

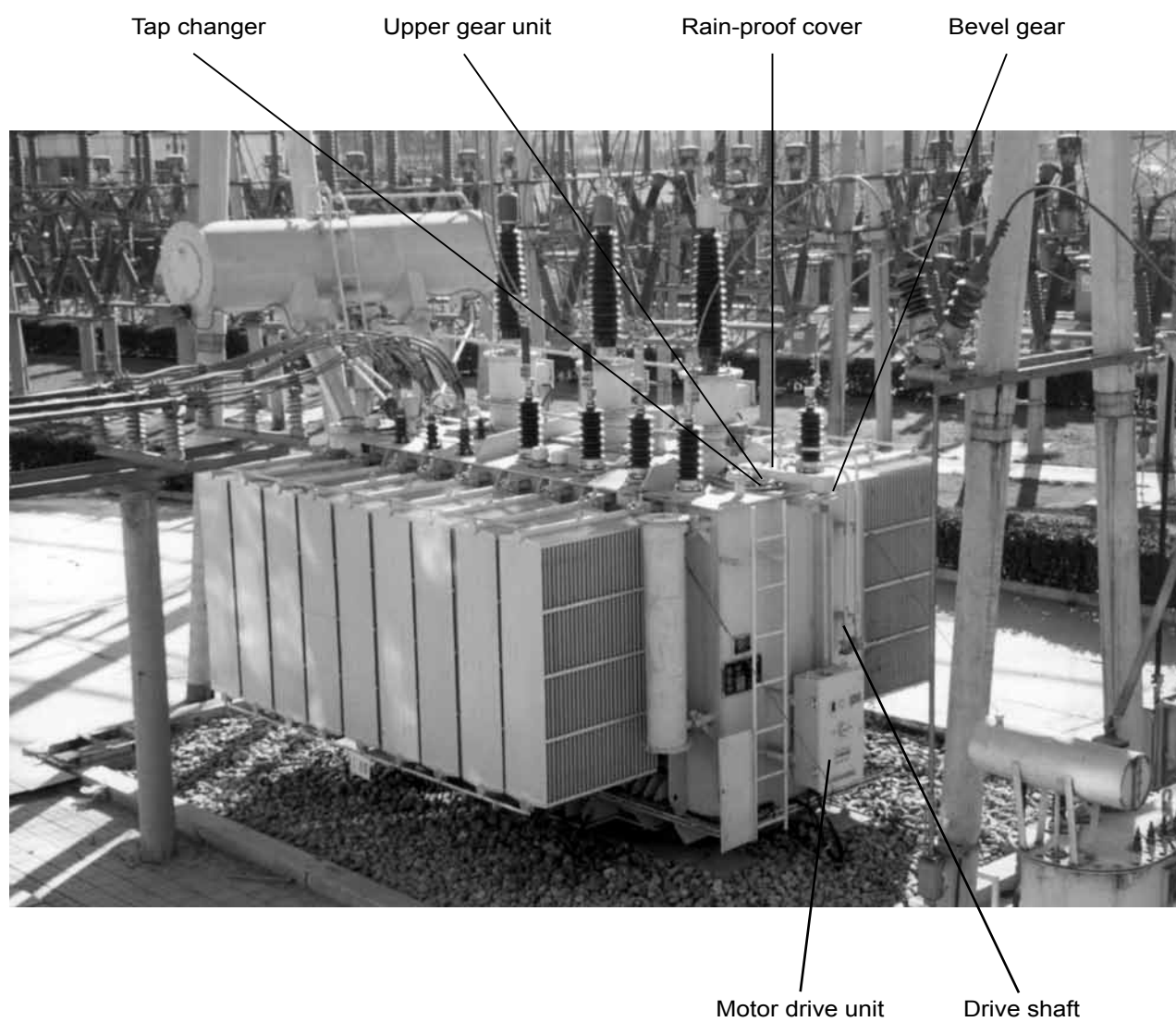


On-Load Tap Changer Type CM Operation Instructions

HM 0.460.301



Shanghai Huaming Power Equipment Co.,Ltd.



Thank you for using our on load tap changer

Prior to use our on load tap changer, make sure to pay attention to the following item:

1. Don't remove Pins on diverter switch and tap selector before tap changer start up.
2. Check 6 lead wires on tap selector, if loosen, the fixing screw under lead wire must be secured.
3. Diverter switch, tap selector and motor drive must be connected at the same position.
4. The tap selector mustn't be operated after it has been dried but not filled with oil. If the operation is inevitable, the turn part and touch part of diverter switch and tap selector must be lubricated with grease.
5. The tap selector must be checked and the motion angles must be adjusted after the drive shaft has been installed on transformer (See operation instruction for details).
6. The drive shaft must be exactly fit for operation, can't be too short in order to prevent from falling off.
7. Tap changer head worm and worm gear reducer can be adjusted according to customer's need. Loose press bolt to adjust angle. Please be sure to secure the press bolt upon the completion of adjustment.

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1. General

CM on load tap changer (OLTC) applies to power and rectifier transformers with rated voltage 35kV, 63kV, 110kV, 150kV and 220kV, maximum rated through current 600A for three poles and 1500A for single pole, to change the taps under load for the purpose of voltage regulation. Three phase OLTCs are used at the neutral point of the Y connection, the single phase OLTC may be used for any connections. CM OLTC is a typical OLTC of combined structure, which consists of diverter switch and tap selector.

CM on load tap changer is to be fastened to the transformer tank cover by its tap changer

head which serves also for connecting to the motor driver CMA7 or SHM-1 via the worm wheel reducer and bevel gear box for the purpose of tap changing.

When CM OLTC is used without a change-over selector, the maximum operating positions available will be 18, and will be up to 35 when it is used with a change-over selector. (special design is exclusive).

This operating instruction includes all the necessary information for the installation and operation of CM OLTC.



Fig.1 Outline view of CM OLTC

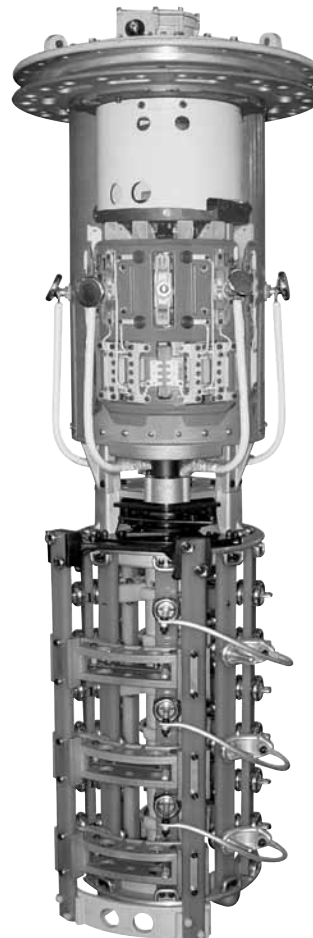
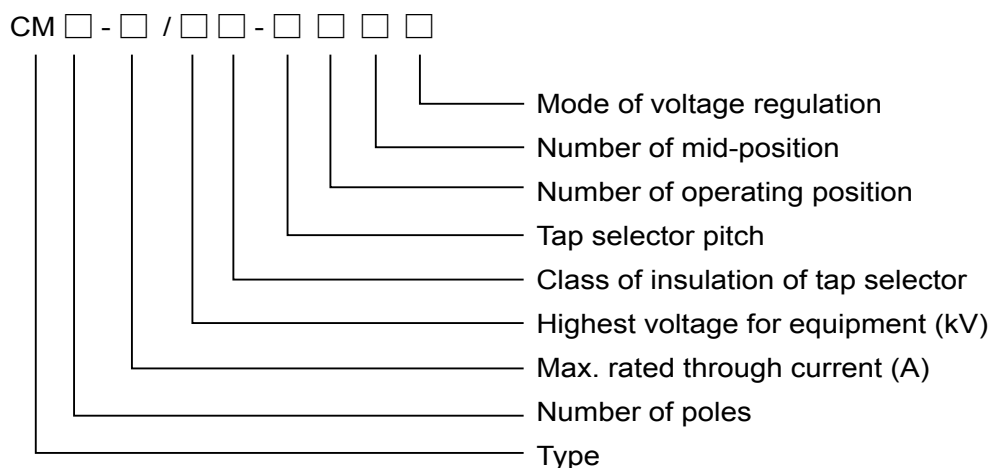


Fig.2 Perspective view of CM OLTC

1.1 Type designation



1.1.1 Indication of voltage regulation steps for OLTC

a. Linear voltage regulation: It is indicated by 5-digit number. For example, 14140 represents an OLTC with 14 inherent contacts, 14 operating positions, and the number of mid-position is 0.

b. Reversing voltage regulation: It is indicated by a 5-digit number plus a suffix W. For example, 14131 W represents an OLTC of reversing voltage regulation with 14 inherent contacts, 13 operating positions and a mid position of 1.

c. Coarse and fine voltage regulation: It is indicated by a 5-digit number plus a suffix G. For example, 14131 G represents an OLTC of coarse and fine voltage regulating with 14 inherent contacts, 13 operating positions and a mid-position of 1.

1.2 Indication of insulation class of tap selector

The insulation for the tap selector can be classified into 4 grades, namely B,C,D,DE. Table 2 shows the data of the different insulation grades. The symbol for insulation distance is shown in Fig.4.

1.3 The operating condition of OLTC

The storage ambient temperature of OLTC is from -25°C to 40°C . The storage humidity of the OLTC should be no more than 85 percent.

The service temperature of standard designed OLTC is -25°C to 40°C

If the temperature exceeds the range of above (-25°C to 40°C), please specify when ordering.

To meet the ordering requirements and comply with the operating environment, if the requested service temperature is out of the range of -25°C to 40°C , the material and accessories of the OLTC will be specially designed and selected.

The non-perpendicularity of OLTC on the transformer with the ground level should not exceed 2%

The space for mounting OLTC should be free from serious dust and other explosive and corrosive gases.

1.4 Technical data of CM OLTC See table 1.

1.5 Mode of voltage regulation

There are 3 modes of voltage regulation of CM OLTC, namely linear voltage regulation,

reversing voltage regulation, coarse and fine voltage regulation. See Fig 4 for the mode of connections.

1.6 Under max. rated through current of OLTC, the temperature rise of each of the long term current carrying contacts and the current conducting parts should not exceed 20K.

1.7 OLTC, under 1.5 times of the maximum through current, when continuously change from the first position for half a cycle, the maximum temperature rise of the transition resistor shall not exceed 350K (in oil)

1.8 The long term current carrying contacts of OLTC shall withstand the short circuit current test as shown in Table 3.

1.9 OLTC shall be able to switch a load under rated step capacity as shown in Table 1, the electrical life of its contacts should not be lower than 200,000 times.

