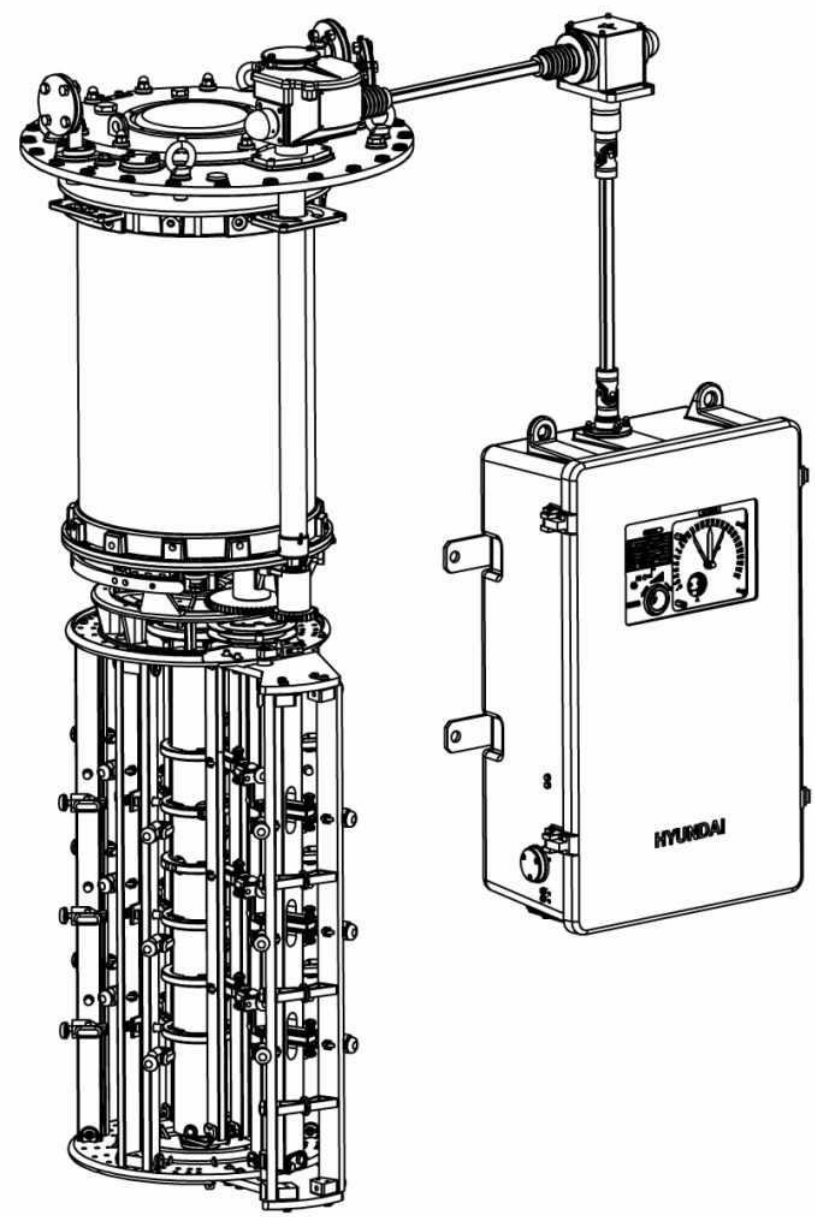
HYUNDAI
HEAVY INDUSTRIES CO. BULGARIA



RS9.3 and RSV9.3 On-Load Tap Changers
Installation and Operation Manual
R2.1-2.4.0001.0000.5.e

Contents:

1. General aspects.

1.1.Safety instructions.

The installation and commissioning of the RS 9.3 and RSV 9.3 on-load tap changers must be performed only by qualified personnel who are responsible for observing strictly the instructions in the present Installation and Operation Manual.

The personnel should constantly and thoroughly review the safety instructions paying special attention to them.

There are three kinds of warnings related to the safety requirements:

Danger!
Points to a danger for the health and life of the personnel. Ignoring these warnings may lead to serious or fatal injury of the personnel, or serious damage of the product.

Attention!
Points to a potential danger for the equipment.

Note!
Gives important information on a specific topic.

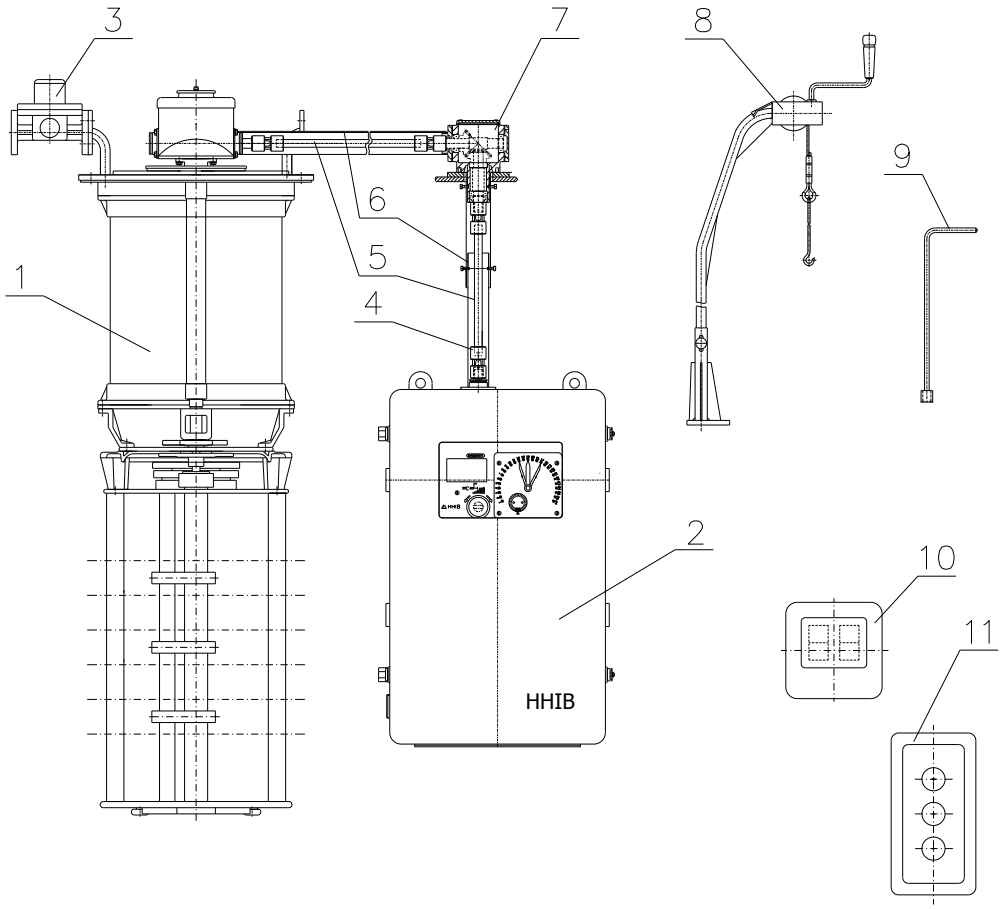
1.2.Application.

The OLTC may be installed and operated only with the transformer specified in the client's order.
Altering of equipment without consulting the manufacturer is not permissible.
It is the buyer's sole responsibility to use the equipment properly.
Improper installation and operation may lead to breakdown of the equipment and injury of the personnel.

2.Complete set of product delivery.

2.1.Standard set.

The standard set that we deliver consists of the following units (Fig. 1):



1. On-load tap changer RS9.3/RSV9.3
2. Motor drive unit MZ 4.4
3. Protective relay, URF 25/10 type
4. Cardan coupler
5. Vertical and horizontal shafts
6. Protective pipes and covers
7. Bever gear
8. Hoist for taking out of the the diverter switch
9. Special wrench
10. Remote position indicator
11. Remote control buttons

Fig.1 – Standard set

2.2.Main units.
2.2.1.Tap changer RS9.3/RSV9.3.

- Diverter switch oil compartment
- Diverter switch
- Tap selector with change-over selector

2.2.2. Motor drive unit.
2.2.3. Shafts, cardan couplers, bevel gears.

2.3. Additional equipment (optional).

- Pressure relief device (Qualitrol)
- Automatic voltage regulator
- Monitoring system
- Oil filter
- Other

3. Delivery and packaging.

The RS9.3/RSV9.3 tap changers combined with MZ4.4 are usually delivered in four parts, and namely:
- Oil compartment with a diverter switch installed in it
- Selector with a change-over selector
- MZ4.4 motor drive unit
- Drive shafts with additional accessories

The abovementioned units are packaged in metal tanks or wooden cases.

