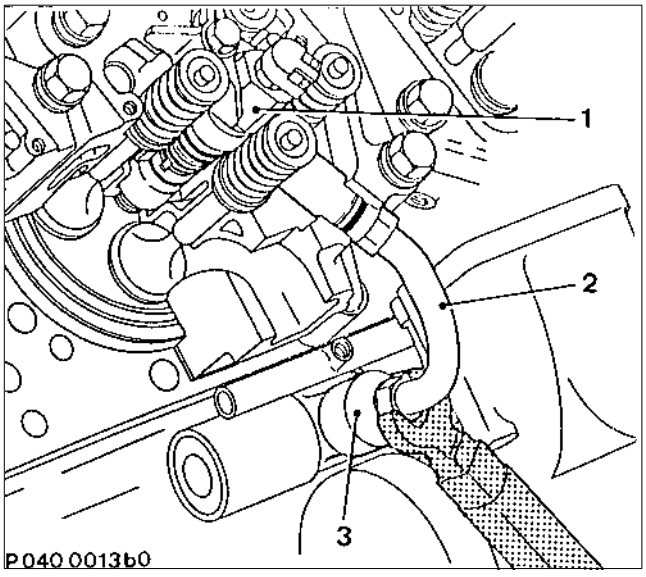
WARNING

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 H.P. line threaded connections and catch fuel emerging in a suitable container.

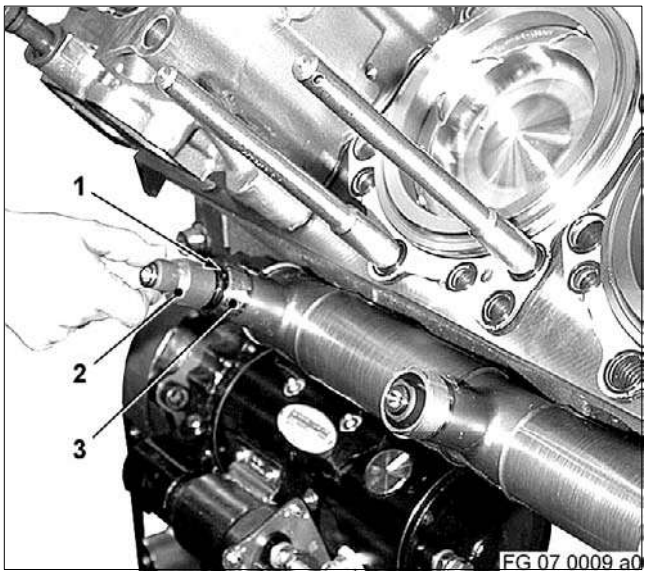
Remove H.P. fuel lines between H.P. pump and H.P. accumulator – see C 077.05.01.

After removing H.P. lines, seal all open connections by installing suitable plugs.



Removing H.P. lines

Unscrew and remove H.P. line (2) from injector (1) and limiting valve (3).

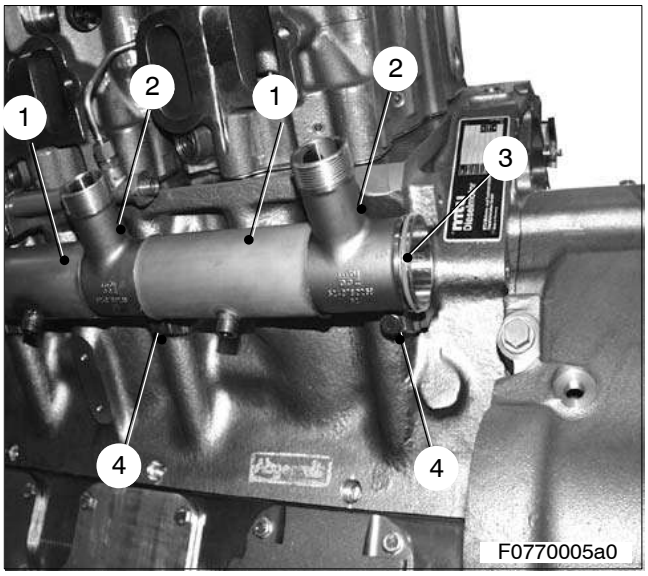


Removing H.P. accumulator

Remove limiting valve (2) from connector (3).

Remove fuel return lines and plug-in pipe end pieces (1) or pressure relief valve as per overview drawing (see C 077.05.01) from H.P. accumulator.

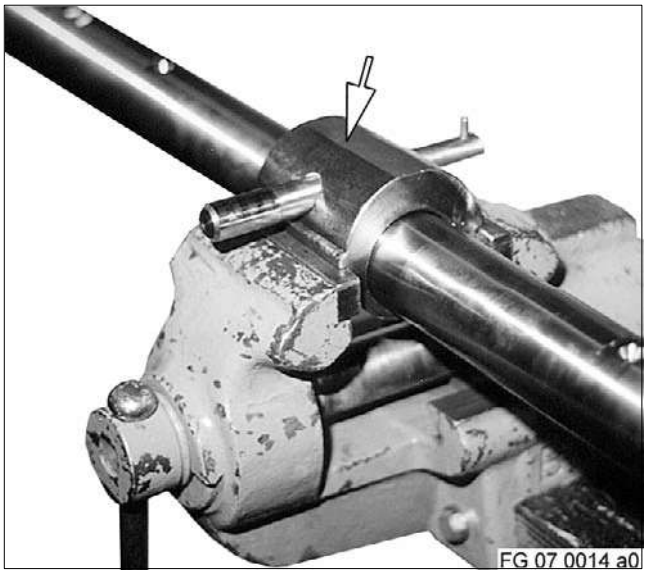
Carefully remove H.P. accumulator from connectors and plug-in pipes.



Release connector (2), hex screws (4) and remove with plug-in pipe (1) from crankcase.

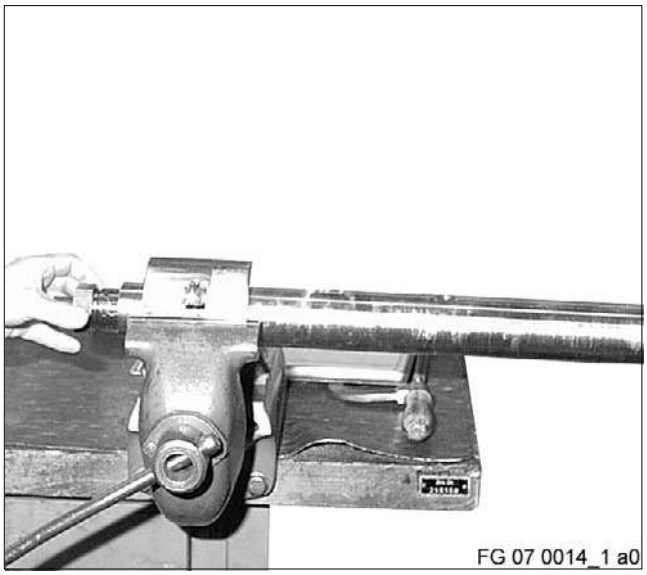
Remove O-ring (3) from connections.

C077.05.06 Disassembly



Disassembling H.P. accumulator

Use retaining device (arrow) to clamp H.P. accumulator in vice.



Remove thrust screws.

Remove thrust pad and pressure relief valve.

C077.05.07 Inspection and repair

Clean all components.

Check thread of hex screws for damage; replace screws if necessary.

Check condition of threads of H.P. lines and connectors for ease of movement; replace components as necessary.

Check sealing cones of thrust pads and pressure relief valve for damage and wear, and replace as necessary.

Check sealing taper of H.P. accumulator for damage and wear; replace component if necessary.

Using the magnetic crack-testing method with fluorescent magnetic powder, check H.P. accumulator for cracks; replace component if necessary.

Check H.P. lines, plug-in pipes and fuel return line for damage and wear; replace components as necessary.

After damage to the ceramic bearing of the high-pressure pump, flush the H.P. lines and check that they are particularly clean; see also Section C 083.05.07 Fuel filter.

For checking limiting valves and pressure relief valves, see Manufacturer's Documentation.

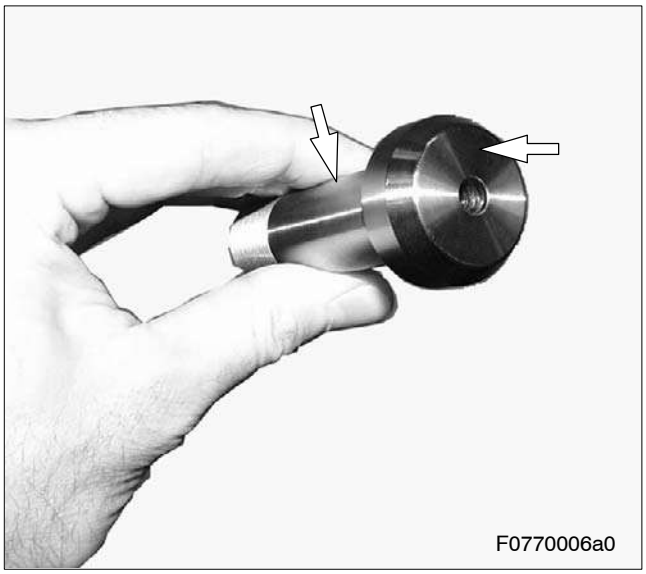
Consult MTU service for further information.

Check that H.P. lines and H.P. accumulator are perfectly clean.

Note: Do not bend the H.P. line!

Replace O-rings and sealing rings at every assembly.

C077.05.10 Assembly

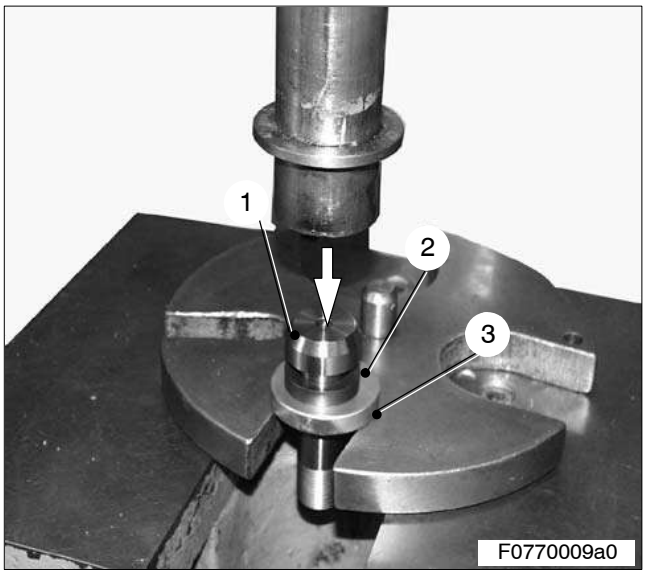


Assembling H.P. accumulator

Note: Make sure parts are perfectly clean.

Clean and degrease surfaces (arrows) of thrust pad.

Coat surface (arrow) with oil.

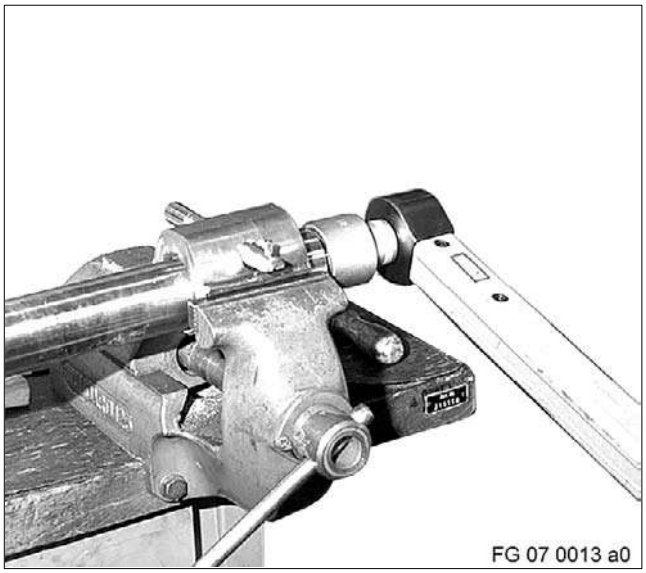


Press-fit washer (2) on thrust pad (1), ensuring there is no gap.

Note: Protect washer with disc (3) against damage.

Coat thread and pressure surface (arrows) of thrust screws with engine oil.

Join thrust screw to preassembled thrust pad.



Use retaining device to clamp H.P. accumulator in vice.

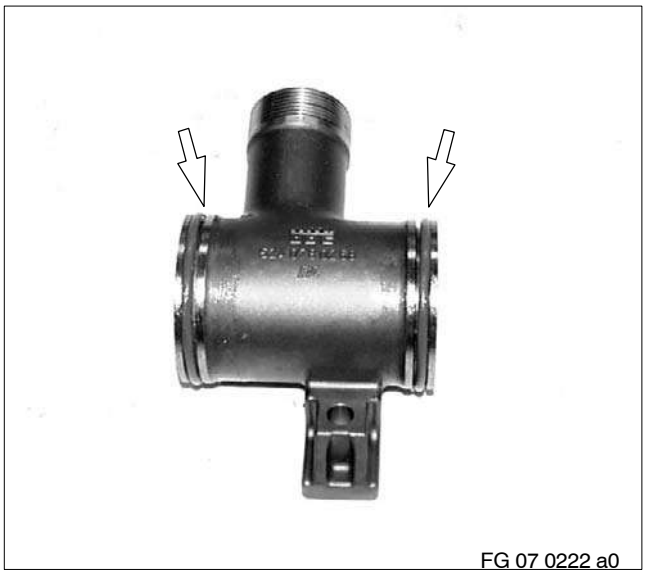
Insert prepared thrust pad with thrust screw in support bore and tighten to specified tightening torque – see C 077.05.01.

Insert pressure relief valve in opposite support bore of H.P. accumulator.

Insert thrust screw and tighten to specified torque.

C077.05.11 Installation

Note: Make sure fuel-carrying components are perfectly clean.
Prior to installation, remove all blanking plug and/or covers.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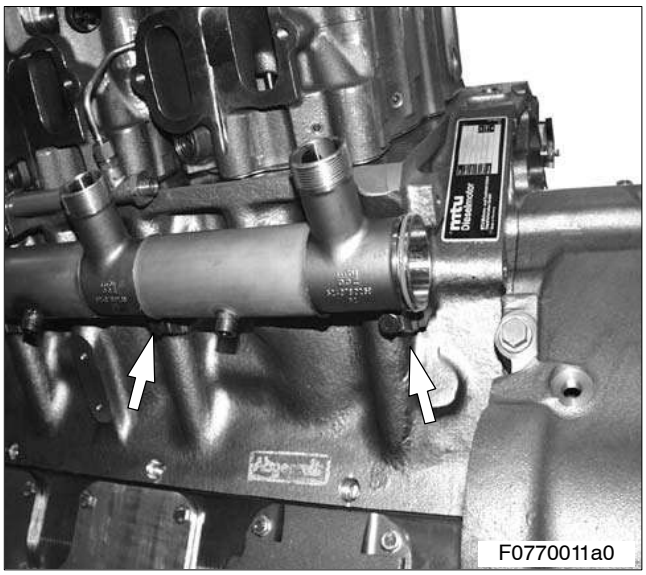
Installing H.P. accumulator

Insert O-rings in grooves (arrow) on connector and coat with petroleum jelly.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Fit connectors and plug-in pipes together in alternating sequence.

Fit plug-in pipes over O-rings of connectors.

Note: Make sure mating face of connector is correctly positioned with regard to crankcase, corresponding to left or right engine side.

Fit hex screws (arrow) to secure connectors on crankcase and tighten to 5 Nm to 10 Nm.

Carefully insert H.P. accumulator in preassembled connector and plug-in pipe assembly.

Note: Ensure that H.P. accumulator is correctly positioned.

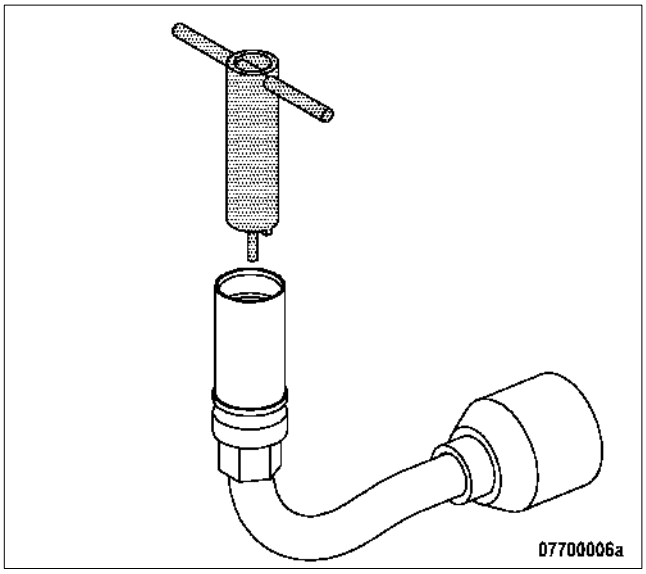
Insert alignment tools in tightened connectors (first and last connector of respective engine side).

Align H.P. accumulator until alignment tool taper is centred in bore of H.P. accumulator.

Tighten alignment tools to 20 Nm + 2 Nm.

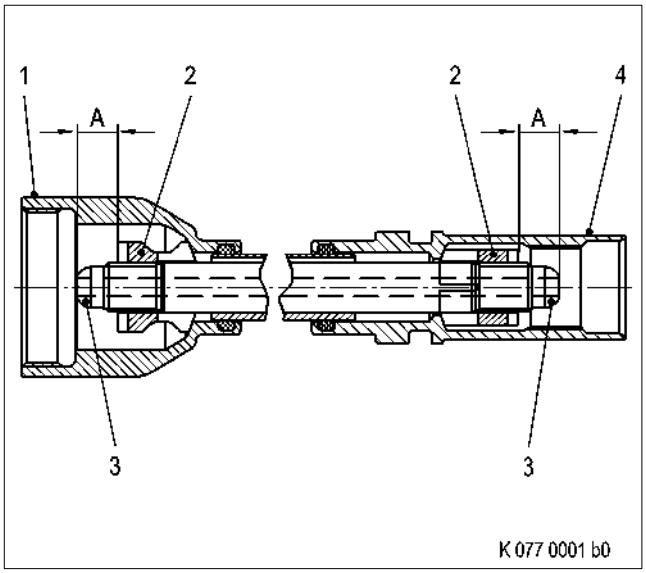
Insert limiting valves into free outlets (arrow) of connectors.

Note: Remove alignment tools only after injection lines have been installed.



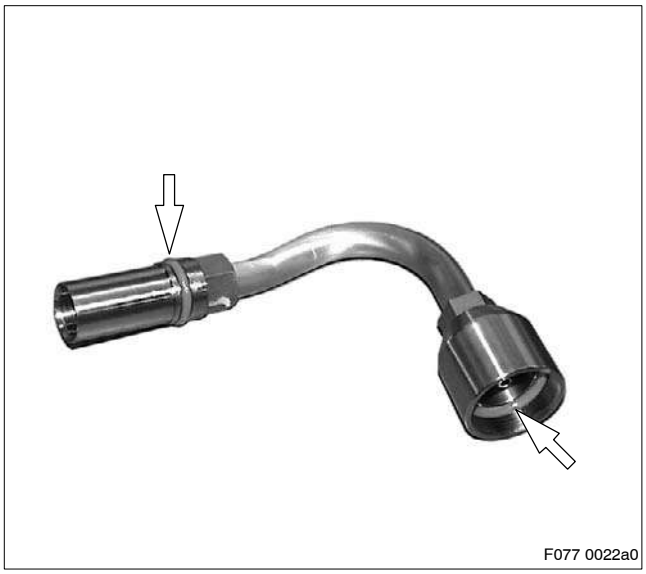
Installing H.P. lines

Check thrust rings at both ends of line for security with face spanner (10 Nm).

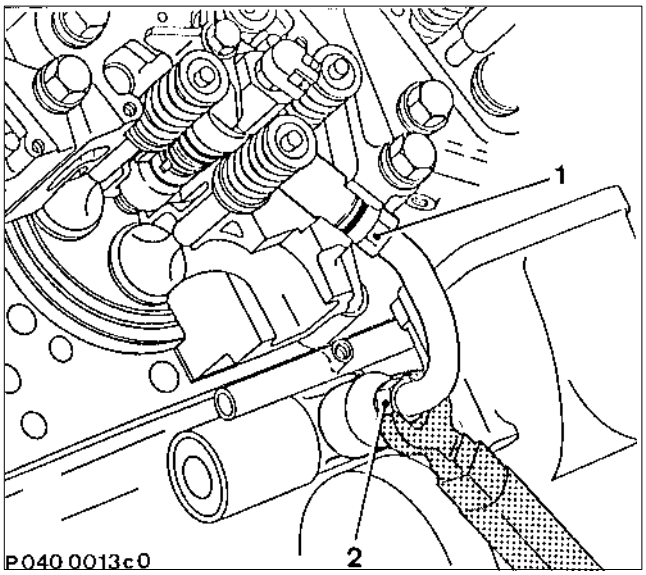


Measure distance (A) from end of line to thrust ring.

A = 11.7 mm.



Insert O-rings (arrows) in grooves.



Note: If injectors are removed, procedure as in Section C 075.05 11.

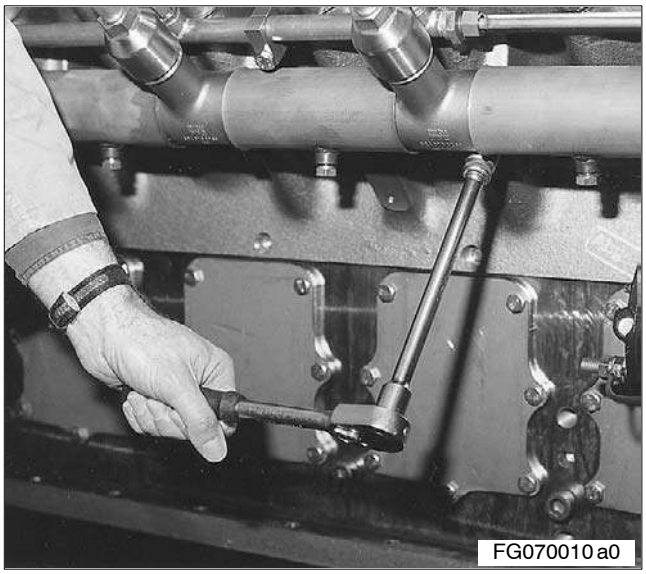
Install H.P. line on injector and on limiting valve.

Pretighten union nuts (1) and (2) to 5 Nm to 10 Nm.

Note: If necessary, for further tension-free assembly, release hex screws for connectors – see next illustration.

Tighten union nuts to specified tightening torque – see overview drawing C 077.05.01.

Remove alignment tools for H.P. accumulator and other H.P. lines as described.



Tighten hex screws for connectors to crankcase to specified tightening torque – see overview drawing C 077.05.01.

Tightening sequence: From centre outwards.

Complete H.P. accumulator and connect to return lines – see overview drawing C 077.05.01.

Installing H.P. lines between H.P. pump and H.P. accumulator

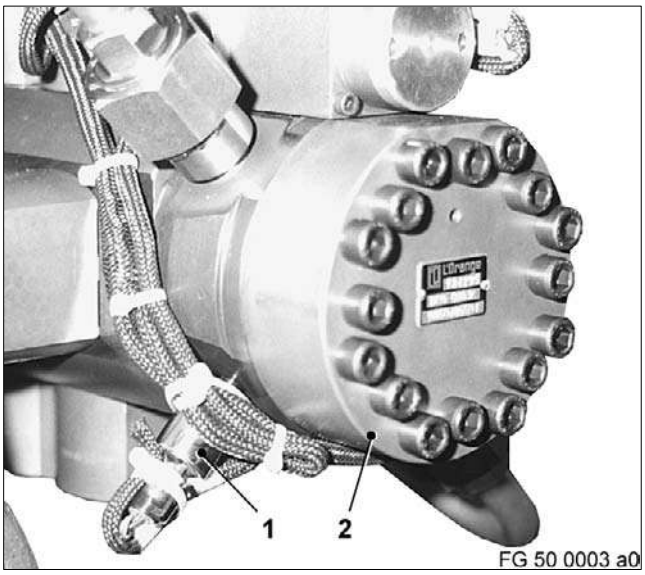
Note: Before installation, remove all blanking plugs.

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 H.P. lines with compressed air and make sure they are perfectly clean.

Install H.P. lines with securing elements in accordance with overview drawing (see C 081.05.01), or install tension-free as shown in the photo or as per markings.



Leak-checking COMMON Rail System

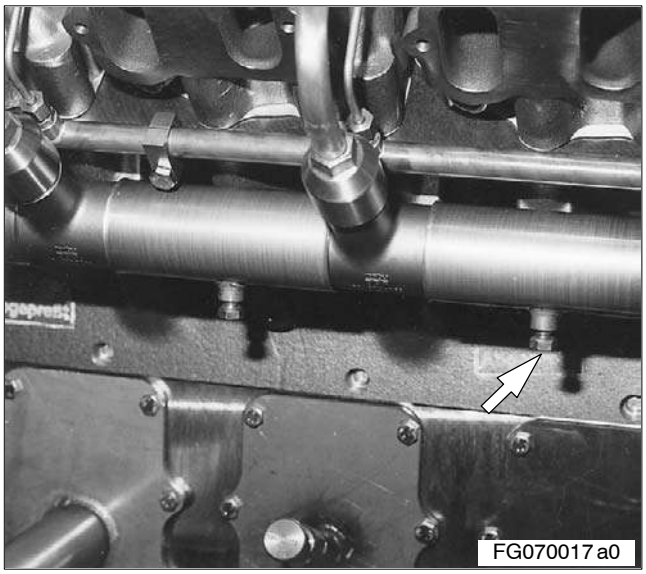
Remove pressure sensor (1) from high-pressure pump (2).

⚠ WARNING

Compressed air is highly pressurized.
Risk of injury!
Test pressure must not be exceeded.
Always wear protective clothing, protective gloves and protective goggles/safety mask.

Install H.P. line and apply pressure to system.

Test pressure = 3 bar



Remove control screws (arrow) from H.P. accumulator.

Check all threaded connections in system for leaks.

Remove H.P. inspection line.

Install high-pressure sensor – see C 507.00.

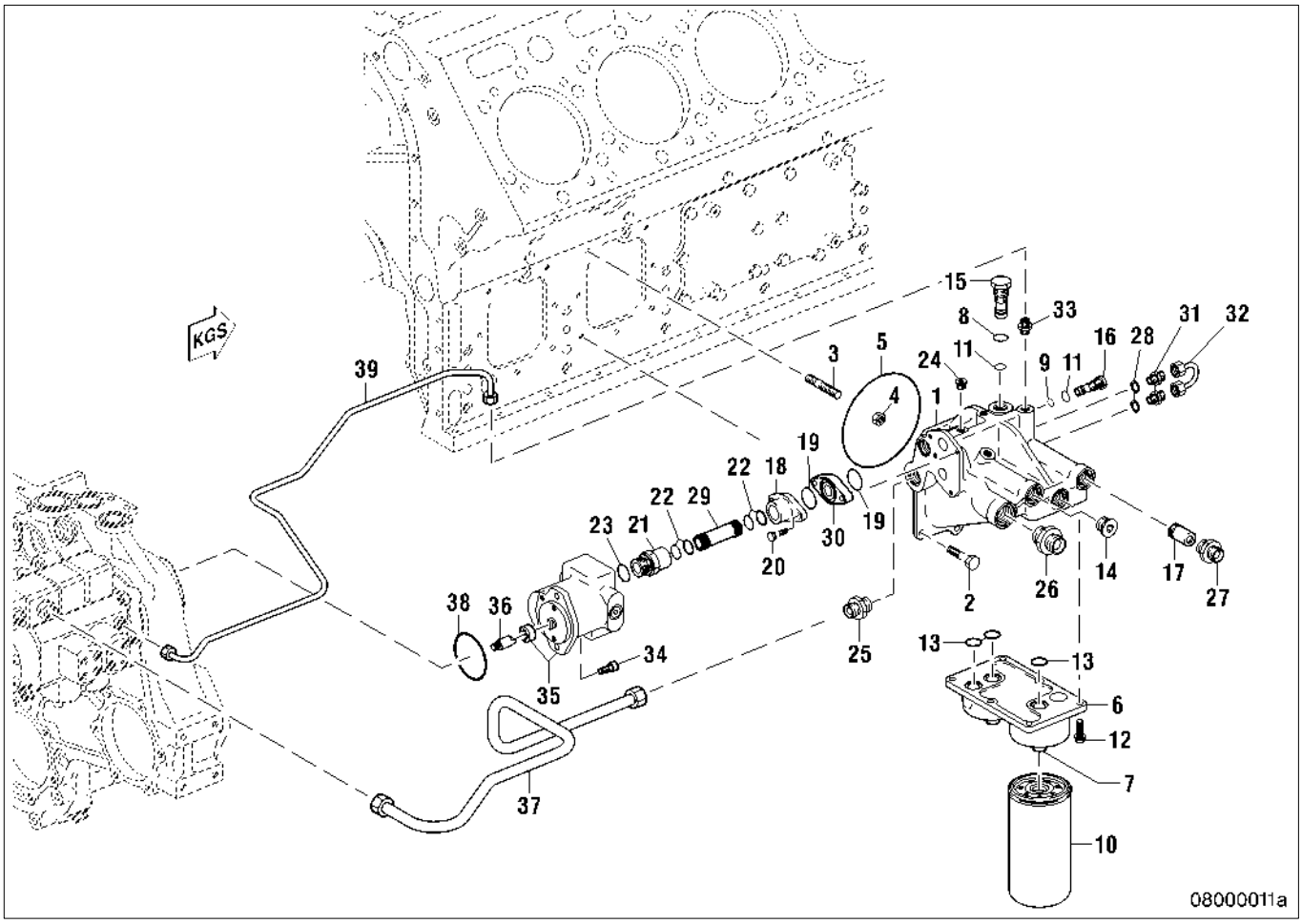
Fit checking screws.

C077.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled / The engine is removed but was not disassembled / The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Installation in reverse sequence to removal	→ C 077.05.04
–	–	x	Fill fuel system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

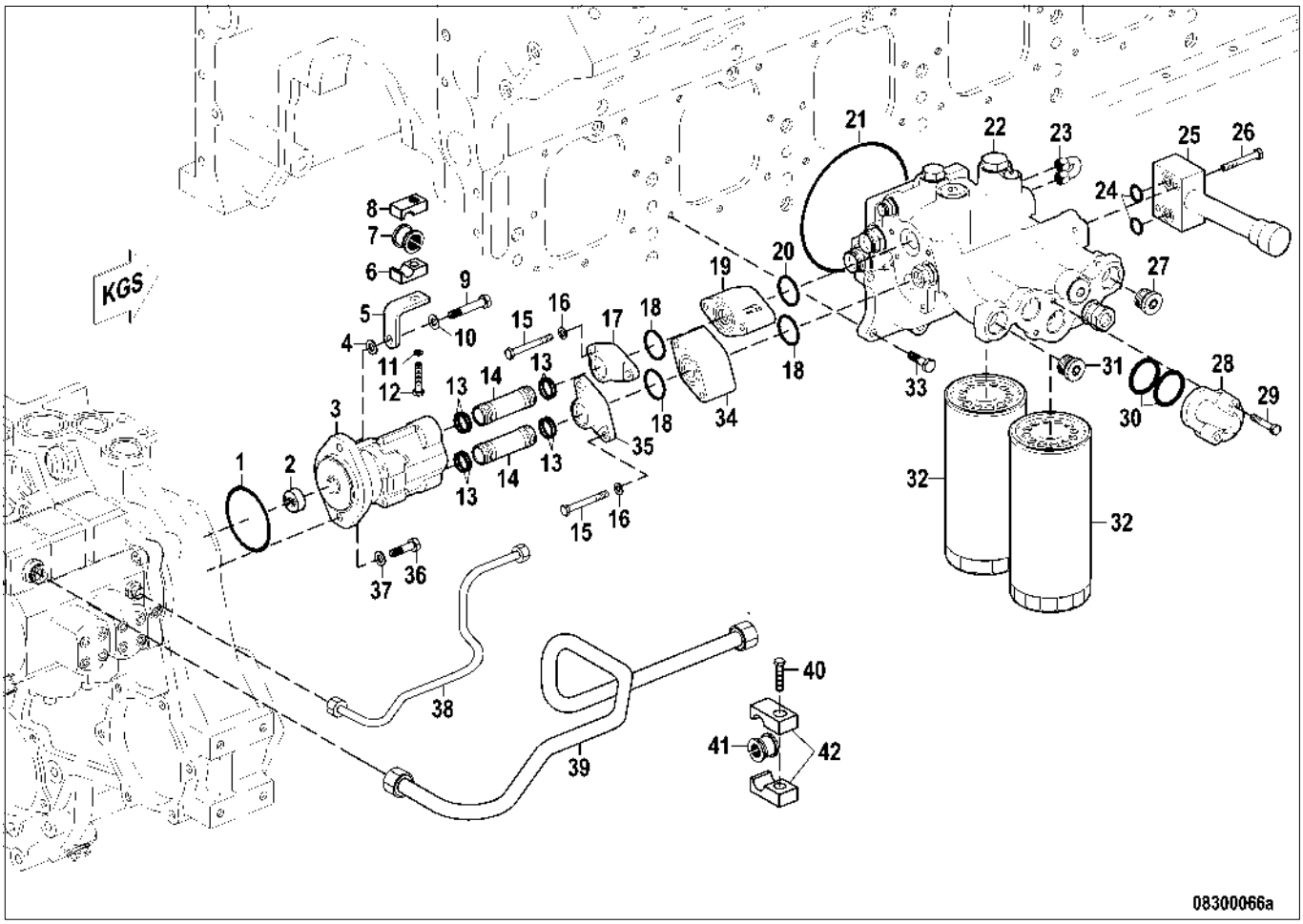
C080 L.P. fuel system

Version 1



1 Fuel distributor housing
2 Hex screw
3 Stud
4 Nut
5 O-ring
6 Filter head
7 Bracket
8 O-ring
9 O-ring
10 Filter head
11 O-ring
12 Hex screw
13 O-ring
14 Blanking plug
15 Pressure maintaining valve
16 Valve (1.7 bar)
17 Valve
18 Flange
19 O-ring
20 Hex screw
21 Union
22 O-ring
23 O-ring
24 Blanking plug
25 Union
26 Union
27 Union
28 O-ring
29 Plug-in pipe
30 Flange
31 Union
32 Fuel line
33 Union
34 Socket-head screw
35 Fuel delivery pump with coupling element
36 Intermediate element
37 Fuel line
38 O-ring
39 Fuel return line

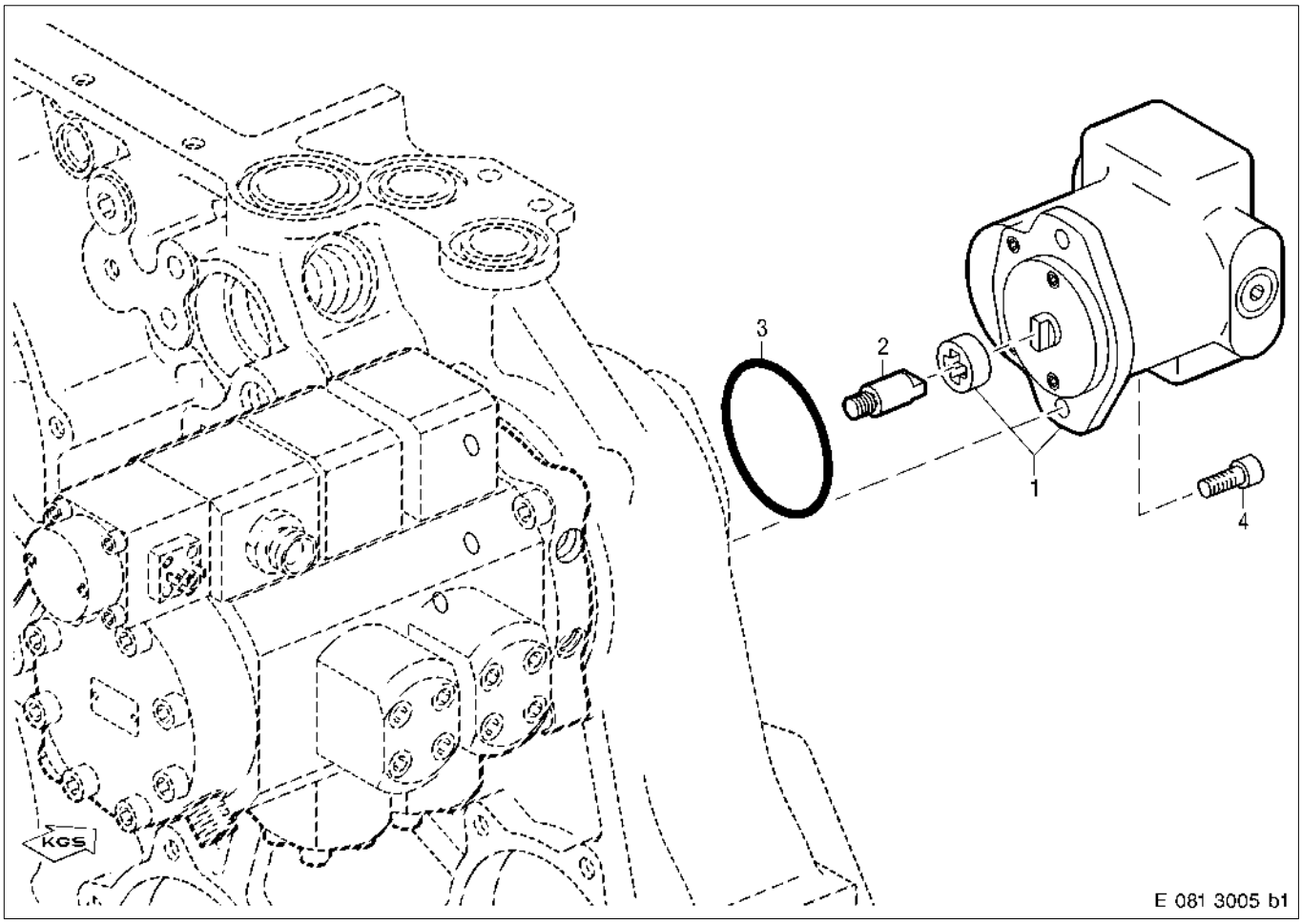
Version 2



C081.10 Fuel pump

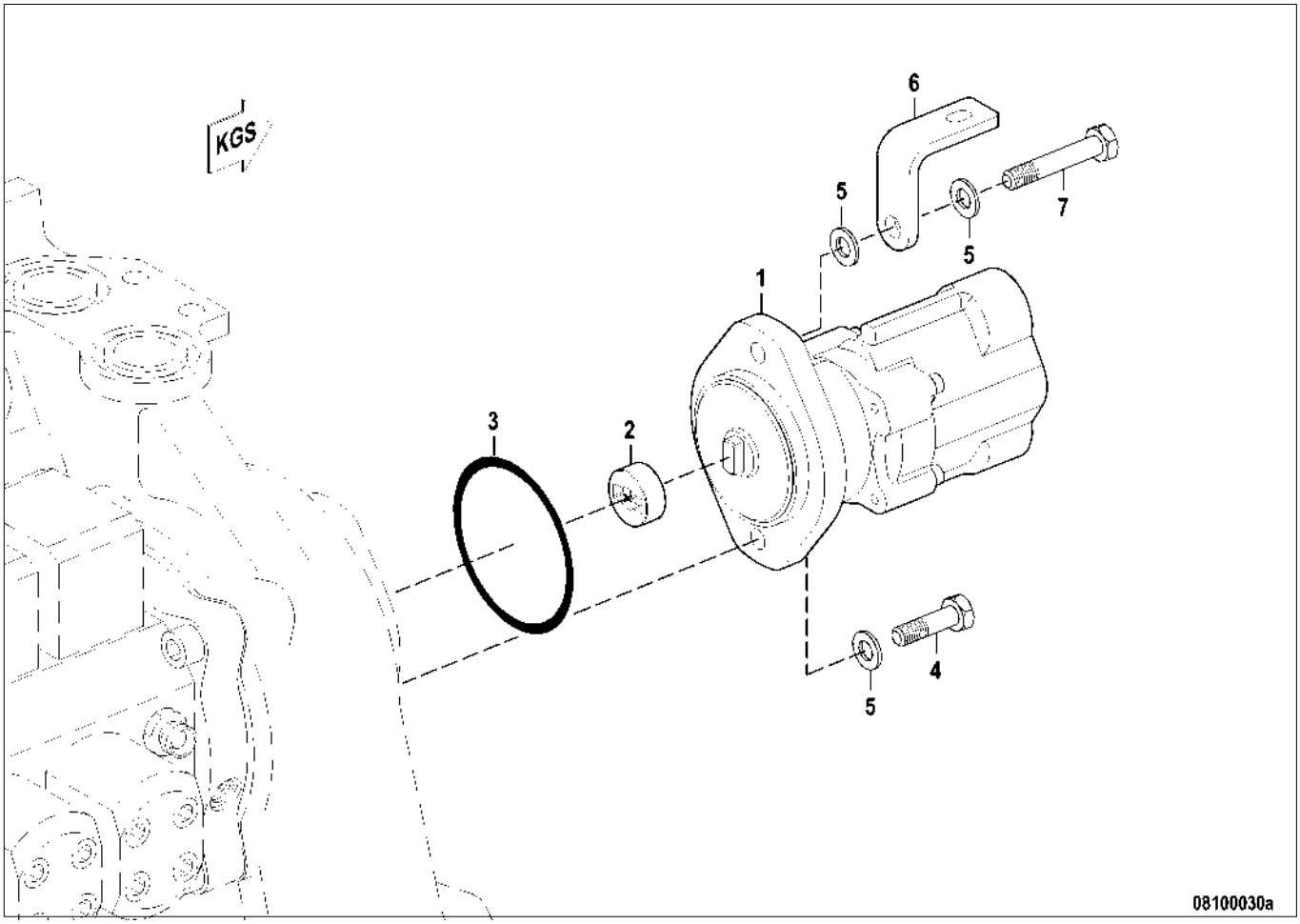
C081.10.01 Overview drawing

Version 1



1 Fuel delivery pump with coupling element
2 Intermediate element
3 O-rIng
4 Socket-head screw

Version 2



1 Fuel delivery pump
2 Coupling element
3 O-ring
4 Hex screw
5 Washer
6 Bracket
7 Hex screw

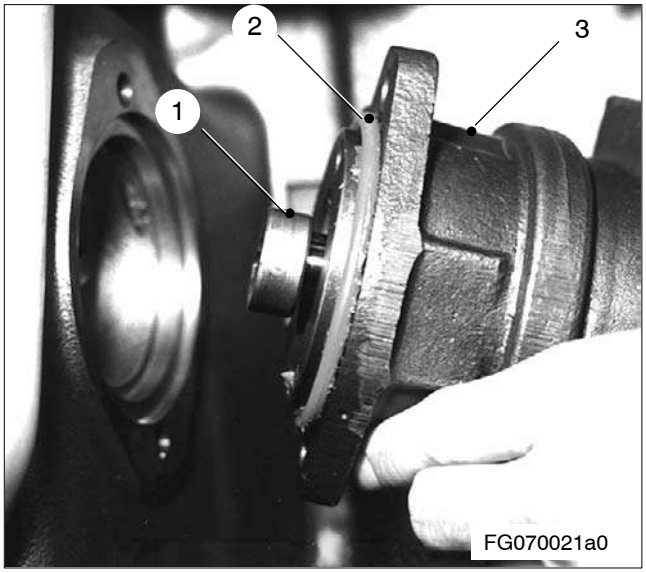
C081.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove charge air manifold	→ C 124.05.05
–	x	x	Remove fuel supply line	→ C 086.05.05
–	x	x	Remove plug-in pipes	→ C 083.05.05

C081.10.05 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.



Remove fuel delivery pump

Remove screws for fuel delivery pump.

Pull fuel delivery pump (3) from its seat and remove.

For Version 1, remove coupling element (1) from the drive shaft of the fuel delivery pump.

Remove O-ring (2).

C081.05.06 Disassembly

Fuel delivery pump must not be disassembled.

In event of wear or other defects, the fuel delivery pump must be replaced.

C081.05.08 Inspection and repair

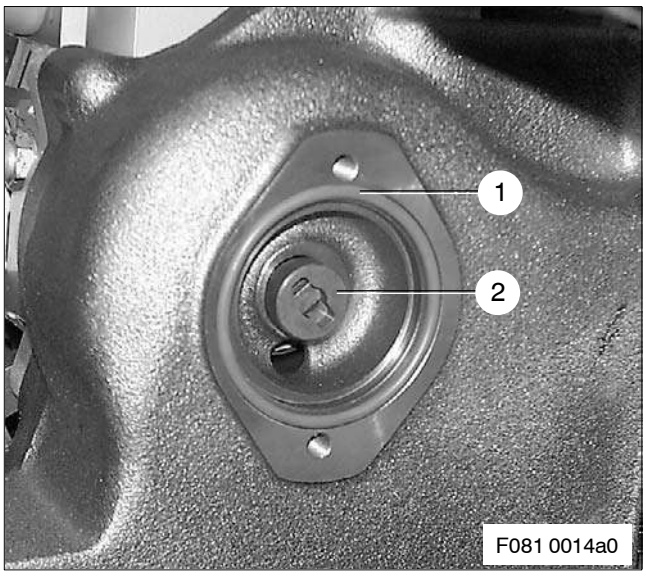
Check fuel delivery pump externally for damage and condition.

Check securing screws for condition and thread for ease of movement; replace screws if necessary.

Check coupling element for wear and damage, replace component if necessary.

Check pump shaft driver for wear; rub down with an emery cloth or oilstone, replace delivery pump if necessary.

C081.10.11 Installation

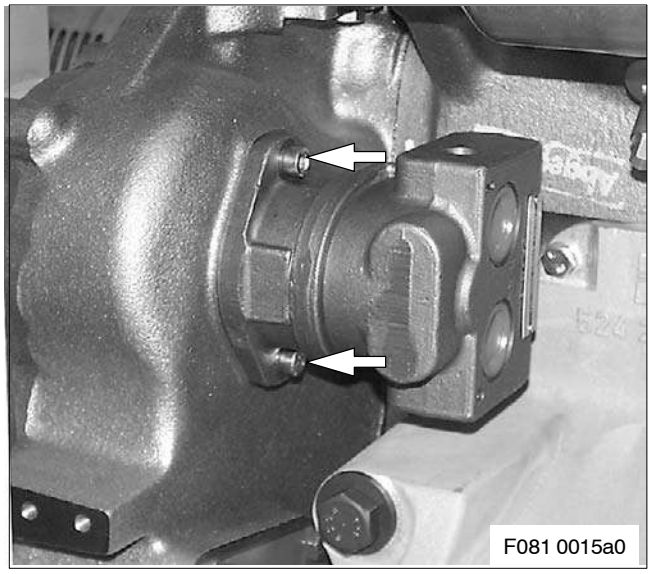


Installing fuel delivery pump

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

Insert O-ring (1) in equipment carrier.

Mount coupling piece (2) on H.P. pump driver.



Align driver of fuel delivery pump driver to coupling element.

Install fuel delivery pump in equipment carrier, making sure driver is correctly positioned on coupling element.

Note: If the pump does not move in as far as the stop, withdraw the pump again and check the position of the driver with regard to the coupling element.

Tighten fuel delivery pump with socket-head screws (arrows).

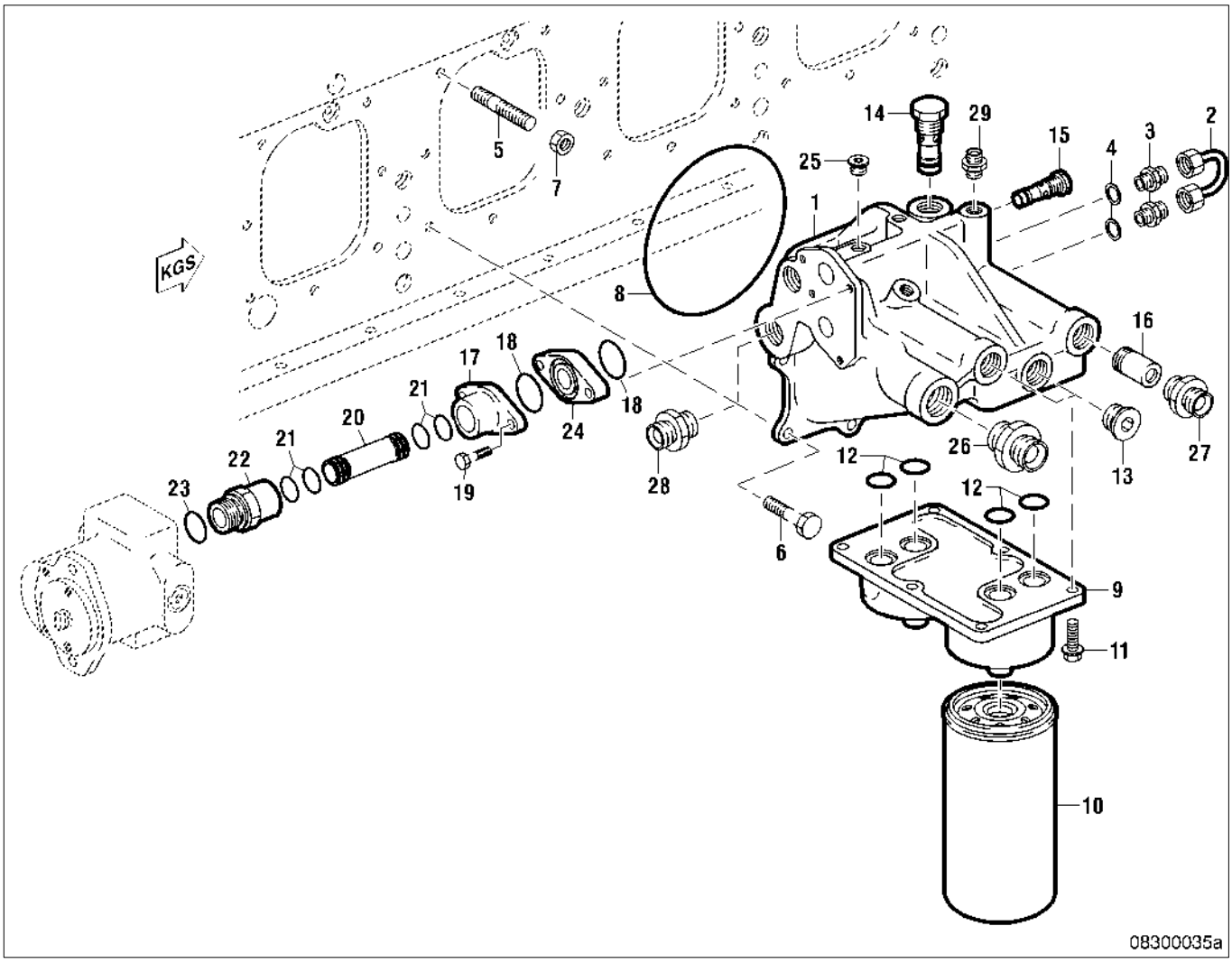
C081.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 081.10.04
–	–	x	Fill fuel system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C083.05 Fuel filter

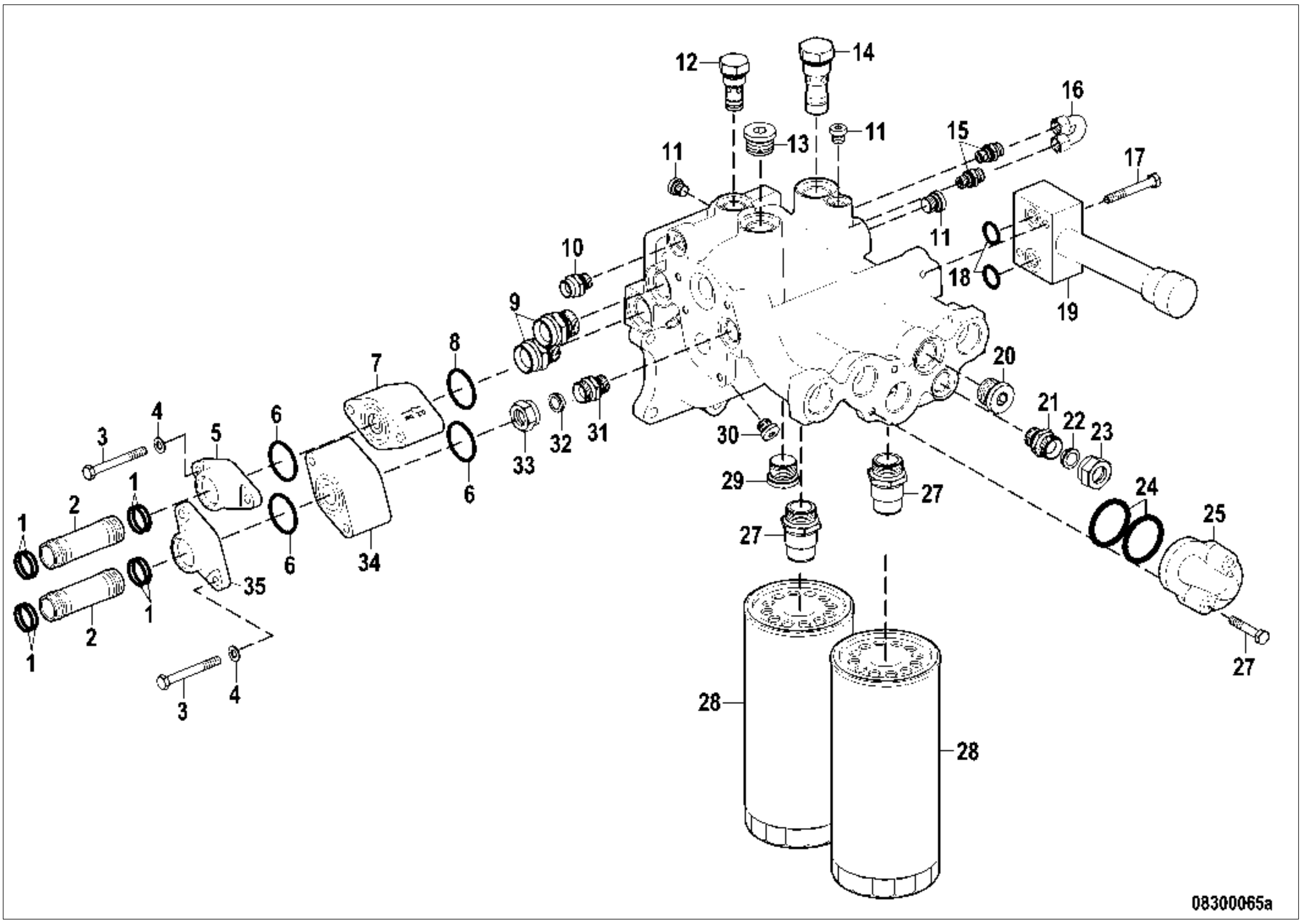
C083.05.01 Overview drawing

Version 1



1 Fuel distribution housing
2 Fuel line
3 Adapter
4 Sealing ring
5 Stud M 10
6 Hex screw
7 Nut
8 O-ring
9 Filter head
10 Filter cartridge
11 Screw
12 O-ring
13 Blanking plug
14 Pressure maintaining valve (2 bar)
15 Valve (1.7 bar)
16 Valve
17 Flange
18 O-ring
19 Hex screw
20 Plug-in pipe
21 O-ring
22 Union
23 O-ring
24 Flange
25 Blanking plug
26 Union
27 Union
28 Union
29 Union

Version 2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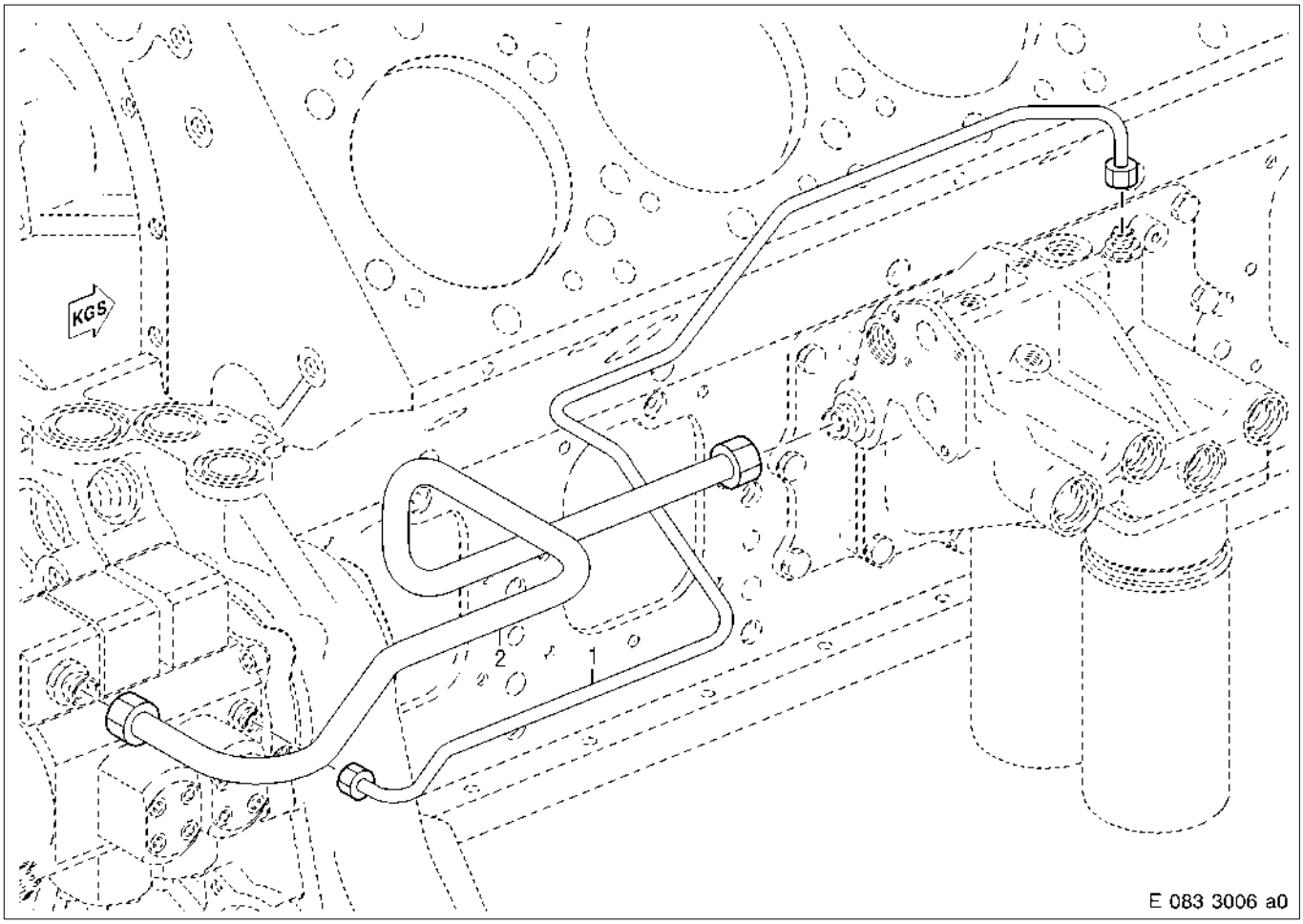


1 Fuel line
2 Fuel return line

C083.05.02 Special tools

Designation	Use/dimension	Number
• Oil filter wrench	also for fuel filter	1

C083.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove charge air manifold	→ C 124.05.05
–	x	x	Remove fuel supply line	→ C 086.05.05

C083.05.05 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

Remove fuel filter with oil filter wrench and dispose of in accordance with local regulations.

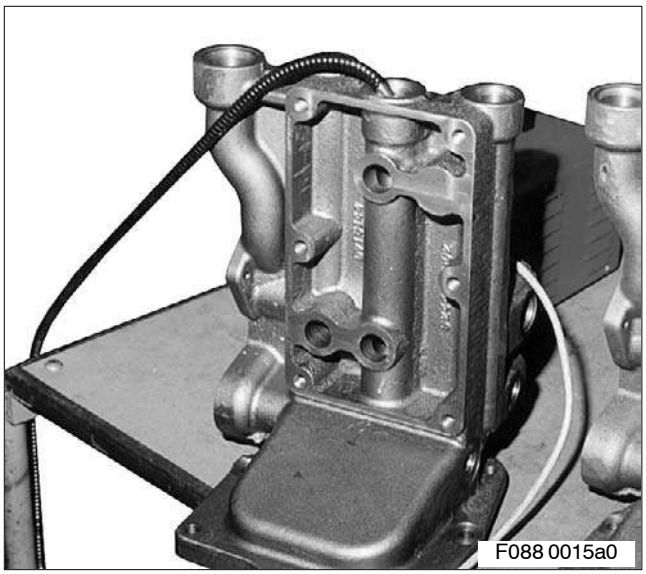
Remove plug-in pipes and flanges as shown in overview drawing – see C083.05.01.

Remove fuel distribution housing as shown in overview drawing – see C083.05.01.

C083.05.06 Disassembly

Disassemble filter head and distribution housing as shown in overview drawing – see C 083.05.01.

C083.05.08 Inspection and repair



Examine all channels with cold light and check for contamination.

Clean channels with nylon brush and fuel.

Visually inspect valves and hand pump for condition and damage; replace if necessary.

Check valves for leaks and correct opening pressure; if leaks are found or opening pressure is incorrect, replace valves.

Note: Make sure fuel-carrying components are perfectly clean.

Clean fuel lines, flanges and valves with cleaner, check for damage (visual inspection) and replace 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 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.

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

Note: The component must likewise reach this temperature.

Test pressure: 0.5 bar

Check threads of union nuts and single-ended unions for ease of movement; recondition or replace part as required.

Check condition of studs in crankcase (see overview drawing C083.05.01) and thread for ease of movement; replace studs if necessary.

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

Replace components with damaged or indented sealing tapers.

Replace gaskets and O-rings.

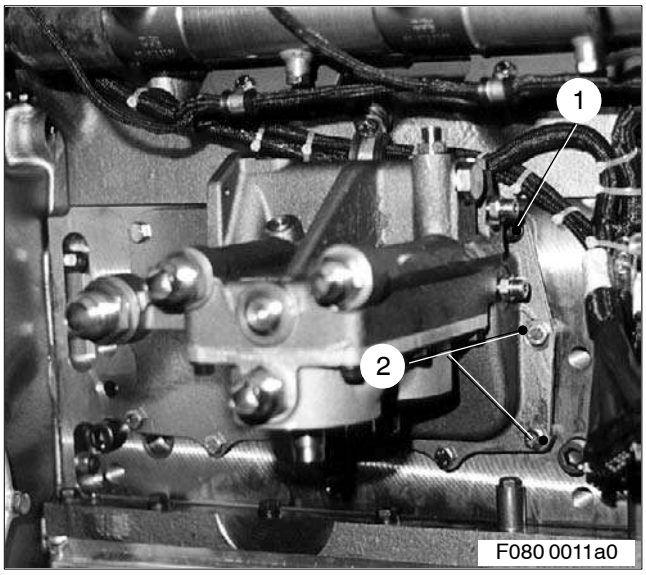
C083.05.10 Assembly

Note: Make sure fuel-carrying components are perfectly clean.
Coat O-rings with petroleum jelly and place in filter bowl.
When installing the valve (16) (see overview drawing C 083.05.01), pay attention to direction of flow.

Assemble filter head and distribution housing as shown in overview drawing – see C 083.05.01.

C083.05.11 Installation

Note: Make sure fuel-carrying components are perfectly clean.



