ZVMD有载分接开关
On-Load Tap-Changer Type ZVMD

使用说明书
Operating Instructions

贵州长征电气有限公司
GUIZHOU CHANGZHENG ELECTRIC CO., LTD.

Welcome to Use Guizhou Changzheng OLTC

Please read this instruction carefully before you operate the purchased on load tap changer. Be sure to pay attention to the following matters:

1. Check and accept the products according to the packing list when receiving products. Keep the evidence if there are any damages during transportation in order to claim compensation from the responsible party and protect your rights.
2. The tap changer only can be used with the transformer which specified in the order. You need to consult with our company in advance if you want to change the purpose of this product.
3. The installation, put into operation, maintenance and repair of the product should be complied with the operating instruction and relevant provisions of security.

The figures, charts, and other data in this manual may differ from the products delivered. These drawings are for reference only and we reserve the right to make changes. If there is any change, no further notice.

Give the word of “Warning” when ignoring a requirement will cause the life damage of operator. This is a warning of danger to life and health, disregarding this warning can lead to the serious or fatal injury.

Give the word of “Careful” when ignoring a requirement will lead to the damage to the equipment. This information indicates particular danger to this device or other equipment of the user, but the serious or fatal injury can’t be excluded.

In order to emphasize at any time, the word of “Caution” will be used, remind it should be careful when operating according to the requirements of “Warning” and “Caution”.

These are additional explanations for a certain subject.

Content

January, 2018

1. General introduction

The ZVMD on-load tap-changer is a combined vacuum-modified type. It is a high-quality, high-tech product that has been innovatively designed by Guizhou Changzheng on the basis of switch manufacturing technology and experience accumulation for nearly half a century. The tap selector adopts an integral epoxy glass fiber reinforced insulation cylinder, which has higher mechanical strength, stronger deformation resistance, better insulation performance and more beautiful appearance.

The ZVMD vacuum on-load tap-changer is a buried type, combined tap changer with resistance transition, which consists of a toggle switch and a tap selector.

The technical performance of ZVMD vacuum on-load tap-changer complies with the requirements of GB/T10230.1, Tap-changer Part 1: Performance requirements and test methods. Meets the requirements of IEC 60214-1 "Certain tap-changers Part 1: Performance requirements and test methods".

This on-load tap-changer can only be used on transformers specified in the ordering specifications of the tap-changer.

On-load tap-changer installation, electrical wiring and commissioning must be performed by qualified and skilled personnel in accordance with this manual.

Without prior consultation with our company, we are not allowed to change or modify switch devices.

During the installation of the on-load tap-changer, the electrical connection and the commissioning, if the operation is not carried out according to the provisions of this manual, the motor-drive mechanism, the tap-changer and the transformer may cause malfunctions or even personal injury and equipment damage.

This instruction manual applies to ZVMD vacuum on-load tap-changers of the following model standards design, both with or without a change-over selector:

Three phase Y connection tap switch:

ZVMDIII300, ZVMDIII500, ZVMDIII600, ZVMDIII1000

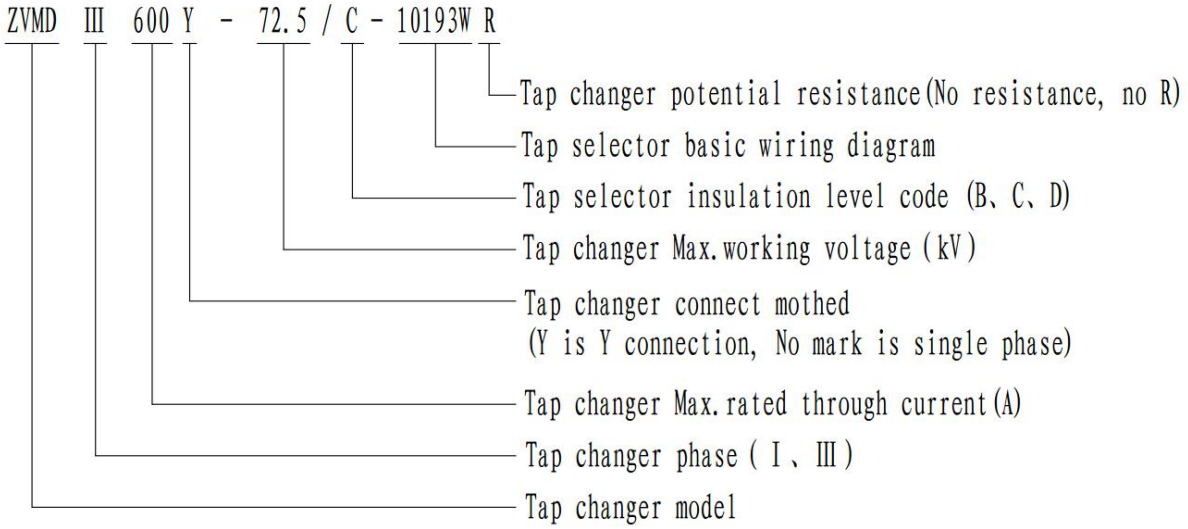
Single-phase tap changer:

ZVMDI301, ZVMDI501, ZVMDI601,

ZVMDI800, ZVMDI1200, ZVMDI1500

All single-phase tap-changers can be supplied as a three-phase group 3 × ZVMDI with a common motor-drive mechanism. Under special circumstances, each switch can be equipped with an electric mechanism and the shunt controller can be used to achieve simultaneous voltage regulation. When the shunt controller is not used, each switch is individually adjusted.

1.1 Model representation



Note:

① Switch connection mode: D is D connection, no sign Y connection

② Tap selector insulation level number indicates: tap selector is divided into 3 different insulation levels, respectively denoted by B, C, D

③ The basic wiring diagram is as follows:

10 19 3 W

10 ----- Number of contacts per circumferential distribution of tap selector.
19 ----- Number of Max.working tap position.
3 ----- Middle position: 3 kind, 0,1,3
W ----- Change-over selector:
W for Reversing regulating, G for coarse and fine regulating

1.2 Environmental Conditions

1.2.1 The oil temperature is not higher than +100° C and not lower than -25° C.
1.2.2 The ambient air temperature is not higher than +40° C and not lower than -25° C.
1.2.3 The inclination of the mounting plane and the vertical plane does not exceed 2%.
1.2.4 The installation site is free of serious dust and other explosive and corrosive gases.

1.3 Basic parameters

1.3.1 The main parameters of the switch are shown in Appendix 1 and Appendix 2, and the overall installation layout of the switch is shown in Appendix 3.
1.3.2 The contact resistance of each single contact of the contact is not more than 500 μ Ω.
1.3.3 On-load tap-changer Under 1.2 times the maximum rated passing current, the temperature rise of each long-term current-carrying contact and conductive part does not exceed 20K.

2. product structure

The ZVMD vacuum on-load tap-changer consists of a change-over switch and a tap selector mounted below. (Figure 1a, Figure 1b).

Figure 1a

Figure 1b

2.1 Diverter switch

The diverter switch (Figure 2b) consists of the diverter switch body and the diverter switch oil compartment(Figure 2a).

Figure 2a

Figure 2b

The ZVMD vacuum on-load tap-changer is mounted on the transformer cover by the head flange. The speed reduction mechanism, the bevel gear transmission box and the motor-drive mechanism are connected (Appendix 3), which can be manually or electrically operated locally or remotely. Control operation.

The ZVMD vacuum on-load tap-changer tap-change operation starts from the motor-driven mechanism, and the transmission force is transmitted to the worm-gear reducer on the top cover of the tap-changer via the drive shaft, and then transmitted to the energy storage mechanism for energy storage (the energy storage mechanism releases energy). Switching switch action) and passing through the switch to the drive shaft of the bottom of the cylinder, the bottom gear clutch and the tap selector sheave mechanism are coupled, and the rotation of the sheave makes the contact of the tap selector rotate by one level. Angle, in this way, the contact bridge is connected to the required voltage regulating coil tap without power.

2.1.1 The diverter switch body consists of an insulating shaft, an energy storage mechanism, main contact system and a transition resistor.

2.1.2 Diverter switch oil chamber consists of the tap changer head, insulation barrel, and barrel bottom.

The tap changer head is composed of a head flange, a head cover, a head worm gear mechanism, a blasting cover, an oil chamber observation window, and an oil venting screw.

There are four connecting flanges on the head of the tap-changer head, three of which have elbows. The elbow R is connected to the oil conservator through a gas relay; the elbow S is connected to the oil suction pipe in the switch, and the oil suction pipe extends into the bottom of the oil chamber for sucking oil, and the pipe has a vent screw; Q is used for oil filtering, The filtered oil is sent back to the switch oil chamber; E2 is used as a transformer oil spill.

Depending on the actual use, the elbow joints R and Q can be used interchangeably when installed. All connecting pipes can be fixed at a free angle of rotation according to the installation requirements.

The head cover can be with or without a pressure relief valve (Fig. 3a without pressure release, Figure 3b with pressure relief valve). The pressure relief valve is specially designed, and its electrical wiring is shown in Figure 4.

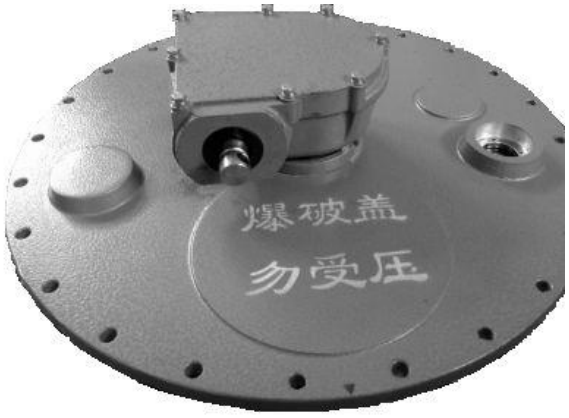


Figure 3a

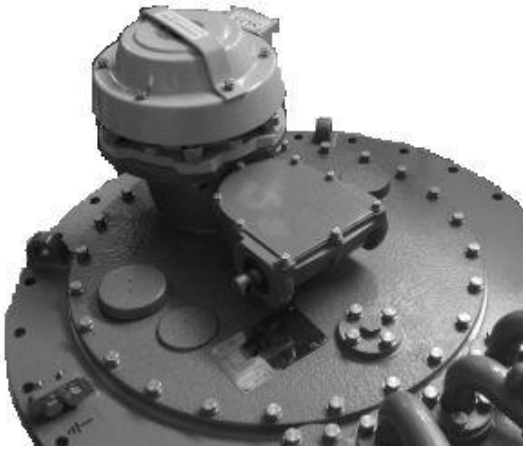


Figure 3b

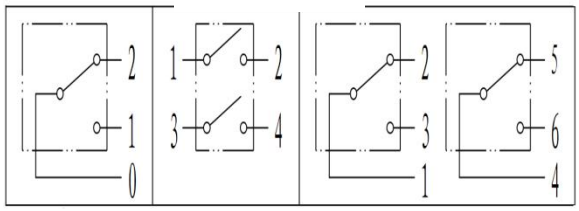


Figure 4

2.2 Tap selector

The tap selector consists of a progressive mechanism and a contact system. The tap selector can also be used with or without a selector (Figure 5a, Figure 5a).

Figure 5a
(3 phase current ≤600A)

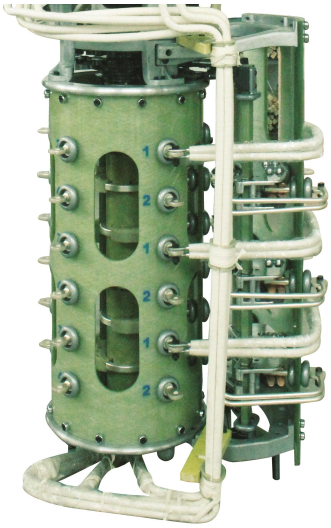


Figure 5b
(3 phase current ＞ 600A)

2.2.1 Progressive Mechanism

It is a progressive gear consisting of two sheaves and a dial member (Figure 6). During each tap change operation of the apparatus, the rotation of the dial member is converted into a 72° or less than 72° progressive movement. Thus the tap selector bridge contacts are moved from one terminal to the other terminal, and the two groove wheels alternately work intermittently.

The coupling of the coupling on the transmission shaft of the advancement sheave mechanism to the bottom gear of the progressive sheave mechanism is a sliding joint. When the direction of tap change is reversed, the transmission of the

motor-driven mechanism only causes the change-over switch to operate and the tap selector is not actuated.

The mechanical positioning pin in the advance sheave mechanism is to prevent the tap selector from exceeding the leading and trailing positions.

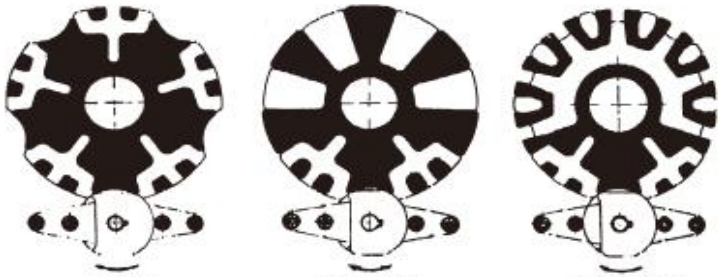


Figure 6

2.2.2 Contact System

The tap selector contact system adopts a cage-type "outer-inside-out" sleeve shaft structure, including a central insulation barrel equipped with a contact ring, an insulation barrel with a fixed contact, a bridge contact of a transmission pipe and a bow type part , and a up-down flange and other components.

The insulation cylinders are installed between the circumference of the upper and lower flanges. The cylinders are equipped with single and double number of static contacts, and an “orange-shaped” shielding cover is installed so that the surface electric field is uniform and the static contact passes through the bridge contacts and the central insulation cylinder. The contact ring is connected, and the connection line of the contact ring is led out from the center insulation cylinder and connected to the diverter switch.

The tap selector bridge contact adopts an upper and lower clip-type structure bent into a “mountain” shape, driven by a progressive mechanism through a transmission pipe, and rotated along a conductive ring on a central insulation cylinder to select a tap on the insulation cylinder. Since the two main springs of the bridge contact are fastened on the movable contact, therefore, the contact is always maintained at four points. As shown in Figure 7, the automatic adjustment and effective cooling can be achieved.

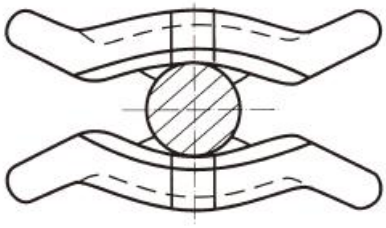


Figure 7

2.2.3 Conversion Selector

The conversion selector includes a polarity selector (Fig 31a)and a coarse selector (Fig 31b).

The polarity selector is suitable for reversing regulating. It is a very simple and compact device. The middle static contact of the polarity selector is also the contact K of the tap selector. Its "+", "-" fixed contact are installed to the circumference of the

upper and lower flanges of the insulating cylinder.

The coarse regulating selector is suitable for coarse and fine regulating. The coarse regulating selector is provided with fixed contact strips on two cantilever arms, which are supported on the upper and lower flanges. And it's move contact use clamping piece width model moving contact bridge construction, make fixed contact K bridge conected with one of the relevant "+" or "-" fixed contact. change-over selector contact active only pass "K".

The coarse regulating selector is suitable for coarse and fine regulating. The coarse regulating selector is provided with fixed contact strips on two cantilever arms, which are supported on the upper and lower flanges. Because impluse voltage level of coverse regulating selector is higher, its fixed contact insulation panel are installed on the cantilever outside the circumference of the selector stationary contact. In this time, the clamping piece width model moving contact bridge construction connect with one of the relevant "O" & "+" or "-" fixed contact. And fixed contact K is electric connected to "+".

The change-over selector is operated by the lower wheel of the advance mechanism.

2.3 Motor Driver Mechanism and Its Controllers, Other Components

2.3.1 Motor Mechanism and Its Controller

For details of the motor-drive mechanism, please read the corresponding instruction manual in the attachment.

2.3.2 Other accessories

The connection of the ZVMD on-load tap-changer to the motor-drive unit is connected via a bevel gear box and horizontal and vertical drive shafts. (See Appendix 3)

2.3.3 Potential resistance

For the combined on-load tap changer switching selector, when the recovery voltage ≥35kV, a potential resistor should be configured to connect the transformer regulator winding and the tap changer to limit the recovery voltage and ensure that the recovery voltage is lower than the tap changer insulation Level.

For the linear tap changer, the main winding and the regulator winding are fixedly connected. There is no problem of restoring the voltage, and it is not necessary to add a potential resistor.

ZVMD OLTC with potential resistance, when 3 phase ≤600A and single phase tap changer could with cylinder structure or strip structure (Fig 8a, 8b); When 3 phase ＞600A only with strip structure (Fig 8b).

Figure 8a

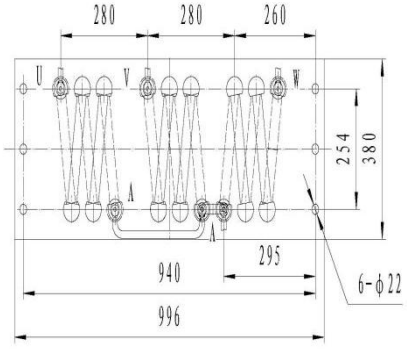


Figure 8b

Cartridge type potential resistance installation method:

Move the canister type potential resesteence to the bottom of the switch and fix the potentiometer resistor on the base of the switch tap selector with the standard part (with the box accessory). Then the three wires with the good (with the box attachment) are respectively connected to the intermediate switch of each phase of the selector switch (for example, the intermediate gear of 10191/3W is 5 gears, the intermediate gear of 12231/3W is 6 gears, and the intermediate gear of 14271/3W is 7). The gear, 16311/3W intermediate gear is 8 gear, 18351/3W intermediate gear is 9 gear), and the other end is connected to the U, V, W terminals on the barrel potentiometer.

Strip type potential resistance installation method:

Fix the Strip type potentiometer to the corresponding location, first use 3 guide line(provided by transformer)'s terminal respectively connected to middle step of selective switch (eg: 10191/3W middle step is 5, 12231/3W middle step is 6, 14271/3W middle step is 7, 16311/3W middle step is 8, 18351/3W middle step is 9), and the another termianl respectively connected to U, V, W terminal strip type potential resistance. Than use one guide line(provided by transformer)'s terminal connected to neutral point of OLTC, the another termianl connected to neutral point A of strip type potential resistance.