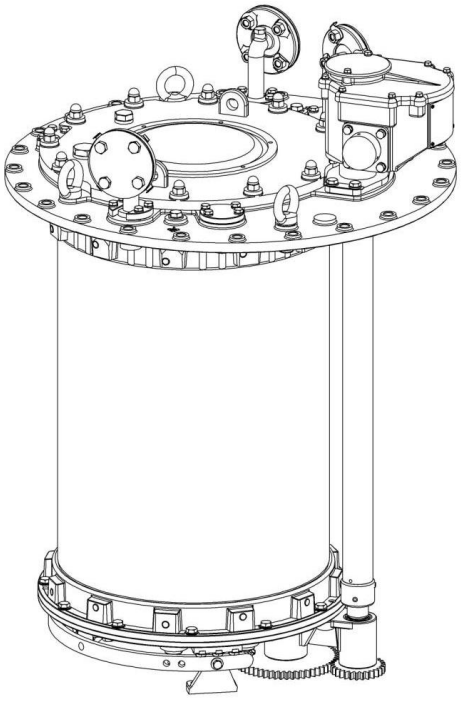


Fig.2 –Oil compartment

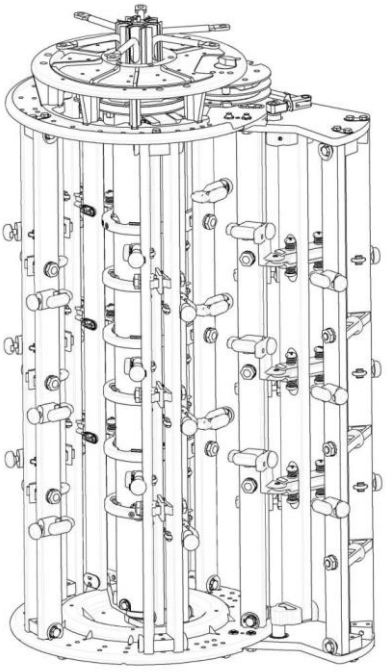


Fig.3 –Selector

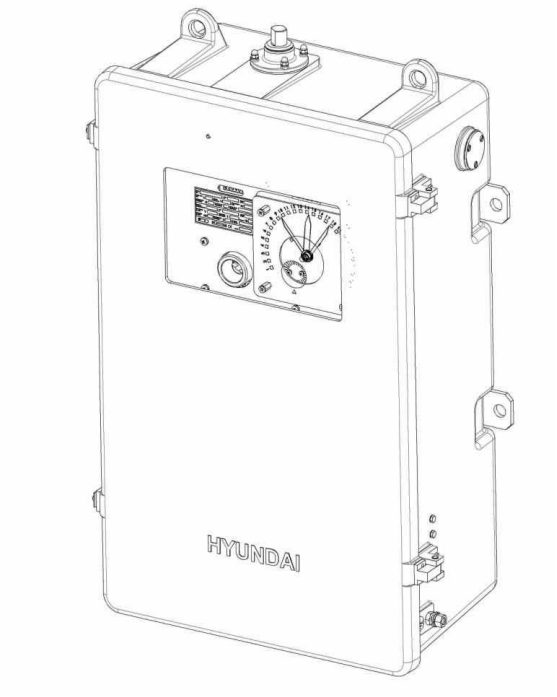


Fig.4 –Motor drive unit MZ 4.4

Fig.5 – Protective relay URF25/10

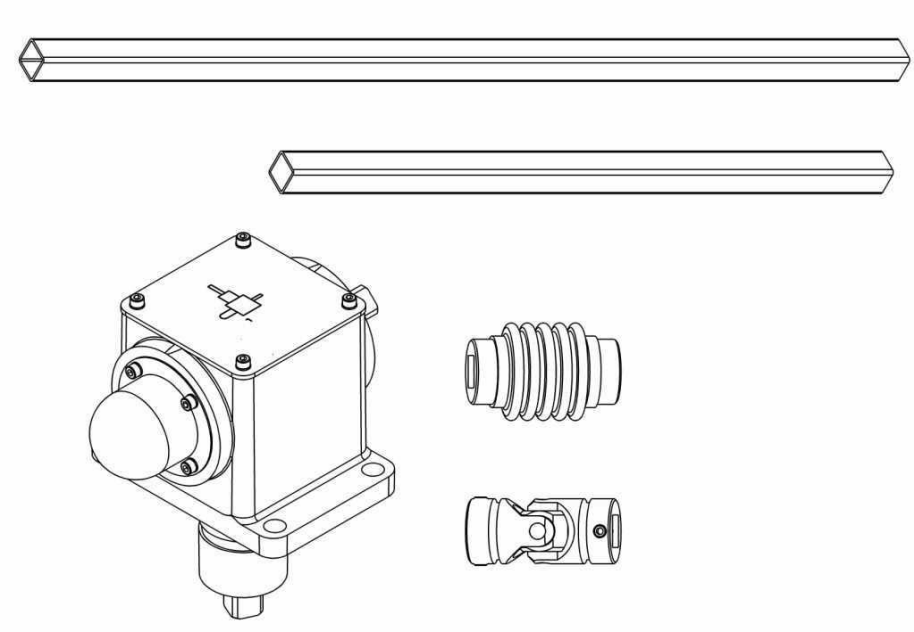
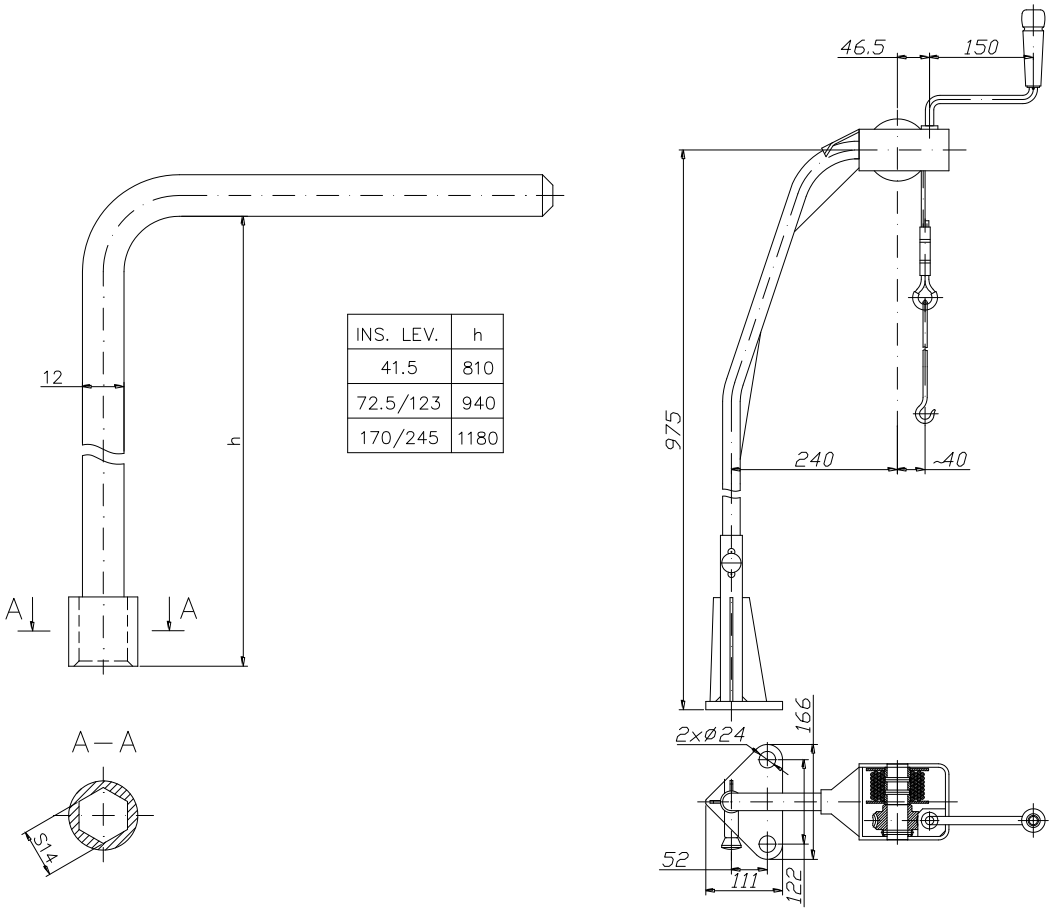


Fig.6 – Bevel gear, cardan couplers, shafts



INS. LEV.	h
41.5	810
72.5/123	940
170/245	1180

Fig.7 – Wrench, hoist

The buyer is responsible for checking whether the delivered units form a complete set, in accordance with the delivery documents.

4.Storage.

The metal tanks and wooden cases containing OLTC units and parts must be stored in dry premises.
While in storage, the OLTCs must be kept in their packaging and should be taken out of them only immediately before installation.

5. Installation of RS9.3/RSV9.3 on the transformer cover.

The RS9.3/RSV9.3 tap changer is installed on a flange of the transformer cover, which must correspond to the carrying flange of the OLTC head. The OLTC flange dimensions are shown in Fig. 8.

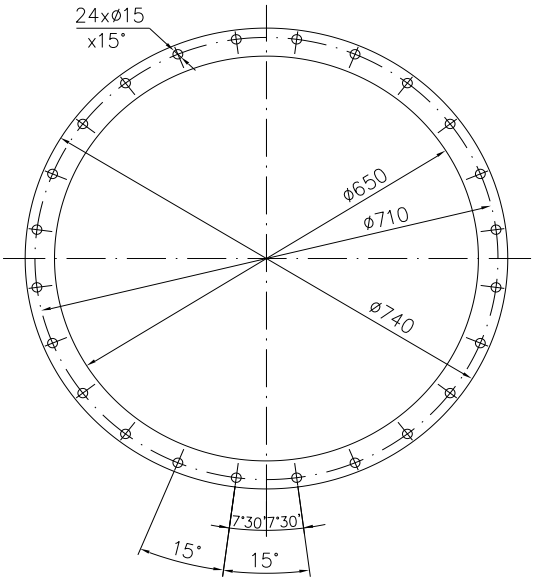


Fig.8 – Dimensions of the installation flange located on the transformer cover

5.1. Installation of RS9.3/RSV9.3 tap changers: insulation size K and L (10,12,14 divisions) with a change-over selector; insulation size M and N without a change-over selector.

5.1.1. Remove the tap selector from its packaging and place it on a horizontal, even and clean surface.
5.1.2. The tap selector is delivered in a ready-to-be-assembled position arrangement corresponding to Tap Position 10 (12,14,16,18).

Note:
The phrase „ready-to-be-assembled position arrangement corresponding to Tap Position 10 (12,14,16,18)" will be used several times in the present manual. The ready-to-be-assembled position arrangement includes the positions of the different elements described below:

5.1.2.1. Tooth 9 of the tap selector must be at the left side of the vertical axis looking from the side of the change-over selector (Contact K).

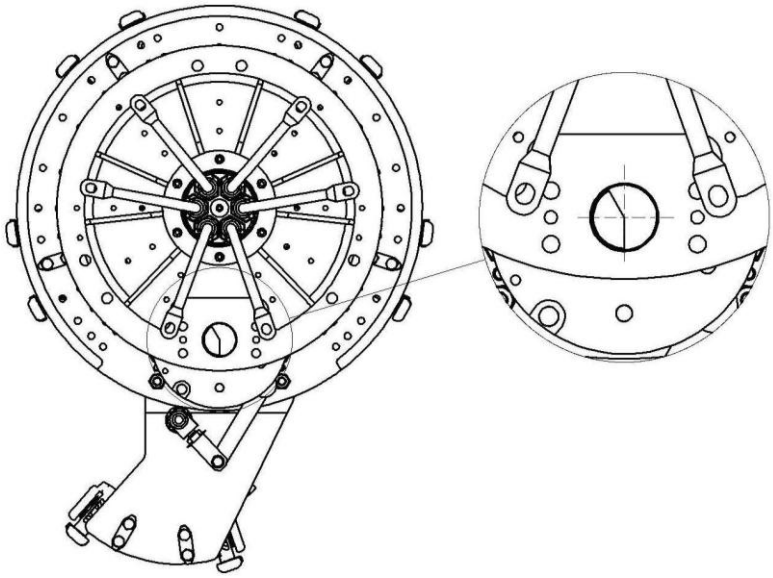


Fig.9 – Ready-to-be-assembled position of the incoming shaft of the selector

5.1.2.2. The moving even contacts are located upon the fixed even contacts 10 (12,14,16,18) for selectors with 10 (12,14,16,18) divisions.

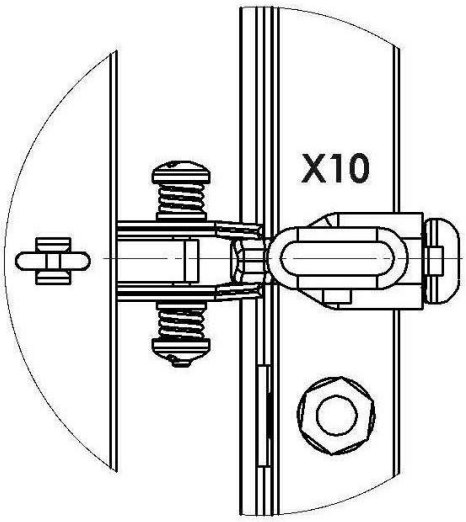


Fig.10 – Ready-to-be-assembled position of the moving even contacts of the selector

5.1.2.3. The moving odd contacts are located upon the fixed odd contacts 9 (11,13,15,17) for selectors with 10 (12,14,16,18) divisions.

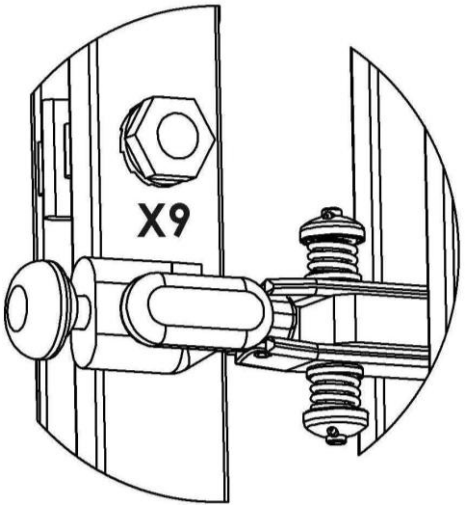


Fig.11 – Ready-to-be-assembled position of the moving odd contacts of the selector

5.1.2.4. The change-over selector is situated at the plus (+) contact. (This paragraph applies to the cases in which the selector is equipped with a change-over selector.)

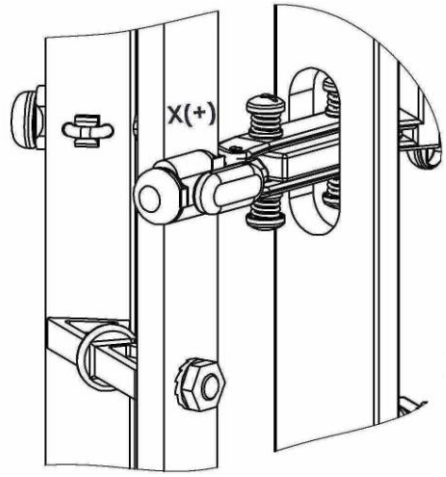


Fig.12 – Ready-to-be-assembled position of the moving contacts of the change-over selector

5.1.3. Remove the diverter switch oil compartment together with the installed diverter switch in it and place it on a horizontal, even and clean surface.
5.1.4. The diverter switch oil compartment, together with the installed diverter switch in it, is delivered in a ready-to-be-assembled position arrangement corresponding to Tap Position 10 (12,14,16,18) shown by the position indicator of the worm gear box.