Coat O-ring with petroleum jelly and insert in distributor housing.

Fit fuel distribution housing on studs on crankcase.

Fit nuts (1).

Screw in hex screws (2).

Install nuts and hex screws and tighten.

Assemble plug-in pipes and flanges as shown in overview drawing – see C083.05.01.

Note: Fit O-rings on plug-in pipes or in annular grooves of flanges and coat with petroleum jelly.

Coat sealing ring (filter) with fuel.

Install fuel filter and tighten manually.

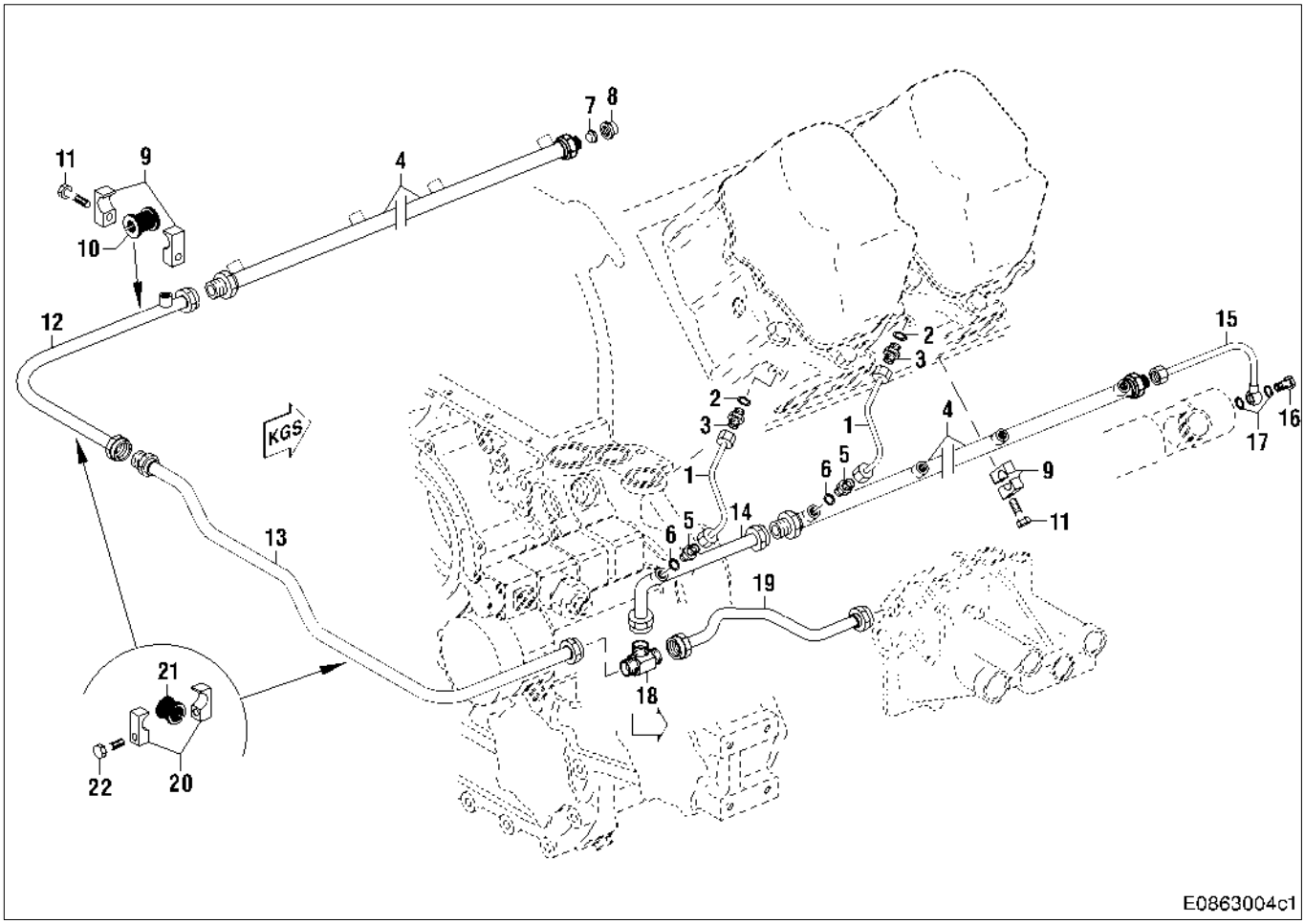
Note: Do not use any tool to attach filter element!

C083.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Install fuel supply line	→ C 086.05.11
–	x	x	Installing charge air manifold	→ C 124.05.11
–	–	x	Release engine start	→ Operating Instructions
–	–	x	Vent fuel system	→ Operating Instructions

C086.05 Leak-off fuel guide

C086.05.01 Overview drawing



1 Fuel return line
2 Sealing ring
3 Union
4 Fuel collecting line
5 Union
6 Sealing ring
7 Sealing cone
8 Sealing nut
9 Pipe clamp half
10 Grommet
11 Hex screw
12 Fuel return line
13 Fuel return line
14 Fuel return line
15 Fuel return line
16 Banjo screw
17 Sealing ring
18 T-piece
19 Fuel return line
20 Pipe clamp half
21 Grommet
22 Hex screw

C086.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Remove charge air manifold (as required)	→ C 124.10

C086.05.05 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.

C086.05.08 Inspection and repair

Clean fuel lines with cleaner. Check condition of lines and inspect for damage; replace lines 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 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.

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

Note: The component must likewise reach this temperature.

Test pressure: 0.5 bar

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 sealing rings as part of every assembly.

Replace grommets as part of every W6 overhaul.

C086.05.11 Installation

Connecting leak-off fuel lines

Note: Before installation, remove all blanking plugs.

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 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.

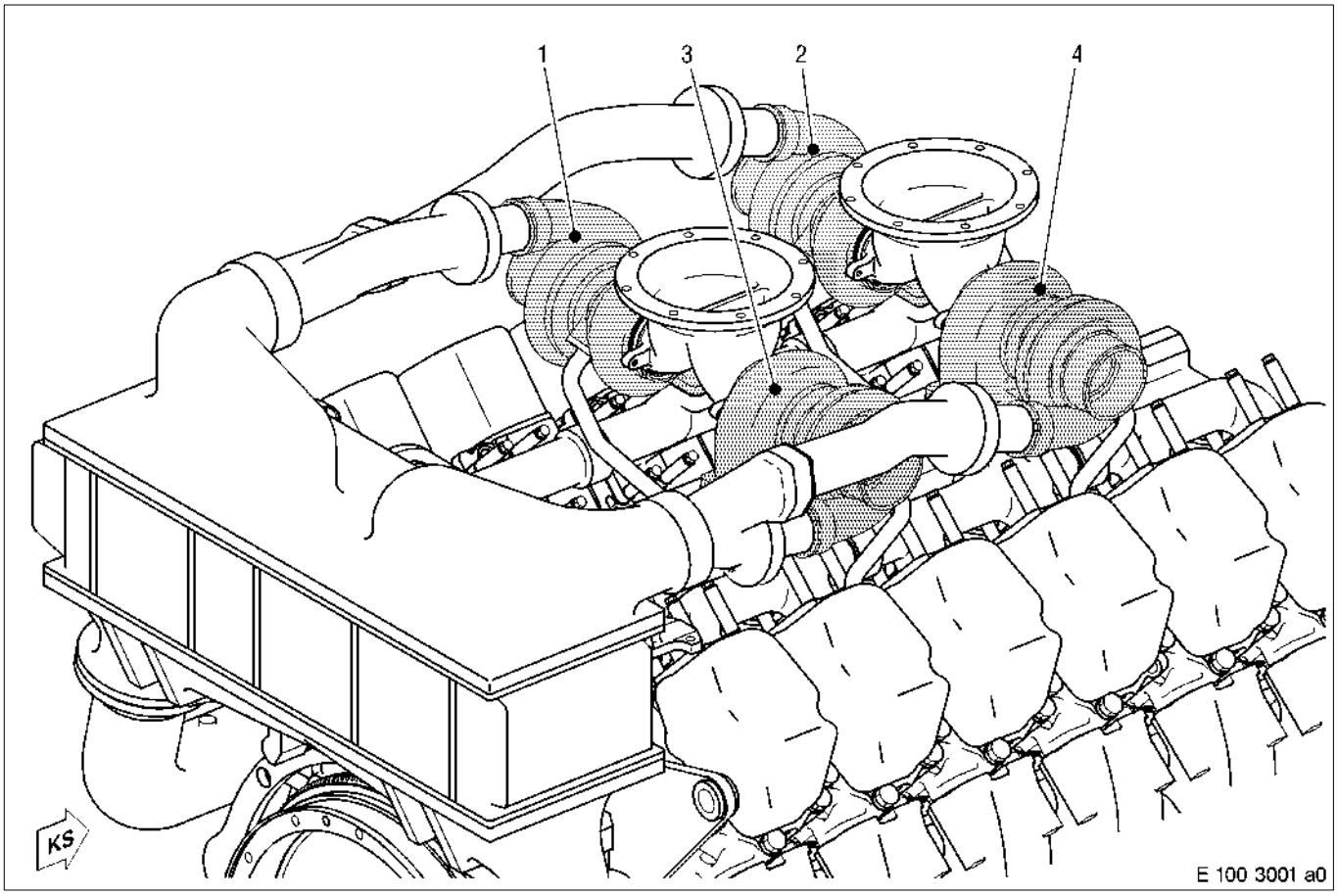
Install leak-off fuel lines with securing elements in accordance with overview drawing (see C 086.05.01) or as per the photos or markings, ensuring they are free of tension.

Note: After engine start, visually inspect fuel system for leaks.

C086.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 086.05.04
–	–	x	Release engine start	→ Operating Instructions

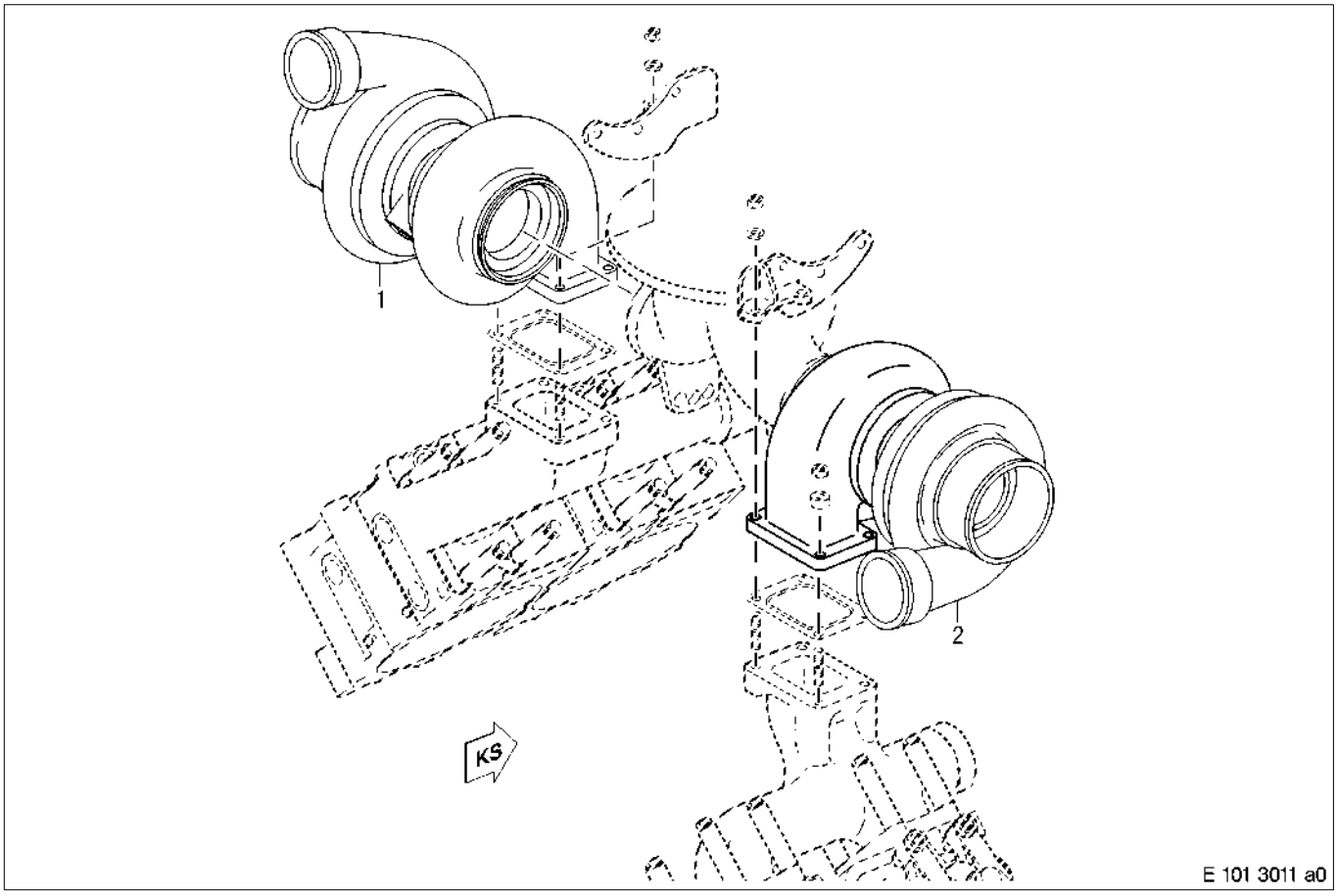
C100 Exhaust turbocharger



1 Exhaust turbocharger, front left
2 Exhaust turbocharger, rear left
3 Exhaust turbocharger, front right
4 Exhaust turbocharger, rear right

C101.01 Exhaust turbocharger

C101.01.01 Overview drawing



1 Exhaust turbocharger, left (2 x)
2 Exhaust turbocharger, right (2 x)

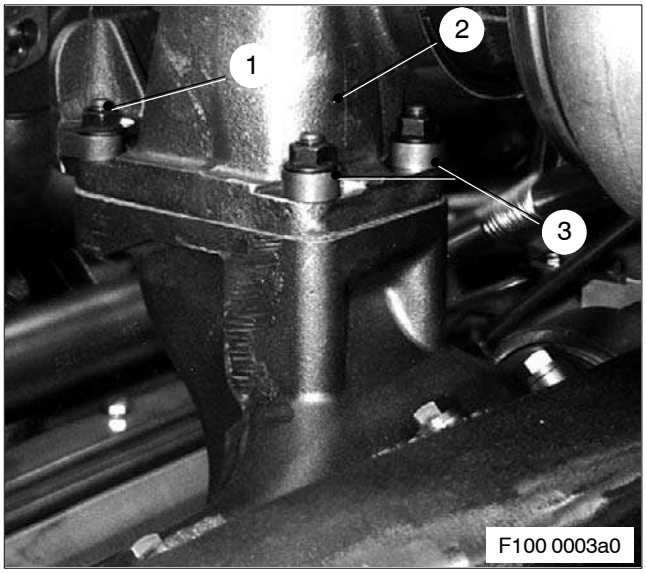
C101.01.02 Special tools

Designation	Use/dimension	Number
• Support bracket	for 2 exhaust turbochargers with Y-pipe (G00 engines)	1

C101.01.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	→ –
–	x	x	Remove exhaust system after Y-pipe	→ –
–	x	x	Remove intermediate element of charge air manifold on exhaust turbocharger	→ C 125.05
–	x	x	Remove oil supply lines for turbochargers	→ C 185.10
–	x	x	Remove oil return lines for turbochargers	→ C 185.25

C101.01.05 Removal



Unscrew hex nuts (1) on flange of exhaust turbocharger (2), left and right engine side.

Remove spacer bushes (3).

⚠ WARNING

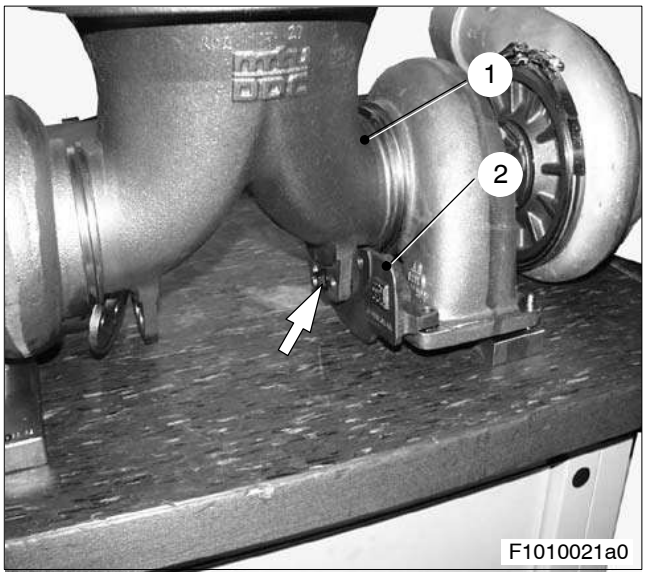
Heavy object.
Risk of injury!
Use suitable tools and lifting equipment.

Install support bracket on left and right of exhaust distribution housing. Use crane to carefully lift entire assembly, including Y-pipe, from studs.

Support bracket on this picture corresponds to workshop fittings.

Note: When lifting turbocharger, secure Y-pipe to prevent it slipping out of turbocharger.

Remove gasket from exhaust line.



Remove carrier.

Note: Secure Y-pipe against twisting in the exhaust turbocharger.

Release nut (arrow), unscrew washer and hex screw from Y-pipe (1) and bracket (2).

Remove brackets and both turbochargers from Y-pipe.

Remove both turbochargers from Y-pipe.

Remove piston rings from Y-pipe.

C101.01.06 Disassembly

Disassembly of the turbocharger is not planned.

The turbocharger is an exchangeable component and can be obtained in the exchange procedure.

C101.01.08 Inspection and repair

Testing and repairing the turbocharger is not planned.

The exhaust turbocharger is a replacement component.

Clean Y-pipe and visually inspect for damage and defects; replace as necessary.

Using the surface crack-testing method with fluorescent penetrant dye, check Y-pipe for cracks.

Check all sealing and seating faces for damage and surface irregularities; rub down with an oilstone or emery cloth as necessary.

Check thread of studs for ease of movement; replace studs as necessary.

Always replace nuts securing exhaust turbocharger, sealing rings and gaskets.

C101.01.10 Assembly

See remarks under C 101.01.06.

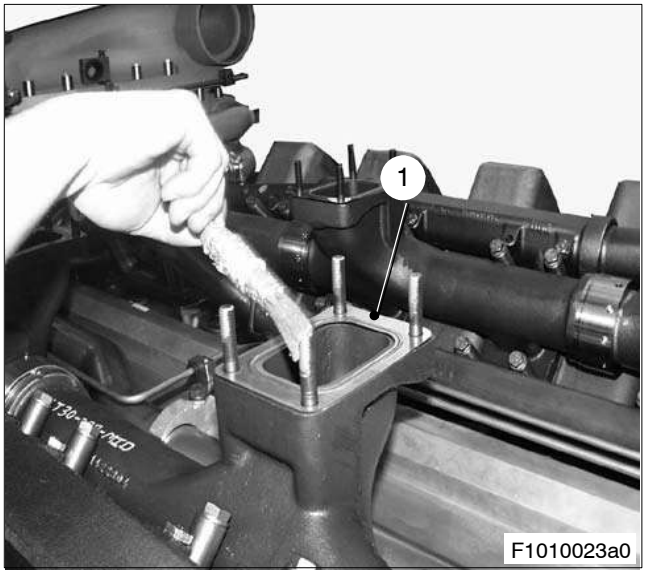
C101.01.11 Installation

Installing turbocharger

Insert piston ring in groove (arrow) provided on Y-pipe.

Coat piston ring outer surface with Ultratherm assembly paste.

Insert end unions (arrow) of Y-pipe on turbine side into exhaust turbocharger.

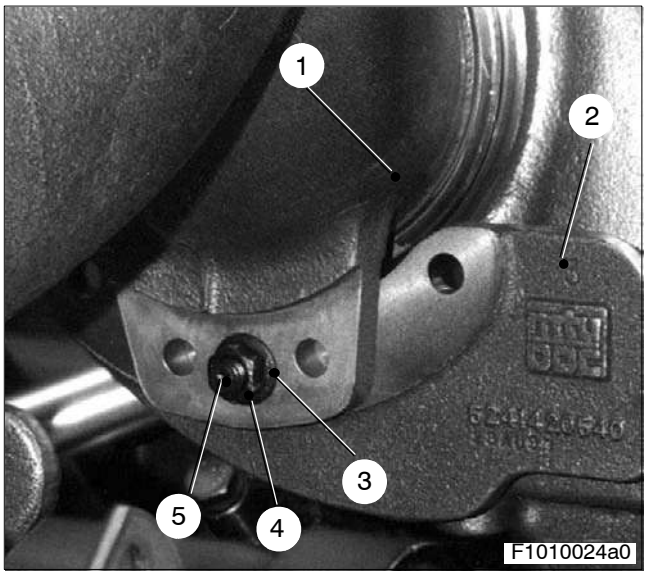


Fit gasket (1) and coat studs with Ultratherm assembly paste.

⚠ WARNING

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

Install support bracket on left and right of exhaust distribution housing. Attach four chains and carefully lift entire assembly, including Y-pipe, and place on appropriate point of installation.

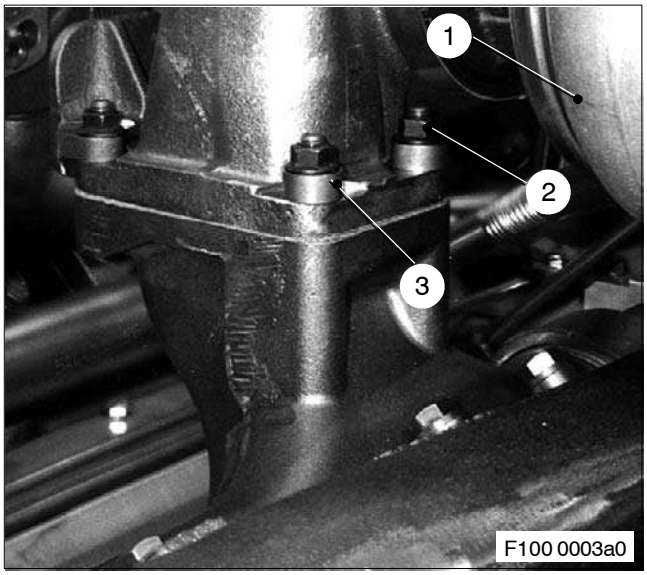


Bolt bracket (2) and Y-pipe (1) together with hex screw (5), washer (3) and nut (4).

- Tightening torque: 40 Nm

Note: Secure Y-pipe to prevent slipping.

Note: Join retainers on Y-pipe and bracket at central bores. Final alignment of Y-pipe with exhaust pipework can be carried out in installed condition.



⚠ WARNING

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

Fit spacer bushes (3).

Tighten exhaust turbocharger (1) diagonally and evenly with hex nuts (2).

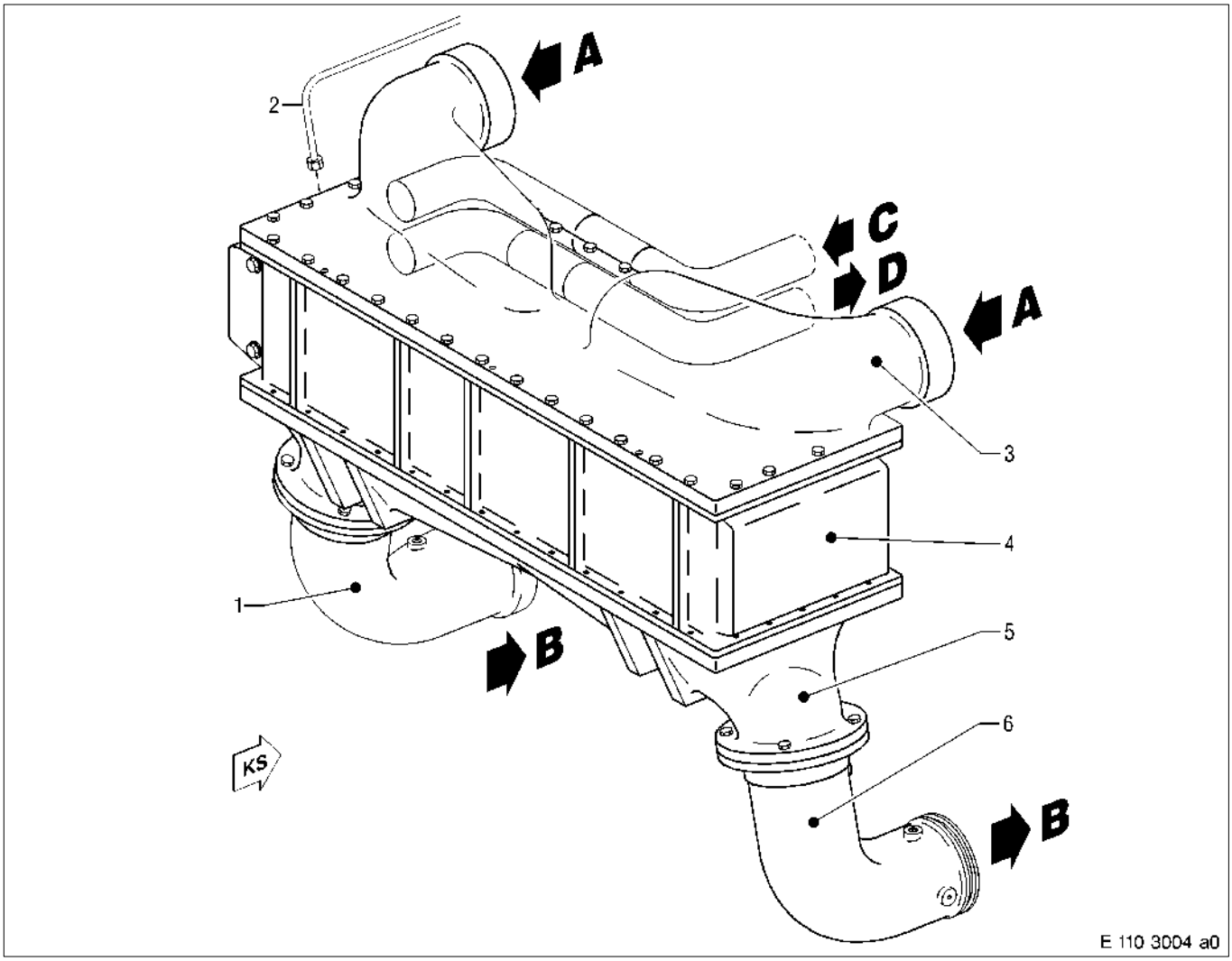
– Tightening torque: 40 Nm

Install support brackets on left and right of turbocharger and align entire assembly.

C101.01.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 101.01.04
–	–	x	Release engine start	→ Operating Instructions

C110 Charge air cooling

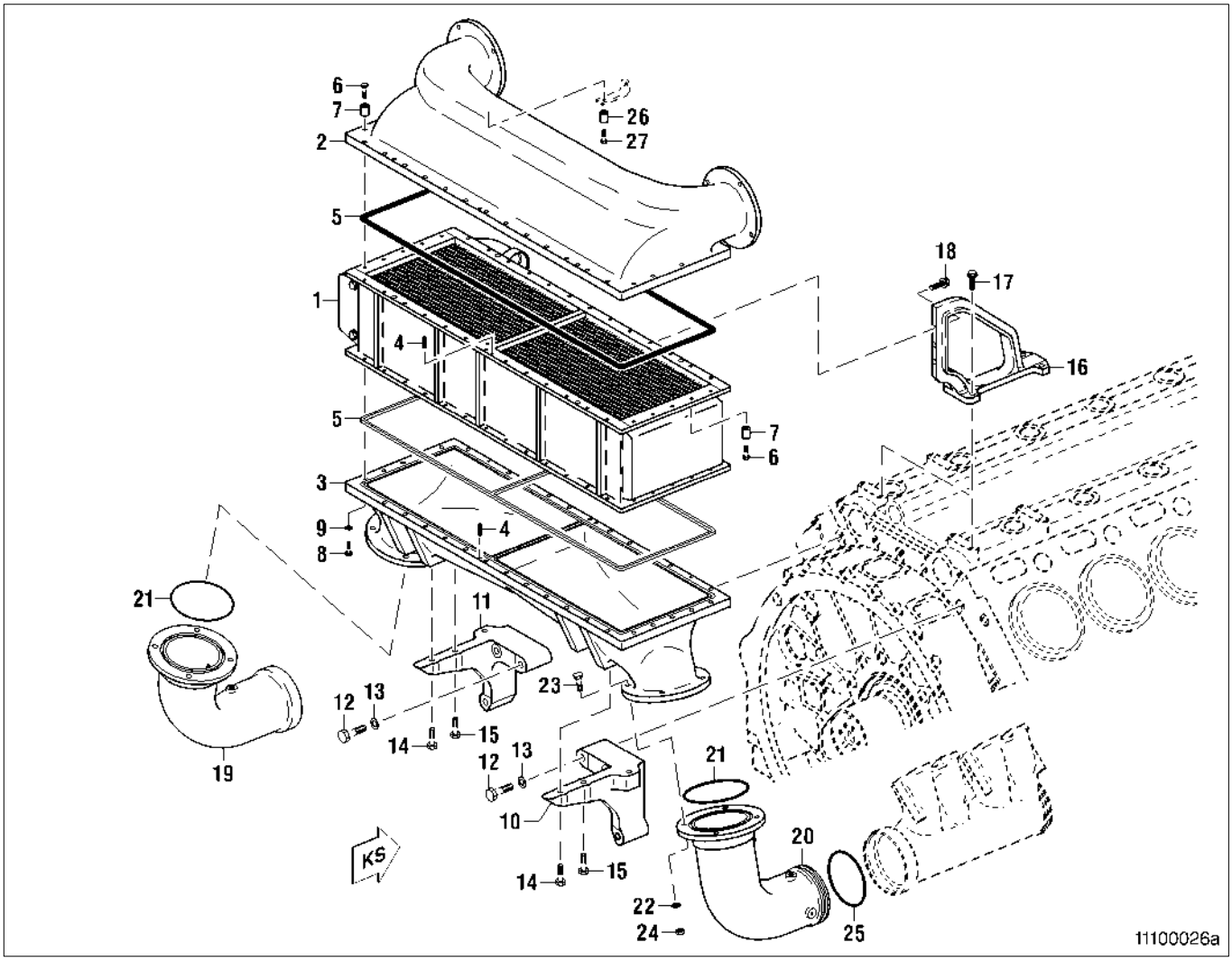


1 Elbow, left side
2 Vent side
3 Connecting housing, top
4 Intercooler element
5 Connecting housing, bottom
6 Elbow, right side

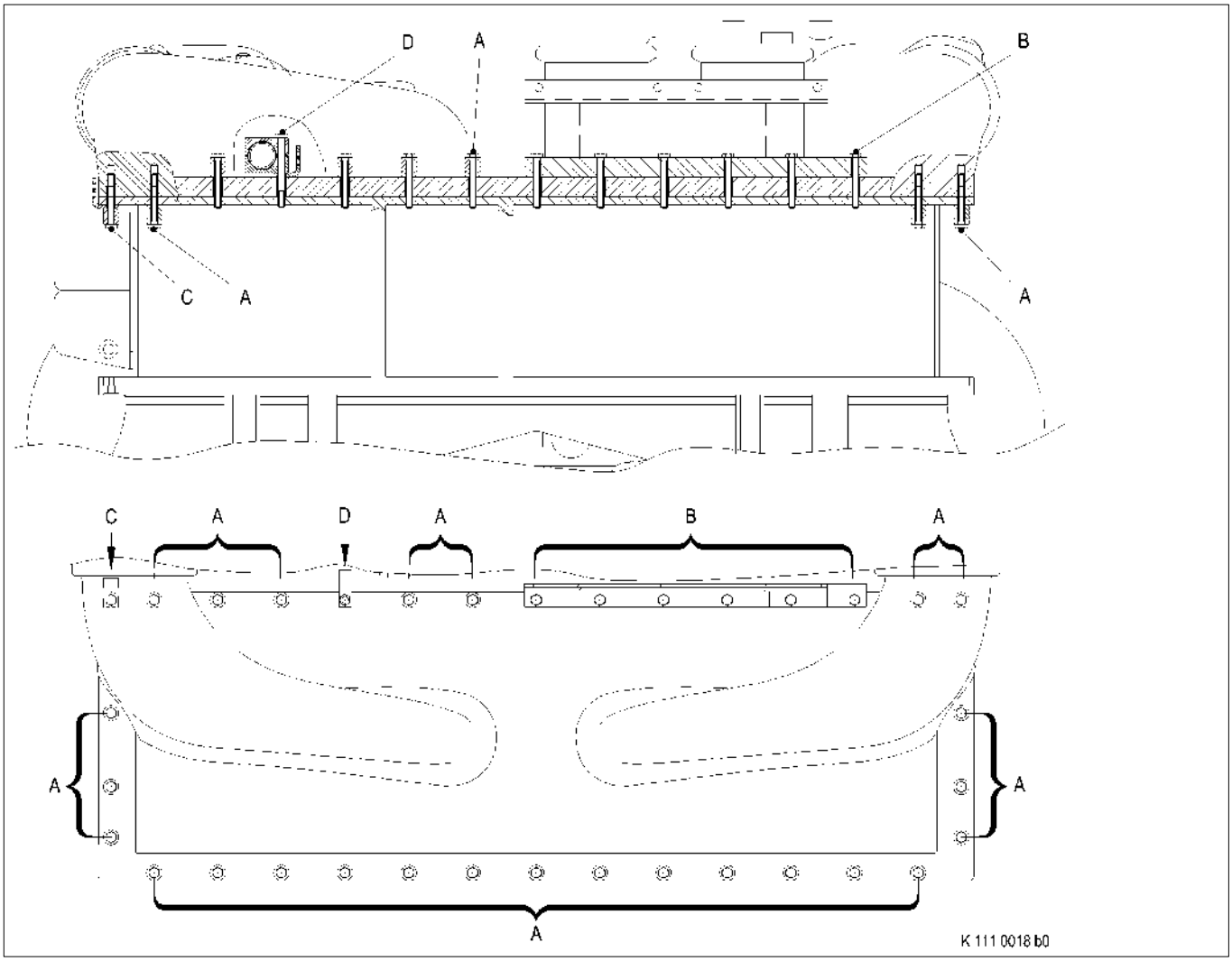
A Air inlet (from exhaust turbocharger)
B Air outlet (to cylinder)
C Coolant inlet
D Coolant outlet

C111.05 Intercooler

C111.05.01 Overview drawing



1 Intercooler	8 Hex screw	15 Hex screw	22 Washer
2 Connecting housing, top	9 Washer	16 Bracket	23 Hex screw
3 Connecting housing, bottom	10 Bracket, right	17 Hex screw	24 Nut M12
4 Dowel pin	11 Bracket, left	18 Hex screw	25 O-ring
5 O-ring	12 Hex screw	19 Elbow	26 Spacer sleeve
6 Hex screw	13 Washer	20 Elbow	27 Hex screw
7 Spacer sleeve	14 Hex screw	21 O-ring	



A Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

B Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

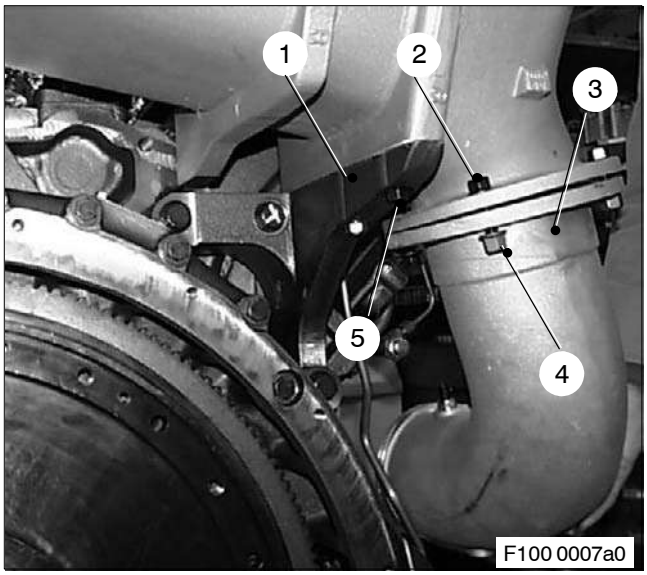
C Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

D Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

C111.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Remove monitoring system	→ C 500.05.04
–	–	x	Remove charge air manifolds	→ C 125.05.04
–	–	x	Remove coolant vent line	→ C 206.05.04
–	–	x	Drain engine coolant	→ Operating Instructions
–	x	x	Remove coolant lines	→ C 202.15.04

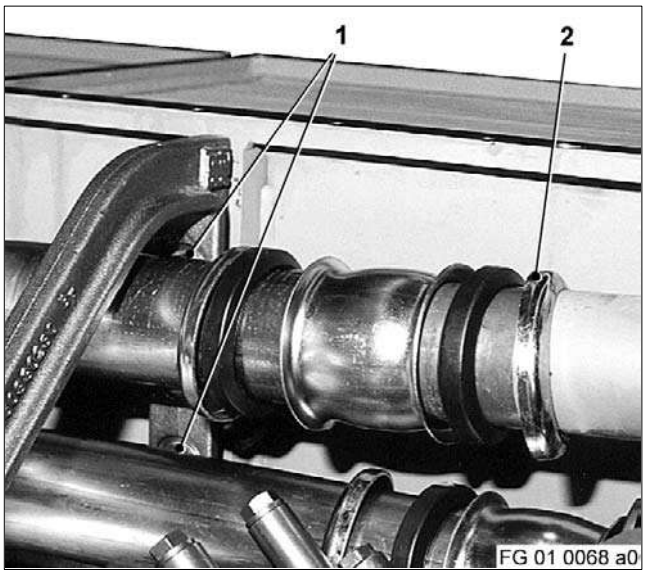
C111.05.05 Removal



Removing intercooler

Remove hex screws (5) from bracket (1).

Unscrew nuts (2) from elbow (3) and remove hex screws (4).



Release pipe clamps (2) from coolant inlet and outlet.

Remove pipes for coolant inlet and outlet.

Remove securing screws (1) between intercooler and bracket.

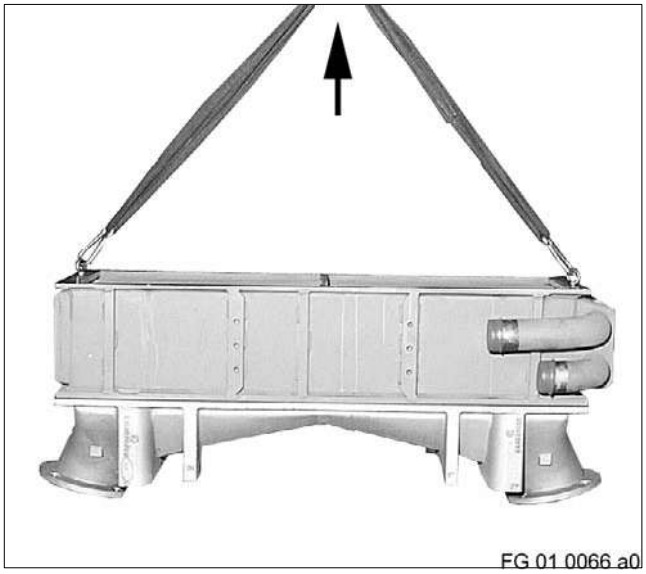
⚠ WARNING

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

Attach intercooler to crane with rope and carefully raise from engine.

Note: After removing intercooler, seal all connections on engine with suitable plugs and covers.

C111.05.06 Disassembly



Unscrew hex screws between intercooler and connecting housing, top.

Lift off connecting housing.

Unscrew hex screws between connecting housing, bottom, and intercooler.

Remove intercooler from connecting housing, bottom.

Remove rubber profile from connecting housings.

Note: Protect intercooler (in particular the cooling fins) from mechanical damage (e.g. jolts, etc.), e.g. by covering cooling fins with firm cardboard.

C111.05.08 Inspection and repair

The intercooler is an exchangeable component and can be obtained in the exchange procedure.

Clean all components and visually inspect for damage and defects; replace as necessary.

Check connecting housing for cracks using surface crack-testing method with red penetrant dye.

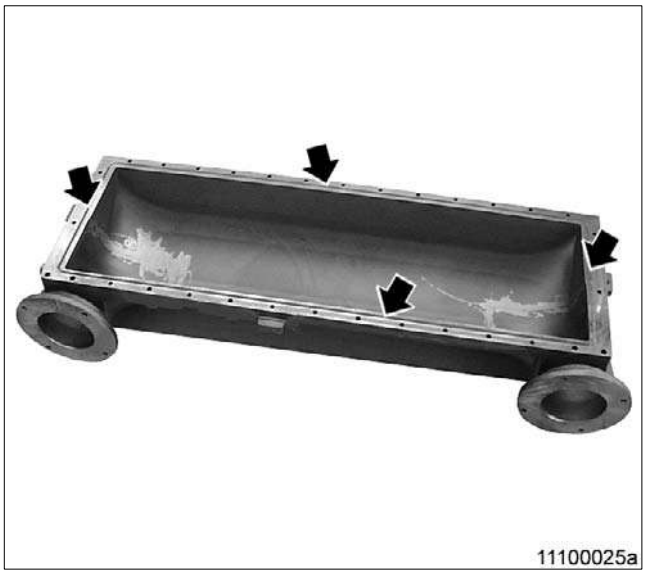
If cracks are detected, replace part.

Clean all sealing, contact and mating faces off remaining particles of seal and check for damage and unevenness; if necessary, smooth with oilstone or emery cloth.

Check thread in connecting housing for ease of movement; recondition as necessary.

Replace sealing rings and gaskets.

C111.05.10 Assembly

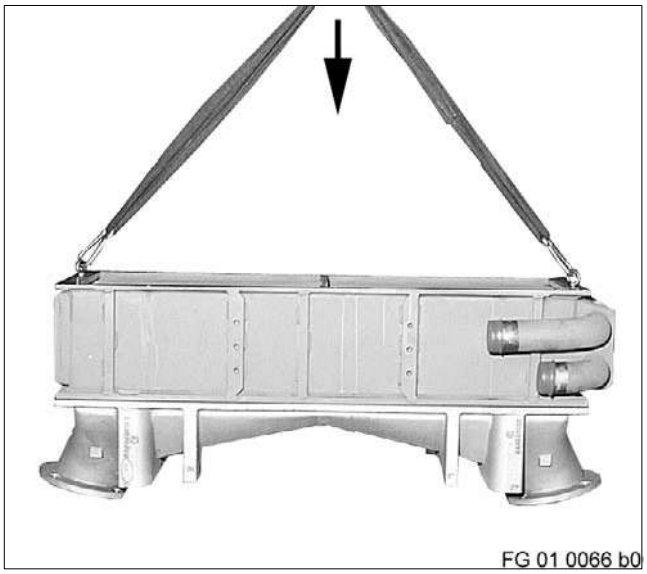


Preparing connecting housing

Insert O-ring in groove (arrow) on upper connecting box.

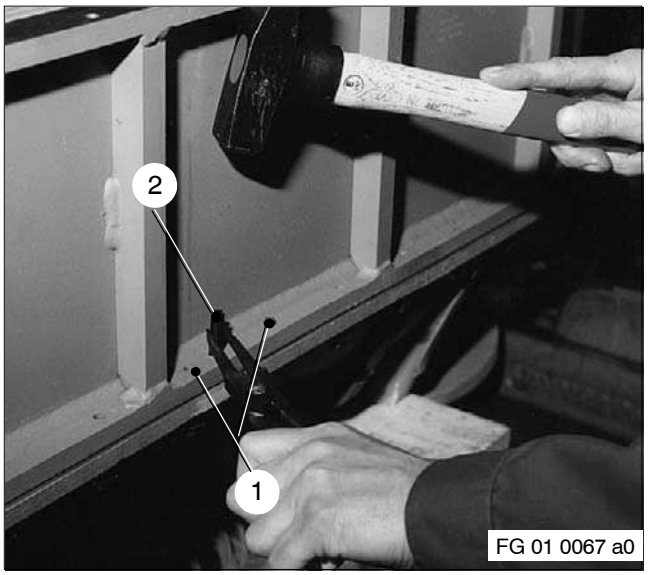
Insert rubber profile in groove on lower connecting box.

Note: Insert dry rubber profile.
Insert T-shaped profile with wide side into groove.



Installing intercooler on lower connecting box

Using rope and crane, carefully place intercooler on lower connecting housing.



Screw in hand-tight the two hex screws (1) in centre of front and rear of intercooler (i.e. immediately to left and right of bore for guide pin (2)).

Drive guide pin into bore provided.

Starting in centre on both front and rear of intercooler, secure four hex screws from centre in both directions, tightening in several stages to specified tightening torque. Then tighten all other hex screws in sequence to tightening torque.

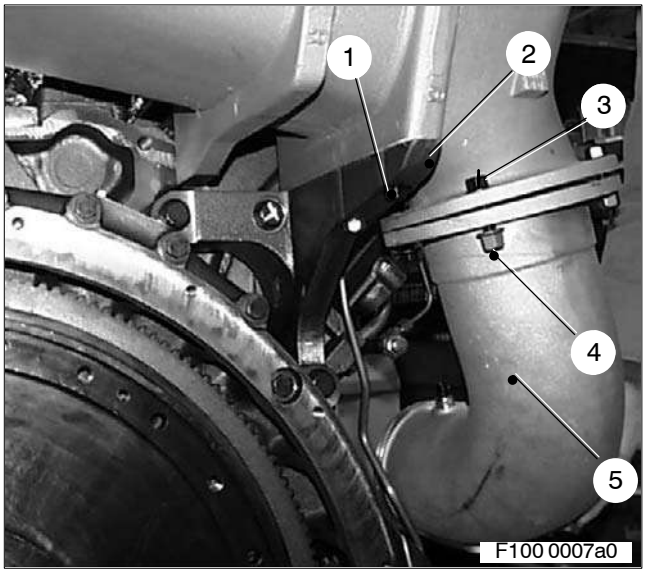
Installing upper connecting box on intercooler

Mount upper connecting box on intercooler. Insert hex screws with spacer sleeves (observe positioning of spacer sleeves) all around and tighten to specified torque, see C 111.05.01.

Proceed as for installing lower connecting box.

C111.05.11 Installation

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



Installing intercooler

Coat O-ring with petroleum jelly and fit on elbow flange.

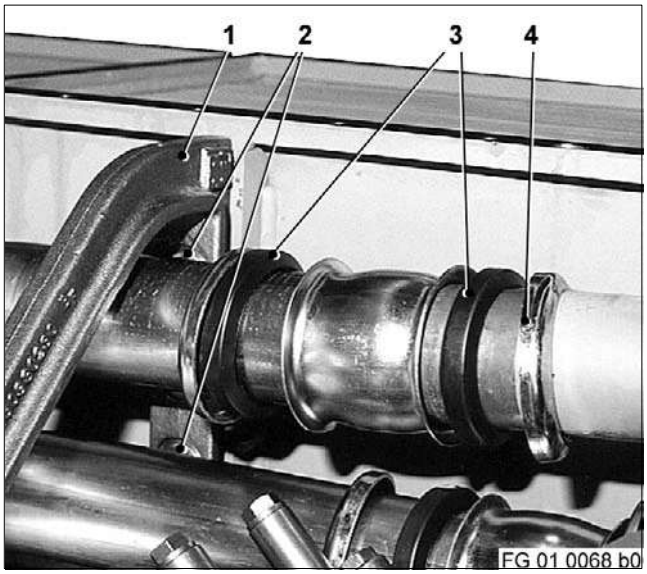
⚠ WARNING

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

Attach intercooler to crane with rope and place on engine.

Screw hex screws (1) in bracket (2).

Secure elbow (5) with hex screws (3) and nuts (4) on intercooler.



Install securing screws (2) between intercooler (1) and bracket.

Fit seal (3).

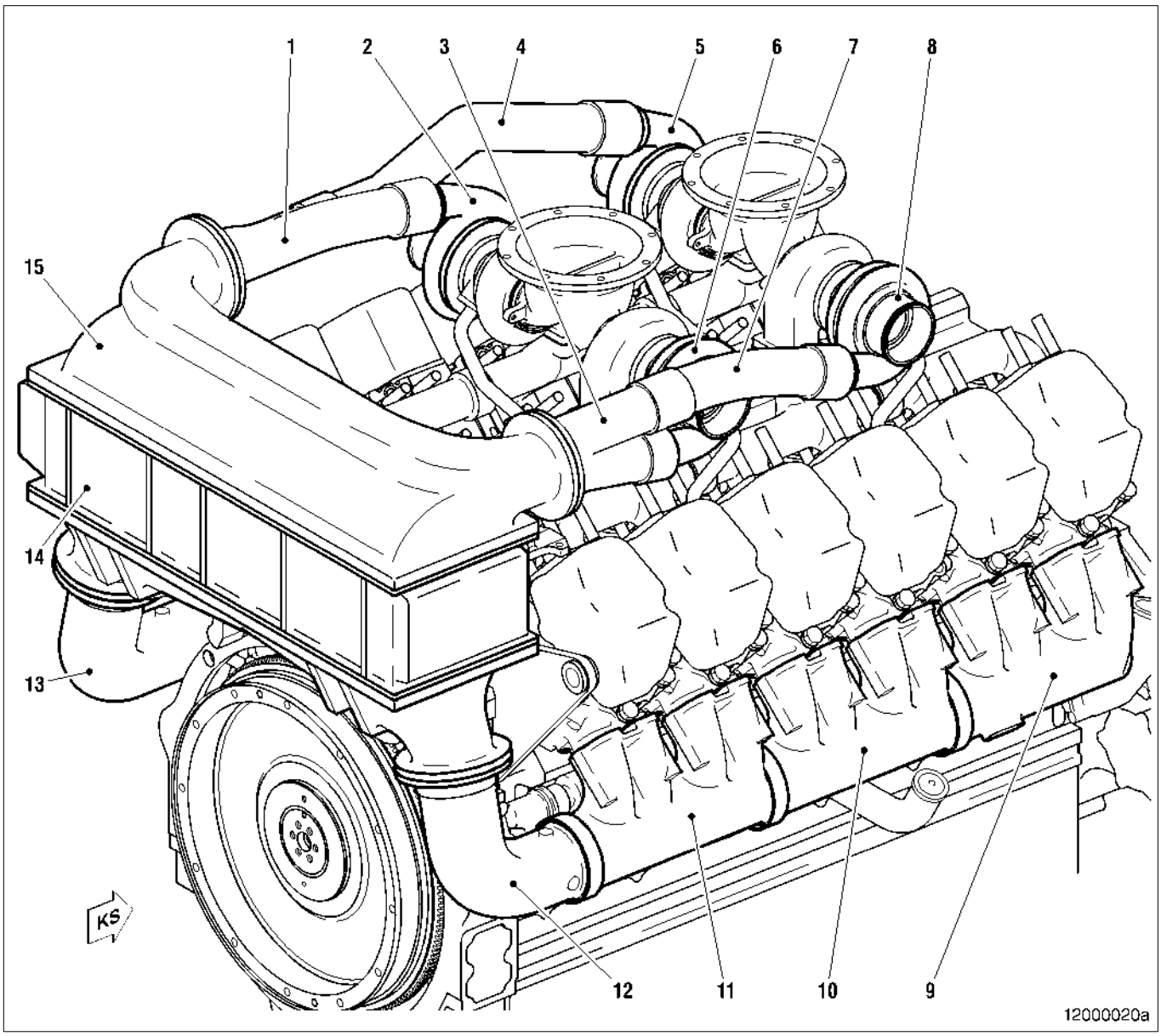
Secure thrust pad (4) for coolant inlet and outlet with appropriate V-clamps.

C111.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Install charge air manifolds	→ C 125.05.11
–	–	x	Install coolant vent lines	→ C 206.05.11
–	–	x	Install monitoring system	→ C 500.05
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C120 Air intake / intake air system

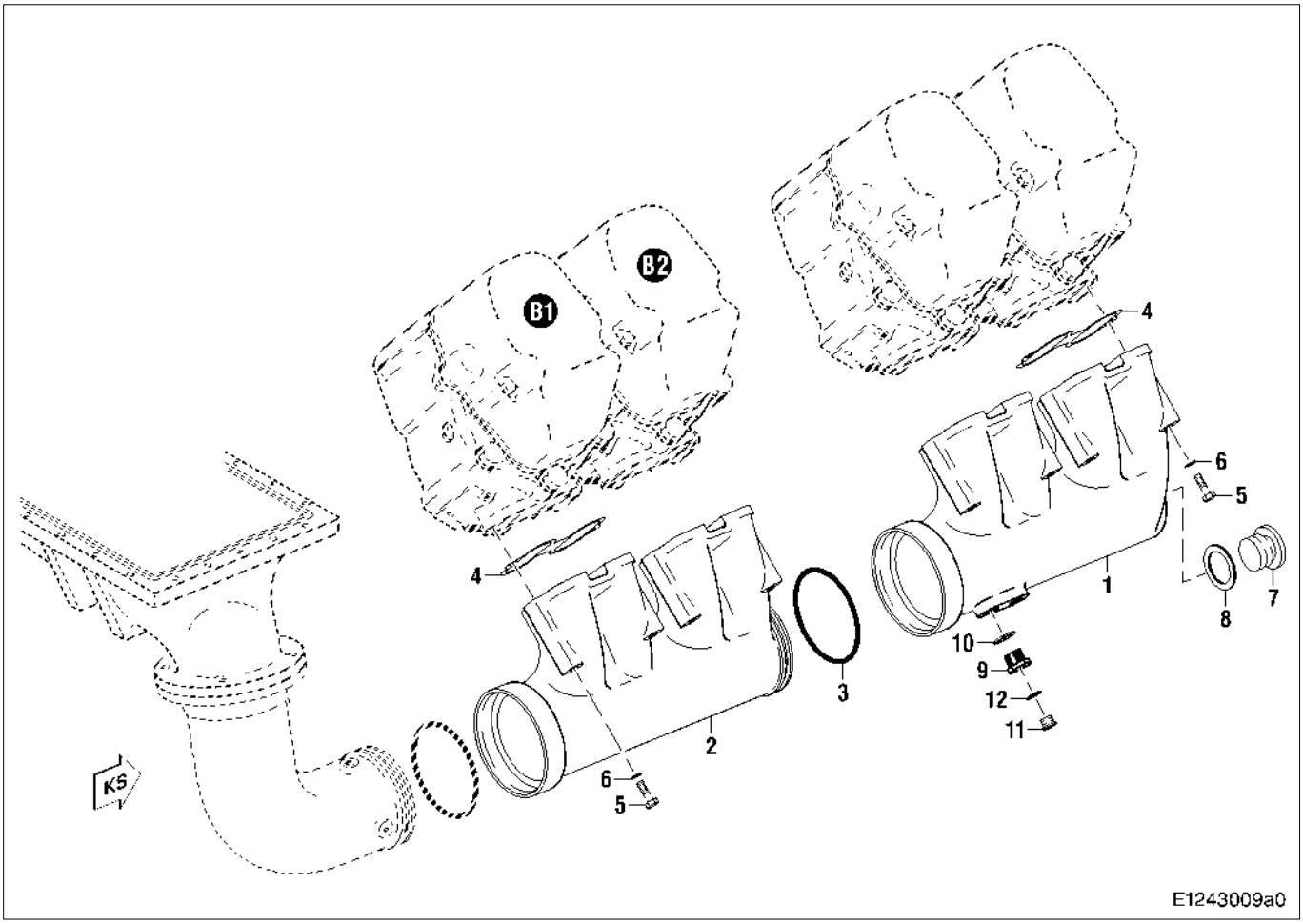
Illustration also applies to 16V 4000 G



1 Connection elbow, left side
2 Exhaust turbocharger, left side (front)
3 Connection elbow, right side
4 Charge air manifold, left side
5 Exhaust turbocharger, left side (rear)
6 Exhaust turbocharger, right side (front)
7 Charge air manifold, right side
8 Exhaust turbocharger, right side (rear)
9 Charge air manifold
10 Charge air manifold
11 Charge air manifold
12 Elbow, right side
13 Elbow, left side
14 Intercooler
15 Connecting housing

C124.05 Air supply to cylinders

C124.05.01 Overview drawing



1 Charge air manifold
2 Charge air manifold
3 O-ring
4 Gasket
5 Hex screw
6 Washer
7 Plug
8 Sealing ring
9 Threaded bush
10 Sealing ring
11 Blanking plug
12 Sealing ring

C124.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C124.05.05 Removal

Remove charge air manifold

Note: Removal starts from the free end.

Remove charge air manifold as per overview drawing C 124.05.01.

Remove gaskets and O-rings.

After removal, seal all apertures with suitable plugs or covers.

C124.05.08 Inspection and repair

Clean all air-carrying components with cleaning agent.

Pressure-test charge air manifold for leaks 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.

Air pressure = 0.5 bar

Replace blanking plugs if necessary (e.g. if leaking) or reseal.

Check charge air manifold for cracks using surface crack-testing method with red penetrant dye as necessary.

Replace charge air manifold in event of cracks.

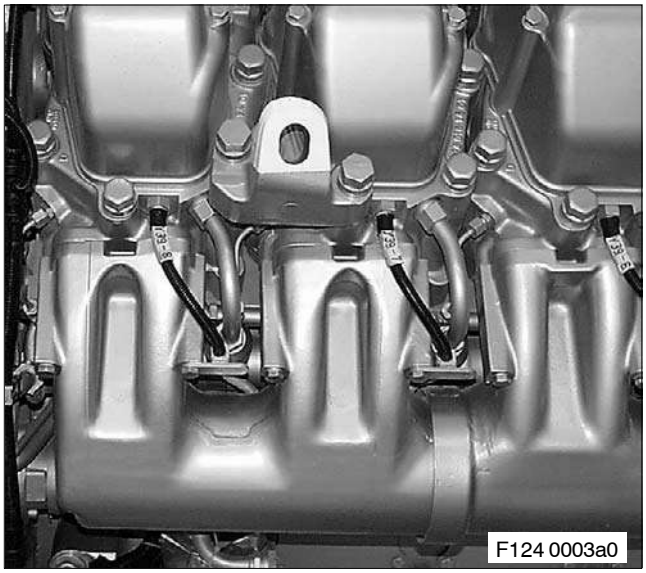
Check sealing and mating faces for surface irregularities and damage; rub down with an oilstone if necessary.

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

Check hex screws for damage and wear; replace as necessary.

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

C124.05.11 Installation



Installing charge air manifold

Note: Prior to installation, remove all plugs and seals and ensure air-carrying lines are perfectly clean.

Fit O-rings on elbow and charge air manifold, see overview drawing C 124.05.01.

Coat gaskets with petroleum jelly and place on charge air manifold sealing surface.

Note: Installation starts from the driving end. Before tightening hex screws, check that gasket is correctly positioned.

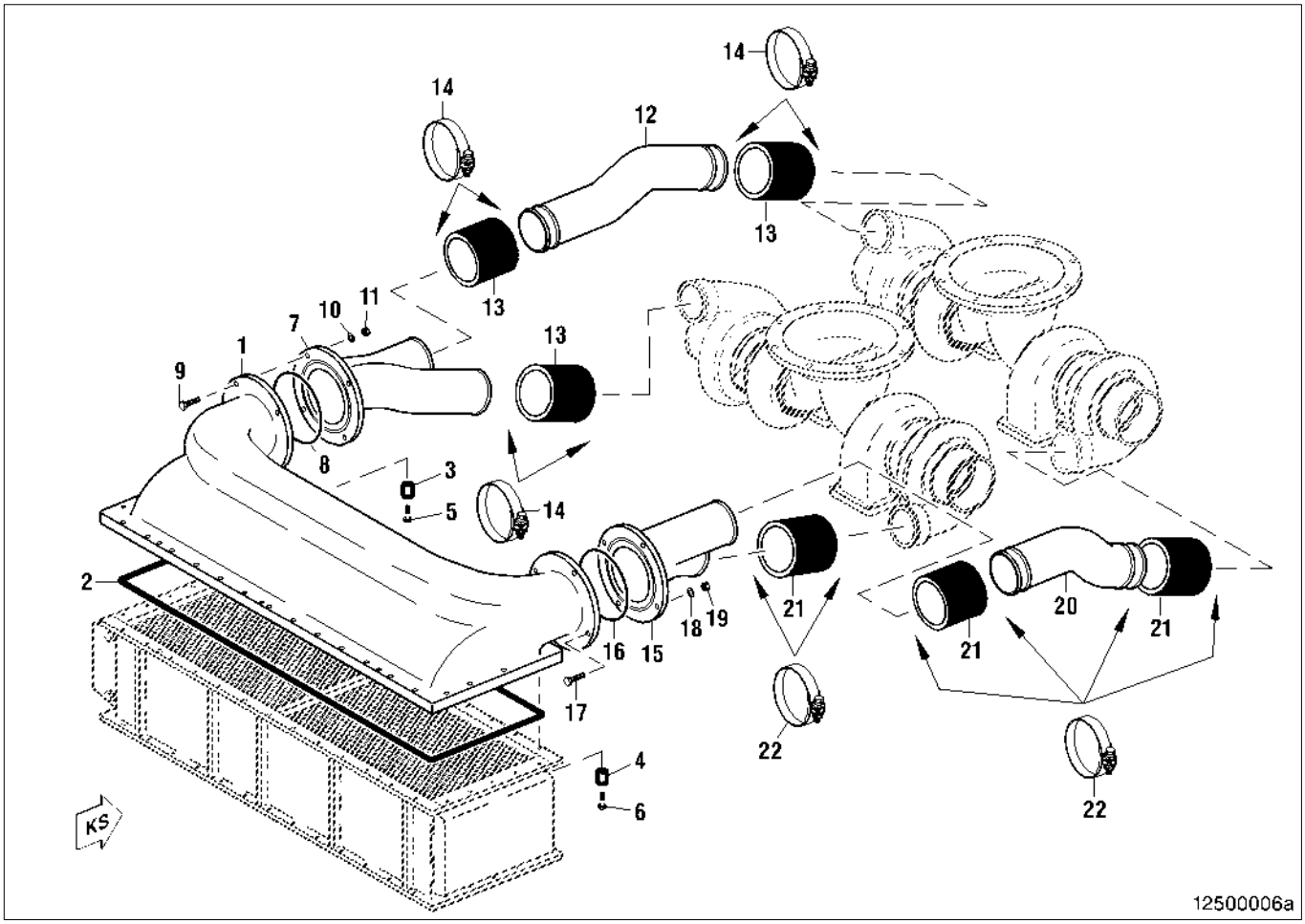
Install charge air manifold as per illustration.

C124.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C125.05 Air pipework from exhaust turbocharger to intercooler

C125.05.01 Overview drawing



1 Connecting housing
2 O-rIng
3 Spacer sleeve
4 Spacer sleeve
5 Hex screw
6 Hex screw
7 Connection elbow
8 O-ring
9 Hex screw
10 Washer
11 Hex nut
12 Charge air manifold, left side
13 Rubber sleeve
14 Clamp
15 Connection elbow
16 O-ring
17 Hex screw
18 Washer
19 Hex nut
20 Charge air manifold, right side
21 Rubber sleeve
22 Clamp

C125.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C125.05.05 Removal

Remove charge air manifold

Remove charge air manifolds as per overview drawing – see C 125.05.01.

Remove O-rings.

After removal, seal all apertures with suitable plugs or covers.

C125.05.08 Inspection and repair

Clean all air-carrying components with cleaning agent.

Pressure-test charge air manifold with air in water bath for leaks.

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.

Air pressure = 0.5 bar

Check charge air manifold for cracks using surface crack-testing method with red penetrant dye as necessary.

Replace charge air manifold in event of cracks.

Check sealing and mating faces for surface irregularities and damage; rub down with an oilstone if necessary.