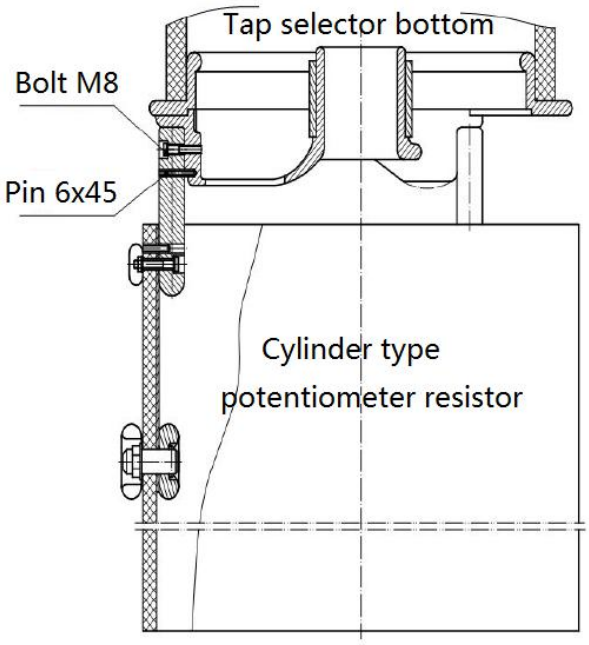


Figure 9

3. Receipt notice

After the on-load tap-changer and motor-drive mechanism are tested in the factory, they are set in the specified working position. Then take a moisture-proof protective package.

Both the changeover switch and the tap selector are locked in the setting position.

When the product is received, it shall be checked and accepted according to the packing list. If any damage is found, you should take pictures of the damage of the packing box and the packaged goods to keep the evidence to the responsible party to protect your rights and interests.

The on-load tap-changer shall be stored in the warehouse where the air is free, the relative humidity is not more than 85%, the temperature is not higher than +40° C, and not lower than -25° C. The storage environment shall not contain corrosive gas and shall not be affected by rain or snow.

The on-load tap-changer is stored in an air-tight envelope and opens when installed.

When working on on-load tap-changers, motor-drive mechanism and various components, these components must be firmly secured. Otherwise, there may be danger of overturning, resulting in serious injury and even personal accidents.

4. Installation

4.1 Installation of on-load tap-changer in box top transformer (Figure 10)

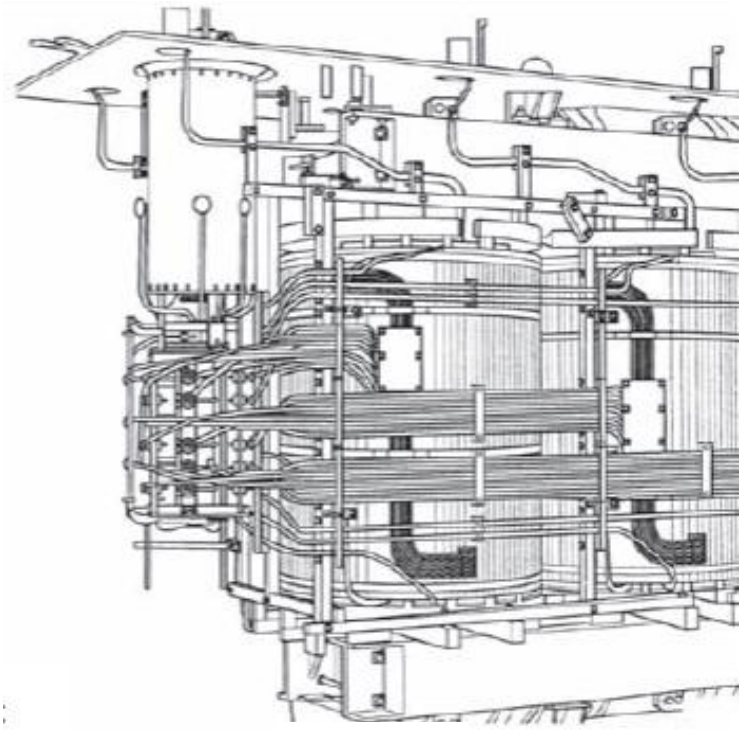


Figure 10

4.1.1 Installation flange

The on-load tap-changer head must be mounted on the tank cover with a mounting flange (see appendix 6) and an oil-resistant sealing gasket (figure 11).(provided by user)

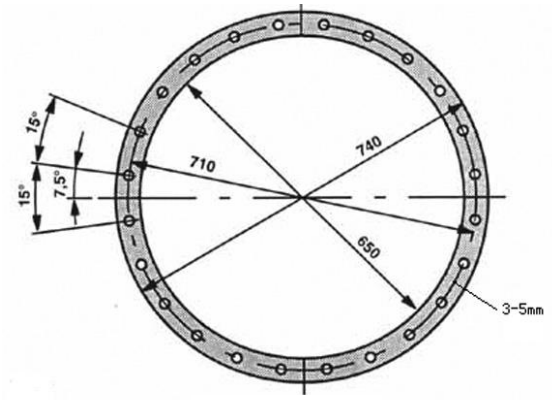


Figure 11

The design of the mounting flange and the oil seal gasket must be identical to the seal face of the on-load tap-changer switch head.

4.1.2 On-load tap-changer with change-over selector, tap changer head mounted on transformer tank cover

The diverter switch oil compartment falls through the opening of the transformer cover and the switch head is bolted to the mounting flange. Then connect the tap selector below the diverter switch oil compartment (Section 4.1.3).

The steps are as follows:

(1) Place the diverter switch housing on the water platform.

(2) Wipe the sealing surface of the switch head and mounting flange.

(3) Place an oil-resistant seal on the mounting flange of the transformer cover (Figure 11).

(4) Lift the diverter switch oil compartment and carefully drop it into the opening of the mounting flange.

Note: Avoid damage to grading ring (only for Um≥170kV)

(5) Correct the position of the switch head.

(6) Fasten the switch head to the mounting flange with bolts.

(7) Remove the positioning piece on the coupler at the bottom of the diverter switch oil compartment (Figure 12).

Figure 12

4.1.3 Assembly of the diverter switch oil chamber and tap selector

Lift the tap selector to align the switch oil chamber, first connect the two with bolts, and then mechanically couple the drive mechanism of the tap selector.

The steps are as follows:

(1) 3 phase current≤600A & single phase OLTC: Put the tap selector on the surface of the horizontal table. Remove the bolts (6 M12 hex socket bolts, 8th wrench) and nuts on the tap selector support. And save it. Also check and tighten the mounting screws (M6 socket head cap screws)(Fig. 10) of the tap selector connection wires (Fig. 13a).

3 phase current＞600A: Place the tap selector on the surface of the horizontal table. Remove the bolts (6 M12 hex socket bolts) and nuts on the tap selector support. And save it. Also check and tighten the mounting screws (M6 socket head cap screws) of the tap selector connection (Fig. 13b).

Figure 13a

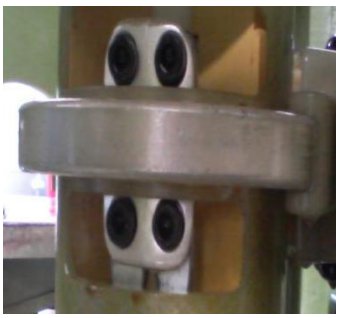


Figure 13b

(2) Remove the red paint mark locating member of the lock coupling on the tap selector. Do not rotate the coupler and the dial member (Figure 14a, 14b).

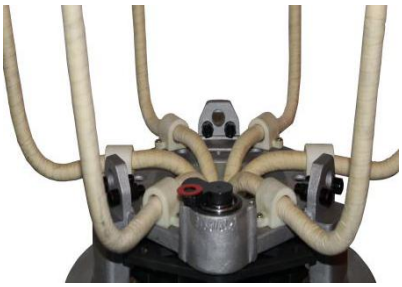


Figure 14a

Figure 14b

(3) The tap selector is fitted with a suitable lifting device.
(4) Raise the tap selector below the diverter switch oil compartment.
(5) Align the position of the two coupling members, and the bearing on the tap selector should be aligned with the hole in the base of the oil chamber.
(6) Raise the tap selector to the appropriate height.
(7) 3 phase current≤600A & single phase OLTC: Connect the tap selector to the oil chamber base with the 6 pcs M12 bolts and nuts that removed. The tightening torque is 60 Nm (Fig. 15a)
3 phase current＞600A: Connect the tap selector to the oil chamber base with the 6 pcs M12 bolts and nuts that removed.

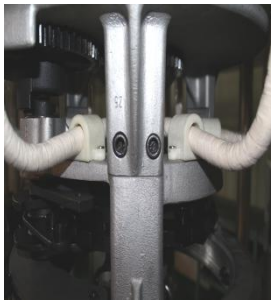


Figure 15a

Figure 15b

(8) Remove the M10 bolts, shields and other parts of the connecting wires on the diverter switch oil compartment, and fasten the tap selector wires to the corresponding outlet contacts of the diverter switch, and cover the shield. The tightening torque is 50 Nm (Fig. 16a,16b).

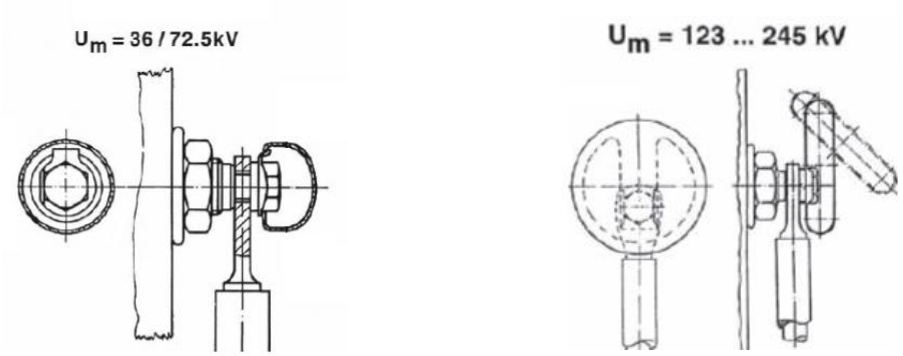


Figure 16a. 3 phase current≤600A & single phase OLTC

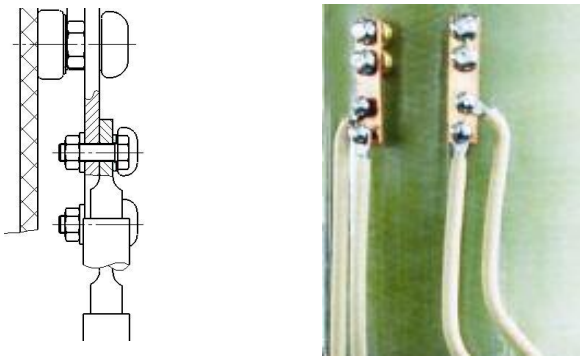


Figure 16b. 3 phase current＞600A OLTC

BE CAREFUL

Do not damage the insulation of the tap selector connection wires. All lead connections must be handled in detail. The specified tightening torque must be applied. Make sure that each connecting bolt is securely connected and shielded with a shielded cap supplied with the switch.

4.1.4 On-load tap-changer without conversion selector

This design involves the assembly of a complete tap changer from the opening of the transformer cover.

The steps are as follows:

(1) Place the diverter switch oil chamber on the water platform surface and remove the positioning member on the coupler at the bottom of the diverter switch oil chamber (Fig 12).

(2) Assemble the tap selector and diverter switch as described in Section 4.1.3.

(3) Wipe the sealing surface of the switch head and the mounting flange.

(4) Place an oil-resistant gasket on the mounting flange of the transformer cover (Fig 11).

(5) Lift the entire switch and carefully drop it into the opening of the mounting flange.

Note:

Avoid damage to grading ring (only for Um≥170kV)

(6) Correct the position of the switch head.
(7) Fasten the switch head to the mounting flange with bolts.

4.2 Installation of on-load tap-changer on bell-type transformer (Fig. 17)

When the on-load tap-changer is installed on a bell-type fuel tank, the tap-changer is designed with a support flange temporarily mounted on the transformer bracket and a detachable head flange fixed to the bell-type transformer cover. The two flanges are connected by an O-ring and a solid piece.

When the tap-changer head flange is installed on the transformer cover, the mounting flange (see Appendix 6) and the oil-resistant gasket (Fig. 11) must be used.

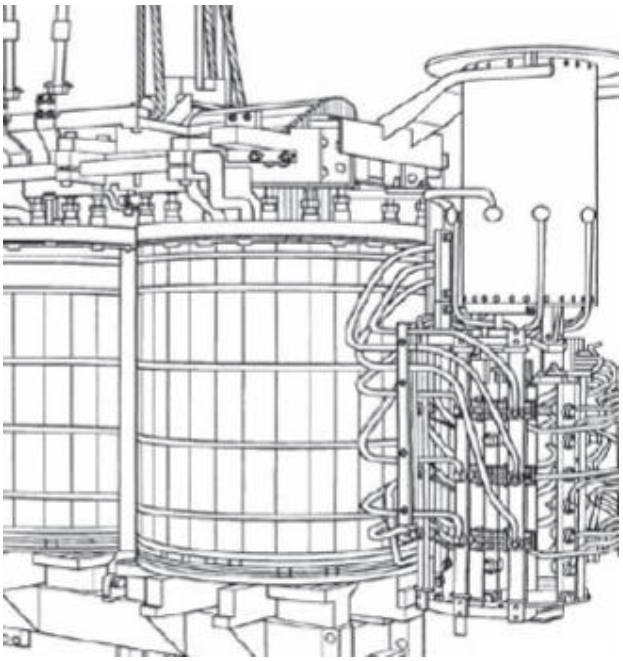


Figure 17

Installation steps

4.2.1 Disconnect the switch head flange

Place the diverter switch on a clean water platform.

(1) Remove the tap-changer head cover (24 M10 bolts, wrench No. 17), taking care not to damage the O-ring on the head cover (Fig. 18).

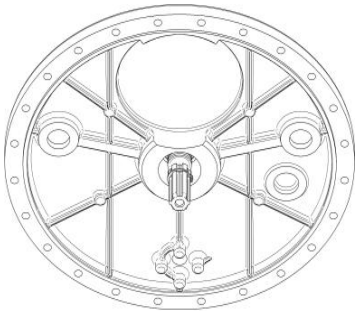


Figure 18

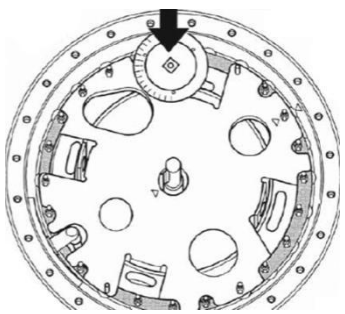


Figure 19

(2) Remove the tap position indicator disc (pull the open spring retainer ring from the shaft end) (Fig. 19).
(3) Remove the fastening nut (5 M8 nuts, No. 13 wrench) on the switch support body support plate (no red area) (Fig. 20).

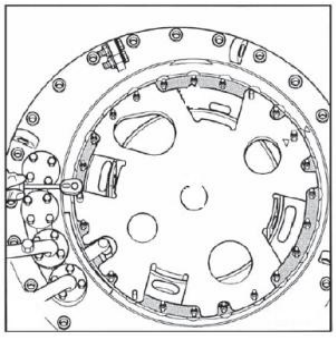


Figure 17

Figure 18

(4) Carefully pull the diverter switch core vertically from the oil chamber (Fig 21).
(5) Remove the suction pipe and pull out the connecting elbow inserted into the head flange from the inside (Fig. 22), taking care not to damage the O-ring on the elbow.
(6) Remove the fixing nut (17 M8 nuts, No. 13 wrench) in the red paint mark area of the head flange and lift the switch head from the support flange (Figure 23). Be careful not to damage the O-ring. Place the switch head flange on a flat surface with clean oil paper for use.

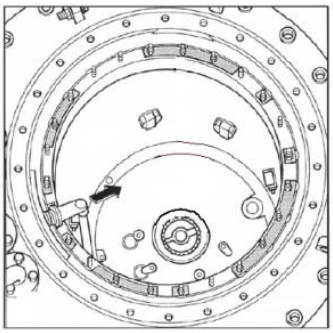


Figure 19

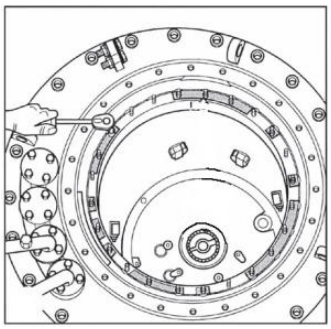


Figure 20

BE CAREFUL

Do not turn the head gear mechanism drive shaft after the switch head is separated from the support flange.

Always avoid any parts falling into the diverter switch oil compartment, otherwise there is a danger of jamming the diverter switch and damaging the tap-changer and transformer. Therefore, the number of small parts must be fully counted during disassembly and reassembly, and no shortage of parts is guaranteed.

Place the tap selector and diverter switch on a clean water platform.

(1) Check and tighten the mounting screws (M6 socket head cap screws) of the tap selector connecting wires, don't loosen the clamped wire (Fig. 13).

(2) Remove the red paint mark on the tap selector on the tap selector. Do not turn the coupler and the dial (Figure 14).

(3) Remove the bolts on the tap selector holder(Fig 15) (6 M12 hex socket bolts, 8th wrench) and prepare the connection between the diverter switch and the tap selector.

(4) Lift the diverter switch oil chamber with the lifting plate (see Appendix 8), wipe the contact surface, align the two coupling parts, and slowly place them on the tap selector. Be careful not to touch the tap selector connector wire. Insulation. Fasten with 6 M12 bolts removed from the front.

(5) Remove the positioning piece coated with the red paint mark on the diverter switch (Fig. 23).

(6) Remove the M10 bolts, shields and other parts of the connecting wires on the diverter switch oil compartment, fasten the tap selector wires to the corresponding contacts of the diverter switch, and cover the shield (Fig. 16).

BE CAREFUL

Do not lift the tap-changer with the fixing bolts at any time, as this may damage the parts on the upper part of the switch head.

4.2.3 Preloading of the tap changer

In order to ensure that the tap-changer is installed in the correct position, an adjustable mounting bracket must be designed inside the transformer and must be pre-installed. Specific steps are as follows:

(1) The support middle flange is aligned with the head flange.

Use the hanger plate of Appendix 8 to lift the tap-changer to the appropriate position on the bracket.

CAUTION

Make sure that all the screws on the intermediate flange slide easily in the fixing holes of the switch head.

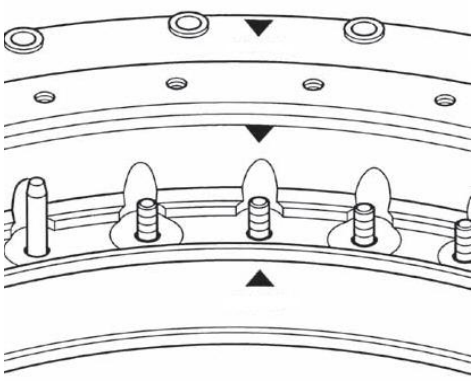


Figure 21

Lift the transformer cover and place it in the working position of the transformer.

The head flange is pre-installed on the mounting flange of the transformer cover (the gasket must be installed), this head part flange's red △ mark is aligned with support flange's △ mark, and the position of the tap changer and the mounting bracket is adjusted to make the intermediate flange The two positioning pins of middle flange and all the screws pass through the coupling holes of the head flange (Fig. 21).

(2) Adjust the assembly clearance between the support flange and the head flange.

