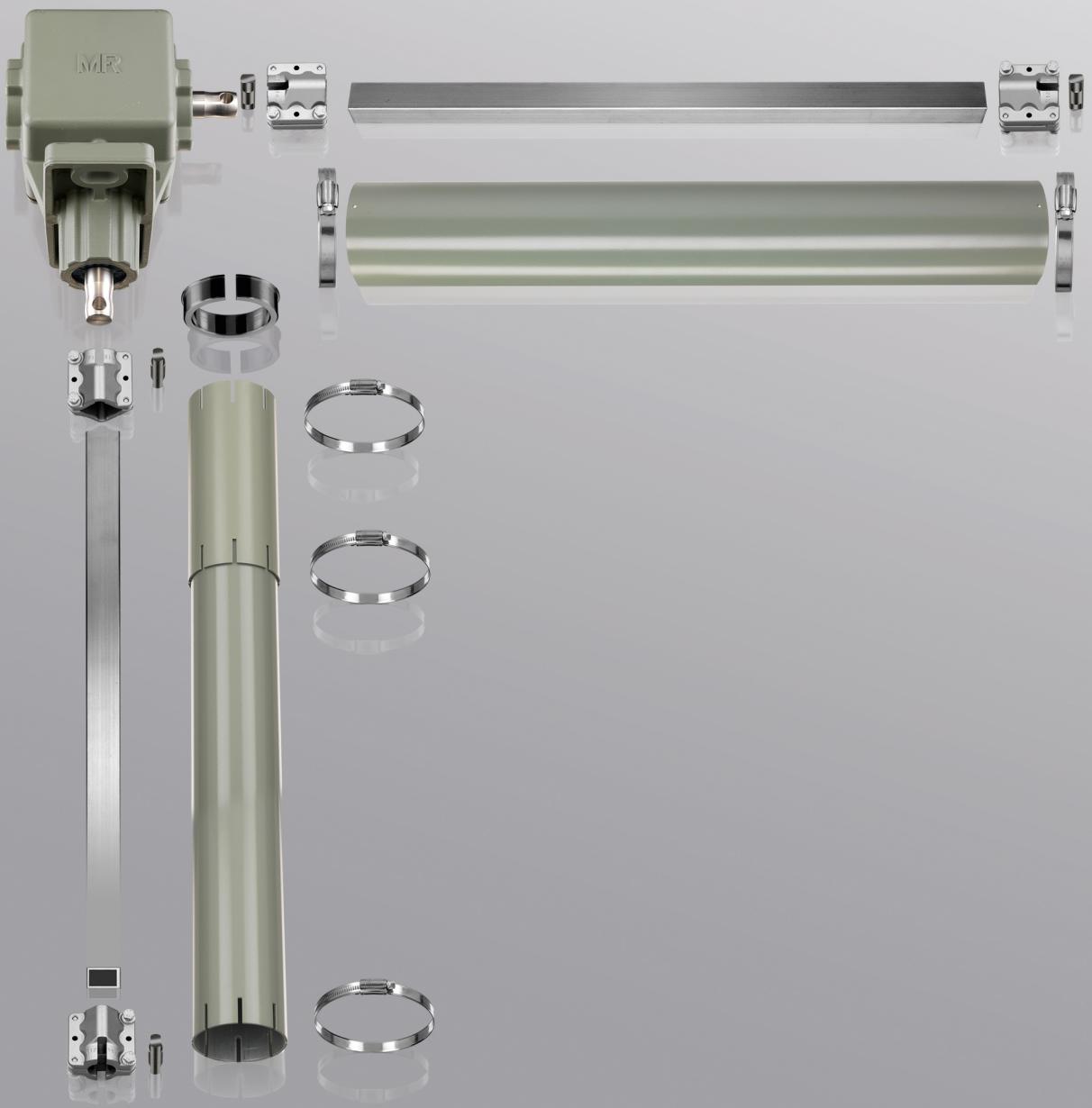
Drive Shaft

Operating Instructions

042/09 EN



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The product may have been altered since this document was published.

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 on the safe and proper installation, connection, commissioning and monitoring of the product.

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

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

1.1 Validity

This technical file applies to the following types of drive shaft:

- Drive shaft
- Drive shaft with insulator
- Drive shaft with cardan joints

1.2 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8
93059 Regensburg, Germany
Tel.: (+49) 9 41/40 90-0
Fax: (+49) 9 41/40 90-7001
E-mail: sales@reinhausen.com

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

1.3 Subject to change without notice

The information contained in this technical file comprises the technical specifications approved at the time of printing. Significant modifications will be included in a new edition of the technical file.

The document number and version number of this technical file are shown in the footer.

1.4 Completeness

This technical file is incomplete without the supporting documentation.

The following documents apply:

- Supplement (included in the scope of delivery)
- Dimensional drawings (included in the scope of delivery)

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

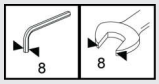
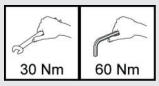
1.5 Safekeeping

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

1.6 Notation conventions

This section contains an overview of the symbols and textual emphasis used.

1.6.1 Symbols

Symbol	Meaning
	Wrench size
	Tightening torque
	Number and type of fastening material used
	Fill with oil
	Cut open, cut through
	Clean
	Visual inspection
	Use your hand
	Adapter ring
	Apply a coat of paint
	Use a file

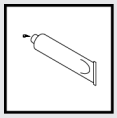
Symbol	Meaning
	Grease
	Coupling bolt
	Use a ruler
	Use a saw
	Hose clip
	Wire eyelet, safety wire
	Use a screwdriver
	Apply adhesive
	Lock tab

Table 1: Symbols

1.6.2 Hazard communication system

Warnings in this technical file are displayed as follows.

1.6.2.1 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 and source of danger

Consequences

- ► Action
- ► Action

1.6.2.2 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.

1.6.2.3 Signal words and pictograms

The following signal words are used:

Signal word	Meaning
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 injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 2: Signal words in warning notices

Pictograms warn of dangers:

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

Table 3: Pictograms used in warning notices

1.6.3 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.

2 Safety

2.1 General safety information

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

- Read this technical file through carefully to familiarize yourself with the product.
- Particular attention should be paid to the information given in this chapter.

2.2 Appropriate use

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 hazards to people, property or the environment. This applies throughout the product's entire life, from delivery through installation and operation to disassembly and disposal.

The operational quality assurance system ensures a consistently high quality standard, particularly in regard to the observance of health and safety requirements.

The following is considered appropriate use:

- Only operate the product in accordance with this technical file and the agreed delivery conditions and technical data
- Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file
- Use the product only with the transformer specified in the order
- You will find the standard valid for the product and the year of issue on the nameplate
- The serial numbers of on-load tap-changers and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay etc.) must match if the on-load tap-changers and on-load tap-changer accessories are supplied as a set for one order

2.3 Inappropriate use

Use is considered to be inappropriate if the product is used other than as described in the Appropriate use section. Please also note the following:

- Risk of explosion and fire from highly flammable or explosive gases, vapors, or dusts. Do not operate product in areas at risk of explosion.
- Unauthorized or inappropriate changes to the product may lead to personal injury, material damage, and operational faults. Only modify product following discussion with Maschinenfabrik Reinhausen GmbH.

2.4 Personnel qualification

The product is designed solely for use in electrical energy systems and facilities operated by appropriately trained staff. This staff comprises people who are familiar with the installation, assembly, commissioning and operation of such products.

2.5 Operator's duty of care

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:

- All warning and hazard notices are complied with.
- Personnel are instructed regularly in all relevant aspects of operational safety, the operating instructions and particularly the safety instructions contained therein.
- Regulations and operating instructions for safe working as well as the relevant instructions for staff procedures in the case of accidents and fires are kept on hand at all times and are displayed in the workplace where applicable.
- The product is only used when in a sound operational condition and safety equipment in particular is checked regularly for operational reliability.
- Only replacement parts, lubricants and auxiliary materials which are authorized by the manufacturer are used.
- The specified operating conditions and requirements of the installation location are complied with.
- All necessary devices and personal protective equipment for the specific activity are made available.
- The prescribed maintenance intervals and the relevant regulations are complied with.
- Installation, electrical connection and commissioning of the product may only be carried out by qualified and trained personnel in accordance with this technical file.
- The operator must ensure appropriate use of the product.

2.6 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.
- Follow information about personal protective equipment provided in the work area.

Always wear	
	Protective clothing Close-fitting work clothing with a low breaking 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.

Table 4: Personal protective equipment to be worn at all times

Wear the following in special environments	Special personal protective equipment is needed in special environments. The choice of equipment depends on the circumstances.
	Safety glasses To protect the eyes from flying parts and splashing liquids.
	Hard hat To protect from falling and flying parts and materials.
	Hearing protection To protect from hearing damage.
	Protective gloves For protection from mechanical, thermal, and electrical hazards.

Table 5: Personal protective equipment to be worn in special environments

2.7 Drying transformer

2.7.1 Drying transformer in autoclave

Observe the following information when drying the transformer in an autoclave.

NOTICE **Damage to drive shaft, on-load tap-changer and transformer!**

If the drive shaft is dried in a furnace, this may cause damage to the drive shaft and restrict its correct function.

► Do not dry drive shaft in an autoclave.

2.7.2 Drying transformer in the transformer tank

If you dry the active part in the transformer tank, the drive shaft may remain fitted to the transformer.

3 Product description

This chapter contains an overview of the design and function of the product.

3.1 Function description

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

The bevel gear changes the direction from vertical to horizontal (see drawing 892916).

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.

3.2 Scope of delivery

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

- Drive shaft
- Bevel gear
- Operating instructions
- Supplements
- Dimensional drawing

Please note the following:

- 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

3.3 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 drive / driven shaft end of the device to be connected.

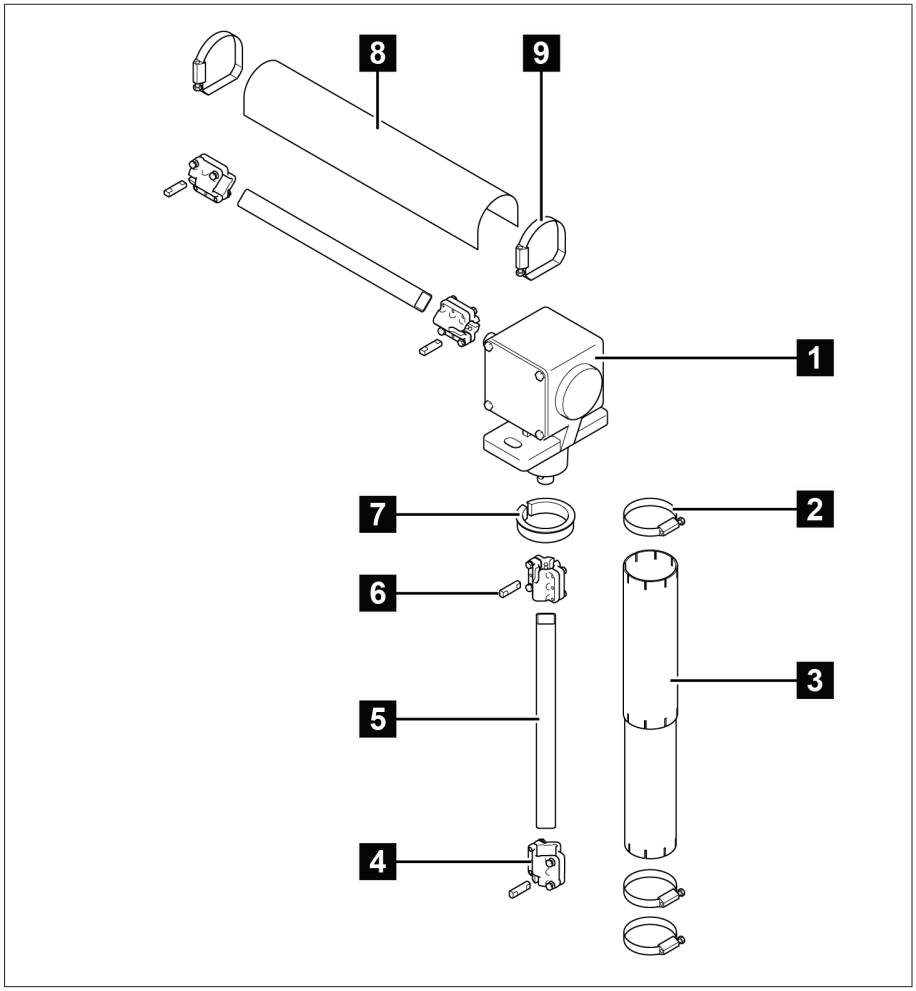


Figure 1: Components of the drive shaft

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
9	Hose clip		

3.3.1 Drive shaft without cardan joint and without insulator

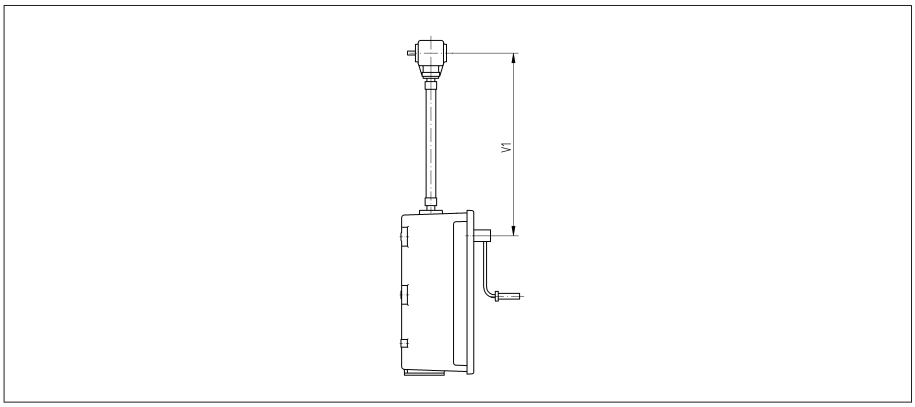


Figure 2: Drive shaft without cardan joint and without insulator (= normal model)

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 Drive shaft without cardan joint and with insulator

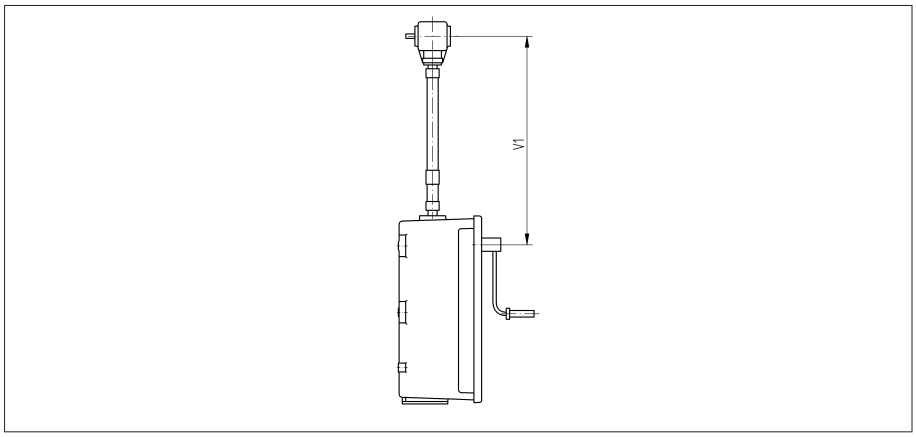


Figure 3: Drive shaft without cardan joint and with insulator (= special model)

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)

3.3.3 Drive shaft with cardan joint and without insulator

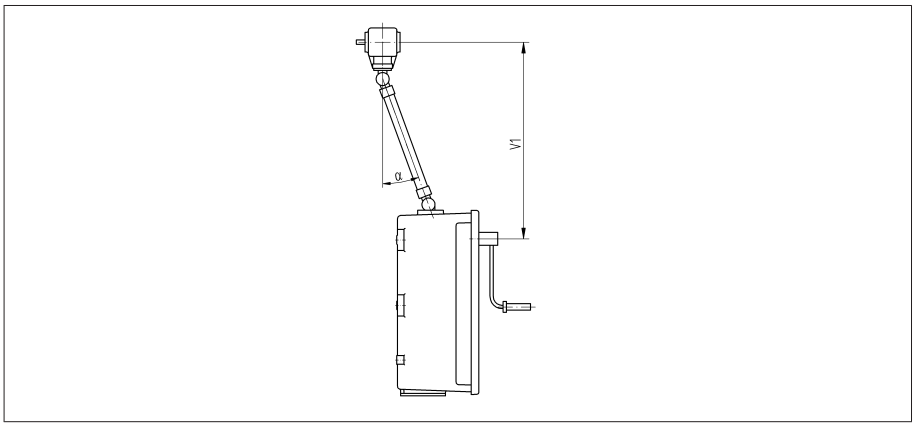


Figure 4: Drive shaft with cardan joint and without insulator (= special model)

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

3.3.4 Drive shaft with cardan joint and with insulator

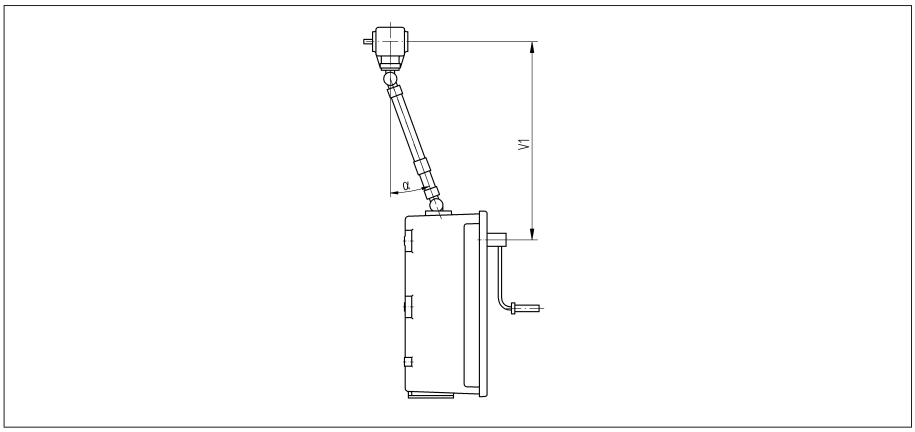


Figure 5: Drive shaft with cardan joint and with insulator (= special model)

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

3.4 Identification plate

The identification plate is on the telescopic protective tube.

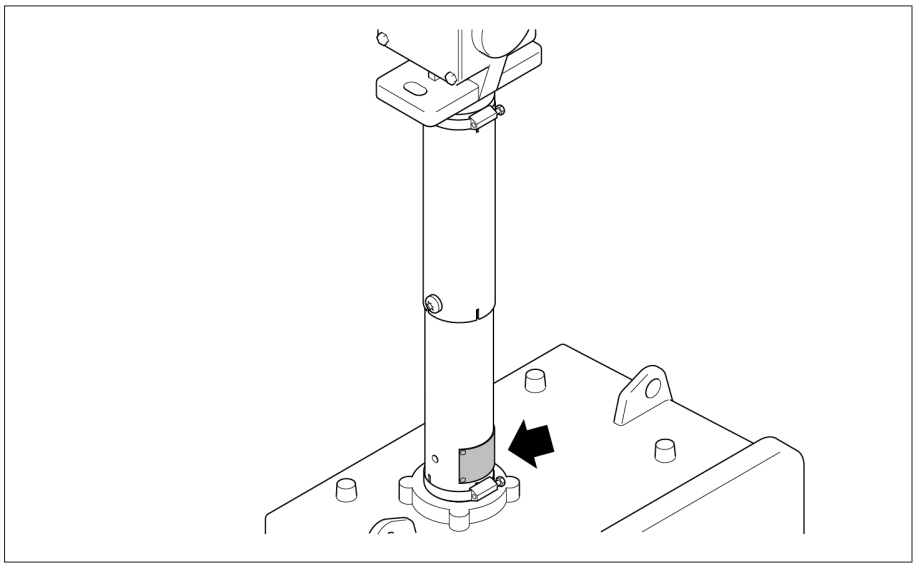


Figure 6: Position of the identification plate

4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with a sealed packaging and sometimes also dried depending on what is required.

A sealed packaging surrounds the packaged goods on all sides with plastic foil. Products that have also been dried are identified by a yellow label on the sealed packaging.

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!

- ► Only stack up to 2 equally sized crates on top of one another.
- ► Do not stack crates above a height of 1.5 m.

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

The packaged goods are packed in a stable 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.

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 6: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

⚠ WARNING

Risk of severe injury or death!

Danger due to tipping or falling load!

- ► Only trained and appointed persons may select the sling gear and secure the load.
- ► Do not walk under the hanging load.
- ► Use means of transport and lifting gear with a carrying capacity of > 500 kg.

NOTICE

Damage to packaged goods!

Damage due to tipping or falling load!

- ► Only trained and appointed persons may select the sling gear and secure the load.
- ► Use means of transport and lifting gear with a carrying capacity of > 500 kg.

In addition to oscillation stress and shock 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 experiences 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 detected on receipt of the shipment, proceed as follows:

- Immediately record the transport damage found 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 sales department at Maschinenfabrik Reinhausen GmbH 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 onsite together with the carrier involved. This is essential for any claim for damages!

- If possible, 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).
- Name 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 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.

4.4 Unpacking shipments and checking for transportation damages

- Wherever possible keep the crate packaged for transport to the place where installation will take place.
- When unpacking, check the condition of the packaged goods.
- Check completeness based on the delivery slip.

5 Mounting

This chapter describes how to fit and connect the drive shaft.

5.1 Fitting drive shaft

Observe the following during mounting:

NOTICE

Damage to drive and on-load tap-changer or de-energized tap-changer!

Trouble-free operation of the drive and the on-load tap-changer or de-energized tap-changer cannot be guaranteed.

► The shaft ends to be connected must be exactly aligned.