Visually check retaining plates and brackets for cracks; replace components as 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 if necessary.

Check hex screws for damage and wear; replace as necessary.

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

Replace rubber sleeves and clamps during W6 overhaul.

C125.05.11 Installation

Installing charge air manifold

Note: Prior to installation, remove all plugs and seals and ensure air-carrying lines are perfectly clean.

Insert O-ring in annular groove of connecting housing and coat with petroleum jelly.

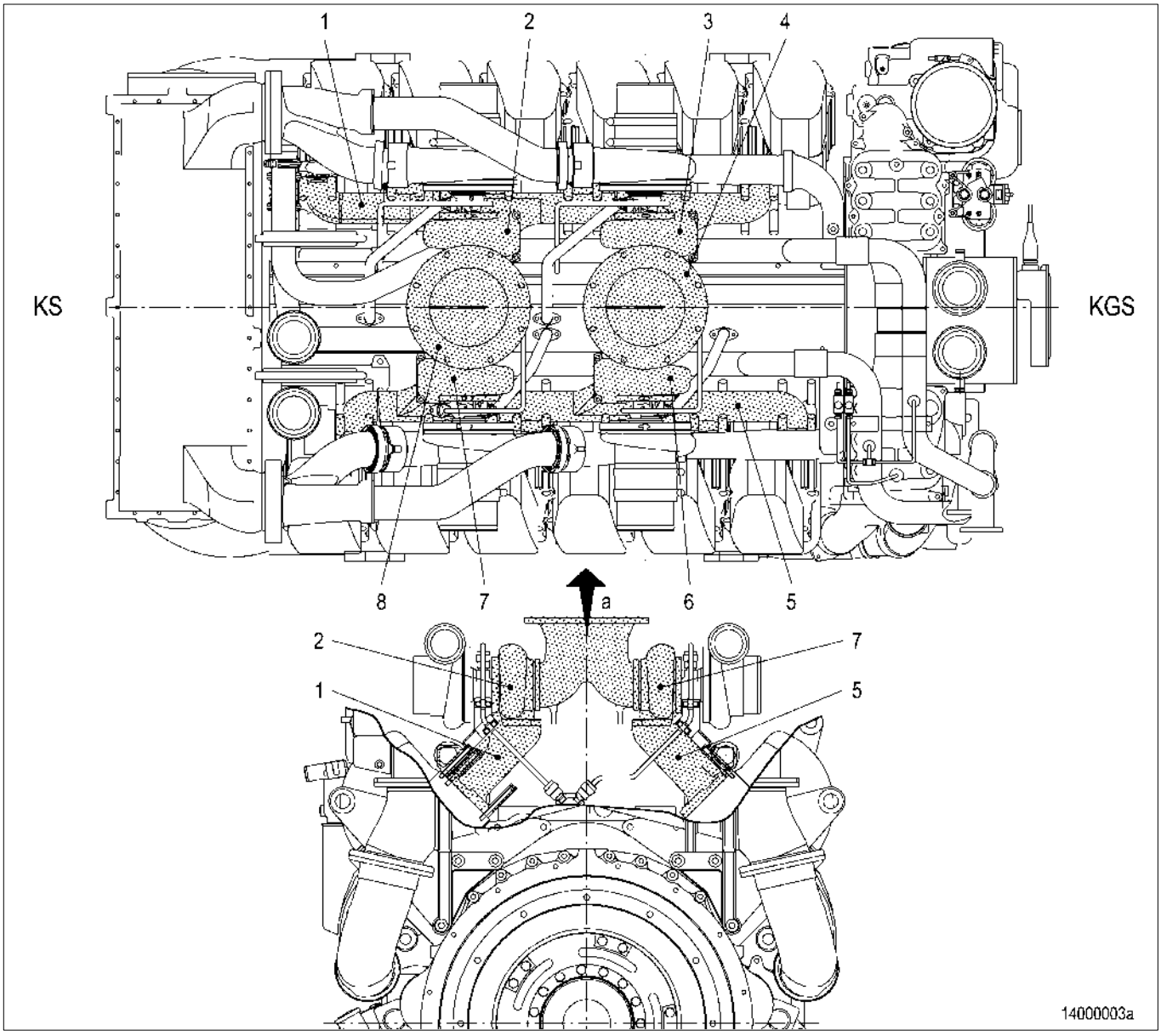
Install connection elbow as per overview drawing (see C 125.05.01) on connecting housing.

Coat rubber sleeves, connection elbows and charge air manifolds with denaturated ethanol and install as per overview drawing (see C 125.05.01).

C125.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

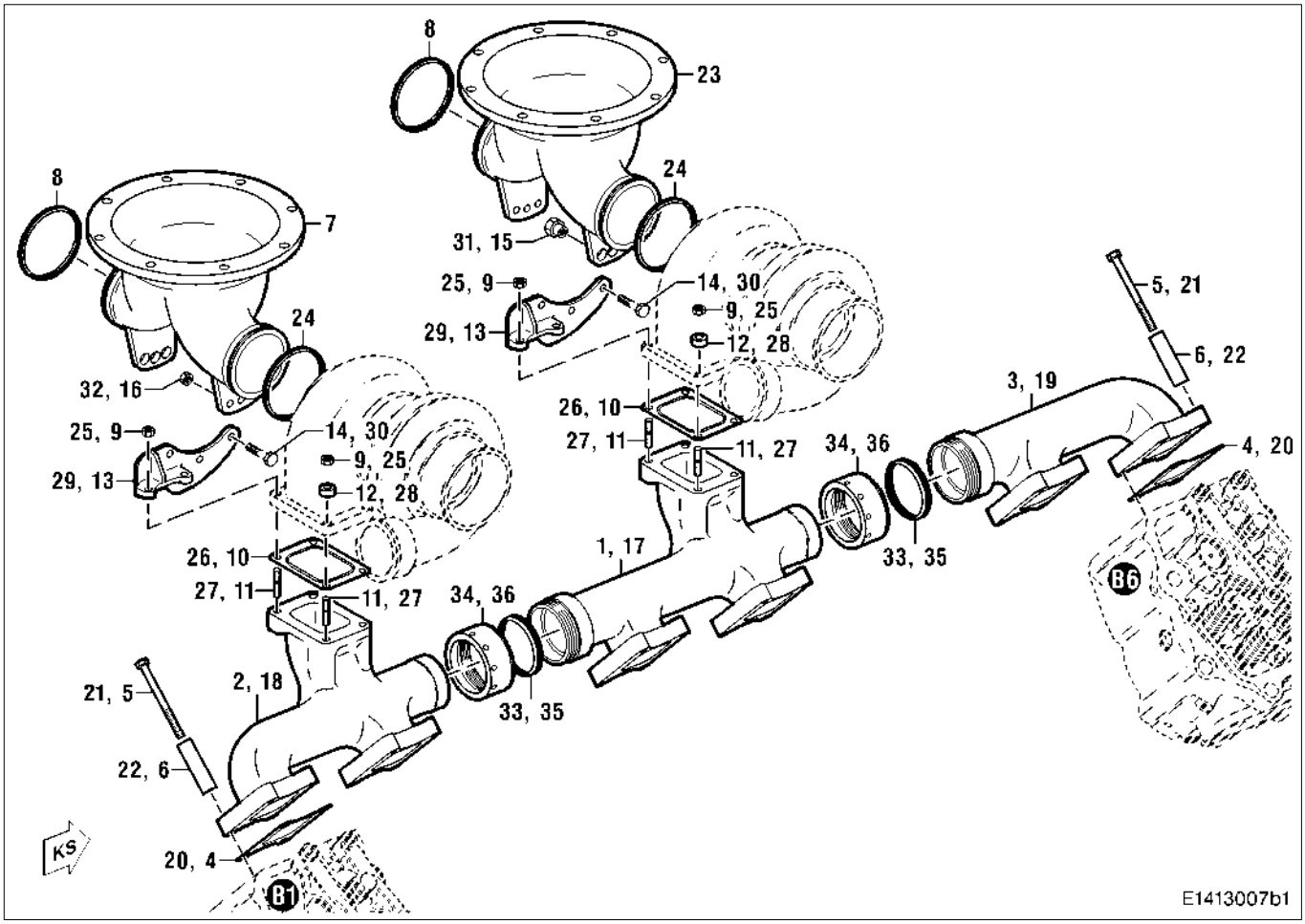
C140 Exhaust system



1 Exhaust manifold, left
2 Exhaust turbocharger, left, driving end
3 Exhaust turbocharger, left, free end
4 Y-pipe, free end
5 Exhaust manifold, right
6 Exhaust turbocharger, right, free end
7 Exhaust turbocharger, right, driving end
8 Y-pipe, driving end

C141.10 Exhaust system after cylinder head

C141.10.01 Overview drawing



1 Exhaust line
2 Exhaust line
3 Exhaust line
4 Gasket
5 Screw
Lubricant: Assembly paste
Tightening torque: 70 Nm
6 Spacer sleeve
7 Y-pipe
8 Piston ring
9 Hex nut
10 Gasket
11 Stud
12 Spacer washer
13 Bracket
14 Hex screw
15 Washer
16 Nut
17 Exhaust line
18 Exhaust line
19 Exhaust line
20 Gasket
21 Hex screw
Lubricant: Assembly paste
Tightening torque: 70 Nm
22 Spacer sleeve
23 Y-pipe
24 Piston ring
25 Hex nut
26 Gasket
27 Stud
28 Spacing washer
29 Bracket
30 Hex screw
31 Washer
32 Nut
33 Sealing ring
34 Union nut
35 Sealing ring
36 Union nut

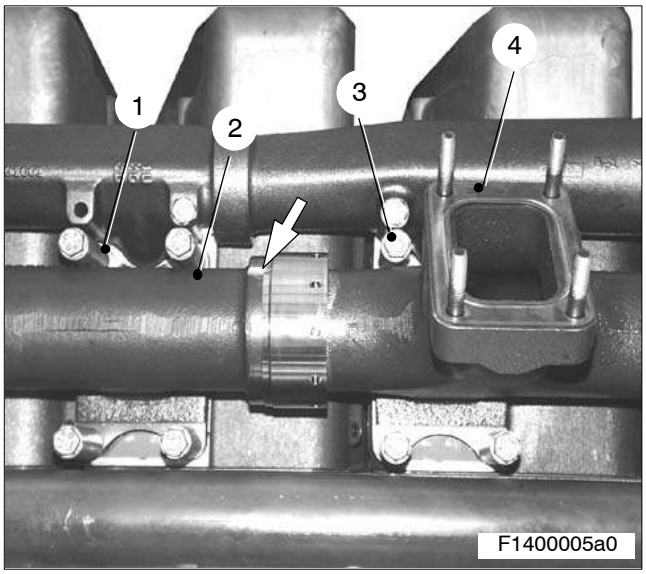
C141.10.02 Special tools

Designation	Use/dimension	Number
• Joint C-wrench	90–155 mm	1
• Torque wrench		1

C141.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	→ –
–	x	x	Remove exhaust system after Y-pipe	→ –
–	x	x	Remove intermediate element of charge air manifold on exhaust turbocharger	→ C 124.05
–	x	x	Remove oil supply lines for turbochargers	→ C 185.10
–	x	x	Remove oil return lines for turbochargers	→ C 185.25
–	x	x	Remove exhaust turbocharger	→ C 101.05
–	x	x	Remove Y-pipe with bracket	→ C 101.01.05

C141.10.05 Removal



Remove gasket (4).

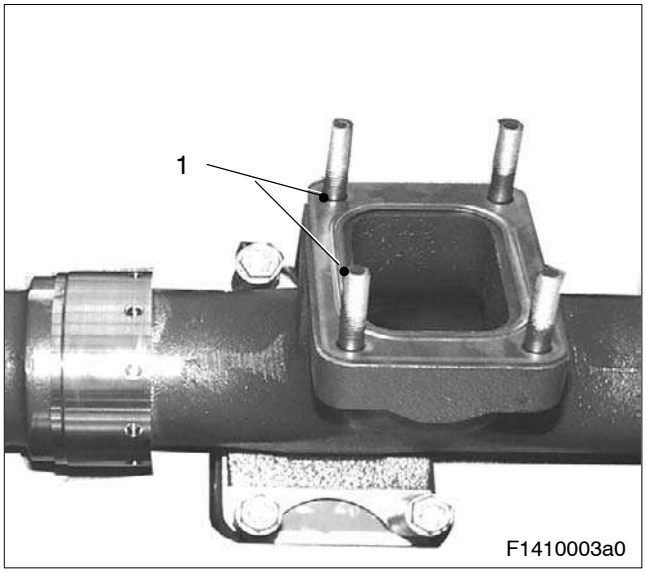
Release peening (arrow) and unscrew union nut with an articulated C-wrench.

Remove all hex screws (3) securing exhaust lines (2) and spacer sleeves (1).

Remove exhaust pipework from engine.

Note: Provide suitable protective covers for openings, cylinder head exhaust outlet.

C141.10.06 Disassembly



Removing studs

Note: Remove studs (1) from exhaust line only if necessary.

Fit hex nut on stud and lock with second hex nut.

Place box wrench on locked hex nut and unscrew stud.

⚠ CAUTION

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

Note: If stud cannot be released with box wrench, slightly heat stud in area of thread. Ensure that only under the colour is heated.

C141.10.08 Inspection and repair

Clean all components and visually inspect for damage and defects; replace as necessary.

⚠ CAUTION

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

Place exhaust elbow and exhaust pipes in a container containing decarbonizer.

Duration of exhaust manifold immersion in cleaning bath depends on thickness of deposit layer.

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 lines for cracks; replace component if cracks are found.

Check exhaust lines for warping; replace line in event of warping.

Check sealing and mating faces; rub down with emery cloth or an oilstone or replace components as necessary.

Check stud thread for damage and ease of movement; rechase as necessary.

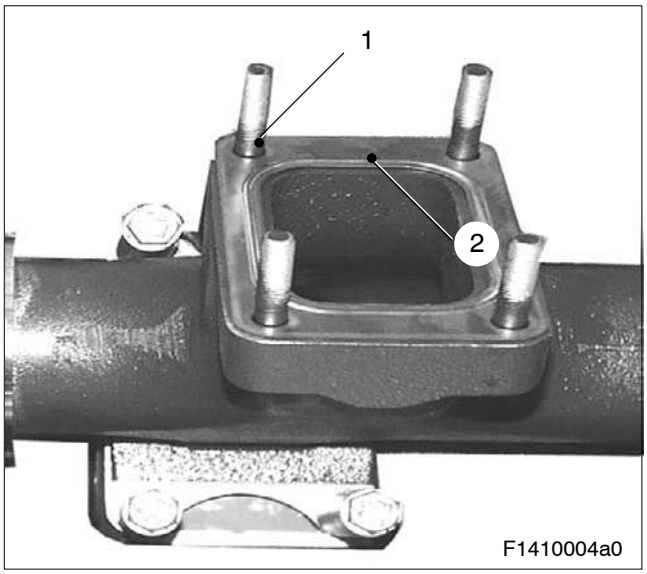
Replace gaskets, studs and nuts.

Remove sealing ring from exhaust manifold and check surface for damage; smooth with emery cloth as necessary.

Check threads of union nuts or replace part as required.

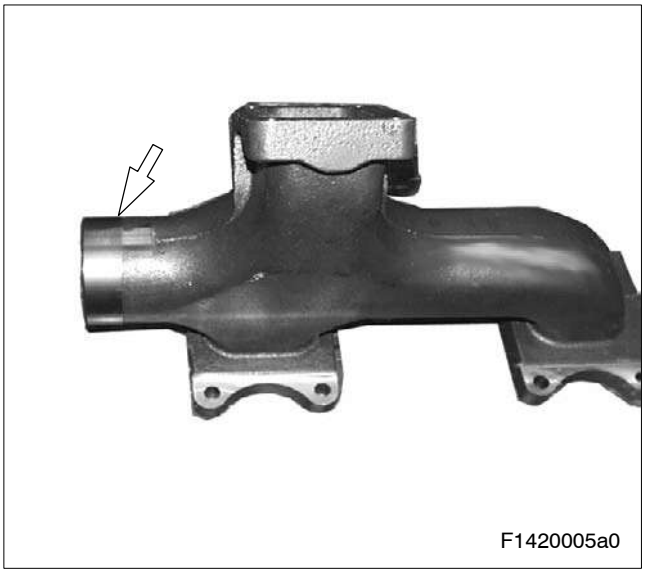
Exhaust manifold, recondition threads if necessary.

C141.10.10 Assembly

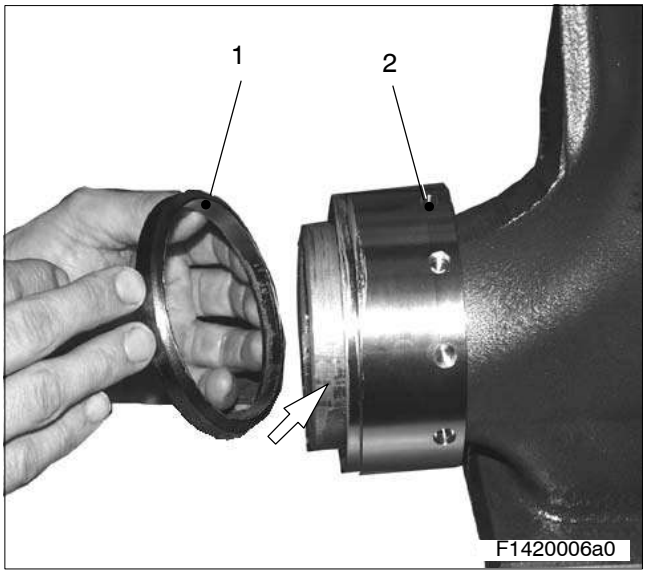


Installing stud

Insert dry stud (1) in flange of exhaust line (2) and tighten to stop by means of locked hex nut.



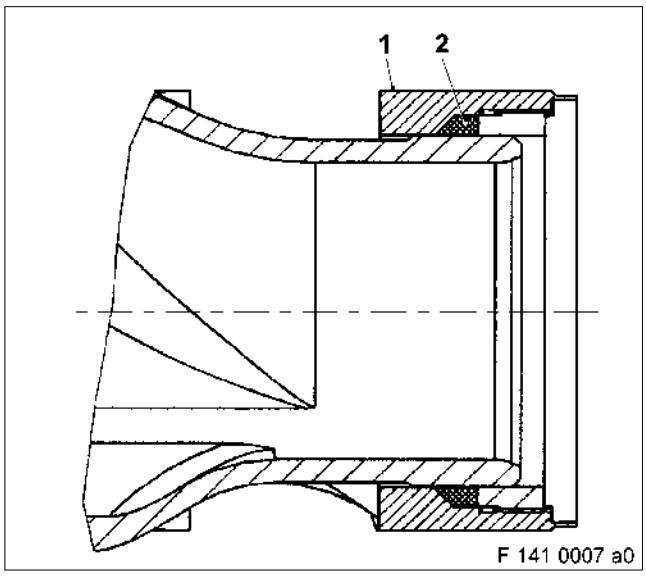
Before installing union nut and sealing ring, clean and degrease sealing surface (arrow).



Preassemble exhaust line with union nut (2) and sealing ring (1). Do not yet tighten connection.

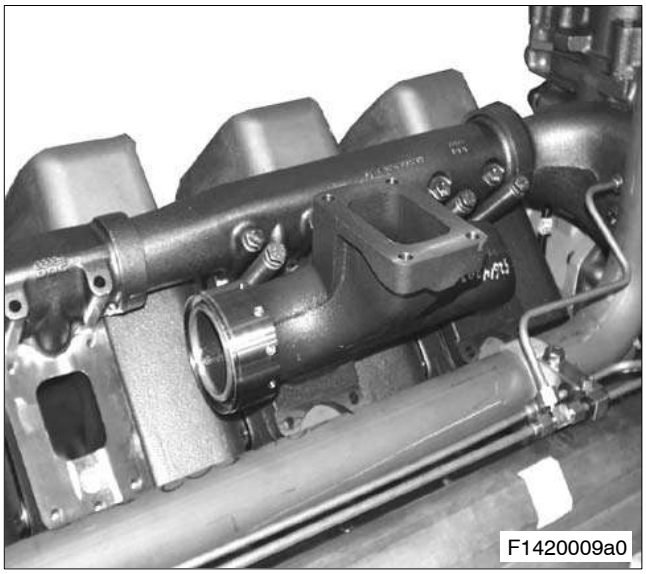
Refer to next illustration for a more comprehensible presentation.

Coat thread of union nuts and screw-on face (arrow) with assembly paste Ultratherm.



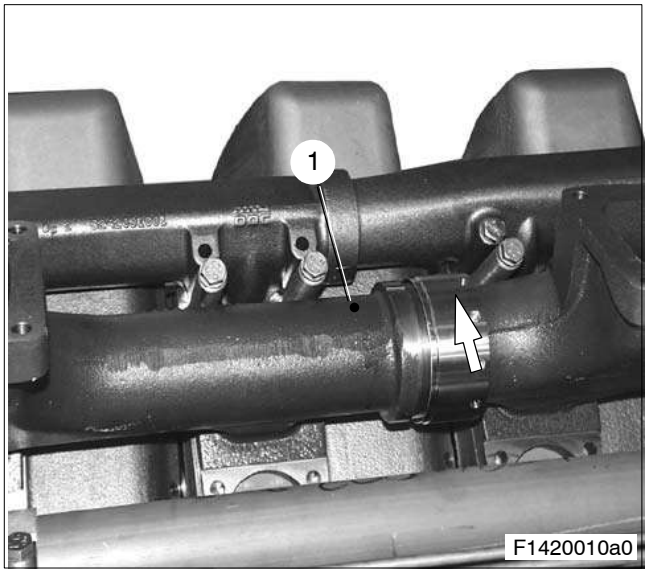
When assembling exhaust manifold, ensure that union nut (1) and sealing ring (2) are installed in correct positions.

C141.10.11 Installation



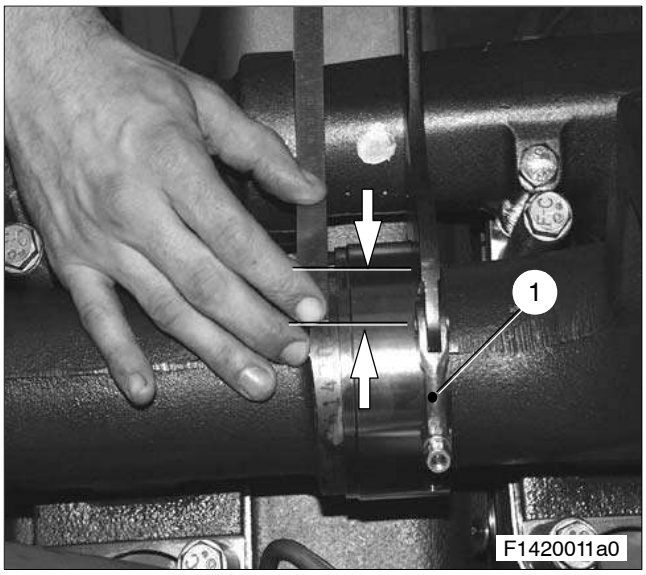
Clean and degrease screw-on surfaces of cylinder heads and exhaust line.

Install exhaust lines with gaskets as per overview drawing (see C 141.05.01) on cylinder heads, but do not tighten.

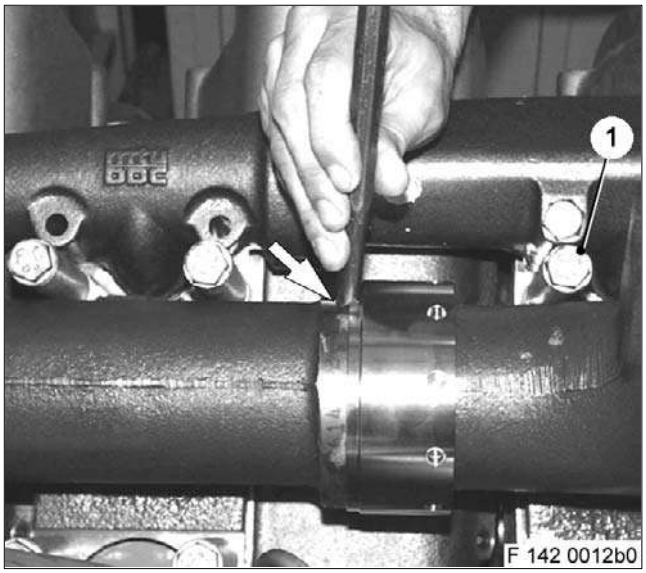


Coat thread of union nuts and screw-on face of exhaust manifold with assembly paste Ultratherm.

Tighten union nut by hand (arrow) against exhaust manifold (1).

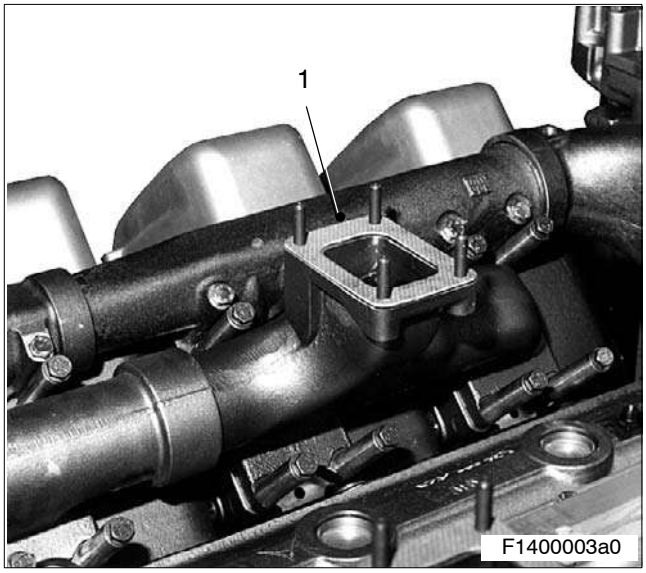


Turn union nut further with joint C-wrench (1) by 35 mm (arrows), corresponds to 40° at circumference.



Tighten all hex screws (1) diagonally and evenly to specified tightening torque – see C 141.10.01.

Secure union nuts against turning by means of peening, observe specified groove (arrow) in exhaust manifold.

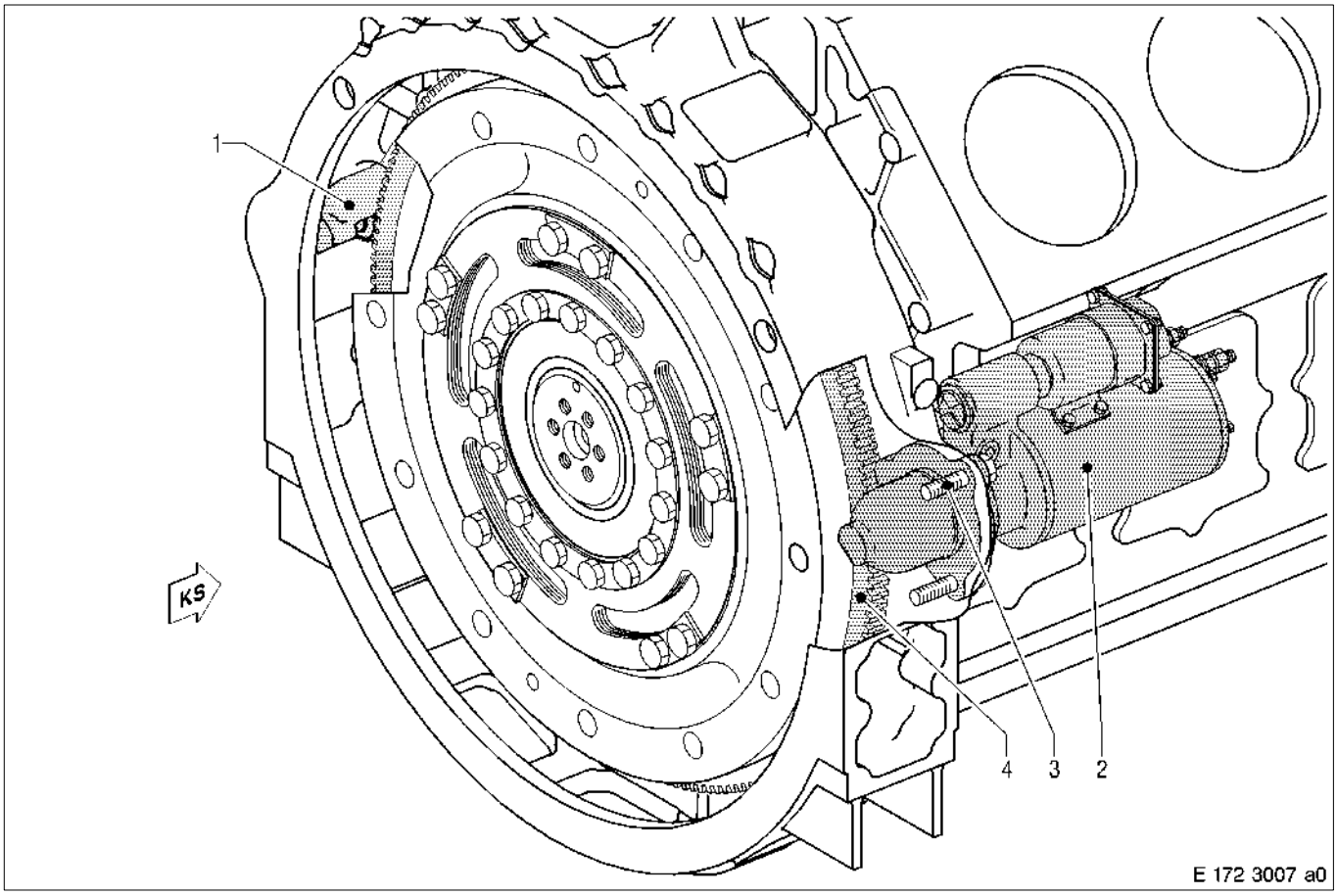


Fit dry gasket (1) on turbocharger flange.

C141.10.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Install exhaust turbocharger with Y-pipe	→ C 101.01.11
–	x	x	Install oil supply lines for turbochargers	→ C 185.10.11
–	x	x	Install oil return lines for turbochargers	→ C 185.25.11
–	x	x	Install intermediate element of charge air manifold on exhaust turbocharger	→ C 124.05.11
–	x	x	Install exhaust pipework after Y-pipe	→ –
–	x	x	Install air system before exhaust turbocharger	→ –
–	–	x	Release engine start	→ Operating Instructions

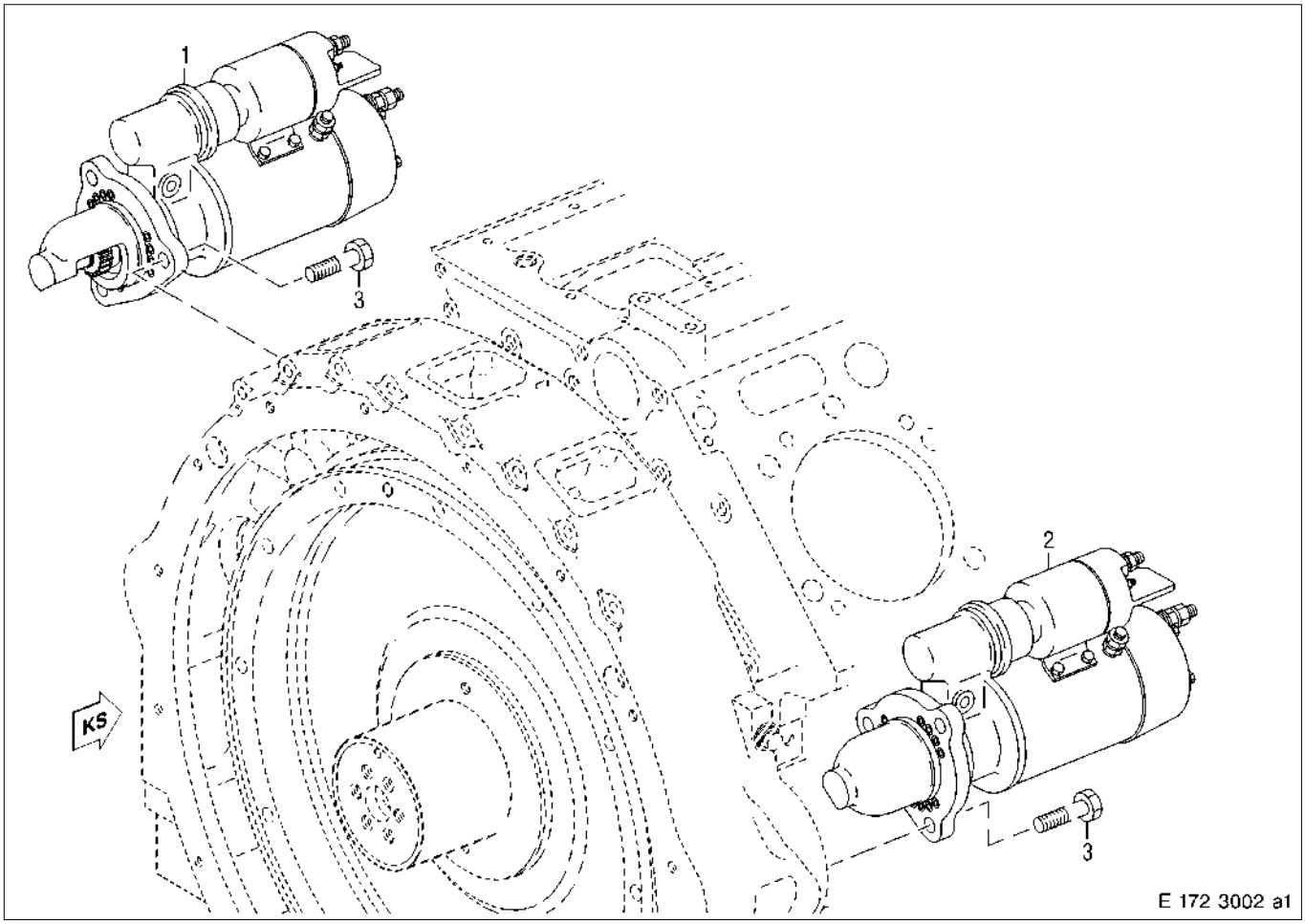
C170 Starting system



1 Starter, left
2 Starter, right
3 Hex socket screw
4 Ring gear

C172.05 Starter

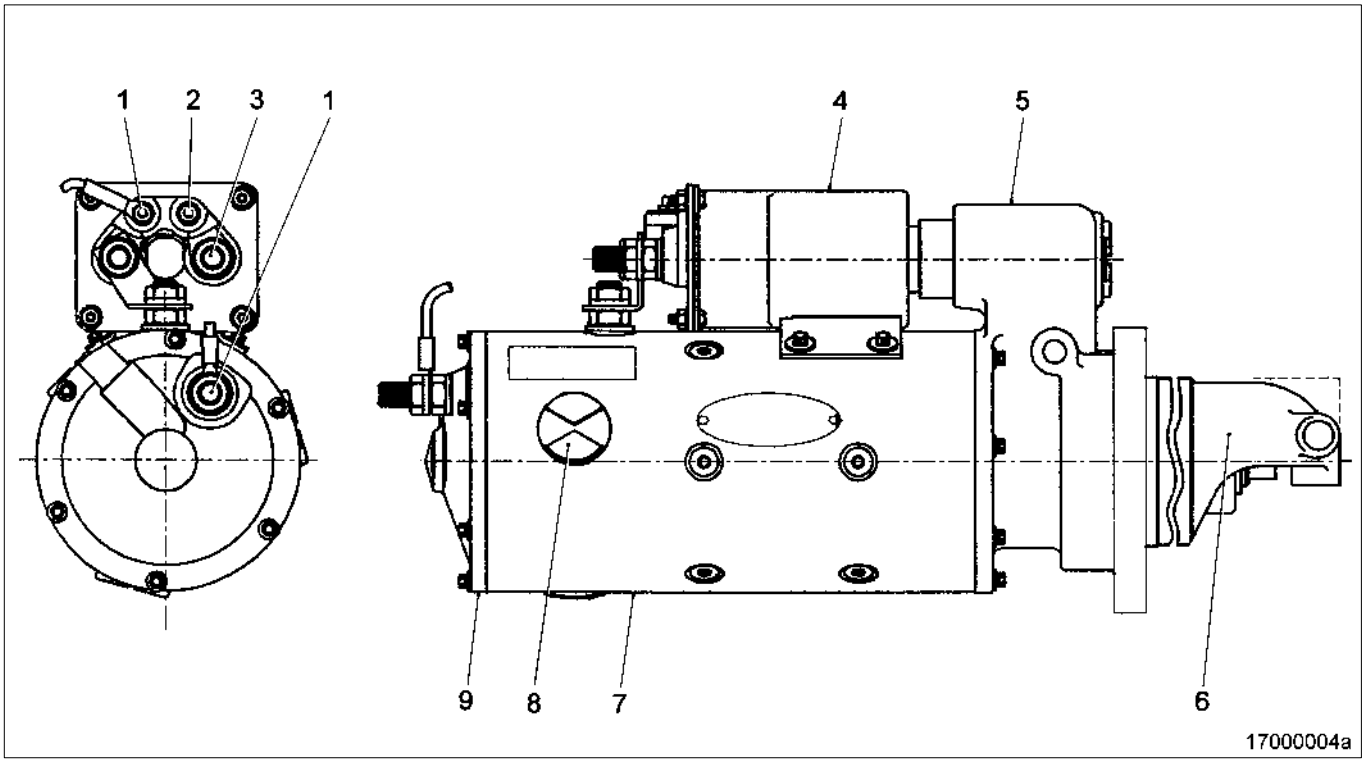
C172.05.01 Overview drawing of starter



1 Starter, left
2 Starter, right
3 Hex socket screw

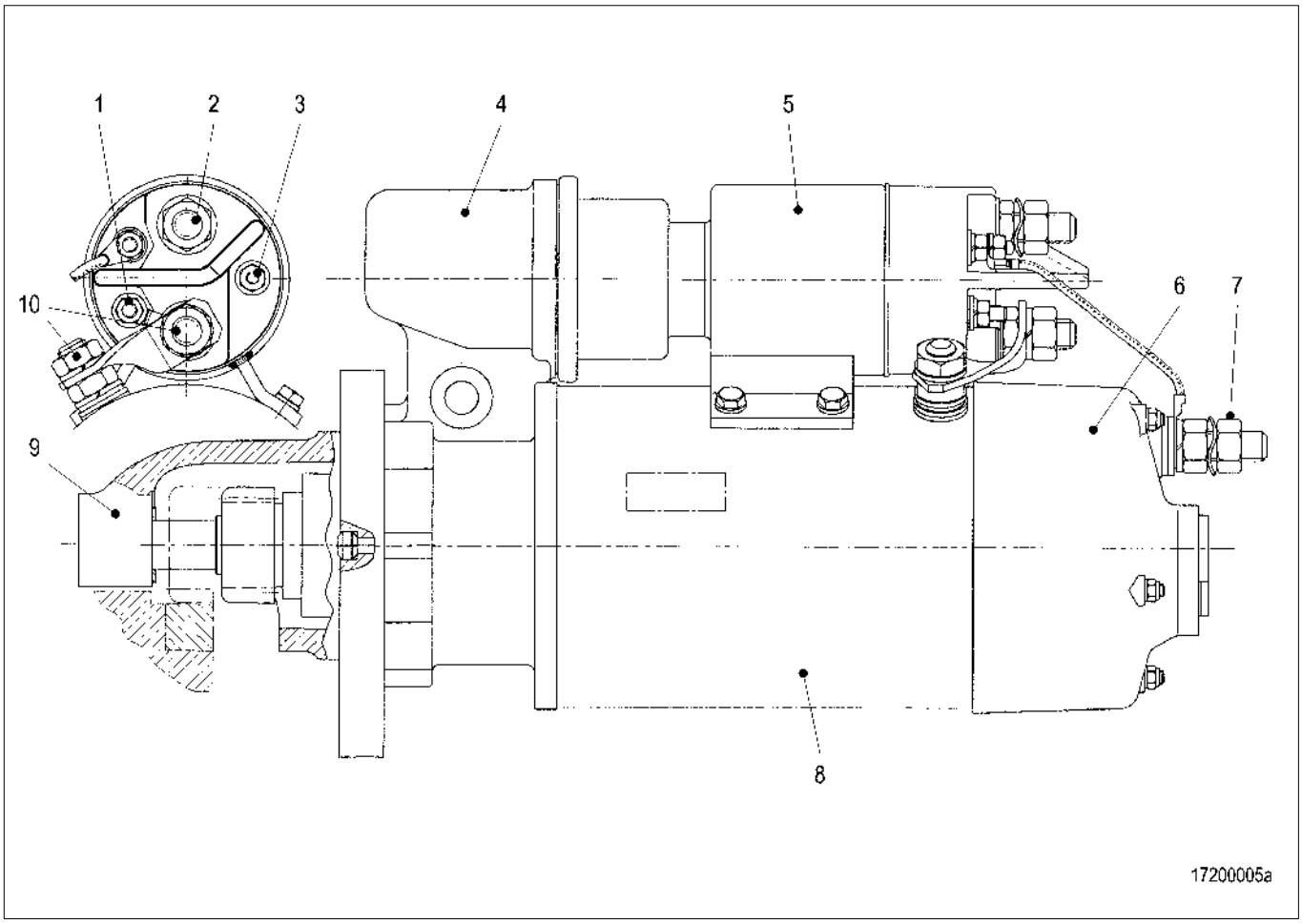
Overview drawing of starter

Version 1



1 Terminal 31
2 Terminal 50
3 Terminal 30
4 Engagement relay
5 Housing for engagement lever
6 Driver housing
7 Stator housing
8 Inspection port cover for inspecting carbon brushes
9 Commutator cover

Version 2



1 Terminal 45
Tightening torque: 4 Nm ± 0.5 Nm
2 Terminal 30
Tightening torque: 30 Nm ± 3 Nm
3 Terminal 50
Tightening torque: 4 Nm ± 0.5 Nm
4 Housing for engagement lever
5 Engagement relay
6 Commutator cover
7 Terminal 31
Tightening torque: 30 Nm ± 3 Nm
8 Starter housing
9 Driver housing
10 Terminal 45
Tightening torque: 30 Nm ± 3 Nm

C172.05.02 Special tools

Designation	Use/dimension	Number
• Tools from the W4 tool kit		1

C172.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Remove charge air manifold if necessary	→ C 124.05

C172.05.05 Removal

Removing starter

Note: Before removal, ensure that the negative battery pole is disconnected!

Mark cable at starter if necessary and remove.

WARNING

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

Note: Secure starter to prevent it falling out.

Remove socket-head screws for starter as per overview drawing – see C 172.05.01.

Pull starter from its seat and remove.

C172.05.06 Disassembly

See Manufacturer's Documentation.

C172.05.08 Inspection and repair

If required, send starter to authorised dealer. Consult MTU service for further information.

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 mating face on flywheel housing for wear, smooth with emery cloth or oilstone as necessary.

Check condition of threads; rechase threads if necessary.

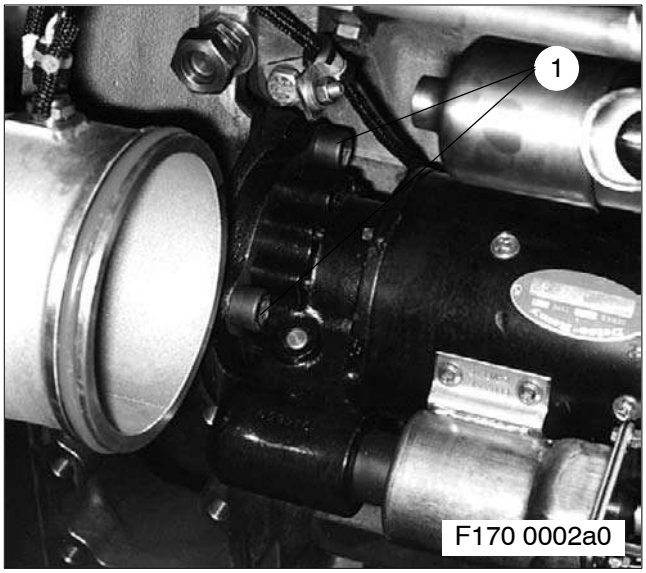
Check screws for condition and thread for ease of movement; replace screws if necessary.

C172.05.10 Assembly

See Manufacturer's Documentation.

C172.05.11 Installation

Note: Prior to installing starter, coat starter pinion with long-lasting lubricant grease.



Installing starter

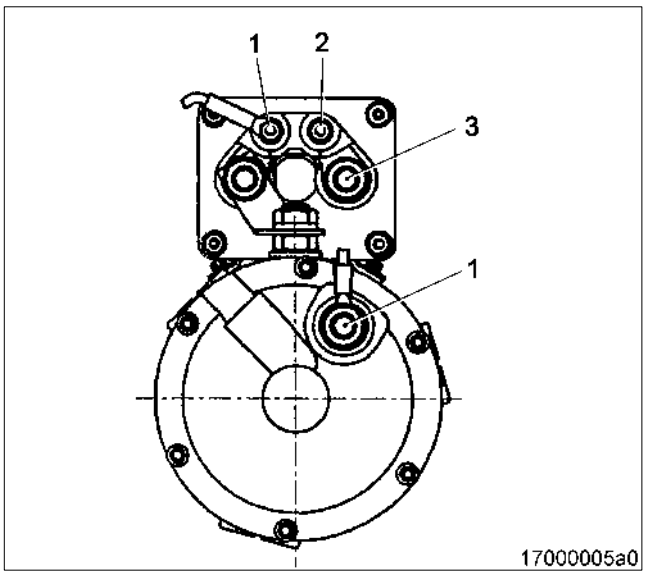
⚠ WARNING

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

Insert starter in fit in flywheel housing and align bores in starter flange to support bores.

Screw in socket-head screws (1) and tighten.

Version 1



Making starter electrical connections

Connect lines to starter, ensuring that lines are correctly laid.

Terminal 31 (1): Earth wire

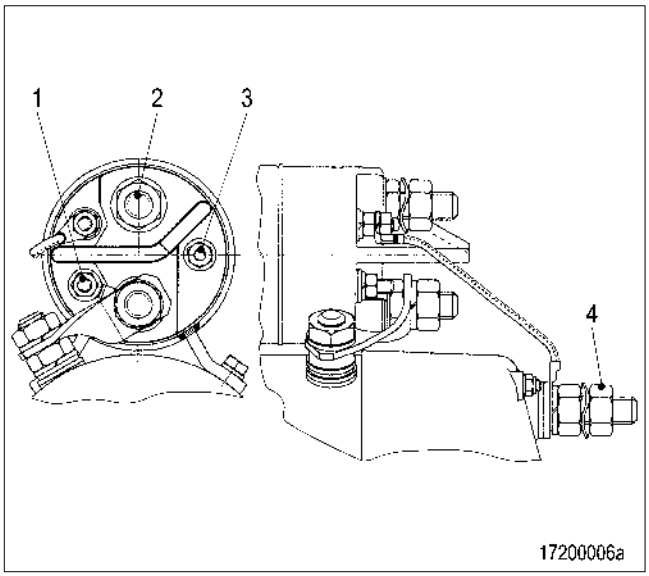
Terminal 50 (2): Control line

Terminal 30 (3): Plus line

Connect battery ground strap.

Note: When connecting to ground, ensure that the electric circuit is correctly poled (plus or minus).
Check starter direction of rotation.

Version 2



Making starter electrical connections

Connect lines to starter, ensuring that lines are correctly laid.

Tightening torques as shown in overview drawing, see
C 172.05.01.

Terminal 45 (1): Control line

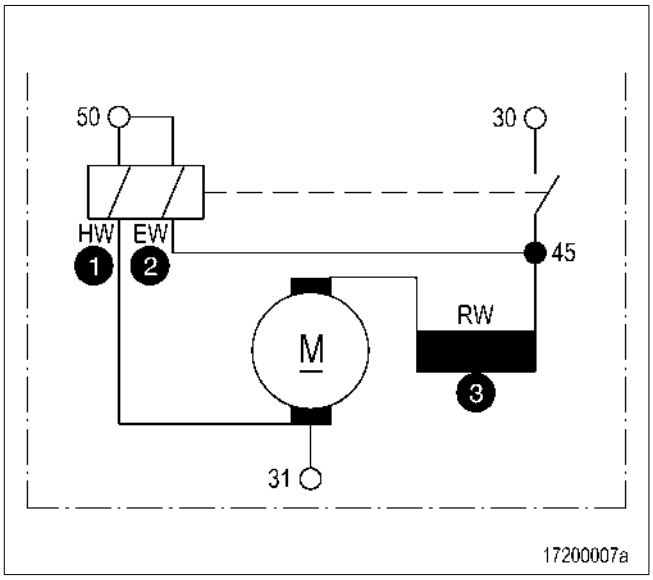
Terminal 30 (2): Plus line

Terminal 50 (3): Control line

Terminal 31 (4): Earth wire

Connect battery ground strap.

Note: When connecting to ground, ensure that the electric circuit is correctly poled (plus or minus).
Check starter direction of rotation.



Circuit diagram

HW (1) Hold-in coil

EW (2) Pull-in coil

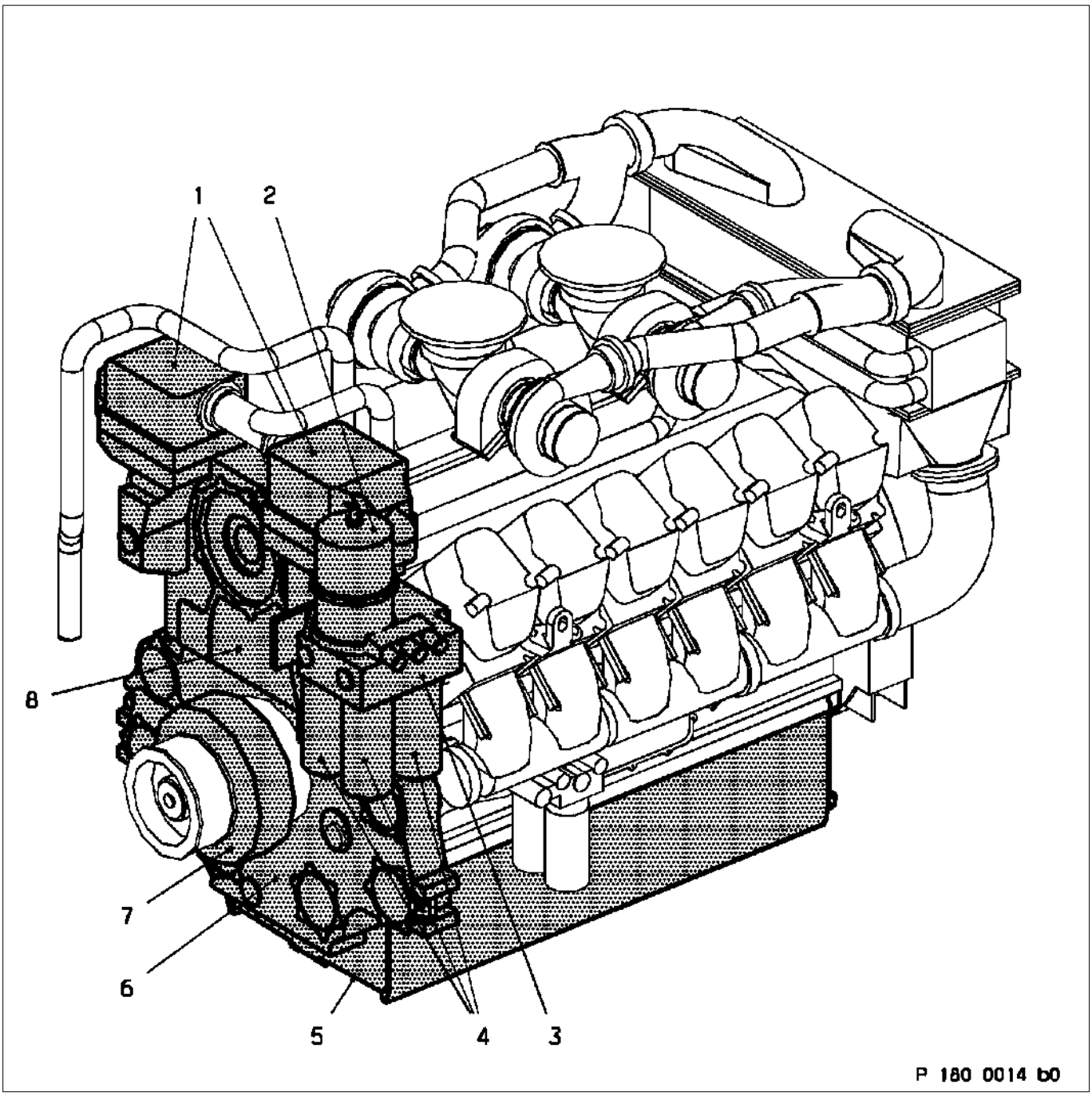
RW (3) Series winding

C172.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Install charge air manifold if necessary	→ C 124.05
–	–	x	Release engine start	→ Operating Instructions

C180 Lube oil system

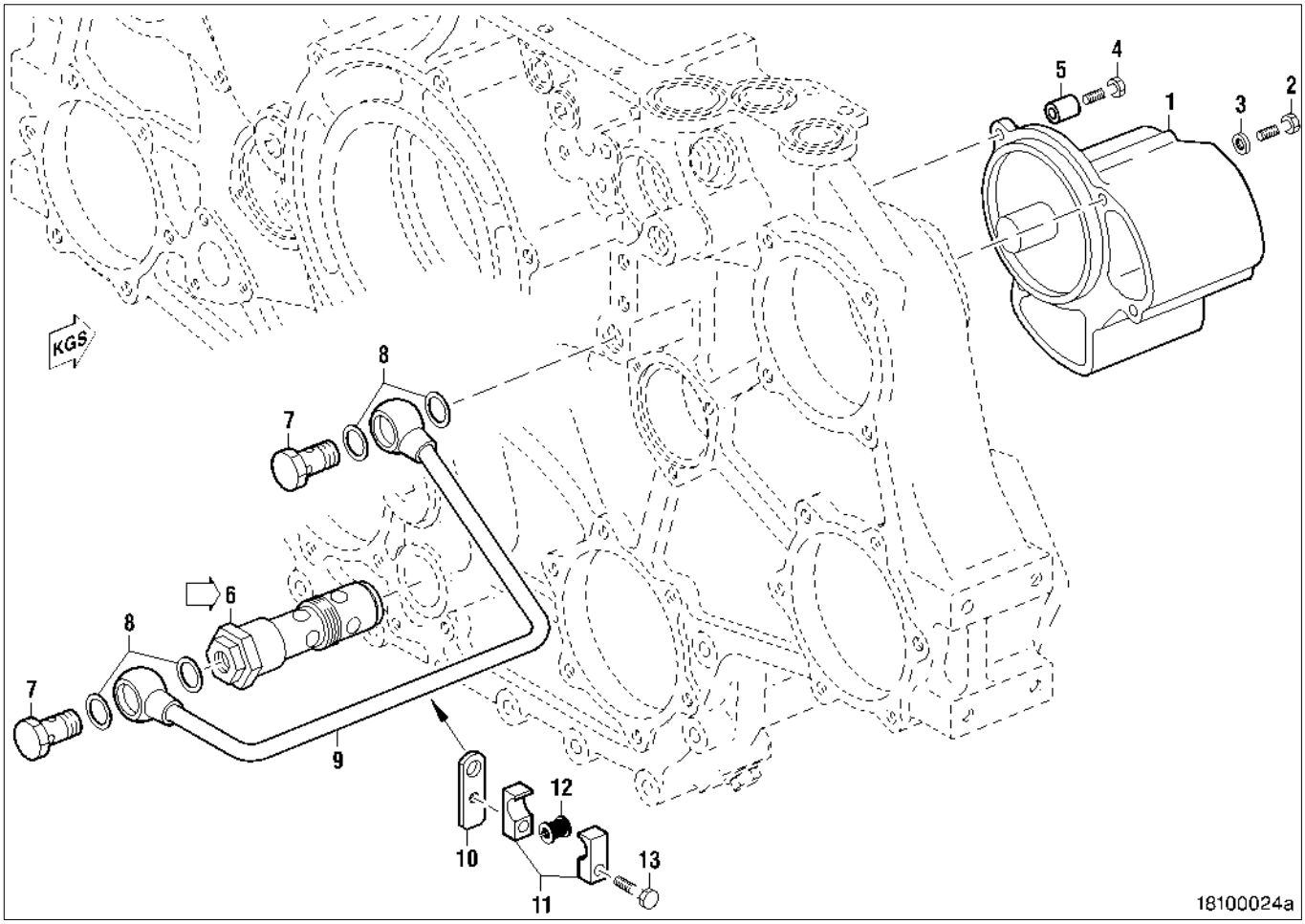
Illustration also applies to 16V 4000 G



1 Oil cooling (oil heat exchanger)
2 Centrifugal oil filter
3 Mounting bracket (centrifugal oil filter)
4 Oil filter
5 Crankcase lower section (oil pan)
6 Equipment carrier with oil pump and valves
7 Vibration damper
8 Coolant distribution housing with oil pipework

C181.05 Lube oil pump with drive

C181.05.01 Overview drawing



1 Oil pump

2 Hex screw
Lubricant: Engine oil
Tightening torque: 60 Nm + 7 Nm

3 Washer

4 Hex screw
Lubricant: Engine oil
Tightening torque: 60 Nm + 7 Nm

5 Spacer sleeve

6 Pressure reduction valve
Lubricant: Engine oil
Tightening torque: 60 Nm + 20 Nm

7 Banjo screw

8 Sealing ring

9 Oil line

10 Bracket

11 Pipe clamp half

12 Grommet

13 Hex screw

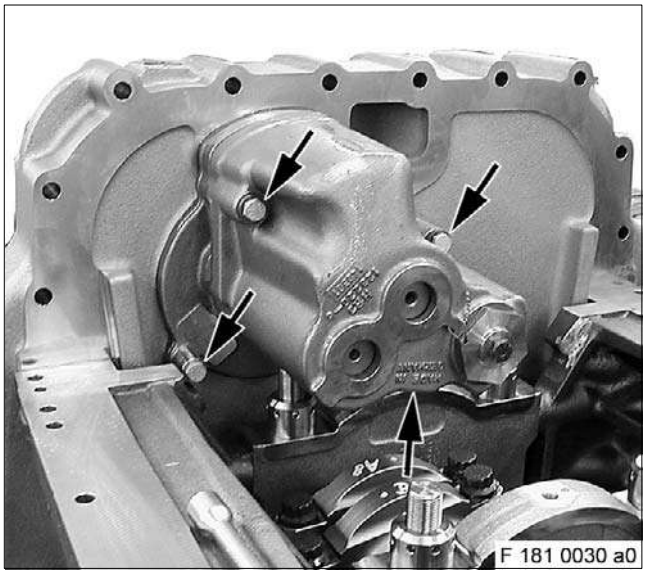
C181.05.02 Special tools

Designation	Use/dimension	Number
• Support bracket	for oil pump	1

C181.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	→ C 014.05
–	x	x	Remove engine mounts	→ C 231.05

C181.05.05 Removal



Removing oil pump with safety valve

Note: Illustration does not show engine in installation position.

Remove hex screws (arrows) for oil pump.

⚠ WARNING

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

Mount support bracket on oil pump and, using a lightly tensioned rope, hang onto crane.

Remove oil pump from equipment carrier.

Removing oil line and pressure reduction valve

Remove oil line from equipment carrier, see overview drawing C 181.05.01.

Remove pressure reduction valve from equipment carrier.

Remove sealing rings.

Seal connections with suitable plugs.

Protect oil line from damage.

C181.05.06 Disassembly

Disassembling lube oil pump

The lube oil pump must not be disassembled.

C181.05.08 Inspection and repair

Oil line

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).

Clean oil line with cold cleaner and blow clear with compressed air.

Visually inspect components for condition and damage; recondition as necessary or replace.

Machine defective sealing face and check for surface irregularities with ink-check plate.

Check condition of threads; replace components as necessary.

Replace gaskets

Oil pump with safety valve

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 pressure relief valve opening pressure of 15 bar.

Test medium: Engine oil SAE 30

Medium temperature: from 90 °C to 100 °C

If values are above or below opening pressure, replace pressure relief valve.

Check securing screws for condition and thread for ease of movement; replace screws if necessary.

Pressure reduction valve

Visually inspect pressure reduction valve for damage; replace if necessary.

Check pressure reduction valve opening pressure.

Operation: The valve limits the oil flow so that a constant pressure of 5.5 bar $\pm$ 1 is maintained at the last main bearing.

Medium temperature: from 90 °C to 100 °C

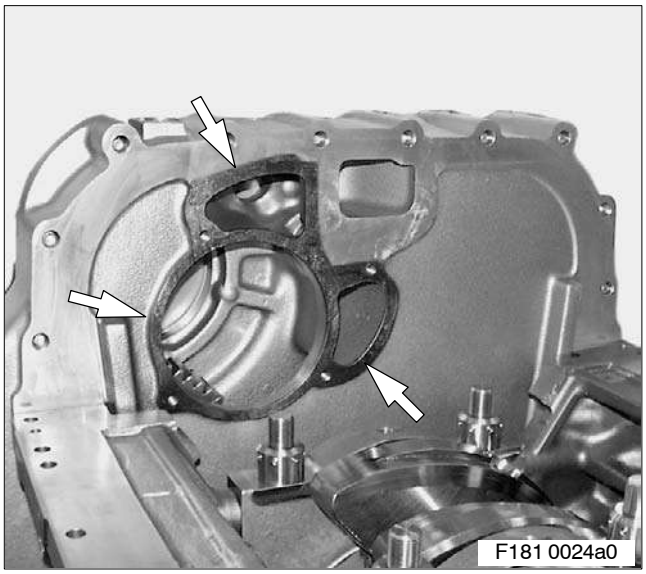
Design pressure at

n/min n/max of oil pump: 1.5 bar / 7 bar

If opening pressure is exceeded or not reached, replace pressure reduction valve.

C181.05.11 Installation

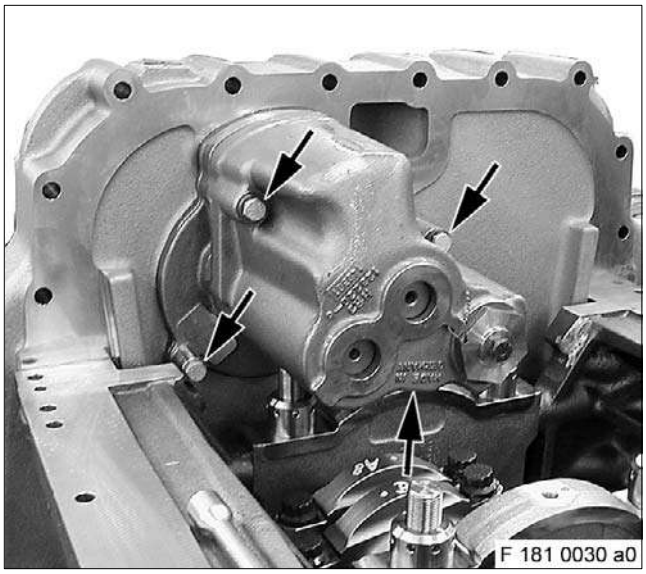
Note: When performing any tasks ensure that components are perfectly clean!



Installing oil pump with safety valve

Degrease and dry mating face on oil pump.

Using a spatula/roller, coat sealing surface (arrows) of equipment carrier with surface sealant Loctite 518.