Adjust the height position of the mounting bracket to ensure that the clearance between the support flange and the head flange meets the requirements of 5~20mm, and the actual clearance value is measured (see Appendix 5).

After the tap-changer is pre-installed on the transformer mounting bracket, lift the transformer box cover, use the lifting plate to slowly lift the tap-changer (be careful not to move the position horizontally), and place the actual clearance value on the mounting bracket. Pad, then lower the switch and fix it to prevent displacement when connecting the leads.

(3) Wiring of the voltage regulating winding and the tap changer is described in Section 4.3.

The connected tap leads must not have any pulling force on the tap changer. The tapping leads should be provided with sufficient room for the tap-changer to be raised to the final position after the bell jar cover is snapped.

(4) Installation of the bell cover

Before the bell cover is fastened, wipe the sealing surface of the oil chamber support flange (Fig. 25) and place the seal on the flange.

Hang the transformer bell cover over the transformer body and fasten the transformer bell cover.

(5) Before installing the switch head, clean the sealing surface (the lower edge of the switch head and the mounting flange). Place an oil-resistant gasket on the mounting flange (see Appendix 6).

(6) Place the tap changer head on the mounting flange, paying attention to the position of the two positioning pins and the markings on the support flange and switch head (Figure 24). These two mark alignments ensure that the OLTC head is installed in the correct position. Depending on the final height, a gap of 5 - 20 mm should be left between the tap changer head and the support flange.

(7) Gently lift the tap-changer with the spreader to ensure that all the screws of the support flange can slide easily in the fixing holes of the switch head. Secure the switch head to the support flange with 16 M8 nuts, tighten the torque to 14 Nm, and lock the lock washer on the nut.

(8) Secure the switch head to the mounting flange with 24 M12 bolts.

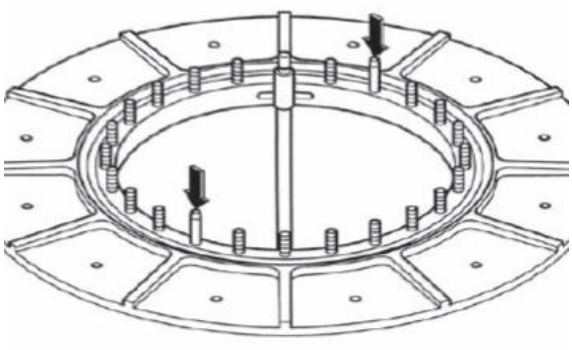


Figure 25

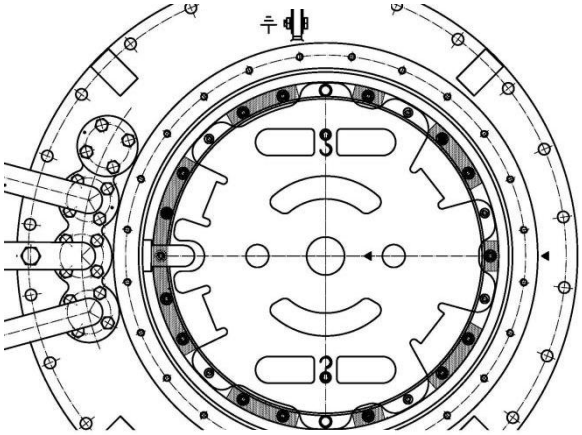


Figure 26

(9) Install the diverter switch core

a. Check if the gear mechanism on the base of the diverter switch oil compartment is in the recording position. Confirm the coupling head size direction.

b. Lift the diverter switch core with a crane and move it to the top of the diverter switch oil compartment. Observe the direction of the sleeve size of the bottom of the switch core, align the sleeve size gap with the size of the coupling head, and ensure that the suction pipe notch on the switch core support plate is facing the suction pipe side.

c. The ▲ mark on the diverter switch core support plate and the mark (red triangle) of tap changer head (Fig. 26) must be aligned with each other.

d. Slowly insert the diverter switch core into the oil chamber to the final position.

e. Gently apply pressure to the upper support plate to the flange support surface.

f. Fix the switch core support plate to the flange support surface with a nut.

(10) Put the switch head cover and cover the tap changer. The O-ring on the head cap must be placed in the correct position.

(11) Evenly tighten the 24 M12 bolts on the cover of the tap-changer with a tightening torque of 34 Nm (Fig. 27).

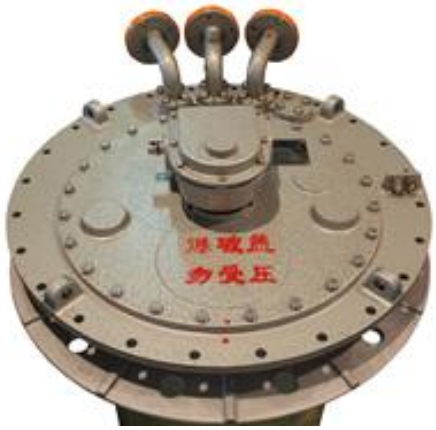


Figure 27

4.3 Connection of voltage regulating winding lead and tap changer tap

The connection of the voltage-regulating winding leads to the tap-changer taps must be in accordance with the specified wiring diagram supplied with the tap-changer (see Appendix 13-19, Special Design Additional).

All lead connections must be careful and secure. All tap leads must be assembled with no pull on the leads attached to the tap selector. If necessary, the end of the tapping lead should be bent into a buffered arc.

4.3.1 Wiring of the tap selector terminal

The number of the tap selector terminals is marked on the tap selector insulation strip.

The taper of the tap selector terminal has a hole for the M10 bolt, and is provided with an M10 bolt, an M10 nut, a washer 10, and a shield cover for facilitating the connection of the winding lead terminal and the tap selector terminal. (Figure 28)

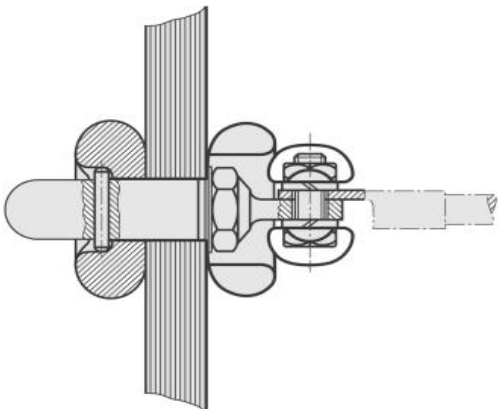


Figure 28

4.3.2 Polarity selector wiring terminals

The polarity selector terminals (+) and (-) are in the shape of lugs with M10 wiring holes (three-phase current ≤ 600A and single-phase OLTC) and M12 wiring holes (three-phase current > 600A OLTC) . The polarity selector terminal K is the extension of the tap selector terminal (there are also M10 wiring holes (three-phase current ≤ 600A and single-phase switch) and M12 wiring holes (three-phase current > 600A switch), extending to the insulation board The outer portion of the strip (Fig. 29a, Fig. 29b) serves as a fixed contact for the polarity selector.

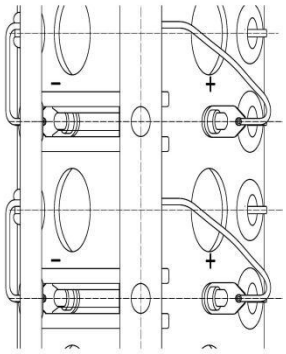


Figure 29a

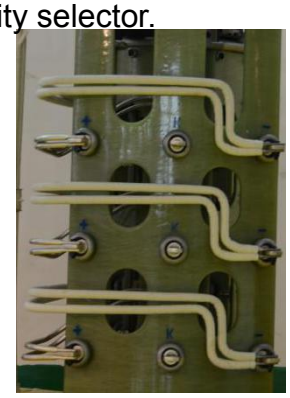


Figure 29b

Terminal K must not be bent or twisted, otherwise it will affect the function of the polarity selector.

4.3.3 Terminal of the coarse adjustment selector

The terminals (+) and (-) of the coarse selector are the same as the tap selector terminals, and the direction of the M10's wiring holes is always vertical and is located on each coarse selector insulation strip (Fig. 30a, 30b).

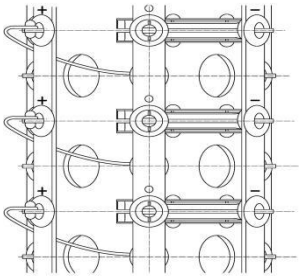


Figure 30a

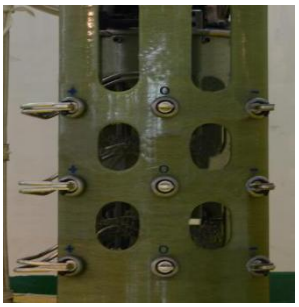


Figure 30b

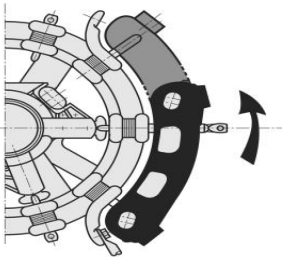


Figure 31a

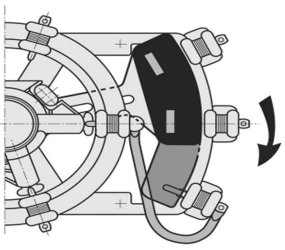


Figure 31b

BE CAREFUL

The wiring of the tap selector lead near the converter selector (polar selector or coarse selector) must leave enough space for the active part of the converter selector (polar selector see Figure 31a, coarse selection See Figure 32b). Otherwise, the action of the conversion selector may be hindered.

CAUTION

(1) The connecting lead should be bidirectionally guided from the two sides of the tap selector to the voltage regulating coil to avoid the one-way force of the tap selector, so that the tap selector cage is distorted and the connecting lead should not be attached to the insulating strip.

(2) The connection between the tap selector tap and the last clamp of the transformer lead should be left with a certain degree of deflection. It should not be too short, and the connection should be soft. It is recommended that the section be lined without insulating paint to avoid drying. Hard to make the tap selector tap deformed.

(3) The tap selector tap leads must not deform the tap selector.

(4) Tap selector The tap lead should be taken from the outside of the cage and never allowed to pass through the inside of the cage.

(5) The bell-type on-load tap-changer must be lifted 5~20mm after the lead wire is connected. For this reason, the tightness of the joint wire should be paid special attention and attention. It is recommended that the support flange be mounted on the support structure and temporarily raised to the support. After the flange and the head flange are assembled with the actual gap, the lead wire (same as the actual installation) is removed. After the lead wire is completed, the height of the temporary pad is removed, and the tightness of the wire and the force of the switch are checked.

(6) Installing the lead wires does not damage the terminals of the tap selector.

(7) All leads must be connected securely. All tap leads must be assembled with no pull pull on the leads attached to the tap selector. If necessary, the end of the tapping lead should be bent into a buffered arc and should not be too short.

(8) It is strictly forbidden to step on the parts on the tap selector with your foot.

4.4 transformation ratio test

It is recommended to use low-voltage alternating current as the transformer transformation ratio test before drying.

When operating the tap-changer, a short tube with a nominal inner diameter of Ø25 can be inserted into the horizontal shaft of the tap-changer head cover gear box, and the M8 bolts are used to connect the two. The other end of the short tube can be equipped with a hand wheel or crank. .

BE CAREFUL

Remember to always operate the on-load tap-changer from the head cover gear. Acting directly from the coupling axis can cause some trouble.

For the 3 × ZVMDI three-phase group, there are three switch heads, which are connected to each other by a horizontal axis.

Each time the tap change operation, the horizontal axis needs to be rotated 16.5 turns, and the working position of the tap changer can be observed by the glass observation window that the head cover gear box is closed (see Figure 32. Since the tap-changer has not been immersed in oil, the number of tap-changes must be minimized.

After the transformation ratio test, the tap changer must be transferred to the original factory working position of the switch manufacturer.

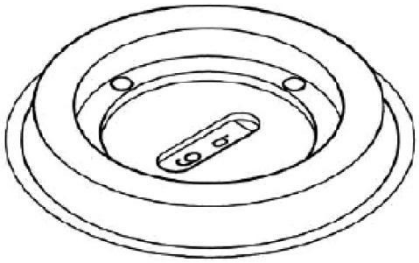


Figure 32

4.5 Drying and oiling

4.5.1 Drying step

In order to ensure the insulation level of the tap-changer, the tap-changer (generally with the transformer) must be subjected to a minimum drying process as described below.

CAUTION

OLTC head cover gear box, motor driver mechanism, gas relay, pressure release valve, CX10 gear box, temperature sensor, oil filter. These parts when the OLTC is drying must be removed and placed outside the drying furnace saved.

4.5.1.1 Vacuum drying treatment

(1) Drying in a vacuum tank

CAUTION

When drying in a vacuum tank, the cover of the switch head must be removed and placed outside the vacuum tank.

Warming up:

The tap changer heats up in a normal air pressure at a rate of 10℃ per hour until the final temperature, up to 110℃.

Pre-drying:

The tap changer was continuously dried for 20 h in circulating hot air at a maximum temperature of 110℃.

Vacuum drying:

The tap changer was continuously dried for 50 h at a maximum temperature of 110℃ and a residual pressure of up to 133 Pa.

(2) Drying in the transformer tank

If the transformer is dry in its own tank, the cover of the switch head must be closed during the entire drying process, so it must be connected to the oil-filled flange of the tap-changer and the oil-filled flange of the transformer tank with a bypass pipe (see Appendix 7). between. In order to speed up the drying speed of the switching device, a bypass pipe with a nominal inner diameter of at least 25 mm must be connected between the transformer fuel tank and the tap changer head directly to the pipe joint of the diverter switch oil chamber.

The drying process steps, temperature, pressure and duration are as described in the previous section.

4.5.1.2 Vapor phase drying treatment

The drain plug at the bottom of the oil compartment must be opened before the drying process begins (Fig. 30), and after the vapor phase drying process, re-tighten the drain screw.

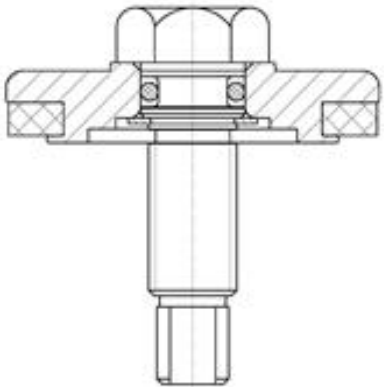


Figure 33

After drying, the kerosene drain plug must be resealed to ensure that the oil in the diverter switch oil compartment does not flow into the transformer tank.

When drying in an oven, the tap-changer head cover must be removed.

Heating: Pass kerosene vapor at around 90℃. This temperature is kept constant for 3 to 4 hours.

Drying: Increase the vapor temperature at 10℃ per hour until the specified final temperature (maximum 125℃). The drying duration is usually the same as the drying time of the transformer.

(2) Vapor phase drying in the transformer tank

If the transformer is vapor-phase dried in its fuel tank, the tap-changer head

cover must remain sealed throughout the drying process. At this time, the transformer tank and the diverter switch oil chamber should be simultaneously connected to the kerosene steam to dry. In order to accelerate the drying speed of the switch oil compartment and the diverter switch device, at least one kerosene steam input pipe with a diameter of Φ50 mm is coupled to the tapping switch head oil filler flange or the oil suction flange.

The steps, temperature and duration of the drying process are as described in the previous section.

After drying, check if the fastener is loose. If it is loose, it must be retightened and retracted. If the tap-changer needs to be operated, the diverter switch oil compartment must be filled with insulating oil and the tap selector must be lubricated with oil.

4.5.2 Oiling

WARNING

The oil filling of the tap-changer oil compartment and its oil conservator must use the transformer oil that meets the requirements of GB2536. The use of other oils will endanger the safe operation of the tap-changer and transformer.

Cover the tap-changer head cover. Tighten all 24 M12 bolts (wrench #17, maximum torque 34Nm). The tap changer and the transformer simultaneously inject new transformer oil under vacuum.

The ZVMD series of on-load tap-changers are suitable for switching switch oils operating from -25℃ to +115℃.

Use the pipe connection Q or R on the tap-changer head for oil filling. When the on-load tap-changer is evacuated, a communication pipe is connected between the pipe joints E2 and Q, so that the diverter switch oil chamber and the transformer can simultaneously draw a vacuum.

4.6 Installation of other on-load tap-changer components

4.6.1 Installation of connecting pipe

There are three pipe joints on the tap changer head. Loosen the pressure ring (4 M10 bolts, No. 17 wrench), and these pipe joints (Fig. 31) can be rotated freely.

Figure 31

(1) Pipe joints for protective relays

For details on the installation of the protective relay QJ4-25, refer to the instruction manual of the protective relay.

The relay should be installed in the connecting line between the head of the switch and the oil pillow, and as close as possible to the head of the switch, usually directly attached to the flange of the elbow, and keep the relay in a horizontal position.

When installing, the arrow mark on the relay should point to the oil pillow.

The connecting pipe should be raised at least 2% in the direction of the oil pillow

Elbow - [R and elbow Q positions can be interchanged as needed.

If the height difference between the on-load tap-changer head cover and the oil level of the oil conservator is greater than 5M, please contact us to discuss the problem of static over-pressure rise.

(2) Pipe joint trumpet of oil suction pipe

This is the pipe joint that connects the fixed oil filter inlet pipe. If the oil filter is not used, this connector is connected to a pipe with a valve at the end, which is placed on the side of the transformer tank for easy operation. It is used to pump oil from the diverter switch oil compartment when the switch is overhauled or changed.

(3) Pipe joint of oil injection pipe Q

This pipe joint is used to connect the oil return pipe of the online oil filter. It is recommended to use a pipe with a valve at the end. If there is no oil filter, you can seal it with a stuffy cover.

This pipe joint can also be used for special design and is used to install a tap change monitoring device when there is a tap change monitoring device.

(4) Connector flange E2

This flange is usually sealed with a cover. The flange hole is straight through the transformer tank from under the switch head.

If necessary, it can also be connected to the collector of the transformer gas relay.

4.6.2 Installation of the motor-drive mechanism

Detailed installation instructions can be found in the instruction manual of the MA7B or MAE motor-drive mechanism.

The factory number of the motor-drive mechanism must match the tap-changer.

The motor-drive unit and the tap-changer must be in the same set working position. This position is indicated in the tap-changer wiring diagram provided with the switch.

4.6.3 Installation of the bevel gearbox

The bevel gearbox (see Appendix 10) is fastened to the bracket welded to the transformer cover with two M16 bolts.

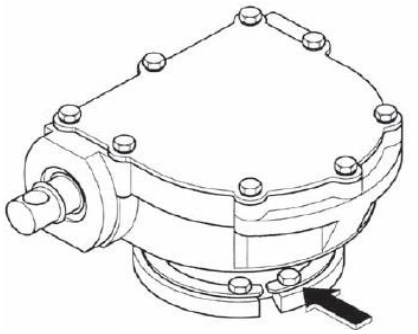


Figure 35

CAUTION

The bevel gear transmission box should be matched with the tap changer. The factory serial number of the print must be the same.