Permitted axial displacement for the drive shaft without cardan joint

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

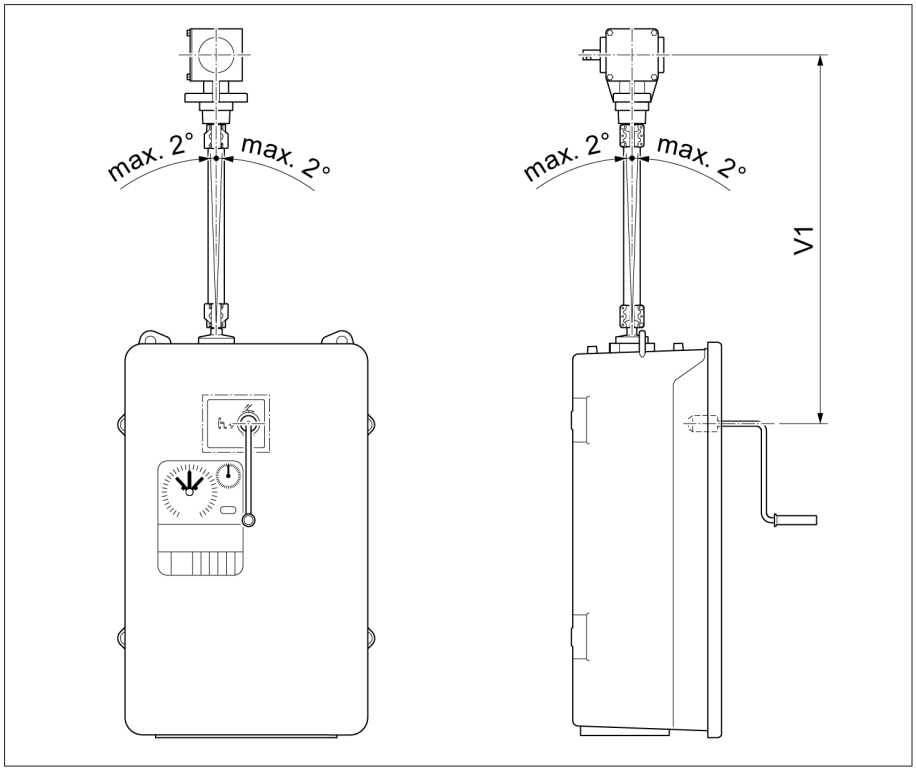


Figure 7: Permitted maximum axial displacement of vertical drive shaft

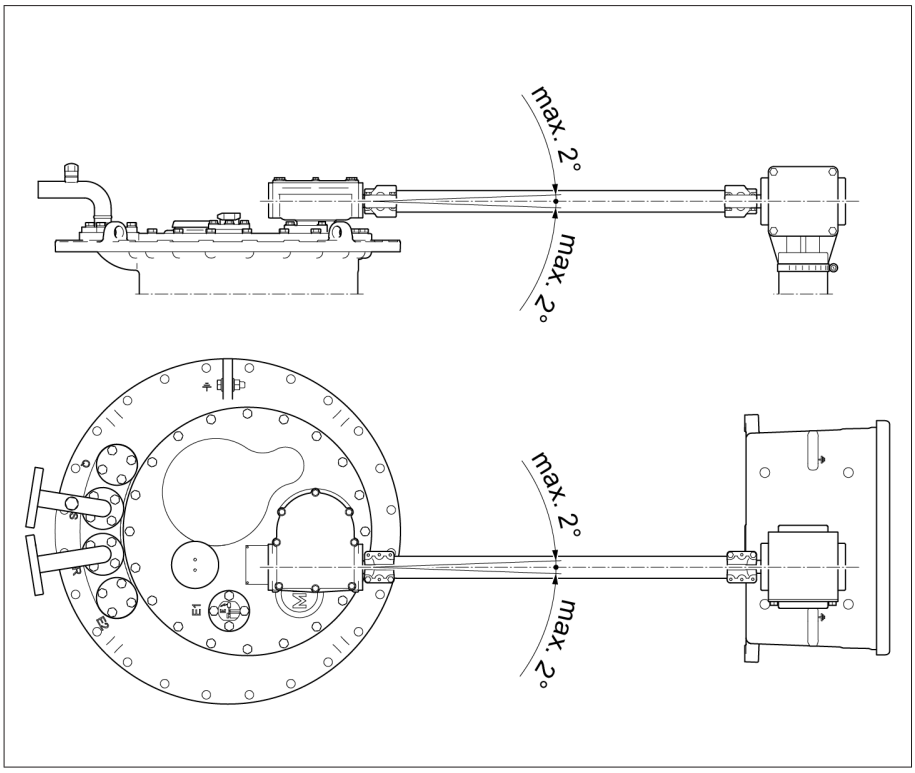


Figure 8: Permitted maximum axial displacement of horizontal drive shaft

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 in overlengths (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	•	•

Standard lengths	Motor-drive unit	Manual drive
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 should be delivered vertically, similar to the motor-drive unit with intermediate bearing.

5.1.1 Fitting a 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 by accident and thereby cause injuries.
2. Fasten the bevel gear to the transformer.

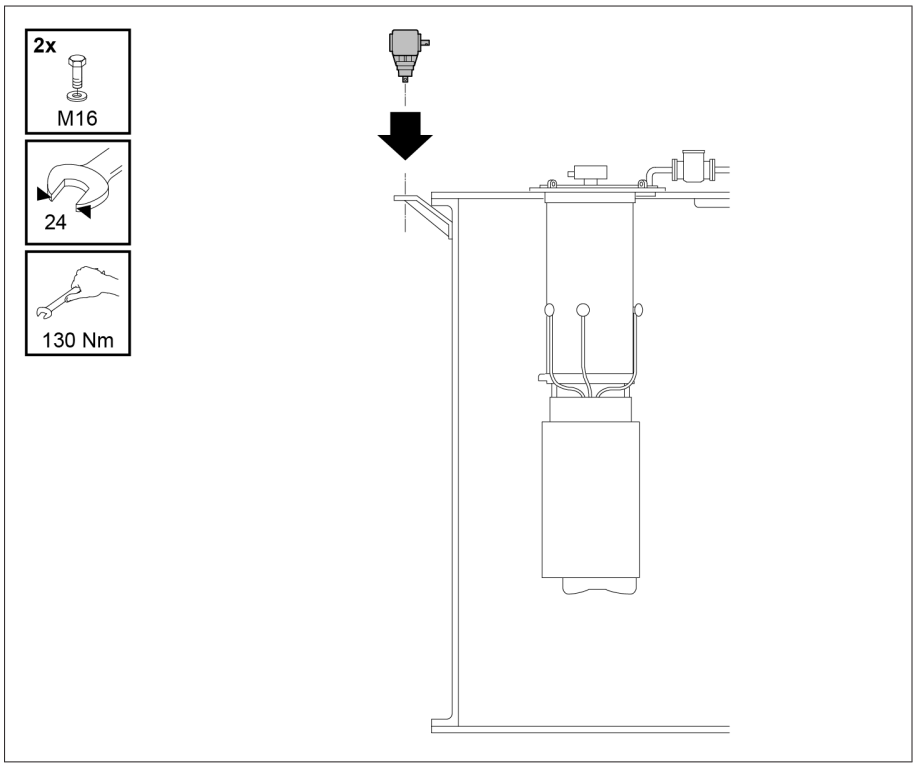


Figure 9: Bevel gear

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

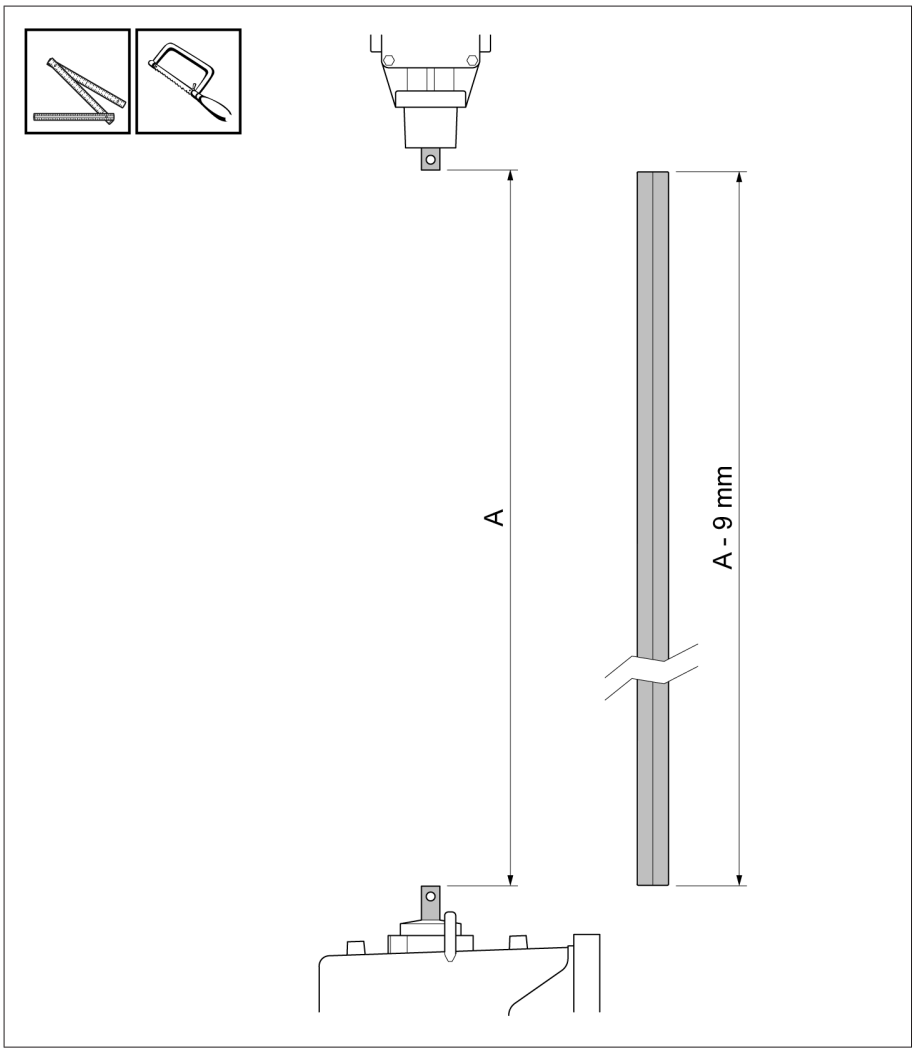


Figure 10: Shortening square tube

4. Deburr cut surfaces of square tube.

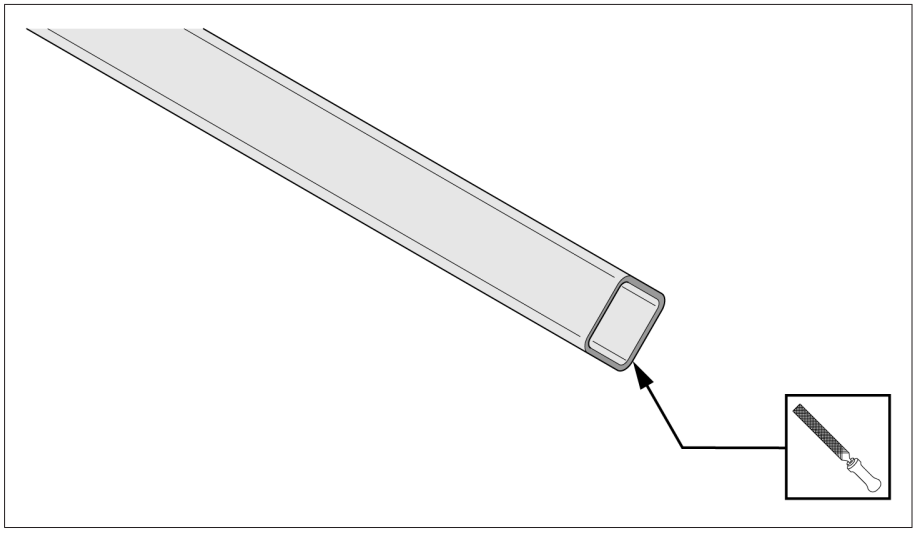


Figure 11: Deburring cut surfaces

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

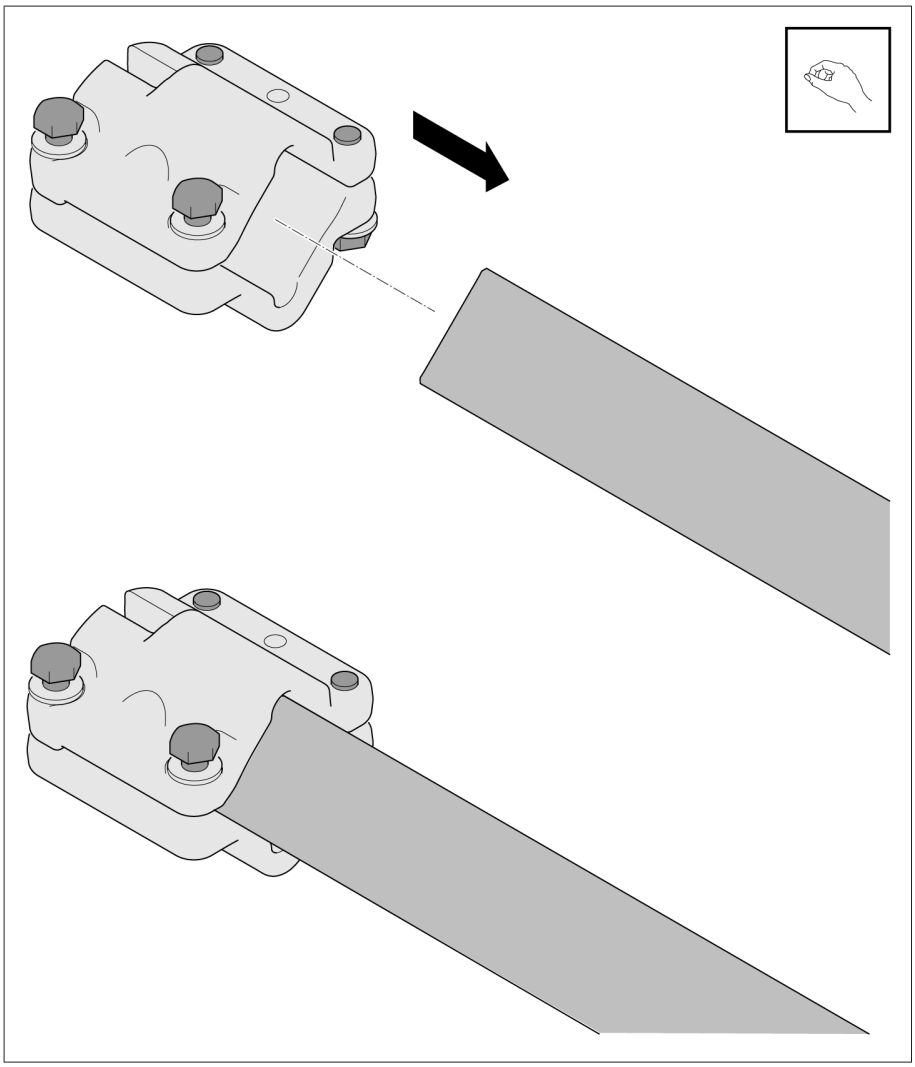


Figure 12: Slide coupling part onto square tube

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.

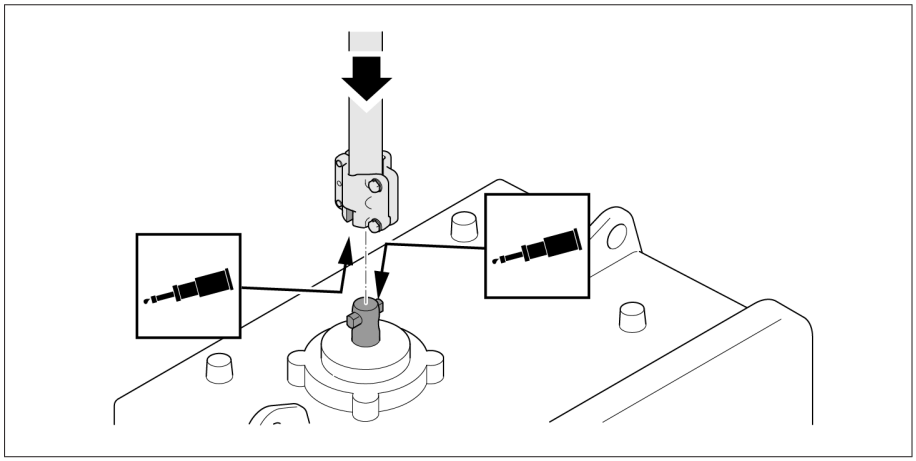


Figure 13: Slide square tube with coupling part onto shaft end

7. Secure square tube onto drive.

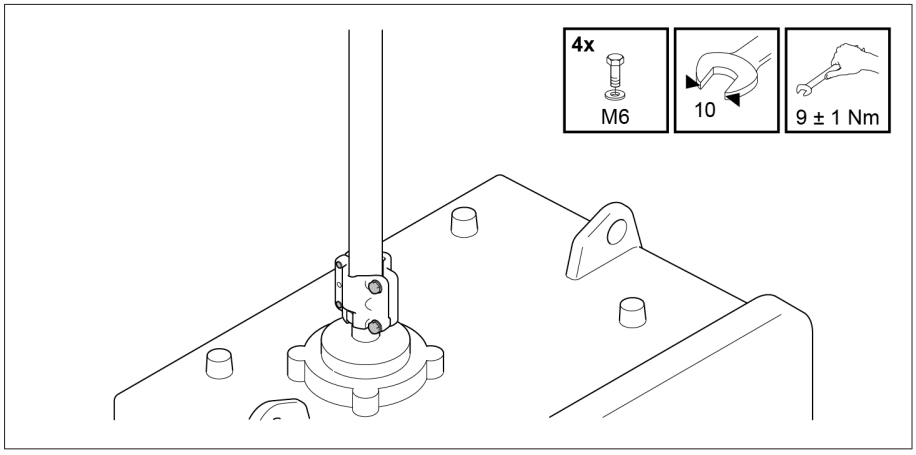


Figure 14: Secure square tube onto drive

8. Pivoting square tube.

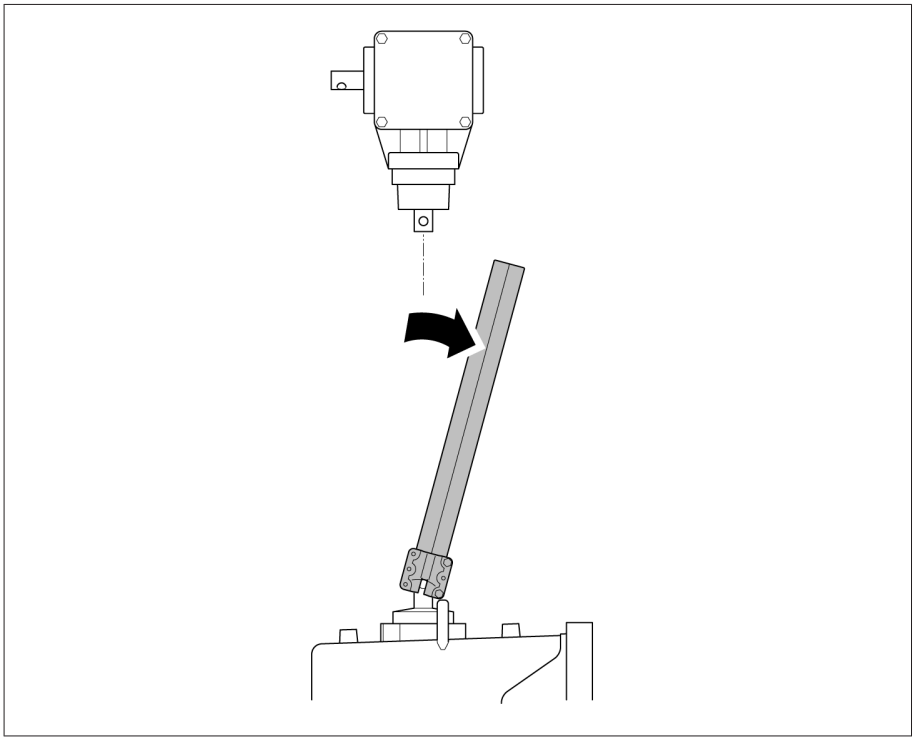


Figure 15: Pivoting square tube

9. When installing inner tube of telescopic protective tube, if necessary shorten on side without slits. 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.

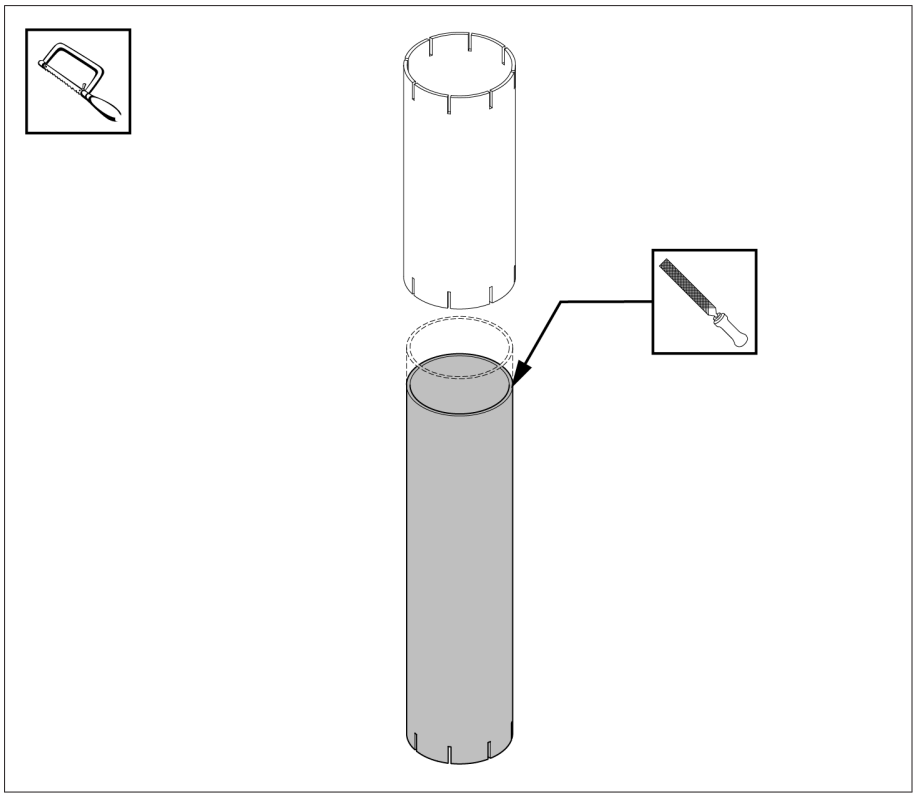


Figure 16: Deburring inner tube

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...1130 mm	Dimension A + 20 mm	= 200 mm
1131 mm...1598 mm	= 700 mm	= 1150 mm
1599 mm...2009 mm	= 1150 mm	= 1150 mm

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

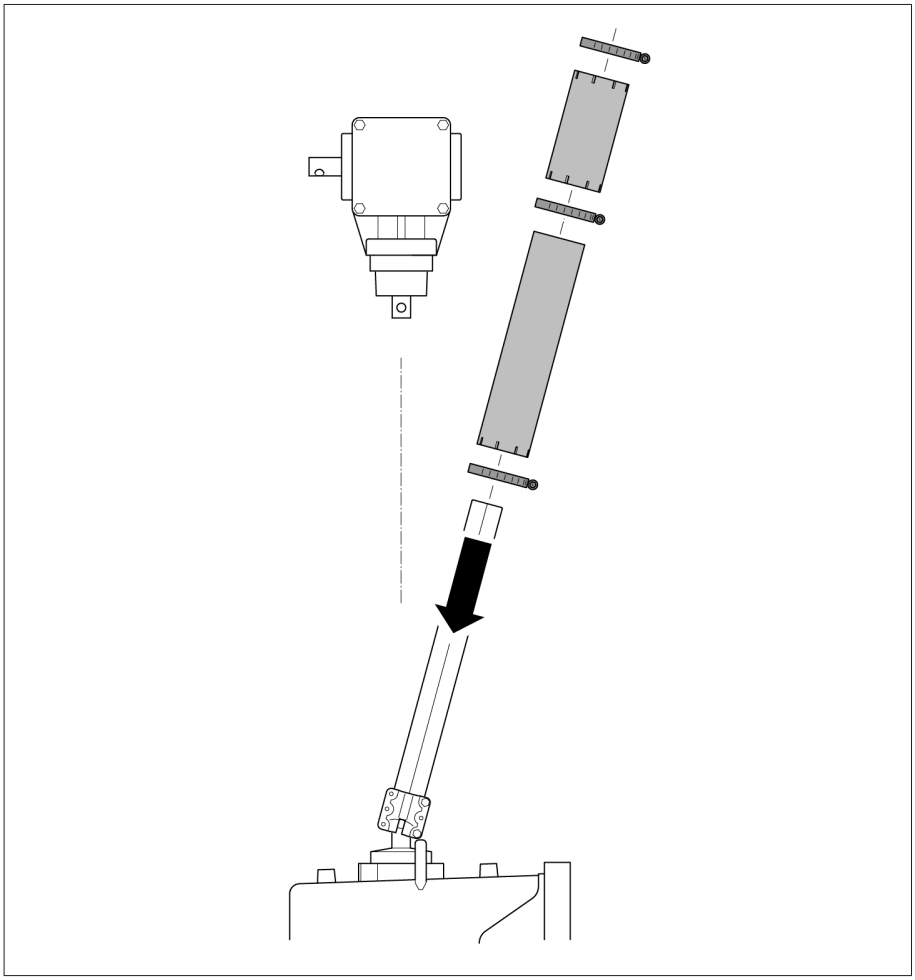


Figure 17: Sliding on telescopic protective tube

11. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Swing square tube in.