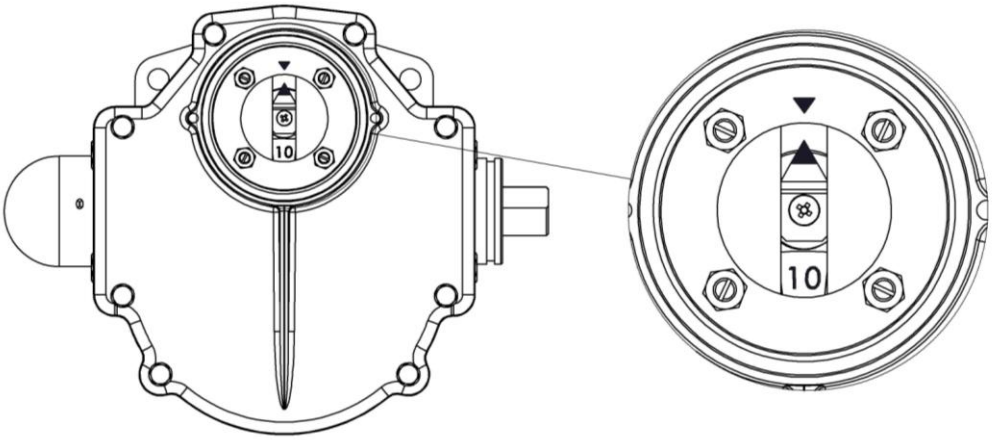


Fig.13 – Position indicator of the worm gear box showing Tap Position 10

5.1.5. The gear wheels of the oil compartment are in a position shown in Fig. 14 (see marking "O").

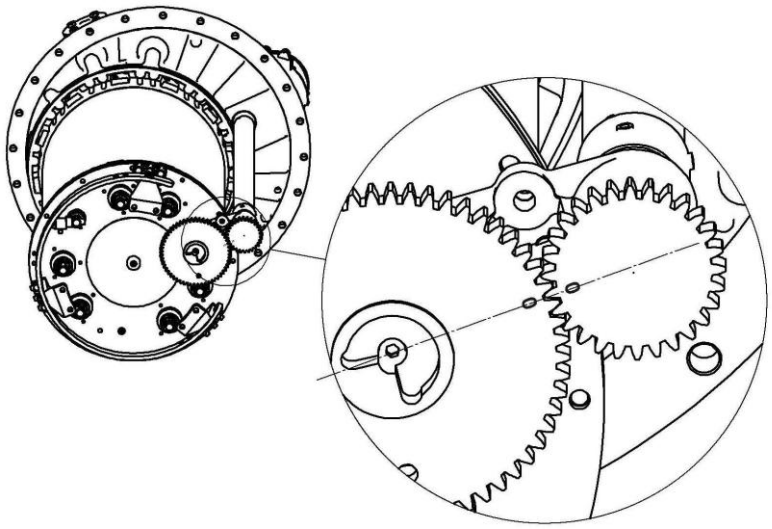


Fig.14 – Marking "O" of the gear wheels of the oil compartment

Attention!
At this stage, do not remove the protective clamp of the incoming shaft of the worm gear box, since it is possible to disturb the ready-to-be-assembled position of the oil compartment.

Attention!
During installation, special care should be taken in order not to damage the membrane on the cover. Attention should be paid to the following sign on the cover: "DO NOT STEP!".

5.1.6. Using the lifting eye bolts, lift the oil compartment with the diverter switch installed in it, and carefully place it on the upper shield of the selector. In this process, make sure that the potential conductor (Position 1) enters in the contact bushing at the bottom of the oil compartment (Position 2) and that the large gear wheel (Position 3) of the oil compartment is coupled properly with the selector shaft.

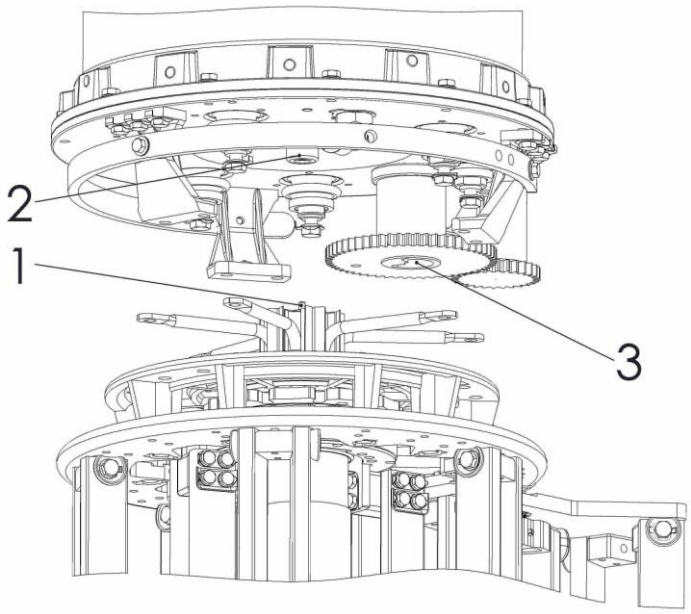


Fig.15 – Coupling the oil compartment with the selector

5.1.7. Using a torque of 40 Nm, screw the six M12 bolts that connect the selector with the legs of the oil compartment, and secure them against unlocking by means of safety washers.

Fig.16 – Connecting the legs of the oil compartment with the selector

5.1.8. Using M10 bolts and a torque of 25 Nm, fasten the conductors situated inside the central insulation pipe of the selector to the contacts of the diverter switch compartment. All bolts must have screen caps (like the ends of the selector contacts). After tightening the bolts, secure them with safety washers.

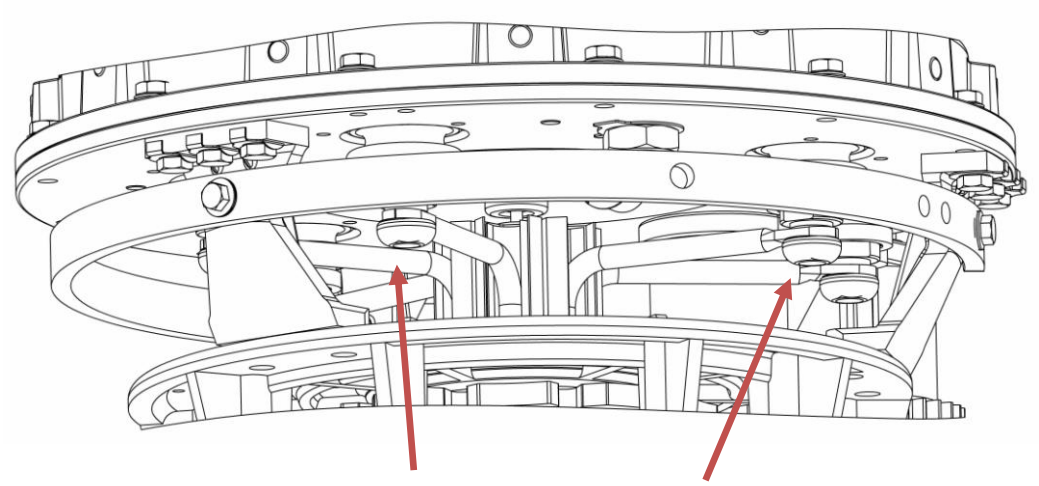


Fig.17 – Connecting the internal current-carrying conductors of the selector to the oil compartment (all bolts with screen caps!)

5.1.9. Using the lifting eye bolts of the oil compartment, lift the fully assembled OLTC and carefully lower it through the opening of the transformer's cover. The surfaces that are to be sealed need to be cleaned beforehand and an oilresistant gasket provided by the transformer's manufacturer must be placed on the installation flange.
5.1.10. The fastening of the carrying shield on the installation flange must be performed by means of M14 nuts or bolts in the sequence shown in Fig. 18:

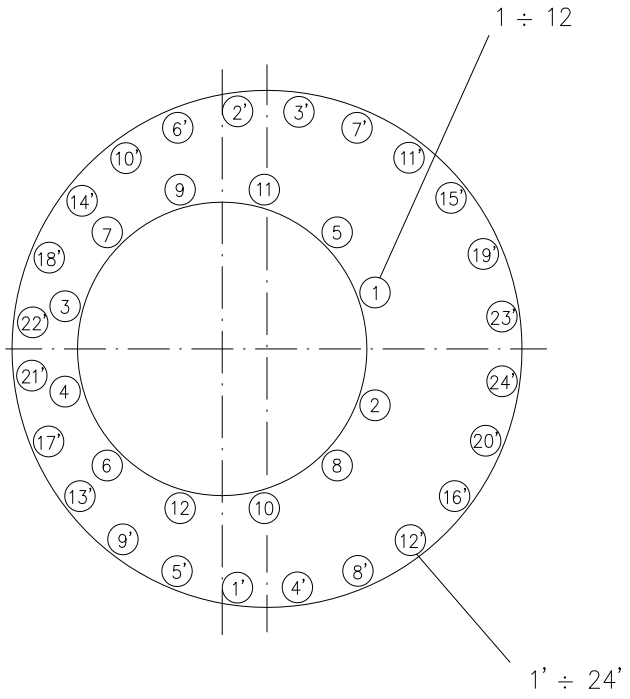


Fig.18 – Tightening sequence of the nuts on the shield of the oil compartment

Attention!
The nuts should be tightened according to the diagram above in four stages:
First stage: 3÷5Nm; Second stage: 18÷20Nm;
Third stage: 28÷30Nm; Fourth stage: 38÷40Nm.

5.1.11. See Paragraph 7 for instructions about connecting the take-off leads of the regulation winding to the selector.
5.1.12. Remove the clamp blocking the incoming shaft of the worm gear box.

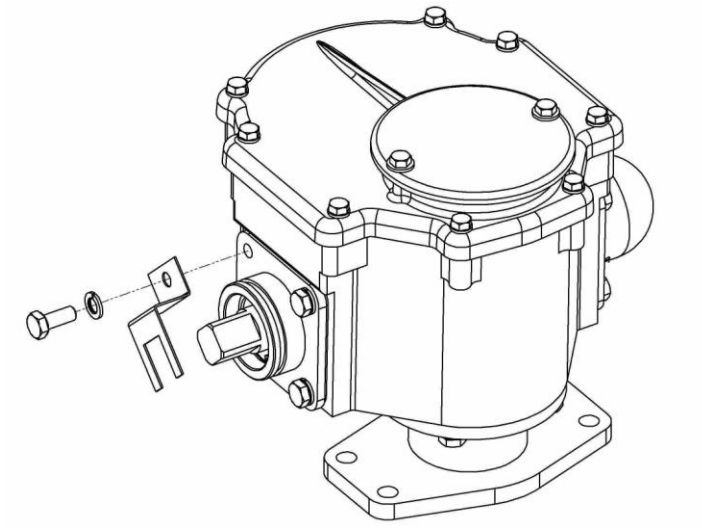


Fig.19 – Transportation clamp of the incoming shaft of the worm gear box

5.1.13. Check if the coupling of the selector with the oil compartment was performed properly. The sequence of the check-up should be as follows:

5.1.13.1. Check the ready-to-be-assembled position arrangement. The positions of the different elements should be as follows:
-reading of the indicator of the worm gear box: Tap 10 (12,14,16,18)
-moving even contacts of the selector: Tap 10 (12,14,16,18)
-moving odd contacts of the selector: Tap 9 (11,13,15,17)
-moving contacts of the change-over selector: Position (+).

5.1.13.2. By means of the worm gear box, perform one switching operation in the Raise direction to Position 11 (13,15,17,19). After the switching operation, the positions of the different elements should be as follows:
-reading of the indicator of the worm gear box: Tap 11 (13,15,17,19)
-moving even contacts of the selector: Tap 10 (12,14,16,18)
-moving odd contacts of the selector: Tap 1
-moving contacts of the change-over selector: Position (-).

5.1.13.3. By means of the worm gear box, perform two switching operations in the Lower direction to Position 9 (11,13,15,17). After the switching operation, the positions of the different elements should be as follows:
-reading of the indicator of the worm gear box: Tap 9 (11,13,15,17)
-moving even contacts of the selector: Tap 10 (12,14,16,18)
-moving odd contacts of the selector: Tap 9 (11,13,15,17)
-moving contacts of the change-over selector: Position (+).

5.1.13.4. By means of the worm gear box, perform one switching operation in the Raise direction to Position 10 (12,14,16,18) corresponding to the overall ready-to-be-assembled position arrangement. After the switching operation, the positions of the different elements should be as follows:
-reading of the indicator of the worm gear box: Tap 10 (12,14,16,18)
-moving even contacts of the selector: Tap 10 (12,14,16,18)
-moving odd contacts of the selector: Tap 9 (11,13,15,17)
-moving contacts of the change-over selector: Position (+).

5.1.14. See Paragraph 8 for checking the transformation ratio.

5.1.15. See Paragraph 9 for drying the OLTC.

5.2. Installation of RS9.3/RSV9.3 tap changers: insulation size K and L (16, 18 divisions) with a change-over selector; insulation size M and N with a change-over selector; insulation size P.

5.2.1. Perform all steps described in Paragraphs **5.1.1. ÷ 5.1.5**..

5.2.2. Using the lifting eye bolts of the oil compartment, lift the oil compartment and carefully lower it through the opening of the transformer's cover. The surfaces that are to be sealed need to be cleaned beforehand and an oilresistant gasket provided by the transformer's manufacturer must be placed on the installation flange.

5.2.3. The fastening of the carrying shield on the installation flange of the transformer cover should be performed in accordance with Paragraph **5.1.10**.

5.2.4. Coupling of the selector and the oil compartment should be performed in accordance with Paragraphs **5.1.6. ÷ 5.1.8**..

5.2.5. See Paragraph 7 for instructions about connecting the take-off leads of the regulation winding to the selector.

5.2.6. Perform all steps described in Paragraphs **5.1.12.** to **5.1.13**.

5.2.7. See Paragraph 8 for information about checking the transformation ratio.

5.2.8. See Paragraph 9 for information about drying the OLTC.

6. Installation of RS9.3/RSV9.3 on bell-type transformers.

6.1. Perform all steps described in Paragraphs **5.1.1. ÷ 5.1.8**..

6.2. Using the lifting eye bolts of the oil compartment, lift the fully assembled OLTC and carefully lower it towards the supporting structure of the active part of the transformer placing the OLTC upon the carriers for fork installation of the OLTC head. The OLTC should be in a vertical position with a deviation of maximum 1˚.