The horizontal drive shaft of the bevel gearbox must be in line with the shaft end of the switch head gearbox.

After removing the pressure plate of the head gear box and loosening the pressure ring of the gear box, the head gear box can be freely rotated.

After the position of the head gear box is adjusted, the pressure ring (maximum torque 15Nm) must be tightened, the gear box pressure plate is covered, and the bolts are locked with the locking piece (Fig. 35).

The installation of a specially designed bevel gear box and its intermediate bearing of a vertical or horizontal drive shaft can be performed as described above.

The motor-drive mechanism is mounted vertically on the side wall of the transformer tank and must not be skewed and can prevent the effects of excessive vibration of the transformer.

4.6.4 Installation of the drive shaft

The drive shaft (see Appendix 11) is the mechanical connection between the motor-drive mechanism and the tap-changer, which converts the vertical rotation into a horizontal rotation through the bevel gearbox.

The drive shaft and shroud should be cut to the actual required size according to the assembly requirements before installation. Considering thermal expansion and contraction, there is a certain gap (total clearance of about 2 mm) at the joints of the horizontal drive shafts.

When installing, first install a vertical drive shaft between the motor-drive mechanism and the bevel gear transmission box, and then install a horizontal drive shaft between the bevel gear transmission box and the switch head.

When the length of the drive shaft exceeds 2m, the intermediate support box should be provided to prevent sloshing, but it must be made at the time of ordering and special supply.

3 × ZVMDI... Three single-phase switch consisting of tap changer drive shaft installation steps:

The following procedure also applies to all other structured ZVMD on-load tap-changers.

For a special arrangement of three phases, the switch heads must be coupled together above the transformer cover. Since the transmission shaft of the slewing head gear mechanism causes the switching switch to operate, it is necessary to check whether the switching switch is accurately returned to the set position after the gear mechanism is adjusted.

The steps are as follows:

(1) First check whether the operation positions of the respective tap-changers are

the same (see the head gear box observation window), and each single-phase switch must be in the set position.

(2) Turn the head gear mechanism to the appropriate mounting position and fix it (tighten the ring bolt and lock the lock pad). Note that the position of each head gear mechanism must be the same.

(3) Rotate each shaft end counterclockwise to make the switch act once, that is, the single tap changer changes one stage, and then check whether the operation positions of the switch heads are consistent.

(4) Install a horizontal drive shaft between each switch head.

(5) Turn the coupled switch group together to the set position.

Note that the position must be in the middle of the direction in which the tap changer descends. Check that all tap-changers and motor-drive mechanisms are in the same position.

(6) Install a protective cover.

(7) Install the vertical drive shaft.

4.6.5 Tap-changer and motor-drive unit connection check

After the tap changer is connected with the motor-drive mechanism, it must be manually operated to check that the switch-switching action time should be completed before the motor-drive mechanism stops, and there is an obvious time interval (1.5~2 grids before the geer green area on the tap change indicator), and It should be symmetrical in both directions.

Check that the tap-changer is in the same set position as the motor-drive unit.

Use the handle to shake in the direction of 1→N. When the switch is activated (when the switching sound is heard), continue to rotate the handle and start recording the number of rotations of the handle until the motorized mechanism taps and changes the pointer to the red mark in the center of the green band (MAE).) or the red indicator of the center of the green band of the tap change indicator wheel appears in the middle of the observation window (MA7B), stop shaking, and record the number of rotations of the handle m.

Shake the handle in the direction of N→1, and record the number k of the handle rotation as described above.

If m=k, the connection is correct. If m≠k and mk>1, it is necessary to balance the rotation difference, that is, loosen the coupling between motor-drive mechanism and the vertical transmission shaft, and swing the 1/2 (mk) circle in the direction of multiple turns with the handle, and then vertical. The drive shaft is coupled to motor-drive mechanism. Re rotate number of turns in both directions until m-k < 1.

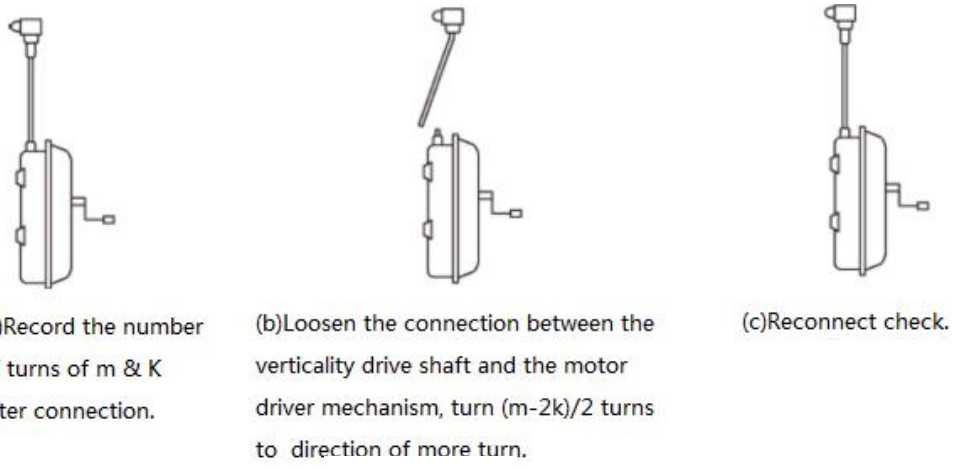


Figure 36

4.7 tap changer commissioning at transformer manufacturer

4.7.1 Mechanical operation test

Before the transformer is energized, the tap changer must perform a complete operation cycle. Check that the tap changer and the motor-drive mechanism should not have any faults; the position indication of the motor-drive mechanism, the remote position indication, and the position indication of the tap-changer in each operating position. The same should be true; the electrical and mechanical terminal limit protection should be reliable at both end positions.

BE CAREFUL

Do not operate the tap-changer after drying without oil lubrication. Otherwise the bearings and seals will be damaged.

The coupling position of the tap-changer and the motor-drive unit must be the same, otherwise the tap-changer and motor-drive unit will be seriously faulty.The motor-drive mechanism is mounted vertically on the side wall of the transformer tank and must not be skewed and can prevent the effects of excessive vibration of the transformer.

4.7.2 Final oiling

Pay attention to the full insulation oil and deflate through the oil conservator. The steps are as follows:

Use the bleed screw plug (Fig. 33) of the switch head cover to deflate the switch head: Open the bolt and remove the slotted plug screw M6 with a maximum torque of 2Nm.

Use the bleed plug on the elbow (Fig. 34) to deflate the suction pipe (S): Remove the M16 cap nut, wrench No. 22, maximum torque 9 Nm, and remove the slotted plug screw M6 with a maximum torque of 2 Nm.

Figure 37

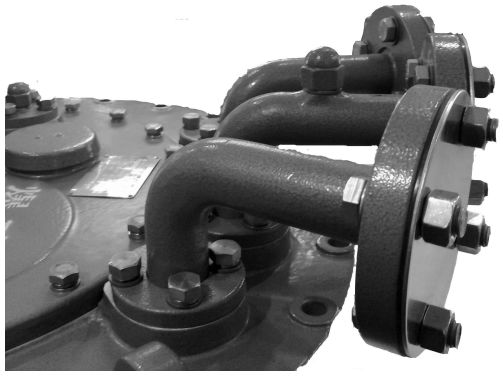


Figure 38

WARNING

The suction pipe must be completely deflated. Otherwise, the grounding resistance of the tap-changer will be significantly impaired.

4.7.3 Ground Connection

Connect the tap-changer to the transformer tank through the conductor, switch head grounding bolt (2-M12 bolt and nut, wrench #19) (Fig. 35).

Connect the motorized mechanism box to the transformer tank through the conductor and grounding bolt M12.

The earth screw of the protective relay is also connected to the cover of the transformer box.

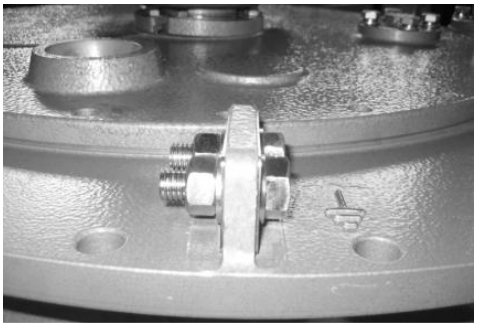


Figure 39

4.7.4 Electrical test of transformers

After the above operations are completed, the electrical test required for transformer acceptance can be performed.

4.7.5 Setting working position of the tap changer

After all tests have been completed, the tap-changer and motor-drive mechanism should be rotated to the working position at the time of delivery.

4.8 Transformer together with the tap changer

After the OLTC and the transformer are assembled, the safety of the product during transportation (such as the increase of temporary support) must be carefully considered.

CAUTION

In order to prevent the OLTC from being damaged by the clamping of the moving parts during the transportation of the transformer, the moving parts must be temporarily supported firmly.

The tap changer is a buried type structure, which does not need to be removed during transportation. If there is difficulty in transportation, when the motor-drive mechanism is not removed, the motor-drive mechanism should be placed in the set position and then the coupling should be disassembled, and then the drive shaft and motor-drive mechanism should be disassembled. Enables the motor-drive mechanism to be transported horizontally to reach the unit of use.

CAUTION

The motor-drive mechanism is not allowed to operate when the tap-changer is not coupled.

The reinstallation of the electric mechanism shall be as described in sections 4.6.2, 4.6.4 and 4.6.5.

If the transformer is filled with oil but not stored and transported with oil pillows, a bypass pipe must be installed between the inside of the diverter switch oil compartment and the transformer tank to compensate for the static pressure generated by oil expansion. The bypass pipe is mounted between the pipe joints E2 and Q of the switch head.

For short-term storage of 2 to 4 weeks without oil conservator, the oil level of the tap-changer should be reduced by about 5 liters.

If the transformer is not fully transported or stored, the oil in the diverter switch oil compartment should also be released. At this time, it is still necessary to install a bypass pipe to balance the pressure inside the switch oil chamber and the transformer tank.

The bypass pipe and temporary support shall be removed before the transformer is installed and put into use at the working site.

4.9 put into operation at the operation site

When the transformer is installed at the working place, the core should be lifted or enter the inside of the transformer tank to check whether the installation position of the tap changer is correct and the tightness of the connecting leads. In particular, the bell-type tap-changer must thoroughly check whether the tap-changer is subjected to force deformation after the clamping of the transformer core coil during transportation, thereby ensuring the reliability of the tap-changer operation.

Before the transformer is put into operation, both the on-load tap-changer and the motor-drive unit must be filled in accordance with Section 4.7.2 and tested in accordance with Section 4.7.1. Also check the function of the protective relay.

The protective relay must be connected to the trip circuit of the circuit breaker so that the transformer can be removed immediately when the protective relay is activated.

When the test button "trip" of the protective relay is pressed, the circuit breaker must trip and the transformer is removed. And check to confirm that only after pressing the "Reset" button of the protection relay, the circuit breaker can be closed and the transformer can be re-energized. Open the valve between the oil pillow and the tap changer, close the transformer, and confirm that the tap changer is all normal, then it can be put into use.

Be sure to follow the safety precautions specified by the transformer manufacturer.

Always check that all throttles between the oil conservator and the tap-changer head have been opened.

5. Operational monitoring

The operational monitoring of the on-load tap-changer and the motor-drive unit is only a periodic visual inspection of the on-load tap-changer switch head, protective relay and motor-drive unit.

These checks can be performed simultaneously with the usual transformer control checks. There are the following points:

5.1 Check the switch head to protect the seal of the relay and the connection of the pipeline from leaking oil.

5.2 Check that the motor-drive mechanism is sealed properly.

5.3 Check if the function of the electric heater installed in the motor-drive mechanism case is normal.

5.4 Check whether the appearance of each electrical component installed in the chassis of the motor-drive mechanism is normal.

5.5 Check that the silicone moisture absorber of the on-load tap-changer oil storage cabinet is in good condition.

5.6 Perform the functional test of the protective relay according to the instruction manual.

5.7 The insulating oil in the transformer shall be monitored by the user in accordance with the relevant regulations. The quality of the on-load tap-changer oil must be monitored simultaneously with the transformer oil. It is recommended to perform a sampling test after switching about 4000-6000 times under the rated working current, and check that the oil withstand voltage is not lower than 30kV.

5.8 When replacing the silicone moisture absorber of the on-load tap-changer oil storage cabinet, as a precautionary measure, the insulation strength of the diverter switch oil should be determined.

5.9 When the transformer is overloaded, the on-load tap-changer cannot be operated frequently. If the user installs the automatic control, there must be “overcurrent self-locking”, so that the tap-changer is not switched when the load current is greater than 2In.

5.10 The head cover of the tap changer is equipped with an overpressure protection blasting cover. The blasting cover should not be damaged during the normal change operation of the diverter switch. Only when the internal switch fails, the pressure inside the fuel tank exceeds 4.5 × 105Pa and blasts. Pressure protection to prevent accidents from expanding.

When installing and overhauling the OLTC, be careful not to step on or heavy objects impact the bursting cover.

5.11 Gas relay trip contact setting shall be operated when the oil speed is 1.0m/s±10%. This contact shall be connected to the trip circuit of the transformer's circuit breaker. When the internal tap changer fails, a large amount of gas will be generated. The oil flow rate is increased, so that the relay baffle action and the trip contact are closed to cut off the power supply of the transformer and avoid accidents from expanding.

Once the protection relay is activated, it must not be reclosed until the tap-changer and transformer have completed the inspection. In this case, the diverter switch core should be taken out for inspection. It is necessary to check whether the tap changer and the transformer are damaged, find out the cause of the fault, and discharge the fault, and the transformer can be put back into operation. Failure to do so may result in serious damage to the tap-changer and transformer.

This warning also applies to the action of other protective devices, such as the pressure relief valve of an on-load tap-changer. The device can only be re-run if it is believed that the on-load tap-changer and transformer are indeed not damaged.

For other protection devices, the device can only be re-run if it is sure that the tap-changer and transformer are indeed not damaged.

6. Maintenance and overhaul

If the preparation is sufficient, the normal inspection can be completed within one day.

The diverter switch core must be replaced after 1.5 million operations.

The tap selector must be serviced after 1 million operations (calculated by the motor-drive unit's counter).

6.1 Maintenance and overhaul cycle

In the long-term operation of the on-load tap-changer, only the switch needs to be regularly inspected, and the tap selector does not need to be repaired under normal circumstances.

6.1.1 For the inspection of the oil-immersed vacuum on-load tap-changer during normal use, refer to DL/T574.

6.1.2 The oil-immersed vacuum on-load tap-changer shall be sampled and monitored for the new oil quality of the injection switch before it is put into operation or after regular maintenance. The oil is regularly monitored with the transformer at least once a year or according to the requirements of the transformer operation. If the pressure or micro water detection of the insulating oil in the switch is unqualified, only cleaning, oil change or oil filtering treatment is required, and generally no lifting core treatment is required.

6.1.3 When the insulation oil pressure in the oil compartment of the on-load tap-changer is lower than 30kV, the new oil must be replaced.

The insulating oil meets the requirements of Table 1.

Table 1: Limits of the diverter switch oil replacement process

On Load Tap Changer	Water content	Water content
Neutral point regulation	<40ppm	≥30kV/2.5mm
In addition to the neutral point regulator	<30ppm	≥40kV/2.5mm

Note:

1. The maximum working voltage of the tap-changer equipment is 126kV, 170kV grade tap changer water content ≤ 30ppm, breakdown voltage ≥ 35kV / 2.5mm;

2. The tap changer with the highest working voltage of 252kV is ≤25ppm and the breakdown voltage is ≥40kV/2.5mm.

When changing the oil, first drain the insulating oil in the diverter switch, then rinse the diverter switch and the insulation tube with clean oil, and then drain the flushed oil again, then fill it with clean oil.

6.1.4 The maintenance and maintenance of the oil pillow and respirator used in the tap changer are the same as those of the general transformer.

6.1.5 The insulating oil injected into the diverter switch oil compartment and its oil conservator must comply with the GB2536 standard and the IEC60422 standard (guidelines for monitoring and maintenance of mineral insulating oil for electrical equipment).

6.1.6 The insulation oil detection period of the vacuum on-load tap-changer is synchronized with the transformer.

6.1.7 Vacuum on-load tap-changer When the gas relay light gas transmission is sent, the voltage-regulating operation should be suspended immediately, and the accumulated gas and insulating oil should be chromatographically analyzed. According to the analysis result, it is determined whether the pressure-regulating operation is resumed or repaired.

6.1.8 According to DL/T1538, for the oil-immersed vacuum on-load tap-changer, in order to accumulate the operating experience, the oil-immersed vacuum on-load tap-changer after the new operation and overhaul can be put into operation and converted after tapping. Chromatographic tracking was performed for 24 hours, 3 days, 1 week, and 1 month (or 100 times), and there should be no significant increase in the value of the characteristic gas components. After that, a chromatographic trace was performed according to the oil micro water and breakdown pressure detection cycle.

Neglecting the inspection cycle or incomplete and irregular inspections can result in serious damage to the on-load tap-changer and transformer.

The on-load tap-changer must be regularly maintained and serviced to maintain a high degree of operational reliability.

The protection action of the vacuum on-load tap-changer should inform the tap-changer manufacturer immediately after the transformer trips, and it is forbidden to operate the change tap, even if the electrical test does not perform the change operation of the on-load tap-changer.

If the overhaul is not carried out by our customer service department, it must be ensured that the personnel engaged in maintenance have received training from our company or qualified to undertake maintenance. For repairs not performed by our customer service department, please send a suitable maintenance report for our company to update the maintenance record. If you need to repair spare parts, please specify the factory serial number (see the on-load tap-changer and motor-drive name plate) and the number of operations that have been performed.

6.1.9 The on-load tap-changer must be serviced after every 300,000 operations.

6.2 Inspection contents and steps

6.2.1 Regular maintenance includes the following:

Lifting and reassembling the diverter switch core;

Clean the diverter switch oil compartment and the diverter switch core, and if necessary, clean the diverter switch oil pillow;

Check the diverter switch oil compartment and the diverter switch insert;

Check the vacuum interrupter;

Measuring the transition resistance;

Replace the switch insulating oil;

Check the protective relay, motor-drive mechanism, drive shaft, controller, oil filter, etc.

6.2.2 The vacuum on-load tap-changer also requires the core inspection when the transformer is overhauled, but it must be carried out under the guidance of the customer service personnel of the on-load tap-changer manufacturer.

6.2.3 When the vacuum on-load tap-changer is abnormal, notify the switch manufacturer immediately, negotiate with the OLTC manufacturer's customer service personnel to determine the maintenance project, and try to hang the core after the customer service personnel of the tap-changer manufacturer arrive at the site. .

6.2.4 The sling inspection items and requirements for the on-load tap-changer that meets the specified number of load switching cycles or years are as follows:

1) Check if the resulting firmware is loose.
2) Measure the single and double main contacts, the contact resistance in the closed state.
3) Check the appearance and whether it is normal.
4) Check the main spring of the energy storage mechanism, return the spring, and whether the card is deformed or broken.
5) Check if the internal connection of the switch is normal.

