SHZVG Oil-Immersed Vacuum On-Load Tap-Changer

Operating Manual

HM 0.460.7202-20260317-EN-A03

Applicable product model: SHZVG I/II/III



Important Note!

Read carefully before use.

Keep for future reference.

Shanghai Huaming Power Equipment Co., Ltd.

Legal notice

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1. About this manual

This manual provides an overview and essential safety instructions for the SHZVG Oil-Immersed Vacuum On-Load Tap-Changer (OLTC). It also offers comprehensive instructions on transporting, installing, commissioning, and maintaining the OLTC to ensure proper integration with the corresponding transformer.

1.1. Target audience

This manual is intended for qualified personnel involved in the installation, commissioning, operation, and maintenance of the OLTC.

Roles	Responsibilities
Technical Field Assistant (TFA) or Commissioning Engineer	• Installing and commissioning OLTC • Integrating OLTC into transformers • Verifying functional and safety compliance
Operator	• Monitoring operating parameters • Performing routine tap-change operation • Reporting abnormal conditions
Maintenance Technician	• Performing inspections, oil sampling, and maintenance • Conducting mechanical/electrical safety checks • Conducting minor repair operations

Important:
This equipment must only be operated by qualified technical personnel. Untrained personnel shall not operate, maintain, or modify OLTC. For required personnel qualifications, refer to 2.5 Personnel qualifications.

1.2. Document retention

Keep this manual and all related documents in a safe place for future reference.

1.3. Related documents

This manual should be used in conjunction with the following documents. Reading this manual in isolation may not provide a complete understanding of the product.

- Wiring diagram
- Order documentation
- Routine test report
- Packing list
- Motor Drive Unit (MDU) manual
- Protective relay manual
- Supplementary documents (if any)

1.4. Conventions

1.4.1. Warning messages

The warning messages in this manual follow the format below:

⚠ DANGER



Identify type of hazard
Identify consequences of not avoiding the hazard
✓ Identify how to avoid the hazard

⚠ WARNING



Identify type of hazard
Identify consequences of not avoiding the hazard
✓ Identify how to avoid the hazard

⚠ CAUTION



Identify type of hazard
Identify consequences of not avoiding the hazard
✓ Identify how to avoid the hazard

NOTICE

Identify type of risk
Identify consequences of not avoiding the risk
✓ Identify how to avoid the risk

Table 1-1 Classification of signal words

Signal word	Hazard level	Potential consequences
Danger	Imminent hazard	Death or serious injury
Warning	Potential hazard	Death or serious injury
Caution	Potential hazard	Minor or moderate injury
Notice	Potential risks	Damage to the supported product (or to other property)

Table 1-2 Safety symbols

Symbol	Meaning
	Danger: Indicates a hazard that will result in serious injury or death if not avoided.
	Warning: Indicates a hazard that could result in serious injury or death if not avoided.
	Overhead load
	High voltage
	Explosive material
	Flammable material

1.4.2. Notes

The following symbols are used to highlight information worth noting:

Important: Indicates key information and requires attention.

Note: Indicates an ordinary note.

1.4.3. Procedural instructions

Procedural instructions are presented as single-step or multi-step operations.

Single-step operations

Pre-operation preparation (Optional)

Background information (Optional)

This is a step.

1. This is a substep.
2. This is a substep.

Expected results (Optional)

Follow-up actions (Optional)

Multi-step operations

Pre-operation preparation (Optional)

Background information (Optional)

1. This is a step.
2. This is a step.
    a. This is a substep.
    b. This is a substep.
    c. This is a substep.

Expected results (Optional)

Follow-up actions (Optional)

1.5. Abbreviations

The following table lists the abbreviations used in this manual and their full forms.

Table 1-3 Abbreviations and full forms

Abbreviations	Full form
FAT	Factory Acceptance Test
MDU	Motor Drive Unit
OLTC	On-Load Tap-Changer
PPE	Personal Protective Equipment
TFA	Technical Field Assistant

2. Safety notes

This manual is an integral part of the product.

Read this manual thoroughly to familiarize yourself with the product.

Pay close attention to all warning and cautionary information in this manual to prevent hazards.

Read and follow all safety instructions in this chapter.

While this product is designed and manufactured using state-of-the-art technology, improper use may result in personal injury, equipment damage, or property loss.

2.1. Safety instructions

To prevent possible injury, read and follow the instructions in the table below.

Table 2-1 Potential danger and preventive measures

Potential hazards	Description	Instructions
Electric shock	Contact with live electrical parts can cause serious injury or death.	• Before inspection or maintenance, take the following safety actions: 1. Cut off the power supply for the equipment. 2. Prevent the equipment from re-energization. 3. Verify that no voltage is present. 4. Discharge, ground, and short circuit as required. 5. Isolate adjacent live parts to prevent accidental contact. • For the specific task, wear the proper Personal Protective Equipment (PPE), for example, safety helmets and work gloves.
Arcing and flashover	Arcing during switching or insulation failure can cause burns or fires.	• Maintain insulation integrity. • Wear arc-rated PPE. • Maintain safe distance during operation.
Explosion or fire	Highly flammable or explosive gases, vapors, and dust can cause serious explosions and fires.	• Operate the product only in a non-explosive environment. • Keep oil away from open flames, sparks, or any potential fire sources. • In case of a fire, use dry powder, foam, or carbon dioxide extinguishers. Never use water.

Table 2-1 Potential danger and preventive measures (continued)

Potential hazards	Description	Instructions
Improper grounding	Improper grounding can cause dangerous potential difference and equipment fault.	Before installation, operation, or testing, ensure correct grounding.
Chemical hazards	Transformer oil degradation may release harmful substances.	• Use approved transformer oil. • Equip with appropriate PPE such as work gloves to avoid direct contact with transformer oil. • Ventilate area during operation.
Mechanical hazards	Moving or rotating parts can cause entanglement risks.	• Wear well-fitting clothing. • Do not wear rings, necklaces, or other jewelry. • Those having long hair must wear a hairnet.
Work area hazards	Poor lighting and a cluttered area can increase the risk of accidents.	• Keep the work area clean and well-lit. • Obey national accident prevention regulations.
Noise hazards	Tap-change operation can produce high noise levels.	Wear hearing protection as required.
Waste disposal	Incorrect disposal of waste materials, such as insulating oil, packaging, or removed parts, can harm the environment and lead to health risks.	• Collect used transformer oil in designated containers and store them properly. • Dispose of waste according to local regulations. • Different waste categories require specific disposal methods. Improper waste disposal can harm the environment and human health.

2.2. Safety Label

The rupture disk of the On-Load Tap-Changer (OLTC) diverter switch is affixed with the following safety label: "NO STEP". It indicates that it is strictly forbidden to step on the rupture disk, as it may lead to structural damage or personal injury.

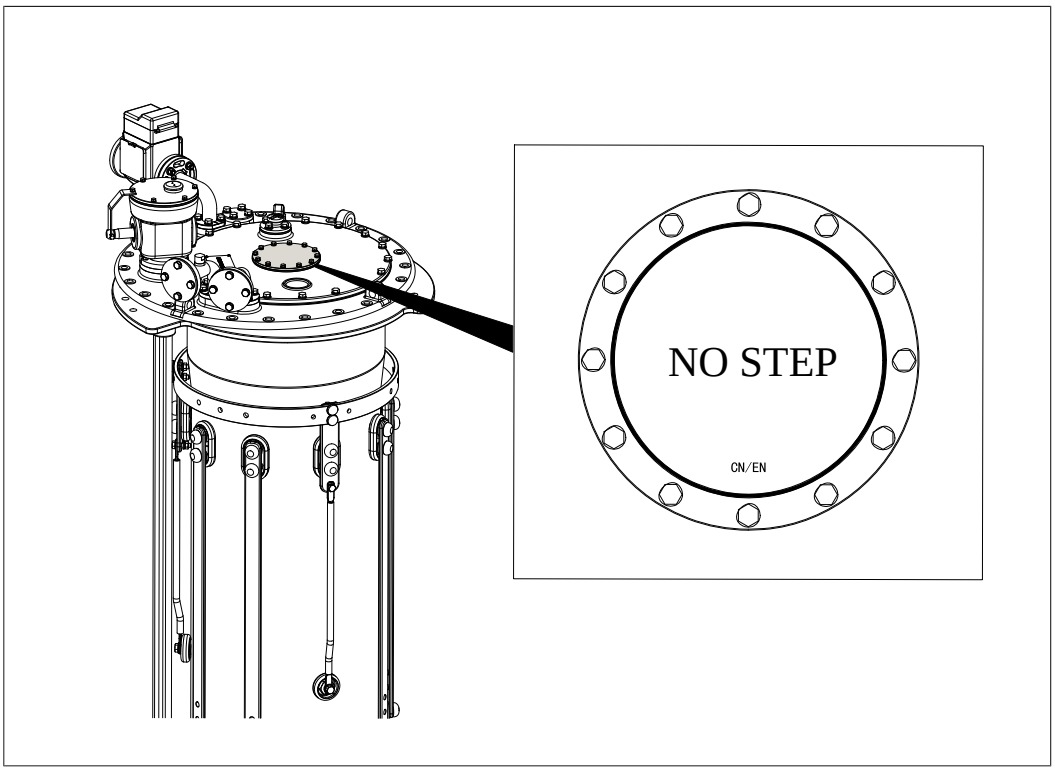


Figure 2-1 Safety label on the rupture disk

⚠ WARNING	
	**Risk of structural damage or personal injury!** Hazards may not be identified if safety labels are missing. ✓ Keep all safety labels intact and legible. ✓ If a label is missing or damaged, replace it immediately.

2.3. Intended use

This product (SHZVG Oil-Immersed Vacuum On-Load Tap-Changer) is designed for regulating the transformer turns ratio while the transformer is energized.

It is intended for use in electrical power systems and related installations.

When operated in accordance with the instructions, conditions, and safety warnings provided in this manual and on the product itself, it does not pose a hazard to personnel, equipment, or the environment.

This assurance applies throughout the product's entire lifecycle—from delivery and installation to operation, maintenance, and final disposal.

The following table shows the intended use of this product.

Table 2-2 Intended use

Aspect	Requirements & specifications
Equipment compatibility	Install and operate this product only with the transformer and the Motor Drive Unit (MDU) as specified in the order documentation. If this product and accessories are supplied as a complete set, verify that the serial numbers of all components match and are compatible.
Product identification	Use the nameplate data (compliance standards, model, serial number, year of manufacture) to verify specifications before installation. For the location of this nameplate, see 3.8.1 Nameplate.
Operating conditions	Operate this product strictly under the environmental and electrical conditions defined in 3.4 Technical specifications and 3.5 Operating conditions. These include ambient temperature, humidity, and voltage range.
Personnel qualification	All installation, commissioning, inspection, maintenance, and disposal work must be performed by personnel qualified as described in 2.5 Personnel qualifications. Operators must ensure: • Regular safety training regarding procedures and guidelines. • Safety instructions and emergency protocols are displayed and accessible in work area.
Operating procedures	Operators must: • Strictly follow all warnings and safety instructions as described in this manual. • Strictly follow procedures for transportation, installation, commissioning, testing, and disposal as described in this manual. • Operate this product exclusively only when in good working condition. Regularly inspect safety devices to ensure reliable operation. • Provide all necessary tools and PPE for each task as described in this manual.
Tools and equipment	Use the provided tools and equipment solely for their intended purpose and in accordance with the instructions in this manual. Do not modify or misuse the tools.
Auxiliary equipment	The use of auxiliary equipment such as an oil purification system is optional and depends on the specific application and customer requirements. Only use auxiliary equipment approved by the manufacturer.
Spare parts	Only use spare parts and consumables that have been approved by the manufacturer to ensure continued safety and functionality.
Modifications	Any modification or alteration of the product that has not been authorized by the manufacturer is strictly prohibited. Unauthorized modifications may lead to personal injury, equipment failure, or loss of warranty.

2.4. Foreseeable misuse

Any use of the product beyond the scope of intended use as described in 2.3 Intended use is considered improper and may pose significant hazards to personnel, equipment, and the environment.

Foreseeable forms of misuse include, but are not limited to:

- Operation with incompatible equipment: Using this product with transformers, Motor Drive Units (MDUs), or accessories not specified in the order documentation.
- Use outside specified environmental conditions: Operating this product in environments that exceed the permitted temperature, humidity, or other conditions specified in 3.5 Operating conditions.
- Unauthorized modifications: Making mechanical or electrical modifications to this product or its components without explicit written approval from the manufacturer.
- Bypassing safety devices: Disabling or tampering with protective relays, or warning systems integrated into this product or associated equipment.
- Improper electrical connections: Incorrect wiring or voltage application that does not comply with the connection diagrams or rated electrical values.
- Neglecting maintenance and inspection intervals: Failing to carry out the prescribed inspections and maintenance tasks, which could lead to unsafe operating conditions or premature failure.
- Inadequate qualification of personnel: Allowing untrained or unauthorized individuals to install, commission, maintain, or operate this product.
- Stepping on or placing weight on critical components: Ignoring safety labels (for example the “NO STEP” safety label on the rupture disk of the diverter switch) may result in mechanical damage or personal injury.
- Unauthorized or inappropriate changes to this product may lead to personal injury, material damage and operational faults.

2.5. Personnel qualifications

All personnel involved in the installation, commissioning, operation, and maintenance of the product must meet the qualification levels in the table below.

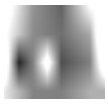
Table 2-3 Personnel qualifications

Qualification level	Applicable positions	Core competencies and requirements
Electrical Technical Personnel	• Technical Field Assistant (TFA) • Commissioning Engineer • Maintenance Technician	• Holding valid technical certifications as required by national safety regulations (e.g., Certified Electrician/ Registered Engineer) • Possessing specialized knowledge in identifying and avoiding electrical hazards (e.g., electric arc and high-voltage risks) • Demonstrating proficiency in electrical system operation and maintenance • Understanding local electrical codes and accident prevention regulations • Receiving complete training for operation in specific environments • Completing internal training on transformer installation. (TFA and Commissioning Engineers)
Trained Electrical Personnel	Operator (working under supervision)	• Receiving task-specific training from electrical technical personnel, covering: ◦ Equipment-specific hazards ◦ Safety procedures and protective measures ◦ High-voltage equipment operation • Performing work under the direct supervision of Electrical Technical Personnel
Maintenance Technician	Maintenance Technician	Holding certification in Mechanical and Electrical Safety Regulations
All positions	All personnel	Possessing fundamental knowledge of transformers and On-Load Tap-Changer systems

2.6. Personal Protective Equipment (PPE)

The following table lists the mandatory personal protective equipment during operation and maintenance to mitigate potential risks.

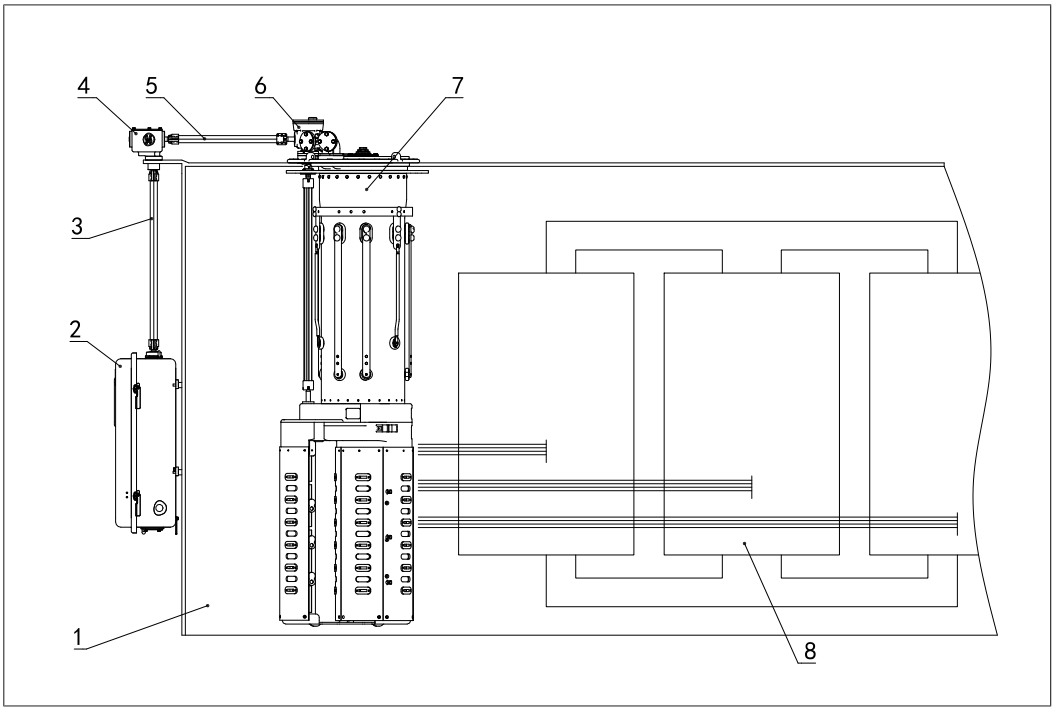
Table 2-4 Personal Protective Equipment

	Wear close-fitting workwear made of low-tear-strength material, with tight cuffs and no protruding parts, to minimize the risk of being caught by moving mechanical components.
	Wear safety shoes with puncture-resistant and slip-resistant soles.
	Use protective goggles to shield the eyes and the face from impact, dust, splashes, and high-temperature hazards.
	Wear a safety helmet to protect the head against impact.
	Use hearing protection in noisy environments to prevent hearing impairment. Certain operations of On-Load Tap-Changers, especially during switching sequences, functional tests or fault conditions, may generate impulse noise levels exceeding 85 dB(A). Repeated or prolonged exposure to such noise levels can cause permanent hearing impairment.
	Wear insulated gloves to protect your hands from mechanical, thermal and electrical hazards.

3. Product overview

3.1. Location of OLTC in transformer

The SHZVG type oil-immersed On-Load Tap-Changer is securely fixed to the transformer tank cover via a mounting flange. It is connected to the Motor Drive Unit (MDU) through the top gearbox, bevel gearbox as well as the horizontal and vertical driving shafts, enabling electric and remote tap-change operations.

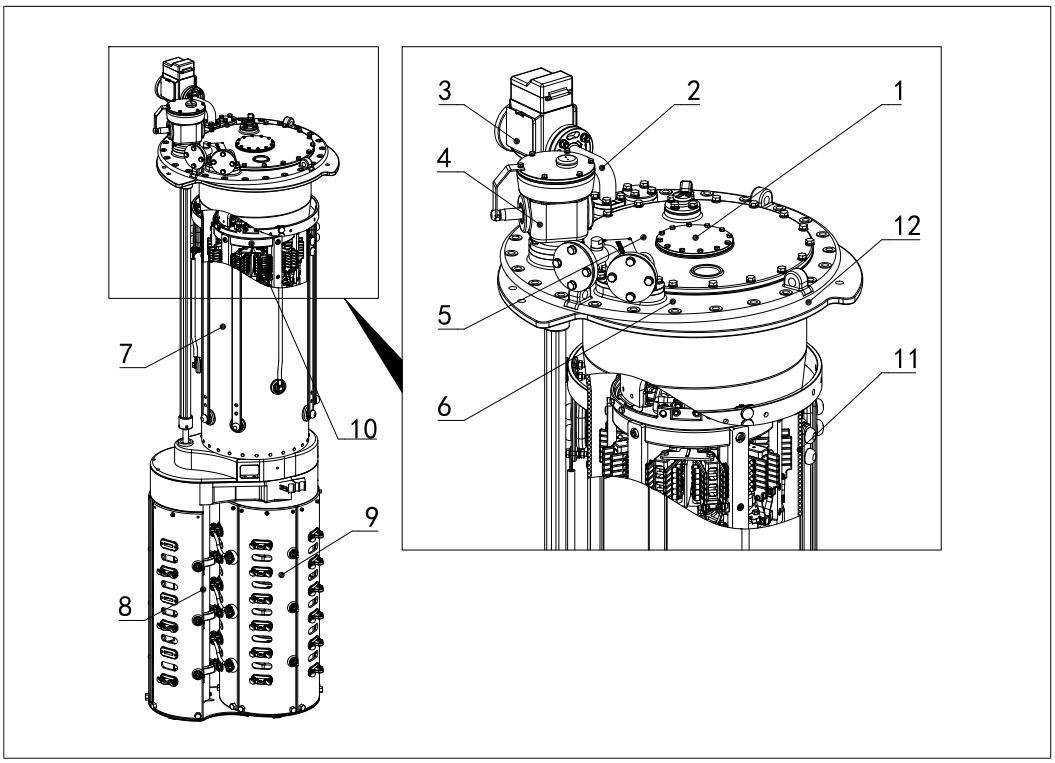


1. Transformer tank	2. Motor drive unit (MDU)
3. Vertical driving shaft	4. Bevel gearbox
5. Horizontal driving shaft	6. Top gearbox
7. OLTC main body	8. Transformer winding

Figure 3-1 OLTC in the transformer

3.2. OLTC main body

The SHZVG type oil-immersed On-Load Tap-Changer (OLTC) is a combined-type On-Load Tap-Changer, mainly consisting of a diverter switch and a tap selector.



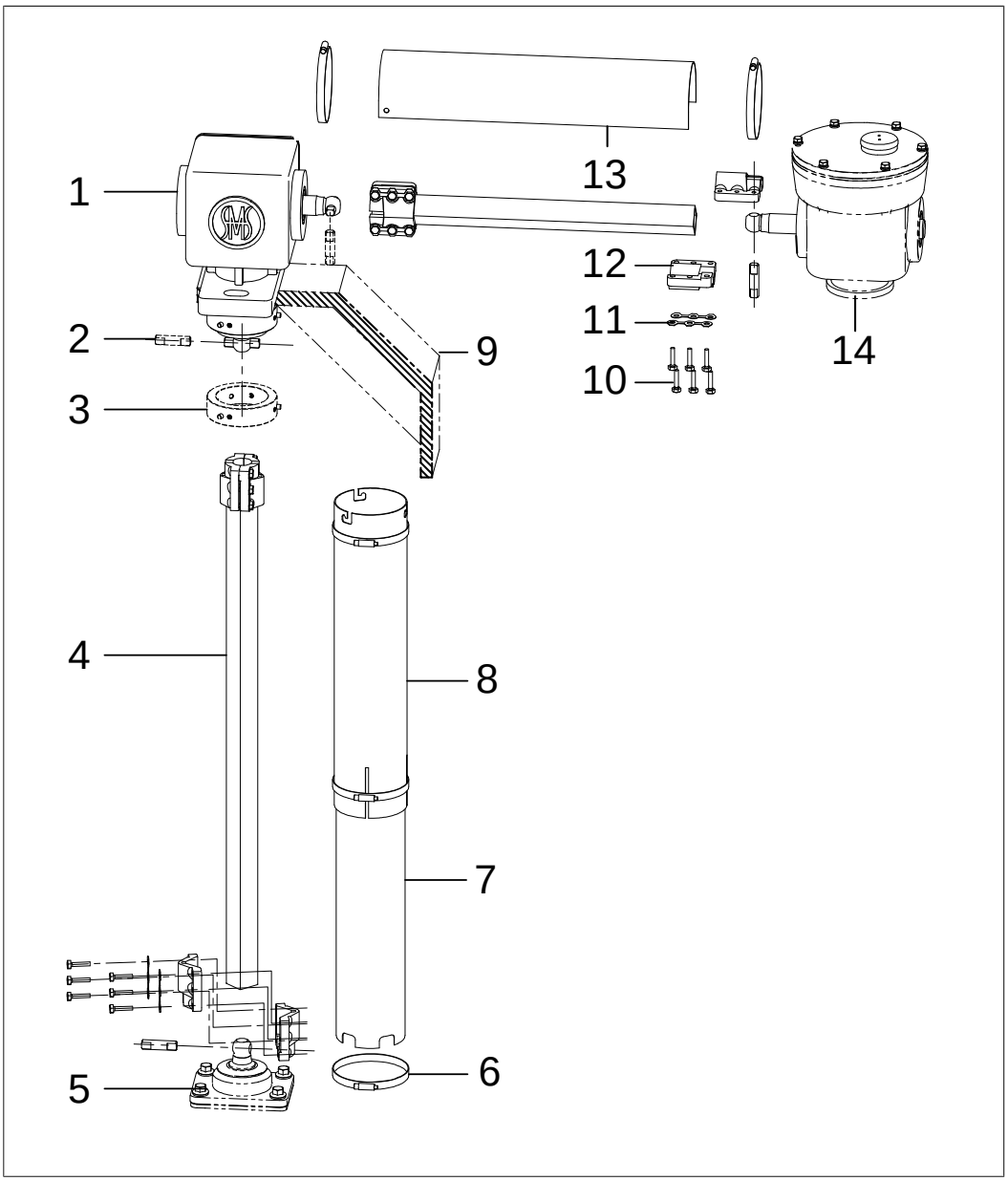
1. Rupture disk	2. Oil pipe
3. Protective relay	4. Top gearbox
5. Top cover	6. Mounting flange
7. Diverter switch	8. Change-over selector
9. Tap selector	10. Diverter switch insert
11. Oil compartment	12. Support flange

Figure 3-2 Overview of the OLTC structure

Important:
It is recommended to adopt a protective relay with gas detection signals for the vacuum OLTC.

3.3. Drive mechanism components

Drive mechanism components consist of the bevel gearbox, driving shafts, couplings and other accessories.



1. Bevel gearbox	2. Cylindrical pin	3. Bushing
4. Driving shaft	5. Motor Drive Unit (MDU)	6. Clamp
7. Vertical guard 1	8. Vertical guard 2	9. Gearbox bracket (transformer)
10. M6 screw	11. Lock washer	12. Coupling
13. Horizontal guard	14. Top gearbox	

Figure 3-3 Drive mechanism components

3.4. Technical specifications

The tap-changer complies with the standards of IEC 60214-1:2014 and GB/T 10230.1-2019.

Item	Model		SHZVG III 1300Y / SHZVG I 1300	SHZVG III 1500Y / SHZVG I 1500	SHZVG I 2000	SHZVG I 2400	SHZVG I 3000	SHZVG I 3600
1	Maximum rated through-current (A)		1300	1500	2000	2400	3000	3600
2	Rated frequency (Hz)		50/60					
3	Connection mode		Three-phase Y connection, single-phase (arbitrary)					
4	Maximum rated step voltage (V)		6000					
5	Rated step capacity (kVA)		6000		9600		14400	
6	Short-circuit withstand capability (kA)	Thermal stability (3 s)	15	20	24	30	32	40
		Dynamic stability (peak)	37.5	50	60	75	80	100
7	Maximum number of tap positions		• Change-over selector not equipped: 18 • Change-over selector equipped: 35					
8	Ground insulation level (kV)	Highest equipment voltage	72.5	126	170	252	300	363
		Rated external withstand voltage (50 Hz, 1 min)	140	230	325	460	480	510
		Rated lightning impulse withstand voltage (1.2/50 μs)	350	550	750	1050	1100	1175
9	Tap selector		It is classified into five specifications based on insulation level: B, C, D, DE and E.					
10	Mechanical lifespan		1.5 million operations					
11	Maintenance-free operation times		300,000 operations					
12	Diverter switch oil compartment	Operating pressure	0.03 Mpa					
		Sealing performance	No leakage for 24 hours under 0.1 MPa pressure					
		Overpressure protection	Explosion pressure of the rupture disk: 0.3 ± 20% MPa					
		Protective relay	Set oil flow rate: 2.5 m/s±10%					

Note: The step capacity equals to the product of the stage voltage and the load current, while the rated step capacity is the maximum allowable capacity under continuous operating conditions.

3.5. Operating conditions

The On-Load Tap-Changer (OLTC) must operate under the following conditions:

Operating conditions	Requirements
Allowable operating temperature range	-25°C to +105°C **Note:** Under emergency loading of the transformer, the maximum temperature is +115 °C.
Ambient temperature range	-25°C to +50°C
Relative humidity range	≤ 85% **⚠ WARNING**  **Explosion risk!** Condensation water may affect electrical performance and damage equipment. In extreme cases, it may even lead to an explosion. ✔ It is not allowed to install the On-Load Tap-Changer in a place with a relative humidity of over 85%.
Ground verticality deviation of the OLTC after installation on the transformer	≤ 2%
Requirements for installation location of the OLTC	No excessive dust, explosive gases or corrosive gases

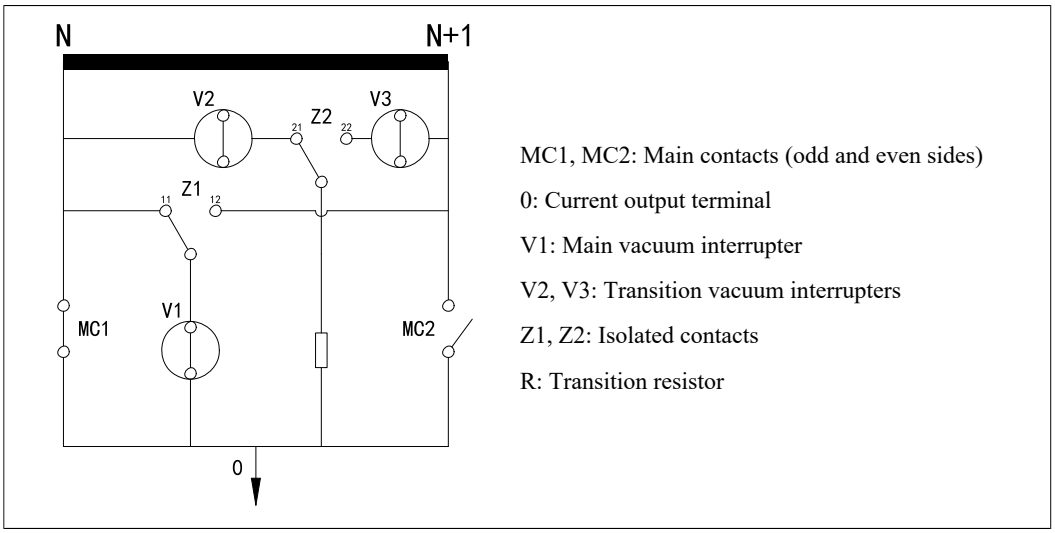
Important:
If customized solutions are required for special environment conditions, contact Huaming.

3.6. Product compatibility requirements

To ensure safe and reliable operation, the On-Load Tap-Changer (OLTC) must be correctly matched with the key components of the system. Compatibility with the transformer, protective relay, and installation ports is crucial for achieving optimal performance and avoiding damage or safety hazards.

- MDU: HM CMA7 or SHM series
- Protective relay: QJ-25 or equivalent products

3.7. Electrical topology diagram



3.8. Model description

3.8.1. Nameplate

The nameplate of the On-Load Tap-Changer is located on the top cover. The nameplate provides key identification information, including the serial number, date of manufacture, model, technical specifications, and applicable compliance standards.

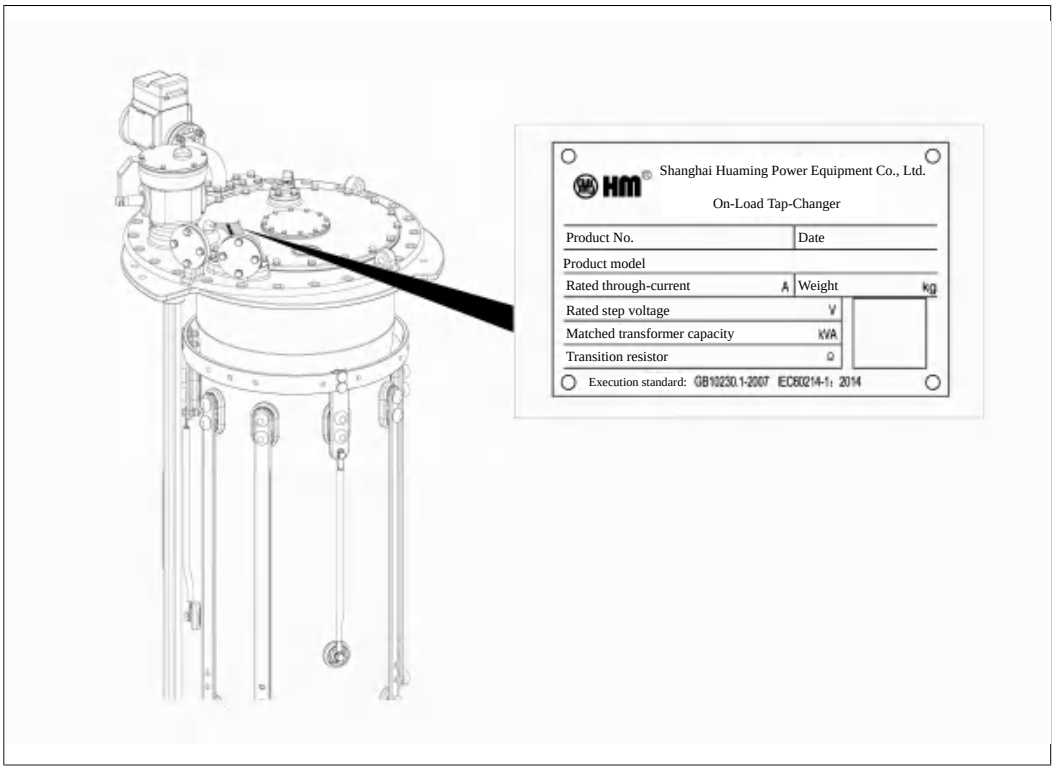


Figure 3-4 Nameplate of the On-Load Tap-Changer

3.8.2. Model number structure

The model number of the On-Load Tap-Changer reflects its key specification parameters, including the number of phases, maximum rated through-current, highest voltage for the equipment, tap selector insulation class, and connection mode.