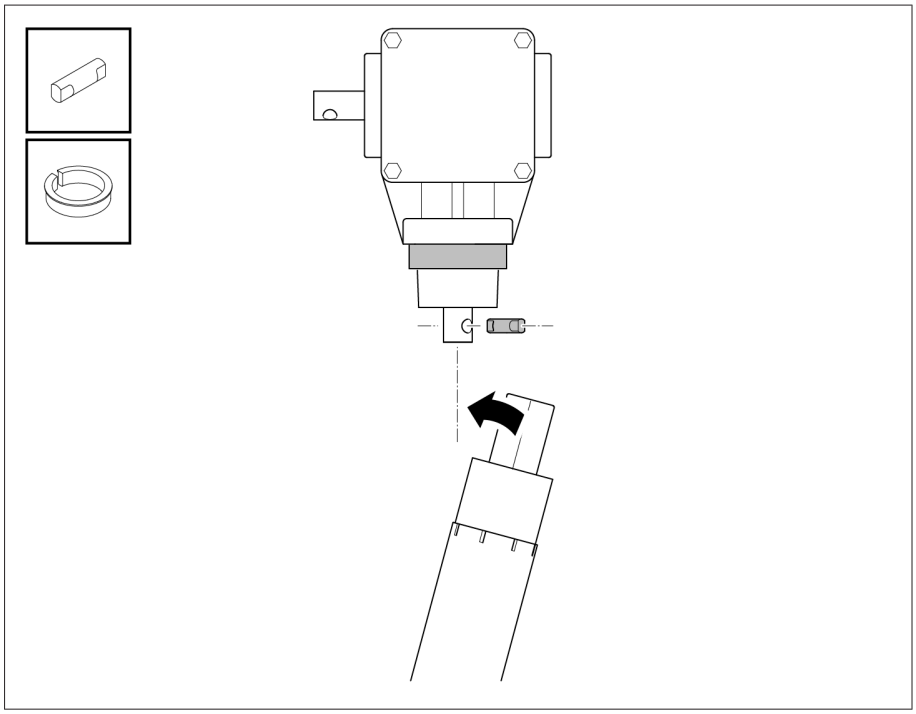


Figure 18: Fitting adapter ring and coupling bolt

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 coupling bolt and upper coupling piece.

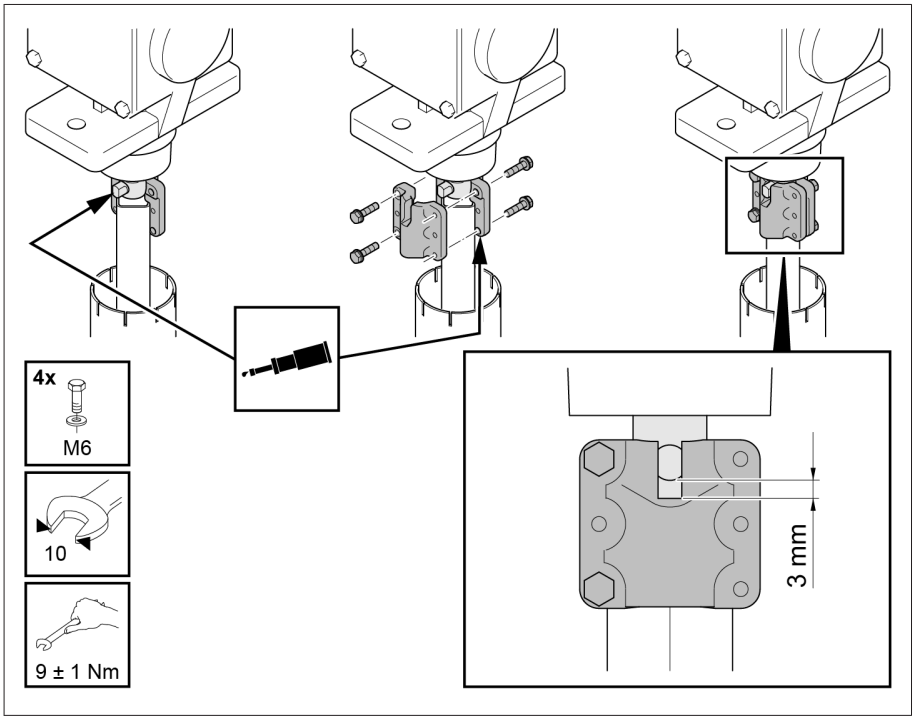


Figure 19: Mounting coupling brackets

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**.

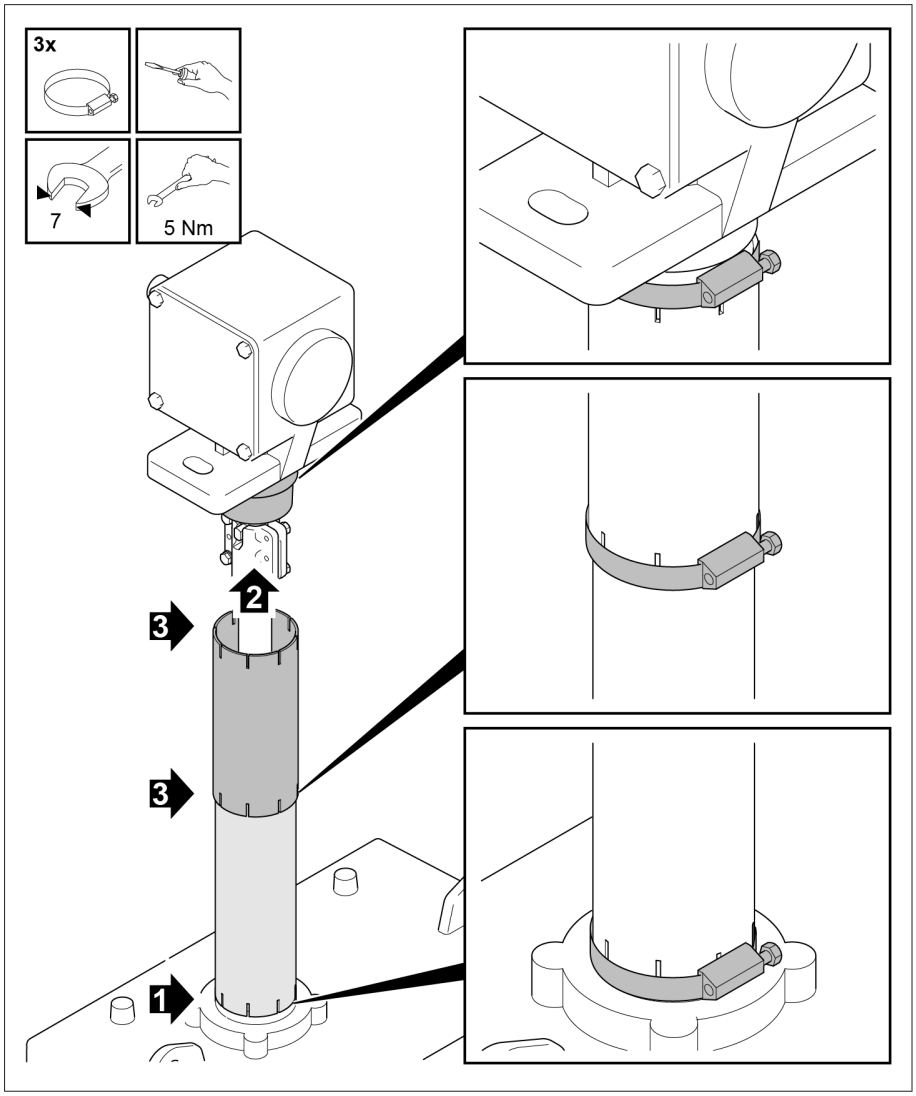


Figure 20: Mounting protective tube

5.1.2 Fitting a horizontal drive shaft without cardan joint

Aligning upper gear unit on the on-load tap-changer head

In order to correctly install the horizontal drive shaft, under certain circumstances you may have to first align the upper gear unit such that the horizontal drive shaft is flush with the shaft end of the upper gear unit.

Proceed as follows:

1. **NOTICE!** Make sure the oil compartment is filled completely with oil. Aligning the gear unit after drying without filling the oil compartment completely with oil will damage the on-load tap-changer.
2. Loosen screws and turn pressure ring segments to one side.

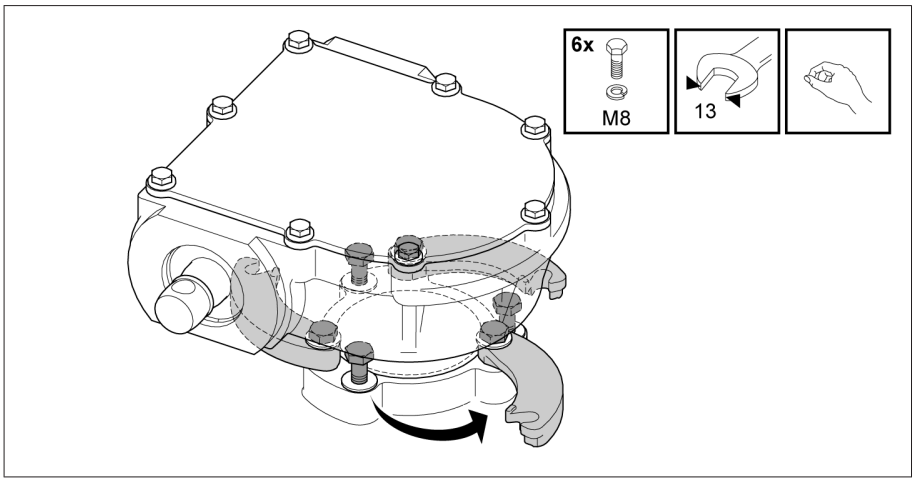


Figure 21: Pressure ring segments

3. **NOTICE!** Align gear unit such that the horizontal drive shaft is flush with the drive shaft of the gear unit. While aligning the gear unit, turn the unit's drive shaft such that its output shaft retains its original position. Failure to do so may result in damage to the de-energized tap-changer and transformer when starting up.

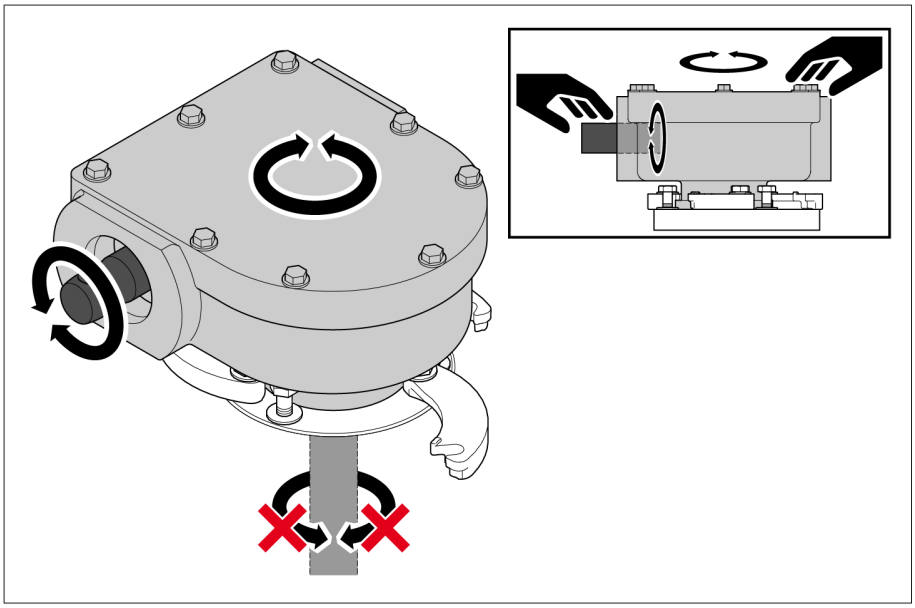


Figure 22: Aligning gear unit

4. Swivel pressure ring segments back towards gear unit and tighten screws. Ensure that the spring washer is between the screw head and pressure ring segment and that the pressure ring segments are firmly in contact with the gear unit housing.

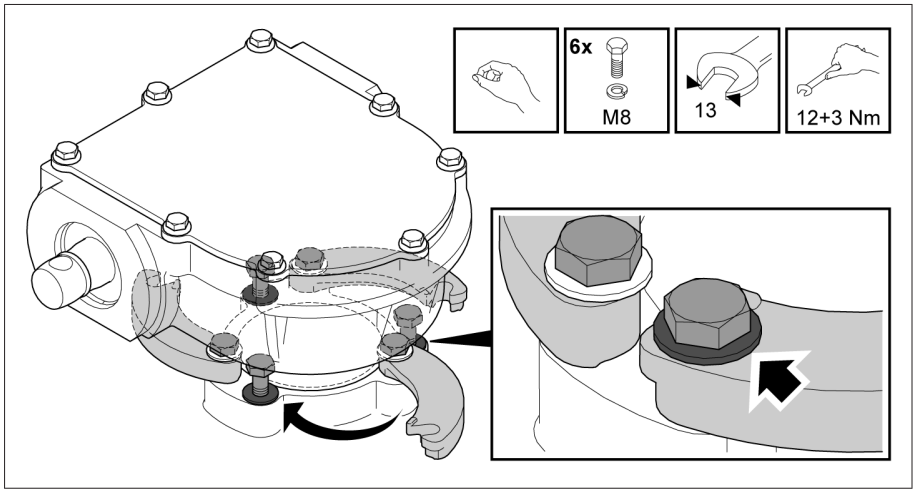


Figure 23: Securing pressure ring segments

Aligning upper gear unit on the de-energized tap-changer head

In order to correctly install the horizontal drive shaft, under certain circumstances you may have to first align the upper gear unit such that the horizontal drive shaft is flush with the shaft end of the upper gear unit.

Proceed as follows:

1. Loosen screws and turn pressure ring segments to one side.

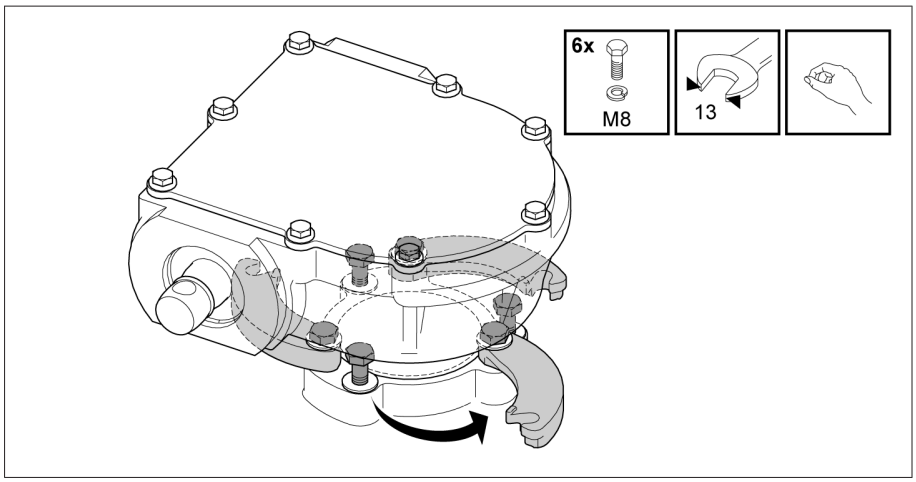


Figure 24: Pressure ring segments

2. **NOTICE!** Align gear unit such that the horizontal drive shaft is flush with the drive shaft of the gear unit. While aligning the gear unit, turn the unit's drive shaft such that its output shaft retains its original position. Failure to do so may result in damage to the de-energized tap-changer and transformer when starting up.

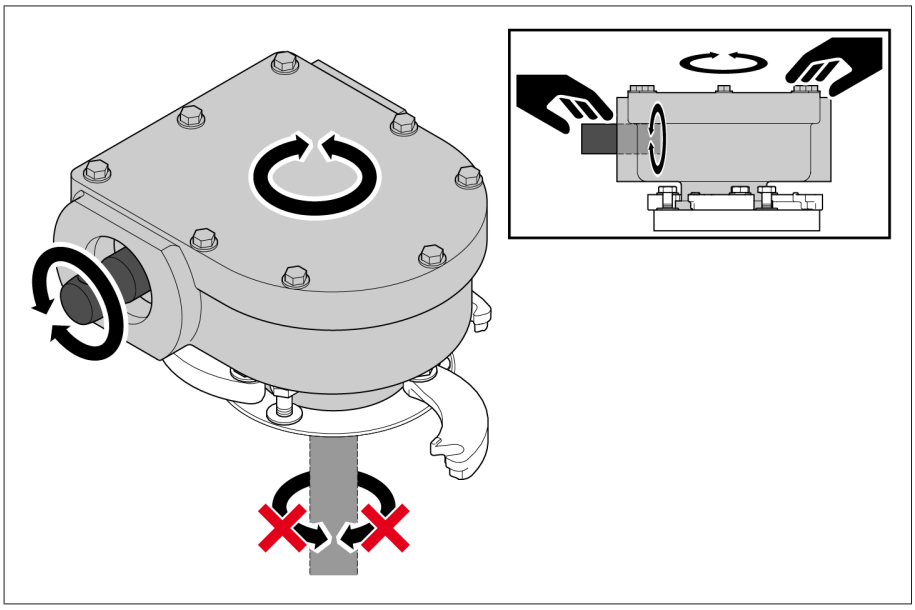


Figure 25: Aligning gear unit

3. Swivel pressure ring segments back towards gear unit and tighten screws. Ensure that the spring washer is between the screw head and pressure ring segment and that the pressure ring segments are firmly in contact with the gear unit housing.

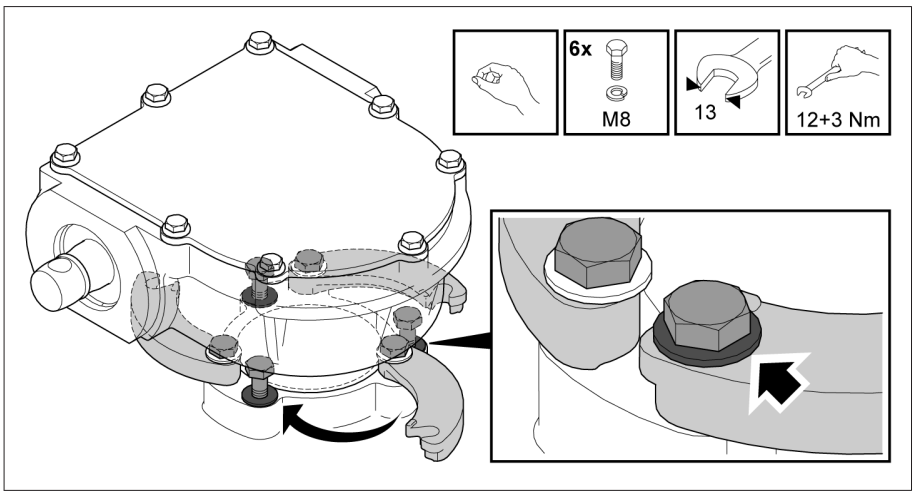


Figure 26: Securing pressure ring segments

Aligning upper gear unit on the COMTAP® ARS head

In order to correctly install the horizontal drive shaft, under certain circumstances you may have to first align the upper gear unit such that the horizontal drive shaft is flush with the shaft end of the upper gear unit.

Proceed as follows:

1. Loosen screws and turn pressure ring segments to one side.

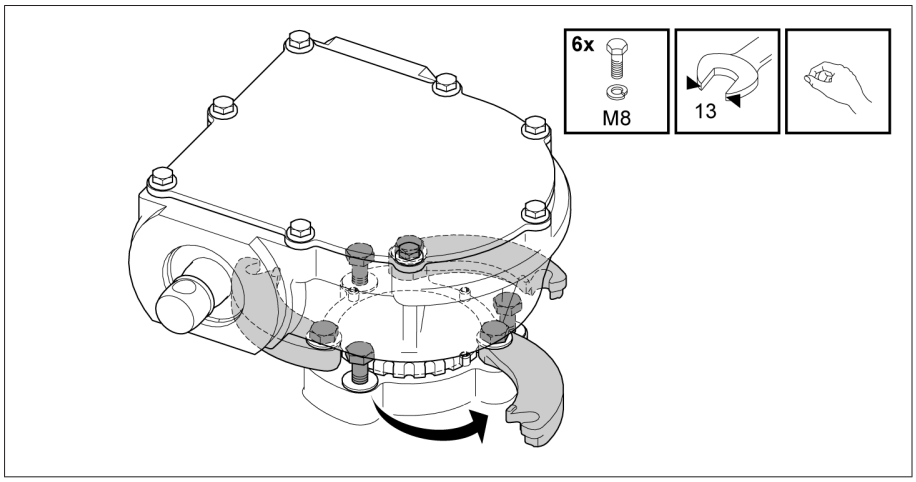


Figure 27: Pressure ring segments

2. Pull the gear unit upwards approx. 10-12 mm out of the locking range of the retention pins.

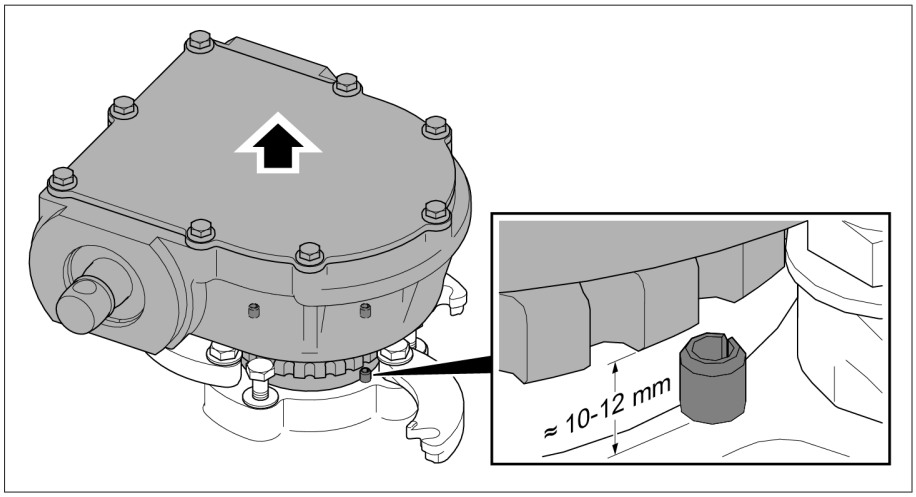


Figure 28: Retention pin

3. **NOTICE!** Align gear unit such that the horizontal drive shaft is flush with the drive shaft of the gear unit. While aligning the gear unit, turn the unit's drive shaft such that its output shaft retains its original position. Failure to do so may result in damage to the de-energized tap-changer

and transformer when starting up. Due to the retention pins and the grooves in the housing of the gear unit fastening is possible only in 15° steps.