During the overhaul, care must be taken to keep it clean and the inspection process should not be interrupted. The time when the diverter switch core is exposed to the air shall not exceed 10 hours (in the case of relative humidity not greater than 65%), otherwise it shall be dried as specified in this manual.

6.3 Inspection preparation work

(1) The tap changer is usually stopped after being set to the working position.

(2) Necessary equipment:

Max.service voltage of tap changer (kV)	72.5	126	170	252
Oil filling of tap changer (L)	140	160	180	200

Empty bucket for loading oil;
An oil pump for draining and filling oil;
a plate for dripping oil;
Various brushes for cleaning, absorbents and rags that are not velvet;
Lifting equipment;
Overhaul tool
Various spare parts.

Spring washers and self-locking nuts are not reusable after they have been removed and should be replaced with new ones.

The transformer must be cut from the network and ensure that it is no longer closed. All bushing terminals must be grounded (using a ground wire or grounding switch).
Be sure to clearly mark the work area.
Maintenance work may not begin until safety measures are implemented.

6.4 Diverter switch lifting core step

(1) Reduce the oil level

Close the valve between the oil conservator and the tap changer, open the exhaust oil spill screw on the head cover, and then open the drain valve of the tap changer to lower the oil level of the switch.

The oil of the tap-changer must be treated as flammable liquid. In addition, flammable gases may accumulate under the switch head cover, in the switch oil, or inside the switch oil chamber. Therefore, you must avoid open flames. Use only oil rigs that are approved for use with flammable gases.

(2) Disassemble the head cover

Remove the 24 M10 bolts, washers on the head cover and store them. Remove the cover and take care not to damage the O-ring on the cover.

(3) Remove the fixing nut of the switchboard body support plate. Be careful to keep nuts and washers.

(4) Use the hook to carefully lift the diverter switch core vertically and place it in a flat, clean place. Be careful not to damage the suction pipe.

Do not remove the nut on the screw in the red mark area of the switch head. Otherwise, the tap changer may fall into the transformer tank, causing serious damage to the tap changer and transformer.

6.5 Cleaning

Oil storage cabinet, oil room cleaning:

Discharge all the oil in the diverter switch oil compartment and open the valve between the switch head and the conservator until the clean oil flows out of the conservator. Flush the oil conservator with clean insulating oil if necessary.

Release the oil from the oil compartment and flush the oil compartment with clean insulating oil. If necessary, use a brush to wash and attach to the inner wall of the insulation tube.

Remove the suction pipe, rinse it with clean insulating oil, and then reinstall it.

For safety reasons, after the diverter switch core is lifted, cover the cap and tighten the bolts.

Toggle switch core cleaning:

After the diverter switch core is lifted out, first check the appearance, rinse with clean insulating oil, and clean the supporting insulation strip with a brush. Thorough cleaning will be carried out during the disassembly and inspection.

Use only clean insulating oil when cleaning the oil compartment, suction pipe and diverter switch insert. Do not use other cleaning fluids.

6.6 Diverter switch core maintenance

(1) Record the hanging position:

Before starting maintenance, record the last stop position of the switch and record the release position of the slide on the spring energy storage mechanism to return to this position after the switch is reassembled.

(2) Check if the fasteners are loose.

(3) Check whether the main spring, return spring, and claw of the energy storage mechanism are deformed or broken.

(4) Check if the internal cable is normal.

(5) Reassembly of the diverter switch core:

Lift the diverter switch core over the oil chamber and slowly drop it into the oil chamber. Secure the diverter switch core support plate to the oil chamber with a nut.

(6) Check the single and double main contact circuit contact resistance, which can be detected by the transformer value resistance detection.

6.7 Oiling

Inject the new required transformer oil into the switch oil compartment until the oil level reaches the support plate. Then replace the O-ring on the head cover, cover the switch head cover, and tighten the switch head cover with 24 M10 bolts. Open the valve between the protective relay and the switch oil pillow, loosen the bleed screw cap on the head cover with a wrench, and loosen the plug with a screwdriver to remove the air from the switch head. At the same time, the deflation screw on the suction pipe should be vented, and the oil pump should be injected to inject new oil.

If the tap changer is equipped with an oil filter, the oil filter unit is activated and deflated.

The oil conservator injects new oil into the original oil level.

Parking time of the transformer after oil filling for at least 1 hour.

6.8 Further inspection

It is forbidden to send power to the transformer before the following inspections (1) to (4) are completely completed.

(1) Transmission shaft

Check whether the bolts and nuts at the horizontal drive shaft and the vertical drive shaft coupling bracket are tight and the lock pieces are locked. If necessary, add some grease to the coupling bolts and O-rings.

(2) Functional test of motor-drive mechanism and tap changer

Check that the motorized mechanism and the tap changer are in the same position. If it is inconsistent, there is a coupling error between the motor-drive mechanism and the tap-changer.

Check the symmetry of the coupling of the motor-drive unit and the tap-changer. The hysteresis stop of the motor-drive mechanism must be the same in both directions. If it is not the same, it must be readjusted. After adjusting, press the coupling of (1) section to tighten the bolt and lock the locking piece.

Perform a full-scale test operation to check the electrical and mechanical end limit protection of the motor-drive unit.

(3) Protection relay

Once the protective relay is activated, the transformer must be removed immediately by the circuit breaker. To this end, the operational test of the protective

relay should include checking that the function of the circuit breaker is good.

In this test, it must be ensured that the transformer is not energized and the ground connection of the transformer is not removed. Secondly, if the trip circuit of the protective relay is connected to the fire fighting equipment, it is also necessary to ensure that the fire fighting equipment does not operate.

The inspection method is as follows:

Open the isolating switch, ground the transformer terminal, and close the circuit breaker.

Open the protective relay cover (3-M6 screw) and press the trip button. The circuit breaker must be disconnected.

Check that the protective relay is in the trip position and the circuit breaker must not be closed.

Reposition the protective relay in the reset position and close the shield.

Once the protective relay is activated, the tap-changer and transformer are not allowed to re-close before the inspection is completed. In this inspection, the core check of the diverter switch must be performed.

Be sure that the cause of the fault has been eliminated or that the tap-changer and transformer are indeed not damaged before they can be put back into operation. The transformer must never be put back into operation before it has been inspected, otherwise it may cause serious damage to the tap-changer and transformer.

(4) Voltage regulator

If the tap-changer has voltage regulator control, check the voltage level, sensitivity (bandwidth) and action delay settings according to their operating instructions to avoid unnecessary tap-change actions.

When further inspection confirms that the tap-changer is all right, it can be put into operation.

7. Common faults and their treatment

7.1 DC resistance is unqualified

Cause of issue:

(1) The static contact produces an oxide film:

Due to the presence of traces of moisture in the transformer, the static contacts on stalls that have not been used for a long time produce an oxide film under the action of oil temperature.

Inspection and elimination method: Combine the transformer minor repair every year and perform 3 cycles of tap change.

(2) When the main contact spring is subjected to high temperature and pressure for a long time, the spring force is reduced to cause poor contact.

(3) Poor contact in a part of the tap changer:

Poor contact between the main contact of the diverter switch and the static contact.

Poor contact between the oil chamber static contact and the core contact.

Poor contact in the connecting wire between the diverter switch insulation barrel and the selector.

The contact between the moving and closing contacts of the selector switch is not good.

The selector is deformed by an external force.

The transformer lead tap is not properly fastened to the selector terminal.

7.2 Tap changer oil leakage

Symptoms and causes:

(1) Oil leakage at each seal of the head cover - seal aging.

(2) Oil leakage between the upper and lower flanges - the seal is aging or the bolts are not tightened.

(3) Oil leakage at the output shaft at the bottom of the oil chamber - oil seal aging.

(4) Oil leakage in the oil switch of the tap-changer - sealing aging.

(5) New switch oil leakage:

The drain valve is not tightened after the second drying.

The bolts between the upper and lower flanges are not tightened.

The head seal is damaged during secondary assembly.

If the oven temperature is too high, the seal will be baked.

7.3 Light gas action

Cause of issue:

(1) The inclination of the connecting pipe from the gas relay to the switch oil bolster (2%) does not meet the requirements, and the gas generated by the normal pressure regulation cannot be smoothly discharged.

(2) The gas relay malfunctions.

7.4 Heavy gas action

Cause of issue:

(1) The internal screw of the switch is loose and falls off, causing the transition resistance to be short-circuited.

(2) The energy storage mechanism trips, causing an open circuit.

(3) The switch spring breaks to cause slow motion, causing the transition resistance to generate a large amount of gas due to the long switching time.

(4) The contact pressure between the diverter switch and the oil chamber contact is insufficient, causing the contact temperature to be too high and burning.

(5) The insulation is aged and broken down.

(6) The oil insulation is lowered due to poor sealing, so that the tap changer is subjected to the breakdown of the ground insulation portion.

7.5 The motor-drive mechanism completes a tap-change operation, but the tap-changer does not operate.

Cause of issue:

(1) The mechanical connection of the tap changer to the motor-drive mechanism is disengaged (for example, the vertical or horizontal rotation of the connecting pin is detached).

(2) The combined tap changer drive shaft is broken. (The drive shaft includes a connecting shaft that protrudes from the upper portion of the switching core and meshes with the head gear, an intermediate insulating shaft, a transmission shaft that passes through the contact system, and an output shaft that is at the bottom of the oil chamber.)

(3) The gears inside the gear cover of the switch head cover or the gears of the angle gear box are detached or damaged.

(4) The number of connection points of the tap changer and the motor-drive mechanism is incorrect (the switch has not been switched after the motor-driven mechanism stops).

Inspection and troubleshooting methods:

Parts that have been damaged must be replaced. After checking that the position of the tap-changer is the same as the position indicated by the motor-drive mechanism, reconnect and perform the connection test.

7.6 Reflecting the switching time is too long or not switching in the oscillogram

Cause of issue:

The energy storage spring is fatigued, weakened, broken or mechanically stuck.

Inspection and troubleshooting methods:

Replace the spring or overhaul the transmission machinery.

7.7 The oil level of the oil storage cabinet of the tap changer is abnormally raised

Cause of issue:

If the similar fault phenomenon continues to occur after adjusting the oil level of the

tap changer oil storage cabinet, it should be judged that the oil chamber seal is defective, causing the oil in the oil chamber to leak with the transformer body oil. During installation, the oil release valve at the bottom of the oil compartment is not closed or the communication pipe between the oil compartment and the transformer tank is not removed. If the oil drain bolts in the oil compartment are not tightened, it will also cause oil leakage.

Inspection and troubleshooting methods:

The tap-changer is uncovered to find the leaking point. If there is no leakage oil, the core should be lifted out, the insulating oil in the oil chamber should be exhausted, and the inner wall of the insulating cylinder, the tapped lead bolt and the shaft seal should be observed under the oil pressure of the transformer body. Is there any leakage oil? Then, replace the seal or seal it. If there are venting holes or oil drain bolts, tighten the bolts and replace the seals. Remove the connecting pipe between the oil compartment and the transformer tank.

7.8 Hydrogen, acetylene and total hydrocarbon content in the chromatographic analysis of the insulating oil in the transformer body

Cause of issue:

Chromatographic tracking analysis of the insulating oil of the transformer body, if the dissolved gas combination content and the gas production rate show a downward trend, it is judged that the insulating oil of the oil chamber leaks into the transformer body.

Inspection and troubleshooting methods:

Check the oil chamber first and check the oil chamber for leaks. After this reason is ruled out, it may be caused by poor contact of the selector.

7.9 Failure of the energy storage mechanism (only for the combined tap changer with the gun type energy storage mechanism)

Cause of issue:

After the tap changer is dry, there is no oil operation; the foreign matter falls into the diverter switch core; the misplaced gun machine causes the mechanism to be in the tripped state.

Inspection and troubleshooting methods:

It is strictly forbidden to operate without oil after drying to remove foreign matter.

8. Warranty

The manufacturer shall provide free repairs if the product fails to function properly due to manufacturing quality problems within 12 months from the date of installation or use, or within 18 months from the date of shipment to the manufacturer.

If the tap changer or motor-drive unit has a serious fault, and it is not easy to repair at the operation site, or the protection relay has tripped, please contact the after-sales service department of Changzheng Electric Co., Ltd. directly.

9. Appendices

Appendix 1 ZVMD OLTC technical data
Appendix 2 ZVMD OLTC internal insulation level
Appendix 3 ZVMD OLTC overall installation layout
Appendix 4 Box type installation dimension drawing
Appendix 5 Bell type installation dimension drawing
Appendix 6 Box cover installation flange drawing
Appendix 7 Bypass structure drawing
Appendix 8 Bell type installation spreader
Appendix 9 Protective relay overall dimension drawing
Appendix 10 Cone gear box installation dimension
Appendix 11 Horizontal and vertical drive shaft installation diagram
Appendix 12 ZVMD OLTC 10193W Working position table and wiring diagram
Appendix 13 ZVMD OLTC 10191W Working position table and wiring diagram
Appendix 14 ZVMD OLTC 10071W Working position table and wiring diagram
Appendix 15 ZVMD OLTC 10070 Working position table and wiring diagram
Appendix 16 ZVMD OLTC I500 34320 Working position table and wiring diagram
Appendix 17 ZVMD OLTC 10191G Working position table and wiring diagram
Appendix 18 ZVMD OLTC 10193G Working position table and wiring diagram

Appendix 1 ZVMD OLTC technical data

Item	Specifications		III400	III500	III600	III1000	I401	I501	I601	I800	I1200	I1500
1	Max. rated through current (A)		400	500	600	1000	400	500	600	800	1200	1500
2	Rated frequency (Hz)		50 or 60									
3	Phase & Connection method		3 Phase Y connect neutral point				Single phase Arbitrary connection mode					
4	Max. rated step voltage (V)		4000									
5	Rated step capacity (kVA)		1320	1400	1500	3000	1320	1400	1500	2640	3100	3500
6	Short circuit current (kA)	Thermal (3s)	6	8	8	15	6	8	8	16	24	24
		Dynamic (peak)	15	20	20	37.5	15	20	20	40	60	60
7	Operating position number		Linear regulating 7, 10, 12, 14, 16, 18, 22, 34 Reversing and coarse regulating: ±3~±17									
8	Insulation level of tap changer (kV)	Rated voltage	35		66		110		150		220	
		Max. service voltage	40.5		72.5		126		170		252	
		Power frequency withstand voltage (50Hz, 1min)	85		140		230		325		460	
		Lightning impulse withstand voltage (1.2/50μs)	200		350		550		750		1050	
9	Tap selector		3 Grades of B, C, D according to insulation level									
10	Mechanical service life		⩾1500000 times									
11	Electric service life		⩾350000 times									
12	Oil compartment for diverter switch	Service pressure	3×10^{5}Pa									
		Sealing property	No leakage under 6×104Pa for 24 hours									
		Over pressure protection	Blasting cap blast at (4~5) ×105Pa									
		Protective relay	QJ4-25 oil flow speed set at 1.0m/s±10%									
13	Oil drainage volume (L)		Above 240~300									
14	Oil filling volume (L)		Above 168~223									
15	Weight (kg)		Above 250~370									
16	Motor-driven mechanism		ZD/MAE/MA7B									

Note:

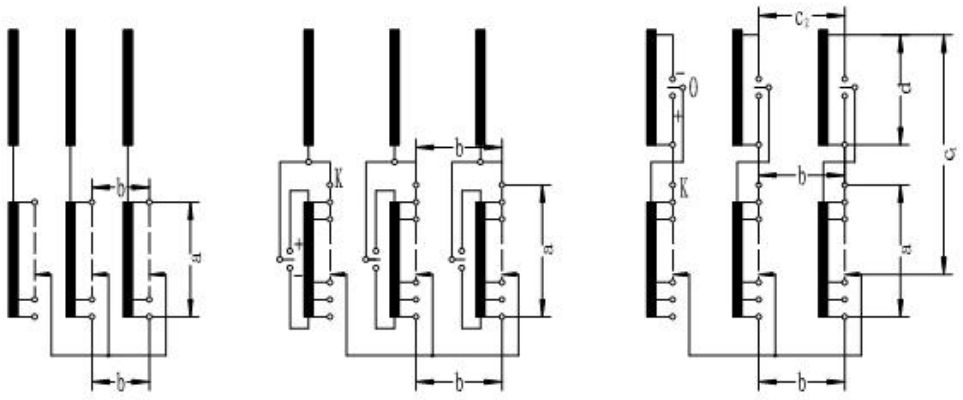
1. Step capacity=Step voltage × Load current, Rated step capacity is the maximum allowed continuous capacity.
2. When 3 phase tap changer parallel to be a single phase tap changer, should think about transformer coil shunt, ZVMDI800 two way shunt, ZVMDI1200, I1500 three way shunt.
3. The single-phase linear tap changer with 34 working positions only has: I500A、I800A、I1500A.

