



On-load tap-changer OILTAP[®] G

Installation and commissioning instructions

4446958/01 EN



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We reserve the right to change the technical data, design and scope of supply.

Generally the information provided and agreements made when processing the individual quotations and orders are binding.

The original operating instructions were written in German.



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1 Introduction

This technical file contains detailed descriptions of the safe and proper installation, connection, and commissioning of the product.

It also includes safety instructions and general information about the product.

Information about operation can be found in the operating instructions.

This technical file is intended solely for specially trained and authorized personnel.

1.1 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8
93059 Regensburg
Tel.: (+49) 9 41/40 90-0
E-mail: sales@reinhausen.com

Further information on the product and copies of this technical file are available from this address if required.

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

- Unpacking instructions (included in the scope of delivery)
- Routine test report (included in the scope of delivery)
- Connection diagrams (included in the scope of delivery)
- Dimensional drawings (included in the scope of delivery)
- Technical data - General section (available on request)
- Technical data - Product-specific section (available on request)

Also observe generally valid legislation, standards, and guidelines as well as specifications on accident prevention and environmental protection in the respective country of use.

1.3 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

1.4 Notation conventions

1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:

▲ WARNING



Type of danger!

Source of the danger and outcome.

- ▶ Action
- ▶ Action

1.4.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

▲ DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words and pictograms

The following signal words are used:

Signal word	Definition
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

Pictograms warn of dangers:

Pictogram	Definition
	Warning of a danger point
	Warning of dangerous electrical voltage
	Warning of combustible substances
	Warning of danger of tipping
	Warning of danger of crushing

Table 2: Pictograms used in warning notices

1.4.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:



Important information.

1.4.3 Instruction system

This technical file contains single-step and multi-step instructions.

Single-step instructions

Instructions which consist of only a single process step are structured as follows:



Aim of action

- ✓ Requirements (optional).
- ▶ Step 1 of 1.
 - ⇒ Result of step (optional).
- ⇒ Result of action (optional).

Multi-step instructions

Instructions which consist of several process steps are structured as follows:

Aim of action

- ✓ Requirements (optional).
- 1. Step 1.
 - ⇒ Result of step (optional).
- 2. Step 2.
 - ⇒ Result of step (optional).
- ⇒ Result of action (optional).



2 Safety

- Read this technical file through to familiarize yourself with the product.
- This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

2.1 Appropriate use

The product is an on-load tap-changer and adjusts the transmission ratio of transformers without interrupting the load flow. The product is designed solely for use in electrical energy systems and facilities. If used as intended and in compliance with the requirements and conditions specified in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any danger to people, property or the environment. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered intended use:

- Use the product only with the transformer/motor-drive unit specified in the order.
- The serial numbers of on-load tap-changer and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay, etc.) must match if the on-load tap-changer and on-load tap-changer accessories are supplied as a set for one order.
- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this provided technical file, the agreed delivery conditions and technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical document.

Permitted electrical operating conditions

In addition to the design data in accordance with the order confirmation, observe the following limits for the through-current and the step voltage:

In the standard version, the on-load tap-changer is designed for sinusoidal 50/60 Hz alternating current with a curve form symmetrical to the zero axis and can switch 2 times the rated through-current I_r at its rated step voltage U_{ir} .



Exceeding the rated step voltage U_{ir} by up to 10% for a short period is permitted as long as the rated step capacity P_{sin} permissible for this step voltage is not exceeded.

2.2 Inappropriate use

Use is considered inappropriate if the product is used in a way other than as described in the "Appropriate use" section. In addition, observe the following:

Prohibited electrical operating conditions

All operating conditions that do not comply with the design data in accordance with the order confirmation are prohibited.

Prohibited operating conditions may arise due to short circuits as well as due to inrush current impulses when energizing transformers or other electrical machines. This applies to the affected transformer itself just as it does to transformers electrically connected in parallel or serially or other electrical machines.

Higher voltages may occur due to transformer overexcitation following load shedding, for example.

Operations outside of the permitted operating conditions can lead to injury to persons and damage to the product.

- Prevent any such operations outside of the permitted operating conditions by taking suitable measures.

2.3 Fundamental safety instructions

To prevent accidents, disruptions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.



Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Working during operation

The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire. This increases the danger to life and limb.

- Do not install, operate or perform maintenance work on the product in areas where a risk of explosion is present.

Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.

Auxiliary materials and operating materials

Auxiliary materials and operating materials not approved by the manufacturer can lead to personal injury, damage to property and malfunctions of the product.

- Only use insulating fluids [► Section 10.1, Page 210] approved by the manufacturer.
- Only use conductive and grounded hoses, pipes and pump equipment that are approved for flammable liquids.



- Only use lubricants and auxiliary materials approved by the manufacturer.
- Contact the manufacturer.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

2.4 Personnel qualification

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.
- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.



Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.5 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

Protective clothing	Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
Safety shoes	To protect against falling heavy objects and slipping on slippery surfaces.
Safety glasses	To protect the eyes from flying parts and splashing liquids.
Visor	To protect the face from flying parts and splashing liquids or other dangerous substances.
Hard hat	To protect against falling and flying parts and materials.
Hearing protection	To protect against hearing damage.
Protective gloves	To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment



3 Product description

3.1 Scope of delivery

The product is packaged with protection against moisture and is usually delivered as follows:

- Oil compartment with on-load tap-changer head
- Diverter switch insert
- Selector
- Motor-drive unit
- Drive shaft with coupling parts and bevel gear
- Protective device
- Lifting traverse (only included in the initial delivery, otherwise available as optional equipment)
- Lifting cross (only included in the initial delivery, otherwise available as optional equipment)
- Tracing template (only included in the initial delivery, otherwise available as optional equipment)
- Technical files

Please refer to the delivery slip for full details of scope of delivery.



On-load tap-changers can also be provided as an on-load tap-changer set with a common motor-drive unit.

Note the following information:

- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation
- The product must remain in its airtight, protective wrapping and may only be removed immediately before installation

You will find more information in the "Packaging, transport, and storage" [► Section 4, Page 32] chapter.



3.2 On-load tap-changer

3.2.1 Function description

On-load tap-changers are used to adjust the transmission ratio of transformers without interrupting the load flow. Fluctuations in voltage occurring in the power transmission grid, for example, can therefore be compensated for. For this purpose, on-load tap-changers are fitted in transformers and connected to the active part of the transformer.

A motor-drive unit, which receives a control impulse (e.g. from a voltage regulator), changes the on-load tap-changer's operating position, which adapts the transmission ratio of the transformer to the respective operating requirements.

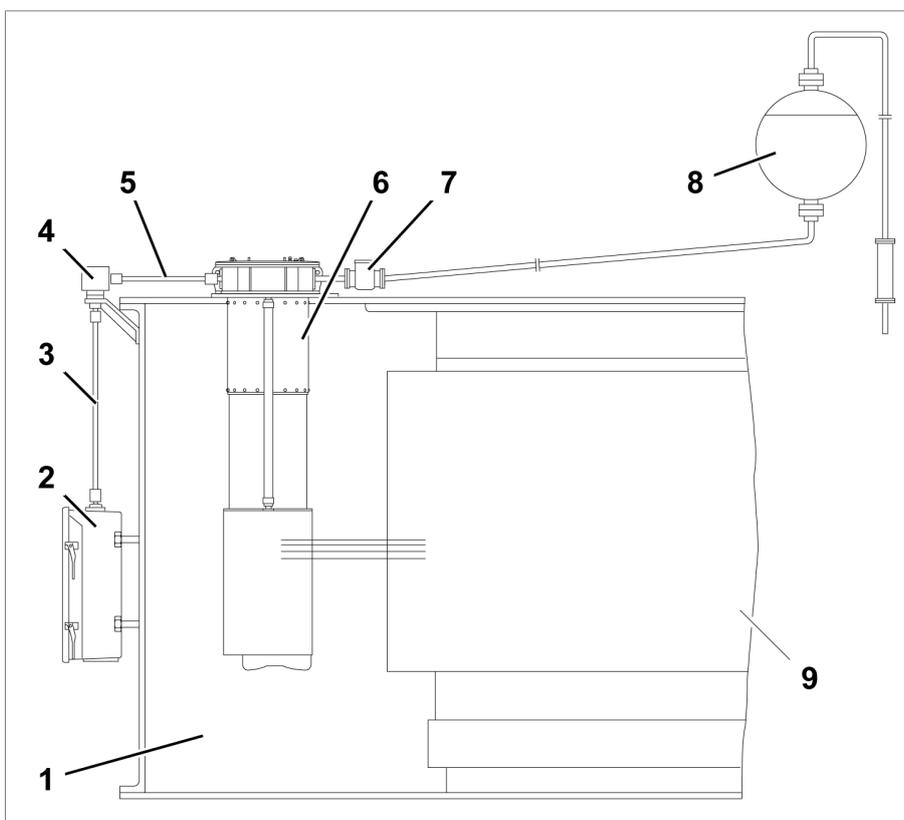


Figure 1: System overview of on-load tap-changer Transformer

1 Transformer tank	2 Motor-drive unit
3 Vertical drive shaft	4 Bevel gear
5 Horizontal drive shaft	6 On-load tap-changer
7 RS protective relay	8 Oil conservator
9 Active part of the transformer	

3.2.2 Design/versions

The on-load tap-changer consists of the on-load tap-changer head, oil compartment with built-in diverter switch insert and the tap selector mounted below (also available with change-over selector on request).

The design and designation of the most important on-load tap-changer components are shown in the installation drawings in the appendix.

For the number of maximum operating positions of the on-load tap-changer, refer to the technical data.

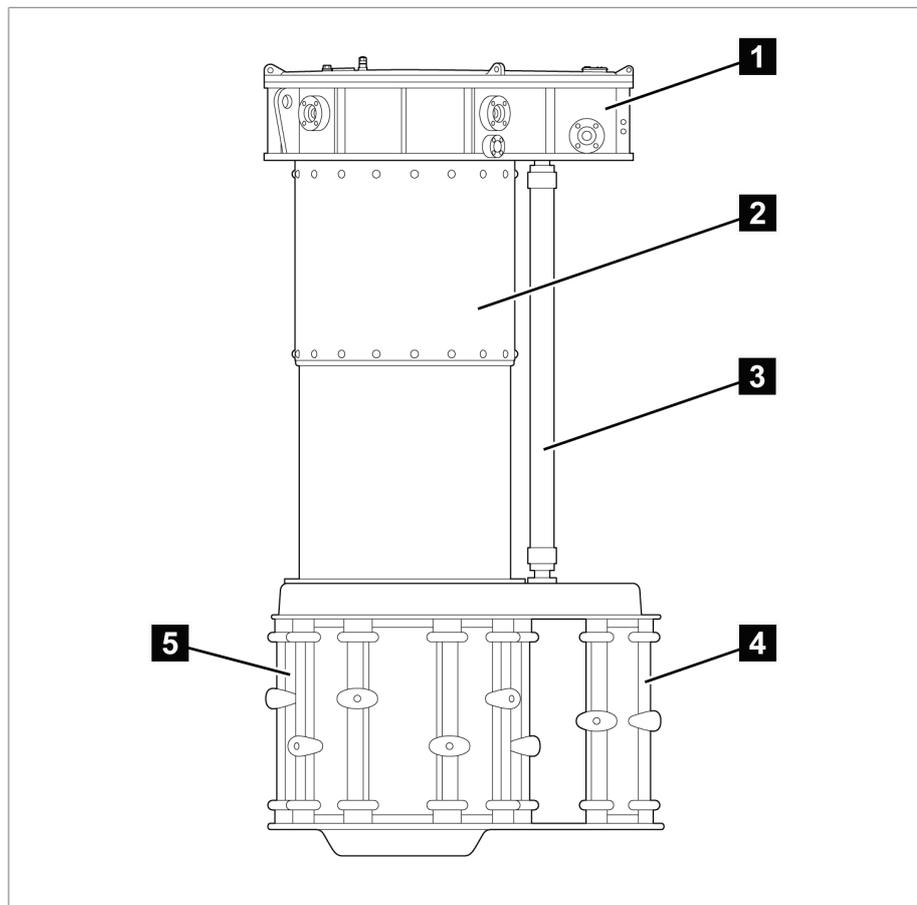


Figure 2: OILTAP® G

1 On-load tap-changer head	2 Oil compartment
3 Selector drive shaft	4 Change-over selector
5 Tap selector	

3.2.2.1 Pipe connections

The on-load tap-changer head features 6 pipe connections for different purposes.

Detailed information about the pipe connections is available in the drawing in the appendix [► Section 11.2, Page 218].

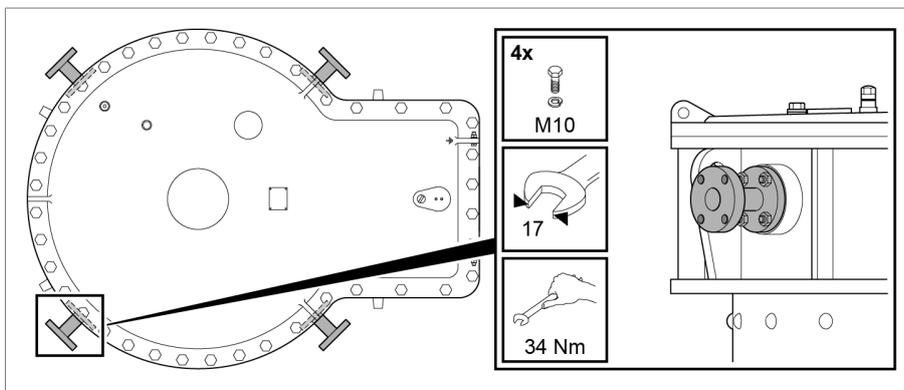


Figure 3: Pipe connections

3.2.3 Name plate

The nameplate is on the on-load tap-changer head cover.

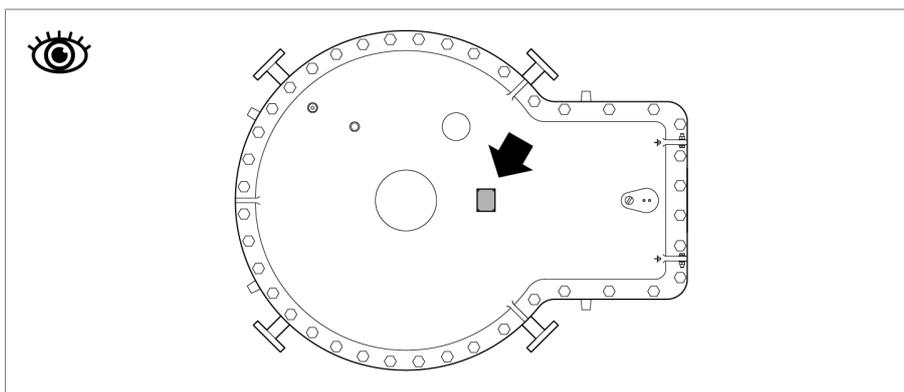


Figure 4: Position of nameplate

3.2.4 Protective devices

The on-load tap-changer is equipped with the following protective devices.

3.2.4.1 Protective relay

3.2.4.1.1 Function description

The protective relay is looped into the circuit breaker tripping circuit. It is tripped when the specified speed of flow from the on-load tap-changer head to the oil conservator is exceeded due to a fault. The flowing insulating fluid actuates the flap valve which tips over into position OFF. The contact in the dry-reed magnetic switch is thereby actuated, the circuit breakers are tripped, and the transformer is de-energized.

The protective relay is a component of an on-load tap-changer filled with insulating fluid and its properties conform to the respective applicable version of IEC publication 60214-1.



Diverter switch operations at rated switching capacity or at permissible overload will not cause the protective relay to trip.



The protective relay responds to flow, not to gas accumulated in the protective relay. It is not necessary to bleed the protective relay when filling the transformer with insulating fluid. Gas accumulation in the protective relay is normal.

3.2.4.1.2 Design/versions

Front view

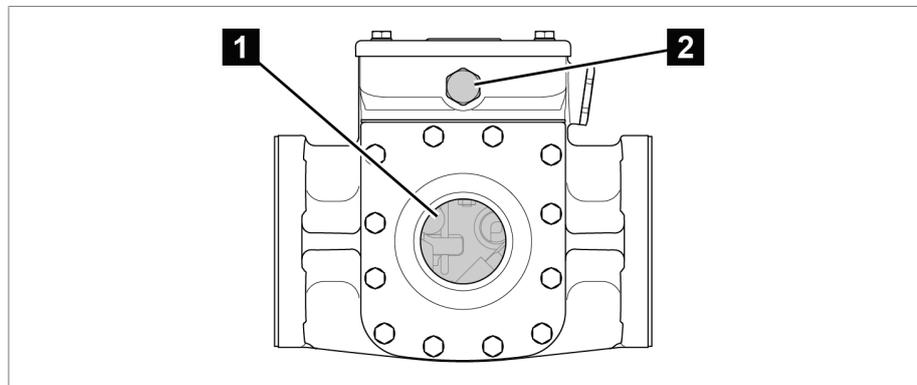


Figure 5: Protective relay RS 2001

1 Inspection window

2 Pressure equalization element

Rear view

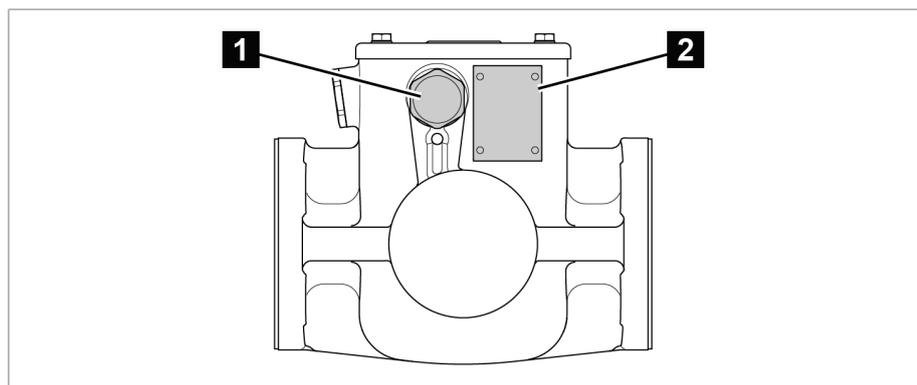


Figure 6: Protective relay RS 2001

1 Dummy plug

2 Nameplate



The protective relay RS 2001/R has an extra inspection window on the rear.

View from above

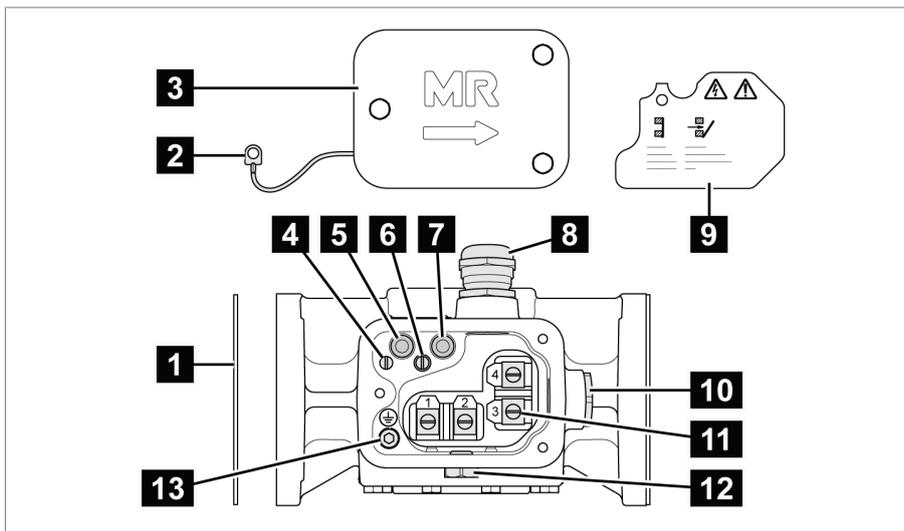


Figure 7: Protective relay RS 2001

1 Gasket	2 Potential tie-in
3 Terminal box cover	4 Slotted head screw for potential tie-in
5 OPERATION (reset) test button	6 Slotted head screw for protective cover
7 OFF (test tripping) test button	8 Cable gland
9 Protective cover	10 Dummy plug
11 Connection terminal	12 Pressure equalization element
13 Cylinder head screw for protective conductor connection	



The protective relays RS 2003 and RS 2004 have a 1/2"-14NPT adapter in place of the cable gland.

3.2.4.1.3 Nameplate

The nameplate is on the back of the protective relay.

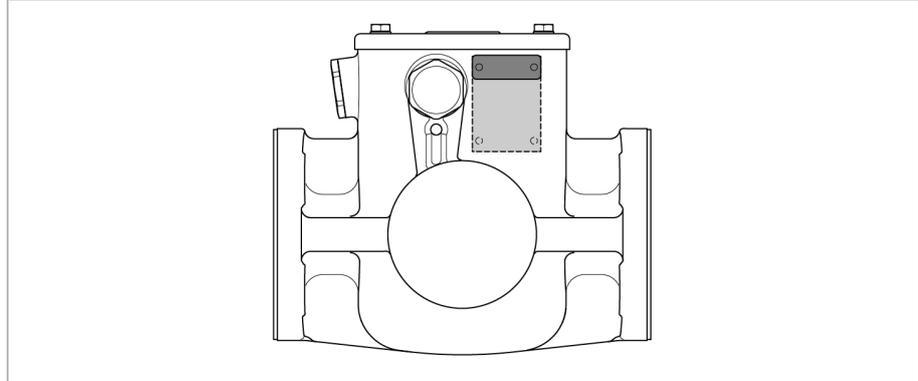


Figure 8: Nameplate

3.2.4.2 Pressure monitoring device DW

3.2.4.2.1 Function description

The DW 2000 pressure monitoring device protects the on-load tap-changer from impermissible pressure increases, contributing to the safety of the transformer. The pressure monitoring device is installed on the outside of the on-load tap-changer and is tripped by impermissible static and dynamic pressures in the on-load tap-changer oil compartment.

The pressure monitoring device uses a concept where a corrugated tube acts as a barometer together with a spring providing counter force. This assembly is mechanically linked to the sensor on the snap-action switch.

The pressure increase activates the sensor on the snap-action switch, which flips into the OFF position. This triggers the circuit breaker and de-energizes the transformer. The sensor on the snap-action switch has to be reset to the initial position by hand after tripping.

Low-energy interference does not cause the pressure monitoring device to trip since the required tripping pressure is not reached. The tripping pressure is set at the factory and prevented from being changed.

The pressure monitoring device responds to large pressure increases faster than the protective relay. The protective relay is part of the standard MR protection system and comes as standard.



Additional use of a pressure monitoring device also requires installation of the provided protective relay.

The features and characteristics of the pressure monitoring device comply with the respective applicable version of IEC publication 60214-1.



Diverter switch operations at the rated switching capacity or permitted overload do not cause the pressure-operated relay to trip.



The pressure-operated relay responds to a pressure change and not to gas accumulation under the pressure-operated relay. Gas accumulation under the pressure-operated relay is normal.

3.2.4.2.2 Design/versions

This chapter gives you an overview of the design of the pressure monitoring device.

For the OILTAP® G, use the pressure monitoring device variant for horizontal mounting.

The pressure monitoring device consists of a pressure measuring element and an adjacent snap-action switch.

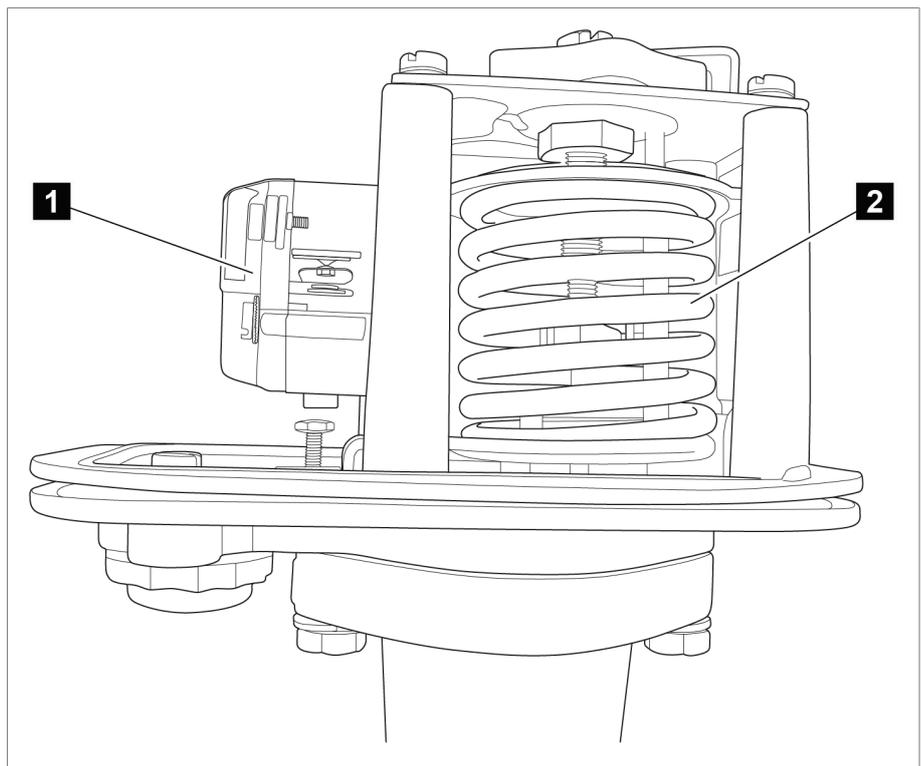


Figure 9: Snap-action switch and pressure measuring element

1 Snap-action switch

2 Pressure measuring element

The snap-action switch has one normally open switch and one normally closed switch with snap actuation.

During operation, the snap-action switch and pressure measuring element are protected by a cover cap. Ventilation is provided on the top of the pressure monitoring device.

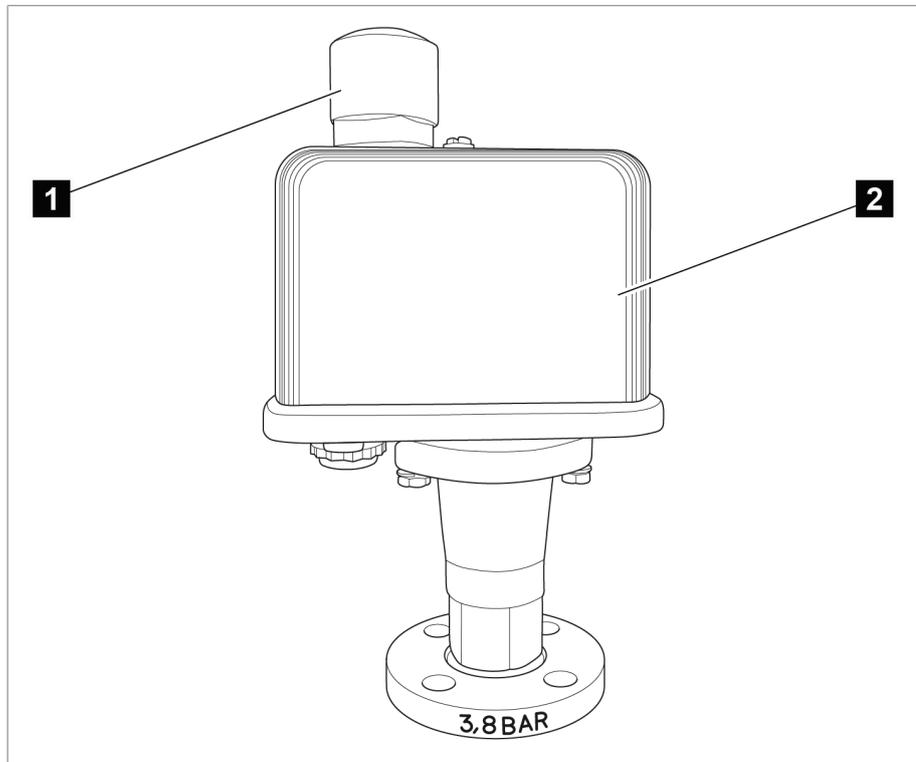


Figure 10: Pressure monitoring device with cover cap and ventilation

1 Ventilation

2 Cover cap

The housing and the cover cap of the pressure monitoring device consist of lightweight, corrosion-resistant metal.



3.3 Drive shaft

3.3.1 Function description

The drive shaft is the mechanical connection between the drive and the on-load tap-changer/de-energized tap-changer.

The bevel gear changes the direction from vertical to horizontal.

Accordingly, the vertical drive shaft has to be mounted between drive and bevel gear, and the horizontal drive shaft between bevel gear and on-load tap-changer or de-energized tap-changer.

3.3.2 Design/versions

The drive shaft consists of a square tube and is coupled at each end by two coupling brackets and one coupling bolt to the driving or driven shaft end of the device to be connected.

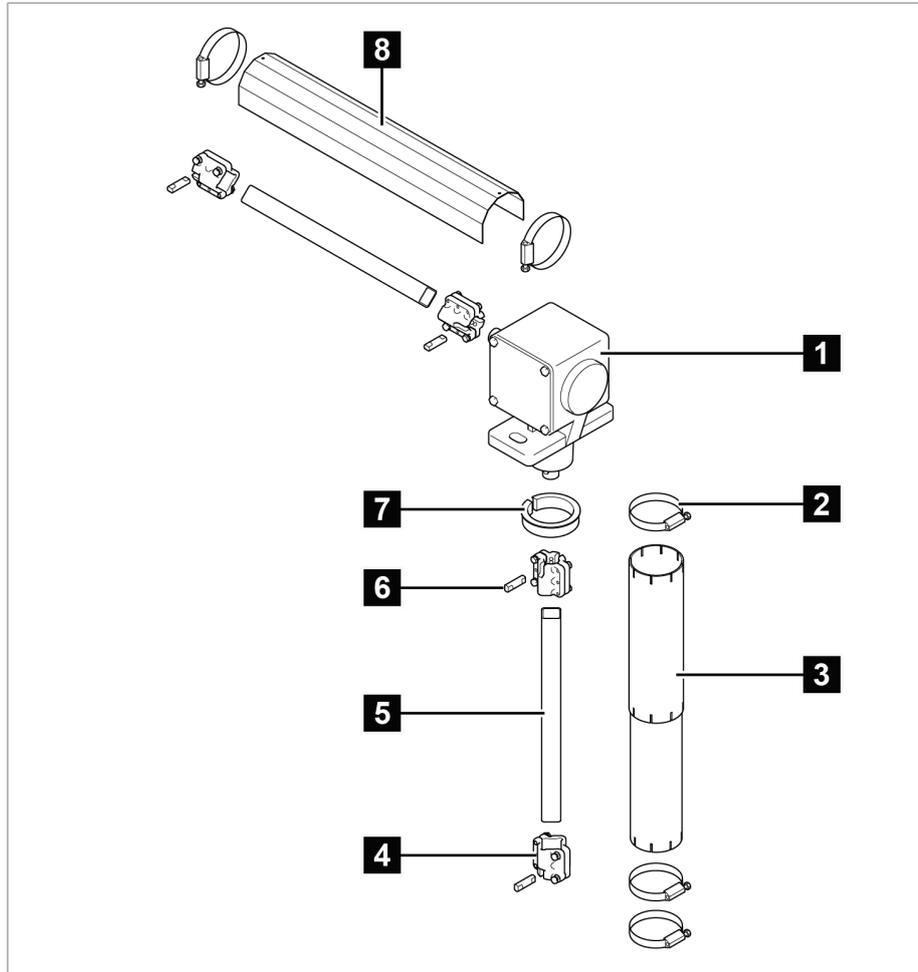


Figure 11: Components of the drive shaft

1 Bevel gear	2 Hose clip
3 Telescopic protective tube	4 Coupling bracket
5 Square tube	6 Coupling bolt
7 Adapter ring	8 Protective cover

3.3.2.1 Drive shaft without cardan joint and without insulator

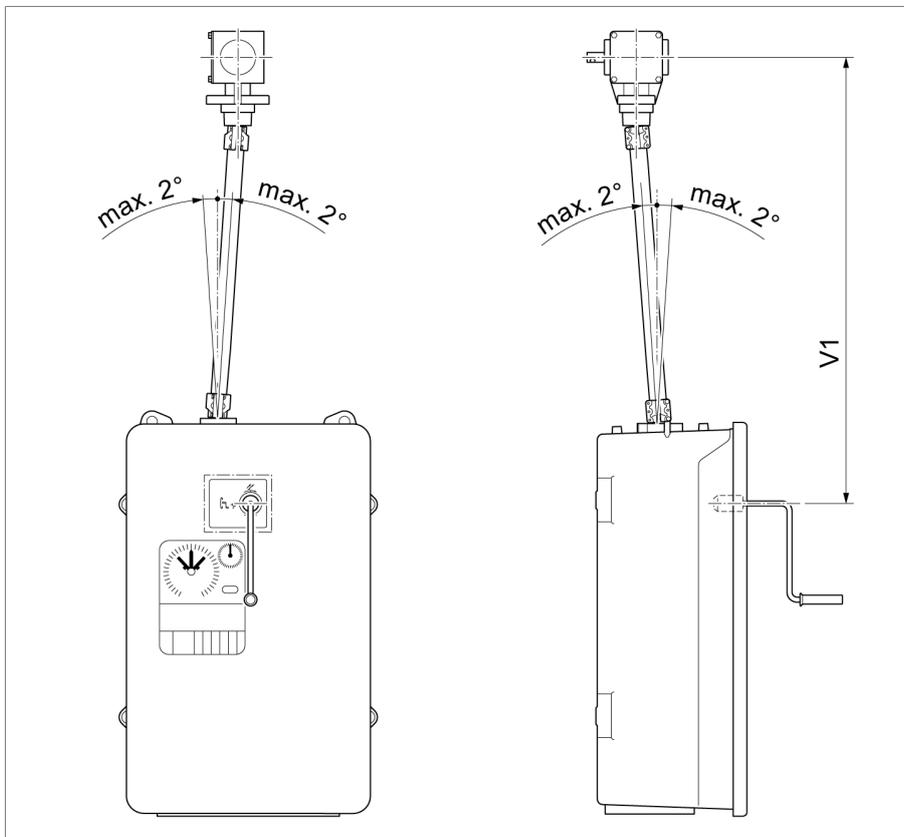


Figure 12: Drive shaft without cardan joint and without insulator (= standard version)

Configuration	V 1 min	Intermediate bearing
Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°)	536 mm	When the maximum value of 2472 mm is exceeded, it is necessary to use an intermediate bearing. V 1 ≤ 2472 mm (without intermediate bearing) V 1 > 2472 mm (with intermediate bearing)

3.3.2.2 Drive shaft without cardan joint and with insulator

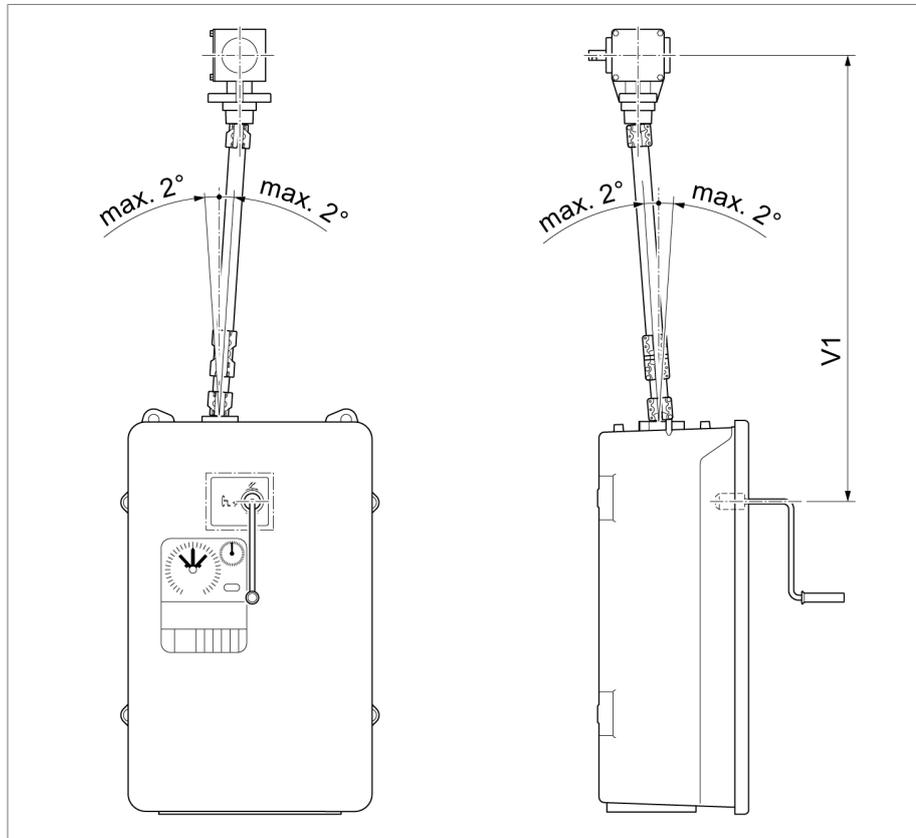


Figure 13: Drive shaft without cardan joint and with insulator (= special model)

Configuration	V 1 min	Intermediate bearing
Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°)	706 mm	When the maximum value of 2472 mm is exceeded, it is necessary to use an intermediate bearing. V 1 ≤ 2472 mm (without intermediate bearing) V 1 > 2472 mm (with intermediate bearing)

3.3.2.3 Drive shaft with cardan joints, without insulator

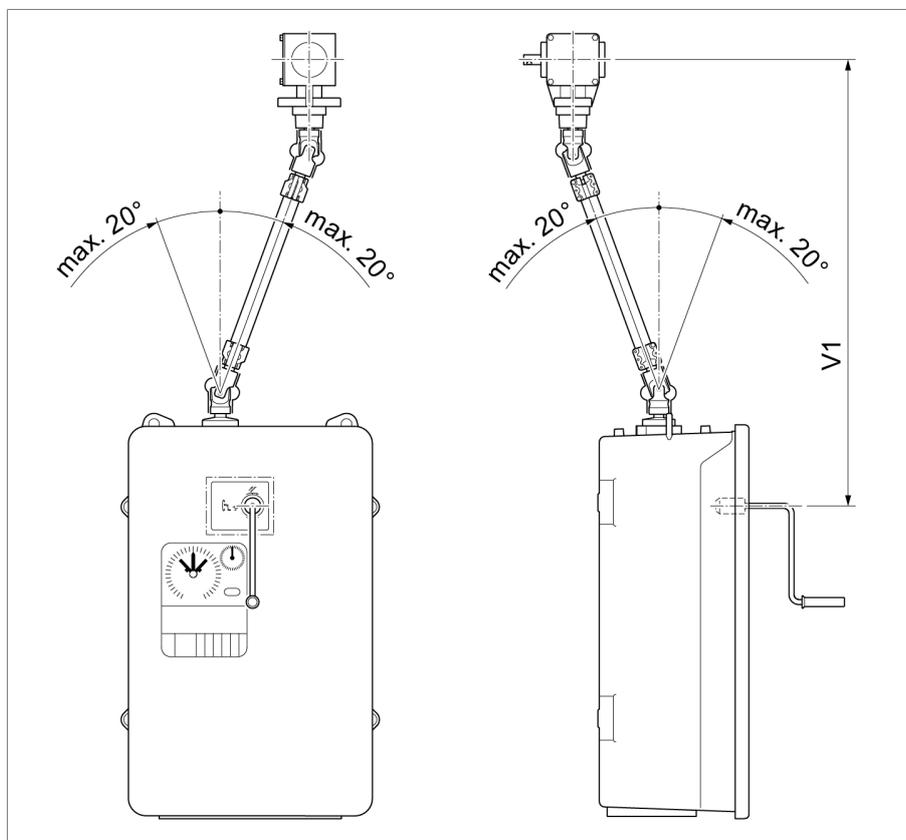


Figure 14: Drive shaft with cardan joints, without insulator (= special model)

Configuration	V 1 min [mm]	Intermediate bearing for [mm]
Middle of hand crank – middle of bevel gear (maximum permissible axial offset 20°)	798	V 1 > 2564

3.3.2.4 Drive shaft with cardan joints, with insulator

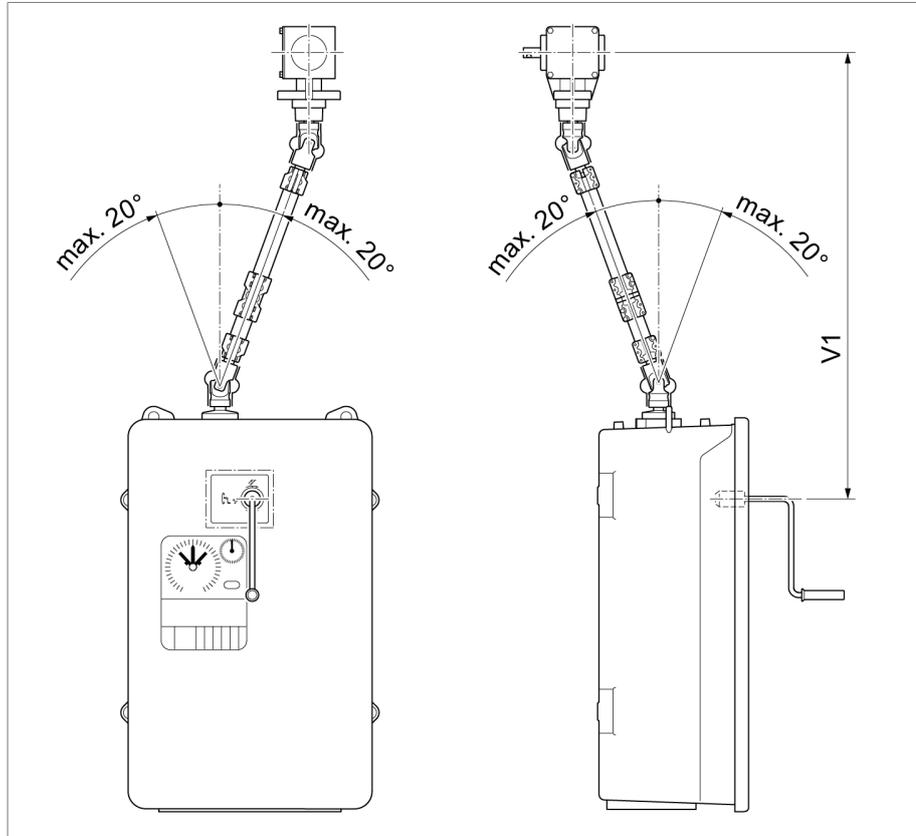


Figure 15: Drive shaft with cardan joints, with insulator (= special model)

Configuration	V 1 min [mm]	Intermediate bearing for [mm]
Middle of hand crank – middle of bevel gear (maximum permissible axial offset 20°)	978	V 1 > 2772



3.4 OF 100 Oil Filter Unit

The purpose of the OF 100 oil filter unit is to clean the on-load tap-changer's insulating fluid with the paper filter insert and to clean and dry the fluid with the combined filter insert.

For on-load tap-changers where the number of tap-change operations per year is higher than 15,000, we recommend the use of the OF 100 oil filter unit with paper filter insert. This can extend the intervals between maintenance.

For more information, consult the MR operating instructions "OF 100 oil filter unit".

You must use the OF 100 oil filter unit with combined filter insert for OILTAP® G on-load tap-changers where $U_m > 245$ kV (insulated to ground).



4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with sealed packaging and sometimes in a dry state, depending on requirements.

Sealed packaging surrounds the packaged goods with plastic foil on all sides.

Products that have also been dried are identified by a yellow label on the sealed packaging. In the dry state, delivery is also possible in a transport container.

The information in the following sections should be applied as appropriate.

4.1.1 Suitability

NOTICE

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods.

- ▶ The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.
- ▶ General rule: Do not stack crates above a height of 1.5 m.
- ▶ For other crates: Only stack up to 2 equally sized crates on top of one another.

The packaging is suitable to ensure undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a sturdy crate. This crate ensures that, when in the intended transportation position, the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.

Sealed packaging surrounds the packaged goods with plastic foil on all sides. The packaged goods are protected from humidity using a desiccant. The plastic foil was bonded after the desiccant is added.



4.1.2 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

Table 4: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

▲ WARNING



Danger of death or severe injury!

Danger of death or serious injuries due to tipping or falling load.

- ▶ Only transport the crate when closed.
- ▶ Do not remove the securing material used in the crate during transport.
- ▶ If the product is delivered on a pallet, secure it sufficiently.
- ▶ Only trained and authorized persons may select the sling gear and secure the load.
- ▶ Do not walk under the suspended load.
- ▶ Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or is subject to an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type

The checks must take place after unloading when the crate or transport container can be accessed from all sides.

Visible damage If external transport damage is found upon receipt of the shipment, proceed as follows:

- Immediately record the identified transport damage in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the manufacturer and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately on site together with the carrier involved. This is essential for any claim for damages.
- Photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- **NOTICE!** Damage to packaged goods due to damaged sealed packaging. If the product is delivered in sealed packaging, check the sealed packaging immediately. If the sealed packaging is damaged, do not under



any circumstances install or commission the packaged goods. Either re-dry the dried packaged goods as per the operating instructions, or contact the manufacturer to agree on how to proceed.

- Identify the damaged parts.

Hidden damage When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

4.3 Storage of shipments

Packaged goods dried by Maschinenfabrik Reinhausen

Upon receipt of the shipment, immediately remove the packaged goods dried by Maschinenfabrik Reinhausen from the sealed packaging and store air-tight in dry insulating fluid until used if the packaged goods were not supplied in insulating fluid.

Non-dried packaged goods

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.



If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

- Correctly regenerate the drying agent and restore the sealed packaging.
- Unpack the packed goods and store in a suitable storage space (well ventilated, as dust-free as possible, humidity < 50% where possible).

4.4 Unpacking shipments and checking for transportation damages

- **NOTICE!** Damage to packaged goods due to ineffectively sealed packaging. Transport the packaged crate to the place where the packaged goods are to be installed. Do not open the sealed packaging until just before installation.
- **▲ WARNING!** Serious injuries and damage to the packaged goods due to the packaged goods tipping out. Place the packaged goods in an upright crate and protect it from tipping out.
- Unpack the packaged goods and check the condition.
- Check the completeness of the accessories kit using the delivery slip.

5 Mounting

▲ WARNING



Risk of crushing!

When the on-load tap-changer undertakes a tap-change operation, components – some of which are freely accessible – move on the selector, change-over selector, and potential connection unit. Reaching into the selector, change-over selector, or potential connection unit during a tap-change operation may result in serious injuries.

- ▶ Keep at a safe distance of at least 1 m during tap-change operations.
- ▶ Do not reach into the selector, change-over selector, or potential connection unit during tap-change operations.
- ▶ Do not switch the on-load tap-changer during work on the selector, change-over selector, or potential connection unit.

5.1 Preparatory work

A mounting flange is required for fitting the on-load tap-changer head on the transformer cover.

To fasten the mounting flange to the transformer cover, proceed as follows:

1. Produce your own mounting flange as shown in the corresponding drawing in the appendix [▶ Section 11.1, Page 217].
2. Use the tracing template [▶ Section 11.6, Page 223] (available on request) to fit the stud bolts on the mounting flange.
3. **NOTICE!** Fit mounting flange on transformer cover (pressure-tight). Ensure that the sealing surface makes complete contact and is not damaged.

5.2 Installing the on-load tap-changer in the transformer (standard version)

5.2.1 Fastening on-load tap-changer to transformer cover

5.2.1.1 Lifting the on-load tap-changer head off the oil compartment

Proceed as follows to lift the on-load tap-changer head off the oil compartment:

1. **⚠ WARNING!** Place the oil compartment on a level surface and secure it against tipping. An unstably positioned oil compartment may tip over, resulting in injuries and property damage.
2. Remove nuts, screws and locking elements from the on-load tap-changer head cover.

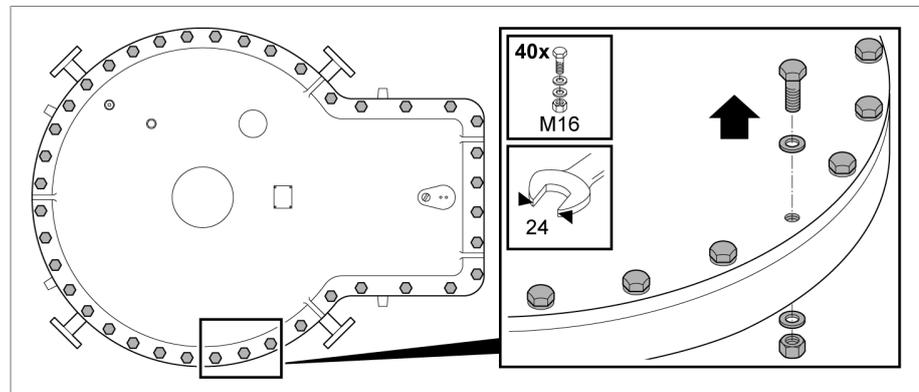


Figure 16: On-load tap-changer head cover

3. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer dam-

age. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

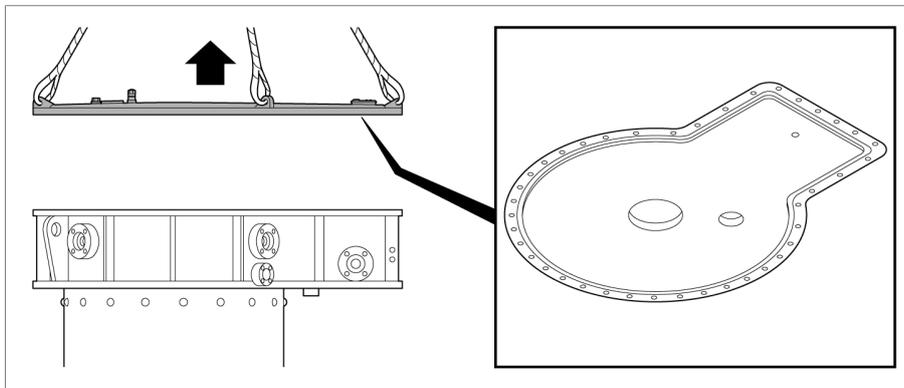


Figure 17: On-load tap-changer head cover

4. Remove screws from the oil suction pipe and pull the oil suction pipe down to remove it. Store the screws to be used for subsequent oil suction pipe fastening.

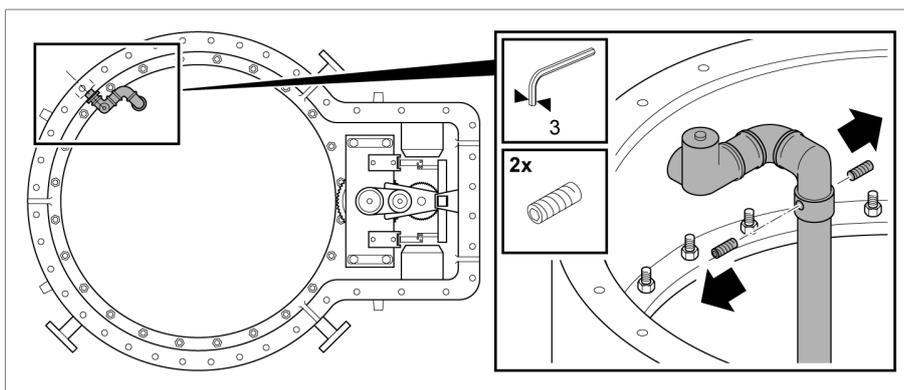


Figure 18: Oil suction pipe

5. **NOTICE!** Remove nuts and locking elements in the on-load tap-changer head. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

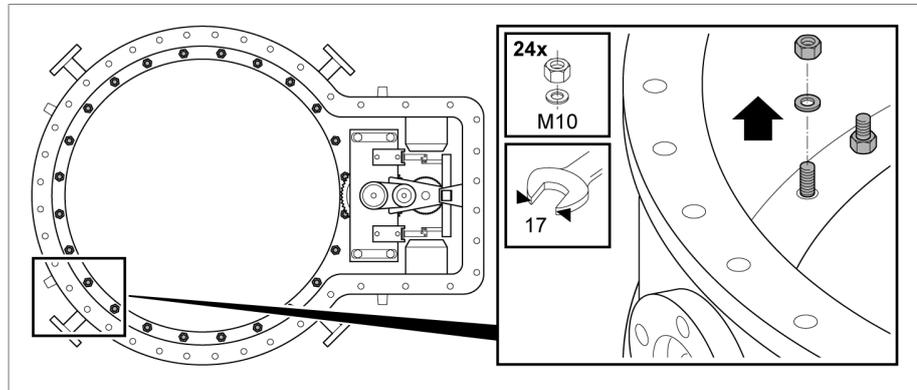


Figure 19: On-load tap-changer head

6. **NOTICE!** Lift the on-load tap-changer head off the oil compartment. For all work, check that the sealing surfaces on the on-load tap-changer head and oil compartment flange, and the gasket between the on-load tap-changer head and oil compartment, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage.

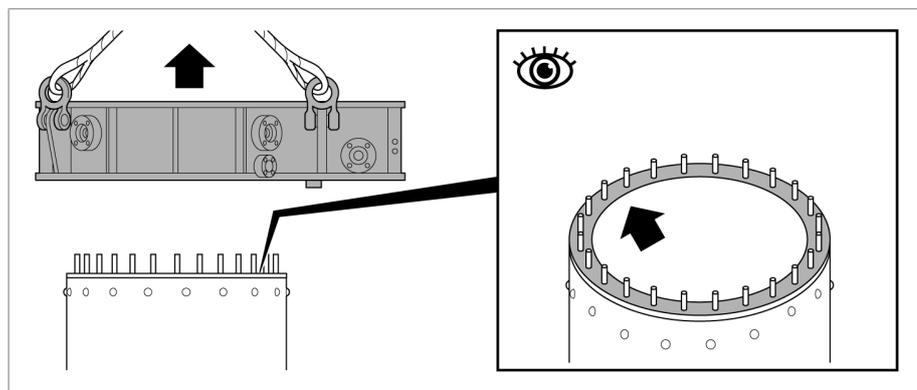


Figure 20: On-load tap-changer head

5.2.1.2 Fastening the on-load tap-changer head to the transformer cover

1. Clean sealing surfaces on mounting flange and on-load tap-changer head, place the provided gasket on mounting flange. For on-load tap-changer heads with O-rings, insert the O-ring into the groove in the on-load tap-changer head.

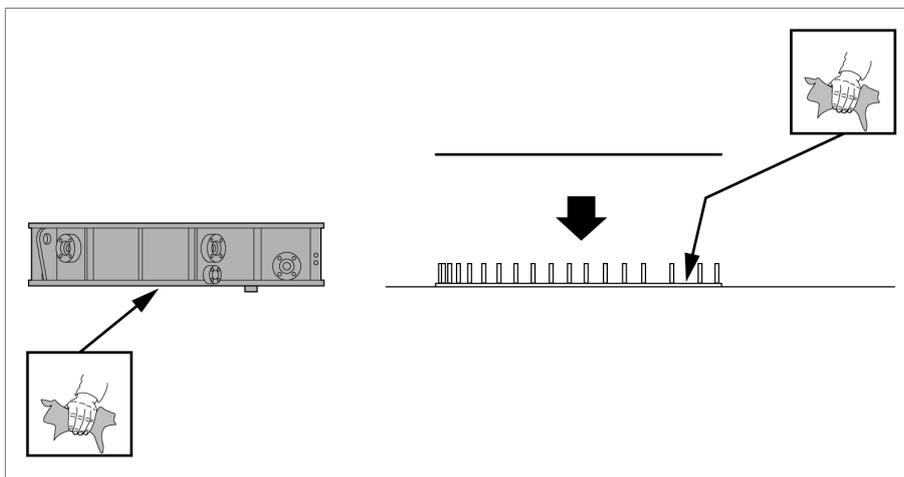


Figure 21: Mounting flange and on-load tap-changer head

2. Position the on-load tap-changer head on the mounting flange.

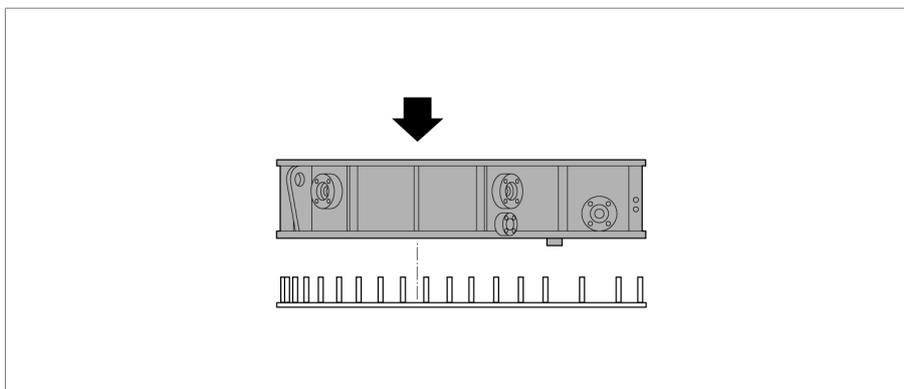


Figure 22: On-load tap-changer head

3. Screw on-load tap-changer head to mounting flange.

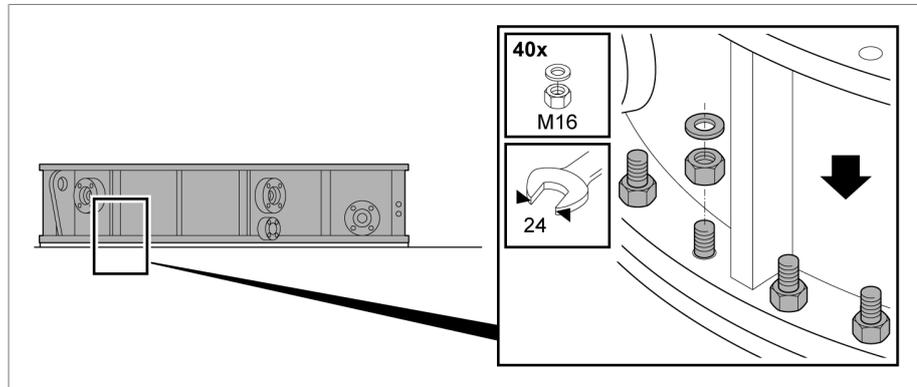


Figure 23: Screwing down on-load tap-changer head

5.2.1.3 Securing selector on oil compartment

1. **⚠ CAUTION!** Leave the selector on the base plate of the delivery box, place this on a level surface and secure it against tipping. An unstably positioned selector may tip, resulting in injuries and property damage.
2. Remove nuts and locking elements from the selector suspension screws.

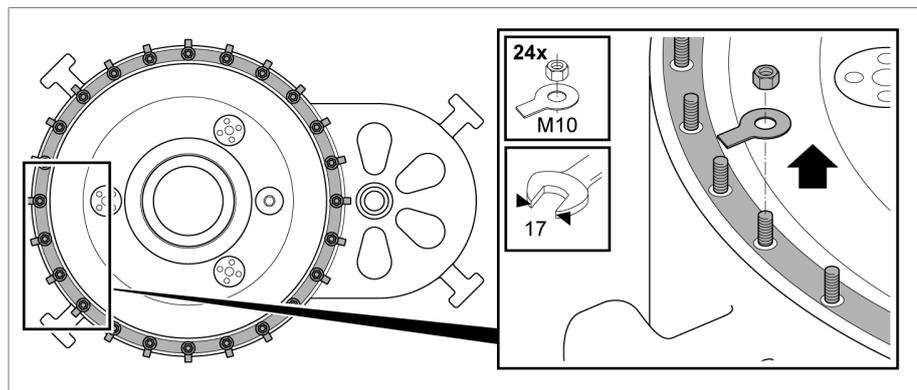


Figure 24: Nuts and lock tabs

3. Clean the gasket and sealing surfaces on the selector.

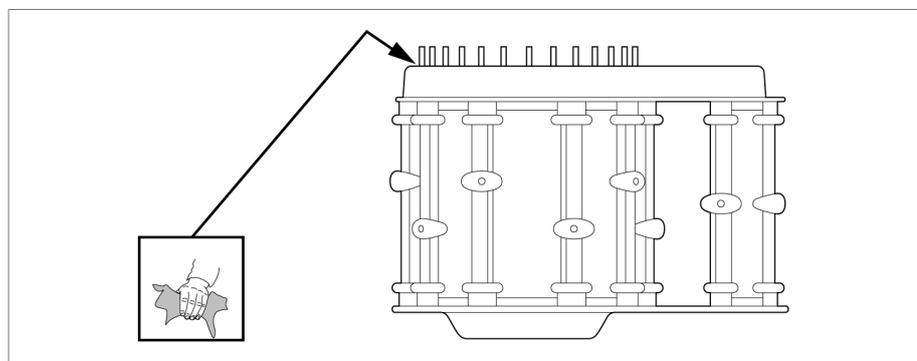


Figure 25: Gasket on selector

- Place the selector drive shaft (arrow facing down) on the end of the selector shaft. A groove in the end of the shaft and a locating pin in the selector drive shaft only allow for assembly in the correct position.

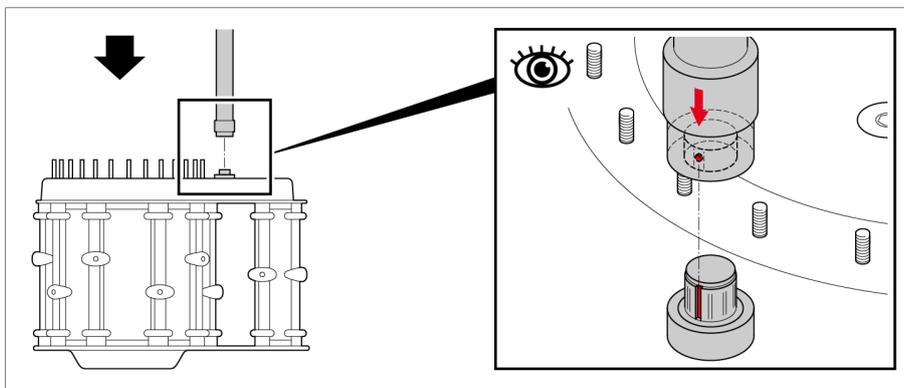


Figure 26: Drive shaft on selector

- Clean the gasket and sealing surfaces on the upper and lower oil compartment flanges.

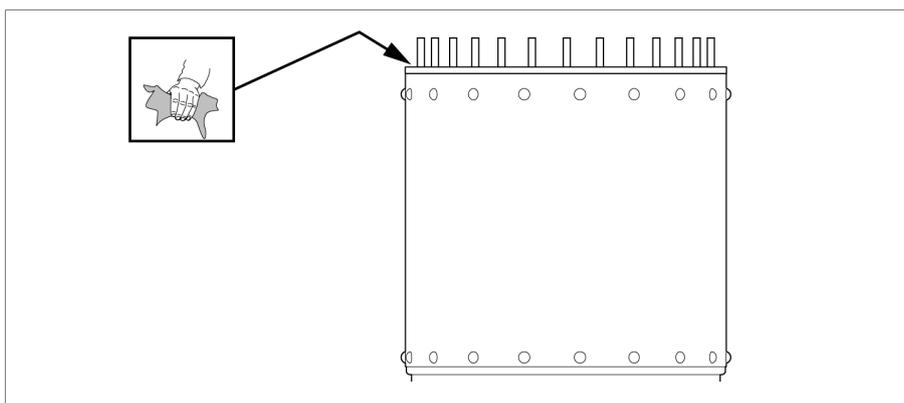


Figure 27: Gasket on oil compartment flange

6. Insert the lifting traverse into the oil compartment.

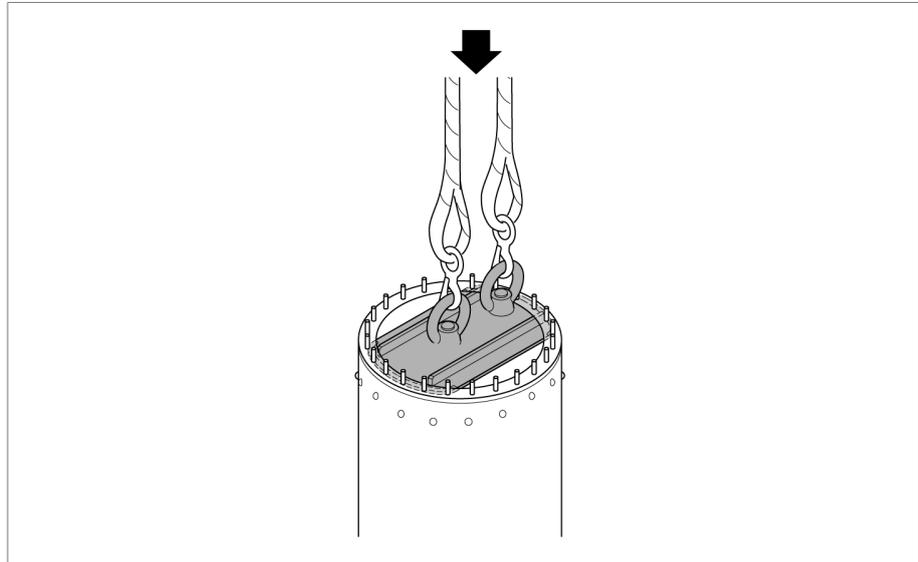


Figure 28: Lifting traverse

7. Carefully raise the oil compartment above the selector and ensure that the selector suspension screws match the through-holes in the lower oil compartment flange.

8. **NOTICE!** Lower the oil compartment slowly and in an upright position and align it such that the red 0 mark on the lower oil compartment flange is directly across from the selector drive shaft. Ensure that the oil compartment does not damage the selector drive shaft.