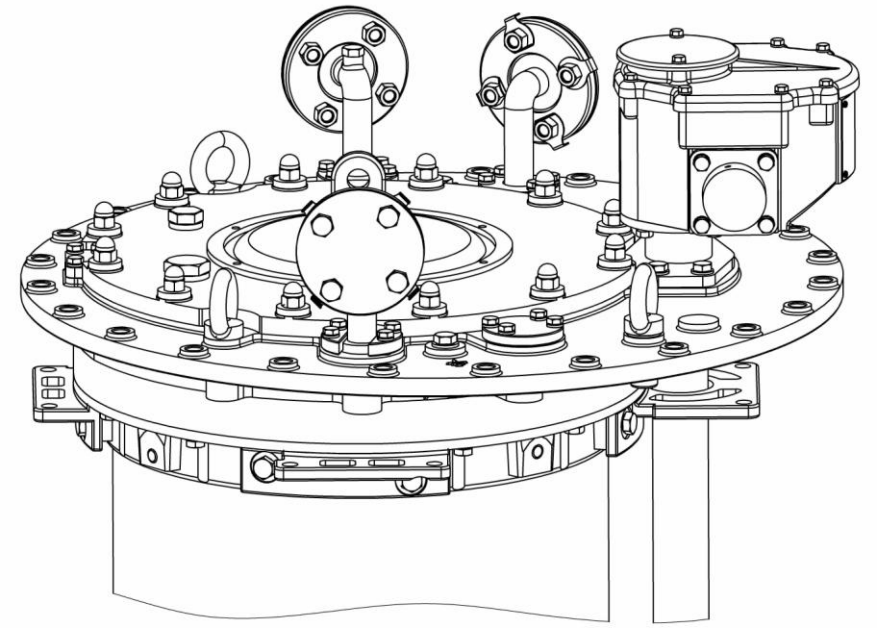


Fig.20 – Arrangement of the carriers for fork installation

Note:
Before installing the take-off leads from the regulation winding to the tap selector, it is recommended to place temporary spacers between the supporting structure and the pairs of carriers. The thickness of these spacers should be equal to the height at which the OLTC is lifted in order to reach its installation position (maximum of 20 mm). The spacers help decrease the tension caused by the take-off leads coming from the regulation winding and connected to the selector. This could be taken into account when designing the take off leads of the regulation winding. After installing the take-off leads of the regulation winding, the spacers are removed and the OLTC is placed on the supporting structure of the transformer active part.

Attention!
The maximum height to which the OLTC may be lifted from the supporting structure of the transformer active part is 20 mm.

Note:
All thread connections should be carefully tightened with the specified torques.
The respective torques are as follows: M8 – 14 Nm; M10 – 25 Nm; M12 – 40 Nm.

6.3. See Paragraph 7 for instructions about connecting the take-off leads of the regulation winding to the selector.

6.4. Perform all steps described in Paragraphs **5.1.12.** to **5.1.13**.

6.5. See Paragraph 8 for checking the transformation ratio.

6.6. Uninstall the cover of the oil compartment after unscrewing the twelve M12 cap nuts and their respective washers.

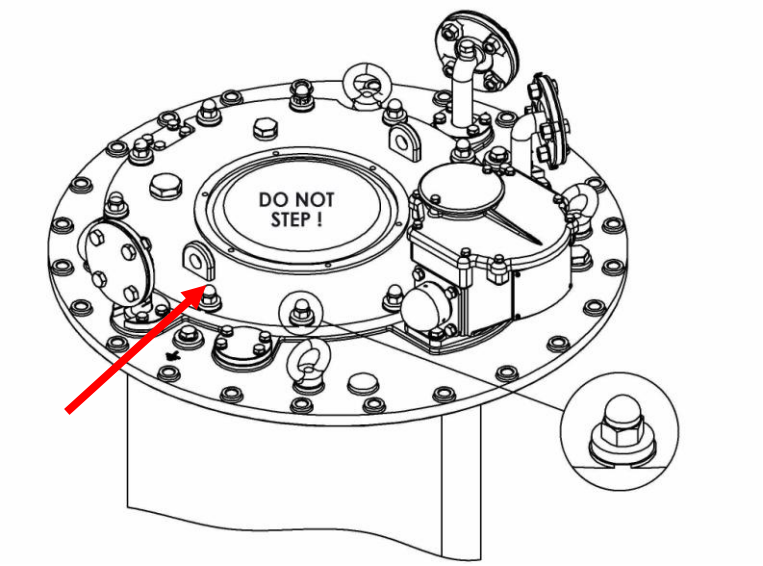


Fig.21 – Cap nuts on the cover of the oil compartment

6.7. Uninstall the siphon of the oil compartment.

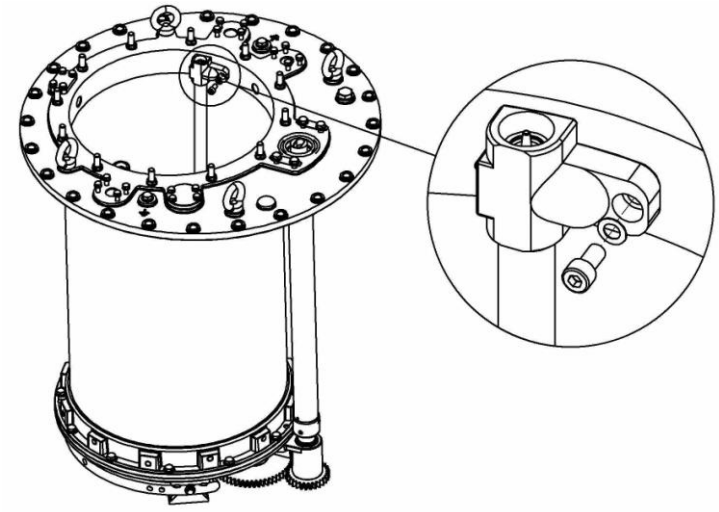


Fig.22 – Unistalling the siphon of the oil compartment

6.8. Uninscrew the twelve M12 nuts and their respective washers.

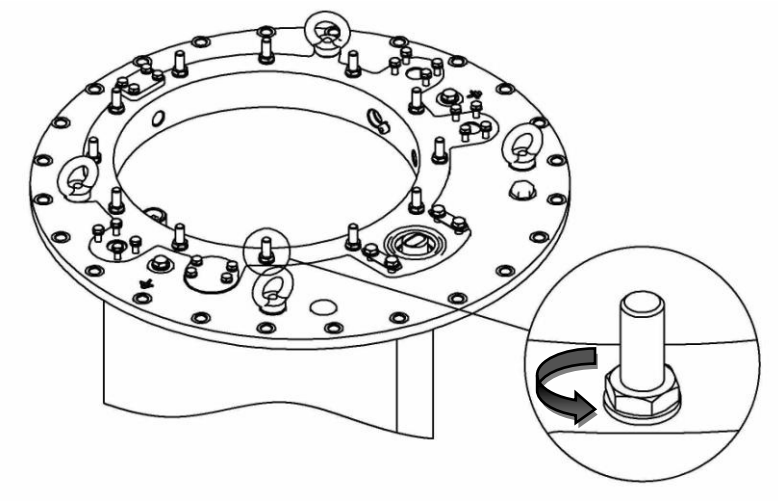


Fig.23 – View from the shield of the twelve M12 nuts

6.9. Turn the incoming shaft of the worm gear box for ***8 revolutions and remember the direction of turning***.

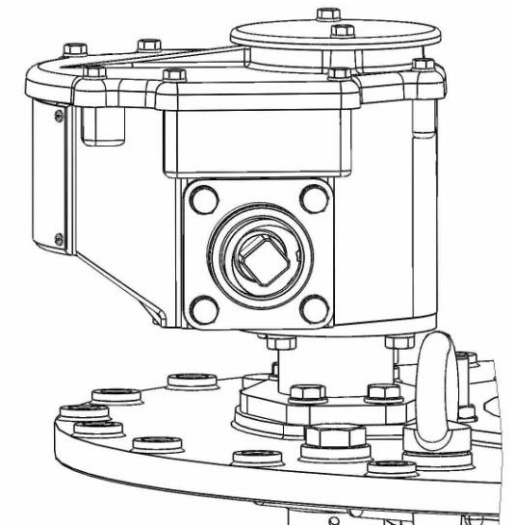


Fig.24 – Turning the incoming shaft of the worm gear box for 8 revolutions

6.10. Uninstall the worm gear box after unscrewing the four M10 bolts and their respective washers.

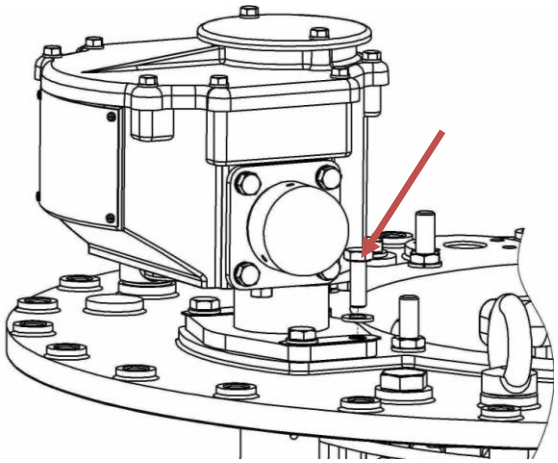


Fig.25 – Bolts for installation of the worm gear box.

Attention!
The number of revolutions needed for a single switching operation is 33.
Every time, before uninstalling the worm gear box, it is VERY IMPORTANT to turn the incoming shaft of the worm gear box for 8 revolutions and remember the direction of turning. This is of utmost importance in the installation and uninstalling process of the RS9.3/RSV9.3 on-load tap changers. After the worm gear has been turned for 8 revolutions, uninstalled and placed in a safe location, it should not be handled until its reinstallation. After it is reinstalled, the worm gear should be turned for 25 revolutions in the same direction as the original 8 revolutions, in order to complete the switching operation that has been started previously.
Failure to observe this requirement may lead to serious damage of the equipment.

Attention!
Please do not attempt in any way to turn the insulation shaft coupled to the oil compartment while the worm gear box is uninstalled.

6.11. Uninstall the carrying shield.

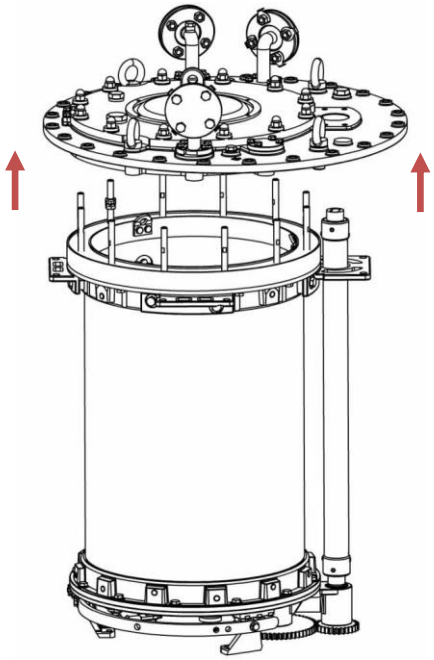


Fig.26 – Uninstalling the carrying shield

6.12. See Paragraph 9 for information about drying the OLTC.

6.13. Lower the transformer bell.

6.14. Place the carrying shield on the installation flange of the transformer bell. The surfaces that are to be sealed need to be cleaned beforehand and an oilresistant gasket provided by the transformer manufacturer must be placed on the installation flange.