Appendix 2 ZVMD OLTC internal insulation level

Insulation distance symbol	Tap selector type B		Tap selector type C		Tap selector type D	
	kV 1.2/50μs	kV 50Hz1min	kV 1.2/50μs	kV 50Hz1min	kV 1.2/50μs	kV 50Hz1min
a	265	50	350	82	490	105
b	265	50	350	82	490	146
c_1	485	143	545	178	590	208
c_2	495	150	550	182	590	225
d	265	50	350	82	490	105

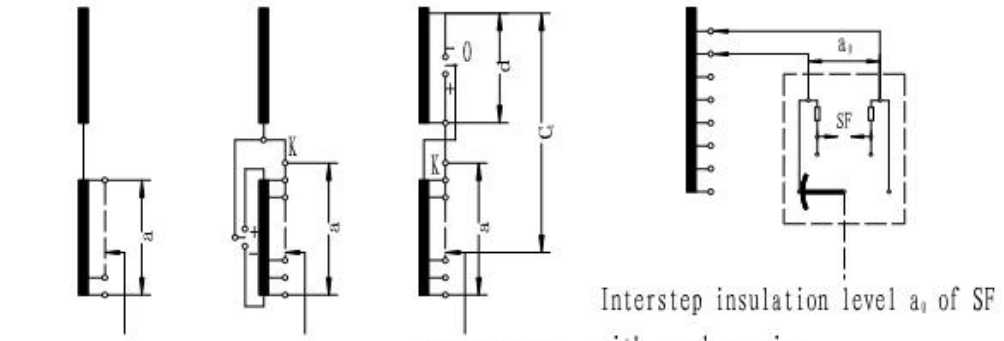
Insulation distance of every part of voltage regulating coil

Ⅲ400、Ⅲ500、Ⅲ600、Ⅲ1000



Linear regulating　　Reversing regulating　　Course and fine regulating

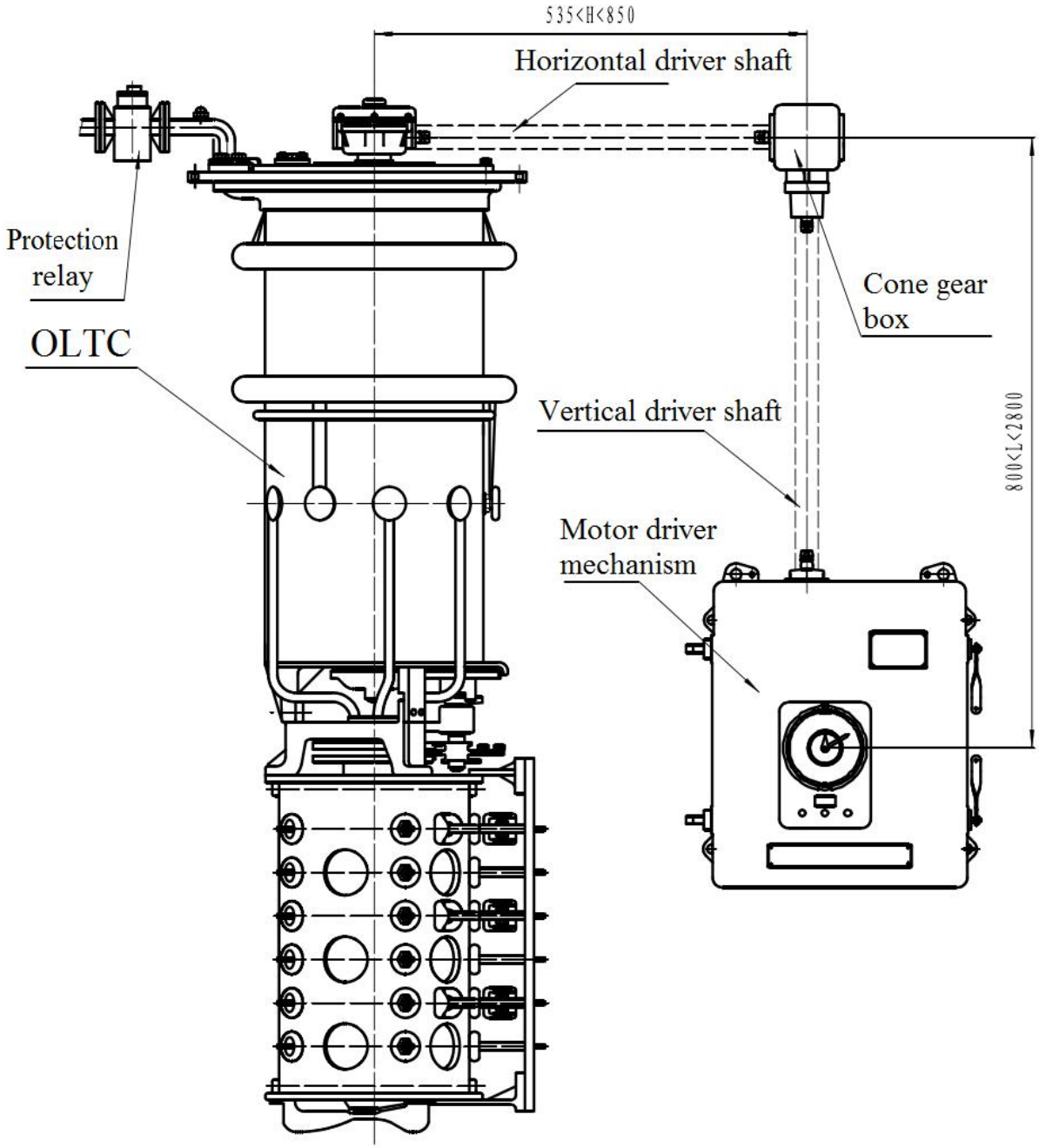
Ⅰ401、Ⅰ501、Ⅰ601、Ⅰ800、Ⅰ1200、Ⅰ1500



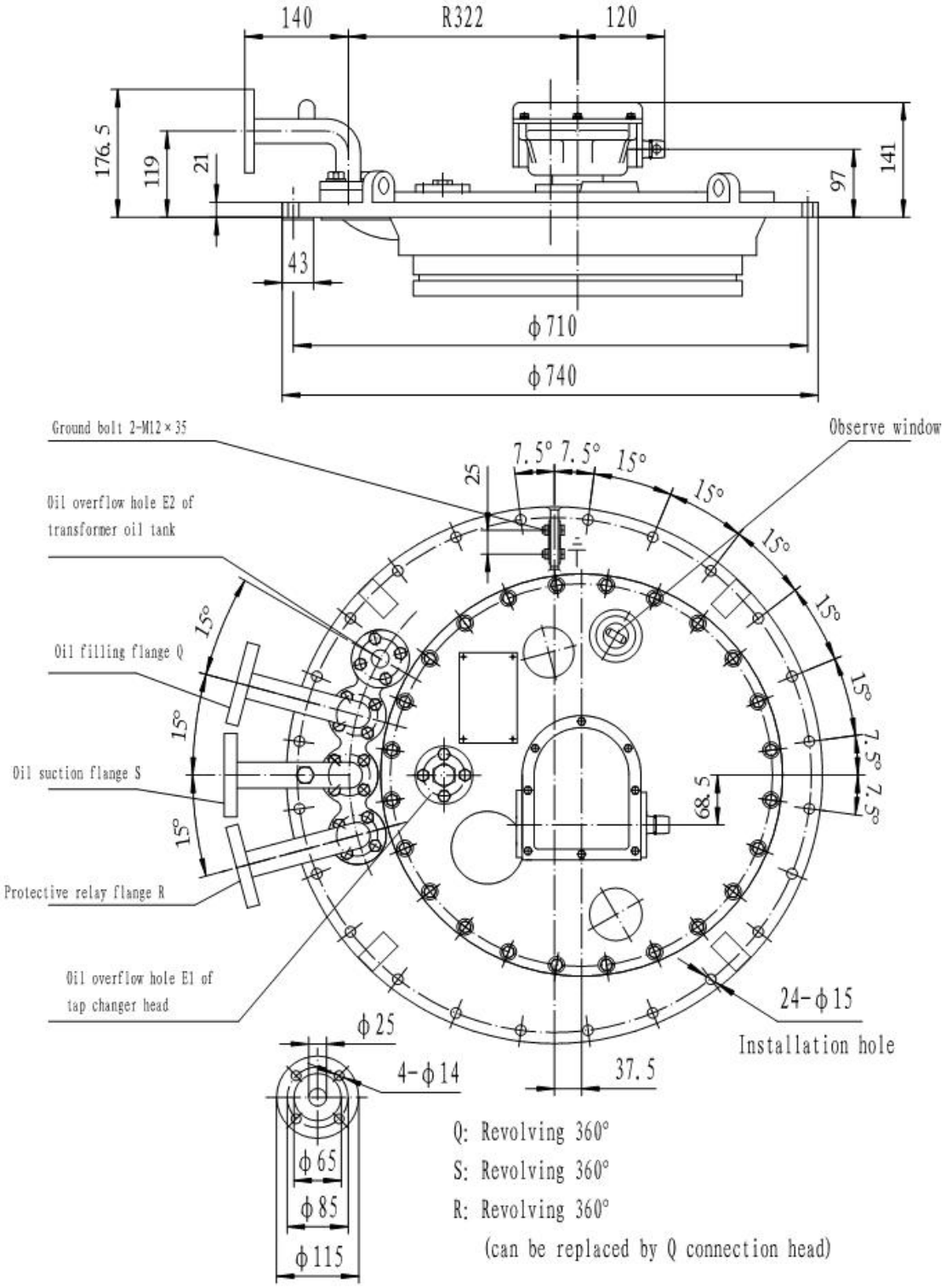
Linear regulating　Reversing regulating　Course and fine regulating

Interstep insulation level a_s of SF with spark gap is:
50Hz 1min 20kV & 1.2/50μs 90kV

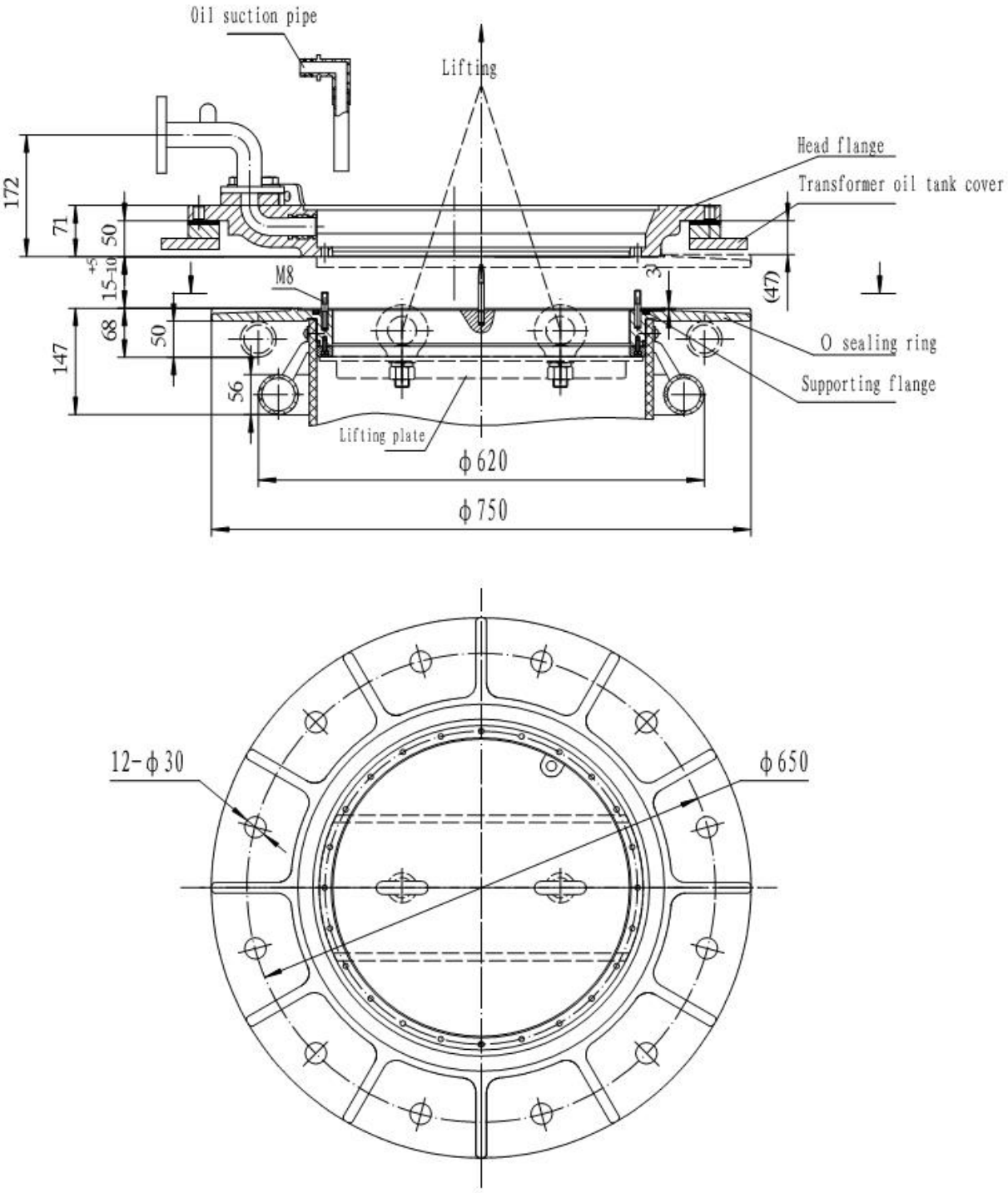
Appendix 3 OLTC overall installation layout



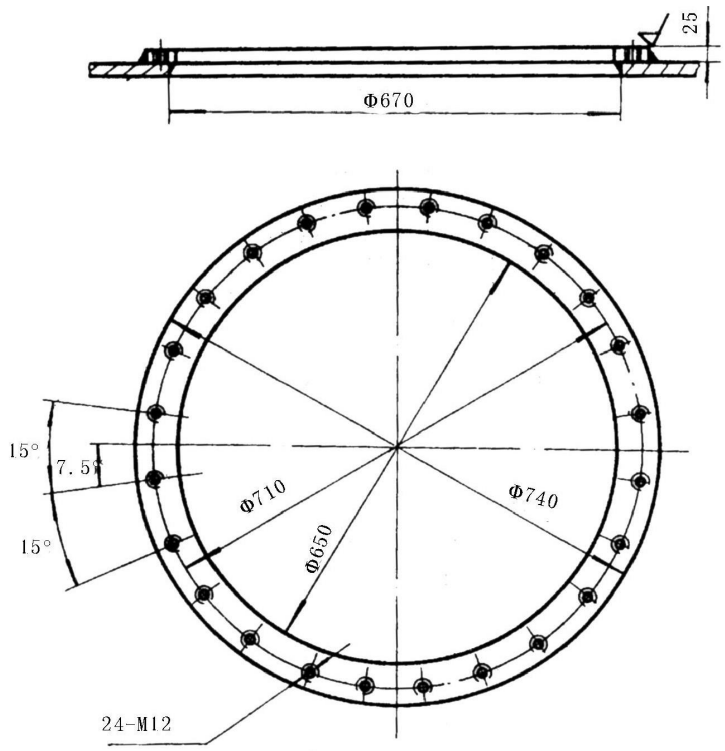
Appendix 4 Box type installation dimension drawing



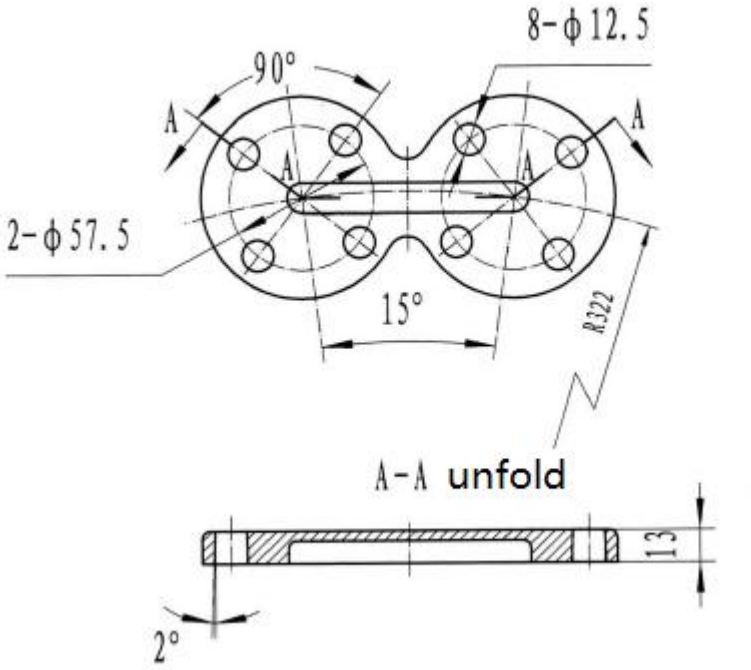
Appendix 5 Bell type installation dimension drawing



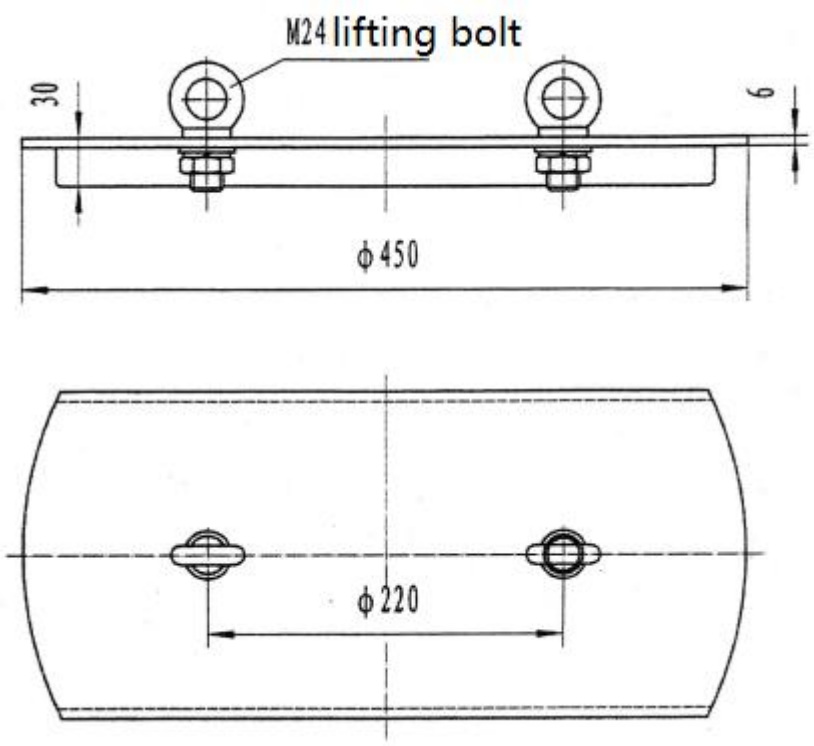
Appendix 6 Box cover installation flange drawing