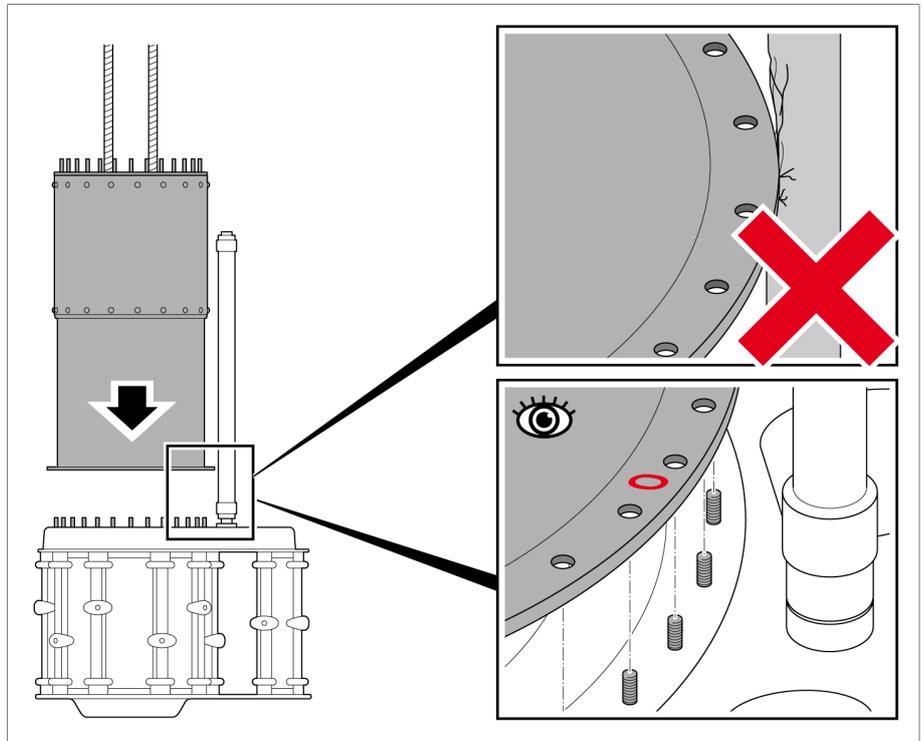


Figure 29: Aligning the oil compartment

9. Screw selector onto oil compartment. Secure the nuts to prevent them from turning.

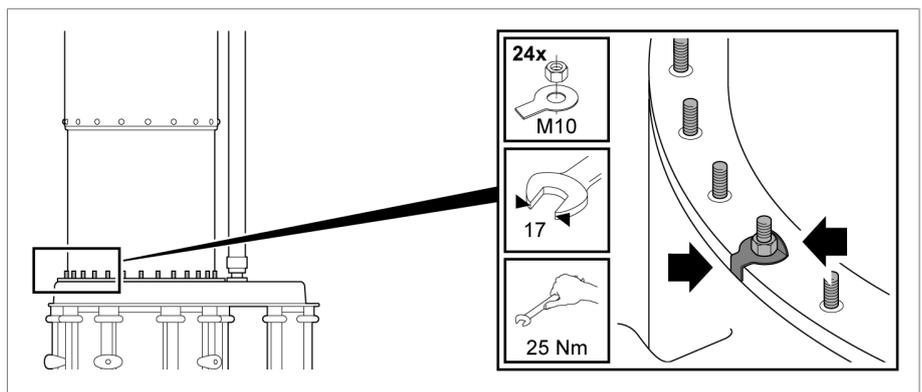


Figure 30: Oil compartment on selector

5.2.1.4 Connecting the oil compartment and selector with the on-load tap-changer head

1. **NOTICE!** Lift the oil compartment with selector attached below using only the specified lifting traverse.

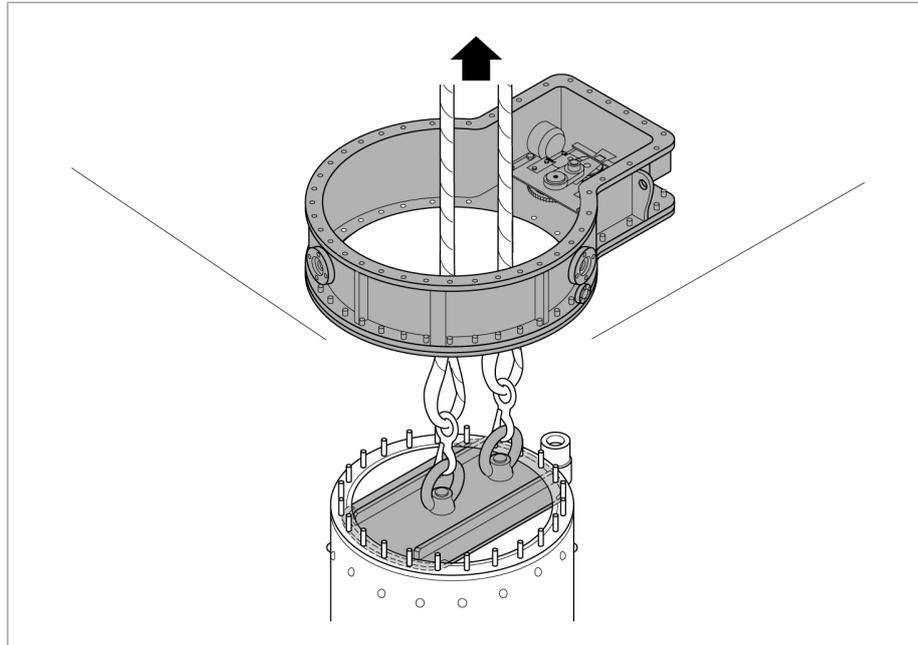


Figure 31: Lifting traverse

2. **NOTICE!** Couple the drive shaft in the on-load tap-changer head with the selector drive shaft. When doing so, ensure that the drive shaft does not collide with the transformer cover. A groove in the drive shaft and a locating pin in the selector drive shaft only allow for assembly in the correct position.

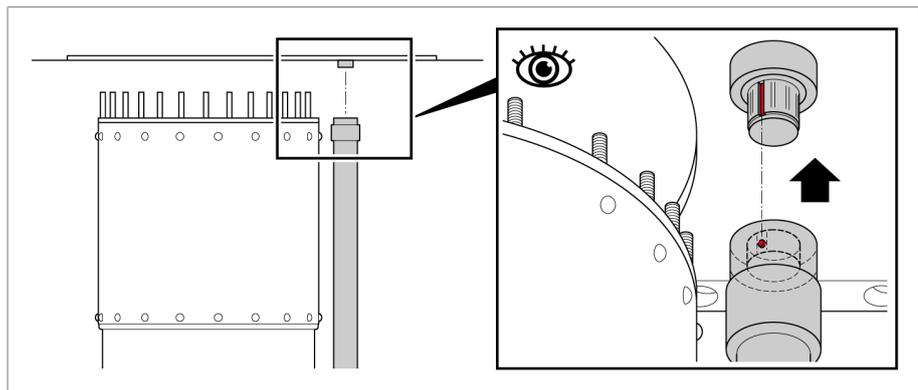


Figure 32: Selector drive shaft

3. **NOTICE!** Fasten the on-load tap-changer head to the oil compartment using only the new locknuts provided in the scope of delivery.

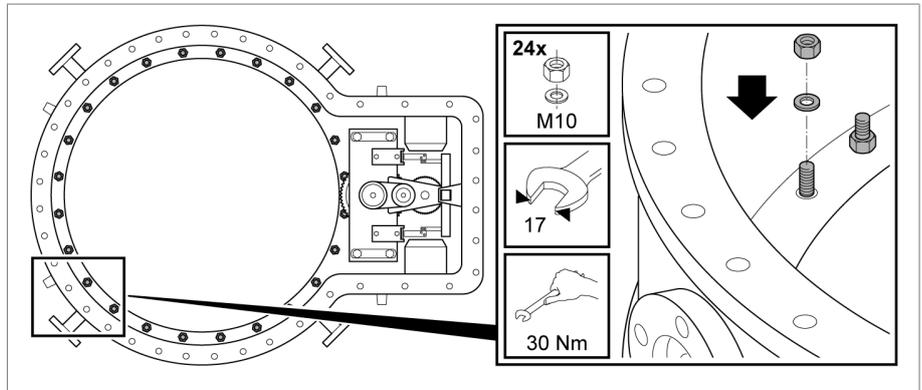


Figure 33: Fastening the on-load tap-changer head to the oil compartment

4. Remove lifting traverse.
5. Insert the oil suction pipe into the oil compartment and connect it to the clamping sleeve at the bottom of the oil compartment.

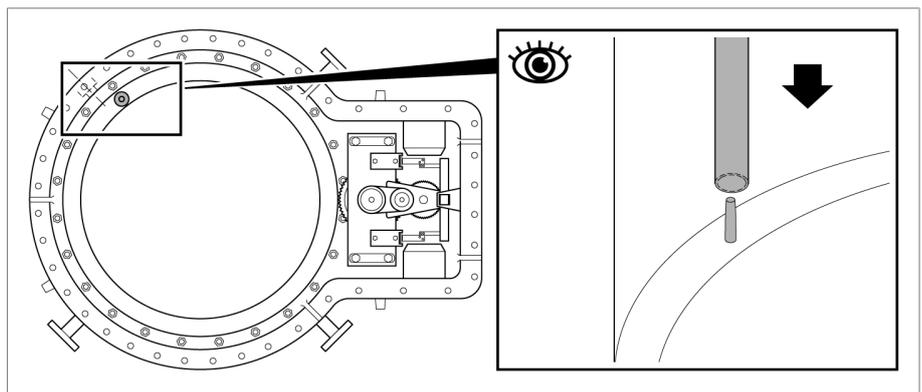


Figure 34: Clamping sleeve

6. Fasten the oil suction pipe to the oil suction pipe manifold.

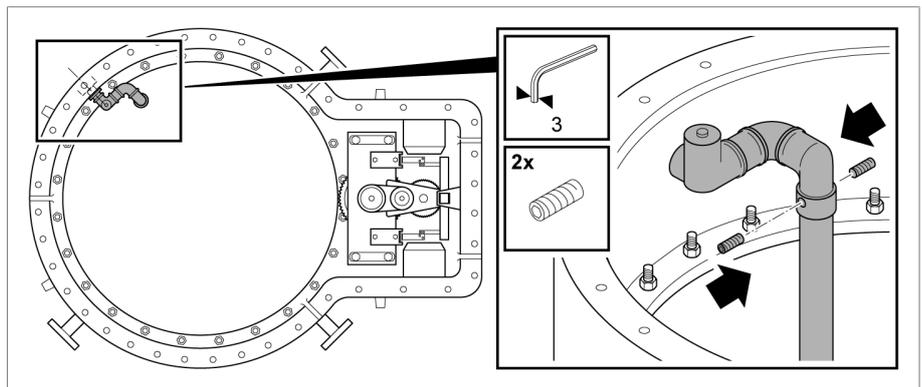


Figure 35: Oil suction pipe

5.2.1.5 Inserting the diverter switch insert into the oil compartment

1. **⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
2. Remove nuts and locking elements on the 3 bearing bolts in the on-load tap-changer head.

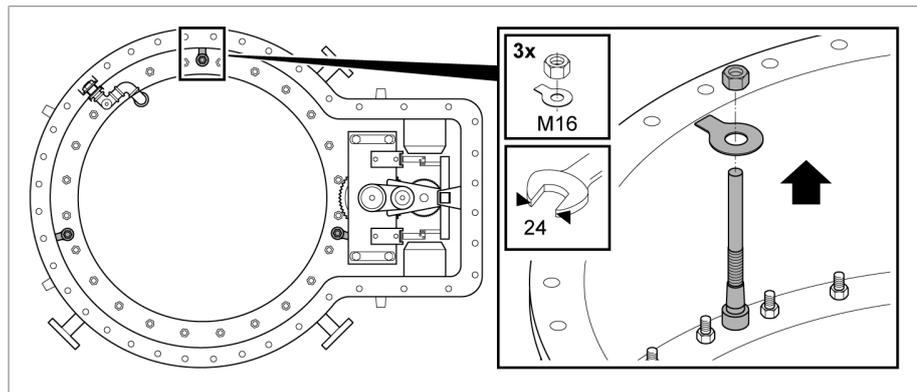


Figure 36: Bearing bolts

3. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
4. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

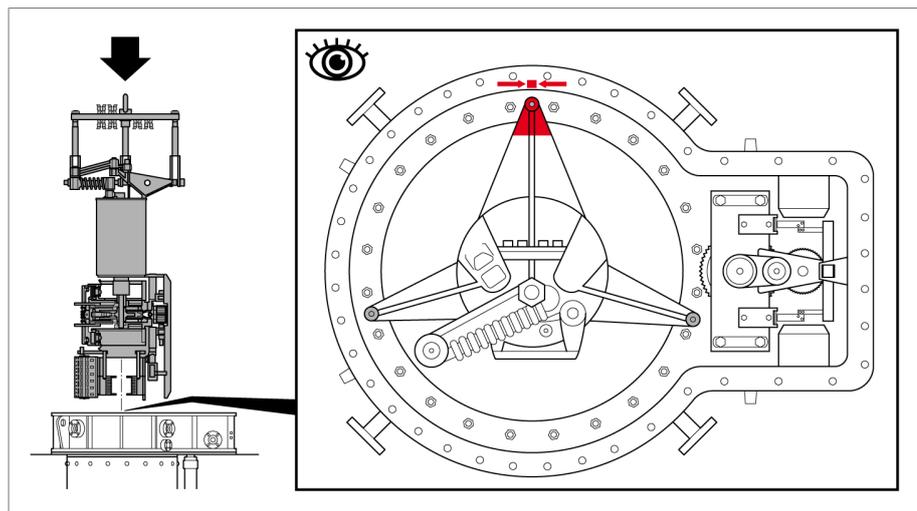


Figure 37: Inserting diverter switch insert

5. Fasten the diverter switch insert to the 3 bearing bolts. Secure the nuts to prevent them from turning.



Do not fasten the nuts until drying is complete if the on-load tap-changer is to be dried later using kerosene and the diverter switch insert has to be removed and reinserted to open and close the kerosene drain plug.

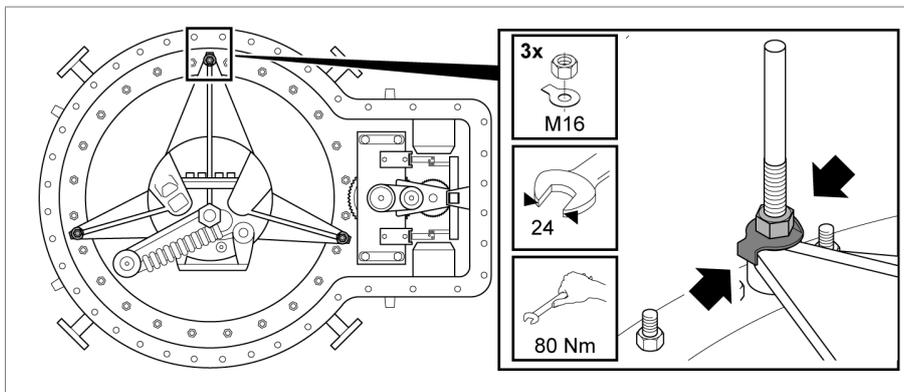


Figure 38: Fastening the diverter switch insert

6. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

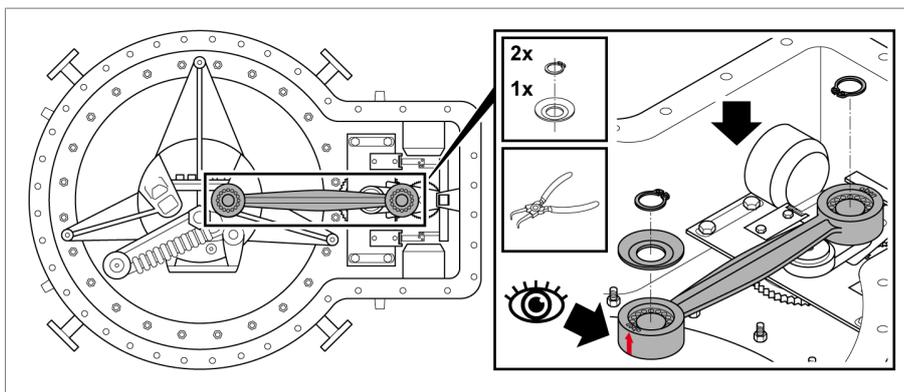


Figure 39: Fastening the coupling rod

7. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

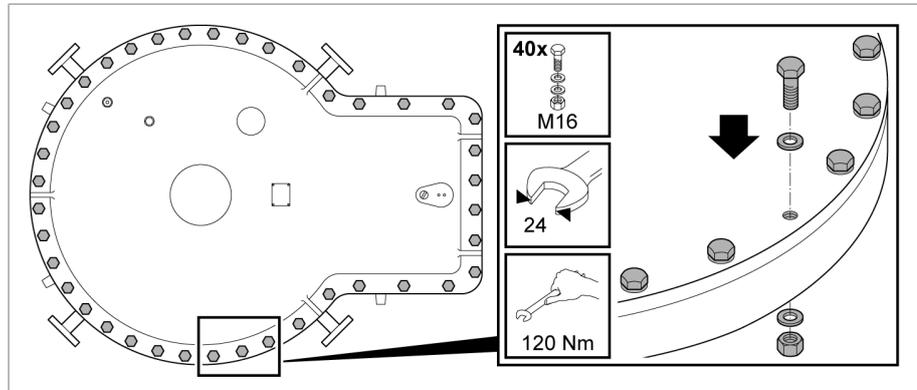


Figure 40: On-load tap-changer head cover

5.2.1.6 Removing the transport feet and transport locks

Remove the transport locks mentioned below and the transport feet from the selector before performing further work.

1. If present, remove the transport feet from the selector.

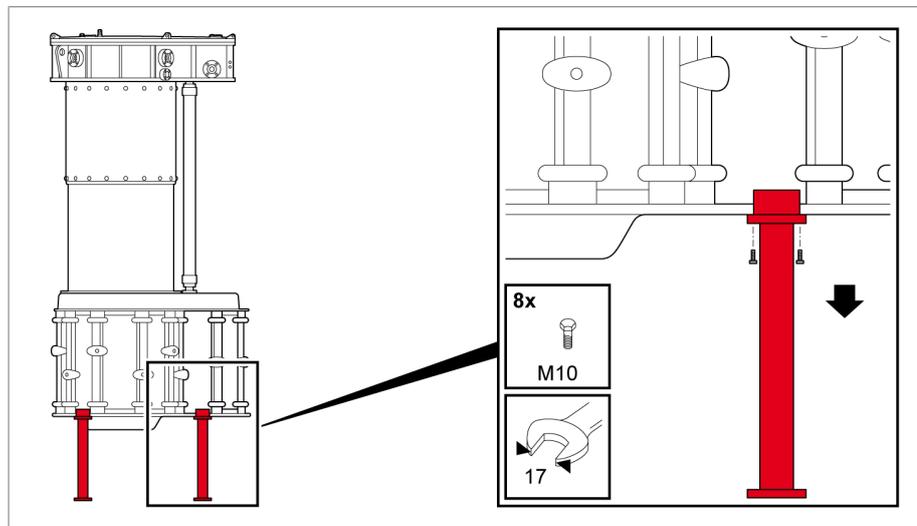


Figure 41: Removing transport feet

2. Remove the blocking bracket from the drive shaft of the on-load tap-changer head.

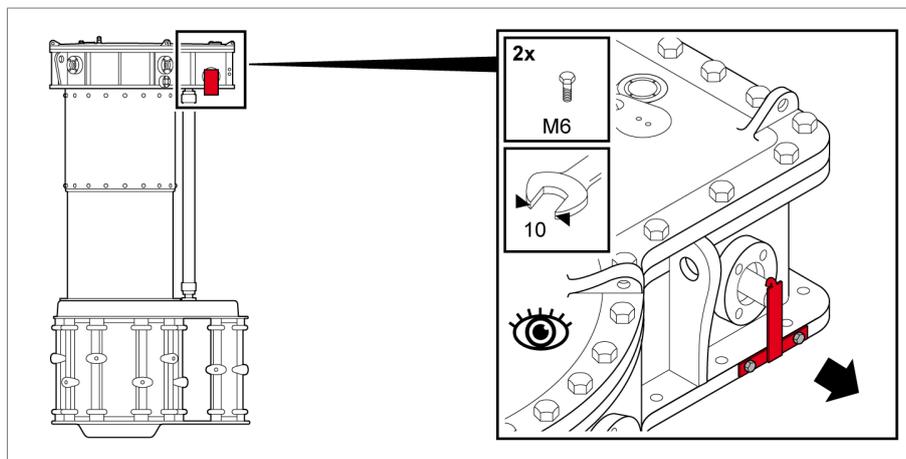


Figure 42: Blocking bracket

3. Remove the lower blocking pin from the selector drive shaft.

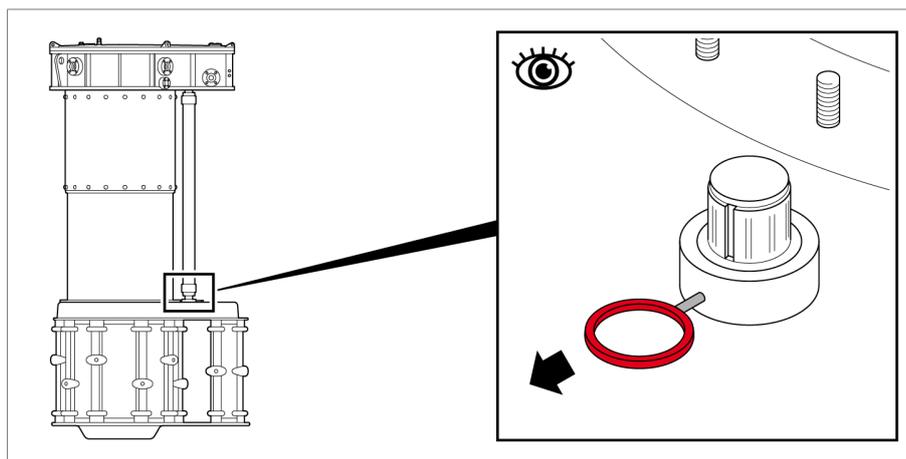


Figure 43: Blocking pin on the lower selector drive shaft

4. Remove the blocking strip from the change-over selector.

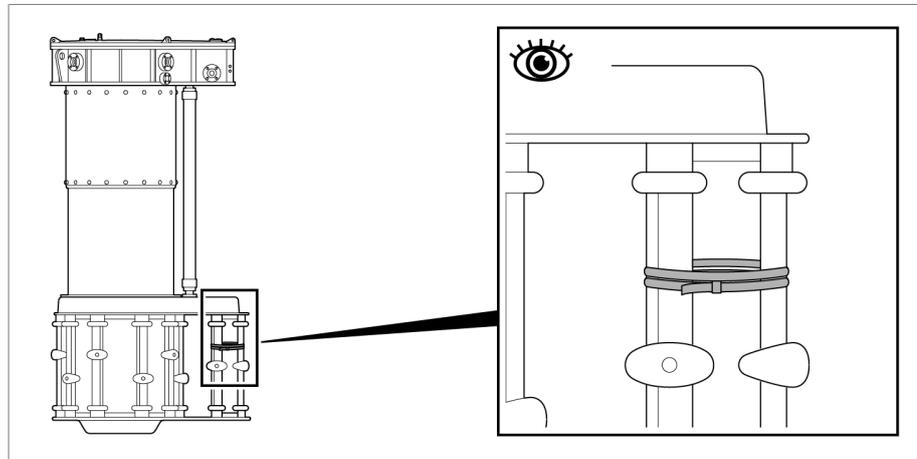


Figure 44: Removing the blocking strip from the change-over selector

5.2.2 Connecting tap winding and on-load tap-changer take-off lead

NOTICE

Damage to the on-load tap-changer!

Connecting leads that place mechanical strain on the on-load tap-changer will damage the on-load tap-changer.

- ▶ Establish connections carefully.
- ▶ Do not twist connection contacts.
- ▶ Connect connecting leads without warping or deforming.
- ▶ If necessary, use an expansion loop for connecting leads.
- ▶ Fit screening caps provided to screw connections.

Connect tap winding and on-load tap-changer take-off lead in accordance with the connection diagram included with the delivery.

5.2.2.1 Connecting the tap winding

The selector's connection contacts are indicated on the selector bars. The connection contacts are equipped with connecting pieces that, depending on the order, are designed for a soldered connection, a screw connection or a combined screw/soldered connection. You can find more information on connecting pieces in the appendix [► Section 11.5, Page 221].

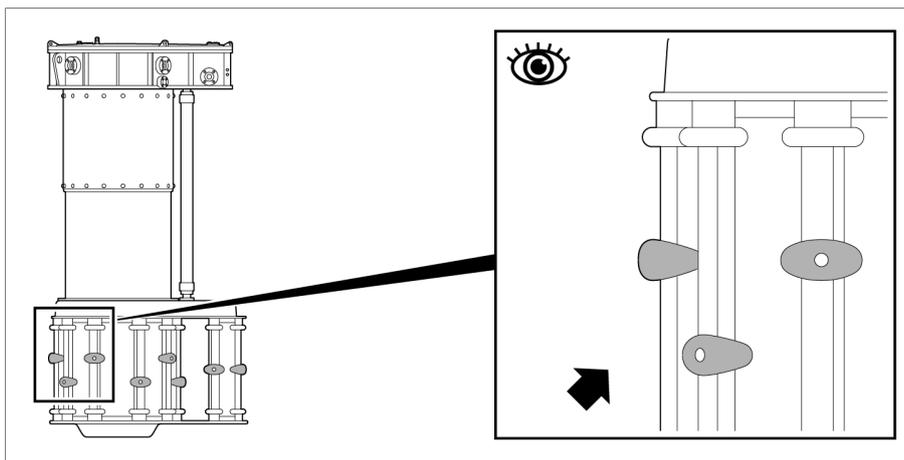


Figure 45: Connection contacts on the selector

5.2.2.2 Connecting on-load tap-changer take-off lead

The **neutral terminal** on the OILTAP® G III 1602 and OILTAP® G III 2002 is located on the lower oil compartment flange, which features a total of 6 M12 tapped holes.

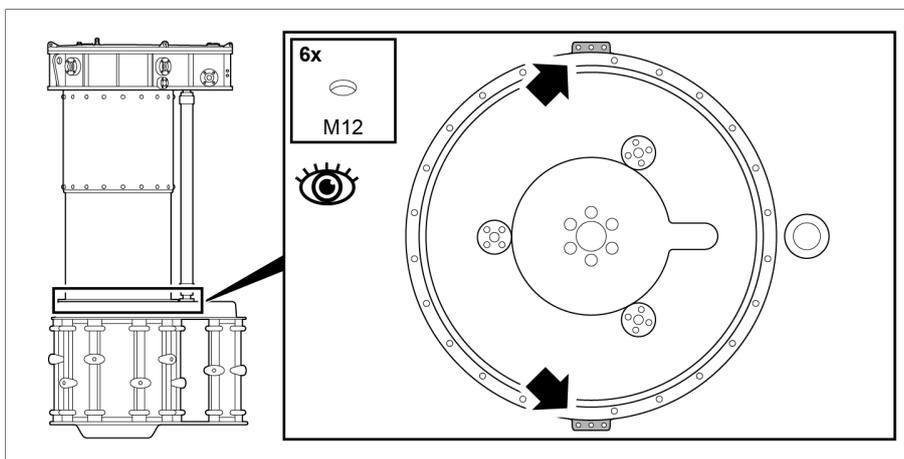


Figure 46: Neutral terminal

In contrast, on the OILTAP® G I 1602, OILTAP® G I 1612, OILTAP® G I 1622, G I 3002 and OILTAP® G I 3022, the **on-load tap-changer take-off lead** is connected to a special take-off lead connection underneath the selector base.

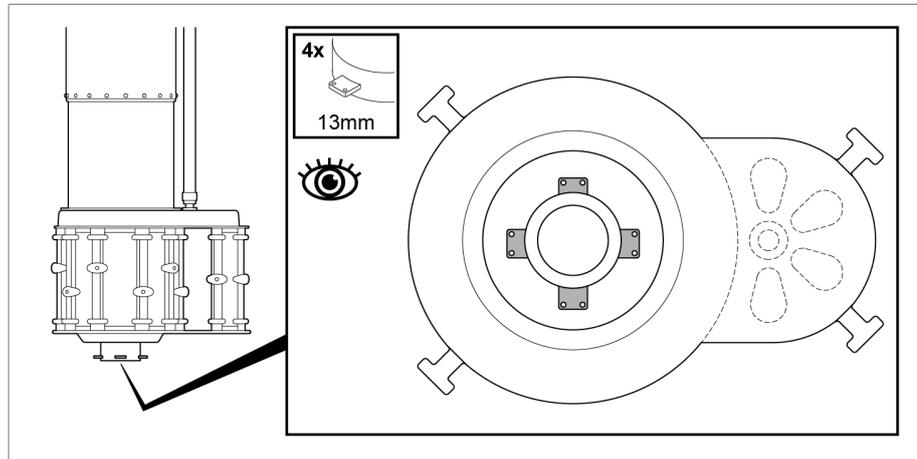


Figure 47: Take-off connection lead underneath the selector

On-load tap-changers with tie-in switches feature a special connection for the on-load tap-changer take-off lead (see order-related dimensional drawing).

5.2.3 Carrying out transformer ratio test before drying

To actuate the drive shaft on the on-load tap-changer head, you can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank.

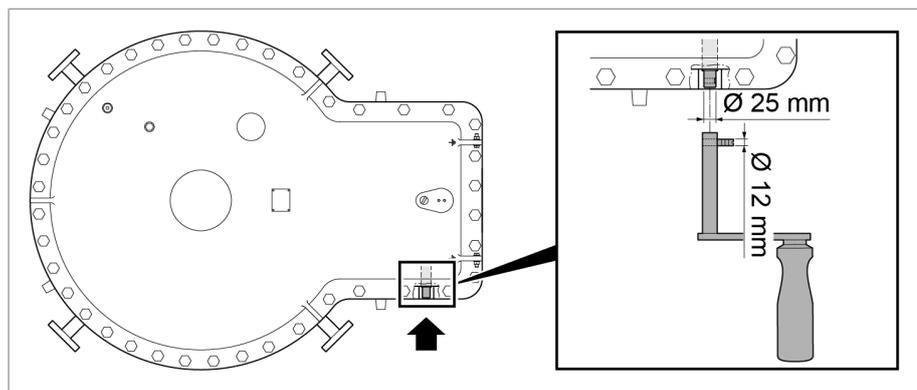


Figure 48: Drive shaft with hand crank

If using a 3 x G I... [► Section 5.4.5.2.1, Page 159] on-load tap-changer set, you have to link all on-load tap-changer heads to one another via the horizontal drive shaft part.



5.2.3.1 Transformer ratio test before drying - on-load tap-changer with tap-change supervisory device

To perform the transformer ratio test, proceed as follows:

NOTICE

Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Do not perform more than 250 tap-change operations on the on-load tap-changer. If more than 250 tap-change operations are to be performed, completely fill oil compartment with insulating oil and lubricate sliding surfaces of contacts on selector and selector gear with insulating oil.
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. **NOTICE!** Fill the oil compartment completely with oil via the S pipe connection because tap-change operations without oil can damage the on-load tap-changer.
2. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

3. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the on-load tap-changer head in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
4. Carry out the transformer ratio test.
5. Repeat the transformer ratio test in all operating positions.
6. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.2.3.2 Transformer ratio test before drying - on-load tap-changer without tap-change supervisory device

To perform the transformer ratio test, proceed as follows:

NOTICE

Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Do not perform more than 250 tap-change operations on the on-load tap-changer. If more than 250 tap-change operations are to be performed, completely fill oil compartment with insulating oil and lubricate sliding surfaces of contacts on selector and selector gear with insulating oil.
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

2. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the on-load tap-changer head in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
3. Carry out the transformer ratio test.
4. Repeat the transformer ratio test in all operating positions.
5. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.2.4 Performing DC resistance measurement on transformer



The measured DC current is normally restricted to 10% of the rated current of the measured transformer winding in order to prevent the winding from overheating.

Perform the DC resistance measurement in various on-load tap-changer operating positions. You need to distinguish here whether the measured current is interrupted when changing operating position or not.

Status of oil compartment	Without interruption in measured current	With interruption (measured current = 0 A before change of operating position)
Oil compartment empty	Maximum 10 A DC	Maximum 50 A DC
Oil compartment filled with insulating fluid	Maximum 50 A DC	Maximum 50 A DC

Table 5: Maximum permitted measured currents when performing DC resistance measurement on transformer

5.2.5 Drying on-load tap-changer in autoclave

NOTICE

Damage to the on-load tap-changer!

Moisture in the oil compartment reduces the dielectric strength of the insulating fluid and thus leads to damage to the on-load tap-changer.

- ▶ Within 10 hours of drying, seal off oil compartment with on-load tap-changer head cover.

Dry on-load tap-changer in accordance with the following instructions to ensure the dielectric values assured by MR for the on-load tap-changer.

If drying in an autoclave, the following methods are possible:

- Vacuum drying
- Vapor-phase drying

As an alternative to drying the on-load tap-changer in an autoclave, it can also be dried in the transformer tank.

5.2.5.1 Vacuum-drying in the autoclave

To vacuum dry the on-load tap-changer in the autoclave, proceed as follows.



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [▶ Section 5.2.8, Page 77].

Removing on-load tap-changer head cover

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

NOTICE

Damage to the on-load tap-changer!

Small parts in the oil compartment may block the diverter switch insert, thereby damaging the on-load tap-changer.

- ▶ Ensure that parts do not fall into the oil compartment.
- ▶ Check that all small parts are accounted for.

1. Operate on-load tap-changer to adjustment position.

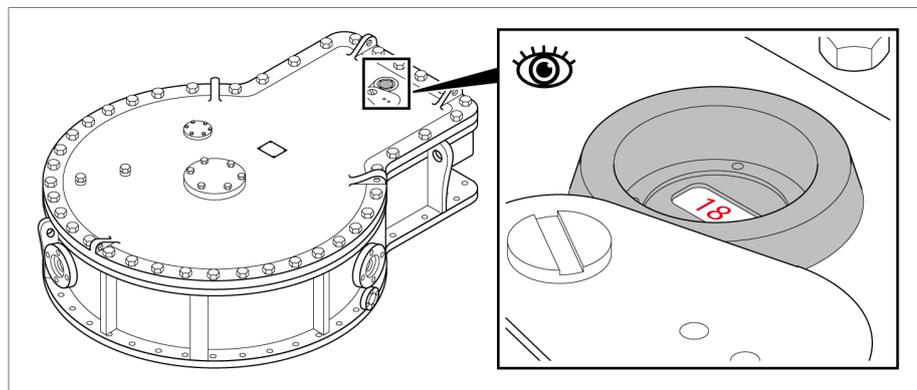


Figure 49: Adjustment position

- Remove nuts, screws and locking elements from the on-load tap-changer head cover.

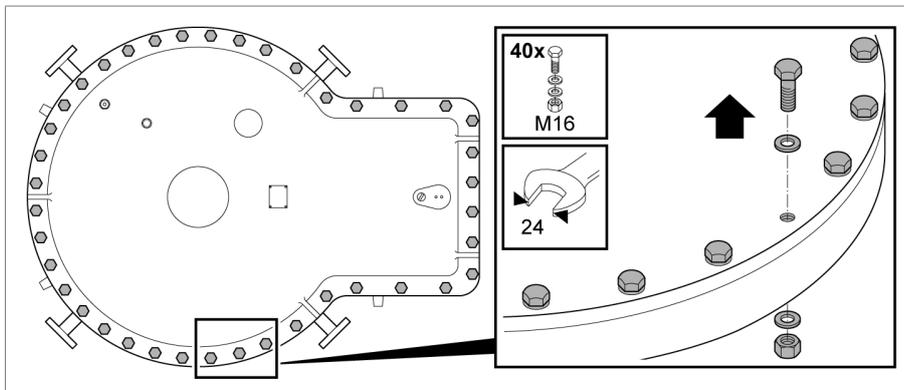


Figure 50: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage.

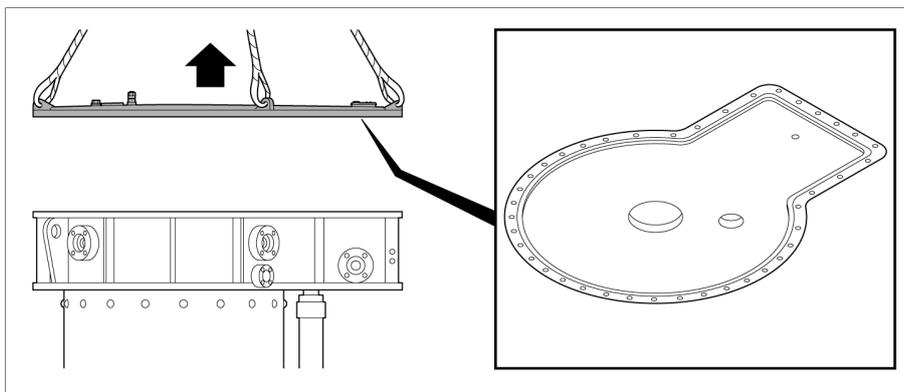


Figure 51: On-load tap-changer head cover

- NOTICE!** Do not expose the open oil compartment to ambient humidity for more than 10 hours after drying. Otherwise, damage may result to the on-load tap-changer and transformer due to insufficient dielectric strength of the diverter switch oil.

NOTICE

Drying the on-load tap-changer

Damage to the on-load tap-changer head cover and on-load tap-changer accessories.

Both the on-load tap-changer head cover and the on-load tap-changer accessories will become damaged if they are dried.

► Never dry the on-load tap-changer head cover or the following accessories: motor-drive unit, drive shaft, protective relay, pressure monitoring device, pressure relief device, bevel gear, temperature sensor, oil filter unit.

1. Heat up the on-load tap-changer in air at atmospheric pressure with a temperature increase of approximately 10 °C/h to a final temperature of maximum 110 °C.
2. Pre-dry the on-load tap-changer in circulating air at a maximum temperature of 110 °C for a period of at least 20 hours.
3. Vacuum-dry on-load tap-changer at between 105 °C and maximum 125 °C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

Securing on-load tap-changer head cover

► Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

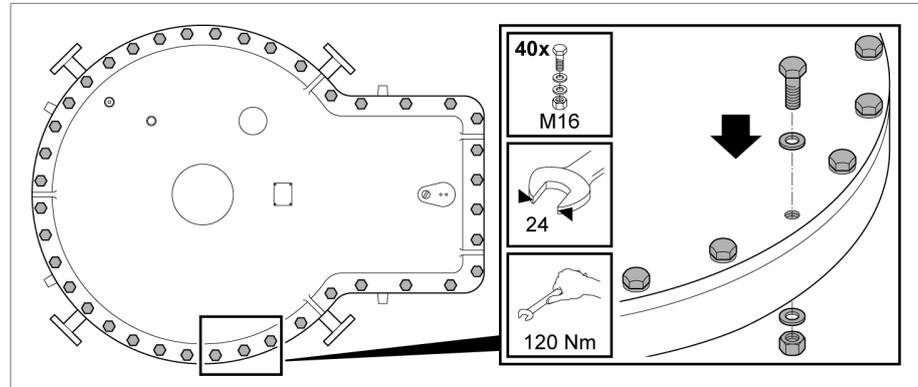


Figure 52: On-load tap-changer head cover

5.2.5.2 Vapor-phase drying in the autoclave

For kerosene drying in the autoclave, you must remove the diverter switch insert from the oil compartment and open the kerosene drain plug in the oil compartment base before drying so that the kerosene condensate can drain from the oil compartment. After the drying process, you have to close the kerosene drain plug and reinsert the diverter switch insert into the oil compartment.

Proceed as follows:



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [▶ Section 5.2.8, Page 77].

5.2.5.2.1 Opening kerosene drain plug

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

1. Operate on-load tap-changer to adjustment position.

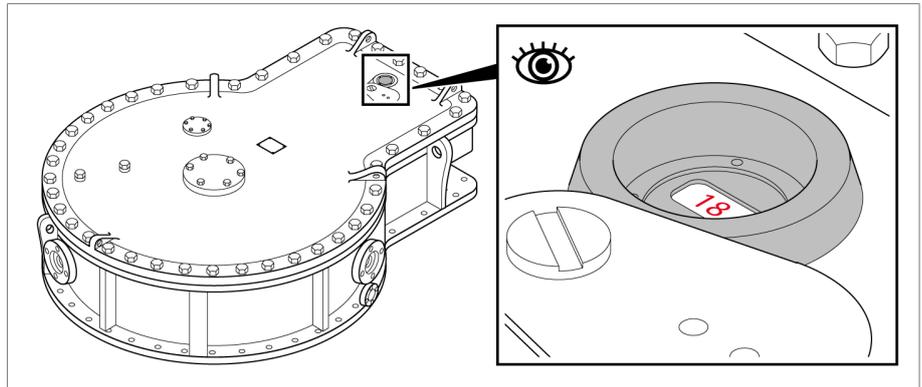


Figure 53: Adjustment position

- Remove nuts, screws and locking elements from the on-load tap-changer head cover.

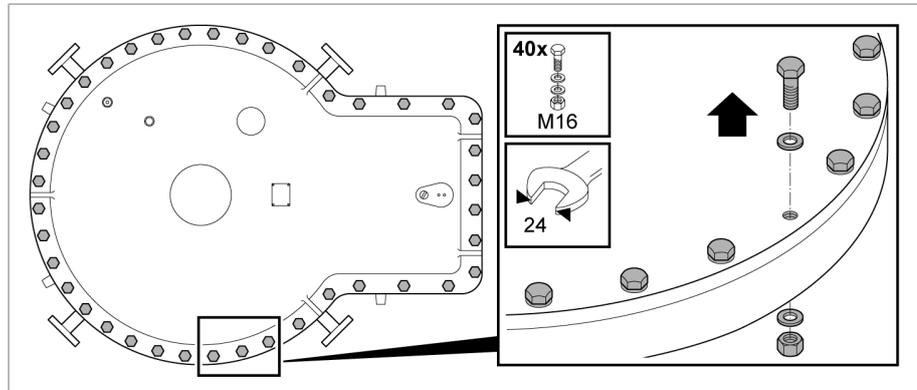


Figure 54: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

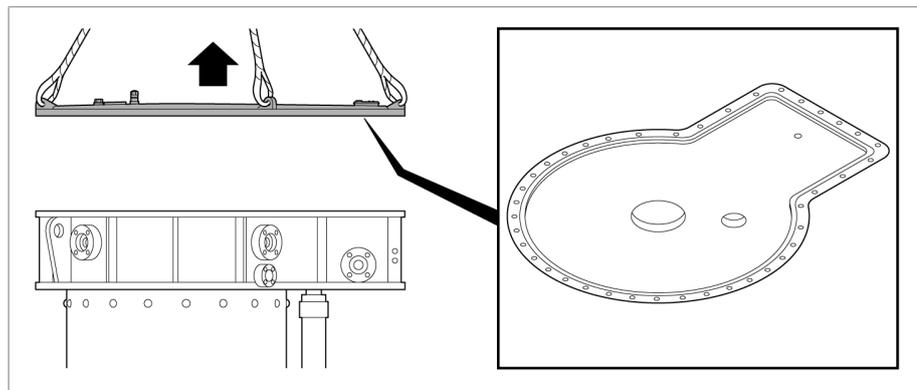


Figure 55: On-load tap-changer head cover

4. Remove nuts and locking elements on the 3 bearing bolts in the on-load tap-changer head.

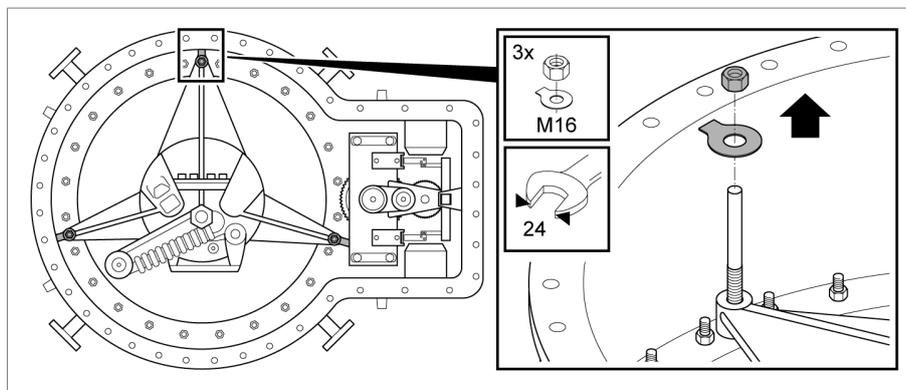


Figure 56: Nuts and lock tabs

5. Remove retaining rings from the coupling rod of the diverter switch insert. Lift off the coupling rod with cover plate between the gear crank and energy accumulator.

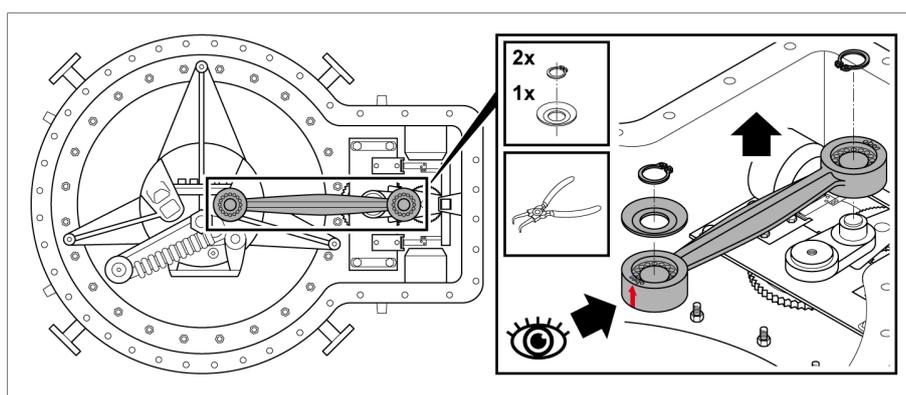


Figure 57: Coupling rod

- Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

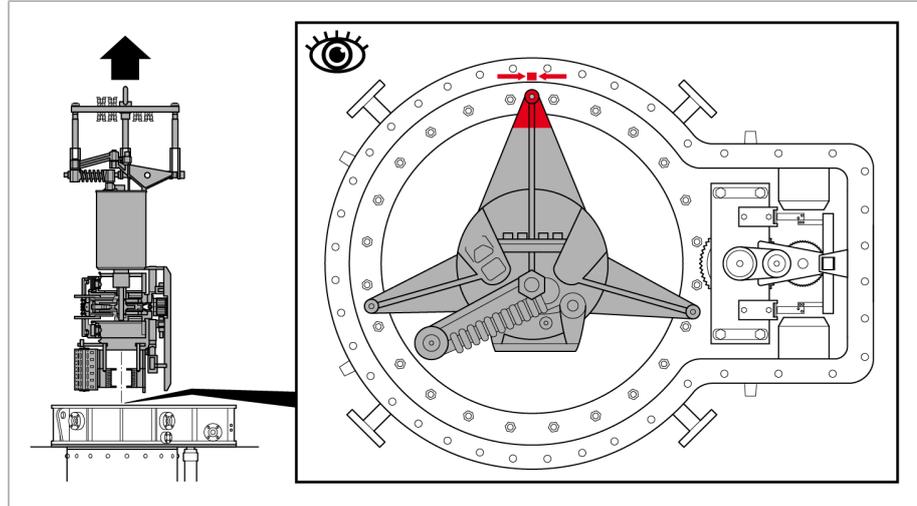


Figure 58: Diverter switch insert

- ⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
- NOTICE!** Unscrew kerosene drain plug counter-clockwise until it starts to get hard to turn. Never unscrew the kerosene drain plug all the way.

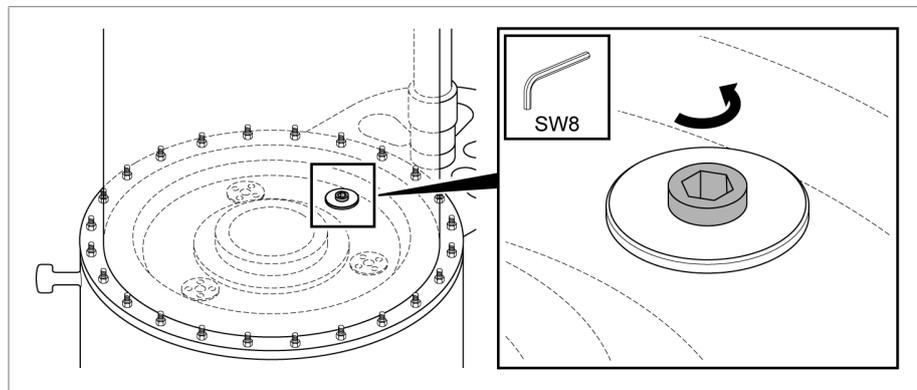


Figure 59: Kerosene drain plug

5.2.5.2.2 Drying the on-load tap-changer

- NOTICE!** Remove on-load tap-changer accessories (motor-drive unit, drive shaft, protective relay, pressure monitoring device, pressure relief device, bevel gear, temperature sensor, oil filter unit) and store outside autoclave. Otherwise, the on-load tap-changer accessories may be damaged.
- NOTICE!** Store the on-load tap-changer head cover outside the autoclave. Otherwise, the on-load tap-changer head cover may be damaged.

3. Dry the on-load tap-changer and diverter switch insert in accordance with the following regulations.

Vapor-phase drying in the autoclave

1. Supply kerosene vapor at a temperature of around 90°C. Keep this temperature constant for 3 to 4 hours.
2. Increase the kerosene vapor temperature by approx. 10°C/hour to the desired final temperature of max. 125°C at the on-load tap-changer.
3. Vacuum-dry on-load tap-changer at between 105°C and maximum 125°C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.2.5.2.3 Closing kerosene drain plug

1. Close kerosene drain plug clockwise (tightening torque 20 Nm).
2. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
3. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

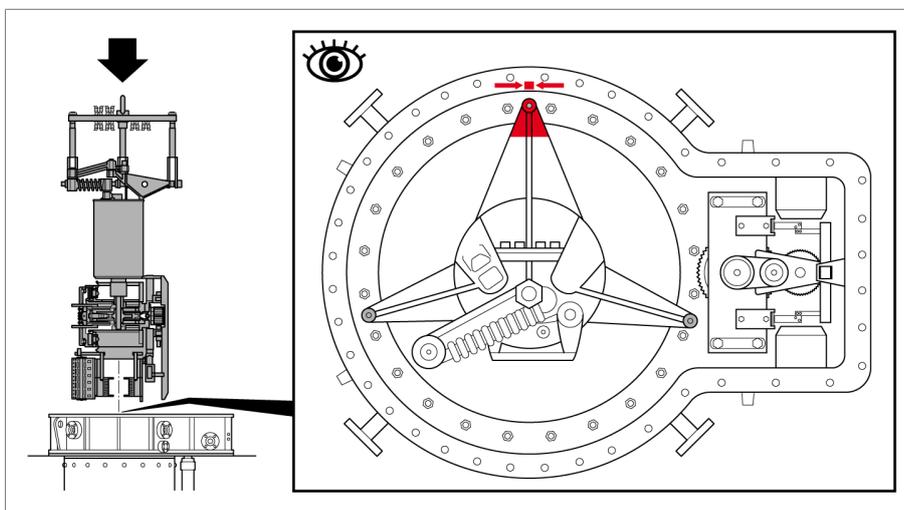


Figure 60: Inserting diverter switch insert

4. Fasten the diverter switch insert to the 3 bearing bolts. Secure the nuts to prevent them from turning.

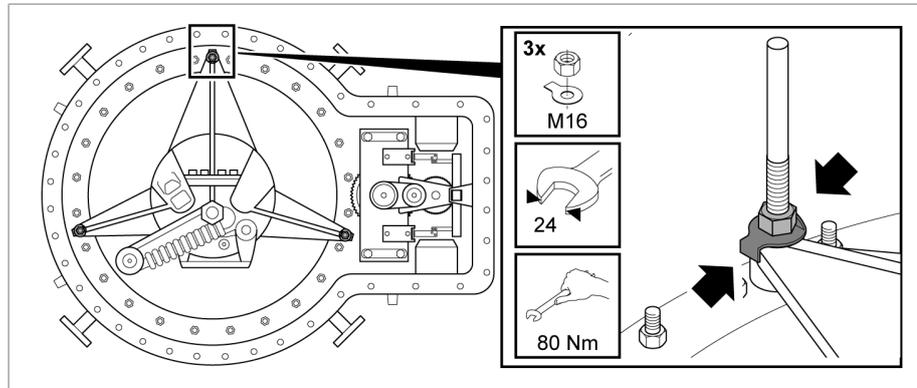


Figure 61: Fastening the diverter switch insert

5. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

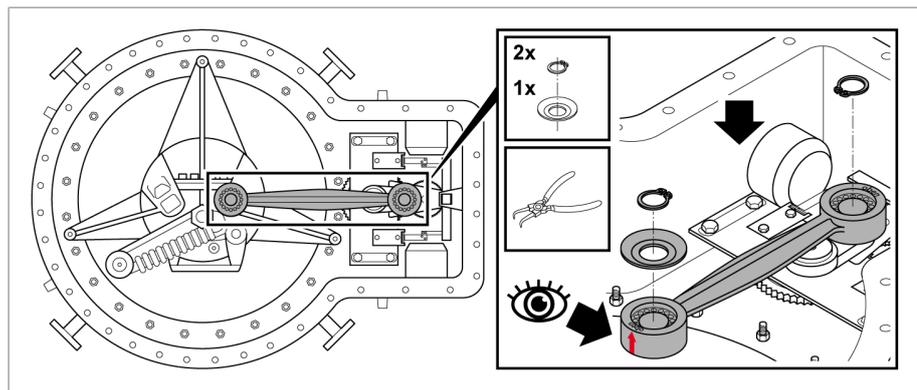
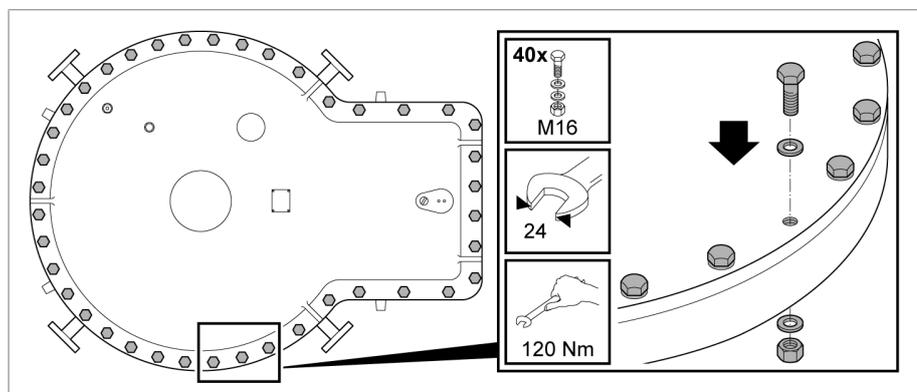


Figure 62: Coupling rod

6. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.



7. On-load tap-changer head cover

5.2.6 Drying on-load tap-changer in transformer tank

Dry on-load tap-changer in accordance with the following instructions to ensure the dielectric values assured by MR on the on-load tap-changer.

If you want to dry the on-load tap-changer in the transformer tank, fully assemble the transformer first and then undertake drying.

If drying in the transformer tank, the following methods are possible:

- Vacuum-drying
- Vapor-phase drying

As an alternative to drying the on-load tap-changer in the transformer tank, it can also be dried in an autoclave.

5.2.6.1 Vacuum-drying in the transformer tank

Before you start vacuum-drying in the transformer tank, you must place a connecting lead between the corresponding pipe connections and seal off the pipe connections not being used with blank covers.



The on-load tap-changer head cover remains closed during the entire drying process.



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [► Section 5.2.8, Page 77].

1. Establish the connecting lead on the on-load tap-changer head between connections E and Q or E and R.

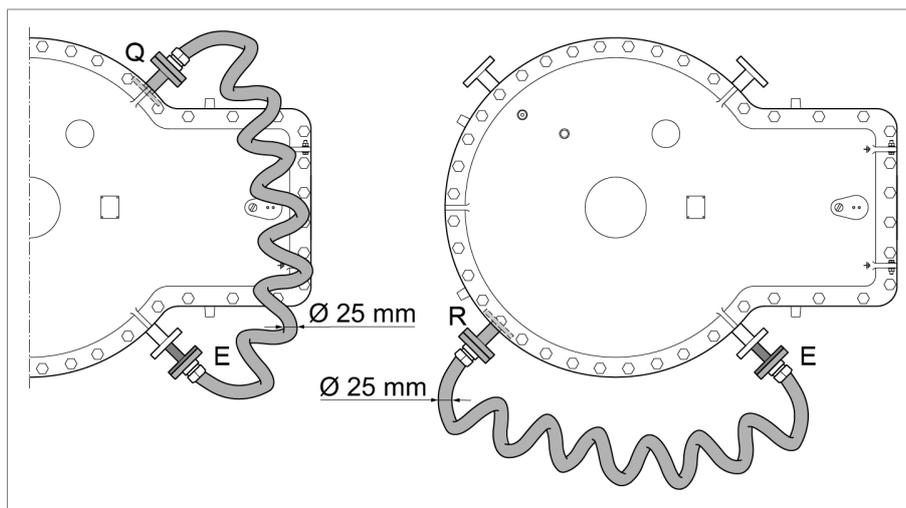


Figure 63: Connecting lead

2. Seal off unused pipe connections with suitable blank covers.

Vacuum-drying in the transformer tank

1. Heat up the on-load tap-changer in air at atmospheric pressure with a temperature increase of approximately 10 °C/h to a final temperature of maximum 110 °C.
2. Pre-dry the on-load tap-changer in circulating air at a maximum temperature of 110 °C for a period of at least 20 hours.
3. Vacuum-dry on-load tap-changer at between 105 °C and maximum 125 °C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.2.6.2 Vapor-phase drying in the transformer tank

For vapor-phase drying in the transformer tank, you must remove the diverter switch insert from the oil compartment and open the kerosene drain plug in the oil compartment base before drying so that the kerosene condensate can drain from the oil compartment. After the drying process, you have to close the kerosene drain plug and reinsert the diverter switch insert into the oil compartment.

Proceed as follows:



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [► Section 5.2.8, Page 77].

5.2.6.2.1 Opening kerosene drain plug

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

1. Operate on-load tap-changer to adjustment position.

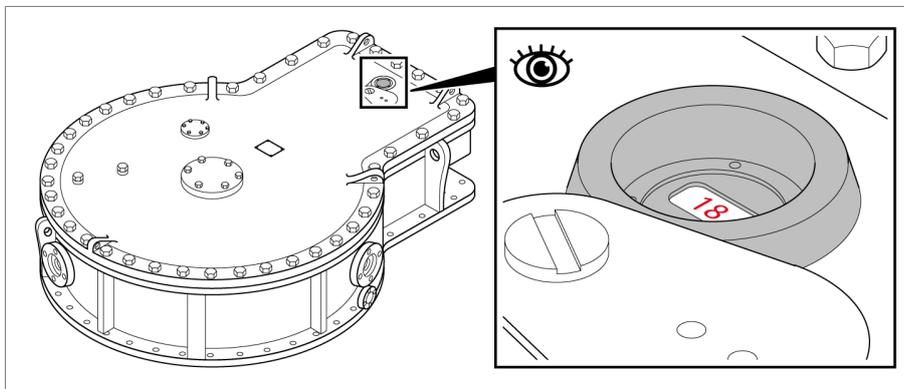


Figure 64: Adjustment position

2. Remove nuts, screws and locking elements from the on-load tap-changer head cover.

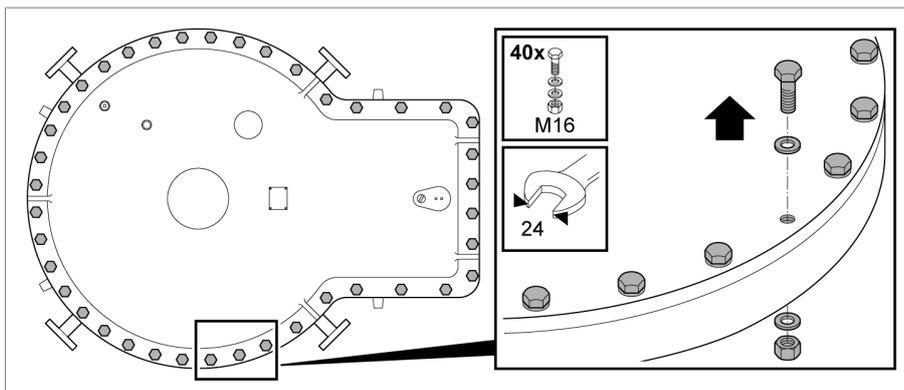


Figure 65: On-load tap-changer head cover

3. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer dam-

age. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

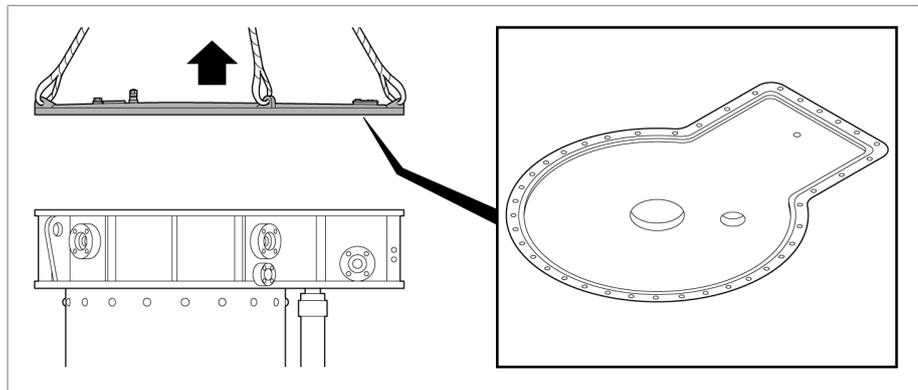


Figure 66: On-load tap-changer head cover

4. Remove nuts and locking elements on the 3 bearing bolts in the on-load tap-changer head.

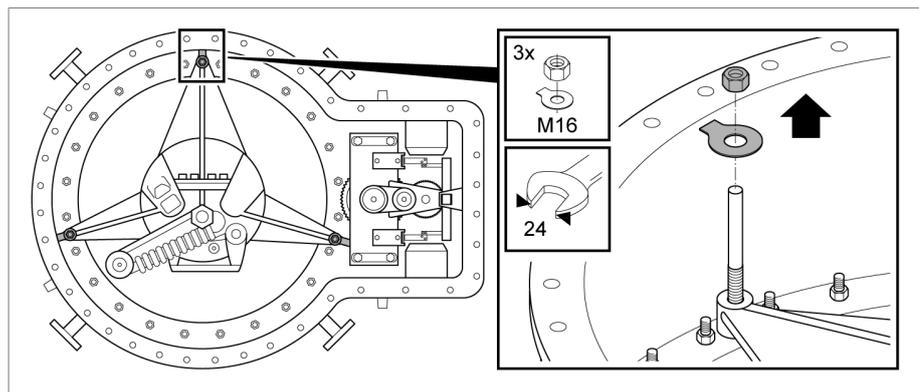


Figure 67: Nuts and lock tabs

5. Remove retaining rings from the coupling rod of the diverter switch insert. Lift off the coupling rod with cover plate between the gear crank and energy accumulator.

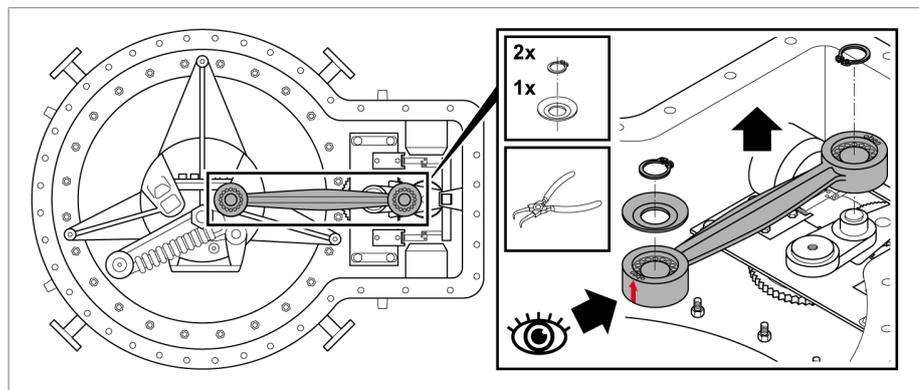


Figure 68: Coupling rod

6. Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

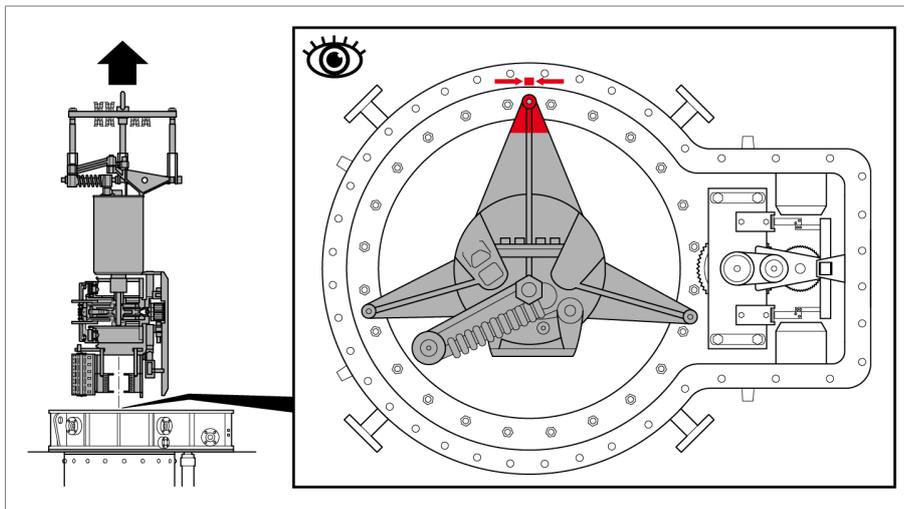


Figure 69: Diverter switch insert

7. **⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
8. **NOTICE!** Unscrew kerosene drain plug counter-clockwise until it starts to get hard to turn. Never unscrew the kerosene drain plug all the way.

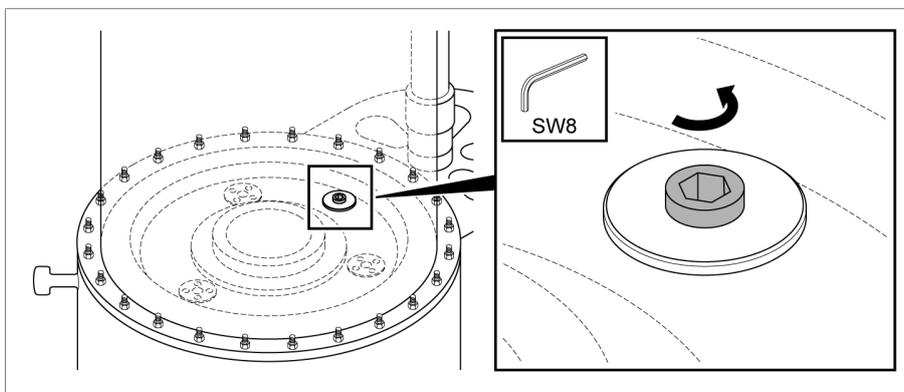


Figure 70: Kerosene drain plug

5.2.6.2.2 Inserting the diverter switch insert into the oil compartment

1. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
2. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match.