1.10 OLTC should withstand 2 times of the rated current in breaking capacity test for 100 times as shown in table 1.

1.11 The mechanical life of OLTC should not be lower than 800,000 times.

Table 1 Technical data of series CM on load tap changer

Item	Specification		CMI 500 CMIII 500	CMI 600 CMIII 600	CMI 800	CMI 1200	CMI 1500
1	Max. rated through-current(A)		500	600	800	1200	1500
2	Rated frequency(Hz)		50 or 60				
3	Connection		Three-phases for neutral point of star connection Single-phase for any selectable winding connection				
4	Max. rated step voltage(V)		3300				
5	Rated step capacity(kVA)		1400	1500	2000	3100	3500
6	Short Circuit Current Test(kA)	Thermal (3s)	8	8	16	24	24
		Dynamic (peak)	20	20	40	60	60
7	Max. Operating Positions	Without change-over selector With change-over selector	18(special linear regulation can be up to 34) 35(special multiple coarse regulation can be up to 107)				
8	Insulation to ground (kV)	Highest voltage for equipment Um	72.5	126	170	252	
		Rated power frequency withstand voltage(50Hz, 1min)	140	230	325	460	
		Rated lightning impulse withstand voltage(1.2/50μs)	350	550	750	1050	
9	Tap selector		4 grades of B,C,D and DE according to insulation level				
10	Mechanical life		Not less than 1,500,000 operations				
11	Contact life		Not less than 200,000 operations				
12	Oil compartment of diverter switch	Service pressure	0.03MPa				
		Leakage test	No leakage under 0.08MPa for 24 hours				
		Over pressure protection	Bursting cap bursts at 300 ± 20%kPa				
		Protection relay	Oil flow speed set at 1.0m/s ± 10%				
13	Motor drive unit		SHM-III or CMA7				

**Note: Step capacity equals to step voltage times load current
Rated step capacity refer to the max. allowable continuous step capacity.**

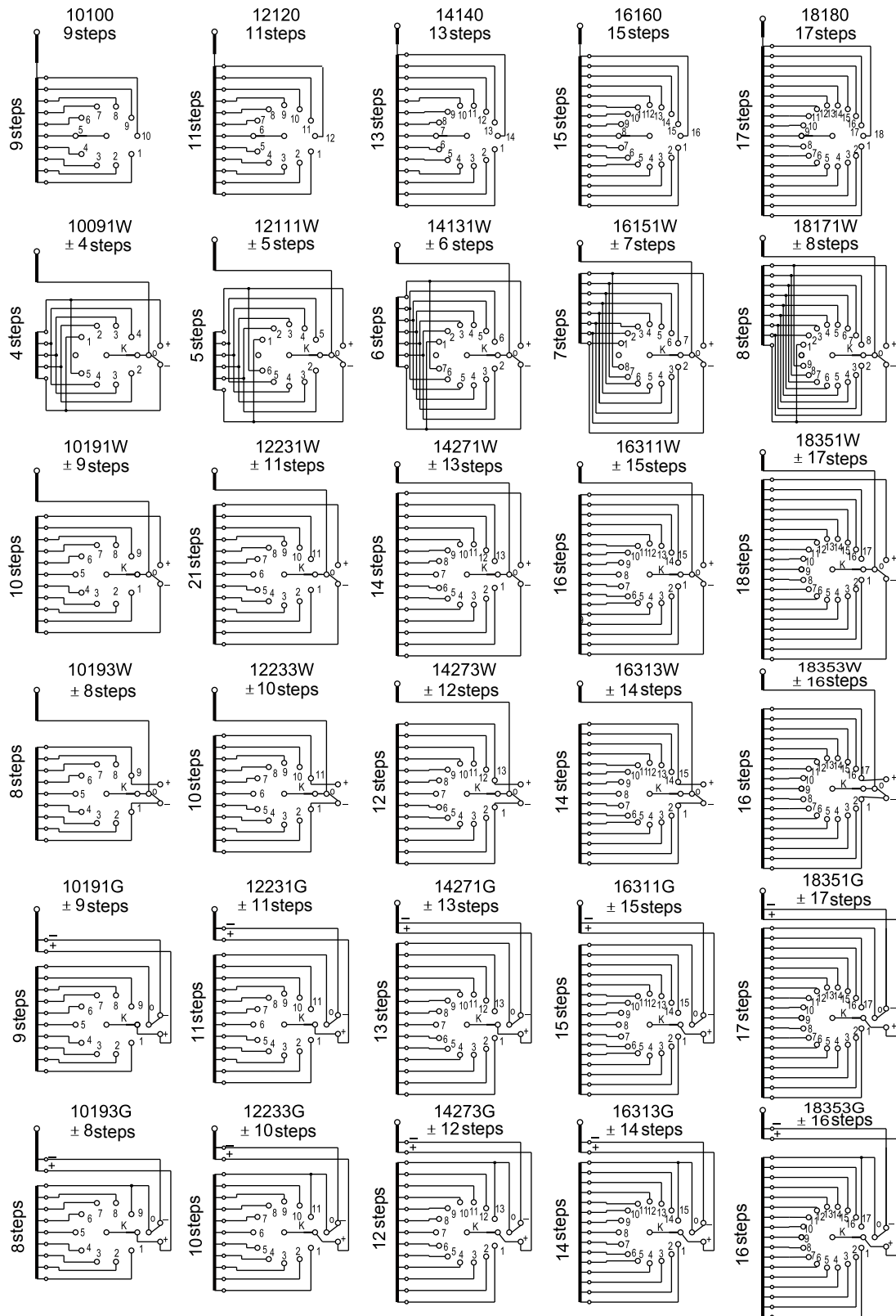
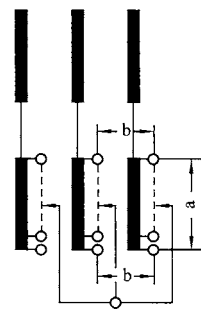


Fig.3 Basic Circuit Diagram

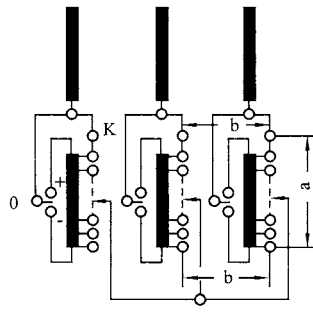
Table 2 Insulation grade of tap selector
Unit: kV

Insulation distance mark	Tap selector size B		Tap selector size C		Tap selector size D		Tap selector size DE	
	1.2/50 μ s	50Hz 1min	1.2/50 μ s	50Hz 1min	1.2/50 μ s	50Hz 1min	1.2/50 μ s	50Hz 1min
a	265	50	350	82	460	105	550	120
b	265	50	350	82	460	146	550	160
a ₀	90	20	90	20	90	20	90	20
a ₁	150	30	150	30	150	30	150	30
c ₁	485	143	545	178	590	208	660	230
c ₂	495	150	550	182	590	225	660	250
d	265	50	350	82	460	105	550	120

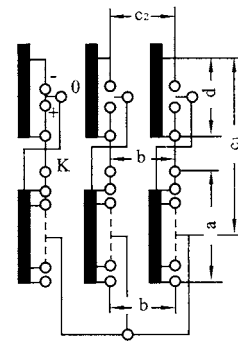
a₀ : The inherent insulation level refers to insulation level with spark gap protection when full voltage impulse is 130kV, the spark gap will response 100%



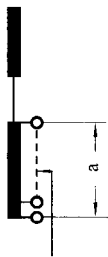
10 10 0 ... 18 18 0



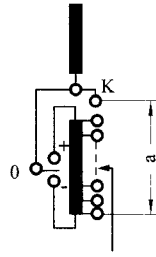
10 09 1W ... 18 17 1W
10 19 3W ... 18 35 3W
10 19 3G ... 18 35 3G



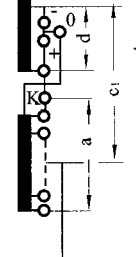
10 19 1W ... 18 35 1W
10 19 1G ... 18 35 1G



10 10 0 ... 18 18 0



10 09 1W ... 18 17 1W
10 19 3W ... 18 35 3W
10 19 3G ... 18 35 3G

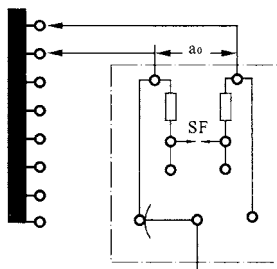


10 19 1W ... 18 35 1W
10 19 1G ... 18 35 1G

a. Linear regulation

b. Reverse regulation

c. Coarse & fine regulation



d. Diverter switch

Explanation of insulation distance symbol:

- a — Between max. tap and mini. tap of the same phase
- b — Between taps of different tap windings
- a₀ — Between two adjacent taps
- c₁ — Between beginning of coarse winding and output of fine winding
- c₂ — Between beginning of coarse tap windings of different phases
- d — Between beginning and end of the coarse tap winding of the same phase

Fig 3 Basic connection mode of tap winding

2. Structure of OLTC

This product is a type of in tank combined structure on load tap changer. It consists of diverter switch unit, oil compartment and tap selector (with or without changer- over selector), as shown in Fig. 1 and 2.

2.1 Diverter switch unit

Diverter switch unit consists of driving unit, insulation shaft, energy accumulation mechanism, switching mechanism (contact system) and transition resistor. The energy accumulation mechanism is placed on the top of the switching mechanism and driven by the insulation shaft and the transition resistor is installed on the lower part of the switching mechanism, thus it forms a complete plug-in set which facilitates to be installed in the diverter switch oil compartment, as shown in Fig.5.



Fig.5 Diverter switch unit

2.1.1 Insulated rotating shaft

Insulated rotating shaft consists of specially fabricated insulating bar, corona ring and shaft pin. The shaft itself is not only a driving shaft, driving the diverter switch and the tap selector, but also represents the main insulation of the

switch which withstands the voltage to ground of the tap changer.

2.1.2 Energy accumulating unit

The operation of the diverter switch is realized by the energy accumulating unit. This unit employs triggering principle and consists of eccentric wheel driven upper slide, lower slide, energy storing compressing spring, guide rail, chuck, cam wheel and bracket, as shown in Fig 6. The chuck, controlled by the side wall of the upper slide locks the cam wheel in place so as to maintain the lower slide in its original position. When the eccentric wheel moves the upper slide along the guide rail, the spring is compressed for energy storage. As soon as the side wall of the upper slide makes the corresponding chuck to move away from the locked cam wheel, the plate of the lower slide will actuate the rotating force to the shaft sleeve of the cam wheel, thus makes the diverter switch to operate.



Fig.6 Energy accumulating unit

2.1.3 Contact mechanism

The contact system of the diverter switch employs "dual resistor transiting", parallel double break "tapered tail compensation" split contact. The contact system comprised of stationary contact system and moving contact system. Fig 7 and 8 illustrate the actual mechanism.