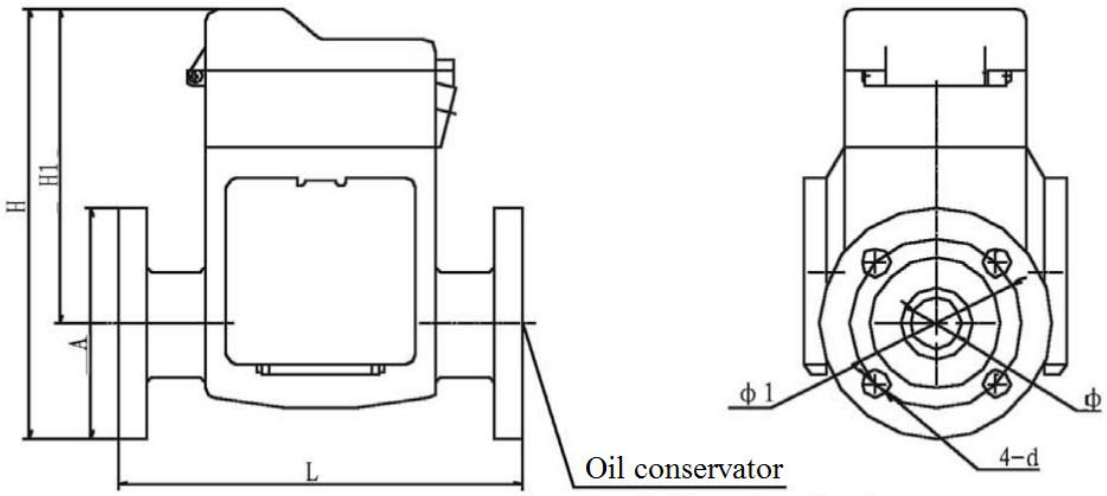
Appendix 7 Bypass structure drawing



Appendix 8 Lifting plate



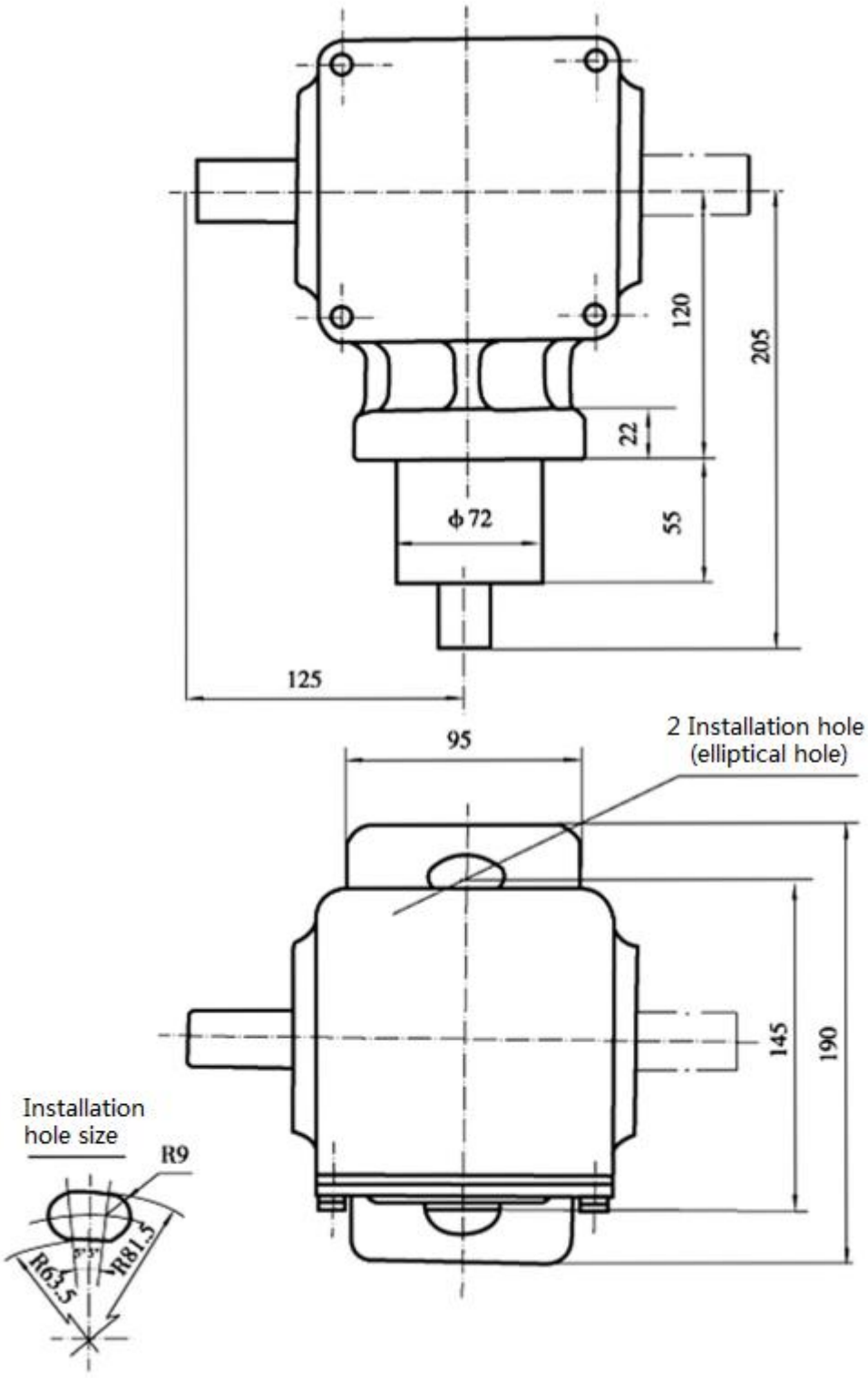
Appendix 9 Protection relay overall dimension drawing



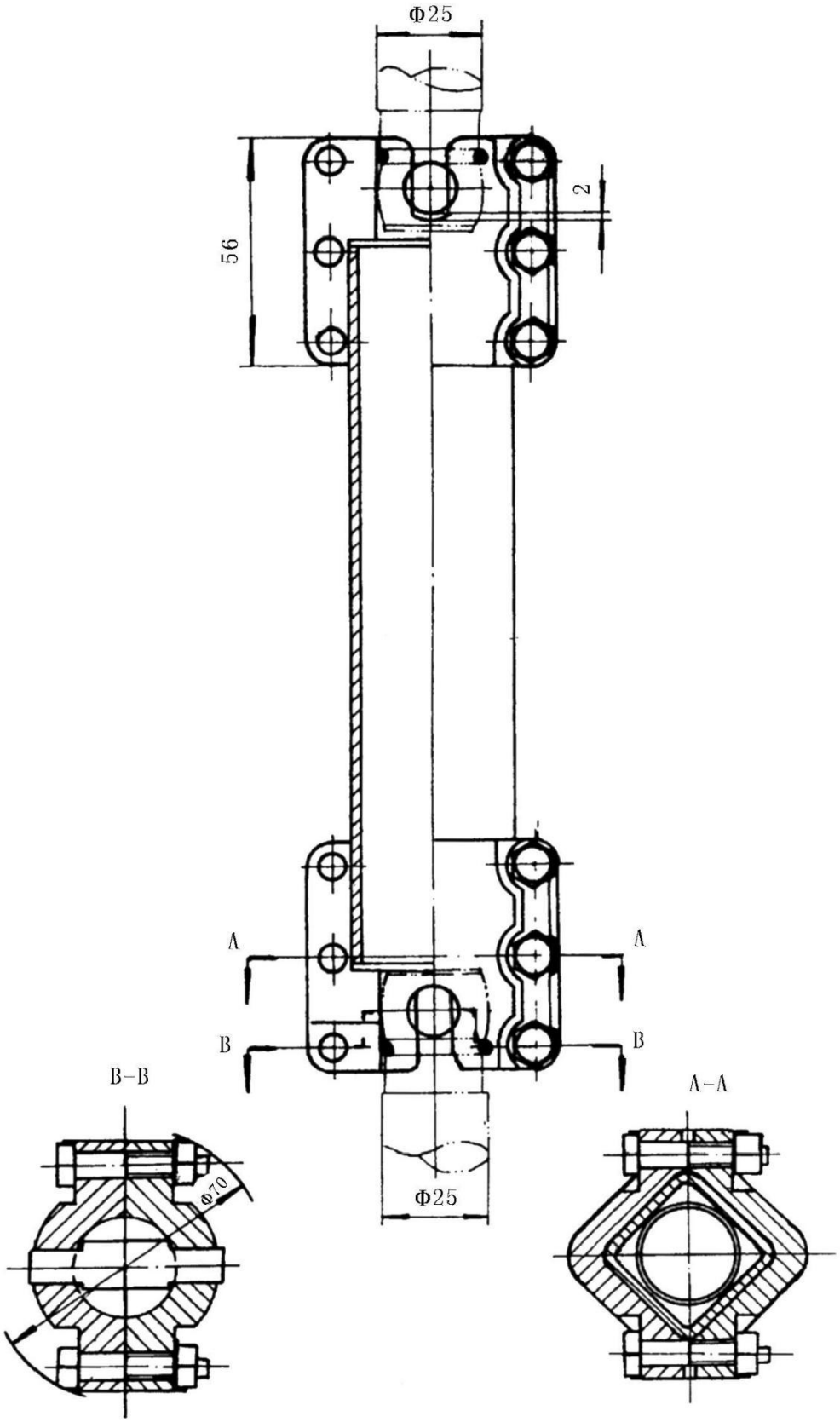
QJ4-25, QJ4G-25, QJ6-25 type gas relay overall dimension drawing

Type	Connection	L	Φ	Φ1	d	H	H1	A	Note
QJ₄-25	25	200	25	85	ϕ14	215	153	ϕ115	Single trip, single signal
QJ₄G-25	25	200	25	85	ϕ14	195	133	ϕ115	Single trip
QJ₆-25	25	200	25	85	ϕ14	215	153	ϕ115	Double trip

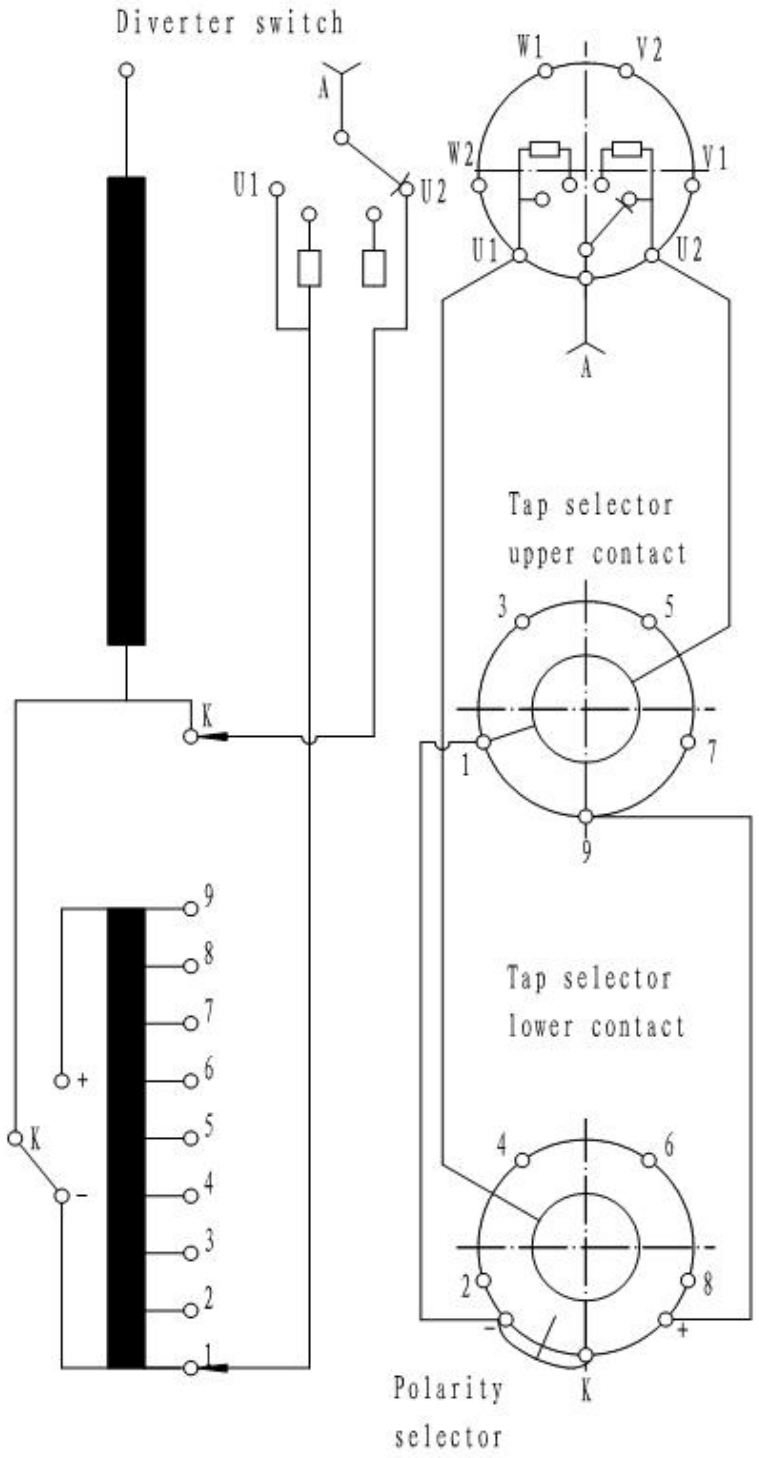
Appendix 10 Cone gear box installation dimension



Appendix 11 Horizontal and vertical drive shaft installation diagram



Appendix 12 ZVMD OLTC 10193W Working position table and wiring diagram

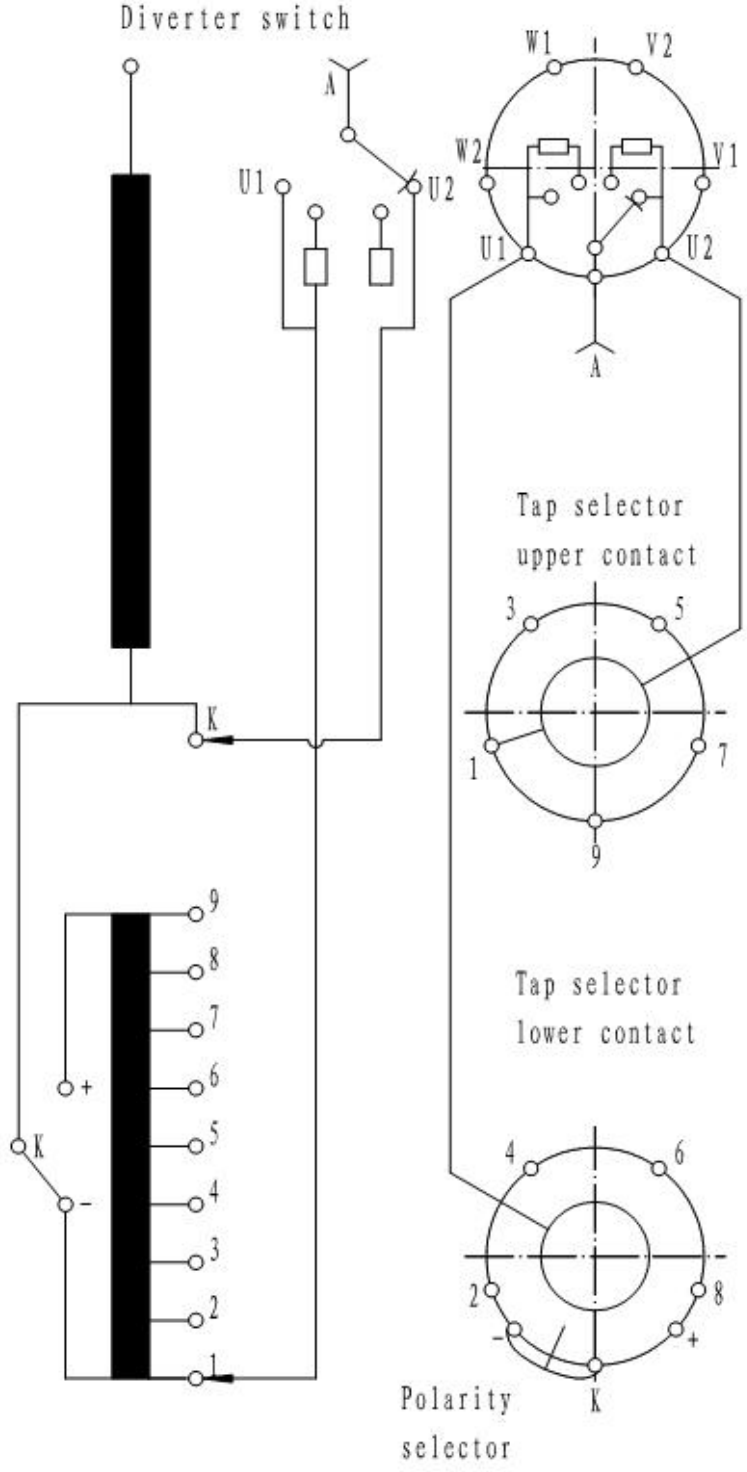


Indicated position	Tap selector position	Polarity selector position	Diverter switch position	Switching direction 1 → N	Contact position Tap selector Upper	Contact position Tap selector Lower	Switching direction N → 1	Contact position Tap selector Upper	Contact position Tap selector Lower
1	1		U1		◤1	2		◤1	2
2	2		U2		1	◤2		3	◤2
3	3		U1		◤3	2		◤3	4
4	4		U2		3	◤4		5	◤4
5	5		U1		◤5	4		◤5	6
6	6		U2		5	◤6		7	◤6
7	7		U1		◤7	6		◤7	8
8	8		U2		7	◤8		9	◤8
9a	9		U1		◤9	8		◤9	K
●9b	K		U2		9	◤K		◤1	K
9c	1		U1		◤1	K		◤1	2
10	2		U2		1	◤2		3	◤2
11	3		U1		◤3	2		◤3	4
12	4		U2		3	◤4		5	◤4
13	5		U1		◤5	4		◤5	6
14	6		U2		5	◤6		7	◤6
15	7		U1		◤7	6		◤7	8
16	8		U2		7	◤8		9	◤8
17	9		U1		◤9	8		◤9	8

Note:

1. "●"mark is setting working position.
2. "◤"mark is working contact of tap selector contact.
3. 9a, 9b, 9c the three positions equipotential

Appendix 13 ZVMD OLTC 10191W Working position table and wiring diagram

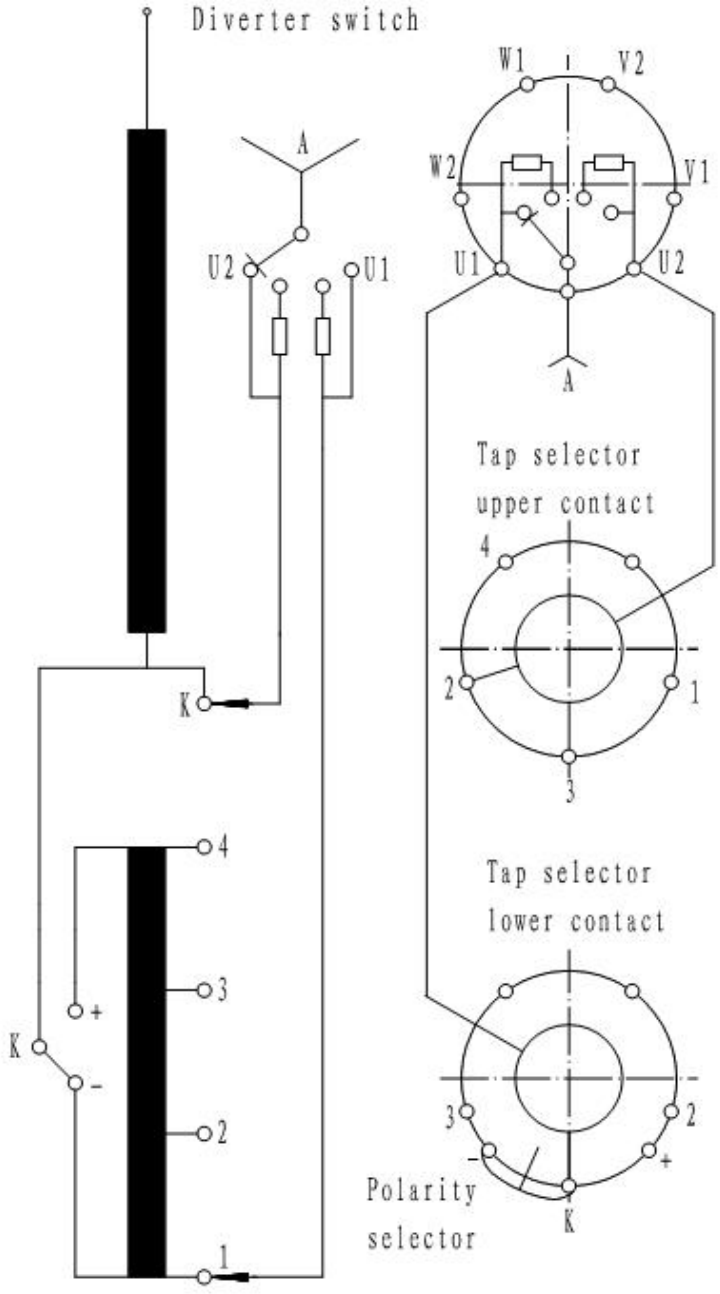


Indicated position	Tap selector position	Polarity selector position	Diverter switch position	Switching direction 1 → N	Tap selector	Contact position	Switching direction N → 1	Tap selector	Contact position
					Upper	Lower		Upper	Lower
1	1		U1		1	2		1	2
2	2		U2		1	2		3	2
3	3		U1		3	2		3	4
4	4		U2		3	4		5	4
5	5		U1		5	4		5	6
6	6		U2		5	6		7	6
7	7		U1		7	6		7	8
8	8		U2		7	8		9	8
9	9		U1		9	8		9	K
●10	K	+K	U2		9	K		1	K
11	1		U1		1	K		1	2
12	2		U2		1	2		3	2
13	3		U1		3	2		3	4
14	4		U2		3	4		5	4
15	5		U1		5	4		5	6
16	6		U2		5	6		7	6
17	7		U1		7	6		7	8
18	8		U2		7	8		9	8
19	9	-K	U1		9	8		9	8