6.15. Using the lifting eye bolts (Position 1, Fig. 27), lift the OLTC at a maximum height of 20 mm.

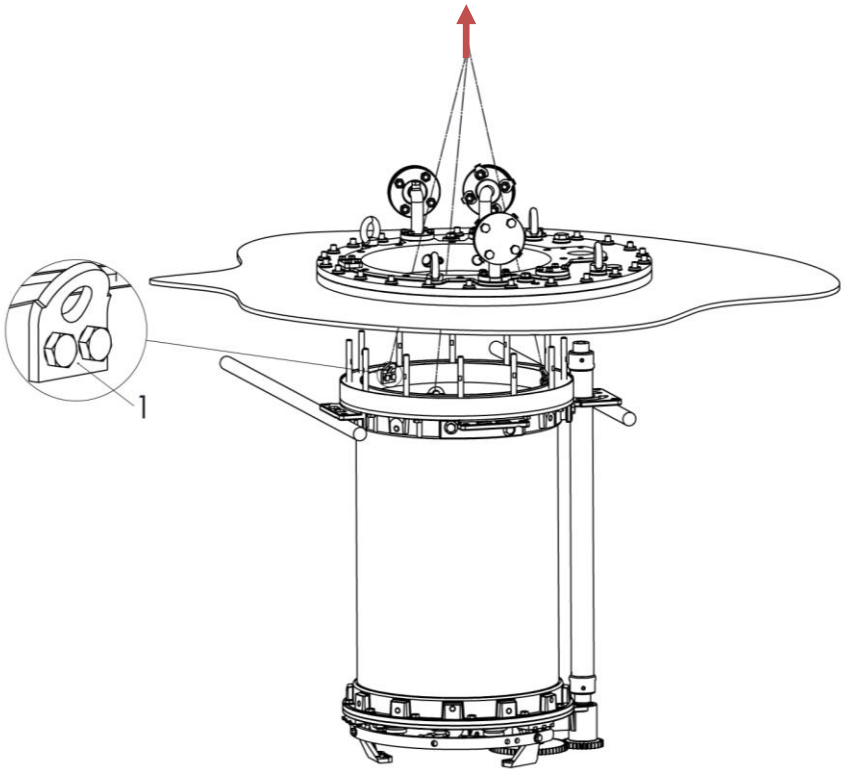


Fig.27 – Lifting the OLTC

6.16. Screw the M12 nuts (40Nm torque) and the washers on the twelve studs that have appeared above the level of the carrying shield. See Fig. 23.

6.17. Install the siphon pipe. See Fig. 22.

6.18. Install the cover using washers and M12 cap nuts (40 Nm torque). See Fig. 21.

6.19. Install the worm gear box using washers and M10 bolts (25 Nm torque). See Fig. 25.

6.20. Using the incoming shaft of the worm gear box, complete the switching operation that was started with 8 revolutions as described in Paragraph **6.9** (the 25 revolutions should be in the same direction as in 6.9.). Afterwards, perform the necessary number of switching operations until reaching Tap Position 10 (12,14,16,18) shown by the indicator of the worm gear box. As stated previously, this tap position corresponds to the ready-to-be-assembled position arrangement of the different elements.

6.21. Perform several switching operations in order to check whether the tap changer functions properly.

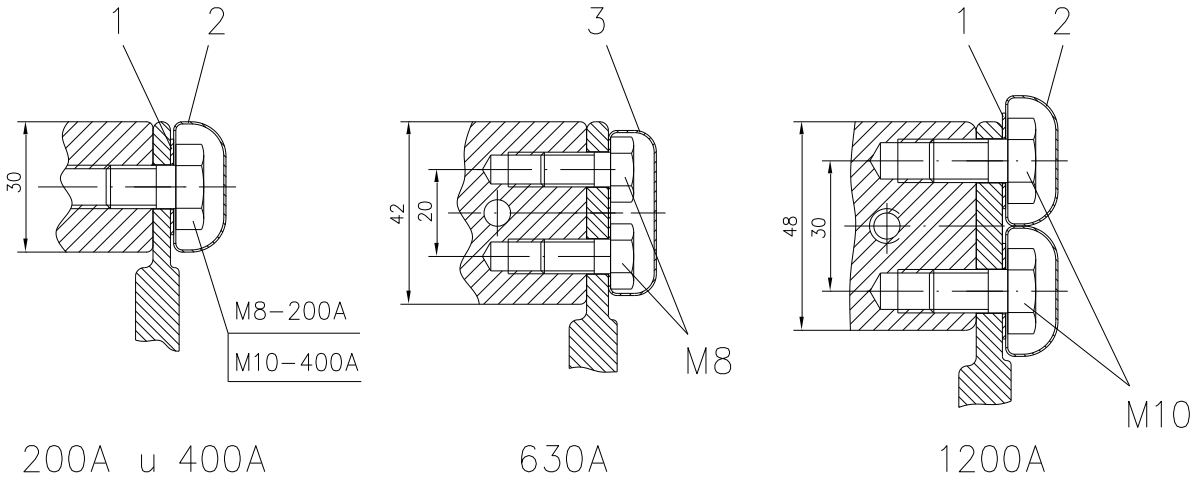
7. Connecting the take-off leads of the regulation winding.

The take-off leads of the regulation winding should be connected to the fixed contacts of the selector, the fixed contacts of the change-over selector and the copper bar of the oil compartment in accordance to the respective connection diagram of the OLTC. Insulating and fastening the conductors should ensure the necessary dielectirc strength between them and their adjacent parts as well as their resistance to short-circuit currents.

Attention!
The take-off leads of the regulation winding should be connected to the OLTC carefully. Their connections should be joined to the contacts in such a way as to not exert stress on the OLTC.

Note:
The dimensions of the connections must allow for lifting the OLTC to its final installation position. If necessary, the connection ends of the tap selector leads can be shaped with ellyptic openings or flexible copper conductors.

The fixed contact ends for connection of the take-off leads from the regulation winding are shown in Fig. 28.



1. Safety washer
2. Shield cap

Fig.28– Fixed contact ends for connecting the leads from the regulation winding

Attention!
The tap leads located in proximity to the change-over selector should be situated in such a way as to be sufficiently distanced from its moving parts.

The current-carrying bar of the oil compartment is shown in Fig. 29.

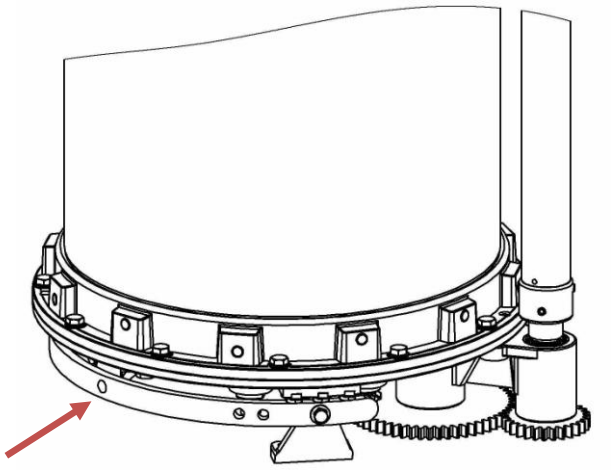


Fig.29– Current-carrying bar of the oil compartment

When the on-load tap changers are with tie-in resistors (fig.30), the current-carrying conductors xp, yp and zp of the tie-in resistors to the selector (pos.1), must be situated in such a way as to be minimum 25mm distanced from the selector's metal parts.

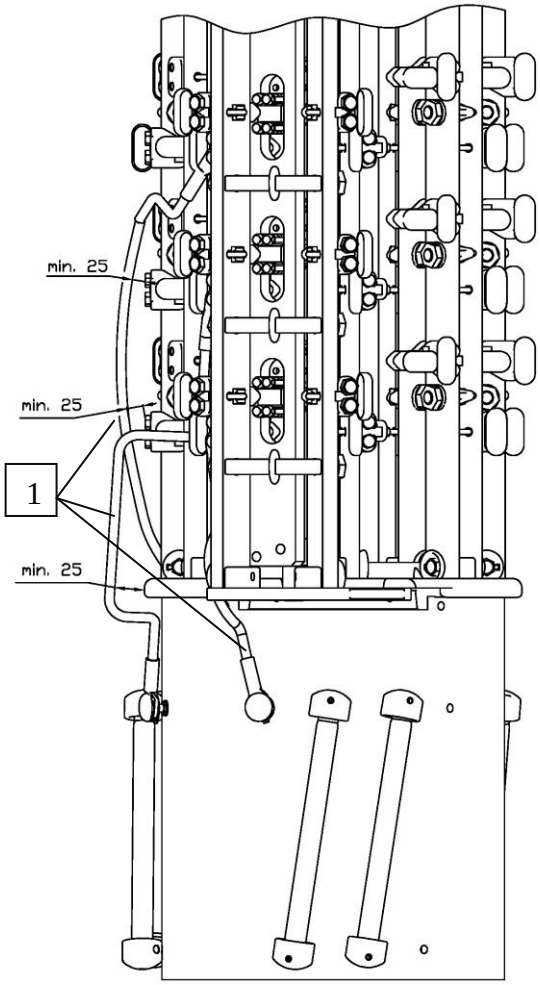


Fig.30 – Tie-in resistors mounted under the selector.

Attention!
When connecting the take-off leads of the regulation winding, take care, the current-carrying conductors of the tie-in resistors to the selector to be minimum 25mm distanced from the selector's metal parts.

8. Checking the transformation ratio.

We recommend that the transformation ratio be checked before drying the transformer.

Note!
When the OLTC has been in storage for a longer period of time, it is recommended that all the friction parts be oiled before starting the switching operation.

The switching of the OLTC may be performed by means of a handle driving the incoming shaft of the worm gear. For one switching operation, 33 revolutions of the incoming shaft are needed. During the switching process, special care should be taken in order not to move beyond the end taps.

The number of the switching operations of the OLTC should be limited to the minimum number needed for performing the measurements.

Attention!
After checking the transformation ratio, the OLTC should be brought to the overall ready-to be-assembled position arrangement. The positions of the different elements should be as follows:
-reading of the indicator of the worm gear box: Tap 10 (12,14,16,18)
-moving even contacts of the selector: Tap 10 (12,14,16,18)
-moving odd contacts of the selector: Tap 9 (11,13,15,17)
-moving contacts of the change-over selector: Position (+).

9. Drying and filling with oil.

9.1. Vaccum autoclave drying.

Attention!
Before drying a RS9.3/RSV9.3 tap changer that is installed on the cover of a tank-type transformer, the cover of the diverter switch oil compartment and the worm gear box, together with their gaskets, must be uninstalled and taken out of the autoclave.
(For details about the uninstalling procedures, see Section 6.6, 6.9, 6.10).

Attention!
Before drying a RS9.3/RSV9.3 tap changer that is installed on a bell-type transformer, the cover of the diverter switch oil compartment, the carrying shield and the worm gear box, together with their gaskets, must be uninstalled and taken out of the autoclave.

The drying procedure must be carried out in the following sequence:

- Heating of the OLTC under air pressure to a maximum temperature of 110°C; the maximum rate of temperature increase should be 15°C per hour.
- Preliminary drying of the OLTC in circulating air at maximum temperature of 110°C for a period of 20 hours
- Vacuum drying at a residual pressure 10^{-3} bar and maximum temperature 110°C.

The duration of the drying procedure for the OLTC depends on that of the transformer.

- Gradual lowering of temperature to 50°C.
- Filling with pure transformer oil in vaccuum.

Attention!
Fast drying with high temperature and vacuum at the start is not permissible, since it may cause defects in the insulation elements.

Attention!
The drying times specified above are the minimum ones needed for ensuring the appropriate dielectric strength of the tap changer insulation.

Attention!
Switching operations of the OLTC after drying may be performed only after oiling the diverter switch (through filling the oil compartment with transformer oil), the drive mechanism of the selector and the contact systems of the selector. If the abovementioned parts are not oiled, there is a danger of damaging the gaskets, the bearings and other friction parts.

9.2. Drying in the transformer tank.

If the transformer needs to be dried in its own tank, in order to ensure drying of the interior of the diverter swich compartment, a bypass pipe with a minimum inner diameter Ø 20 needs to be installed. This pipe connects the interior of the transformer tank with that of the diverter switch oil compartment. The pipe connection is joined to the bleeding plugs of the shield and the cover of the OLTC. If it is necessary to install a bypass pipe, you may request that this operation be performed by HHIB . The drying procedure is like that in Section 9.1.

Attention!
Switching operations of the OLTC after drying may be performed only after oiling the diverter switch (through filling the oil compartment with transformer oil), the drive mechanism of the selector and the contact systems of the selector. If the abovementioned parts are not oiled, there is a danger of damaging the gaskets, the bearings and other friction parts.

9.3. Kerosine vapour drying in a vacuum autoclave.

Attention!
Before drying a RS9.3/RSV9.3 tap changer that is installed on the cover of a tank-type transformer, the cover of the diverter switch oil compartment and the worm gear box, together with their gaskets, must be uninstalled and taken out of the autoclave.
(For details about the uninstalling procedures, see Section 6.6, 6.9, 6.10).

Attention!
Before drying a RS9.3/RSV9.3 tap changer that is installed on a bell-type transformer, the cover of the diverter switch oil compartment, the carrying shield and the worm gear box, together with their gaskets, must be uninstalled and taken out of the autoclave.

Attention!
Before starting the drying procedure, the drain plug at the bottom of the diverter switch oil compartment must be opened in order to drain the kerosene condensate from the oil compartment.

Attention!
The OLTC should not be exposed directly to the influence of kerosene vapour (minimum 1.5 m from the nozzle to the OLTC surface). The drain plug must be screwed back after drying in order to prevent oil leakage from the oil compartment into the transformer tank.

The drying procedure is performed by heating in kerosene vapour to a maximum temperature of 125°C, with a maximum speed of temperature increase of 15°C per hour. The duration of the drying procedure is the same as that of the drying procedure for the transformer.