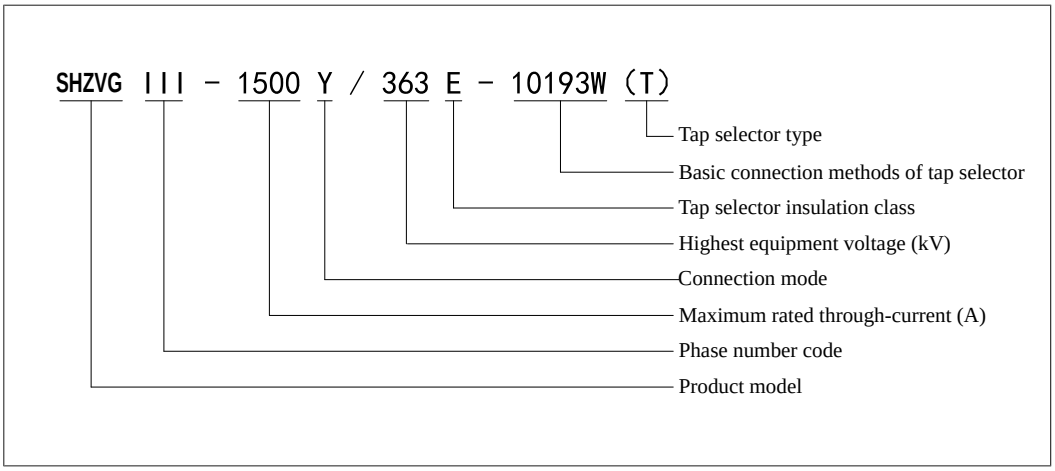


Figure 3-5 Model number description

3.8.3. Basic connection types

Various tap selector configurations are available to accommodate different voltage regulation ranges and winding connection modes. The tap selector type is determined by the number of

contacts, operating positions, intermediate positions, and whether it is equipped with a change-over selector.

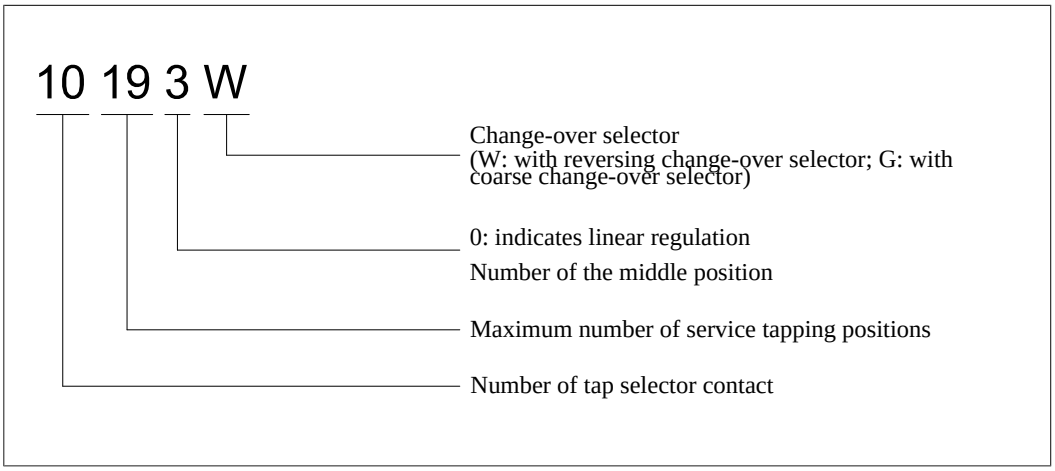


Figure 3-6 Description of connection type

The following examples illustrate how the numbering indicates the basic connection type:

- 10090: Indicates a tap selector with 10 contacts, 9 operating positions, and without change-over selector.
- 10191W: Indicates a tap selector with 10 contacts, 19 operating positions, 1 intermediate position, and with a reversing change-over selector (W).
- 10191G: Indicates a tap selector with 10 contacts, 19 operating positions, 1 intermediate position, and with a coarse change-over selector (G).

3.9. Tap selector type

The types of tap selectors are represented by T and L respectively.

T represents drum type tap selectors. They can be used when all the following three conditions are met:

- The number of distributed contacts is not above 14.
- The three-phase rated current is not above 1300 A.
- The insulation level is not above D.

L represents cage type tap selectors. They can be used when any of the following conditions are met:

- The number of distributed contacts is above 14.
- The three-phase rated current is above 1300 A.
- The insulation level is above D.

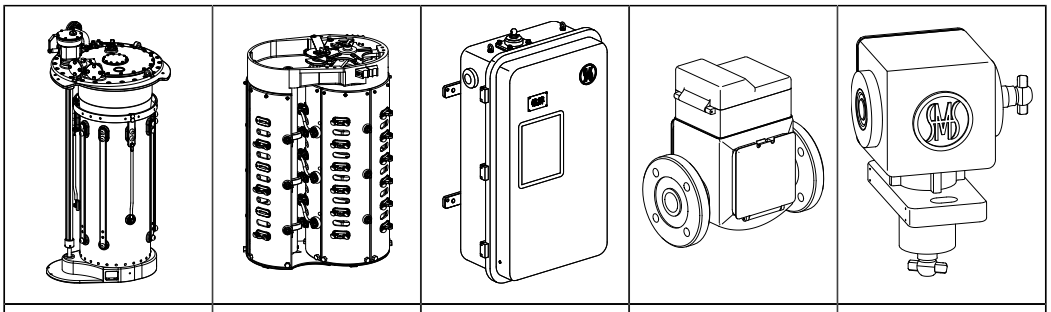
4. Packaging, transportation, and storage

4.1. Supplied components

The On-Load Tap-Changer is delivered as a complete set, including the following components:

1. Diverter switch
2. Tap selector
3. Motor drive unit (MDU)
4. Protective relay
5. Bevel gearbox
6. Driving shaft, coupling and other accessories
7. Special tools and accessories for OLTC assembly
8. Customer-required special accessories (if any)

Components 1 to 5 are illustrated as follows (Figure 4-1).



1. Diverter switch	2. Tap selector	3. Motor drive unit (MDU)	4. Protective relay	5. Bevel gearbox

Figure 4-1 Supply components (partial)

Important:
The actual supplied components shall be based on the packing list provided with the goods.

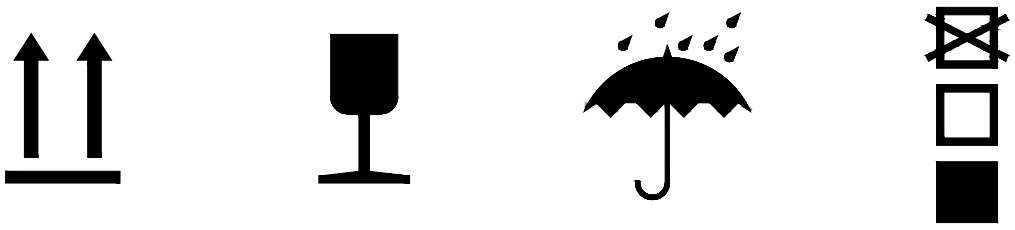
4.2. Transportation

⚠ WARNING	
	**Risk of Toppling!** A falling or toppling package may cause severe personal injury and equipment damage. ✓ Only trained and designated personnel may select slings and secure loads. ✓ Do not stand under a suspended load. ✓ Use transport and lifting equipment with a load capacity greater than 1,000 kg.

⚠ CAUTION	
	**Risk of improper transport!** Improper handling may lead to product damage, functional failure, or secondary safety incidents. ✓ Transport and lifting must be carried out by qualified personnel. ✓ Only use the lifting and transport equipment with a rated load capacity not below 1,000 kg. ✓ Only use the designated lifting points marked on the package. ✓ Secure the packaging case firmly during the transport and lifting process. Prevent vibration, impact, tilting, falling, or collision to avoid product damage. ✓ If the package has dropped or sustained a severe impact, check whether OLTC is damaged. If necessary, contact Huaming for inspection and repair.

The factory packaging is suitable for multiple transport methods. Always follow these instructions during transport:

- Always position the package according to the mark of the center of gravity.
- During storage, stack packages only when the load on the top surface does not exceed 500 kg/m².
- Always follow the markings on the package during transport (as shown in the figure below).



This side up | **Handle with care** | **Protect from rain and moisture** | **Stacking layer limit**

Gross weight (G.W.) | **Net weight (N.W.)** | **Kilogram (KG)**

4.2.1. Receiving inspection

Upon receiving the packages, inspect each package and verify that the packaging is intact and undamaged. If any damage is found (for example dents, tears, moisture), perform these steps:

1. Refuse delivery and immediately notify the carrier.
2. Take photos of the damaged packaging and contents if possible.
3. If the issue cannot be resolved with the carrier, contact Huaming After-Sales Service in writing.

4.2.2. Transshipment

After the receiving inspection, you may need to transship the packages to another location.

1. Unload and handle the OLTC in accordance with the instructions on the packaging.
2. Use the designated lifting points for hoisting or follow the forklift markings when transporting with a forklift.

> **Important:**
> Select an appropriate forklift and/or crane based on the dimensions and gross weight of the crate or package.

4.2.3. Unpacking and inspection

To unpack and inspect the packages, perform these steps:

1. Before unpacking, move the package to the installation site.

> **Important:** Take care not to damage the original packaging during unpacking and inspection.

2. Inspect each package against the packing list and Confirmation of Acceptance form. Verify the following:
   - The quantity of items matches the packing list.
   - The product specifications match the order documentation.

> **Important:**
> - Missing components may affect subsequent operation. If any item or accessory does not match the packing list, contact Huaming immediately.
> - If the package has been dropped or subjected to impact after delivery, assume potential damage. Thoroughly inspect the OLTC. If necessary, contact Huaming to arrange inspection and/or repair by qualified personnel.

3. Before installation, store all components in a dry location and keep OLTC sealed in its original packaging.

4.2.4. Lifting

⚠ WARNING	
	**The lifting process involves risks of personal injury and equipment damage!** Improper lifting may lead to load falling or instability, causing serious personal injury or equipment damage. ✓ Use the lifting equipment with a rated load capacity not below 1,000 kg. ✓ According to the regulations, always use at least two horizontal lifting points or all the designated lifting points. ✓ Avoid sudden movement or shaking when lifting or lowering the load. ✓ Never stand or walk under a suspended load.

Use all the designated lifting points on the mounting flange to vertically lift the OLTC.

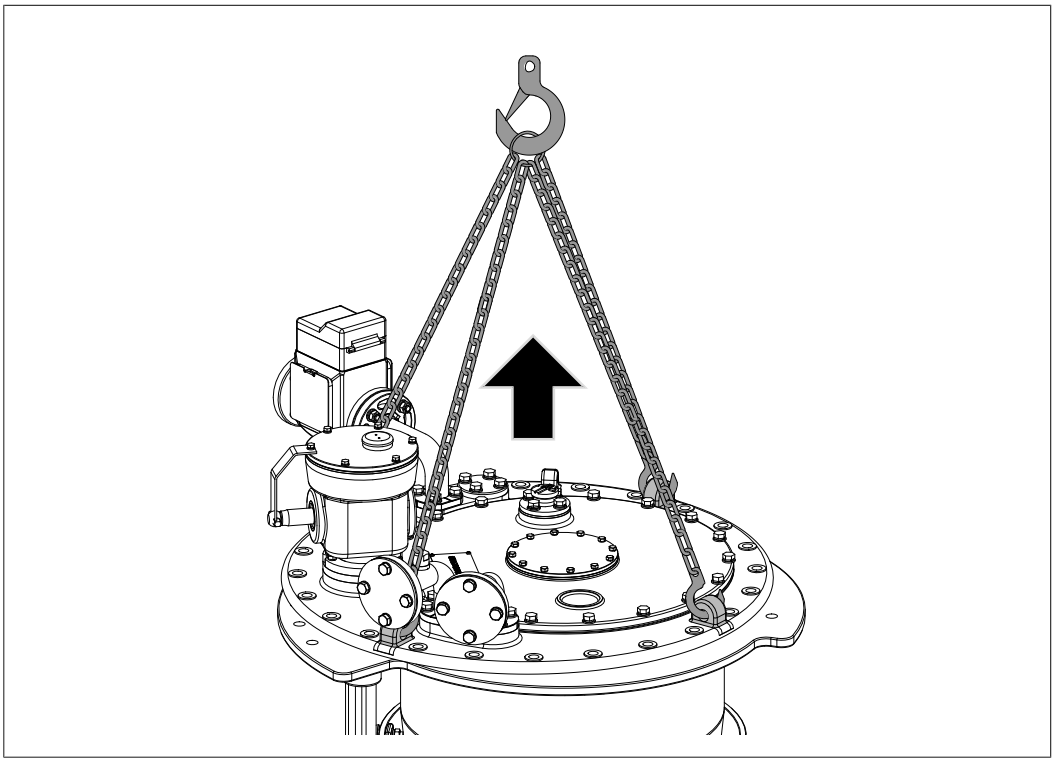


Figure 4-2 Lift the OLTC

4.3. Storage

Specially-sealed units can be stored outdoors if the following conditions are met:

- The ambient temperature is between -25°C and +50°C.
- The storage area is away from flammable, explosive, or corrosive gases.
- Protect the OLTC against moisture, dust, rodents, and insects.
- Provide the corresponding protection, to protect the OLTC against moisture, dust accumulation, rodents and insects.
- Regularly check the stored equipment for any abnormalities.
- Regularly replace desiccants during long-term storage and ensure the packaging remains sealed.

5. Installation of the OLTC on the transformer

5.1. Safety

⚠ WARNING



Risk of injury from unstable placement!

- ✓ Placing components (e.g., top cover, OLTC mounting flange) that are removed from the OLTC on uneven or unstable surfaces may cause them to tilt or fall, leading to injury.
- ✓ Always place components on a level, stable, and clean surface.

NOTICE

Risk of equipment damage from dropped fasteners!
Dropped fasteners (e.g., bolts, nuts) can contaminate the insulating oil, damage internal components, and lead to malfunction or abnormal operation.

- ✓ Store all fasteners securely.
- ✓ Take precautions to prevent fasteners from falling into the oil compartment.

NOTICE

Risk of sealing failure!
Improper sealing may occur if the component's sealing ring or sealing surfaces are damaged, potentially leading to equipment failure or leakage.

- ✓ Preserve the sealing rings during handling and installation.
- ✓ Avoid damaging the sealing surfaces of the top cover and the flanges.

5.2. Preparations

Important:
Each OLTC is matched to a specific transformer.

Carefully inspect the OLTC and accessories before installation.

Verify the OLTC specifications match the transformer requirements.

Before installing the OLTC on the transformer, get the following items prepared:

- The diverter switch and its accessory box
- The tap selector and its accessory box
- The transformer mounting flange
- A temporary support structure for temporarily supporting the OLTC during installation
- Tools that need to be prepared by the customer (see 5.2.2 List of Tools)

5.2.1. Transformer mounting flange

The OLTC is mounted to the transformer cover via the transformer mounting flange. This flange is not a part of the OLTC delivery and needs to be custom-made by the customer according to the drawing provided by Huaming.

The making of this flange must meet the following requirements (see Figure 5-1):

- The transformer mounting flange must match the sealing surface of the OLTC mounting flange
- The double-ended studs (M12, maximum length 45mm) must be precisely positioned.

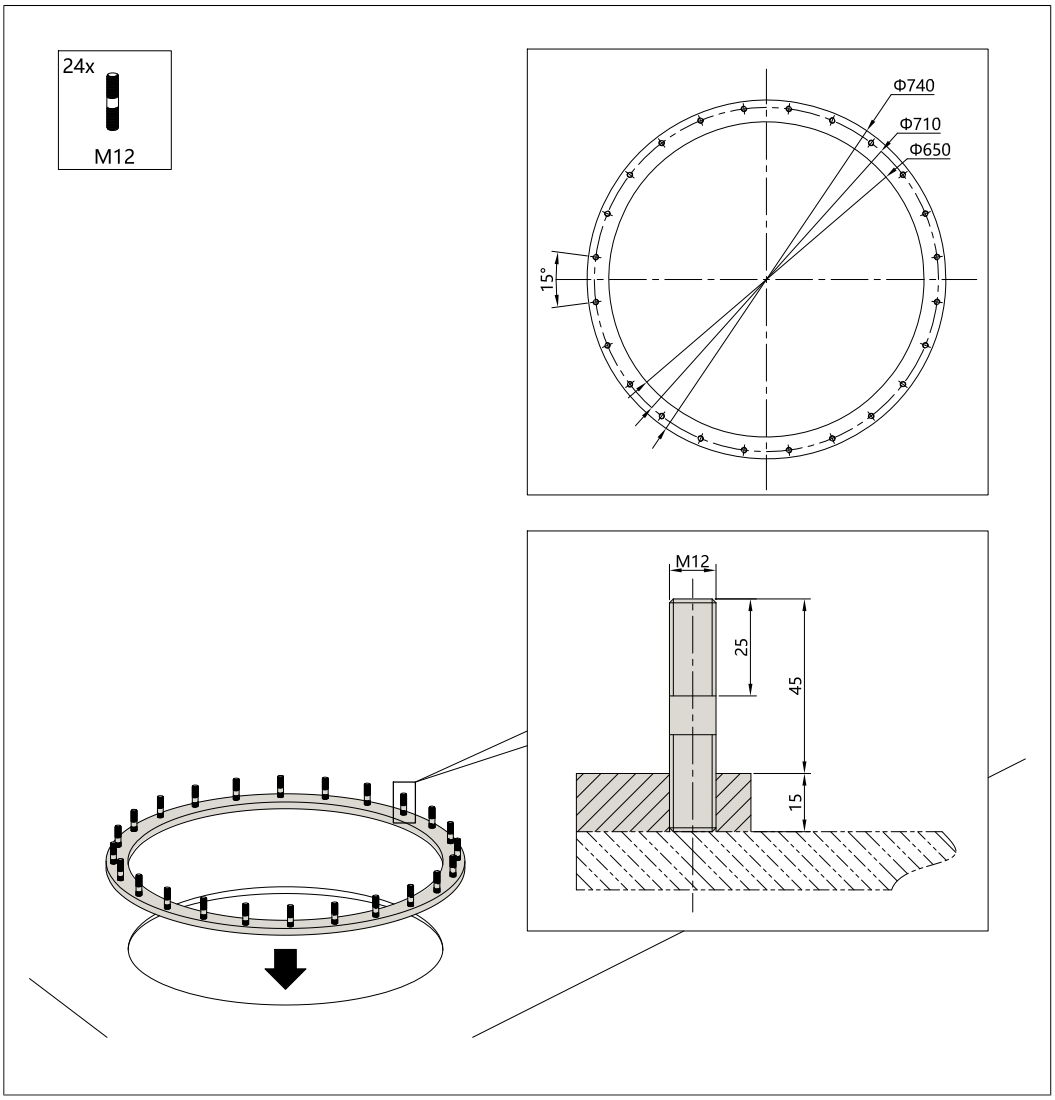


Figure 5-1 Transformer mounting flange

5.2.2. List of Tools

Tools required for the entire installation process:

- Lifting equipment with a rated load capacity not below 1,000 kg
- Special lifting tools, such as lifting rings
- 5 mm hex key
- 10 mm hex key
- 10 mm open-end wrench/socket wrench
- 13 mm open-end wrench/socket wrench
- 17 mm open-end wrench/socket wrench
- 19 mm open-end wrench/socket wrench
- 24 mm open-end wrench/socket wrench

5.3. Install the On-Load Tap-Changer (OLTC) on a bell-type transformer

5.3.1. Overview

Installation of the OLTC on the transformer includes the following steps:

No.	Step	Reference
1	Remove the top cover and pull out the diverter switch insert.	5.3.2 Remove the top cover and pull out the diverter switch insert.
2	Remove the OLTC mounting flange.	5.3.3 Remove the OLTC mounting flange.
3	Assemble the oil compartment and tap selector.	5.3.4 Assemble the oil compartment and tap selector.
4	Install the OLTC into the bell-type transformer.	5.3.5 Install the OLTC into the bell-type transformer.
5	Install the bell-type transformer tank cover and OLTC mounting flange.	5.3.6 Install the bell-type transformer tank cover and OLTC mounting flange.
6	Install the diverter switch insert.	5.3.7 Install the diverter switch insert.
7	Install the top cover.	5.3.8 Install the top cover.

5.3.2. Remove top cover and lift out diverter switch insert

Perform the following steps to remove the top cover and lift the diverter switch insert out from the oil compartment:

1. Check that the limit plate of the OLTC top gearbox is fixed as required in the figure below.

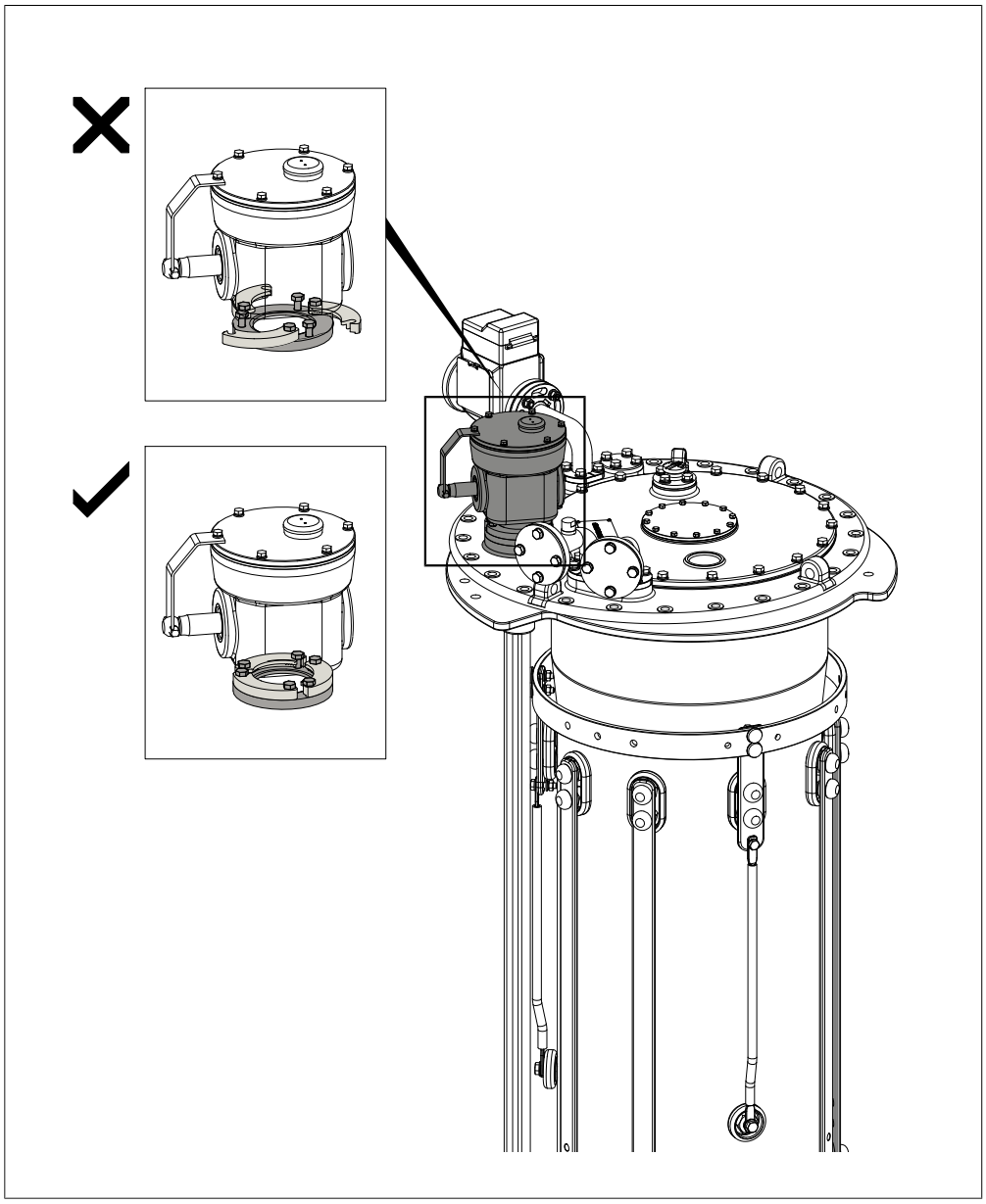


Figure 5-2 Fix the top gearbox limit plate

2. Use a 13 mm open-end/socket wrench to remove 18 sets of M8 bolts, each set with spring washer x1 and flat washer x1, and remove the top cover bolts from the OLTC mounting flange.

Notice: Properly store all fasteners. Prevent fasteners from falling into the oil compartment.

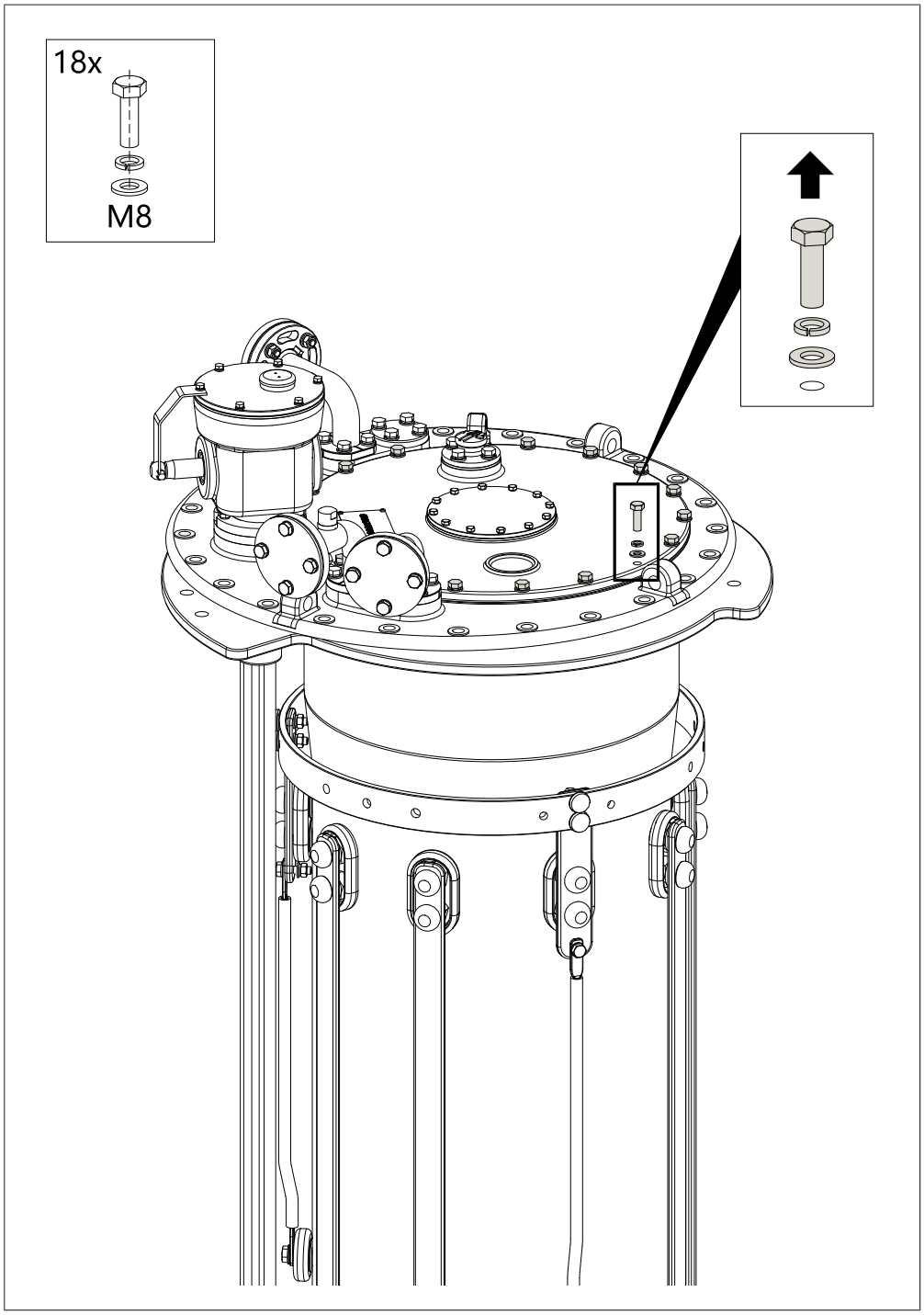


Figure 5-3 Remove the top cover bolts

3. Remove the OLTC top cover.

Notice: Place the top cover on a level, stable, and clean surface. Keep the top cover sealing ring intact and clean.

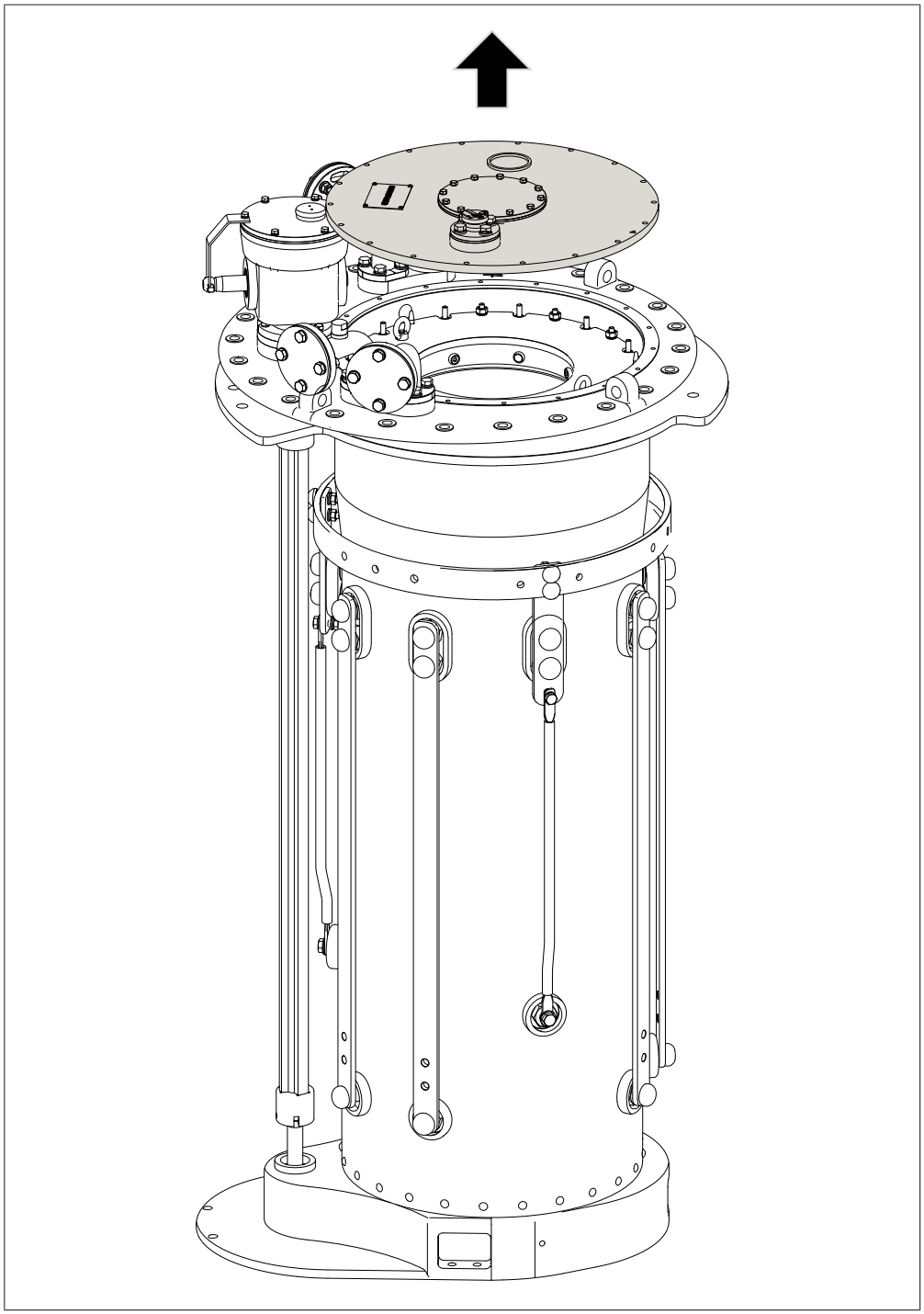


Figure 5-4 Remove the top cover

4. Use a 13 mm open-end/socket wrench to remove 8 sets of M8 nuts, each set with belleville washer x4, from the areas of the OLTC mounting flange that are not painted red.