When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

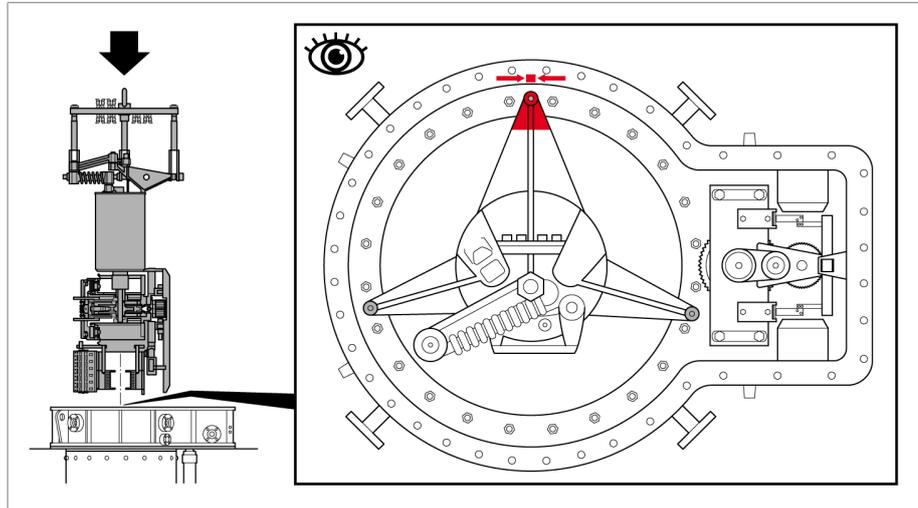


Figure 71: Inserting diverter switch insert

3. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

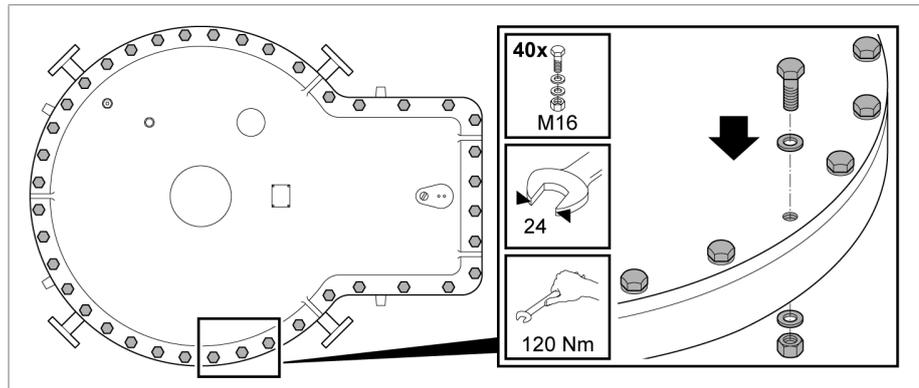


Figure 72: On-load tap-changer head cover

5.2.6.2.3 Drying the on-load tap-changer

1. Connect pipe connections R and Q of on-load tap-changer head to the kerosene vapor lead using one shared lead. Note that the R and Q pipe connections may be located in another location on the on-load tap-changer head [► Section 11.2, Page 218].

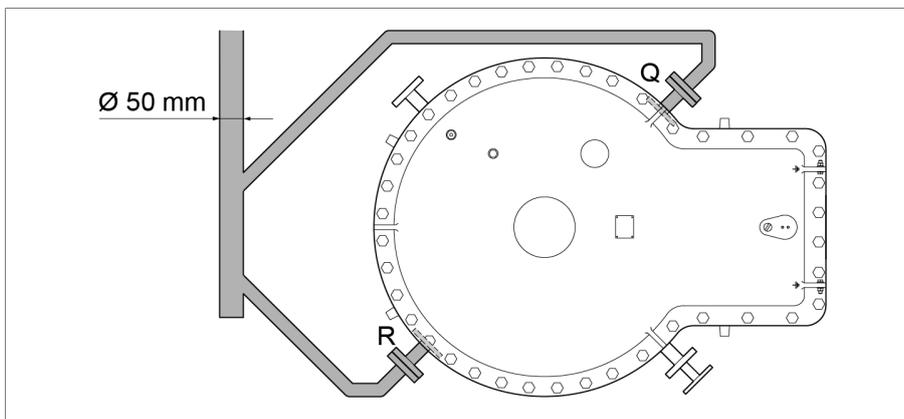


Figure 73: Shared lead

2. Seal off unused pipe connections with suitable blank covers.

Vapor-phase drying in the transformer tank

1. Supply kerosene vapor at a temperature of around 90°C. Keep this temperature constant for 3 to 4 hours.
2. Increase the kerosene vapor temperature by approx. 10°C/hour to the desired final temperature of max. 125°C at the on-load tap-changer.
3. Vacuum-dry on-load tap-changer at between 105°C and maximum 125°C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.2.6.2.4 Closing kerosene drain plug

1. Remove nuts, screws and locking elements from the on-load tap-changer head cover.

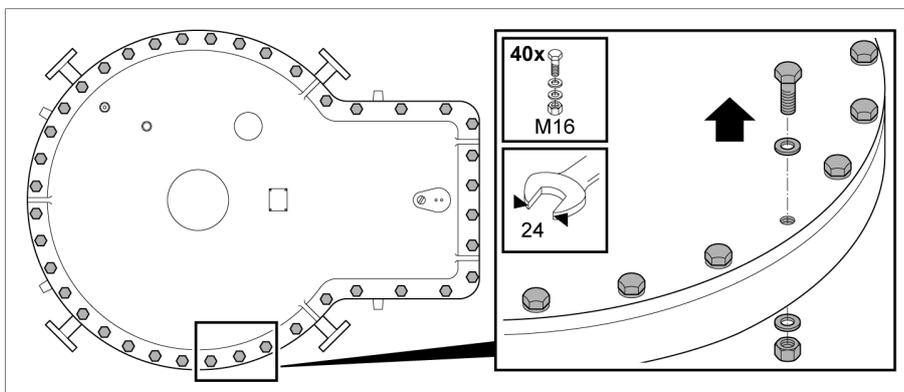


Figure 74: On-load tap-changer head cover

2. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

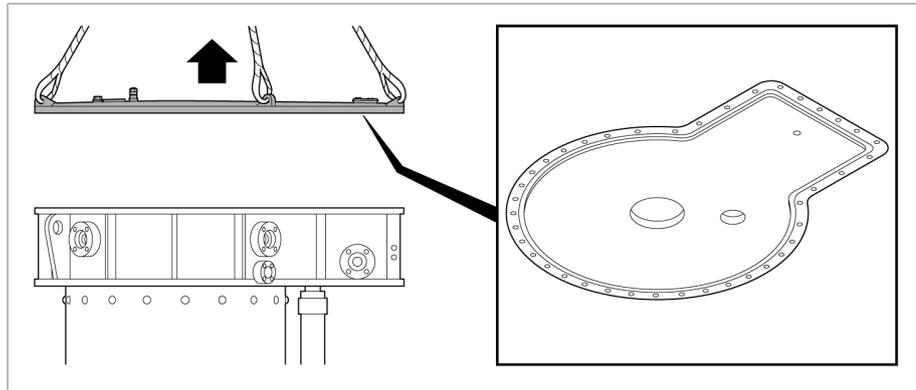


Figure 75: On-load tap-changer head cover

3. Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

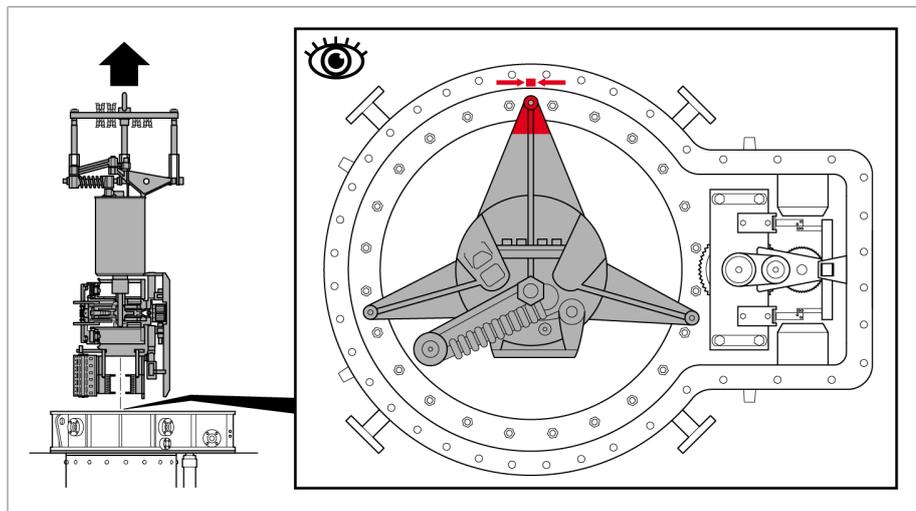


Figure 76: Diverter switch insert

4. **⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
5. Close kerosene drain plug clockwise (tightening torque 20 Nm).
6. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.

7. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

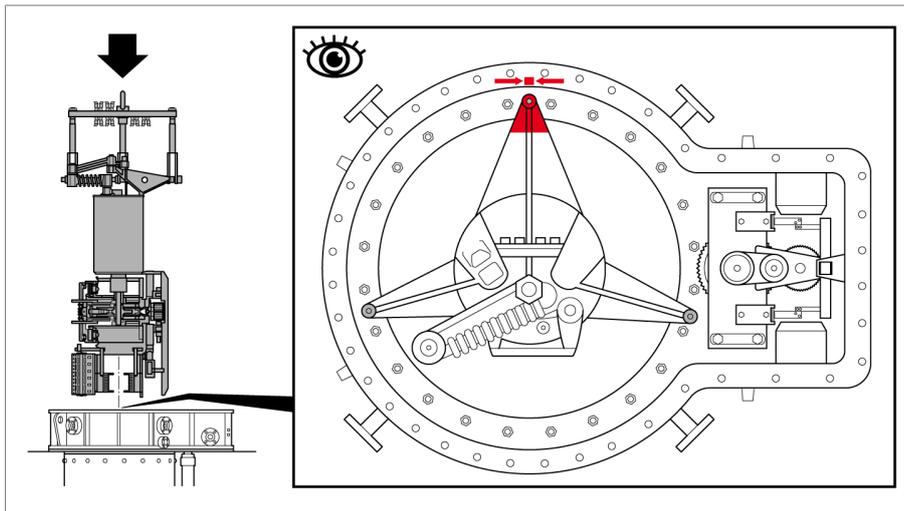


Figure 77: Inserting diverter switch insert

8. Fasten the diverter switch insert to the 3 bearing bolts. Secure the nuts to prevent them from turning.

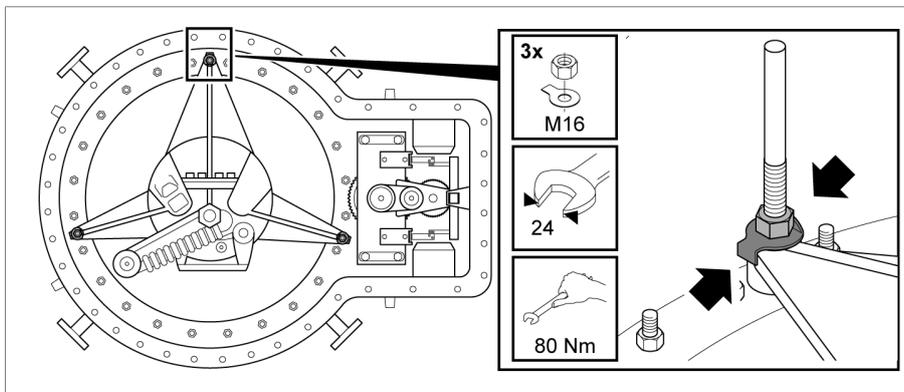


Figure 78: Fastening the diverter switch insert

9. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

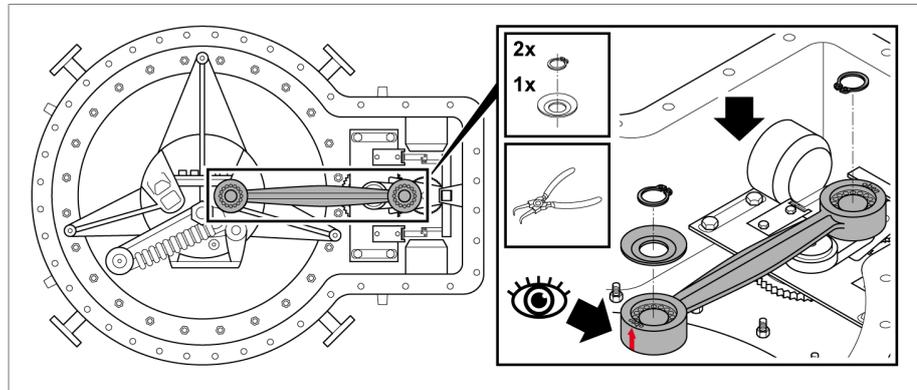
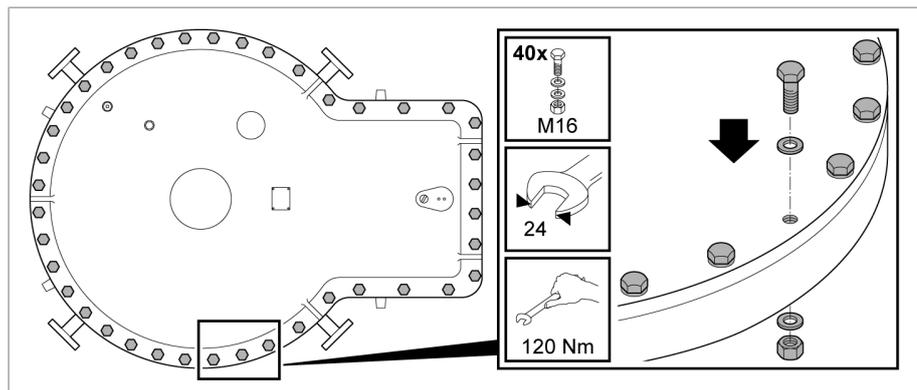


Figure 79: Coupling rod

10. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.



11. On-load tap-changer head cover

5.2.7 Filling the oil compartment of the on-load tap-changer with oil and bleeding it

NOTICE

Damage to the on-load tap-changer!

Unsuitable insulating fluids cause damage to the on-load tap-changer.

- Only use insulating fluids [► Section 10.1, Page 210] approved by the manufacturer.

After drying, completely fill the oil compartment (diverter switch insert fitted) with oil again as soon as possible so that an impermissible amount of humidity is not absorbed from the surroundings.

1. Establish a connecting lead between the pipe connection E and one of the pipe connections R, S or Q to ensure uniform pressure conditions in the oil compartment and transformer during evacuation.

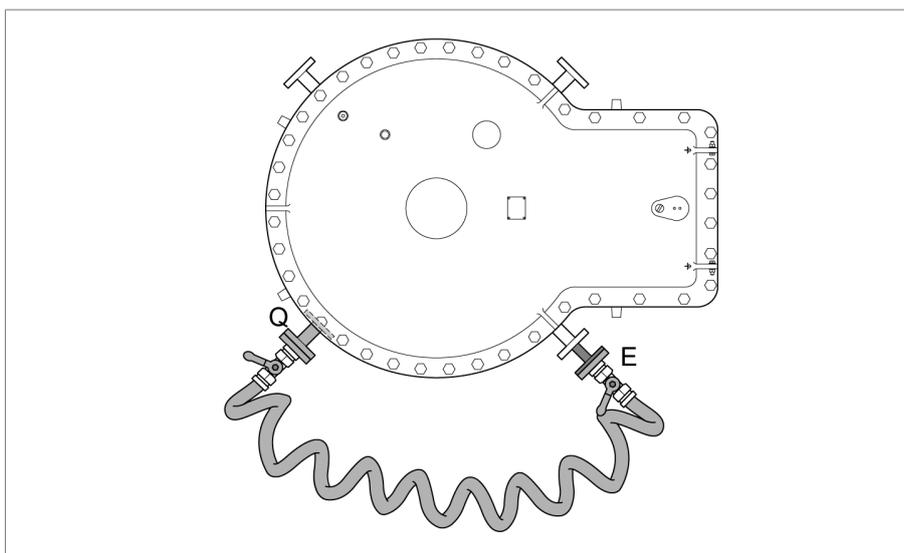


Figure 80: Connecting lead between E and Q.

2. Perform an evacuation.
3. Fill the oil compartment completely with oil via the S pipe connection. During this process, the oil suction pipe is bled.
4. Drain the oil conservator until the minimum volume for switching gases and thermal expansion has been reached in accordance with the technical data for the OILTAP® G.

5.2.8 Carrying out transformer ratio test after drying

To perform the transformer ratio test, proceed as follows:

NOTICE

Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Make sure that the selector is fully immersed in transformer oil and that the oil compartment of the on-load tap-changer is completely filled with oil.
- ▶ The on-load tap-changer can be operated in the temperature range of the surrounding transformer oil of between -25 °C and $+105\text{ °C}$ and in accordance with IEC 60214-1 up to $+115\text{ °C}$ (during emergency transformer operation in accordance with IEC 60076-7).
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

2. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the upper gear unit in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
3. Carry out the transformer ratio test.
4. Repeat the transformer ratio test in all operating positions.
5. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.3 Installing on-load tap-changer in transformer (bell-type tank version)

5.3.1 Inserting on-load tap-changer into supporting structure

5.3.1.1 Securing selector on oil compartment

1. **⚠ CAUTION!** Leave the selector on the base plate of the delivery box, place this on a level surface and secure it against tipping. An unstably positioned selector may tip, resulting in injuries and property damage.
2. Remove nuts and locking elements from the selector suspension screws.

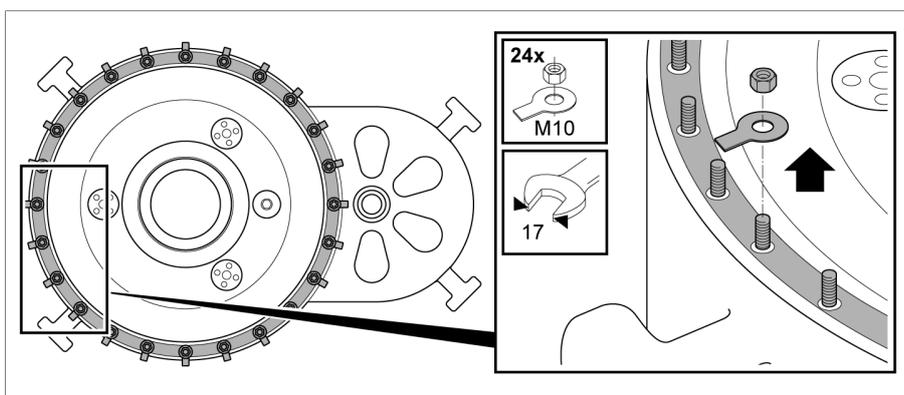


Figure 81: Nuts and lock tabs

3. Clean the gasket and sealing surfaces on the selector.

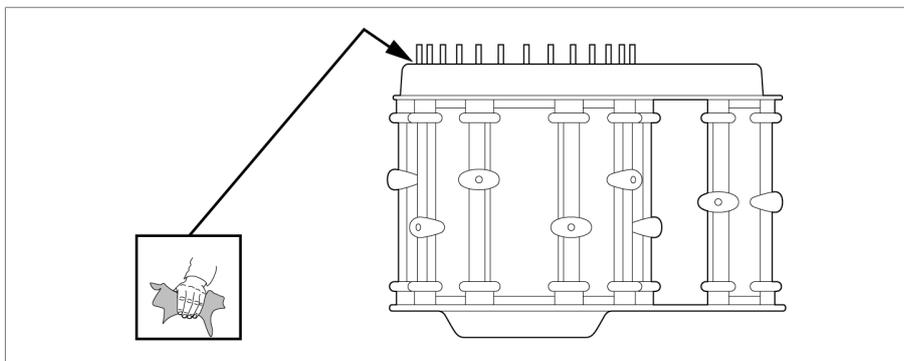


Figure 82: Gasket on selector

- Place the selector drive shaft (arrow facing down) on the end of the selector shaft. A groove in the end of the shaft and a locating pin in the selector drive shaft only allow for assembly in the correct position.

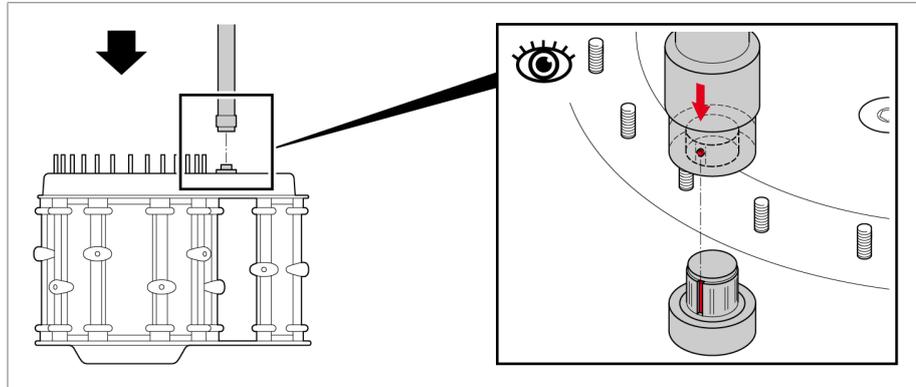


Figure 83: Drive shaft on selector

- ⚠ WARNING!** Place the oil compartment on a level surface and secure it against tipping. An unstably positioned oil compartment may tip over, resulting in injuries and property damage.
- Remove nuts, screws and locking washers on on-load tap-changer head cover.

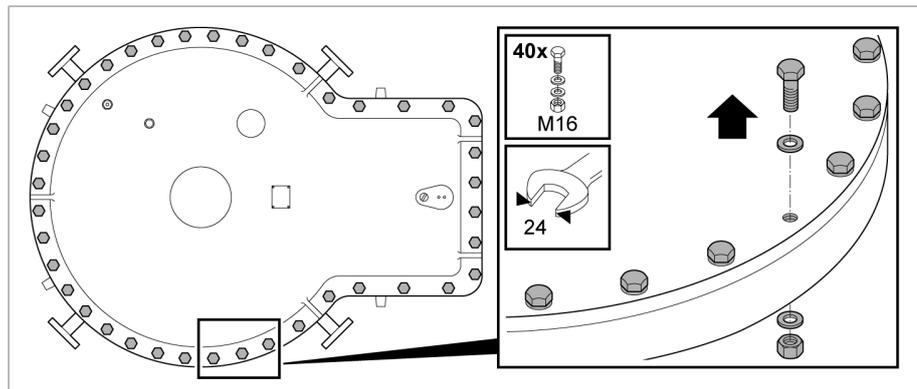


Figure 84: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer dam-

age. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

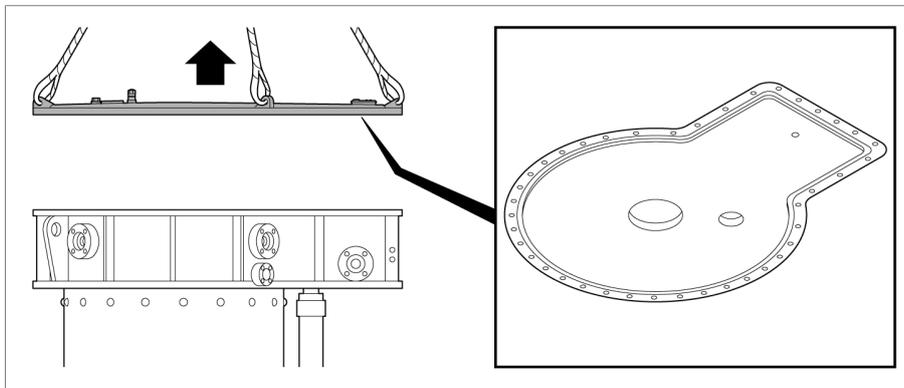


Figure 85: On-load tap-changer head cover

8. Insert the lifting traverse into the oil compartment.

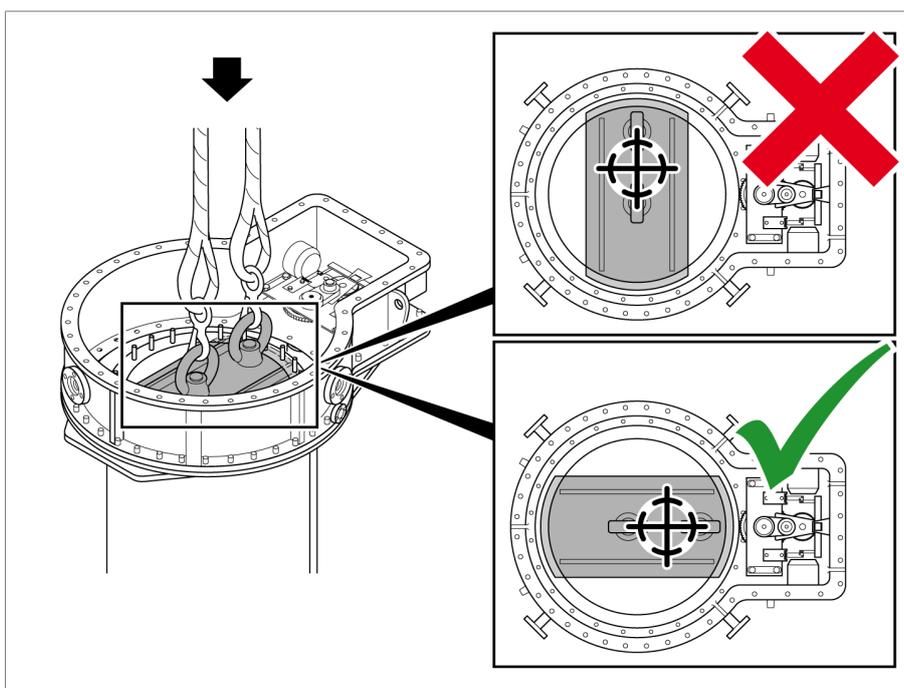


Figure 86: Inserting the lifting traverse

9. Carefully raise the oil compartment above the selector and ensure that the selector suspension screws match the through-holes in the lower oil compartment flange and that the drive shaft in the on-load tap-changer head and the selector drive shaft match.
10. **NOTICE!** Lower the oil compartment slowly and in an upright position and align it such that the red 0 mark on the lower oil compartment flange is directly across from the selector drive shaft. Ensure that the oil compartment does not damage the selector drive shaft and the selector drive shaft does not collide with the on-load tap-changer head. Couple the

drive shaft in the on-load tap-changer head with the selector drive shaft. A groove in the drive shaft and a locating pin in the selector drive shaft only allow for assembly in the correct position.

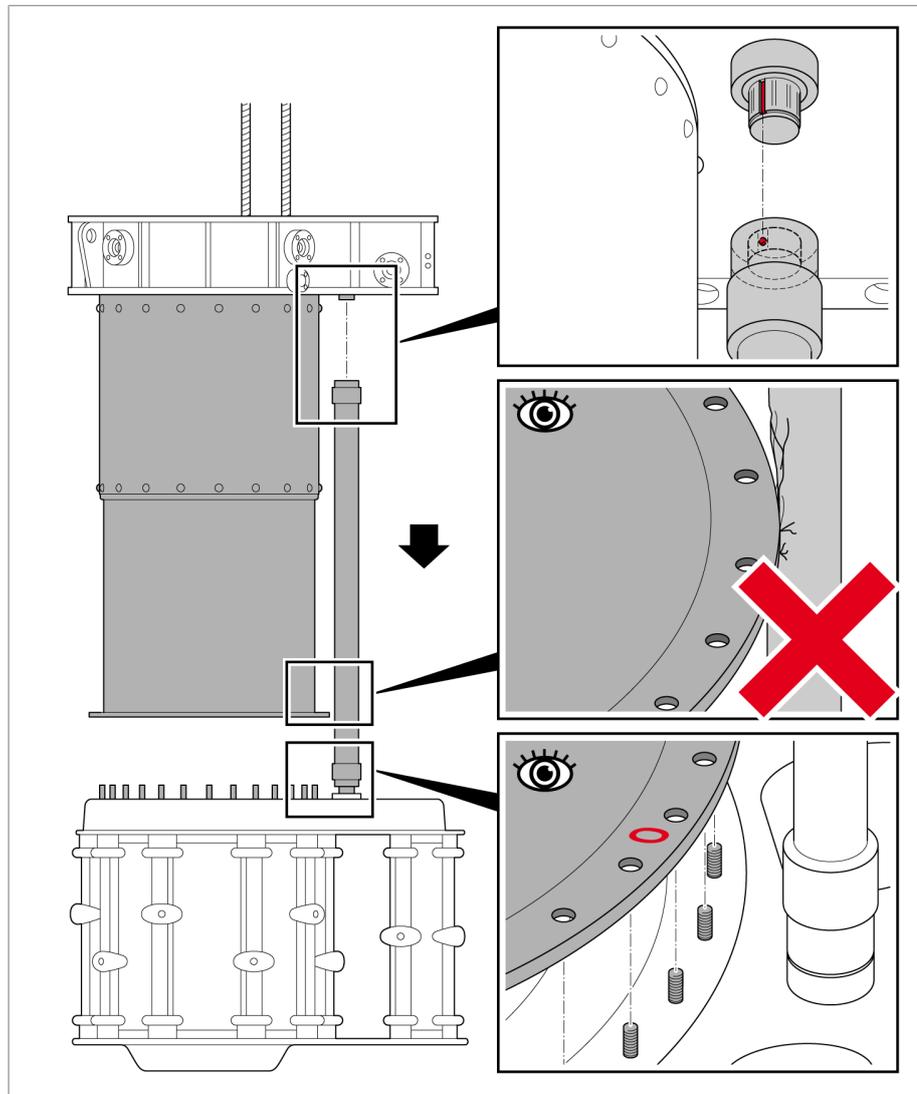


Figure 87: Lowering oil compartment

11. Screw selector onto oil compartment. Secure the nuts to prevent them from turning.

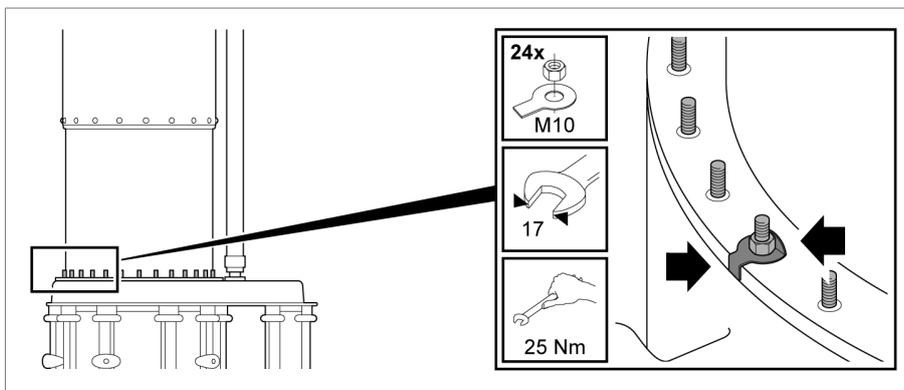


Figure 88: Oil compartment on selector

12. Remove nuts and lock tabs on the 3 bearing bolts in the on-load tap-changer head.

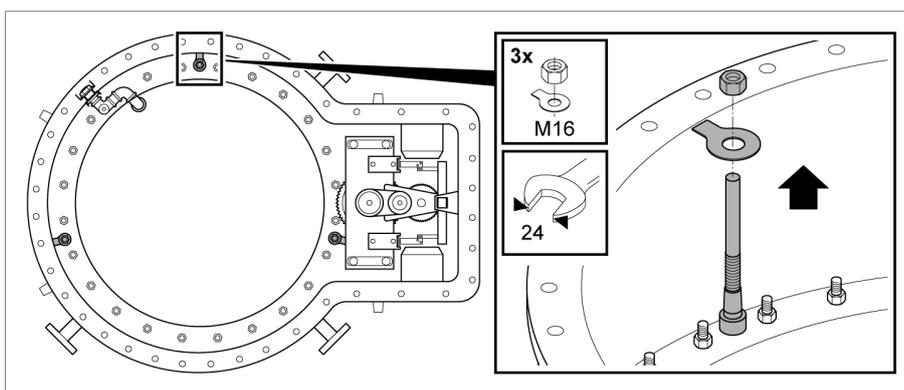


Figure 89: Bearing bolts

5.3.1.2 Hooking the oil compartment and selector into the supporting structure

1. **NOTICE!** Using spacers, insert on-load tap-changer vertically into supporting structure (maximum 1° deviation from the vertical) so that the on-load tap-changer reaches its final installation height and only has to be raised a maximum of 5 to 20 mm after fitting the bell-type tank. If this is not done, once the tap winding and on-load tap-changer take-off lead are

connected, tension may occur which will damage the on-load tap-changer and transformer. There is also a risk of malfunctions from selector contacts closing incorrectly.

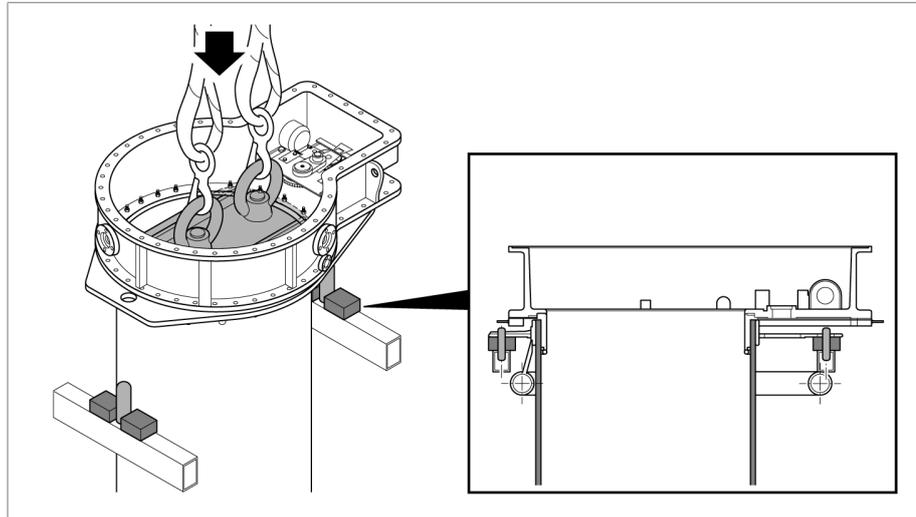


Figure 90: On-load tap-changer with spacers on supporting structure

2. Remove lifting traverse.
3. Temporarily fasten on-load tap-changer to supporting structure. The supporting flange has through holes for this purpose.

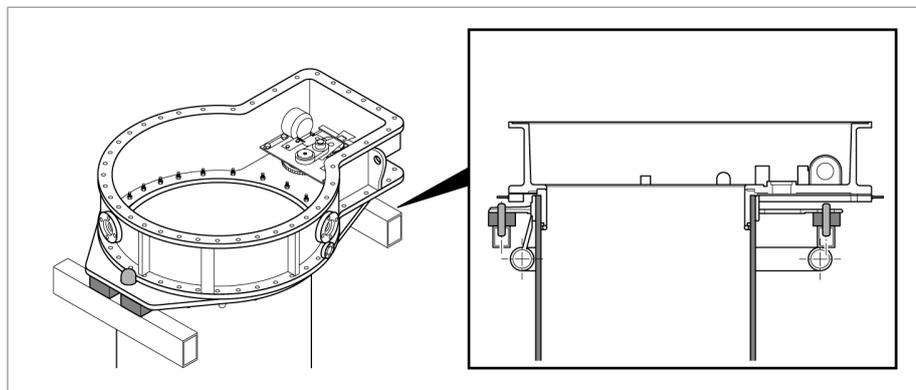


Figure 91: Fastening the on-load tap-changer

5.3.1.3 Inserting the diverter switch insert into the oil compartment

1. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
2. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match.

When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

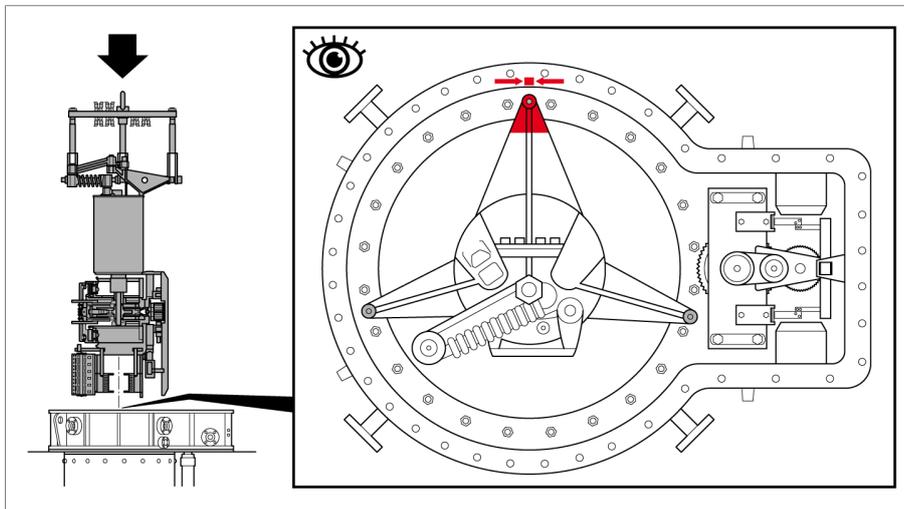


Figure 92: Inserting diverter switch insert

3. Fasten the diverter switch insert to the 3 bearing bolts.

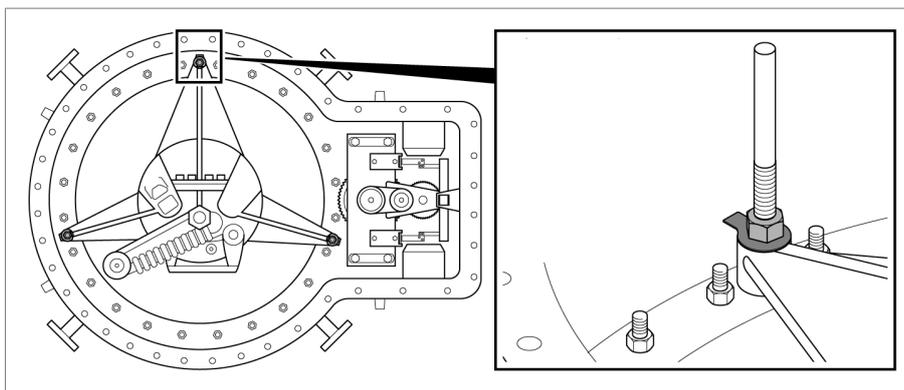


Figure 93: Fastening the diverter switch insert

4. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

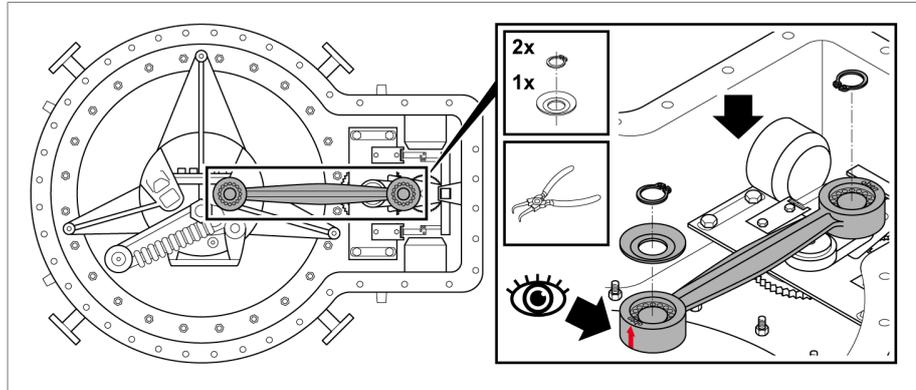


Figure 94: Fastening the coupling rod

5. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

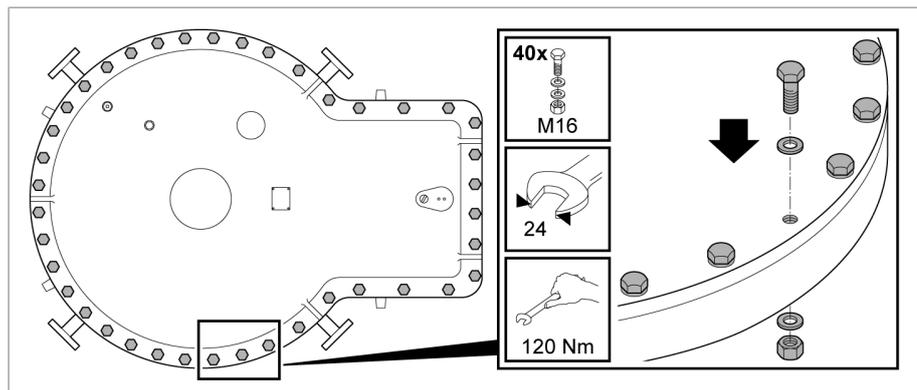


Figure 95: On-load tap-changer head cover

5.3.1.4 Removing the transport feet and transport locks

Remove the transport locks mentioned below and the transport feet from the selector before performing further work.

1. If present, remove the transport feet from the selector.

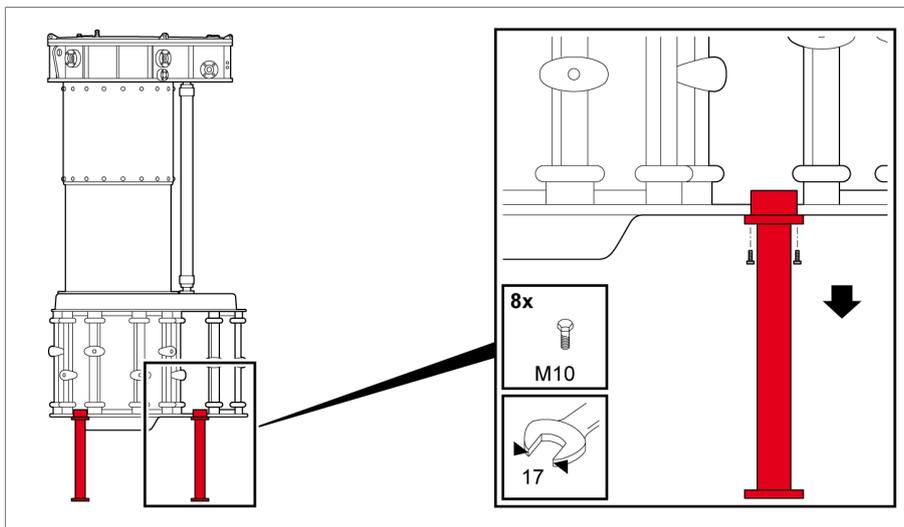


Figure 96: Removing transport feet

2. Remove the blocking bracket from the drive shaft of the on-load tap-changer head.

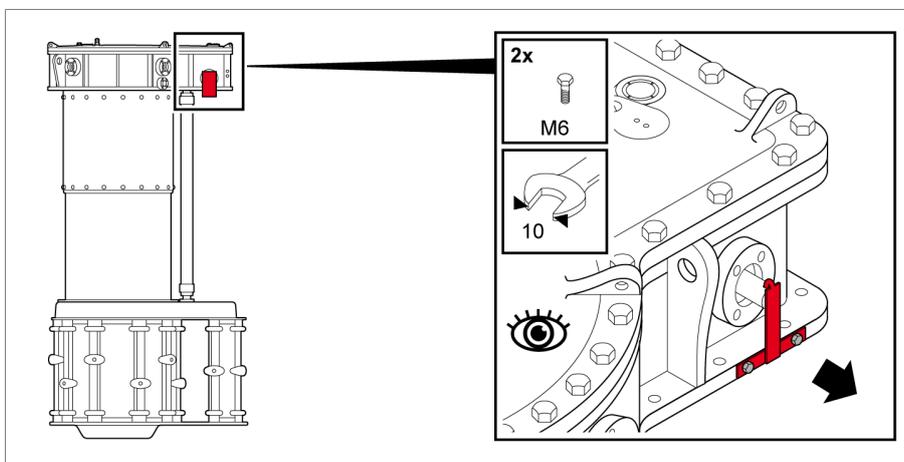


Figure 97: Blocking bracket

3. Remove the lower blocking pin from the selector drive shaft.

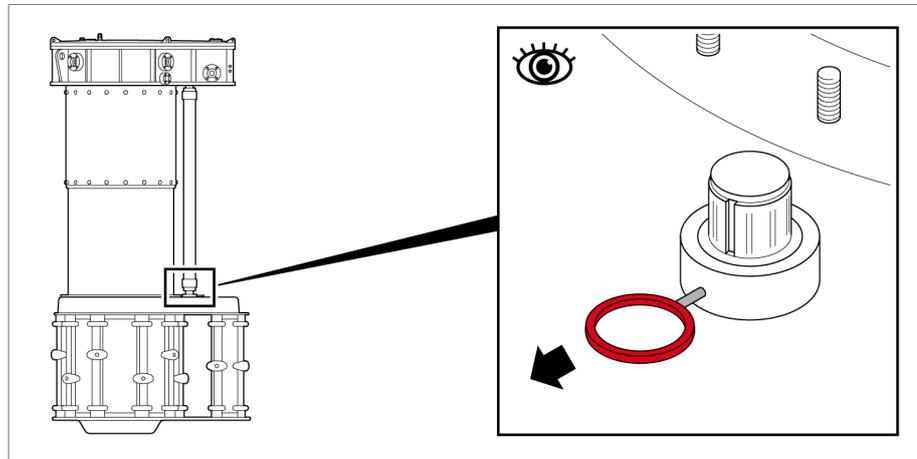


Figure 98: Blocking pin on the lower selector drive shaft

4. Remove the blocking strip from the change-over selector.

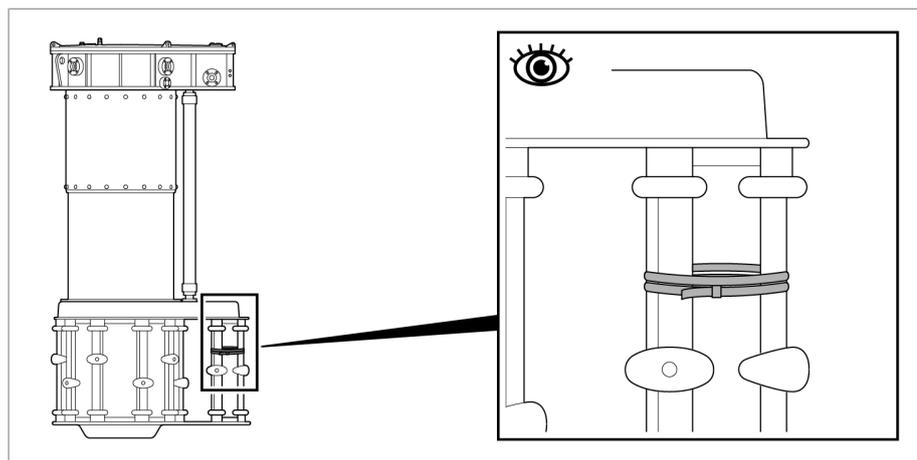


Figure 99: Removing the blocking strip from the change-over selector

5.3.2 Connecting tap winding and on-load tap-changer take-off lead

NOTICE

Damage to the on-load tap-changer!

Connecting leads that place mechanical strain on the on-load tap-changer will damage the on-load tap-changer.

- ▶ Establish connections carefully.
- ▶ Do not twist connection contacts.
- ▶ Connect connecting leads without warping or deforming.
- ▶ If necessary, use an expansion loop for connecting leads.
- ▶ Fit screening caps provided to screw connections.

Connect tap winding and on-load tap-changer take-off lead in accordance with the connection diagram included with the delivery.

5.3.2.1 Connecting the tap winding

The selector's connection contacts are indicated on the selector bars. The connection contacts are equipped with connecting pieces that, depending on the order, are designed for a soldered connection, a screw connection or a combined screw/soldered connection. You can find more information on connecting pieces in the appendix [► Section 11.5, Page 221].

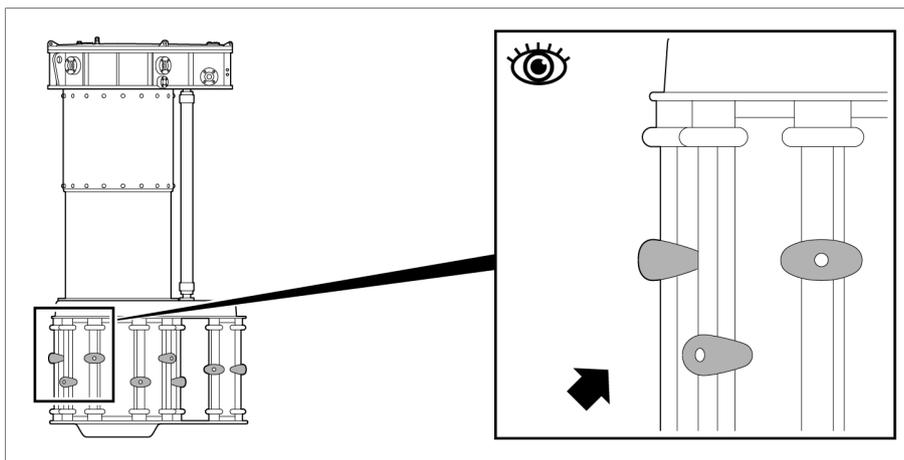


Figure 100: Connection contacts on the selector

5.3.2.2 Connecting on-load tap-changer take-off lead

The **neutral terminal** on the OILTAP® G III 1602 and OILTAP® G III 2002 is located on the lower oil compartment flange, which features a total of 6 M12 tapped holes.

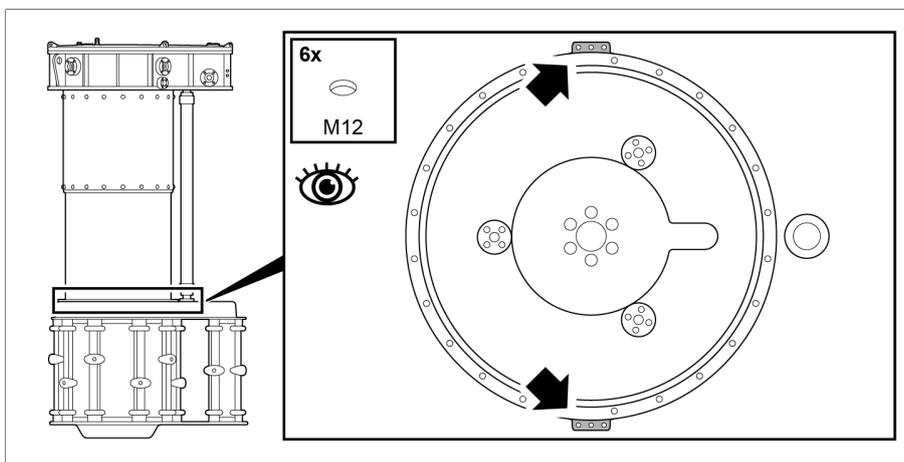


Figure 101: Neutral terminal

In contrast, on the OILTAP® G I 1602, OILTAP® G I 1612, OILTAP® G I 1622, G I 3002 and OILTAP® G I 3022, the **on-load tap-changer take-off lead** is connected to a special take-off lead connection underneath the selector base.

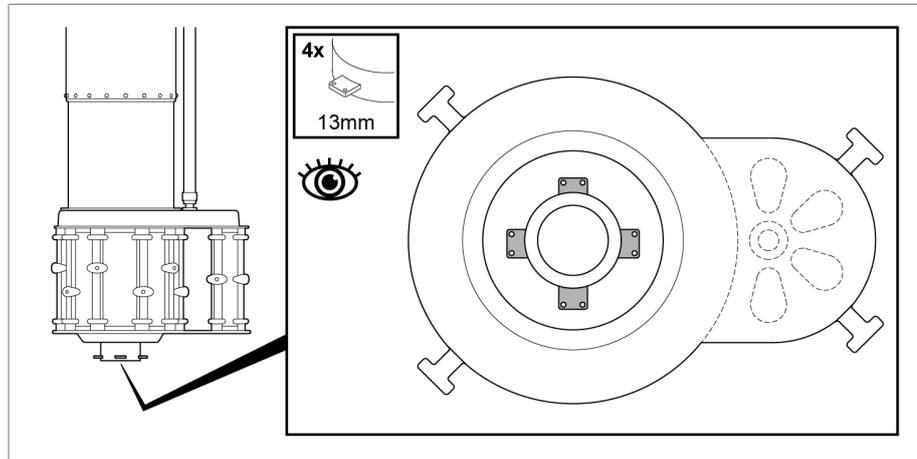


Figure 102: Take-off connection lead underneath the selector

On-load tap-changers with tie-in switches feature a special connection for the on-load tap-changer take-off lead (see order-related dimensional drawing).

5.3.3 Carrying out transformer ratio test before drying

To actuate the drive shaft on the on-load tap-changer head, you can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank.

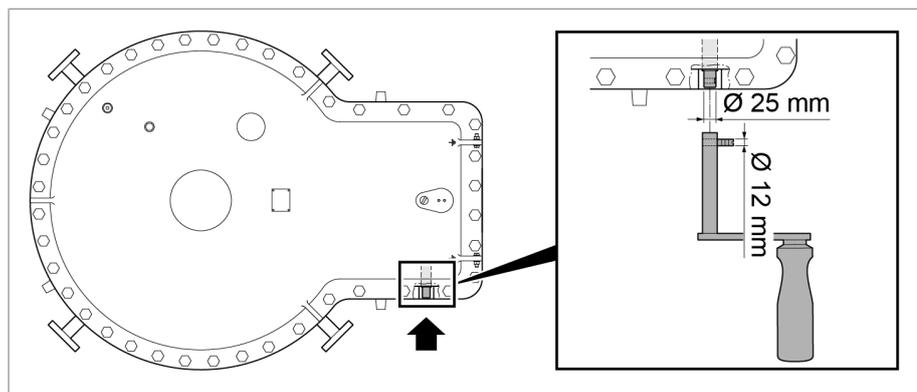


Figure 103: Drive shaft with hand crank

If using a 3 x G I... [► Section 5.4.5.2.1, Page 159] on-load tap-changer set, you have to link all on-load tap-changer heads to one another via the horizontal drive shaft part.



5.3.3.1 Transformer ratio test before drying - on-load tap-changer with tap-change supervisory device

To perform the transformer ratio test, proceed as follows:

NOTICE

Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Do not perform more than 250 tap-change operations on the on-load tap-changer. If more than 250 tap-change operations are to be performed, completely fill oil compartment with insulating oil and lubricate sliding surfaces of contacts on selector and selector gear with insulating oil.
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. **NOTICE!** Fill the oil compartment completely with oil via the S pipe connection because tap-change operations without oil can damage the on-load tap-changer.
2. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

3. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the on-load tap-changer head in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
4. Carry out the transformer ratio test.
5. Repeat the transformer ratio test in all operating positions.
6. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.3.3.2 Transformer ratio test before drying - on-load tap-changer without tap-change supervisory device

To perform the transformer ratio test, proceed as follows:

NOTICE

Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Do not perform more than 250 tap-change operations on the on-load tap-changer. If more than 250 tap-change operations are to be performed, completely fill oil compartment with insulating oil and lubricate sliding surfaces of contacts on selector and selector gear with insulating oil.
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

2. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the on-load tap-changer head in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
3. Carry out the transformer ratio test.
4. Repeat the transformer ratio test in all operating positions.
5. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.3.4 Performing DC resistance measurement on transformer



The measured DC current is normally restricted to 10% of the rated current of the measured transformer winding in order to prevent the winding from overheating.

Perform the DC resistance measurement in various on-load tap-changer operating positions. You need to distinguish here whether the measured current is interrupted when changing operating position or not.

Status of oil compartment	Without interruption in measured current	With interruption (measured current = 0 A before change of operating position)
Oil compartment empty	Maximum 10 A DC	Maximum 50 A DC
Oil compartment filled with insulating fluid	Maximum 50 A DC	Maximum 50 A DC

Table 6: Maximum permitted measured currents when performing DC resistance measurement on transformer

5.3.5 Drying on-load tap-changer in autoclave

NOTICE

Damage to the on-load tap-changer!

Moisture in the oil compartment reduces the dielectric strength of the insulating fluid and thus leads to damage to the on-load tap-changer.

- ▶ Within 10 hours of drying, seal off oil compartment with on-load tap-changer head cover.

Dry on-load tap-changer in accordance with the following instructions to ensure the dielectric values assured by MR for the on-load tap-changer.

If drying in an autoclave, the following methods are possible:

- Vacuum drying
- Vapor-phase drying

As an alternative to drying the on-load tap-changer in an autoclave, it can also be dried in the transformer tank.

5.3.5.1 Vacuum-drying in the autoclave

To vacuum dry the on-load tap-changer in the autoclave, proceed as follows.



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [▶ Section 5.3.9, Page 124].

Removing on-load tap-changer head cover

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

NOTICE

Damage to the on-load tap-changer!

Small parts in the oil compartment may block the diverter switch insert, thereby damaging the on-load tap-changer.

- ▶ Ensure that parts do not fall into the oil compartment.
- ▶ Check that all small parts are accounted for.

1. Operate on-load tap-changer to adjustment position.

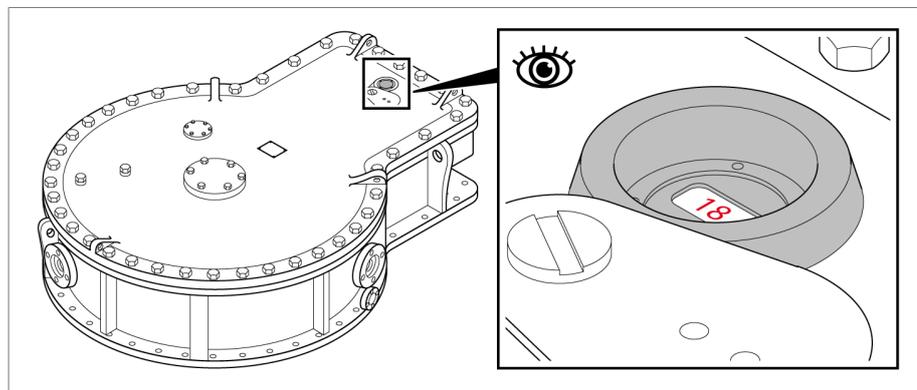


Figure 104: Adjustment position

- Remove nuts, screws and locking elements from the on-load tap-changer head cover.

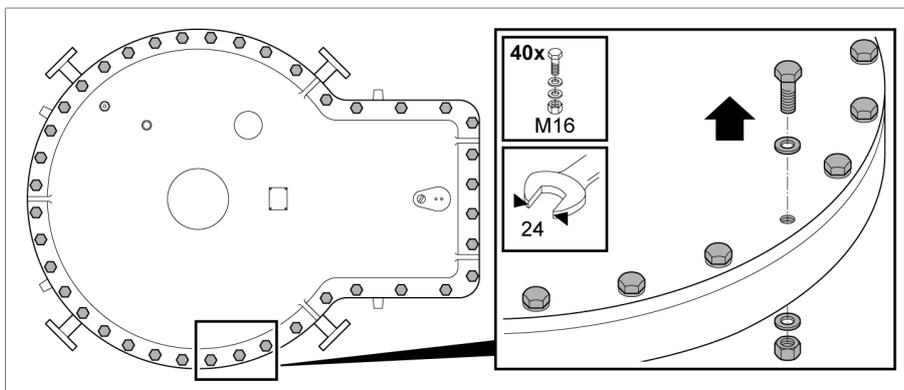


Figure 105: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage.

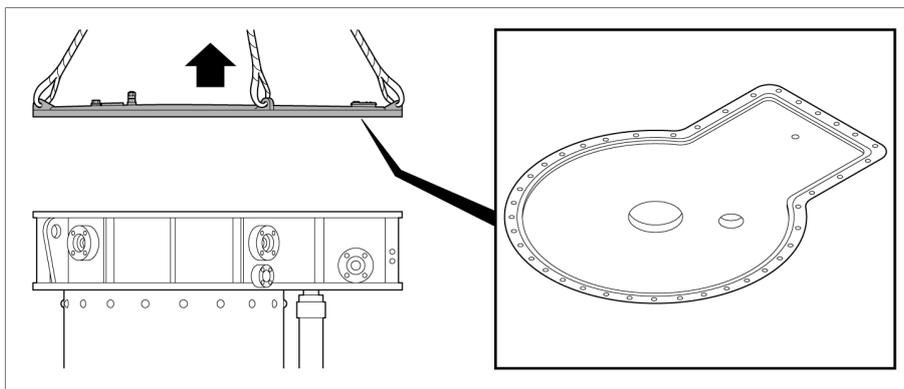


Figure 106: On-load tap-changer head cover

- NOTICE!** Do not expose the open oil compartment to ambient humidity for more than 10 hours after drying. Otherwise, damage may result to the on-load tap-changer and transformer due to insufficient dielectric strength of the diverter switch oil.

NOTICE

Drying the on-load tap-changer

Damage to the on-load tap-changer head cover and on-load tap-changer accessories.

Both the on-load tap-changer head cover and the on-load tap-changer accessories will become damaged if they are dried.

► Never dry the on-load tap-changer head cover or the following accessories: motor-drive unit, drive shaft, protective relay, pressure monitoring device, pressure relief device, bevel gear, temperature sensor, oil filter unit.

1. Heat up the on-load tap-changer in air at atmospheric pressure with a temperature increase of approximately 10 °C/h to a final temperature of maximum 110 °C.
2. Pre-dry the on-load tap-changer in circulating air at a maximum temperature of 110 °C for a period of at least 20 hours.
3. Vacuum-dry on-load tap-changer at between 105 °C and maximum 125 °C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

Securing on-load tap-changer head cover

► Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

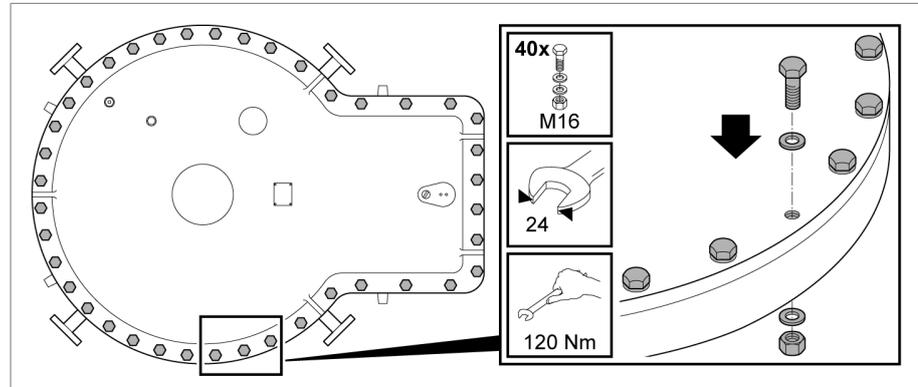


Figure 107: On-load tap-changer head cover

5.3.5.2 Vapor-phase drying in the autoclave

For kerosene drying in the autoclave, you must remove the diverter switch insert from the oil compartment and open the kerosene drain plug in the oil compartment base before drying so that the kerosene condensate can drain from the oil compartment. After the drying process, you have to close the kerosene drain plug and reinsert the diverter switch insert into the oil compartment.

Proceed as follows:



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [▶ Section 5.3.9, Page 124].

5.3.5.2.1 Opening kerosene drain plug

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

1. Operate on-load tap-changer to adjustment position.

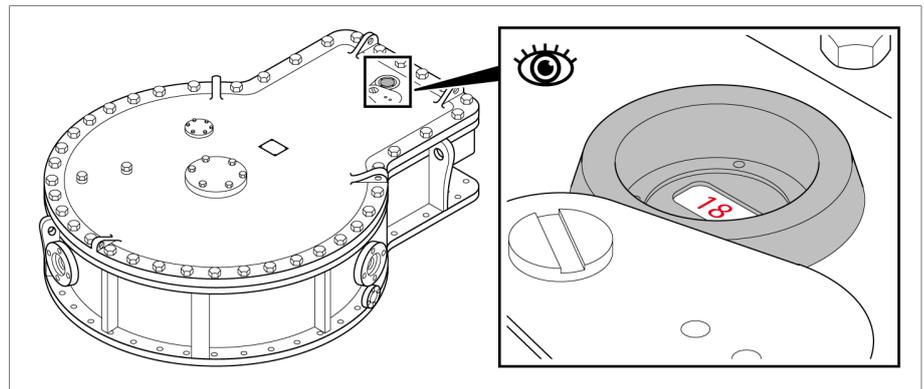


Figure 108: Adjustment position

- Remove nuts, screws and locking elements from the on-load tap-changer head cover.