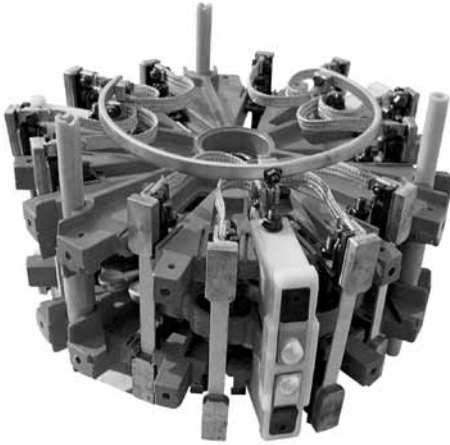
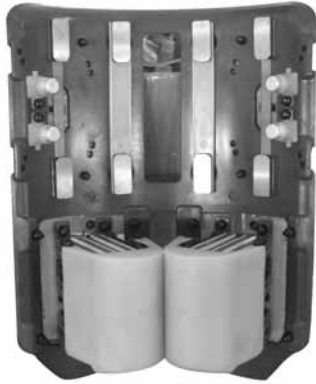


Fig.7 Contact structure of diverter switch



**Fig.8 Contact shell
(stationary contact of the diverter switch)**

Moving contacts are installed in the guide slot of the upper and lower guide with good insulation strength, and are connected to the curved slot of the converting sector with rolling pins. The stationary contacts are separated by arc extinguish chamber and placed on a contact shell, as shown in Fig.8.

There is a compensating spring installed at the tail of the sector, so that the switching sequence will not be disturbed after the contacts are burned.

2.1.4 Transition resistor

Transition resistors are made of high heat

resistant nickel chromium wire wound in spiral form and are separated by ceramic clamping plates mounted inside and insulating frame. See Fig.9.

Transition resistor are arranged evenly in radial direction and connected to the transition contacts of the diverter switch. See Fig.10.



Fig.9 Resistor units of insulating frame



When the switching mechanism operates, the moving contacts make linear motion along the guiding groove of the guiding plate, and carry out switching operation according to specified sequence with the stationary contacts arranged on the inner wall of the contact shell.

2.2 Diverter switch oil compartment

Diverter switch oil compartment functions isolate oil carbonized by the electrical arc of the switch from the oil in the transformer oil tank, so as to maintain the cleanness of the transformer. It is composed of four parts: head flange, top cover, insulated cylinder and bottom of the cylinder. See Fig.11.



Fig.11 Diverter switch oil compartment

2.2.1 Head flange

Head flange is precision casting of aluminum alloy and riveted to the insulation cylinder. It is divided into tank top type and bell type. Tap changer is installed on the transformer tank cover by means of the head flange.

There are three elbow pipes and a through tube on the tap changer head flange. The elbow R is connected to the conservator via the tap changer protective relay. Oil suction elbow S is used to suck the oil from the bottom of the oil compartment for oil change of the diverter switch. It connects to an insulating oil pipe through tap changer head flange. This oil suction pipe extends straight down to the bottom of the oil compartment. The oil filling elbow Q acts as the oil return pipe for the diverter switch. Another through pipe E acts as the vent pipe for transformer oil overflow. (See Appendix 1)

2.2.2 Top cover

A bursting cap is installed on the tap changer top cover to prevent the oil compartment from overpressure. Also on the top cover are installed horizontally driven worm wheel

reducer, inspection window for tap position and bleeding screw. See Fig.12. O ring is employed for sealing against leakage of tap changer.



Fig 12 Top cover

2.2.3 Insulating cylinder

Insulating cylinder is made of epoxy fiber glass, possessing excellent insulation property and mechanical property. The upper end of which is riveted to the head flange, while the lower end is riveted to the cylinder bottom. O rings are used for sealing the joint.

2.2.4 Bottom of compartment

The bottom is made of precision casting aluminum alloy, a driving shaft passed through the bottom. The upper end of the shaft is connected to the diverter switch unit via a connector and the lower end drives tap selector through the gearing on the cylinder bottom. There is a self-locking device for tap position indication on the cylinder bottom. The position indication driving mechanism will be self-locked during lifting the diverter switch unit so that the position will be self-locked and the position will not be disturbed. See Fig.13.

2.3 Tap selector

Tap selector is composed of step-by-step drive mechanism and contact system. Tap selector can be installed with or without change-over selector. See Fig.14.



Fig.13 Bottom of compartment

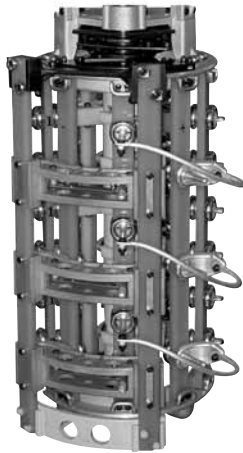


Fig.14 Tap selector (with change-over selector)

2.3.1 Step-by-step drive mechanism (also referred to as Geneva wheel mechanism)

It consists of two grooved wheels and a driving piece. During each tap changing operation, the driving piece rotates a half turn, the motion of it is transformed into an irregular step-by-step drive motion of 72° or less, thus moving the bridge contact of the tap selector from one tap to the other. The two Geneva wheels run alternately. The mechanical pin in the groove wheel mechanism is used to prevent the tap selector from overriding at the start and end position. See Fig.15.

2.3.2 Contact system

The tap selector contact system employs cage type "outer sleeve inner draw" shaft sleeve construction, including a central insulating cylinder with current ring, insulation bars with stationary contacts, driving shaft, bridge

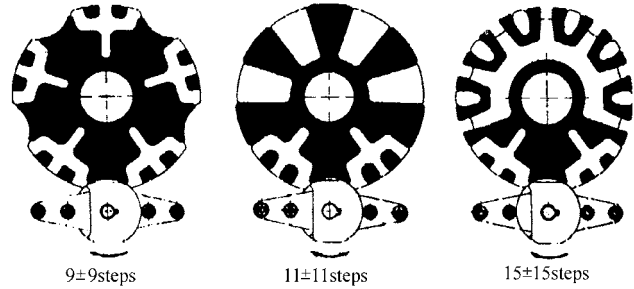


Fig.15 Geneva wheel system

contact and upper and lower flange.

The insulation bars are arranged around the periphery of the upper and lower flanges. Odd and even number stationary contacts are installed in the bars. In addition, a corona ring is also installed, so as to even the surface electric field. The stationary contacts connect to the current ring on the central insulating cylinder through the bridge contact.

The connecting wire of the contacting ring is leading out of the central insulating cylinder and connecting to the diverter switch.

Tap selector bridge contact adopts an upper and lower clamping structure. It is driven by the Geneva wheel mechanism through the driving shaft, which makes it rotating around the contacting ring, thus contacts the taps on the selector insulation bars in sequence. Because the two main springs tensely compress on the moving contacts, therefore, a four-point contact is always maintained as shown in fig.16, realizing adjustment-free and efficient cooling.

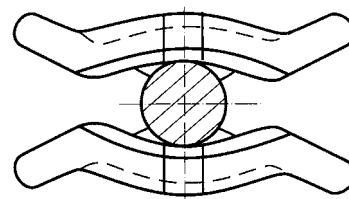


Fig.16 The contact of tap selector

2.3.3 Change-over selector

Change-over selector is classified into reversing regulation and coarse and fine regulation. See Fig.17 and 18. It is a simple and compact device. The insulating bars of

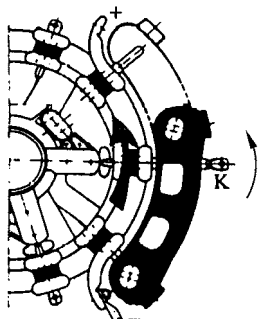


Fig.17 Contact system of reversing change-over selector

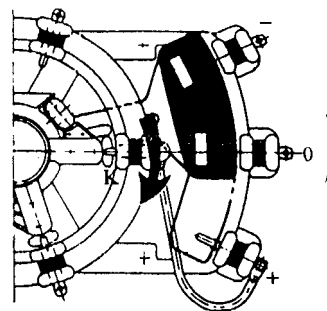


Fig.18 Contact system of coarse changeover selector

3. Operating principle

On load tap changer employs resistor transition principle. It can change under load the taps of transformer tap winding. The switch of a tap changer is realized in the combination of the odd and even numbered contacts switching and switching of diverter switch. The sequence of tap change is shown in Fig.19 and 20. The bold line represents the path of the current.

Example 1 switching sequence from tap position 4→5

(a) 4 is under conduction before switching operation of the tap changer. The odd number contact group of the tap selector are first switched from tap position 3 to tap position 5.

(b) diverter to bridge connection K2, K3 a circulating current is generated between the transition resistors. The load current will then runs through the contacts K2 and K3.

(c) The diverter switching is completed, tap 5

the stationary contact are arranged on the upper and lower flange periphery of the tap selector. Change-over selector is operated by the Geneva wheel.

is now under conduction.

Example 2 switching sequence from tap position 4→3. Because the switching of diverter switch is carried out either to the left or to the right for each switching. If the switching is from tap position 4 to tap position 3, the moving contacts of the tap selector may stand still. However, in case the continuous switching is from tap 3→2, then the sequence and operation will be restored entirely to the same as that of example 1.

3.1 Mechanical operation principle of the tap changer

The operation of tap change begins with the electric motor of the motor drive unit. The driving force is transferred to the worm wheel reducer on the top cover of the tap change through driving shaft and belt pulley box. After the reducer, it is actuated to the energy accumulation mechanism and the shaft which passes through the diverter switch down to

the cylinder bottom. There the cylinder bottom gear clutch is connected to the Geneva wheel mechanism of the tap selector. The rotation of Geneva wheel makes the contacting bridge to rotate an angle corresponding to one step, thus the connecting bridge will be connected to the desired tap of the tap winding without load.

In the same time, the eccentric wheel of the energy accumulation mechanism makes the upper slide to move along the guide rail. The spring between the upper and lower slide is compressed to store energy, the cam wheel is

locked by the clutch to hold the lower slide in its original position. When the upper slide moves to the release position, the side wall of the upper slide makes the corresponding jaw to move away from the locked cam wheel, thus releases the energy storage mechanism and operates the diverter switch. At this time, the lower slide moves to the new position, the clutch jaw again engages with the cam wheel, the mechanism is locked to prepare for the next tap change operation.

The motor drive mechanism automatically stops after performing one tap change.