Notice: Properly store all fasteners. Prevent fasteners from falling into the oil compartment.

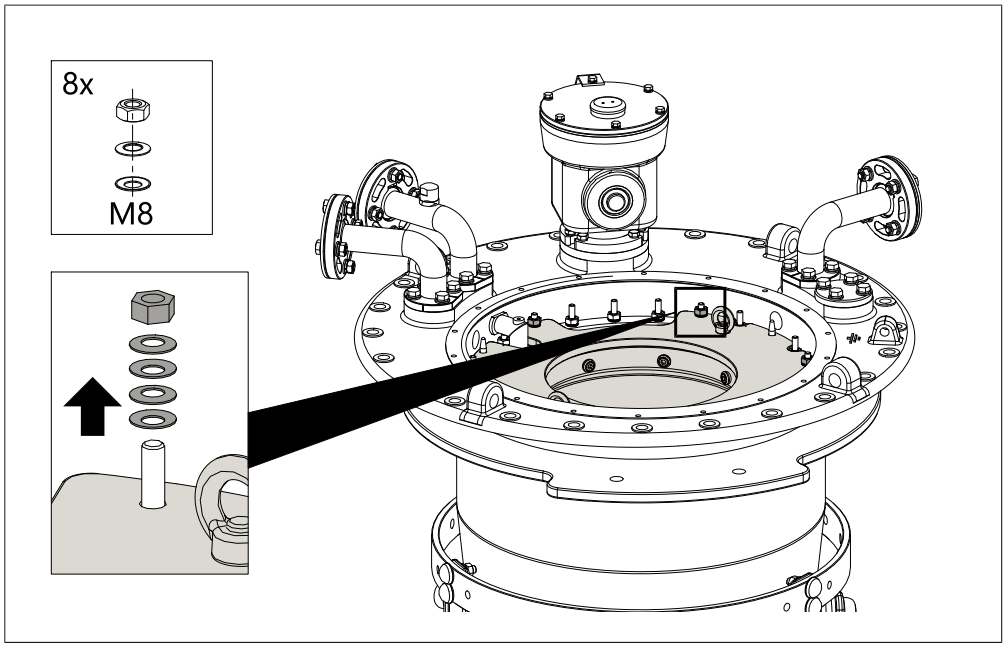


Figure 5-5 Remove the nuts from the OLTC mounting flange

5. Carefully lift the diverter switch insert vertically out from the oil compartment using lifting equipment with a rated load capacity of no less than 1,000 kg.

NOTICE

Risk of equipment damage
Improper handling of the diverter switch insert may cause component damage, equipment fault, and operational failure.
✓ Do not rotate the diverter switch insert until it is completely installed.

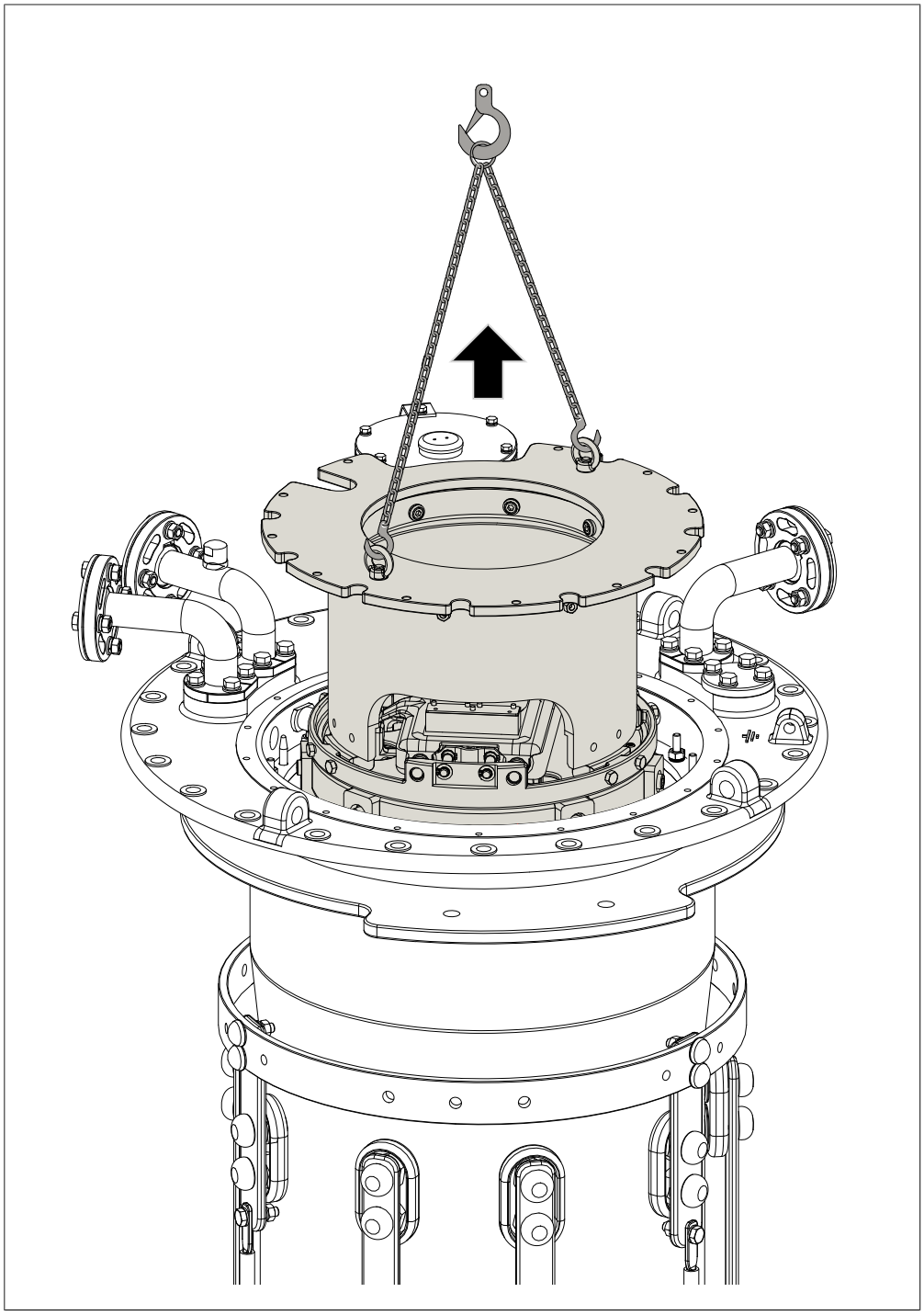


Figure 5-6 Lift the diverter switch insert out from the oil compartment

6. Place the diverter switch insert on a level, stable, and clean surface.

Notice: Use suitable supports or padding to make sure that the driving shaft at bottom of the diverter switch insert does not contact the ground.

7. Remove the oil suction pipe from the OLTC mounting flange.

Notice: Properly store the oil suction pipe. Prevent it from falling into the oil compartment.

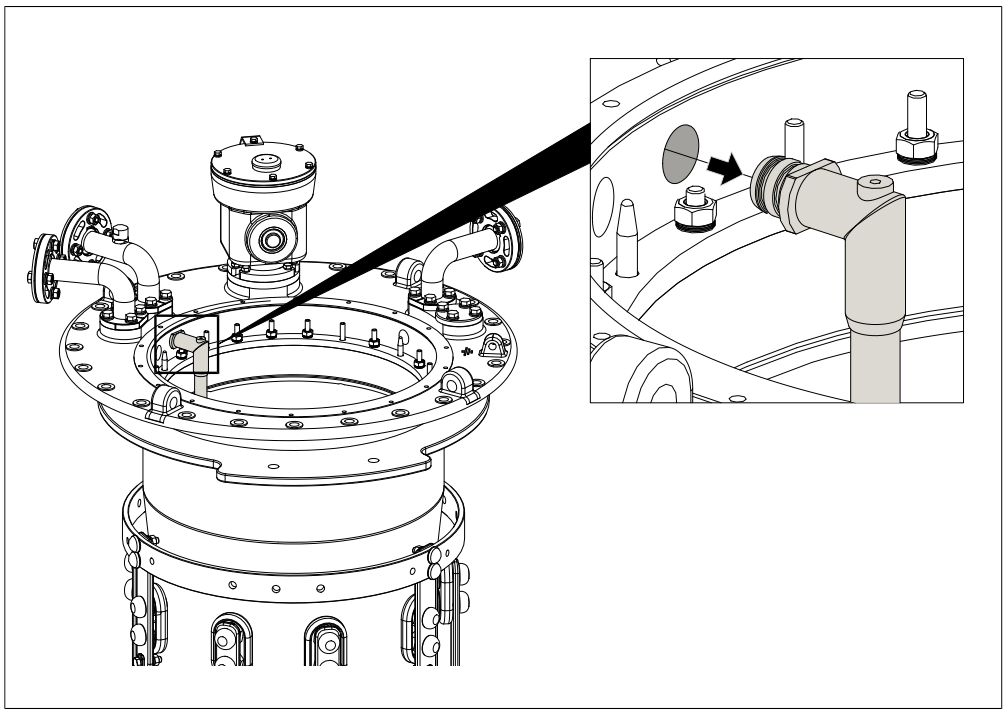


Figure 5-7 Remove the oil suction pipe from the OLTC mounting flange

5.3.3. Remove OLTC mounting flange

Perform the following steps to remove the OLTC mounting flange from the diverter switch:

1. Use a 13 mm open-end/socket wrench to remove 13 sets of M8 nuts, each set with belleville washer x4.

Notice: Properly store all fasteners. Prevent fasteners from falling into the oil compartment.

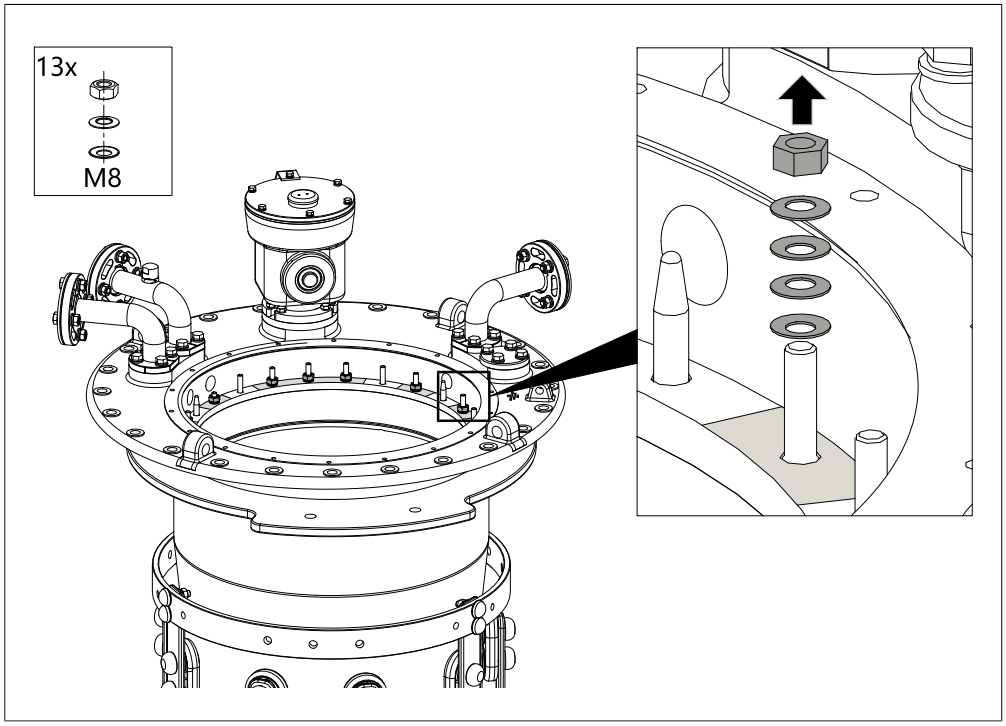


Figure 5-8 Remove the nuts on the OLTC mounting flange

2. Carefully lift the mounting flange off the support flange.

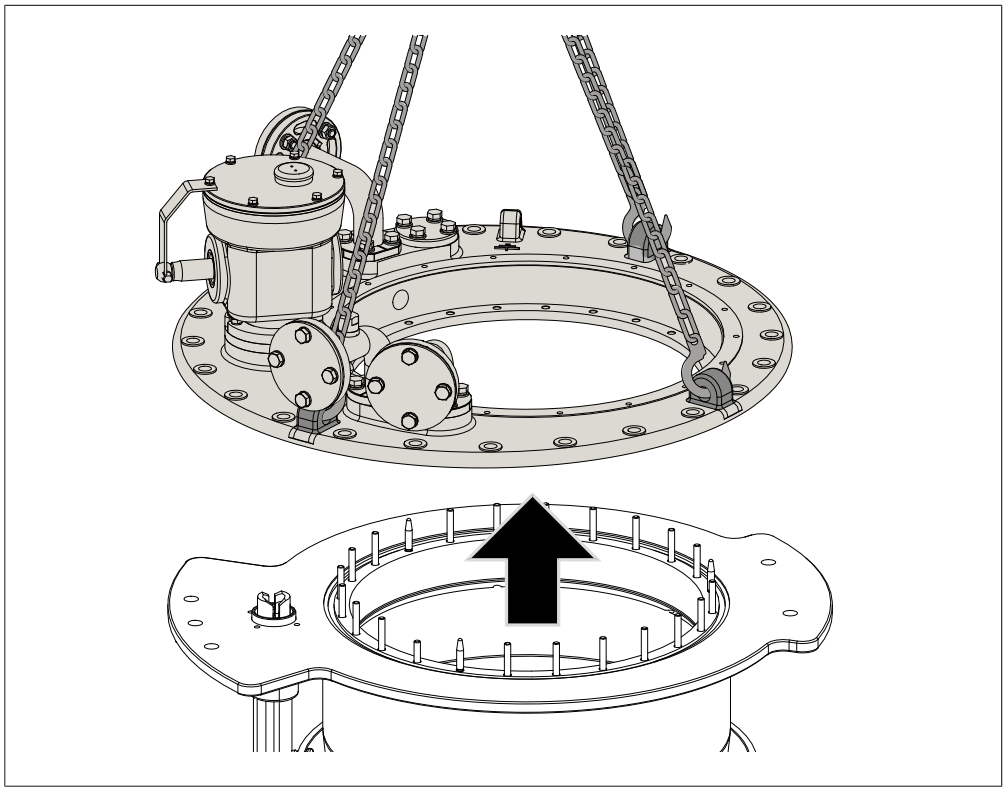


Figure 5-9 Diagram of lifting off the mounting flange

3. Place the OLTC mounting flange on a level, stable, and clean surface.

5.3.4. Assemble oil compartment and tap selector

Perform the following steps to assemble the oil compartment and the tap selector:

1. Place the tap selector on a level surface.
2. Take 7 sets of M12 bolt fasteners from the accessory box and set them aside.
3. Use a 19 mm open-end/socket wrench to remove the M12 bolt fasteners and remove the locating plate of the tap selector.

Notice: After removing the locating plate, do not rotate the tap selector.

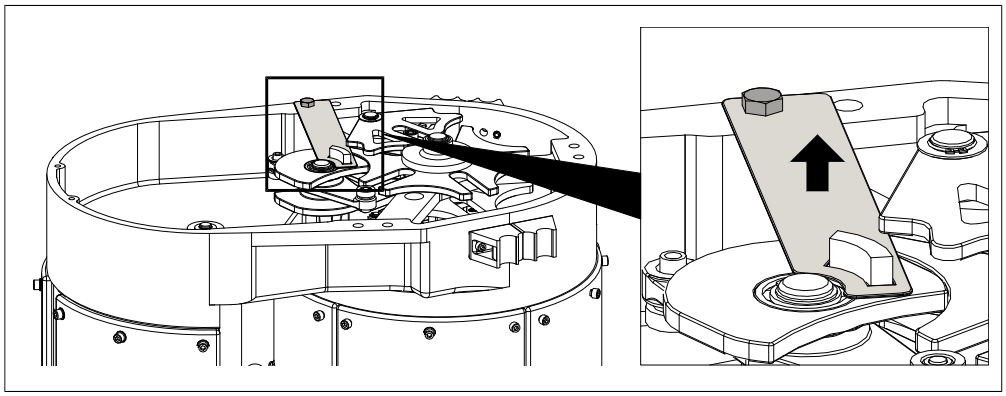


Figure 5-10 Remove the locating pin from the tap selector

4. Use a 10 mm open-end/socket wrench to remove the M6 bolts and remove the locating plate of the oil compartment.

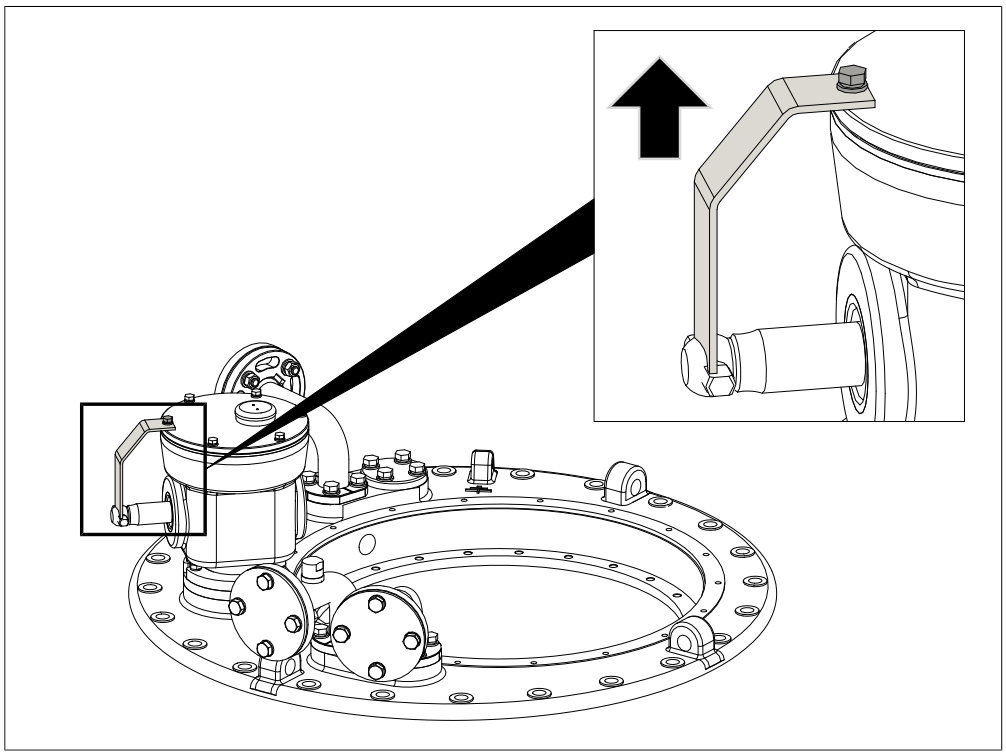


Figure 5-11 Remove the locating plate of the oil compartment

5. Perform the following steps to install the oil compartment onto the tap selector:

a. Lift the oil compartment of the diverter switch by the special lifting lugs and position it above the tap selector.

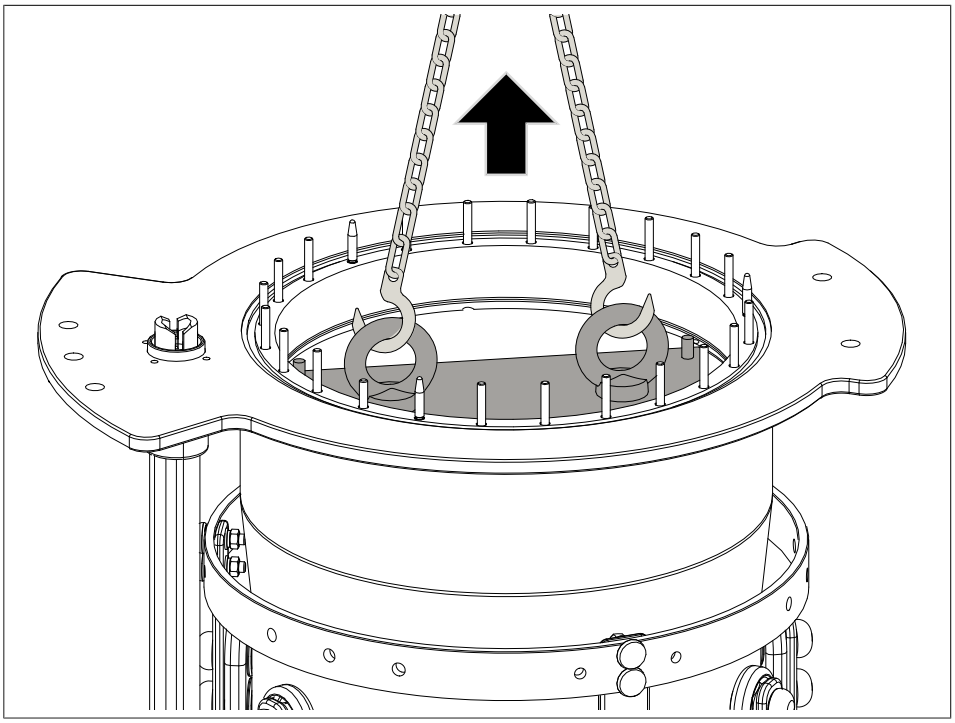


Figure 5-12 Lift up the oil compartment

b. Align the upper and lower coupling pieces.

Notice: Ensure that the connecting lugs of the coupling pieces are staggered to avoid colliding.

Notice: Keep the oil compartment vertical and prevent it from rotating.

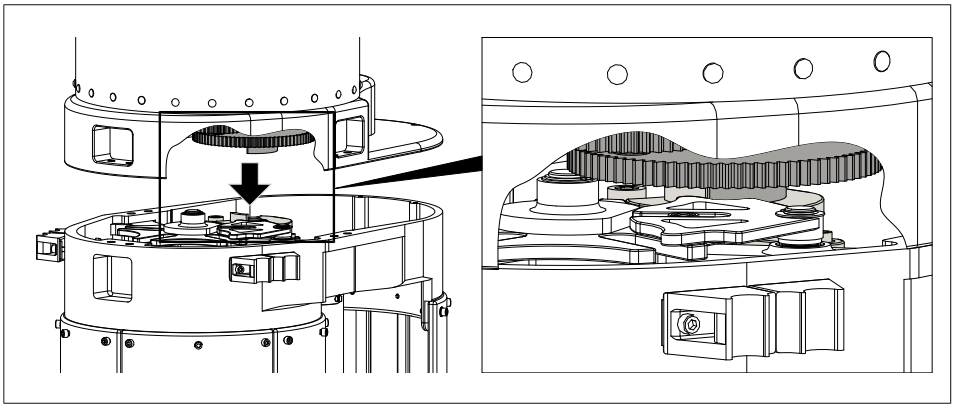


Figure 5-13 Align the coupling pieces

c. Align the mounting holes of the oil compartment with those of the tap selector.

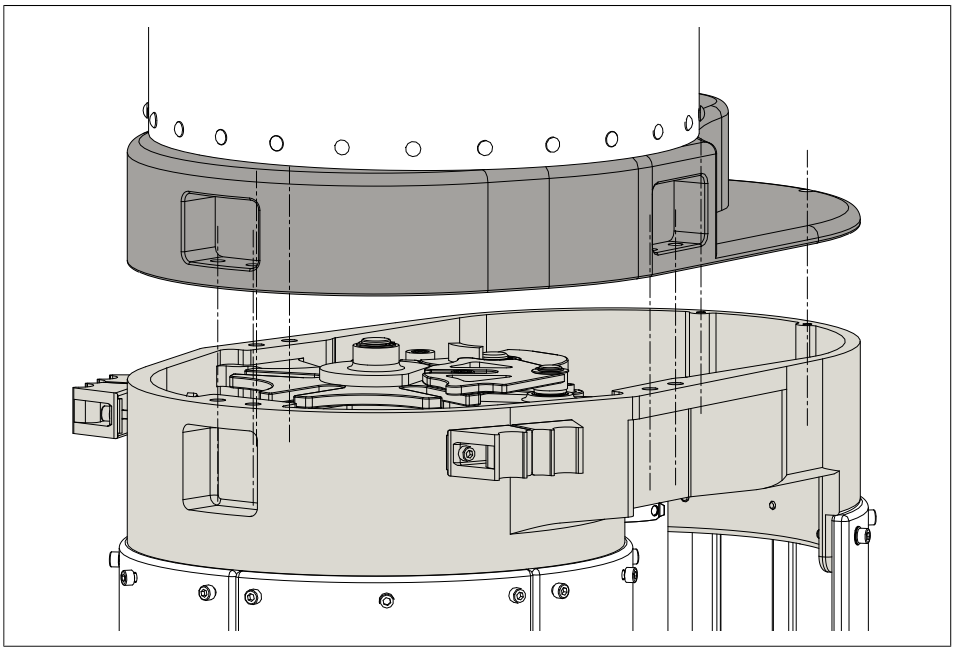


Figure 5-14 Align the mounting holes

d. Carefully lower the oil compartment onto the tap selector.

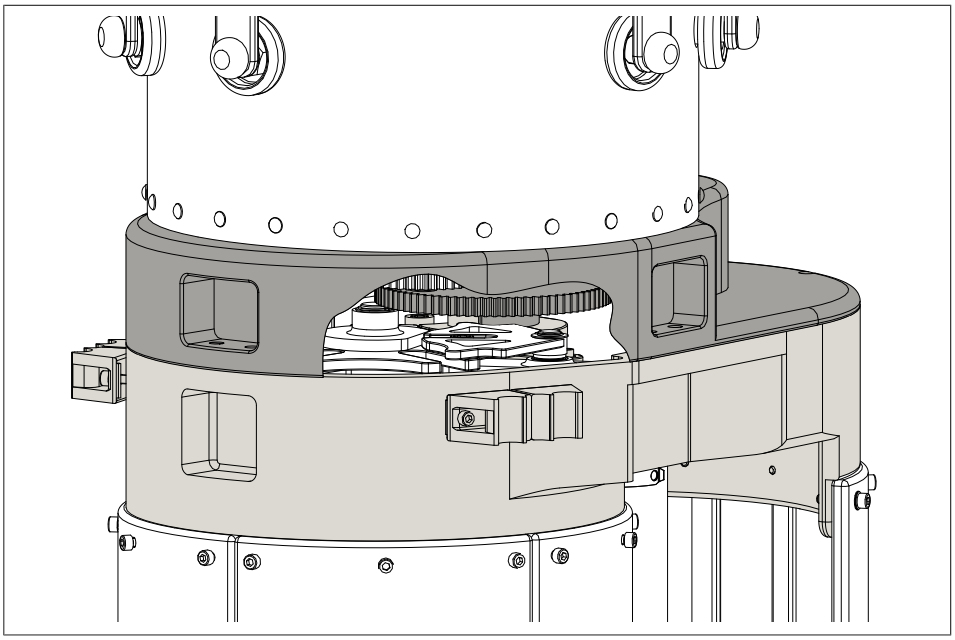


Figure 5-15 Lower the oil compartment onto the tap selector

e. Use a 19 mm open-end/socket wrench to install 8 sets of M12 bolt fasteners, each set with spring washer x1 and flat washer x1.

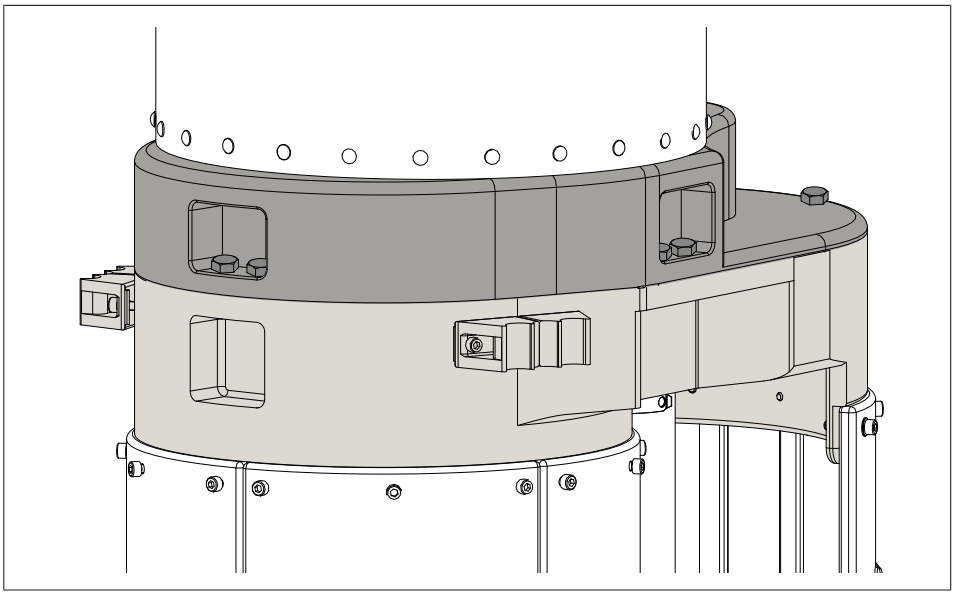


Figure 5-16 Install the oil compartment onto the tap selector

6. Perform the following steps to install the numbered leads between the tap selector and the oil compartment:

   a. Take the leads (if any), M10 bolt fasteners, and screening caps from the diverter switch accessory box.

   b. Connect the corresponding leads to the tap selector and the oil compartment respectively.

   c. Use a 17 mm open-end/socket wrench to install M10 bolt fasteners, each set with spring washer x1, flat washer x2, and screening cap x2, for connecting the leads to the oil compartment.

d. Use a 17 mm open-end/socket wrench to install M10 bolt fasteners, each set with spring washer x1, flat washer x2, concave washer x1, and screening cap x2, for connecting the leads to the tap selector.

Important:

- To ensure correct installation, strictly follow the numbers marked on each lead and the oil compartment.
- Make sure that the leads are arranged flat.
- When connecting the leads between the tap selector and the diverter switch, be careful not to damage the insulation layer of the leads.

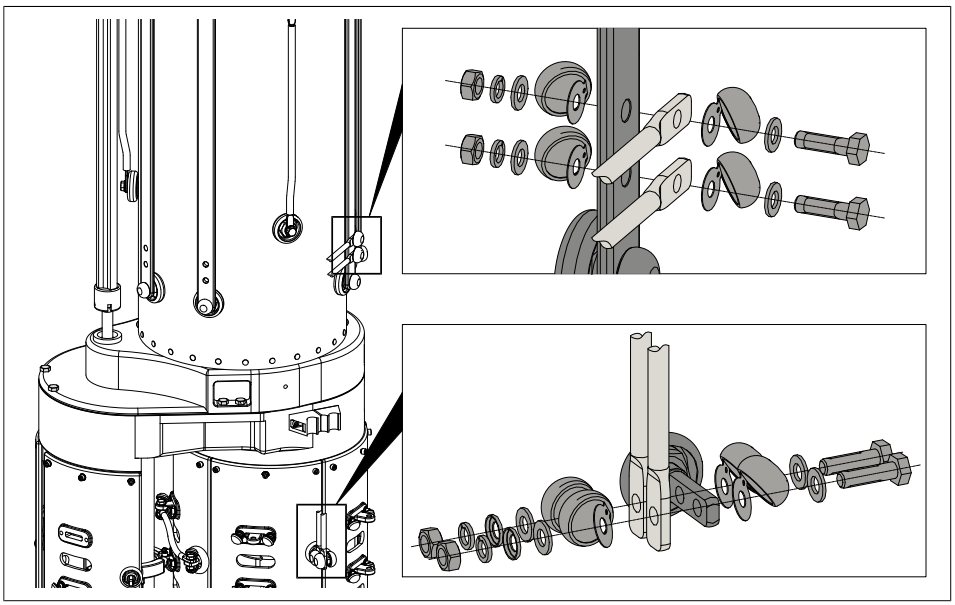
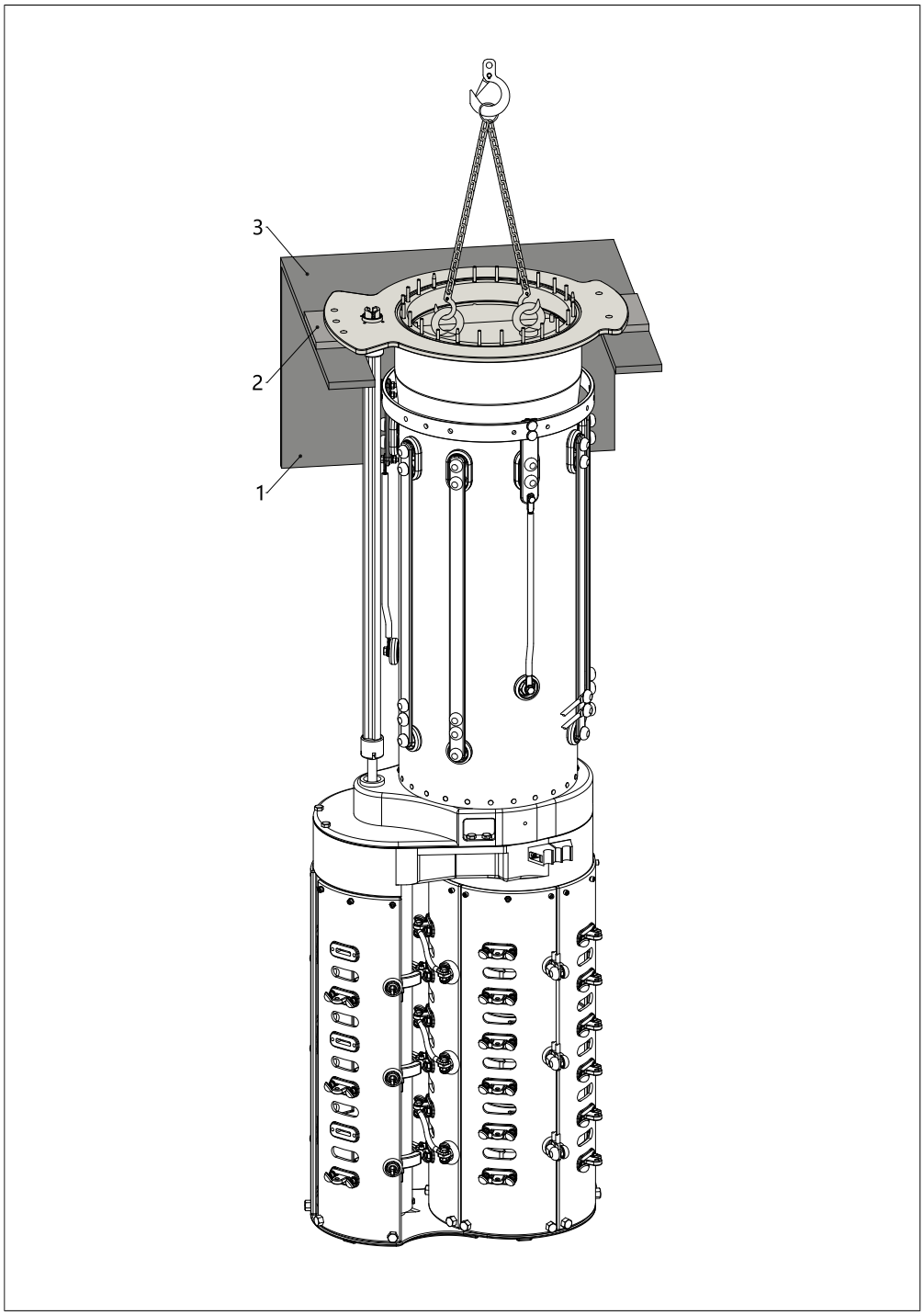


Figure 5-17 Connect the numbered leads

5.3.5. Install OLTC into bell-type transformer

Install the assembled OLTC (consisting of the oil compartment and the tap selector) onto the bell-type transformer as follows:

1. Lift the OLTC and carefully place it on the support structure. Use temporary shims to adjust its height to the final mounting height (raised by approximately 5-20 mm).