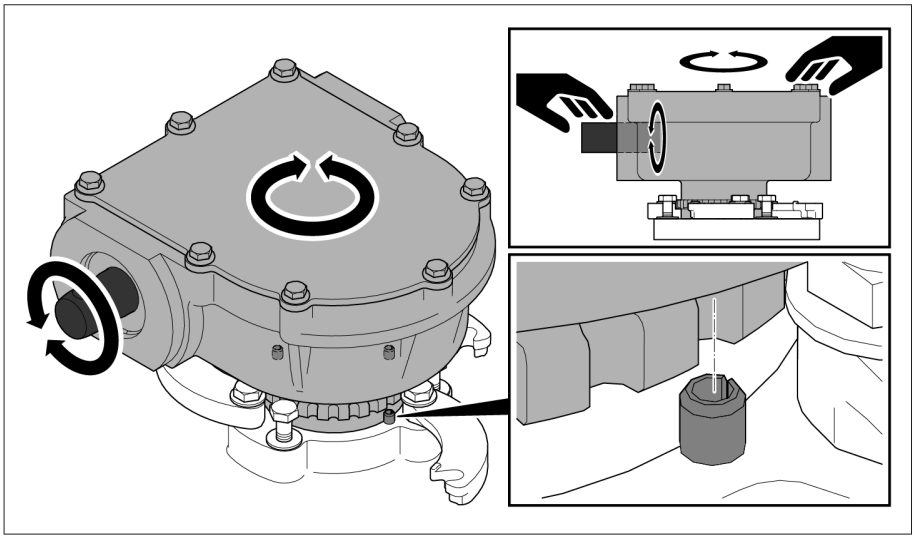


Figure 29: Aligning gear unit

4. Press gear unit down until it again makes contact with the COMTAP® ARS head. Ensure that the retention pin engages in one of the grooves in the housing of the gear unit.

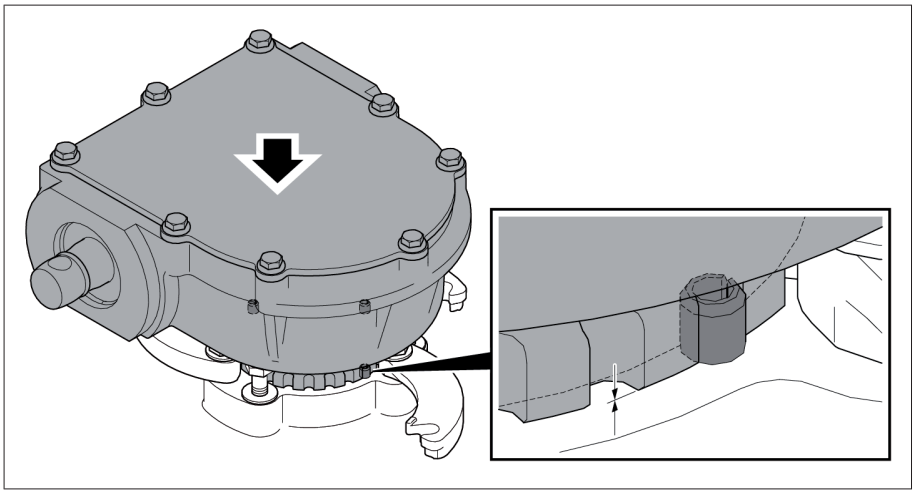


Figure 30: Pressing down gear unit

5. Swivel pressure ring segments back towards gear unit and tighten screws. Ensure that the spring washer is between the screw head and pressure ring segment and that the pressure ring segments are firmly in contact with the gear unit housing.

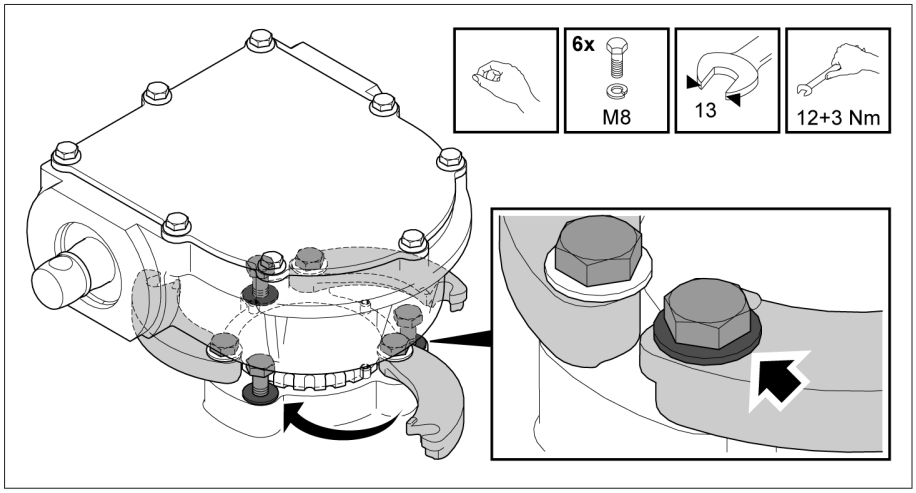


Figure 31: Securing pressure ring segments

Fitting horizontal drive shaft

To fit the horizontal drive shaft, proceed as follows.

1. Calculate dimension A between shaft end of upper gear unit and shaft end of bevel gear and shorten square tube to length A–9 mm.

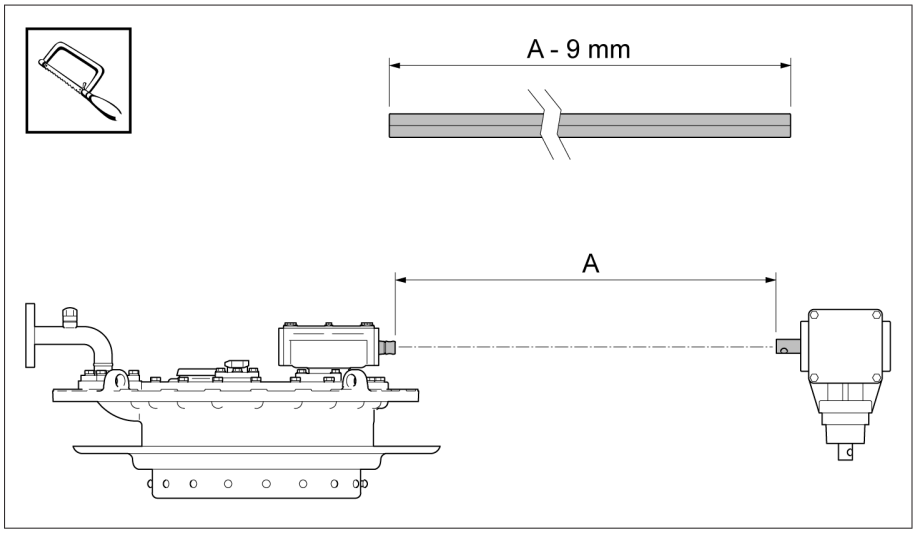


Figure 32: Shortening square tube

2. Calculate inside width B between housings of upper gear unit and bevel gear. Cut down the protective cover to B-2 mm and deburr the cuts. Protect protective cover against corrosion with a coat of paint.

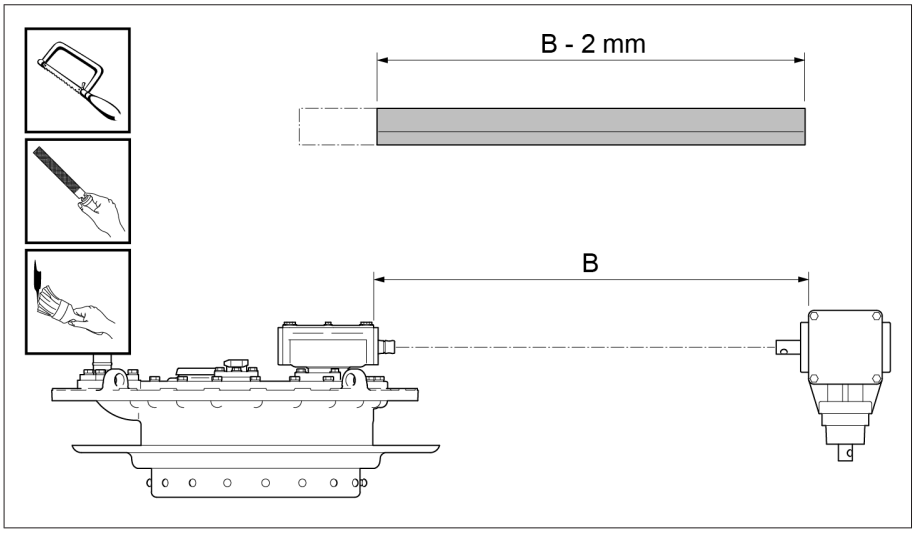


Figure 33: Shorten, deburr, and coat protective cover

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

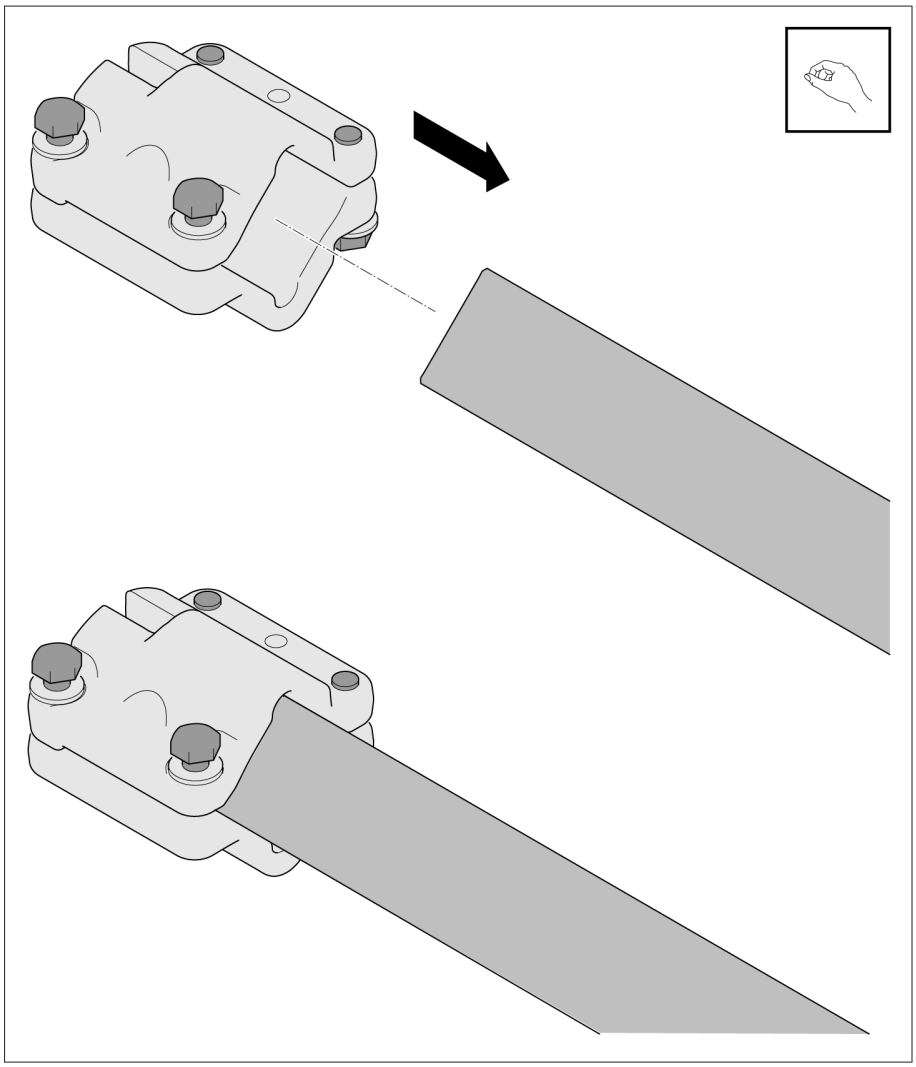


Figure 34: Slide coupling part onto square tube

4. Grease coupling bolt, coupling part and shaft end of the bevel gear (e.g. ISOFLEX TOPAS L32) and insert coupling bolt into shaft end. Thread hose clip onto square tube and slide square tube with coupling part onto shaft end.

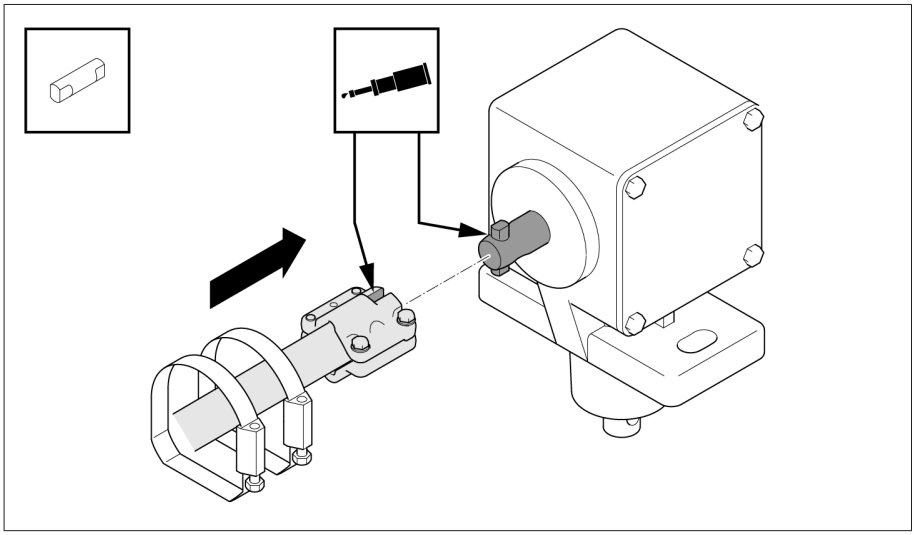


Figure 35: Slide square tube with coupling part onto shaft end

5. Secure square tube on bevel gear.

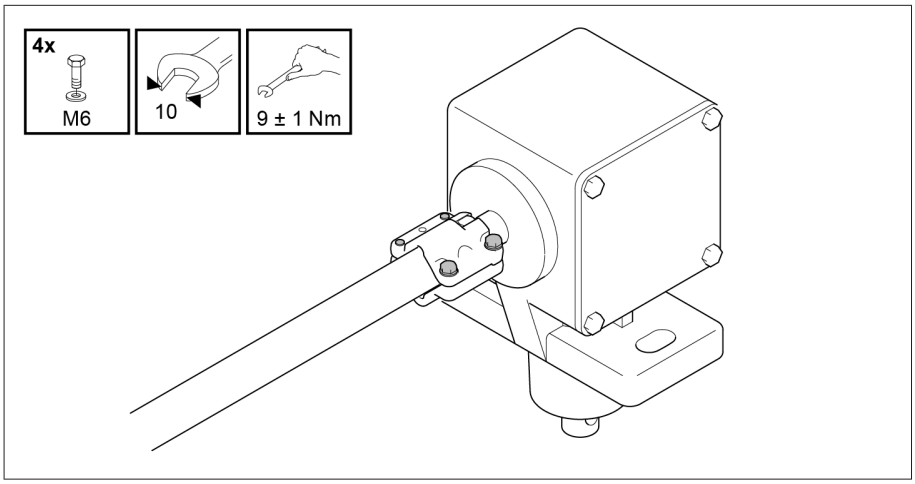


Figure 36: Secure square tube on bevel gear

6. Grease coupling bolt, coupling brackets and shaft end of the upper gear unit (e.g. ISOFLEX TOPAS L32) and insert coupling bolt into shaft end. Secure square tube with coupling brackets on upper gear unit.

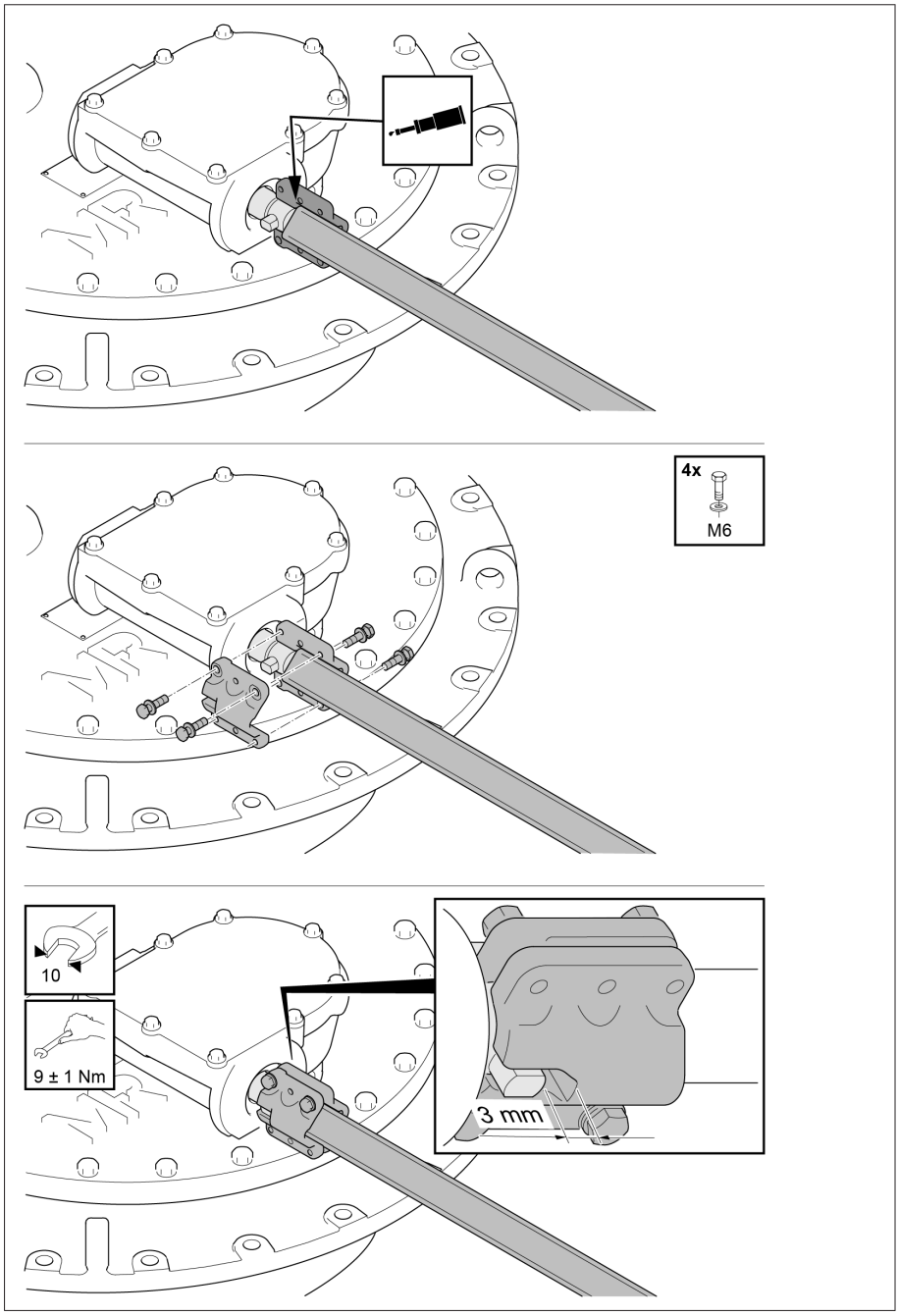


Figure 37: Secure square tube on upper gear unit.

7. Attach shortened protective cover to housing lugs on the on-load tap-changer head and bevel gear. Secure each end of protective cover with a hose clip.