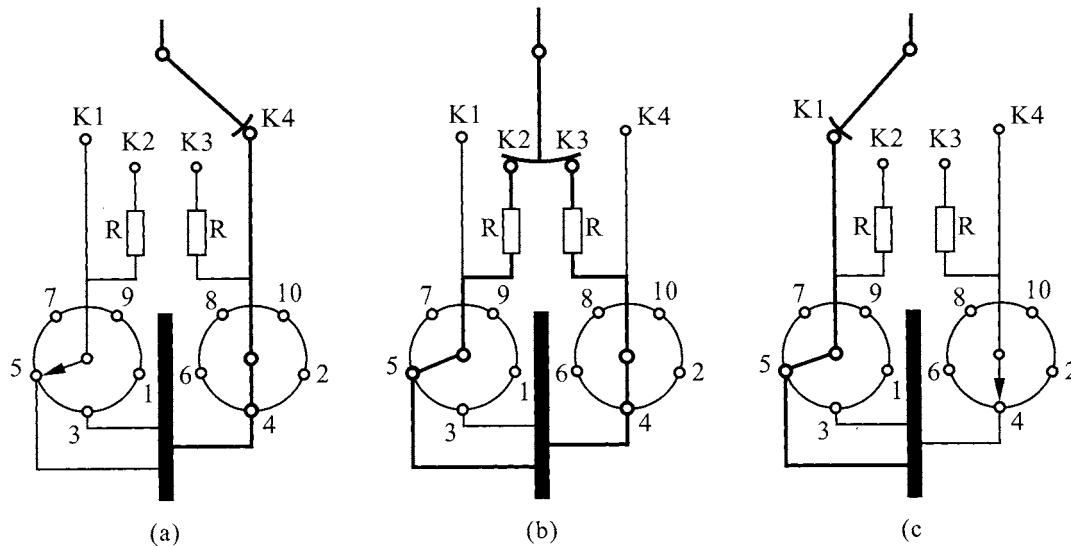


Fig 19 Switching sequence from tap position 4 → 5

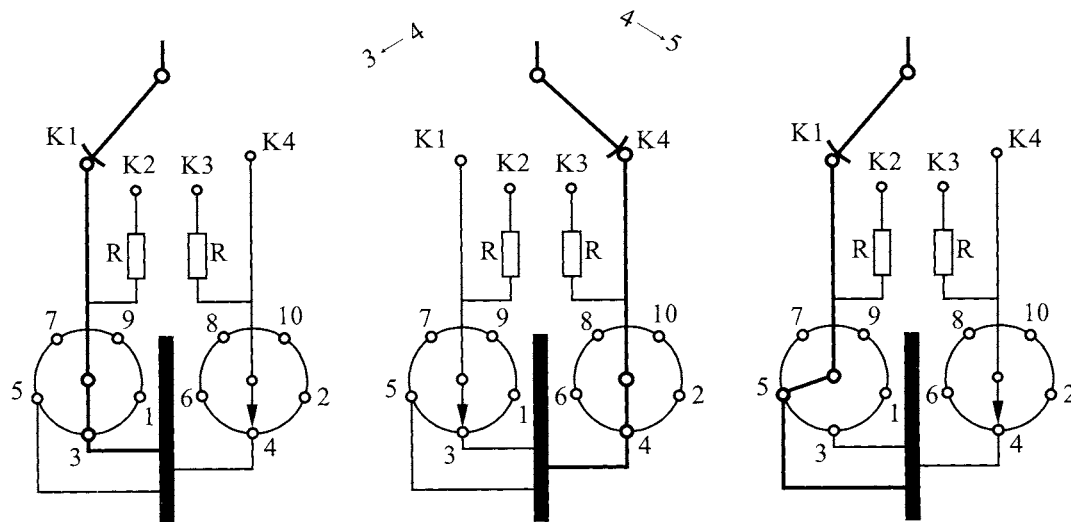


Fig 20 Switching sequence from tap position 4 → 3 or 4 → 5

4. Installation method of OLTC

4.1 The overall dimension of OLTC

4.1.1 Mounting dimension of the on load tap changer

The installation diagram of the tap changer and its mounting dimension are shown in the enclosed drawings of Appendix.

4.1.2 The tap changer is installed on the transformer oil tank cover with the aid of its head flange. Therefore, a mounting flange with 650mm inner diameter will be required on the tank cover together with oil resistant sealing gasket (supplied by the user). The thickness of the sealing gasket may be the same as the sealing gasket of the transformer oil tank cover (see Appendix 5).

Studs will be used with its one end threaded into the mounting flange, the stud should project at least 45mm above the mounting flange.

4.1.3 The installation of OLTC tank-top type transformer tank cover.

The detailed installation procedures are as follows:

4.1.3.1 Put the diverter switch and tap selector of the tap changer separately on a level surface.

4.1.3.2 Remove the connecting screws (6×M12) between the diverter switch and the tap selector.

4.1.3.3 Remove the red painted dowel pin from the sliding connector of the tap selector's step-by-step Geneva wheel mechanism. Do not move the connector.

4.1.3.4 The conductor of the tap selector has been installed during factory delivery.

4.1.3.5 Lift the diverter switch and put it on the tap selector. Take care not to damage the sliding connector of the step-by-step Geneva wheel mechanism.

4.1.3.6 Tighten six M12 recessed cap screws between the supporting stand of the tap selector's Geneva wheel mechanism and cylinder bottom of the diverter switch. Pay attention to the perpendicularity of the diverter switch and tap selector.

4.1.3.7 Thoroughly clean the bottom surface of the tap changer head flange and the sealing surface of the mounting flange. Put an oil-resistant sealing gasket on the mounting flange.

4.1.3.8 Lift the complete tap changer and carefully insert it into the transformer through the mounting hole on the transformer tank cover. Take care not to damage the terminals on the tap selector and corona rings on the diverter switch compartment.

4.1.3.9 Check the head position and its setting position. Secure the tap change head flange to the mounting flange. At last, remove the red-painted dowel pin from the intermediate gear wheel connector at the cylinder bottom of the diverter switch. (See fig 21)

4.1.4 Installation of OLTC on the bell type transformer cover

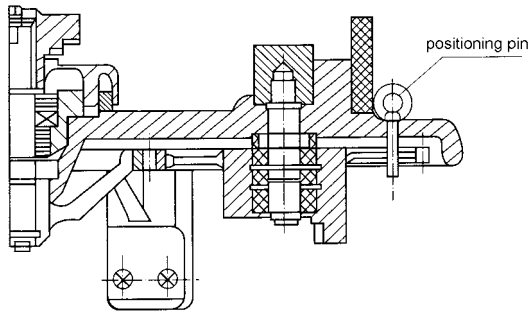


Fig 21 Diverter switch set positioning pin

The “bell type” installation of OLTC has specially designed tap changer head which is able to be dismantled (See Appendix 3). It is composed of two parts: one is an intermediate flange temporarily installed on the transformer supporting structure. The insulating cylinder of the diverter switch oil chamber is installed on that flange; the second is the head flange secured on the bell type transformer tank cover. These two flanges are firmly connected together by means of sealing gasket and fasteners.

The procedures for installing OLTC on the bell type transformer tank cover are as follow:

4.1.4.1 Dismantle the tap changer's head

For installing the tap changer. It is required to separate the tap changer's head flange from the oil chamber.

- Remove the top cover of the tap changer. Take care the O ring on cover.
- Remove the position indicator. Save the spring washers for future reassembling.
- Unscrew the five M8 fixing nuts from the diverter switch upper supporting plate in the area without red paint.

d. Carefully lift out the diverter switch proper. Pay close attention not to damage it. Keep the switch proper in the upright position.

e. Remove the oil suction pipe. Take care of the O ring on the suction pipe head when the suction pipe is taken out of the tap changer.

f. Remove the 17×M8 nuts from the red painted area of the tap changer head flange.

g. Lift out tap changer head flange from the intermediate flange. Pay attention to the sealing gasket.

4.1.4.2 Fasten the tap selector to the bottom of the diverter switch oil compartment.

- Remove the joining screws between the diverter switch and the tap selector.
- From the sliding connector of the stepped grooved wheel mechanism of the tap selector remove the red-painted dowel pin. Do not move the connector's groove moving piece.
- With the lifting plate (see Appendix 6) provided by the factory, lift the diverter switch and place it on the tap selector. Take care not to damage the sliding connector of the Geneva wheel mechanism.
- Tightening 6×M12 cylindrical head socket screw between the supporting stand of the tap selector's Geneva wheel mechanism and the diverter switch oil compartment bottom.
- Fix the connecting conductor with M10 hexagonal screw. Be sure to directly stick the lead wire level with contacts on insulation

cylinder. Don't clip the screening cover between them (See figure 22).

f. From the intermediate gear connector at the oil compartment bottom remove the red-painted dowel pin (see fig 18). To ensure the proper operation of the tap changer and the correct mounting position, the bell type tap changer should be pre-assembled. The actual procedure for pre-assembling are as follows.

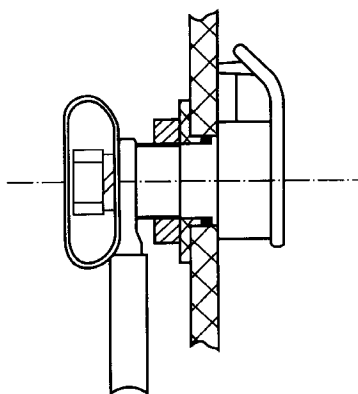
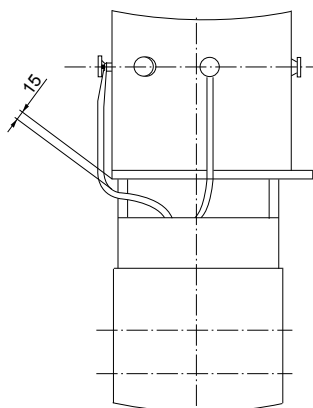


Fig.22 Diagram of connection between tap selector lead wire and diverter switch



To ensure electrical insulation performance of switch, the distance between connecting lead wire and cylinder bottom metal element must be over 15mm

a. Pre-matching of intermediate flange and head flange (alignment of “△” on both flange). For the installation and connection

To ensure electrical insulation performance of

switch, the distance between connecting lead wire and cylinder bottom metal element must be over 15mm bell type tap changer, there should be an adjustable supporting structure in the transformer. Temporary mounting of tap changer on the supporting structure: By means of the lifting plate (see Appendix 6) supplied by the factory, place the assembled tap changer on the supporting structure. Allow the intermediate flange to install temporarily on the supporting structure. Alignment of pre-installed flange and intermediate flange:

Move head flange to the flange installed on the cover of transformer, pay attention to the alignment of “△” symbol, adjust the position of tap changer and supporting structure, which allow the head flange to be aligned naturally with intermediate flange, thus confirm the installation position of tap changer on supporting structure.

b. Adjusting the assembly space between intermediate flange and head flange.

To adjust flexible supporting structure, rise or lower the installation position of intermediate flange to ensure the installation space between intermediate flange and head flange conform to 5~20mm (see Appendix 3).

When the pre-installation of tap changer on the supporting structure of transformer has been confirmed correct, connect the leading wire between tap changer and tap coil as per the section 4.2 of this manual.

After the tap leading wire has been connected, preinstall once again, if the position of tap changer is unchanged and the leading

wire is in conformity with requirement (with suitable length, without the deformation and enforced on tap changer), it can ensure that the position of two flanges is correct when assembling the tap changer transformer.

4.2 The connection of leading wire between voltage regulation tap winding and tap changer

4.2.1 Tap selector and connection leading wire

The tap windings should be connected according to the wire diagram supplied along with delivery. The terminals of the tap selector are on the insulating bar where the contact position are marked.

There is a M10 bolt on each of tap selector terminals, the connectors of the tap winding can be installed directly on this bolt. Corona rings are employed and locked the M10 nuts.

After tightening the connecting bolts, turn up the washer of the shield cover for 90°, thus lock the nut from loosening. (see figure 23)

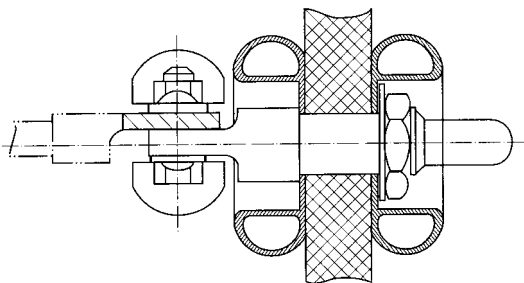


Fig.23

The positive and negative (\pm) connecting terminals of the tap selector is a tongue shaped connecting plate, there is a hole for the hexagonal bolt on the plate. The connecting terminal K is an extension of the

connecting terminal of the tap selector also has a hole for the hexagonal bolts.