1. Support structure	2. Temporary shim	3. Support flange

Figure 5-18 OLTC placed on temporary support

2. After checking that the OLTC reaches the final mounting height, pass bolts through the mounting holes of the support flange to fix it to the temporary support structure, so as to prevent it from moving.
3. Use a 17 mm open-end/socket wrench to install M10 bolt fasteners, each set with spring washer x1, flat washer x2, and screening cap x2. Install the transformer regulating winding leads as shown in the figure.

Notice: Screening caps must be installed for OLTCs of 35 kV and above.

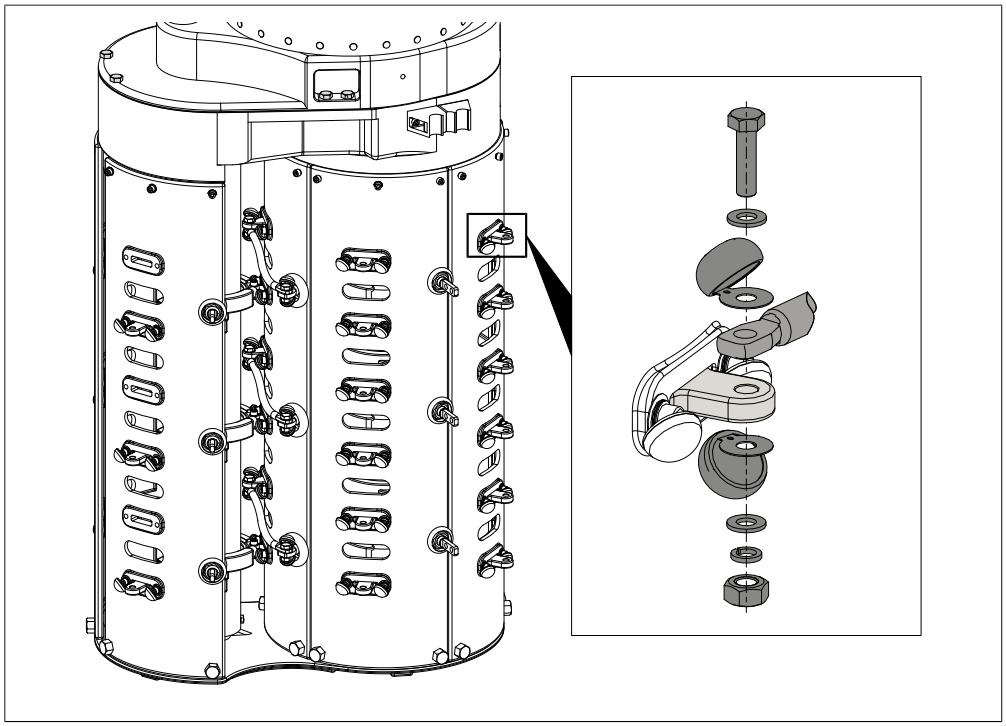


Figure 5-19 Connect the tap selector terminal to the transformer regulation winding

4. Check the lead tension to ensure that the OLTC is not under stress.

Important:

- The tap selector must not be subjected to the pulling force or stress from the leads. Improper lead routing or excessive pulling force may cause the components to deform and result in faults.
- Route the transformer winding leads out from both sides to avoid applying unbalanced force to the tap selector.

5. Remove the temporary shims.

5.3.6. Install bell-type transformer tank cover and OLTC mounting flange

Perform the following steps to install the bell-type transformer tank cover onto the OLTC support flange:

1. Clean the sealing surface of the OLTC support flange. Install the sealing ring onto the support flange.

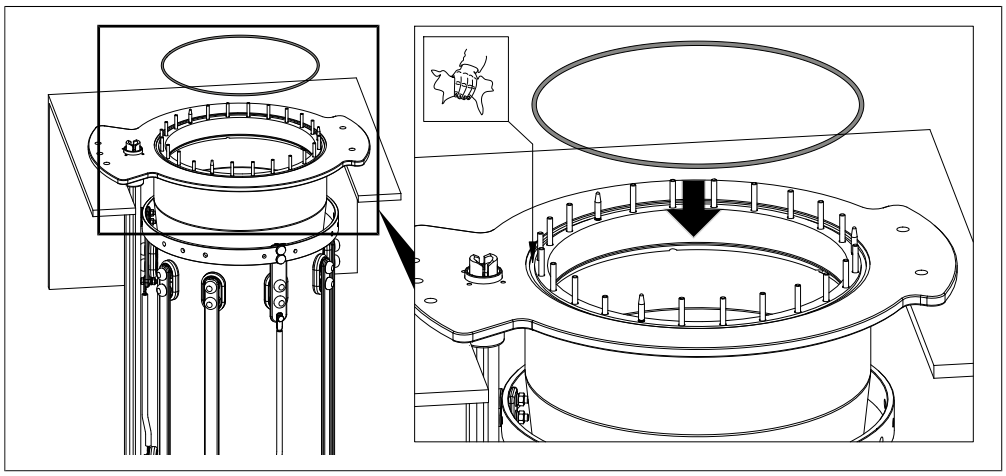


Figure 5-20 Sealing ring of the support flange

2. Lift the bell-type transformer tank cover above main body of the transformer, and securely assemble it onto the transformer.
3. Clean the sealing surfaces of the OLTC mounting flange and the transformer mounting flange.

4. Place the sealing ring on the transformer mounting flange.

Notice: To avoid oil leakage and/or equipment fault, make sure that the sealing ring is intact without damage.

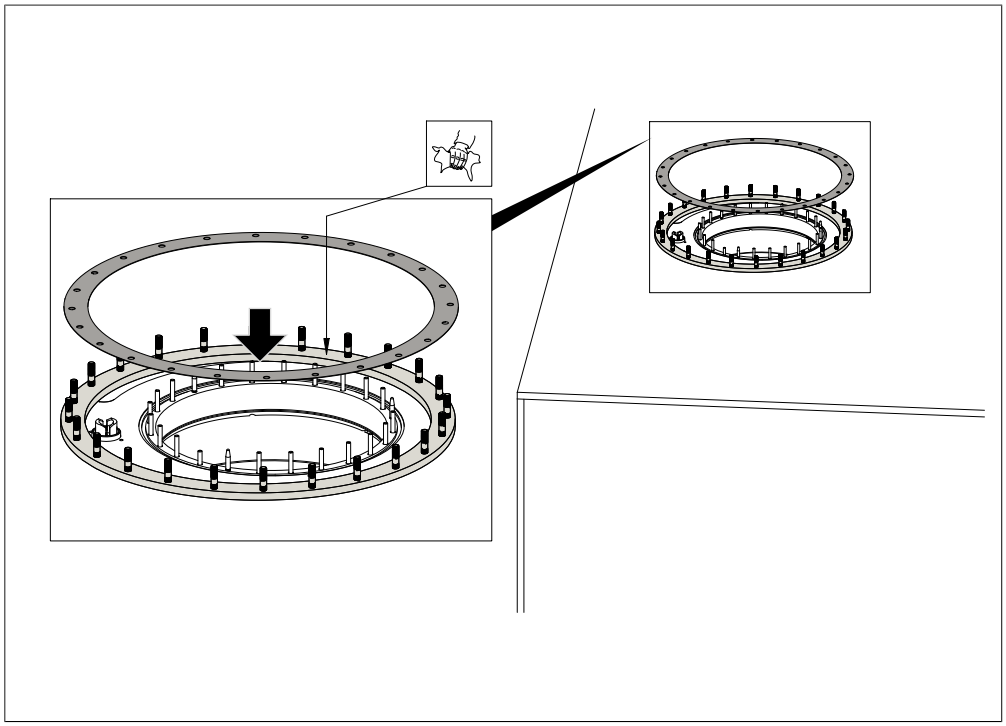


Figure 5-21 Bolts and sealing ring of the transformer mounting flange

5. Lift the OLTC mounting flange, align its holes with the bolts of the transformer mounting flange. Then lower the OLTC mounting flange. Make sure that it is firmly fixed onto the transformer mounting flange.

Notice: Prevent fasteners from falling into the oil compartment.

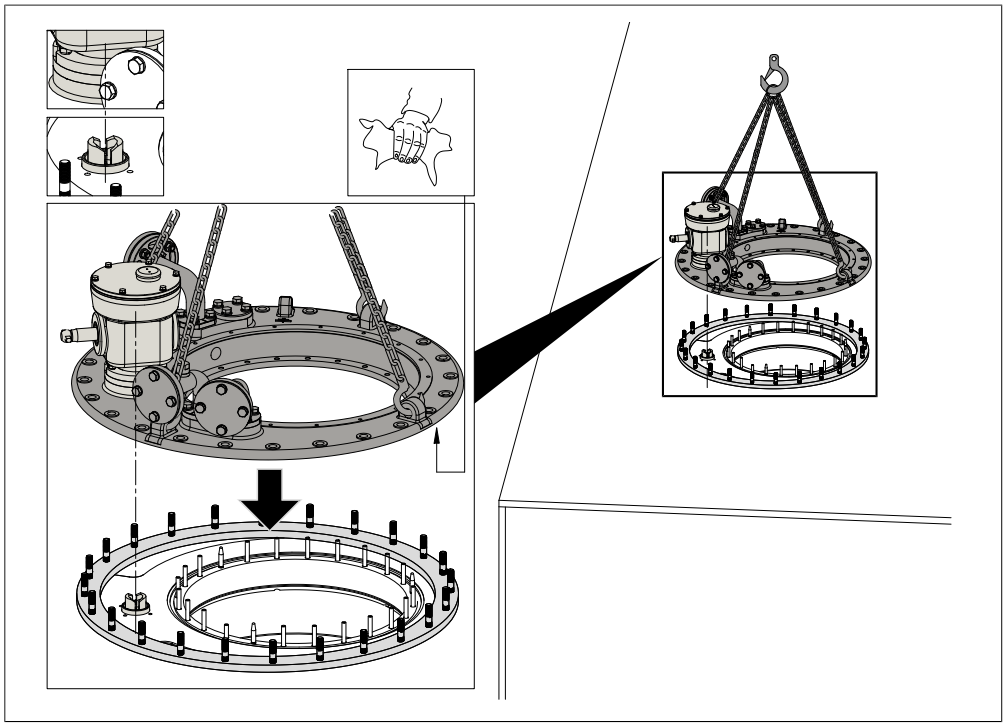


Figure 5-22 Align the mounting flange

6. Use a 13 mm open-end/socket wrench to install 13 sets of M8 nuts, each set with belleville washer x4. Lift the OLTC support flange and align it with the OLTC mounting flange. When the support flange is in tight contact with the mounting reference surface of the mounting flange, install the nuts on the areas of the mounting flange ring that are not painted red.

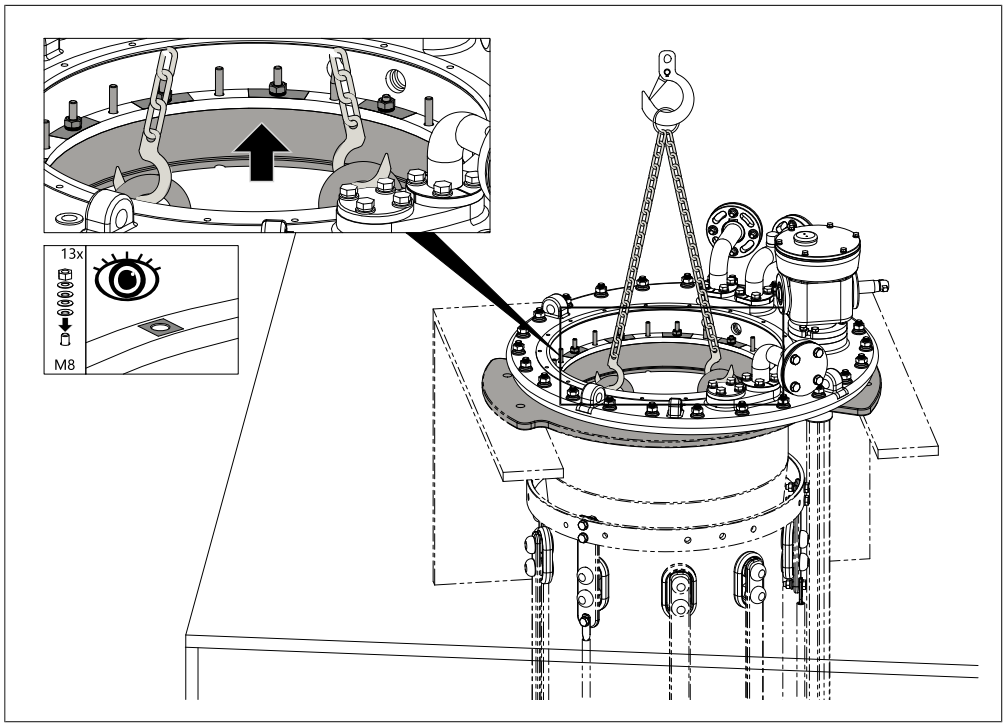


Figure 5-23 Install the OLTC mounting flange

5.3.7. Install diverter switch insert

Perform the following steps to install the diverter switch insert into the oil compartment:

1. Insert one end of the oil suction pipe into the designated hole on the oil compartment and the other end into the corresponding hole on the OLTC mounting flange.

> **Notice:** To avoid oil leakage and/or equipment fault, make sure that the sealing rings on the pipe connectors are intact without damage.

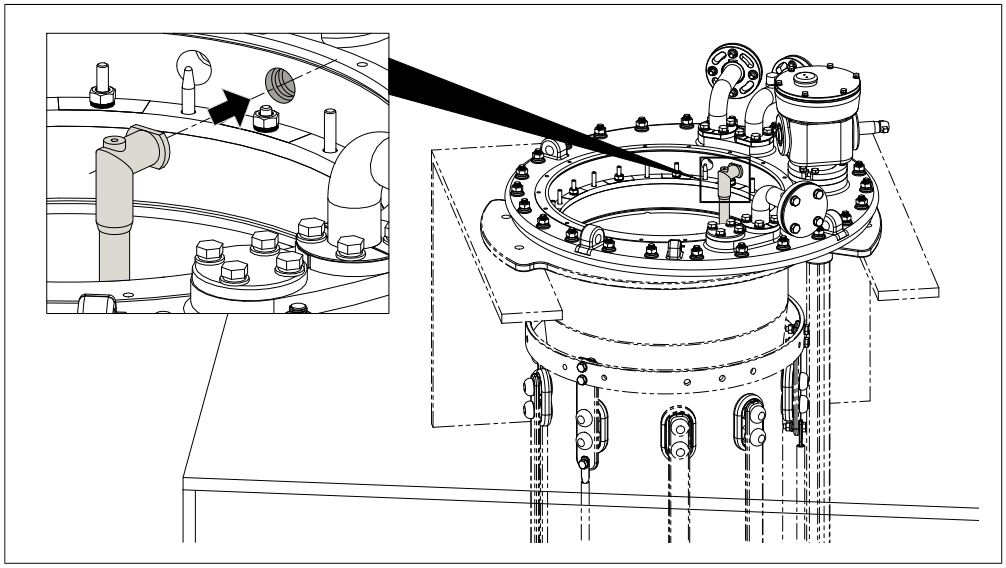


Figure 5-24 Install the oil suction pipe

2. Install the diverter switch insert.

> **Important:** The flange faces must be in complete contact. The flange ring must not extend beyond the red marker line.

a. Before lowering the diverter switch insert, make sure that the coupling at the bottom of the oil compartment is accurately aligned with the smaller coupling half on the diverter switch insert.

b. Lift the diverter switch insert and position it above the oil compartment. Slowly lower the diverter switch insert into the oil compartment.

Important: Make sure that the bottom surface of the diverter switch insert flange ring is completely aligned with the mating surface of the OLTC mounting flange without any gap.

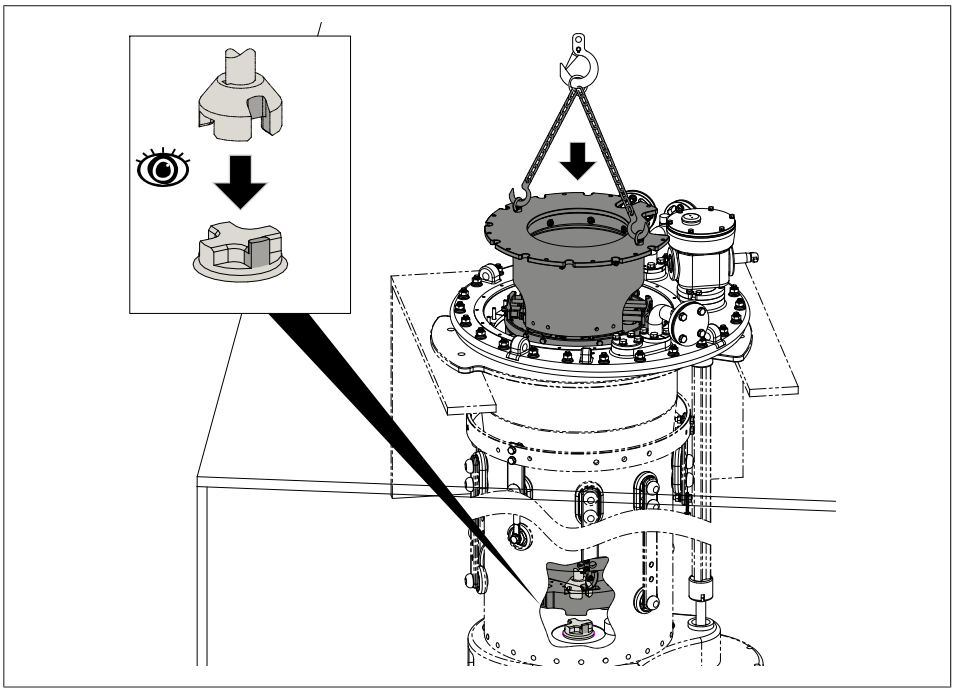


Figure 5-25 Align the diverter switch insert with the oil compartment

c. Check that the top surface of the flange ring does not exceed the red line.

d. Use a 13 mm open-end/socket wrench to install 8 sets of M8 nuts, each set with belleville washer x4. Install the nuts on the areas of the flange ring that are not painted red.

Notice: Prevent fasteners from falling into the oil compartment.

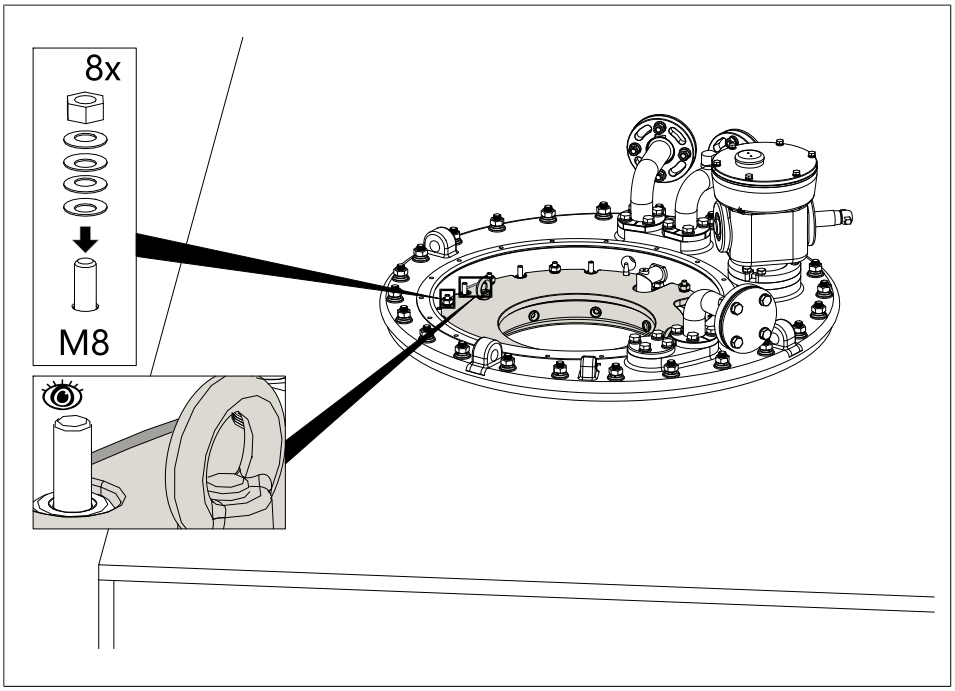


Figure 5-26 Install the diverter switch insert

5.3.8. Install top cover

Perform the following steps to install the top cover onto the OLTC mounting flange:

1. Before installing the top cover, clean its sealing surface. Install the sealing ring onto the top cover. Make sure that the sealing ring is intact and installed in the correct position.

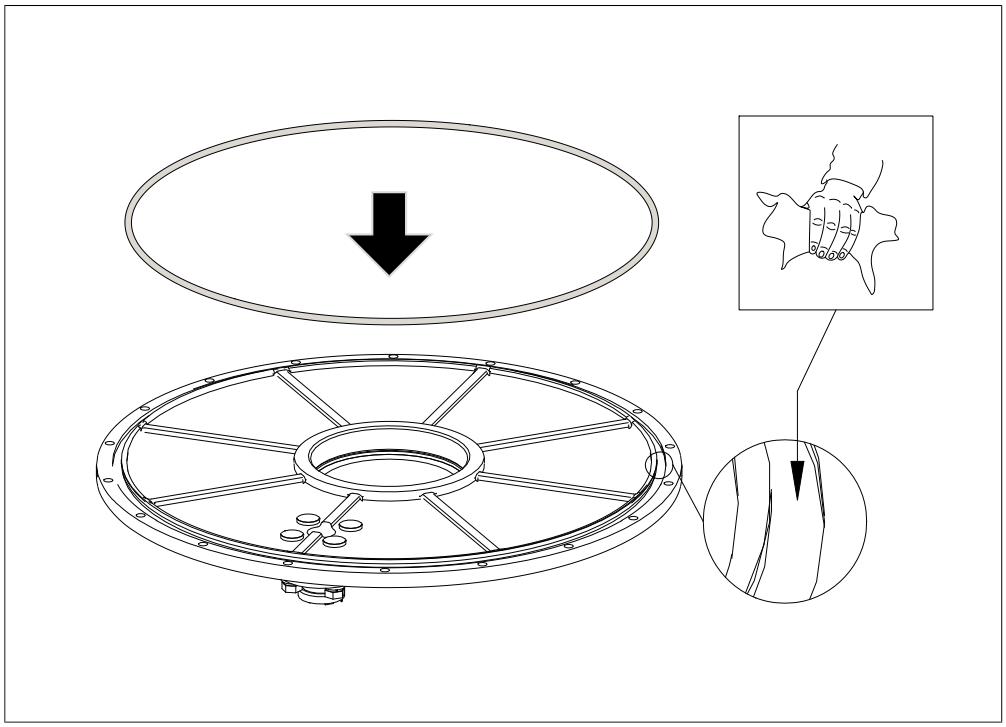


Figure 5-27 Install the sealing ring onto the top cover

2. Align the triangular mark on the top cover with the triangular mark on the mounting flange.

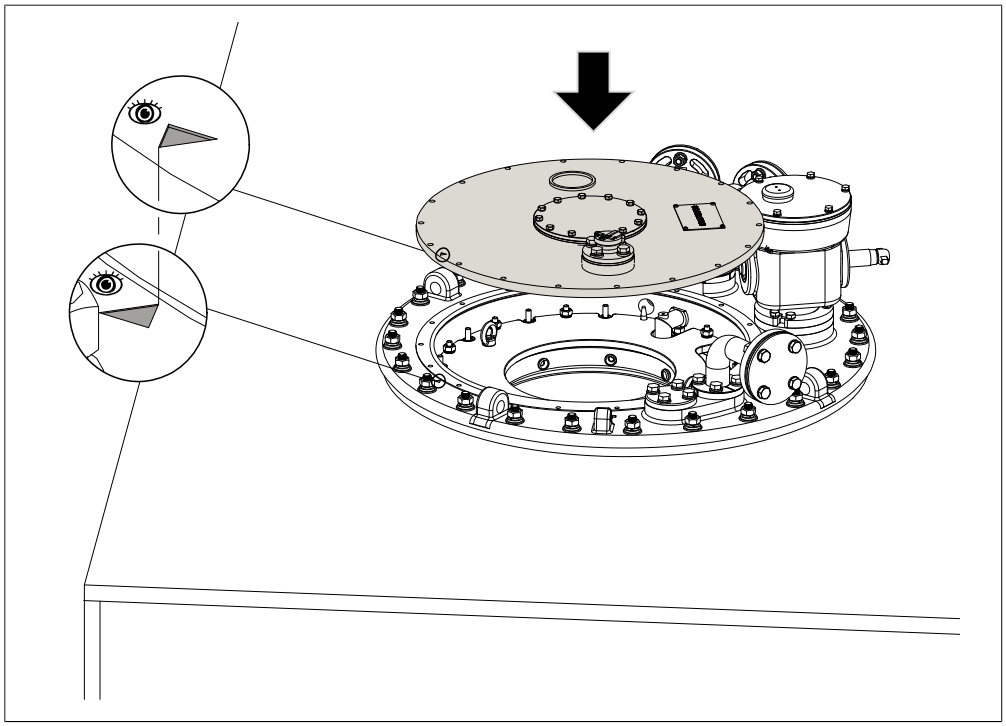


Figure 5-28 Align the triangular marks

3. Place the top cover onto the OLTC mounting flange.

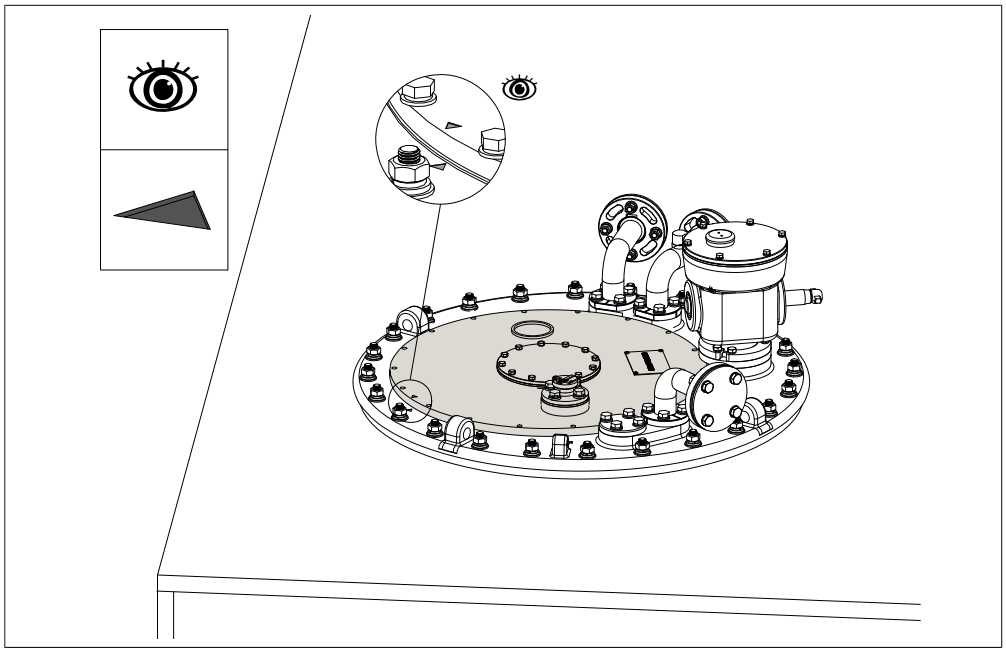


Figure 5-29 Place the top cover onto the OLTC mounting flange.

4. Use a 13 mm open-end/socket wrench to install 18 sets of M8 bolts, each set with spring washer x1 and flat washer x1, to fix the top cover to the OLTC mounting flange.

Notice: Prevent fasteners from falling into the oil compartment.

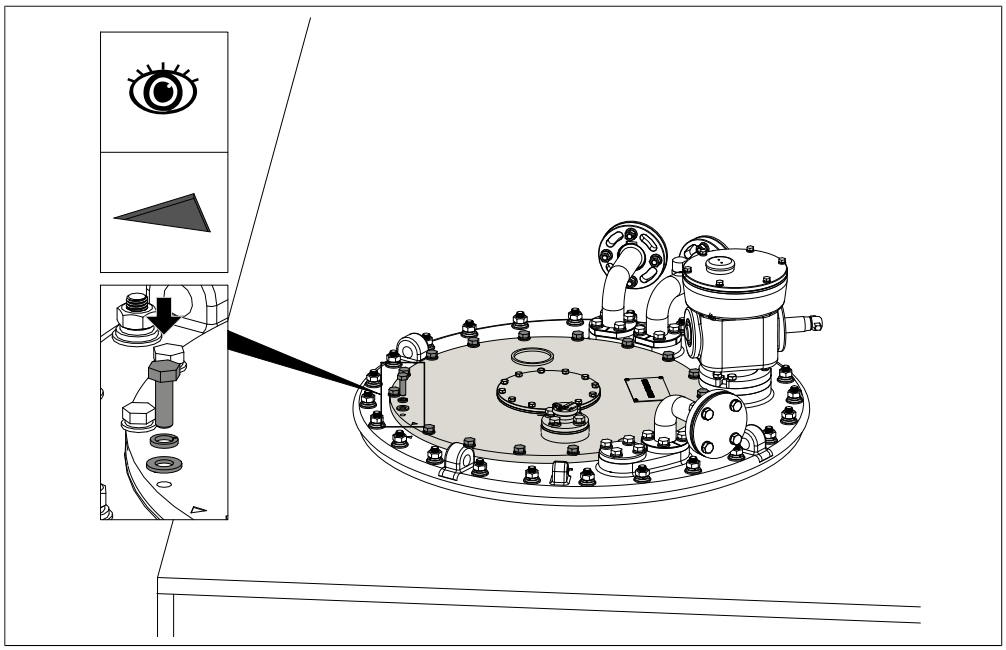


Figure 5-30 Install the top cover

6. Transformer turns ratio test and DC winding resistance measurement

Important: It is recommended to perform the turns ratio test and DC winding resistance measurement before the drying process.

6.1. Turns ratio test

NOTICE

Damage to the OLTC!
Incorrect handling will lead to OLTC damage and functional failure.

- ✓ Do not operate the OLTC more than 10 cycles without oil before drying. Operating the OLTC without oil can cause damage.
- ✓ If performing the transformer ratio test after drying, ensure that the tap selector is fully immersed in oil and the diverter switch oil compartment is fully filled with oil before operating OLTC.
- ✓ Perform each tap-change operation completely.