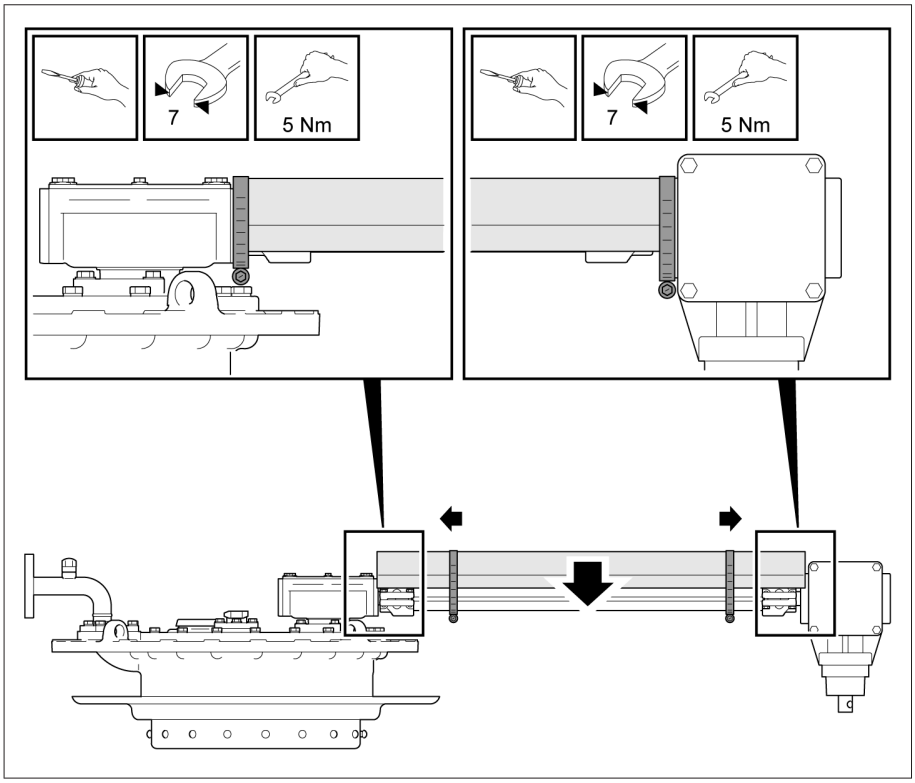


Figure 38: Fitting protective cover

8. If using a bearing block or angle gear, attach caps to the protective cover.

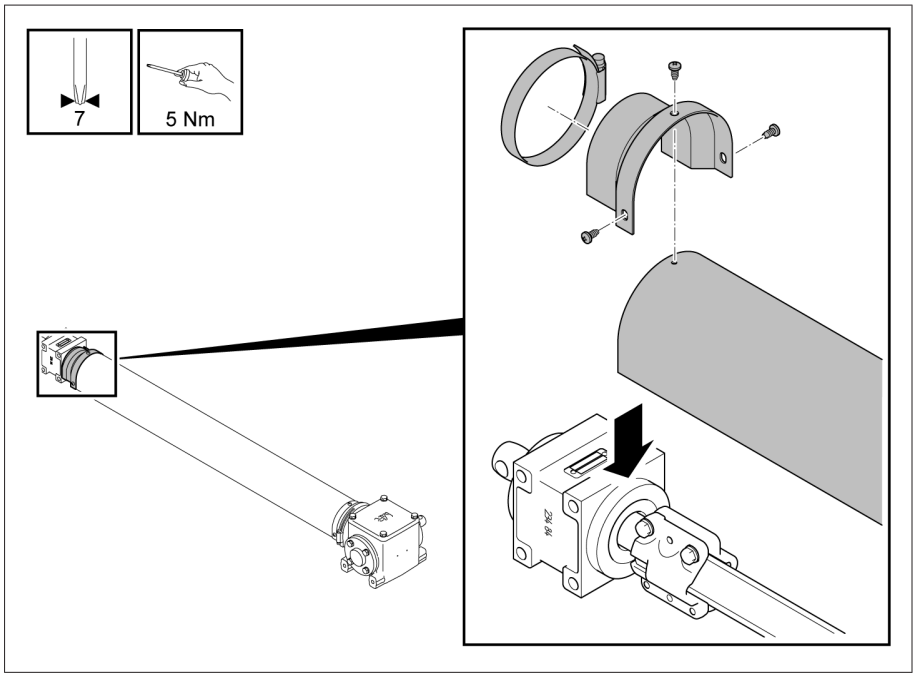


Figure 39: Bearing block caps

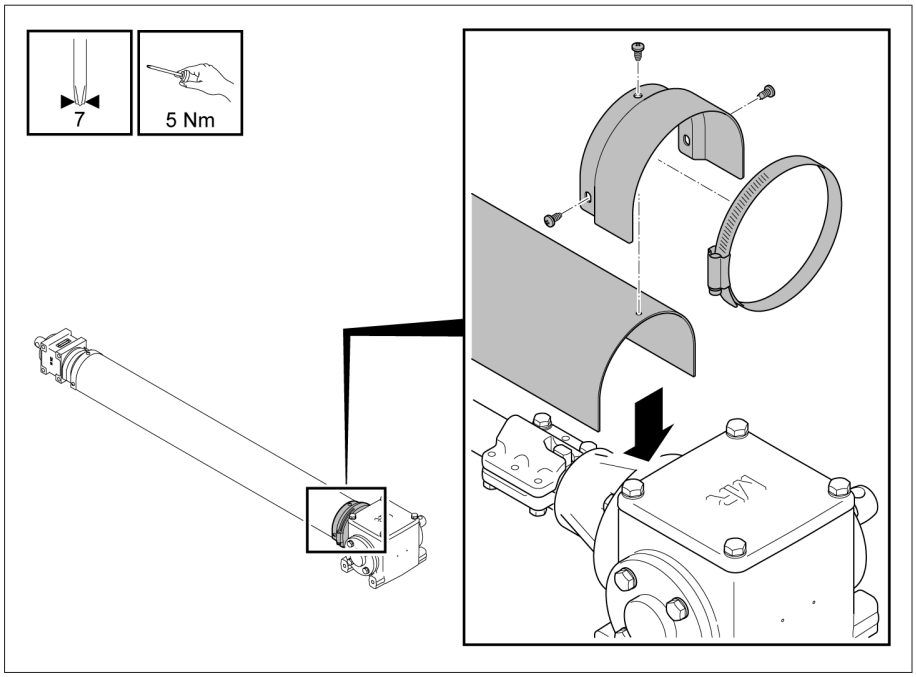


Figure 40: Angle gear caps

5.2 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 displacement

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

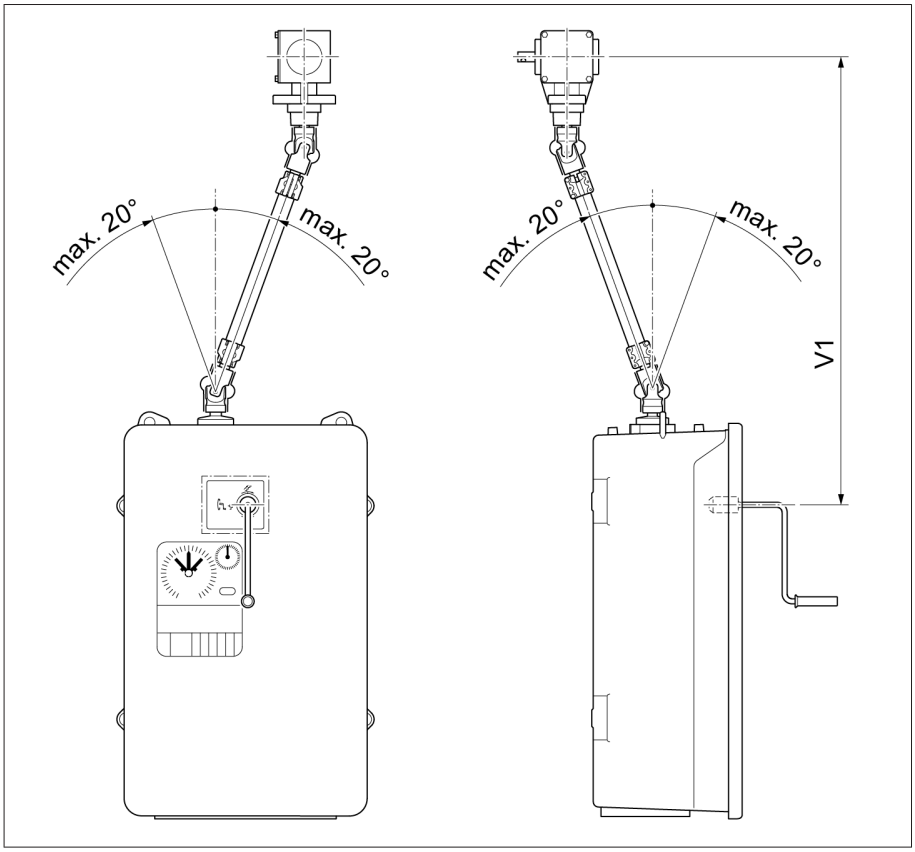


Figure 41: Permitted maximum axial displacement of vertical drive shaft with cardan joints

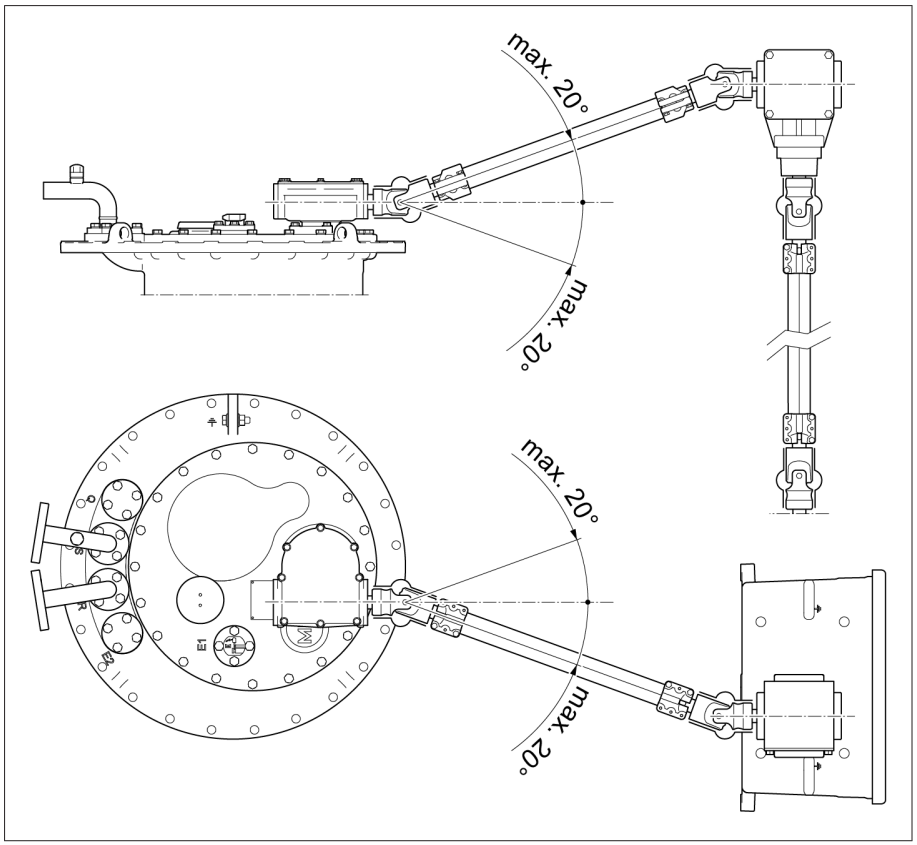


Figure 42: Permitted maximum axial displacement of horizontal drive shaft with cardan joints

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.

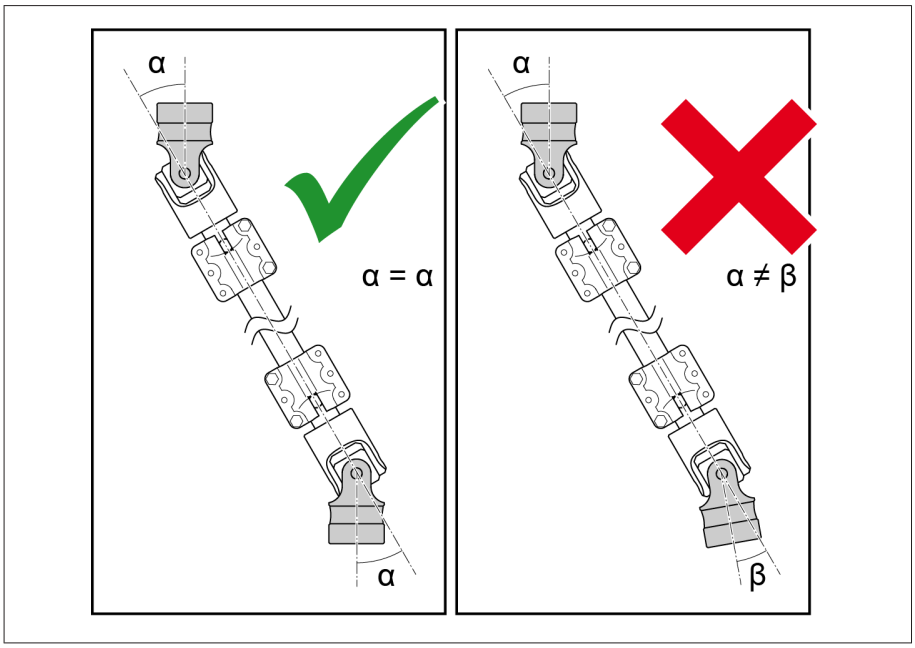


Figure 43: Angle of deflection α

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.

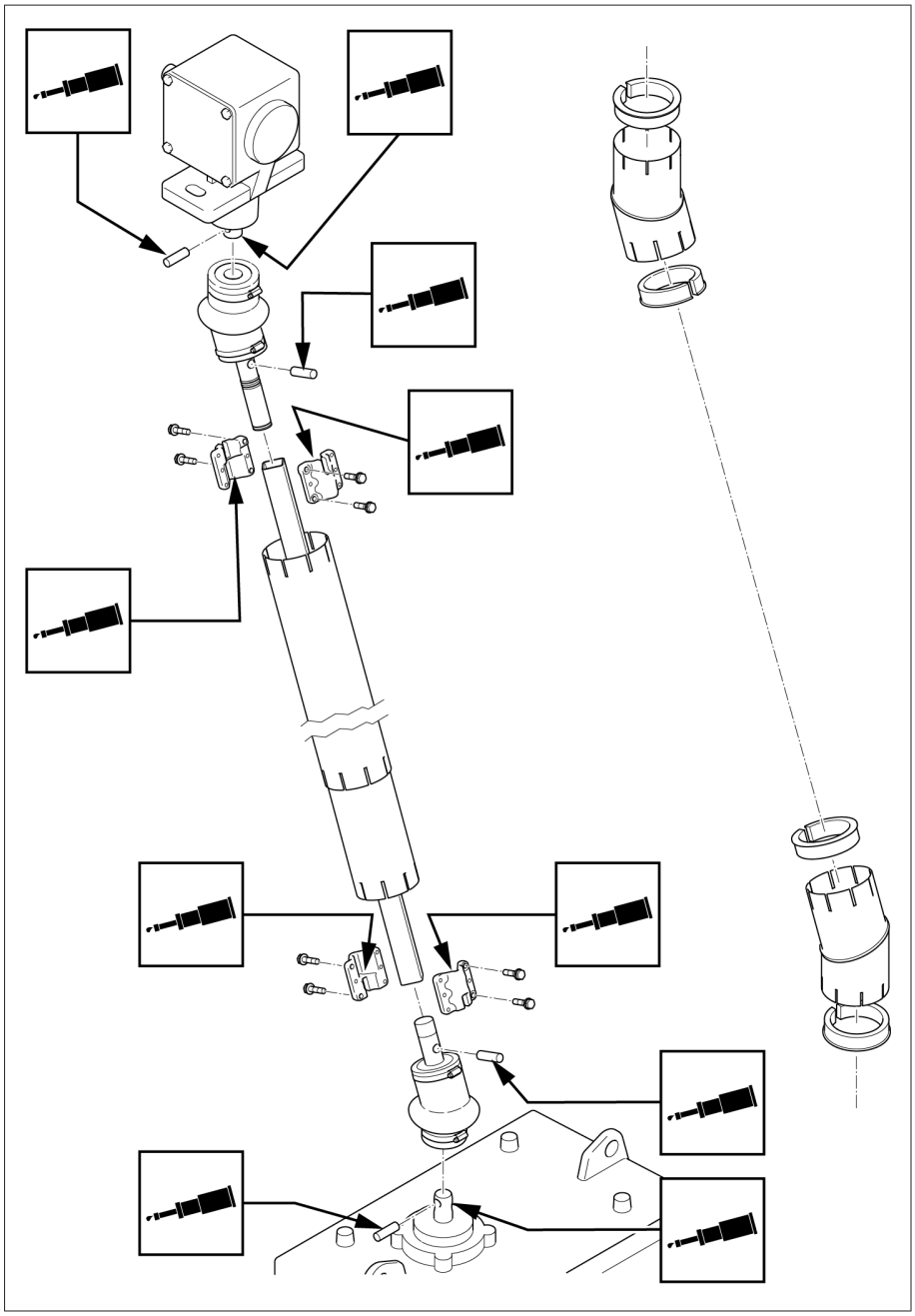


Figure 44: Greasing coupling bolts, coupling brackets, and shaft ends

2. Insert adapter rings into the collar of the rotating protective tube 1. Place both parts of pivotable protective tube inside one another 2 and turn towards one another 3 to set the corresponding angle.

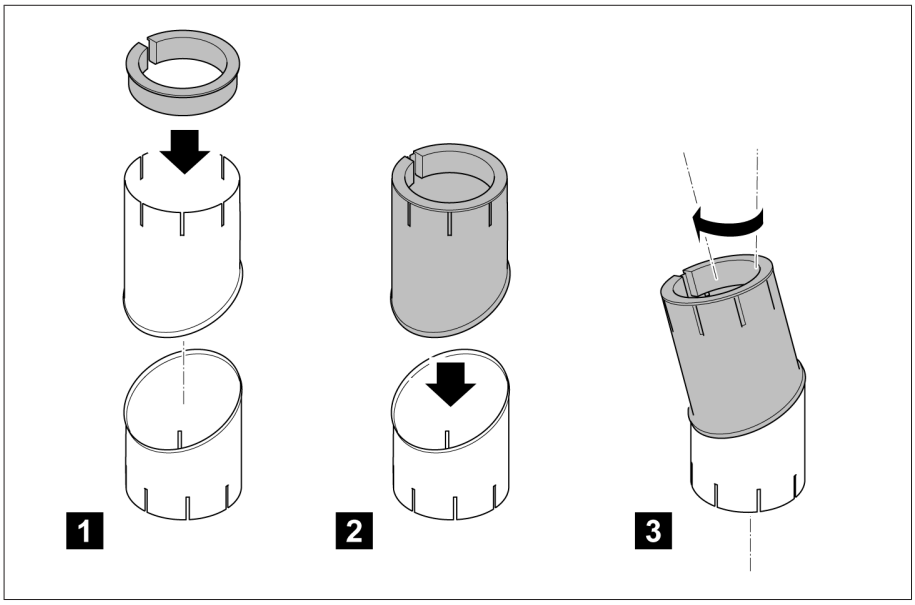


Figure 45: Inserting adapter in pivotable protective tubes

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**.

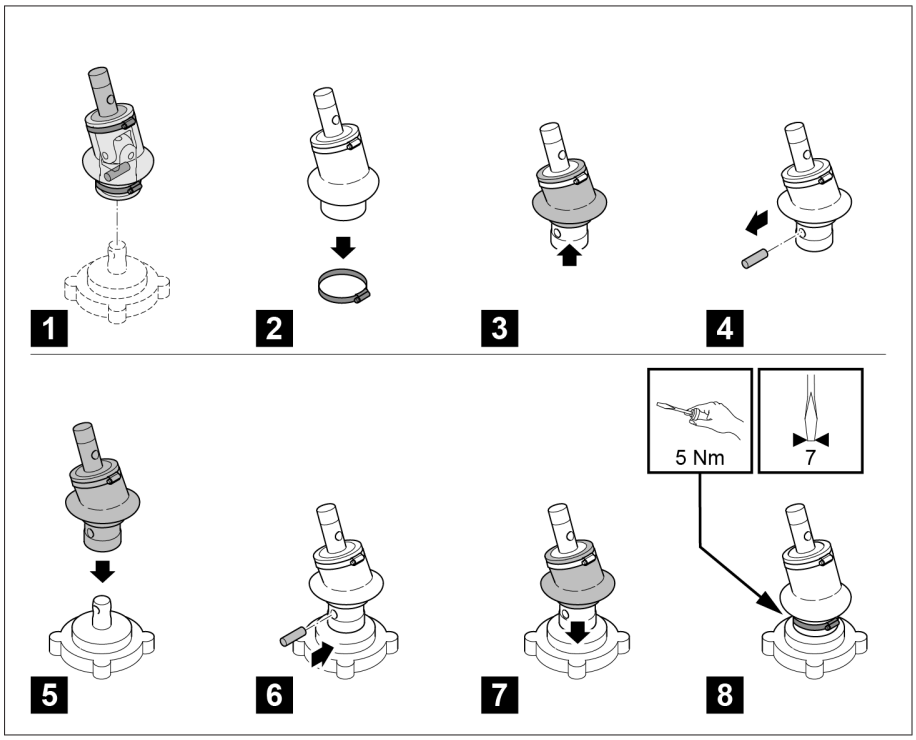


Figure 46: Mounting cardan joints

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

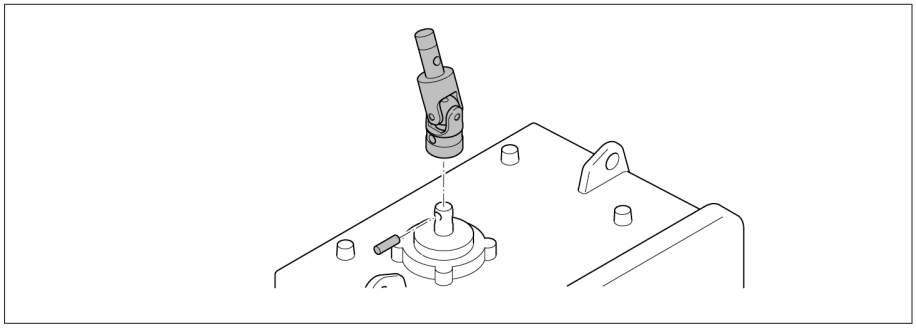


Figure 47: Attach cardan joint on shaft end of motor-drive unit

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

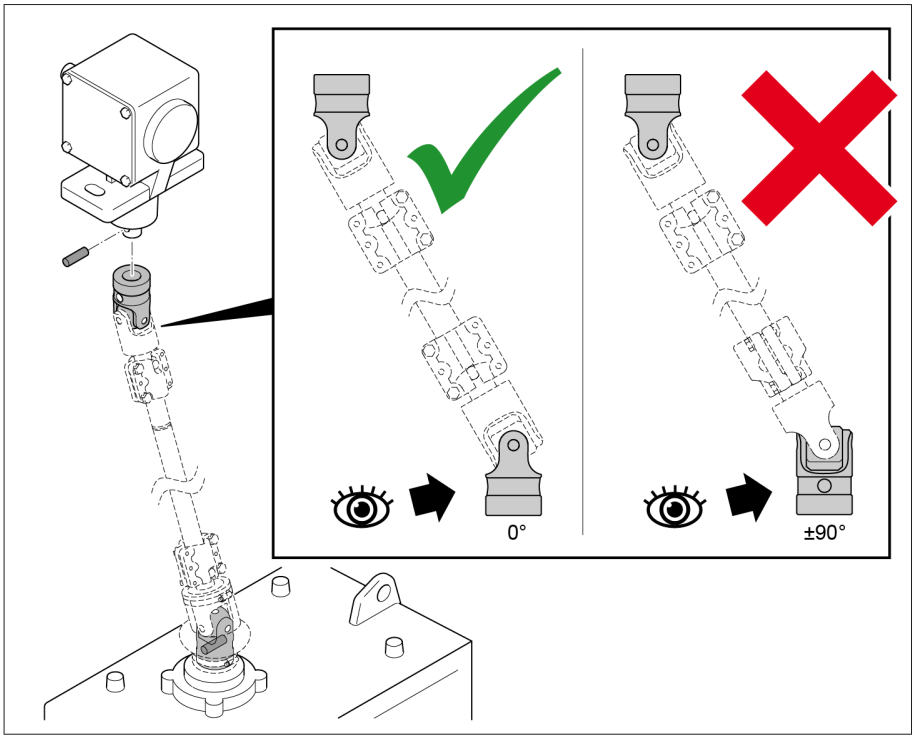


Figure 48: Fit second cardan joint on bevel gear

6. Secure expansion bellows with hose clip.

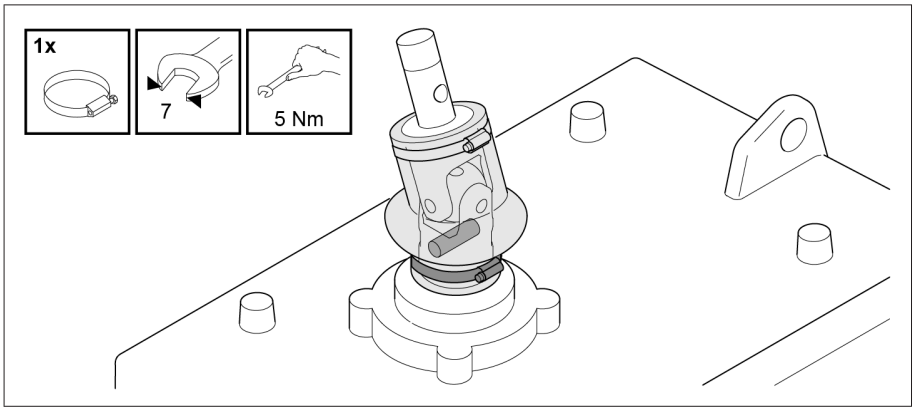


Figure 49: Secure expansion bellows with hose clip

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

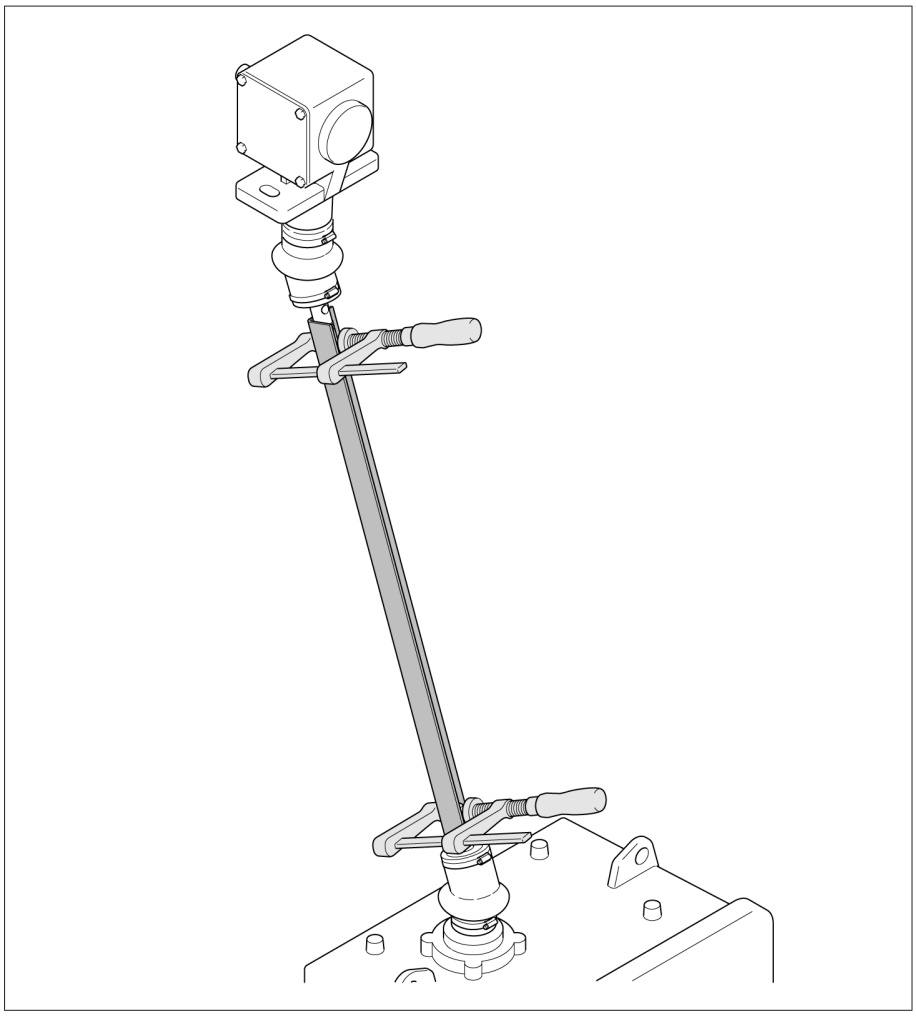


Figure 50: Connect shaft ends with angle bar

8. Determine dimension A between the shaft ends. Cut square tube to LR = A + 106 mm (LR = length of square tube). Deburr cut surfaces of square tube.