Attention!
Switching operations of the OLTC after drying may be performed only after oiling the diverter switch (through filling the oil compartment with transformer oil), the drive mechanism of the selector and the contact systems of the selector. If the abovementioned parts are not oiled, there is a danger of damaging the gaskets, the bearings and other friction parts.

Attention!
After completing the drying procedure, the drain plug should be screwed back on.

9.4. Kerosene vapour drying in the transformer tank.

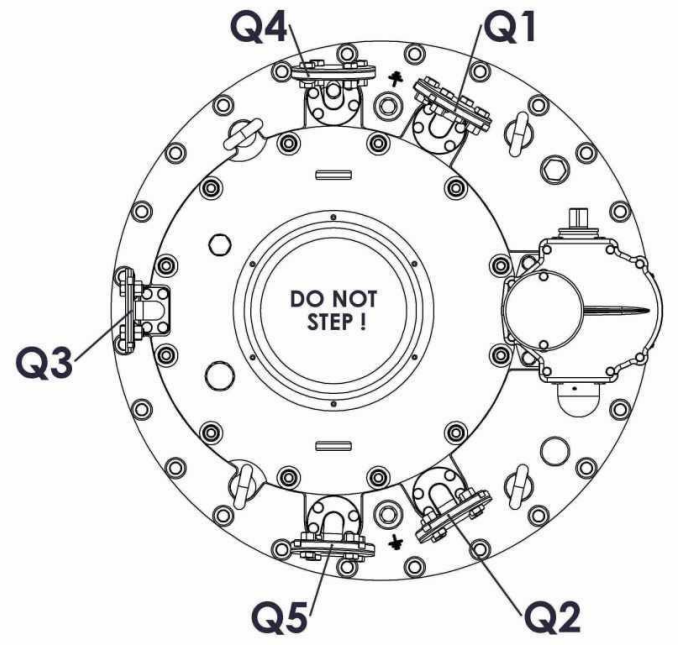
Drying in the transformer tank is performed by installing a bypass pipe with a minimum diameter Ø 20mm. The procedure is the same as that given in Paragraph 9.3.

Attention!
Switching operations of the OLTC after drying may be performed only after oiling the diverter switch (through filling the oil compartment with transformer oil), the drive mechanism of the selector and the contact systems of the selector. If the abovementioned parts are not oiled, there is a danger of damaging the gaskets, the bearings and other friction parts.

Attention!
The diverter switch oil compartment and the conservator that is connected to it must be filled with pure transformer oil according to IEC60296.

10. Pipe connections.

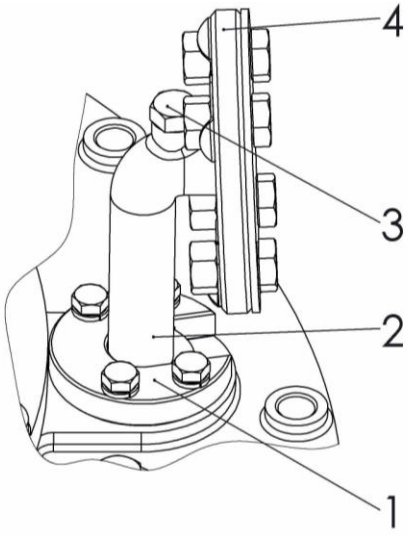
The RS9.3/RSV9.3 tap changers have 5 pipe connections as shown in Fig. 31.



Q1, Q2 – flange for a protective relay or filtering system (rotating at 360˚).
Q3 – flange for a protective relay or filtering system (non-rotating).
Q4, Q5 – flange for a siphon pipe or protective relay (rotating at 360˚).

Fig.31– Pipe connections

The designs of the rotating pipe connections and the drain pipe bleeding plug are shown in Fig.32. After loosening the flange (Pos. 1), the rotating elbow with a flange (Pos. 2) can be freely rotated at the desired angle. The flange (Pos. 4) can also be rotated to the desired position.



1. Flange.
2. Rotating elbow.
3. Drain pipe bleeding plug.
4. Rotating flange.

Fig.32– Design of the pipe connection

11. Connecting the RS9.3/RSV9.3 tap changer with the motor drive unit.

The OLTC is connected with the motor drive unit by means of vertical and horizontal shafts, bevel gear and cardan couplers.

Attention!
The OLTC should be connected with the motor drive unit only in the ready-to-be-assembled position arrangement corresponding to Tap Position (10, 12, 14, 16, 18) and under the following conditions:

1. The local indicators of the OLTC position and the motor drive unit must be showing the same operating position (Fig. 33, arrow A)

2. The normal position indicators of the OLTC and the motor drive unit are set to "normal position" (Fig. 33, arrow B)

3. After connecting the OLTC to the motor drive unit, consecutive switching operations must be performed in such a way that the position indicators show the same position at the same time.

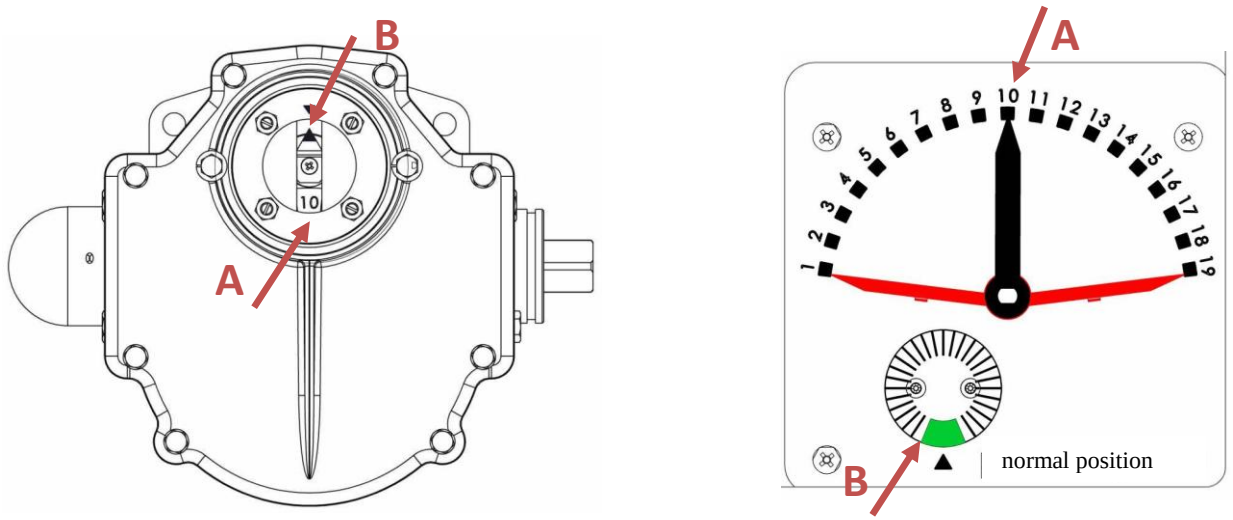


Fig.33– Local indicators of the worm gear box and the motor drive unit

11.1. Installation of a vertical shaft with protective pipes (Fig. 34).

Before coupling the vertical shaft (Pos. 1) with the outgoing shaft of the motor drive unit (Pos. 2) it is recommended that the shaft (Pos. 1) be coupled to the cardan couplers (Pos. 3) and be inserted in the protective pipe (Pos. 4).

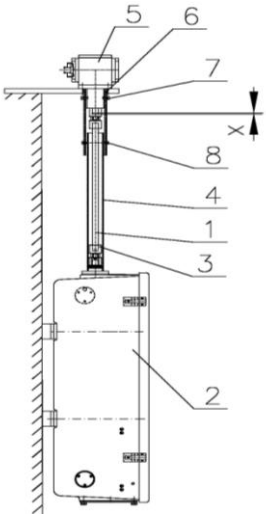


Fig.34 – Vertical shaft with protective pipes

Note:
The cardan couplers (Pos. 3) are without straight protective bellows (Fig. 36).

11.1.1. While coupling the shaft (Pos. 1) with the shaft of the bevel gear (Pos. 5), it is necessary to lift the bevel gear (Pos. 5) upwards, and the wide protective pipe (Pos. 6) to be brought in a telescope like fashion upon the narrow pipe (Pos. 4) downwards.

11.1.2. After fastening the bevel gear (Pos. 5), it is necessary to check the size of axial clearance X, as the shaft (Pos.1) is being lifted manually. The permissible size of the axial clearance is X=2÷3mm.

11.1.3. After being assembled, the wide protective pipe (Pos. 6) must be lifted upwards and fixed to the bevel gear (Pos. 5) with two screws (Pos. 7), as well as to the narrow pipe with three screws (Pos. 8).

11.2. Installation of a vertical shaft without protective pipes (Fig. 35).

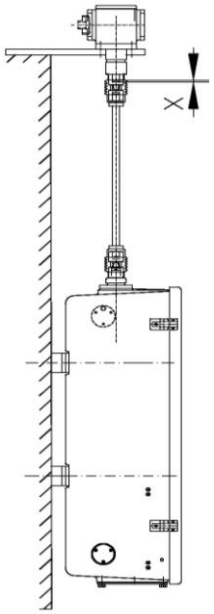


Fig.35 – Vertical shaft without protective pipes

Note:
In the case of a vertical shaft without protective pipes, the following items should be used: cardan couplers with protective bellows (Fig. 37) as well as another type of protective cap for the outgoing shaft of the motor drive unit.

11.2.1. Before coupling the vertical shaft with the outgoing shaft of the motor drive unit, it is recommended that the shaft (Pos. 1) be coupled to the cardan couplers.

11.2.2. When coupling the vertical shaft (Pos.1) with the bevel gear (Pos.5), it is necessary to lift the bevel gear (Pos. 5) manually.

11.2.3. After fastening the bevel gear (Pos. 5), it is necessary to check the size of axial clearance X, as the shaft (Pos. 1) is being lifted manually. The permissible size of the axial clearance is X = 2÷3 mm.

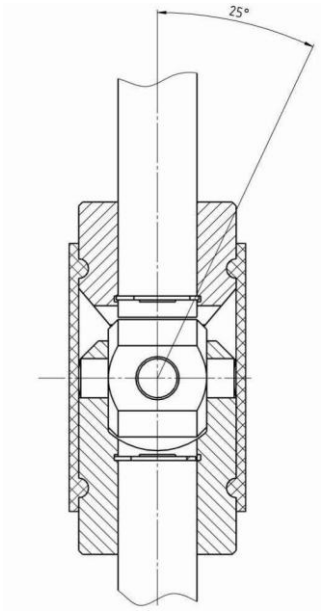


Fig.36– Cardan coupler without a bellows

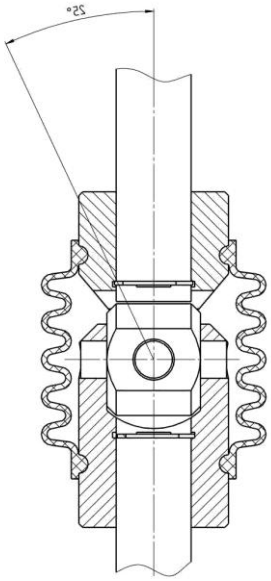


Fig.37 – Cardan coupler with a bellows

11.3. Installation of the bevel gear and the horizontal shafts (Fig. 38).

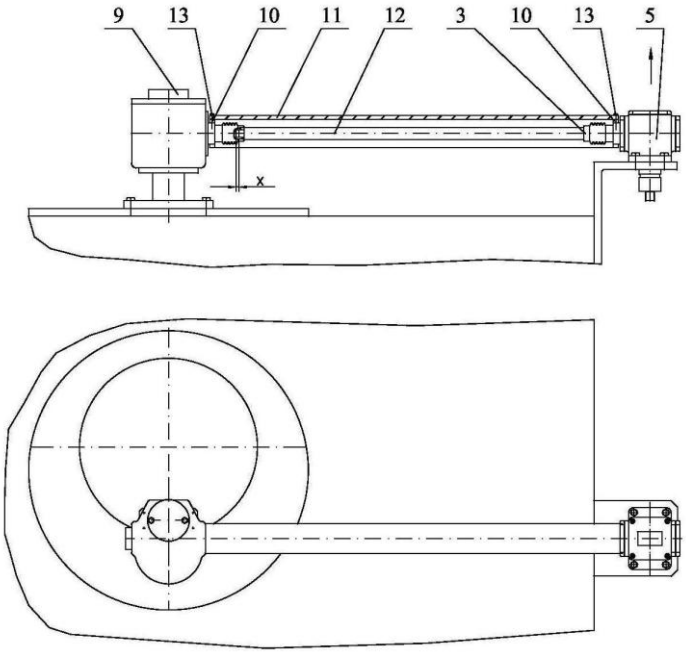


Fig.38 – Horizontal shafts with protective pipes

11.3.1. Before installation, it is necessary to connect the supporting rings (Pos. 10) designated for fastening the protective cover (Pos. 11) to the bevel gear (Pos. Pos. 5) / the worm gear (Pos. 9) of the OLTC. The cardan couplers (Pos. 3) must be equipped with rubber bellows.