Important: Ensure that the OLTC mounting flange, diverter switch, and top cover are properly installed before testing.

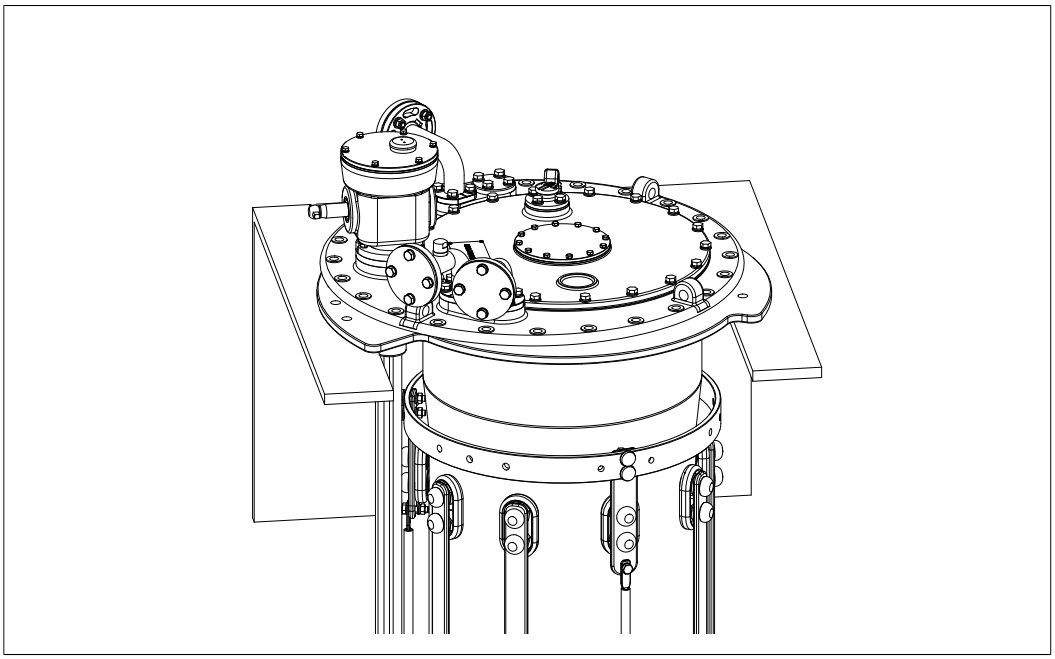


Figure 6-1 OLTC head arrangement

To perform the turns ratio test, follow these steps:

1. Rotate the driving shaft of the top gearbox using a short pipe with an inner diameter of 25 mm (insert a 12 mm diameter bolt into the pipe) and a handwheel or crank.
2. For ganged OLTC installations (two or three units), connect all OLTC top gearboxes using horizontal shafts.
3. Switch the OLTC into the required operating position. Each tap change produces an audible click from the diverter switch.
4. After you hear the click from operating the diverter switch, continue to rotate the driving shaft for two and a half additional turns in the same direction to complete the tap-change operation.

Notice: An incomplete tap-change operation may damage the OLTC.

5. Observe the tap position through the inspection window on the OLTC head (see the figure below) to avoid exceeding the OLTC's limits.

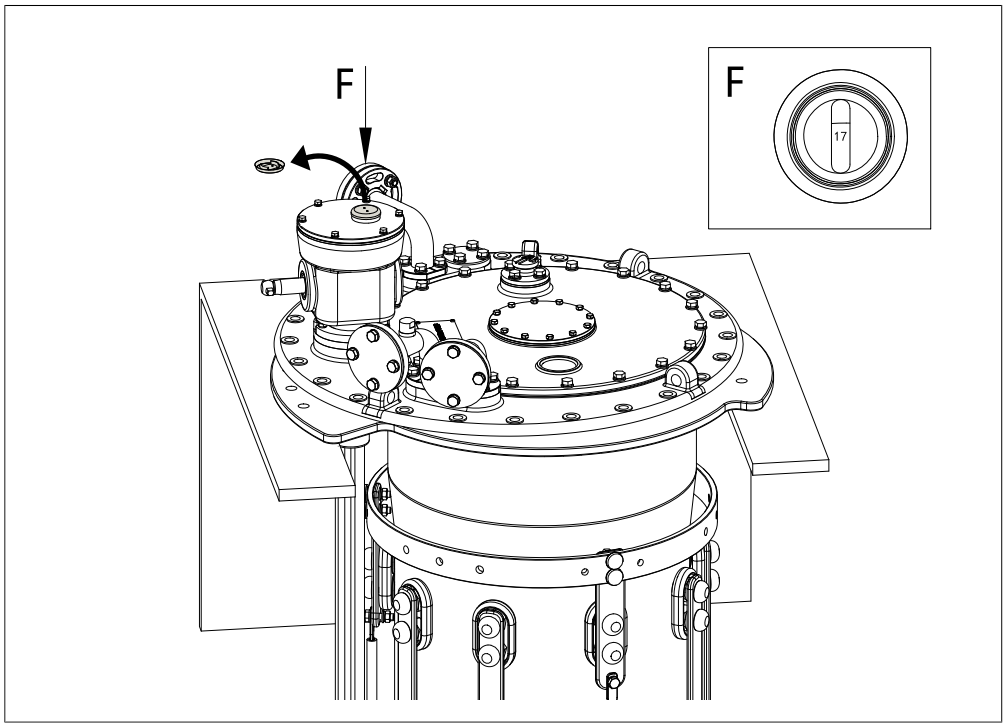


Figure 6-2 OLTC inspection window location

6. Perform the transformer turns ratio test for all operating positions.
7. Refit the OLTC to its set position.

6.2. DC winding resistance measurement

NOTICE

Risk of OLTC damage!
Incorrect operations can lead to damage and malfunctions on the OLTC.
- ✓ Do not operate the OLTC more than 10 cycles without oil before drying. Operating the OLTC without oil can cause damage.
- ✓ Perform each tap-change operation completely.

To perform a DC winding resistance measurement, follow these steps:

1. Perform the DC winding resistance measurement with the OLTC.

   Notice: If you perform the measurement in a no-oil state, minimize OLTC operations during this procedure.

2. Return the OLTC to its set position after the DC winding resistance measurement.

7. Drying and oil filling

7.1. Vacuum drying

Important:
To ensure the insulation performance of the OLTC, thorough drying must be carried out using a vacuum drying or vapor-phase drying process.

7.1.1. Vacuum drying in a drying oven

NOTICE

Damage to the OLTC!
Improper drying operations can cause component damage or malfunction, affecting the normal operation of the OLTC.

- ✓ Do not dry the following components when drying in a drying oven: top cover, top gearbox, MDU, protective relay, top cover gasket, pressure relief device, bevel gearbox, and other accessories.
- ✓ Prevent components from falling into the diverter switch oil compartment during disassembly and reassembly. Inspect all components for completeness.

To perform vacuum drying in a drying oven, follow these steps:

1. Remove the top cover if it is installed. See 5.3.2 Remove top cover and lift out diverter switch insert.
2. Perform the drying procedure:
   a. Heat the OLTC in normal atmospheric air at a rate of approximately 10°C per hour until it reaches 110°C.
   b. Maintain the OLTC at 110°C for 20 hours with circulating hot air.
   c. Dry the OLTC under vacuum for 50 hours, maintaining a temperature between 105°C and 125°C. The maximum residual pressure should be 133 Pa.
3. Reinstall the top cover. See 5.3.8 Install top cover.

7.1.2. Vacuum drying in the transformer tank

NOTICE

Risk of OLTC damage!
Improper drying operation may cause component damage or fault, affecting the normal operation of the OLTC.

- ✓ During the drying process inside the transformer tank, the OLTC top cover must remain closed.
- ✓ Prevent components from falling into the diverter switch oil compartment during disassembly and assembly. Check whether all components are present.

Perform vacuum drying inside the transformer tank as follows:

1. Use a 17 mm open-end/socket wrench to remove 8 sets of M10 bolts, each set with spring washer x1 and flat washer x1. Remove pipe connectors E2 and R from the OLTC mounting flange.

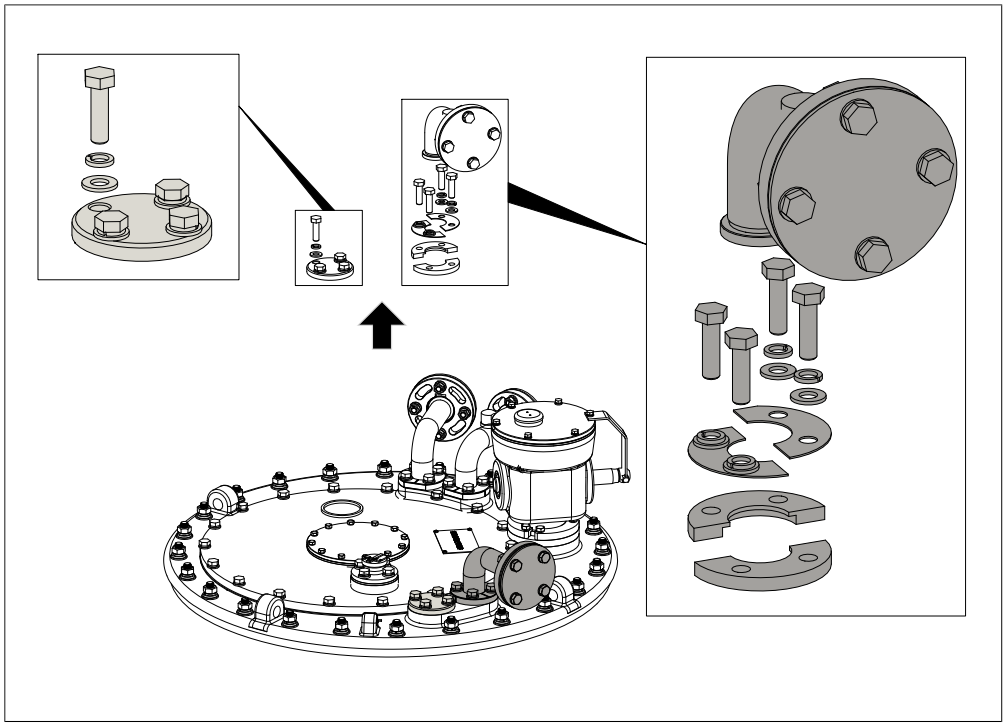


Figure 7-1 Remove the pipe connectors from the OLTC top

2. Use a 17 mm open-end/socket wrench to install 8 sets of M10 bolts, each set with spring washer x1 and flat washer x1. Connect E2 and R using a bypass pipe with an internal diameter of at least 25 mm.

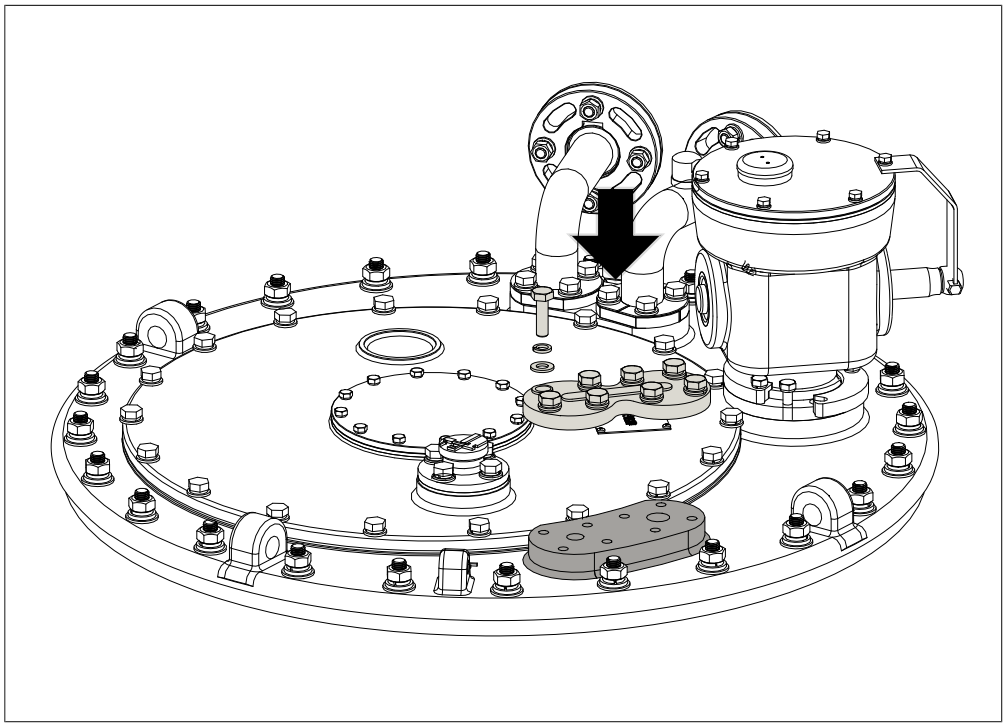


Figure 7-2 Connect E2 and R with a bypass pipe

3. Perform the drying procedure:
   a. Heat the OLTC in air at atmospheric pressure at a rate of approximately 10 °C per hour until reaching 110 °C.
   b. Maintain the OLTC at 110 °C for 20 hours using circulating hot air.
   c. Dry the OLTC under vacuum for 50 hours, maintaining the temperature between 105 °C and 125 °C. The maximum residual pressure should be 133 Pa.
4. Remove the bypass pipe and reinstall pipe connectors E2 and R.

7.2. Vapor-phase drying

Important:
To ensure the insulation performance of the OLTC, thorough drying must be carried out using a vacuum drying or vapor-phase drying process.

1. Use a special wrench to turn the oil drain bolt in the diverter switch oil compartment counterclockwise, rotating no more than 10 turns.

Note:
This bolt is located between the bottom of the diverter switch oil compartment and the tap selector.

Depending on the installation method and actual conditions, choose Method A or Method B to loosen the oil drain bolt:

- Method A: Use a special wrench to loosen the oil drain bolt.
- Method B: Use a 10 mm open-end/socket wrench to loosen the oil drain bolt.

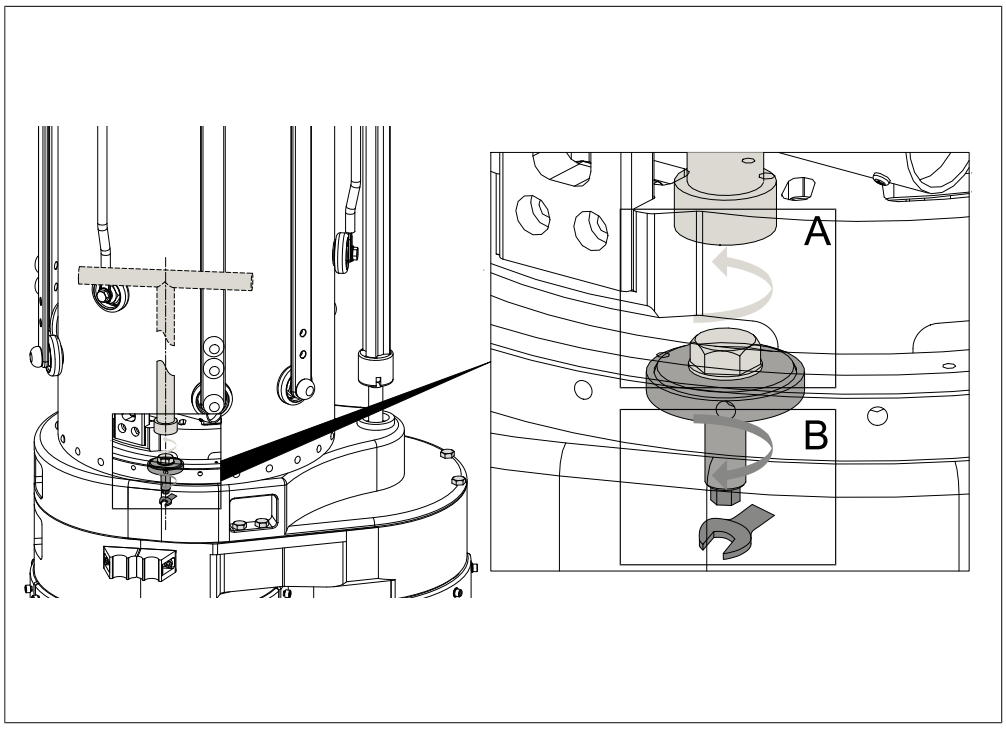


Figure 7-3 Loosen the oil drain bolt

2. After drying treatment, tighten the oil drain bolt.

7.2.1. Vapor-phase drying in a drying oven

NOTICE

Risk of OLTC damage!
Improper drying operation may cause component damage or fault, affecting the normal operation of the OLTC.

- ✓ When drying in a drying oven, the following components must not be placed inside the oven: top cover, top gearbox, MDU, protective relay, top cover sealing gasket, pressure relief device, bevel gearbox, and other accessories.
- ✓ Prevent components from falling into the diverter switch oil compartment during disassembly and assembly. Check whether all components are present.

Important:

- Before drying the OLTC, open the oil drain bolt.
- After drying treatment, tighten the oil drain bolt.

Perform vapor-phase drying in a drying oven as follows:

1. Remove the top cover. (See 5.3.2 Remove top cover and lift out diverter switch insert)
2. Use a 10 mm open-end/socket wrench to loosen the oil drain bolt (see Method B in the figure below).

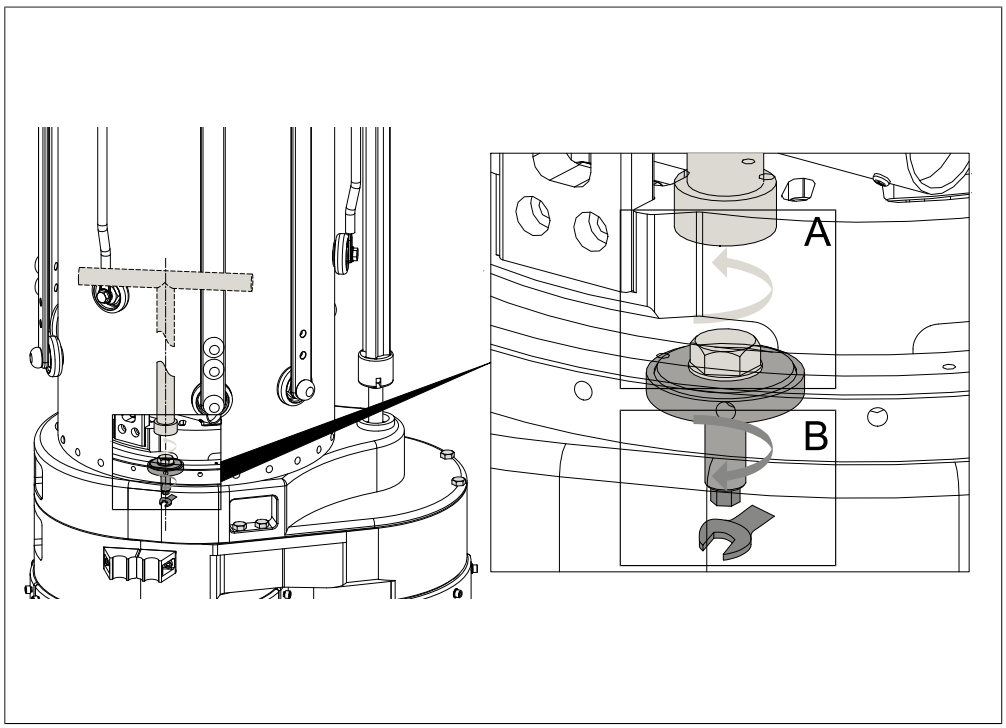


Figure 7-4 Loosen the oil drain bolt

3. If the oil drain bolt cannot be loosened directly (Method B), perform the following steps:
   a. Remove the diverter switch insert. (See 5.3.2 Remove top cover and lift out diverter switch insert)
   b. Use a special wrench to loosen the oil drain bolt (Method A).

c. Reinstall the diverter switch insert. (See 5.3.7 Install diverter switch insert)
d. Reinstall the OLTC top cover. (See 5.3.8 Install top cover)

4. Perform the drying procedure:
   a. Inject kerosene vapor at approximately 90 °C and maintain this temperature for 3–4 hours.
   b. Increase the kerosene vapor temperature at a rate of 10 °C per hour until the required final temperature is reached. The maximum OLTC temperature should not exceed 125 °C.
   c. Dry the OLTC under vacuum, maintaining the temperature between 105 °C and 125 °C. The maximum residual pressure should be 133 Pa. The drying time should be the same as that for the transformer, but should not be less than 50 hours.
5. Tighten the oil drain bolt.
6. Reinstall the top cover. (See 5.3.8 Install top cover)

7.2.2. Vapor-phase drying in the transformer tank

NOTICE

Risk of OLTC damage!
Improper drying operation may cause component damage or fault, affecting the normal operation of the OLTC.
✓ During the drying process inside the transformer tank, the OLTC top cover must remain closed.
✓ Prevent components from falling into the diverter switch oil compartment during disassembly and assembly. Check whether all components are present.

Important:
- Before drying the OLTC, open the oil drain bolt.
- After drying treatment, tighten the oil drain bolt.

Perform vapor-phase drying inside the transformer tank as follows:

1. Use a 17 mm open-end/socket wrench to remove 8 sets of M10 bolts, each set with spring washer x1 and flat washer x1, and remove pipe connectors E2 and R from the OLTC mounting flange.

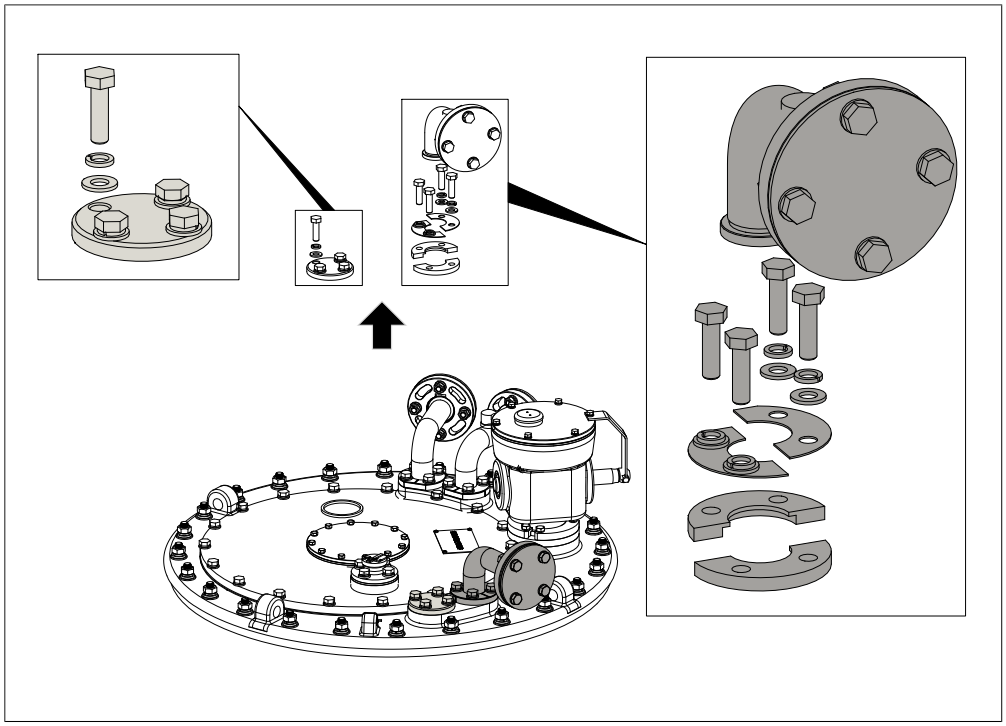


Figure 7-5 Remove the pipe connectors from the OLTC top

2. Connect E2 and R using a bypass pipe (internal diameter at least 25 mm).
3. Remove the top cover. (See 5.3.2 Remove top cover and lift out diverter switch insert)
4. Remove the diverter switch insert. (See 5.3.2 Remove top cover and lift out diverter switch insert)
5. Loosen the oil drain bolt.
6. Reinstall the diverter switch insert. (See 5.3.7 Install diverter switch insert)
7. Reinstall the OLTC top cover. (See 5.3.8 Install top cover)
8. Perform the drying procedure:
   a. Inject kerosene vapor at approximately 90 °C and maintain this temperature for 3–4 hours.
   b. Increase the kerosene vapor temperature at a rate of 10 °C per hour until the required final temperature is reached. The maximum OLTC temperature should not exceed 125 °C.
   c. Dry the OLTC under vacuum, maintaining the temperature between 105 °C and 125 °C. The maximum residual pressure should be 133 Pa. The drying time should be the same as that for the transformer, but should not be less than 50 hours.
9. Tighten the oil drain bolt and reassemble the OLTC.

7.3. Oil filling

Important: During disassembly, assembly, or other operations, avoid damaging the sealing surfaces of the OLTC mounting flange. After the transformer has been dried, before operating the OLTC, ensure that the tap selector is completely immersed in transformer oil and that the OLTC oil compartment is filled with insulating oil.

Notice:

- After drying treatment, fill the OLTC oil compartment (with the diverter switch insert installed) with oil as soon as possible to minimise moisture ingress.
- Only use new transformer oil that complies with the relevant standards for filling the oil compartment and its conservator.
- Both the OLTC and the transformer should be filled with new oil simultaneously under vacuum.

The oil filling steps are as follows:

1. Ensure that the top cover is installed.
   a. Ensure that the sealing ring is in the correct position.
   b. Tighten the top cover bolts.
2. Install the bypass pipe.
   a. Connect a bypass pipe between pipe connector E2 and R.
   b. Ensure that both the OLTC and the transformer are evacuated simultaneously.
3. Use one of the spare pipe connectors (S or Q) for oil filling.

8. Installation of protective devices and drive unit

Note: Illustrations are for installation reference only; the actual product shall prevail.

8.1. Install protective relay

Install the protective relay according to the instructions provided in the protective relay manual.

8.2. Install pressure relief valve

Notice: If a pressure relief valve is used, remove the red protection strip from the top of the pressure relief valve before operating the OLTC.

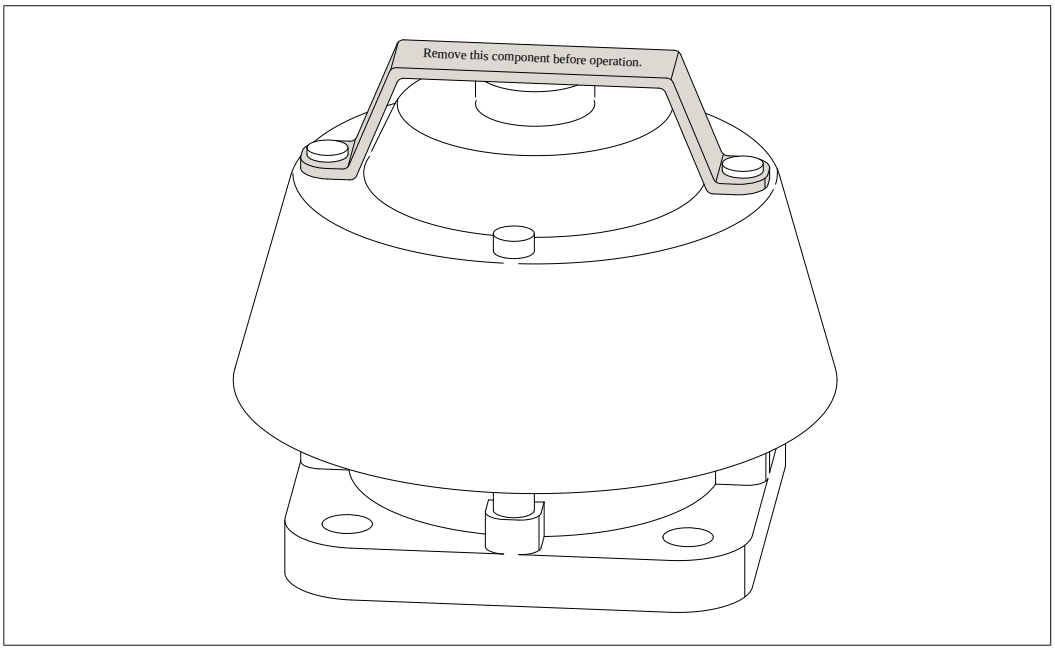


Figure 8-1 Red protection strip on pressure relief valve

8.3. Install Motor Drive Unit (MDU)

NOTICE

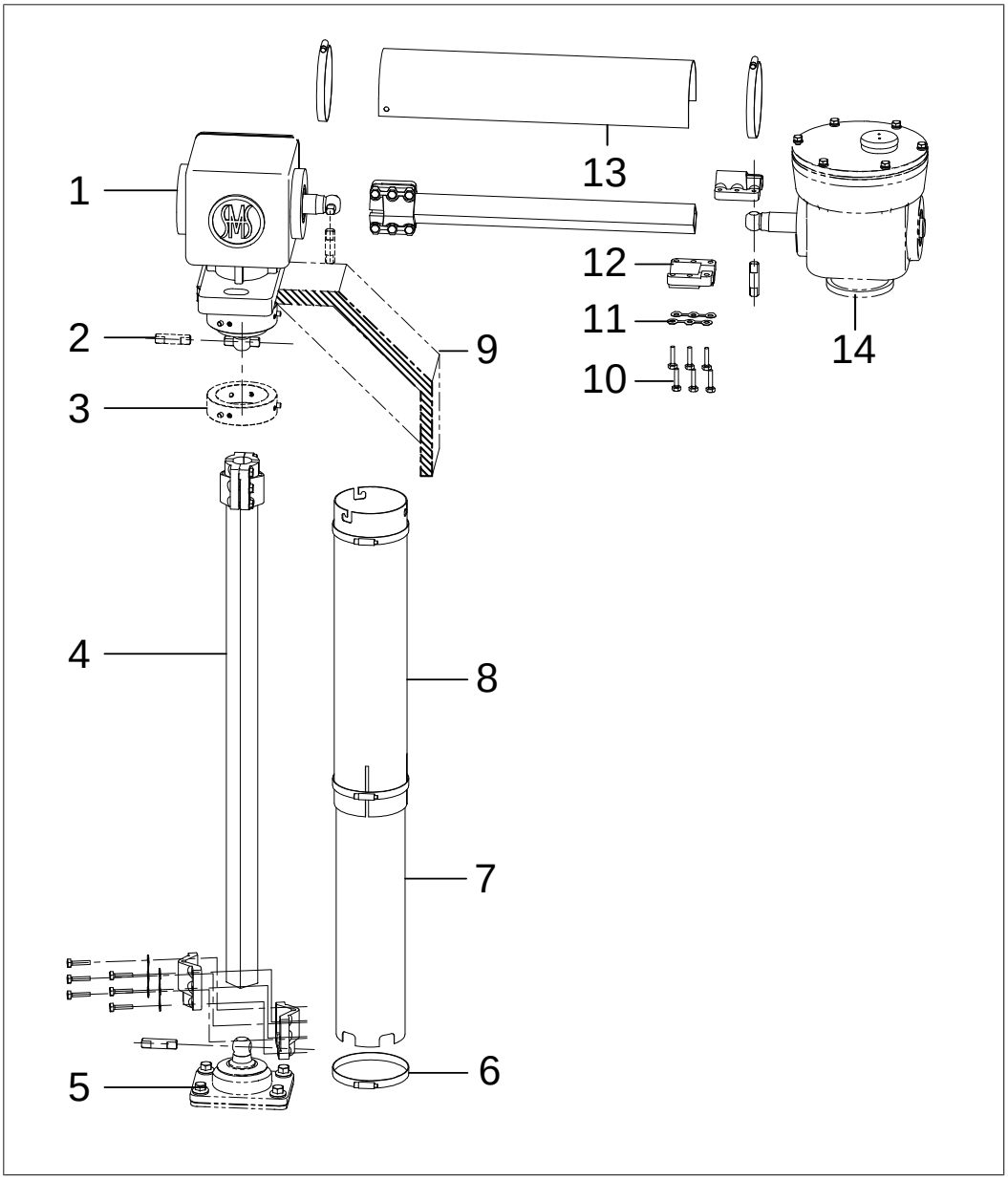
Improper MDU installation!
Improper installation of the MDU will affect the operation of the OLTC.
- ✓ Connect the MDU to the OLTC only when both units are in their set positions.
- ✓ Mount the MDU vertically on the transformer tank wall, ensuring accurate alignment.
- ✓ Ensure that the MDU mounting plate is flat to prevent deformation, which can affect operation.

The MDU drives the OLTC during tap-changing operations, either electrically or manually. Refer to the Huaming MDU manual for detailed installation procedures.

8.4. Install drive mechanism components

8.4.1. Drive mechanism components

Drive mechanism components consist of the bevel gearbox, driving shafts, couplings and other accessories.



1. Bevel gearbox	2. Cylindrical pin	3. Bushing
4. Driving shaft	5. Motor Drive Unit (MDU)	6. Clamp
7. Vertical guard 1	8. Vertical guard 2	9. Gearbox bracket (transformer)
10. M6 screw	11. Lock washer	12. Coupling
13. Horizontal guard	14. Top gearbox	

Figure 8-2 Drive mechanism components

8.4.2. Adjust the top gearbox

NOTICE

Mismatched OLTC components!
Mismatched components will affect the normal and stable operation of the OLTC.
✓ Ensure that the nameplate numbers match. Each gearbox is specific to a particular OLTC.