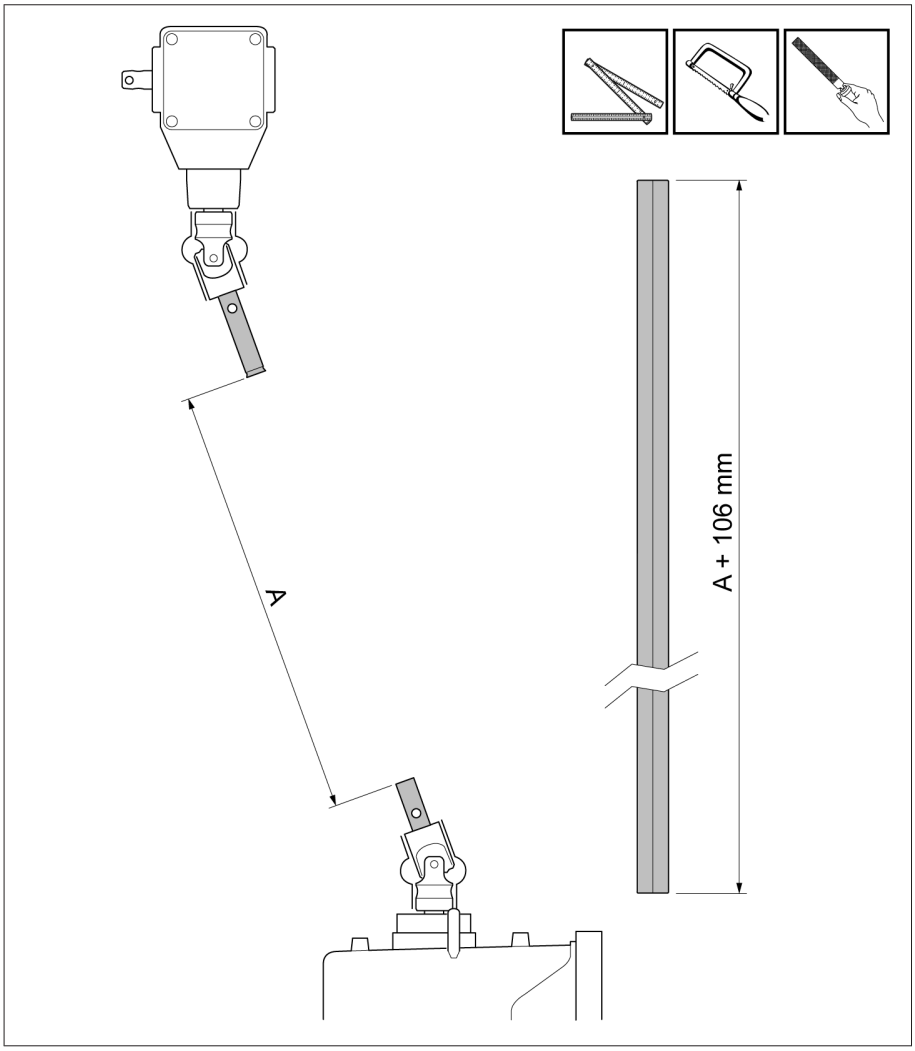


Figure 51: Shortening square tube

9. Before mounting, shorten both telescopic tubes to dimension A/ 2 + 120 mm (A = dimension between both cardan joint ends) and deburr.

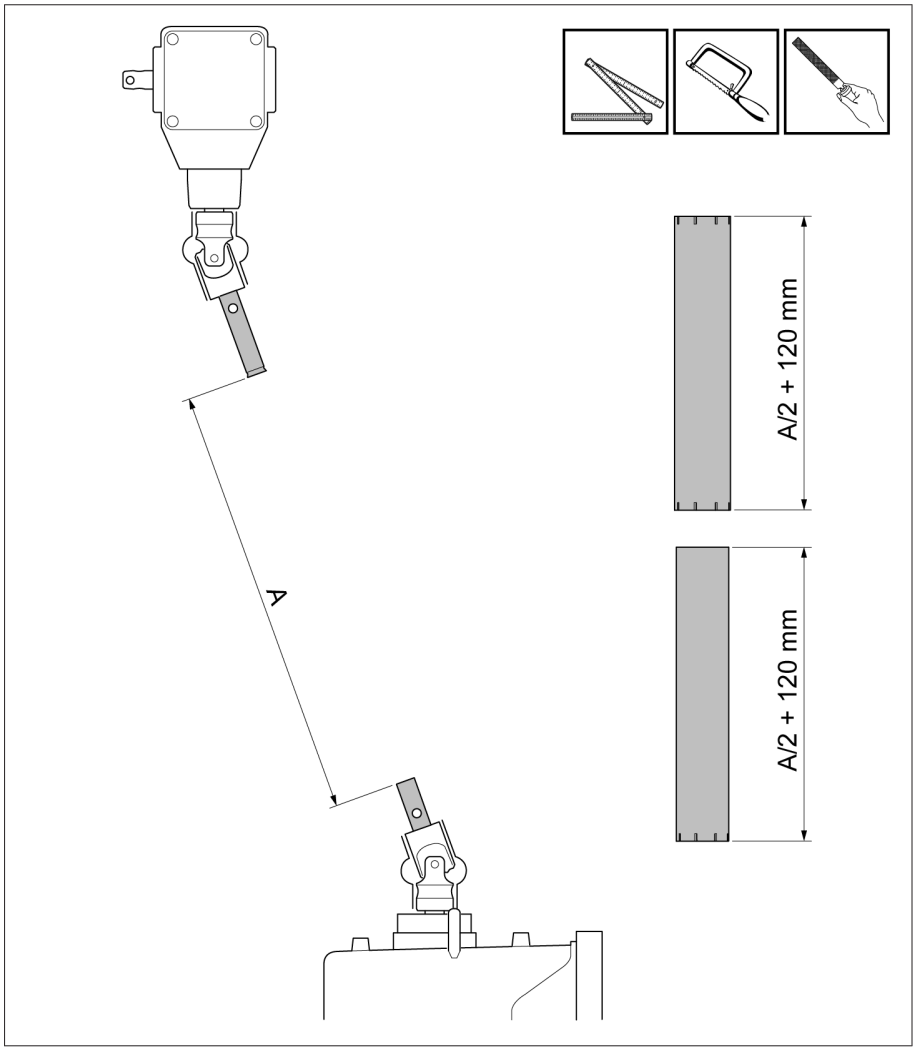


Figure 52: Shortening telescopic tubes

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

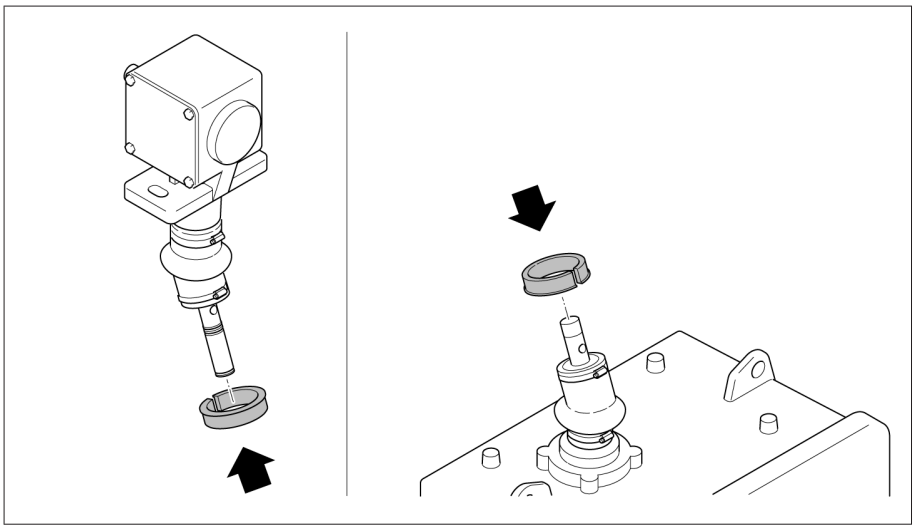


Figure 53: Fitting adapters

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

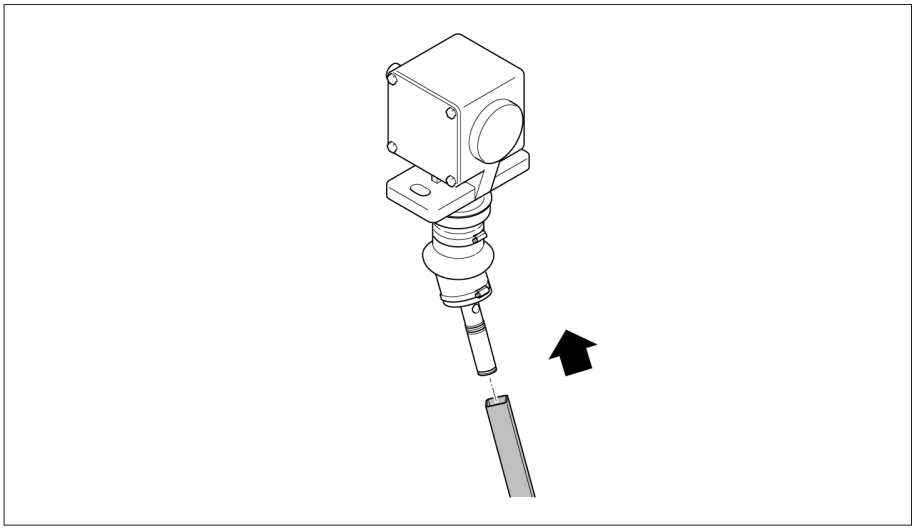


Figure 54: Sliding square tube over upper cardan joint end

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

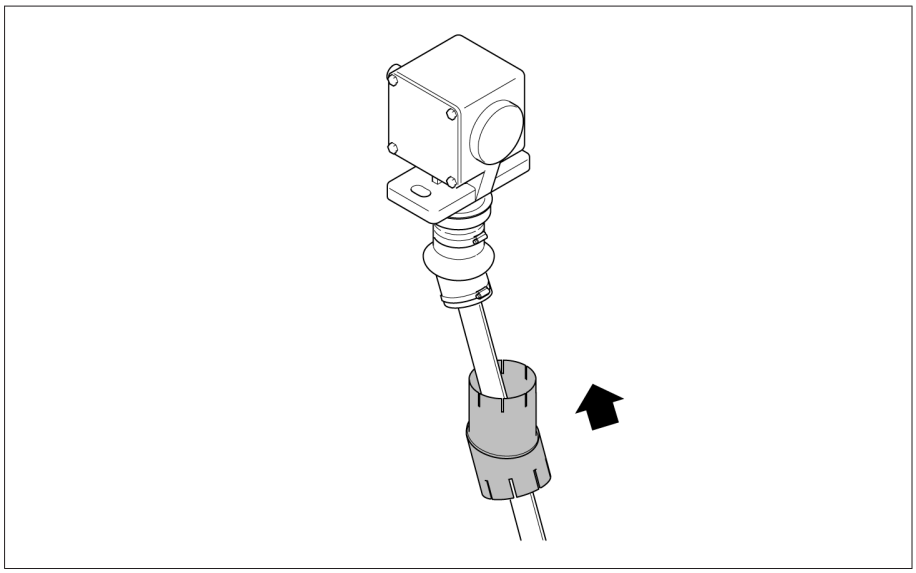


Figure 55: Sliding flexible protective tube over square tube

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.