Attentions during the lead wire connection between the tap selector and the tapped winding:

4.2.1.1 The terminal wire should not apply any force to the tap selector (see figure).

a. The connection wire should be wired to the tap winding in dual directions from the tap selector. Avoid stressing the lead wire in single direction causing twist deformation of the cage of the tap selector.

b. The connecting wire between the end clamping of tap selector's terminal and the transformer lead wire should not too short. It should be soft and should not be coated with insulating paint to avoid the hardening of the coated paint after drying which makes the insulating bar to deform under force.

c. The end of the lead wire connecting the tap selector should take the form of an expanded ring (circled), so that the insulating bar of the tap selector will not be influenced by force.

d. The terminal wire of the tap selector should be led out from the exterior of the cage. Never allow the wire passing through the interior of the cage.

e. The terminal wire of the change-over selector should be led out from the exterior of the insulating bar of change-over selector. Adequate clearance shall be maintained between the lead wire and the insulating bar of the change-over selector's moving contacts,

so that the obstruction to the operation of the change-over selector can be avoided.

f. The bell type tap changer shall be lifted up 5-20mm after the connection of lead wire. Therefore, special care should be given to the degree of tightness of the connecting wire. It is recommended to install the intermediate flange on the supporting structure, then put the pad between the intermediate flange and the head flange, so as to obtain the required actual assembly gap, then the lead will be wire and after that the temporary pad will be removed. Check for the degree of tightness of the lead wire and whether the tap changer is affected by force.

4.2.1.2 Don't damage the connecting terminal of the tap selector during installing the lead out wire.

4.2.2 The connecting wire of the tap changer

4.2.2.1 Three phase tap changer

For three phases tap changer, the interior of the diverter switch will be Y connected. Therefore, there is only one neutral point on the oil compartment of the switch. The neutral point connecting terminal has a M10 threaded hold.

4.2.2.2 Single phase tap changer

A single phase tap changer, formed by parallel connection of the contacts of three phase tap changer, on the oil compartment of the diverter switch, there is a conducting ring. The lead out wire of the tap changer is connected to the conducting ring. On this ring, there are three Ø12.5 through holes, screws pass through these holes and connect with the lead-out wire

and are locked by the corona rings together with the M10 nuts. After tightening up the nuts, the lock washer of the corona rings is to be turned up to stop the nut from loosening.

4.3 Transforming ratio test

Before drying the transformer, a transforming ratio test should be carried out with alternating voltage. To operate the tap changer, insert a short pipe of Ø25mm nominal diameter into the horizontal shaft of the worm wheel reducer on the head of the tap changer, and fastened with a M8 set screw. A crank handle is filled on the other end of the short pipe. 16.5 turns of the horizontal driving shaft are required for each tap transforming operation. Because the tap changer is not oil immersed, so the number of tap change should be reduced to a minimum. After the ratio test, the tap changer must be turned to the set position set at factory. This position can be seen from the set position diagram supplied together with the tap changer during delivery.

4.4 Drying and oil filling

4.4.1 The purpose of drying is to maintain the insulation level of the tap changer. Generally the tap changer is dried together with the transformer, however, it can be dried separately means of the same drying process. The process is as follows:

4.4.2 Vacuum drying

a. Drying in the oven room

During drying in the oven room, the tap changer's cover must be removed.

Care to keep the oil pipe unobstructed.

The tap changer is entered the oven room with a temperature of about 60°C, and heated in the air under atmospheric pressure. The rate of temperature rise is 10°C/h and the max. heating temperature is 110°C.

Preliminary drying:

Drying is carried out in the circulating air, max. temperature is 110°C, duration 20 hours.

b. Drying in the transformer oil tank

When the transformer is vacuum drying in its oil tank, the top cover of the tap changer is kept tightly closed, throughout the whole process. To enhance the rate of drying of diverter switch oil compartment and switch mechanism, by-pass pipe supplied by our factory (see Appendix 8) must be used to connect the oil filling flange on tap changer head to the overflow pipe flange on the transformer oil tank (see Appendix 1 for the flange position).

4.4.2.1 Vapor phase drying When vapor phase drying is employed for drying the transformer and tap changer, the oil drain screw at the bottom of the oil compartment should be unscrewed to facilitate the draining of kerosene vapor condensate. After the vapor phase drying, the drain screw should be tightened again.

a. Drying in the oven

In the case of oven drying, the top cover of the tap changer must be removed. Care to keep the oil extraction pipe unobstructed.

Heating:

Under the kerosene vapor temperature of 90°C, the duration of heating is 3-4 hours.

Drying:

Raise the temperature of kerosene vapor with a temperature of 10°C/h. Max. temperature is 125°C. The time for drying basically depends upon the time required for transformer drying.

b. Drying in the transformer oil tank

If the transformer is vapor-phase dried in its oil tank, the head cover of the tap change should be tightly closed during the whole drying process. At the time, kerosene vapor for drying should enter the transformer oil tank and the diverter switch oil compartment in the same time.

To accelerate the rate of drying of diverter switch oil compartment and its mechanism, at least one Ø50mm kerosene vapor inlet pipe should be used to connect to the tap changer oil filling pipe flange and the oil suction pipe flange.

After the vapor phase drying, check the oil drain screw at the bottom of the oil compartment for tightness.

Attentions after the drying process of a tap change:

a. The tap changer without oil filling after drying process must not be operated. If operation is required after drying, then the diverter switch oil compartment shall be fully filled with transformer oil and the tap selector oil lubricated.

b. Check the tightness of fasteners. Of any fastener is found loose, it must be retightened and locked against looseness.

4.4.3 Oil filling

The head cover of the tap changer is again close. Tighten the 24 bolts M10. Take care the correct position of the O ring. Both the transformer and diverter switch are filled under vacuum. New transformer oil is filled into the tap changer up to the level of the transformer top cover. For this reason, by pass pipe supplied by our factory should be used to install between the tap changer's head oil filling flange and the transformer oil overflow pipe flange, in order that the oil compartment of the diverter switch and the transformer can be vacuum extracted in the same time.

4.5 The installation of connection pipes

The head flange of the tap changer is equipped with three connection pipes. The orientation of these connection pipes can be determined as required by the customer that is after loosening the clamping ring, the connection pipes can be turned at will. So it is very easy to install the connection pipes.

4.5.1 Tube connection of protective relay

Protective relay can be installed on the connection tube between the head of the tap changer and the oil conservator, and should be as close as possible to head of the tap changer. Frequently it is connected directly to the flange of the elbow pipe R. It must be installed horizontally with the arrow pointing to the oil conservator.

4.5.2 Oil suction pipe connection

The tap changer is equipped with an oil suction connection pipe. It is used to suction the oil in the diverter switch oil compartment during maintenance or oil changing. Therefore, a pipe must be installed at a level below the bottom of the oil compartment. The upper end

of the pipe is connected to the oil suction pipe flange, and the lower end is fixed with an oil drain valve.

This oil suction connection pipe may also be used as the oil discharge pipe of an oil filter.

4.5.3 Oil filling connection pipe

This pipe is used as the oil return pipe of the oil filter. It is sealed when no filtering is required. It is recommended that as pipe is also connected with the lower end filled with an oil drain valve. Thus circulating oil filtering through the oil suction and oil filling pipe may be performed by the oil filter.

4.6 The installation of motor drive unit

The motor drive unit performs the position control and the starting of the tap change of on-load tap changer. Within the box of the motor drive unit are installed complete set of mechanical and electrical components required to operate the tap changer. Electrical and manual operation are possible.

Attentions during the installation of motor drive unit.

4.6.1 The serial number of the motor drive unit should be same as that of the tap changer.

4.6.2 The motor drive unit must be of the same setting position as that of the tap changer. This position is indicated in the wiring diagram delivered with the equipment.

4.6.3 The installation of the motor drive unit should be square to transformer oil tank wall. No obliquity is permitted. Care not to be affected by the excessive vibration of the

transformer. Adjust its horizontal and vertical position. Attention: The mounting plate of the motor drive unit should be flat, otherwise it will be deformed by twisting and its operation will be affected. For the actual installation of the motor drive unit, see the operation instruction of motor drive unit.

4.7 Installation of bevel gear box

The overall and mounting dimension of bevel gear box, see Appendix

4.7.1 Bevel gear box is mounted on the supporting bracket of the transformer tank cover with 2 bolts M16

4.7.2 Driving shaft

4.7.2.1 Installation of horizontal driving shaft

a. Loose the sleeve (6 bolts M8) of the worm wheel reducer on the tap changer's head. Swiveling the reducer to align its horizontal shaft with the horizontal shaft of the bevel gear box.

b. Find out the actual length of the horizontal shaft between the horizontal shafts of the worm wheel reducer of the tap changer and the bevel gear reducer. A clearance (a total of about 2mm) is reserved at the connection of the two horizontal driving shafts after taking into account of the expansion and contraction.

c. Install the sleeve on the horizontal driving shaft. Adjust the worm wheel reducer and tighten the sleeve.

d. After installing the horizontal driving shaft, cut off the extra dimension of the guard plate according to the gap between the two

connection flanges.

4.7.2.2 Installation of the vertical driving shaft:

a. According to the dimension between the bevel gear driving box and the vertical driving shaft of the motor drive unit, determine the actual length of the vertical driving shaft. Cut the shaft to the require length, taking account of the expansion and contraction. Certain clearance (a total of clearance about 2mm) should be reserved for connection of vertical driving shafts.

b. Install the vertical driving shaft, the connection pin near the motor drive unit can only be fixed after checking the connection of the motor drive unit.

c. In case the length of the vertical driving shaft exceeds 2m, to avoid swaying, the shaft shall carry an intermediate bearing. This can be supplied if requested during ordering.

4.8 Verification of the connection of the tap changer and motor drive unit

Having connected the tap changer with the motor drive unit, the mechanism should first be manually turned a full cycle of operation.

When the tap changer has been connected to the motor drive unit, the time elapsed between the instant of switching of the diverter switch and the ending of operation of the motor drive unit should be the same in both direction of rotation. Generally, the verification of the connection of the tap changer to the motor drive unit has been done in the factory and is positioned and lead sealed in the setting position. However, for proper operation of the tap changer, the verification shall still be performed.

The verification of connection is carried out according to the following procedure:

4.8.1 Rotate the handle in the 10→11 direction. After the diverter switch has operated (start when the sound of switching is heard), turn the handle continuously and record the number of turns until a red mark within the green belt area on the indicating wheel of the motor drive unit appears in the middle of the inspection window. Take the number of turns as m.

4.8.2 Turn the handle in the reverse direction 11→10 to return to its setting position. Record the number of turns K in the same way as mentioned above.

4.8.3 The connection will be correct if $m=K$. If $m \neq K$ and $m-K > 1$, then the difference of turns shall be compensated. Loosen the vertical driving shaft, turn the handle $1/2(m-K)$ turns in the direction of increment of turns, and finally connect the vertical driving shaft to the motor drive unit.