Important:
For driving shafts longer than 2 m, an intermediate support gearbox must be installed.

Adjust the top gearbox according to the following steps:

1. Loosen the six bolts that fix the clamping plates under the top gearbox (do not remove the bolts completely).
2. Pry the three clamping plates outward, then rotate the top gearbox to align its output shaft with the MDU.
3. Tighten the bolts. Reposition the clamping plate to ensure that the top gearbox is securely installed without looseness.

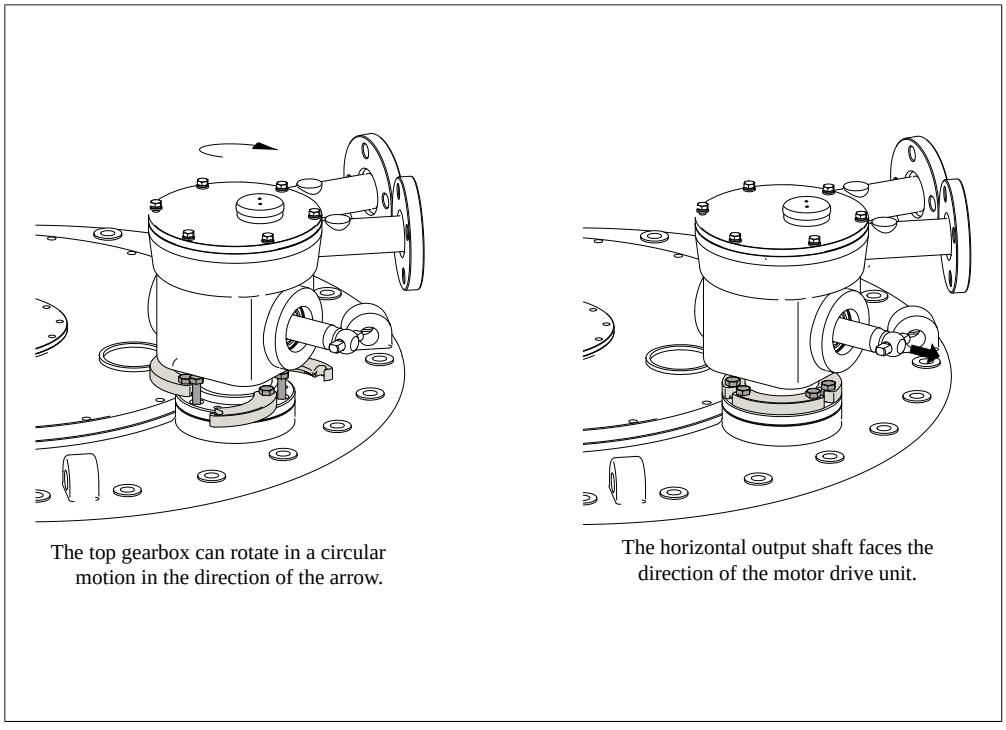


Figure 8-3 Top gearbox adjustment and fixing

8.4.3. Install the bevel gearbox

NOTICE
Mismatched OLTC components! Mismatched components can affect the normal and stable operation of the OLTC. ✓ Ensure that the nameplate serial number match. Each gearbox corresponds to a specific OLTC.

Important:
For driving shafts longer than 2 meters, install an intermediate support gearbox.

1. Align the shaft of the bevel gearbox vertically with the shaft of the MDU. Make sure that they are precisely aligned.

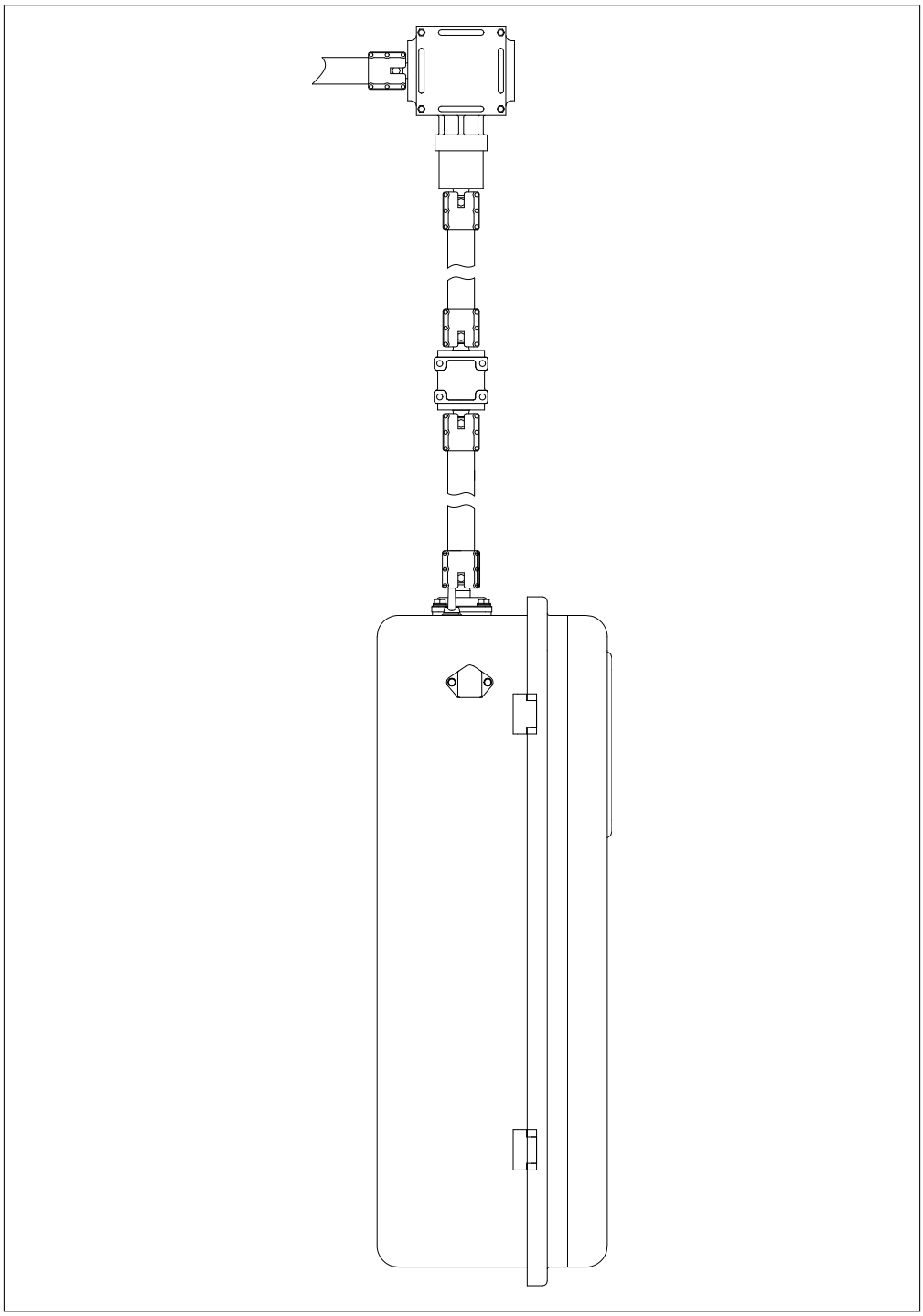


Figure 8-4 Align the shaft of the bevel gearbox and the shaft of the MDU

2. Secure the bevel gearbox on the transformer cover bracket with two bolts (18 mm diameter). (The transformer cover bracket and fasteners are supplied by the transformer manufacturer.)

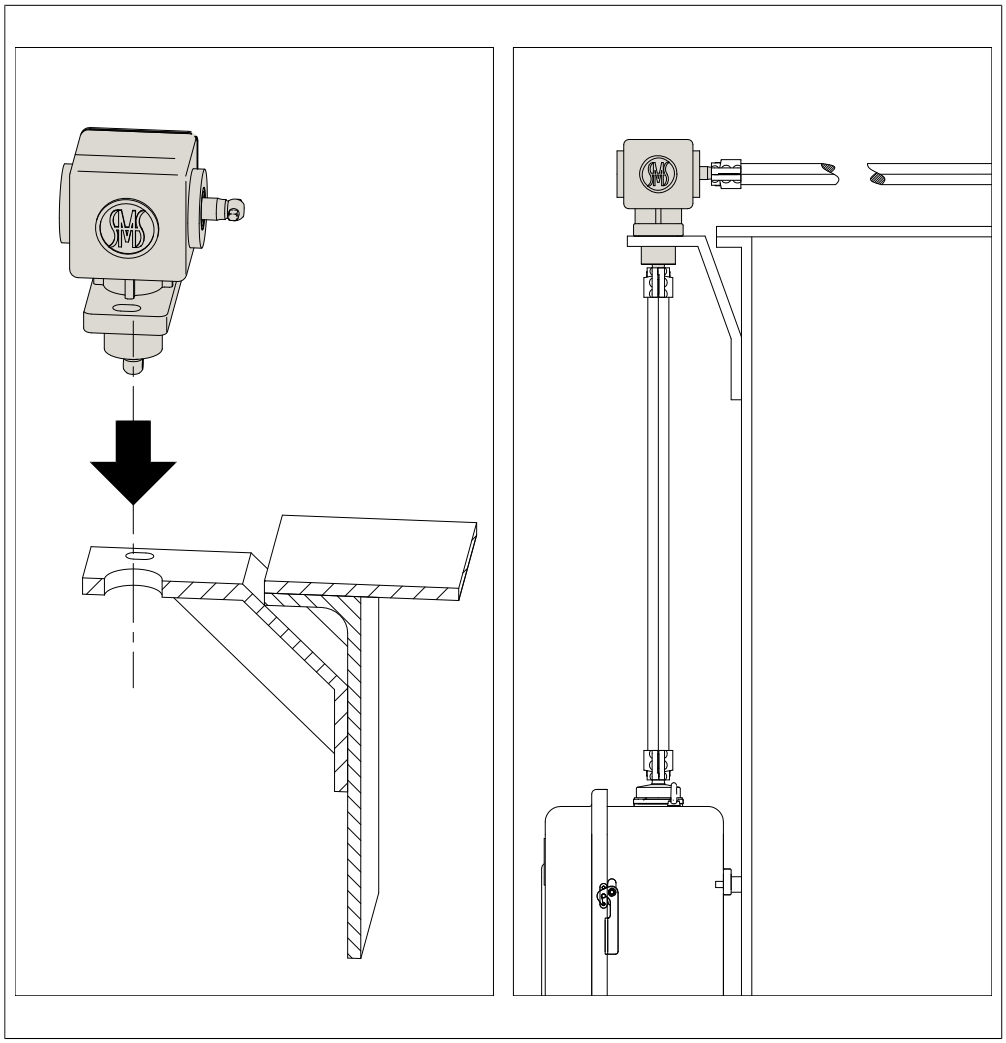


Figure 8-5 Install the bevel gearbox

8.4.4. Install the intermediate support gearbox

When the driving shaft length exceeds 2 m, it is recommended to install intermediate support components to improve drive stability.

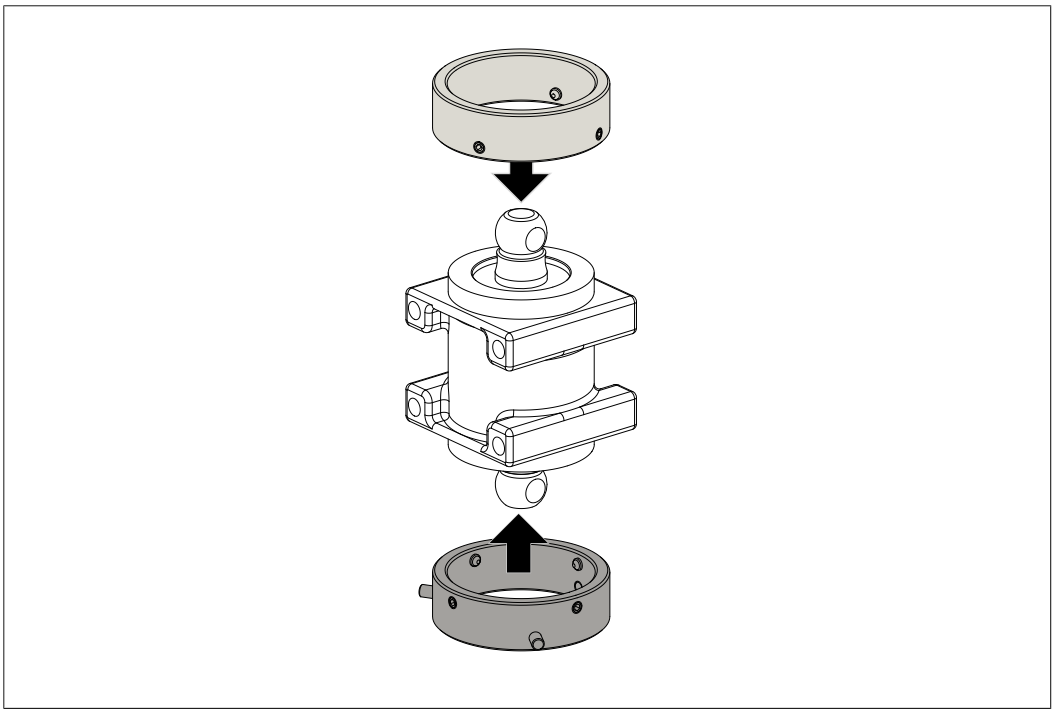


Figure 8-6 Install the vertical shaft intermediate support gearbox

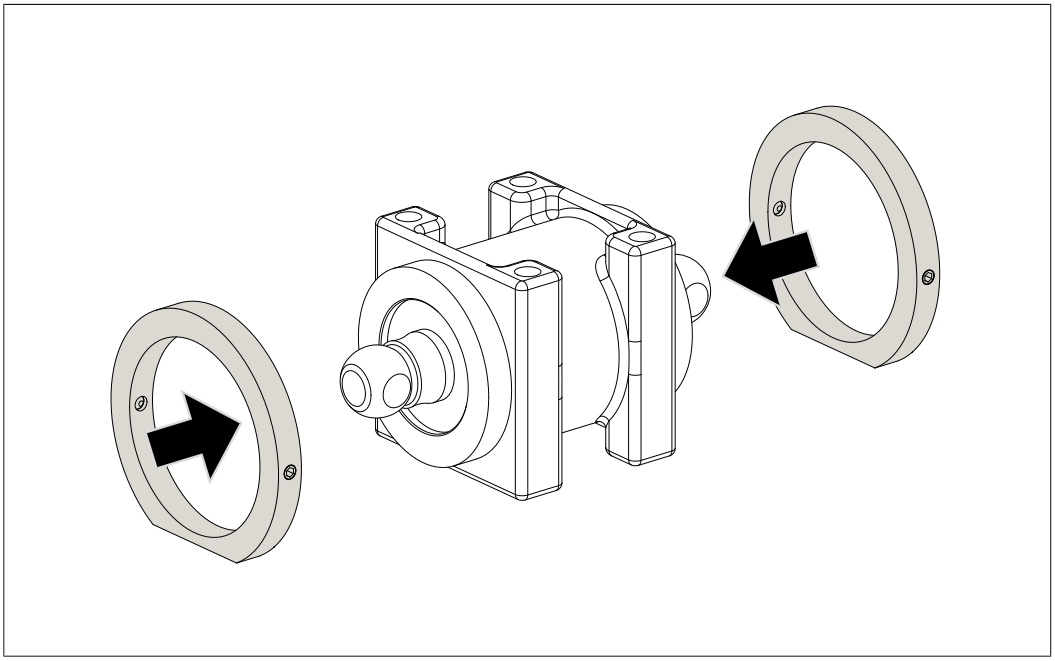


Figure 8-7 Install the horizontal shaft intermediate support gearbox

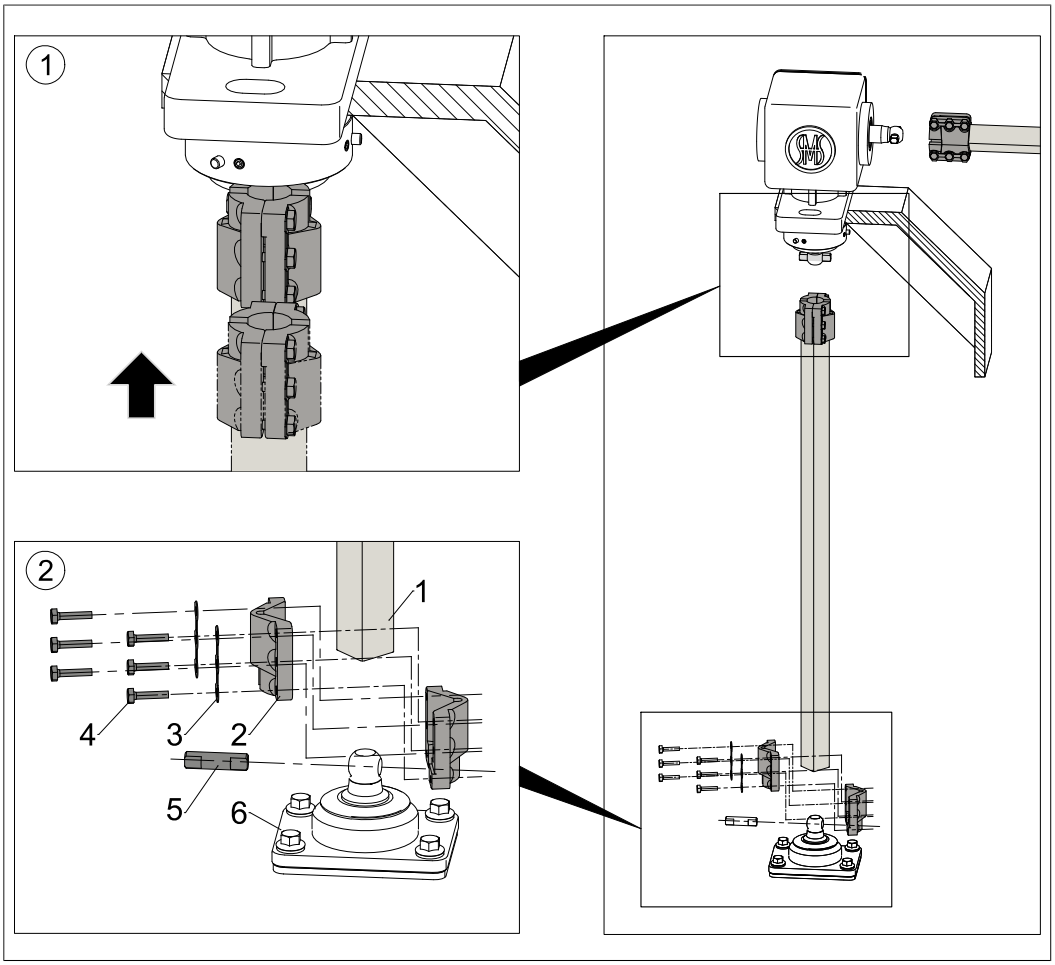
8.4.5. Install the horizontal driving shaft and vertical driving shaft

Important:

- For a driving shaft longer than 2 meters, install an intermediate support gearbox.
- To install the vertical guard, install it when installing the vertical driving shaft. See 8.4.6.0 Install the vertical guard for details.

Connect the driving shaft, the MDU and the tap-changer.
The figure below shows the connection of the coupling between the bevel gearbox and the vertical driving shaft. The installation modes of the horizontal driving shaft coupling and vertical driving shaft coupling are the same.

Use a 10 mm open-end/socket wrench to install M6 screws, torque: 7–9 Nm.



1. Driving shaft	2. Coupling	3. Lock washer
4. M6 screw	5. Cylindrical pin	6. Motor Drive Unit (MDU)

Figure 8-8 Install the bevel gearbox and the driving shaft

8.4.6. Install the driving shaft guards

Important:
For a driving shaft longer than 2 meters, install an intermediate support gearbox.

Install the horizontal guard

The length of the horizontal guard is determined by the transformer manufacturer.

1. After installing the driving shaft, place the associated clamps on both ends of the horizontal guard.
2. Position the guard on the mounting surfaces of the top gearbox and the bevel gearbox. Slide the clamps onto the mounting surfaces and tighten them.

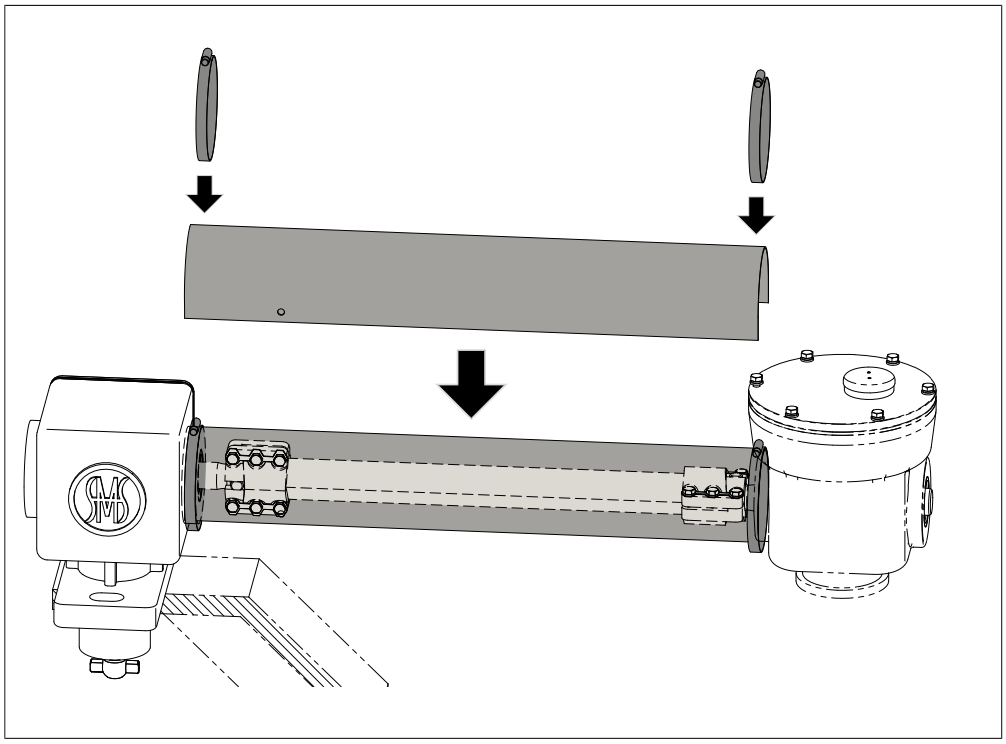


Figure 8-9 Install the horizontal guard

Install the vertical guard

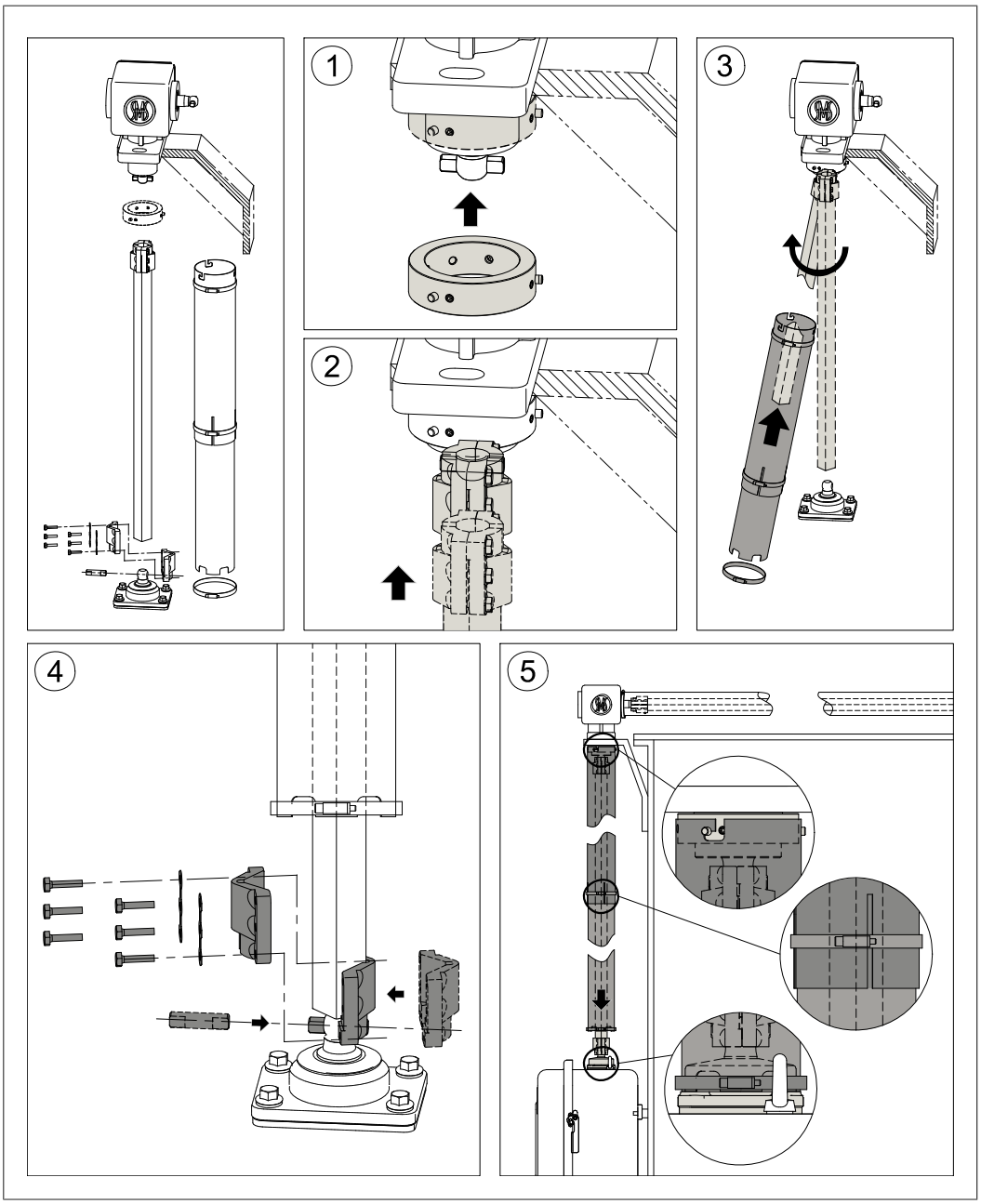


Figure 8-10 Installation steps for the vertical guard

To install the vertical guard, perform these steps:

1. Install the three 6 x 16 stainless steel cylindrical pins into the bushing (evenly spaced at 120° intervals). The pins should protrude approximately 5 mm beyond the outer diameter of the bushing and should not protrude into the inner diameter.
2. Secure the bushing to the lower end of the bevel gearbox. Use a 5 mm hex key wrench to tighten 4 sets of M6 screws. Tightening torque: 7–9 Nm.

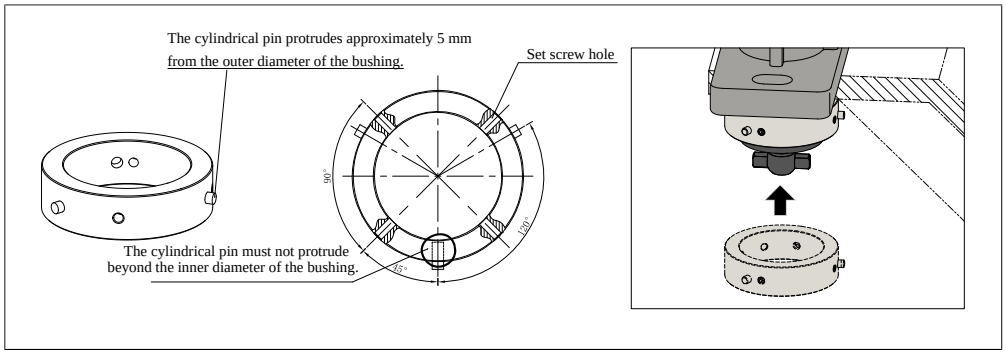


Figure 8-11 Install the bushing

3. Slide the vertical guard upward onto the lower end of the bevel gearbox, ensuring it sleeves over the bushing. Align the three grooves on the guard with the three cylindrical pins. Rotate the guard until the pins snap into the grooves (see Figure 8-12).
4. Slide the thinner lower guard onto the output shaft of the MDU (see Figure 8-12).

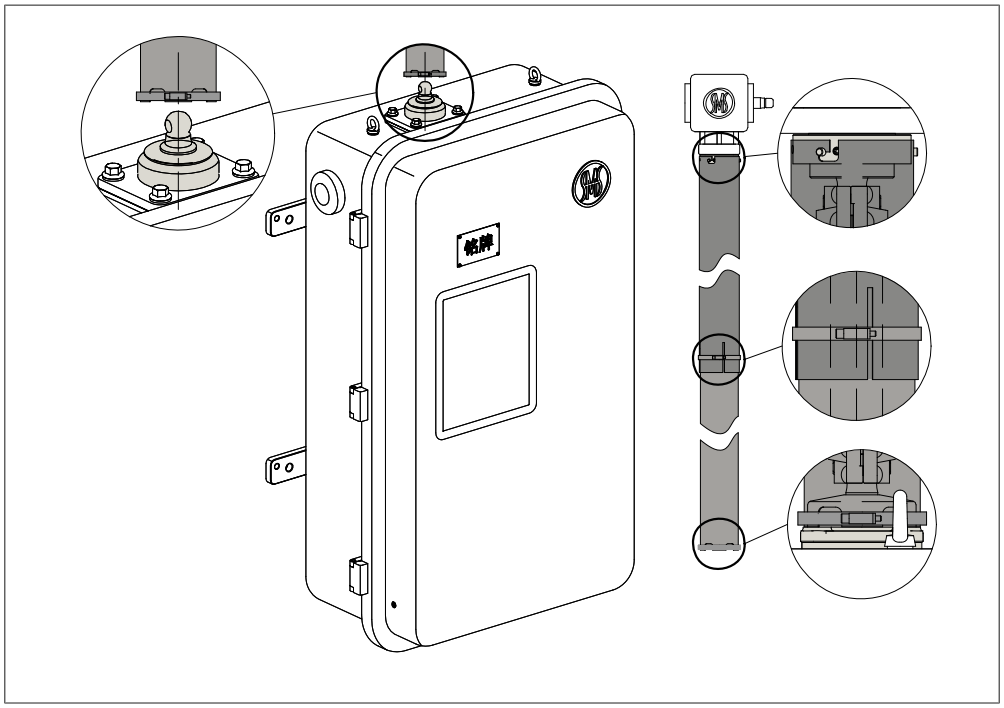


Figure 8-12 Install the vertical guard

5. After positioning both guards in place, secure them with two clamps (see Figure 8-12).
6. If the vertical driving shaft exceeds 2 m and an intermediate connecting shaft is used, repeat Step 1 to Step 5.

8.5. Installation precautions for three single-phase OLTCs or I +II OLTC configuration

Important:
Ensure that all diverter switches are in the same position and operate simultaneously.

When installing three single-phase OLTCs or an I+II OLTC configuration on the same transformer, the adjustment of gearboxes can cause diverter switch operation. Therefore, after adjusting the gearboxes, check all diverter switches one by one to ensure that they are in the same position and can be operated simultaneously during the manual operation.

8.6. Calibrate the drive system of the OLTC

Before electrically operating the MDU, manually operate the tap-changer through one complete cycle. This can verify whether it is aligned and functions correctly. Ensure the time interval between the diverter switch operation and the completion of the MDU movement is the same in both rotation directions.

To ensure reliable operation of the OLTC, calibrate the drive system after disconnecting and reconnecting the horizontal or vertical shaft.

8.6.1. Calibration procedure

Calibrate the drive system as follows (using the SHM-D calibration procedure as an example):

1. Turn the driving shaft in the 1→N direction using the crank handle. When you hear the diverter switch action (click sound), continue to rotate and count the number of handle turns (m) until the center mark of the grey area on the MDU tap position indicator aligns with the arrow.
2. Rotate the handle back to the original set position in the opposite direction (N→1 direction). Count the number of handle turns (k) using the same method.
3. If m = k, the connection is correct. If m ≠ k and the absolute difference (|m - k|) is greater than 1, disconnect the vertical driving shaft and rotate the handle by 1/2 (|m - k|) turns in the direction that had more turns. After completing, reconnect the vertical driving shaft to the MDU.
4. Repeat the above steps until the number of turns in both directions is approximately equal.

8.6.2. Calibration example

Calibrate an OLTC with a 10193W tap selector:

1. Rotate from position 10 (set position) to position 11 (m = 5 turns).
2. Rotate back from position 11 to position 10 (k = 3 turns).
3. Calculate:
   a. Turn difference: $|m - k| = |5 - 3| = 2$ turns
   b. Adjustment turns: $1/2 (m - k) = 1/2 (5 - 3) = 1$ turn
4. Disconnect the vertical driving shaft from the MDU, rotate the handle one turn from position 10 toward position 11, then reconnect the shaft.
5. Verify whether the turn difference between the two directions is balanced.