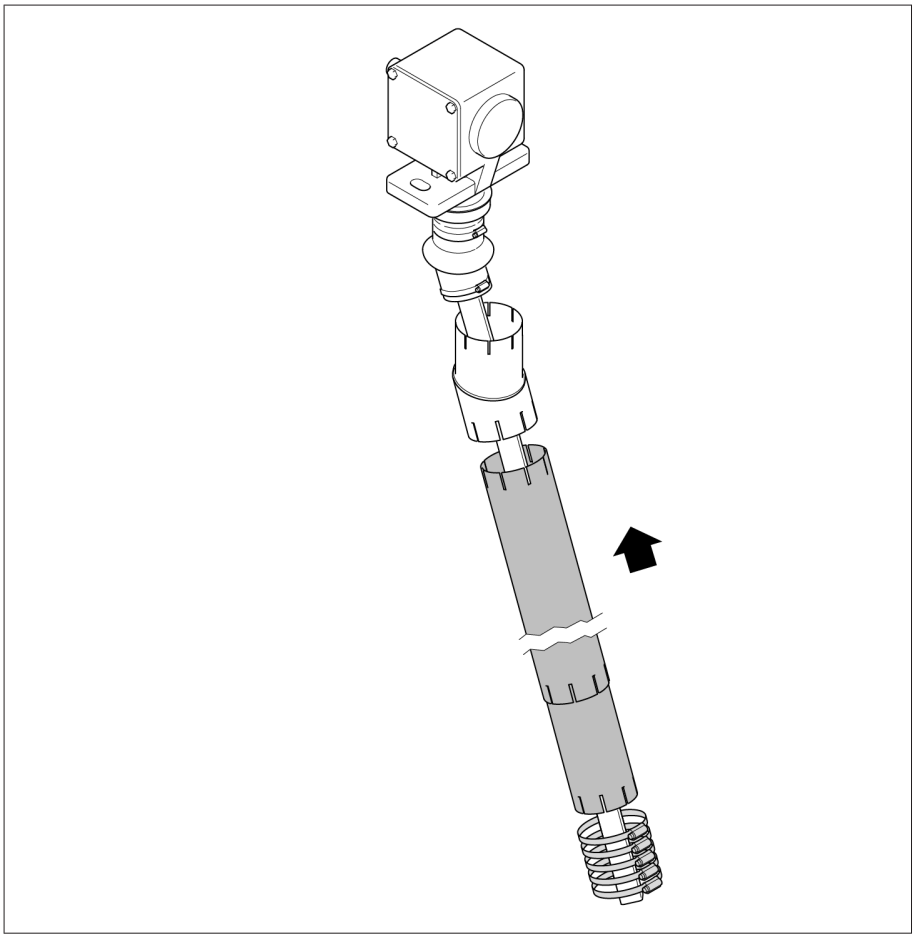


Figure 56: Sliding on telescopic tubes

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

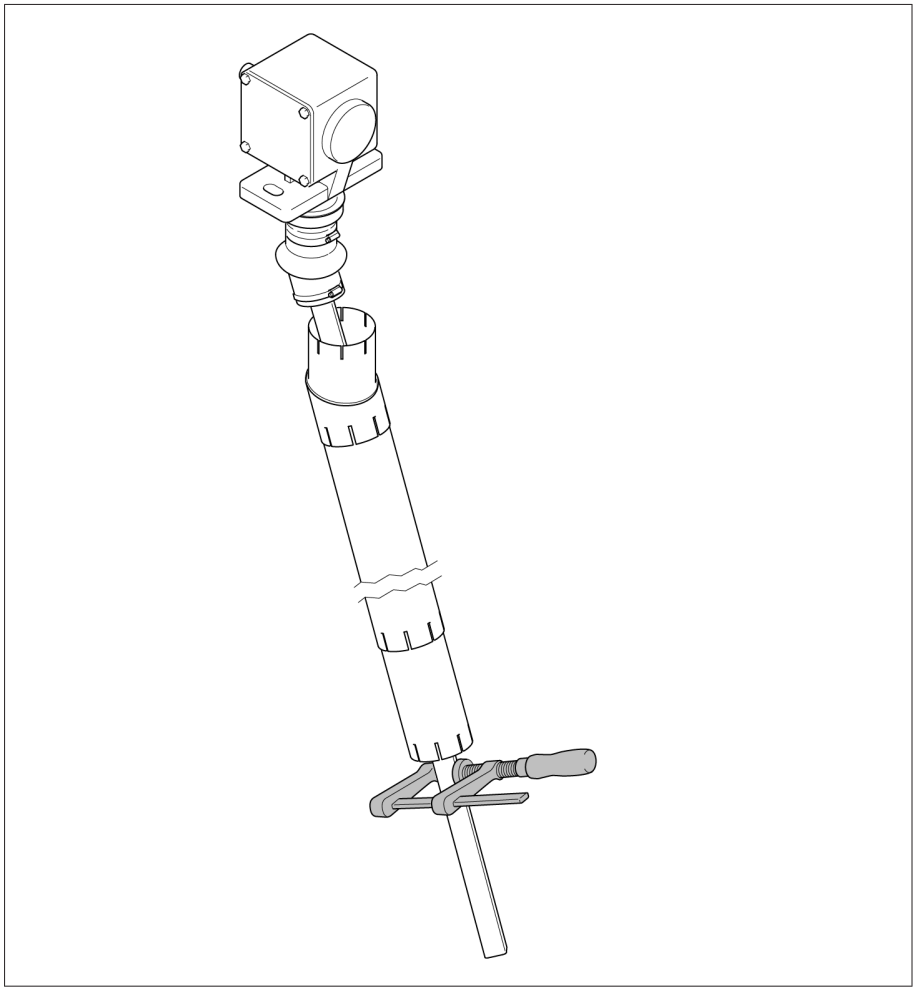


Figure 57: Secure everything with a screw clamp

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

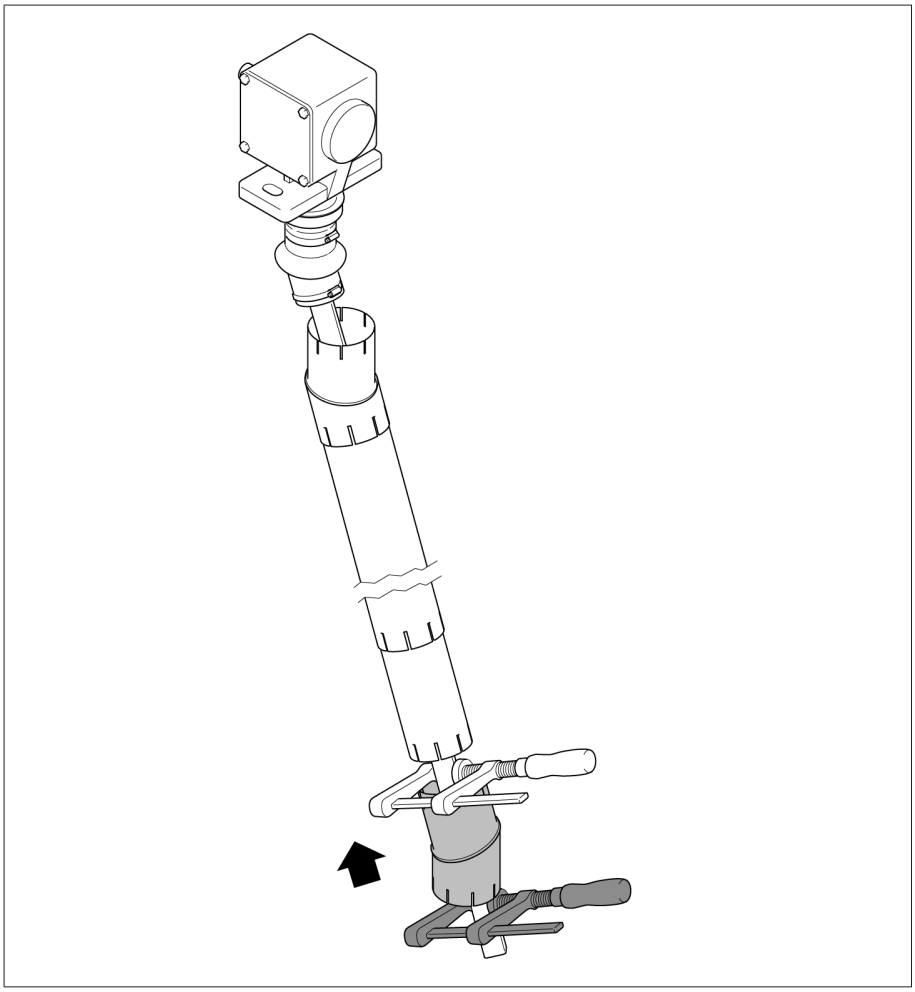


Figure 58: Sliding bottom flexible protective tube onto square tube

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

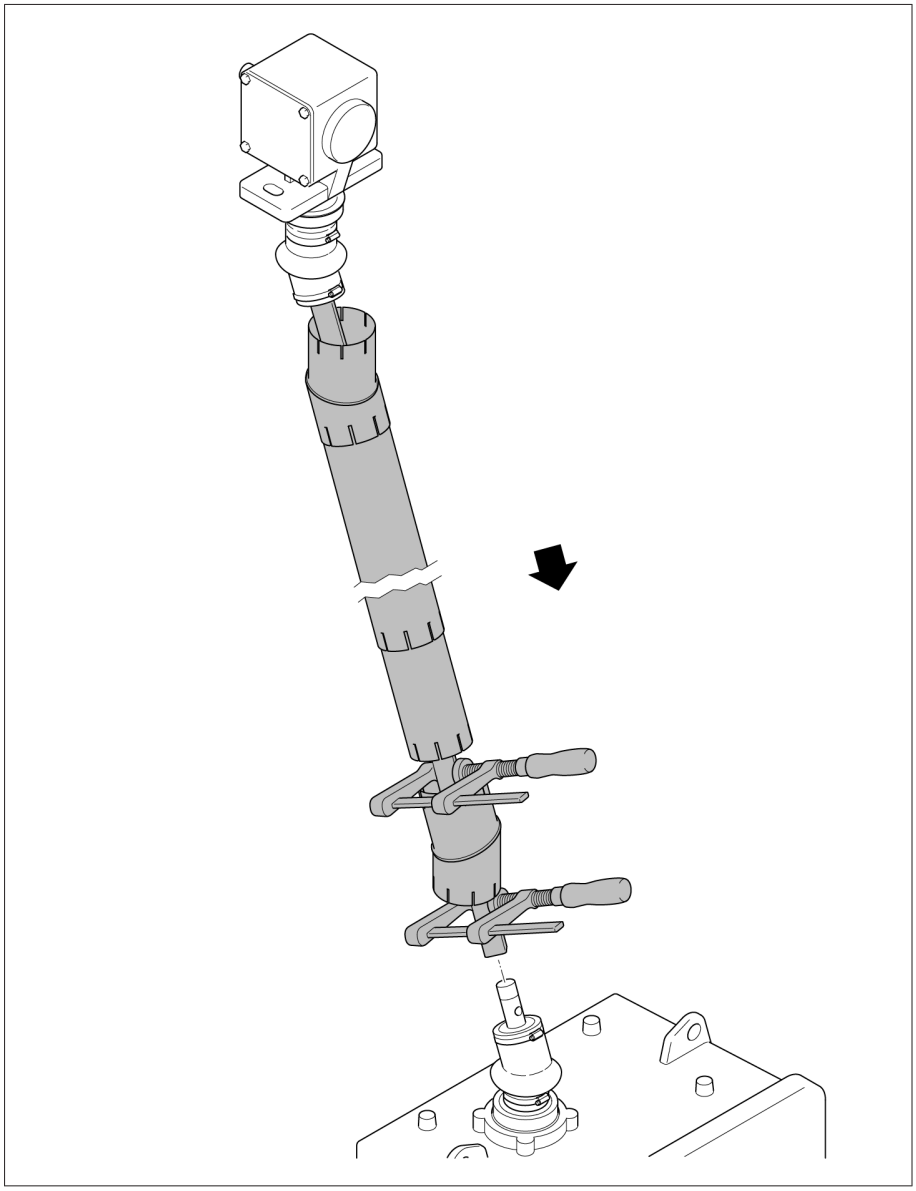


Figure 59: Swinging square tube in

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

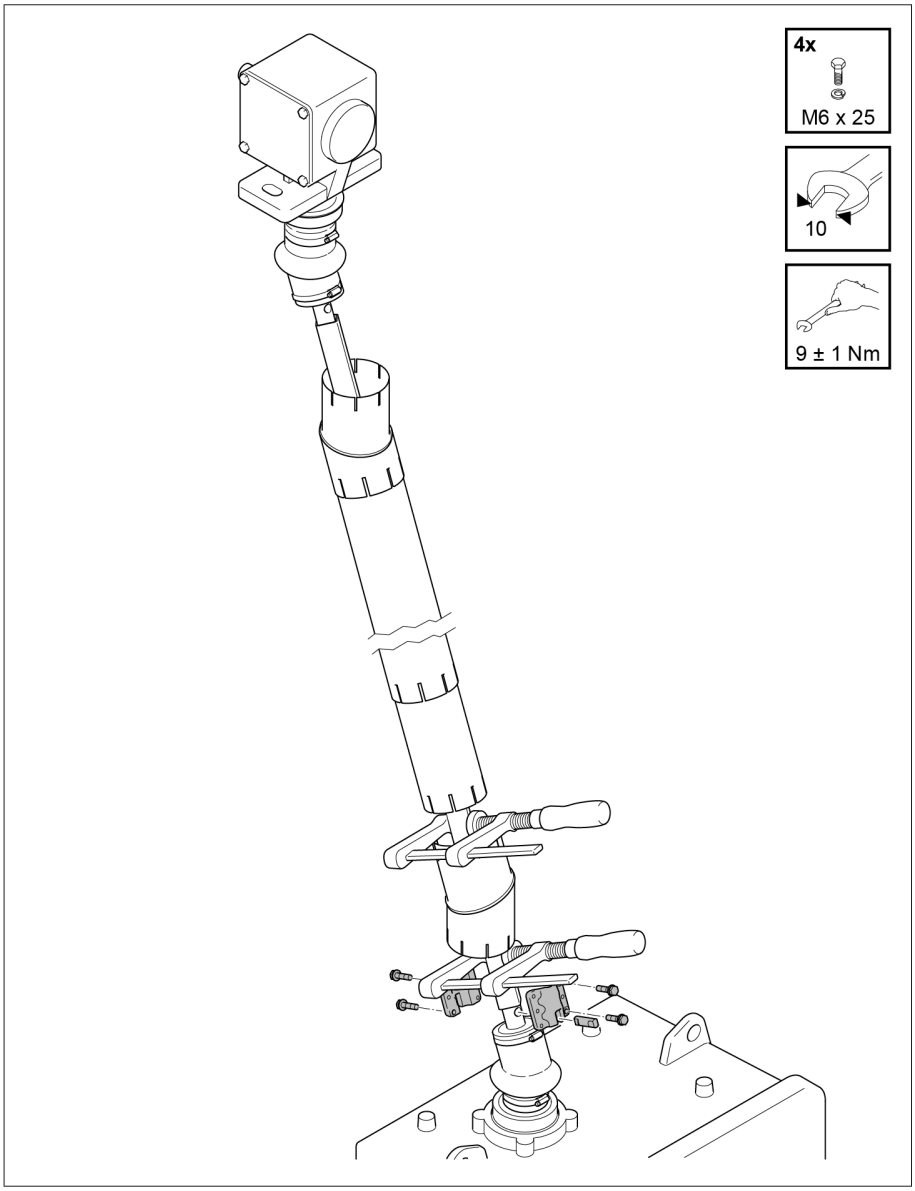


Figure 60: Tightening lower coupling brackets

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

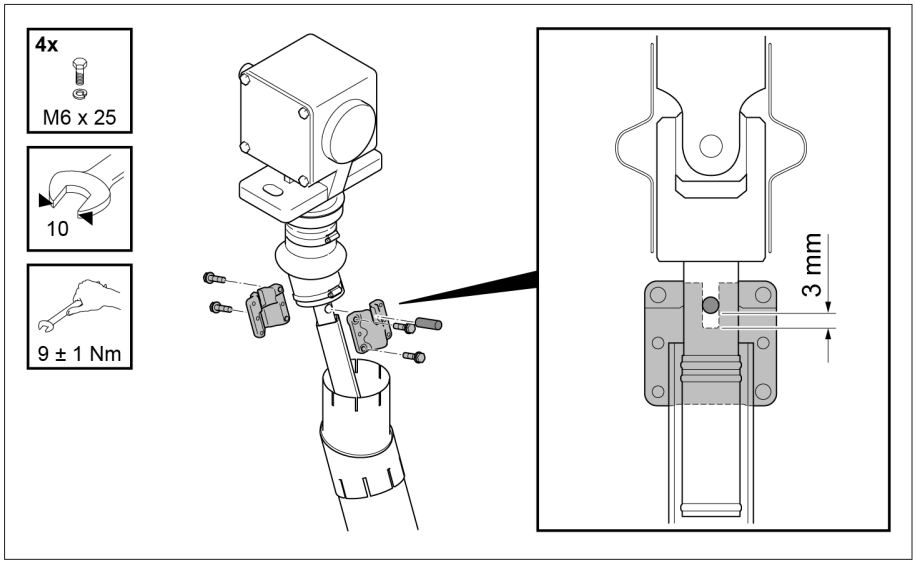


Figure 61: Fitting upper coupling brackets

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.

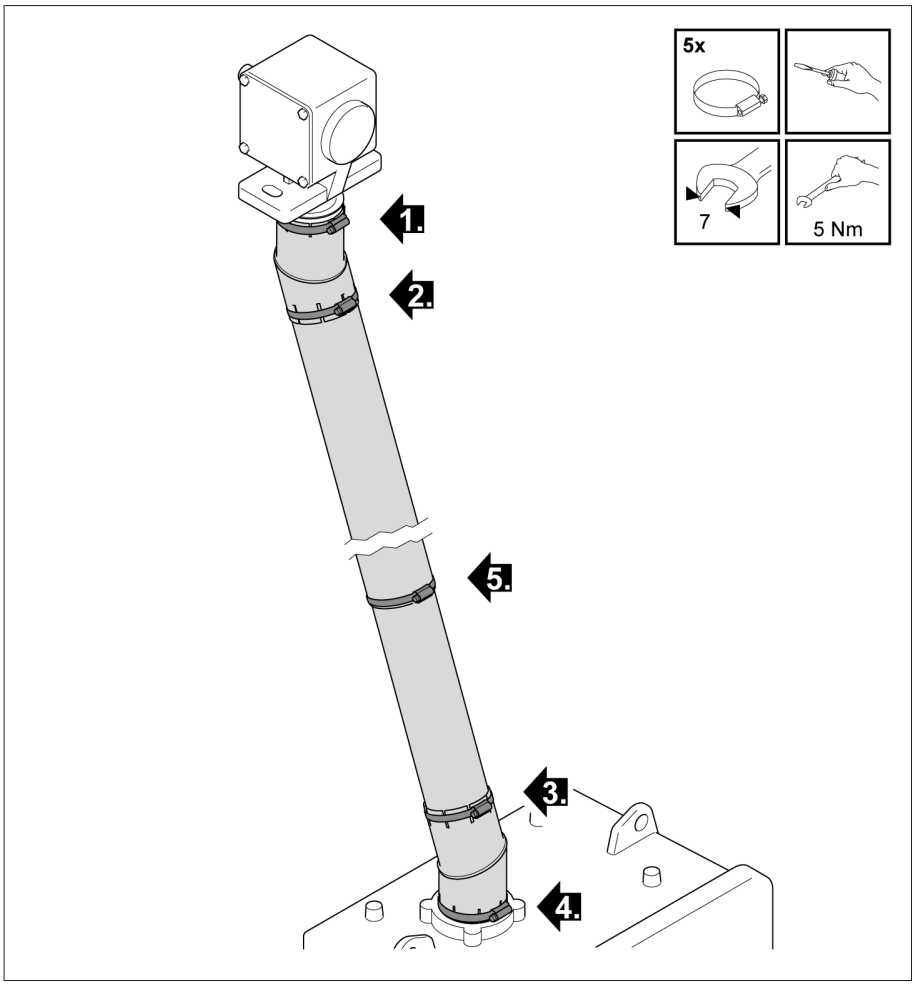


Figure 62: Secure telescopic protective tube and flexible protective tubes with hose clips

5.3 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°).

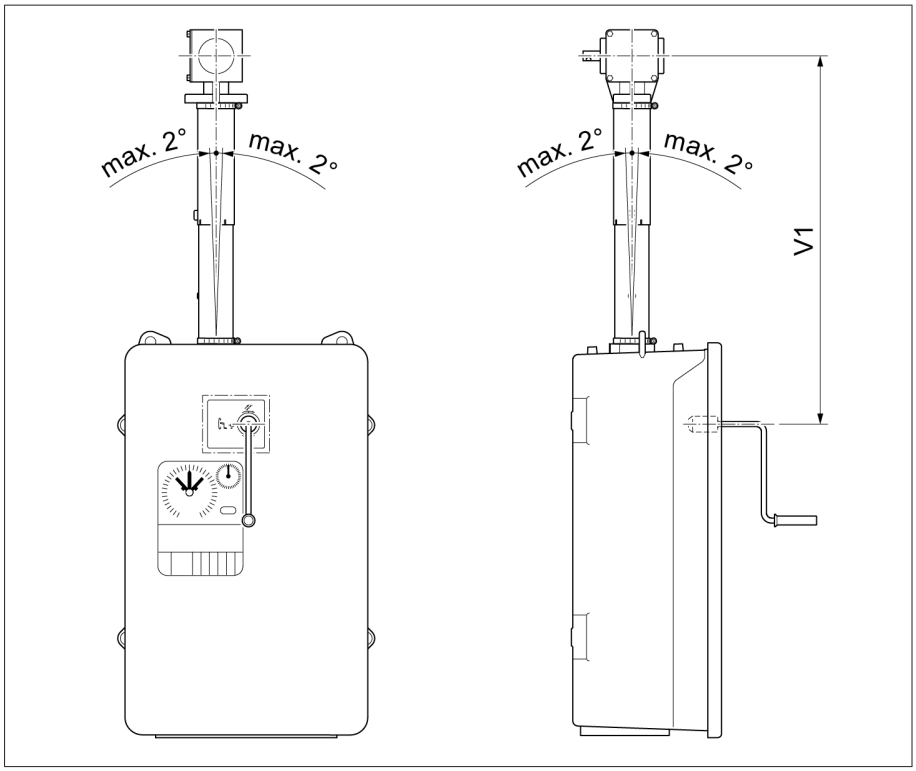


Figure 63: Permitted maximum axial displacement of vertical drive shaft with insulator

5.3.1 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 by accident and thereby cause injuries.

2. Screw down the bevel gear for fastening on the transformer on both sides with the contact washers provided to ensure permanent grounding. Screws are not included in the scope of supply.

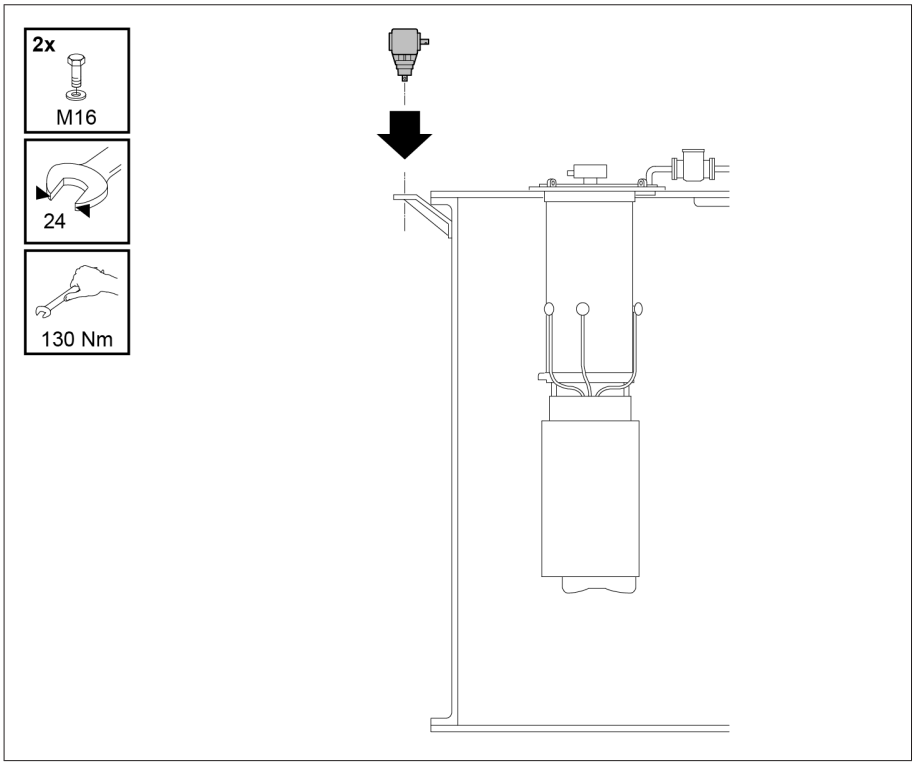


Figure 64: Bevel gear

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.

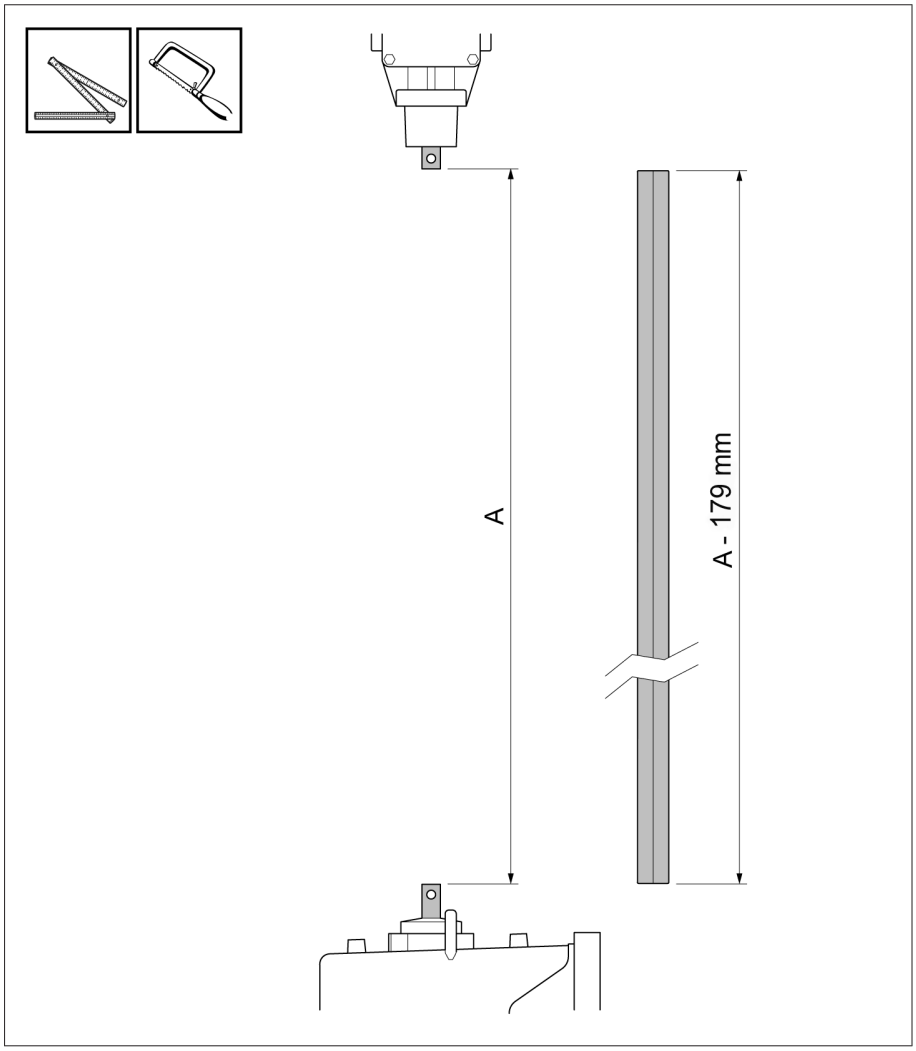


Figure 65: Shortening square tube

4. Deburr cut surfaces of square tube.

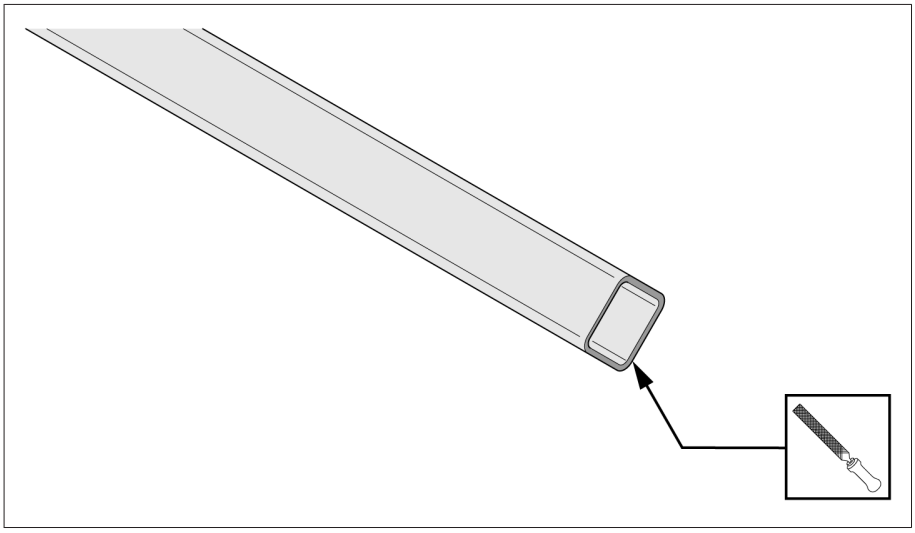


Figure 66: Deburring cut surfaces

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

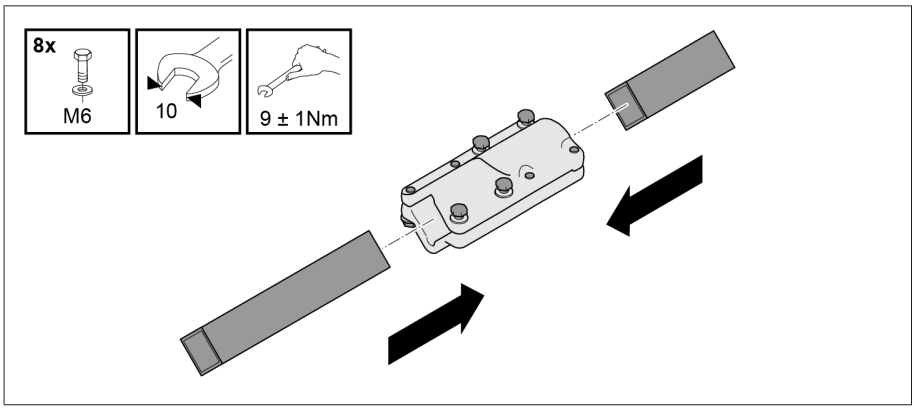


Figure 67: Screwing down square tube and insulator with double coupling part

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

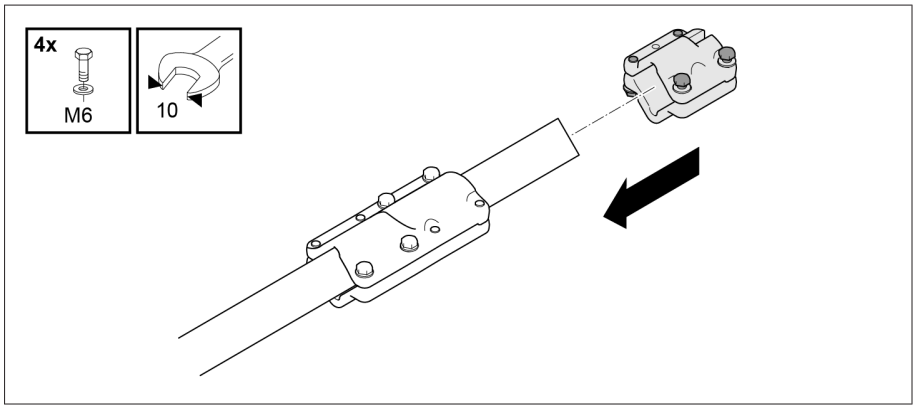


Figure 68: Slide coupling part onto insulator

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

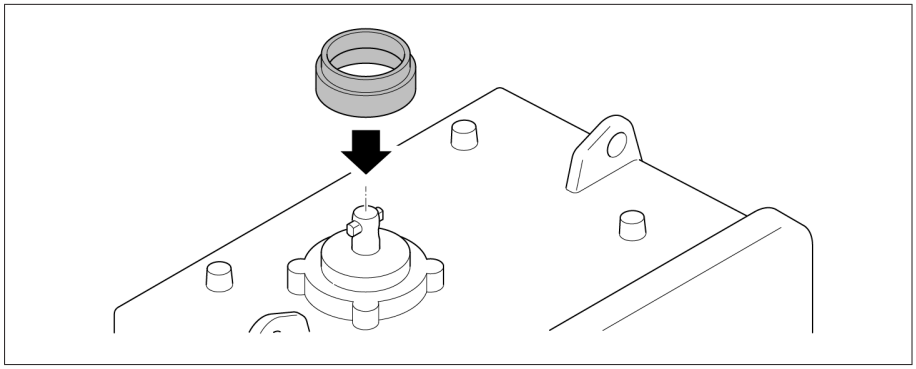


Figure 69: Insulating ring

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.