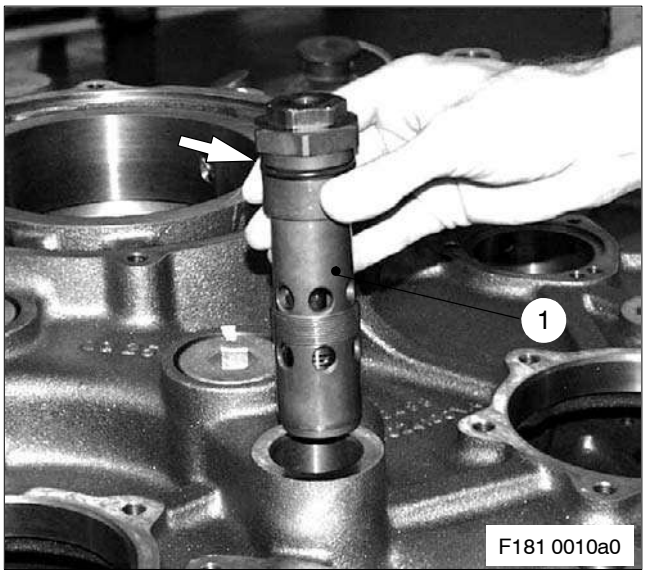


Attach oil pump with support bracket to crane.

Insert oil pump into equipment carrier, making sure gears engage correctly.

Screw in hex screws (arrow) for oil pump and tighten diagonally and evenly to specified tightening torque – see overview drawing C 181.05.01.

Note: Observe identification marking (10.9) on screw head and note different screw lengths.



Installing pressure reduction valve

Coat O-ring with petroleum jelly and insert into groove (arrow) on pressure reduction valve.

Insert pressure reduction valve in equipment carrier (1) and tighten to specified tightening torque, see overview drawing C 181.05.01.

Installing oil line

Note: Before installation, remove all blanking plugs.

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 oil line with compressed air and ensure that it is perfectly clean.

Mount oil line with fastening elements free of tension as shown in overview drawing C 181.05.01.

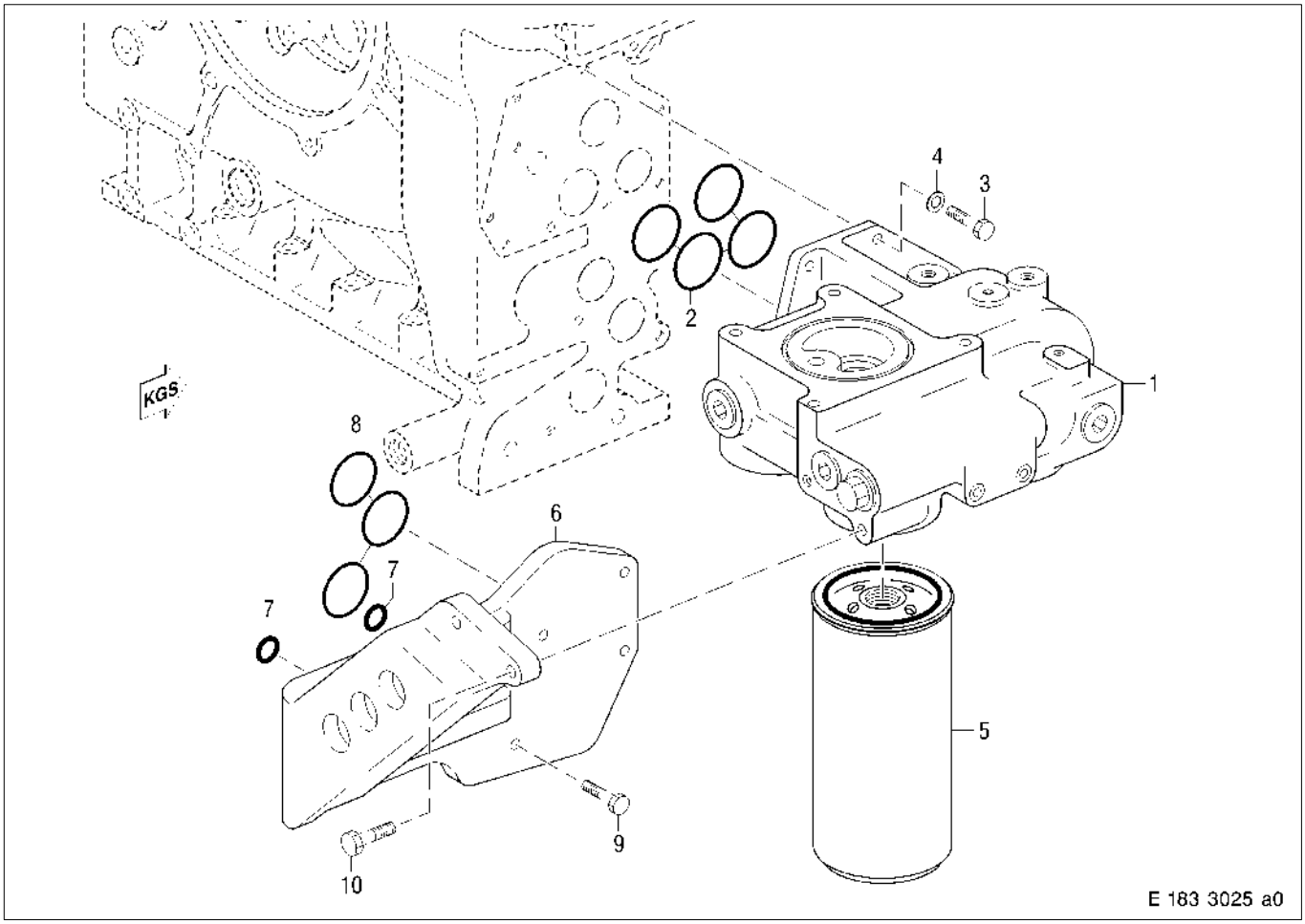
Note: After engine start, visually inspect oil line for leaks.

C181.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 101.01.04
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C183.05 Oil filter

C183.05.01 Overview drawing



1 Mounting bracket
2 Sealing ring
3 Hex screw
4 Washer
5 Oil filter
6 Bracket
7 O-ring
8 Sealing ring
9 Hex screw
10 Hex screw

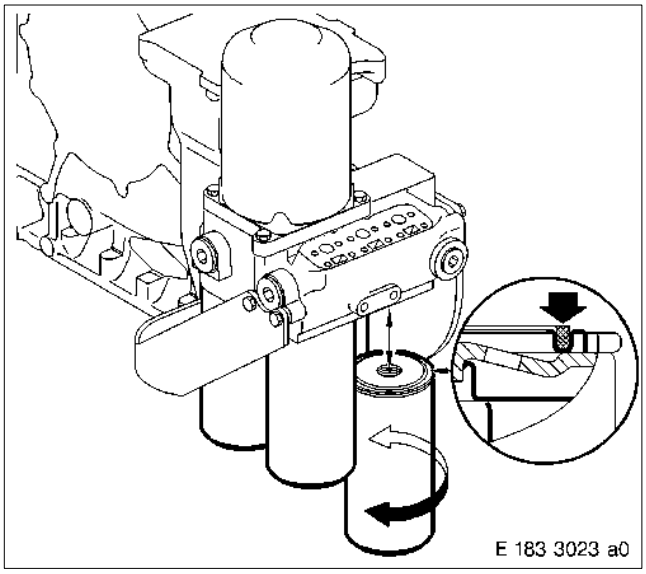
C183.05.02 Special tools

Designation	Use/dimension	Number
• Oil filter wrench	(also for fuel filter)	1

C183.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 centrifugal oil filter	→ Operating Instructions
–	x	x	Remove pressure transmitter and temperature transmitter	→ C 507.98

C183.05.05 Removal



Remove oil filter

Remove oil filter with oil filter wrench and dispose of in accordance with local specifications.

Drain oil residue from oil filter into a container.

Removing oil filter housing

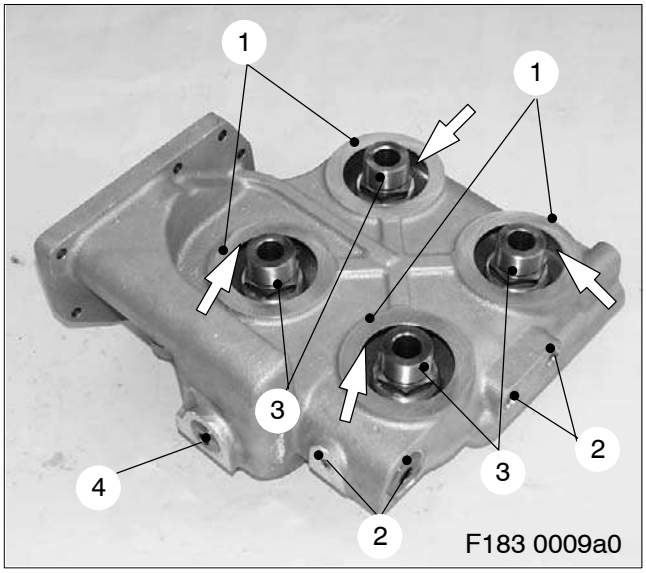
WARNING

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

Remove oil filter housing as shown in overview drawing C 183.05.01.

After removing all connections and openings, seal with suitable plugs.

C183.05.08 Inspection and repair

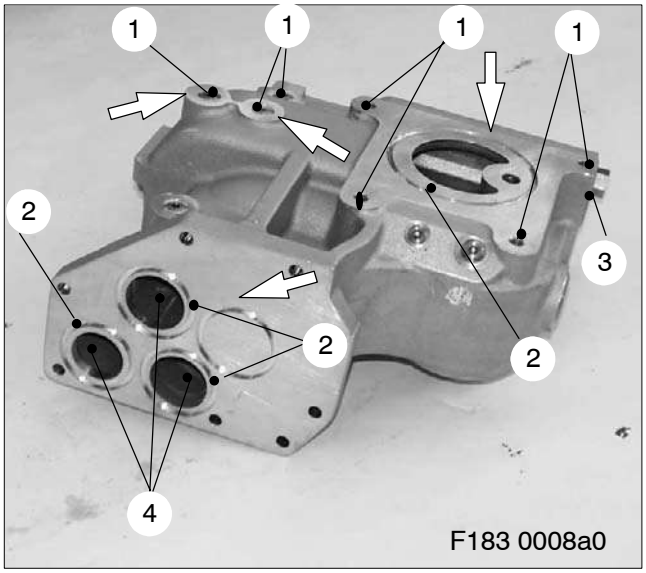


Clean mounting bracket.

Check all sealing, mating and sliding surfaces for wear, scoring and indentations.

Check in particular:

- threaded plugs (3)
- threaded bores (2)
- plane surface (1)
- inner surface, mounting bracket (arrow)
- threaded union (4)



Check components for damage; machine or replace as necessary.

Check all sealing, mating and sliding surfaces for wear, scoring and indentations.

Check in particular:

- threaded bores (1)
- plane surface (arrow)
- inner face (4)
- seating surface of O-rings (2)

Unscrew threaded union (3) and remove pressure limiting valve.

Clean components thoroughly.

If piston jams slightly, recondition by relapping.

Check opening pressure (2.5 bar).

If opening pressure does not correspond to specified value, disassemble valve and readjust by fitting appropriate adjusting shims until correct value is achieved.

Remove minor wear, scoring and indentations by rubbing down with oilstone or emery paper; replace components as necessary.

Check thread for ease of movement; recut as necessary or replace component with thread insert – see Section A 009.

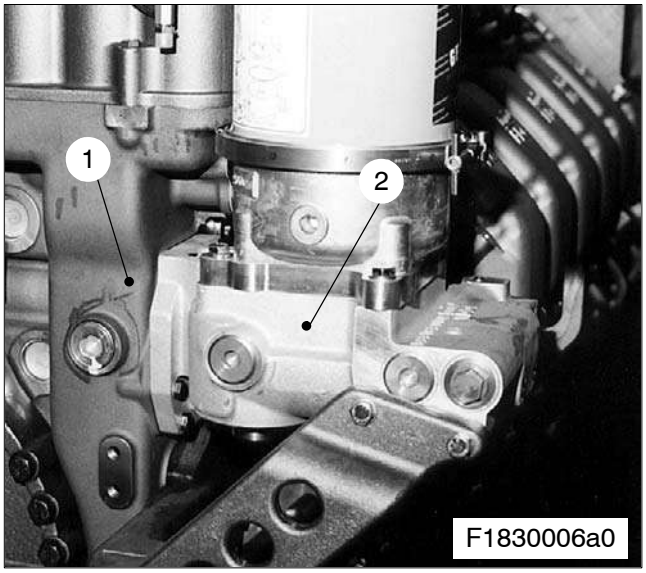
Replace blanking plugs and plugs if necessary (e.g. if leaking).

Replace hose line as part of every W6 overhaul.

Replace gaskets, sealing rings, gasket and O-rings.

Make sure that oil chambers and oilways are perfectly clean.

C183.05.11 Installation



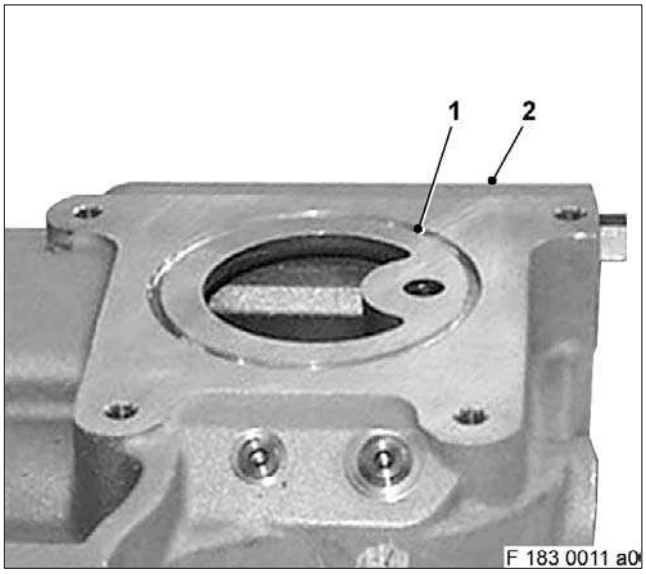
Installing mounting bracket

Note: Prior to installation, remove all blanking plugs and covers.

Make sure that oil chambers and oilways are perfectly clean.

Before installation coat sealing rings and O-rings with petroleum jelly and fit as per overview drawing C 183.10.01.

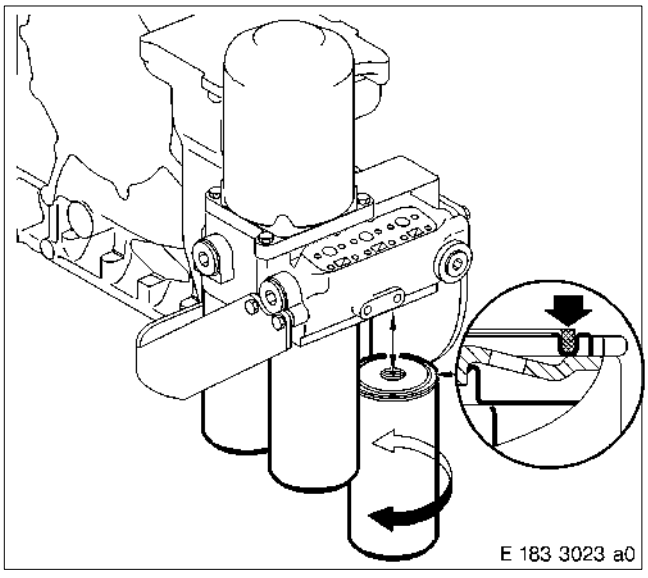
Install mounting bracket (2) with washers and hex screws on coolant distribution housing (1).



Installing centrifugal filter

Coat sealing ring with petroleum jelly and insert into groove (1) of mounting bracket (2).

Install centrifugal oil filter as per overview drawing – see C 183.05.01.



Installing oil filter

Check sealing ring of new oil filter cartridge, clean as necessary and coat with oil.

Install new oil filter cartridges and tighten manually.

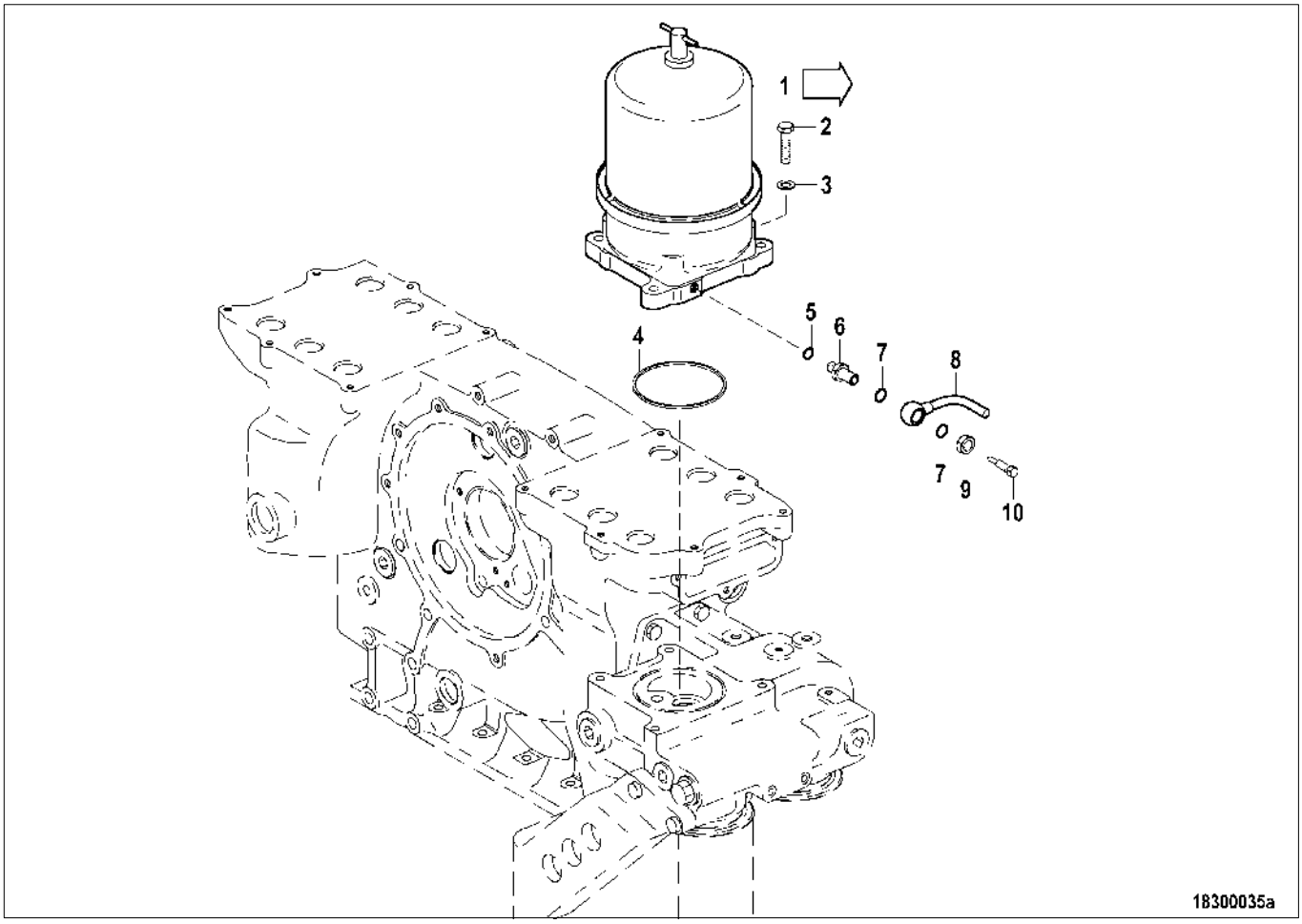
Note: After engine start, visually inspect oil filters for leaks.

C183.05.12 After-installation operations

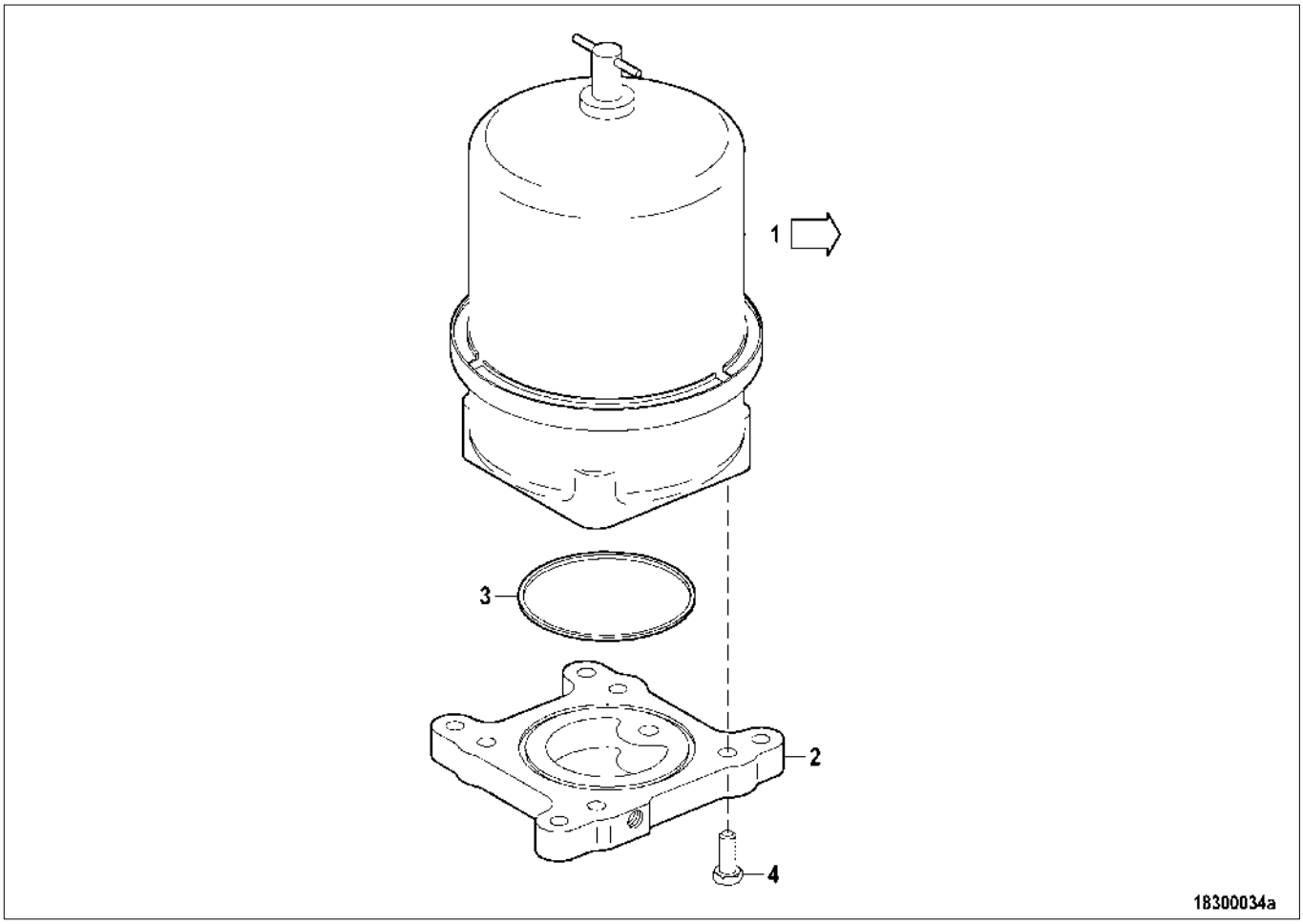
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 183.05.04
–	x	x	Fill engine oil as necessary	→ –
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C183.10 Centrifugal oil filter

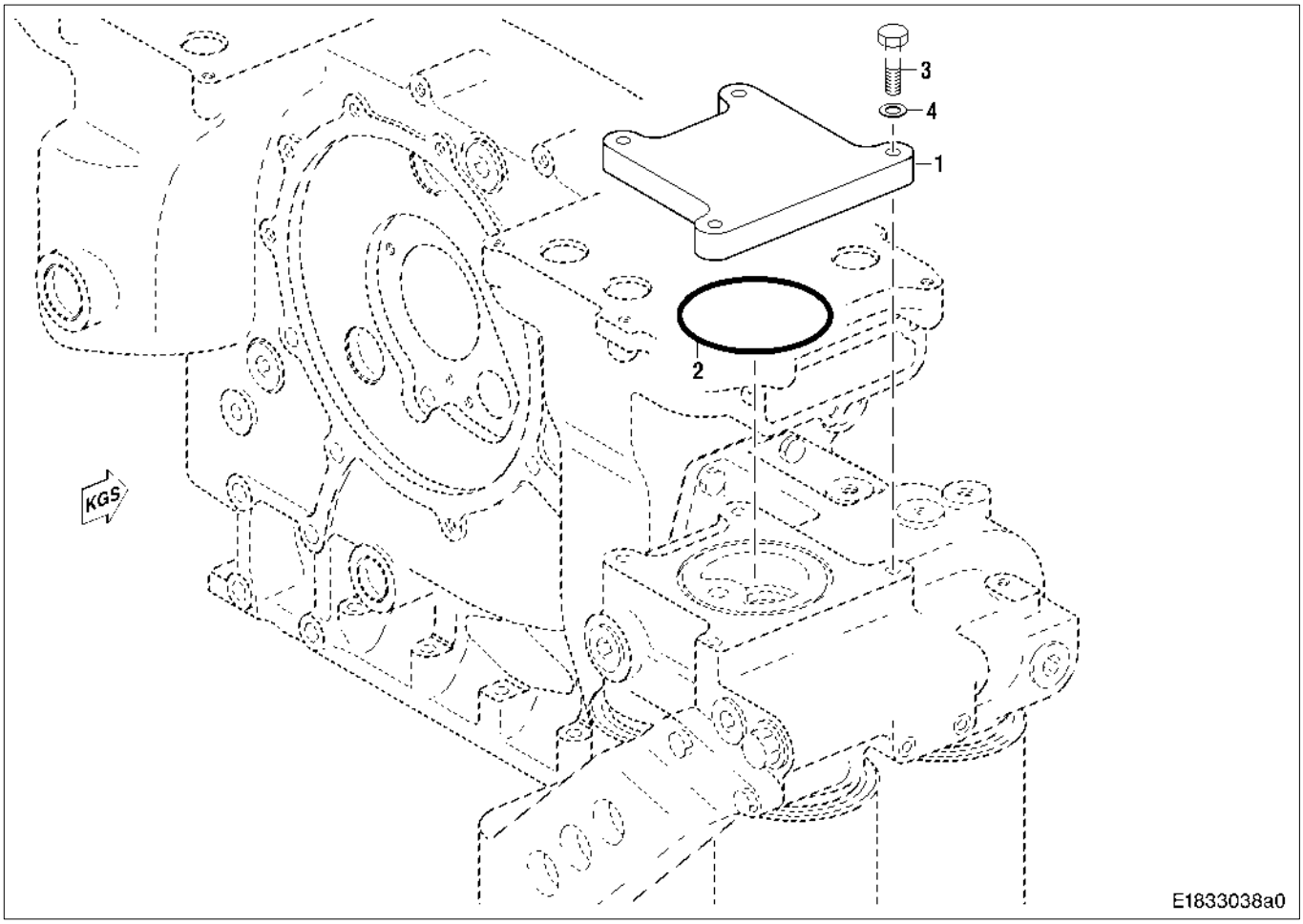
C183.10.01 Overview drawing



1 Centrifugal oil filter
2 Hex screw
3 Washer
4 O-ring
5 Sealing ring
6 Adapter
7 Sealing ring
8 Oil line
9 Hex nut
10 Screw

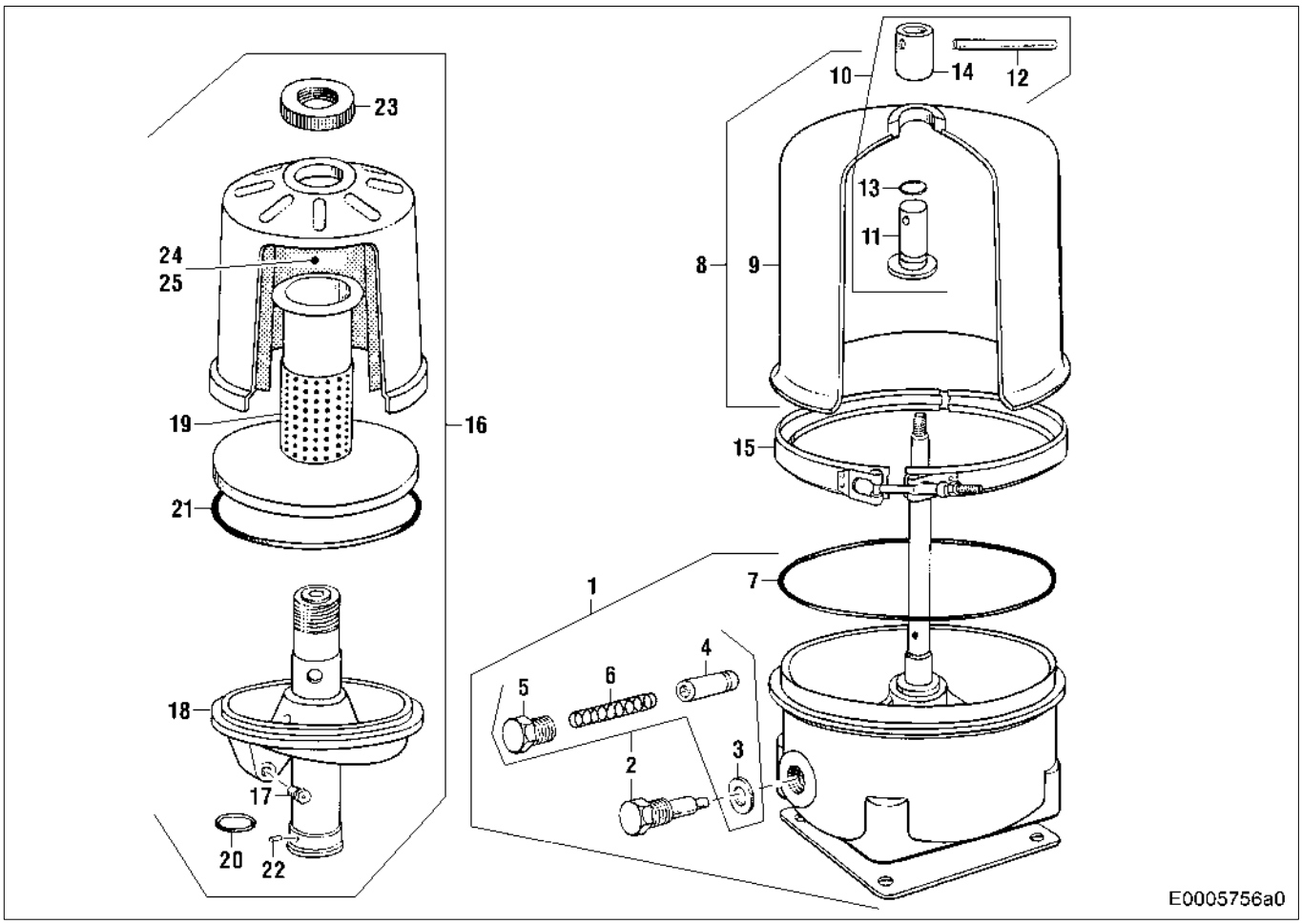


1 Centrifugal oil filter
2 Flange
3 Sealing ring
4 Hex screw



1 Cover
2 Sealing ring
3 Hex screw
4 Washer

Centrifugal oil filter

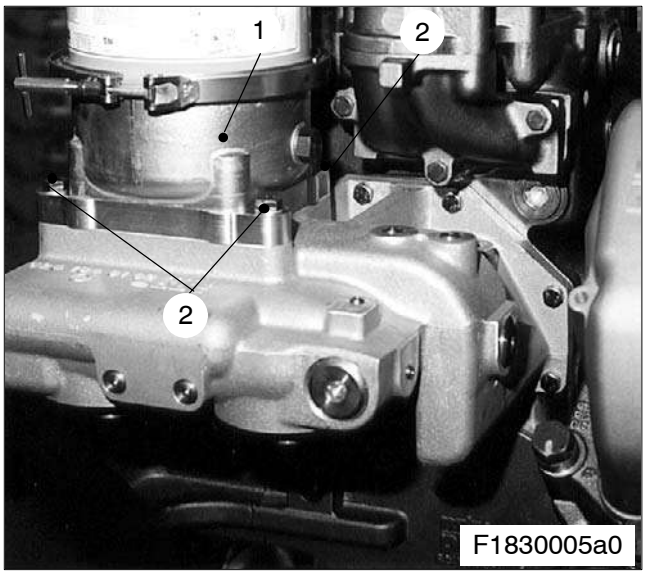


1 Housing
2 Valve
3 Sealing ring
4 Valve plunger
5 Plug
6 Compression spring
7 O-ring
8 Safety cover
9 Cover
10 Cover screw
11 Screw
12 Pin
13 O-ring
14 Drain screw
15 Clamp
16 Rotor unit
17 Nozzle
18 Substructure with bearing
19 Standpipe
20 Snap ring
21 O-ring
22 Pin
23 Knurled nut
24 Sleeve
25 Reinforcing plate

C183.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Drain engine oil from centrifugal oil filter	→ Operating Instructions

C183.05.05 Removal



Removing centrifugal filter

Remove hex screws (2) for centrifugal oil filter (1) and remove centrifugal oil filter from mounting bracket.

Cover installation bore or seal with a suitable plug.

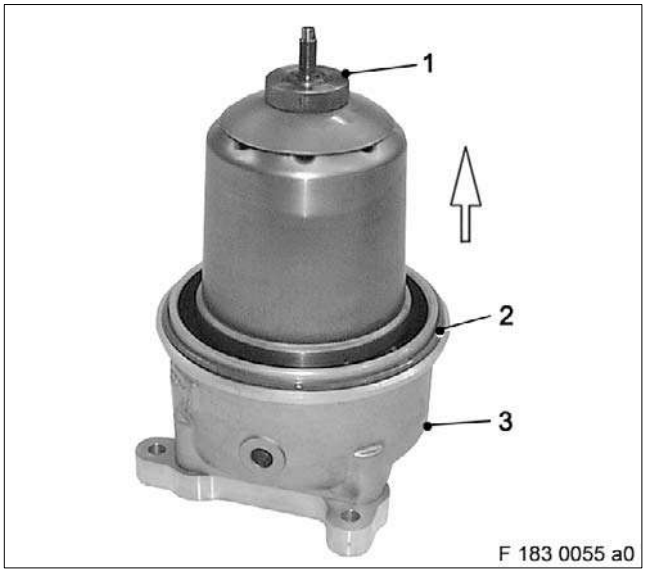
C183.10.06 Disassembly

Disassembling centrifugal oil filter

Release toggle (2) and remove V-clamp (1).

Release cover screw.

Remove centrifugal filter cover (1) from housing substructure (2).



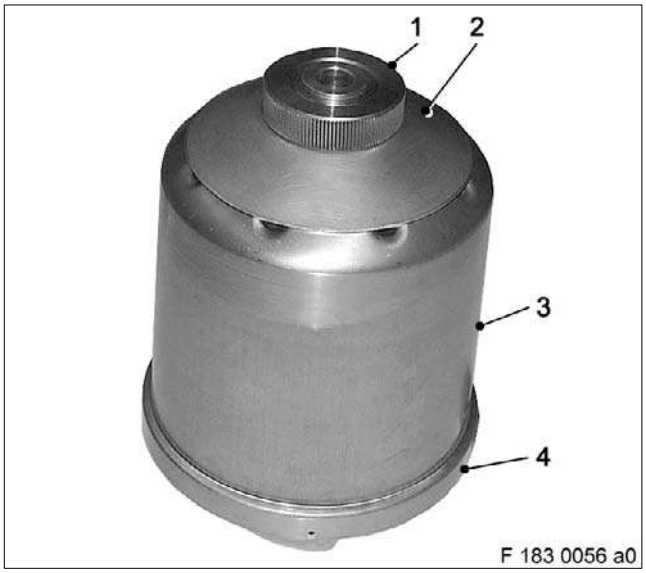
Make sure that rotor unit has been completely drained.

Remove rotor unit (1) carefully from housing (3).

Remove O-ring (2).

Note: Take care not to damage bearings and shaft.

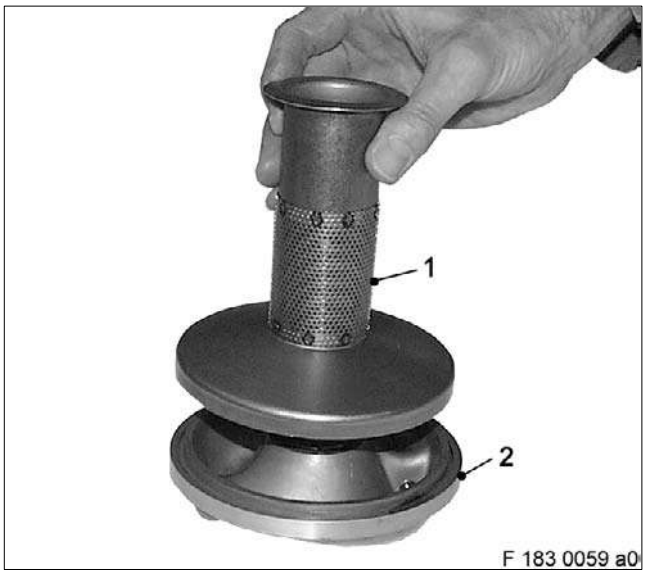
Remove flange from housing and take out sealing ring.



Warning: The rotor must never be clamped in a vice.

Release knurled nut (1) and remove rotor hood (3) with cover plate (2) from rotor substructure (4).

Note: Take care not to interchange rotors belonging to different centrifugal filters because rotor hood and substructure are aligned to one another during manufacture.



Remove standpipe (1) from rotor substructure (2).

Remove blanking plug, compression spring and valve plunger, see overview drawing C 183.10.01.

C183.10.08 Inspection and repair

Use a wooden spatula or similar instrument to remove contaminant deposits from the inside surface of the rotor cap.

Rinse rotor parts and dry. Failure to do this could result in an unbalance, which would lead to increased wear of the shaft bearings.

Check housing and substructure with bearing for cracks using surface crack-testing method with red penetrant dye; replace components if cracks are found.

Remove surface irregularities from sealing and mating faces by rubbing down with an oilstone or emery cloth.

Check rotor bearing journal for wear, smooth with emery cloth as required, replace rotor if necessary.

Note: Rotor substructure and hood must only be installed and replaced as a set since they were manufactured as a complete unit.

Using a brass wire, check that jets of nozzles are perfectly clean and unobstructed.

Check bearing running surfaces on the shaft for wear, rub down with emery cloth if required; if damaged or worn, the entire housing substructure with shaft must be replaced.

Check piston (4) and spring (6) for wear (minimum pressure supply), see overview drawing C 183.10.01; replace housing substructure if necessary.

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 standpipe and nozzle with compressed air and, if required, clean with brass brush; replace parts if necessary.

Replace O-rings, sealing rings and insertion sleeves at every assembly.

Check bearing clearance

Set dial gauge via the dial gauge stylus to zero and measure clearance at the outer edge of the rotor, top and bottom.

– measure clearance

– rotate rotor 90° and repeat measurement

– place dial gauge once again at 90° at previous measuring point and measure

– rotate rotor 90° and repeat measurement

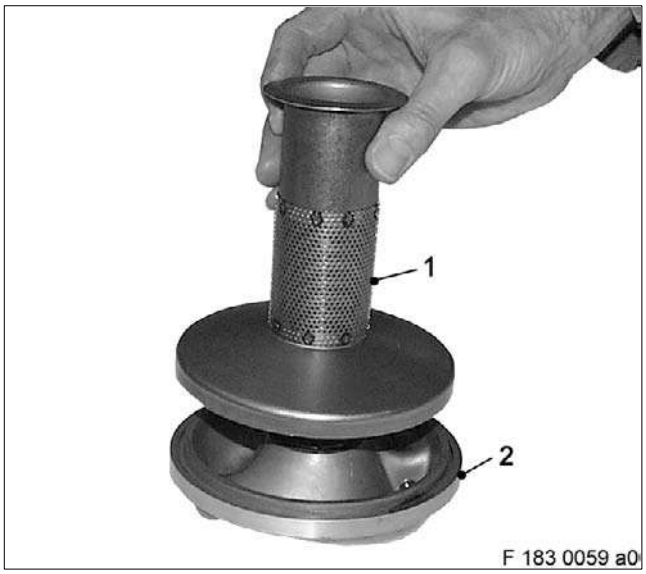
The highest read-off dimension equals the bearing clearance.

Max. clearance new dimension upper bearing 0.08 mm, lower bearing 0.06 mm.

If clearance of upper bearing is greater than 0.25 mm, lower bearing 0.2 mm, replace complete unit of rotor substructure and rotor hood as a pair only.

– Diameter of upper bearing running surface of shaft	14.98 mm
– Diameter of lower bearing running surface of shaft	21.63 mm
– ID of upper bearing	15.06 mm
– ID of lower bearing	21.69 mm

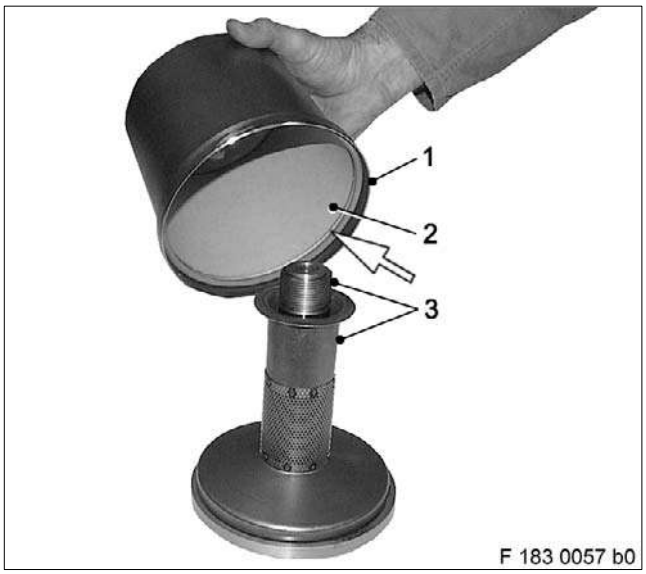
C183.10.10 Assembly



Assembling centrifugal oil filter

Note: Ensure that all components are perfectly clean.

Mount standpipe (1) on rotor substructure (2).



Insert new insert sleeve (2) into rotor hood (1).

Coat O-ring (arrow) with petroleum jelly and insert into groove on rotor hood.

Mount rotor hood and insert sleeve carefully onto rotor substructure.

Slot on rotor hood must be in alignment with pin on rotor substructure, see following illustration.

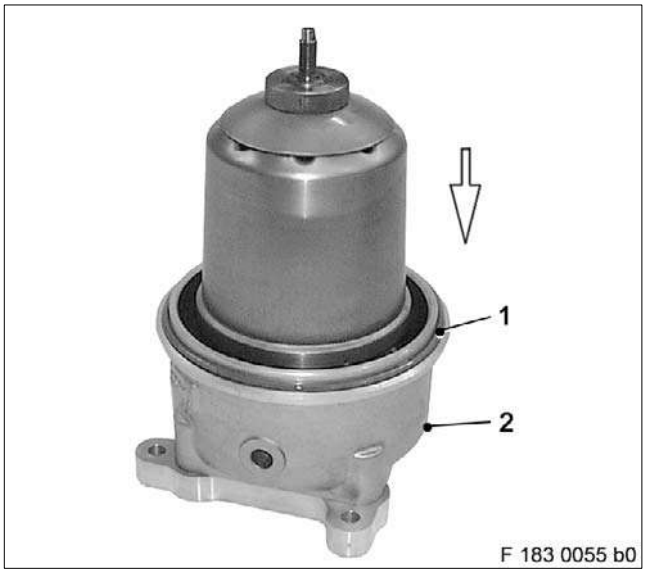
Rotor hood and substructure are aligned to one another.

Mount rotor hood (1).

Note: Slot (3) on rotor hood must be in alignment with pin (4) on rotor substructure (2).

Rotor hood and substructure are aligned to one another.

Mount cover plate (2) and tighten knurled nut (1) by hand.



Insert sealing ring in flange, see overview drawing C 183.10.01.

Mount flange with hex screw on housing (2), ensuring it is correctly positioned.

Coat shaft with engine oil.

Insert rotor unit carefully into rotor substructure.

Note: Take care not to damage bearings and shaft.

Check that rotor rotates freely.

Coat O-ring (1) with petroleum jelly and insert in groove on rotor substructure.

Place centrifugal filter cover (1) carefully onto housing substructure (2) and tighten cover screw.

Fit V-clamp (1) and tighten nut (1) with toggle.

Check cover screw once again for security.

C183.10.11 Installation

Note: Prior to installation, remove all blanking plugs and/or covers.

Make sure sealing surfaces, oil chambers and oilways are particularly clean, clean as required.

Installation is carried out in reverse sequence.

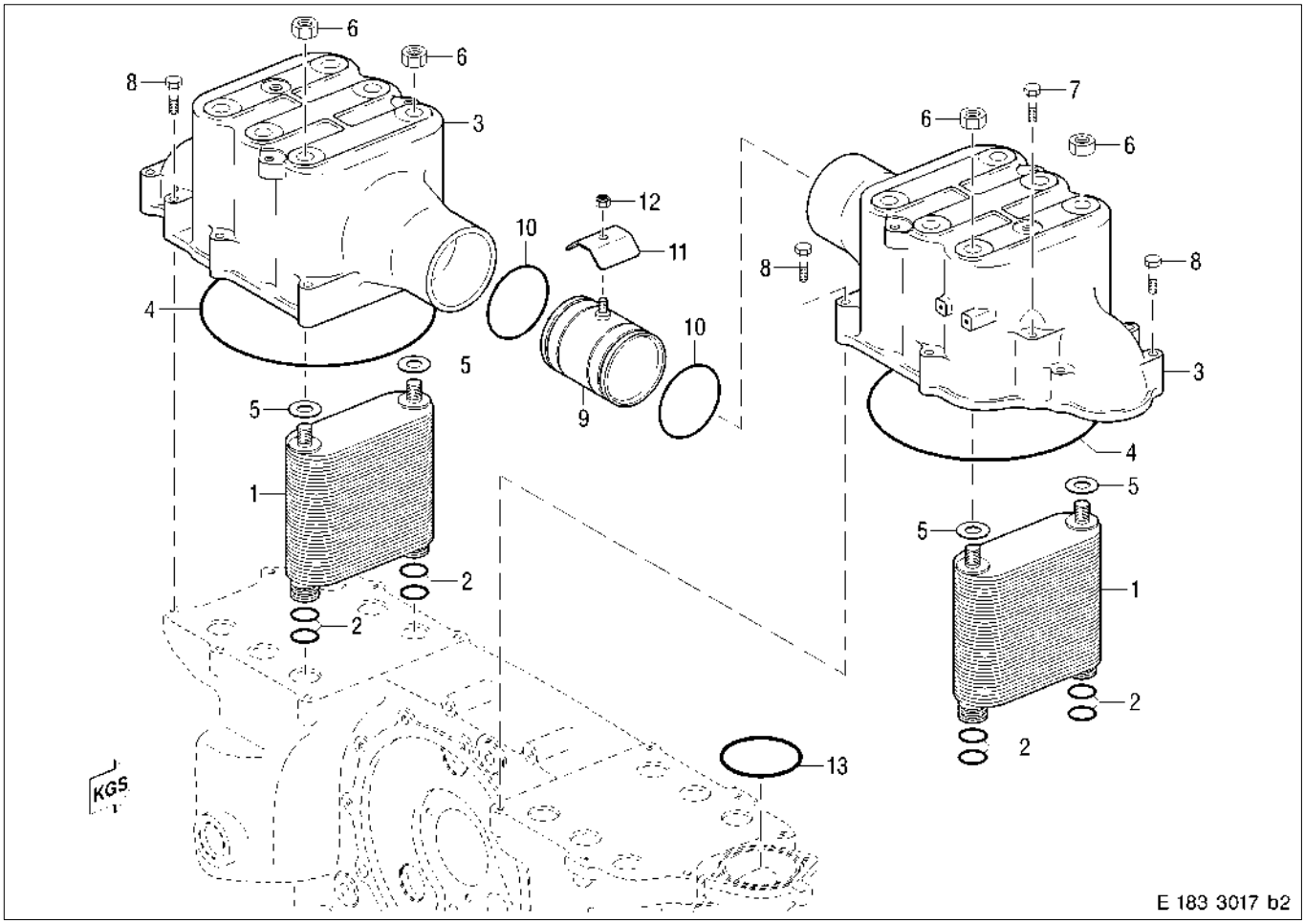
For installation of centrifugal oil filter, see C 183.10.01.

C183.05.12 After-installation operations

x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Fill engine oil as necessary	→ –
–	–	x	Release engine start	→ Operating Instructions

C183.15 Engine oil heat exchanger

C183.15.01 Overview drawing

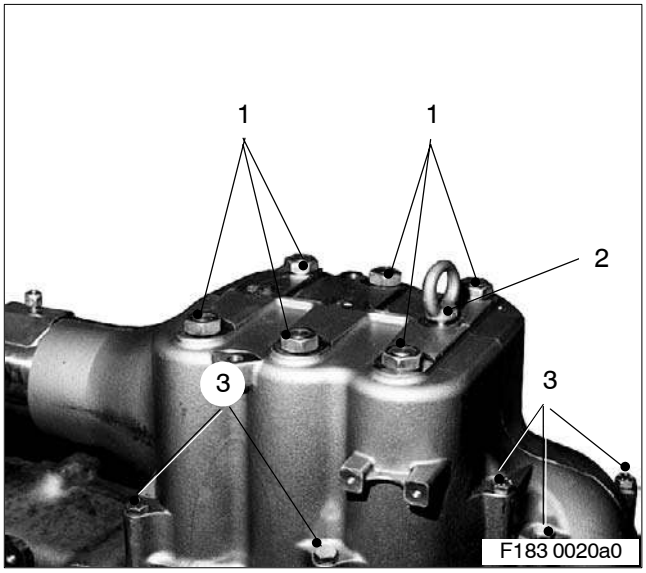


1 Cooler insert
2 O-ring
3 Oil cooler housing
4 O-ring
5 Sealing washer
6 Nut for cooler insert
Lubricant: Engine oil
Tightening torque: 100 Nm
7 Hex screw
Lubricant: Engine oil
Tightening torque: 45 Nm
8 Hex screw
Lubricant: Engine oil
Tightening torque: 45 Nm
9 Plug-in pipe
10 O-ring
11 Bracket
12 Nut
13 O-ring

C183.15.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 charge air coolant	→ Operating Instructions
–	x	x	Remove crankcase breather	→ C 018.10.05
–	x	x	Remove engine coolant vent lines	→ C 202.65.05
–	x	x	Remove coolant line from/to intercooler	→ C 203.25.05

C183.15.05 Removal

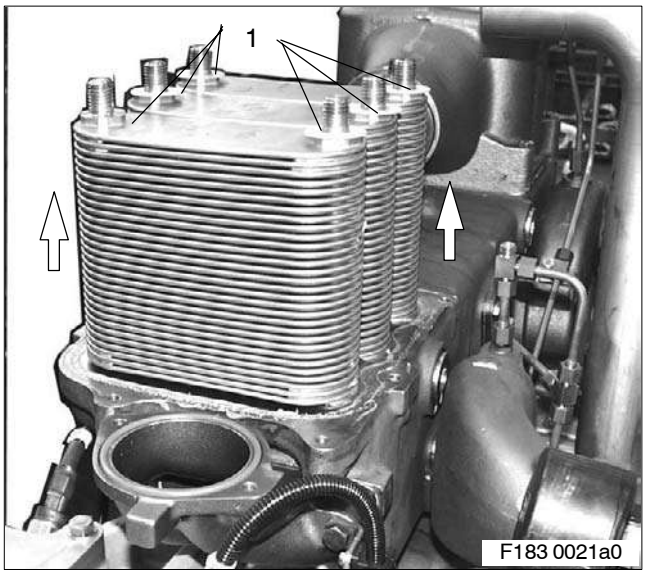


Remove hex screws (3) from oil cooler housing.

Release and remove nuts (1).

Screw eyebolt (2) into left and right oil cooler housing.

Using crane and rope, remove oil cooler housing from coolant distribution housing.



Remove sealing washers (1).

Carefully lift oil heat exchanger (arrow) vertically out of coolant distribution housing fit.

After removing all connections and openings, seal with suitable plugs.

C183.15.08 Inspection and repair

Replace oil filter cartridges.

Clean all components.

Check components for damage; machine or replace as necessary.

Replace cooler insert in event of damage.

Check oil cooler housing for cracks with red penetrant dye. If cracks are detected, replace part.

Check all sealing, mating and sliding surfaces for wear, scoring and indentations.

Remove minor wear, scoring and indentations by rubbing down with oilstone or emery paper; replace components as necessary.

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

Replace gaskets, sealing rings, gasket and O-rings.

Make sure that oil chambers and oilways are perfectly clean.

Clean cooler inserts on coolant and 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.

Cleaning coolant side:

It is essential to examine extent of contamination of coolant side prior to cleaning.

The coolant side must be cleaned if there is visible encrustation on the coolant side due to crustations, contamination and oil deposits.

Soak cooler element in a cleaning bath containing dissolved cleaning agent.

CAUTION

When using these 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.

Cleaning process is completed when loosened contaminants can be flushed away with a powerful water jet.

After cleaning, flush the cooler with water until pH values of clean water and rinsing water are approximately the same (difference 1 pH).

Normal water can be used for flushing purposes.

Cleaning/flushing oil side:

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 these 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.

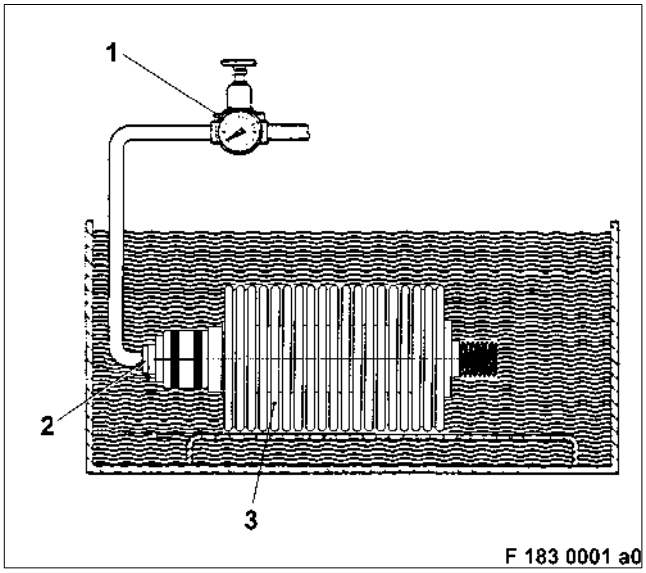
Flushing pressure 3 to 4 bar at 150 to 300 litres/minute.

Note: If the cooler is not put into operation immediately, dry oil side, preserve and seal the openings air-tight with suitable end covers.

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 condenses and falls to form a protective layer over the inner surfaces.
Make sure dosages are correct! 2 ml Branorol 32/10 per litre of coolant.

Cooler insert leak check



Seal oil chamber connections of cooler insert (3) with suitable sleeves, blank plugs, plugs with connection (2) and clamps.

At plug with connection, seal compressed air line.

⚠ WARNING

Compressed air is air pressurised by overpressure.
Test fluid is hot 80 °C (180°F).
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.

Soak cooler insert in test basin filled with water heated to 80 °C.

⚠ CAUTION

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

Open compressed air supply and set pressure reducer (1) to 0.5 bar.

Pressure-test intercooler for leaks with air in water bath; no bubbles should emerge.

If leaks are found, replace cooler insert.

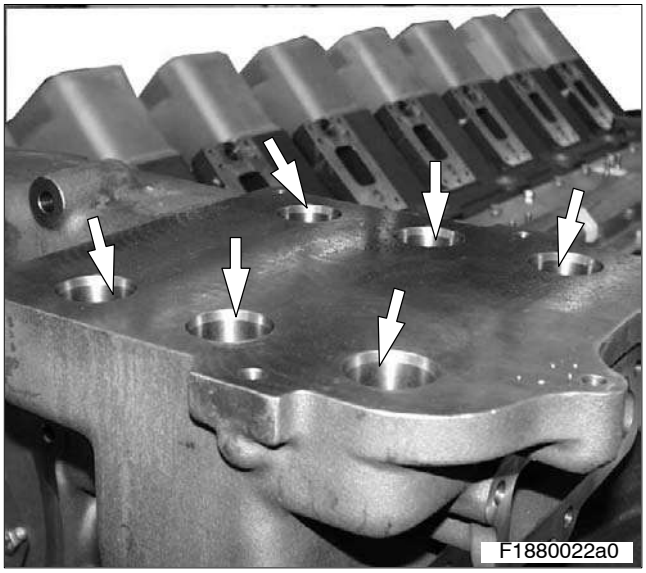
After testing, remove compressed air line, sleeves and plugs.

⚠ CAUTION

Compressed air is air pressurised by overpressure. 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 cooling fins of cooler insert with compressed air in vertical direction.

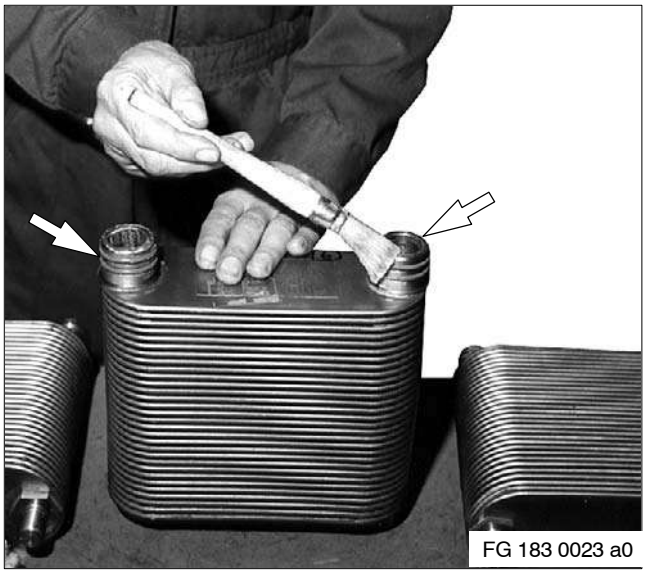
C183.15.11 Installation



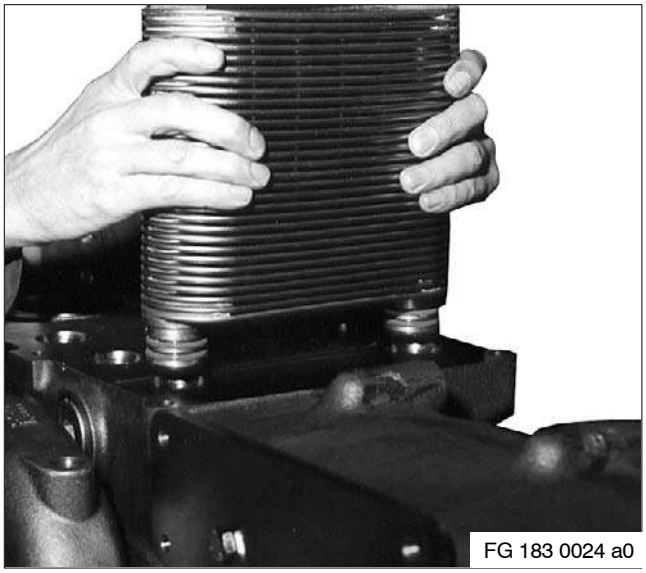
Installing oil heat exchanger

Note: Prior to installation, remove all blanking plugs and/or covers.

Make sure that oil chambers and oilways (arrow) are perfectly clean.

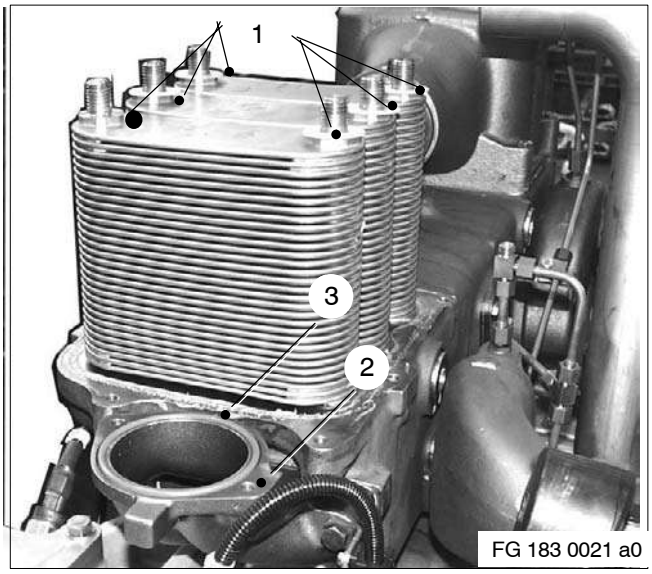


Before installing, coat O-rings (arrow) with petroleum jelly.



If necessary, remove blanking plug and/or covers in cooler insert.

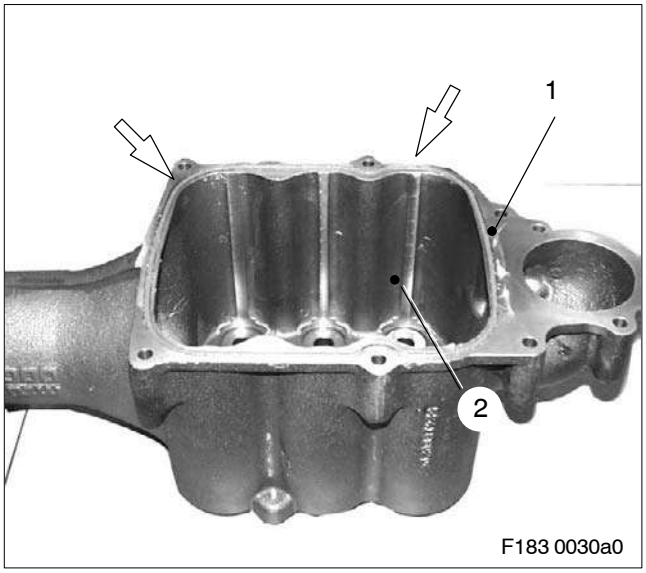
Insert oil heat exchanger in coolant distribution housing.



Place sealing washers (1) over thread of oil heat exchanger.

Coat O-ring (3) with petroleum jelly and insert in groove of elbow (2) for coolant pipework.

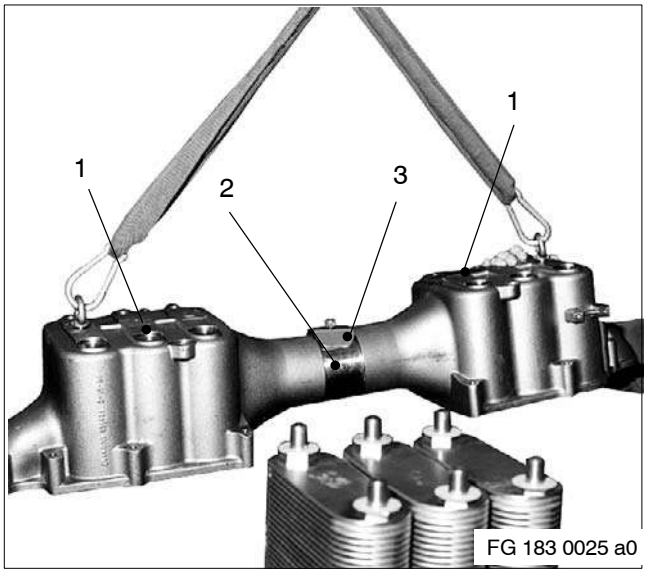
Note: Release securing screws from elbow (2).