4.8.4 Check the difference of turns between the motor drive unit and the tap changer in the same way as mentioned above, until the same number of turns, i.e. $m=k$ is obtained.

Example:

The verification of connection of Type CM tap changer and Type CMA7 motor drive unit: Turn from position 10 (setting position) to position 11, $m=5$ turns, Turn backward from position 11 to position 10 (the original setting position), $k=3$ turns. The difference of turns of the handle $m-k=5-3=2$ turns.

Turns to be adjusted $1/2(m-k)=1/2(5-3)=1$ turn.

Loosen the connection between the vertical driving shaft and the motor drive unit. Turn the handle in the direction 10→11 for one turn.

Then again make connections.

Check that the difference of turns in both directions has been balanced.

a. Record number of turns m and k under connected condition.

b. Turn $1/2(m-k)$ turns in the direction in the increment of turns during loosening of connection.

c. Again make connection and verify until $m=k$.

4.9 Operating test of the tap changer

4.9.1 Mechanical operating test

Before voltage is applied to the transformer, 5 complete cycles of mechanical operating test (no less than 200 times) must be performed. There should be no damage to the tap changer and motor drive unit. The position indication of the motor drive unit, its remote position indication and the position indication of the tap changer should be the same. Both the mechanical and electrical limit protection should be reliable.

4.9.2 Final oil filling

Final oil filling is done after the operating test of the tap changer. Before oil filling, loosen the bleeding screw on the suction pipe and the top cover of the tap changer. Use a spanner to pry up vent oil overflowing in on the top cover of tap changer. (See figure 24)

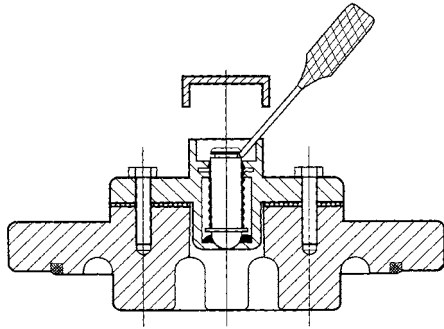


Fig.24 Schematic diagram of exhaust on top cover when filling tap changer with oil

4.9.3 Grounding

Bevel gear box grounding screw (M12) should be connected to the cover of transformer tank.

The grounding screw (M12) on tap changer head should also be connected to the cover of transformer tank.

The grounding screw (M12) on motor mechanism box should be connected to the cover of transformer tank. Grounding screws for protective relay shall be connected to the transformer tank cover.

4.9.4 Transformer electrical test

After completing the above-mentioned operation, the transformer acceptance test can now be performed. The tap changer should be tested with the conservator connected.

4.9.5 The setting position of the tap changer

When the test is completed, the tap changer and the motor drive unit should be turned to the set position during equipment delivery.

4.10 Transportation of transformer together with the tap changer

When the tap changer is assembled to the transformer, careful consideration shall be given to safety of transportation (for example,

to increase the temporary supporting). The tap changer is of the immersed type, it is not necessary to remove it for transportation. If there is trouble which requires to dismantle the motor drive unit should be loosened at the setting position, so that it can be transported in the horizontal position. After arriving on site, the motor drive unit can be restored by means of the method mentioned above.

If the transformer is transported or stored without the conservator, then the bypass pipe (see Appendix 8) supplied by our factory can be installed between the oil filling supplied by our factory can be installed between the oil filling flange of the tap changer and the overflow pipe flange of the transformer (the position of the flange is shown in the Appendix 1), so that the static pressure caused by the oil expansion can be balanced.

If transformer is required to be transported or stored without oil filling, then the oil in the oil compartment of the diverter switch must be completely drained. The bypass pipe must be installed at that time so that the oil compartment and the transformer oil tank will subjected to the same pressure (nitrogen sealing).

In order to avoid damaging the tap changer caused by the displacement of moving parts, they must be temporarily secured.

Note: The bypass pipe shall be removed from the tap changer head when the transformer is installed on-site and before putting it into operation.

4.11 Put into operation on-site

When the transformer is installed in site, the installed position of the tap changer and the tightness of the connecting wire should be checked either by lifting the iron core or by entering into the transformer oil tank, especially for the bell type tap changer, detailed examination shall be done as to the deformation under force of the tap change due to the displacement of transformer core during transportation, so that the proper operation of the tap changer can be assured.

Before putting into operation of the transformer, the operating test of the tap changer and motor drive unit, must be done according to section 7.10, and in the same

time, check the proper functioning of the protective relay. The protective relay should be connected to the tripping circuit of the line circuit breaker, in case the relay trips, it will instantly cut off the transformer circuit. "Transformer Off" test button on the tap of the relay can be used to test the function of the line circuit breaker.

Open all the valves between the conservator and the tap changer to prepare the tap changer for operation, at that time, the gas accumulated the tap changer top cover will expel a slight amount of oil. When the tap changer is determined to the everything all right, then it can be put into operation.

5. Operation supervision

Periodic examination of the contamination of oil in the insulating cylinder of the diverter switch is an effective measure to monitor the normal operation of the on load tap changer.

5.1 For periodic examination of the oil in the insulating cylinder of the diverter switch for the newly energized transformers, we recommend to carry out oil sampling for each 1,000 times of operation under rated current to ascertain that the voltage endurance valued is not under 30kV.

5.2 Do not operate the on load tap changer frequently when the transformer is overloaded. If the customer has installed fully automatic controls, then the tap must be equipped with "over current tripping" device, so that the tap changer will not be operated when the load current exceed $2I_n$. 5.3 The tripping contact of the protective relay is set to operate at an oil speed of $1.0\text{m/s} \pm 10\%$. This contact

should be connected the tripping circuit of the transformer circuit breaker. In case a fault occurs with the on load tap changer, then large amount of gas will generate, causing a rush of oil flow to move the relay flap, which breaks the tripping contacts, and cuts off the transformer incoming current, thus avoid the fault to extend.

5.4 On the top cover of the tap change is installed an overpressure explosion protection cover which should not be damaged during ordinary tap change operation of the diverter switch. Only when a fault is generated within the switch, then the cover bursts when the pressure in the oil cylinder exceeds $2 \times 10^5 \text{ Pa}$, thus it functions as overpressure protection to avoid extension of the fault. During installation and maintenance of the on load tap changer, always pay special attention not to damage the bursting cover.

6. Packing

6.1 Scope of delivery of the complete set of equipment

The tap changer and the motor drive unit are packaged separately for delivery after they have been conducted routine test and set at the specified position.

6.2 Scope of delivery of the tap changer equipment

6.2.1 Diverter switch: Including oil compartment of the switch and the diverter switch unit installed in the oil compartment.

6.2.2 Tap selector including change-over selector

6.2.3 Protective relay

6.2.4 Driving shaft and conical gear driving

box

6.2.5 Motor Drive Unit

6.2.6 Accessories including remote position indicator, etc

Check the contents according to the packing list. Place the tap changer equipment in a well-ventilated weather proof warehouse with relative humidity of less than 85% and temperature between -25°C and $+40^{\circ}\text{C}$. There should be no corrosive gas.

Note: the six lead wires on the tap selector may be loosened due to transportation, therefore, at the time connecting the lead wires to the tap change, the selector end shall also be checked. Tighten it if it is loosened.

7. Maintenance and repair

7.1 Periodical maintenance

The transformer oil in the diverter switch oil compartment will become carbonized after certain times of switching and its voltage endurance value will decrease, so it is recommended that periodic oil sampling should be done according to Section 5.1 for laboratory test. The transformer oil shall be replaced when its voltage endurance value is less than 30kV.

During the oil changing, the contaminated oil is completely removed from the oil compartment, then the insulating cylinder and the diverter switch are flushed with clean oil, this oil is again completely removed. Finally it is filled

with clean oil.

If the number of tap change operation exceeds 20,000 times annually, it is recommended to install an on line oil filter to the tap changer.

The oil conservator and the breather in the safety duct of this on load tap changer is maintained usually the same as the transformer.

7.2 Periodical maintenance

During the long term operation of the on load tap changer, only the diverter switch required to be repaired periodically. Table 6 shows

the time interval of the period maintenance. To enhance the reliability of the tap changer, it should be maintained after five years operation, even if the number of operation has not been reached.

The item for maintenance includes lifting out the diverter switch unit, cleaning the entire switch properly, measuring the contact wear, replacing the contacts of the diverter switch, etc. Small capacity lifting equipment may be used to lift out the diverter switch unit.

During the maintenance, the time of exposure of diverter switch unit shall not exceed 10 hours or it shall be dried as specified in section 4.5.

7.3 Lifting of diverter switch unit

All the terminals shall be shorted and grounded after the transformer has been cut from the network.

The diverter switch unit can be drawn out in any operating position, however, we recommend that the diverter switch unit will be drawn out in its position. (See Appendix for the table of setting positions)

7.3.1 Close all the oil valves on the conservator, transformer oil tank and the head of tap changer.

7.3.2 Loosen the vent and overflow screw, lower the oil level of the tap changer head until it is flushed with the surface of the transformer tank cover.

7.3.3 Loosen the horizontal driving shaft of the motor drive unit and the tap changer.

7.3.4 Dismantle the grounding connection of the tap changer head, loosen the connection bolts of the head cover. Remove the cover, take care of the sealing ring.

7.3.5 Remove the position indicator from the diverter switch.

7.3.6 Carefully lift out the diverter switch unit, don't damage the oil suction pipe and the driving shaft of the position indicator.

7.4 Cleaning

7.4.1 Cleaning of diverter switch oil compartment

Thoroughly drained the dirty oil from the diverter switch oil compartment and flush it with new. If necessary, brush away the carbon powder stuck to the inner wall of the insulating cylinder. Then again flush it with new oil, drain away all the dirty oil.

After cleaning, tightly close the top cover of the diverter switch.

7.4.2 The diverter switch can be washed with new oil after it has been lifted out. It can be brushed if necessary. The thorough cleaning of the diverter switch can be done after it has been dismantled.

7.5 Preliminary examination of the diverter switch unit

7.5.1 Check all fasteners for looseness.

7.5.2 Whether the main spring, reset spring and jaw plate of the energy storage mechanism are deformed or broken.

7.5.3 Whether the braided lead of each contact is not damaged.

7.5.4 Check the wear of moving and stationary contacts of the diverter switch.

7.5.5 Check for any breaking of the flat wire of the transition resistor and whether its resistor value is identical to that stamped on the nameplate (The resistor value should be measured at the open side of the transition contact.)

7.5.6 Measure the contact resistor of the odd and even number contacts of each phase and the neutral lead-out point.

7.5.7 Measure the switching sequence of the moving contact.

7.6 Dismantle the diverter switch unit for cleaning, examination and parts replacement.

Prior to dismantle, pay attention to the following items:

7.6.1 Note the current operating position of the diverter switch, so that it can be restored to the original operating position during reassembly.

7.6.2 When the contact mechanism of the diverter switch is dismantled for examination and cleaning, it should be done on each phase. Never dismantle the three phase in the same time to avoid confusion.