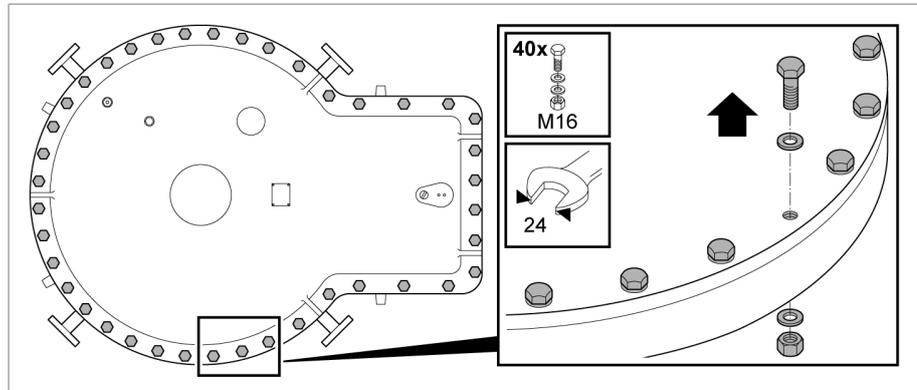


Figure 109: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

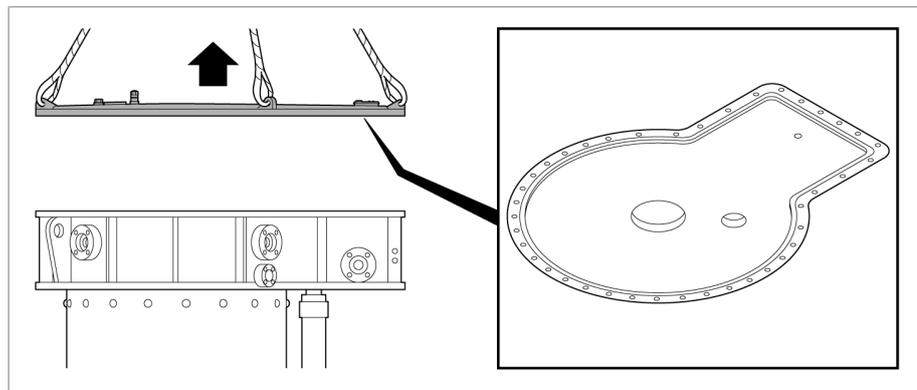


Figure 110: On-load tap-changer head cover

4. Remove nuts and locking elements on the 3 bearing bolts in the on-load tap-changer head.

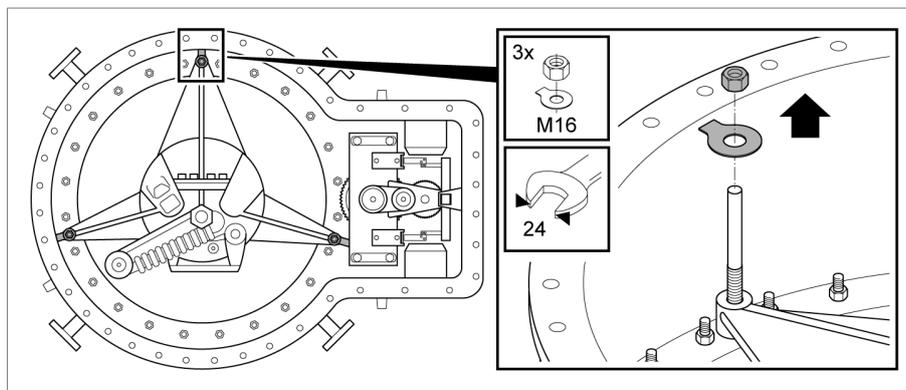


Figure 111: Nuts and lock tabs

5. Remove retaining rings from the coupling rod of the diverter switch insert. Lift off the coupling rod with cover plate between the gear crank and energy accumulator.

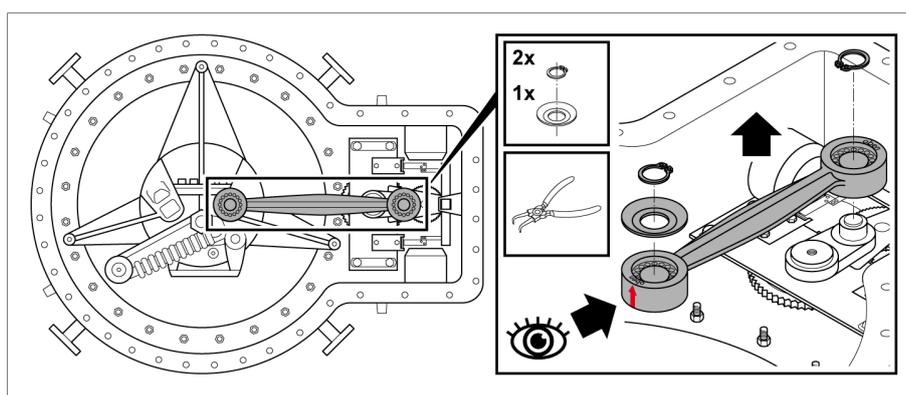


Figure 112: Coupling rod

6. Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

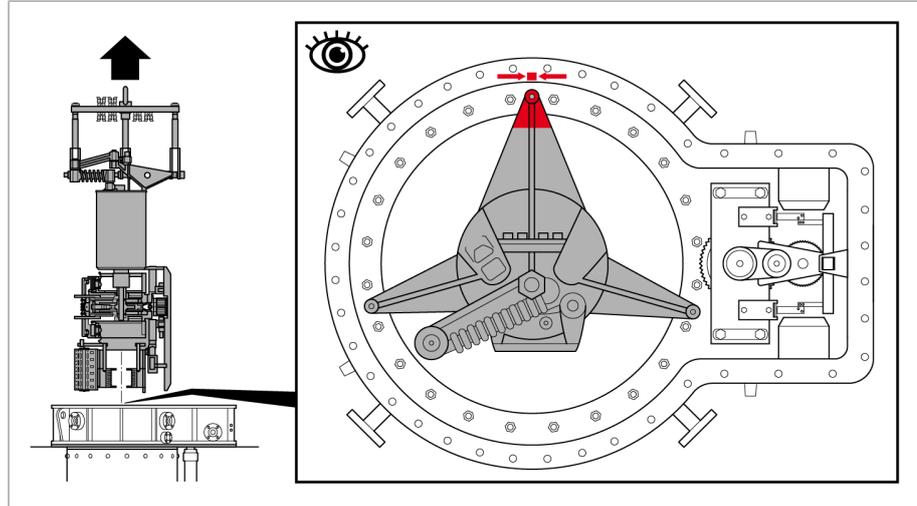


Figure 113: Diverter switch insert

7. **⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
8. **NOTICE!** Unscrew kerosene drain plug counter-clockwise until it starts to get hard to turn. Never unscrew the kerosene drain plug all the way.

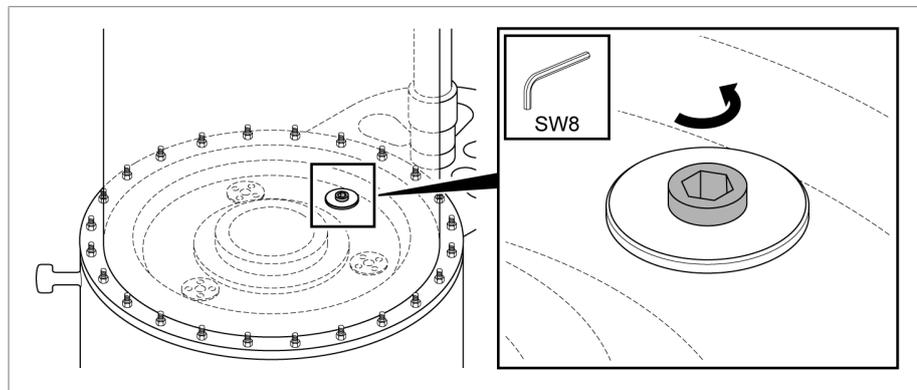


Figure 114: Kerosene drain plug

5.3.5.2.2 Drying the on-load tap-changer

1. **NOTICE!** Remove on-load tap-changer accessories (motor-drive unit, drive shaft, protective relay, pressure monitoring device, pressure relief device, bevel gear, temperature sensor, oil filter unit) and store outside autoclave. Otherwise, the on-load tap-changer accessories may be damaged.
2. **NOTICE!** Store the on-load tap-changer head cover outside the autoclave. Otherwise, the on-load tap-changer head cover may be damaged.

3. Dry the on-load tap-changer and diverter switch insert in accordance with the following regulations.

Vapor-phase drying in the autoclave

1. Supply kerosene vapor at a temperature of around 90°C. Keep this temperature constant for 3 to 4 hours.
2. Increase the kerosene vapor temperature by approx. 10°C/hour to the desired final temperature of max. 125°C at the on-load tap-changer.
3. Vacuum-dry on-load tap-changer at between 105°C and maximum 125°C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.3.5.2.3 Closing kerosene drain plug

1. Close kerosene drain plug clockwise (tightening torque 20 Nm).
2. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
3. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

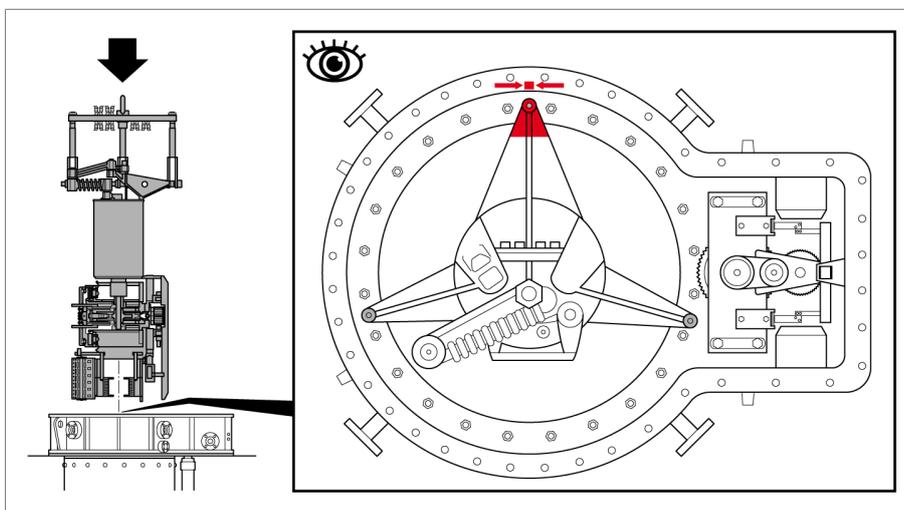


Figure 115: Inserting diverter switch insert

4. Fasten the diverter switch insert to the 3 bearing bolts.

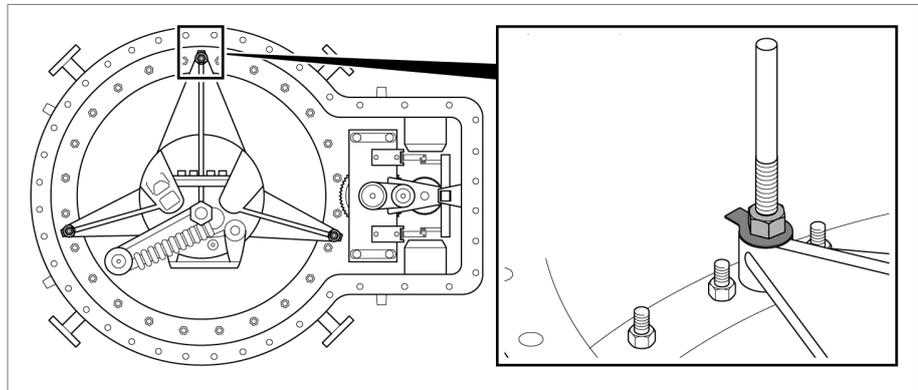


Figure 116: Fastening the diverter switch insert

5. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

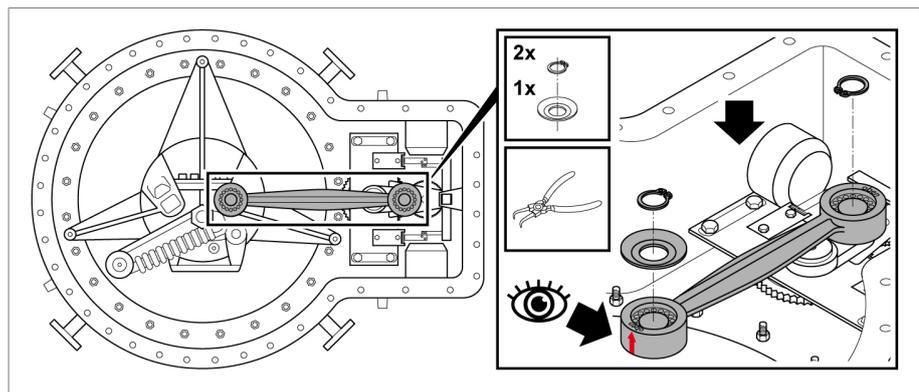
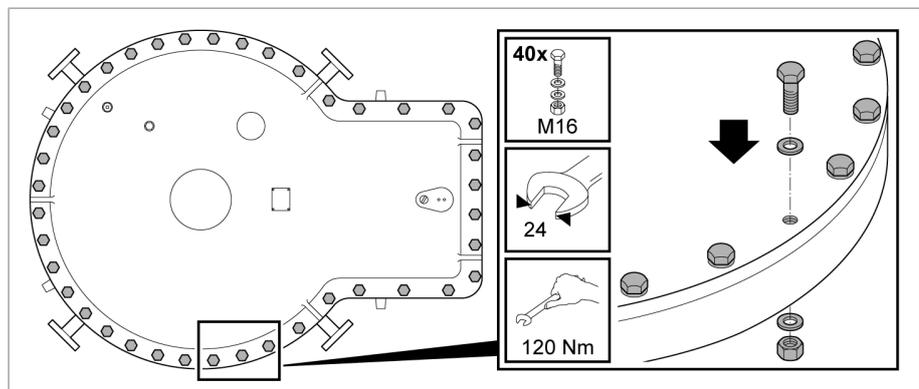


Figure 117: Coupling rod

6. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.



7. On-load tap-changer head cover

5.3.6 Attaching the bell-type tank and connecting the on-load tap-changer to the top part of the on-load tap-changer head

5.3.6.1 Removing the diverter switch insert and dismantling the on-load tap-changer head

1. Remove spacers and slowly lower on-load tap-changer.

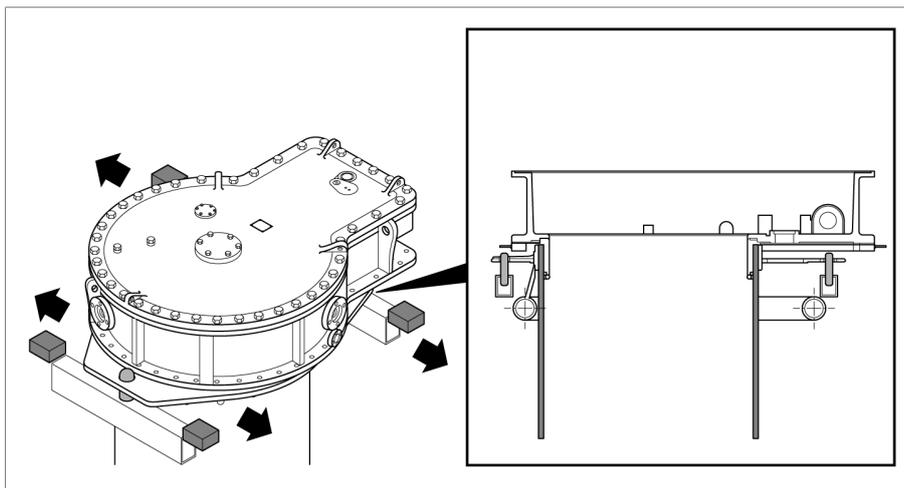


Figure 118: Removing the spacers

2. Operate on-load tap-changer to adjustment position.

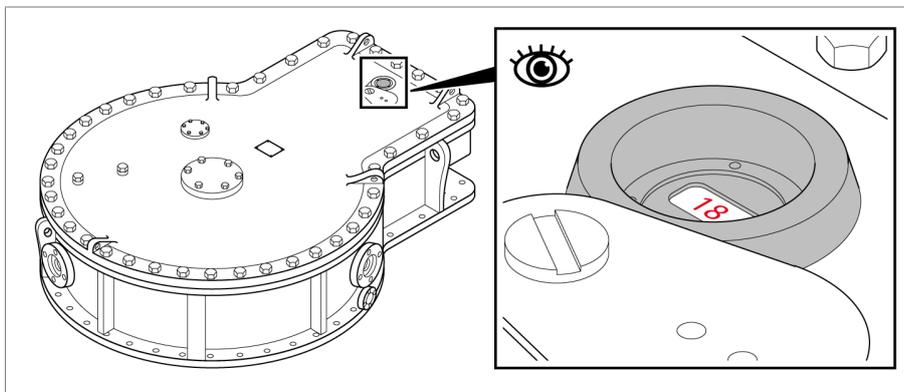


Figure 119: Adjustment position

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

1. Remove nuts, screws and locking elements from the on-load tap-changer head cover.

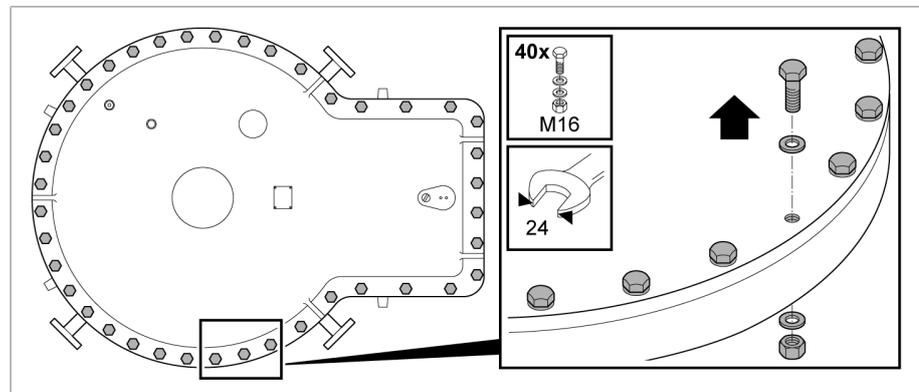


Figure 120: On-load tap-changer head cover

2. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer dam-

age. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

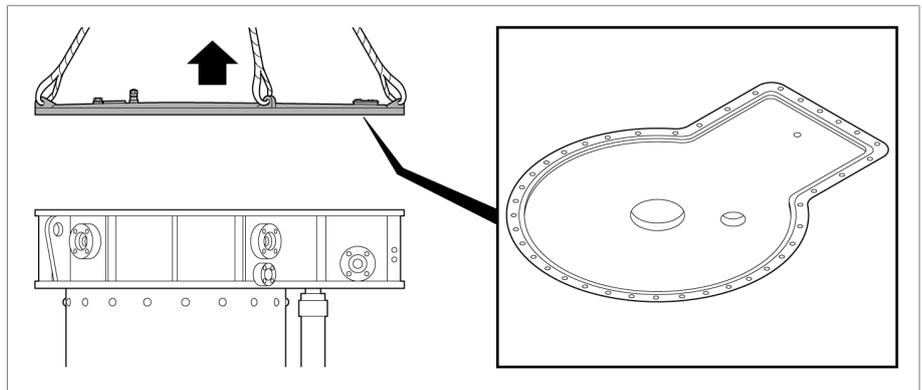


Figure 121: On-load tap-changer head cover

3. Remove nuts and lock tabs on the 3 bearing bolts in the on-load tap-changer head.

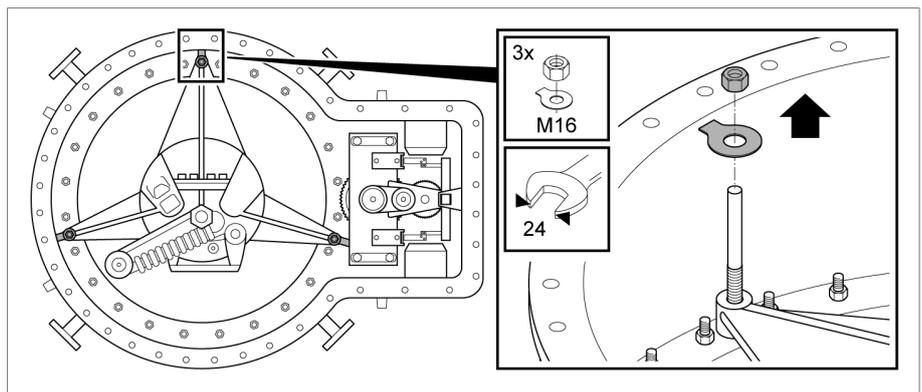


Figure 122: Nuts and lock tabs

4. Remove retaining rings from the coupling rod of the diverter switch insert. Lift off the coupling rod and washers between the gear crank and energy accumulator.

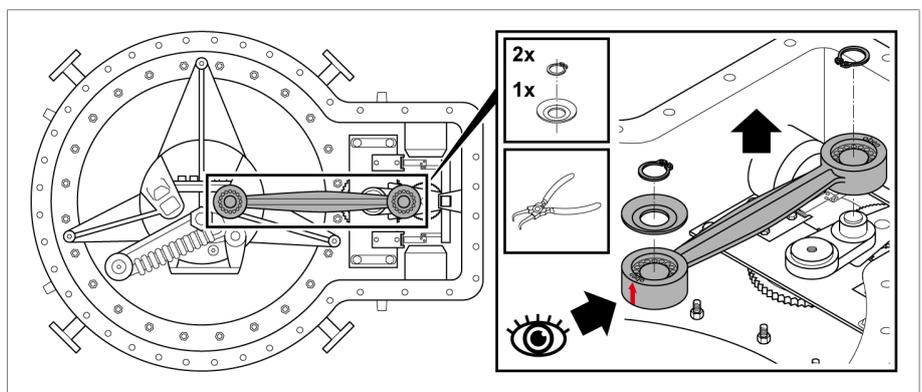


Figure 123: Coupling rod

5. Use the provided lifting cross to carefully lift the diverter switch insert vertically out of the oil compartment.

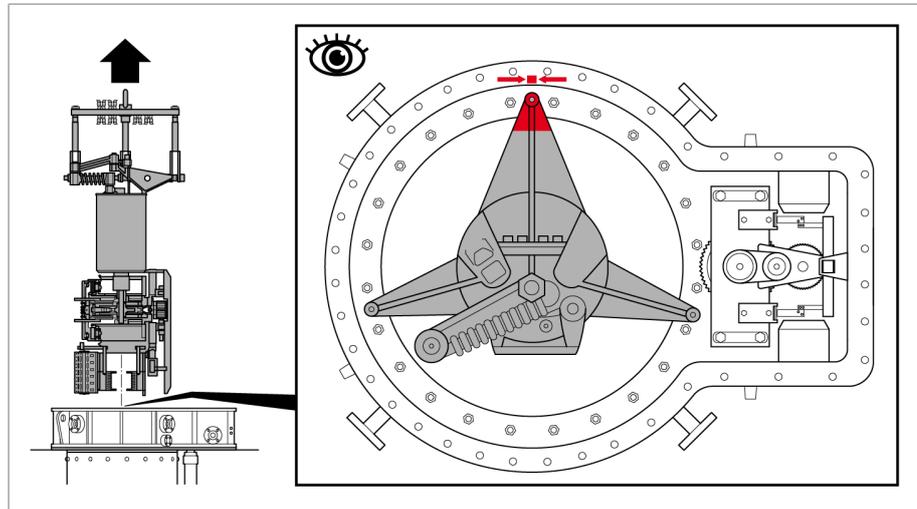


Figure 124: Diverter switch insert

6. **⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
7. Remove screws from the oil suction pipe and pull the oil suction pipe down to remove it. Store the screws to be used for subsequent oil suction pipe fastening.

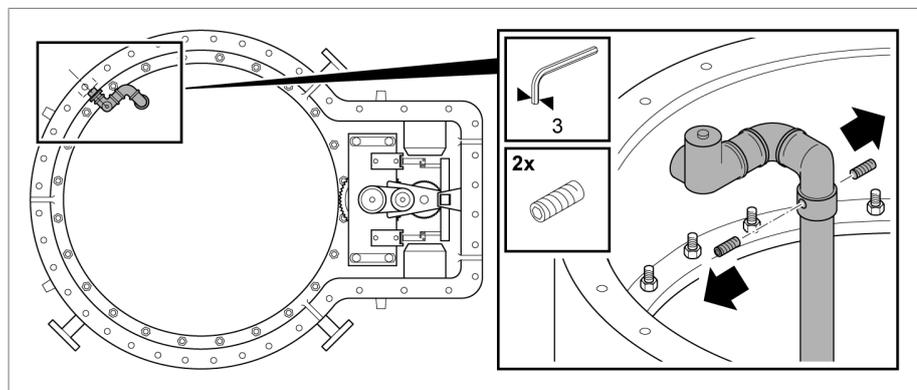


Figure 125: Oil suction pipe

8. **NOTICE!** Remove nuts and locking elements in the on-load tap-changer head. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

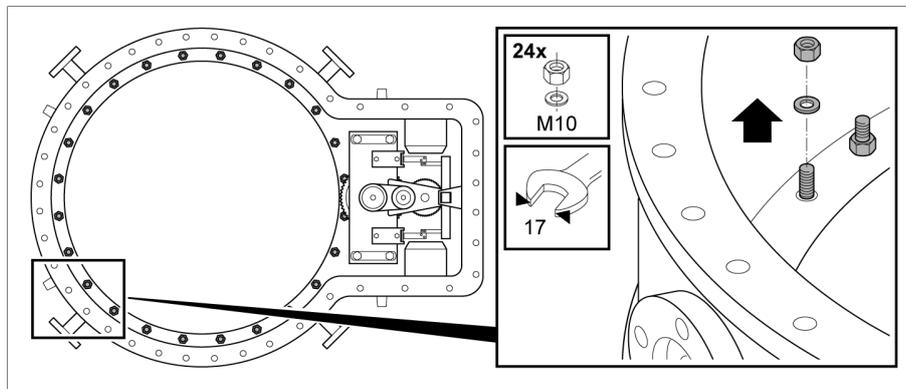


Figure 126: On-load tap-changer head

9. **NOTICE!** Lift the on-load tap-changer head off the oil compartment. For all work, check that the sealing surfaces on the on-load tap-changer head and oil compartment flange, and the gasket between the on-load tap-changer head and oil compartment, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage.

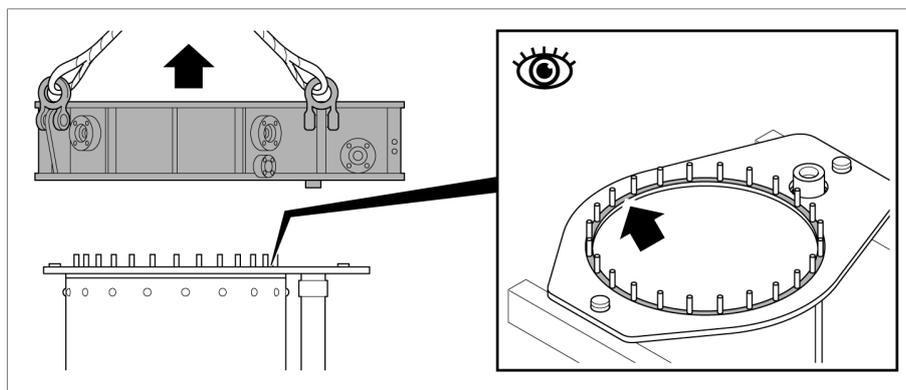


Figure 127: On-load tap-changer head

5.3.6.2 Attaching bell-type tank

1. Clean sealing surface of supporting flange, place flat gasket on supporting flange.

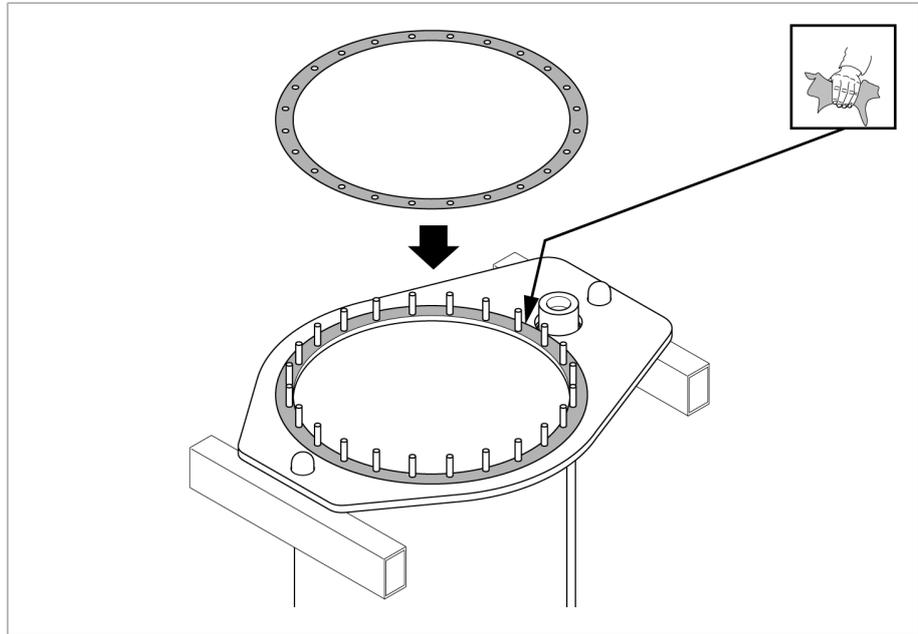


Figure 128: Supporting flange with o-ring

2. Lift the bell-type tank over the active part of the transformer.

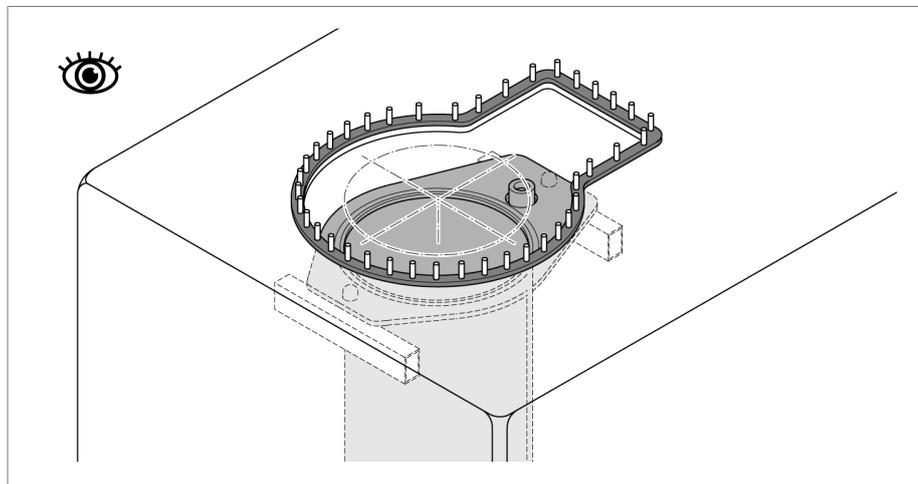


Figure 129: Bell-type tank

5.3.6.3 Fastening the on-load tap-changer head to the transformer cover

1. Clean sealing surfaces on mounting flange and on-load tap-changer head, place the provided gasket on mounting flange. For on-load tap-changer heads with O-rings, insert the O-ring into the groove in the on-load tap-changer head.

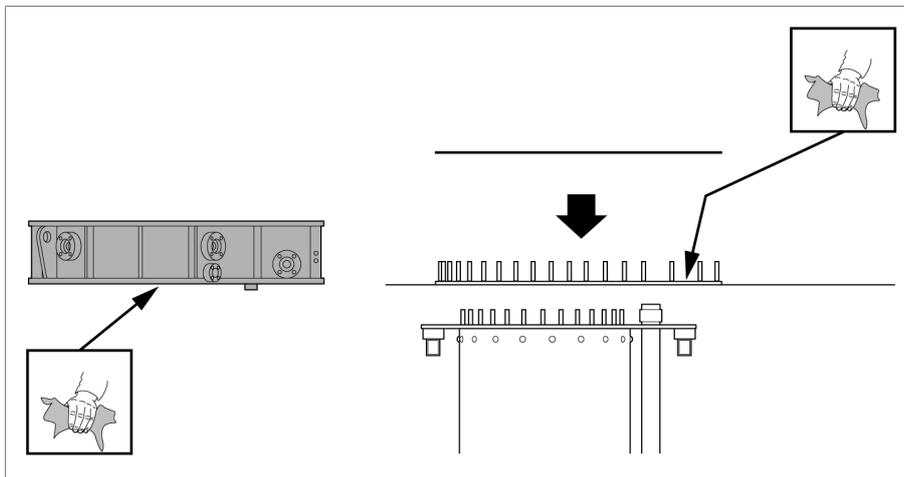


Figure 130: Mounting flange and on-load tap-changer head

2. Place the on-load tap-changer head on the mounting flange. When doing so, ensure that the selector drive shaft does not collide with the transformer cover. Ensure that the groove in the drive shaft and the locating pin in the selector drive shaft are aligned.

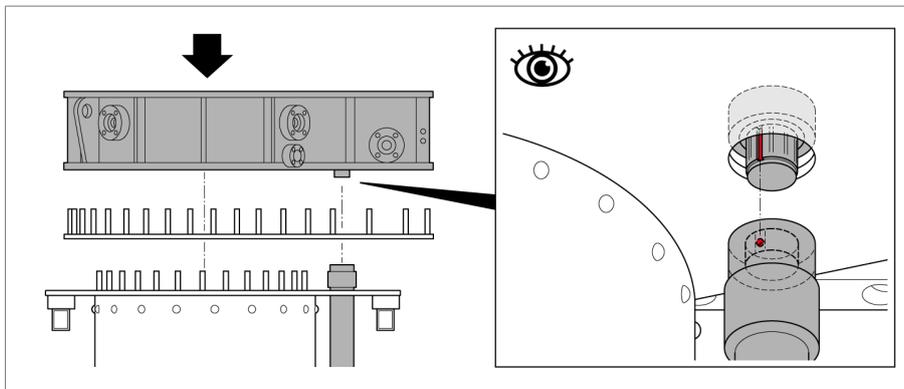


Figure 131: On-load tap-changer head

3. Screw on-load tap-changer head to mounting flange.

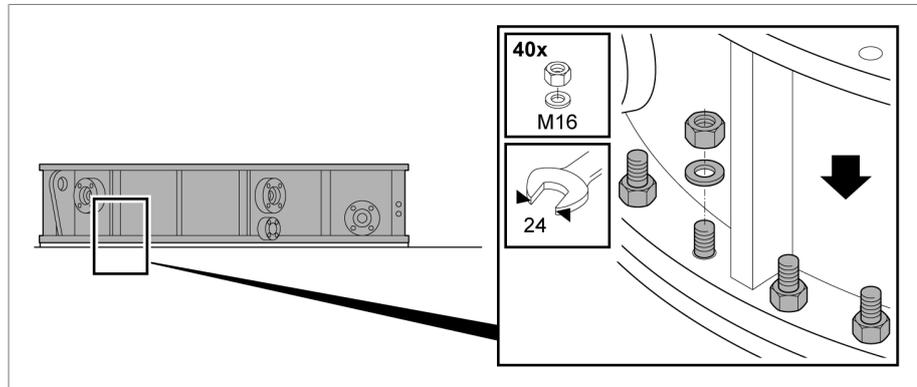


Figure 132: Screwing down on-load tap-changer head

5.3.6.4 Connecting the oil compartment and selector with the on-load tap-changer head

1. **NOTICE!** Lift the oil compartment with selector attached below using only the specified lifting traverse.

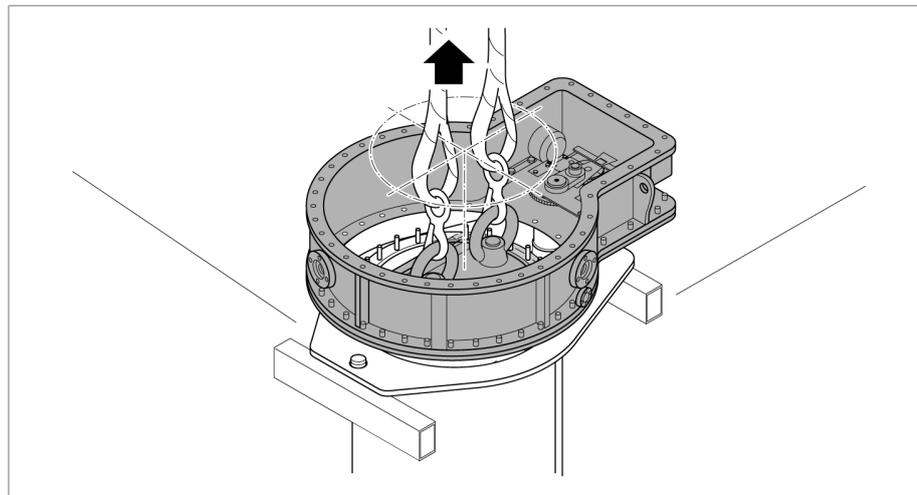


Figure 133: Lifting traverse

2. **NOTICE!** Fasten the on-load tap-changer head to the oil compartment using only the new locknuts provided in the scope of delivery.

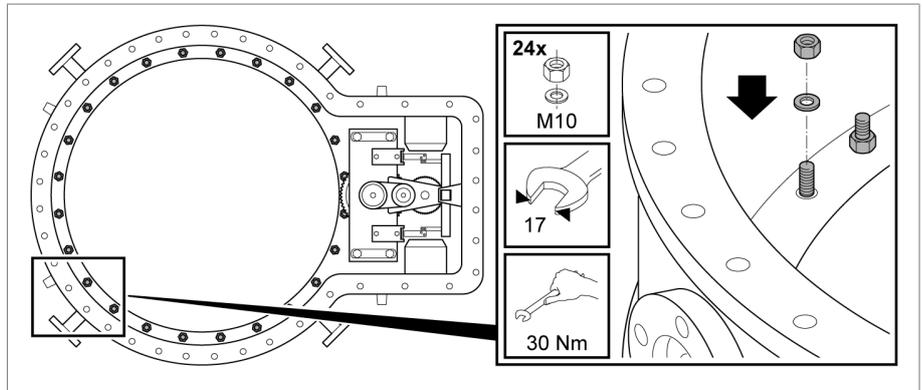


Figure 134: Fastening the on-load tap-changer head to the oil compartment

3. Remove lifting traverse.
4. Insert the oil suction pipe into the oil compartment and connect it to the clamping sleeve at the bottom of the oil compartment.

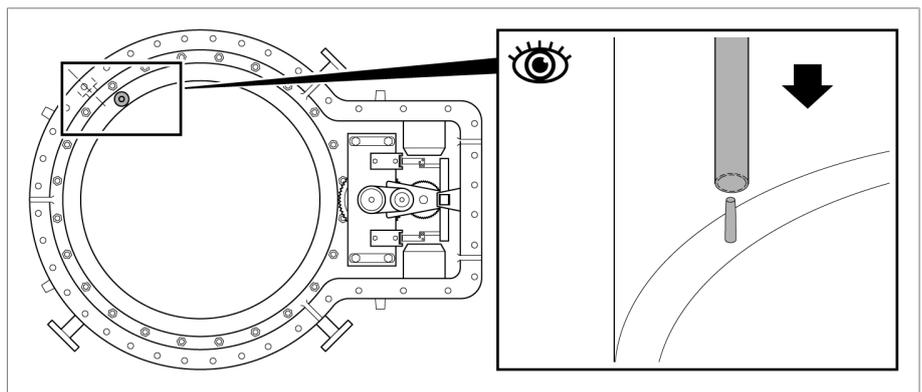


Figure 135: Clamping sleeve

5. Fasten the oil suction pipe to the oil suction pipe manifold.

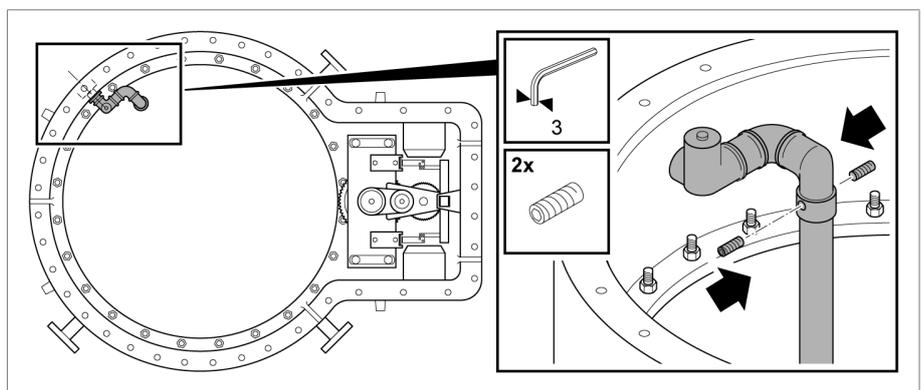


Figure 136: Oil suction pipe

5.3.6.5 Inserting the diverter switch insert into the oil compartment

1. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
2. Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

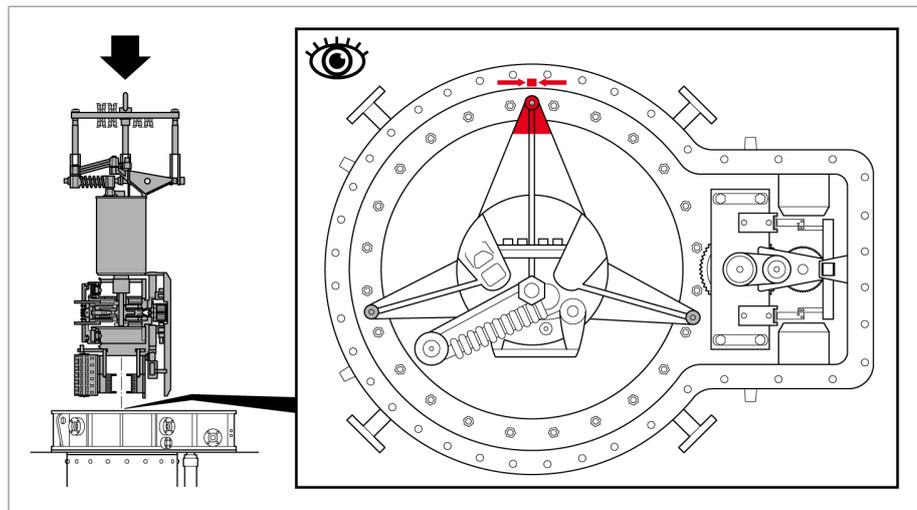


Figure 137: Inserting diverter switch insert

3. Fasten the diverter switch insert to the 3 bearing bolts. Secure the nuts to prevent them from turning.



Do not fasten the nuts until drying is complete if the on-load tap-changer is to be dried later in the transformer tank using kerosene and the diverter switch insert has to be removed and reinserted to open and close the kerosene drain plug.

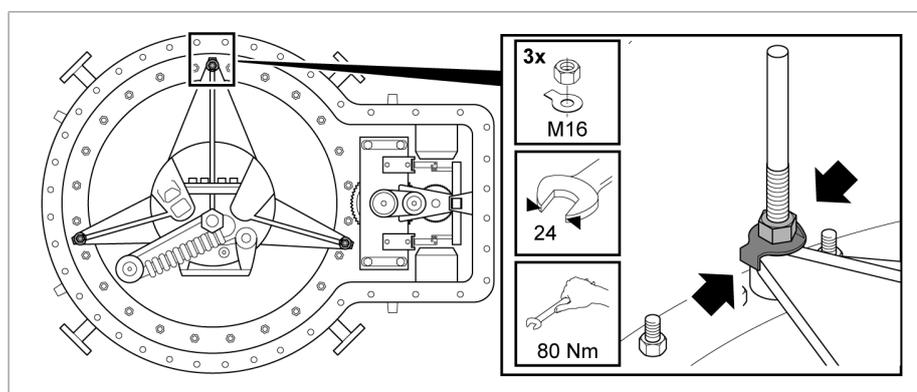


Figure 138: Fastening the diverter switch insert

4. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

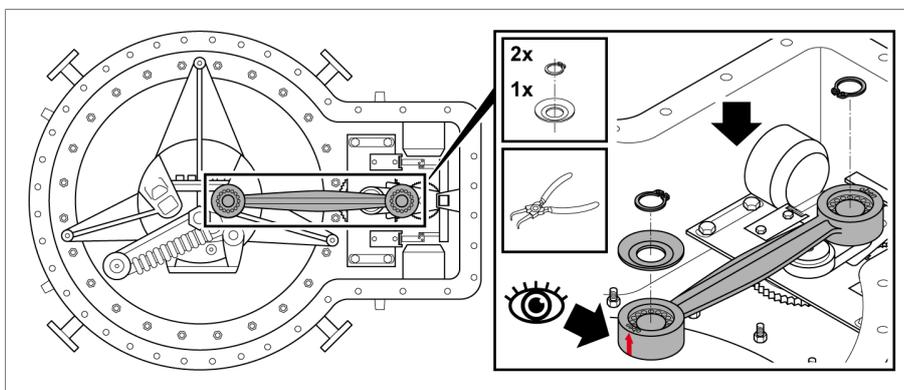


Figure 139: Fastening the coupling rod

5. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

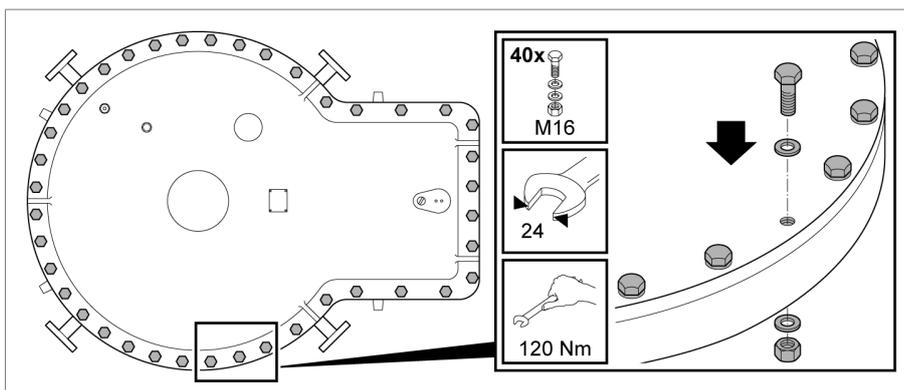


Figure 140: On-load tap-changer head cover

5.3.7 Drying on-load tap-changer in transformer tank

Dry on-load tap-changer in accordance with the following instructions to ensure the dielectric values assured by MR on the on-load tap-changer.

If you want to dry the on-load tap-changer in the transformer tank, fully assemble the transformer first and then undertake drying.

If drying in the transformer tank, the following methods are possible:

- Vacuum-drying
- Vapor-phase drying

As an alternative to drying the on-load tap-changer in the transformer tank, it can also be dried in an autoclave.

5.3.7.1 Vacuum-drying in the transformer tank

Before you start vacuum-drying in the transformer tank, you must place a connecting lead between the corresponding pipe connections and seal off the pipe connections not being used with blank covers.



The on-load tap-changer head cover remains closed during the entire drying process.



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [► Section 5.3.9, Page 124].

1. Establish the connecting lead on the on-load tap-changer head between connections E and Q or E and R.

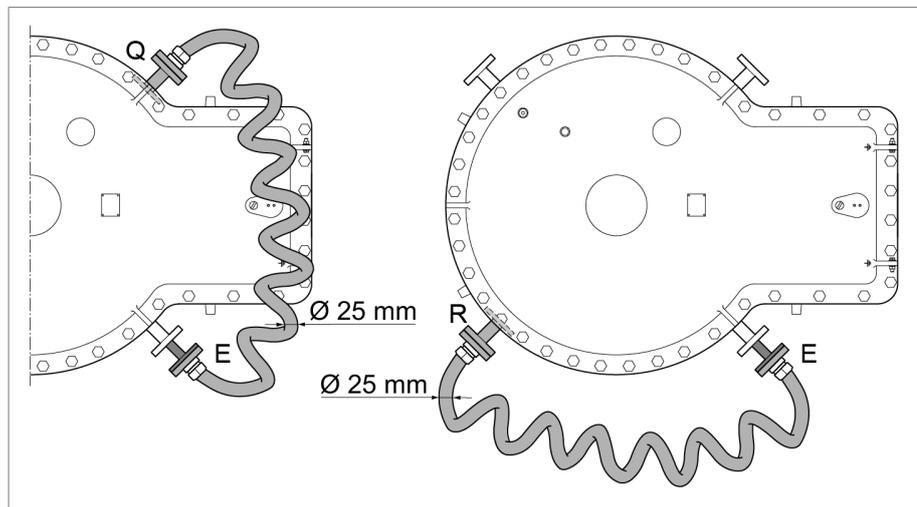


Figure 141: Connecting lead

2. Seal off unused pipe connections with suitable blank covers.

Vacuum-drying in the transformer tank

1. Heat up the on-load tap-changer in air at atmospheric pressure with a temperature increase of approximately 10 °C/h to a final temperature of maximum 110 °C.
2. Pre-dry the on-load tap-changer in circulating air at a maximum temperature of 110 °C for a period of at least 20 hours.
3. Vacuum-dry on-load tap-changer at between 105 °C and maximum 125 °C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.3.7.2 Vapor-phase drying in the transformer tank

For vapor-phase drying in the transformer tank, you must remove the diverter switch insert from the oil compartment and open the kerosene drain plug in the oil compartment base before drying so that the kerosene condensate can drain from the oil compartment. After the drying process, you have to close the kerosene drain plug and reinsert the diverter switch insert into the oil compartment.

Proceed as follows:



If you wish to perform another transformer ratio test after drying, proceed as described in the section "Performing transformer ratio test following drying" [► Section 5.3.9, Page 124].

5.3.7.2.1 Opening kerosene drain plug

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

1. Operate on-load tap-changer to adjustment position.

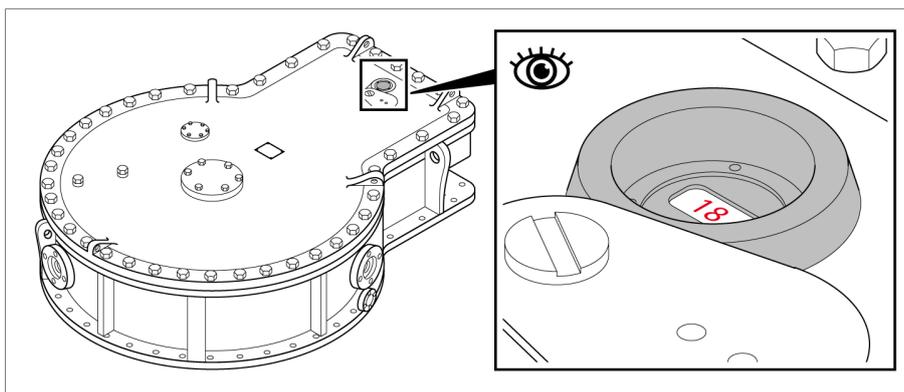


Figure 142: Adjustment position

- Remove nuts, screws and locking elements from the on-load tap-changer head cover.

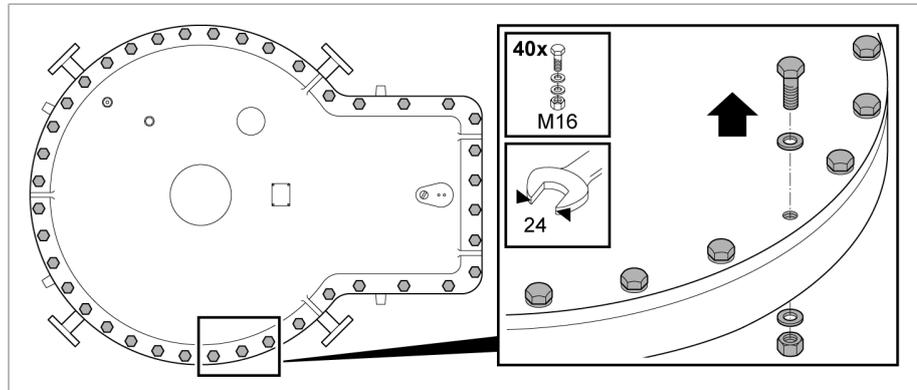


Figure 143: On-load tap-changer head cover

- NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

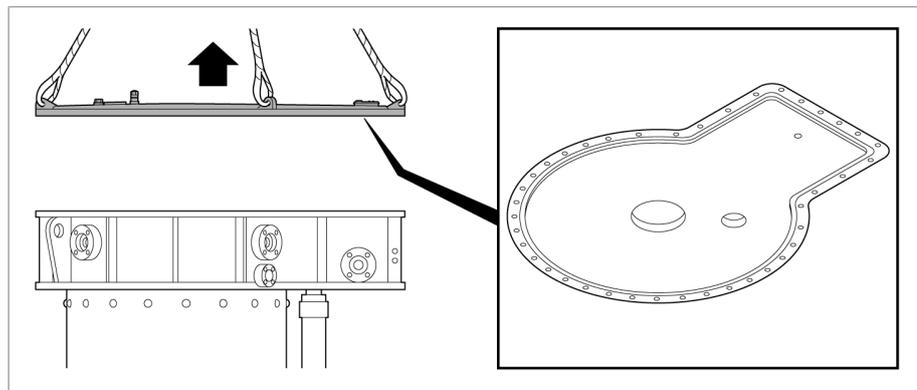


Figure 144: On-load tap-changer head cover

4. Remove nuts and locking elements on the 3 bearing bolts in the on-load tap-changer head.

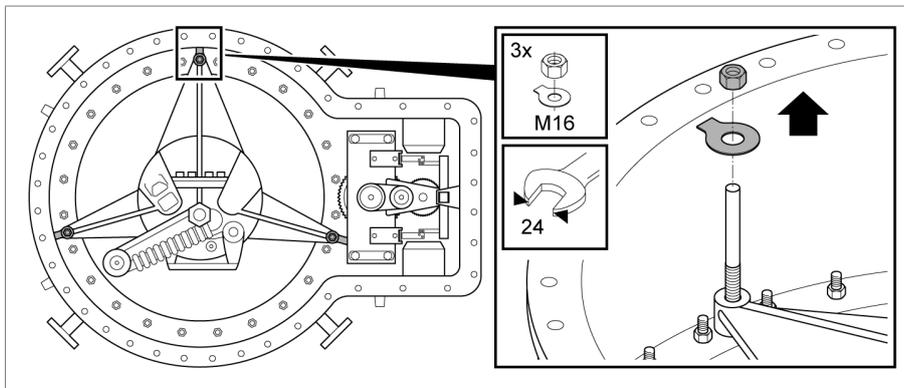


Figure 145: Nuts and lock tabs

5. Remove retaining rings from the coupling rod of the diverter switch insert. Lift off the coupling rod with cover plate between the gear crank and energy accumulator.

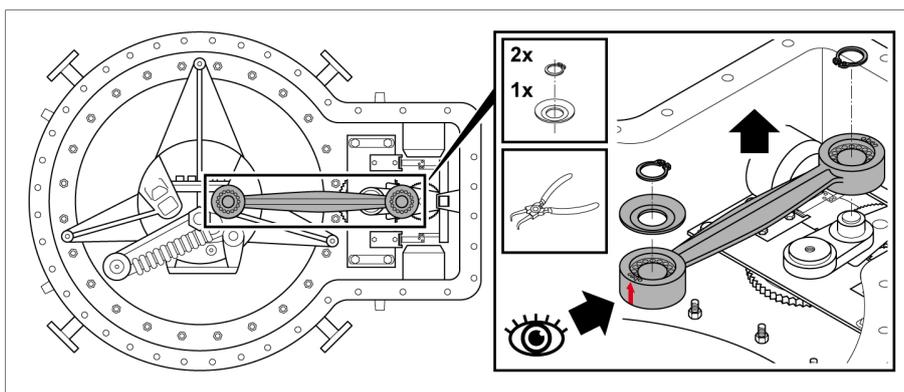


Figure 146: Coupling rod

- Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

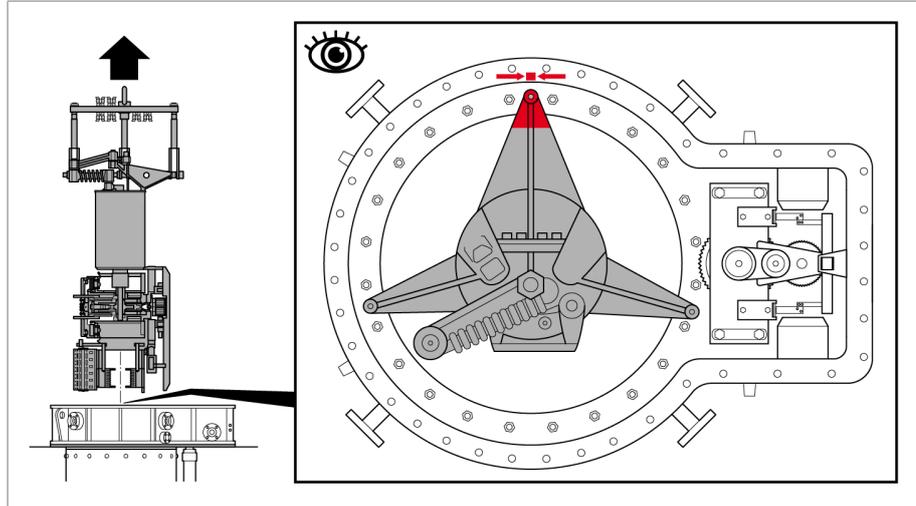


Figure 147: Diverter switch insert

- ⚠ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
- NOTICE!** Unscrew kerosene drain plug counter-clockwise until it starts to get hard to turn. Never unscrew the kerosene drain plug all the way.

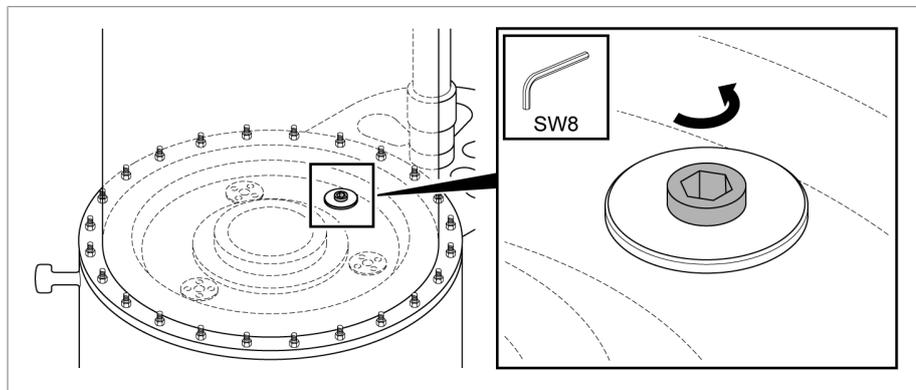


Figure 148: Kerosene drain plug

5.3.7.2.2 Inserting the diverter switch insert into the oil compartment

- Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.
- Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match.

When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

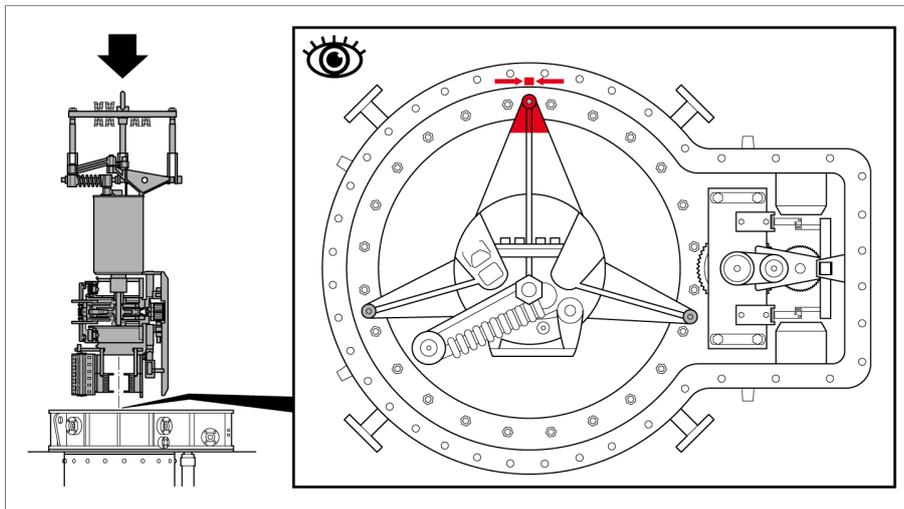


Figure 149: Inserting diverter switch insert

3. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.

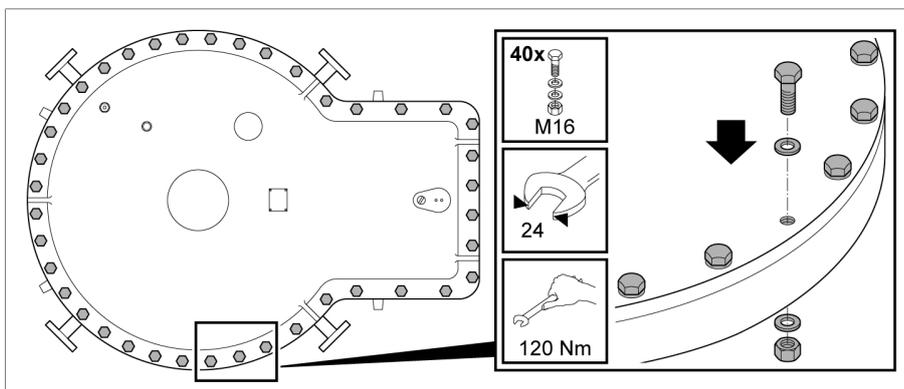


Figure 150: On-load tap-changer head cover

5.3.7.2.3 Drying the on-load tap-changer

1. Connect pipe connections R and Q of on-load tap-changer head to the kerosene vapor lead using one shared lead. Note that the R and Q pipe connections may be located in another location on the on-load tap-changer head [► Section 11.2, Page 218].

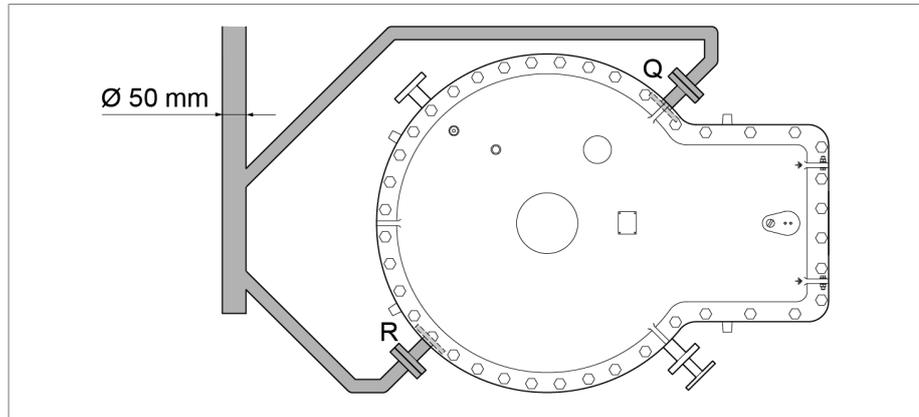


Figure 151: Shared lead

2. Seal off unused pipe connections with suitable blank covers.

Vapor-phase drying in the transformer tank

1. Supply kerosene vapor at a temperature of around 90°C. Keep this temperature constant for 3 to 4 hours.
2. Increase the kerosene vapor temperature by approx. 10°C/hour to the desired final temperature of max. 125°C at the on-load tap-changer.
3. Vacuum-dry on-load tap-changer at between 105°C and maximum 125°C for at least 50 hours.
4. Residual pressure of no more than 10⁻³ bar.

5.3.7.2.4 Closing kerosene drain plug

1. Remove nuts, screws and locking elements from the on-load tap-changer head cover.

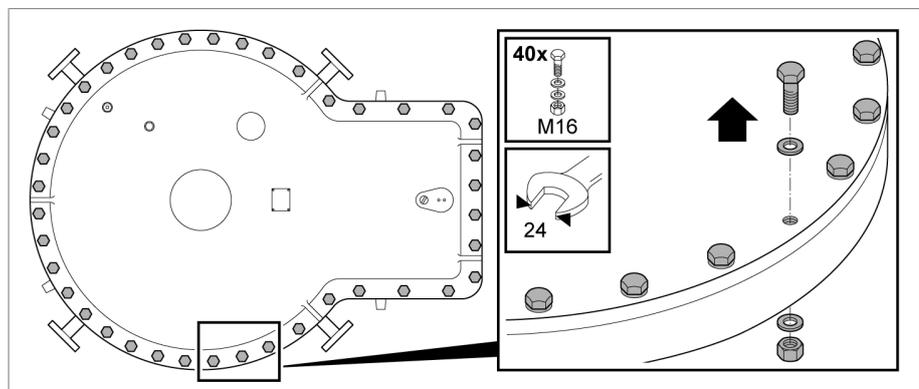


Figure 152: On-load tap-changer head cover

2. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

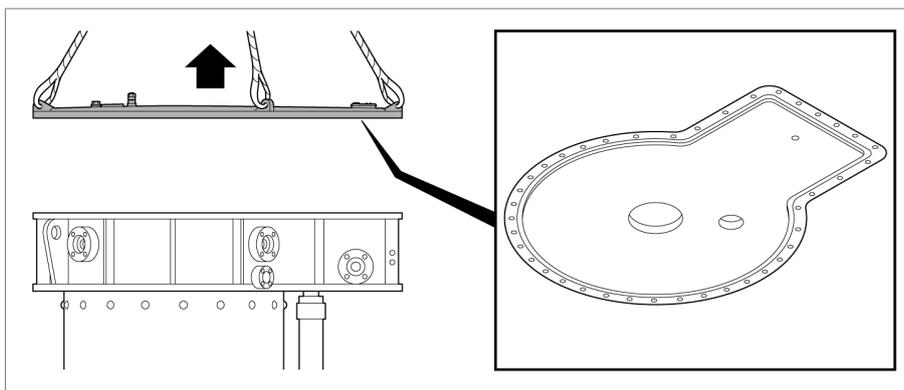


Figure 153: On-load tap-changer head cover

3. Use the provided lifting cross to carefully lift the diverter switch insert vertically from the oil compartment (see provided lifting cross instructions).

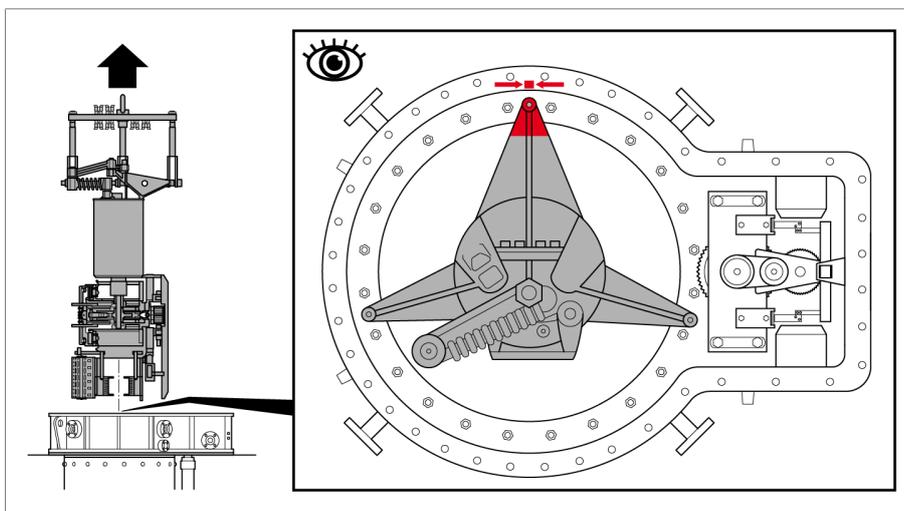


Figure 154: Diverter switch insert

4. **▲ WARNING!** Place the diverter switch insert on a level surface and secure it against tipping. An unstably positioned diverter switch insert may tip, resulting in serious injuries.
5. Close kerosene drain plug clockwise (tightening torque 20 Nm).
6. Use the provided lifting cross to lift the diverter switch insert (see provided lifting cross instructions) and clean the underside of the diverter switch insert.