Clean O-ring groove (arrow).

Coat O-ring (1) with petroleum jelly and insert in groove on oil cooler housing (2).

Note: First equipment (sealing oil cooler housing with gasket), assembly sequence is the same as with O-ring.



Check that sealing surface of coolant distribution housing is particularly clean.

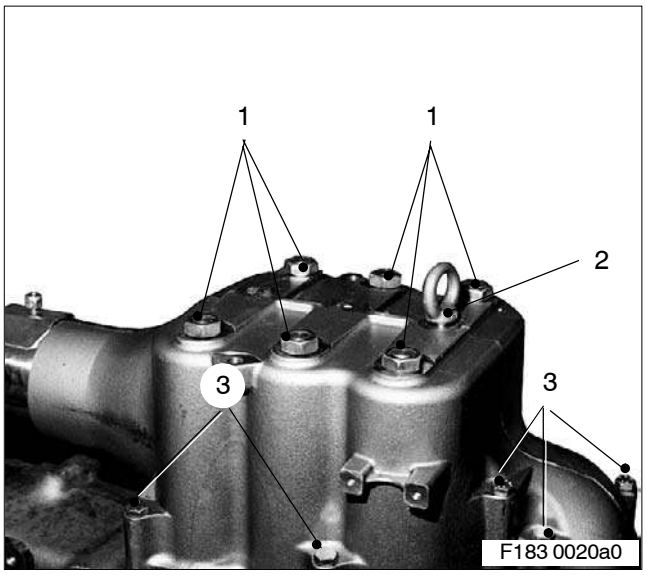
Before installing plug-in pipe (2), coat O-rings with petroleum jelly.

Install plug-in pipe (2) with bracket (3) on oil cooler housing as per overview drawing – see C 183.15.01.

⚠ WARNING

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

Attach oil cooler housing (1) with lifting eyes, rope and crane and install on coolant distribution housing with hex screws.



Remove lifting eye (2).

Tighten screws (3) to specified tightening torque – see overview drawing C 183.15.01.

Fit nuts (1) and tighten to specified tightening torque – see overview drawing C 183.15.01.

Note: Retighten loose securing screws on elbow.

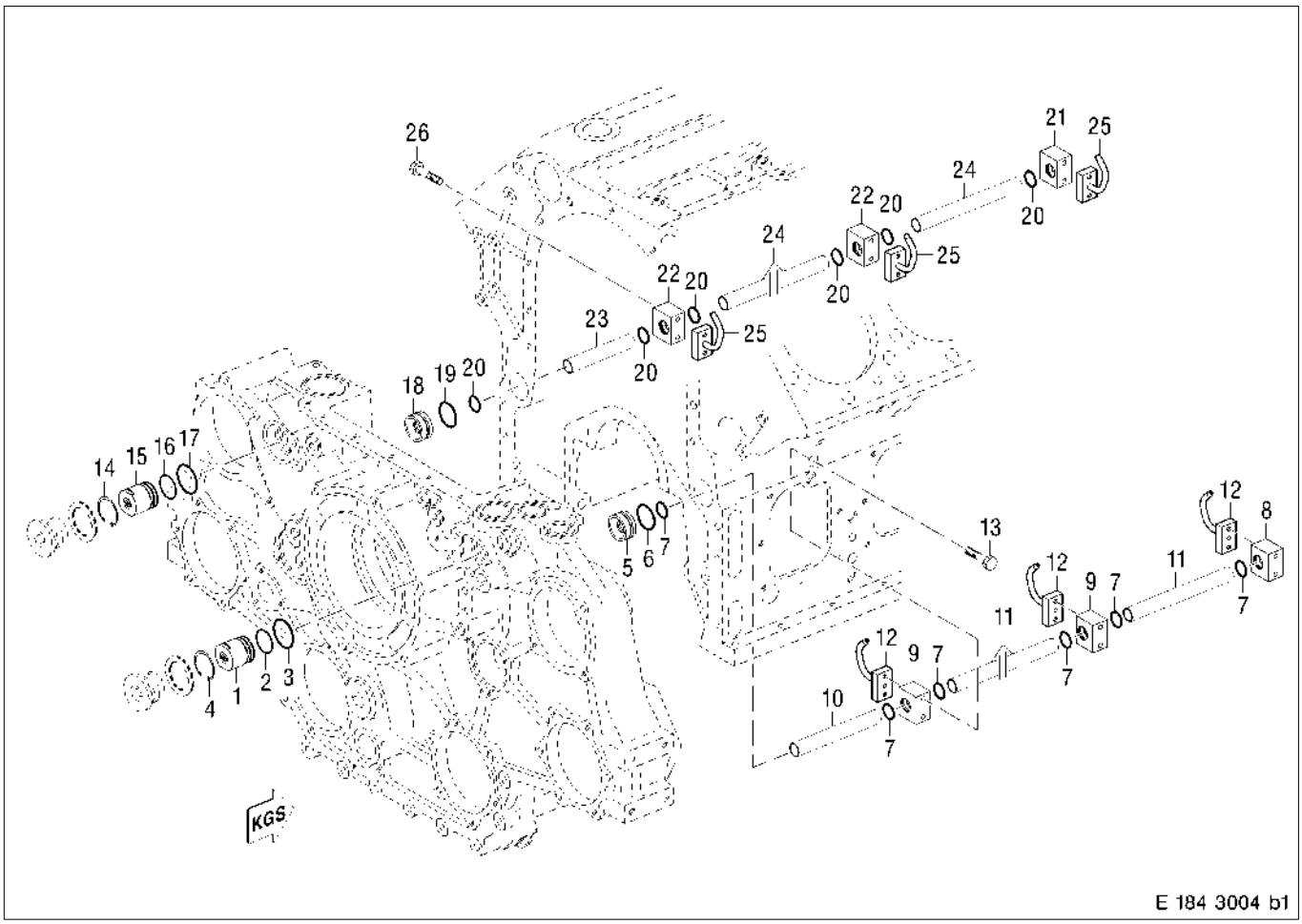
C183.15.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Install coolant line from/to intercooler	→ C 203.25.11
–	x	x	Install engine coolant vent lines	→ C 202.65.11
–	x	x	Install crankcase breather	→ C 018.10.11
–	x	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C184.10 Oil pipework in crankcase

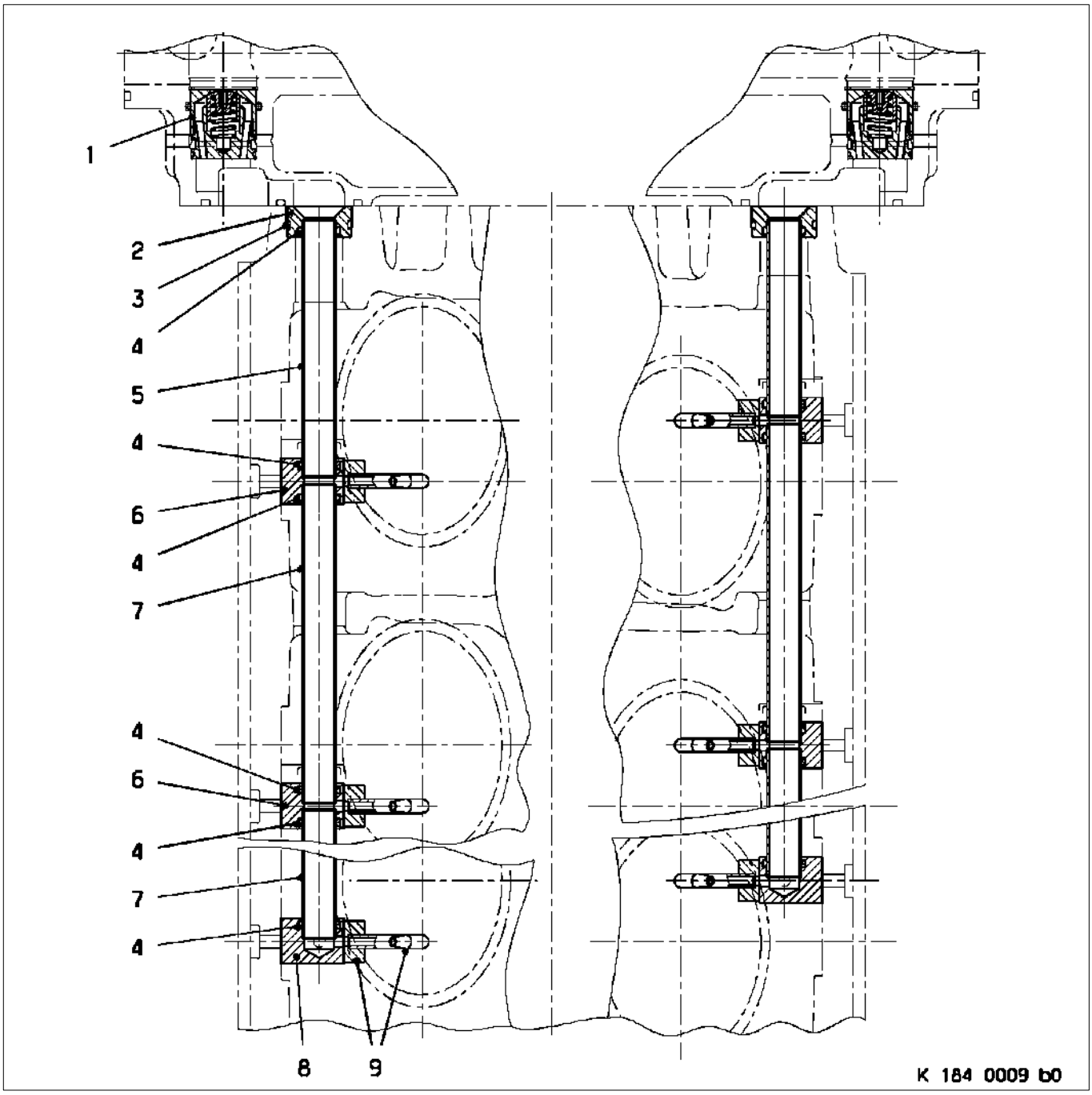
C184.10.01 Overview drawing

Piston cooling



1 Delivery valve
2 O-ring
3 O-ring
4 Snap ring
5 Washer
6 O-ring
7 O-ring
8 Bracket
9 Bracket
10 Pipe
11 Pipe
12 Oil spray nozzle
13 Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm
14 Snap ring
15 Delivery valve
16 O-ring
17 O-ring
18 Washer
19 O-ring
20 O-ring
21 Bracket
22 Bracket
23 Pipe
24 Pipe
25 Oil spray nozzle
26 Hex screw
Lubricant: Engine oil
Tightening torque: 21 Nm + 2 Nm

Piston cooling



1 Pressure valve
2 O-ring
3 Washer
4 O-ring
5 Pipe
6 Bracket
7 Bracket
8 Bracket
9 Oil spray nozzle

C184.10.02 Special tools

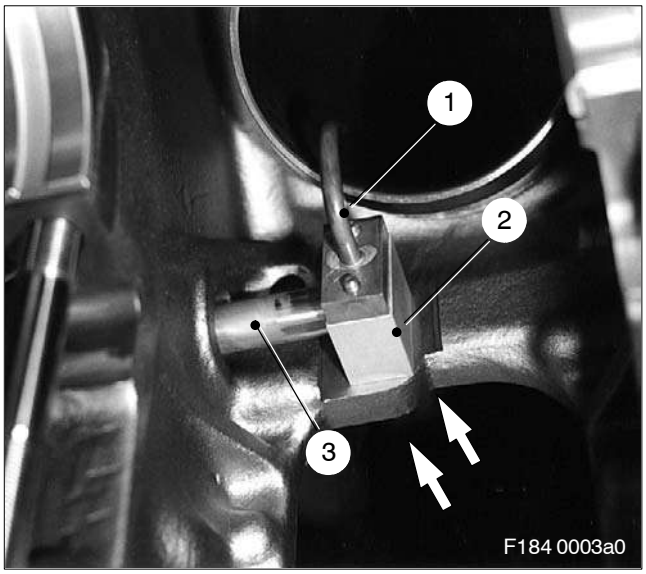
Designation	Use/dimension	Number
• Test device	for oil spray nozzle	1
• Barring tool		1

C184.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	Remove equipment carrier *	→ C 024.05
–	x	x	Remove inspection port cover	→ C 011.05

* – additional task only with removal of washer (sealing fit)

C184.10.05 Removal



Removing oil spray nozzle and oil pipes

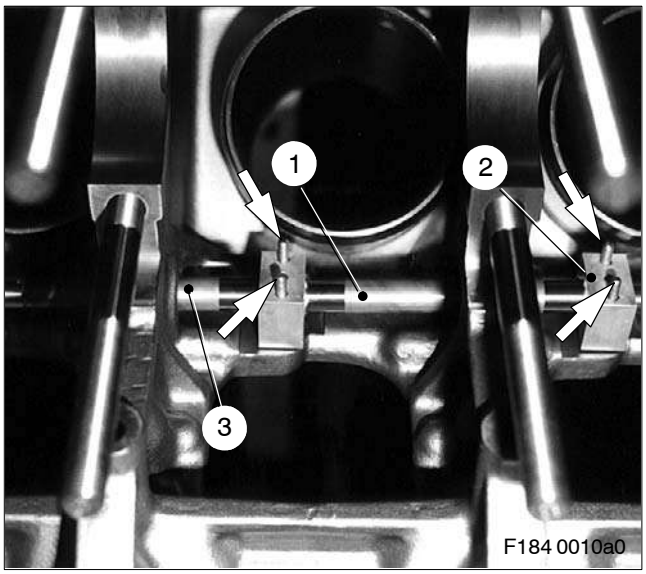
Turn crankshaft until oil spray nozzle (1) to be removed is accessible.

Note: Mark oil spray nozzles appropriately. Disassembly starting at cylinder A1 or B1.

Remove hex screws (arrow) and remove oil spray nozzle (1) from bracket (2).

Protect oil spray nozzles from damage.

Remove bracket from fit on oil pipe (3).



Withdraw and remove oil pipe (1) from released bracket (2).

Remove hex screws (arrow).

Remove bracket from fit on oil pipe (3).

C184.10.08 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 oil spray nozzle, bracket and oil pipe with cleaner and carefully blow clear with dry air.

Visually inspect component for damage and defects; replace if necessary.

Use red penetrant dye to surface crack-test oil spray nozzle. If cracks are found, replace oil spray nozzle.

Pressure-test oil pipe 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 (86°F) – components must also be at this temperature; max. 40 °C, if component must be held in hands.

Test pressure: 0.5 bar

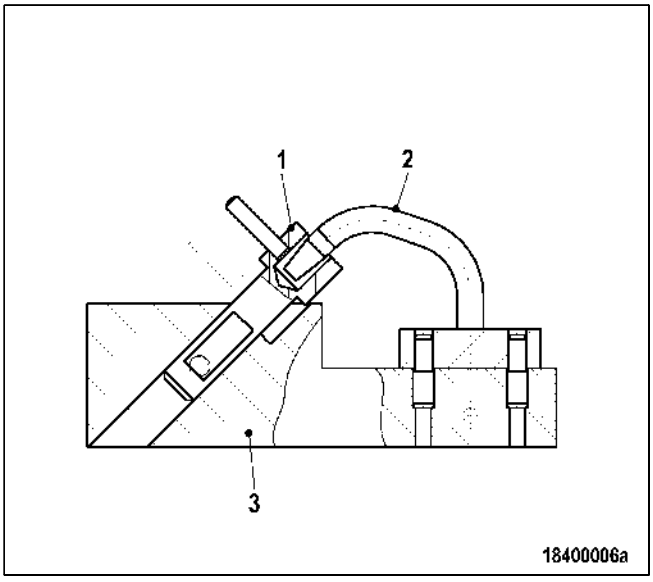
If leaks are found, replace oil pipe.

Then blow pipe dry with compressed air.

Check condition of threads; machine or replace components as necessary.

Check sealing and mating faces of oil spray nozzle; rub down with emery cloth or oilstone as necessary.

Check oil bore of oil spray nozzle for obstruction and ensure it is particularly clean.



Checking spraying direction of oil spray nozzle

Attach oil spray nozzle (2) to testing device (3).

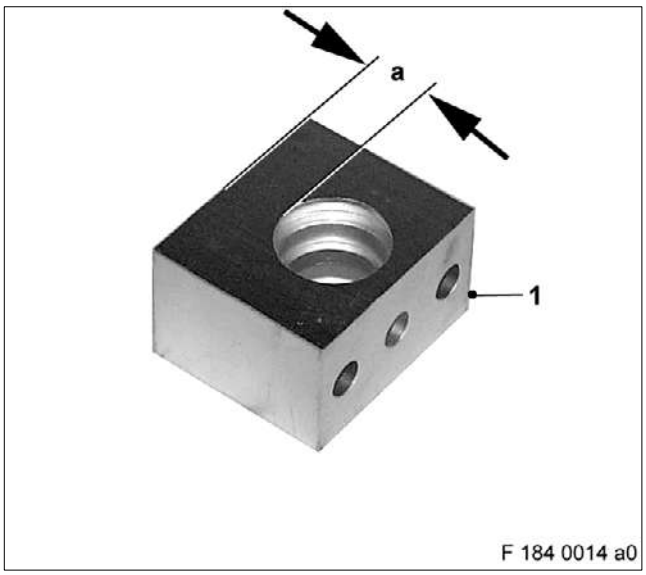
Check oil spray pipe with testing device (1) for deformation.

Replace oil spray nozzle in case of deformation.

Attention: Do not re-bend the oil spray nozzle.

C184.10.11 Installation

Note: Prior to installation, remove all blanking plugs. Make sure that oil chambers and oilways are perfectly clean.

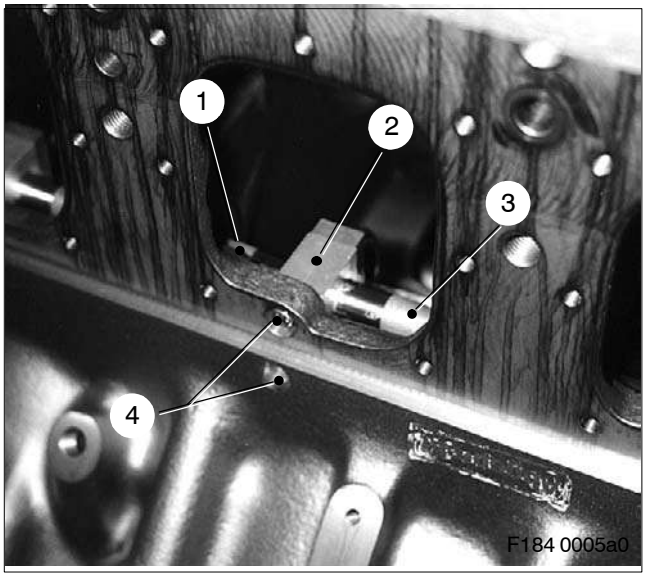


Installing oil spray nozzle and oil pipes

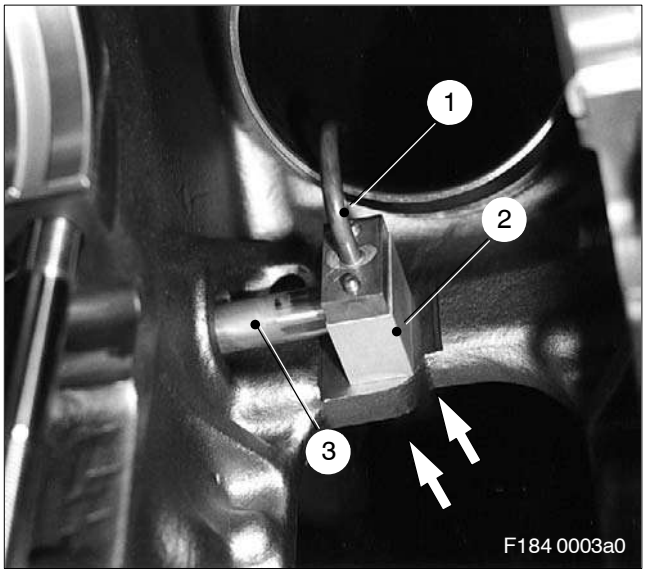
Coat with petroleum jelly and insert in grooves in bracket (1).

Ensure that bracket is correctly positioned, see also overview drawing C 184.10.01.

Note: Distance “a” from bracket towards crankcase.



Fit oil pipe(s) (1) and (3) in bracket(s) (2) and secure with hex screws (4) on crankcase.



⚠ 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 for oil spray nozzle (1) with compressed air and ensure it is perfectly clean and not obstructed.

Fit oil spray nozzle.

Tighten hex screws (2) to specified tightening torque – see overview drawing C 184.10.01.

After installing, bar engine and ensure there is clearance between oil spray nozzle and piston.

C184.10.12 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

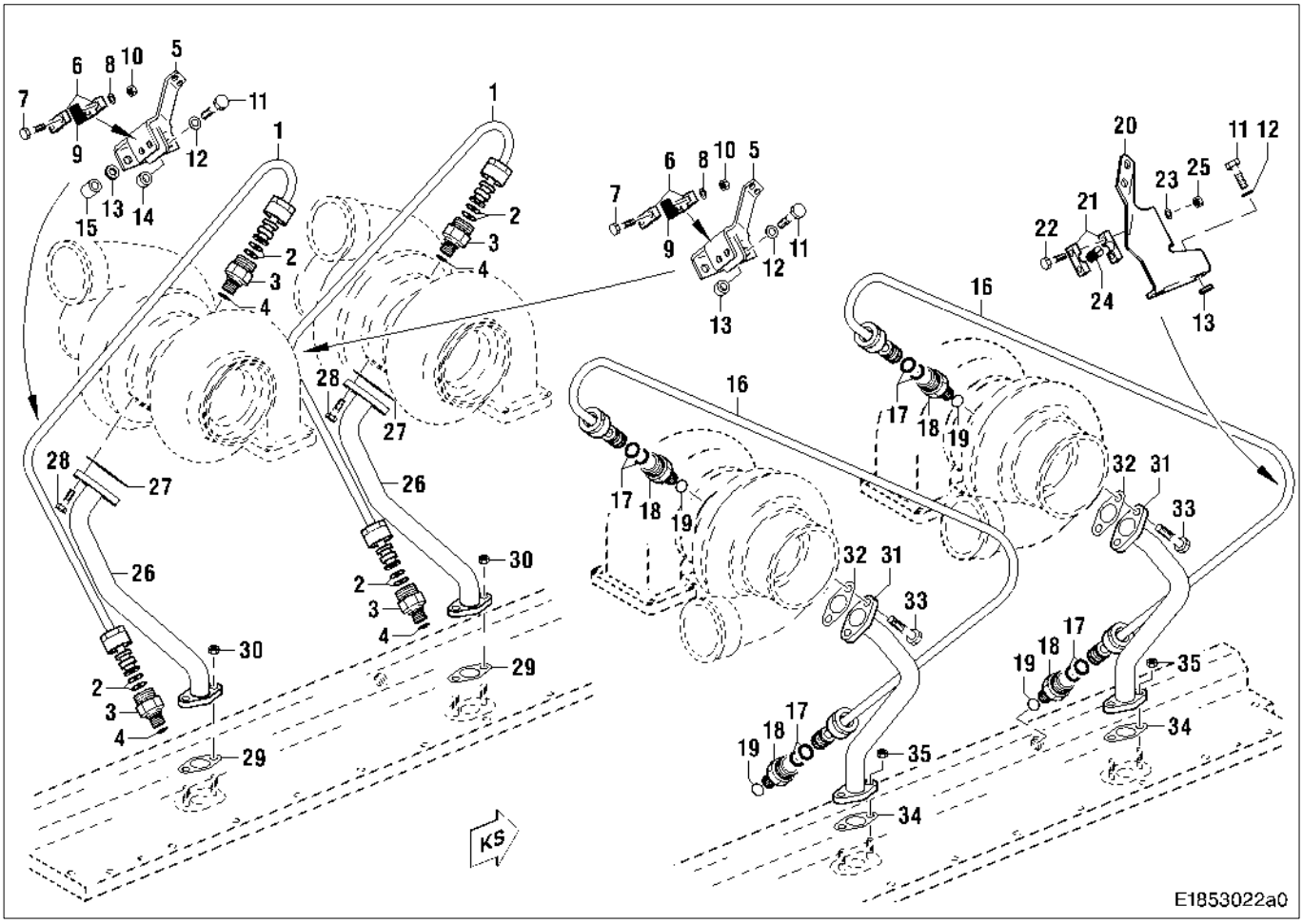
1	2	3	Operations	See
x	–	–	Perform operations as per Assembly Plan	B 005
x	–	–	Install engine	B 007
–	x	x		
–	–	x		
–	–	x		Operating Instructions

For the following tasks, a distinction must be made as to whether:
The engine was completely disassembled
The engine is removed but was not disassembled
The engine is installed

			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 184.10.04
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill oil system with engine oil	→ Operating Instructions

C185.10 Oil supply line for exhaust turbocharger

C185.10.01 Overview drawing



1 Oil line (supply)
Lubricant: Engine oil
Tightening torque: 40 Nm + 5 Nm
2 O-rIng
3 Union
4 O-rIng
5 Bracket
6 Pipe clamp half
7 Hex screw
8 Washer
9 Grommet
10 Hex nut
11 Hex screw
12 Washer
13 Washer
14 Spacer sleeve
15 Spacer sleeve
16 Oil line (supply)
Lubricant: Engine oil
Tightening torque: 40 Nm + 5 Nm
17 O-rIng
18 Union
19 O-rIng
20 Bracket
21 Pipe clamp half
22 Hex screw
23 Washer
24 Grommet
25 Hex nut
26 Pipe, left (return)
27 Gasket
28 Screw
29 Gasket
30 Hex nut
31 Pipe, right (return)
32 Gasket
33 Screw
34 Gasket
35 Hex nut

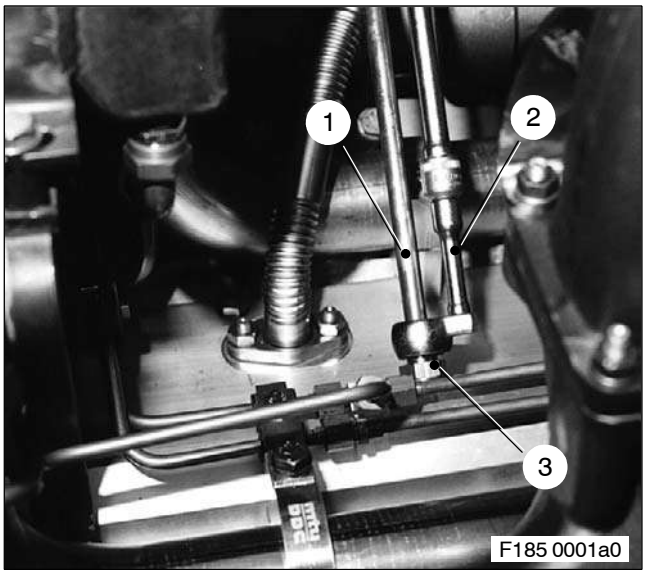
C185.10.02 Special tools

Designation	Use/dimension	Number
• Open-end wrench		1

C185.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C185.10.05 Removal

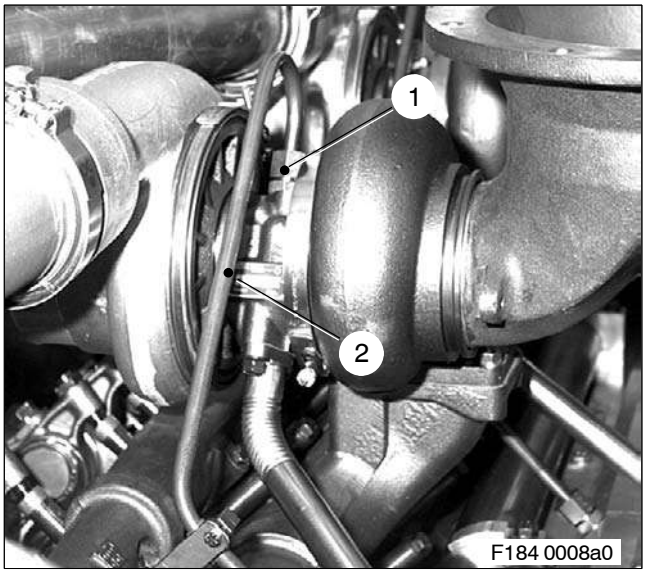


Removing oil supply line

Remove bracket from respective oil supply line – see overview drawing C185.10.01.

Using an open tap ring wrench (2) and extension, remove threaded fitting from line (1).

Note: Adapter (3) must not also rotate. Use an open-end wrench to hold in position.



Unscrew threaded union (1) and remove line (2).

Seal connections with suitable plugs.

Protect oil line from damage.

C185.10.08 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 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.

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

Note: The component must likewise reach this temperature.

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 componentsas necessary.

Replace sealing rings and gaskets.

C185.10.11 Installation

Installing oil supply lines

Note: Before 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 it is perfectly clean.

Install oil line as per overview drawing (see C 185.10.01), ensuring it is tension-free.

Tightening torque – see overview drawing C 185.10.01.

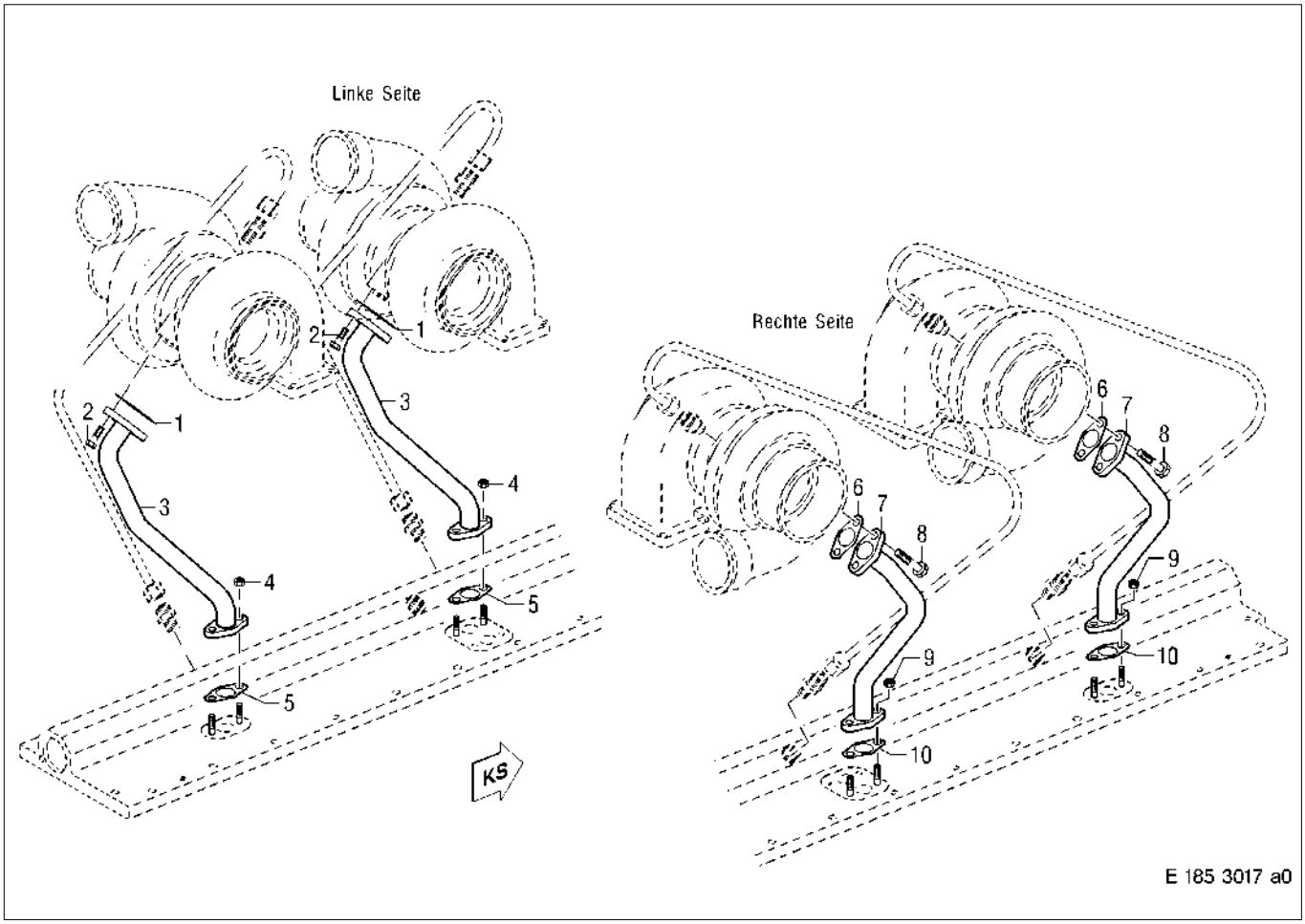
Note: After engine start, visually inspect oil lines for leaks.

C185.10.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C185.25 Oil return lines for exhaust turbocharger

C185.25.01 Overview drawing



1 Gasket
2 Hex screw
3 Pipework, left
4 Hex nut
5 Gasket
6 Gasket
7 Pipework, right
8 Hex screw
9 Hex nut
10 Gasket

C185.25.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C185.25.05 Removal

Removing oil return line

Remove oil return line with gaskets as per overview drawing – see C185.25.01.

Seal connections with suitable plugs.

C185.25.08 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.

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

Note: The component must also reach this temperature.

Test pressure: 0.5 bar

If leaks are found, replace oil line.

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, sealing rings and gaskets.

C185.25.11 Installation

Mounting oil return lines

Note: Before installation, remove all blanking plugs.

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 oil lines with compressed air and ensure that they are, perfectly clean.

Install oil lines with new gaskets, sealing rings and gaskets free of tension as shown in overview drawing – see C 185.25.01.

Note: After engine start, visually inspect oil lines for leaks.

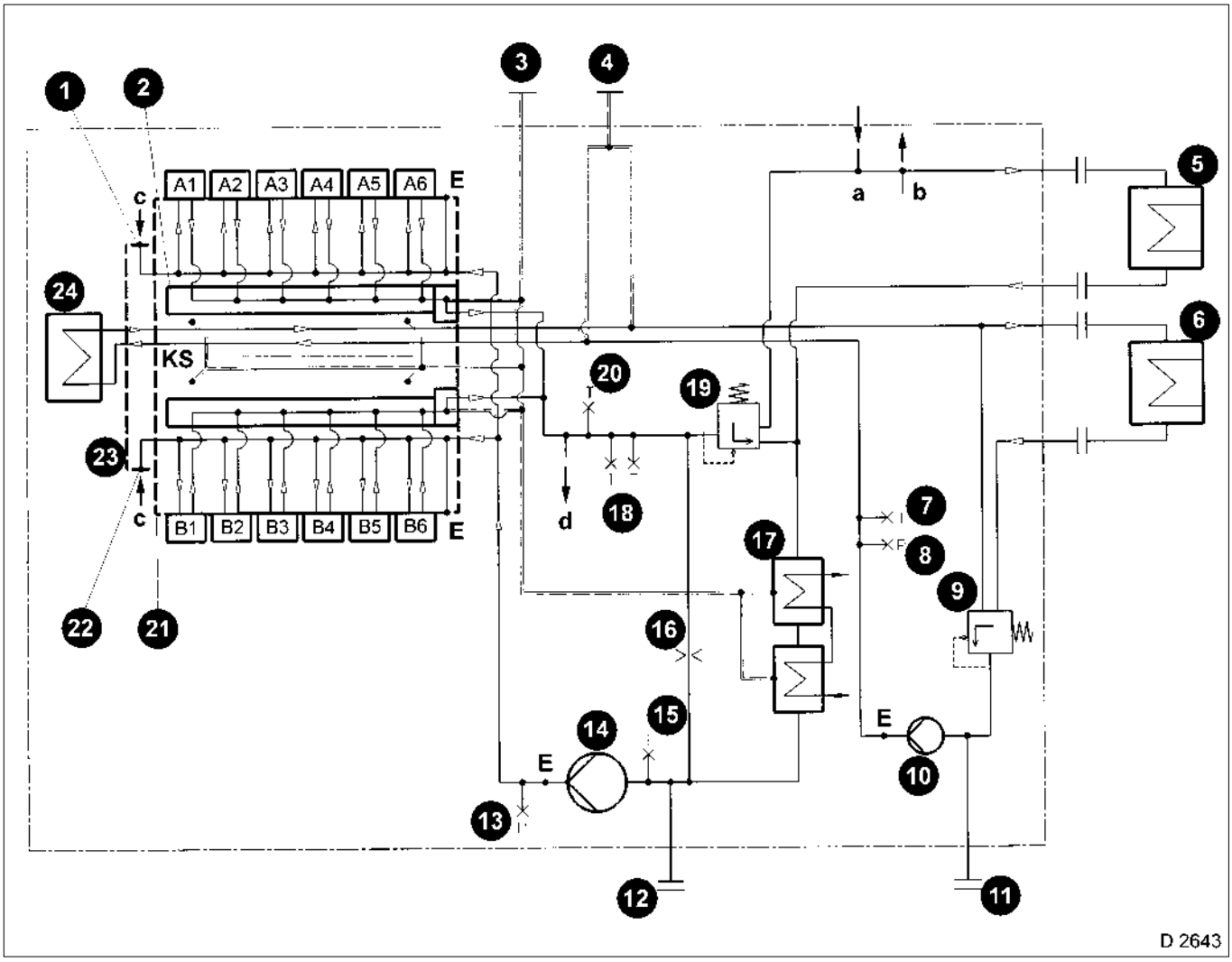
C185.25.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

C200 Coolant system

Illustration also applies to 16V 4000 G

Engine Coolant System



1 Coolant drain plug
2 Engine coolant collecting line
3 Engine coolant vent line
4 Vent line, low-temperature circuit
5 Heat exchanger (high temperature)
6 Heat exchanger (low temperature)
7 Measuring point, coolant temperature after charge air coolant pump
8 Measuring point, pressure after charge air coolant pump
9 Coolant thermostat (low temperature)
10 Coolant pump, charge air coolant system
11 Coolant expansion line (low temperature)
12 Coolant expansion line (high temperature)
13 Measuring point, pressure after engine coolant pump
14 Engine coolant pump
15 Measuring point, pressure before engine coolant pump
16 Restrictor, cooler bypass line
17 Lube oil heat exchanger
18 Connection, temperature sensor after engine
19 Coolant thermostat (high temperature)
20 Measuring point, engine coolant temperature after engine
21 (Crankcase)
22 Coolant drain plug
23 (Flywheel housing)
24 Intercooler

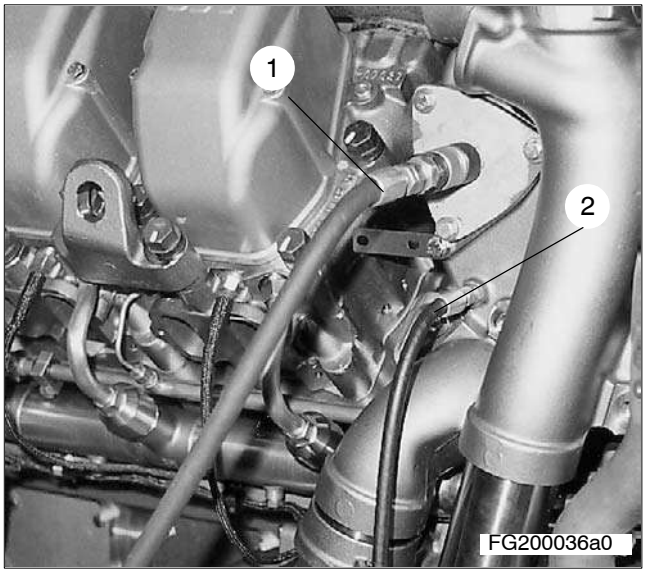
a to compartment heating *
b from compartment heating *
c from preheating unit
d to preheating unit
E Drain

* on appropriately equipped engine

C200.08 Pressure-testing coolant chambers

WARNING

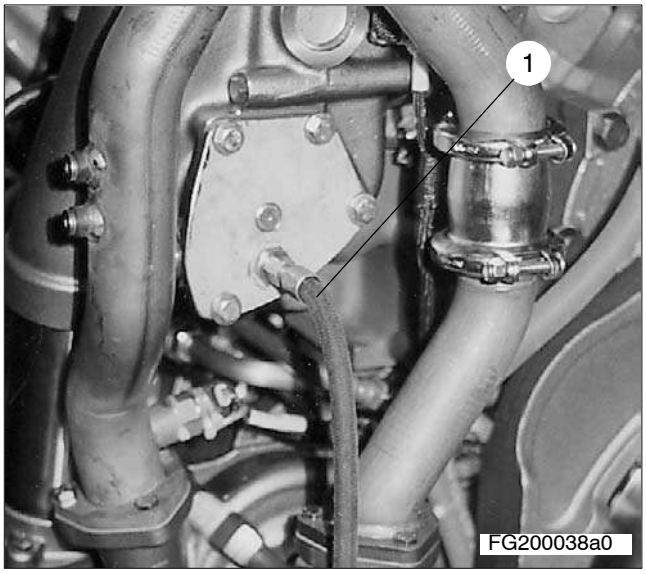
Only use hydraulic pressure testing device specified by Manufacturer.
Observe specified safety and accident prevention regulations!



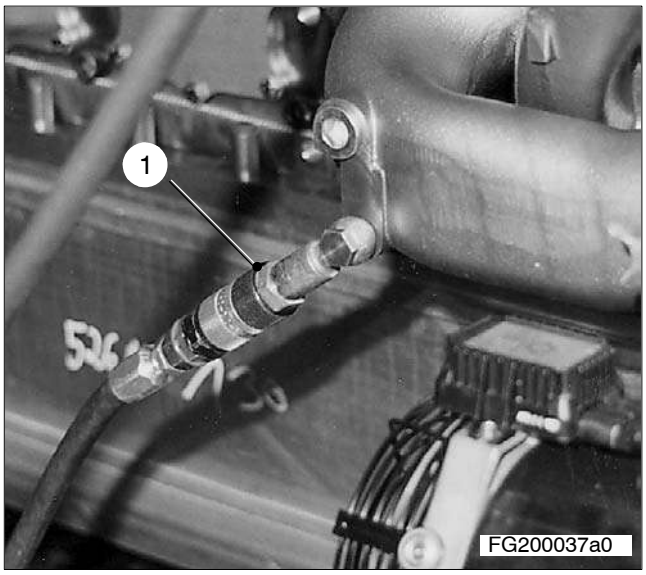
Note: After assembling engine, pressure-test coolant jackets with treated coolant and check for leaks.

Connect supply hose line (1) of hydraulic pressure testing device to thermostat housing.

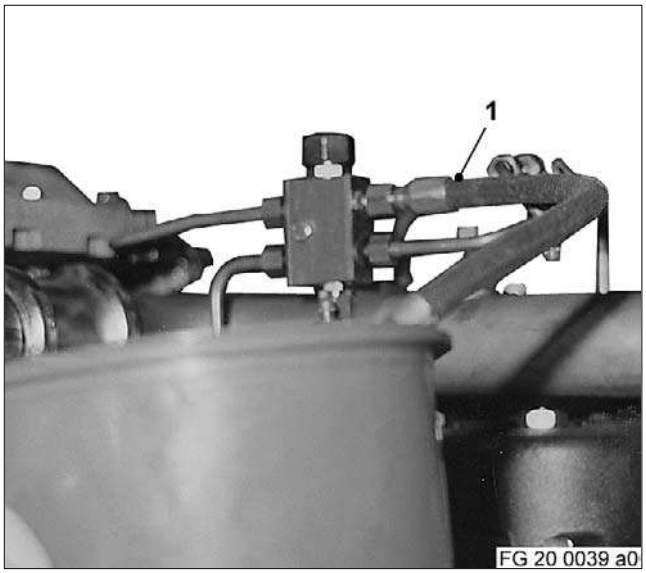
Connect vent line (2) to thermostat housing.



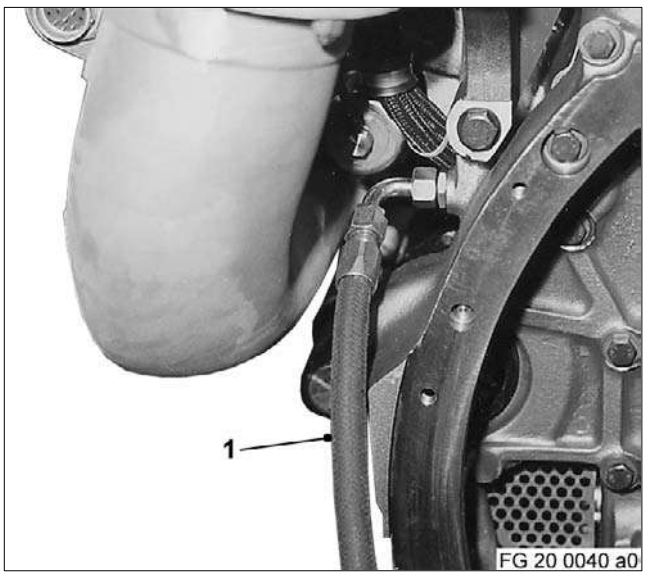
Connect vent line (1) to thermostat housing, free end.



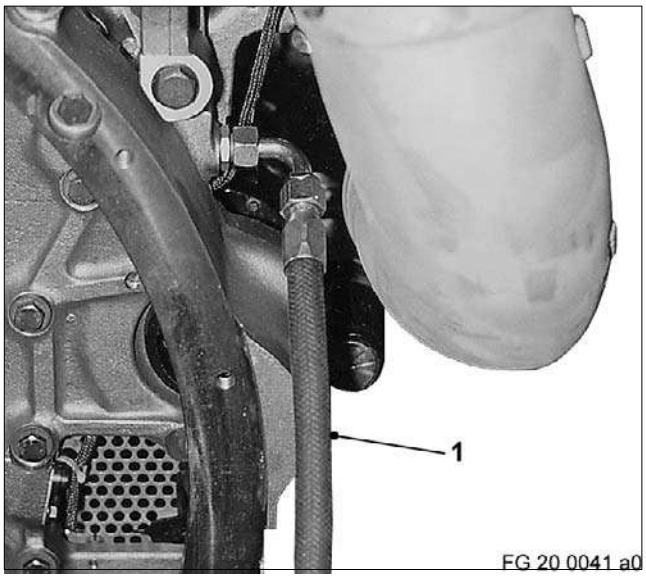
Connect coolant supply line (1) to elbow of engine coolant pump.



Connect vent line (1) of hydraulic pressure testing device to engine vent.



Connect drain hose line (1) of hydraulic pressure testing device to crankcase, left engine side (driving end).



Connect drain hose line (1) of hydraulic pressure testing device to crankcase, right engine side (driving end).

⚠ 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 jackets with treated coolant.

Vent piping system.

Pressure-test coolant chambers with water at 80° C for one hour.

Test pressure = 5 bar

Check all coolant-retaining components for leaks.

After completion of pressure testing, relieve test pressure.

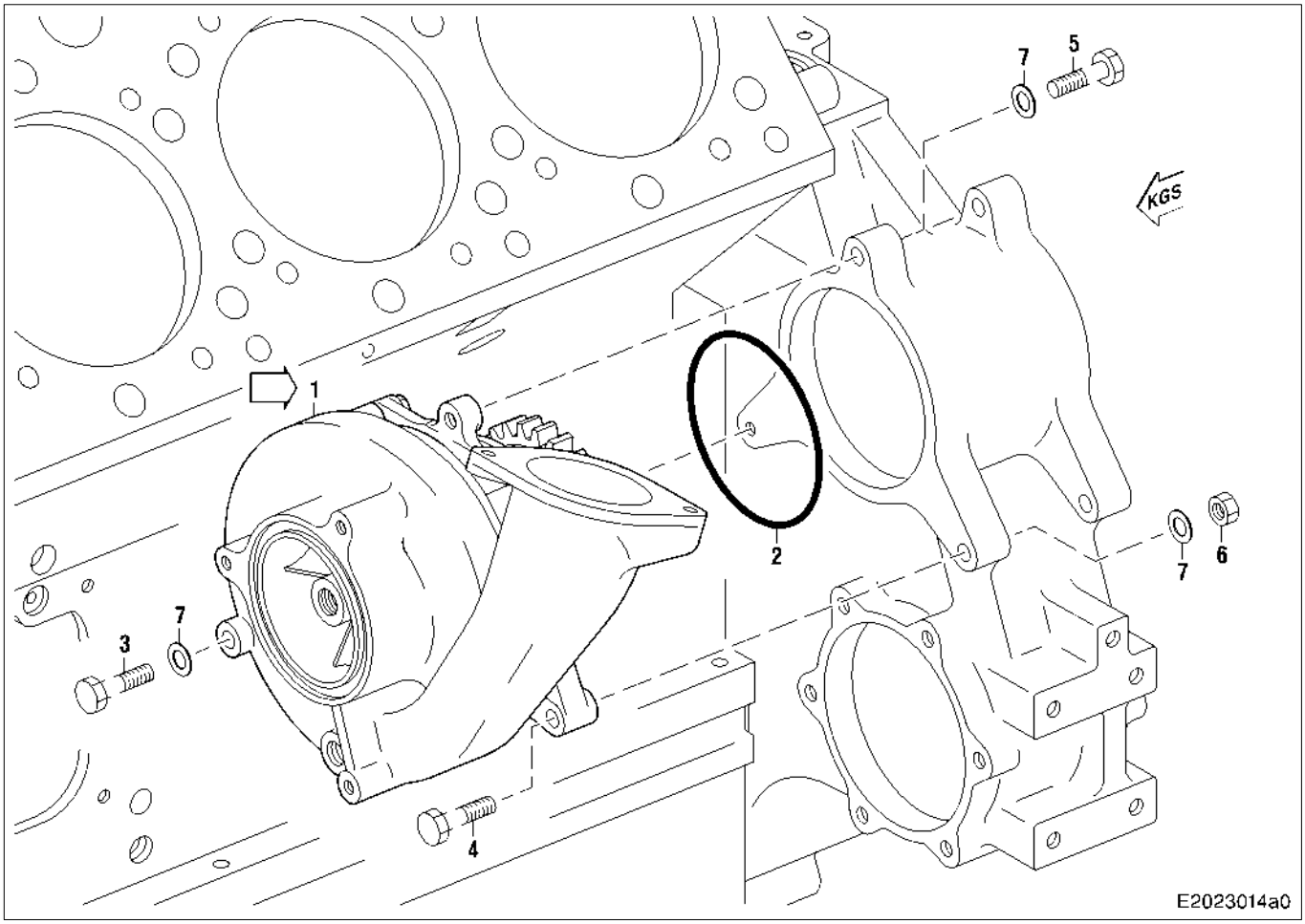
Drain system.

Remove hydraulic pressure testing device.

Refit plugs with new sealing rings.

C202.05 Engine coolant pump

C202.05.01 Overview drawing



1 Engine coolant pump
2 O-ring
3 Hex screw
4 Hex screw
5 Hex screw
6 Hex nut
7 Washer

C202.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	Remove engine coolant line	→ C 202.10

C202.05.05 Removal

Remove engine coolant pump

Remove securing screws for engine coolant pump, see overview drawing C 202.05.01.

WARNING

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

Release engine coolant pump with crowbar from equipment carrier and remove.

If necessary, cover installation bore of engine coolant pump.

Remove O-ring from engine coolant pump.

C202.05.06 Disassembly

Disassembly of engine coolant pump is not planned.

The engine coolant pump is an exchangeable component and can be obtained in the exchange procedure.

C202.05.08 Inspection and repair

Check engine coolant pump externally for damage and condition; replace if necessary.

Check spiral housing and impeller for cavitation. In event of pitting, replace coolant pump.

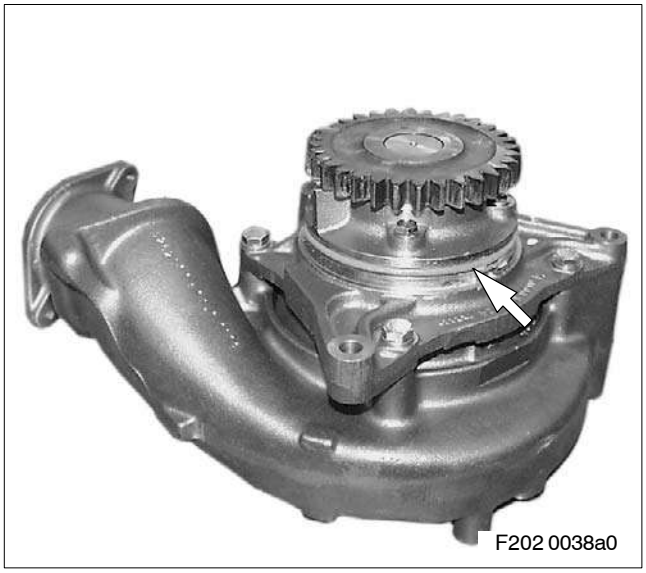
Visually inspect sealing surfaces for wear, pitting and cavitation; rub down with emery cloth or an oilstone or replace component.

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 O-ring.

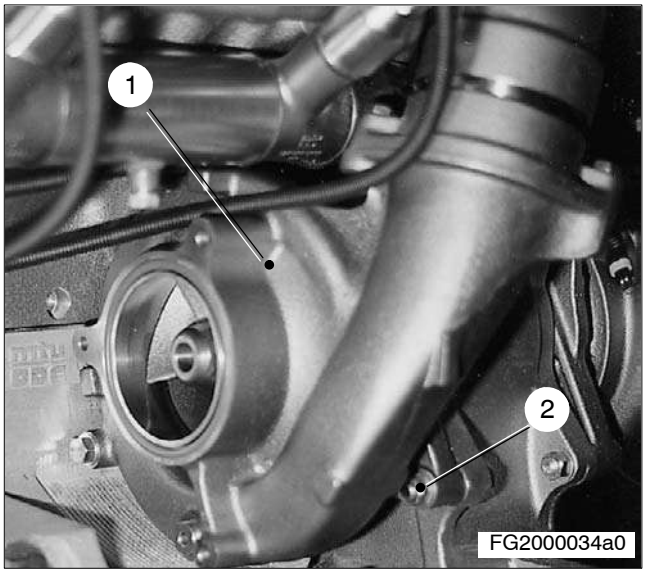
C202.05.11 Installation


F202 0038a0

Install engine coolant pump

Note: Different impeller versions from 12V – 16V are available – ensure engine coolant pump is correct!

Coat O-ring (arrow) with petroleum jelly and insert in groove on bearing housing of engine coolant pump.



Note: Prior to installation, remove cover.

Positioning correctly, insert coolant pump (1) into bore in equipment carrier, ensuring that gear engages.

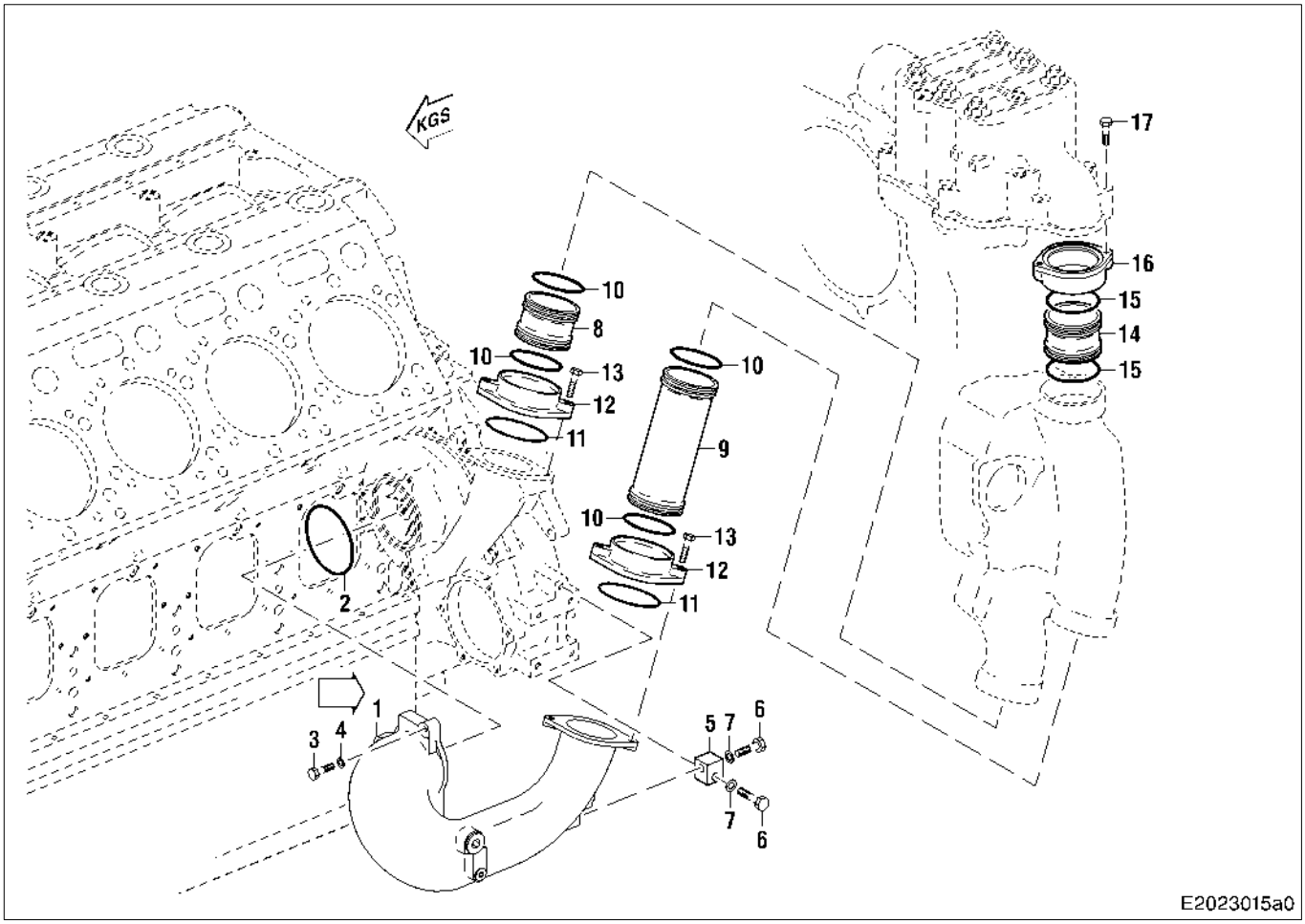
Install hex screws (2) with washers and tighten uniformly.

C202.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled / The engine is removed but was not disassembled / The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 202.05.04
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C202.10 Coolant lines, engine/engine coolant pump

C202.10.01 Overview drawing



1 Elbow
2 O-ring
3 Hex screw
4 Washer
5 Bracket
6 Hex screw
7 Washer
8 Plug-in pipe
9 Plug-in pipe
10 O-ring
11 O-ring
12 Flange
13 Hex screw
14 Plug-in pipe
15 O-ring
16 Flange
17 Hex screw

C202.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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

C202.10.05 Removal

Removing 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 all monitoring units installed in coolant lines.

Remove lines in accordance with overview drawing, see C 202.10.01.

After removing lines, seal all open connections by installing suitable plugs.

C202.10.08 Inspection and repair

Clean lines with cold cleaner and brush.

Visually inspect plug-in connections and ring grooves in elbows and connecting lines for wear, indentations and pitting; rub down with emery cloth or an oilstone if necessary or replace component.

Check all mating and sealing faces for wear and damage; rub down with emery cloth or an oilstone as necessary.

Check lines for damage and condition; if necessary repair and, using corrosion inhibitor, pressure-test with air in water bath for leaks.

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.

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

Note: The component must also reach this temperature.

Test pressure: 0.5 bar

Replace gaskets and O-rings.

C202.10.11 Installation

Installing coolant lines

Note: Before installation, remove all blanking plugs.

Coat O-rings with petroleum jelly.

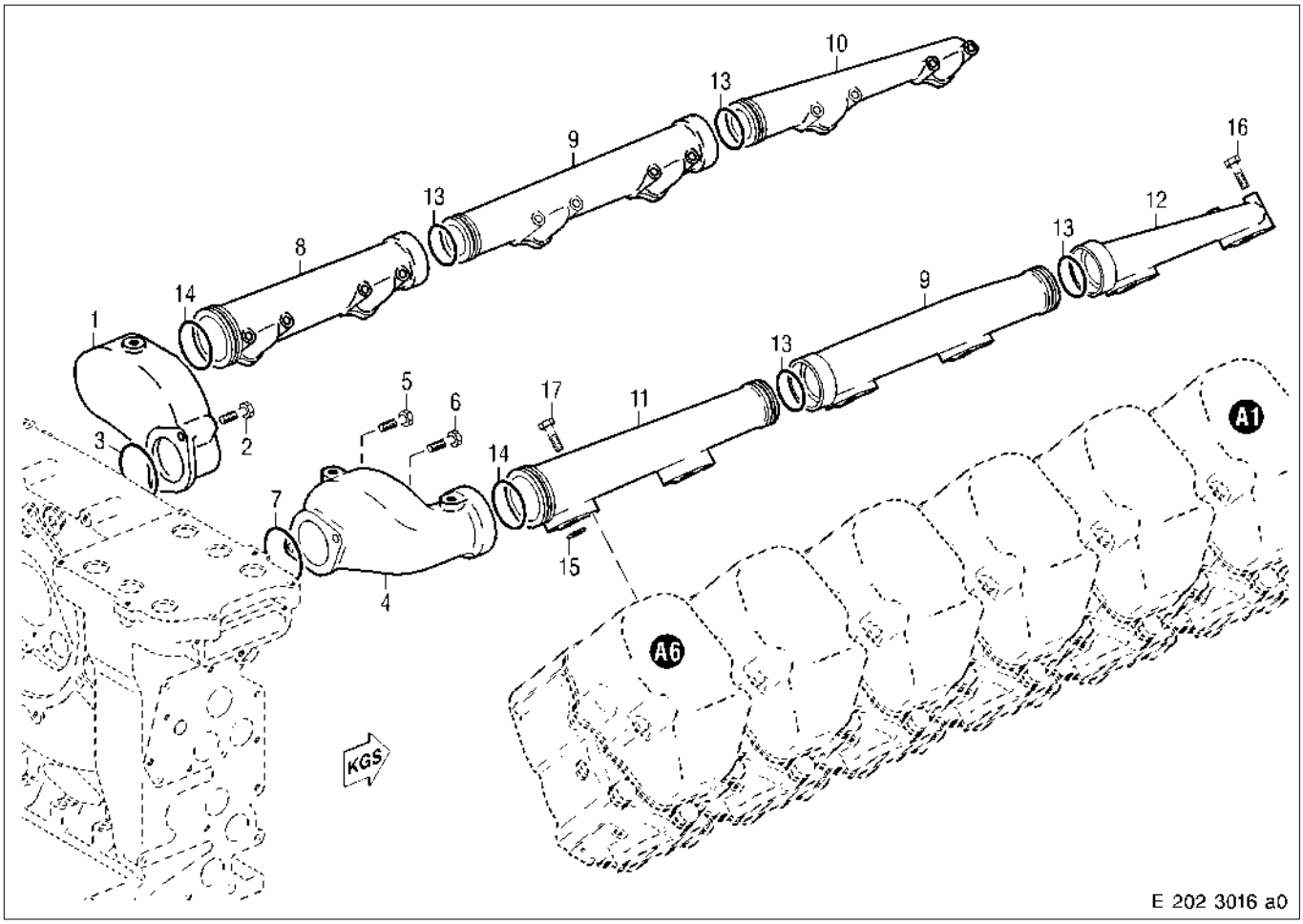
Install lines with new sealing rings and O-rings, with fixtures free of tension – see overview drawing C 202.10.01, and photos.