The sequence for dismantling diverter switch unit is as follows:

a. Release the jaw of the energy storing

mechanism. Place the mechanism to a bridging position of the transition contact so as to facilitate dismantling and reassembling.

b. Loosen the connecting screw on insulating arc plates of the diverter switch stationary contacts. Remove the insulating arc plates.

c. Remove the arc isolating chamber of the contacts of the diverter switch.

d. Thoroughly clean the dismantled contact shell.

e. Check the amount of contact wear. When the amount of wear of any one of the diverter switch arcing contacts exceeds 3mm, then all arcing contacts must be replaced.

f. Check the lead-out braided lead of the main arcing contacts and transition contacts.

g. Check for looseness of the M6×18 countersunk screws connecting to the arcing contacts.

After 250,000 times of operations of the tap changer, the lead-out braided lead must be replaced even if they are not damaged and regardless whether the contacts are replaced or not.

7.7 Reassembly of diverter switch unit

The contact mechanism of the diverter switch shall be reassembled when the mechanism has been dismantled for cleaning and parts replacement.

a. Install the contacts arc-isolating chamber.

b. Assemble the contact shell of the diverter

switch stationary contacts. Tighten and lock eight M6 bolts.

c. Shift the energy storage mechanism to the opposite side of the original operating position. Hook up the lower sliding plate of the mechanism and shift the eccentric wheel of the upper sliding plate, allowing the spring of the energy storage mechanism to store energy. When the upper sliding plate is shifted to the highest point of the eccentric wheel release the lower sliding plate, so the energy storage mechanism is again latched.

d. Check the switching sequence of the diverter switch (by oscilloscope)

The switching time of the diverter switch (direct current oscilloscope) will be 35-50ms. The bridging time for the transition contacts will be 2-7ms, as shown in Fig25.

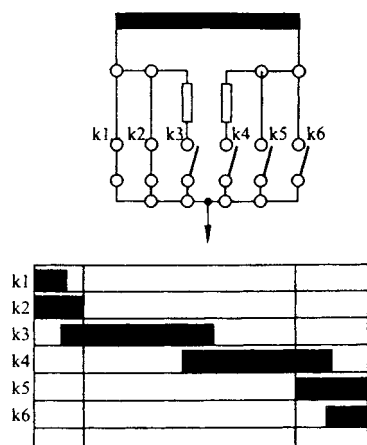


Fig.25 The switching sequence of diverter switch contacts

7.8 The installation of the diverter switch unit

When the diverter switch unit has been verified to be acceptable, it is returned to its original operating position before maintenance, then carefully lifted it into the diverter switch oil

compartment. Fasten the five bolts on the head and installed the position indicator, and after replace the tap change head cover. Take care to place properly the sealing gasket.

7.9 Oil filling

Fill the diverter switch oil compartment with new oil up to the horizontal surface of the tap changer head. Open the valve between the protective relay and the conservator, so as to allow the oil flows smoothly into the oil chamber of the tap changer which is vented through the bleeding hole on its head cover. Open all the valves of the conservator and transformer oil tank, the conservator shall be replenished with new oil up to its original oil level.

7.10 Check before operation

7.10.1 Connect all the grounding screws on the head cover.

7.10.2 Check the tripping function of the protective relay. Press the trip test button, this should cut off the power source of the transformer. The transformer can be put into operation after pressing the reset button.

7.10.3 Check if the position indicator of the tap changer and that of the motor drive unit are identical. Connect the tap changer to the driving shaft of the motor drive unit, and conduct connection check according to 4.8 section.

7.10.4 Mechanical operating test of on-load tap changer Ten cycles of operations by motor drive should be conducted, the result of which shall show no malfunctioning. The

maintenance of the tap selector can only be performed along with the overhaul of the

transformer. No separate repair is usually required.

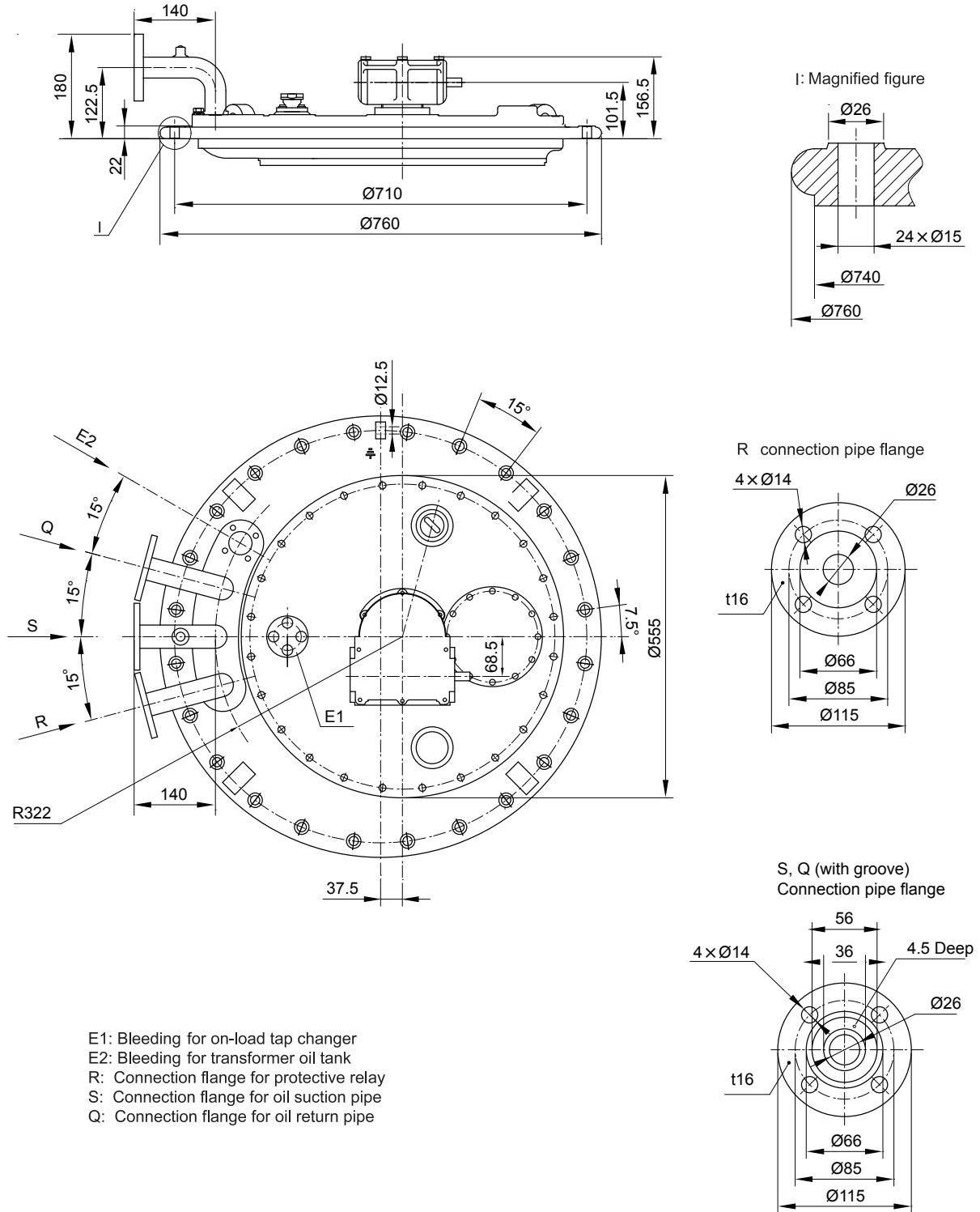
Intervals of maintenance of CM on load tap changer

OLTC Model	Max. rated through current	Operations	
		Without oil filter	With oil filter
CM III 350	≤ 350 A	100.000	150.000
CM III 500	≤ 350 A	100.000	150.000
	≤ 500 A	80.000	150.000
CM III 600	≤ 350 A	100.000	150.000
	≤ 600 A	80.000	150.000
CM III 350	≤ 350 A	100.000	150.000
CM III 500	≤ 500 A	100.000	150.000
CM III 600	≤ 600 A	100.000	150.000
CM III 800	≤ 500 A	100.000	150.000
	≤ 800 A	80.000	150.000
CM III 1200	≤ 800 A	80.000	150.000
	≤ 1200 A	70.000	140.000
CM III 1500	≤ 1200 A	70.000	140.000
	≤ 1500 A	60.000	120.000

8. Appendix

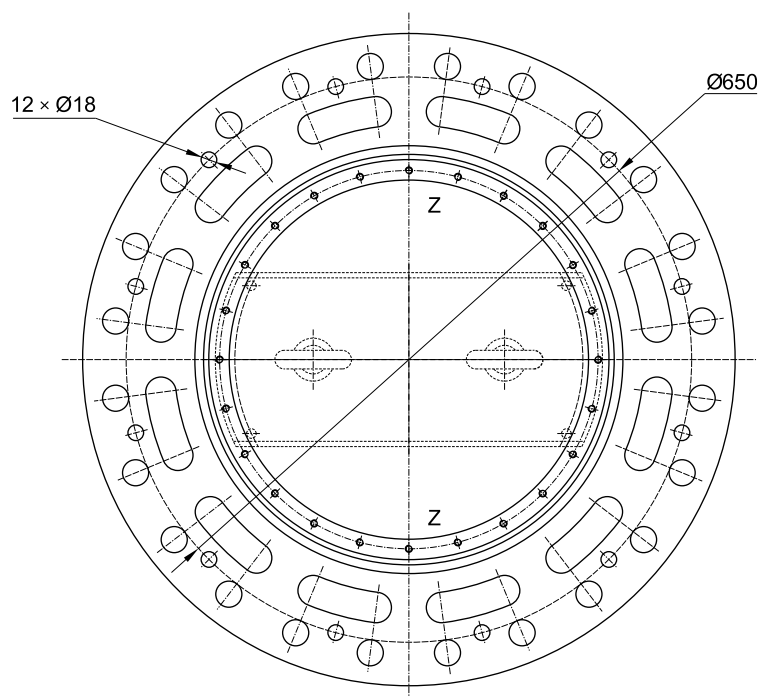
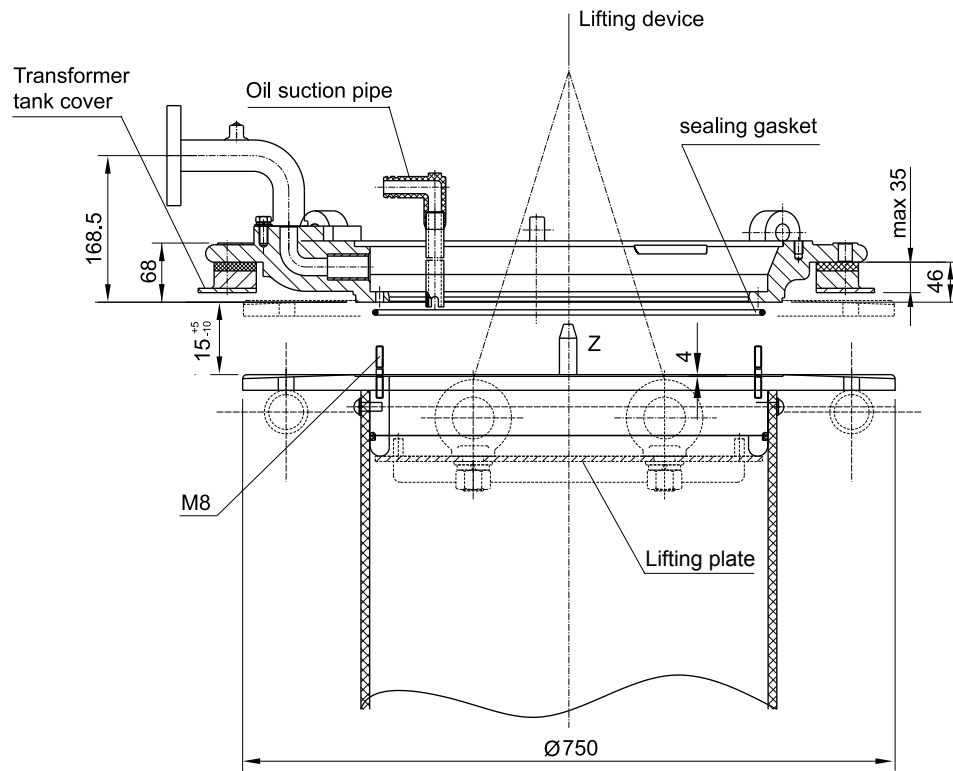
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Appendix 1 CM OLTC head flange for standard tank type, overall dimensions