- Lift the diverter switch insert above the open on-load tap-changer head and slowly lower it vertically into the oil compartment. Ensure that the red marks on the diverter switch insert and on-load tap-changer head match. When the lowering process is complete, ensure that the holes on the bearing arms of the diverter switch insert are aligned with the bearing bolts in the on-load tap-changer head.

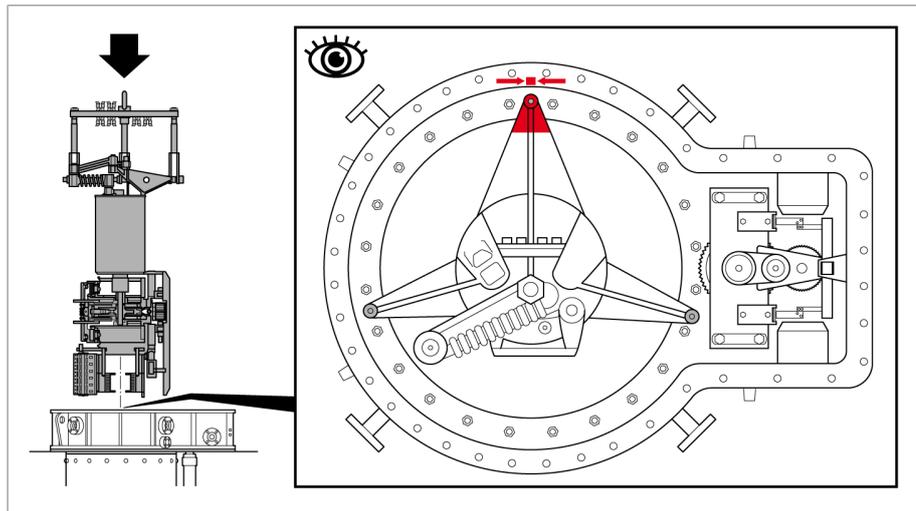


Figure 155: Inserting diverter switch insert

- Fasten the diverter switch insert to the 3 bearing bolts. Secure the nuts to prevent them from turning.

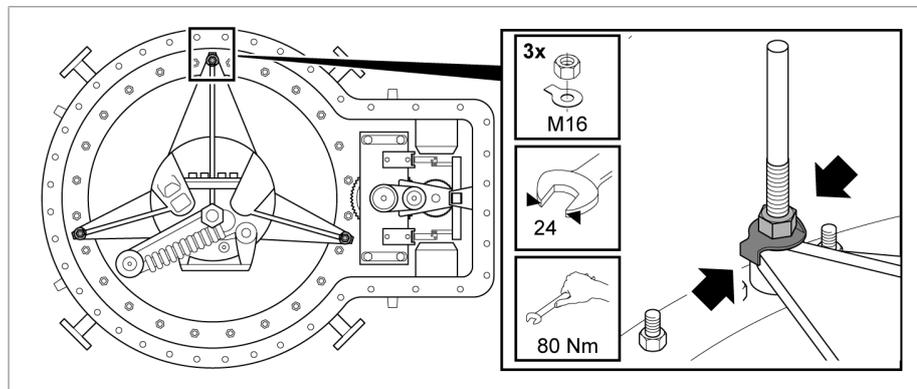


Figure 156: Fastening the diverter switch insert

9. Insert the coupling rod with the "oben" (= "top") marking on top between the gear crank and energy accumulator. Place the cover plate on the coupling rod on the side of the energy accumulator and fasten the coupling rod using retaining rings.

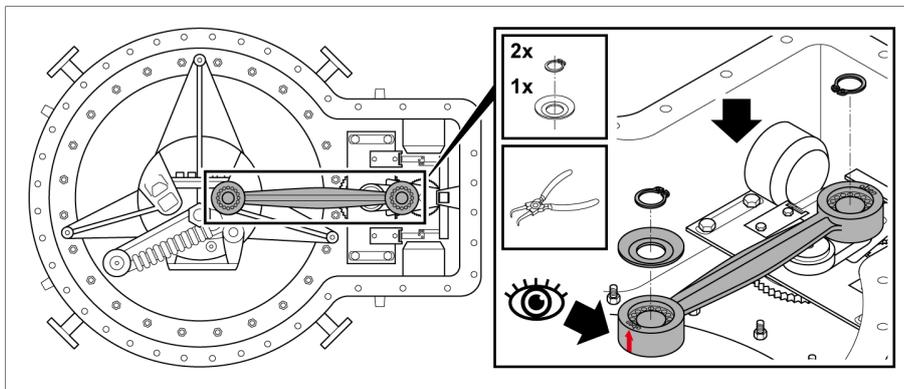
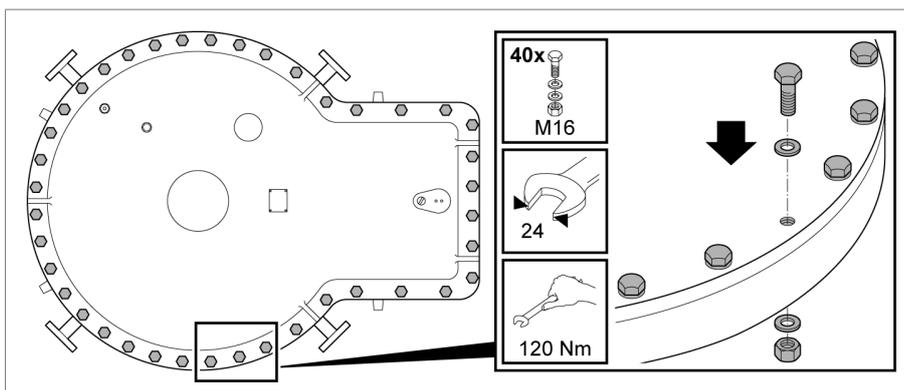


Figure 157: Coupling rod

10. Position the gasket on the on-load tap-changer head, place the on-load tap-changer head cover on the on-load tap-changer head and secure it.



11. On-load tap-changer head cover

5.3.8 Filling the oil compartment of the on-load tap-changer with oil and bleeding it

NOTICE

Damage to the on-load tap-changer!

Unsuitable insulating fluids cause damage to the on-load tap-changer.

- ▶ Only use insulating fluids [▶ Section 10.1, Page 210] approved by the manufacturer.

After drying, completely fill the oil compartment (diverter switch insert fitted) with oil again as soon as possible so that an impermissible amount of humidity is not absorbed from the surroundings.

1. Establish a connecting lead between the pipe connection E and one of the pipe connections R, S or Q to ensure uniform pressure conditions in the oil compartment and transformer during evacuation.

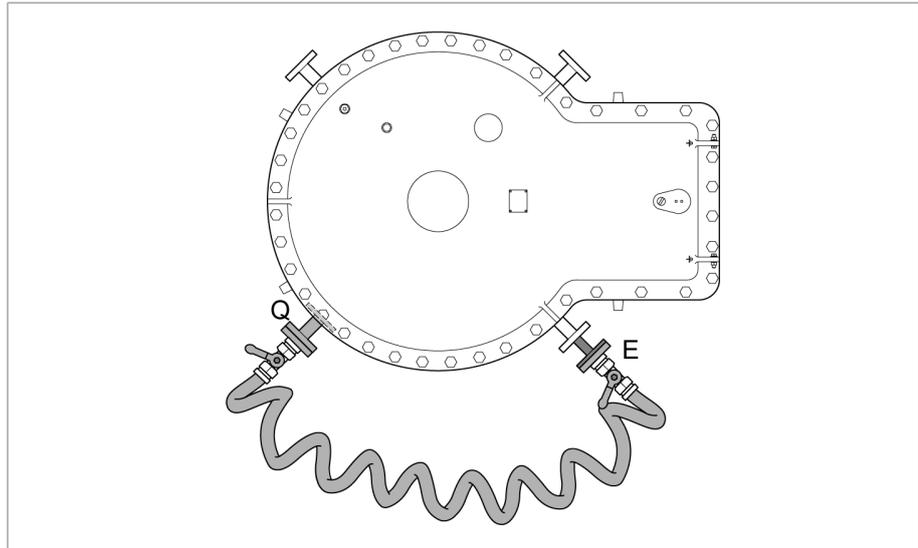


Figure 158: Connecting lead between E and Q.

2. Perform an evacuation.
3. Fill the oil compartment completely with oil via the S pipe connection. During this process, the oil suction pipe is bled.
4. Drain the oil conservator until the minimum volume for switching gases and thermal expansion has been reached in accordance with the technical data for the OILTAP® G.

5.3.9 Carrying out transformer ratio test after drying

To perform the transformer ratio test, proceed as follows:


NOTICE
Damage to property!

Damage to on-load tap-changer due to transformer ratio test being incorrectly performed!

- ▶ Make sure that the selector is fully immersed in transformer oil and that the oil compartment of the on-load tap-changer is completely filled with oil.
- ▶ The on-load tap-changer can be operated in the temperature range of the surrounding transformer oil of between -25 °C and $+105\text{ °C}$ and in accordance with IEC 60214-1 up to $+115\text{ °C}$ (during emergency transformer operation in accordance with IEC 60076-7).
- ▶ Only switch the on-load tap-changer from one operating position to the next via the drive shaft on the on-load tap-changer head. You can use a short tube (diameter 25 mm) with screwed-in coupling bolt (diameter 12 mm) with a hand wheel or crank for this. When using a drill, do not exceed a maximum speed of 250 rpm.
- ▶ Always check the operating position reached through the inspection window in the on-load tap-changer head cover. Never overshoot the end positions, which are indicated in the connection diagram supplied with the delivery.
- ▶ For multiple-column applications with a shared drive, link all on-load tap-changer heads to one another using the horizontal drive shaft part.

1. Switch on-load tap-changer into the desired operating position. The diverter switch operation can be heard distinctly.



When actuating the change-over selector, a higher torque is required.

2. **NOTICE!** After operating the diverter switch, continue to crank 2.5 revolutions in the same direction on the drive shaft of the upper gear unit in order to correctly end the tap-change operation. An incomplete tap-change operation may damage the on-load tap-changer!
3. Carry out the transformer ratio test.
4. Repeat the transformer ratio test in all operating positions.
5. Once the transformer ratio test is complete, return on-load tap-changer to its adjustment position (see supplied connection diagram of the on-load tap-changer).

5.4 Fitting protective devices and drive components

5.4.1 Connecting tap-change supervisory device (if installed)

⚠ DANGER



Risk of fatal injury due to electrical voltage!

Danger of death due to electrical voltage when assembling and connecting the device.

- ▶ De-energize the device and system peripherals and lock them to prevent them from being switched back on.

- ▶ Connect monitoring contacts integrated into the on-load tap-changer head (terminal box on pipe connection M) to the motor-drive unit terminals using a connecting lead as specified in the connection diagram provided.

5.4.2 Installing protective relay in piping and connecting

⚠ WARNING



Danger of explosion!

Explosive gases in the protective relay can deflagrate or explode and result in severe injury or death.

- ▶ Wait 15 minutes after switching off the transformer before beginning further work on the protective relay so that the gases can dissipate.
- ▶ Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits before beginning work.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).



Always perform all transformer tests with the protective relay attached and connected.

5.4.2.1 Checking function of protective relay

Check the function of the protective relay before installing it in piping between on-load tap-changer head and oil conservator. The associated contact positions for checking electrical continuity are shown in the dimensional drawing provided.

1. Loosen the three screws on the terminal box cover and lift off the terminal box cover.

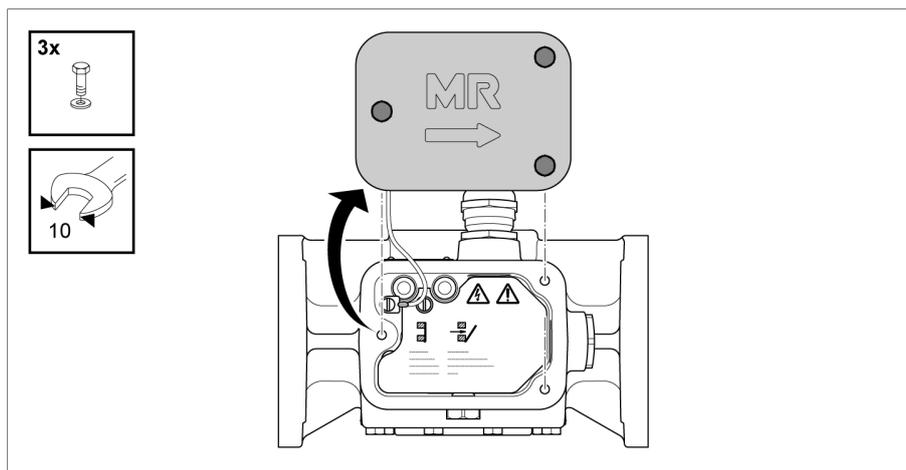


Figure 159: Terminal box cover

2. Remove the slotted head screw for potential tie-in and remove the terminal box cover with wire.

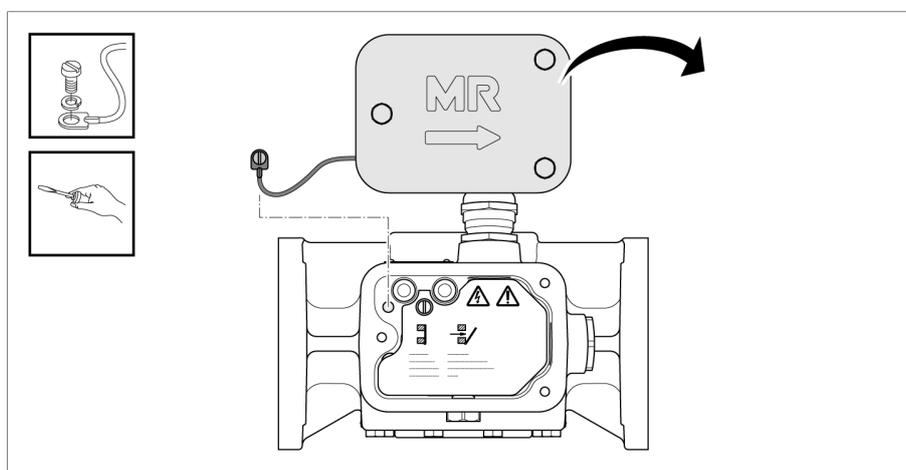


Figure 160: Terminal box cover

NOTICE

Damage to protective relay!

Damage to protective relay resulting from improper operation.

- ▶ Never press both test buttons at the same time.

3. Press OFF test button.

⇒ Flap valve is inclined. Line marker appears in the middle of the inspection window.

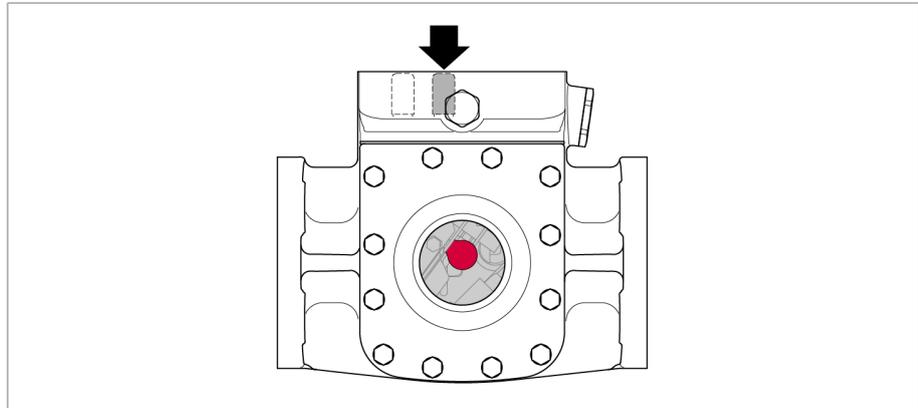


Figure 161: OFF position

4. Press OPERATION test button.

⇒ Flap valve is vertical.

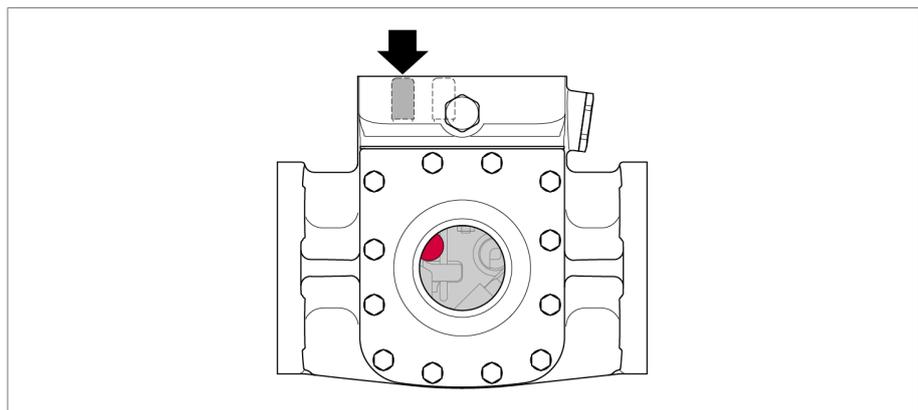


Figure 162: OPERATION position

5. Position the wire for the terminal box cover and affix using the slotted head screw.

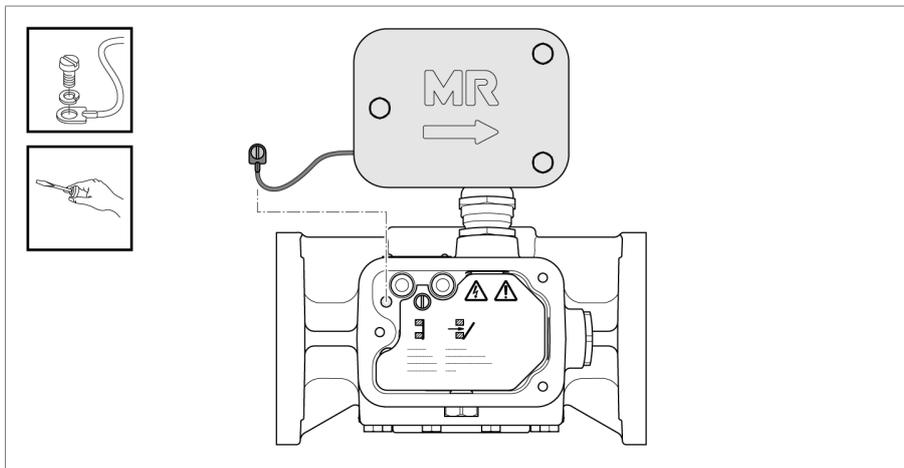


Figure 163: Terminal box cover

6. Attach the terminal box cover and secure with screws.

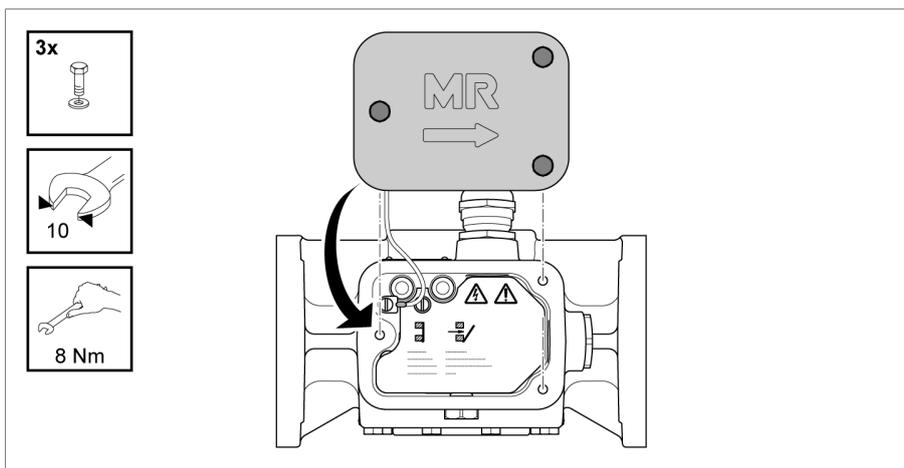


Figure 164: Terminal box cover

5.4.2.2 Installing protective relay in piping

Ensure the following for installation and proper function of the protective relay:

1. Ensure that there are no foreign bodies in the piping or in the oil conservator.
2. Install protective relay such that it can be easily accessed for subsequent maintenance work.
3. Install protective relay with good support and free from vibrations.
4. The test buttons must be at the top.
5. The interior diameter of the piping must be at least 25 mm.

6. The magnetic field strength (bushings, busbars etc.) must be $< 20 \text{ kA/m}$. Higher field strengths have a negative effect on the function of the protective relay.
7. The piping from the protective relay to the oil conservator must be routed with an inclination of at least 2% (1.2°) to ensure the switching gases can escape freely.
8. The protective relay is intended for a horizontal operating position in close proximity to the on-load tap-changer head. A positive inclination of up to 5° from horizontal is permitted in the direction to the conservator. An inclination of up to 5° from vertical to either side is permitted.

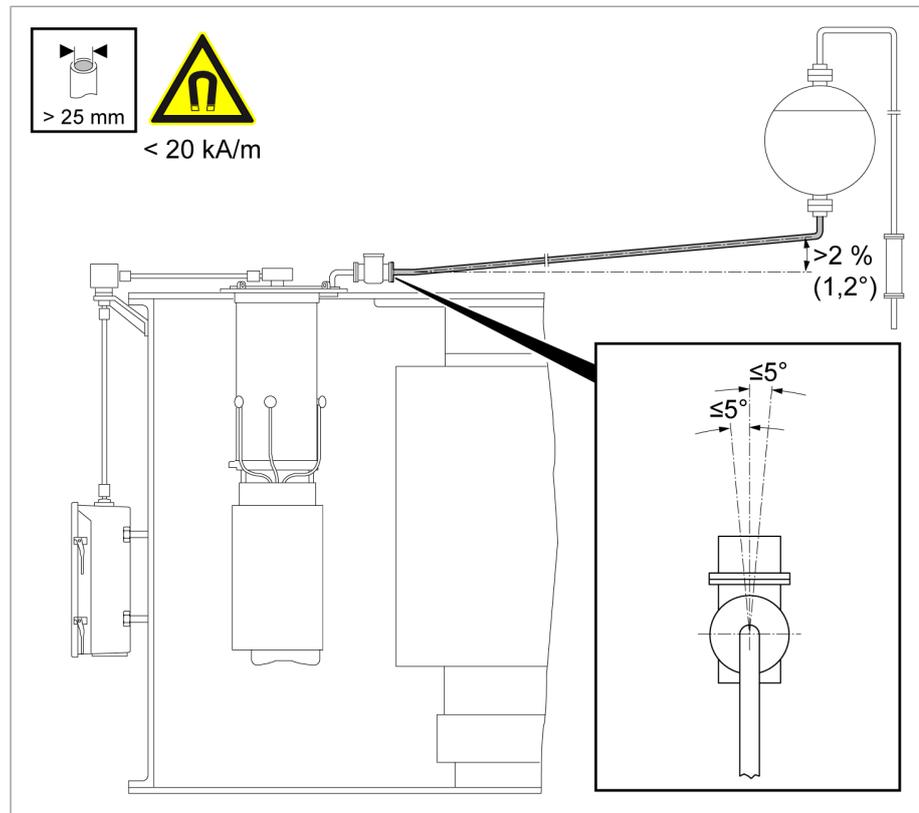


Figure 165: Protective relay installation

9. The reference arrow on the terminal box cover must point toward the on-load tap-changer's oil conservator.

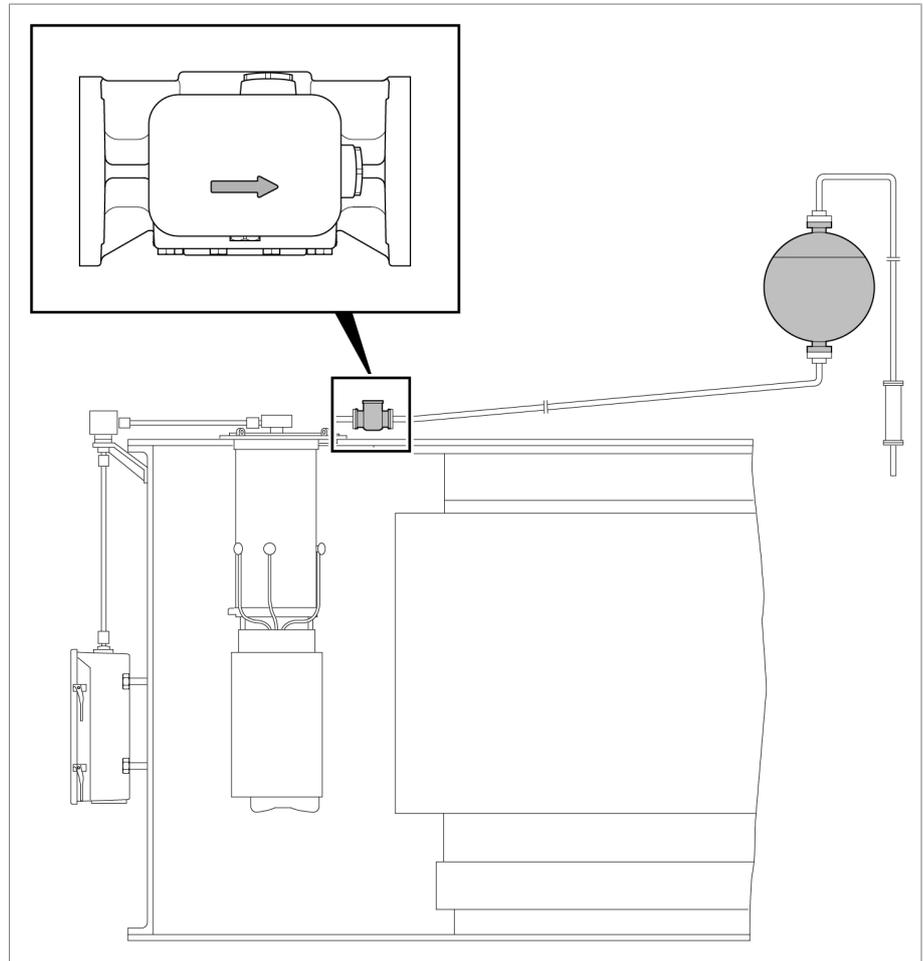


Figure 166: Reference arrow pointing towards the on-load tap-changer's oil conservator

10. Install a stop-cock with a nominal width of at least 25 mm between the protective relay and oil conservator.

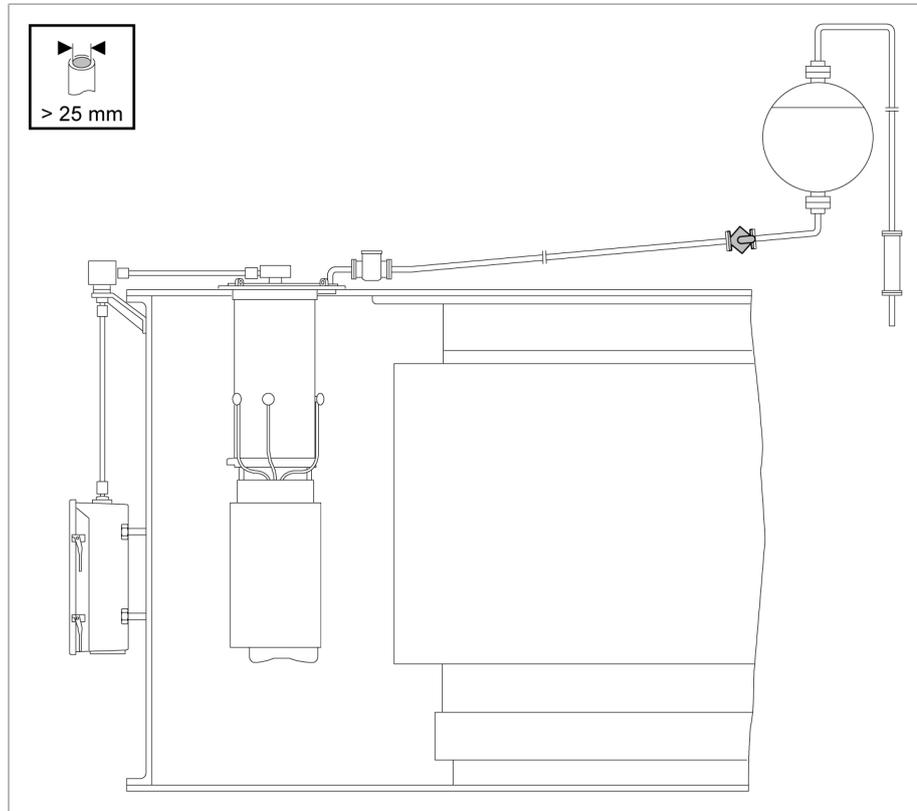


Figure 167: Stop-cock

5.4.2.3 Making the electrical connections for the protective relay

The protective relay's dry-reed magnetic switching tubes are supplied in the standard version as either NC or NO contacts. Other contact combinations can be supplied as special versions and are shown in the dimensional drawing provided.

▲ WARNING



Risk of death or severe injury!

Risk of death or severe injury due to improper electrical connection of the protective relay.

- ▶ Loop the protective relay into the tripping circuit of the circuit breakers of the transformer to be protected so that the transformer is immediately de-energized by the circuit breakers when the protective relay is tripped.
- ▶ Systems which only generate an alarm message are not permitted.

1. Insert cable gland (RS 2001, 2001/V, 2001/H, 2001/E, 2001/5, 2001/R) or adapter (RS 2003 and RS 2004) in the tapped hole with the most favorable position.

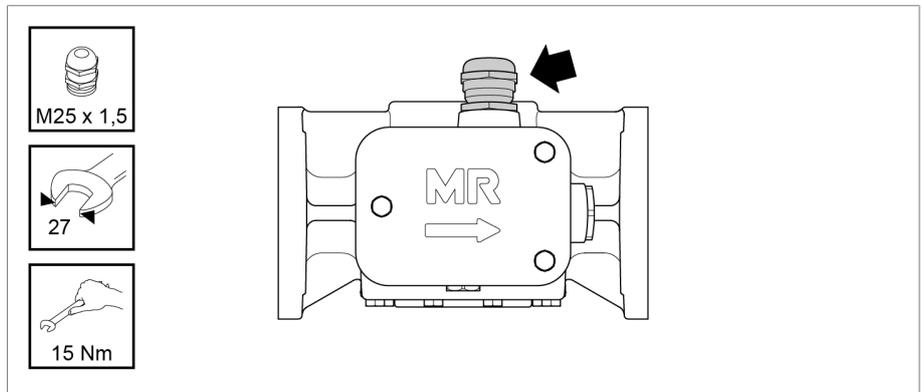


Figure 168: Tapped hole

2. Seal open tapped hole with dummy plug.

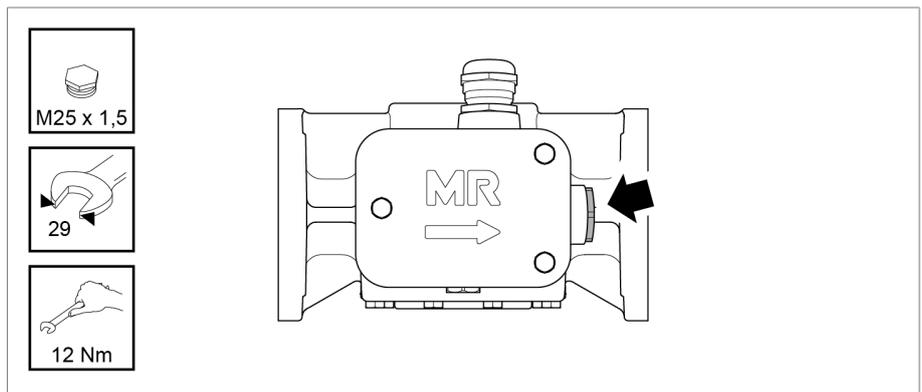


Figure 169: Sealed with dummy plug

3. Loosen the three screws on the terminal box cover and lift off the terminal box cover.

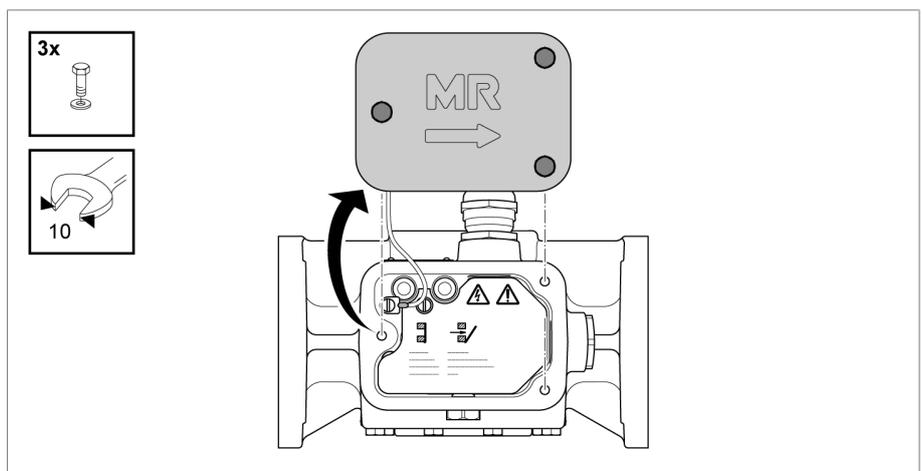


Figure 170: Terminal box cover

4. Take off the slotted head screw for potential tie-in and remove the terminal box cover with wire.

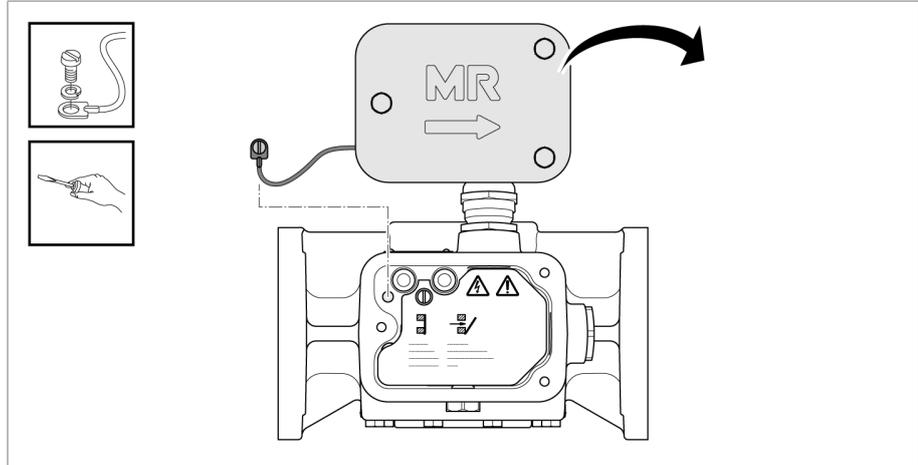


Figure 171: Terminal box cover

5. Remove screw for the protective cover and take off the protective cover.

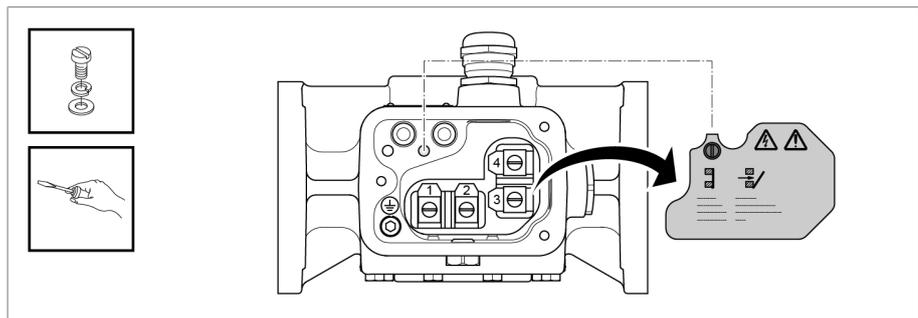


Figure 172: Protective cover

6. Guide cable through cable gland and into protective relay. Ensure that the cable gland is well connected and sealed.

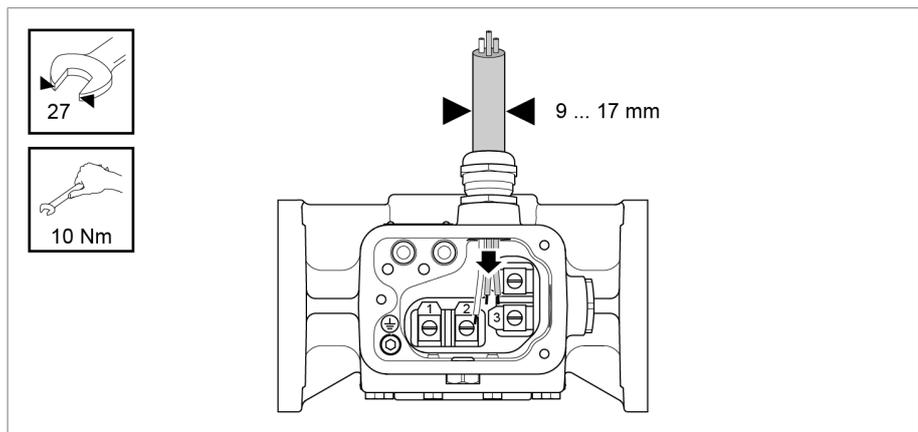


Figure 173: Cable bushing

7. Connect the electric cables to the connection terminals in accordance with the connection diagram on the dimensional drawing.

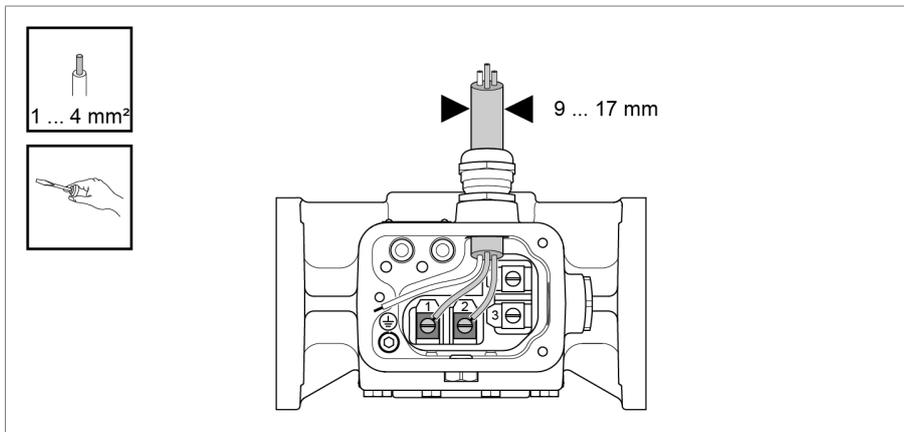


Figure 174: Electrical cables

8. Connect protective conductor to cylinder head screw.

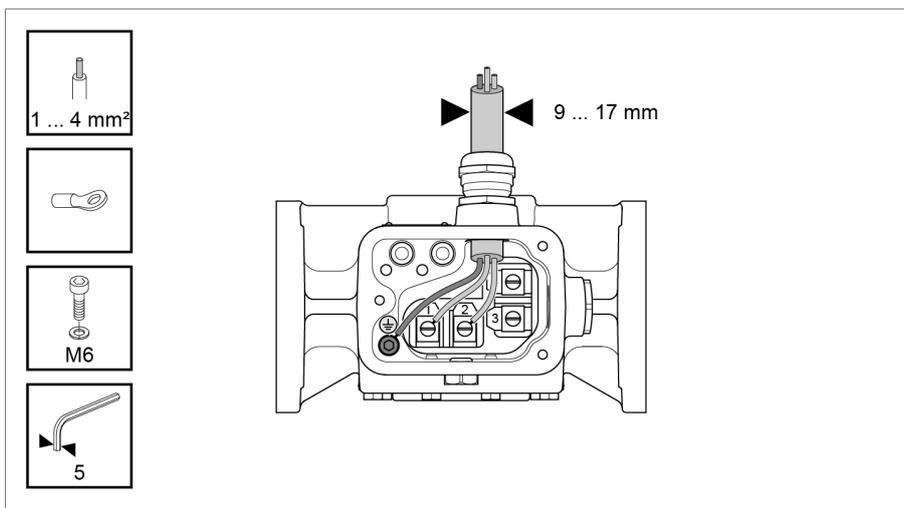


Figure 175: Protective conductor

9. Insert the protective cover and secure using the screw.

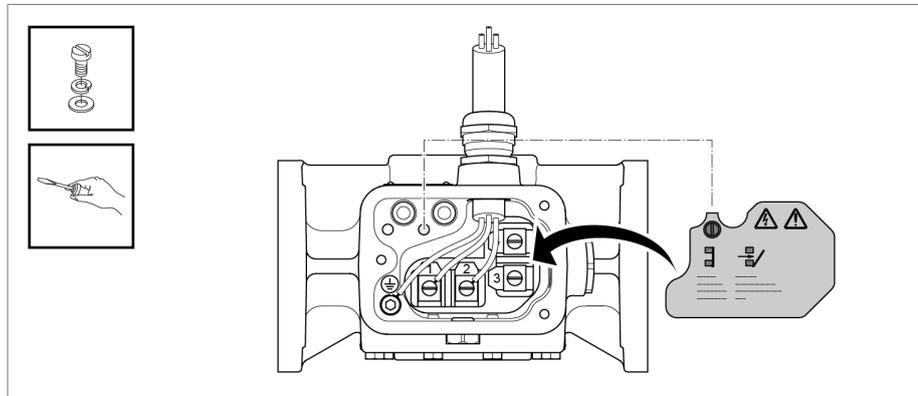


Figure 176: Protective cover

10. Position the wire for the terminal box cover and affix using the slotted head screw.

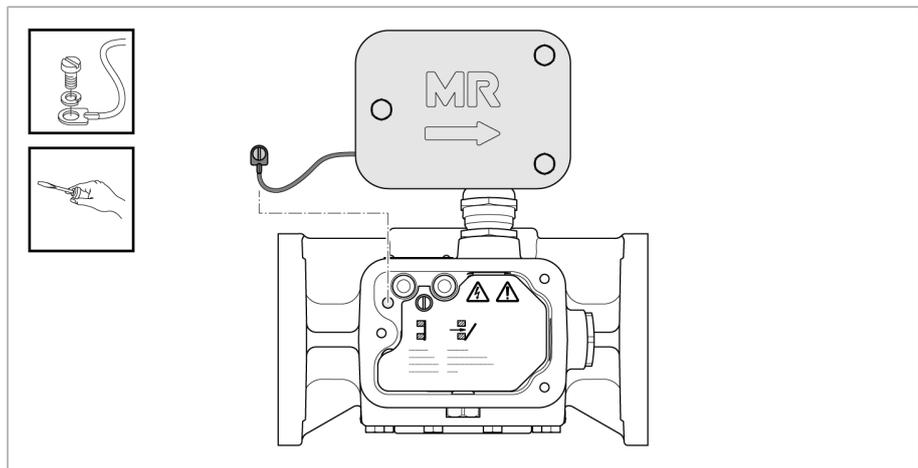


Figure 177: Terminal box cover

11. Attach the terminal box cover and secure with screws.

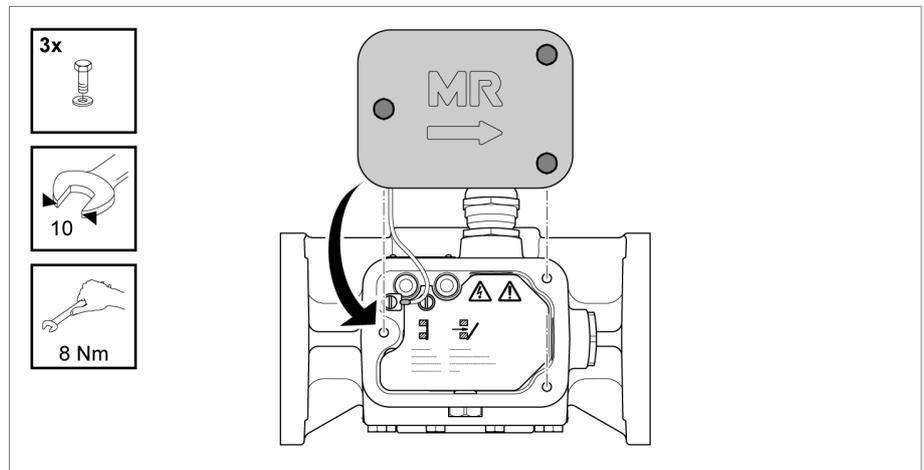


Figure 178: Terminal box cover

5.4.3 Installing and connecting the pressure monitoring device

5.4.3.1 Checking the function of the pressure monitoring device

Check the function of the pressure monitoring device before you install it on the pipe bend or the on-load tap-changer head.

1. Remove the cover cap.

2. Activate the snap-action switch.

⇒ Sensor is in the OFF position above the snap-action switch.

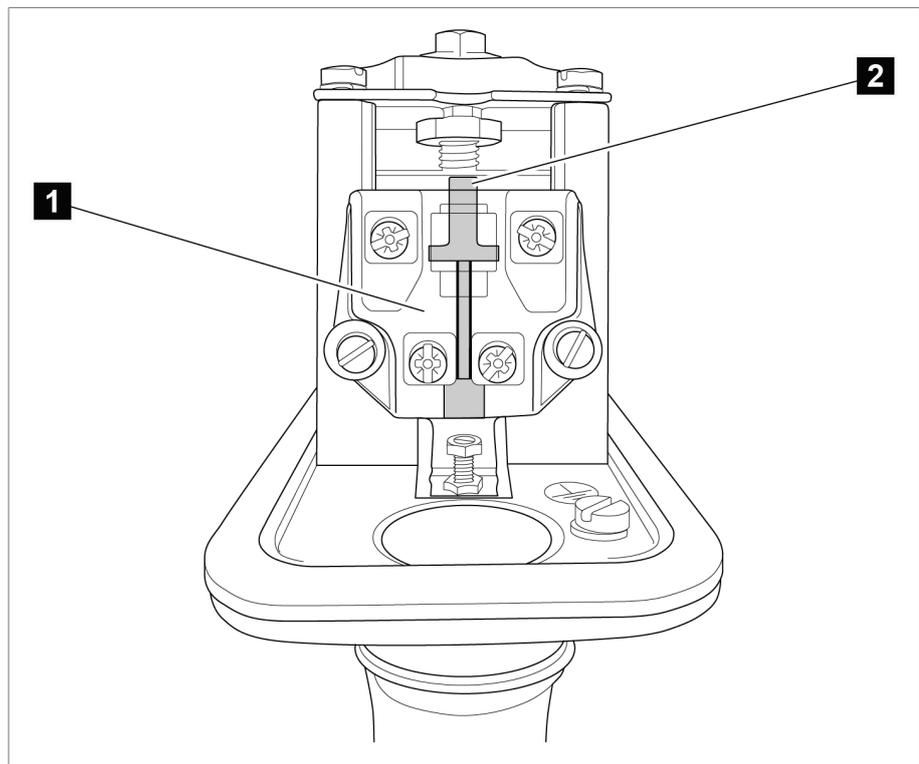


Figure 179: OFF position

1 Snap-action switch

2 Sensor in the OFF position

3. Activate the snap-action switch again.

⇒ Sensor is in the OPERATION position below the snap-action switch.

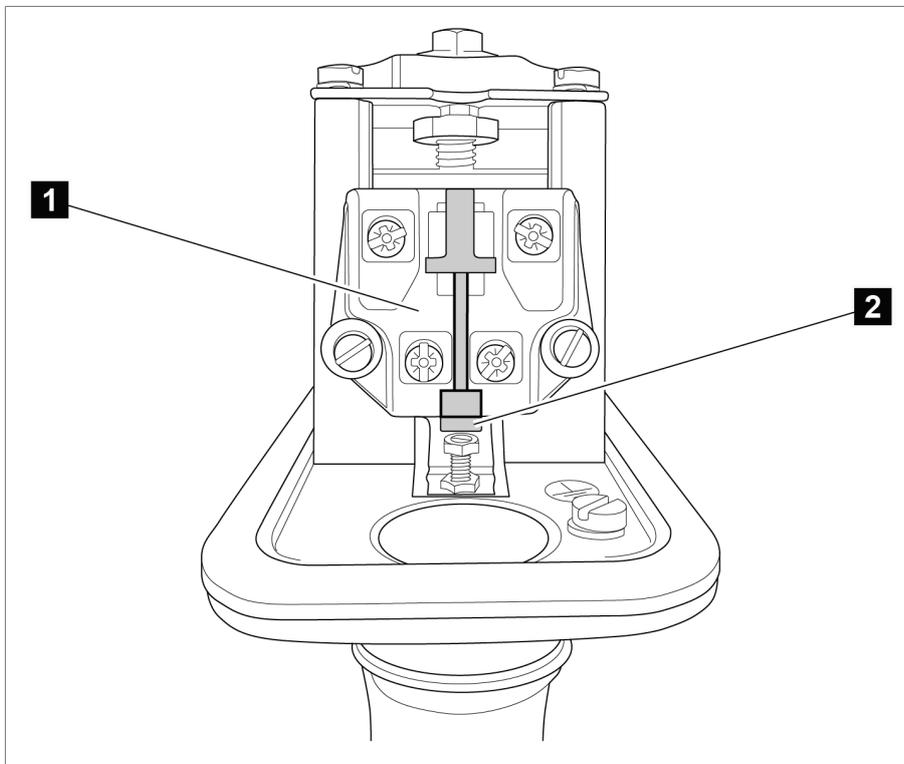


Figure 180: OPERATION position

1 Snap-action switch

2 Sensor in the OPERATION position

4. Secure the cover cap.

Always check the position of the sensor!

5.4.3.2 Installing the pressure-operated relay

For the OILTAP® G, use the pressure monitoring device variant for horizontal mounting. Proceed as follows to attach the pressure monitoring device:

1. Place the mounting seal between the pressure monitoring device and pipe connection and fasten the pressure monitoring device to the pipe connection such that the ventilator is facing upward.
2. Ensure that there is sufficient space above the pressure monitoring device to remove the cover cap.

5.4.3.3 Making the electrical connections for the pressure monitoring device

▲ DANGER



Risk of fatal injury due to electrical voltage!

Danger of death due to electrical voltage when assembling and connecting the device.

- ▶ De-energize the device and system peripherals and lock them to prevent them from being switched back on.

▲ WARNING



Danger of death or severe injury!

Risk of severe injury or death due to improper electrical connection of the pressure monitoring device.

- ▶ Loop the pressure monitoring device into the tripping circuit of the circuit breakers of the transformer to be protected so that the transformer is immediately de-energized by the circuit breakers when the pressure monitoring device is tripped.
- ▶ Circuits which only generate an alarm message are not permitted.

1. Remove the cover cap.
2. Insert Use the tapped hole for routing leads for this.
3. Connect the leads to the terminals of the snap-action switch.
The snap-action switch is designed as a normally open and normally closed switch; it flips after being triggered and can be reset.
4. Connect all of the electrical leads and the protective conductor.
Either 1 or 2 leads can be connected per terminal for the lead connection (\varnothing 0.75...2.5 mm²).
5. Secure the cover cap.
6. Ensure the fixing screw is positioned correctly, see also dimensional drawing supplied.

5.4.4 Fitting motor-drive unit

- ▶ Fit motor-drive unit to transformer as described in relevant MR operating instructions for motor-drive unit.

5.4.5 Fitting drive shaft

Observe the following during mounting:

Resistance to corrosion of components

The square tubes, coupling brackets, coupling bolts, screws, and locking washers are corrosion-resistant. We therefore recommend not applying the same external coating to these parts as to the transformer tank.



Cutting square tubes, telescopic protective tubes, and protective cover

The square tubes, the telescopic protective tube and the protective cover are supplied over-length (graded standard lengths). You must cut these parts to the required size before mounting on the transformer. In rare cases, you also have to cut the inner tube of the telescopic protective tube to the desired length. The maximum permitted total drive shaft length of the drive - last column = 15 m.

Standard lengths	Motor-drive unit	Manual drive
400	•	•
600	•	•
900	•	•
1300	•	•
1700	•	•
2000	•	•
2500	Not permitted	• ¹⁾

Table 7: Graded standard lengths of square tubes

¹⁾ l>2000 only possible for vertical installation without shaft protection! Telescopic protective tubes for manual drives with vertical dimensions V1 > 2462 are to be supplied with vertical intermediate bearing, as with the motor-drive unit.

5.4.5.1 Fitting a vertical drive shaft without cardan joint

Permitted axial displacement

Minor axial displacements of the vertical drive shaft are permitted as long as they do not exceed 35 mm per 1000 mm of square tube length (this corresponds to 2°).

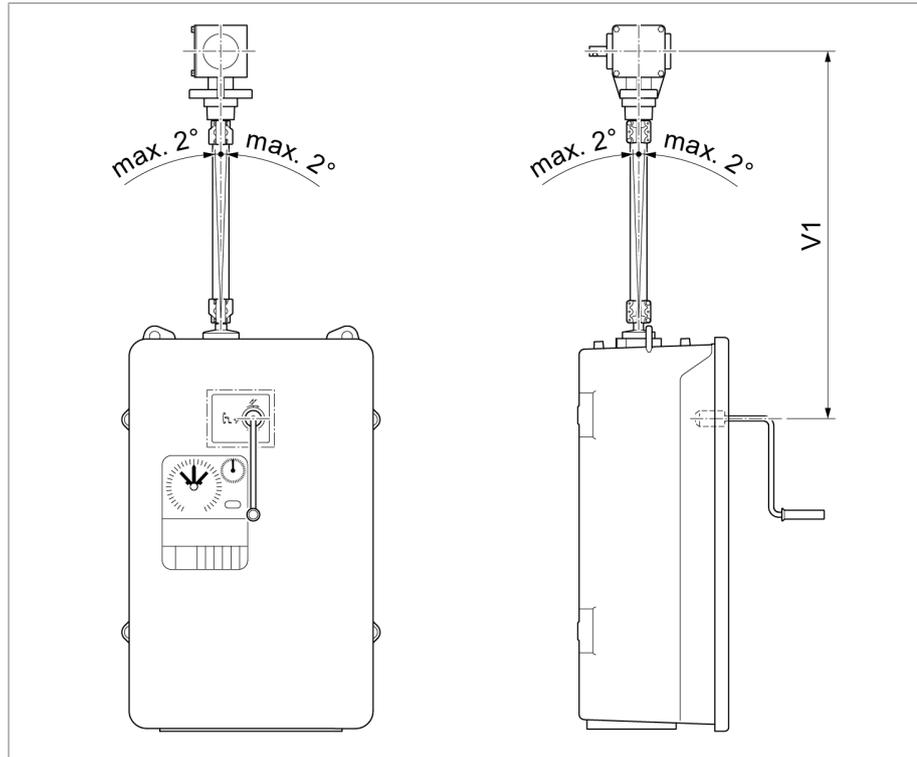


Figure 181: Permitted maximum axial displacement of vertical drive shaft without cardan joint

To fit the vertical drive shaft to the drive, proceed as follows:

1. **⚠ CAUTION!** Switch off motor protective switch Q1 in the motor-drive unit (position O). If this is not done, the motor-drive unit may be started inadvertently and cause injuries.
2. Fasten the bevel gear to the transformer.

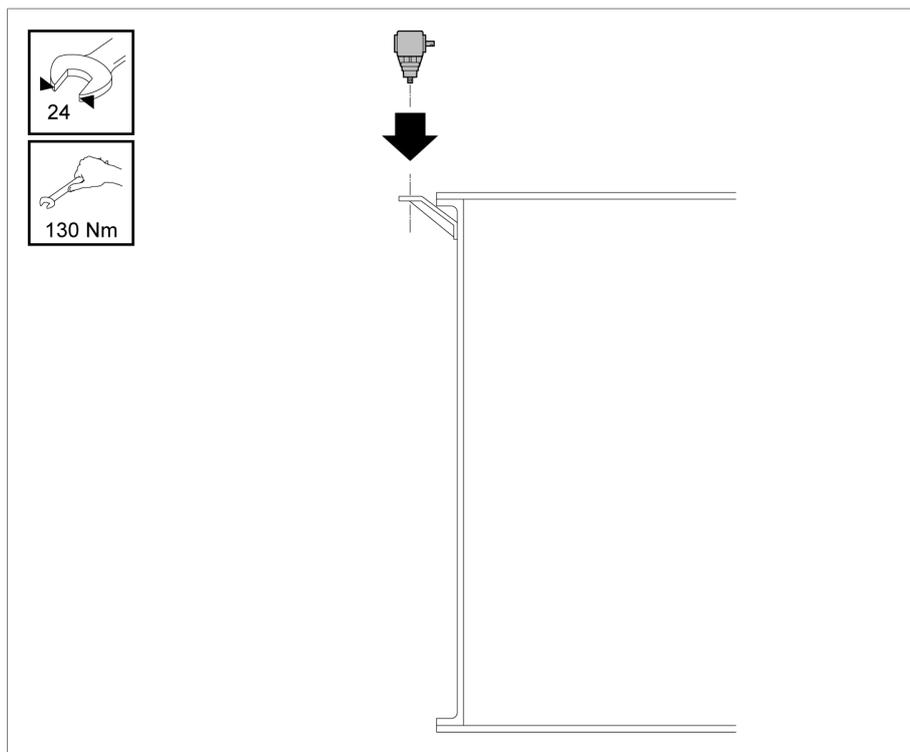


Figure 182: Bevel gear

3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten square tube to length of $A - 9$ mm.

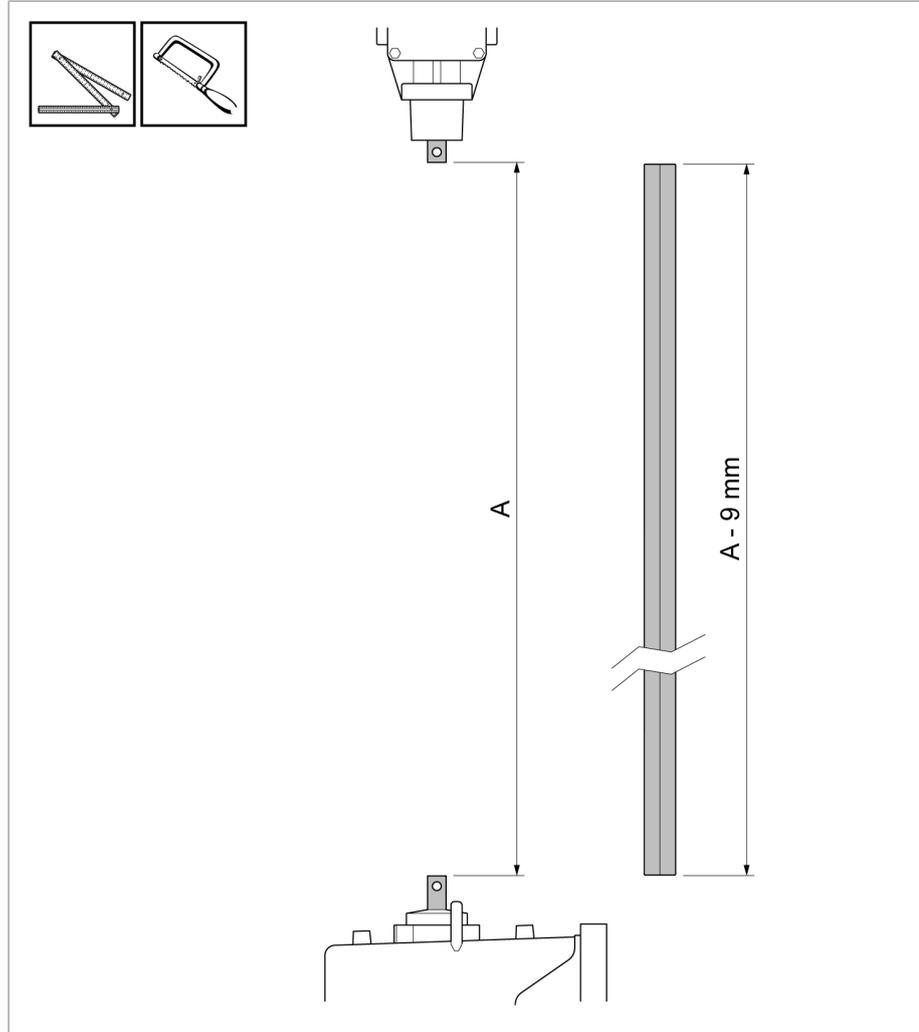


Figure 183: Shortening square tube

4. Deburr cut surfaces of square tube.

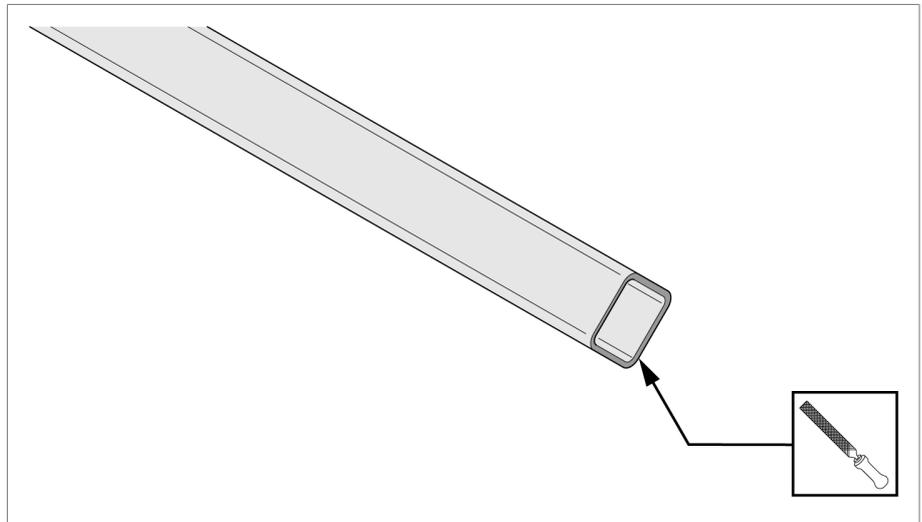


Figure 184: Deburring cut surfaces

5. Slide the loosely screwed-together coupling part onto square tube until stop is reached.

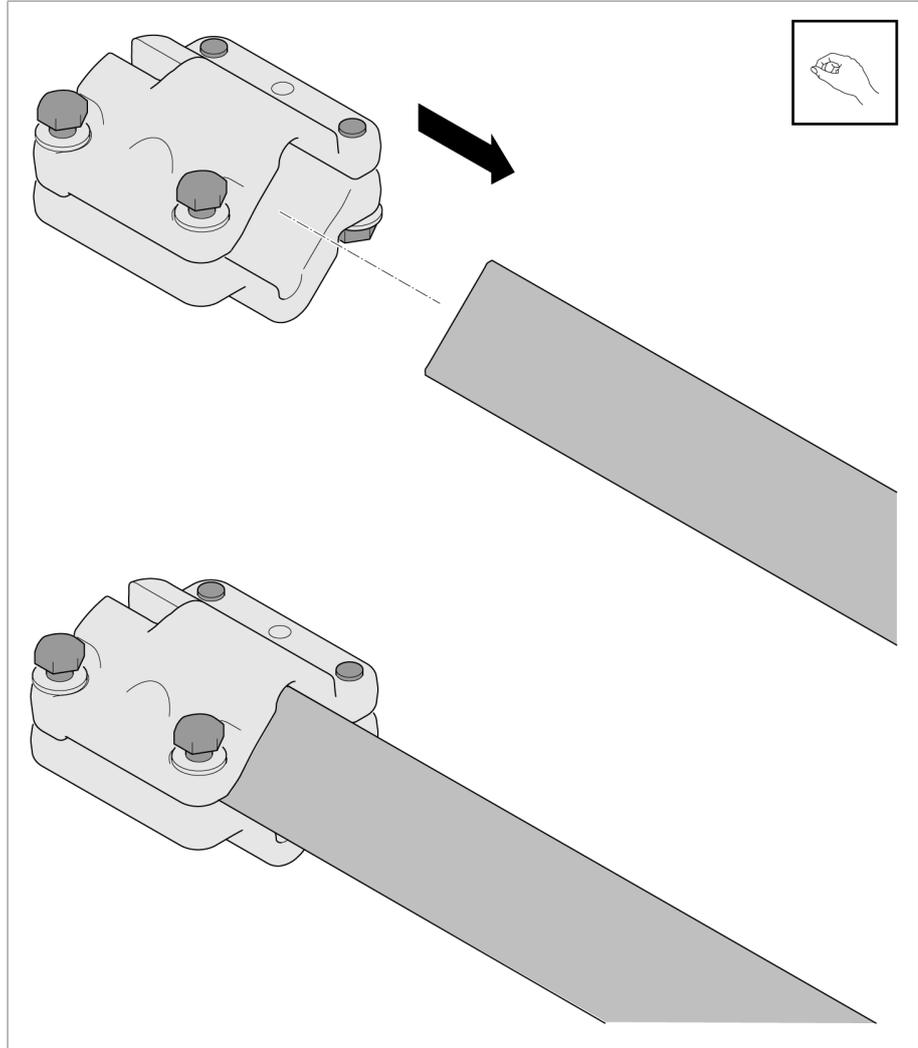


Figure 185: Slide coupling part onto square tube

6. Insert coupling bolt into shaft end of drive. Grease coupling part, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32). Slide square tube with coupling part onto shaft end.