Calibration summary:

1. Record the number of turns in both directions (m and k).
2. After disconnecting the coupling, rotate the handle by 1/2 ($|m - k|$) turns in the direction that had more turns.
3. Reconnect and verify until $|m - k| \leq 1$.

9. Factory Acceptance Tests (FAT)

9.1. Test preparations

9.1.1. Degas the OLTC

Before the first operation, it is necessary to exhaust air from the OLTC head and the oil suction pipe connected to the pipe connector S.

The OLTC exhaust steps are as follows:

1. OLTC head exhaust:

   a. Remove the bolt cap of bleeder valve E1.

   b. Gently pry the valve stem with a screwdriver to exhaust until the oil overflows (see Figure 9-1).

   c. Retighten the bolt cap of bleeder valve E1.

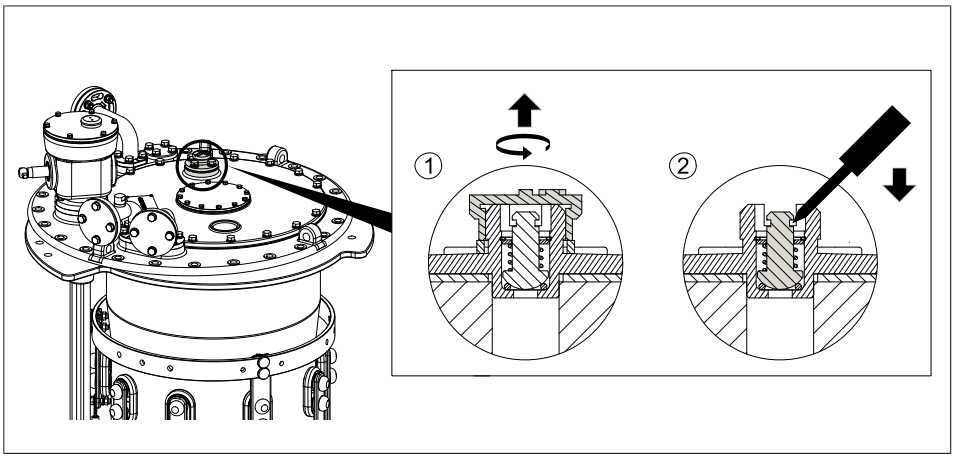


Figure 9-1 Bleeder valve exhaust operation

2. Oil suction pipe exhaust at pipe connector S:

   a. Use a 24 mm open-end wrench to remove the bolt cap from pipe connector S.

   b. Use a 10mm open-end/socket wrench to loosen the M6 vent plug and perform the air release operation.

   c. Use a 10mm open-end/socket wrench to tighten the M6 vent plug.

d. Use a 24 mm open-end wrench to tighten the bolt cap.

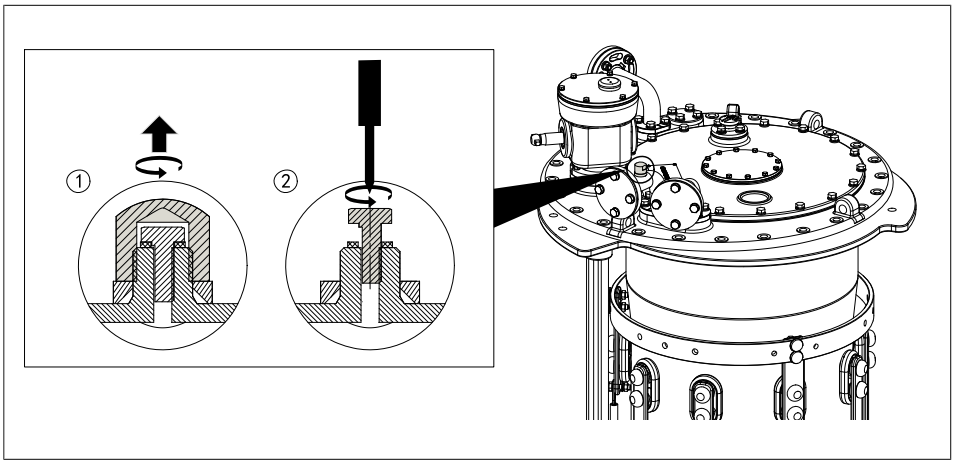


Figure 9-2 Exhaust at pipe connector S

9.1.2. Grounding

The grounding steps are as follows:

1. Use a 19 mm open-end/socket wrench to install the M12 grounding bolt, connecting the grounding bolt on the OLTC head to the transformer tank cover.

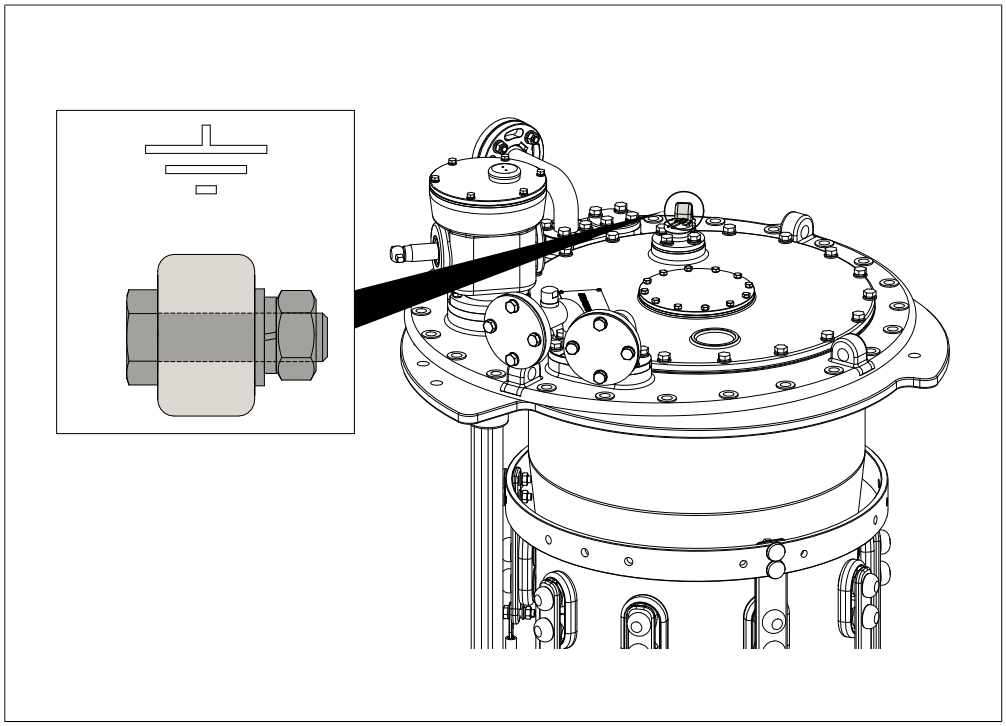


Figure 9-3 Grounding wire connection

2. Use a 19 mm open-end/socket wrench to install the M12 grounding bolt, connecting the grounding bolt on the MDU enclosure to the transformer tank.

9.2. Tests at the transformer manufacturer's facility

9.2.1. Functional test

NOTICE

Damage to the OLTC and malfunction risk!
Operating without oil, failing to perform a full cycle of the OLTC operation, or incorrect connections may result in component damage or malfunction of the OLTC, and disrupt normal operations of the equipment.

- ✓ The tap selector must be fully immersed in oil, and the diverter switch oil compartment must be filled. Do not operate the OLTC without oil.
- ✓ During the test, operate the OLTC through its full range of motion (one complete cycle).
- ✓ Ensure the connection between the OLTC and MDU is correct.

Important: Verify that the position indicators on the MDU and OLTC (observe through the inspection window on the top cover) show the same tap position.

Before energizing the transformer, perform a functional test to check the mechanical operation of the OLTC and MDU.

9.2.2. Transformer electrical tests

⚠ WARNING	
	**Flammable and explosive gases!** Explosive gases can accumulate inside the OLTC, connection system, conservator, and air dehydrator outlet. Ejected components and hot oil spills can cause serious or fatal injuries. ✓ Ensure the environment around the transformer is free of open flames, hot surfaces, sparks (including static electricity), or any potential ignition sources. ✓ All OLTC tests must be performed by qualified personnel following established procedures.

10. Transformer transportation and on-site commissioning

10.1. Remove the MDU for transportation

When transporting the transformer from the manufacturer to the site, if the MDU must be removed because the overall dimensions exceed transportation limits, store and secure the tap-changer and the MDU in their as-delivered condition.

Important:
Do not operate the MDU when disconnected from the OLTC.

To remove the MDU for transportation, perform these steps:

1. Set the MDU to its set position.
2. Disconnect the coupling.
3. Remove the MDU.

After transporting the MDU to the site, reinstall the MDU and components of the drive mechanism. For MDU and driving shaft reinstallation, see the Huaming MDU operating manual.

10.2. Transport with oil and no conservator

Important: If the transformer is stored and transported with oil for 3 to 4 weeks without a conservator, reduce the oil volume in the OLTC by approximately 5 liters.

If the transformer is stored and transported in an oil-filled condition without a conservator installed, connect a bypass pipe between the diverter switch oil compartment and the transformer tank to equalize pressure caused by oil expansion. Connect this bypass pipe between the pipe connection E2 and R on the top of the OLTC.

10.3. Transport without oil

NOTICE
Component moisture damage risk! Moisture may cause component damage, performance degradation, and affect normal operation of the OLTC. ✓ For long-term storage, regularly energize the MDU heater to prevent moisture build-up.

If the transformer is transported or stored without oil, completely drain the oil from the diverter switch oil compartment. It is recommended to protect the interior of the oil compartment using

appropriate methods (such as filling with dry air or inert gas) in accordance with local regulations and actual conditions.

10.4. On-site commissioning

⚠ WARNING	
	**Flammable and explosive gases!** Explosive gases may be present under the OLTC top cover, in the connection system, in the conservator, and at the air dehydrator outlet. Ejected components and hot oil spills can cause serious or fatal injuries. ✓ Ensure that there are no open flames, hot surfaces, or potential ignition sources (including static electricity) in the operating environment. ✓ All OLTC tests must be conducted by qualified personnel following established procedures.

NOTICE
Damage to the OLTC! Operating the OLTC without oil can cause damage to the OLTC. ✓ Ensure that the tap selector is fully immersed in transformer oil, and the diverter switch oil compartment is filled before energizing the transformer.

To perform on-site commissioning, perform these steps before energizing the transformer:

1. Before initial energization, ensure the transformer oil meets these requirements: dielectric strength (Ud) > 40 kV/2.5 mm (minimum) and water content < 30 µL/L (maximum).
2. Degas the OLTC as described in 9.1.1 Degas the OLTC.
3. Perform the functional test as described in 9.2.1 Functional test.
4. Connect the minimum oil level signal contact in the OLTC conservator to the circuit breaker trip circuit.
5. Check whether the protective relay is functioning properly according to the manual of QJ-25 series or equivalent protective relay products.
6. Remove the red protection strip from the pressure relief valve (if presented) before energizing the transformer.

Important:
Ensure the inrush current transient has fully subsided before performing tap-changing operations. Inrush current can be several times the normal operating current, potentially overloading the OLTC during switching. Wait at least 30 seconds after energization for the current to stabilize before operating the OLTC.

Observe all safety precautions and instructions during commissioning and testing. See the safety guidelines in this manual.

After energizing the transformer and allowing the inrush current to subside, tap-changing operations can be performed under no-load or on-load conditions.

11. OLTC operation monitoring

Regular visual inspections of the OLTC, in conjunction with transformer inspections, are necessary to ensure proper operations.

Voltage Regulation Method	Dielectric Strength	Water Content
Neutral Point Regulation	≥30 kV/2.5 mm	<40 μL/L
Other Methods	≥40 kV/2.5 mm	<30 μL/L

Avoid frequent OLTC operation during transformer overload conditions. Install an overcurrent self-resetting contact to prevent tap changes when the load current exceeds twice the rated current (2 * In).

Set the protective relay trip contact to operate at an oil flow rate of 2.5 m/s ± 10%. Connect this contact to the transformer's circuit breaker trip circuit. A fault within the OLTC will generate gas, increasing the oil flow rate and activating the relay to trip the circuit breaker and isolate the transformer. Do not manually close the circuit breaker after a protective relay trip until the OLTC has been inspected.

A rupture disk (or a pressure relief valve) is located on the OLTC top cover. This device will not activate during normal tap-changing operations. It will only rupture if a fault occurs inside the diverter switch, causing the oil compartment pressure to exceed 0.3 ± 20% MPa. This protects against further damage. During OLTC installation and maintenance, avoid stepping on or impacting the pressure relief device.

12. Inspection, maintenance, and disposal

⚠ DANGER	
	**Electric shock hazard!** Working on an energized transformer can cause death or serious injury. ✓ De-energize and disconnect the transformer's high-voltage and low-voltage terminals. ✓ Lock out the transformer to prevent accidental re-energization. ✓ Ensure that all components are de-energized. ✓ Ground all transformer terminals (including ground wires and grounding disconnect switches) and ensure they are short-circuited. ✓ Cover or isolate adjacent energized components.

⚠ DANGER	
	**Electric shock hazard!** Working on an energized OLTC can cause death or serious injury. ✓ Do not operate or work on an energized OLTC. ✓ Disconnect all auxiliary circuits, including tap-changer control, pressure relief valve, and pressure monitoring devices. ✓ Verify that all components are de-energized.

⚠ DANGER	
	**Explosion hazard!** Explosive gases in the OLTC oil compartment, transformer, piping, conservator, and dehydrating breather outlet can ignite or explode, causing death or severe injury. ✓ Ensure that the area around the transformer is free of open flames, hot surfaces, sparks (including static discharge), and any other potential ignition sources. ✓ Do not operate any electrical equipment that could generate sparks (e.g., impact wrenches). ✓ Use only conductive and grounded hoses, piping, and pumping equipment suitable for flammable liquids.

NOTICE
Damage to the MDU! Condensation in the MDU can cause damage. ✓ Always maintain the MDU seal. ✓ If operation is interrupted for more than two weeks, connect and operate the anti-condensation heater in the MDU. If this is not possible, place sufficient desiccant inside the MDU enclosure.

Important:
For troubleshooting and repairing the OTLC, contact Huaming after-sales service.

12.1. Periodic maintenance inspection

Follow the inspection guidelines below.

Table 12-1 Inspection guidelines

Interval	Inspection item	Procedure
Yearly	Door seals, cable entries, MDU enclosure ventilation, and control panel ventilation	• Visually inspect for aging, damage, or oil leaks. Replace any damaged or deteriorated components. • Perform a ventilation test on the MDU and control panel.
Yearly	OLTC top cover seal, protective relay seal, and all piping connections	• Visually inspect for aging, damage, or oil leaks. Check gasket elasticity using an insulated probe. • Replace any damaged or deteriorated seals.
Yearly	MDU enclosure and control panel heaters	• Visually inspect circuit components for discoloration, damage, or broken pins. If damage is found, contact Huaming After-Sales Service. • Perform a temperature test using a thermometer and verify that the heaters reach their specified operating temperature.
Yearly	Silica gel desiccant in the conservator breather	Place a humidity indicator card inside the conservator for at least 30 minutes. If the humidity exceeds 10%, replace the desiccant; alternatively, as a preventive maintenance measure, replace it once every year.
Synchronized with the transformer maintenance cycle	Protective relay function	Visually inspect for discoloration, damage, or broken pins. Contact Huaming After-Sales Service if damage is found.
Every 5 years	Oil sample testing for Class I OLTC	Drain the sampling pipeline (depending on the length and diameter of the pipeline, drain 1 to 5 liters of oil), then extract a 0.5-liter oil sample from the bottom of the OLTC. If the sample does not meet the parameters in Table 12-2, replace or recondition the transformer oil.

Table 12-1 Inspection guidelines (continued)

Interval	Inspection item	Procedure
Every 2 years	Oil sample testing for Class II OLTC	Drain 5 liters of oil from the system before taking a sample. Collect a 50-250 ml oil sample from the bottom using a syringe. If the sample does not meet the parameters in Table 12-2, replace or recondition the OLTC oil.

Note: The above maintenance intervals are based on IEC standards. You may adopt more stringent inspection intervals according to your actual conditions and local regulations.

Table 12-2 Oil sample limits

Parameter		Dielectric strength	Water content
Mineral oil (IEC 60296)			
Initial transformer commissioning		>60 kV/2.5 mm	<15 μL/L
During operation	Class I OLTC	>30 kV/2.5 mm	<40 μL/L
	Class II OLTC	>40 kV/2.5 mm	<30 μL/L
After maintenance		>50 kV/2.5 mm	<15 μL/L
Natural ester oil (IEC 62770), only applicable for vacuum tap-changer			
Initial transformer commissioning		>60 kV/2.5 mm	≤100 μL/L
During operation	Class I OLTC	>30 kV/2.5 mm	≤200 μL/L
	Class II OLTC	>40 kV/2.5 mm	≤200 μL/L
After maintenance		>50 kV/2.5 mm	≤100 μL/L
Synthetic ester oil (IEC 61099), only applicable for vacuum tap-changer			
Initial transformer commissioning		>60 kV/2.5 mm	≤100 μL/L
During operation	Class I OLTC	>30 kV/2.5 mm	≤400 μL/L
	Class II OLTC	>40 kV/2.5 mm	≤400 μL/L
After maintenance		>50 kV/2.5 mm	≤150 μL/L

Note: Class I OLTCs are only suitable for use at the neutral point of windings, while Class II OLTCs suitable for use at any position in the windings (according to IEC 60214-1 classification).

12.2. Maintenance intervals

Table 12-3 OLTC maintenance intervals

Interval	Task
300,000 operations (based on MDU counter)	For OLTC inspection and maintenance, contact Huaming after-sales service.
600,000 operations (based on MDU counter)	For diverter switch insert replacement, contact Huaming after-sales service.
1,500,000 operations (based on MDU counter)	For tap selector replacement, contact Huaming after-sales service.

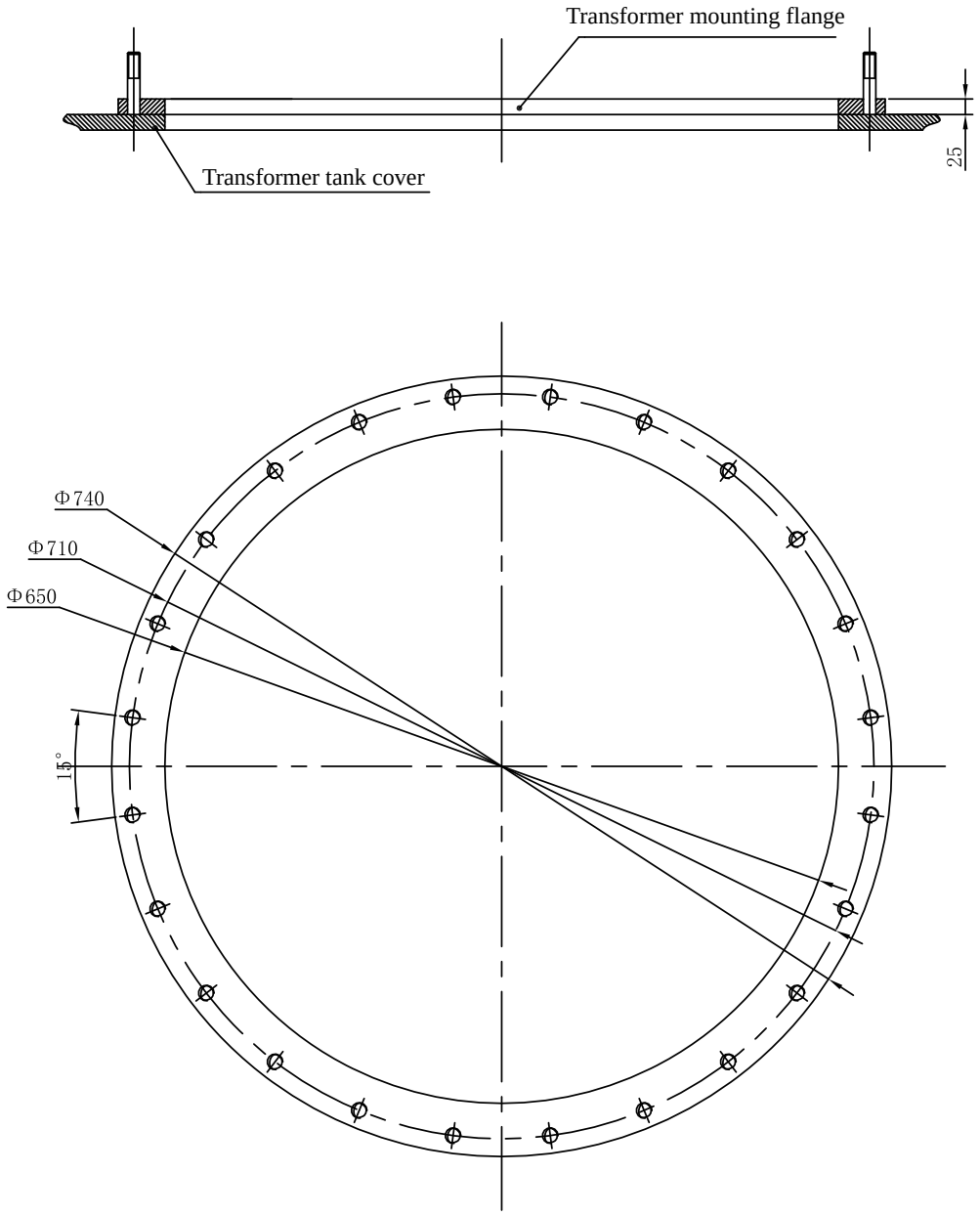
12.3. Disposal

Disposal must obey the applicable national regulations of the country of use. If you have any questions regarding removal or disposal, contact the after-sales service department of Huaming.

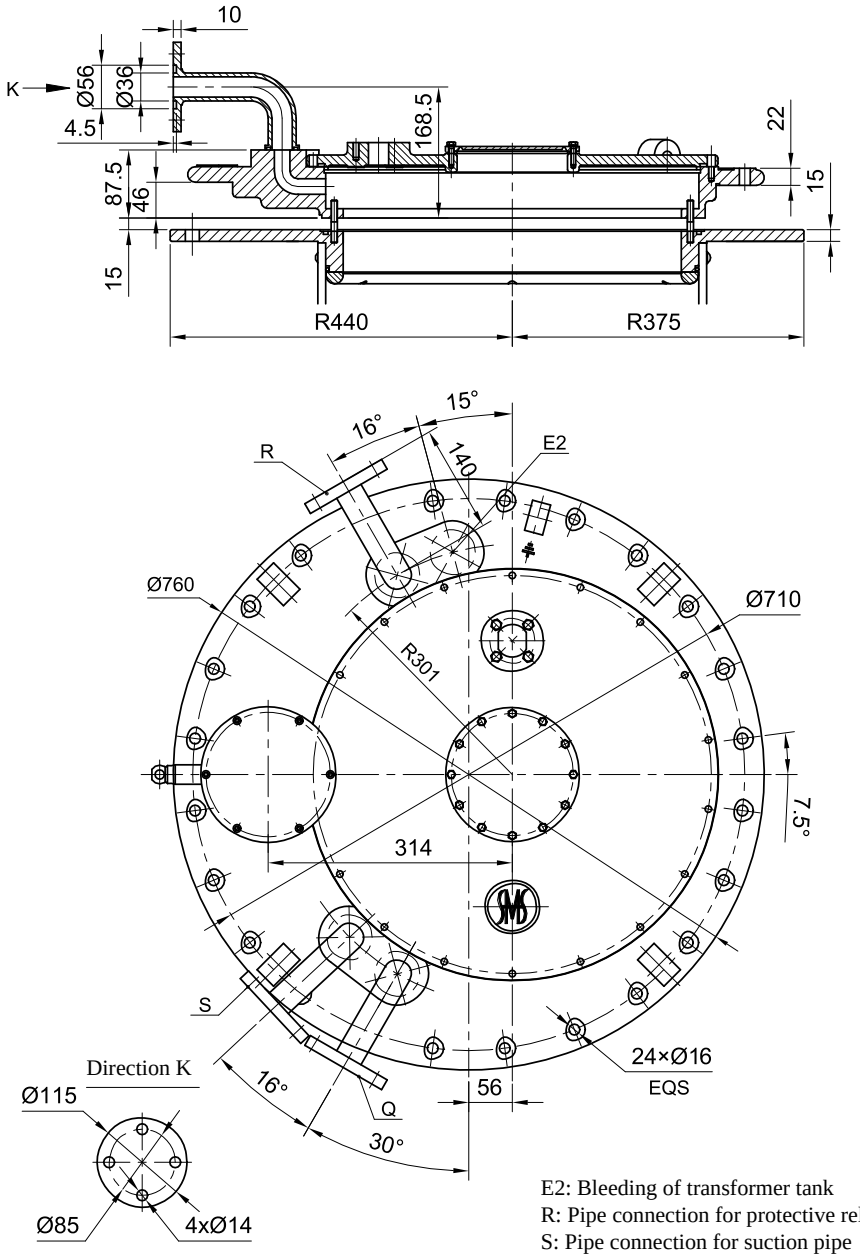
13. Drawings

This chapter contains the main dimension drawings and electrical drawings for the SHZVG type oil-immersed vacuum On-Load Tap-Changer (OLTC).

13.1. Dimension drawing of SHZVG type OLTC transformer mounting flange

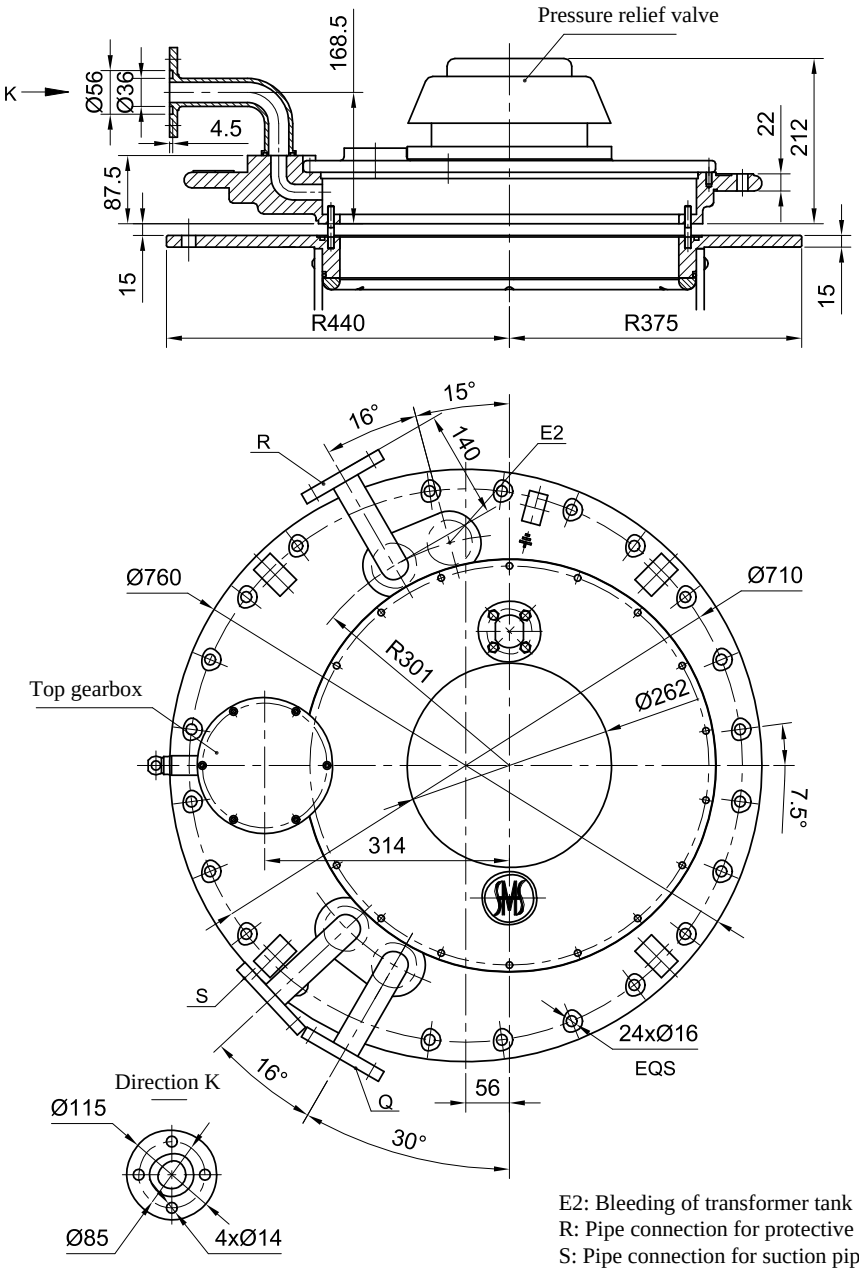


13.2. Outline dimension drawing of SHZVG type OLTC mounting flange



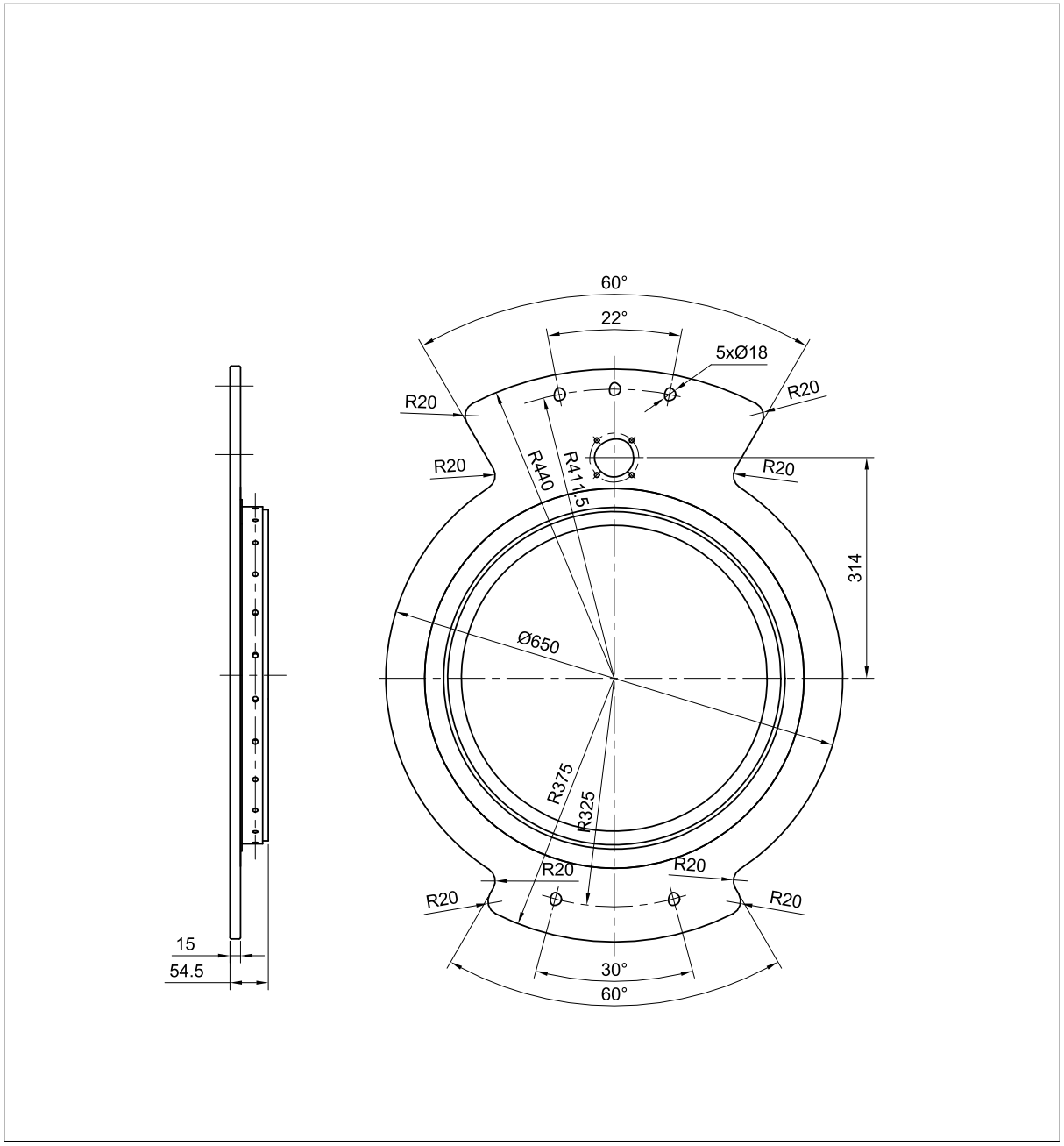
E2: Bleeding of transformer tank
R: Pipe connection for protective relay
S: Pipe connection for suction pipe
Q: Pipe connection for oil return
Note: all oil pipe and gearbox can be rotated by 360°.