C202.10.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	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

C202.20 Coolant pipework after cylinder head

C202.20.01 Overview drawing



1 Connector
2 Hex screw
3 O-ring
4 Connector
5 Hex screw
6 Hex screw
7 O-ring
8 Coolant collecting line
9 Coolant collecting line
10 Coolant collecting line
11 Coolant collecting line
12 Coolant collecting line
13 O-ring
14 O-ring
15 O-ring
16 Hex screw
17 Hex screw

C202.20.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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	Remove coolant vent line	→ C 202.65

C202.20.05 Removal

Removing coolant lines

Remove coolant lines and connectors as per overview drawing – see C 202.20.01.

After removing lines, seal all open connections by installing suitable plugs.

C202.20.08 Inspection and repair

Clean lines and connectors with cold cleaner and brushes.

Visually inspect plug-in connections and ring grooves on connector and connecting lines for wear, indentations and pitting; rub down with emery cloth or an oilstone if necessary or replace component.

Check all mating and sealing faces for wear and damage; rub down with emery cloth or an oilstone as necessary.

Check lines for damage and condition; if necessary repair and, using corrosion inhibitor, pressure-test with air in water bath for leaks.

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.

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

Note: The component must also reach this temperature.

Test pressure: 0.5 bar

Replace gaskets and O-rings.

C202.20.11 Installation

Install coolant lines

Note: Before installation, remove all blanking plugs.

Coat O-rings with petroleum jelly.

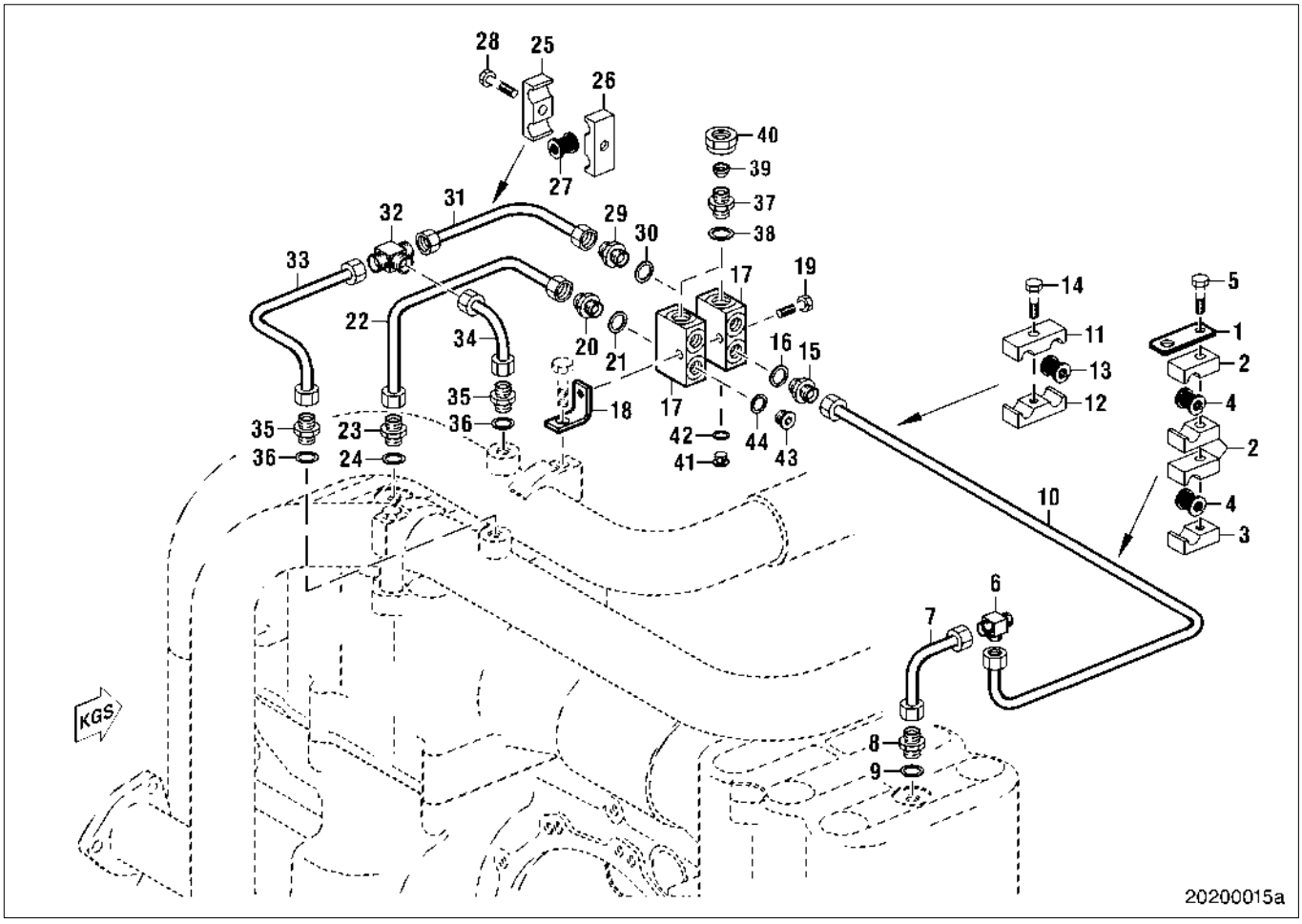
Mount lines and connectors free of tension as shown in overview drawing C 202.20.01.

C202.20.12 After-installation operations

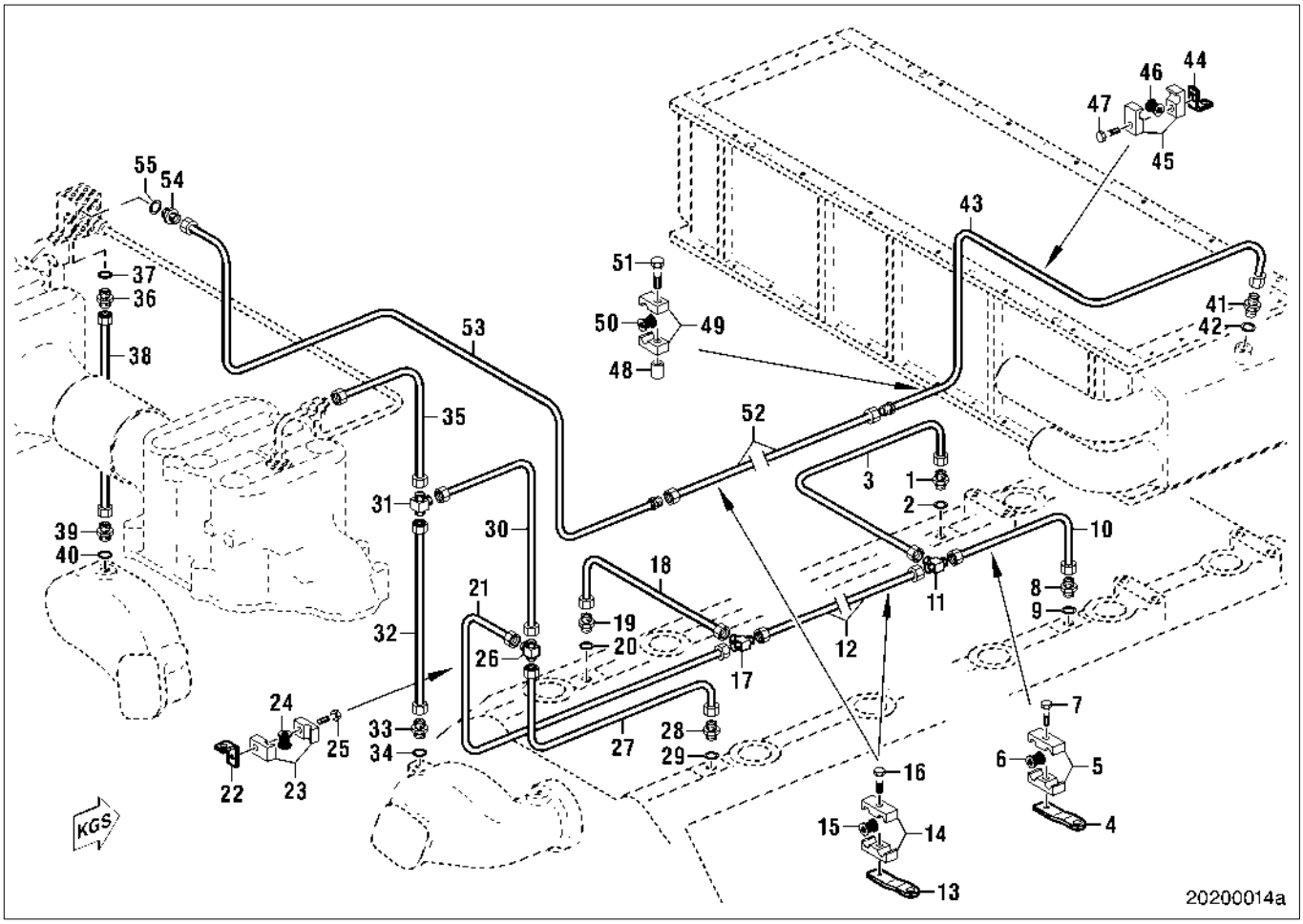
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Install coolant vent line	→ C 202.65
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C202.65 Coolant vent lines

C202.65.01 Overview drawing



1	Bracket, straight	12	Pipe clamp half	23	Reduction union	34	Vent line
2	Grommet	13	Grommet	24	Washer	35	Reduction union
3	Pipe clamp half	14	Hex screw	25	Pipe clamp half	36	Washer
4	Grommet	15	Reduction union	26	Pipe clamp half	37	Reduction union
5	Hex screw	16	Washer	27	Grommet	38	Washer
6	T-piece	17	Distributor block	28	Hex screw	39	Sealing cone
7	Vent line	18	Bracket, angled	29	Reduction union	40	Plug
8	Reduction union	19	Hex screw	30	Washer	41	Plug
9	Washer	20	Reduction union	31	Vent line	42	Washer
10	Vent line	21	Washer	32	T-piece	43	Plug
11	Pipe clamp half	22	Vent line	33	Vent line	44	Washer



1 Reduction union
2 Washer
3 Vent line
4 Bracket, straight
5 Pipe clamp half
6 Grommet
7 Hex screw
8 Reduction union
9 Washer
10 Vent line
11 T-piece
12 Vent line
13 Bracket, straight
14 Pipe clamp half
15 Grommet
16 Hex screw
17 T-piece
18 Vent line
20 Washer
21 Vent line
22 Bracket, angled
23 Pipe clamp half
24 Grommet
25 Hex screw
26 T-piece
27 Vent line
28 Reduction union
29 Washer
30 Vent line
31 T-piece
32 Vent line
33 Reduction union
34 Washer
35 Vent line
36 Reduction union
37 Washer
38 Vent line
39 Reduction union
40 Washer
41 Reduction union
42 Washer
43 Vent line
Low-temperature circuit
44 Bracket, angled
45 Pipe clamp half
46 Grommet
47 Hex screw
48 Spacer bushing
49 Pipe clamp half
50 Grommet
51 Hex screw
52 Vent line
Low-temperature circuit
53 Vent line
Low-temperature circuit
54 Reduction union
55 Washer

C202.65.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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

C202.65.05 Removal

Disconnecting 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 lines in accordance with overview drawing, see C 203.65.01.

After removal, seal all connections with suitable plugs.

C202.65.08 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 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.

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

Note: The component must likewise reach this temperature.

Test pressure: 0.5 bar

If leaks are detected, replace line.

Replace grommets and hose line as part of every W6 overhaul.

Replace sealing rings as part of every assembly.

C202.65.11 Installation

Connect 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 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 203.65.01.

C202.65.12 After-installation operations

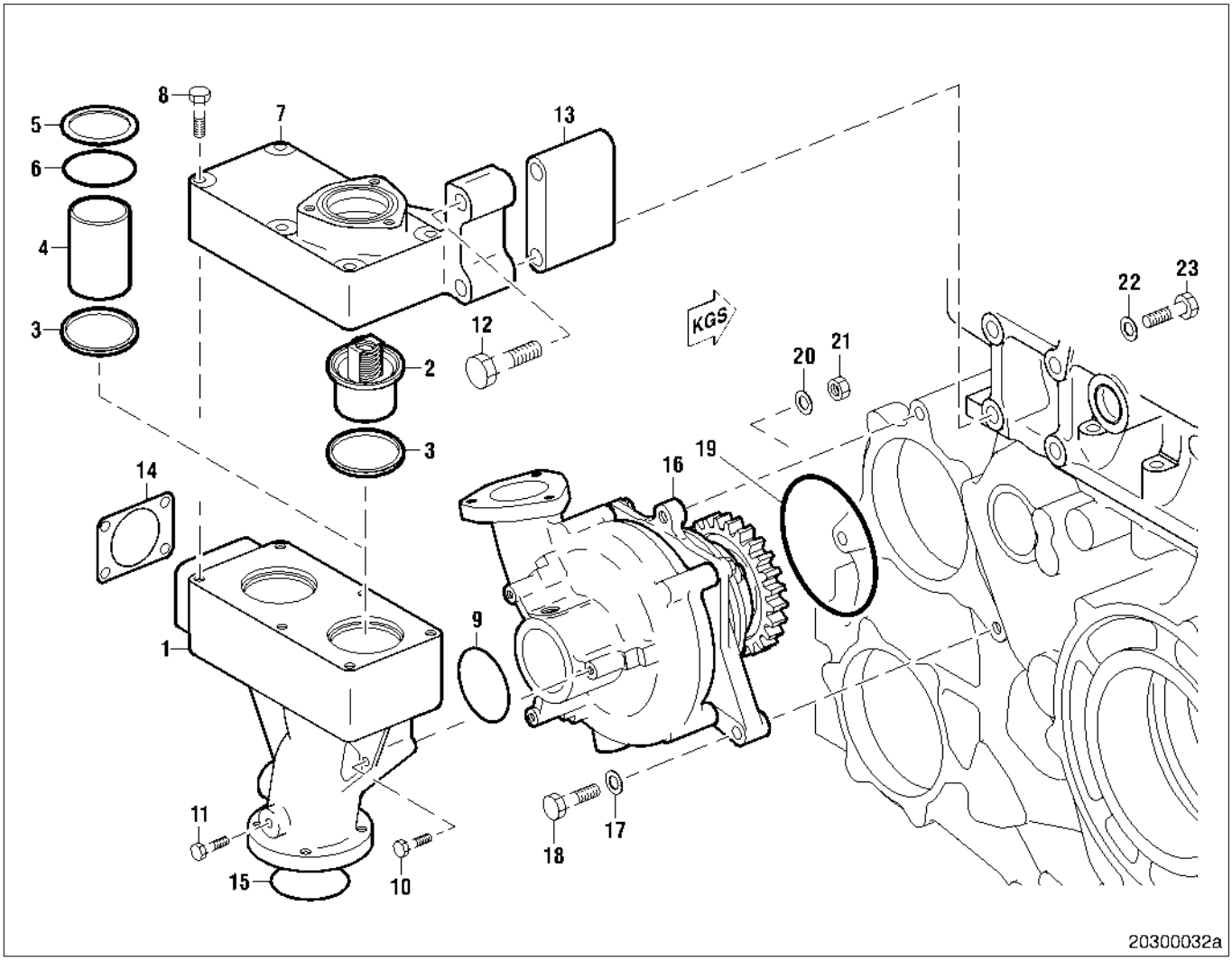
For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C203 Coolant system, low-temperature circuit

C203.05 Charge air coolant pump

C203.05.01 Overview drawing

Charge air coolant pump with attachments



1 Thermostat housing
2 Thermostat element
3 Sealing ring
4 Sleeve
5 Sealing ring
6 O-rIng
7 Cover
8 Hex screw
9 O-rIng
10 Hex screw
11 Hex screw
12 Hex screw
13 Spacer sleeve
14 Gasket
15 O-rIng
16 Charge air coolant pump
17 Washer
18 Hex screw
19 O-rIng
20 Washer
21 Nut
22 Washer
23 Hex screw

C203.05.02 Special tools

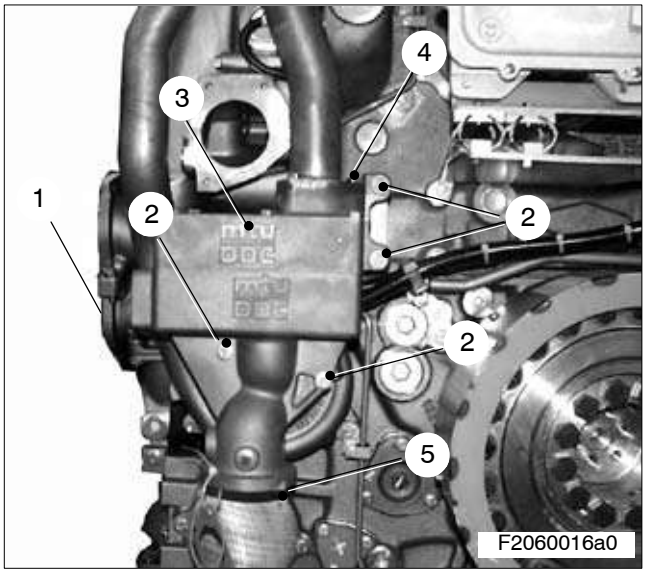
Designation	Use/dimension	Number
• Installation mandrel	for thermostat housing sealing ring	1

C203.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Drain charge air coolant	→ Operating Instructions
–	x	x	Remove temperature switch	→ C 500

C203.05.05 Removal

Removing thermostat housing



Remove hex screws (4) from flange (inlet).

Remove pipework from flange (1) and (5).

Remove hex screws (2) and remove thermostat housing (3).

Remove charge air coolant pump

Remove coolant line from charge air coolant pump – see overview drawing C 203.25.01.

Remove securing screws for charge air coolant pump – see overview drawing C 203.05.01.

WARNING

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

Release charge air coolant pump with crowbar from equipment carrier and remove.

If necessary, cover installation bore of charge air coolant pump.

Remove O-ring from charge air coolant pump.

C203.05.06 Disassembly

Charge air coolant pump

Disassembly of charge air coolant pump is not planned.

The charge air coolant pump is an exchangeable component and can be obtained in the exchange procedure.

Thermostat housing

Remove securing screws and cover.

Remove thermostat elements and sealing rings from thermostat housing – see overview drawing C 203.05.01.

C203.05.08 Inspection and repair

Charge air coolant pump

Check charge air coolant pump externally for damage and condition; replace if necessary.

Check spiral housing and impeller for cavitation. In event of pitting, replace charge air 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 charge air coolant pump if necessary.

Replace O-ring.

Thermostat housing

Using the surface crack-testing method with red penetrant dye, check thermostat housing for cracks; replace if cracks are found.

Check support bores of thermostat elements for damage. Smooth with emery cloth if necessary.

Replace all gaskets, sealing rings and O-rings.

Check thermostat elements – see C 206.05.08.

C203.05.10 Assembly

Thermostat housing

Installing sealing ring in thermostat housing

Fit sealing ring (2) with flat end facing drift (1) onto drift.

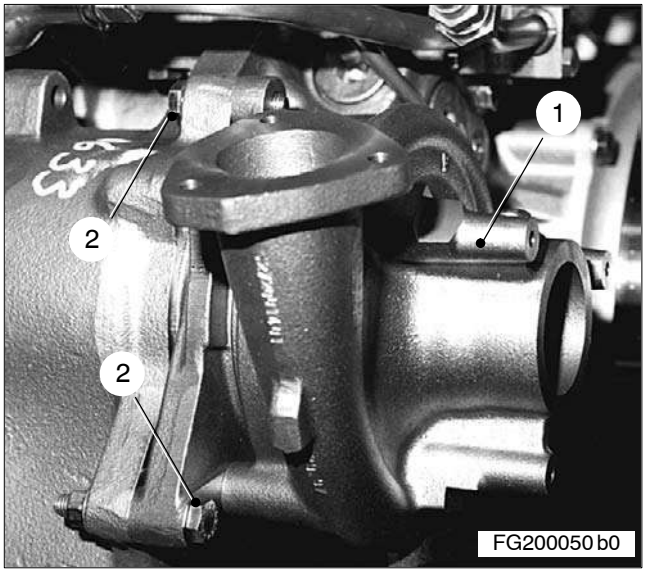
Using mandrel, strike sealing rings into thermostat housing until drift makes contact with thermostat housing.

Coat sealing ring on thermostat element with petroleum jelly.

Press thermostat elements into thermostat housing by hand and assemble thermostat housing – see overview drawing C 203.05.01.

C203.05.11 Installation

Installing charge air coolant pump

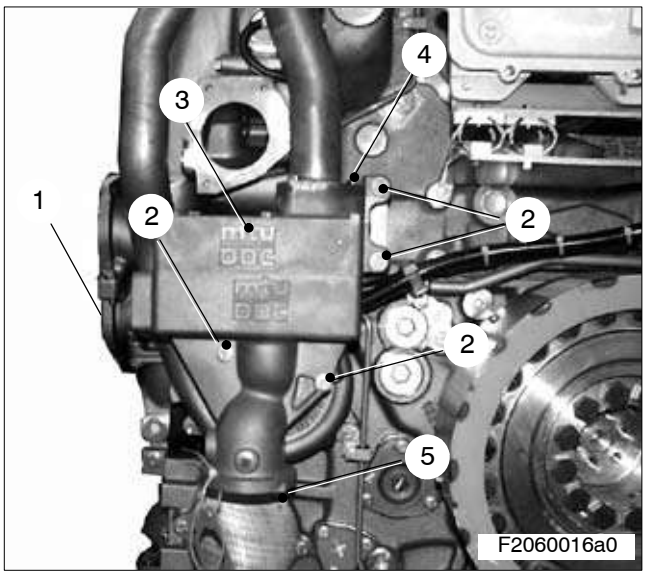


Coat O-ring with petroleum jelly (see overview drawing C 203.05.01) with petroleum jelly and insert in groove on pump housing of charge air coolant pump.

Positioning correctly, insert charge air coolant pump (1) into bore in gear case, ensuring that gear engages.

Install hex screws (2) with washers and tighten uniformly.

Installing thermostat housing



Coat O-ring (see overview drawing C 203.05.01) with petroleum jelly and insert into groove in thermostat housing (3).

Install thermostat housing with spacer and hex screws (2) – see overview drawing C 203.05.01.

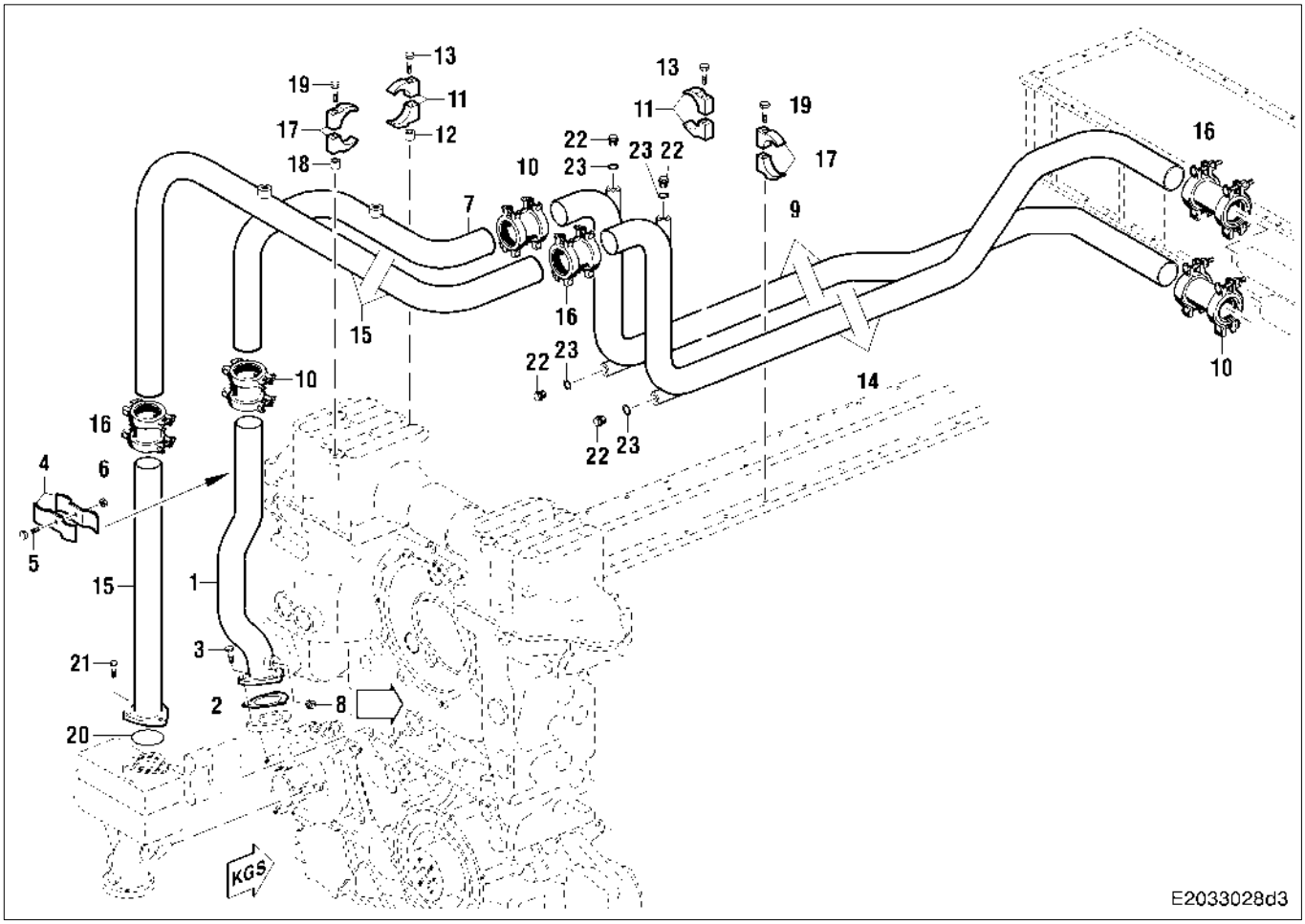
Fit corresponding pipes to flanges (5), (1) and (4).

C203.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 203.05.04
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C203.25 Coolant pipework from/to intercooler

C203.25.01 Overview drawing



1 Pipeline
2 Gasket
3 Hex screw
4 Bracket
5 Screw
6 Nut
7 Pipeline
8 Blanking plug
9 Coolant line
10 Pipe connection
11 Bracket
12 Spacer
13 Screw
14 Coolant line
15 Coolant line
16 Pipe connection
17 Bracket
18 Spacer
19 Screw
20 O-rIng
21 Hex screw
22 Plug
23 Sealing ring

C203.25.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	–	x	Drain charge air coolant	→ Operating Instructions
–	–	x	Remove coolant vent lines	→ C 202.65

C203.25.05 Removal

Removing coolant lines

Remove coolant lines with fixtures as per overview drawing – see C 203.25.01.

After removing coolant lines, seal all connections with suitable plugs.

C203.25.08 Inspection and repair

Clean all components.

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

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

Check coolant lines for damage and condition; if necessary repair and, using corrosion inhibitor, pressure-test with air in water bath for leaks.

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.

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

Note: The component must likewise reach this temperature.

Test pressure: 0.5 bar

Check thread for ease of movement; if necessary, recut or replace part.

Replace gaskets.

C203.25.11 Installation

Note: Before installation, remove all blanking plugs.

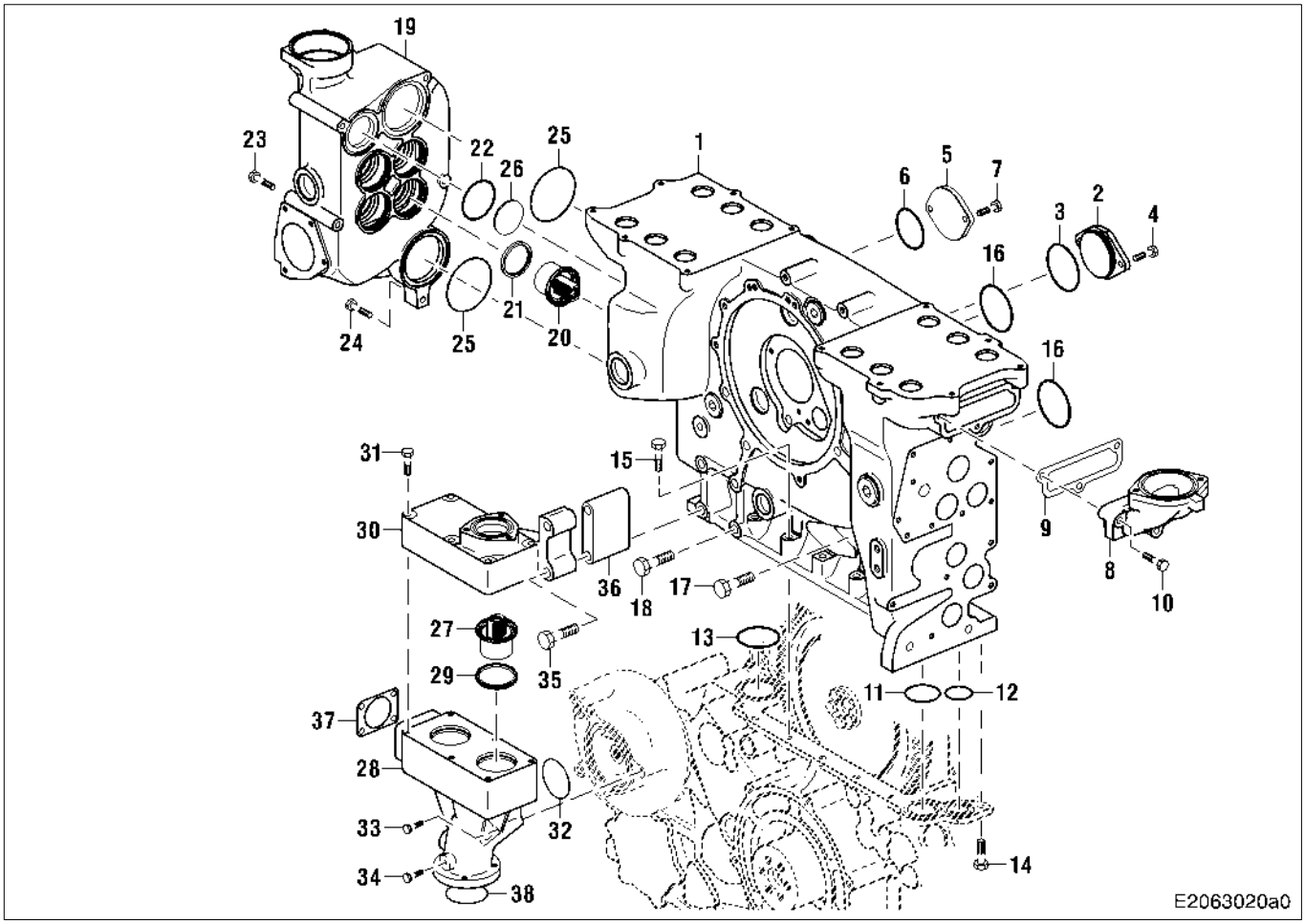
Install coolant lines, Flexmaster pipe connections, gaskets and securing components as per overview drawing C 203.05.01 and in accordance with installation instructions for Flexmaster pipe connections – see A001.

C203.25.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 203.05.04
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C206.05 Coolant pipework with thermostat

C206.05.01 Overview drawing



1 Coolant distribution housing
2 Cover
3 O-ring
4 Hex screw
5 Cover
6 O-ring
7 Hex screw
8 Elbow
9 Gasket
10 Hex screw
11 O-ring
12 O-ring
13 O-ring
14 Hex screw
15 Hex screw
16 O-ring
17 Hex screw
18 Hex screw
19 Thermostat housing (high-temperature circuit)
20 Thermostat element (high-temperature circuit)
21 Sealing ring
22 O-ring
23 Hex screw
24 Hex screw
25 O-ring
26 O-ring
27 Thermostat element (low-temperature circuit)
28 Thermostat housing (low-temperature circuit)
29 Sealing ring
30 Cover
31 Hex screw
32 O-ring
33 Hex screw
34 Hex screw
35 Hex screw
36 Spacer sleeve
37 Gasket
38 O-ring

C206.05.02 Special tools

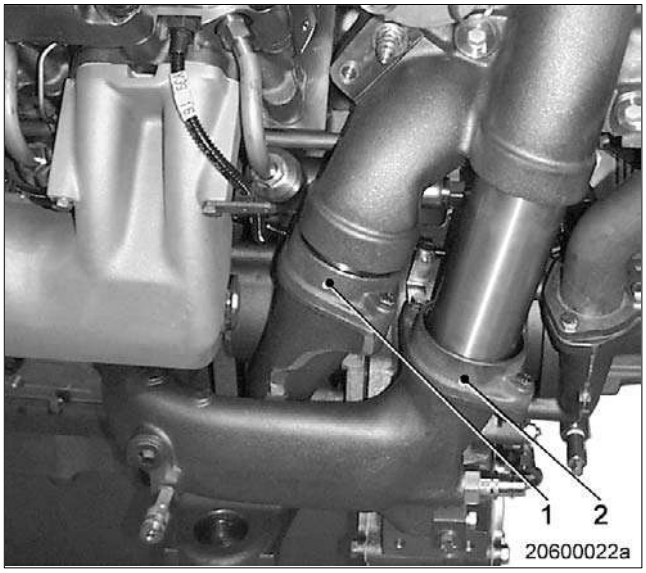
Designation	Use/dimension	Number
• Installation mandrel	for thermostat housing sealing ring	1
• Installation tool	installing/removing restrictors, coolant distribution housing	1
• Guide journal	for restrictor	1
• Guide journal	for restrictor	1
• Guide journal	for restrictor	1
• Guide journal	for restrictor	1

C206.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 charge air coolant	→ Operating Instructions
–	x	x	Remove oil filter *	→ C.183.05
–	x	x	Remove centrifugal oil filter *	→ C.183.10
–	x	x	Remove crankcase ventilation*	→ C.018.10
–	x	x	Remove engine oil heat exchanger *	→ C.183.15
–	x	x	Remove coolant pipe after cylinder *	→ C.202.20
–	x	x	Remove charge air coolant pump *	→ C.203.05
–	x	x	Disconnect electric wiring	→ C 500

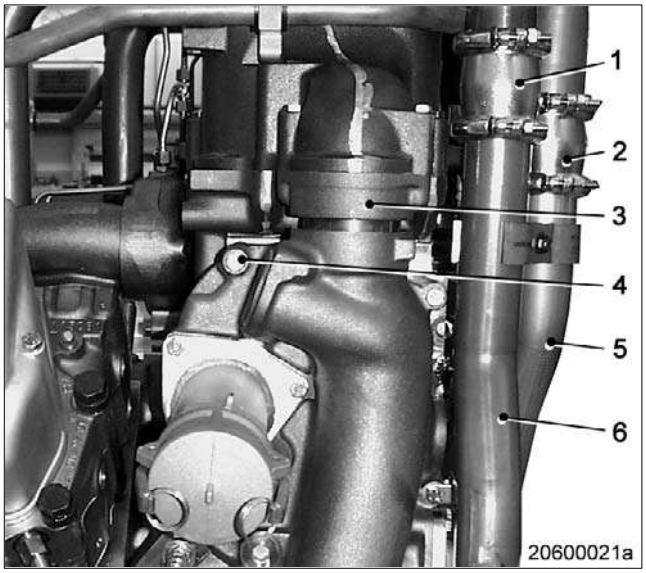
* – in addition only for removal of coolant distribution housing

C206.05.05 Removal



Removing thermostat housing (high-temp. circuit)

Remove hex screws from flange (1) and (2) and press flange from respective sealing surface.



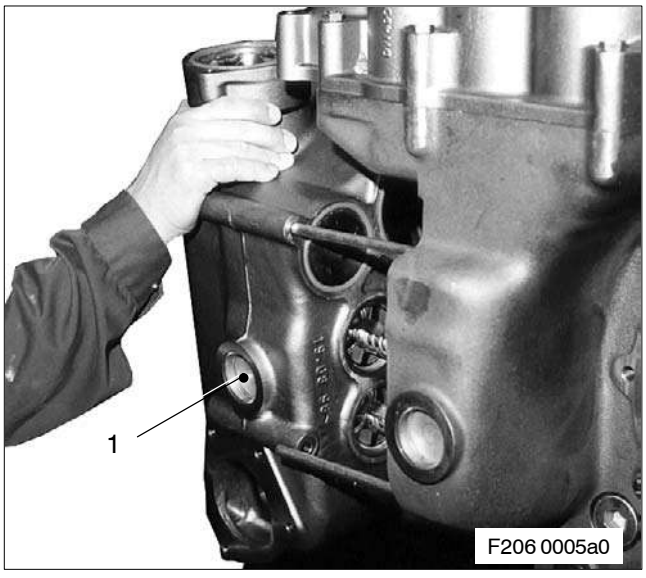
Remove hex nuts for pipe connection (1) and (2). Remove V-clamps and slide pipe connection onto remaining pipe.

Remove hex screws from pipe flange/thermostat housing connection and remove pipes (5) and (6).

Remove hex screws from flange (3) and press flange from respective sealing surface.

Remove hex screws (4).

Note: Replace 2 hex screws with guide pins – see next illustration.



Press off thermostat housing (1) from coolant distribution housing.


FG 20 0048 a0

Remove restrictor or 4 x coolant thermostats, sealing rings and O-rings.

Removing coolant distribution housing

WARNING

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

Screw eyebolts into coolant distribution housing and attach to crane and lifting rope.

Remove hex screws and washers for coolant distribution housing, see overview drawing C 206.05.01.

Using a crane and rope, remove coolant distribution housing from gearcase. Remove O-rings.

C206.05.08 Inspection and repair

Clean all parts with cold cleaner.

Check components for damage and defects; replace components as necessary.

Using the surface crack-testing method with red penetrant dye, check coolant distribution housing and thermostat housing for cracks; replace coolant distribution housing if cracks are found.

Check all mating and sealing faces for wear and damage; rub down with emery cloth or an oilstone as necessary.

Check support bores of thermostat elements for damage. Smooth with emery cloth if necessary.

Check condition of thread in coolant distribution housing; replace thread insert if necessary.

Replace gaskets, sealing rings and O-rings.

Make sure that oil chambers are perfectly clean.

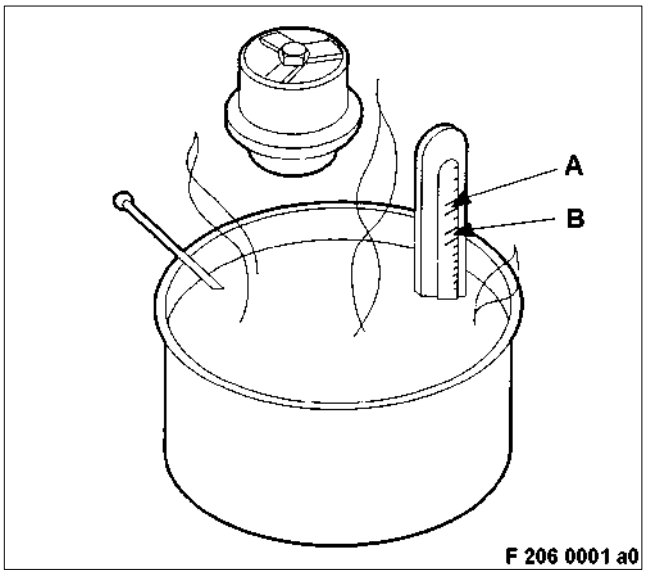
If necessary pressure-test coolant and oil chambers of coolant distribution housing with air in water bath (with corrosion inhibitor) for leaks (excepting coolant chamber).

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

Checking thermostat element (high and low temperature)



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.

High-temperature circuit

– Start of opening (B):	75 ° C ± 2 ° C
– Fully opened (A):	88 ° C ± 2 ° C

Low-temperature circuit

– Start of opening (B:)	45 ° C ± 2 ° C
– Fully opened (A):	58 ° C ± 2 ° C

Note: 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!
Handle 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.

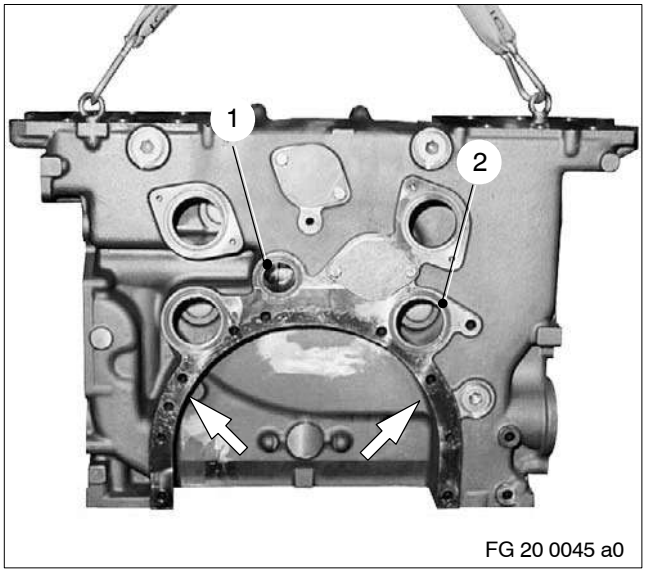
Continue to heat coolant to full-opening temperature (A).

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.

C206.05.11 Installation



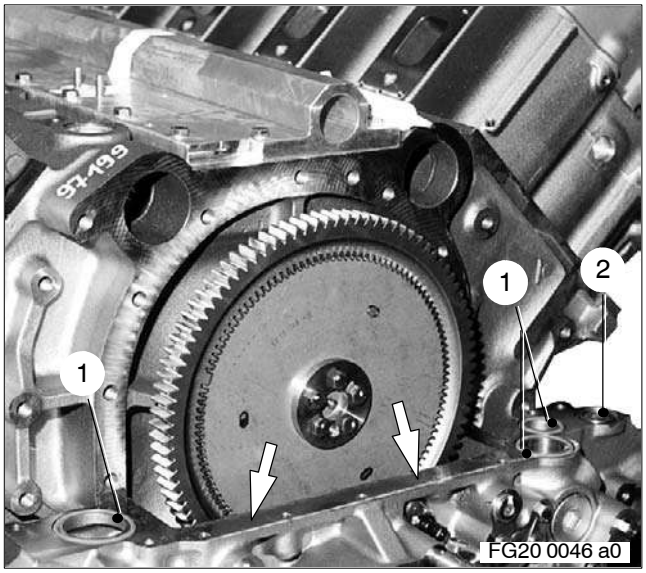
Assembling and installing coolant distribution housing

Install elbow (not shown – see overview drawing C 206.05.01) on coolant distribution housing.

Screw end cover into coolant distribution housing and tighten.

Coat O-rings (1, 2) with petroleum jelly and insert on back of coolant distribution housing.

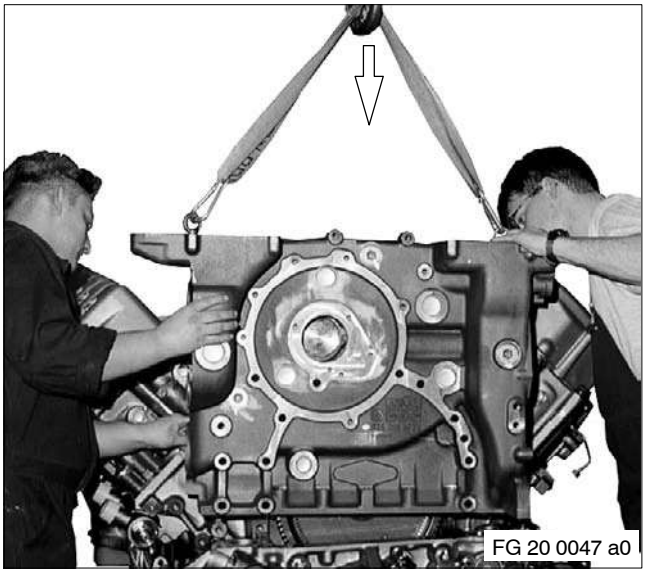
Coat mating face (arrow) between rear of coolant distribution housing and crankcase with surface sealant 518.



Coat O-rings (1) with petroleum jelly and insert into grooves in equipment carrier.

Fit blanking plugs (2) on equipment carrier.

Coat mating face of coolant distribution housing on equipment carrier with surface sealant 518 (see arrow).



⚠ WARNING

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

Carefully align coolant distribution housing, attached to crane with a rope, on equipment carrier.

Place coolant distribution housing on equipment carrier.

Note: When positioning the coolant distribution housing, make sure that O-rings on back of coolant distribution housing are not crushed.

Fit and tighten hex screws and washers for coolant distribution housing, see overview drawing C 206.05.01.

Installing thermostat elements

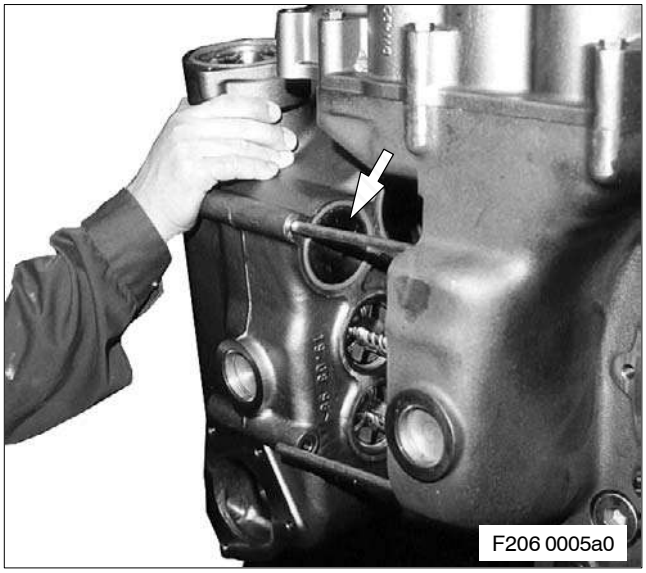
Guide sealing ring (2) over installation tool (1) so that sealing lip of sealing ring is not facing collar of insertion tool.

Drive sealing rings with installation mandrel into thermostat housing.

Check sealing and mating faces for contamination; clean as necessary.

Coat sealing surfaces (arrow) of thermostat elements with petroleum jelly and insert in support bores.

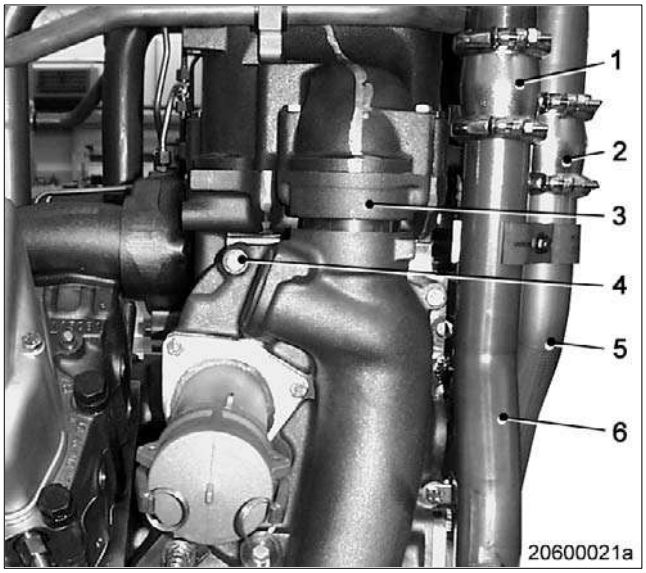
Coat O-rings with petroleum jelly and insert in annular grooves.



Installing thermostat housing (high-temp. circuit)

Insert restrictor (arrow) into support bore.

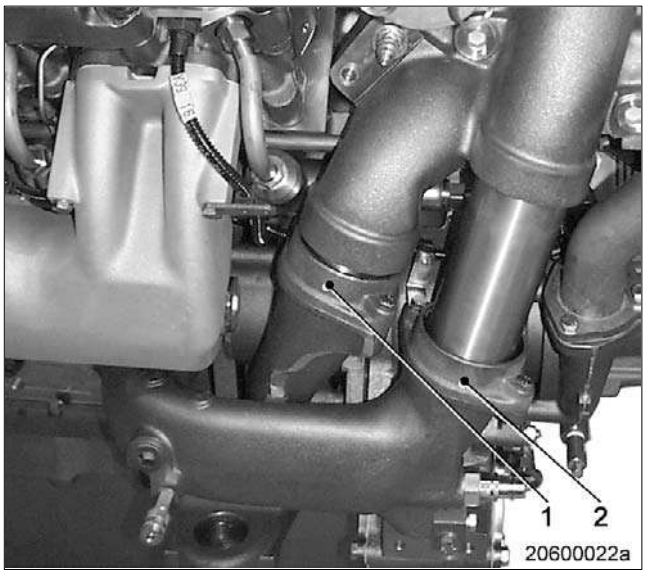
Install thermostat housing on coolant distribution housing by means of guide pins.



Screw in hex screws (4), remove guide pins and replace with hex screws.

Coat seals (1) and (2) with petroleum jelly. Fit pipe connection on pipes (5) and (6), centre and tighten hex nuts of V-clamps.

Install flange (3) with new O-ring.



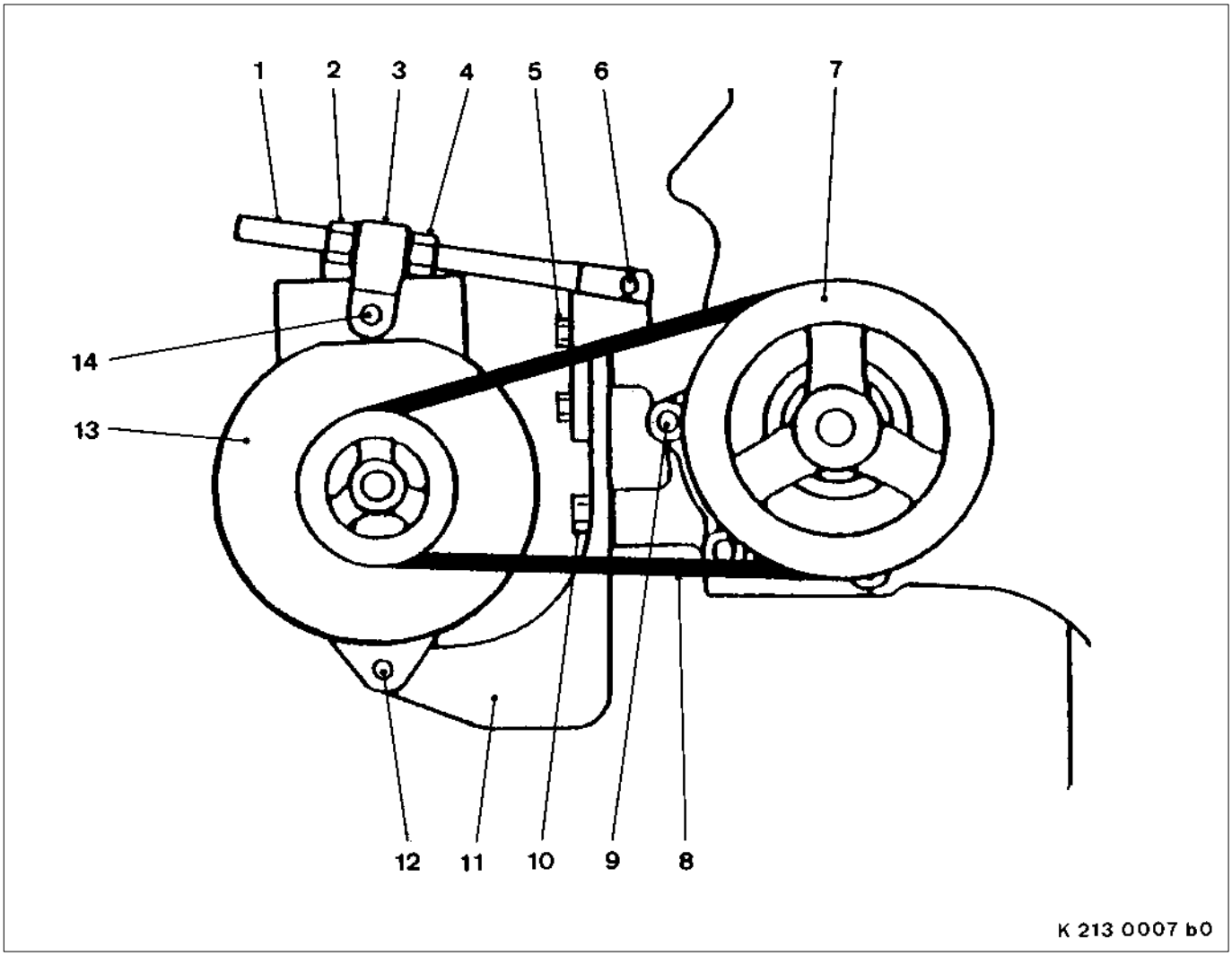
Install flanges (1) and (2) with new O-rings.

Note: See also overview drawing C202.10.01.

C206.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Assembly in reverse sequence to disassembly	→ C 206.05.04
–	–	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Fill oil system with engine oil	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions
–	–	x	Vent fuel system	→

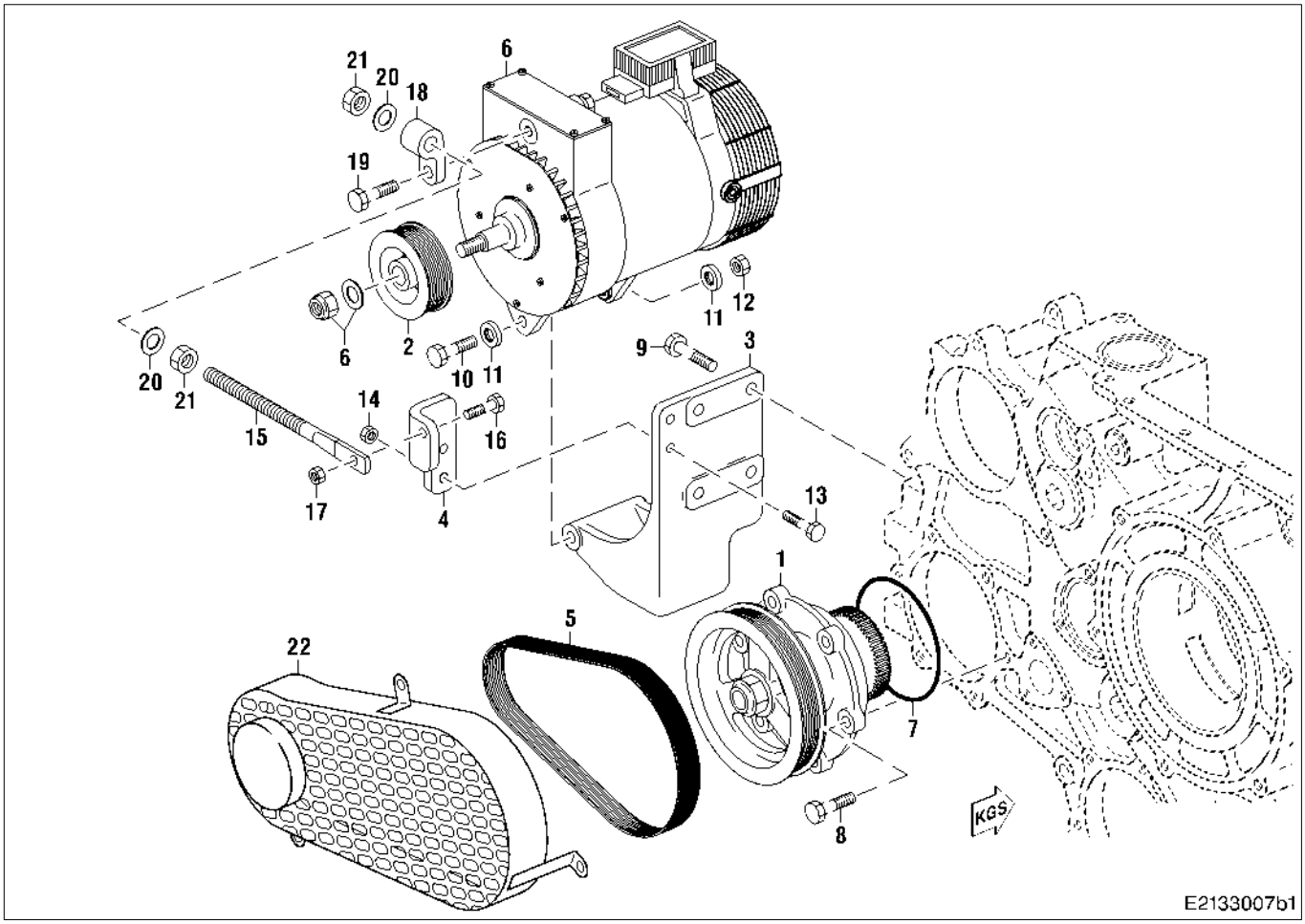
C210 Power supply, engine side



1 Stud
2 Locknut
3 Link
4 Clamping nut
5 Hex screw
6 Hex nut
7 Alternator drive
8 Belt pulley
9 Hex screw
10 Hex screw
11 Bracket
12 Hex screw
13 Generator
14 Hex screw

C213.05 Generator

C213.05.01 Overview drawing

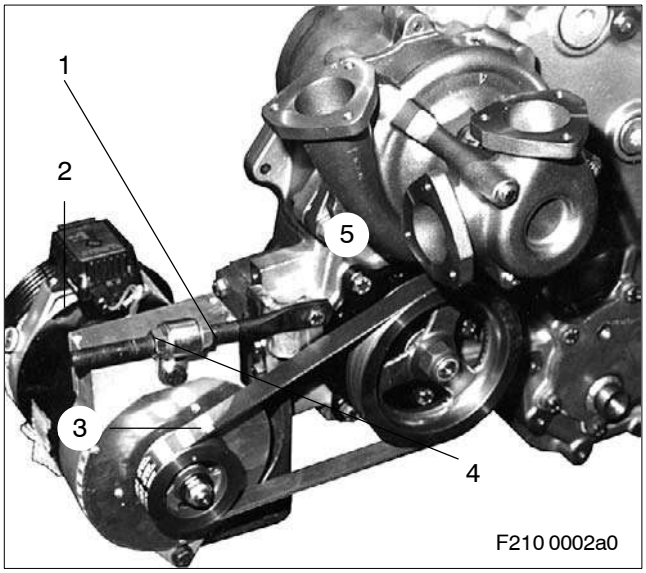


1 Alternator drive
2 Belt pulley
3 Bracket
4 Bracket
5 V-belt
6 Alternator/nut
Lubricant: Engine oil
Tightening torque: 360 Nm to 400 Nm
7 O-ring
8 Hex screw
9 Hex screw
10 Screw
11 Washer
12 Nut
13 Hex screw
14 Hex nut
15 Stud
16 Hex screw
17 Hex nut
18 Link
19 Screw
20 Washer
21 Hex nut
22 Cover

C213.05.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions
–	x	x	Mark and disconnect electric cables	→ –
–	x	x	Remove cover	→ –

C213.05.05 Removal



Removing generator

Note: Before removal, ensure that the negative battery pole is disconnected!

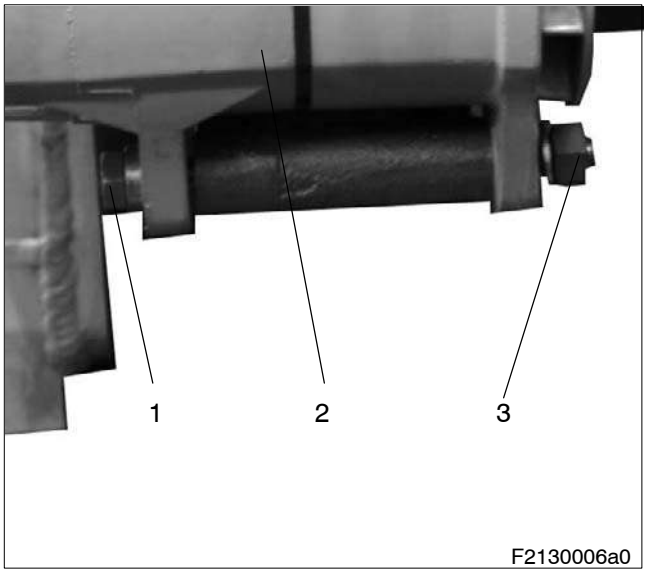
Release clamping nut (1).

⚠ WARNING

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

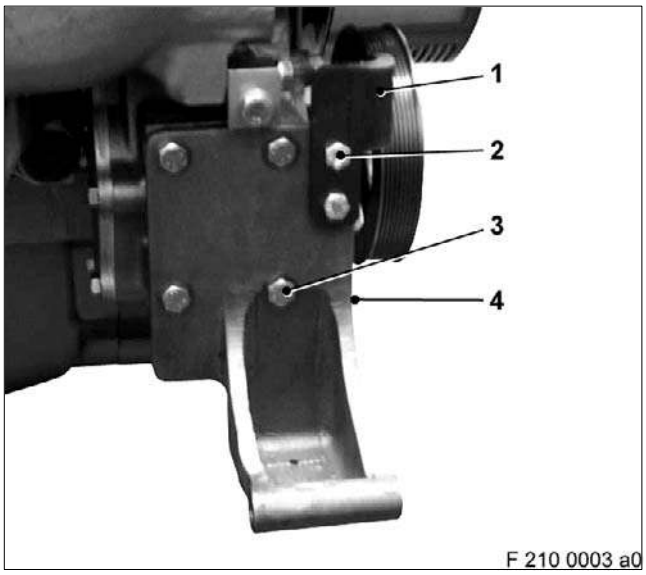
Tilt generator (2) in direction of engine and remove V-ribbed belt (3).

Release hex nut (4) from stud.



Release nut (3) and withdraw hex screw (1) from bracket.

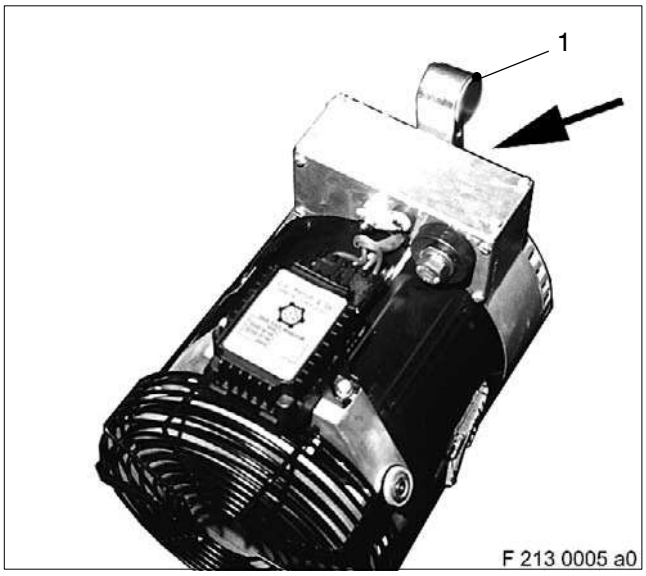
Carefully pull down generator (2).



Removing bracket

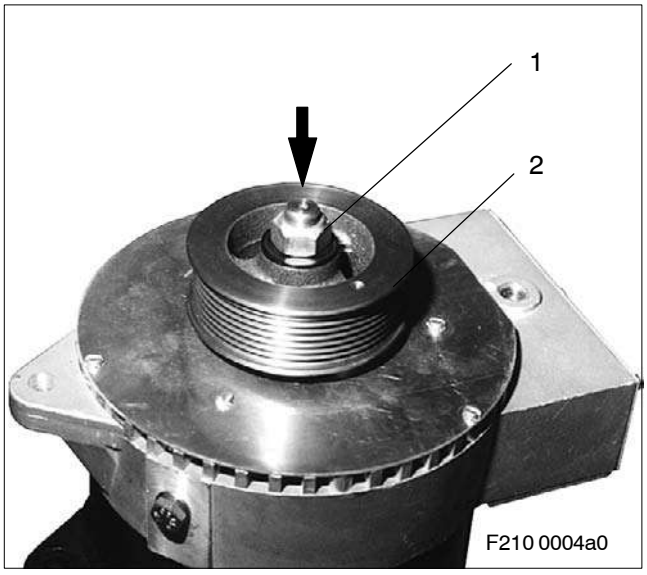
Unscrew hex screws (3) and remove bracket (4).