11.3.2. The horizontal shaft (Pos. 12) with the cardan couplers (Pos. 3) must be coupled first with the worm gear (Pos. 9) of the OLTC and then with the bevel gear (5); for this purpose, the bevel gear (Pos. 5) must be lifted up. After fastening the bevel gear, the size of the axial clearance must be checked (see Paragraph 11.1).

11.3.3. The fastening of the protective cover (Pos. 11) upon the supporting rings (Pos. 10) must be done by means of clamps (Pos. 13, Fig. 39).
Fig. 40 shows a special design of a protective cover for an inclined horizontal shaft.

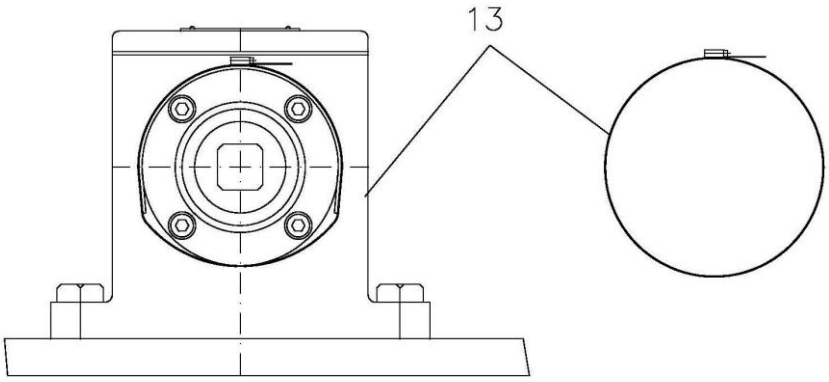


Fig.39– Fastening of the protective cover

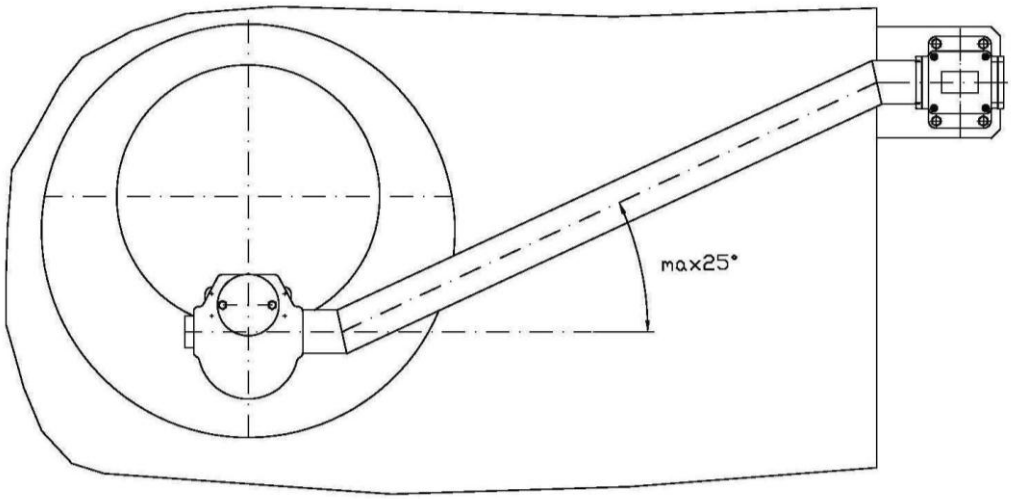


Fig.40– Special design of a protective cover for an inclined horizontal shaft.

11.4. Installation of a horizontal shaft connecting the worm gears of adjacent tap changers.

This type of installation is used in the P3, P4, P9 and P10 arrangements of drive shafts (see Drawing № 209, Sheet 1, 2 and Drawing 209.3, Sheet 1, 2 from the OLTC catalog). These shaft arrangements are used in the cases of joint operation of single-phase OLTCs (3xRS 9.3-I, Fig. 41), or joint operation of RS 9.3-I and RS 9.3-II, Fig. 42 (with a common MDU in both cases).

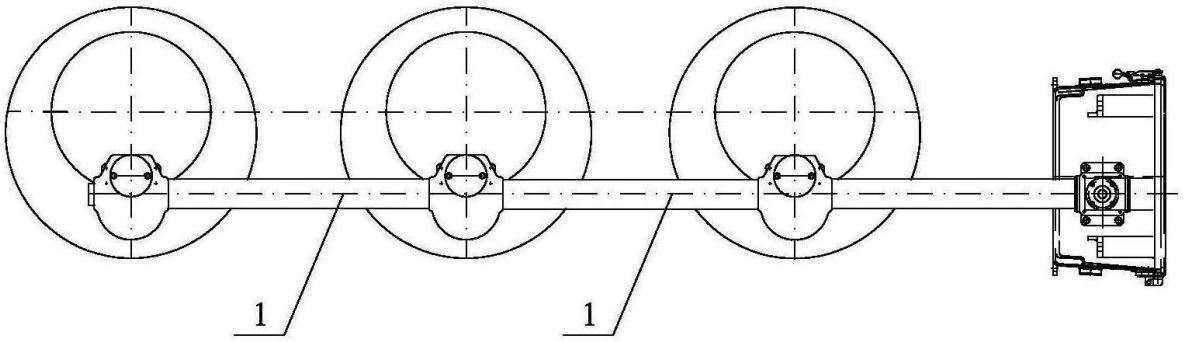


Fig.41 – Connection diagram showing 3xRS9.3-I with MZ 4.4

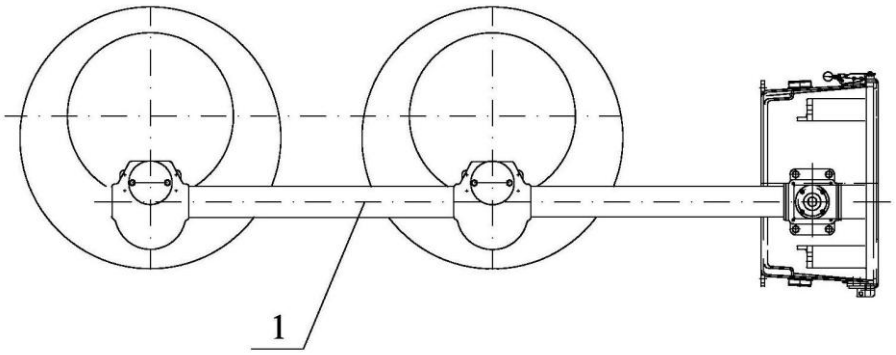


Fig.42 – Connection diagram showing RS9.3-I and RS9.3-II with MZ 4.4

The installation sequence of the shafts (Pos. 1) from Fig. 41 and Fig. 42 is shown on Fig. 43.

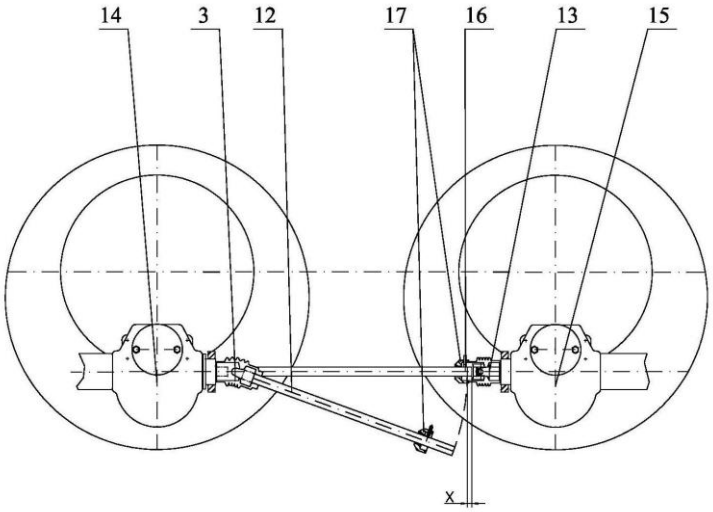


Fig.43 – Installation sequence

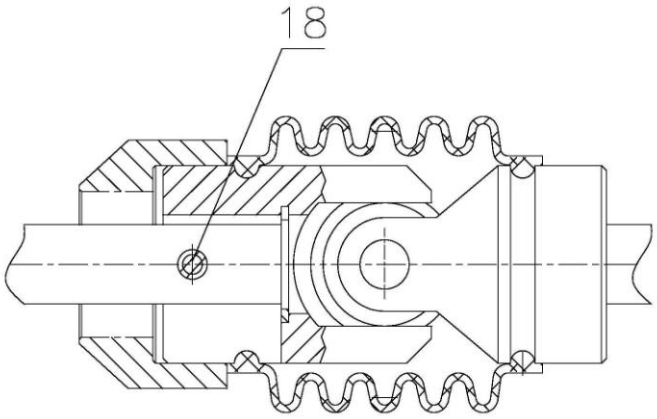


Fig.44 – Cardan coupler with a slot

11.4.1. Connect the first end of the horizontal shaft (Pos. 12, Fig. 43) to the worm gear (Pos. 14) by means of a standard cardan coupler (Pos. 3). Couple the other worm gear (Pos. 15) to a special cardan coupler with a slot (Pos. 16). Uninstall the closing cap (Pos. 17) from the special cardan coupler and place it on the free end of the horizontal shaft (Pos. 12). After installing the shaft's end in the slot of the special cardan coupler, close the cap (Pos. 17) and fix it by means of a screw (Pos. 18).

Check axial gap X (see Paragraph 11.1).

Attention!
It is mandatory to secure the screw (Pos. 18) by pop-centering.

11.5. Special designs of driving shafts.

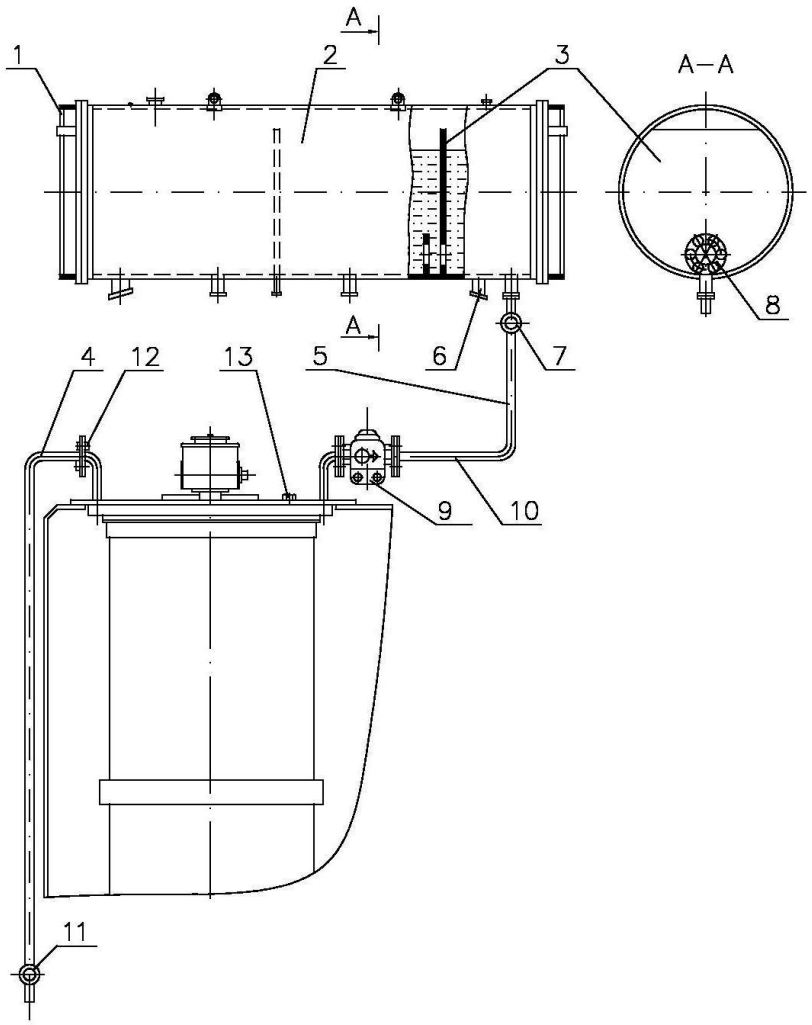
11.5.1. Drive shafts with an insulation insert.
11.5.2. Drive shafts with variable lengths (compensative shafts).
11.5.3. Drive shafts with intermediate supports.

Intermediate supports are used in the case of shafts with great lengths:
- For vertical shafts Lb > 2200 mm
- For horizontal shafts Lx > 1500 mm

Detailed information, overall and assembly dimensions can be found in the EA 581.3 manual.

12. Installation of the protective relay and the drain pipe.

Fig. 45 shows an example of connecting the protective relay with the OLTC and the conservator; an example of the oil draining pipe is shown as well.