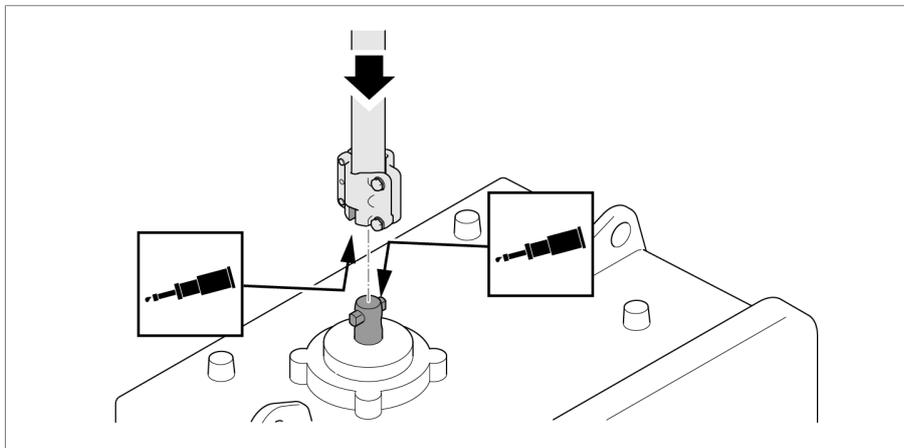


Figure 186: Sliding square tube with coupling part onto shaft end

7. Attach square tube to drive.

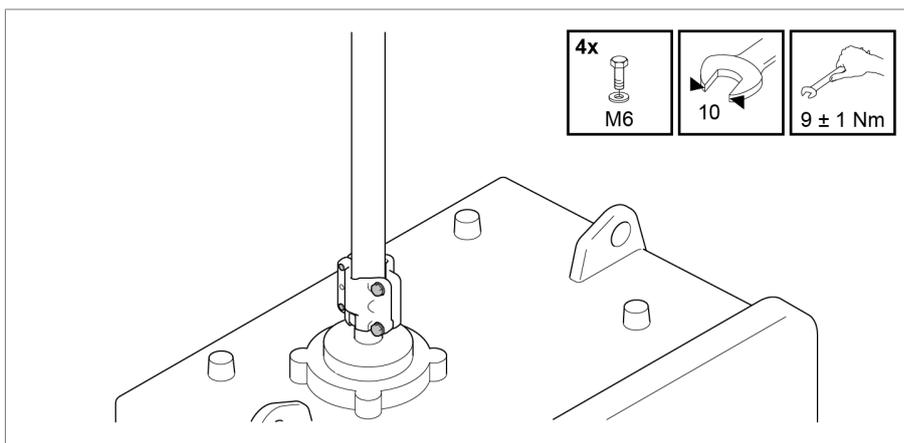


Figure 187: Attaching square tube to drive

8. Pivot square tube away from axis.

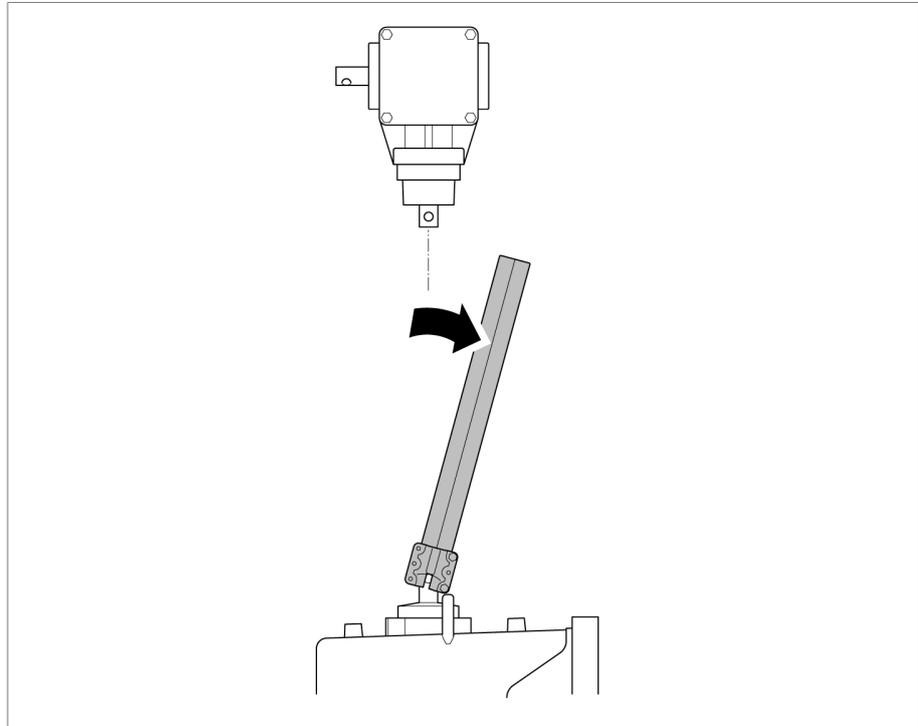


Figure 188: Pivoting square tube away from axis

9. When installing inner tube of telescopic protective tube, shorten on the side without slots if necessary. The minimum dimension for overlapping the two protective tubes is 100 mm.



Inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.

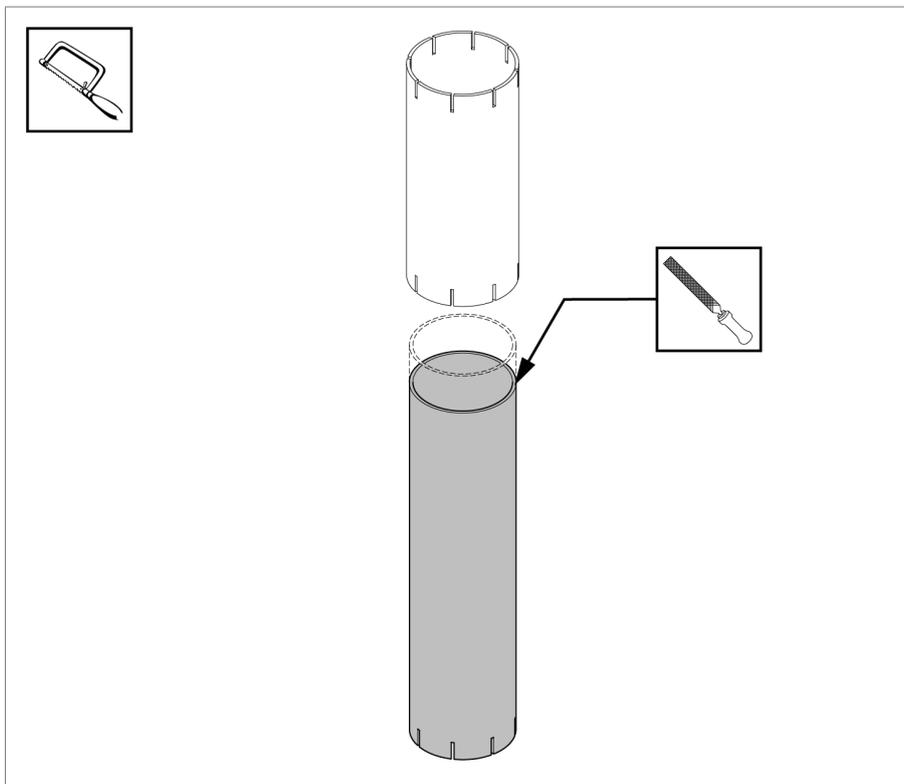


Figure 189: Deburring inner tube

Dimension A (= distance between shaft end of drive and shaft end of bevel gear)	Inner tube	Outer tube
170 mm...190 mm	Shorten to 200 mm	= 200 mm
191 mm...1,130 mm	Dimension A + 20 mm	= 200 mm
1,131 mm...1,598 mm	= 700 mm	= 1,150 mm
1,599 mm...2,009 mm	= 1,150 mm	= 1,150 mm

10. Slide outer tube over inner tube. When doing so, make sure that the non-slotted side of the inner tube is facing upwards. Slide telescopic protective tube onto square tube. Then slide hose clips over telescopic protective tube.

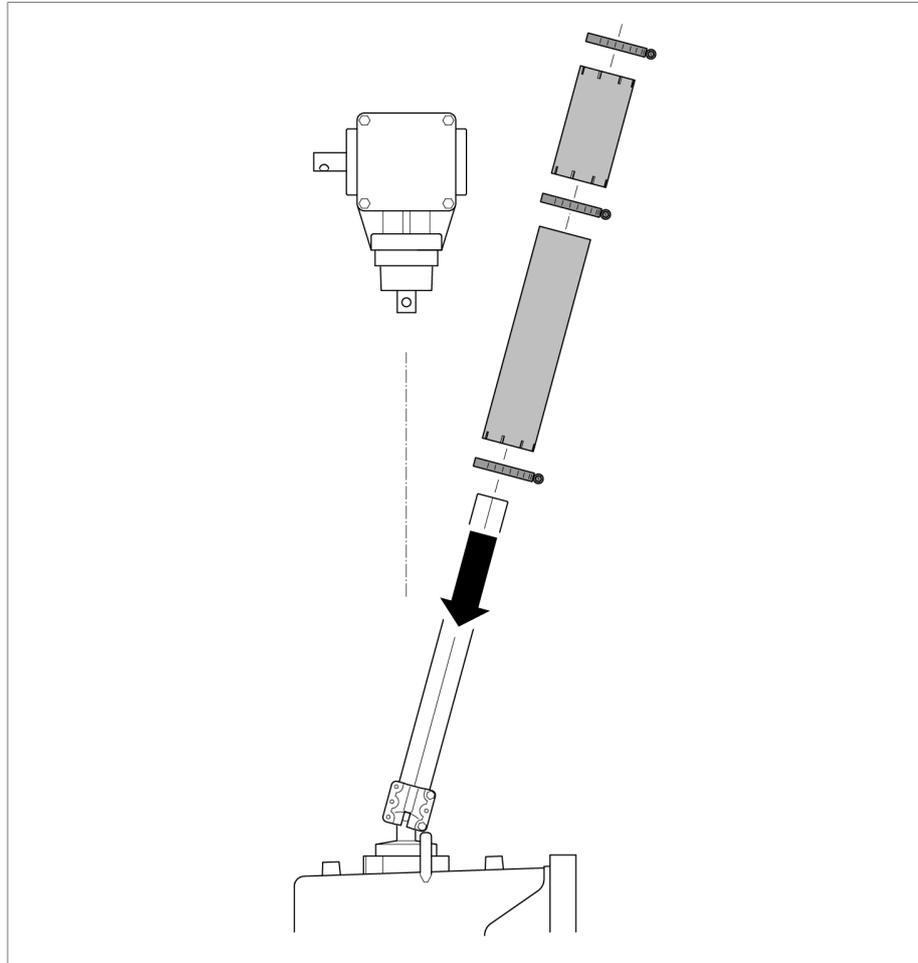


Figure 190: Sliding on telescopic protective tube

11. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Pivot square tube back to axis.

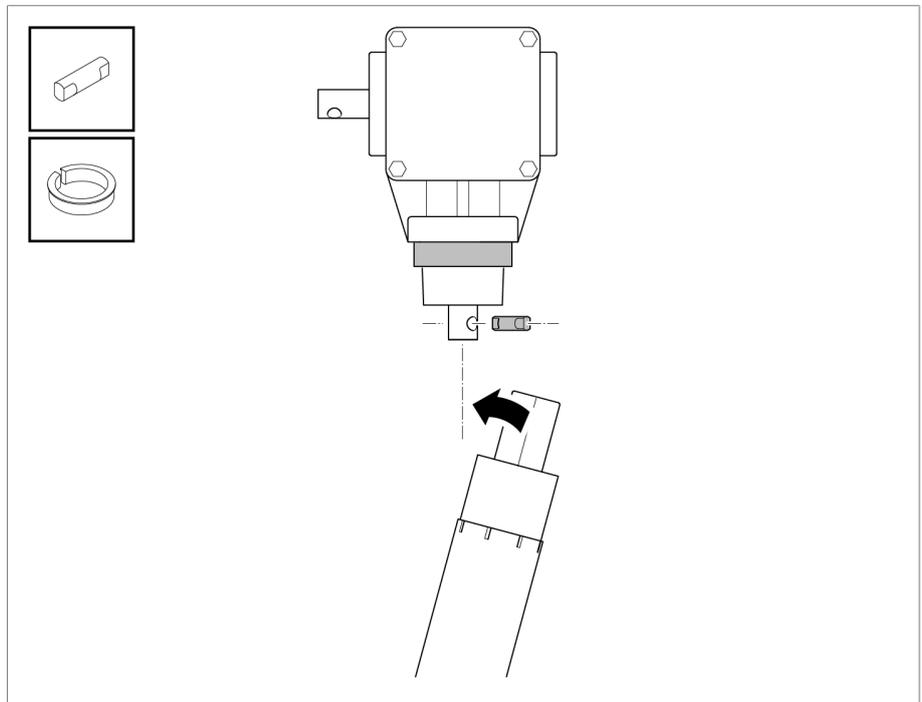


Figure 191: Fitting adapter ring and coupling bolt

12. Grease coupling brackets, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32) and secure square tube with coupling brackets on the bevel gear. Set a unilateral axial clearance of 3 mm between the coupling bolt and upper coupling piece.

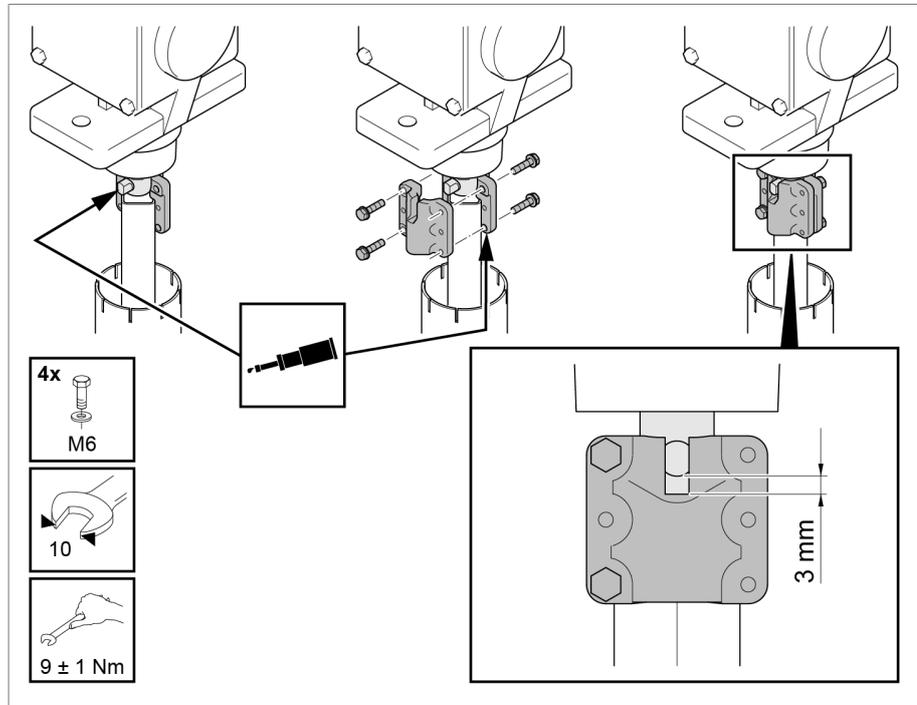


Figure 192: Mounting coupling brackets

13. Attach bottom protective tube (inner tube) with a hose clip to bearing collar of drive **1**. Then slide upper protective tube (outer tube) over adapter ring on bevel gear **2**. Secure upper protective tube to bottom protective tube with hose clip both at top end and at the connection point **3**.

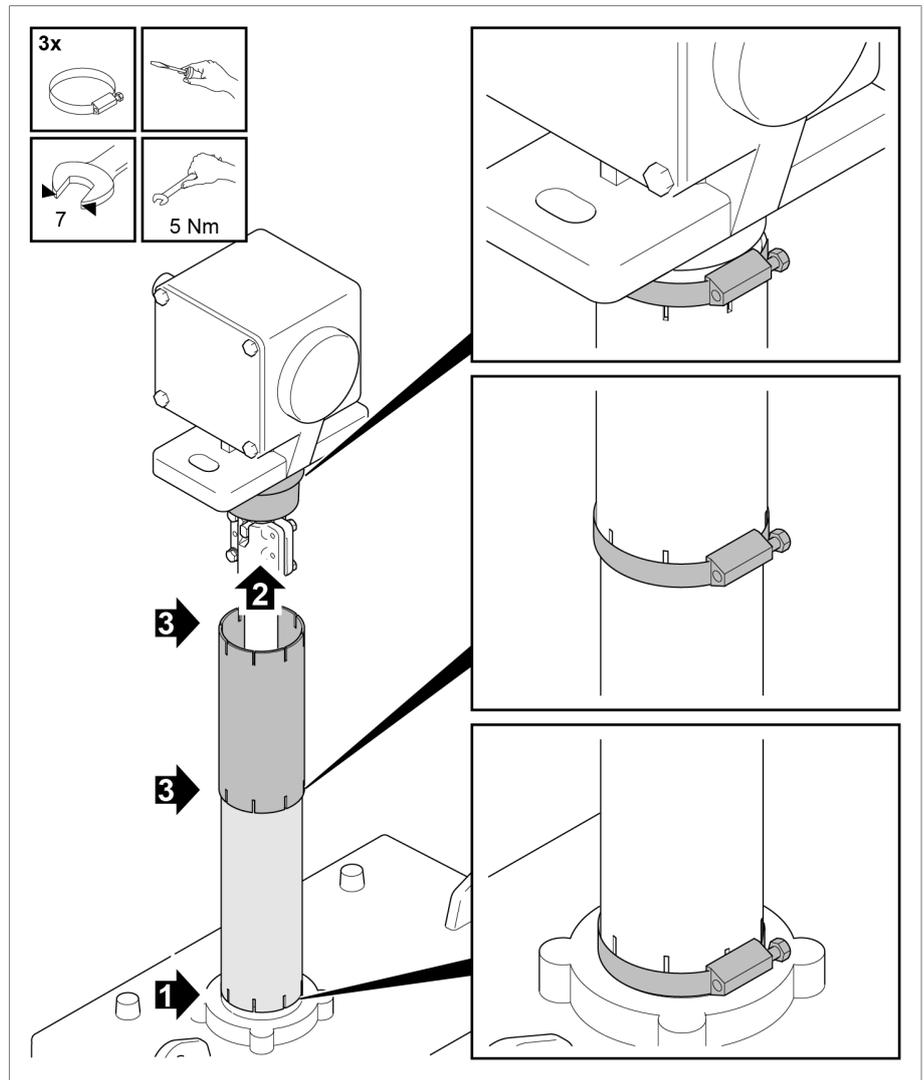


Figure 193: Mounting protective tube

5.4.5.2 Fitting a horizontal drive shaft without cardan joints

Fitting horizontal drive shaft

To fit the horizontal drive shaft, proceed as follows.

1. Calculate dimension A between shaft end in the on-load tap-changer head and shaft end of bevel gear and shorten square tube to length A – 9 mm.

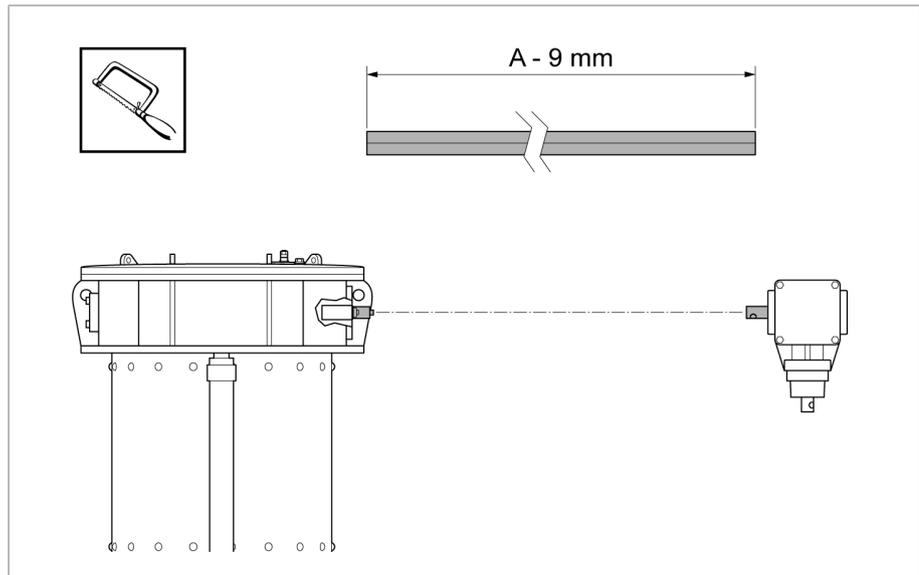


Figure 194: Shortening square tube

2. Fasten a cap to one end of the protective cover.

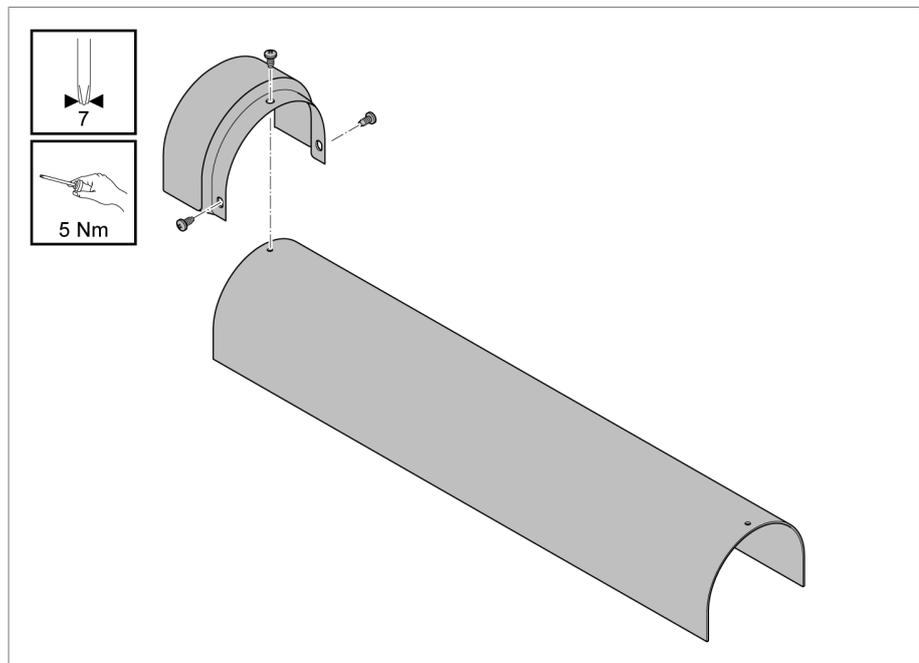


Figure 195: Fastening cap to protective cover

3. Measure distance B between the bearing bush in the on-load tap-changer head and the bevel gear housing. Shorten the protective cover to $B - 2$ mm and deburr the cuts. Protect protective cover against corrosion with a coat of paint.

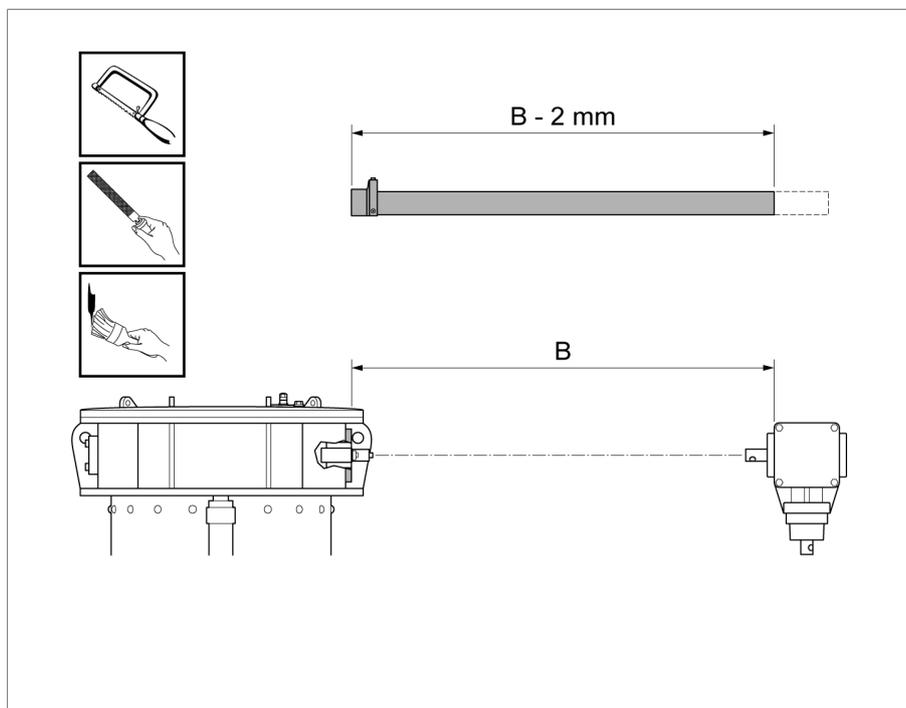


Figure 196: Shorten, deburr, and coat protective cover

4. Slide loosely screwed together coupling part onto square tube until stop is reached.

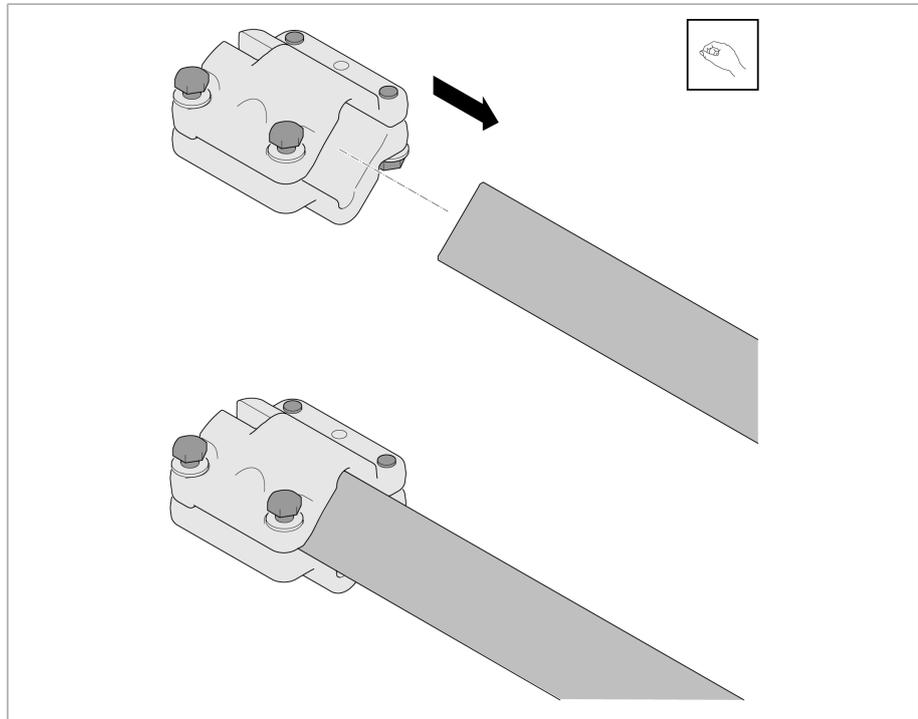


Figure 197: Sliding coupling part onto square tube

5. Grease coupling bolt. Fit coupling bolt onto bevel gear and slide square tube with coupling part over it.

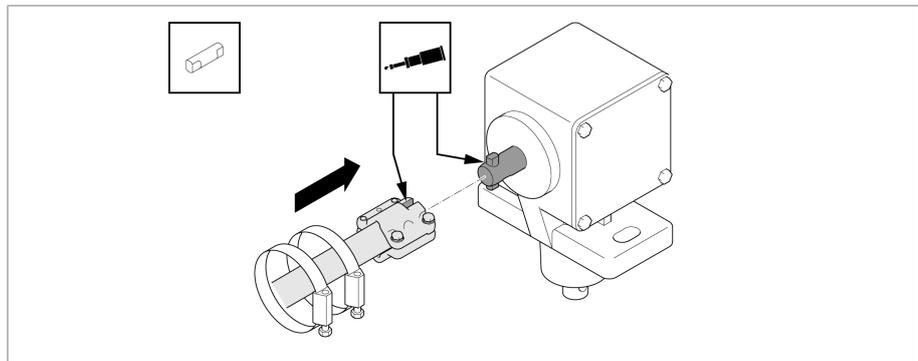


Figure 198: Attaching coupling part to bevel gear

6. Mount horizontal drive shaft on bevel gear.

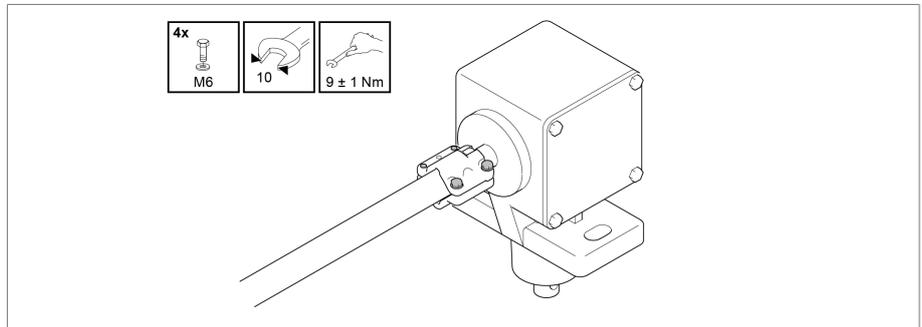


Figure 199: Mounting horizontal drive shaft on bevel gear

7. Grease the coupling bolts and coupling brackets for the shaft in the on-load tap-changer head. Install the coupling brackets on the shaft in the on-load tap-changer head.

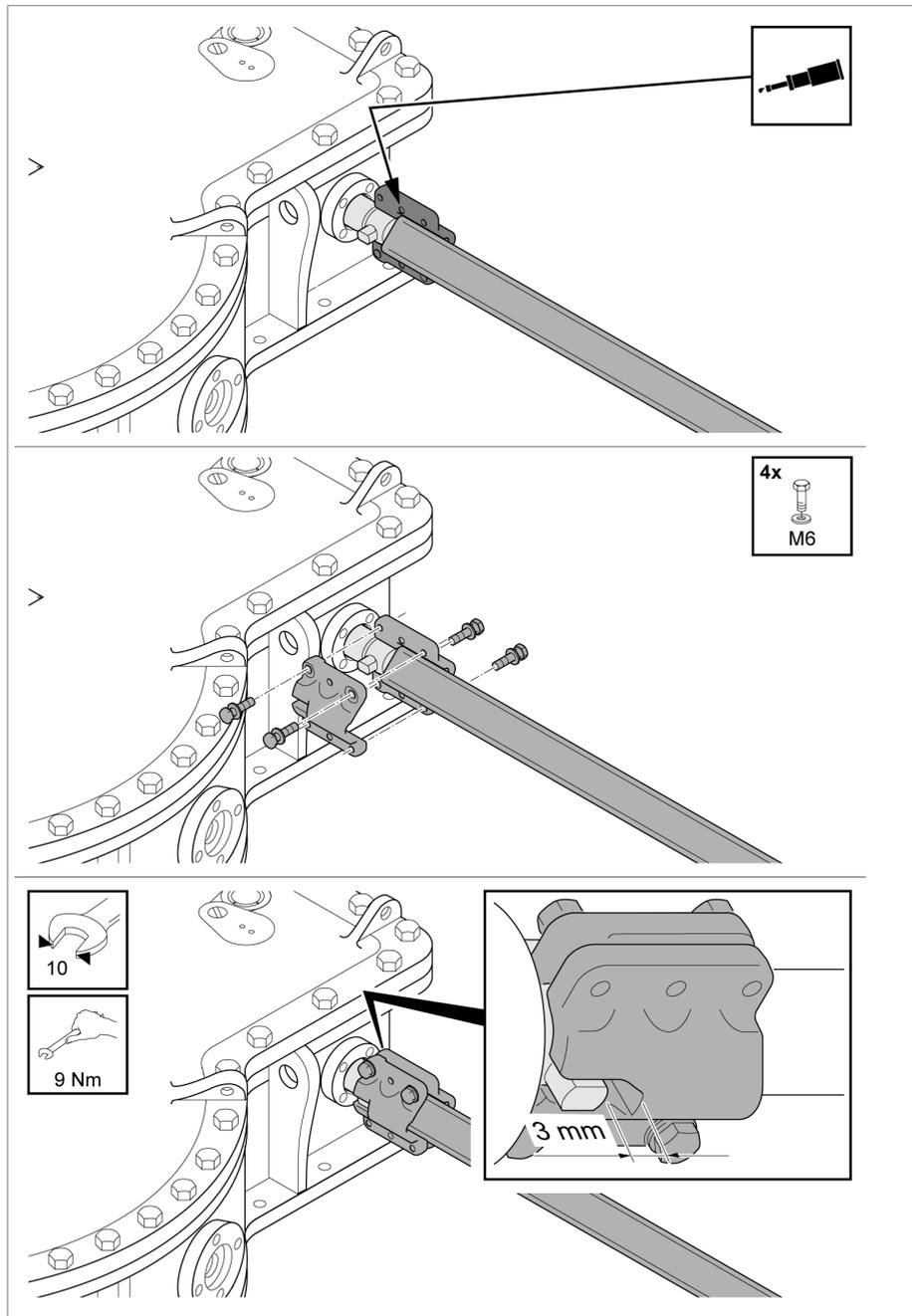


Figure 200: Mounting horizontal drive shaft on upper gear unit

8. Now attach the shortened protective cover to the bearing bush in the on-load tap-changer head and bevel gear. Secure each end of protective cover with a hose clip.

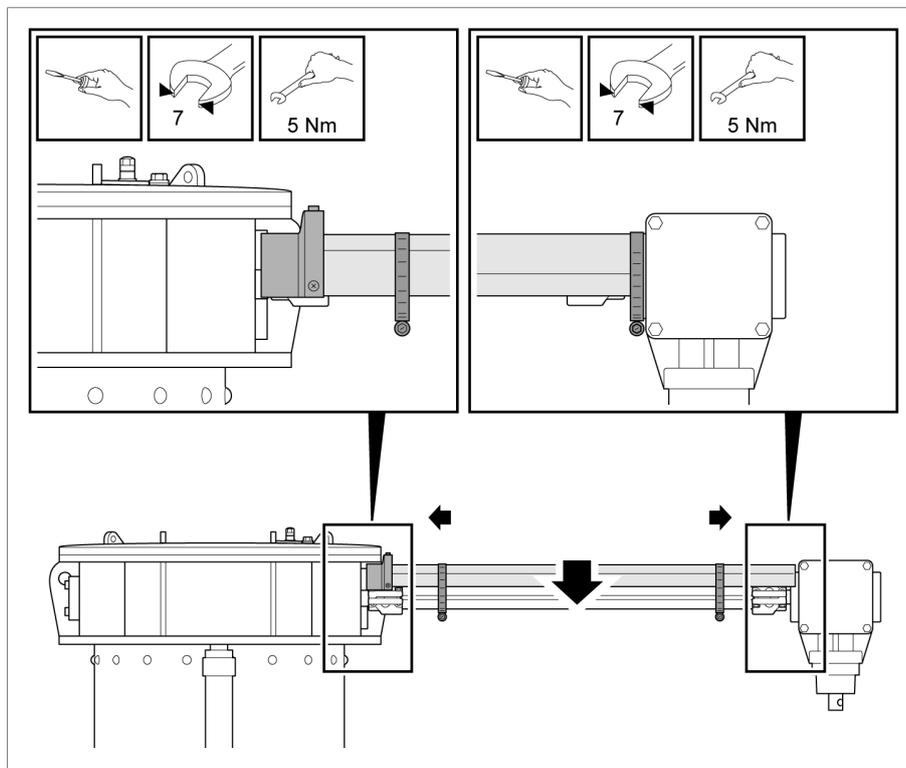


Figure 201: Fitting protective cover

5.4.5.2.1 3 x G I...on-load tap changer set

When using a 3 x G I... on-load tap changer set, note the following:

The individual on-load tap changer columns were adjusted to one another at the factory.

To check that the tap positions are identical on all on-load tap-changer columns, proceed as follows:

1. Remove nuts, screws and locking washers on on-load tap-changer head cover (40 M16 screws, wrench size 24).
2. **NOTICE!** Remove the on-load tap-changer head cover. For all work, check that the sealing surfaces on the on-load tap-changer head cover and on-load tap-changer head, as well as the gasket in the on-load tap-changer head cover, are in sound condition. Damaged sealing surfaces lead to oil escaping and therefore to on-load tap-changer and transformer damage. Make sure that small parts do not fall into the oil compartment. Check that you have the same number of small parts when removing and installing.

3. Turn the worm shaft to ensure that all 4 zero marks match. An error rate of 1 rotation of the drive shaft between the 3 on-load tap changer columns is permitted.
4. Screw down on-load tap-changer head cover onto the on-load tap-changer head.

5.4.5.3 Fitting drive shaft with cardan joints

Installation of the drive shaft with cardan joints is mainly designed as a vertical drive shaft between motor-drive unit and bevel gear.

Technically, a horizontal design is also possible. However, if using a horizontal design, please note that the protective cover supplied must be adapted accordingly and a cardan joint with an inner hub diameter of 25 mm must be used if you want to use the cardan joint on the upper gear unit.

Permitted axial displacements

An axial displacement of 20° is permitted for the vertical and horizontal drive shaft with cardan joints.

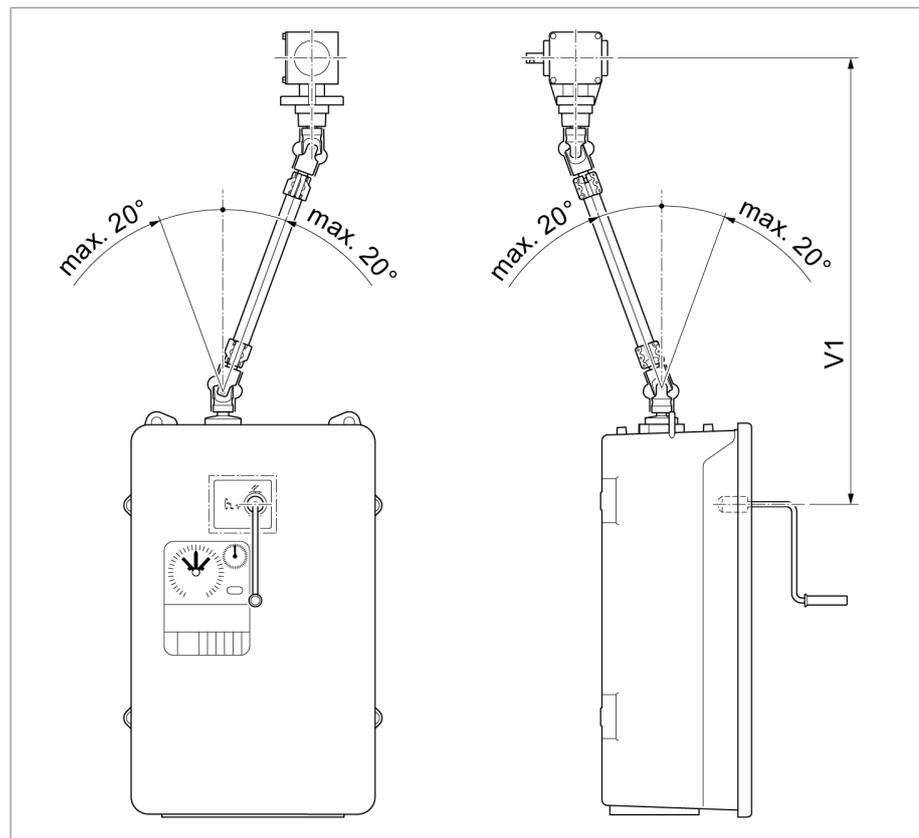


Figure 202: Permitted maximum axial displacement of vertical drive shaft with cardan joints

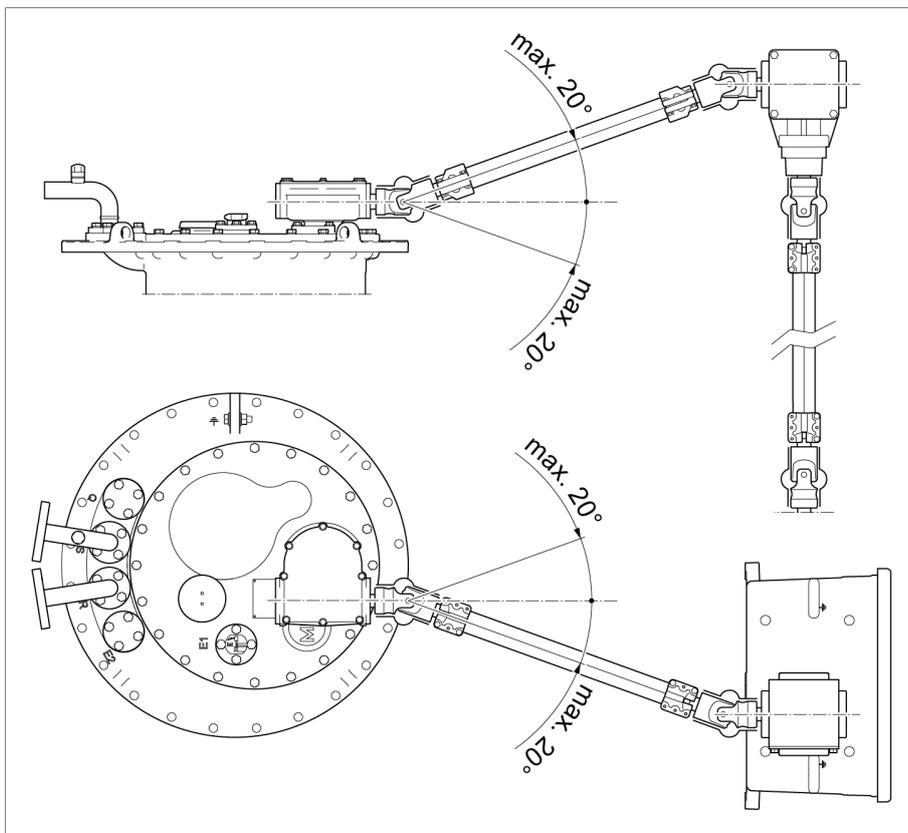


Figure 203: Permitted maximum axial displacement of horizontal drive shaft with cardan joints

NOTICE

Damage to property!

Improper mounting of the cardan joint may result in damage or malfunctions.

- ▶ Ensure that the folding cardan joint does not damage the expansion bellows during mounting.
- ▶ Ensure that the angle of deflection α is no greater than 20° .
- ▶ Ensure that the angle of deflection α is the same on both cardan joints.

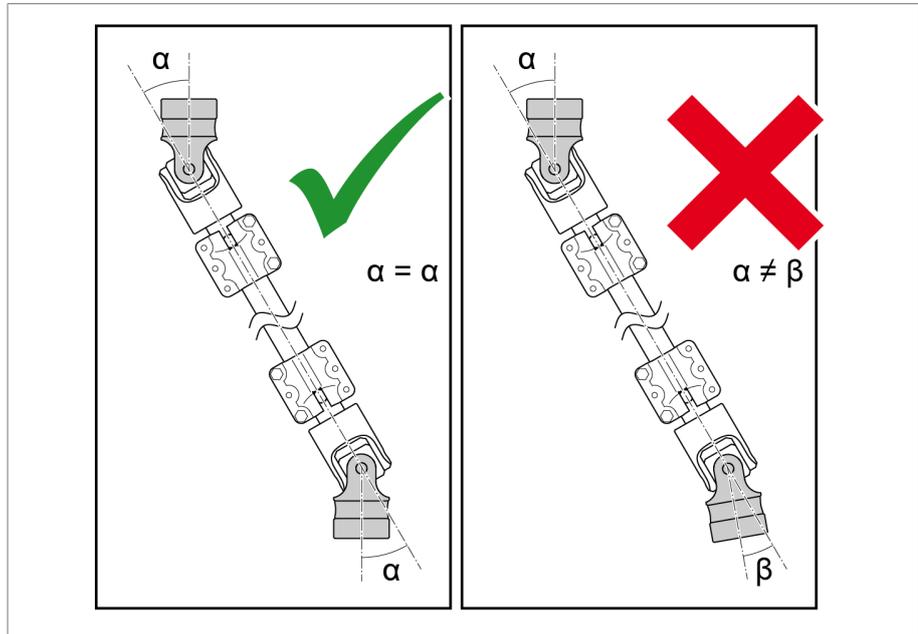


Figure 204: Angle of deflection α

To fit the drive shaft with cardan joints, proceed as follows:

1. Grease coupling bolts, coupling brackets, and shaft ends, e.g. ISOFLEX TOPAS L 32.

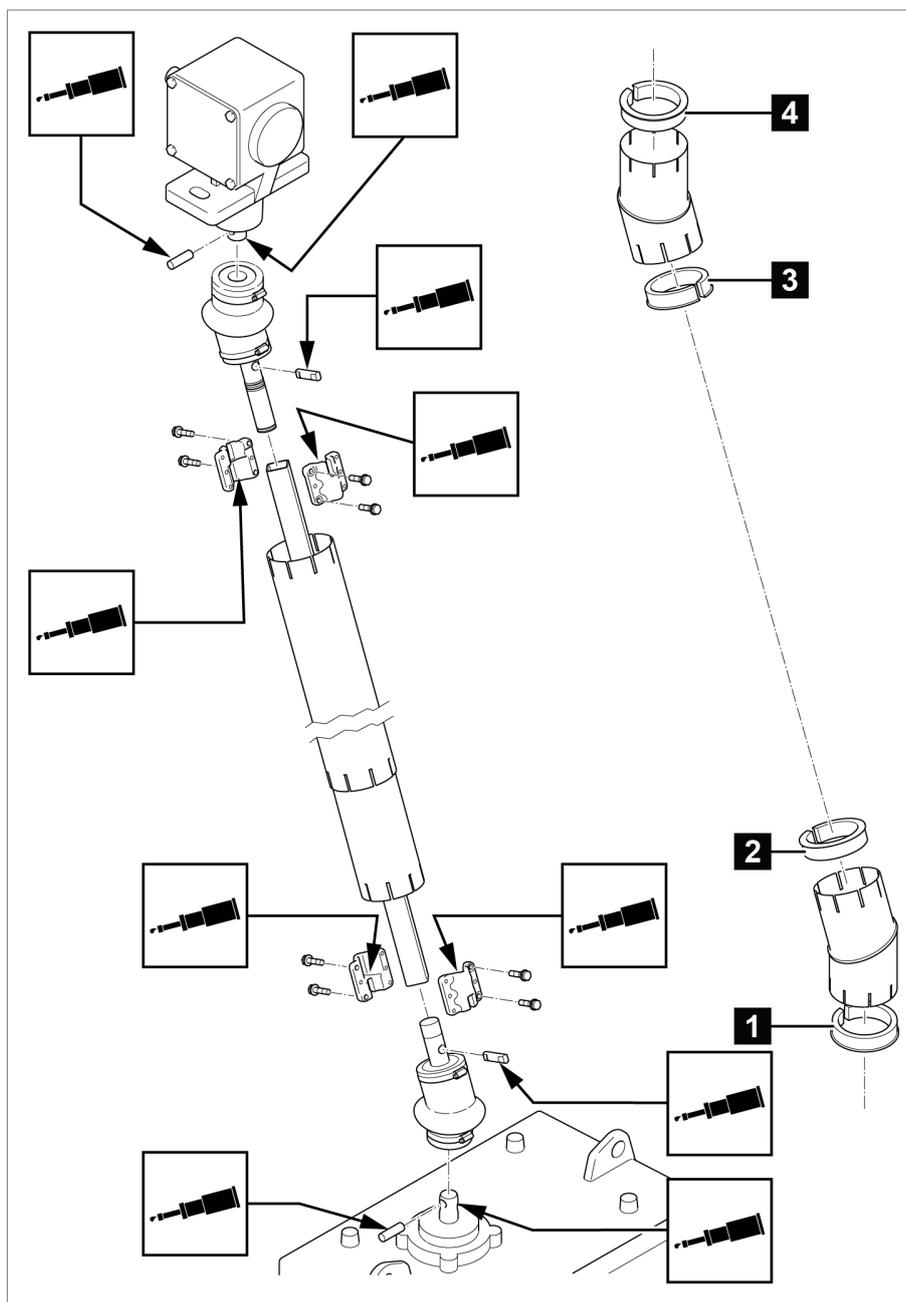


Figure 205: Greasing coupling bolts, coupling brackets, and shaft ends

Position	Name	Quantity
1 below on the ED	Adapter ring Ø 82×102	1
2	Adapter ring Ø 87×102.5	1

3	Adapter ring Ø 94.5×102.5	1
4 above on the CD6400	Adapter ring Ø 71×102.5	1

2. Insert adapter rings into the collar of the rotating protective tube **1**. Fit the two parts of pivotable protective tube together **2** and turn them towards one another **3** to set the corresponding angle.

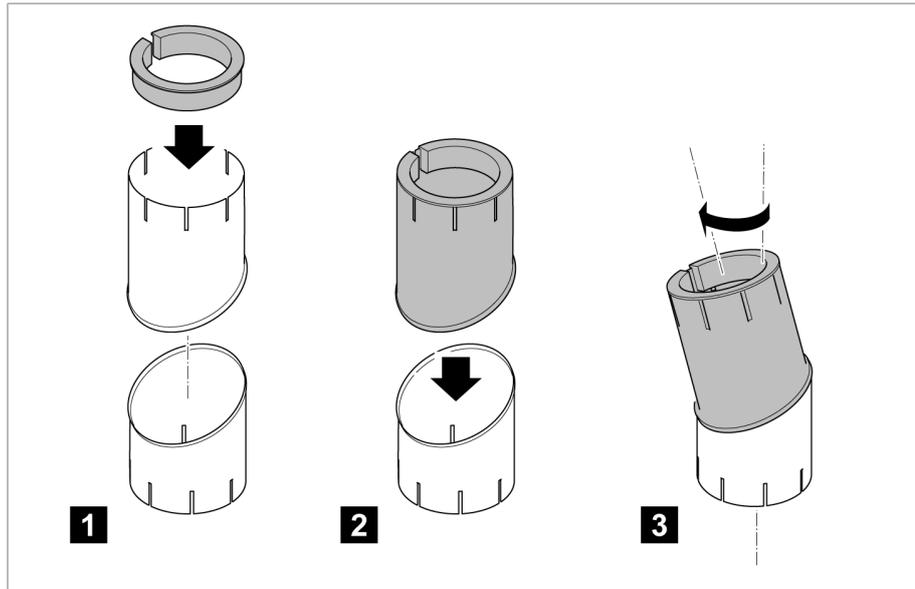


Figure 206: Inserting adapter in pivotable protective tubes

3. When supplied, the cardan joints are fitted with coupling bolts **1**. To mount on the shaft end, the following steps must be taken: Remove hose clip **2**. Slide up expansion bellows **3**. Remove coupling bolt **4**. Slide

cardan joint over device's output shaft **5**. Push in coupling bolt **6**. Slide expansion bellows over this **7**. Secure expansion bellows with hose clip **8**.

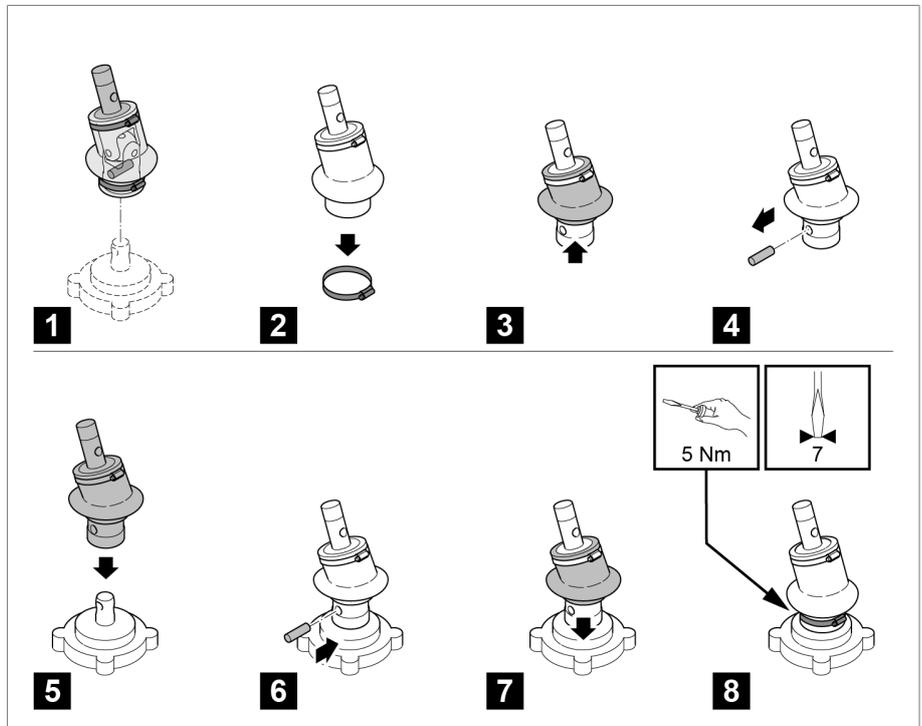


Figure 207: Mounting cardan joints

4. Connect shorter cardan joint supplied to shaft end of motor-drive unit with coupling bolt.

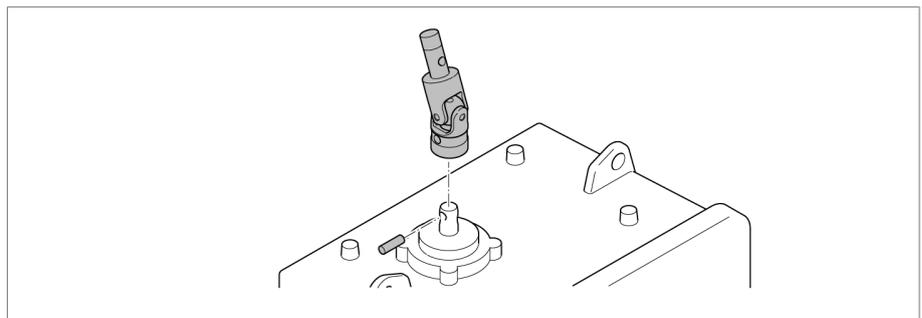


Figure 208: Attaching cardan joint on shaft end of motor-drive unit

5. **NOTICE!** Attach second, longer cardan joint to the bevel gear such that the position of both cardan joint lugs is the same on the bevel gear and motor-drive unit. If this is not done, damage or malfunctions may result.

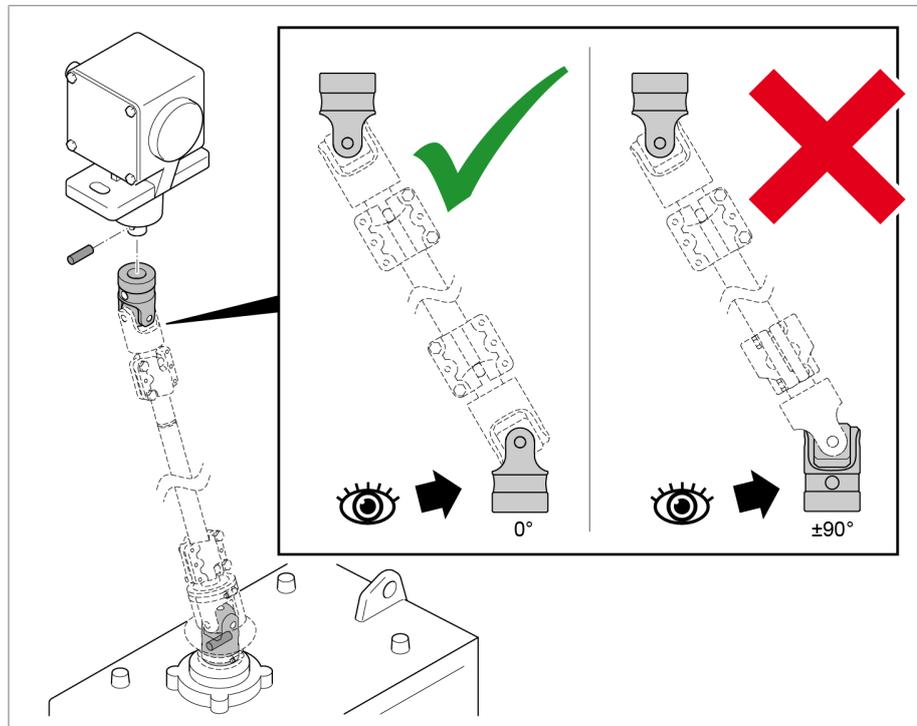


Figure 209: Fitting second cardan joint on bevel gear

6. Secure expansion bellows with hose clip.

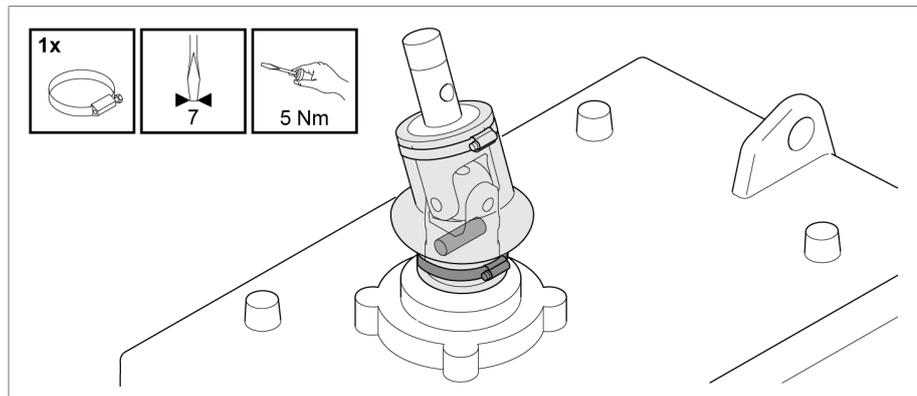


Figure 210: Securing expansion bellows with hose clip

7. Provisionally connect loose shaft ends of the joints to an angle bar and align so that they are in line.

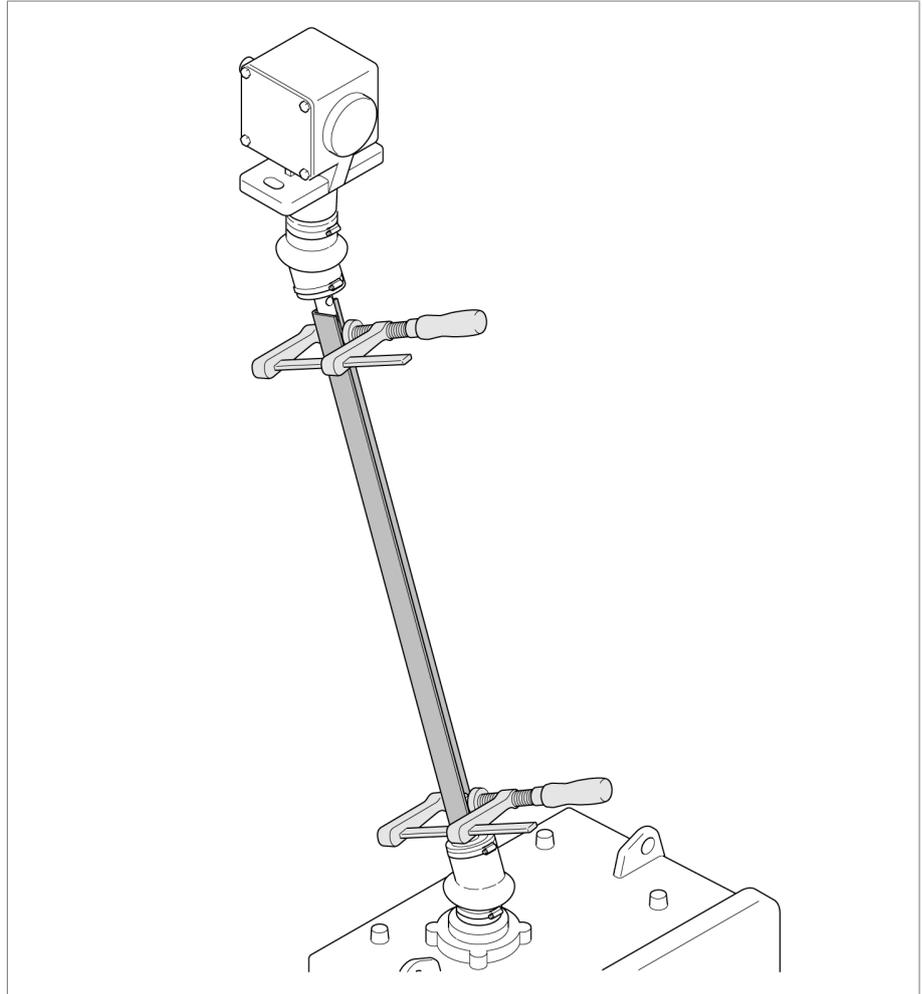


Figure 211: Connecting shaft ends with angle bar

8. Determine dimension A between the shaft ends. Cut square tube to $LR = A + 100$ mm (LR = length of square tube). Deburr cut surfaces of square tube.

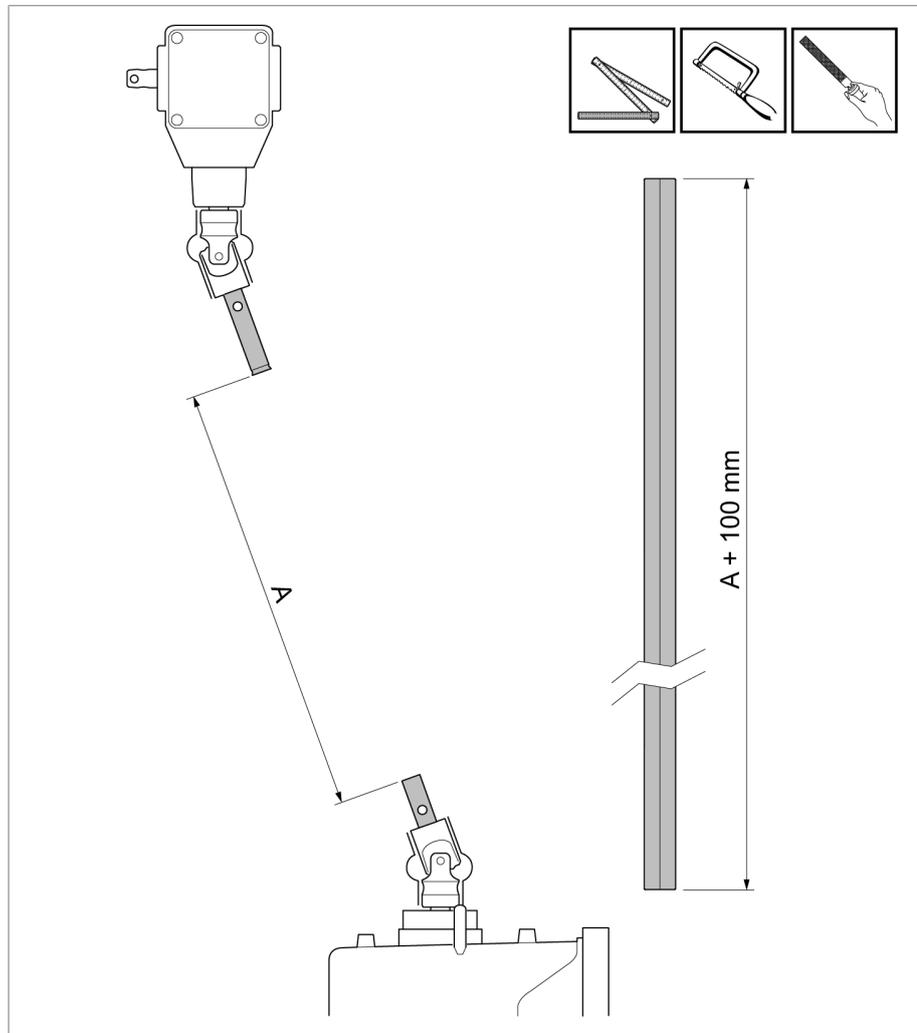


Figure 212: Shortening square tube

9. Before beginning installation, shorten both telescopic tubes to the corresponding dimension A (A = dimension between both cardan joint ends) and deburr.

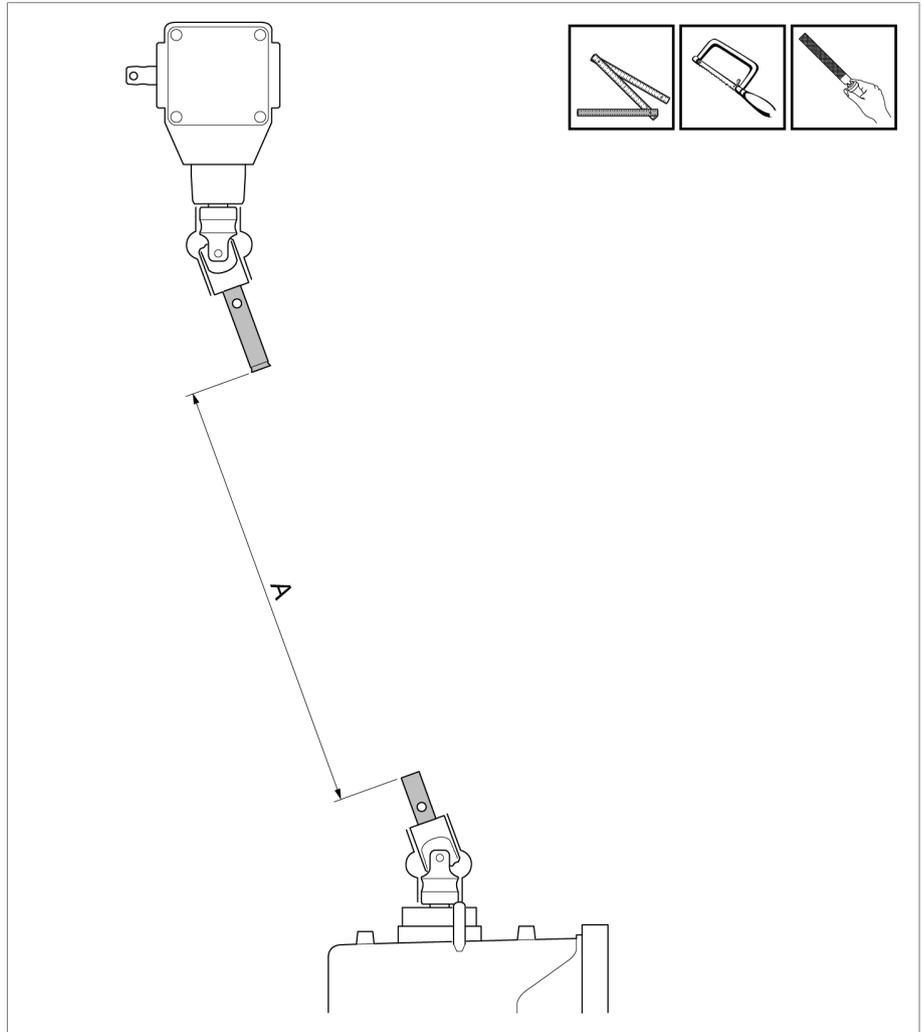


Figure 213: Shortening telescopic tubes

Dimension A (= distance between shaft ends of the drive and the bevel gear)	Inner tube	Outer tube
260 mm	Shorten to 200 mm	200 mm
261 mm...760 mm	Shorten to A-60 mm	200 mm
761 mm...1,090 mm	700 mm	Shorten to A-60 mm
1,091 mm...1,700 mm	700 mm	1,150 mm
1,701 mm...1,900 mm	1,150 mm	1,150 mm

10. Fit one adapter ring to bearing collar of motor-drive unit and fit other adapter ring to bearing collar of bevel gear.