Unscrew nut (not shown) from hex screw (2) and remove bracket (1).



Removing tab from generator.

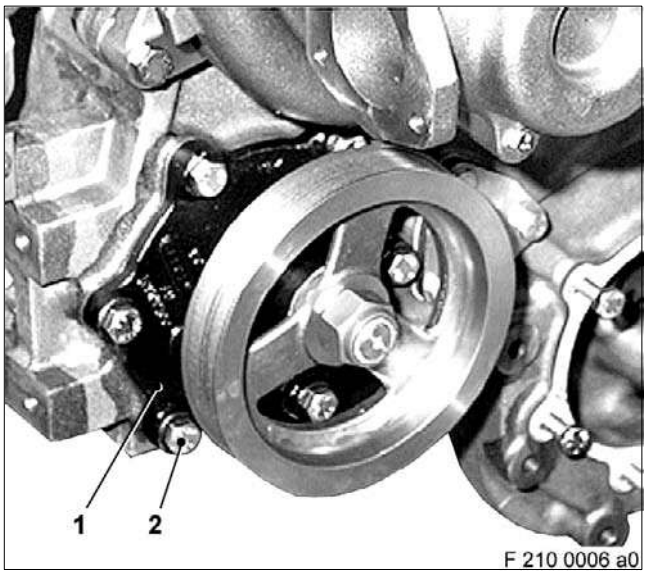
Release hex screw (arrow) and remove connecting element (1) from generator.



Removing belt pulley from generator.

Unscrew nut (1) while holding armature shaft in position with Allen key (see arrow).

Remove belt pulley (2) from shaft.



Removing alternator drive

Unscrew hex screws (2).

Carefully remove alternator drive (1) from gear train.

C213.05.06 Disassembly

Disassembly of the generator is not planned.

The generator is an exchangeable component and can be obtained in the exchange procedure.

C213.05.08 Inspection and repair

Visually inspect outside of generator for damage and defects.

Clean all components and visually inspect condition and check for damage; replace component as necessary.

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

Check condition of threads; machine or replace components as necessary.

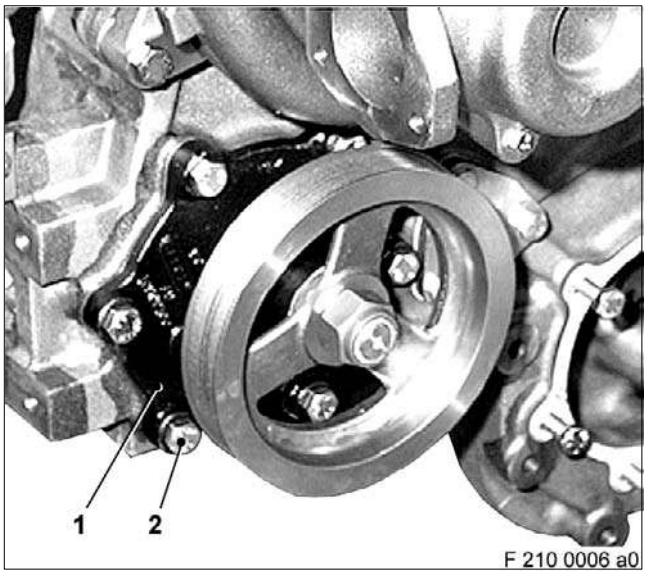
Check alternator drive for abnormal running noises, replace component if necessary.

Always replace V-ribbed belt during major overhaul.

C213.05.10 Assembly

See C 213.05.06

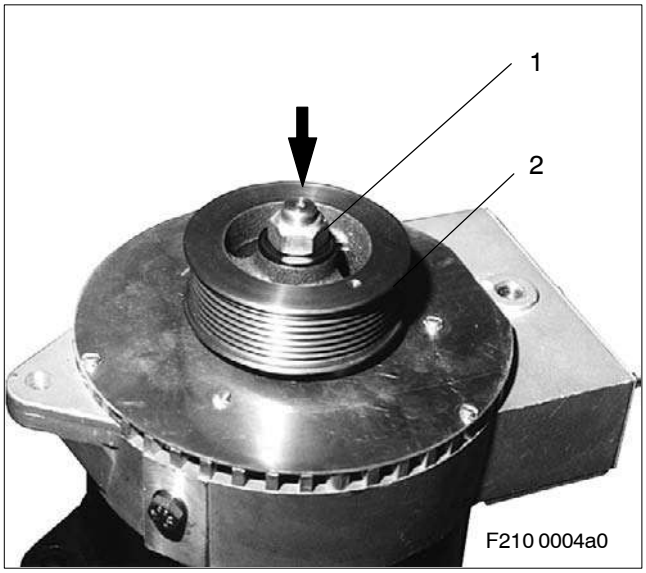
C213.05.11 Installation



Installing alternator drive

Carefully insert alternator drive (1) into gear train.

Insert hex screws (2) and tighten diagonally and evenly.



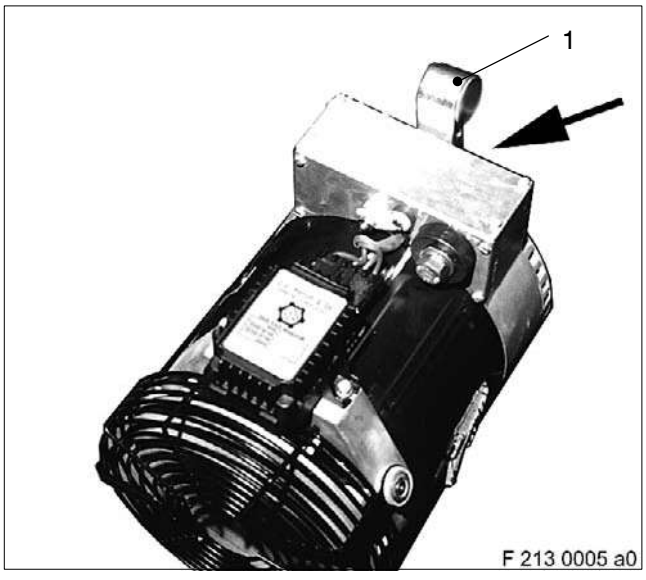
Mounting belt pulley on generator

Fit belt pulley (2) on armature shaft, ensuring it is correctly positioned.

Note: Fit belt pulley on armature shaft so that projecting collar faces generator.
Use straightedge to make comparison.

Fit nut (1) and tighten – see overview drawing C 213.05.01.

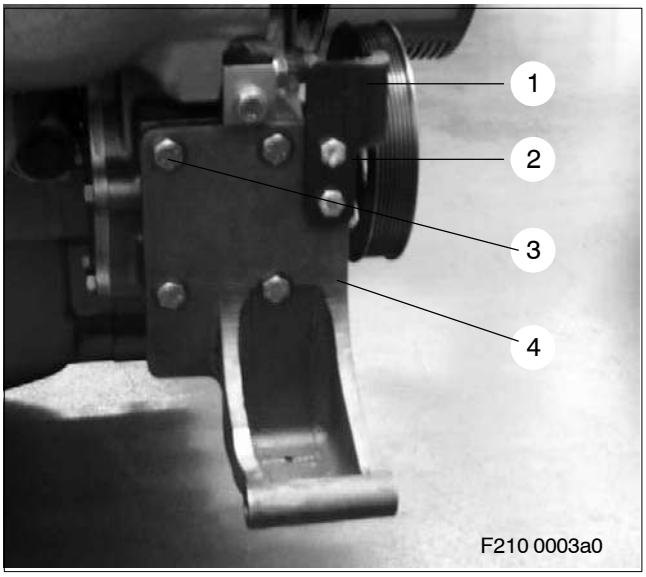
Note: When tightening nut, hold armature shaft in position with Allen key.



Installing connecting element on generator

Fit connecting element (1) with hex screw (arrow) on generator.

Note: First tighten hex screw only by hand so that connecting element can be moved to and fro. Tighten hex screw only when generator has been installed.

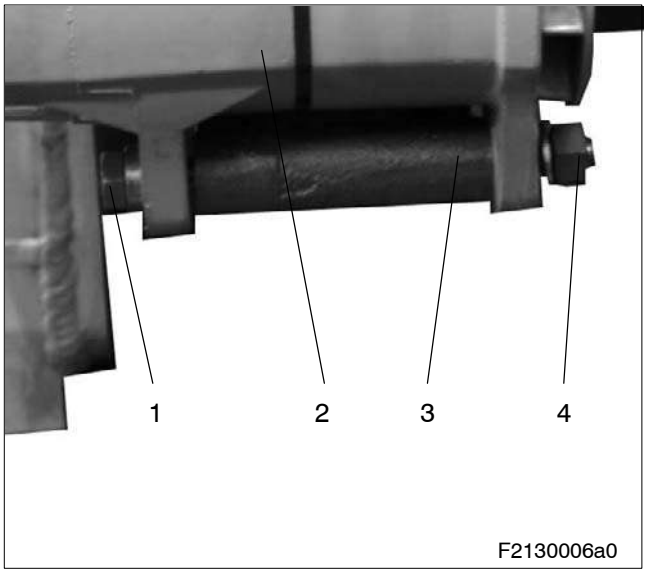


Installing bracket

Position bracket (4) on engine.

Insert hex screws (3) and tighten to specified torque.

Position angle element (1) on bracket, fit hex screws (2) and tighten to specified torque.



Installing generator

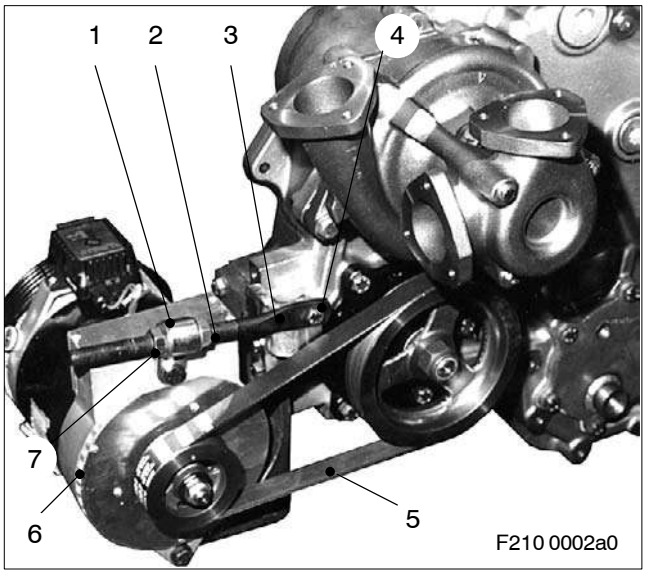
WARNING

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

Align generator (2) with securing elements on hinge of bracket (3).

Insert hex screw (1) through securing elements and hinge.

Fit nut (4) on hex screw and tighten to specified tightening torque.



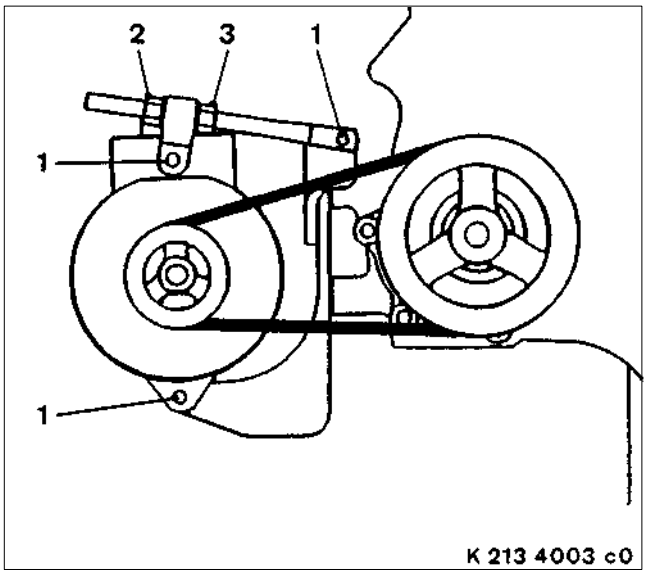
Fit clamping nut (2) on stud (3) and screw on to end of thread.

Insert stud into connecting element (1) and secure with securing screw (4) hand-tight on equipment carrier.

Fit locknut (7) on spring pin and screw on until it engages.

Tilt generator (6) in direction of equipment carrier.

Fit V-ribbed belt (5) and pretension generator.



Pretensioning V-belt

If measured value does not correspond to specified value, V-ribbed belt tension must be corrected.

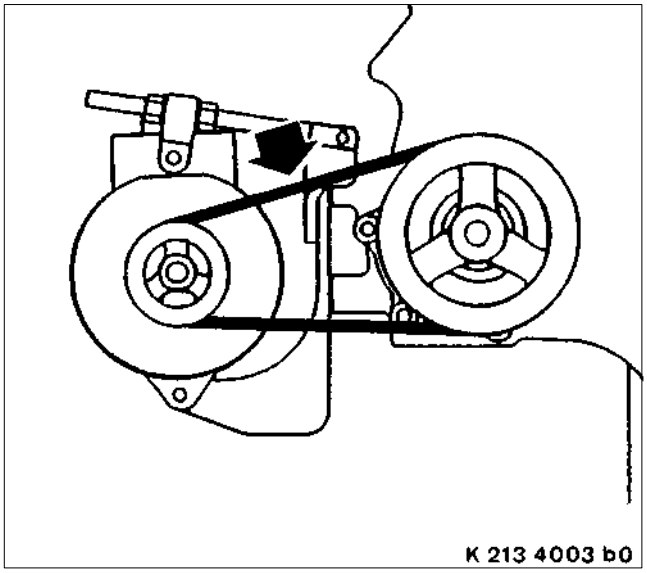
Tighten clamping nut (3) to tension V-ribbed belt away from engine until value on V-belt tension gauge (see next illustration) is within the specified range.

Tighten locknut (2) as per tightening specifications.

Tighten securing screws (1) as per tightening specifications.

Again check V-ribbed belt tension.

Note: If measured value does not correspond to specified value, retension V-belt.



Checking V-belt tension

Position V-belt tension gauge in centre between V-ribbed belt pulleys on V-ribbed belt.

Read off measured value on display.

– Settings: 57–70 kg (125–155 lbs)

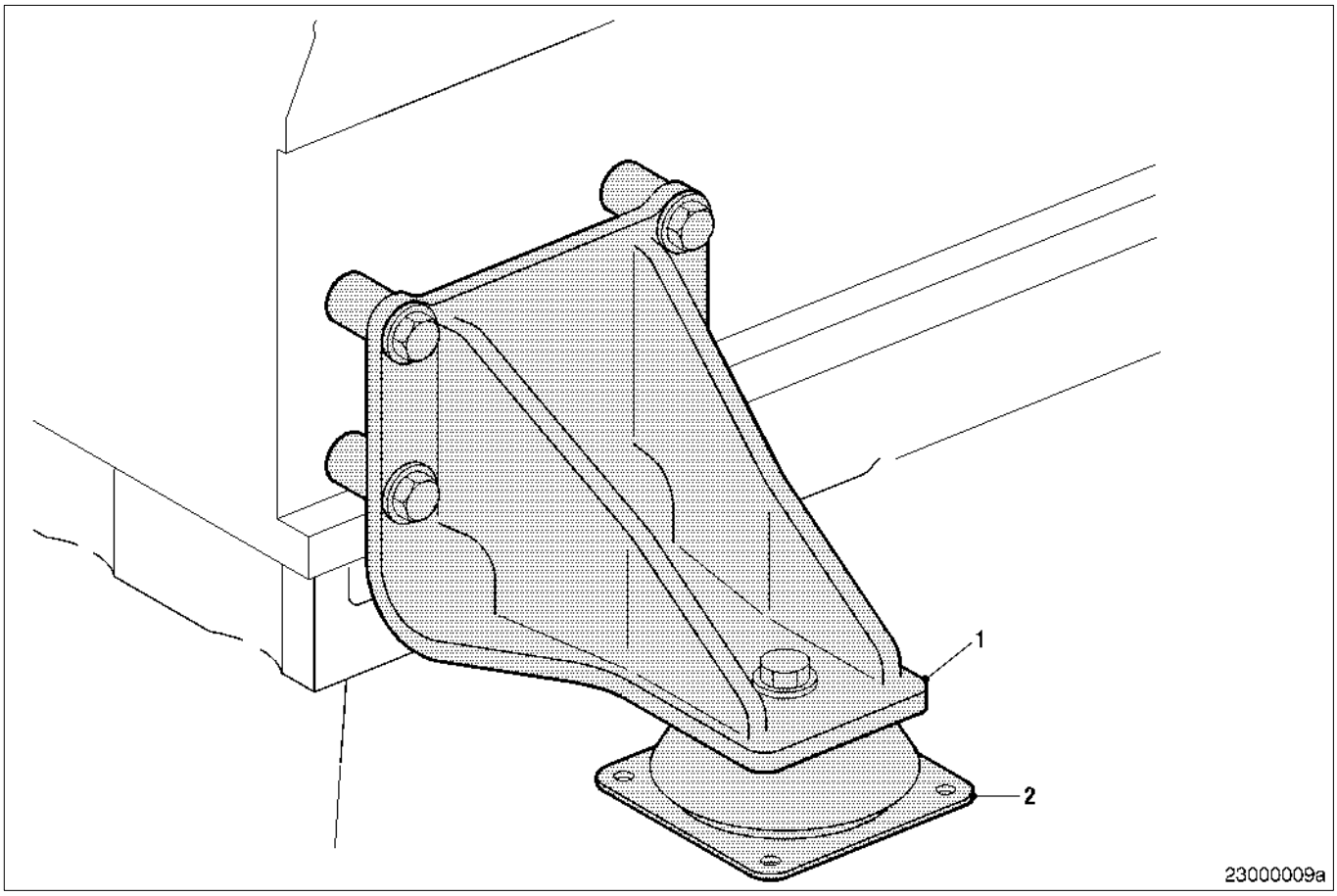
Install cover as per overview drawing C 213.05.01.

C213.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	x	x	Connect electrical cables in accordance with markings	→
–	x	x	Install cover	→
–	–	x	Release engine start	→ Operating Instructions

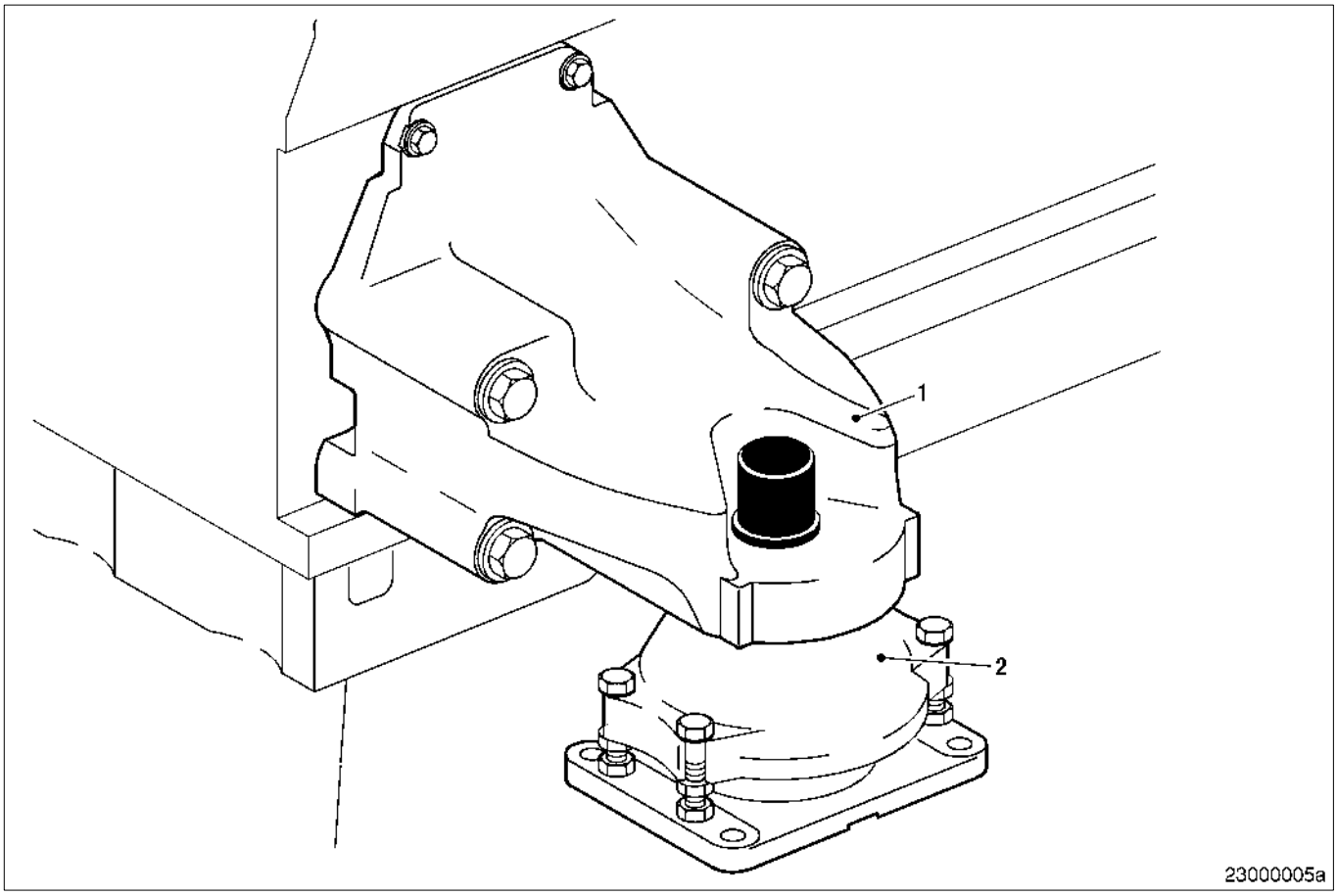
C230 Bearing/support

Version 1



1 Engine carrier
2 Damping element

Version 2

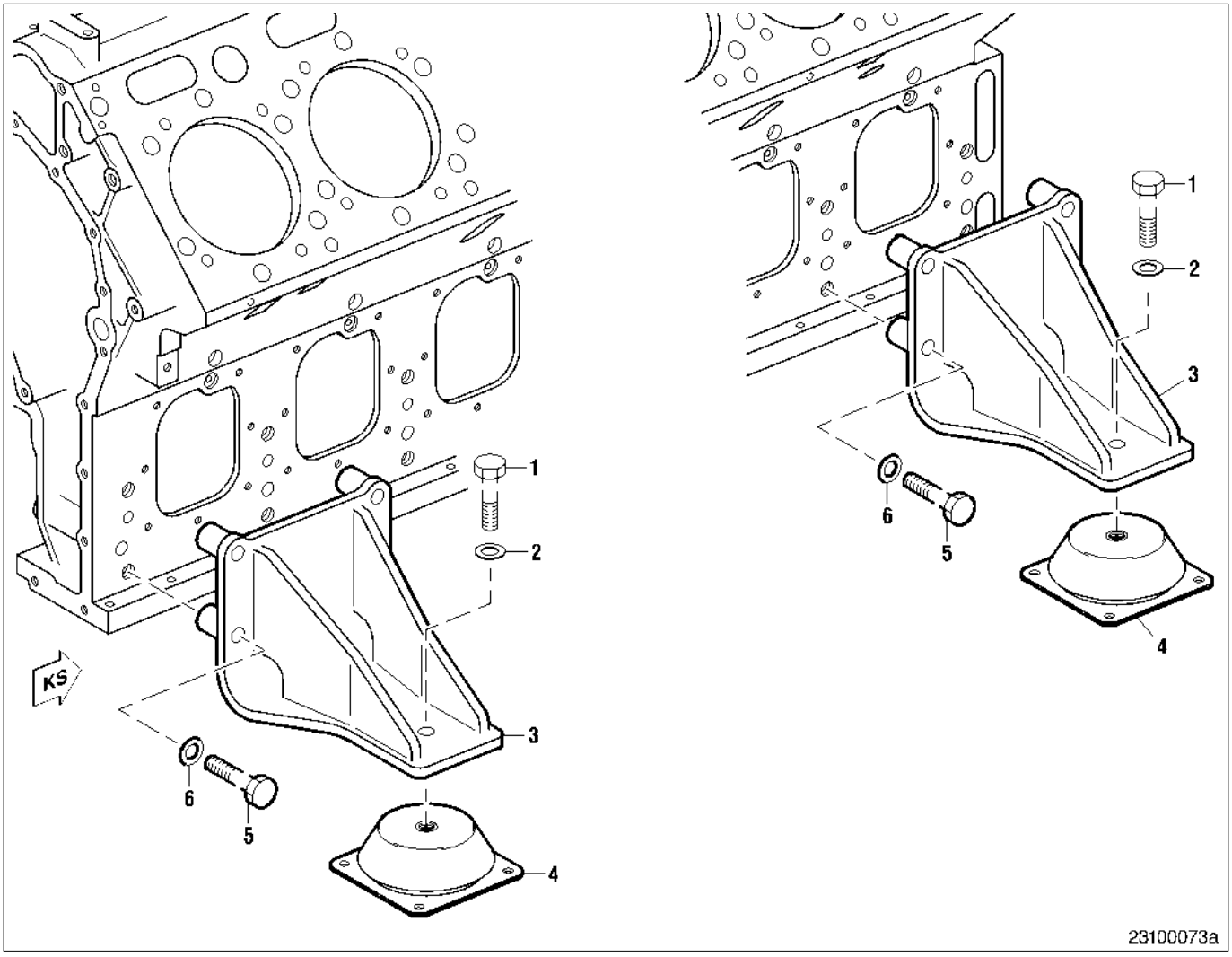


1 Engine carrier
2 Damping element

C231.10 Engine mount

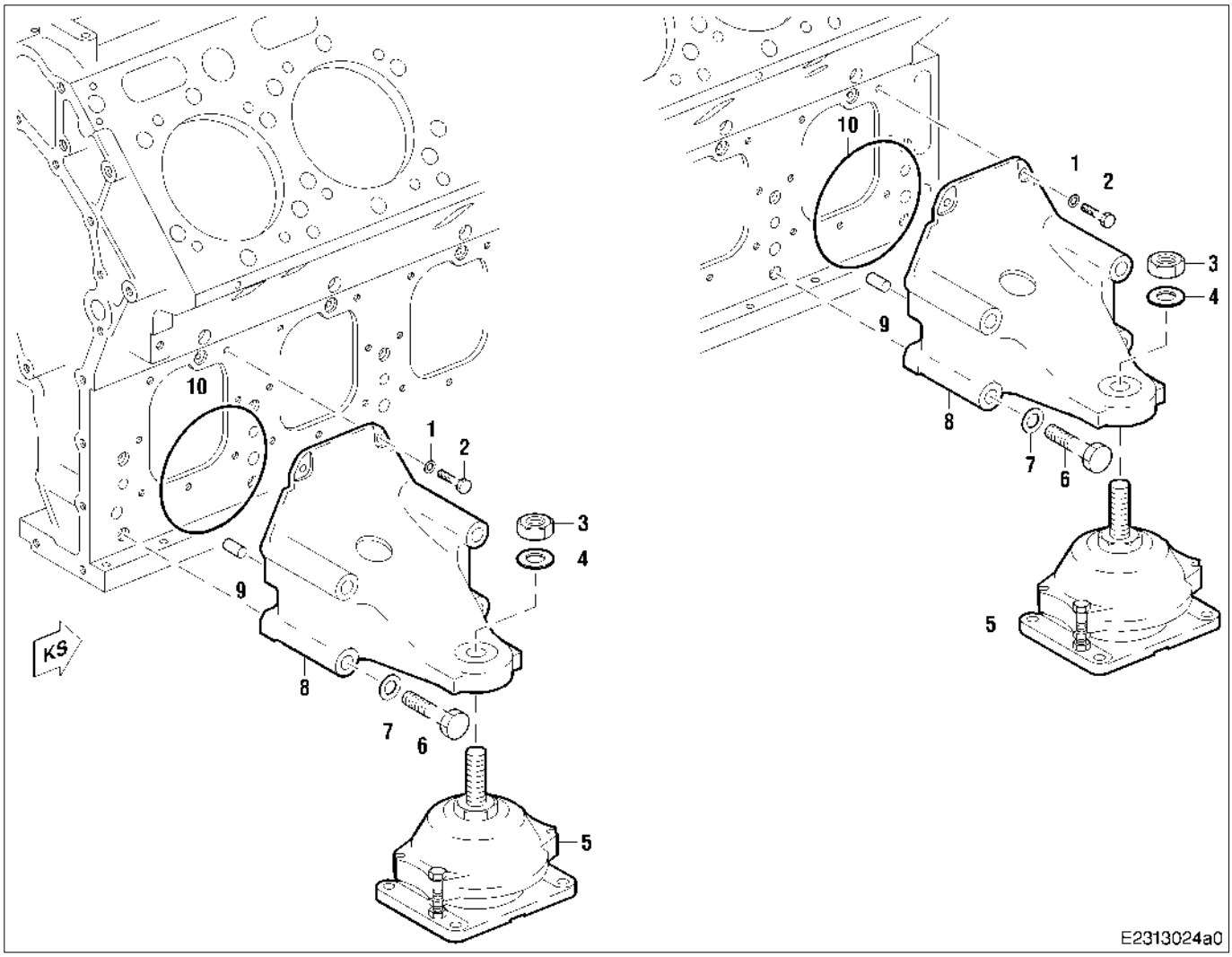
C231.10.01 Overview drawing

Version 1



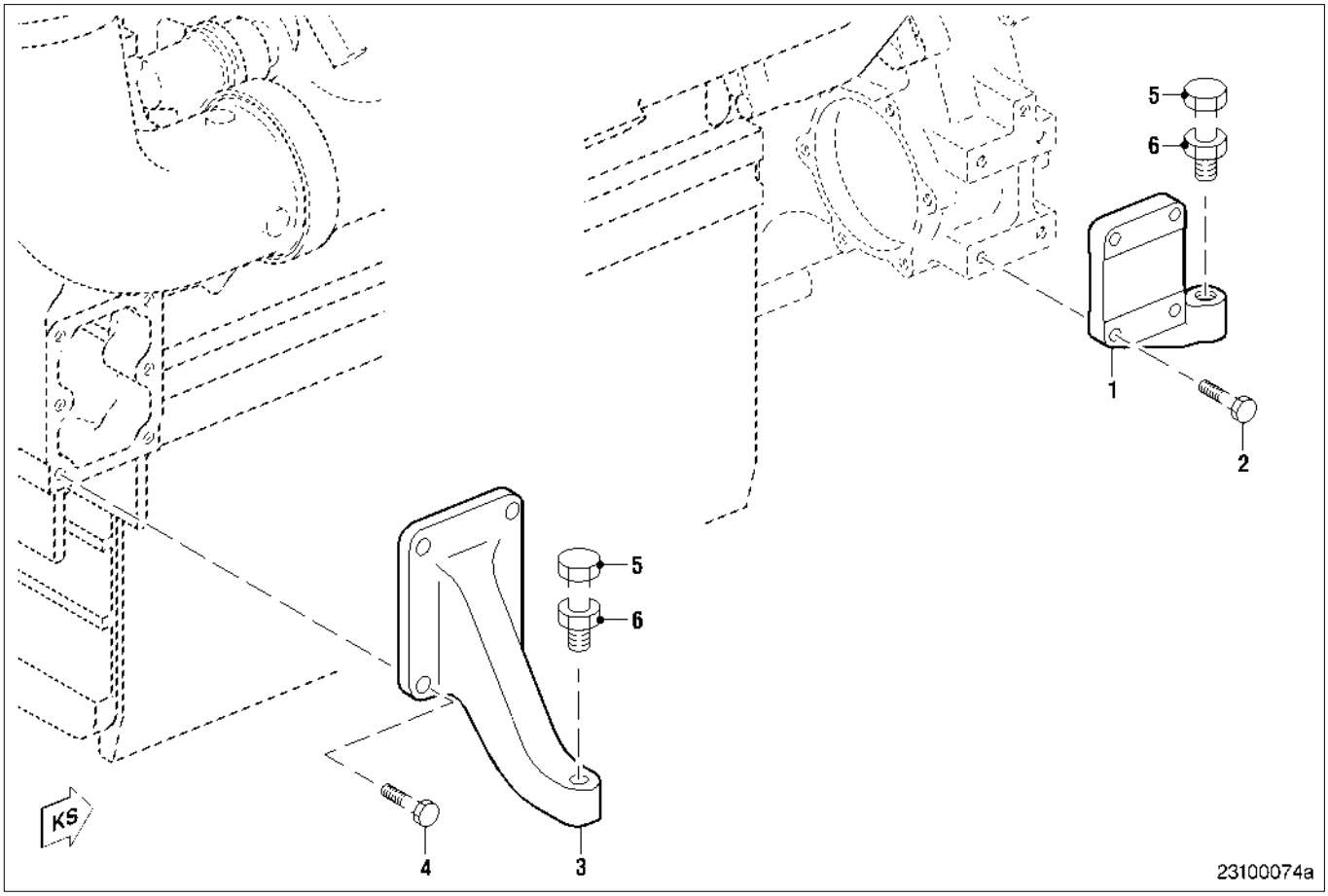
1 Hex screw
Lubricant: Engine oil
Tightening torque: 190 Nm + 19 Nm
2 Washer
3 Engine carrier
4 Damper bearing
5 Hex screw
Lubricant: Engine oil
Tightening torque: 500 Nm + 50 Nm
6 Washer

Version 2



1 Washer
2 Hex screw
Lubricant: Engine oil
Tightening torque: 42 Nm + 4 Nm
3 Nut
Lubricant: Engine oil
Tightening torque: 580 Nm + 50 Nm
4 Washer
5 Damping bearing
6 Hex screw
Lubricant: Engine oil
Tightening torque: 350 Nm + 35 Nm
7 Washer
8 Engine carrier
9 Dowel pin
10 O–ring

Engine supports



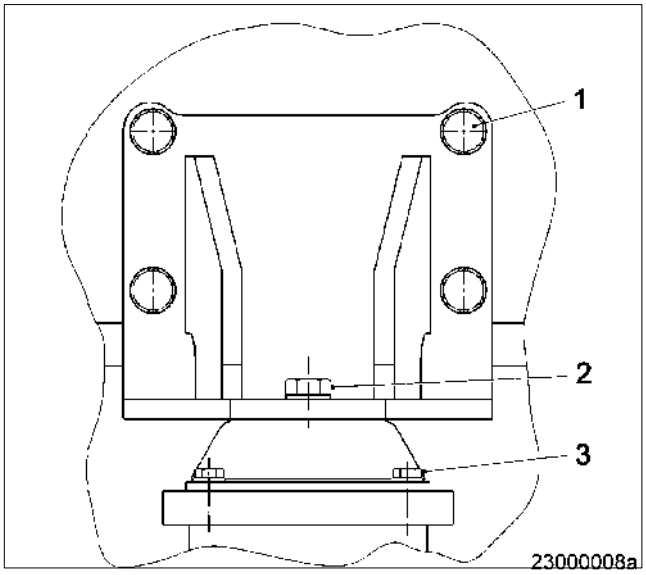
1 Engine support
2 Hex screw
Lubricant: Engine oil
Tightening torque: 74 Nm +7 Nm
3 Engine support
4 Hex screw
Lubricant: Engine oil
Tightening torque: 180 Nm + 18 Nm
5 Hex screw
6 Hex nut

C231.10.04 Before-removal operations

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 charge air coolant	→ Operating Instructions
–	–	x	Disconnect coolant supply and return lines from engine	→ –
–	–	x	Remove coolant pump when disassembling engine mount, left engine side, free end	→ C 202.05.05
–	–	x	Separate engine from alternator	→ –

C231.10.05 Removal

Version 1



Removing engine carrier with damping element

Note: Replace rubber mounts singly, one after the other.

⚠ WARNING

Engine may tilt.
Risk of injury!
Prior to removing engine mount, support or attach engine.
Only use lifting device provided by manufacturer and observe lifting instructions.

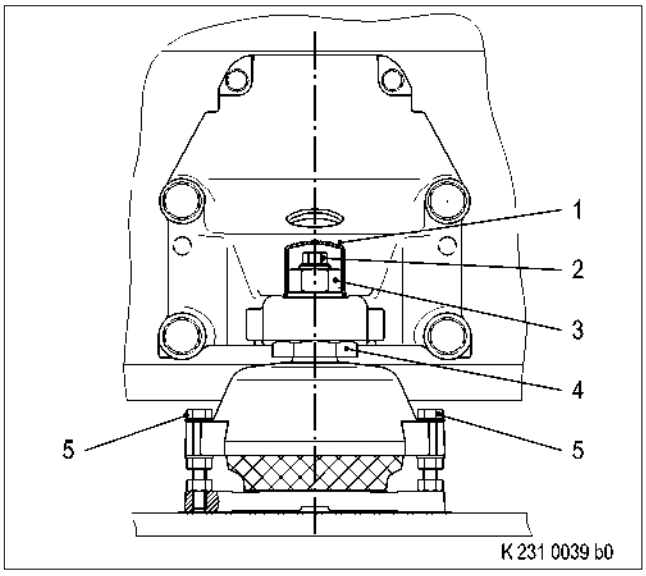
With engine installed and engine supports not installed: Install engine support.

Remove foundation screws (3) and hex screw (2) from damping mount to be removed.

Screw in jackscrews of engine supports into foundation far enough to allow the damping mount to be removed.

Remove securing screws (1) for engine carrier, supporting carrier against dropping, and remove engine carrier.

Version 2



Removing engine carrier with damping element

Note: Replace rubber mounts singly, one after the other.

⚠ WARNING

Engine may tilt.
Risk of injury!
Prior to removing engine mount, support or attach engine.
Only use lifting device provided by manufacturer and observe lifting instructions.

With engine installed, mount engine supports if not installed.

Install engine support jackscrews until they make contact with the foundation and secure the engine against damping element static deflection.

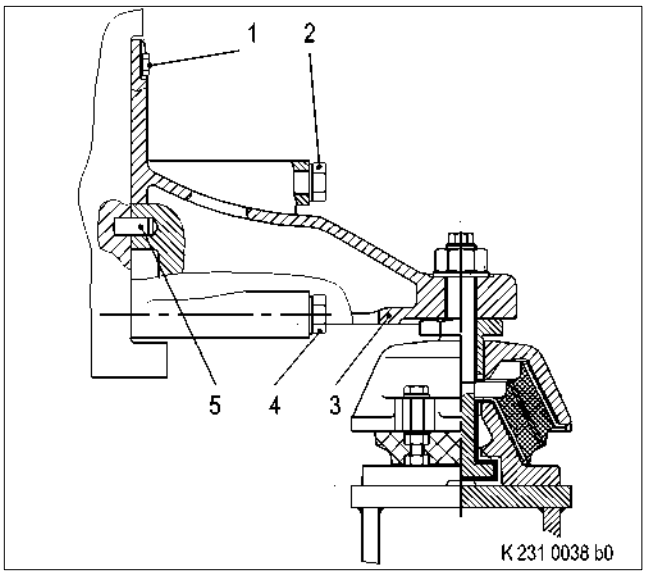
Unscrew all foundation screw fittings on damping element to be removed.

Use locking screws (5) to pull damping elements together until engine carrier can be removed.

If gap between mount base and foundation is not large enough, proceed as follows:

Remove protective cap (1) and release hex screws (3).

Insert height-adjusting screw (4) as far into bearing cap as required to prevent the central buffer (2) from twisting; hold firmly in position at hex if necessary.



⚠ WARNING

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

Remove hex screws (1), (2) and (4) with washers for engine carrier (3).

Press off and remove engine mount from engine housing, observing fit of dowel pin (5).

Note: Only remove dowel pins if necessary (e.g. if damaged).

Removing engine support

Note: Remove supports only if necessary. Ensure that supports are not stressed by engine.

Remove screws and washers for engine support and lift engine support off crankcase, see overview drawing C 231.10.01.

C231.10.08 Inspection and repair

Note: Protect damping mount from exposure to oil and fuel!

Clean all components.

Rub down rubber faces with dry cloth only, never use organic cleaning agents.

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

If cracks are detected, replace part.

Visually inspect damping mount for damage, cracking and deformation; replace as necessary.

Check bolt-on surfaces for irregularities and smooth with oilstone if necessary.

Check condition of threads; machine or replace components as necessary.

Check grooves for O-rings for damage; machine or replace component as necessary.

C231.10.11 Installation

Installing engine support

Install engine support with screws and washers in accordance with installation position on flywheel housing and equipment carrier.

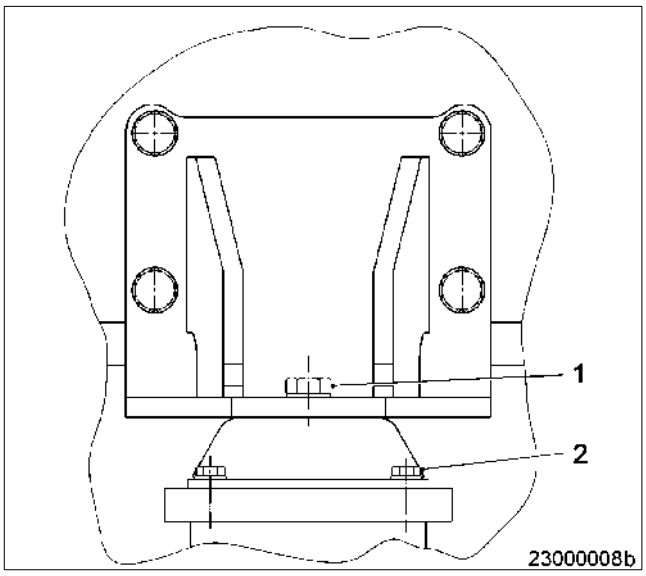
For installation position and tightening torque, see overview drawing C 231.10.01.

Mounting engine carrier

Install engine carrier in accordance with installation position on crankcase.

For installation position and tightening torque, see overview drawing C 231.10.01.

Version 1



Installing damping mount

Note: Replace damping elements only individually and one after the other.

⚠ WARNING

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

Install damping mount on engine carrier and align longitudinally in relation to the engine; tighten hex nut provisionally by hand.

By turning all jacking screws uniformly and alternately, lower support onto foundation.

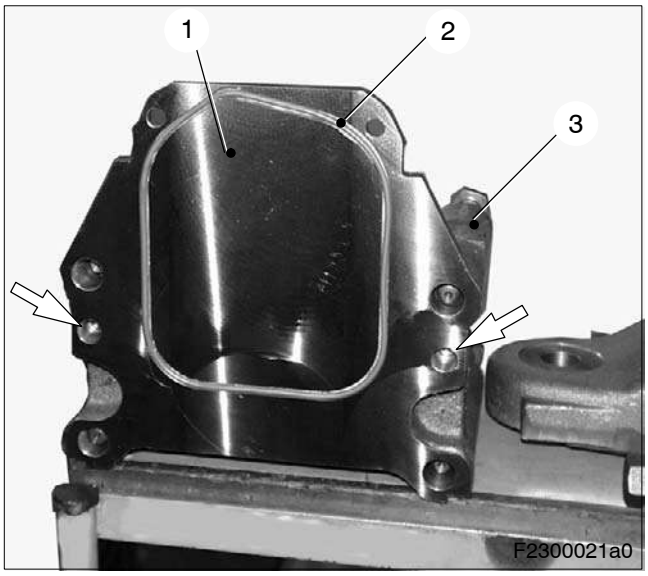
Back off jackscrew by one turn and secure with hex nut.

Bolt damping mount to foundation with hex screws (2).

Tightening torque: 74 Nm +7 Nm

Tighten hex screw to specified tightening torque – see overview drawing C 231.10.01.

Version 2



Installing engine carrier with damping element

Note: Replace rubber mounts singly, one after the other.

Clean and degrease flange-mount surface (1) of engine carrier (3).

Coat O-ring (2) with petroleum jelly and insert in groove.

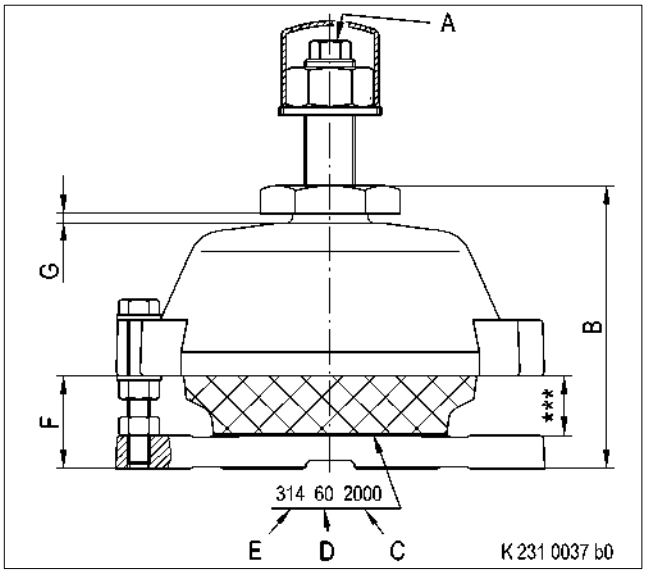
⚠ CAUTION

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 dowel pins (arrow) in liquid nitrogen and press into the engine carrier.

Using a depth gauge, measure blind hole in crankcase.

Protrusion of dowel pin in engine carrier must not be greater than depth of blind hole.



Note: Damping elements are preset and are locked when delivered

Check preset values of the damping element prior to installation; readjust if necessary.

A – marking “30” (corresponds to 6.0 mm buffer clearance)
Marking “40” (corresponds to 8.0 mm buffer clearance)

B – unloaded 152.5 mm

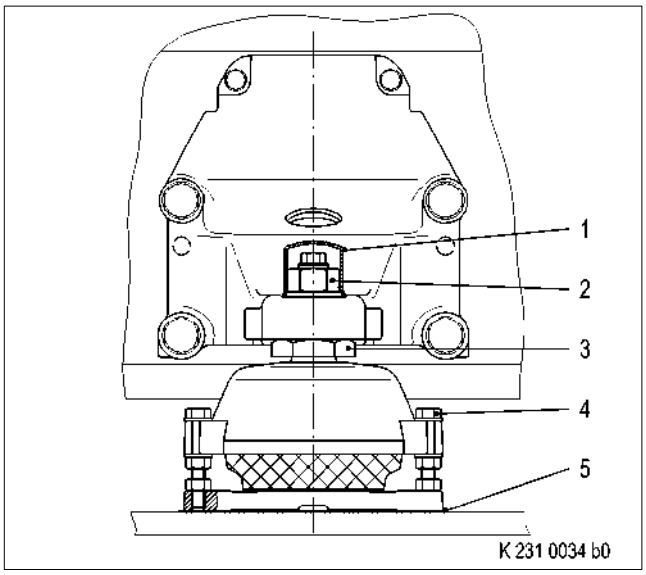
C – serial number

D – Shore hardness

E – model

F – unloaded 50 mm

G – initial dimension 5 mm



Coat mating face of hex nut (2) and thread of central buffer with engine oil.

Note: Remove oil from rubber mount immediately.

⚠ WARNING

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

Mount damping element on engine carrier and align longitudinally in relation to the engine; tighten hex nut provisionally by hand.

Install engine carrier with hex screws and washers on crankcase; for tightening torque, see overview drawing C 231.10.01.

Note: New or unloaded rubber mounts settle and should therefore be subjected to engine load (with oil and coolant) for at least 48 hours.

By turning all jacking screws uniformly and alternately, lower support onto foundation.

Back off jackscrews.

Check engine alignment and, if necessary, adjust height with height-adjusting nut (3) in accordance with alignment instructions.

Unscrew height-adjusting nut no more than 10 mm out of the bearing cap. If this value is exceeded, height adjustment must be carried out by means of packing plates under the mount base (5).

Secure bearing elements to foundation.

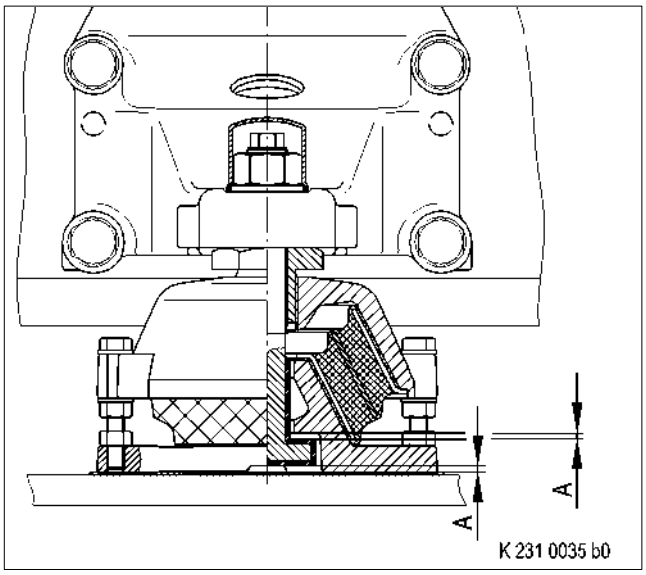
Remove locking screws (4), washers and nuts and store separately beside the engine.

Using a feeler gauge, measure buffer ease of movement on damping element via measuring groove in mount base; readjust central buffer if necessary, see next illustration.

After readjustment, tighten hex nuts to specified tightening torque and mount protective cap (1), see overview drawing C 231.10.01.

Note: When tightening, secure central buffer against twisting, i.e. hold firmly in place at hex.

Check engine alignment.



Note: Measured values are with engine filled with coolant and engine oil and locking devices removed.

Adjust central buffers as follows:

Release hex nut.

Screw central buffer clockwise to upper stop position.

Unscrew central buffer counterclockwise to distance (A).

A (model RD 314 B) = 3 mm ± 0.3 mm

A (model RD 315 HD) = 4 mm ± 0.3 mm

Check clearance with a feeler gauge through control groove in base mount.

Tighten hex nut to specified torque and mount protective cap.

C231.05.12 After-installation operations

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	See
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Check engine alignment; realign if necessary	→ –
–	–	x	Connect engine to alternator	→ –
–	–	x	Secure bearing elements to foundation.	→ –
–	–	x	Install coolant supply and return lines on engine	→ –
–	–	x	Install coolant pump only after disassembly of engine mount, left engine side, free end	→ –
–	–	x	Fill charge air coolant system	→ Operating Instructions
–	–	x	Fill engine coolant system	→ Operating Instructions
–	–	x	Release engine start	→ Operating Instructions

C500 Monitoring, control and regulating system

C507.00 Wiring, engine wiring harnesses

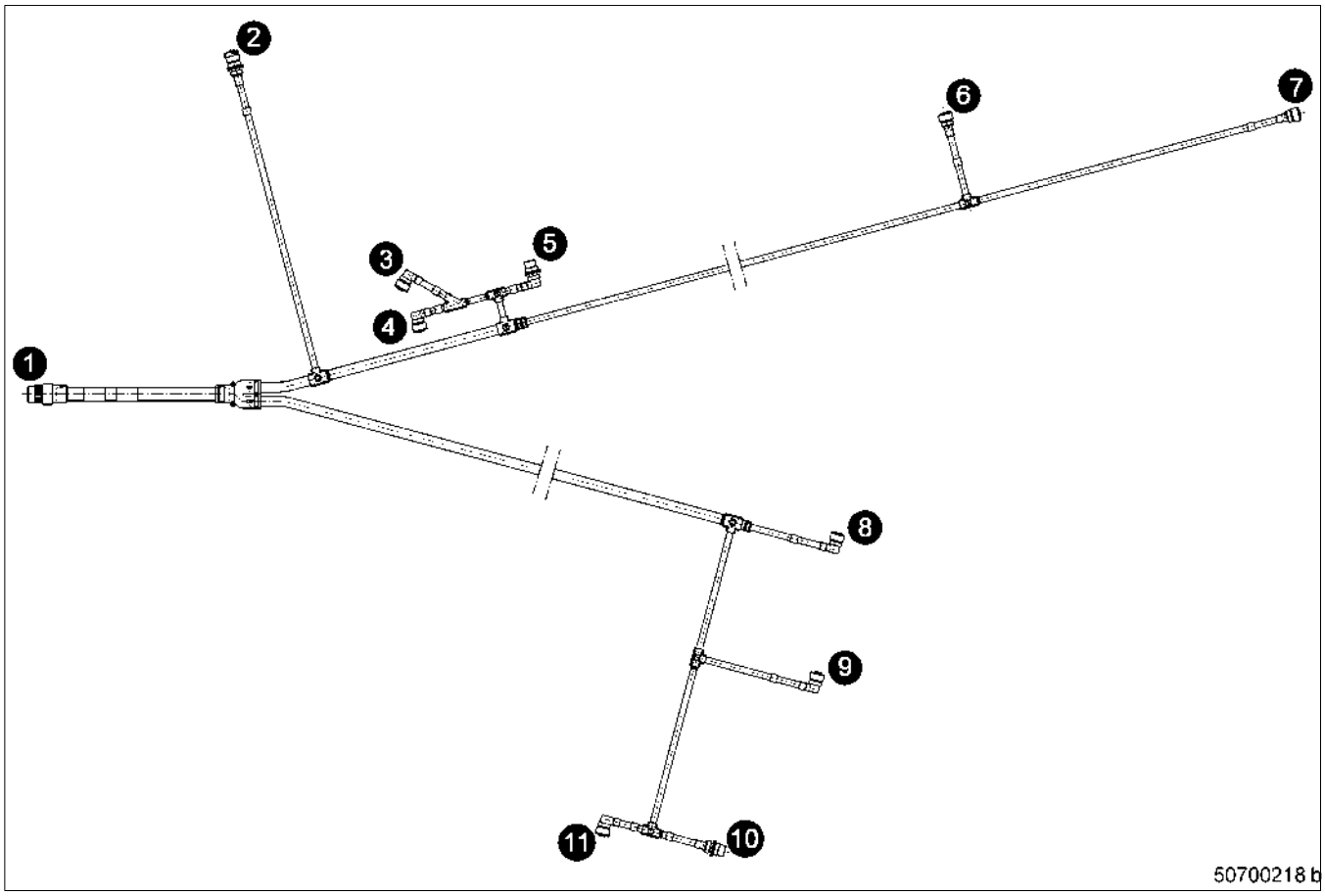
The following is a list of auxiliary equipment and materials needed for the assembly operations:

Materials and consumables	Order No.	Remarks
Connector pliers	013 531 54 83	For assembly of ECU bayonet plug
Cable clamp		Fasteners for cables and wiring harnesses
Petroleum jelly, white	40317	For assembly of rubber sealing rings
Isoprophyl alcohol	46181	Cleaning contaminated sensors and contacts

Designation	Connection assignment
Engine wiring harness W2	• X2 Connector to ECU 4 • B 1 Camshaft speed sensor • B 5 Lube oil pressure sensor • B 6 Engine coolant temperature sensor • B 7 Engine oil temperature sensor • B 9 Charge air temperature sensor • B 10 Charge air pressure sensor • B 13 Engine speed sensor • B 26 Charge air coolant temperature sensor • B 34 Fuel pressure sensor after filter • XF57 Connection for external sensor F57 (charge air coolant level)
Engine wiring harness W3	• X3 Connector to ECU 4 • B 33 Fuel temperature sensor (rail) • B 48 Fuel pressure sensor (rail) • XF33 Connection for external sensor F33 (engine coolant level) • M8 H.P. fuel pump actuator
Engine wiring harness W4	• X4 Connector to ECU 4 • Y39.1 to Y39.6 Injectors, engine side A • Y39.11 to Y39.16 Injectors, engine side B
System cable W003 (power supply)	• X5 ECU 4
System cable W004 (alternator control)	• X1 ECU 4

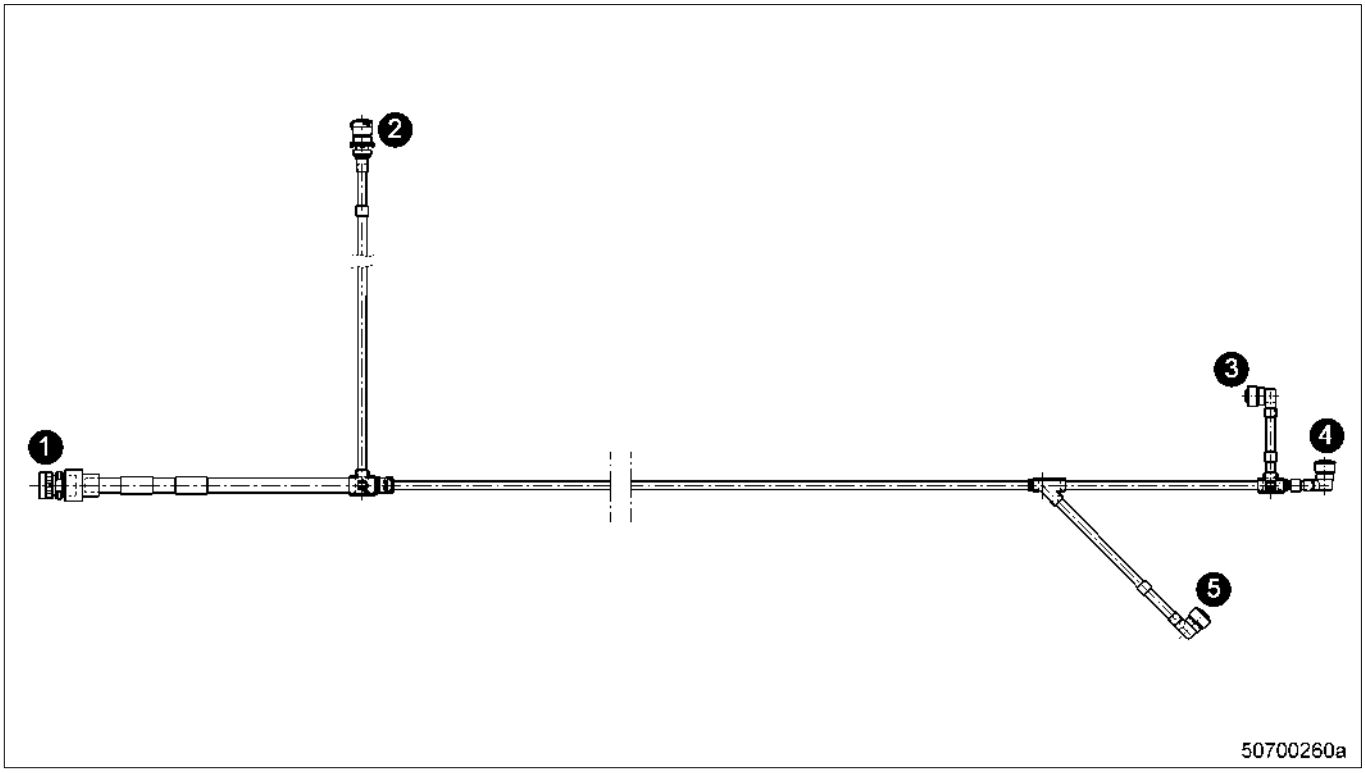
C507.00.01 Overview

Engine wiring harness W2



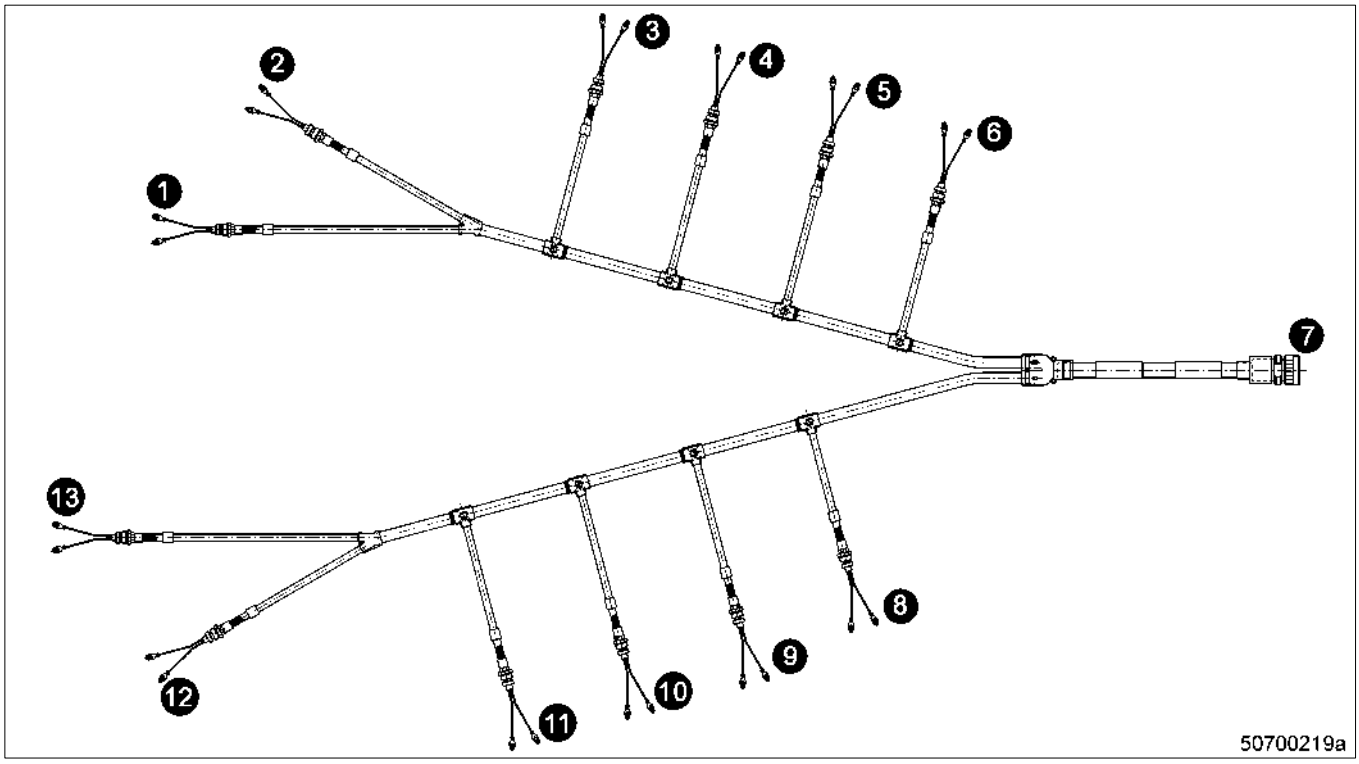
1 Connector X2 (to ECU 4)
2 Connection XF57 for external sensor F57 (charge air coolant level)
3 Sensor B10 (charge air pressure)
4 Sensor B9 (charge air temperature)
5 Sensor B13 (engine speed)
6 Sensor B26 (charge air coolant temperature)
7 Sensor B6 (engine coolant temperature)
8 Sensor B7 (lube oil temperature)
9 Sensor B5 (lube oil pressure)
10 Sensor B1 (camshaft speed)
11 Sensor B34 (fuel pressure after filter)