1.Oil indicator
2.Conservator
3.Barrier
4. Pipe for draining the oil from the diverter switch oil compartment (drain pipe) – maximum of 3/4"
5.Pipe 1"
6.Sediment bowl
7.Valve I
8.Filter
9.Protective relay
10. Oil conduit with an incline of 2÷4˚
11.Valve II
12. Bleeding plug I
13. Bleeding plug II

Fig.45 – Connecting the protective relay with the tap changer and the conservator.

12.1. Installation of the protective relay.

The protective relay is activated at a flow speed greater than 0.9 m/s for nominal rated current up to 700 A and gives an impulse for switching off the transformer. For currents greater than 700A, the activation speed of the relays should be determined by the transformer manufacturer.

When using a filtering system for the oil in the diverter switch oil compartment, the relay is set to be activated at a speed of 1.2 m/s for currents up to 700 A.

When installing the relay, the following rules must be observed:

1. The protective relay must be installed in a horizontal position and as close as possible to the flange or on top of the flange itself designated for the relay.
2. When the relay is installed, its directional arrow must point towards the conservator.
3. The pipe connection to the conservator must have an inner diameter 1" and an incline ranging from 2÷4˚.

For more details, see the manual for installation of the protective relay.

12.2. Installation of the pipe used for draining oil from the diverter switch oil compartment.

For the pipe connection, a pipe of maximum ¾" must be used and the valve (Pos. 11, Fig. 45) must be below the level of the diverter switch oil compartment.

13. Routine tests at the transformer factory.

Before beginning the test, the transformer tank and the diverter switch oil compartment must be filled with pure transformer oil; afterwards the siphon pipe and the diverter switch oil compartment must be bled.

13.1. Filling of the diverter switch oil compartment with oil.

The diverter switch oil compartment must be filled with oil through the protective relay of the conservator.

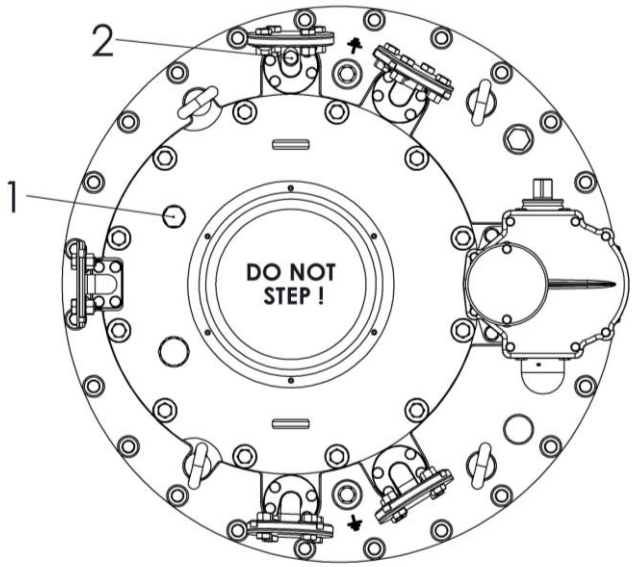
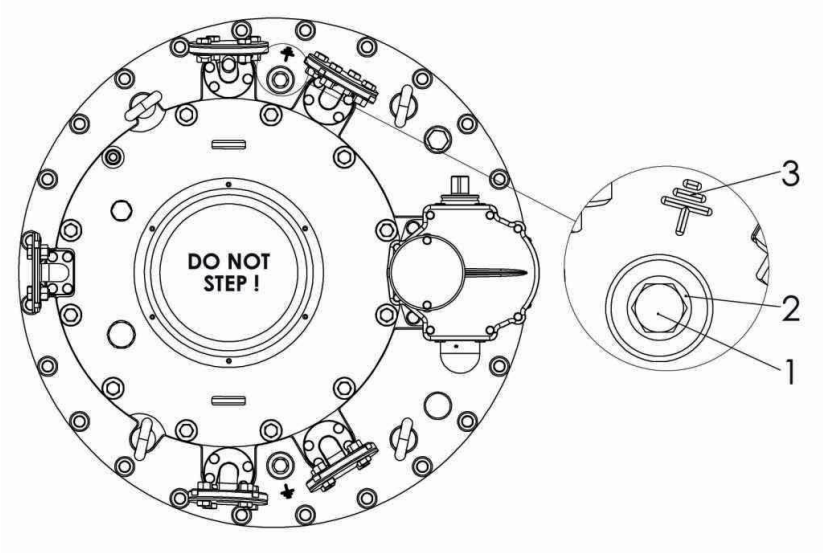


Fig.46 – Bleeding plugs

The bleeding of the diverter switch oil compartment is performed through one of the plugs (Pos.1) using a S27 wrench (S=27mm). The bleeding of the siphon is performed through the other plug (Pos. 2) using a S17 wrench (S=17mm, Fig. 46).

13.2. Grounding.



1.Bolt M12 (S=19)
2.Washer 12 (2pcs.)
3.Earth symbol

Fig.47 – Grounding

Connect the M12 grounding bolt (S=19mm) of the OLTC to the transformer cover.
Connect the M12 grounding bolt (S=19mm) of the motor drive box to the tank of the transformer.

13.3. Functional tests.

Before energizing the transformer, the mechanical functions of the OLTC must be tested throughout its entire operational cycle; this can be done with the help of the motor drive handle. The operating position indicators of the OLTC and the motor drive unit must show the same number in each operating position.

Check the end electrical and mechanical block systems of the OLTC and motor drive unit (see the installation and operation manual for MZ-4.4). After that, with the help of the electrical motor, perform test switching operations for the full operational cycle.

Attention!
The OLTC and the motor drive unit must indicate the same number in each operating position. Misalignment in coupling (different readings of the OLTC and the motor drive unit) would lead to severe damage of the OLTC and the transformer.

13.4. Electrical tests of the transformer.

The procedures described above may be followed by electrical tests needed for verifying that the transformer is fit to use.

Attention!
Before testing the main insulation, check the bleeding of the drain pipe by unscrewing the plugs (Pos. 2, Fig. 46).

14. Electrical connection of the motor drive unit.

The motor drive unit should be connected to the power supply in accordance with the EA-747 manual, Paragraph 6.3.

15. Transportation of the transformer to the operation site and handling before commissioning.

If the motor drive unit was uninstalled for transportation of the trransformer, it must be reinstalled and connected with the OLTC by means of the vertical shaft, the bevel gear and the horizontal shaft.

Note:
1.If the transformer is filled with oil but is being stored and transported without the oil conservator, a bypass pipe must be installed between the inside of the diverter switch oil compartment and the tank of the transformer. This is necessary for the levelling of the pressure difference caused by temperature-induced expansion of the oil.
2. If the transformer is protected by nitrogen filling, the diverter switch oil compartment must also be protected in this way.
3. If the transformer will be kept in storage for more than two weeks, the heater of the motor drive unit must be turned on.

16. Commissioning.

Before commissioning the transformer, functional tests of the OLTC and the motor drive unit must be performed as described in Section 13.3.
The functioning of the protective relay must be checked according to the attached manual for use of the protective relay.

Danger!
The protective relay must be connected in the tripping circuit of the circuit breaker so when it is activated, the transformer may be deenergized immediately.

It must be checked if the circuit breaker turns off the transformer when the protective relay button is pushed to Position 1, after taking off the protective cover. It must also be checked if the transformer can be energized when turning the button counter clockwise as well as when the button is released (see the URF 25/10 protective relay manual).

Attention!
It must be checked if all the stop valves between the conservator and the OLTC are opened.

After energizing the transformer, switching operations of the OLTC must be performed under load.

Danger!
Performing OLTC switching operations is not permissible at temperature of the oil in the transformer below – 25°C.
At temperatures down to – 40°C switching operations can be performed only by OLTC type RSV9.3-I-1200, using special low temperature oil (ex. "Nynas 10XN", "Petro-Canada Luminol Tri" etc.).

17. Supervision and inspection during operation.

17.1. Supervision during operation.

In the supervision of OLTCs and motor drive units during operation, special attention must be paid to the following:

1. The oil-proof tightness of the OLTC head, the protective relay and the pipe connections
2. The sealing of the protective box of the motor drive unit and the proper functioning of the electric heater
3. The condition of the control devices of the motor drive unit.

Danger!
1. When the protective relay is activated, it should not be brought back to its initial position before establishing the cause for its activation. The diverter switch must be uninstalled and the cause for the activation of the protective relay must be established.
2. The relay should be brought back to a normal position only after the cause for the breakdown of the OLTC or the transformer has been eliminated.
3. It is prohibited to energize the transformer without a preliminary check-up and without eliminating the cause for the breakdown, since this may lead to serious damage of the OLTC and the transformer as well as to fatal injuries of the personnel.

If the protective relay is activated, inspection of the diverter switch must be conducted. If it is necessary contact the HHIB manufacturer or the manufacturer's authorized representative.

17.2. Inspections.

The range of the work activities performed during an inspection is given in the manual for inspection, maintenance and repair.

The inspections must be carried out by people who are qualified and trained by HHIB. This guarantees that the inspection will be conducted professionally and provides high operational reliability. When the inspection is not carried out by HHIB personnel, it is necessary to ask HHIB for the spare parts that need to be prepared before the inspection. When ordering spare parts, it is necessary to indicate the factory number of the OLTC and the number of the switching operations that have been performed.

17.2.1. Number of switching operations till inspection for RS9.3.

The number of the switching operations determining the inspection intervals for RS9.3 is given in Table 1.

RS9.3	Rated current of the transformer [A]	Number of switching operations without an oil filter[1]	Number of switching operations with an oil filter
III-200	≤ 200	100 000	150 000
III-400	≤ 400	100 000	150 000
III-630	≤ 630	50 000	80 000
I-200	≤ 200	120 000	150 000
I-400	≤ 400	120 000	150 000
I-630	≤ 630	80 000	120 000
I-800	≤ 800	70 000	100 000
I-1200	≤ 1200	50 000	70 000
I-1600	≤ 1600	40 000	60 000
II-200	≤ 200	100 000	150 000
II-400	≤ 400	100 000	150 000
II-630	≤ 630	50 000	80 000

Table 1

[1] If, for the OLTC, Um>245kV, then the specified number of switching operations should be decreased with 40%. The materials used for the contact plates are as follows: For 400A and 630A currents, the contact plates are made of metal ceramic (W-70% and Cu-30%), and for 200A currents, the contact plates are made of copper. If the thickness of the contact plate is less than 2±0.3 mm, then the whole contact should be replaced. The mechanical endurance of the OLTC and the motor drive unit is 1 000 000 switching operations. The tap selector and the change-over selector of the OLTC do not require maintenance.

17.2.2. Number of switching operations till inspection for RSV9.3.

The number of switching operations determining the inspection intervals for RSV9.3 is given in Table 2.

RSV9.3	Rated current of the transformer [A]	Number of switching operations till inspection	Number of switching operations till vacuum interrupter replacement	Mechanical endurance (in number of switching operations)
I-400	≤ 400	300 000	600 000	1 200 000
I-550	≤ 550	300 000	500 000	1 200 000
I-700	≤ 700	250 000	500 000	1 200 000
I-1200	≤ 1200	150 000	500 000	800 000
I-1500	≤ 1500	150 000	300 000	800 000
III-400	≤ 400	300 000	600 000	1 200 000
III-550	≤ 550	300 000	500 000	1 200 000
III-700	≤ 700	250 000	500 000	1 200 000

Table 2

During each inspection of RS9.3 and RSV9.3, the oil in the diverter switch oil compartment should be changed. First the contaminated oil should be drained and then the oil compartment should be washed with pure oil.
The oil quality in the diverter switch compartment should be checked by the OLTC user according to the instructions.
Table 3 shows the requirements for the transformer oil when tested according to DIN VDE 0370 – Section 1 and IEC Publication 814.

OLTC type: RS9.3, RSV9.3	Dielectric strength acc. DIN VDE 0370-1	Water contents acc. IEC 814
RS9.3-I,II,III-200,400,630A RSV9.3-I,III-400,550,700A	> 30kV/2.5mm	< 40ppm
RS9.3-I-800,1200,1600A RSV9.3-I-1200A	> 40kV/2.5mm	< 30ppm

Table 3

Attention!
The OLTC, the motor drive unit and their equipment should be inspected at regular intervals in order to maintain high level of service reliability. Independently of the number of switching operations given in Table 1, inspections should be conducted as follows:

RS9.3:

- **at 6-year intervals for 200A**
- **at 3-year intervals for 400A**
- **at 2-year intervals for 630A, 800A, 1200A, 1600A**

Attention!
Inspections must be performed only after the transformer has been deenergized and safeguarded against unintentional reactivation.
During inspections, all the personnel should observe strictly the safety regulations of the specific country related to the operation of electrical systems above 1000 V.

The technical characteristics and the design described in the present manual correspond to the current state of the product and may be changed without a prior notice.

Dr. Michael Amon

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