13.3. Dimension drawing of SHZVG type OLTC mounting flange with pressure relief valve

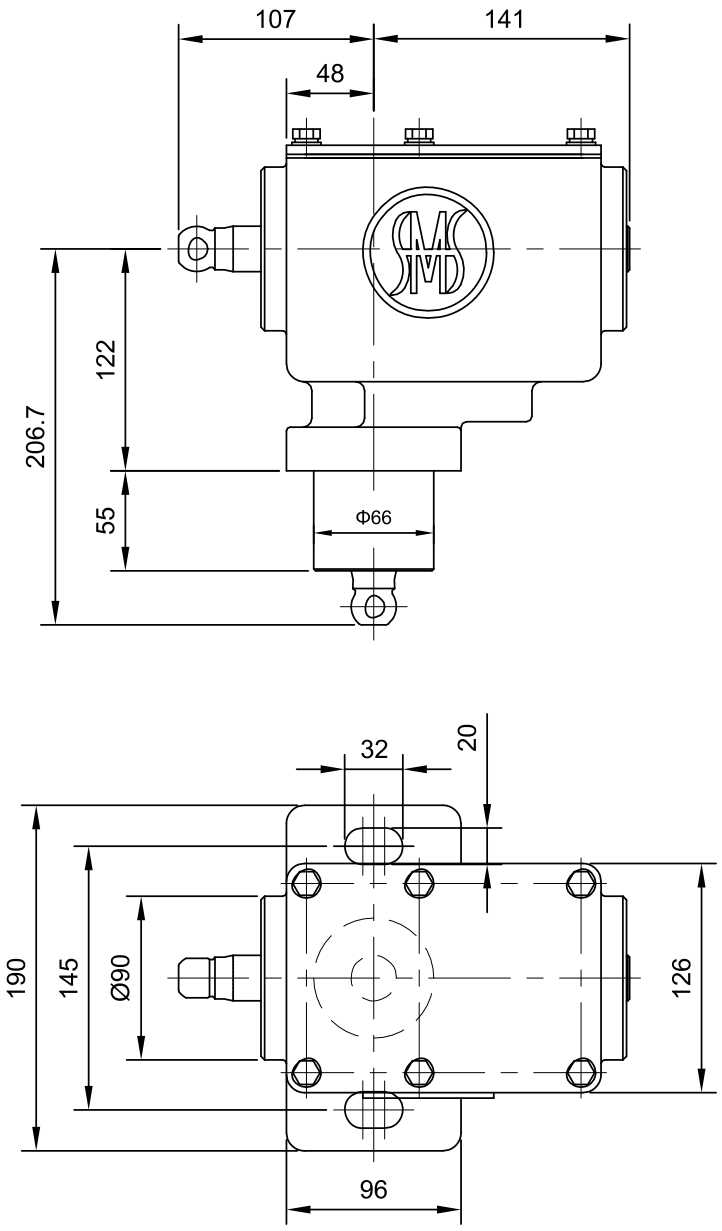


E2: Bleeding of transformer tank
R: Pipe connection for protective relay
S: Pipe connection for suction pipe
Q: Pipe connection for oil return
Note: all oil pipe and gearbox can be rotated by 360°.

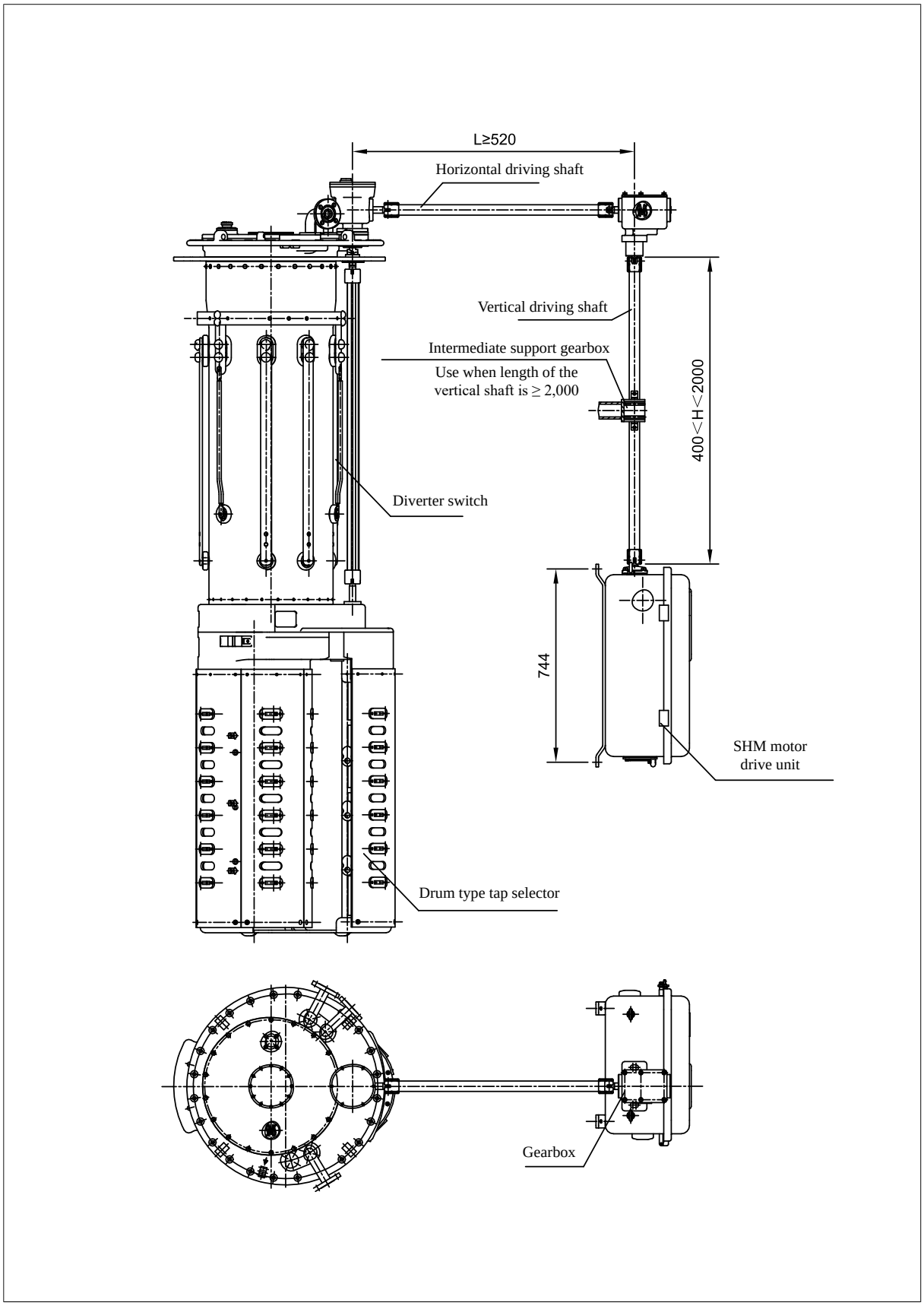
13.4. Outline dimension drawing of SHZVG type OLTC support flange



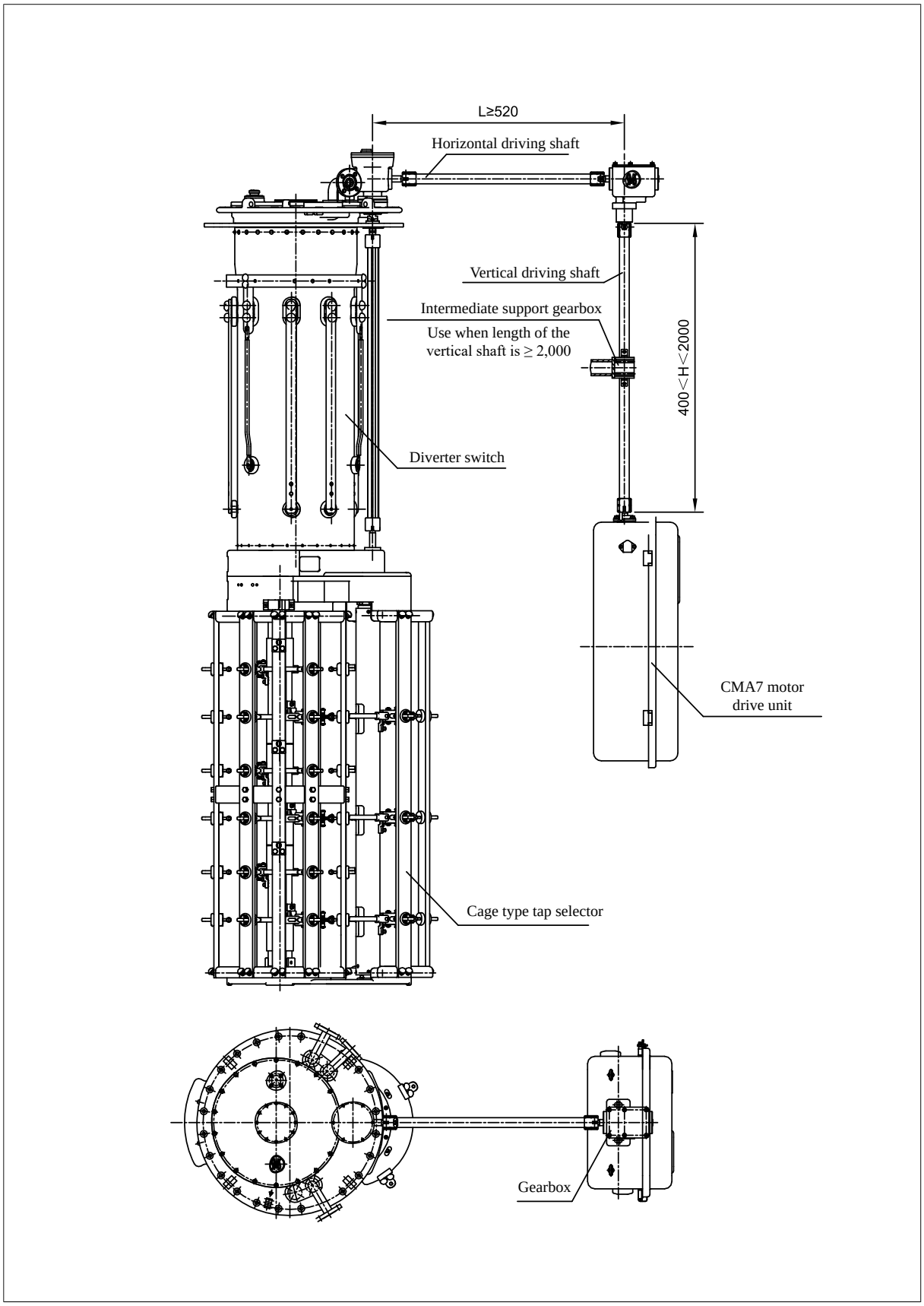
13.5. Bevel gearbox dimensions



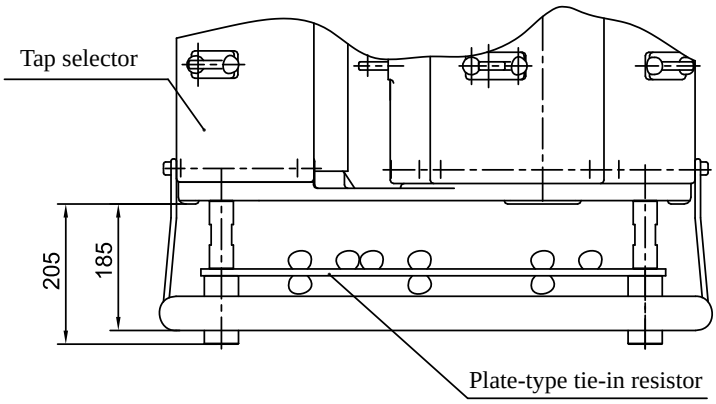
13.6. Connection arrangement drawing of SHZVG type OLTC and SHM series MDU

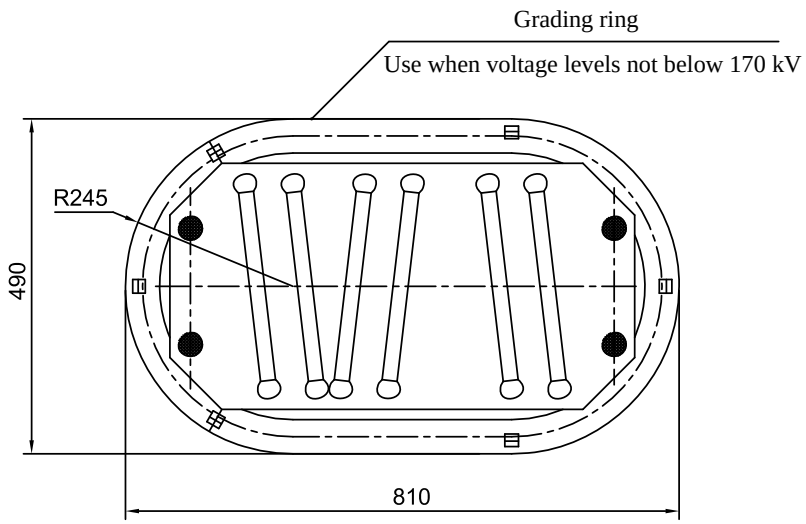


13.7. Connection arrangement drawing of SHZVG type OLTC and CMA7 MDU

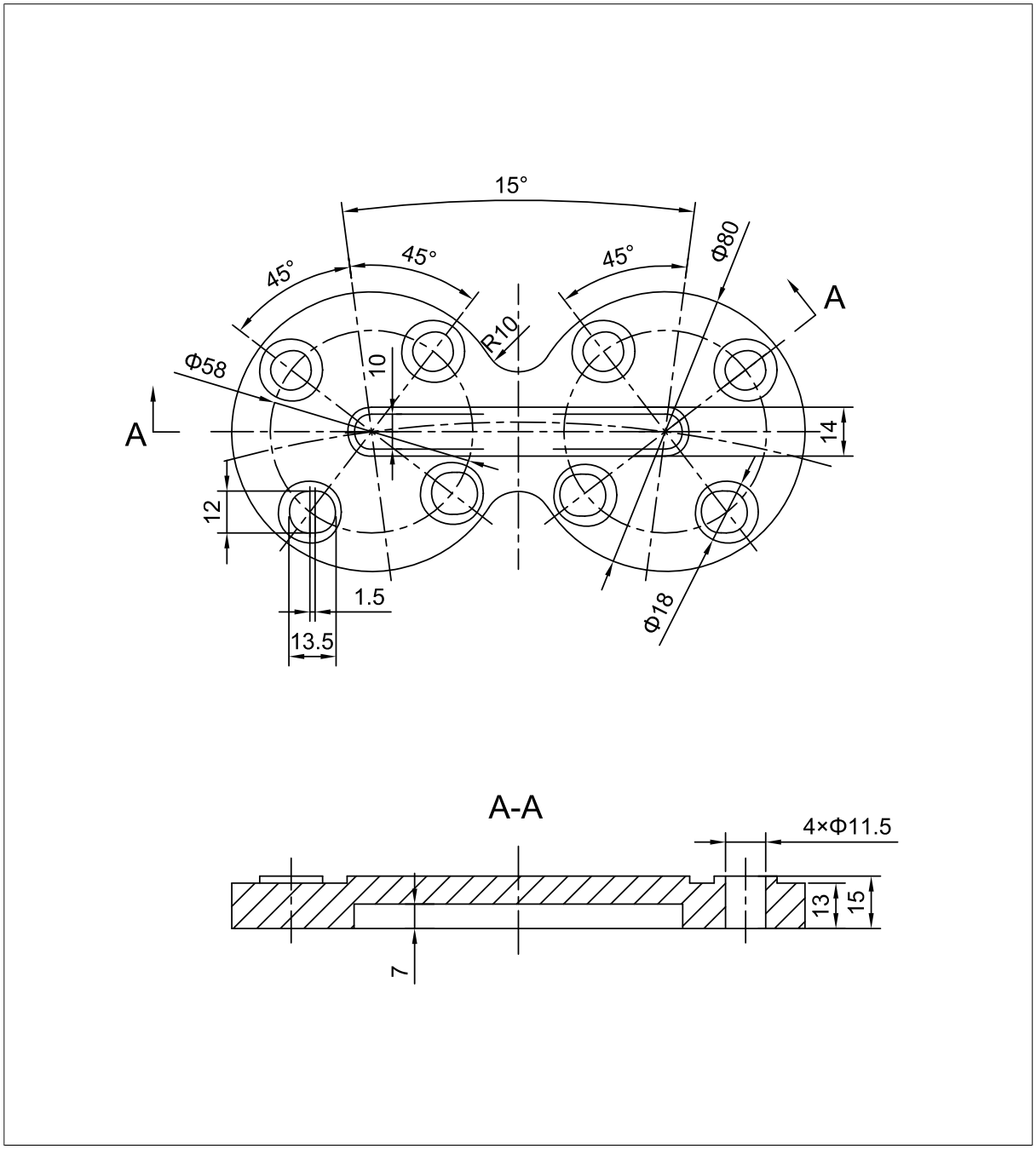


13.8. Installation dimension drawing of plate-type tie-in resistor

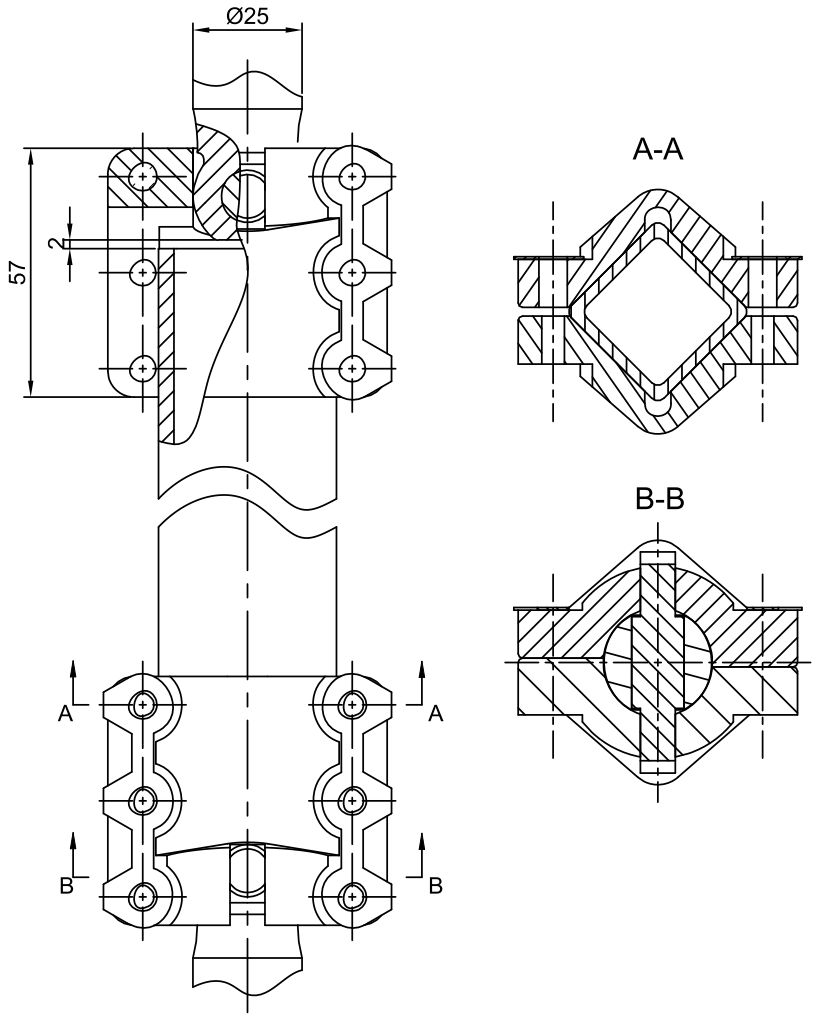




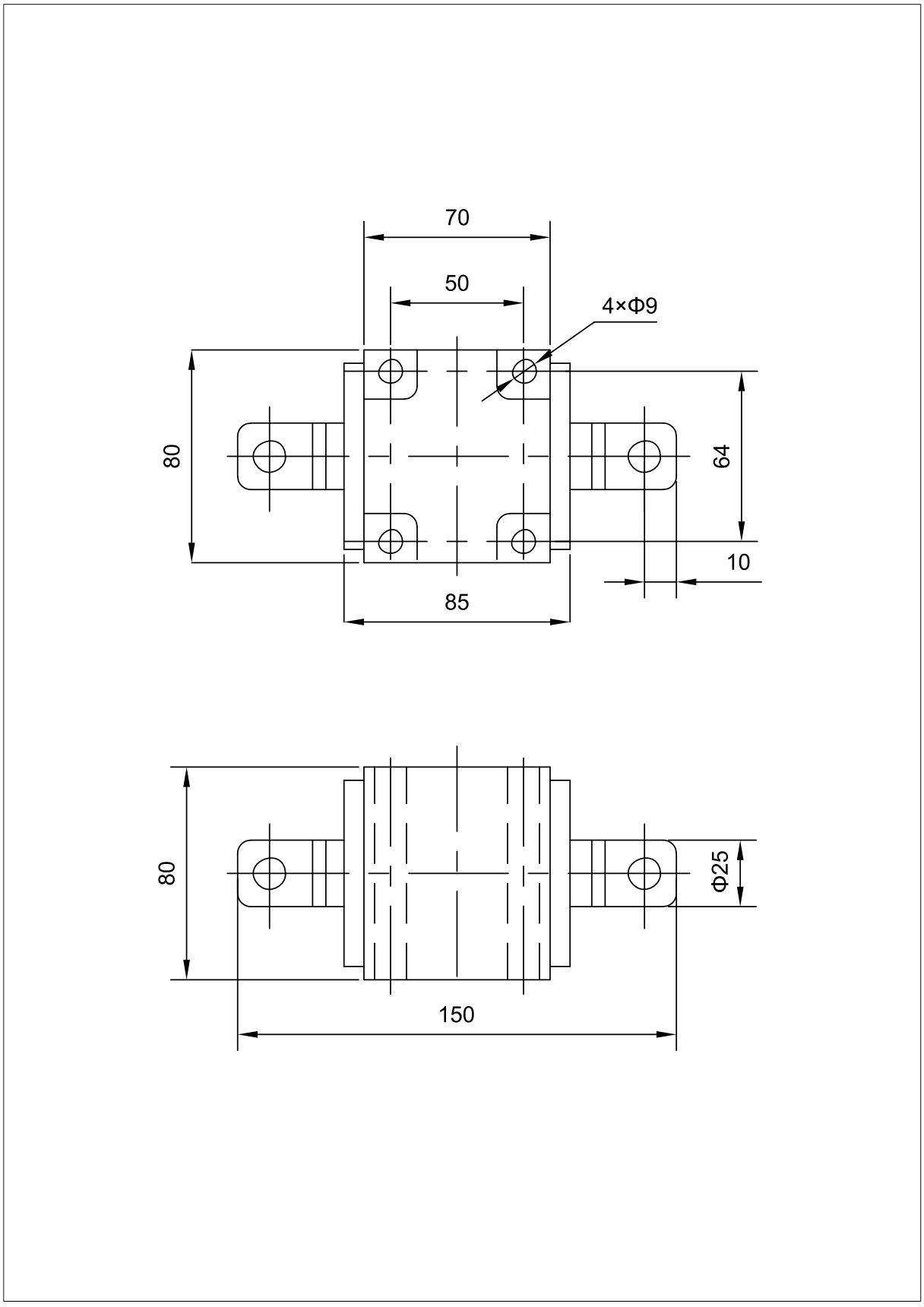
13.9. Bypass pipe structure drawing



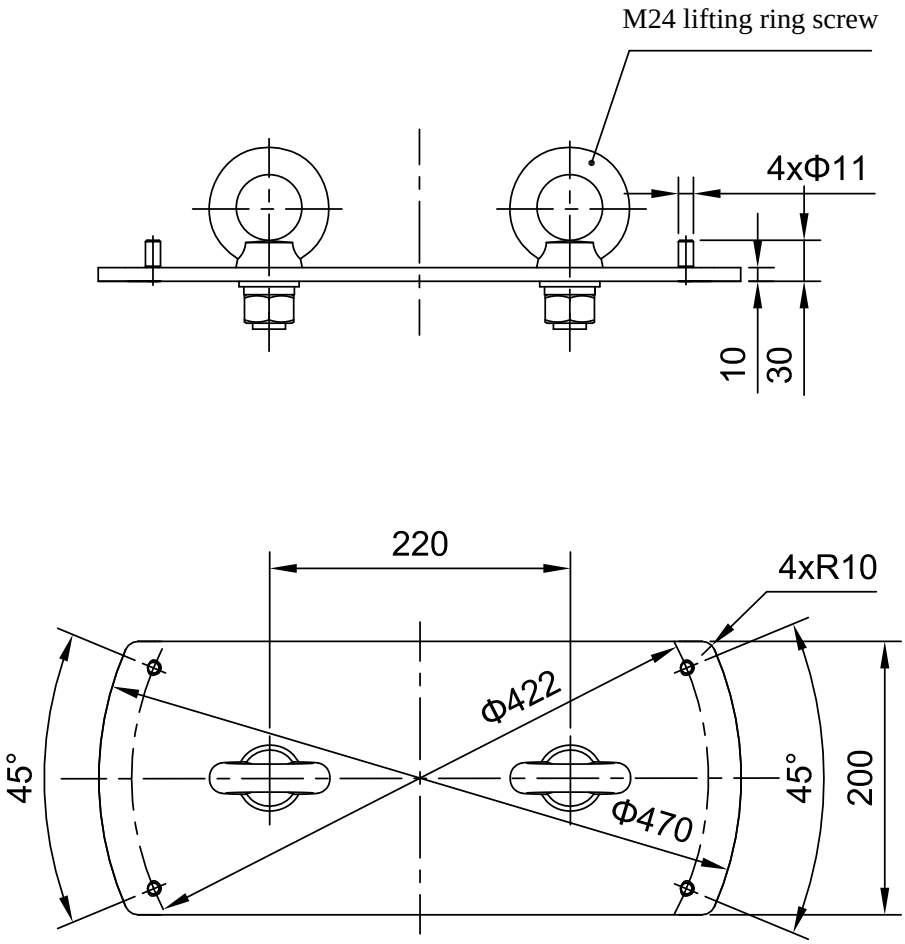
13.10. Horizontal and vertical driving shaft installation



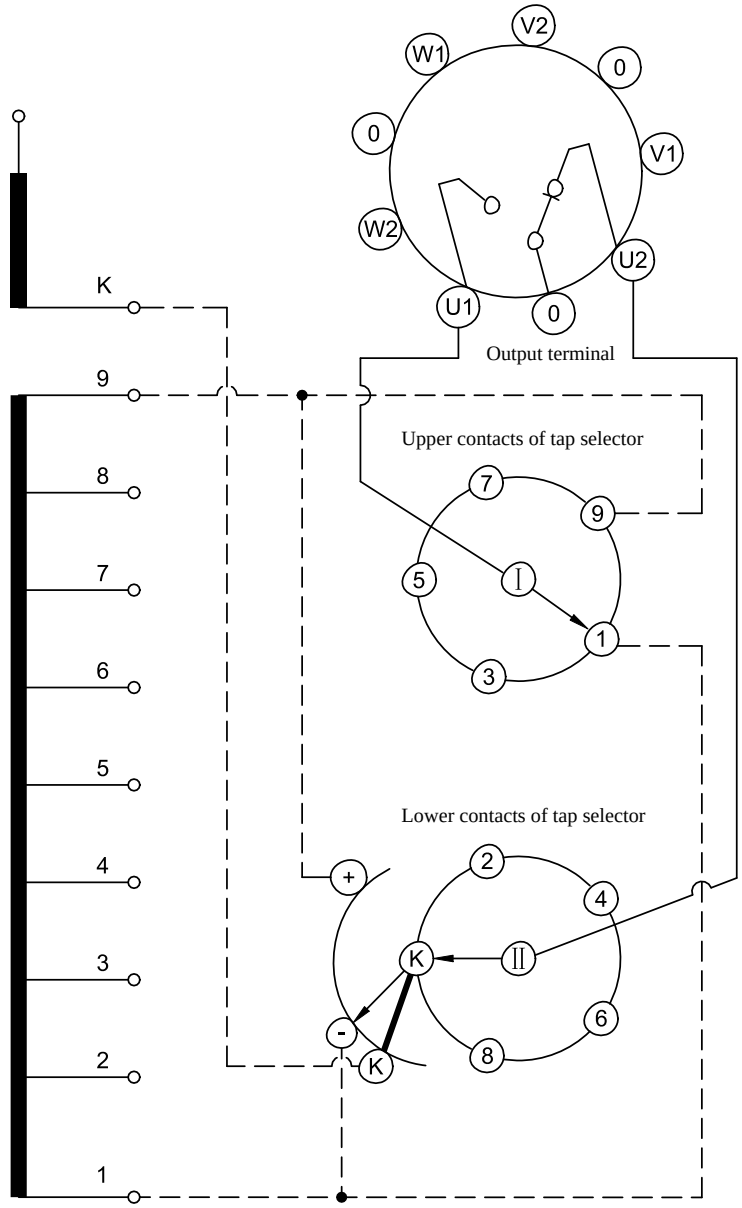
13.11. Dimension drawing of SHZVG type intermediate support gearbox



13.12. Installation dimension drawing of SHZVG type lifting



13.13. SHZVG type OLTC 10193W (T) operating position table and wiring diagram



Operation position number	19
Number of different voltages	17
Set position	9b●

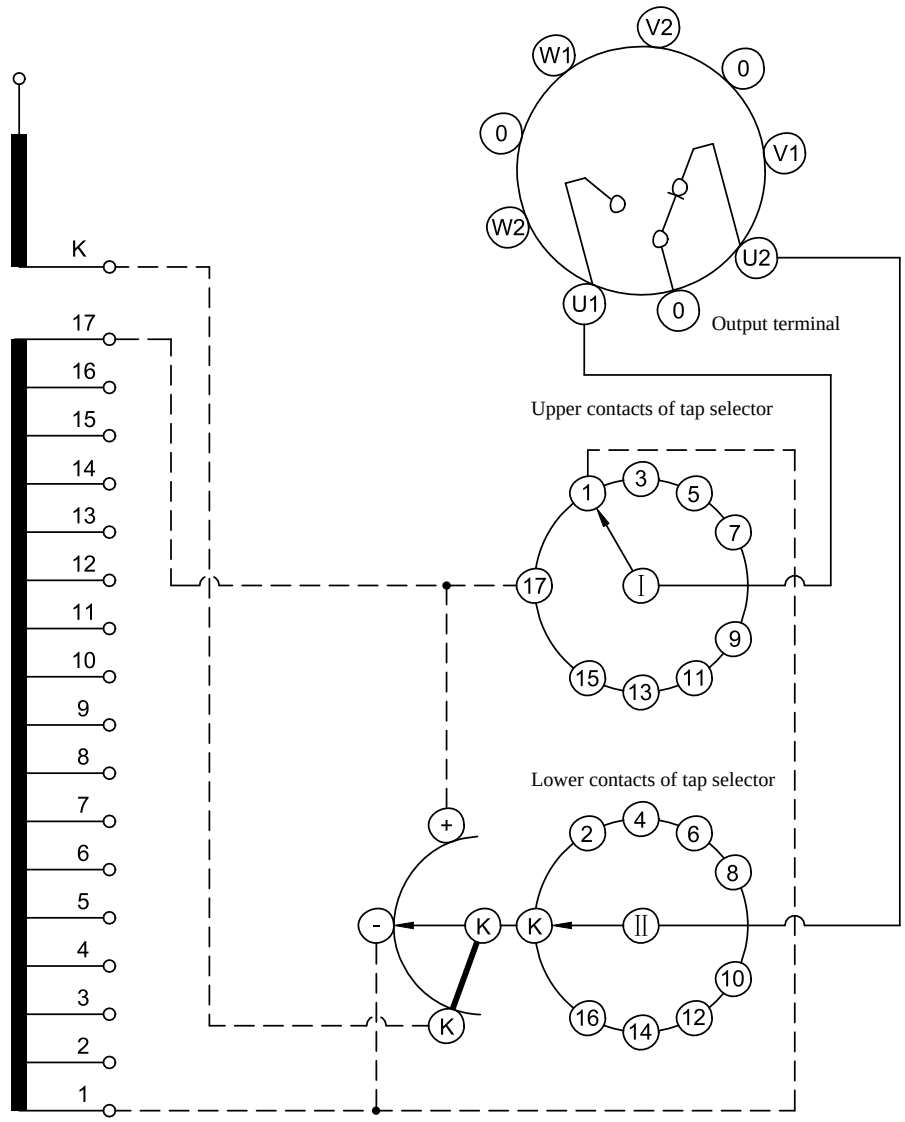
Huaming is responsible for the connection

You are responsible for the connection

Reversing change-over selector position	K+									K-									
Tap selector contact	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Tap position indicator	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17

● The diagram • shows the set working position.

13.14. SHZVG type OLTC 18353W (L) operating position table and wiring diagram



Operation position number	35
Number of different voltages	33
Set position	17b •

Huaming is responsible for the connection

You are responsible for the connection

Reversing change-over selector position	K+																	K-																
Tap selector contact	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	K	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Tap position indicator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17a	17b	17c	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

The diagram • shows the set working position.

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