Note:

1. " ● "mark is setting working position.
2. " ◤ "mark is working contact of tap selector contact.
3. 9a, 9b, 9c the three positions equipotential

Appendix 14 ZVMD OLTC 10071W Working position table and wiring diagram

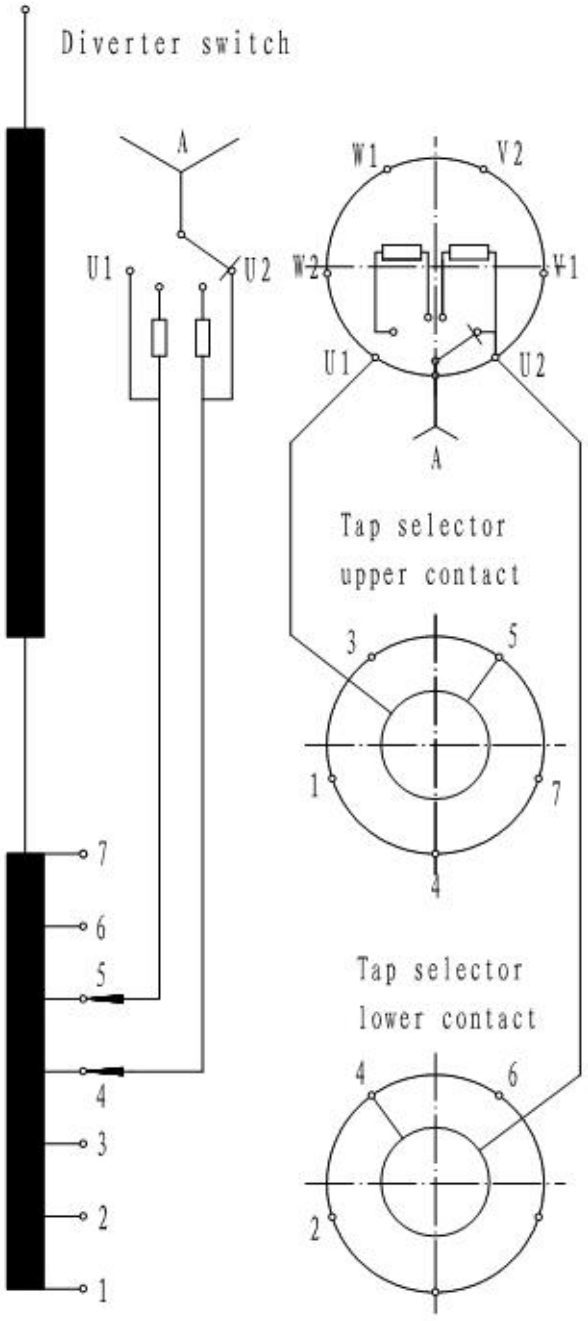


Indicated position	Tap selector position	Polarity selector position	Diverter switch position	Switching direction	Contact position Tap selector Upper	Contact position Tap selector Lower	Switching direction	Contact position Tap selector Upper	Contact position Tap selector Lower
1	1	+ K	U1		1	2		1	2
2	2		U2		1	2		3	2
3	3		U1		3	2		3	K
•4	K		U2		3	K		2	K
5	2		U1		2	K		2	3
6	3	- K	U2		2	3		4	3
7	4		U1		4	3		4	3

Note:

1. " ● "mark is setting working position.
2. " ◤ "mark is working contact of tap selector contact.
3. Connection between tap selector contact"+ - 4", "- - 1", "2-2", "3-3" by user.

Appendix 15 ZVMD OLTC 10070 Working position table and wiring diagram

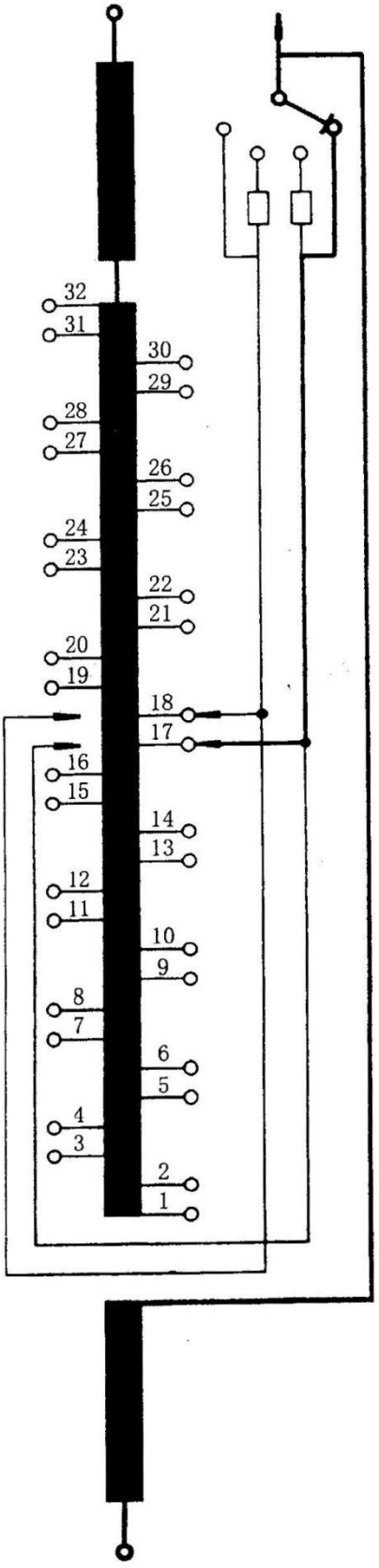


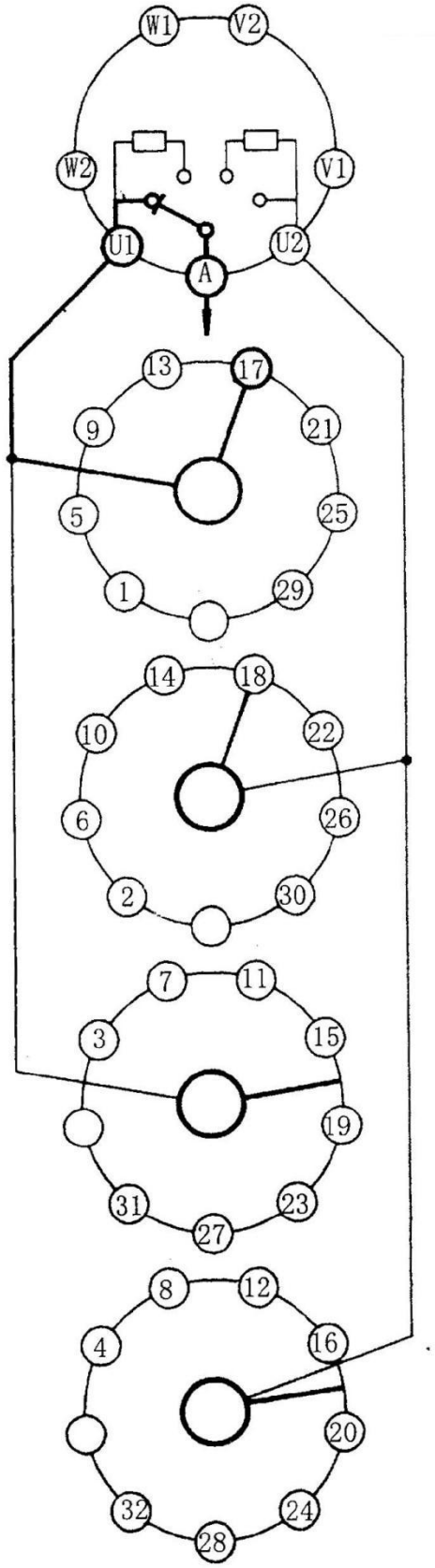
Indicated position	Tap selector position	Diverter switch position	Switching direction	Contact position Tap selector Upper	Contact position Tap selector Lower	Switching direction	Contact position Tap selector Upper	Contact position Tap selector Lower
1	1	U1	↓	◤ 1	2	↑	◤ 1	2
2	2	U2		1	◤ 2		3	◤ 2
3	3	U1		◤ 3	2		◤ 3	4
•4	4	U2		3	◤ 4		5	◤ 4
5	5	U1		◤ 5	4		◤ 5	6
6	6	U2		5	◤ 6		7	◤ 6
7	7	U1		◤ 7	6		◤ 7	6

Note:

1. "●" mark is setting working position.
2. "◤" mark is working contact of tap selector contact.

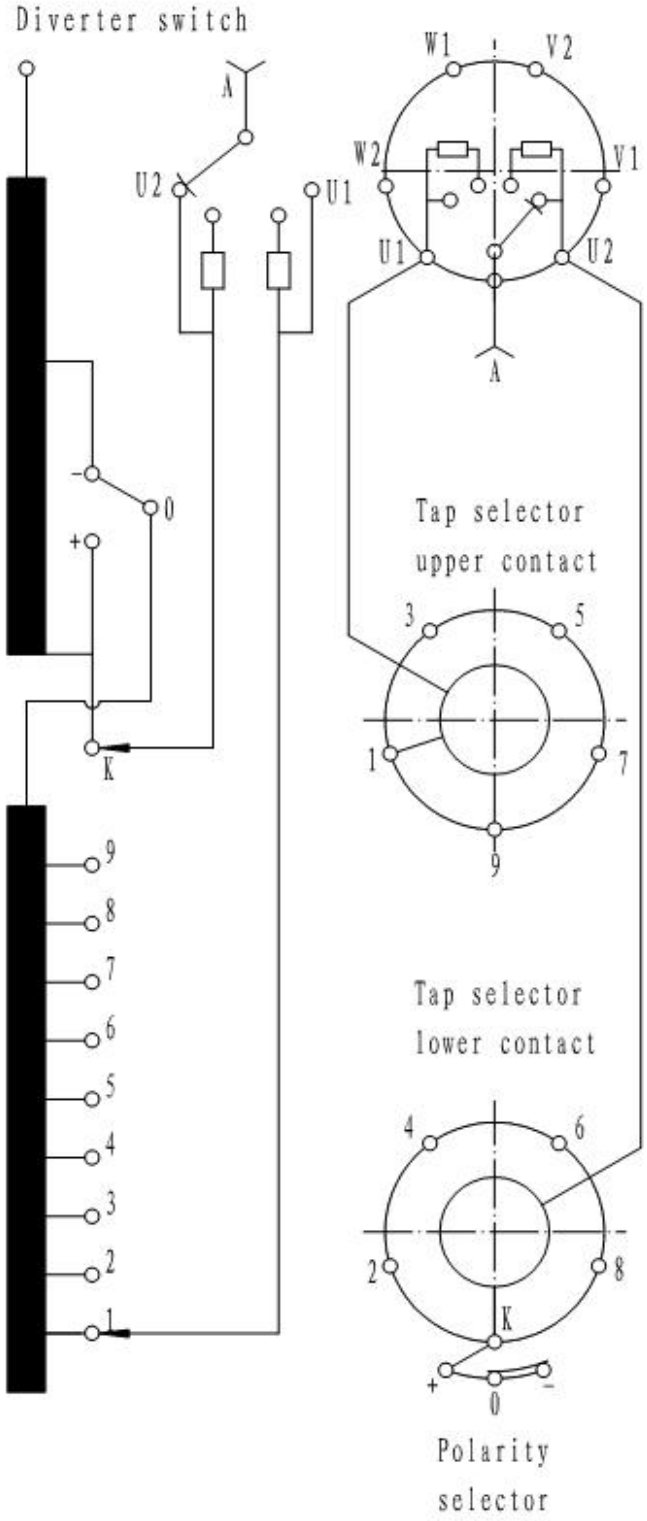
Appendix 16 ZVMD OLTC I500 34320 Working position table & wiring diagram





Indicted position	Tap selector position
32	32
31	31
30	30
29	29
28	28
27	27
26	26
25	25
24	24
23	23
22	22
21	21
20	20
19	19
18	18
•17	17
16	16
15	15
14	14
13	13
12	12
11	11
10	10
9	9
8	8
7	7
6	6
5	5
4	4
3	3
2	2
1	1

Appendix 17 ZVMD OLTC 10191G Working position table and wiring diagram

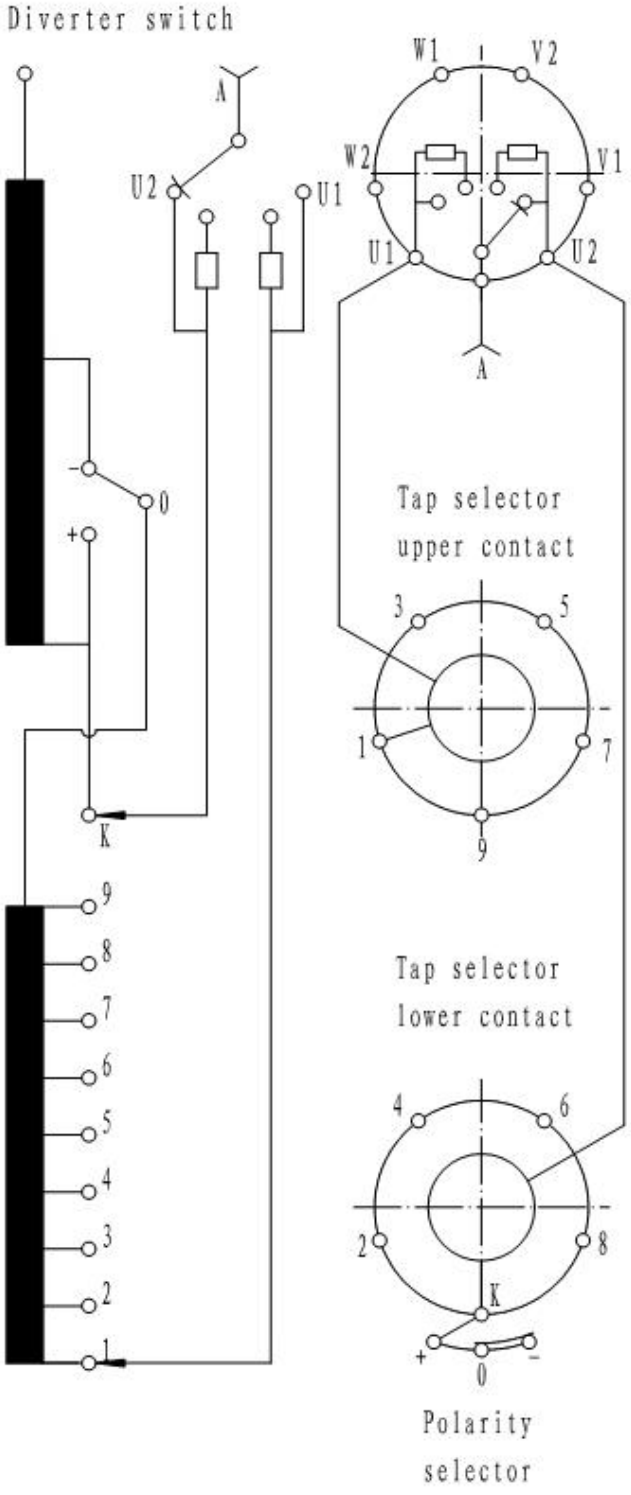


Indicated position	Tap selector position	Polarity selector position	Diverter switch position	Switching direction 1 → N	Contact position		Switching direction N → 1	Contact position	
					Tap selector			Tap selector	
					Upper	Lower		Upper	Lower
1	1		U1		◤1	2		◤1	2
2	2		U2		1	◤2		3	◤2
3	3		U1		◤3	2		3	4
4	4		U2		3	◤4		◤5	4
5	5		U1		◤5	4		◤5	6
6	6	+	U2		5	◤6		7	◤6
7	7		U1		◤7	6		◤7	8
8	8		U2		7	◤8		9	◤8
9	9		U1		◤9	8		◤9	K
●10	K		U2		9	◤K		◤1	K
11	1		U1		◤1	K		◤1	2
12	2		U2		1	◤2		3	◤2
13	3		U1		◤3	2		◤3	4
14	4		U2		3	◤4		◤5	4
15	5		U1		◤5	4		◤5	6
16	6		U2		5	◤6		◤7	6
17	7		U1		◤7	6		◤7	8
18	8	−	U2		7	◤8		9	◤8
19	9		U1		◤9	8		◤9	8

Note:

1. " ● "mark is setting working position.
2. " ◤ "mark is working contact of tap selector contact.

Appendix 18 ZVMD OLTC 10193G Working position table and wiring diagram



Indicated position	Tap selector position	Polarity selector position	Diverter switch position	Switching direction 1 → N	Contact position: Tap selector: Upper	Contact position: Tap selector: Lower	Switching direction N → 1	Contact position: Tap selector: Upper	Contact position: Tap selector: Lower
1	1	+0	U1		1	2		1	2
2	2	+0	U2		1	2		3	2
3	3	+0	U1		3	2		3	4
4	4	+0	U2		3	4		5	4
5	5	+0	U1		5	4		5	6
6	6	+0	U2		5	6		7	6
7	7	+0	U1		7	6		7	8
8	8	+0	U2		7	8		9	8
9a	9	+0	U1		9	8		9	K
●9b	K	+0	U2		9	K		1	K
9c	1	−0	U1		1	K		1	2
10	2	−0	U2		1	2		3	2
11	3	−0	U1		3	2		3	4
12	4	−0	U2		3	4		5	4
13	5	−0	U1		5	4		5	6
14	6	−0	U2		5	6		7	6
15	7	−0	U1		7	6		7	8
16	8	−0	U2		7	8		9	8
17	9	−0	U1		9	8		9	8

Note:

1. " ● "mark is setting working position.
2. " ◤ "mark is working contact of tap selector contact.
3. 9a, 9b, 9c the three positions equipotential

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