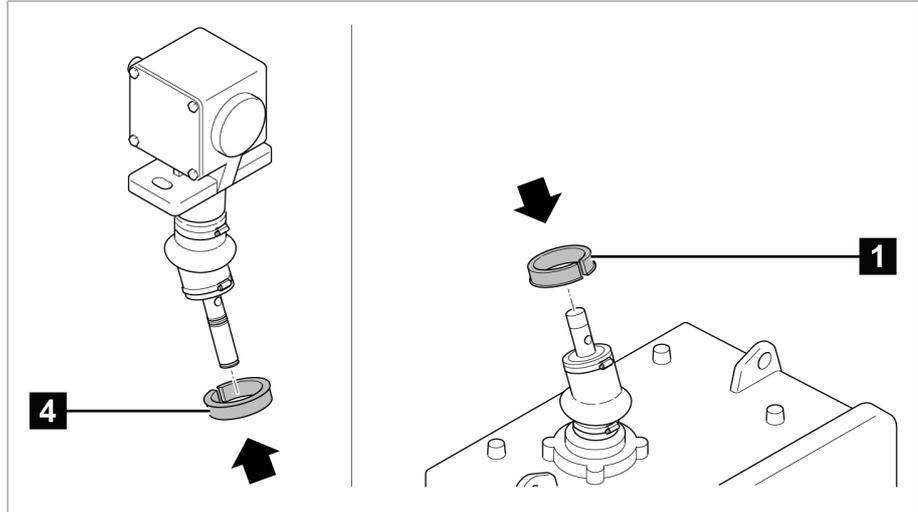


Figure 214: Fitting adapters

11. Slide previously shortened and deburred square tube over upper cardan joint end until stop is reached.

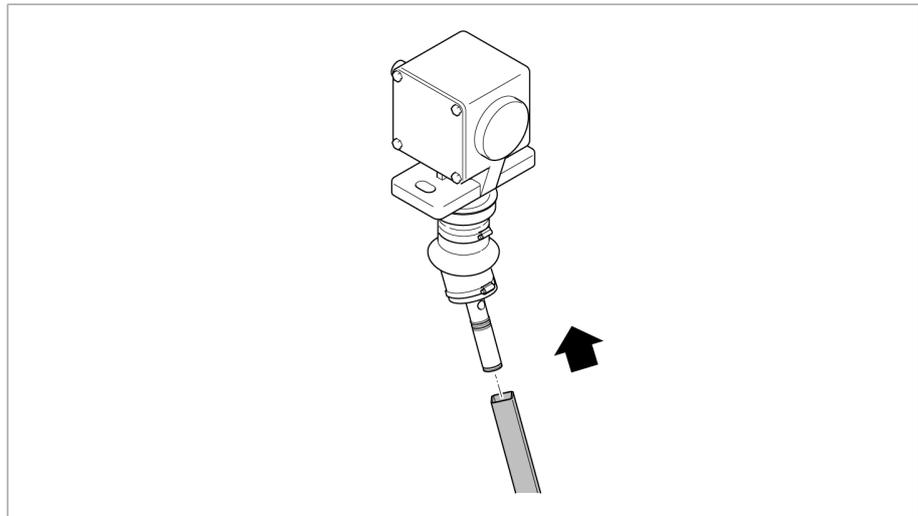


Figure 215: Sliding square tube over upper cardan joint end

12. Thread upper pivotable protective tube with long outlet up onto square tube from below.

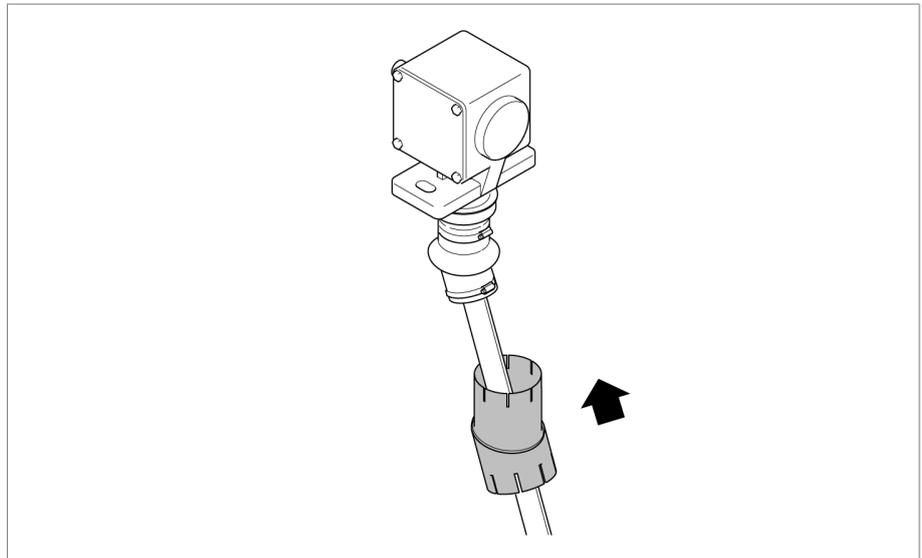


Figure 216: Sliding pivotable protective tube over square tube

13. Slide inner tube into outer tube such that the slotted sides of the outer and inner tube are both facing down. Thread the hose clips.

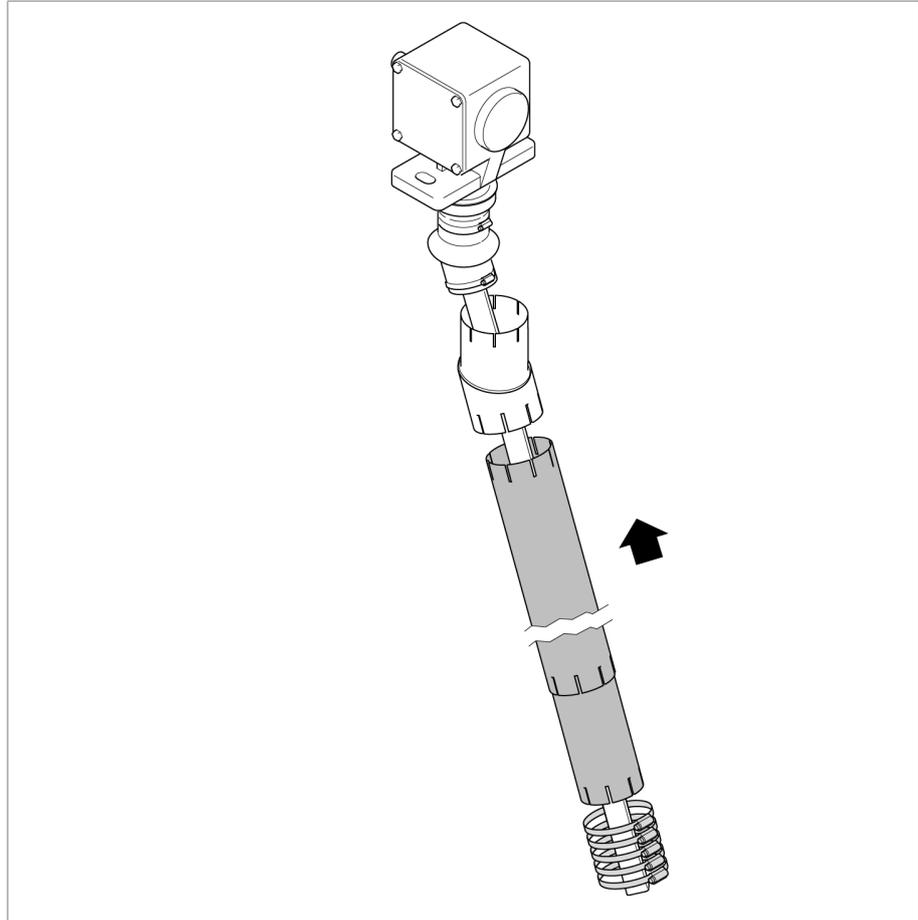


Figure 217: Sliding on telescopic tubes

14. Slide everything up and secure with a screw clamp.

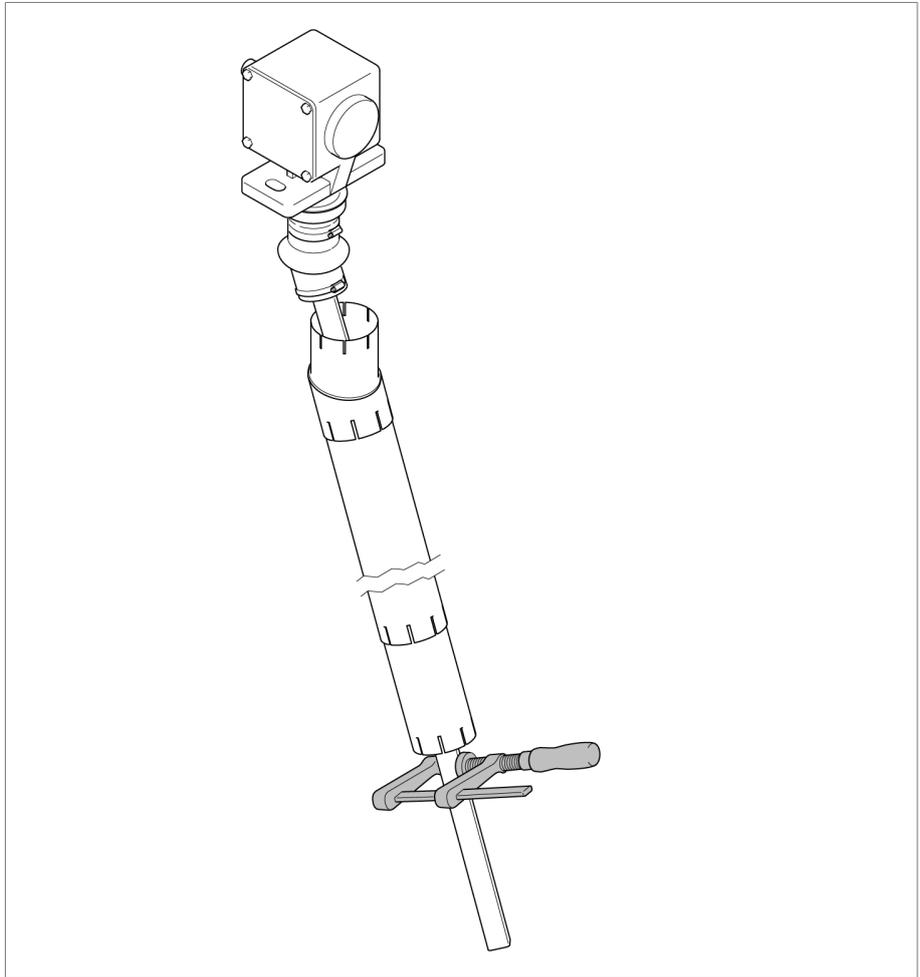


Figure 218: Secure everything with a screw clamp

15. Slide bottom pivotable protective tube (also with long outlet up) on to the square tube and secure with screw clamp.

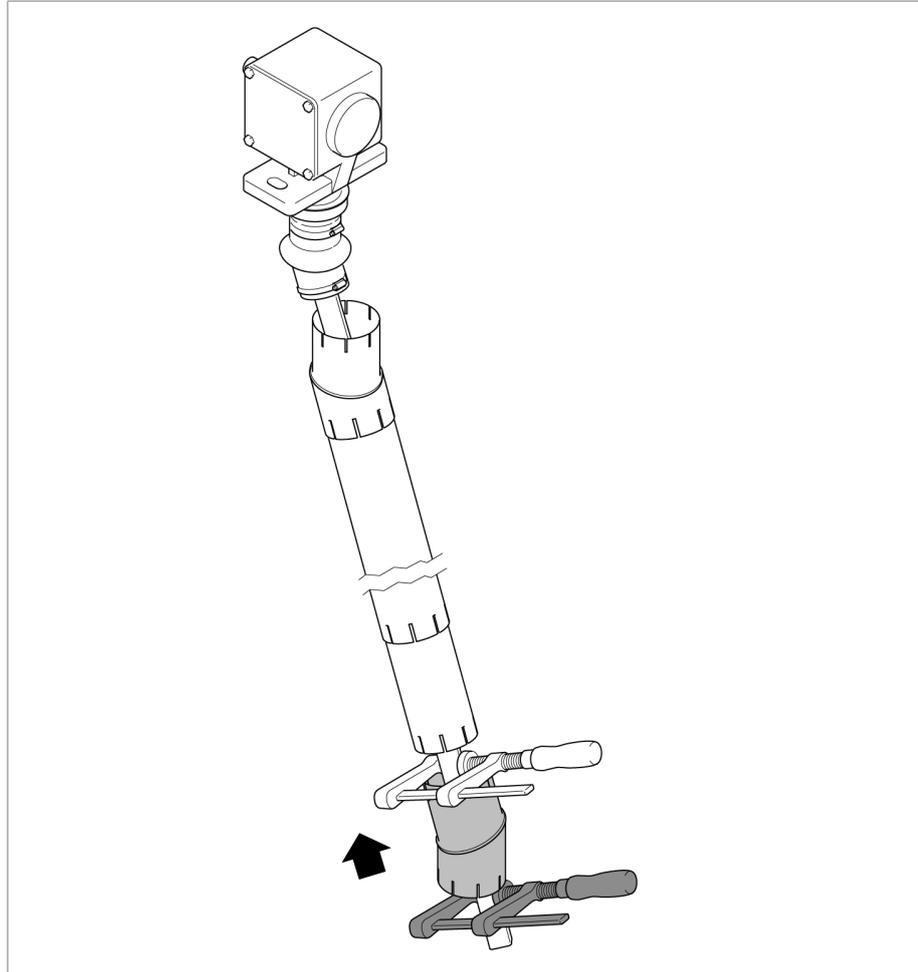


Figure 219: Sliding bottom pivotable protective tube over square tube

16. Swing in square tube and slide all the way down.

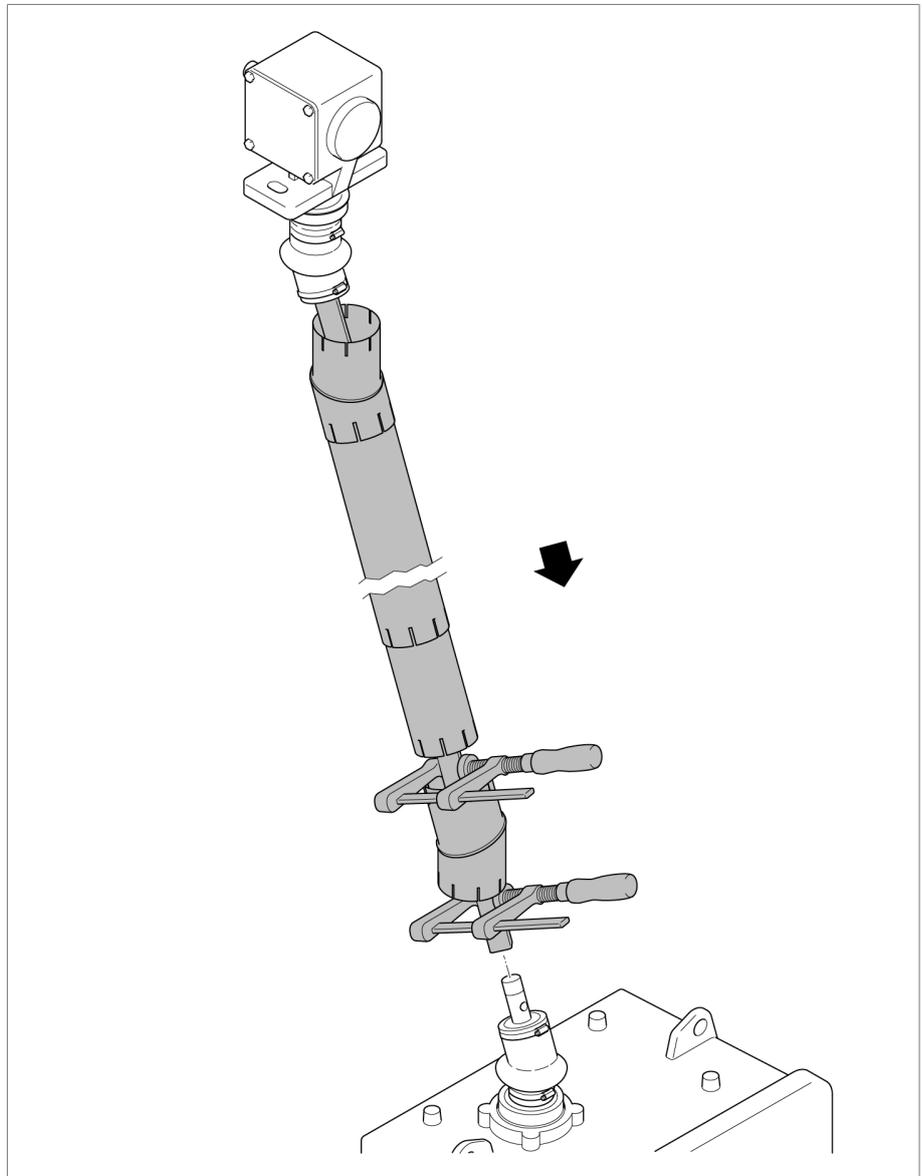


Figure 220: Pivoting square tube back to axis

17. Push the lower coupling bolt in and grease. Tighten lower coupling brackets. Shaft end and coupling part must be securely connected such that no axial clearance remains between the coupling bolt and coupling bracket.

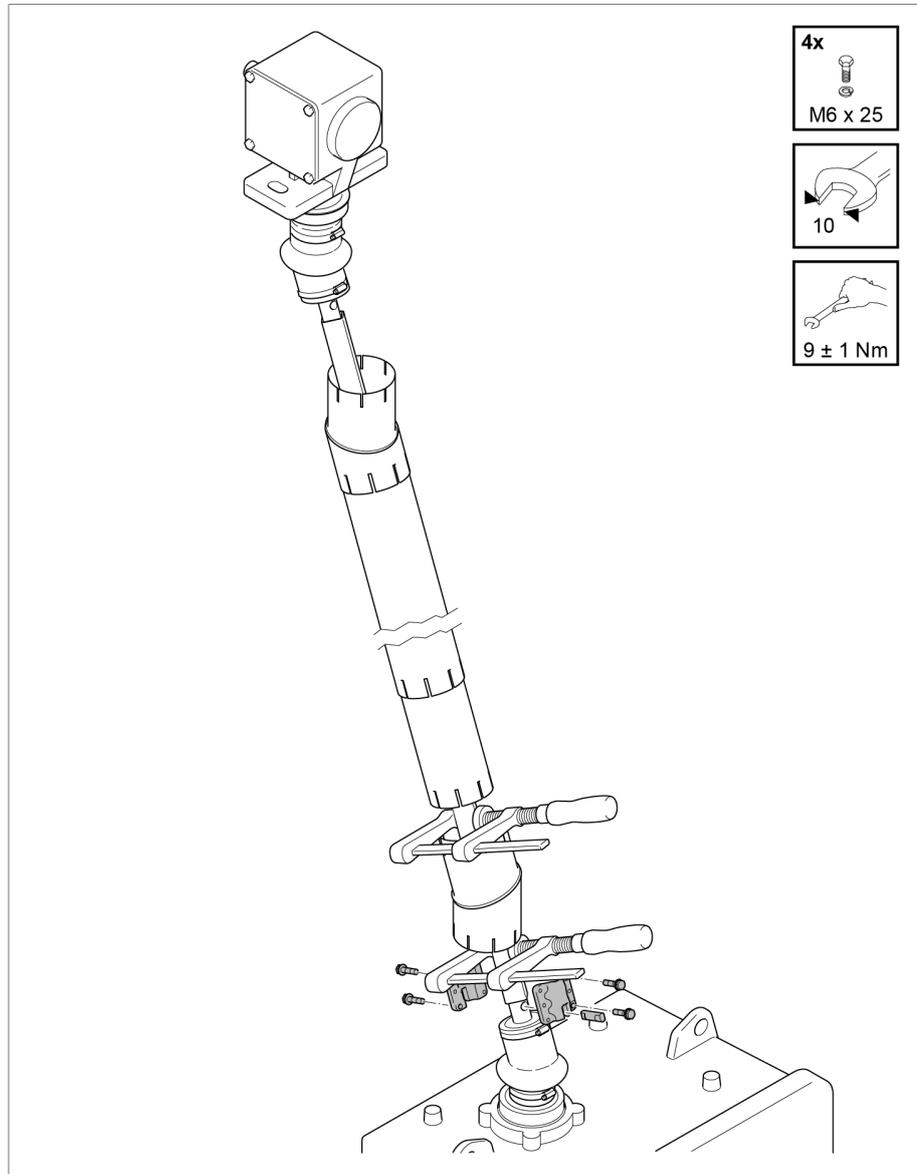


Figure 221: Tightening lower coupling brackets

18. Fit upper coupling brackets with 3 mm axial clearance.

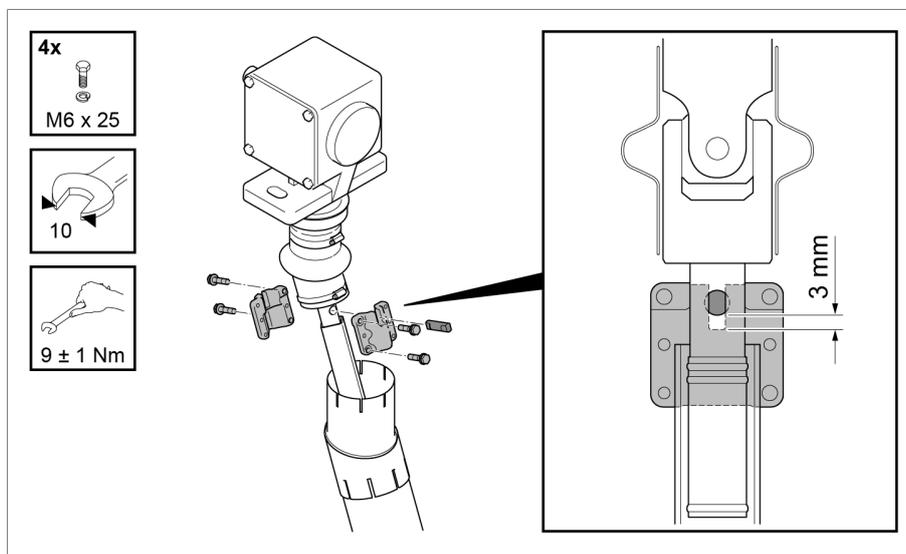


Figure 222: Fitting upper coupling brackets

19. Working from top to bottom, mount the individual parts of the shaft protection. Set angle position between both parts of pivotable protective tube and fix with available hose clip. Secure both upper and lower protective tubes with a hose clip at both ends. Secure the two telescopic protective tubes to one another using a hose clip.



The plastic adapters must be at the respective end of the pivotable protective tube. Only slide telescopic protective tube into upper and lower pivotable protective tubes by the width of the adapter before tightening the hose clips.

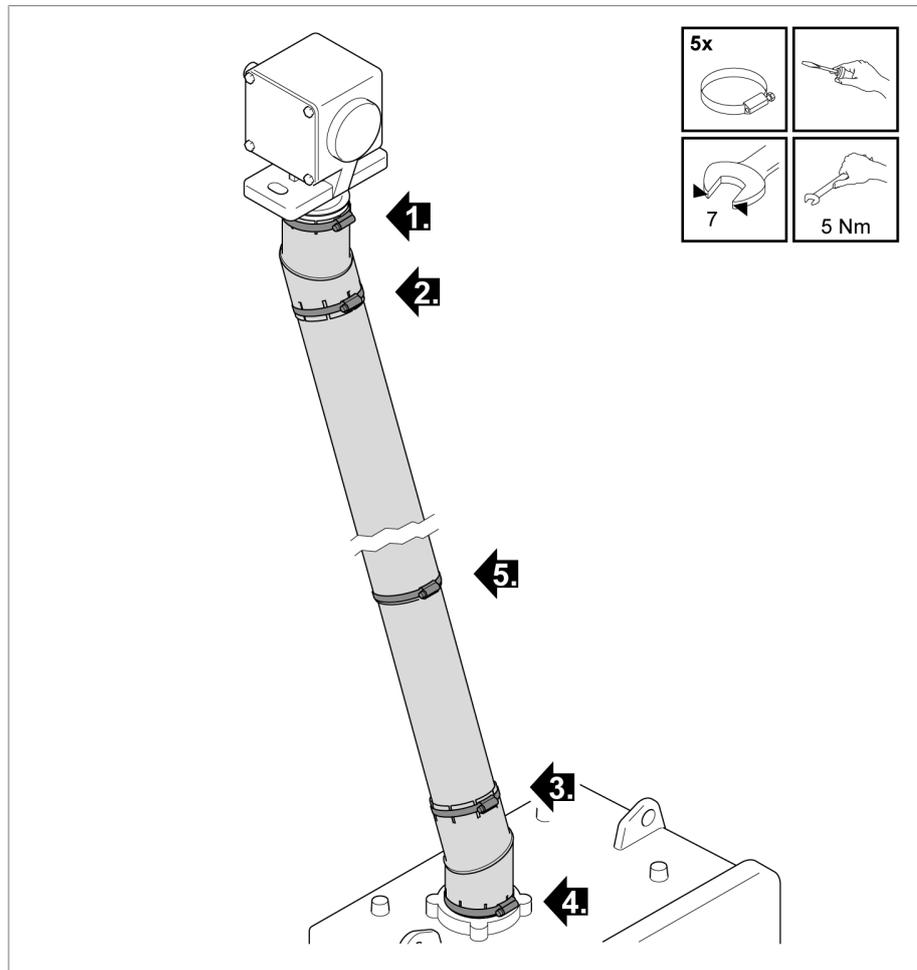


Figure 223: Securing telescopic protective tube and pivotable protective tubes with hose clips

5.4.5.4 Fitting drive shaft with insulator

A model with insulator in the vertical drive shaft is available for insulating installation of the drive shaft.

Permitted axial displacement

Minor axial displacement of the vertical drive shaft with insulator is permitted as long as it does not exceed 35 mm per 1000 mm square tube length (that corresponds to 2°).

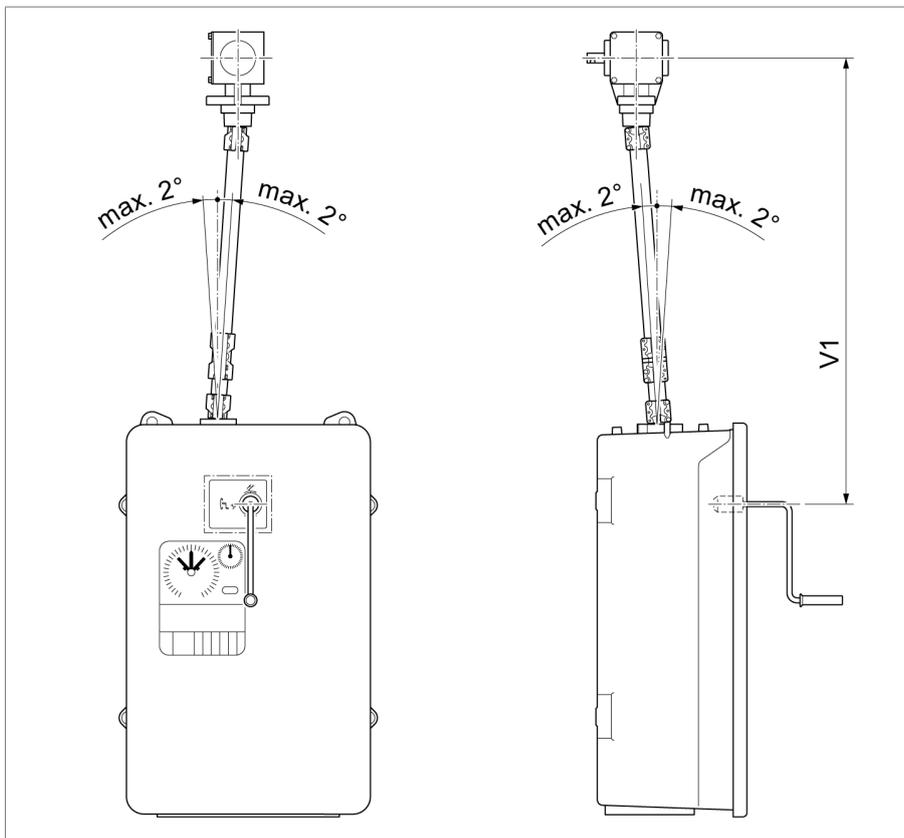


Figure 224: Permitted maximum axial displacement of vertical drive shaft with insulator

5.4.5.4.1 Fitting vertical drive shaft with insulator

To fit the vertical drive shaft, proceed as follows.

1. **⚠ CAUTION!** Switch off motor protective switch Q1 in the motor-drive unit (position O). If this is not done, the motor-drive unit may be started inadvertently and cause injuries.
2. Screw the bevel gear for mounting on the transformer. Screws are not included in the scope of supply.

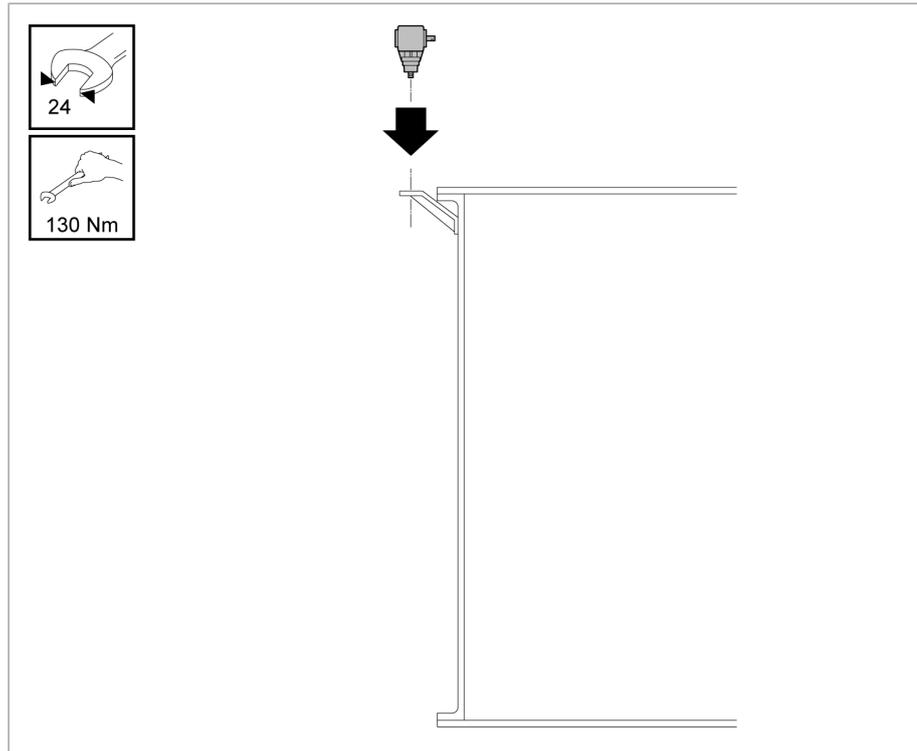


Figure 225: Bevel gear

3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten square tube to length of A-179 mm, taking the insulator into account.

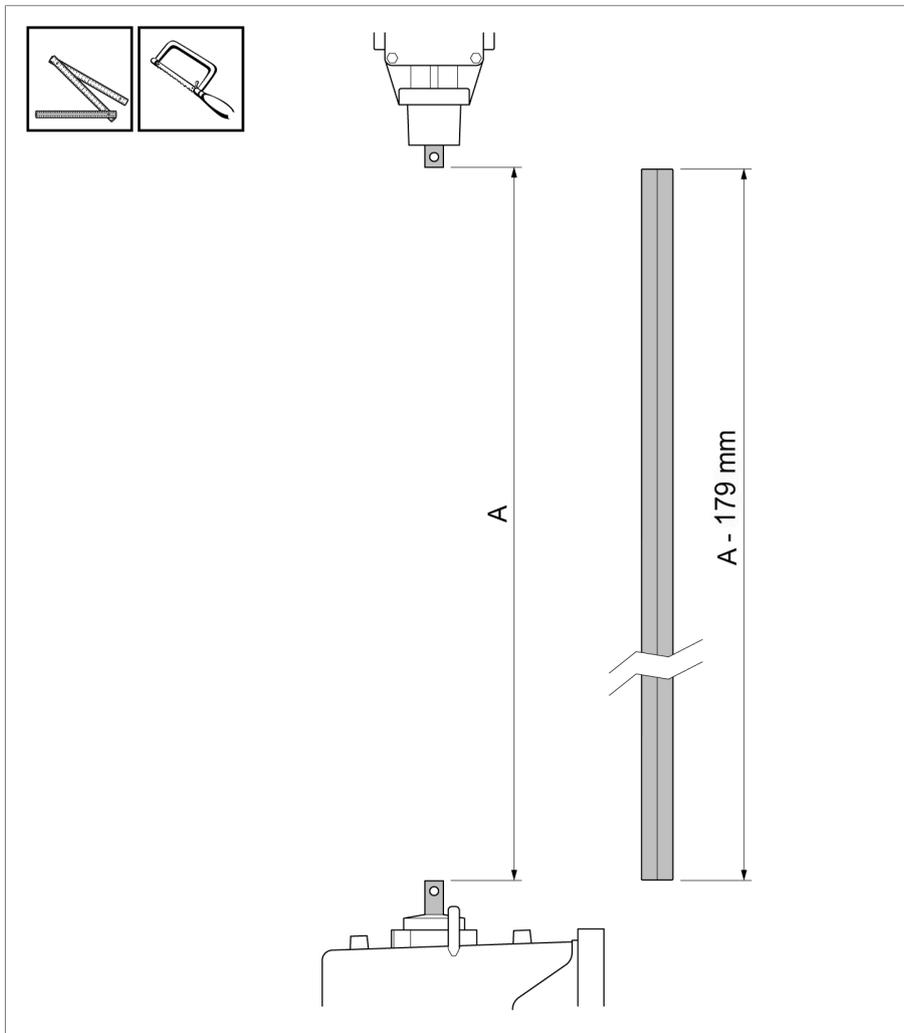


Figure 226: Shortening square tube

4. Deburr cut surfaces of square tube.

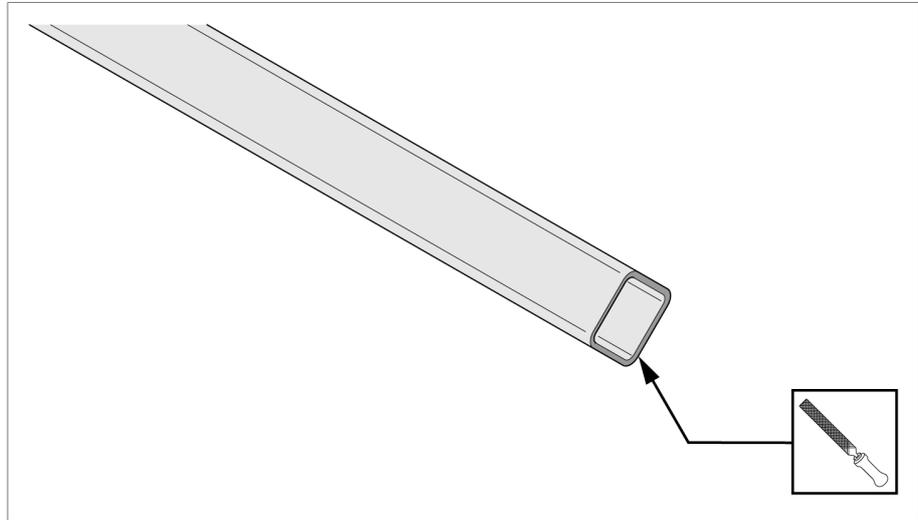


Figure 227: Deburring cut surfaces

5. Screw down double coupling part with insulator supplied and square tube. Mount insulator on the side facing the drive.

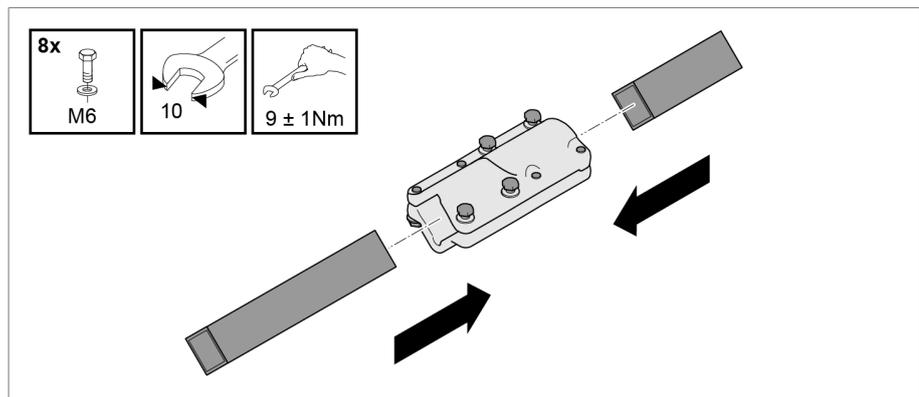


Figure 228: Screwing down square tube and insulator with double coupling part

6. Slide loosely screwed-together coupling part onto insulator until stop is reached.

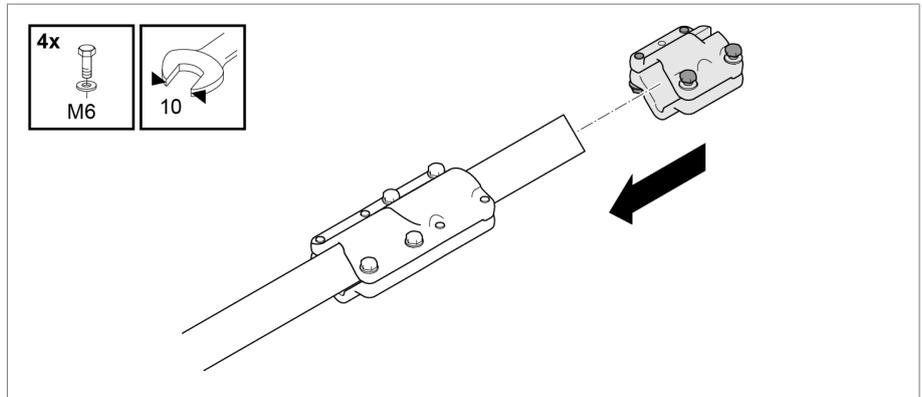


Figure 229: Sliding coupling part onto insulator

7. Place the supplied insulator ring on the bearing collar of the motor-drive unit.

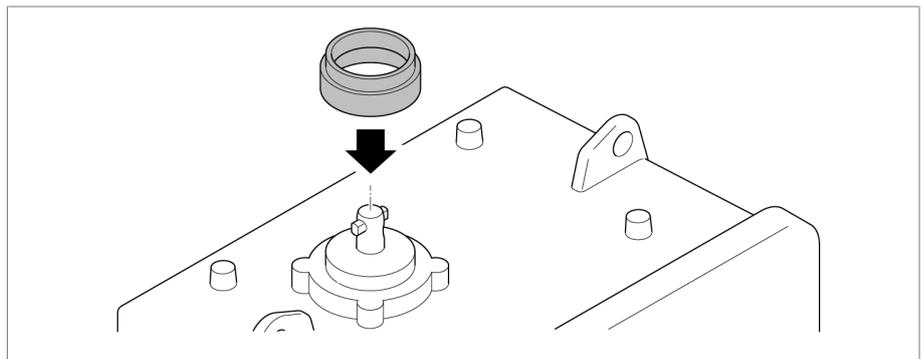


Figure 230: Insulating ring

8. Insert coupling bolt into shaft end of drive. Grease coupling part, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32). Slide square tube with coupling part onto shaft end.

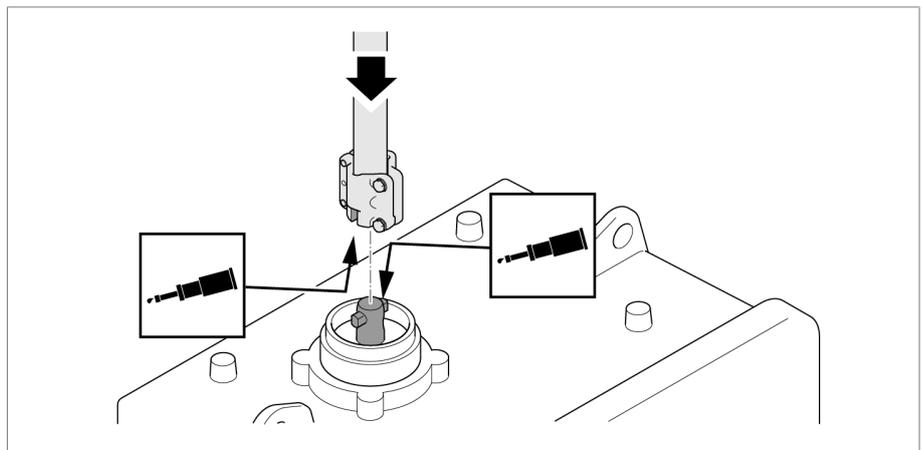


Figure 231: Sliding square tube with coupling part onto shaft end

9. Attach square tube to drive.

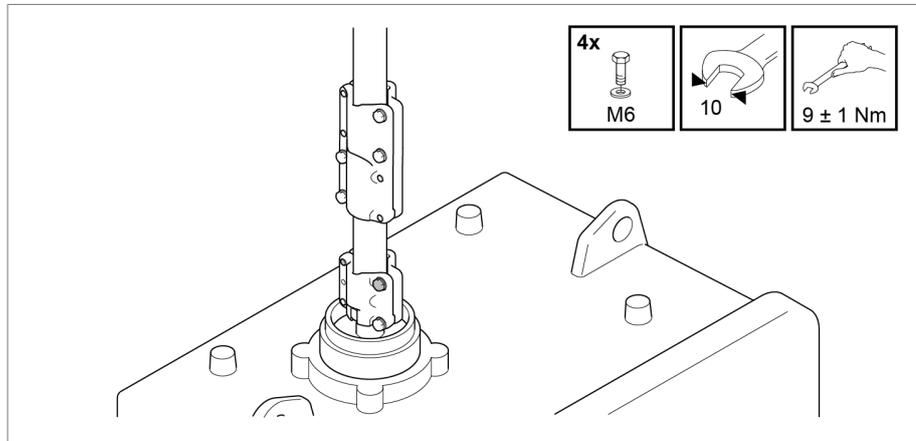


Figure 232: Attaching square tube to drive

10. Pivot square tube away from axis.

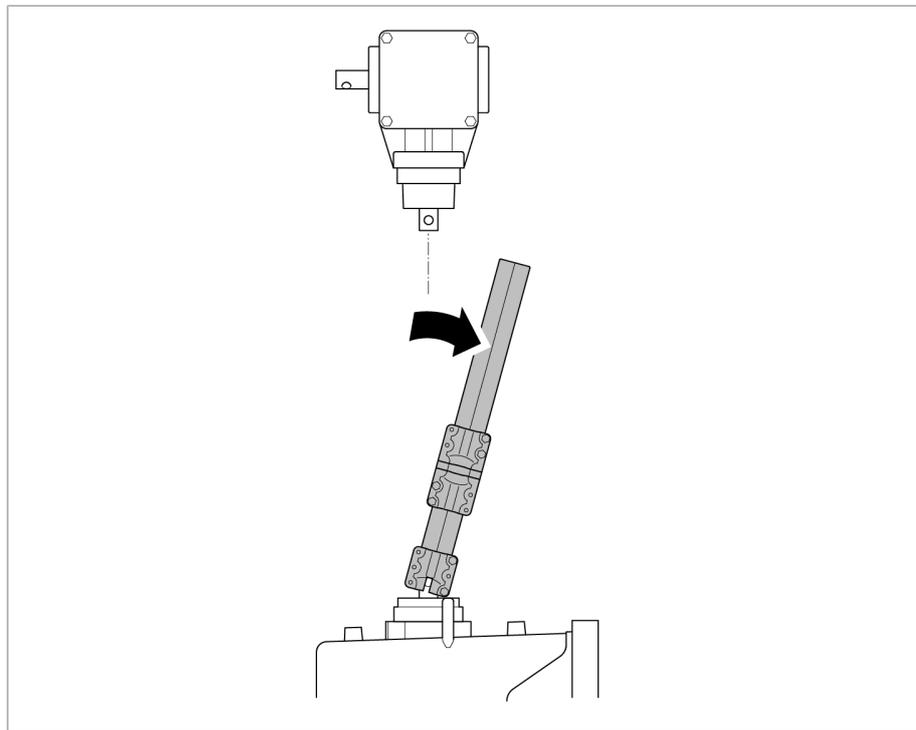


Figure 233: Pivoting square tube away from axis

11. When installing inner tube of telescopic protective tube, shorten on the side without slots if necessary. The minimum dimension for overlapping the two protective tubes is 100 mm.



Inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.

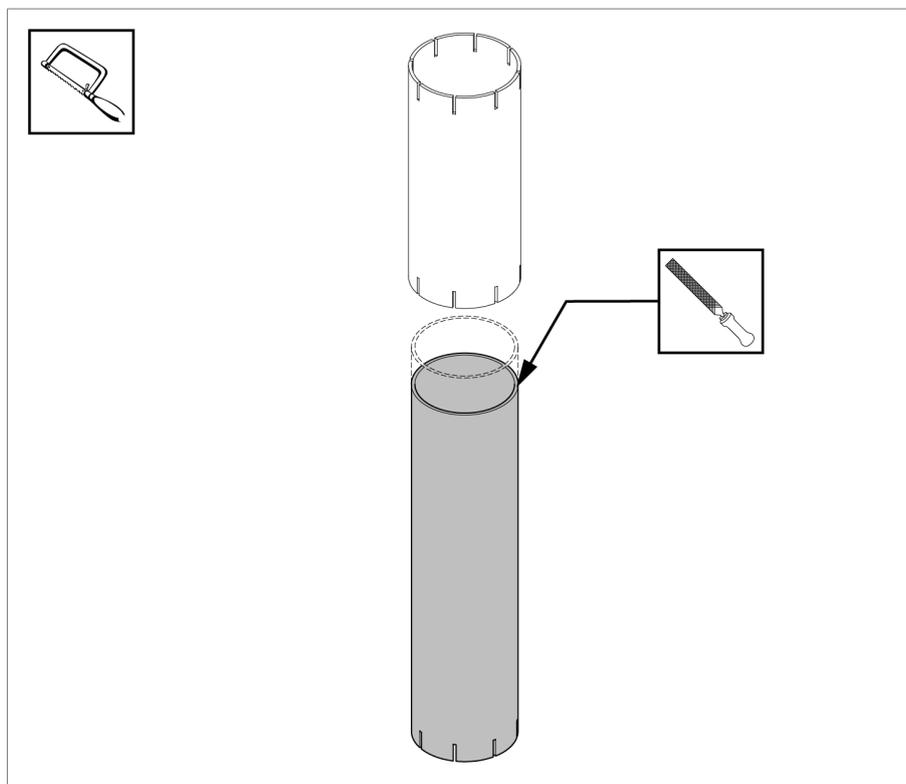


Figure 234: Deburring inner tube

Dimension A (= distance between shaft end of drive and shaft end of bevel gear)	Inner tube	Outer tube
170 mm...190 mm	Shorten to 200 mm	= 200 mm
191 mm...1,130 mm	Dimension A + 20 mm	= 200 mm
1,131 mm...1,598 mm	= 700 mm	= 1,150 mm
1,599 mm...2,009 mm	= 1,150 mm	= 1,150 mm

- Slide outer tube over inner tube. When doing so, make sure that the non-slotted side of the inner tube is facing upwards. Slide telescopic protective tube onto square tube. Then slide hose clips over telescopic protective tube.

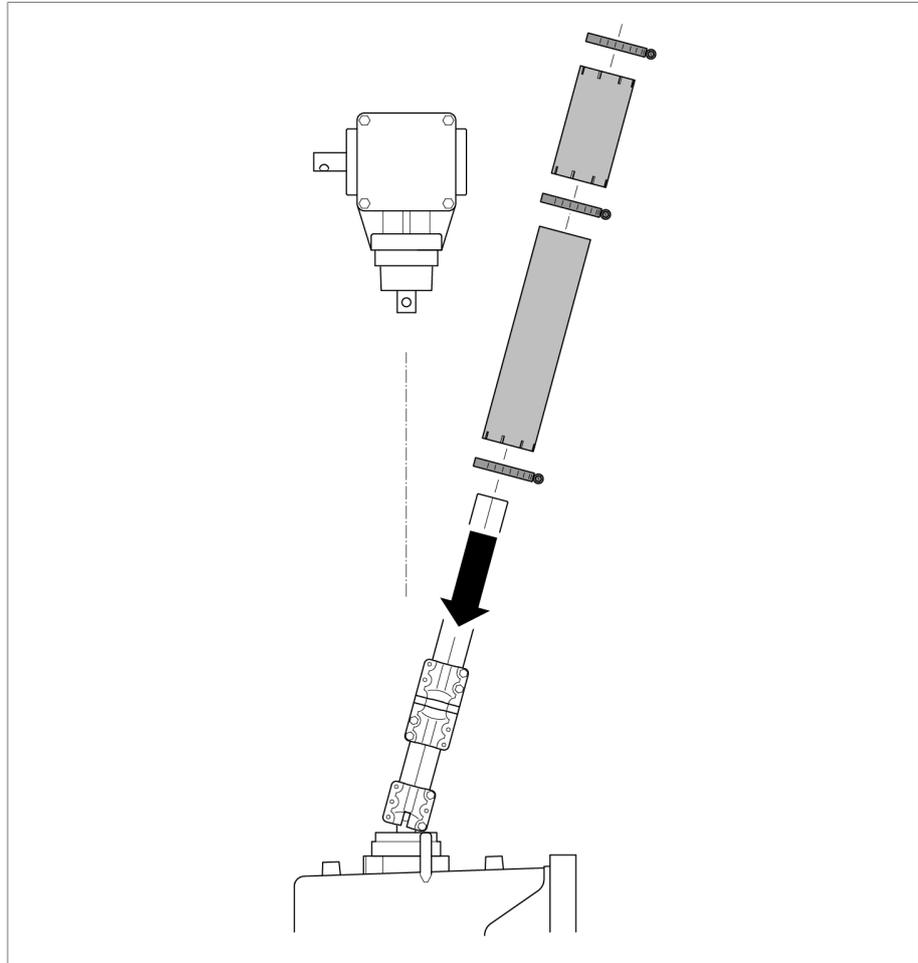


Figure 235: Sliding on telescopic protective tube

13. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Pivot square tube back to axis.

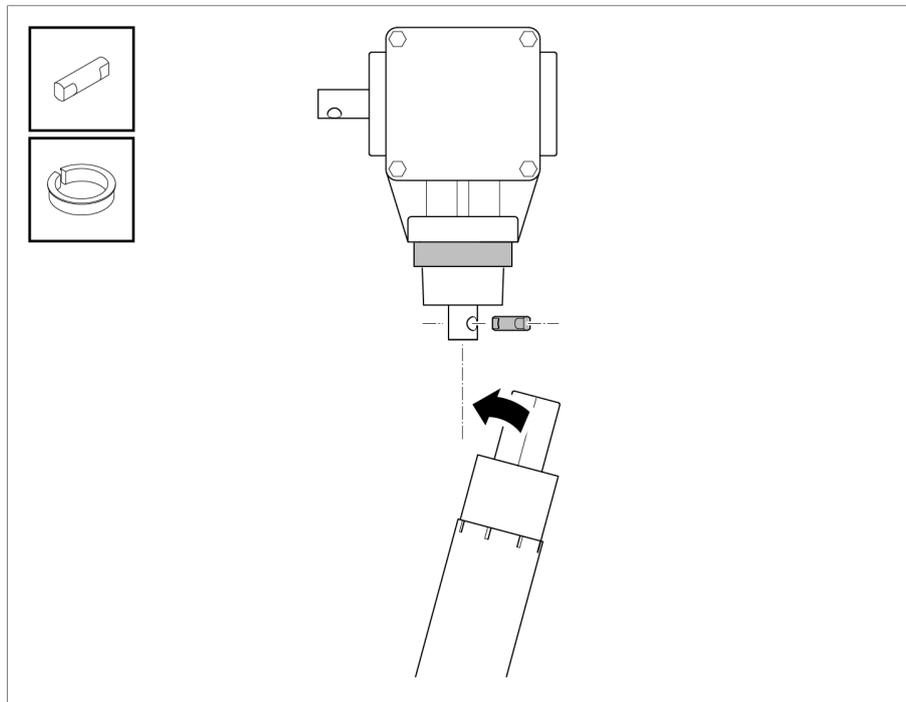


Figure 236: Fitting adapter ring and coupling bolt

14. Grease coupling brackets, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32) and secure square tube with coupling brackets on the bevel gear. Set a unilateral axial clearance of 3 mm between the coupling bolt and upper coupling piece.

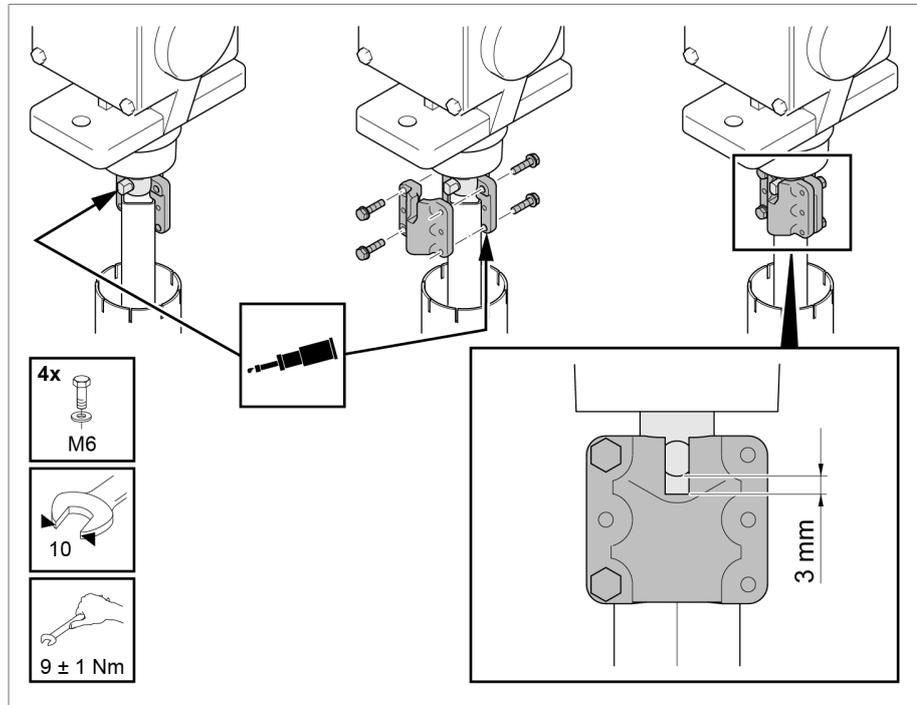


Figure 237: Mounting coupling brackets

15. Attach bottom protective tube (inner tube) with a hose clip to bearing collar of drive **1**. Then slide upper protective tube (outer tube) over adapter on bevel gear **2**. Secure upper protective tube to bottom protective tube with hose clip both at top end and at the connection point **3**.

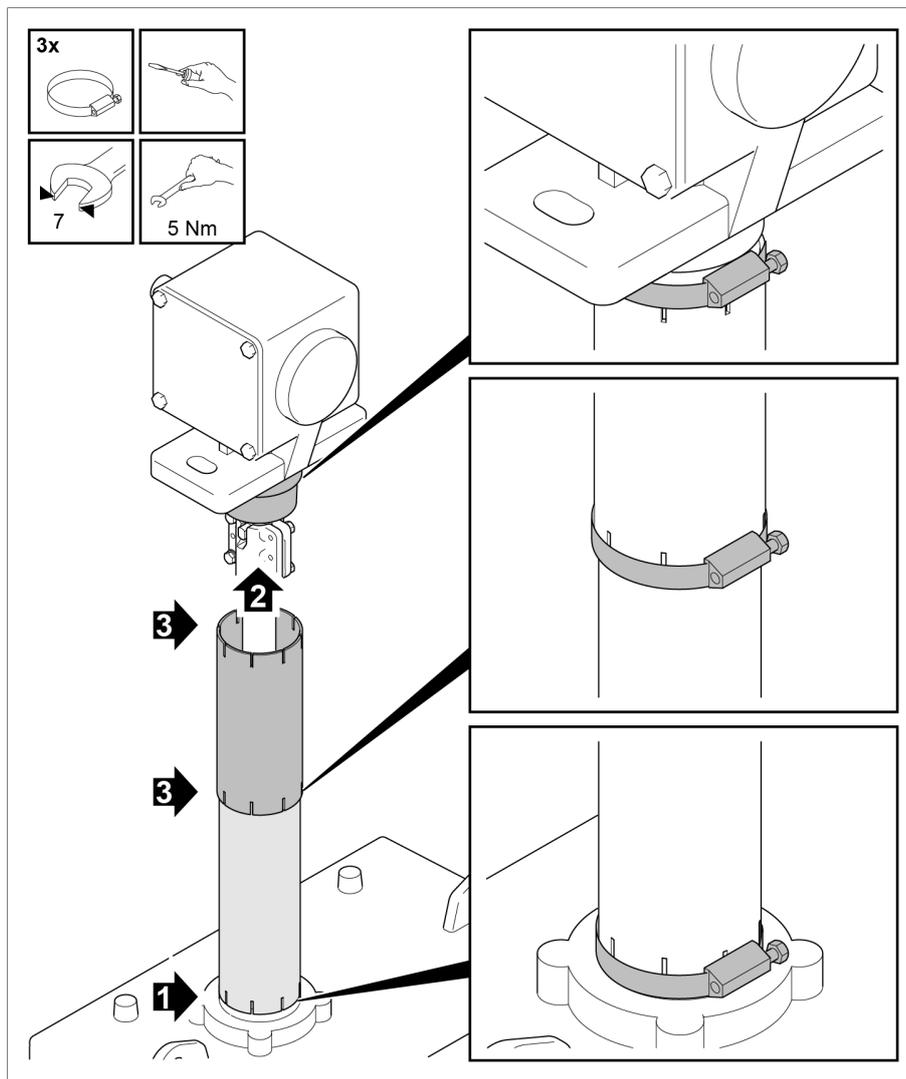


Figure 238: Mounting protective tube

5.4.5.5 Fitting drive shaft with insulator and cardan joint

A model with insulator and cardan joint in the vertical drive shaft is also available for insulating installation of the drive shaft.

Permitted axial displacement

An axial displacement of 20° is permitted for a drive shaft with insulator and cardan joint.

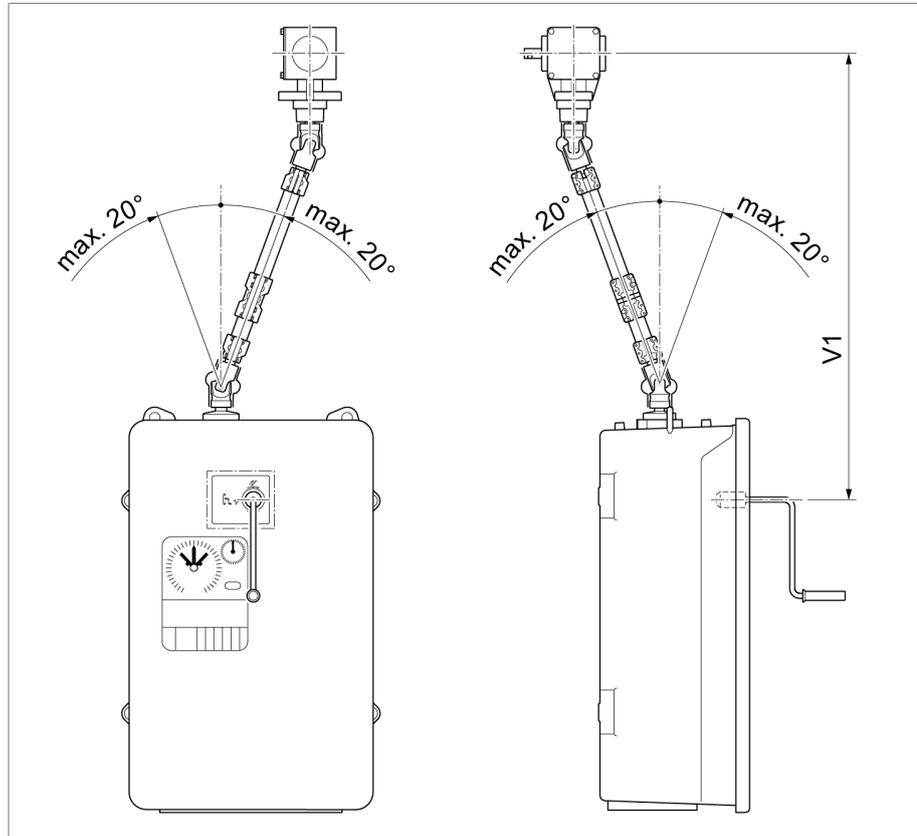


Figure 239: Permitted maximum axial displacement of vertical drive shaft with insulator and cardan joint

5.4.6 Centering on-load tap-changer and motor-drive unit

- ▶ Center on-load tap-changer and motor-drive unit as described in relevant MR operating instructions for motor-drive unit.

5.4.7 Making the electrical connections for the motor-drive unit

- ▶ Make electrical connections for the motor-drive unit as described in relevant MR operating instructions for the motor-drive unit.



6 Commissioning the on-load tap-changer at the transformer manufacturer's site

Perform the following work and functional checks before commissioning the transformer.

6.1 Grounding the on-load tap-changer

1. Visibly ground the on-load tap-changer head cover and on-load tap-changer head with the transformer. When doing so, a CUPAL washer must be positioned between the cable shoe and ground connection. The aluminum side of the CUPAL washers must be facing the ground connection.

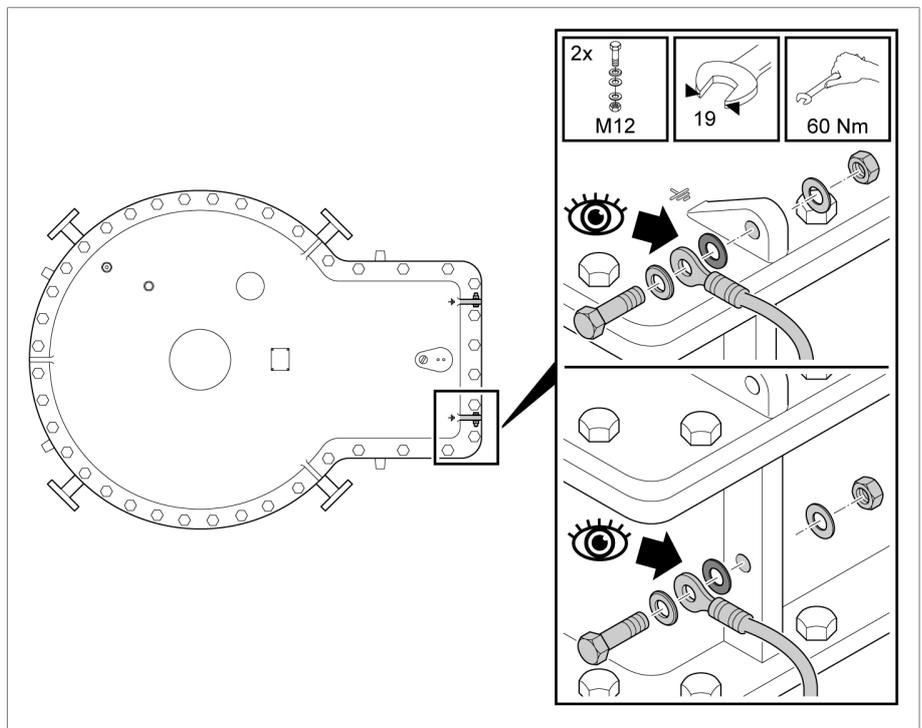


Figure 240: Grounding screw

2. Visibly ground the motor-drive unit with the transformer. It is essential that a CUPAL washer is placed between the cable shoe and connecting lug. The aluminum side of the CUPAL washer must be facing the connecting lug.

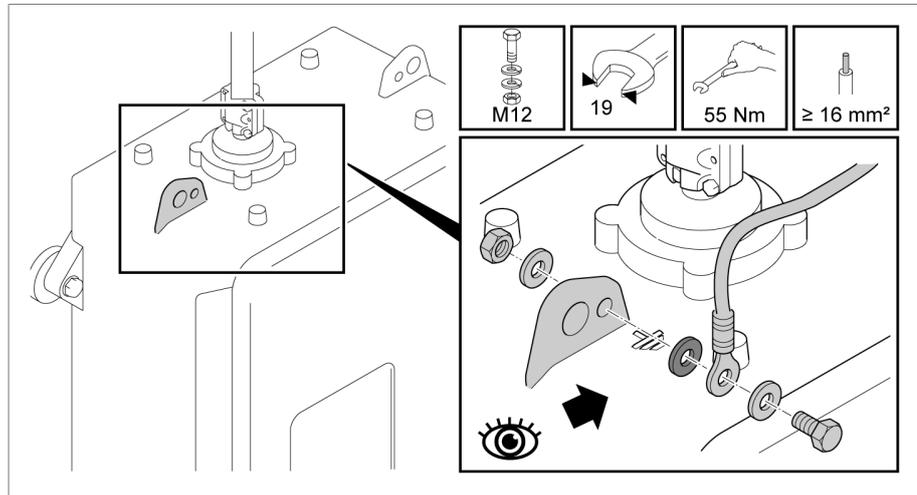


Figure 241: Grounding screw on motor-drive unit

3. When using a temperature sensor, visibly ground the temperature sensor with the on-load tap-changer head or another grounding point on the transformer. It is essential that a CUPAL washer is placed between the cable shoe and temperature sensor housing. The aluminum side of the CUPAL washer must be facing the temperature sensor housing.