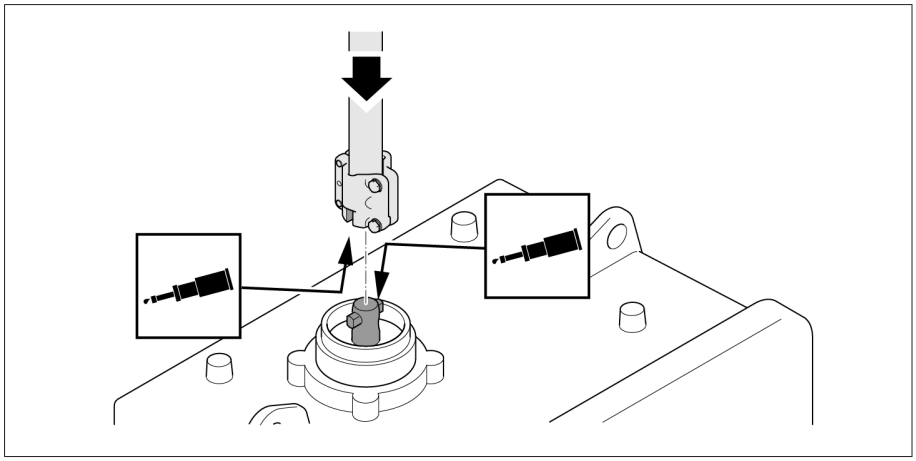


Figure 70: Slide square tube with coupling part onto shaft end

9. Secure square tube onto drive.

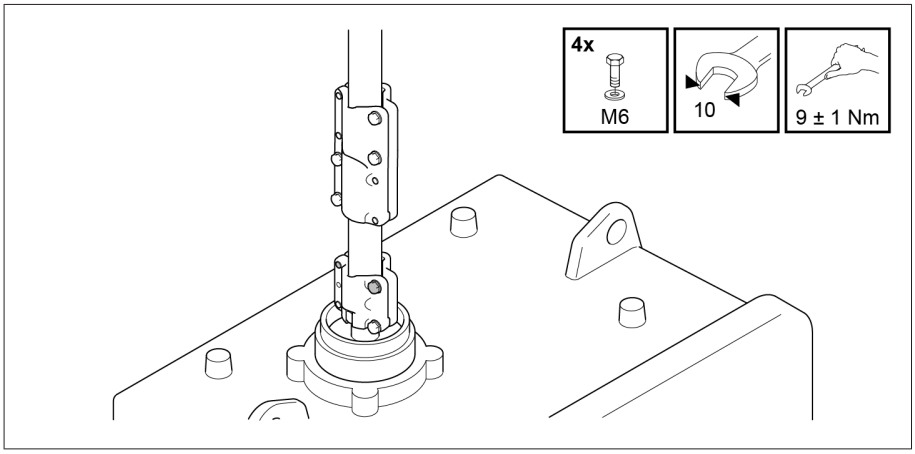


Figure 71: Secure square tube onto drive

10. Pivoting square tube.

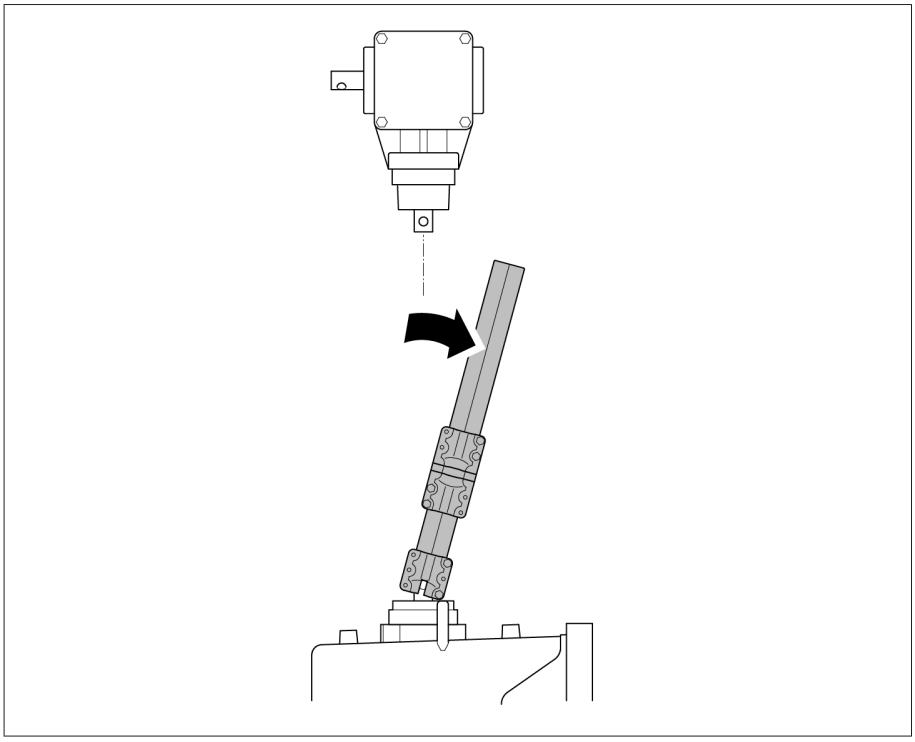


Figure 72: Pivoting square tube

11. When installing inner tube of telescopic protective tube, if necessary shorten on side without slits. 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.

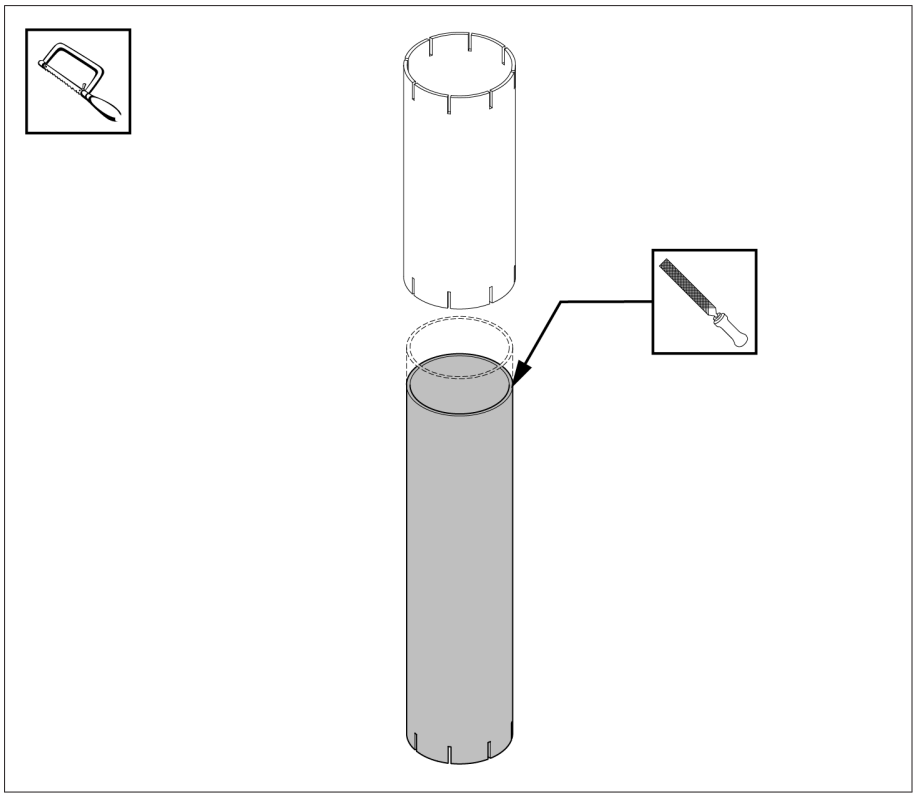


Figure 73: Deburring inner tube

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...1130 mm	Dimension A + 20 mm	= 200 mm
1131 mm...1598 mm	= 700 mm	= 1150 mm
1599 mm...2009 mm	= 1150 mm	= 1150 mm

12. Slide outer tube over inner tube. When doing so, make sure that the unslotted side of the inner tube is facing up. Slide telescopic protective tube onto square tube Then slide hose clips over telescopic protective tube.

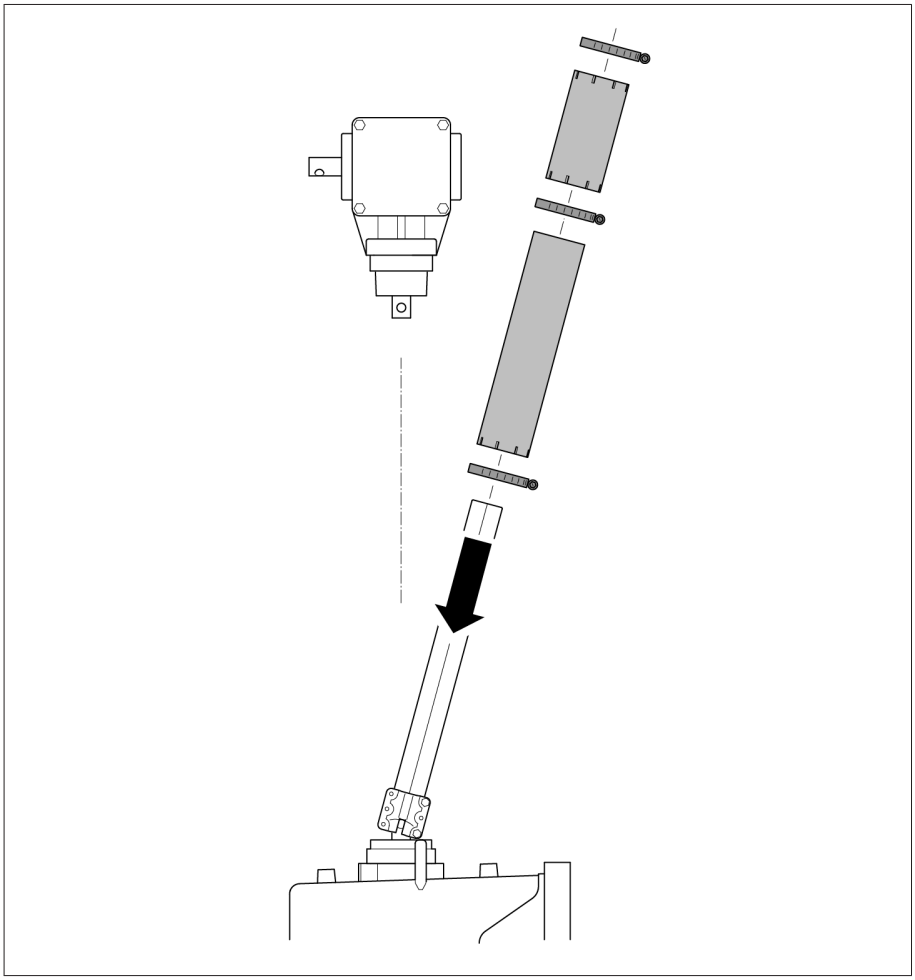


Figure 74: Sliding on telescopic protective tube

13. Place adapter ring over bearing collar of bevel gear and slide upwards. Insert coupling bolt into shaft end of bevel gear. Swing square tube in.

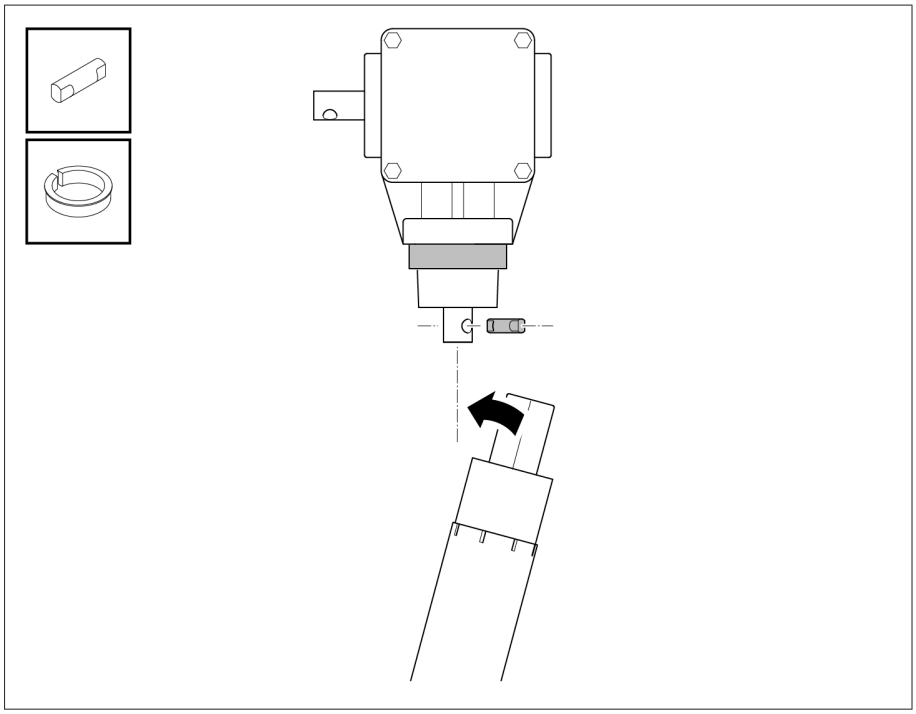


Figure 75: Fitting adapter ring and coupling bolt

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 coupling bolt and upper coupling piece.

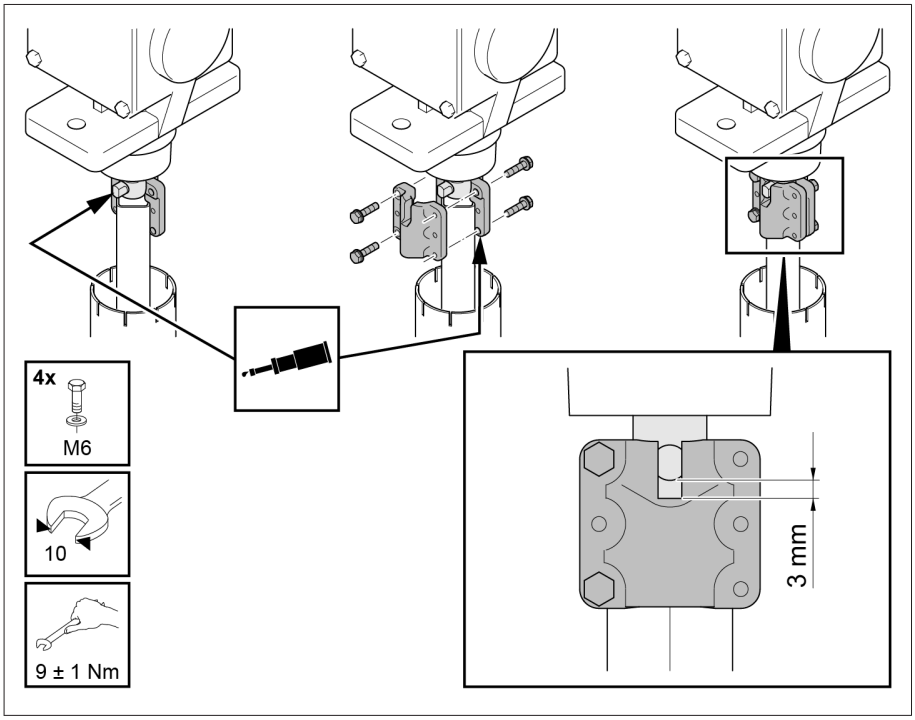


Figure 76: Mounting coupling brackets

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**.

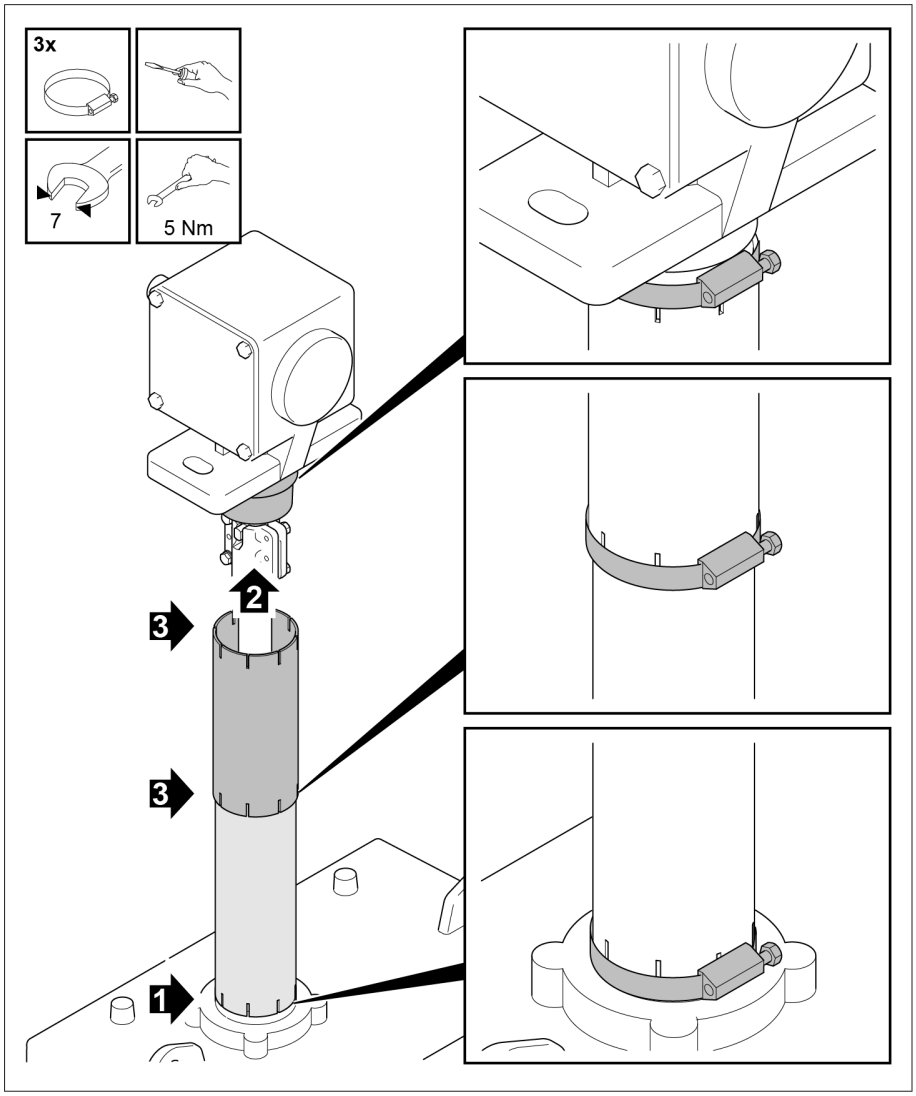


Figure 77: Mounting protective tube

5.4 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.

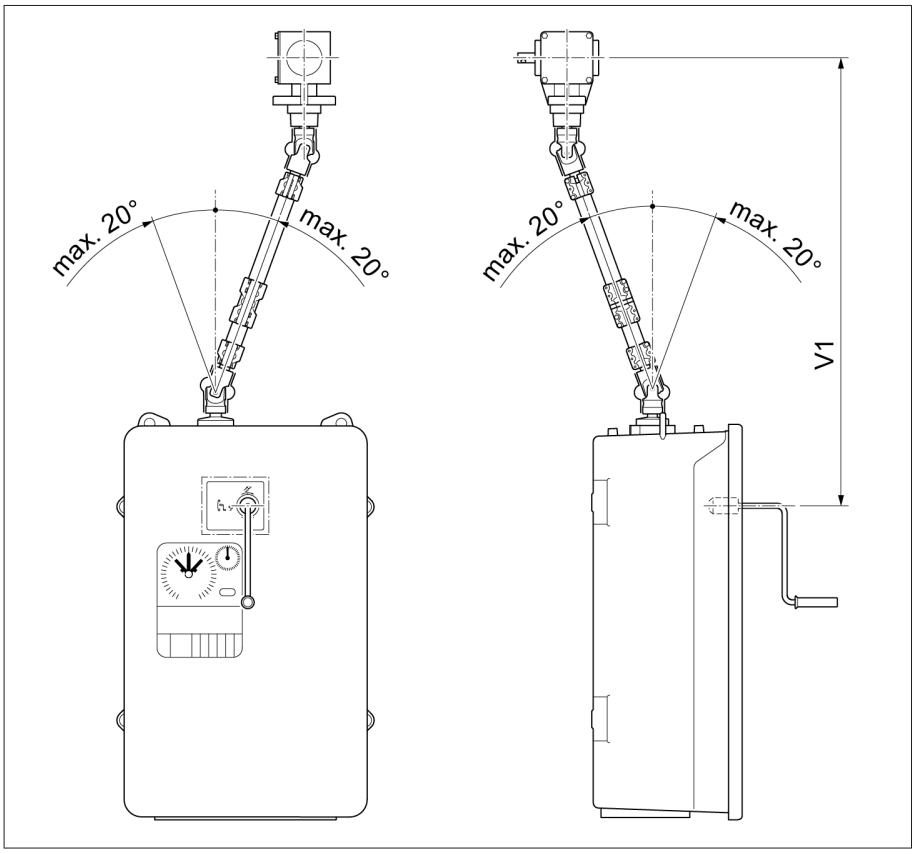


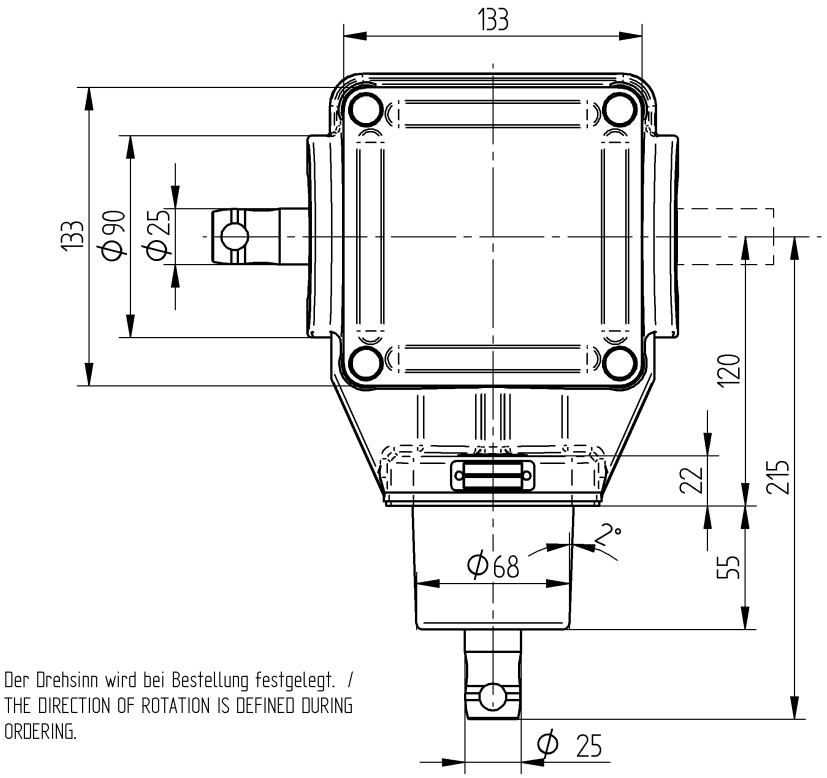
Figure 78: Permitted maximum axial displacement of vertical drive shaft with insulator and cardan joint

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

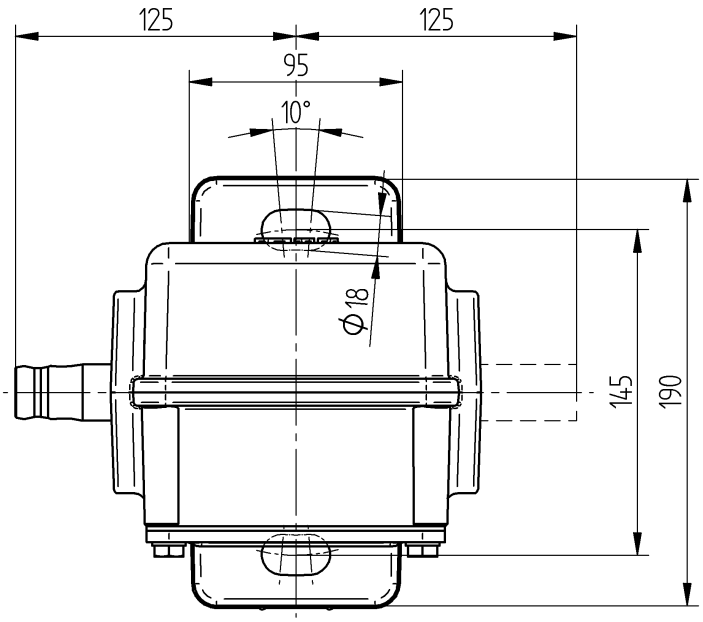
Center on-load tap-changer and motor-drive unit as described in relevant MR operating instructions for motor-drive unit.

6 Appendix

6.1 Bevel gear CD 6400, dimensional drawing (892916)



Der Drehsinn wird bei Bestellung festgelegt. / THE DIRECTION OF ROTATION IS DEFINED DURING ORDERING.



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