Engine wiring harness W3



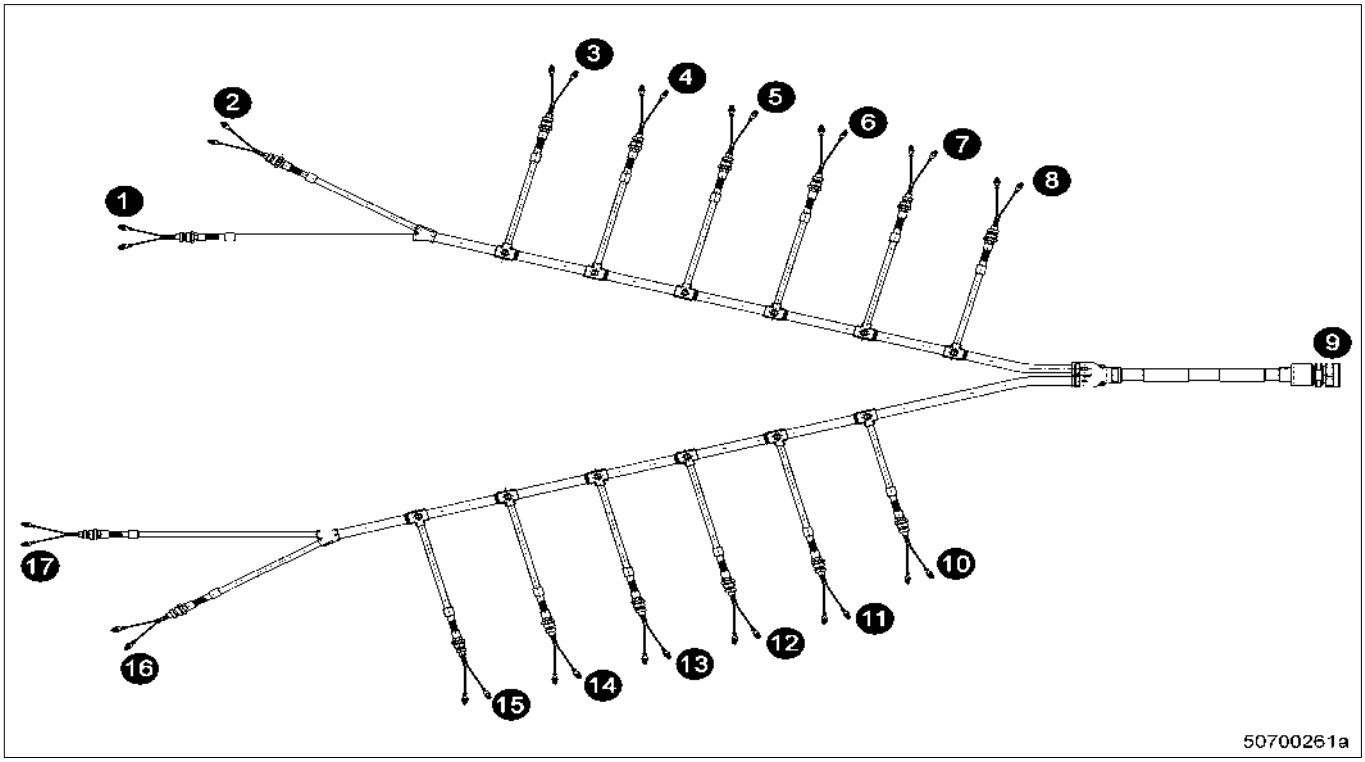
1 Connector X3 (to ECU 4)
2 Connection XF33 for external sensor F33 (engine coolant level)
3 H.P. fuel pump M8
4 Sensor B33 (fuel temperature)
5 Sensor B48 (fuel pressure after high-pressure pump)

Engine wiring harness W4 for 12V



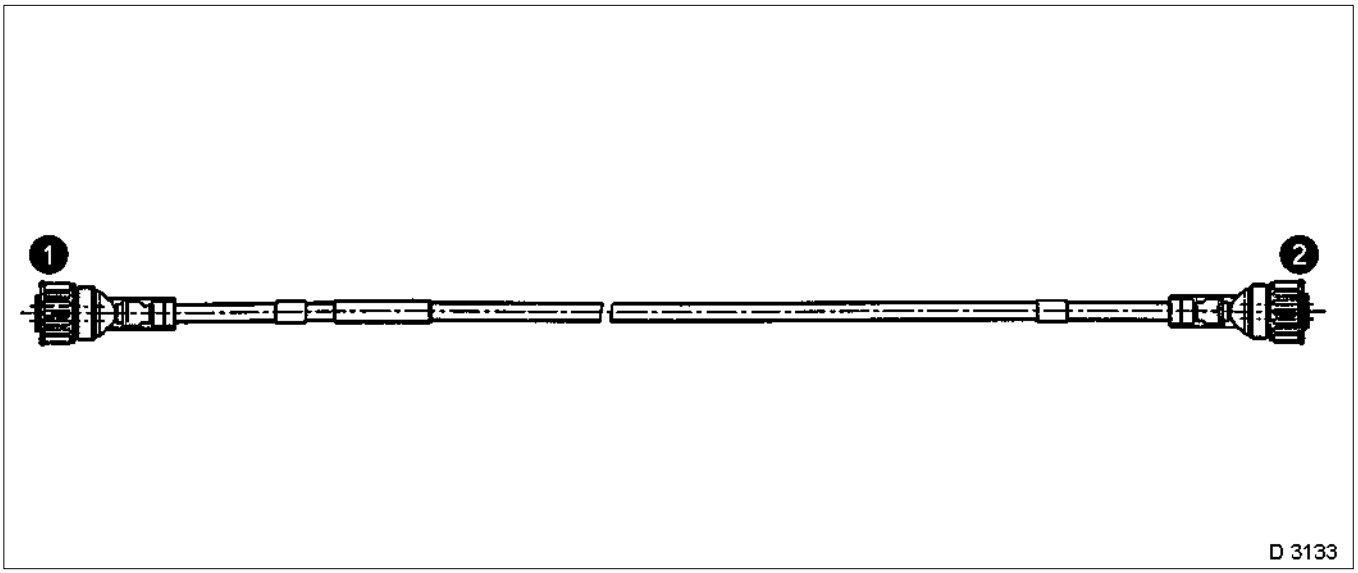
1 Injector Y39.6 (cylinder A6)
2 Injector Y39.5 (cylinder A5)
3 Injector Y39.4 (cylinder A4)
4 Injector Y39.3 (cylinder A3)
5 Injector Y39.2 (cylinder A2)
6 Injector Y39.1 (cylinder A1)
7 Connector X4 (to ECU 4)
8 Injector Y39.11 (cylinder B1)
9 Injector Y39.12 (cylinder B2)
10 Injector Y39.13 (cylinder B3)
11 Injector Y39.14 (cylinder B4)
12 Injector Y39.15 (cylinder B5)
13 Injector Y39.16 (cylinder B6)

Engine wiring harness W4 for 16V



1 Injector Y39.8 (cylinder A8)
2 Injector Y39.7 (cylinder A7)
3 Injector Y39.6 (cylinder A6)
4 Injector Y39.5 (cylinder A5)
5 Injector Y39.4 (cylinder A4)
6 Injector Y39.3 (cylinder A3)
7 Injector Y39.2 (cylinder A2)
8 Injector Y39.1 (cylinder A1)
9 Connector X4 (to ECU 4)
10 Injector Y39.11 (cylinder B1)
11 Injector Y39.12 (cylinder B2)
12 Injector Y39.13 (cylinder B3)
13 Injector Y39.14 (cylinder B4)
14 Injector Y39.15 (cylinder B5)
15 Injector Y39.16 (cylinder B6)
16 Injector Y39.17 (cylinder B7)
17 Injector Y39.18 (cylinder B8)

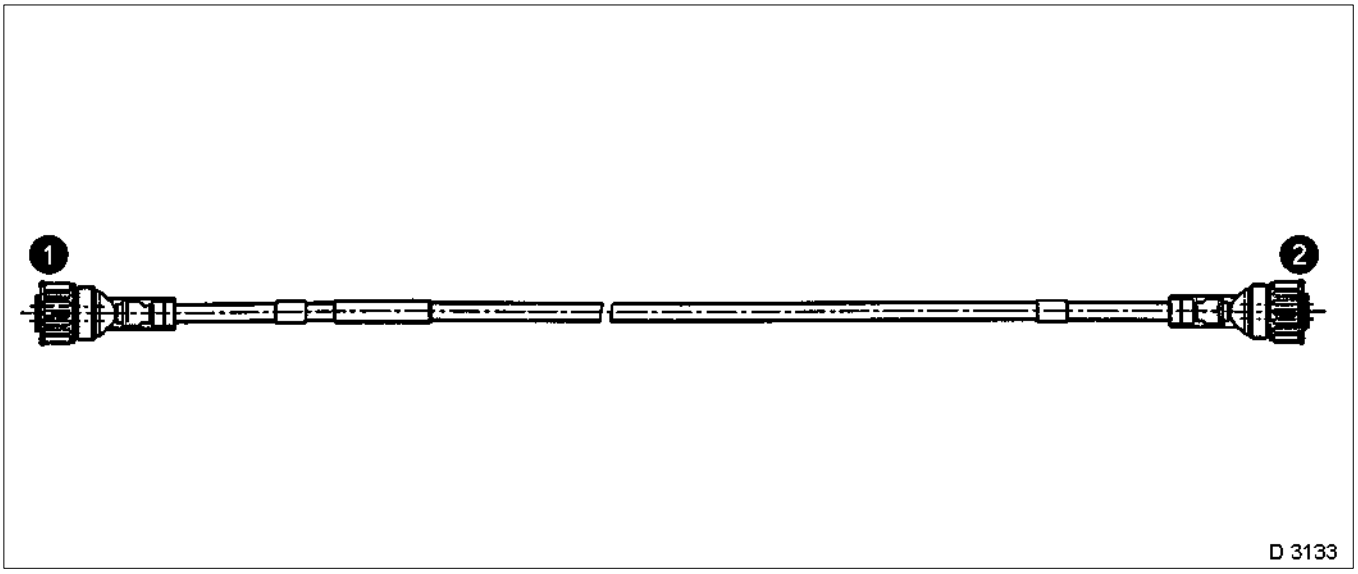
Connecting cable for external sensor F33



1 Connection on adapter XF33

2 Connection on F33 sensor

Connecting cable for external sensor F57



1 Connection on adapter XF57

2 Connection on F57 sensor

C507.00.04 Before-removal operations

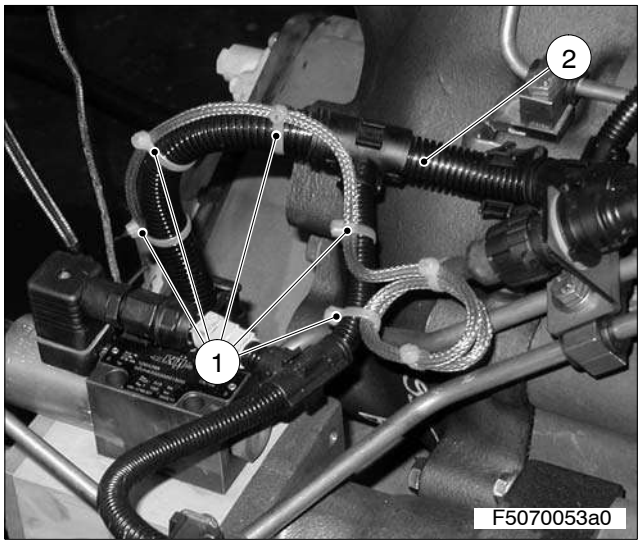
DANGER

Risk of injury!
Before work is carried out on the engine, it must be ensured that:
- the engine is shut down and the power supply switched off and secured against unauthorised switching on
- the engine, coolant, engine oil and exhaust pipework have cooled down

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C507.00.05 Removal

Removing engine wiring harnesses W2 and W3



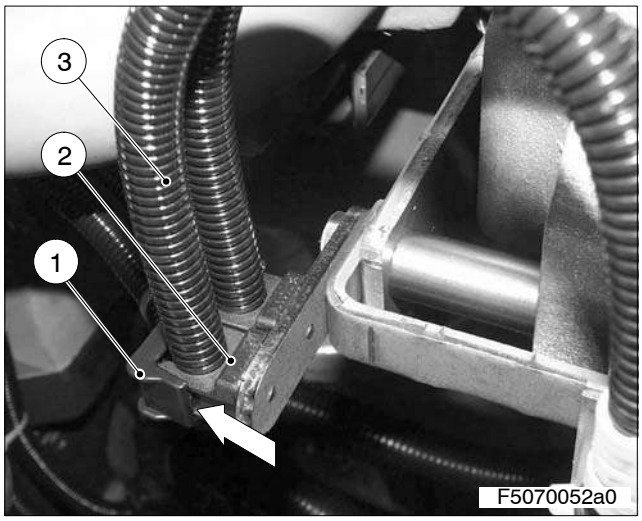
Use the lettering kit (near ECU connector) to identify wiring harness and determine wiring route.

Release bayonet connector at ECU 4 (if necessary using pliers) and withdraw.

Release plug-in connections of connected sensors or actuators and remove.

Remove cable clamps (1) which are secured to wiring harness (2) to be changed.

Note: Note position of cable clamps. The cable clamps must be installed in the position they were in prior to disassembly.

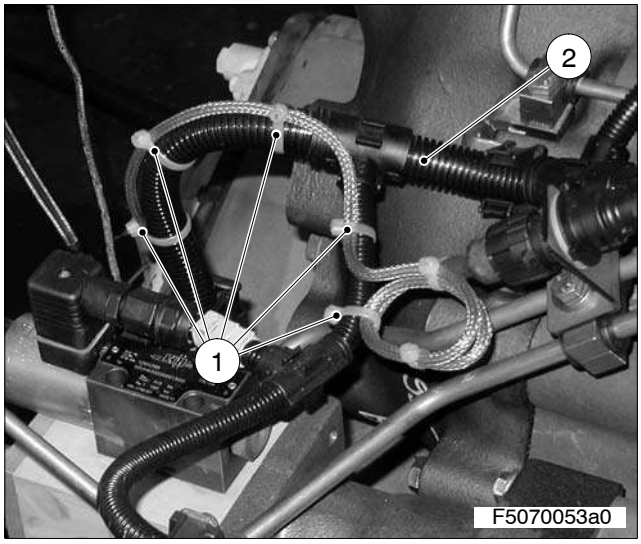


Using a screwdriver, open sealing clips (1) of all cable fasteners (2) and remove (arrow indicates application point of screwdriver).

Withdraw wiring harness (3) from all open cable fasteners.

Carefully remove wiring harness.

Removing engine wiring harness W4



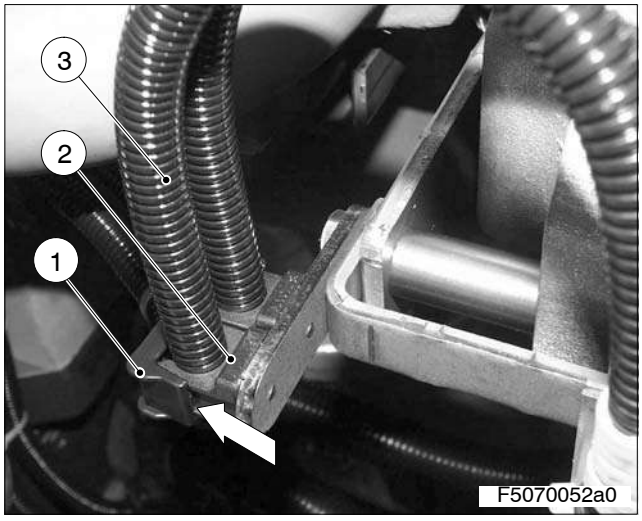
Use the lettering kit (near ECU connector) to identify wiring harness and determine wiring route.

Release bayonet connector at ECU 4 (if necessary using pliers) and withdraw.

Release plug-in connections of connected sensors or actuators and remove.

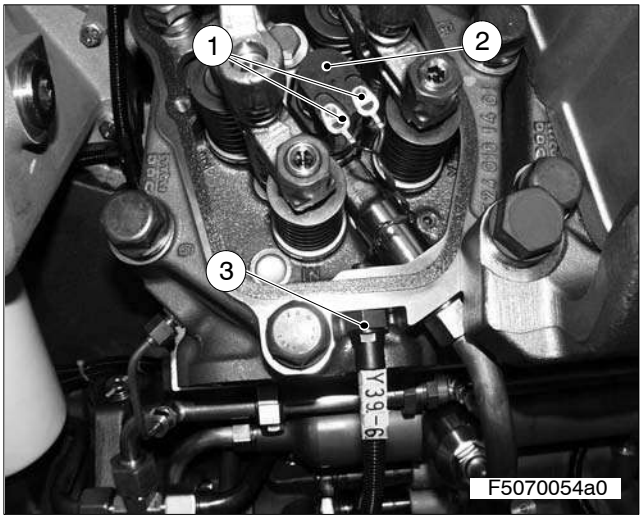
Remove cable clamps (1) which are secured to wiring harness (2) to be changed.

Note: Note position of cable clamps. The cable clamps must be installed in the position they were in prior to disassembly.



Using a screwdriver, open sealing clips (1) of all cable fasteners (2) and remove (arrow indicates application point of screwdriver).

Withdraw wiring harness (3) from all open cable fasteners.



Remove cylinder head covers

Release cable terminals (1) and withdraw from injector (2).

Release cable entry (3) and carefully withdraw connecting wires from cable entry.

Remove wiring harness.

C507.00.08 Inspection and repair

The function of these electrical subassemblies is continuously monitored by the Engine Control Unit ECU 4. Defective electrical component groups, cable breakages, short-circuits or sensor values that lie outside the plausible range are recorded by the ECU 4 and reported to the connected monitoring system.

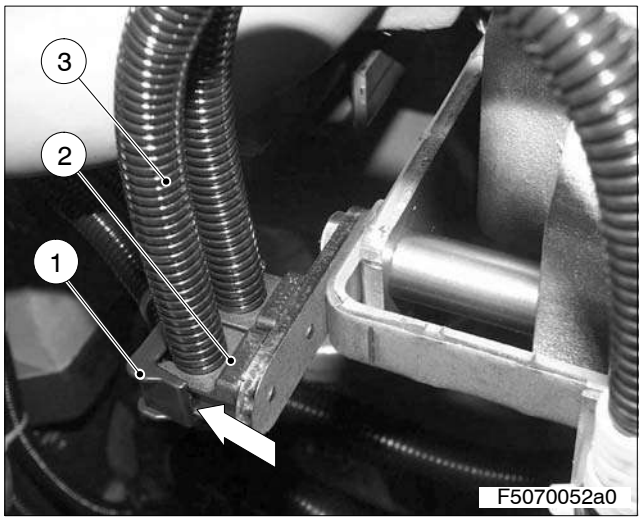
The electrical function of the engine wiring system does not have to be examined separately in the course of scheduled maintenance work.

Maintenance work therefore mainly consists of visible inspections to detect mechanical damage, loose connectors or screws. If deficiencies are found, they must be eliminated immediately.

Component group / test point	Activity
• Engine wiring	Check for: • Cracks, buckles, chafing → Repair with insulating tape or shrinkable hose if necessary → Replace complete cable if necessary → Fasten again with cable clamps if necessary • Loose cables → Fasten again with cable clamps if necessary • Damage to shrink sleeves → Replace shrink sleeve if necessary • Condition of plug contacts (only necessary if plug was not correctly connected) → Correct plug contacts or replace as required

C507.00.11 Installation

Installing engine wiring harnesses W2 and W3

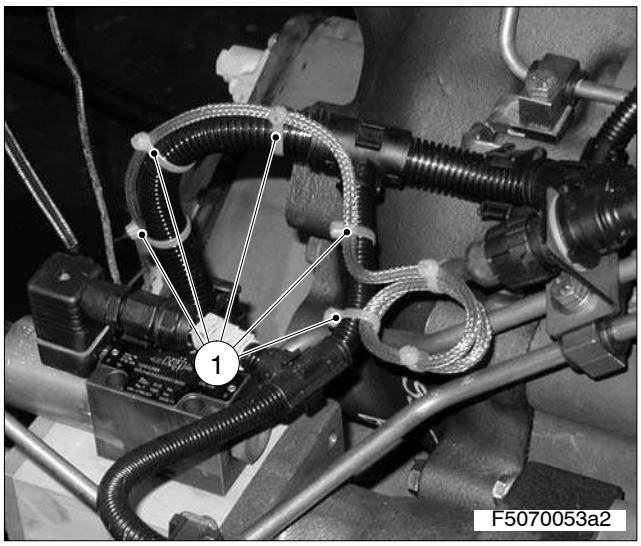


Place wiring harness (3) in position but do not yet press into cable fastener (2).

Align wiring harness so that it is free of tension and can reach the sensors and actuators to be connected.

Connect plug-in connections to sensors and actuators and tighten.

Press wiring harness into cable fasteners. Then press clips (1) firmly onto cable fasteners until they are heard to engage.



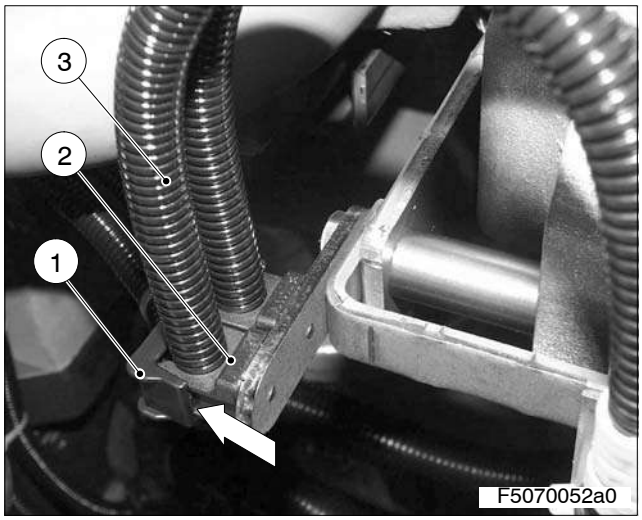
Secure cables and wiring harnesses with cable clamps (1).

Note: The cable clamps must be installed in the position they were in prior to disassembly.

Connect cable connector to ECU 4. Tighten union nut of bayonet connector first by hand and then with connector pliers until it engages firmly in position.

Note: It is not sufficient to tighten the union nut by hand. There is the risk that the lock does not properly engage and the connector may then come loose during engine operation.

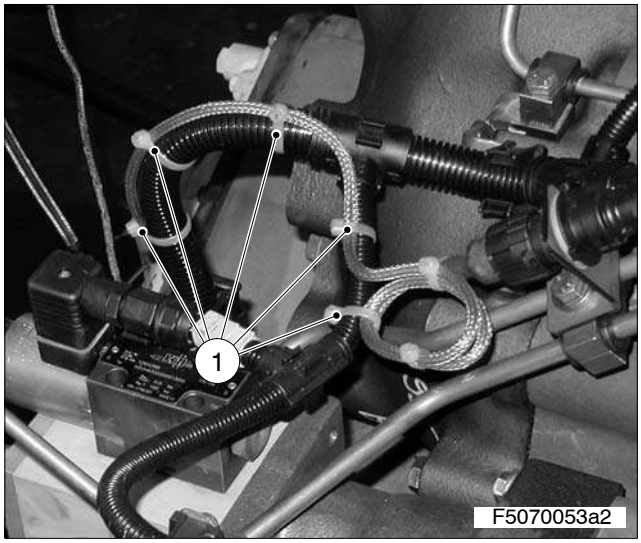
Installing engine wiring harness W4



Place wiring harness (3) in position but do not yet press into cable fasteners (2).

Align wiring harness so that it is free of tension and can reach the injectors to be connected.

Press wiring harness into cable fasteners. Then press clips (1) firmly onto cable fasteners until they are heard to engage.

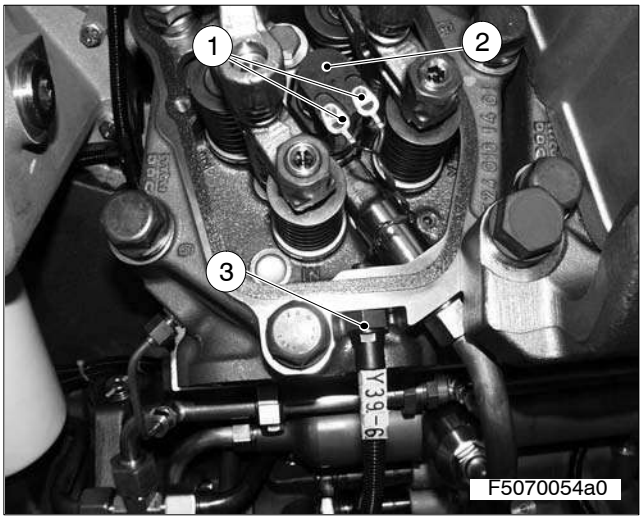


Secure cables and wiring harnesses with cable clamps (1).

Note: The cable clamps must be installed in the position they were in prior to disassembly.

Connect cable connector to ECU 4. Tighten union nut of bayonet connector first by hand and then with connector pliers until it engages firmly in position.

Note: It is not sufficient to tighten the union nut by hand. There is the risk that the lock does not properly engage and the connector may then come loose during engine operation.



Insert the connecting wires carefully into the cable entries (3) and connect the cable terminals (1) to the injector (2).

Install cylinder head cover.

C507.00.12 After-installation operations

Note: Before the engine is restarted, the regulations and operating sequences as stated in the operating instructions must be observed.

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

Maintenance and repair work must be checked to ensure it has been carried out in a professional manner.

The following final checks must be carried out according to the services carried out:

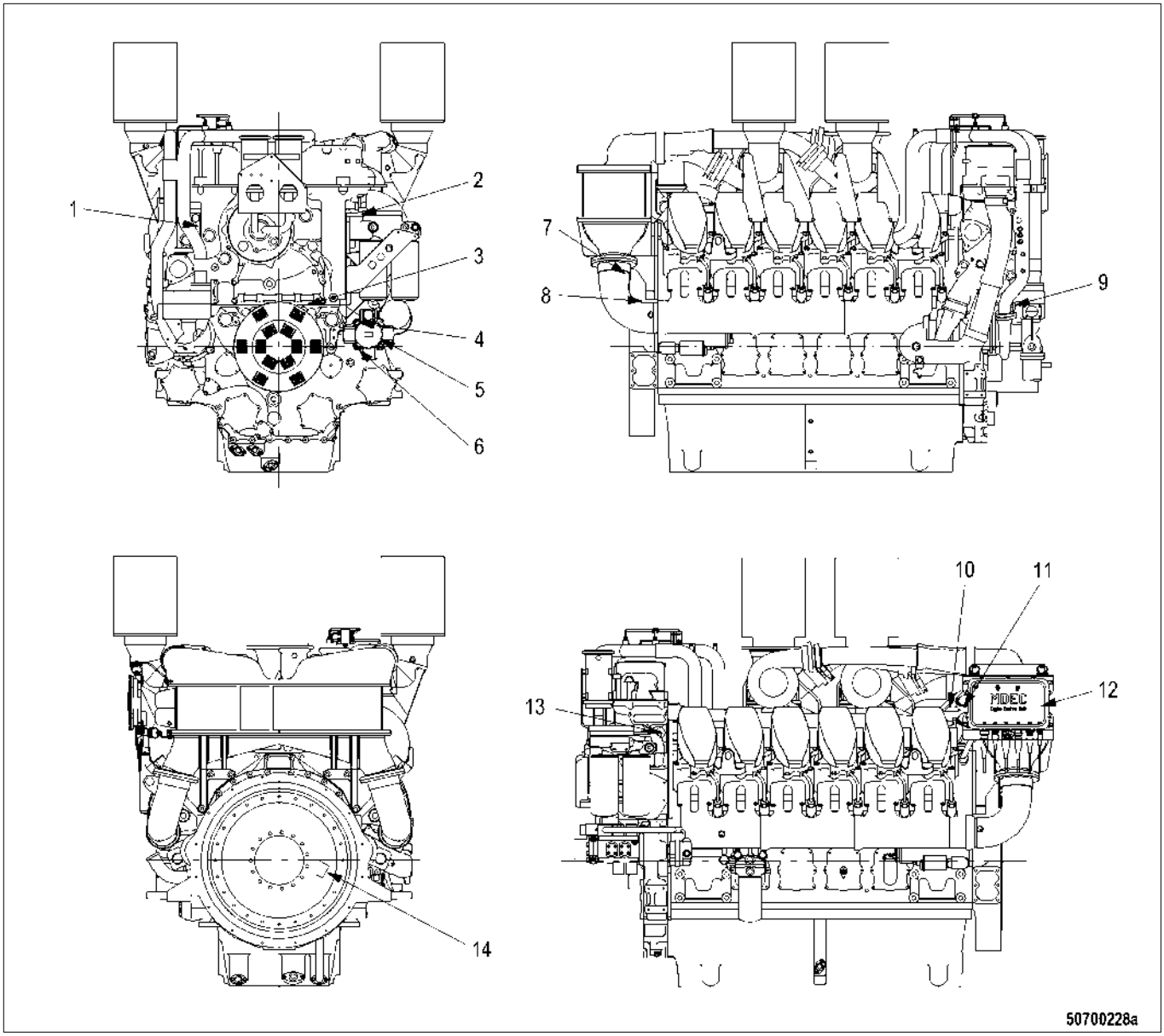
- Check security and perfect seating of all wiring harnesses and sensors
- Check sensor threaded fittings for leak-tightness
- Check security and perfect seating of all plug-in connections
- If necessary, sensor connecting lines must be rolled out to correct length and secured by cable clamps.
- The engine wiring must be secured such that, with respect to vibrations, it forms a unit with the respective subassembly. In the case of vibrations and oscillations, relative motion must not occur between connector and cable.

Note: When the Engine Control Unit ECU 4 is switched on, the operation of the electrical component groups is checked and continuously monitored. Defective or incorrectly connected electrical component groups, cable breakages, short-circuits or sensor values that lie outside the plausible range are recorded by the ECU 4 and reported to the connected monitoring system.

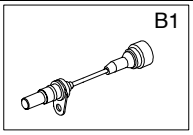
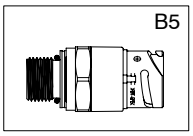
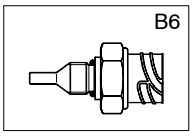
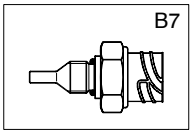
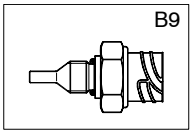
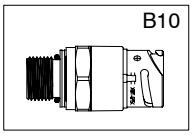
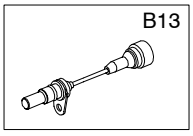
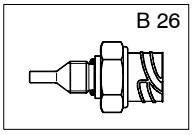
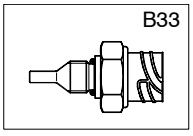
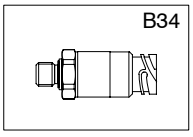
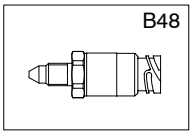
C507.98 Sensors and actuators

C507.98.01 Overview

Sensors and actuators for 12V and 16V



1 Sensor B6 (engine coolant temperature)
2 Sensor B5 (lube oil pressure)
3 Sensor B1 (camshaft speed)
4 Sensor B34 (fuel pressure after filter)
5 Sensor B33 (fuel temperature)
6 Sensor B48 (fuel pressure after high-pressure pump)
7 Sensor B10 (charge air pressure)
8 Sensor B9 (charge air temperature)
9 Sensor B26 (charge air coolant temperature)
10 Connection for external sensor F57 (charge air coolant level)
11 Connection for external F33 (engine coolant level)
12 Engine Control Unit ECU 4
13 Sensor B7 (lube oil temperature)
14 Sensor B13 (crankshaft speed)

Sensor	Model	Operation	Tightening torque
B1 	Speed sensor	Camshaft speed	–
B5 	Pressure sensor	Lube oil pressure	20 Nm … 45 Nm
B6 	Temperature sensor Pt1000	Engine coolant temperature	15 Nm … 30 Nm
B7 	Temperature sensor Pt1000	Lube oil temperature	15 Nm … 30 Nm
B9 	Temperature sensor Pt1000	Charge air temperature	15 Nm … 30 Nm
B10 	Pressure sensor	Charge air pressure	20 Nm … 70 Nm
B13 	Speed sensor	Engine speed	–
B 26 	Temperature sensor Pt1000	Charge air coolant temperature	15 Nm … 30 Nm
B33 	Temperature sensor Pt1000	Fuel temperature	15 Nm … 30 Nm
B34 	Pressure sensor	Fuel pressure after filter	20 Nm (± 3 Nm)
B48 	Pressure sensor	Fuel high pressure	30 Nm (± 3 Nm)
F33	Level monitor	Coolant level (external sensor)	–

Sensor	Model	Operation	Tightening torque
F57	Level monitor	Water in fuel prefilter (external sensor)	–
M 8	Actuator	Intake restrictor actuator of high-pressure pump	–

C507.98.04 Before-removal operations

DANGER

Risk of injury!
Before work is carried out on the engine, it must be ensured that:
- the engine is shut down and the power supply switched off and secured against unauthorised switching on
- the engine and exhaust system have cooled down

DANGER

Poisoning hazard from engine oil!
Engine oil can contain combustion residues which are harmful to health.
Oil vapours must therefore not be inhaled. Direct skin contact must be prevented by means of suitable protective measures (e.g. protective gloves, safety mask).

DANGER

Risk of injury!
During engine operation, the engine oil and coolant may become very hot and highly pressurised.
Work on the engine must therefore only be carried out when the oil and coolant are cooled and not pressurised.

DANGER

Risk of fire and explosion!
Fuels are combustible. Therefore, when working on the fuel system all open flames and sparks must be avoided.
The safety regulations for the use of combustible materials must be observed.

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	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 (only for removal of coolant sensors)	→ Operating Instructions

C507.98.05 Removal

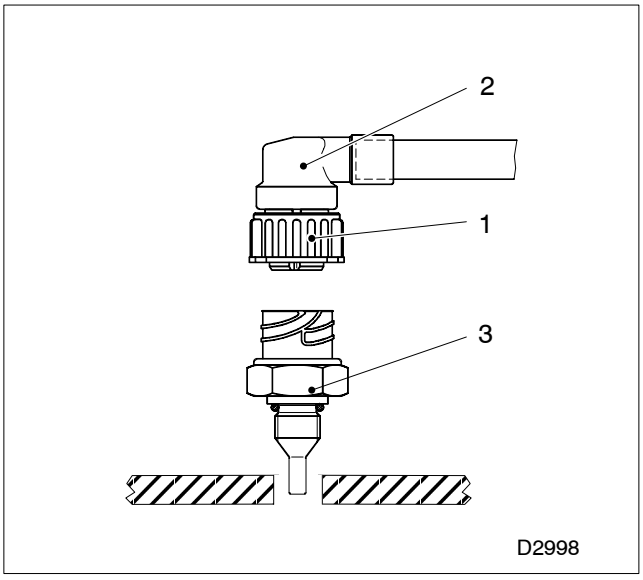
Removing temperature sensors (B6, B7, B9, B26, B33)

The sensors are identical with regard to design and electrical system. Removal of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.

For the sensors listed, the following must be noted before removal:

- **Sensor B6 (engine coolant temperature)**
  Before removal of sensor B6, the coolant must be drained and refilled after installation. The necessary procedure and the safety instructions to be followed are described in the operating instructions, section “Engine coolant changing”.
- **Sensors B7 (lube oil temperature sensor)**
  When sensor B7 is removed, small quantities of engine oil may emerge. Measures must be taken to collect this engine oil (e.g. suitable containers must be provided).
- **Sensor B26 (charge air coolant temperature)**
  Before removal of sensor B26 the coolant must be drained and refilled after installation. The necessary procedure and the safety instructions to be followed are described in the operating instructions, section “Charge air coolant changing”.
- **Sensor B33 (fuel temperature)**
  When sensor B33 is removed, small quantities of fuel may emerge. Measures must be taken to collect this fuel (e.g. suitable containers must be provided).



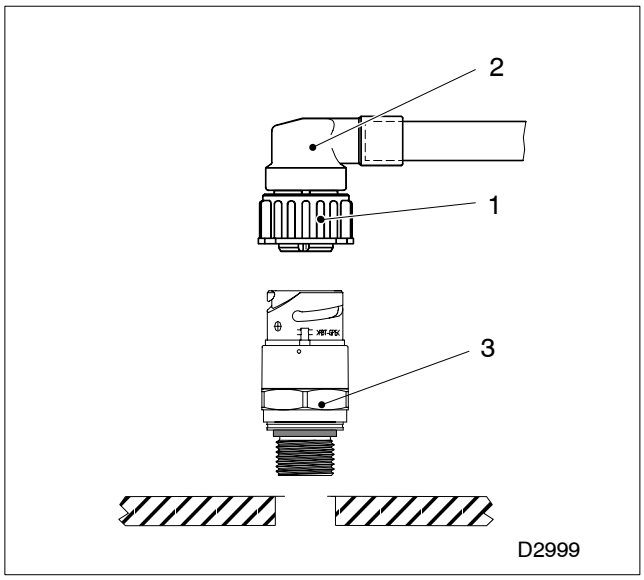
Release bayonet lock (1) and withdraw connector (2).
Place wrench on nut (3) and unscrew sensor.

Removing pressure sensors (B5, B10)

The sensors are identical with regard to design and electrical system. Removal of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.

When sensor B5 is removed (lube oil pressure), small quantities of engine oil may emerge. Measures must be taken to collect this engine oil (e.g. suitable containers must be provided).

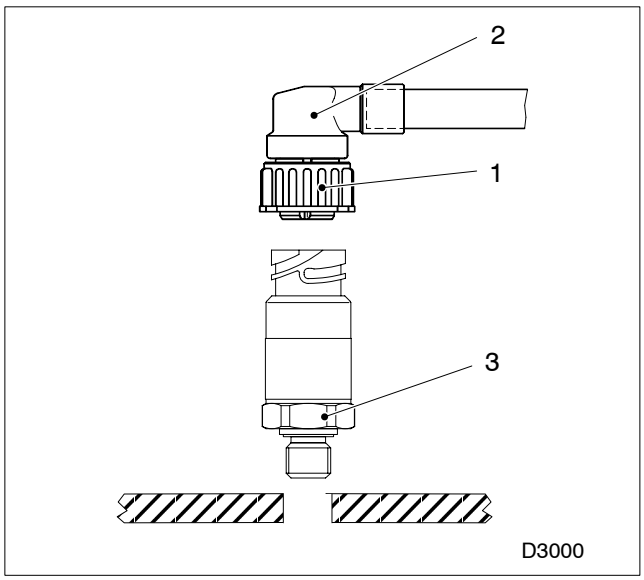


Release bayonet lock (1) and withdraw connector (2).
Place wrench on nut (3) and unscrew sensor.

Removing pressure sensor (B34)

The arrangement and position of the sensor is shown in the section “C507.98.01 Overview”.

When sensor B34 is removed (fuel pressure after filter), small quantities of fuel may emerge. Measures must be taken to collect this fuel (e.g. suitable containers must be provided).

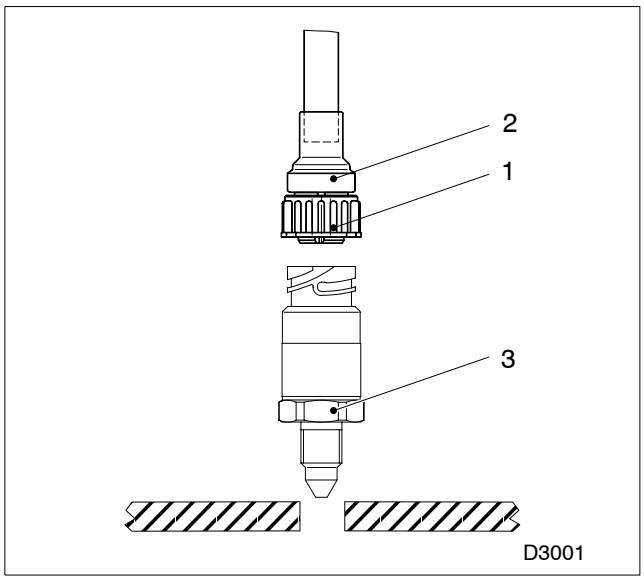


Release bayonet lock (1) and withdraw connector (2).
Place wrench on nut (3) and unscrew sensor.

Removing pressure sensor (B48)

The arrangement and position of the sensor is shown in the section “C507.98.01 Overview”.

When sensor B48 is removed (H.P. fuel pressure), small quantities of fuel may emerge. Measures must be taken to collect this fuel (e.g. suitable containers must be provided).



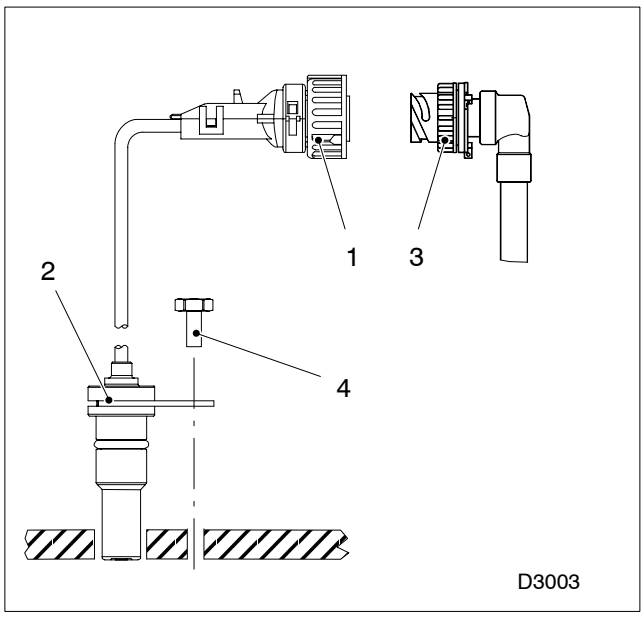
Release bayonet lock (1) and withdraw connector (2).

Place wrench on nut (3) and unscrew sensor.

Removing speed sensors (B1, B13)

The sensors are identical with regard to design and electrical system. Removal of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.



Release bayonet catch (1) of speed sensor (2) and remove connector (3) from engine wiring system.

Release and remove screw (4).

Carefully withdraw speed sensor (2).

C507.98.08 Inspection and repair

The sensors and actuators installed on the engine are largely maintenance-free and have a long service life.

The function of these electrical subassemblies is continuously monitored by the Engine Control Unit ECU 4. Defective electrical component groups, cable breakages, short-circuits or sensor values that lie outside the plausible range are recorded by the ECU 4 and reported to the connected monitoring system.

The electrical function of the sensors and actuators does not have to examined separately in the course of scheduled maintenance work.

Maintenance work therefore mainly consists of visible inspections to detect mechanical damage, loose connectors or screws. If deficiencies are found, they must be eliminated immediately.

Component group / test point	**Activity**
• Installed sensors and actuators	Check for: • Security in installation position → Retighten securing screws if necessary • Security of connectors → Insert connectors properly and tighten if necessary • Mechanical damage which could impair operation → Replace affected subassembly immediately
• Removed sensors and actuators	Check for: • Mechanical damage which could impair operation → Replace affected subassembly immediately. • Contamination (e.g. oil sludge) which could lead to impairment of operation → Clean affected assembly with isoprophyl alcohol

C507.98.11 Installation

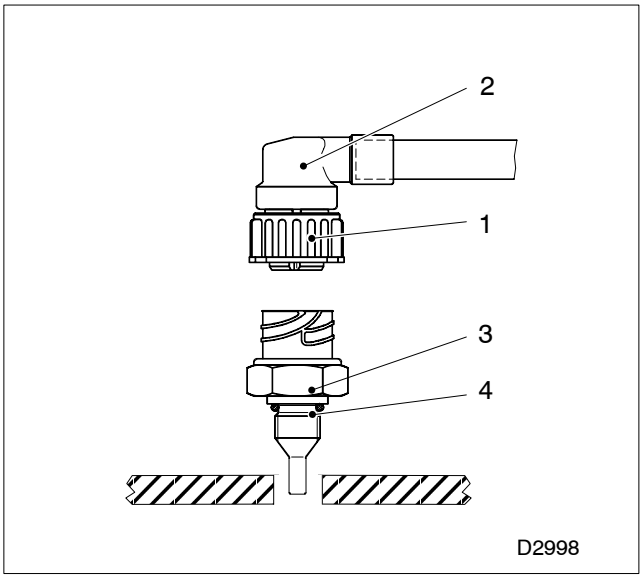
Installing temperature sensors (B6, B7, B9, B26, B33)

The sensors are identical with regard to design and electrical system. Removal of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.

For the sensors listed, the following must be noted before removal:

- **Sensor B6 (engine coolant temperature)**
  Before removal of sensor B6, the coolant must be drained and refilled after installation. The necessary procedure and the safety instructions to be followed are described in the operating instructions, section “Engine coolant changing”.
- **Sensors B7 (lube oil temperature sensor)**
  When sensor B7 is removed, small quantities of engine oil may emerge. Measures must be taken to collect this engine oil (e.g. suitable containers must be provided).
- **Sensor B26 (charge air coolant temperature)**
  Before removal of sensor B26 the coolant must be drained and refilled after installation. The necessary procedure and the safety instructions to be followed are described in the operating instructions, section “Charge air coolant changing”.
- **Sensor B33 (fuel temperature)**
  When sensor B33 is removed, small quantities of fuel may emerge. Measures must be taken to collect this fuel (e.g. suitable containers must be provided).



Coat O-ring (4) of sensor with petroleum jelly.

Insert sensor in bore and screw in by hand.

Place wrench on nut (3) and tighten sensor. The tightening torque is 15 Nm … 30 Nm.

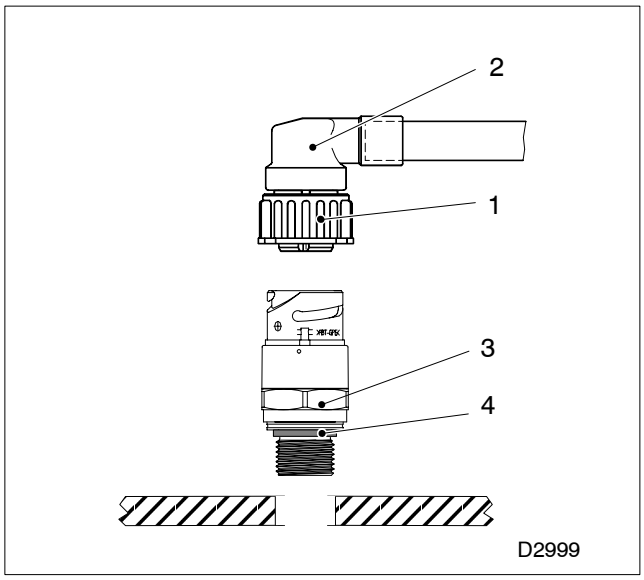
Fit connector (2) and tighten bayonet catch (1).

Note: After installation, sensor threaded fitting must be checked for leaks. In event of leaks, check the tightening torque or replace gasket.

Installing pressure sensors (B5, B10)

The sensors are identical with regard to design and electrical system. Installation of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.



Coat O-ring (4) of sensor with petroleum jelly.

Insert sensor in bore and screw in by hand.

Place wrench on nut (3) and tighten sensor.

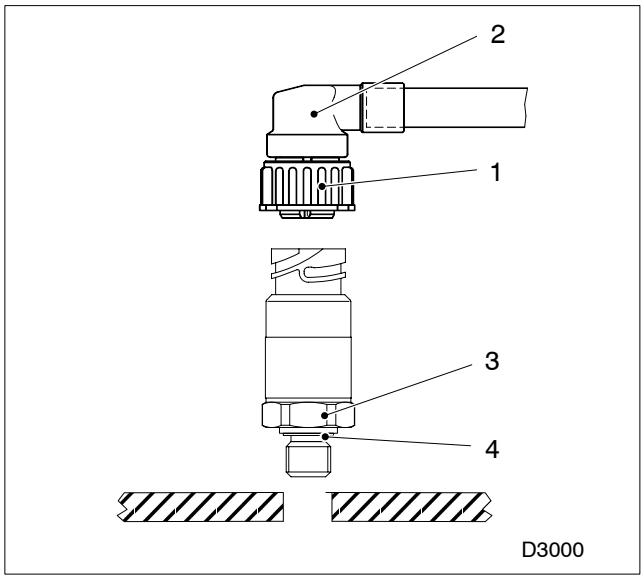
The tightening torques of the sensors is:
B5 = 20 Nm … 45 Nm
B10 = 20 Nm … 70 Nm.

Fit connector (2) and tighten bayonet catch (1).

Note: After installation, sensor threaded fitting must be checked for leaks. In event of leaks, check the tightening torque or replace gasket.

Removing pressure sensor (B34)

The arrangement and position of the sensor is shown in the section “C507.98.01 Overview”.



Coat O-ring (4) of sensor with petroleum jelly.

Insert sensor in bore and screw in by hand.

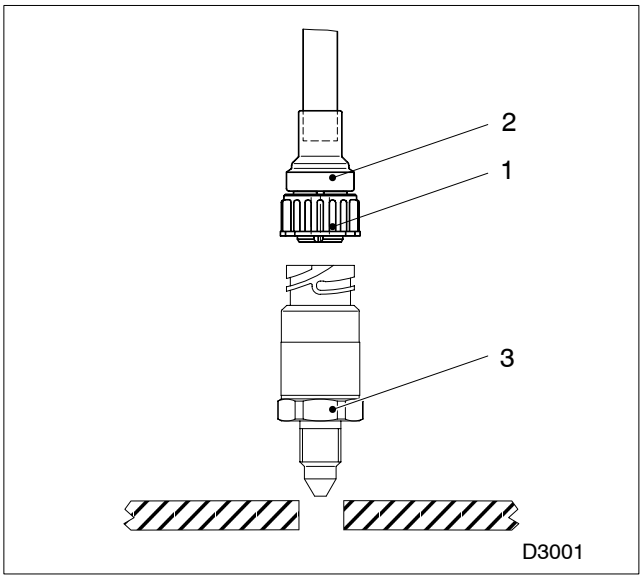
Place wrench on nut (3) and tighten sensor. The tightening torque of the sensor is 20 Nm (±3 Nm).

Fit connector (2) and tighten bayonet catch (1).

Note: After installation, sensor threaded fitting must be checked for leaks. In event of leaks, check the tightening torque or replace gasket.

Installing pressure sensor (B48)

The arrangement and position of the sensor is shown in the section “C507.98.01 Overview”.



Insert sensor in bore and screw in by hand.

Place wrench on nut (3) and tighten sensor. The tightening torque of the sensor is 30 Nm (±3 Nm).

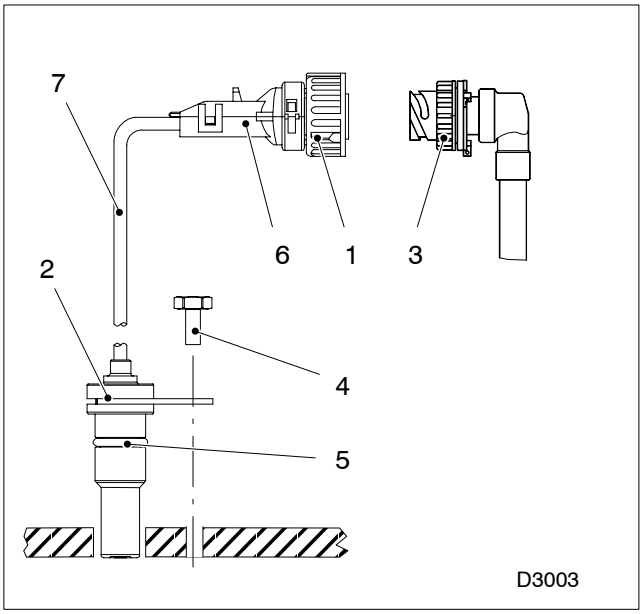
Fit connector (2) and tighten bayonet catch (1).

Note: After installation, sensor threaded fitting must be checked for leaks. In event of leaks, check the tightening torque or replace gasket.

Installing speed sensors (B1, B13)

The sensors are identical with regard to design and electrical system. Installation of the sensors is identical.

The arrangement and position of the sensors is shown in the section “C507.98.01 Overview”.



Coat O-ring (5) of sensor with petroleum jelly.

Fit sensor in bore and press in firmly.

Locate sensor (2) with screw (5) and tighten screw.

Plug connector of speed sensor (6) into bush (3) of engine wiring system and tighten bayonet lock (1) firmly.

Note: If necessary, sensor cable (7) must be rolled out to correct length and secured by cable clamps.

C507.98.12 After-installation operations

Note: Before the engine is restarted, the regulations and operating sequences as stated in the operating instructions must be observed.

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled	The engine is removed but was not disassembled	The engine is installed	Measure	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

Maintenance and repair work must be checked to ensure it has been carried out in a professional manner.

The following final checks must be carried out according to the services carried out:

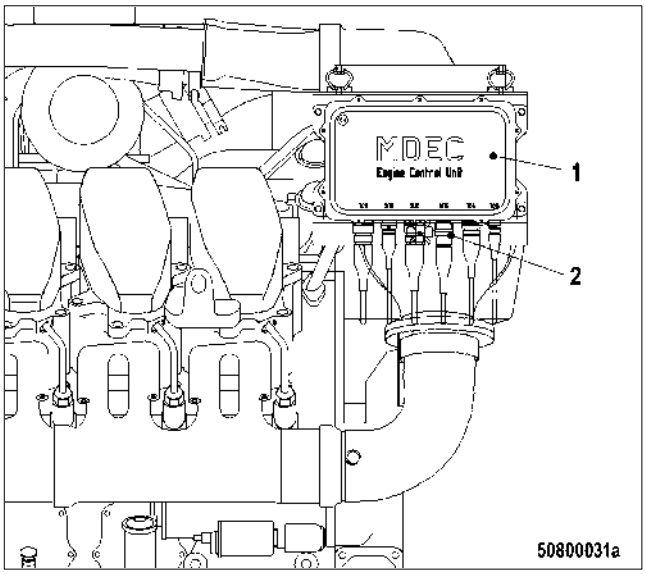
- Check security and perfect seating of all wiring harnesses and sensors
- Check sensor threaded fittings for leak-tightness
- Check security and perfect seating of all plug-in connections
- If necessary, sensor connecting lines must be rolled out to correct length and secured by cable clamps.
- The engine wiring must be secured such that, with respect to vibrations, it forms a unit with the respective subassembly. In the case of vibrations and oscillations, relative motion must not occur between connector and cable.

Note: When the Engine Control Unit ECU 4 is switched on, the operation of the electrical component groups is checked and continuously monitored. Defective or incorrectly connected electrical component groups, cable breakages, short-circuits or sensor values that lie outside the plausible range are recorded by the ECU 4 and reported to the connected monitoring system.

C508.95 Control electronics – ECU 4

C508.95.01 Overview

Electronic governor ECU 4



1 Governor, ECU 4
2 Engine wiring connections

C508.95.04 Before-removal operations

DANGER

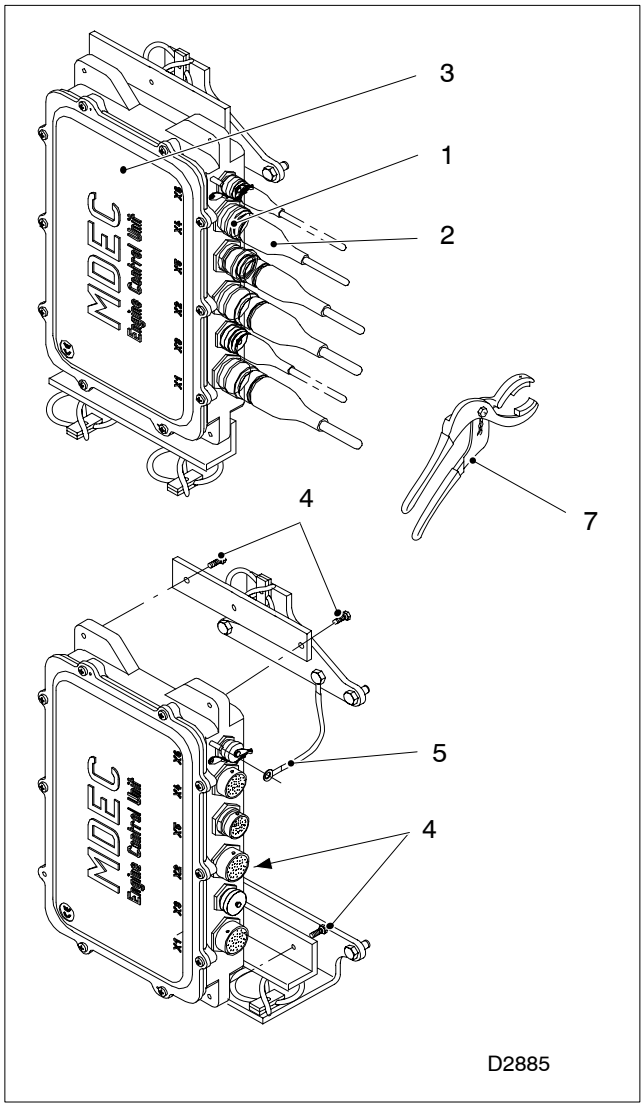
Risk of injury!
Before work is carried out on the engine, it must be ensured that:
- the engine is shut down and the power supply switched off and secured against unauthorised switching on
- the engine and exhaust system have cooled down

For the following tasks, a distinction must be made as to whether: The engine is to be completely disassembled The engine is to be removed but not disassembled The engine is to remain installed			Measure	See
x	–	–	Remove engine	→ B 003
x	–	–	Perform operations as per Disassembly Plan	→ B 004
–	–	x	Disable engine start	→ Operating Instructions

C508.95.05 Removal

The arrangement and position of the ECU 4 is shown in section “C508.95.01 Overview”.

Removing ECU 4



Release all union nuts (1) of bayonet connector and remove all connectors (2) from the ECU 4 (3).

Note: The union nuts can be easily released with connector pliers (7).

Seal all open connecting sockets of the ECU 4 and all engine wiring connectors with dust caps.

Unscrew ground lead (5) from the ECU 4.

Release the four securing screws (M6 x 60) (4) for the ECU 4 and remove the ECU 4.

Note: The ECU 4 weighs approx. 7 kg.

Inside the ECU 4 there are two data modules (MEM) on which engine- and plant-specific software is stored.
When changing ECU 4, these data modules must be taken over into the new ECU 4.
The procedure is described in the Electronics Documentation.

C508.95.08 Inspection and repair

The Engine Control Unit ECU 4 is almost completely maintenance-free and has a long service life.

The function of the Engine Control Unit ECU 4 is continuously checked by an integrated monitoring and test system. Deviations from target state are indicated on the ECU 4 display or on the connected monitoring system. For this reason, the function does not require separate examination in the framework of scheduled maintenance work.

Maintenance work therefore mainly consists of visible inspections to detect mechanical damage, loose connectors or screws. If deficiencies are found, they must be eliminated immediately.

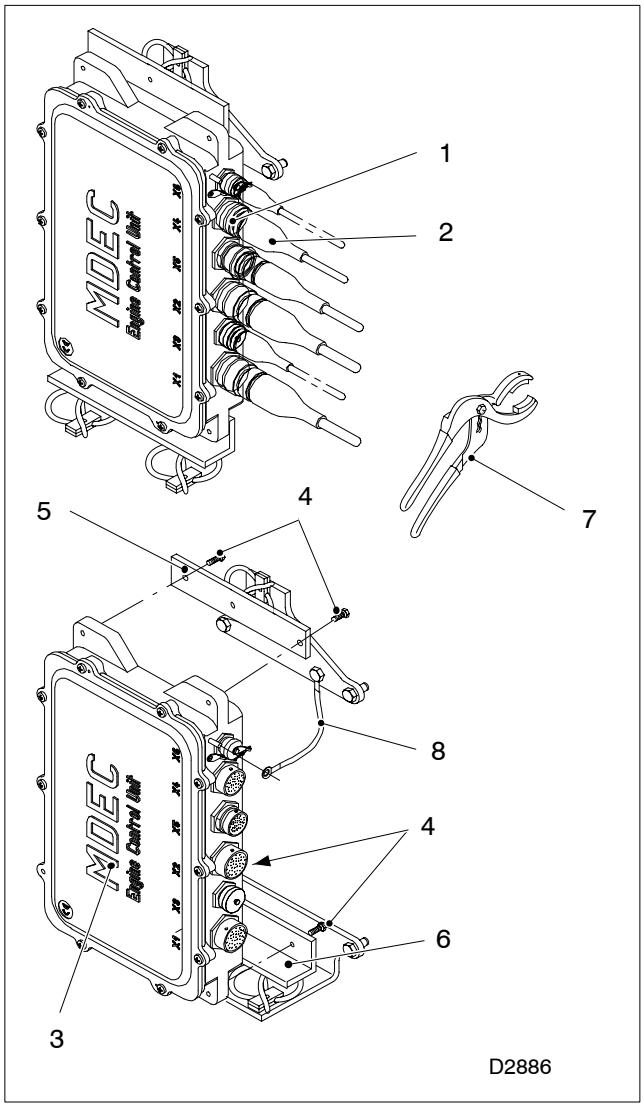
Note: Inside the ECU 4 there are two data modules (MEM) on which engine- and plant-specific software is stored. When changing ECU 4, these data modules must be taken over into the new ECU 4. The procedure is described in the Electronics Documentation.

Component group / test point	Activity
• With ECU 4 installed	Check for: • Security in installation position → Retighten securing screws if necessary • Security of connectors → Insert connectors properly and tighten if necessary • Mechanical damage which could impair operation → Replace affected subassembly immediately
• With ECU 4 removed	Check for: • Mechanical damage or contamination of connecting sockets (only necessary if a connector of engine wiring system has become loose during engine operation!) → Clean connectors, contacts and connector bushes with isoprophyl alcohol as necessary. → Replace ECU 4 if necessary • Contamination of housing (e.g. oil sludge) → Clean housing of ECU 4 with isoprophyl alcohol

C508.95.11 Installation

The arrangement and position of the ECU 4 is shown in section “C508.95.01 Overview”.

Installing ECU 4



Inside the ECU 4 there are two data modules (MEM) on which engine- and plant-specific software is stored.
If the ECU 4 was replaced, the data modules from the old ECU 4 must be incorporated in the new ECU 4.
The procedure is described in the Electronics Documentation.

Place the ECU 4 (3) on the adapter plates (plate (5) and bracket (6)).

Note: The ECU 4 weighs approx. 7 kg.

Secure the ECU 4 with the four securing screw (M6 x 60) (4) and screw in securely.
Tightening torque is 4 Nm.

Screw ground lead (8) onto the ECU 4.

Connect engine wiring connector (2) to corresponding connecting sockets of ECU 4.

Note: To avoid confusion when reconnecting, the connecting sockets of the ECU 4 and engine cables are clearly marked.

Tighten union nut (1) of bayonet connector first by hand and then with connector pliers (7) until it engages firmly in position.

Note: It is not sufficient to tighten the union nut by hand. There is the risk that the lock does not properly engage and the connector may then come loose during engine operation. Pliers must therefore be used to tighten the union nuts.

C508.95.12 After-installation operations

Note: Before the engine is restarted, the regulations and operating sequences as stated in the operating instructions must be observed.

For the following tasks, a distinction must be made as to whether: The engine was completely disassembled The engine is removed but was not disassembled The engine is installed			**Measure**	**See**
x	–	–	Perform operations as per Assembly Plan	→ B 005
x	–	–	Install engine	→ B 007
–	–	x	Release engine start	→ Operating Instructions

Maintenance and repair work must be checked to ensure it has been carried out in a professional manner.

The following final checks must be carried out according to the services carried out:

- Check security and perfect seating ECU 4
- Check security and perfect seating of all plug-in connections
- The engine wiring must be secured such that, with respect to vibrations, it forms a unit with the respective subassembly. In the case of vibrations and oscillations, relative motion must not occur between connector and cable.

Note: When the Engine Control Unit ECU 4 is switched on, operation is checked by an integrated monitoring and test system. Deviations from target state are indicated on the ECU 4 display or on the connected monitoring system.