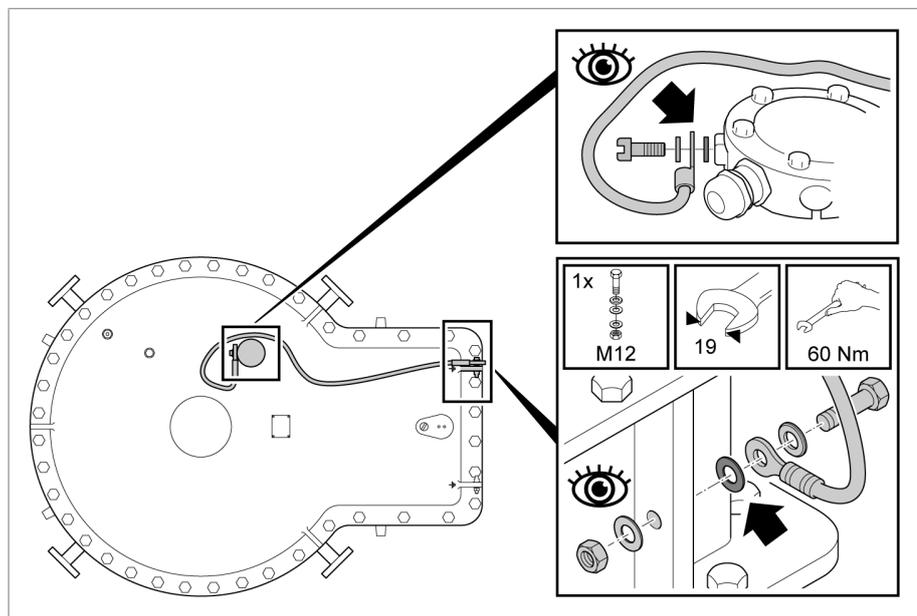


Figure 242: Grounding temperature sensor



6.2 Checking motor-drive unit

NOTICE

Damage to the on-load tap-changer / de-energized tap-changer!

Damage to the on-load tap-changer / de-energized tap-changer due to actuation of the on-load tap-changer / de-energized tap-changer without insulating fluid.

- ▶ Ensure that the selector / de-energized tap changer is fully immersed in insulating fluid and that the oil compartment of the on-load tap-changer is completely filled with insulating fluid.

Prior to commissioning the transformer, check whether the motor-drive unit and on-load tap-changer are correctly coupled and that the motor-drive unit functions correctly.

Tests on the motor-drive unit

1. Perform function checks as described in relevant MR operating instructions for motor-drive unit.
2. **NOTICE!** An incorrectly coupled motor-drive unit will lead to damage to the on-load tap-changer. Undertake trial tap-change operations across the entire range of settings. Ensure that in each operating position, the tap position indicators of motor-drive unit and on-load tap-changer (inspection window in the on-load tap-changer head) match.

Dielectric tests on transformer wiring

- ▶ Note information relating to dielectric tests on transformer wiring in relevant MR operating instructions for motor-drive unit.

Prior to commissioning the transformer, check whether the motor-drive unit is functioning correctly.

Tests on the motor-drive unit

- ▶ Perform function checks as described in relevant MR operating instructions for motor-drive unit.

Dielectric tests on transformer wiring

- ▶ Note information relating to dielectric tests on transformer wiring in relevant MR operating instructions for motor-drive unit.

6.3 High-voltage tests on the transformer

Note the following points before performing high-voltage tests on the transformer:

- Ensure that the oil compartment of the on-load tap-changer is completely filled with insulating fluid.
- Ensure that all protective devices for the on-load tap-changer are functioning correctly and are ready for use.



6 Commissioning the on-load tap-changer at the transformer manufacturer's site

- Ensure that the ground connections on the motor-drive protective housing and protective housing fastening are free of paint.
- Only perform high voltage test if motor-drive unit door is closed.
- Disconnect external connections to electronic components in the motor-drive unit to prevent damage from overvoltage.
- When connecting the motor-drive unit's supply voltage, only use the cable bushings in the protective housing base intended for lead insertion.
- Guide all ground connecting leads to one central connection point (establishment of suitable reference earth).
- Disconnect all electronic components before the high voltage test. Before a dielectric test of the wiring, remove all devices with a withstand voltage of < 1000 V.
- Remove leads used for testing before the high voltage test as these function as antennas.
- Wherever possible, route the measurement leads and data leads separately to the energy cables.

Contact the manufacturer if you have any questions about possible sources of danger.



7 Transporting transformer to the operating site

NOTICE

Damage to motor-drive unit!

Damage to the motor-drive unit due to condensate in protective housing of motor-drive unit.

- ▶ Always keep protective housing of the motor-drive unit tightly closed.
- ▶ In the event of downtime lasting more than 8 weeks prior to initial commissioning, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible, place a sufficient amount of desiccant in the protective housing.

7.1 Transport with drive removed

1. Ensure that the drive and the on-load tap-changer are in the adjustment position.
2. Remove the drive.
3. Do not actuate the drive while the on-load tap-changer is uncoupled and do not turn the output shaft.
4. Do not actuate an on-load tap-changer which is uncoupled and do not turn its drive shaft.
5. Transport the drive to the installation site in the MR delivery packaging.
6. Fit the drive [▶ Section 5.4.4, Page 140] and the drive shaft [▶ Section 5.4.5, Page 140] to the transformer at the installation site.

7.2 Transport with oil fill and without oil conservator

If the transformer is filled with oil but stored or transported without an oil conservator, a connecting lead for pressure compensation must be installed between the interior of the oil compartment and the transformer tank's oil chamber.

To do so, proceed as follows:

- Establish the connecting lead on the on-load tap-changer head between connections E and one of the free pipe connections R, S or Q.

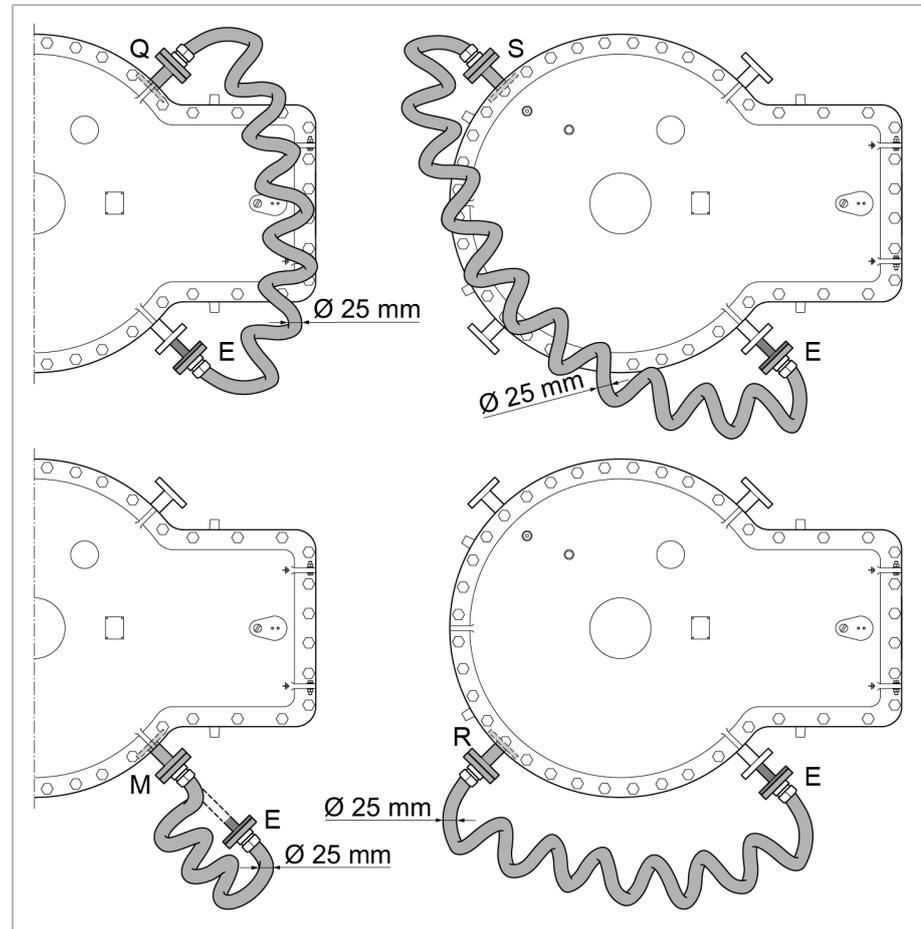


Figure 243: Connecting lead



In case of a short-term immobilization time of maximum 4 weeks without an oil conservator, dropping the oil level in the on-load tap-changer head by about 40 liters is also sufficient.

7.3 Transport with empty transformer tank

NOTICE

Damage to the on-load tap-changer!

The on-load tap-changer may be subject to oscillating movements during transformer transportation if the transformer is transported without insulating fluid and the on-load tap-changer oil compartment is transported with insulating fluid. These oscillating movements can lead to damage to the on-load tap-changer.

- ▶ Completely empty the oil compartment if the transformer is to be transported without insulating fluid.
- ▶ Preserve the oil compartment in the same way as the transformer (for example by filling with N₂).

7.3.1 Emptying oil compartment via pipe connection S

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
 - ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
 - ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).
1. De-energize all auxiliary circuits (for example tap-change supervisory devices, pressure relief devices, pressure monitoring devices).
 2. Open stop-cock (slide valve) between oil conservator and oil compartment.
 3. Open the vent screw on the on-load tap-changer head. Ensure sufficient fresh air (for example in transformer cells and work tents).
 - ⇒ The gas from under the on-load tap-changer cover escapes.
 4. As soon as the gas is removed and the oil flows out of the vent screw, close the vent screw.
 5. Extract oil via pipe connection S.

8 Commissioning transformer at operating site

8.1 Filling the oil compartment of the on-load tap-changer with oil and bleeding it

NOTICE

Damage to the on-load tap-changer!

Unsuitable insulating fluids cause damage to the on-load tap-changer.

- ▶ Only use insulating fluids [▶ Section 10.1, Page 210] approved by the manufacturer.

Filling oil compartment with oil and bleeding it

1. **NOTICE!** Check whether the on-load tap-changer head cover has a flange for attaching a pressure relief device. If it does, operation without a pressure relief device is not permitted and may result in damage to the on-load tap-changer.
 - ⇒ Fit a pressure relief device which is approved for this on-load tap-changer on the on-load tap-changer head.
2. Establish a connecting lead between the pipe connection E and one of the pipe connections R, S or Q to ensure uniform pressure conditions in the oil compartment and transformer during evacuation.

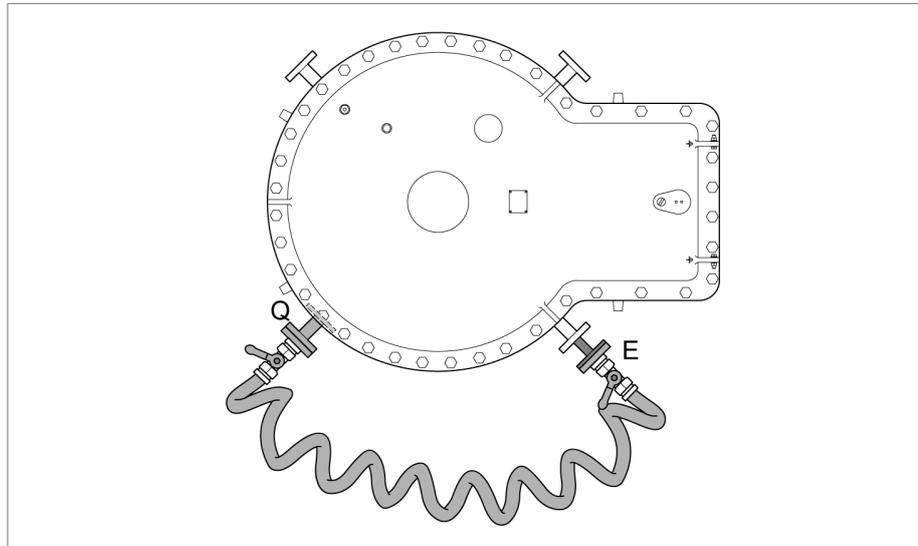


Figure 244: Connecting lead between E and Q

3. Perform an evacuation.
4. Fill the oil compartment completely with oil via the S pipe connection. During this process, the oil suction pipe is bled.
5. Drain the oil conservator until the minimum volume for switching gases and thermal expansion has been reached in accordance with the technical data for the OILTAP® G.



Removing the oil sample

1. Take oil sample from oil compartment.
2. Record temperature of oil sample just after sample is taken.
3. Determine dielectric strength and water content at a diverter switch oil temperature of $20\text{ °C} \pm 5\text{ °C}$. The dielectric strength and water content must comply with the limit values provided in the appendix [► Section 10.5, Page 216].

8.2 Checking motor-drive unit

NOTICE

Damage to the on-load tap-changer / de-energized tap-changer!

Damage to the on-load tap-changer / de-energized tap-changer due to actuation of the on-load tap-changer / de-energized tap-changer without insulating fluid.

- Ensure that the selector / de-energized tap changer is fully immersed in insulating fluid and that the oil compartment of the on-load tap-changer is completely filled with insulating fluid.

NOTICE

Damage to the on-load tap-changer and motor-drive unit!

Damage to on-load tap-changer and motor-drive unit due to incorrect use of position transmitter equipment.

- Only circuits stated in the chapter Technical data for position transmitter equipment may be connected to the position transmitter module connections.
- The switchover point of the position transmitter equipment in the motor-drive unit is not the same as the switchover point of the diverter switch operation. This depends on the type of diverter switch. This fact should be noted when project planning the locking circuits between the motor-drive unit and external equipment (e.g. transformer circuit breaker).
- Therefore, the "Tap changer in operation" position transit contact shown in the connection diagram should be used for external monitoring, locking and control purposes instead of the position transmitter equipment.

Prior to commissioning the transformer, check whether the motor-drive unit and on-load tap-changer are correctly coupled and that the motor-drive unit functions correctly.

Tests on the motor-drive unit

1. Perform function checks as described in relevant MR operating instructions for motor-drive unit.
2. **NOTICE!** An incorrectly coupled motor-drive unit will lead to damage to the on-load tap-changer. Undertake trial tap-change operations across the entire range of settings. Ensure that in each operating position, the tap position indicators of motor-drive unit and on-load tap-changer (inspection window in the on-load tap-changer head) match.



Dielectric tests on transformer wiring

- ▶ Note information relating to dielectric tests on transformer wiring in relevant MR operating instructions for motor-drive unit.

Prior to commissioning the transformer, check whether the motor-drive unit is functioning correctly.

Tests on the motor-drive unit

- ▶ Perform function checks as described in relevant MR operating instructions for motor-drive unit.

Dielectric tests on transformer wiring

- ▶ Note information relating to dielectric tests on transformer wiring in relevant MR operating instructions for motor-drive unit.

8.3 Checking protective relay

8.3.1 Checking protective relay (RS 2001, 2001/V, 2001/H, 2001/E, 2001/5, 2001/R, 2001/T, 2003)

- ✓ Check that the protective relay is functioning correctly before commissioning the transformer:
 1. Ground the transformer on the high-voltage side and low-voltage side. Ensure that the grounding for work connection on the transformer is not removed during testing.
 2. Ensure that the transformer remains de-energized during testing.
 3. Deactivate the automatic fire extinguishing device.
 4. Loosen the three screws on the terminal box cover and lift off the terminal box cover.
 5. Remove the slotted head screw for potential tie-in and remove the terminal box cover with wire.
 6. Press OFF test button.
 7. Leave the transformer's danger zone.
 8. Ensure that the transformer's circuit breaker cannot be closed.
 - ⇒ Passive protection test
 9. Press OPERATION test button.
 10. Leave the transformer's danger zone.
 11. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
 12. Press OFF test button.
 13. Ensure that the transformer's circuit breaker is open.
 - ⇒ Active protection test.
 14. Press OPERATION test button to reset the protective relay.



15. Position the wire for the terminal box cover and affix using the slotted head screw.
16. Attach the terminal box cover and secure with screws.

8.3.2 Checking protective relay (RS 2004)

- ✓ Check that the protective relay is functioning correctly before commissioning the transformer:
 1. Ensure that the flap valve is in the OPERATION position.
 2. Leave the transformer's danger zone.
 3. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
 4. Press OFF test button.
 5. Ensure that the transformer's circuit breaker is open.
 - ⇒ Active protection test



8.4 Checking pressure monitoring device

1. Ground the transformer on the high-voltage side and low-voltage side. Ensure that the grounding for work connection on the transformer is not removed during testing.
2. Ensure that the transformer remains de-energized during testing.
3. Deactivate the automatic fire extinguishing device.
4. Remove the cover cap.
5. Activate the sensor on the snap-action switch.
⇒ Sensor is in the OFF position.
6. Leave the transformer's danger zone.
7. Ensure that the transformer's circuit breaker cannot be closed.
⇒ Passive protection test
8. Activate the sensor on the snap-action switch.
⇒ Sensor is in the OPERATION position.
9. Leave the transformer's danger zone.
10. Close the transformer's circuit breaker with isolating switches open and the transformer grounded on all sides.
11. Activate the sensor on the snap-action switch.
⇒ Sensor is in the OFF position.
12. Ensure that the transformer's circuit breaker is open.
⇒ Active protection test.
13. Activate the sensor on the snap-action switch to reset the pressure monitoring device.
⇒ Sensor is in the OPERATION position.
14. Secure the cover cap.

8.5 Commissioning the transformer

- ✓ The signaling contact for falling below the minimum insulating fluid fill level in the on-load tap-changer's oil conservator is looped into the tripping circuit of the circuit breaker.
 - ✓ The protective relay and additional protective devices are looped into the circuit breaker's tripping circuit.
 - ✓ The motor-drive unit and all protective devices are functioning correctly and are ready for use.
 - ✓ The oil compartment of the on-load tap-changer is completely filled with insulation fluid.
 - ✓ All stop-cocks between on-load tap-changer and oil conservator of the on-load tap-changer are open.
1. Switch on transformer.
 2. **NOTICE!** Inrush current impulses can be significantly greater than the transformer rated current and may lead to current paths with asymmetrical or non-sinusoidal curve shapes and, as a result, overload the on-load tap-



changer during the diverter switch operation. Only perform tap-change operations - whether under no load or under load conditions - once the in-rush current impulse has subsided.

9 Fault elimination

▲ WARNING



Danger of explosion!

Explosive gases under the on-load tap-changer head cover can deflagrate or explode and result in severe injury or death.

- ▶ Ensure that there are no ignition sources such as open flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits (for example tap-change supervisory device, pressure relief device, pressure monitoring device) before removing the on-load tap-changer head cover.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

NOTICE

Damage to the on-load tap-changer and transformer!

If the protective relay or other protective devices trip, this can indicate damage to the on-load tap-changer and transformer. The transformer must not be energized without being inspected first.

- ▶ Check on-load tap-changer and transformer when protective relay or other protective devices have been tripped.
- ▶ Do not use the equipment again until you are sure there is no damage to the on-load tap-changer or transformer.

NOTICE

Damage to motor-drive unit!

Damage to the motor-drive unit due to condensate in protective housing of motor-drive unit.

- ▶ Always keep protective housing of the motor-drive unit tightly closed.
- ▶ In the event of operation interruptions of more than 2 weeks, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible, e.g. during transportation, place a sufficient amount of desiccant in the protective housing.

The table below is intended to assist with detecting and, where possible, remedying faults.

For more information, please consult the operating instructions for the protective relay or the relevant protective device.

In the event of faults on the on-load tap-changer and motor-drive unit which cannot be easily corrected on site, or if the protective relay or additional protective devices have been tripped, please inform your authorized MR representative, the transformer manufacturer or contact MR directly.

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Fault description	Action
Tripping of protective relay	See "Tripping the protective relay and re-commissioning the transformer" Also contact MR.
Tripping of pressure relief device (e.g. MPreC®)	On-load tap-changer and transformer must be checked. Depending on the cause of tripping, take measurements / carry out checks on the transformer. Contact MR to check the on-load tap-changer.
Tripping of pressure monitoring device (e.g. DW 2000)	See "Tripping the pressure monitoring device and putting the transformer back into operation" Also contact MR.
Activation of tap-change supervisory device	The motor-drive unit can no longer be electrically actuated once the tap-change supervisory device has been activated. Manual operation of the motor-drive unit via the hand crank when the transformer is switched on is prohibited. On-load tap-changer and transformer must be checked. Depending on the cause of tripping, take measurements / carry out checks on the transformer. Contact MR to check the on-load tap-changer.
Activation of rupture disk in on-load tap-changer head cover	On-load tap-changer and transformer must be checked. Depending on the cause of tripping, take measurements / carry out checks on the transformer. Contact MR to check the on-load tap-changer.
Tripping of motor protective switch in motor-drive unit	See chapter "Fault elimination" in the operating instructions of the TAPMOTION® ED motor-drive unit
Tripping of signaling contact that indicates that the fill level of the insulating fluid has fallen below the minimum in the on-load tap-changer oil conservator	Check pipe system (pipes etc.) and on-load tap-changer head for leaks. Check the fill level and the quality of the insulating fluid in the oil compartment in accordance with the operating instructions for the on-load tap-changer. If the fill level has fallen below the limit values, also contact MR.
On-load tap-changer not changing tap position (sluggishness, Raise keys / Lower keys not working, no audible diverter switch action)	Contact MR.
No change in voltage on transformer despite change in position on motor-drive unit	Contact MR.
Tap position indicator on motor-drive unit and on-load tap-changer different	Contact MR.
Noises on drive shaft or motor-drive unit when changing tap position	Ensure proper mounting of the drive shaft in accordance with its operating instructions. Check that hose clips and protective covers are seated correctly. Contact MR in the event of noise from the motor-drive unit.

Fault description	Action
Red message on monitoring unit	If possible read out database and send to MR along with error code.
Warning or tripping of Buchholz relay on transformer	Notify manufacturer of transformer.
Deviation from desired value when measuring winding resistance of transformer	Contact manufacturer of transformer and, if necessary, MR, and provide measured values.
Deviation from desired value during dissolved gas analysis (transformer oil)	Contact manufacturer of transformer and, if necessary, MR, and provide measured values.
Deviation from desired value during transformer ratio test	Contact manufacturer of transformer and, if necessary, MR, and provide measured values.
Deviation from limit value for insulating fluids	Carry out insulating fluid change, check oil conservator breather of on-load tap-changer.

Table 8: Fault elimination

9.1 Tripping the protective relay and re-commissioning the transformer

▲ WARNING



Danger of explosion!

Explosive gases in the protective relay can deflagrate or explode and result in severe injury or death.

- ▶ Wait 15 minutes after switching off the transformer before beginning further work on the protective relay so that the gases can dissipate.
- ▶ Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the immediate surroundings and that none occur.
- ▶ De-energize all auxiliary circuits before beginning work.
- ▶ Do not operate any electrical devices during the work (e.g. risk of sparks from impact wrench).

▲ WARNING



Danger of death or severe injury!

Danger of severe injury or death if on-load tap-changer and transformer are insufficiently tested.

- ▶ Be sure to contact Maschinenfabrik Reinhausen to check on-load tap-changer and transformer if the protective relay has tripped.
- ▶ Only use the equipment again when you are sure there is no damage to the on-load tap-changer or transformer.

When the circuit breakers have been tripped by the protective relay, proceed as follows:

1. Establish time of tripping.
2. Determine operating position of on-load tap-changer.
3. As a precaution, block the motor-drive unit by tripping the motor protective switch to prevent the on-load tap-changer from being actuated by remote control.



4. Check the on-load tap-changer head cover. If insulating fluid is leaking, close the oil conservator stop valve immediately.
5. Check whether the flap valve of the protective relay is in the OFF or OPERATION position.

9.1.1 Flap valve in OPERATION position

If the flap valve is in the OPERATION position, there may be a fault in the tripping circuit. Check the tripping circuit in this case. If you are not able to clarify why the protective relay tripped, be sure to contact Maschinenfabrik Reinhausen to check the on-load tap-changer.

9.1.2 Flap valve in OFF position



Note that protective relay RS 2004 features an automatic reset mechanism which means that the flap valve does not remain in the OFF position after tripping. If the protective relay RS 2004 has not tripped due to an error in the tripping circuit, also proceed as described below for RS 2004.

If the flap valve is in the OFF position, proceed as follows:

1. Ensure that the transformer is not started up under any circumstances.
2. Contact and inform Maschinenfabrik Reinhausen of the following:
 - ⇒ Serial number of protective relay and on-load tap-changer
 - ⇒ What was the load of the transformer at the instant of tripping?
 - ⇒ Was the on-load tap-changer moved immediately before or during tripping?
 - ⇒ Did any other protective devices of the transformer respond at the instant of tripping?
 - ⇒ Were switching operations in the network being carried out at the instant of tripping?
 - ⇒ Were overvoltages registered at the instant of tripping?
3. Take further action in agreement with Maschinenfabrik Reinhausen.

9.1.3 Re-commissioning the transformer

Once the reason for the protective relay tripping has been established and remedied, you can re-commission the transformer:

1. Check the protective relay [► Section 8.3.1, Page 200].
2. Commission the transformer.

9.2 Tripping the pressure monitoring device and putting the transformer back into operation

▲ WARNING



Danger of death or severe injury!

Danger of severe injury or death if on-load tap-changer and transformer are insufficiently tested.

- ▶ Be sure to contact Maschinenfabrik Reinhausen to check on-load tap-changer and transformer after the pressure monitoring device has been tripped.
- ▶ Only use the equipment again when you are sure there is no damage to the on-load tap-changer or transformer.

If the circuit breaker is tripped by the pressure monitoring device, proceed as follows:

1. Establish time of tripping.
2. Determine operating position of on-load tap-changer.
3. As a precaution, block the motor-drive unit by tripping the motor protective switch to prevent the on-load tap-changer from being actuated by remote control.
4. Check the on-load tap-changer head cover. If insulating fluid is leaking, close the oil conservator stop valve immediately.
5. Check whether the pressure monitoring device sensor is in the OFF position or OPERATION position.

9.2.1 Sensor in the OPERATION position

If the sensor is in the OPERATION position, there may be an error in the tripping circuit. Check the tripping circuit in this case. If you are not able to clarify why the pressure monitoring device tripped, be sure to contact Maschinenfabrik Reinhausen to check the on-load tap-changer.



9.2.2 Sensor in the OFF position

Proceed as follows if the sensor is in the OFF position.

1. Ensure that the transformer is not started up under any circumstances.
2. Contact and inform Maschinenfabrik Reinhausen of the following:
 - ⇒ What was the load of the transformer at the instant of tripping?
 - ⇒ Was there a tap-change operation on the on-load tap-changer immediately before or during the tripping?
 - ⇒ Did any other protective devices of the transformer respond at the instant of tripping?
 - ⇒ Were switching operations in the network being carried out at the instant of tripping?
 - ⇒ Were overvoltages registered at the instant of tripping?
 - ⇒ How high is the static pressure on the pressure relief device (height difference between the oil level in the on-load tap-changer oil conservator and the pressure relief device)?
3. Take further action in agreement with Maschinenfabrik Reinhausen.

9.2.3 Re-commissioning the transformer

You can re-commission the transformer once the cause for tripping the pressure monitoring device has been determined and resolved:

1. Ensure that the sensor on the snap-action switch is in the OPERATION position.
2. Commission the transformer.



10 Technical data

An overview of all key technical data for the on-load tap-changer and motor-drive unit exists in the form of separate documents, which are available on request.

10.1 Permissible ambient conditions

Air temperature during operation	-25°C...+50°C
Temperature of the insulating fluid in operation	-25°C...+105°C (up to +115°C when the transformer is in emergency operation)
Transport temperature, storage temperature	-40°C...+50°C
Drying temperatures	See installation and commissioning instructions, "Mounting" chapter
Compressive strength	See technical data TD 61 – General section
Insulating fluid	<ul style="list-style-type: none"> ▪ Unused insulating oils derived from petroleum products¹⁾ in accordance with IEC60296 and ASTM D3487 (equivalent standards on request) ▪ Unused insulating oils derived from other virgin hydrocarbons in accordance with IEC60296, or blends of these oils with petroleum products¹⁾ in accordance with IEC60296, ASTM D3487 or equivalent standards on request ▪ Alternative insulating fluids, such as natural and synthetic esters or silicone oils, on request. <p>¹⁾ Gas-to-liquid oils (GTL oils) are understood in this context as petroleum products</p>
Installation height of the oil conservator	See technical data TD 61 – General section
Installation height above sea level	See technical data TD 61 – General section

Table 9: Permissible ambient conditions

10.2 Technical data for protective relay

The technical data for the protective relay RS 2001 is listed in the following. In accordance with DIN EN 60255-1, operational accuracy = base accuracy

Housing	Outdoor model
Degree of protection	IP66
Relay actuation	Flap valve with aperture
Weight	approx. 3.5 kg
Oil flow speed of available types when tripping (oil temperature 20 °C)	0.65 ± 0.15 m/s
	1.20 ± 0.20 m/s
	3.00 ± 0.40 m/s
	4.80 ± 0.60 m/s

Table 10: General technical data



Tripping circuit

The protective relay can be supplied with either a normally open (NO) or a normally closed (NC) dry-reed magnetic switch (see dimensional drawing supplied). Other contact combinations are available as a special version.

Electrical data for normally closed (NC) dry-reed magnetic switch

Electrical data	
DC switching capacity	1.2 W...200 W
AC switching capacity (50 Hz)	1.2 VA...400 VA
Switching voltage AC/DC	24 V...250 V
Switched current AC/DC	4.8 mA...2 A

Table 11: Electrical data

Switching capacity (switching load on an off)	
Minimum switched current AC/DC (lowest voltage)	50 mA (at 24 V)
Minimum switched current AC/DC (highest voltage)	4.8 mA (at 250 V)
Maximum switched current DC (highest current)	1.6 A (at 125 V with L/R = 40 ms)
Maximum switched current DC (highest voltage)	0.9 A (at 250 V with L/R = 40 ms)
Maximum switched current AC (highest current)	2 A (at 125 V with $\cos \varphi = 0.6$)
Maximum switched current AC (highest voltage)	1.6 A (at 250 V with $\cos \varphi = 0.6$)
Switching operations	1,000 cycles

Table 12: Switching capacity (switching load on an off)

Dielectric strength	
AC dielectric strength between all voltage-carrying connections and the grounded parts	2,500 V, 50 Hz, test duration 1 minute
AC dielectric strength between the opened contacts	2,000 V, 50 Hz, test duration 1 minute

Table 13: Dielectric strength

**Electrical data for normally open (NO) dry-reed magnetic switch**

Electrical data	
DC switching capacity	1.2 W...250 W
AC switching capacity (50 Hz)	1.2 VA...400 VA
Switching voltage AC/DC	24 V...250 V
Switched current AC/DC	4.8 mA...2 A

Table 14: Electrical data

Switching capacity (switching load on an off)	
Minimum switched current AC/DC (lowest voltage)	50 mA (at 24 V)
Minimum switched current AC/DC (highest voltage)	4.8 mA (at 250 V)
Maximum switched current DC (highest current)	2 A (at 125 V with L/R = 40 ms)
Maximum switched current DC (highest voltage)	1 A (at 250 V with L/R = 40 ms)
Maximum switched current AC (highest current)	2 A (at 125 V with $\cos \varphi = 0.6$)
Maximum switched current AC (highest voltage)	1.6 A (at 250 V with $\cos \varphi = 0.6$)
Switching operations	1,000 cycles

Table 15: Switching capacity (switching load on an off)

Dielectric strength	
AC dielectric strength between all voltage-carrying connections and the grounded parts	2,500 V, 50 Hz, test duration 1 minute
AC dielectric strength between the opened contacts	2,000 V, 50 Hz, test duration 1 minute

Table 16: Dielectric strength

Ambient conditions

Ambient temperature Ta	-40°C...+50°C
Oil temperature	<130 °C
Air pressure	Corresponds to 0 m...4,000 m above sea level

Table 17: Ambient conditions



10.3 Special models of protective relay

10.3.1 Protective relay with CO change-over contact as tripping switch

The protective relay can be supplied with a dry-reed magnetic switch, CO change-over (variant 3) (see dimensional drawing supplied).

Electrical data for CO change-over dry-reed magnetic switch

Electrical data	
DC switching capacity	1.2 W...150 W
AC switching capacity (50 Hz)	1.2 VA...200 VA
Switching voltage AC/DC	24 V...250 V
Switched current AC/DC	4.8 mA...1 A

Table 18: Electrical data

Switching capacity (switching load on an off)	
Minimum switched current AC/DC (lowest voltage)	50 mA (at 24 V)
Minimum switched current AC/DC (highest voltage)	4.8 mA (at 250 V)
Maximum switched current DC (highest current)	1.0 A (at 150 V with L/R = 40 ms)
Maximum switched current DC (highest voltage)	0.6 A (at 250 V with L/R = 40 ms)
Maximum switched current AC (highest current)	1 A (at 200 V with $\cos \varphi = 0.6$)
Maximum switched current AC (highest voltage)	0.8 A (at 250 V with $\cos \varphi = 0.6$)
Switching operations	1,000 cycles

Table 19: Switching capacity (switching load on an off)

Dielectric strength	
AC dielectric strength between all voltage-carrying connections and the grounded parts	2,500 V, 50 Hz, test duration 1 minute
AC dielectric strength between the opened contacts	1,150 V, 50 Hz, test duration 1 minute

Table 20: Dielectric strength



10.3.2 Protective relay with several dry-reed magnetic switches

The protective relay can be supplied with several independent dry-reed magnetic switches. These can be designed as normally open (NO) or normally closed (NC) contacts and are electrically isolated (see dimensional drawing supplied).

Electrical data for normally open (NO) and normally closed (NC) dry-reed magnetic switch



10.4 Technical data for pressure monitoring device

General technical data

Setup	Outdoor model
Ambient temperature	-40 °C...+80 °C (mechanical)
Cable gland	M25x1.5
Degree of protection	IP55 in accordance with IEC 60529 (enclosed device)
Relay actuation	Corrugated tubing with counter-pressure spring
Oil temperature	-40 °C...+100 °C
Weight	approx. 1.2 kg
Equipment	For standard insulating fluids (IEC60296 and IEC60422)
Sealing material (oil – air)	VITON
Permitted pressure range (absolute pressure)	1 bar...6 bar, vacuum not permitted
Upper switching pressure	3.8 ± 0.2 bar (trip pressure)
Lower switching pressure	2,8 ± 0,2 bar
Snap-action switch	
Connection terminals	Lead connection: 1 or 2 leads per terminal (Ø 0.75...2.5 mm ²)
Contacts	1xNO (normally open), 1xNC (normally closed)
Utilization category	IEC 60947-5-1: AC 15: 230 V/1 A DC 13: 60 V/0.5 A
Maximum continuous current	10 A
Rated insulation voltage	AC: 2.5 kV/min

Table 21: General technical data



10.5 Limit values for dielectric strength and water content of insulating fluids

The following tables provide the limit values for dielectric strength (measured in accordance with IEC 60156) and water content (measured in accordance with IEC 60814) of insulating fluids for OILTAP® on-load tap-changers. The values have been established on the basis of IEC 60422.

In operation	U _d	H ₂ O
When commissioning the transformer for the first time	> 60 kV/2.5 mm	< 12 ppm
During operation	> 30 kV/2.5 mm	< 40 ppm
After maintenance	> 50 kV/2.5 mm	< 15 ppm

Table 22: Limit values for insulating fluids for neutral point applications

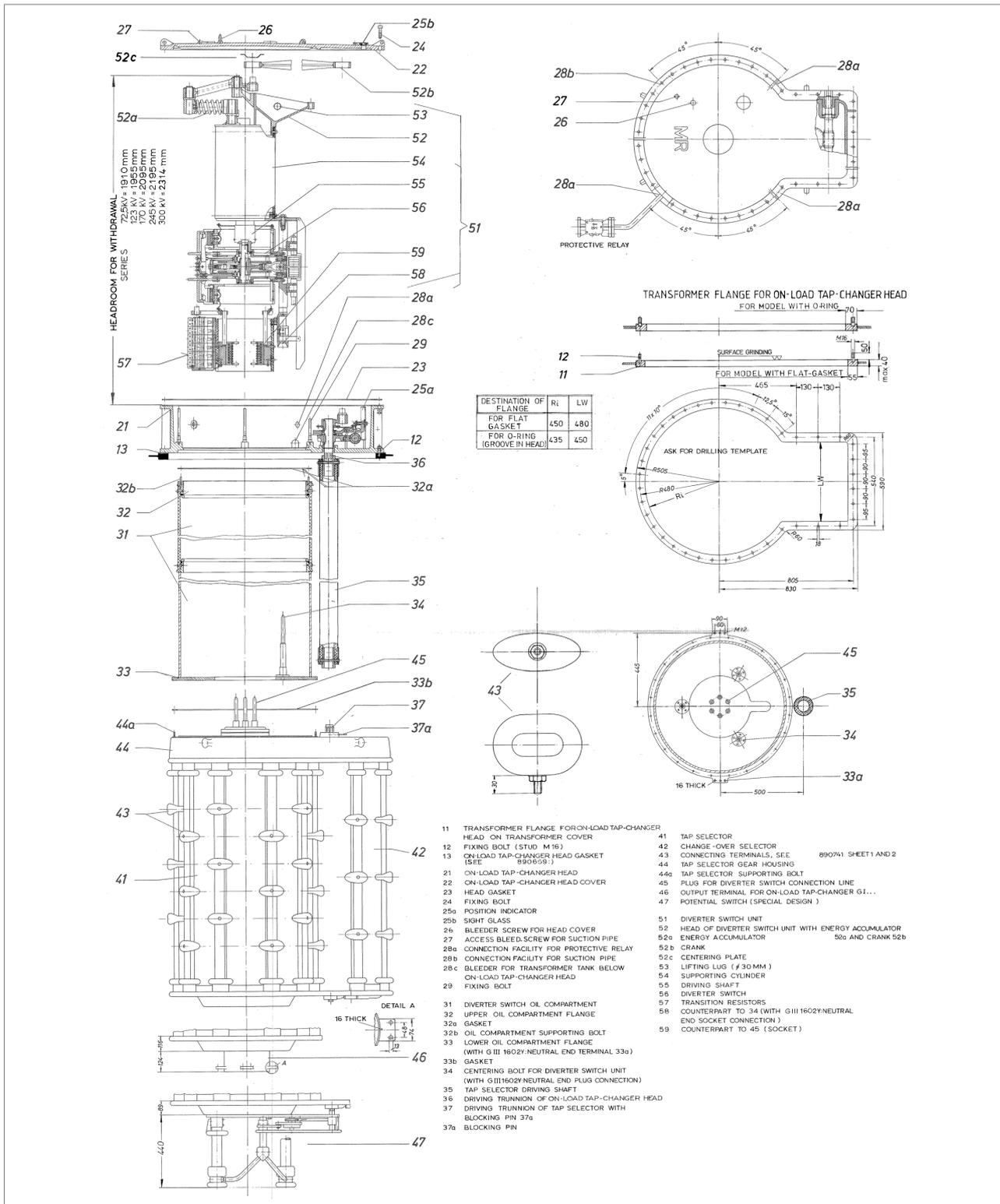
In operation	U _d	H ₂ O
When commissioning the transformer for the first time	> 60 kV/2.5 mm	< 12 ppm
During operation	> 40 kV/2.5 mm	< 30 ppm
After maintenance	> 50 kV/2.5 mm	< 15 ppm

Table 23: Limit values for insulating fluids for non-neutral point applications

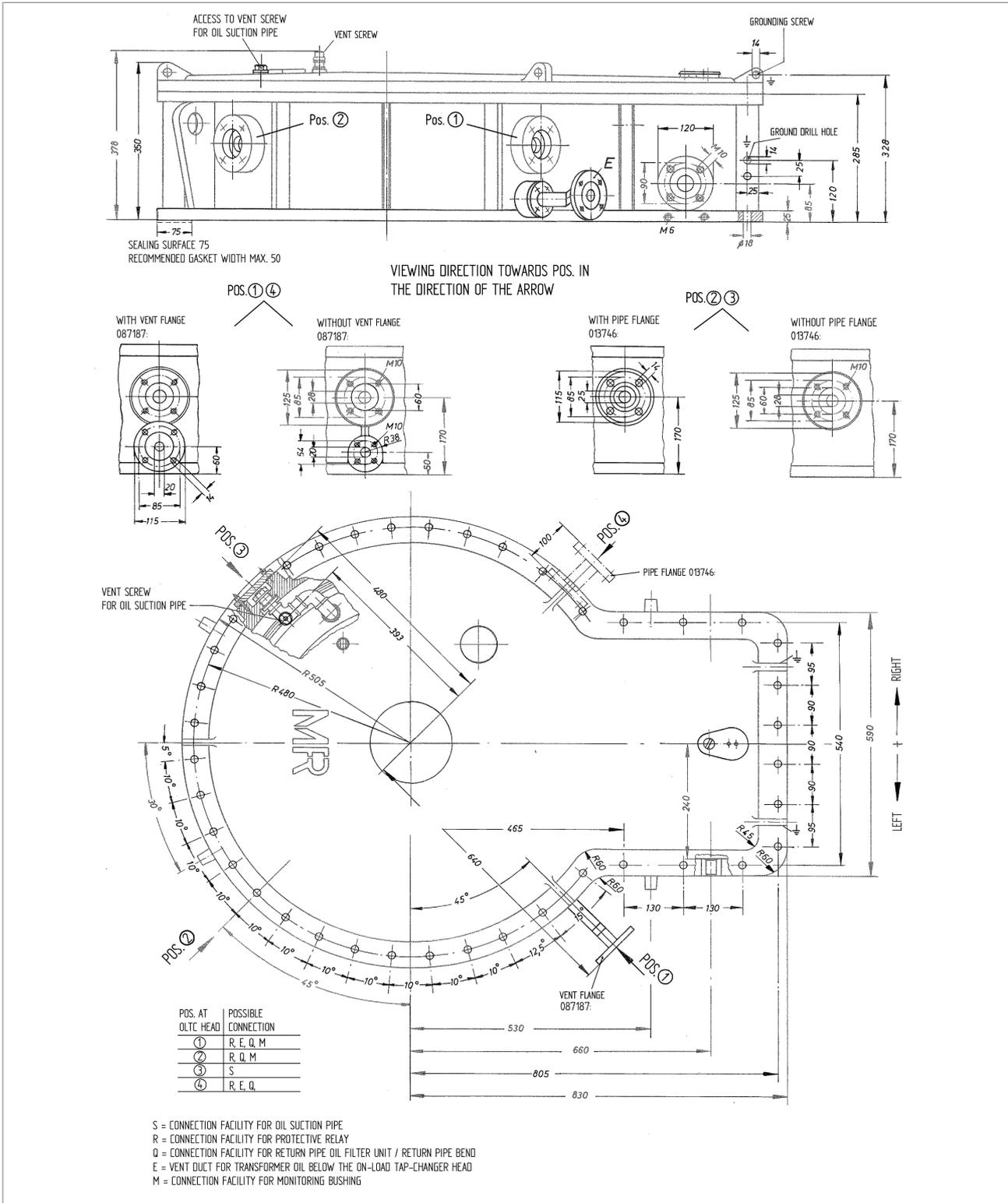


11 Drawings

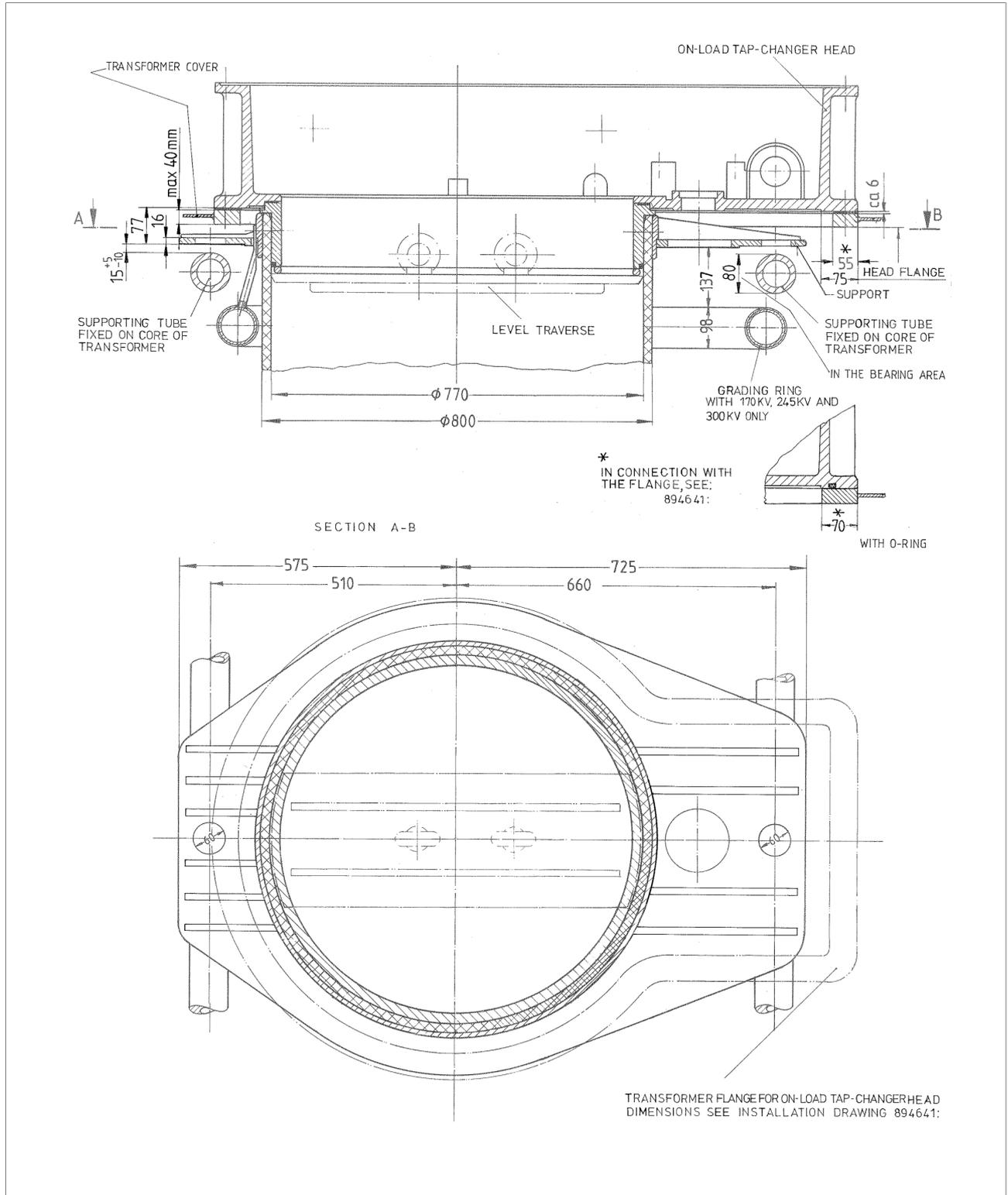
11.1 OILTAP® G, installation drawing (894641)



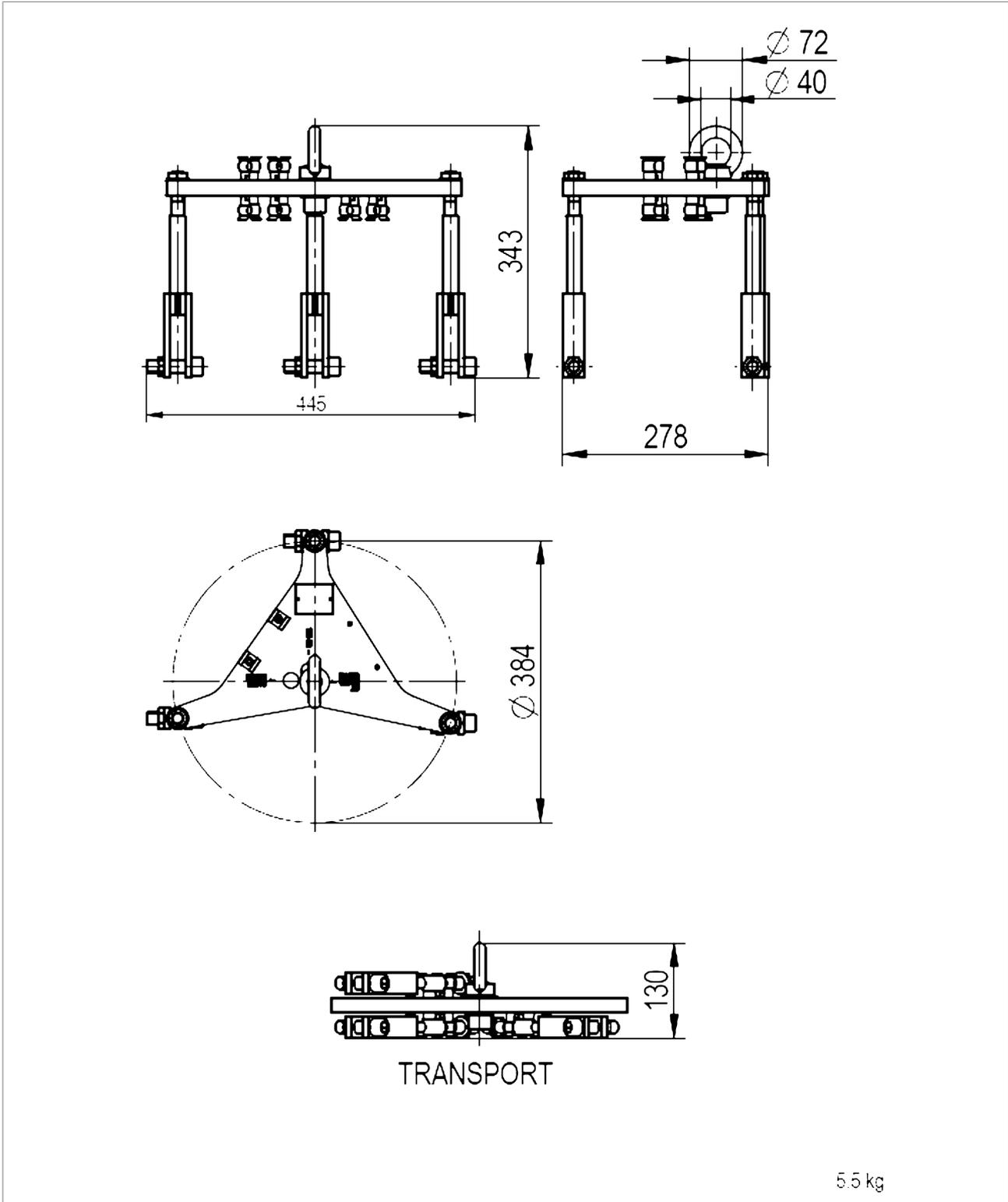
11.2 On-load tap-changer head (890716)



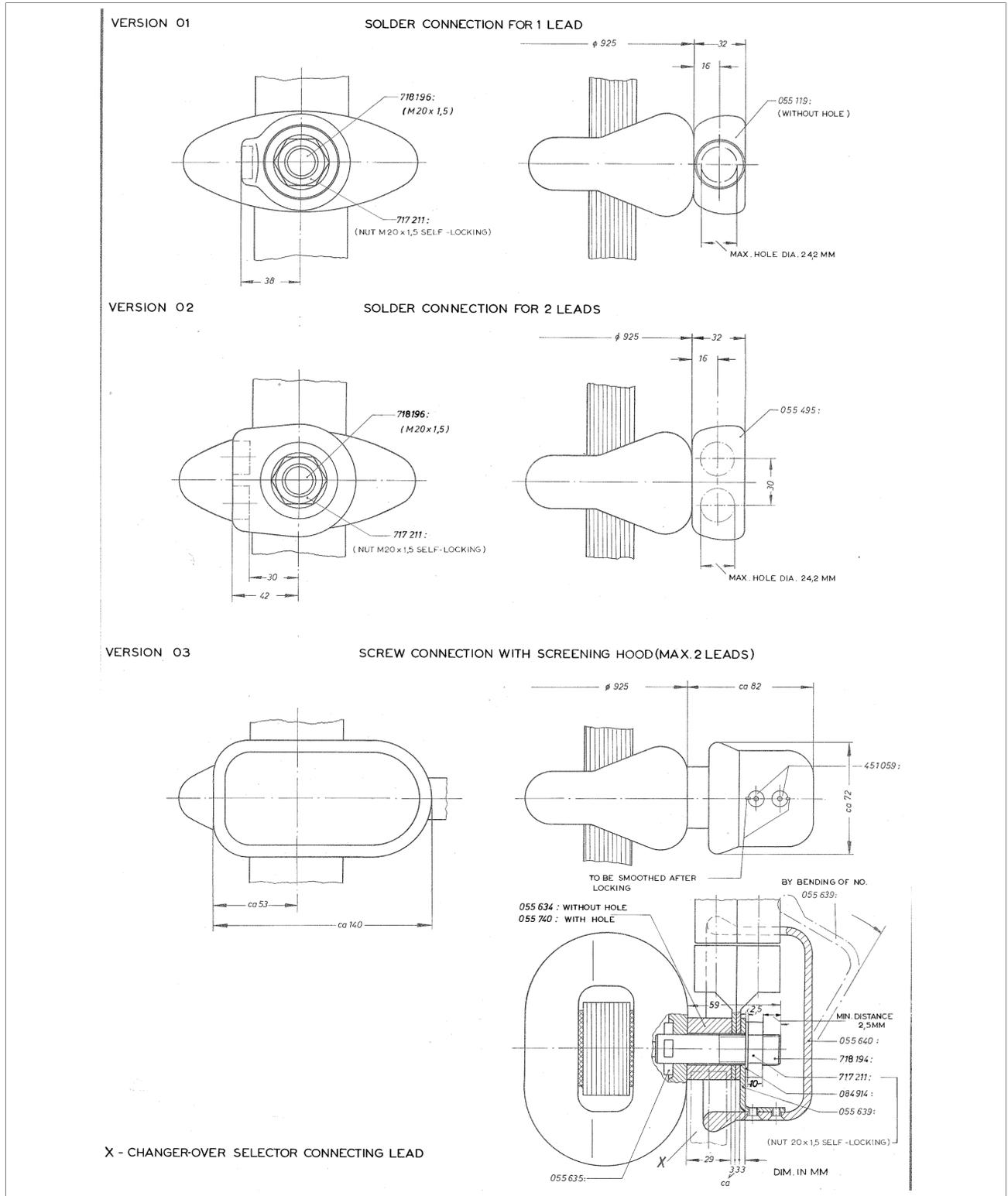
11.3 Special design for bell-type tank installation (890659)



11.4 Lifting cross for installing and removing the diverter switch insert (890442)

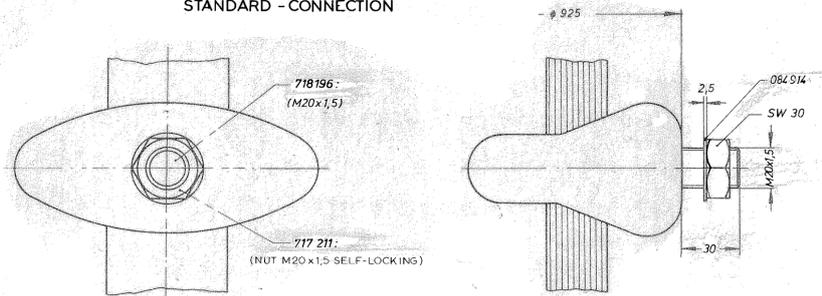


11.5 OILTAP® G - selector connection contacts (890741)



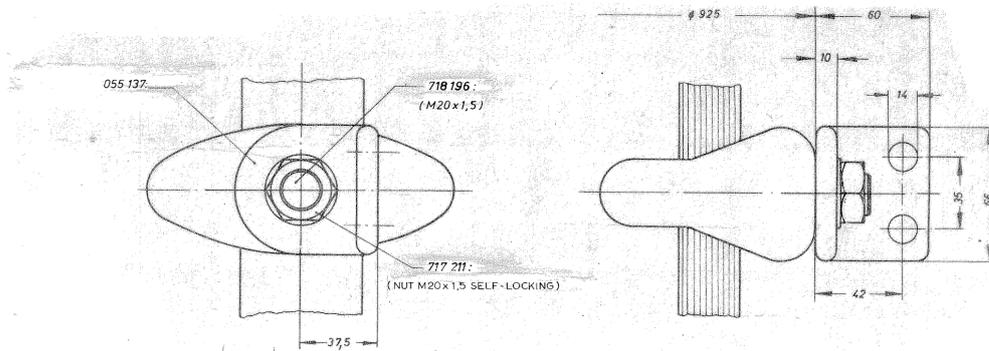
VERSION 04

STANDARD - CONNECTION



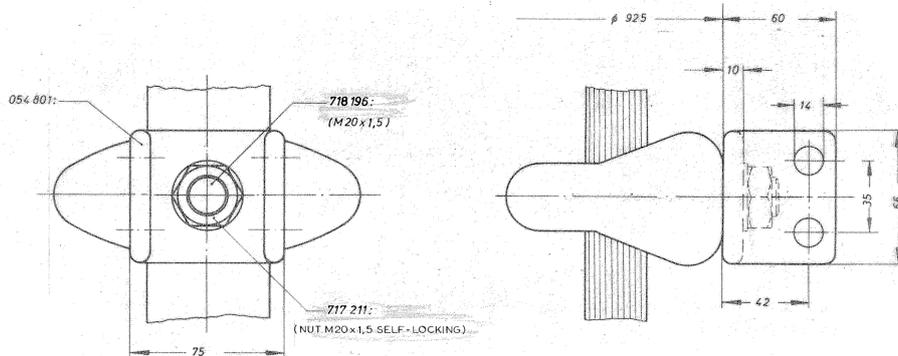
VERSION 05

SCREW CONNECTION FOR MAX. 2 LEADS



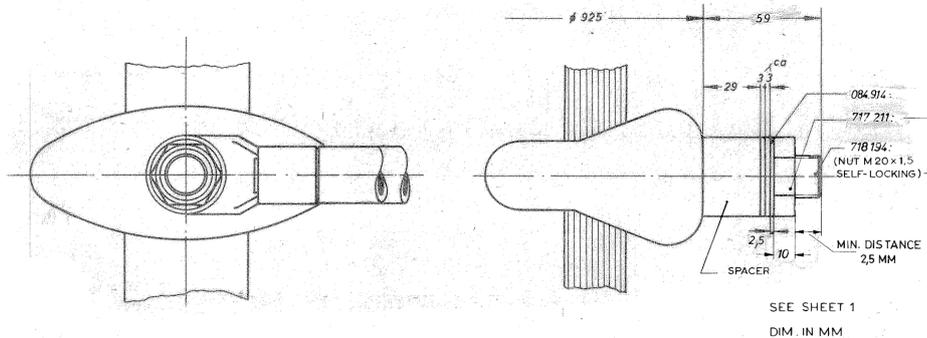
VERSION 06

SCREW CONNECTION FOR MAX. 4 LEADS



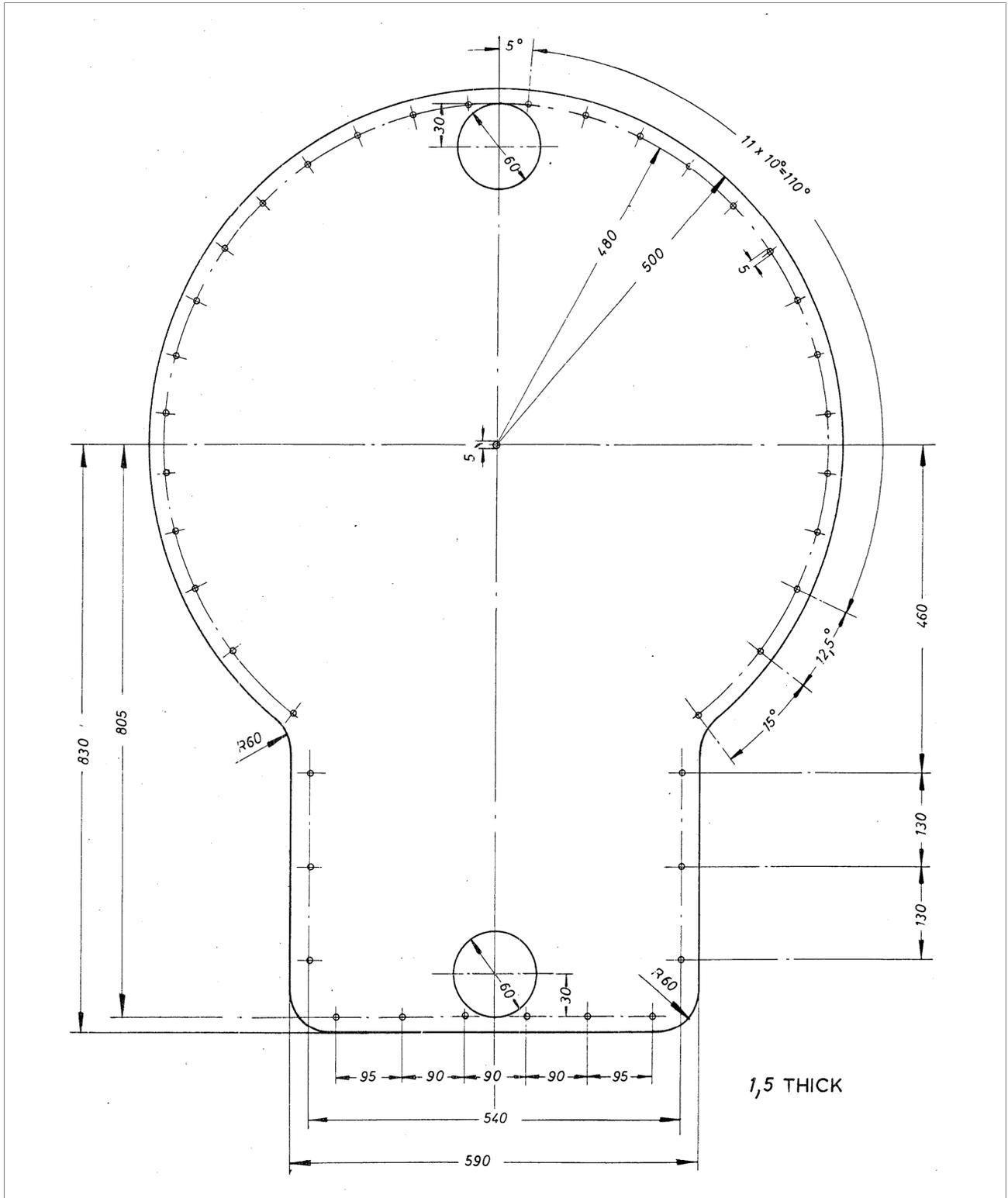
VERSION 07

SCREW CONNECTION FOR 2 LEADS WITH CABLE SHOES

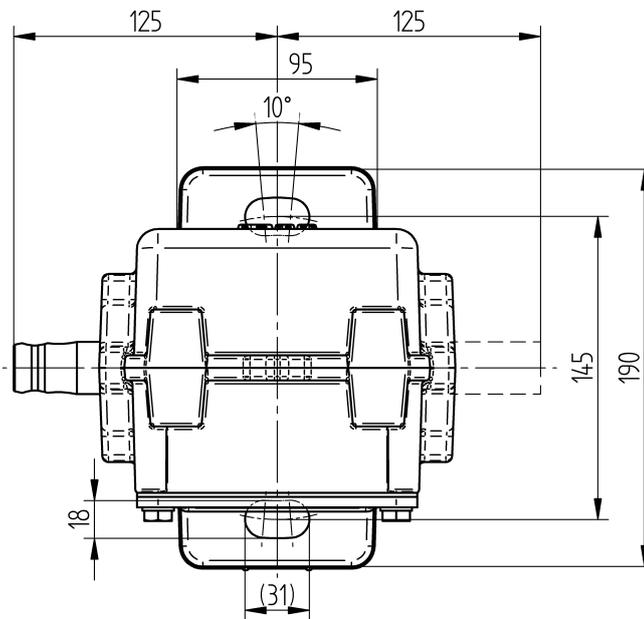
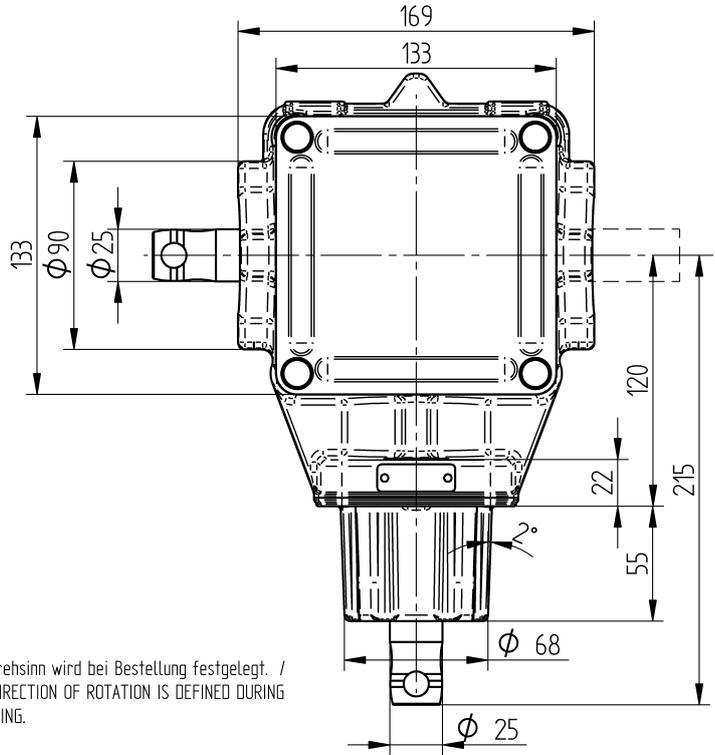


SEE SHEET 1
DIM. IN MM

11.6 OILTAP® G – tracing template (890436)



11.7 Bevel gear CD 6400, dimensional drawing (892916)





Glossary

CO

Change-Over contact

DC

Direct current

Dielectric strength

Material-specific property of isolators [kV/2.5 mm]; maximum electrical field strength without a breakdown (arc)

IEC

The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.

IP

Ingress protection

MR

Maschinenfabrik Reinhausen GmbH

NC

Normally Closed contact

NO

Normally Open contact

NPT

National Pipe Thread (US thread standard)

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- 10/21 - Maschinenfabrik Reinhausen GmbH 2021

THE POWER BEHIND POWER.