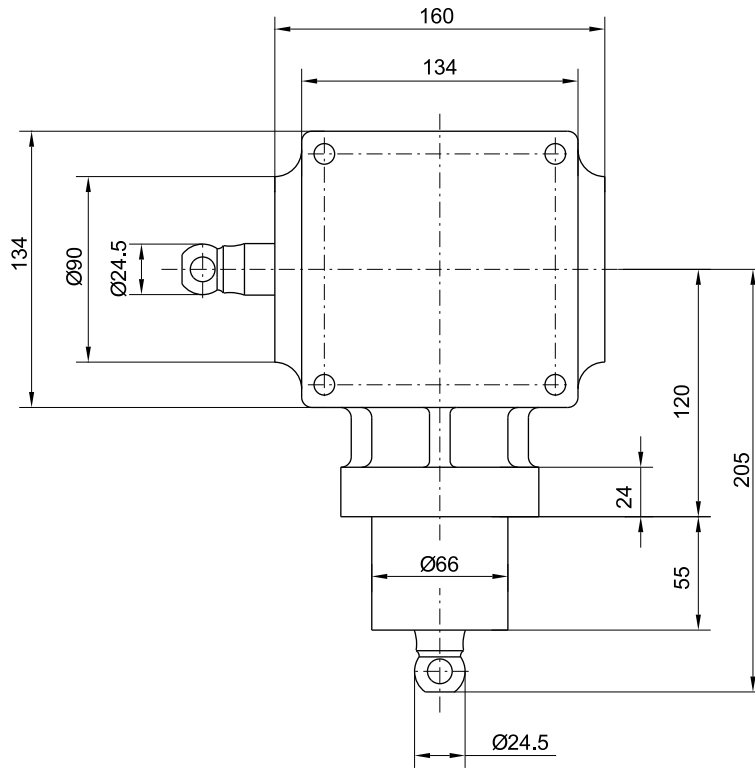
Unit: mm

Appendix 3 CM OLTC head flange installation for bell-type, overall dimensions

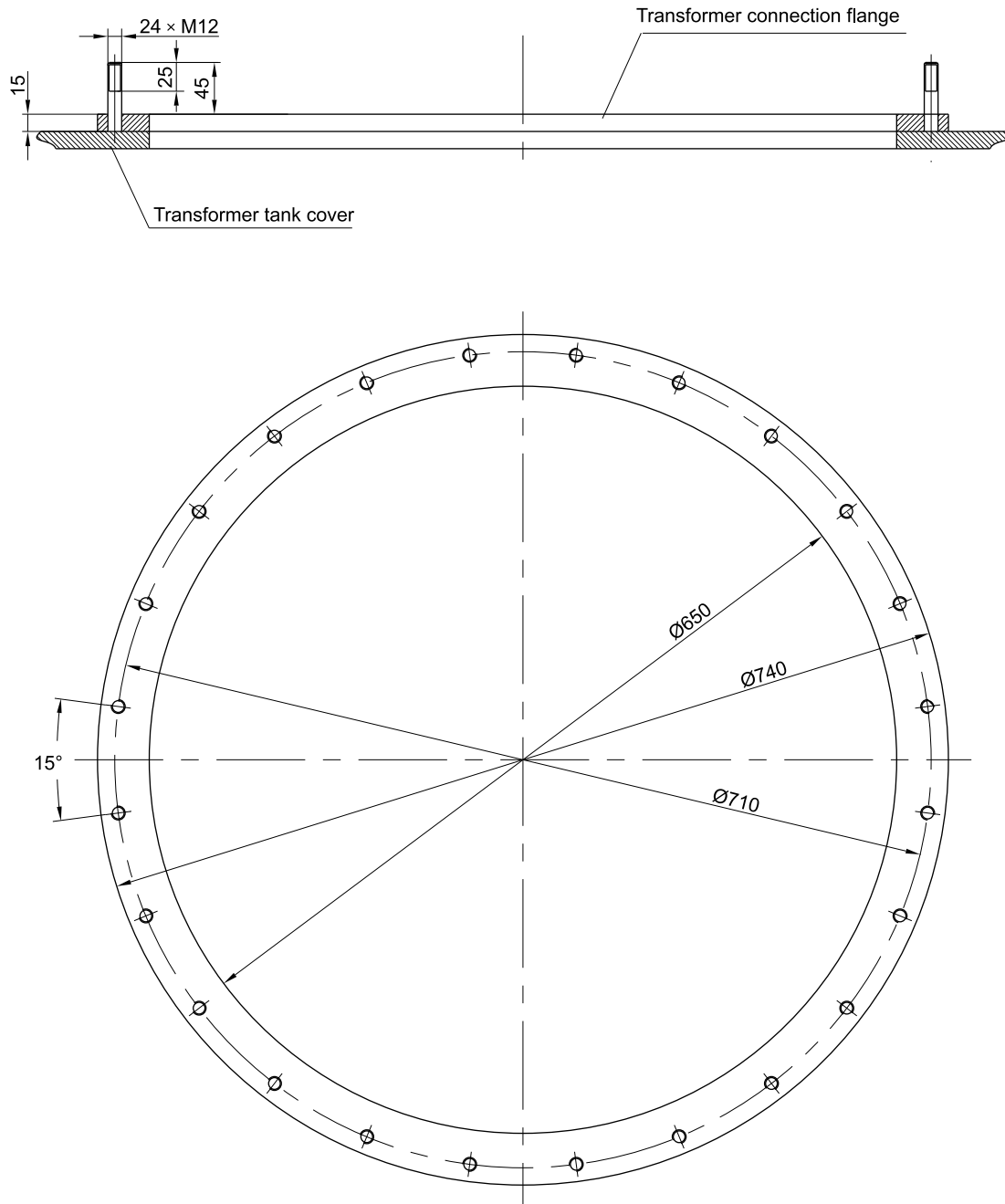


Unit: mm

Appendix 4 The overall dimension of bevel gear

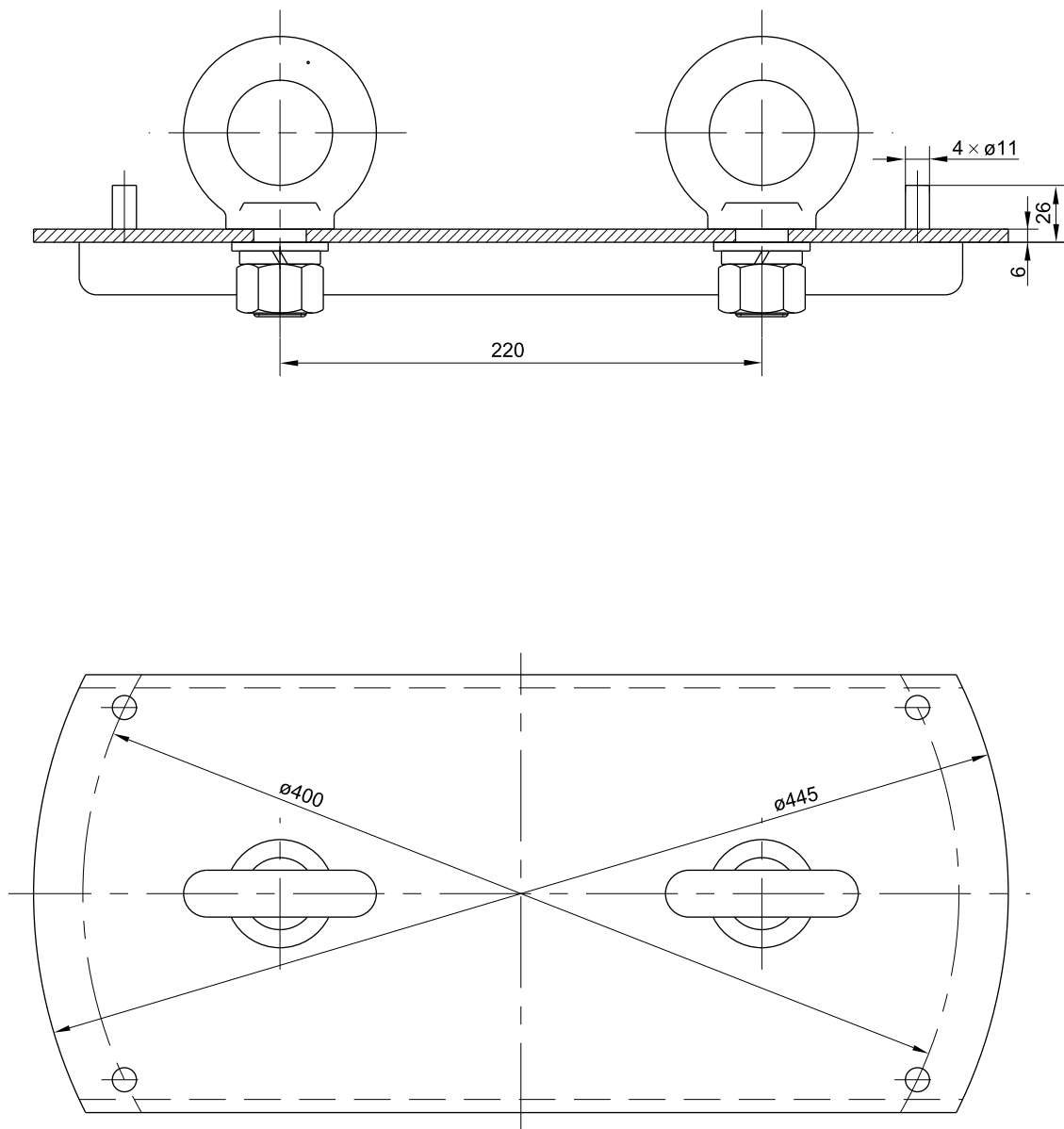


Unit: mm

Appendix 5 Transformer connection flange for CM OLTC, overall dimensions

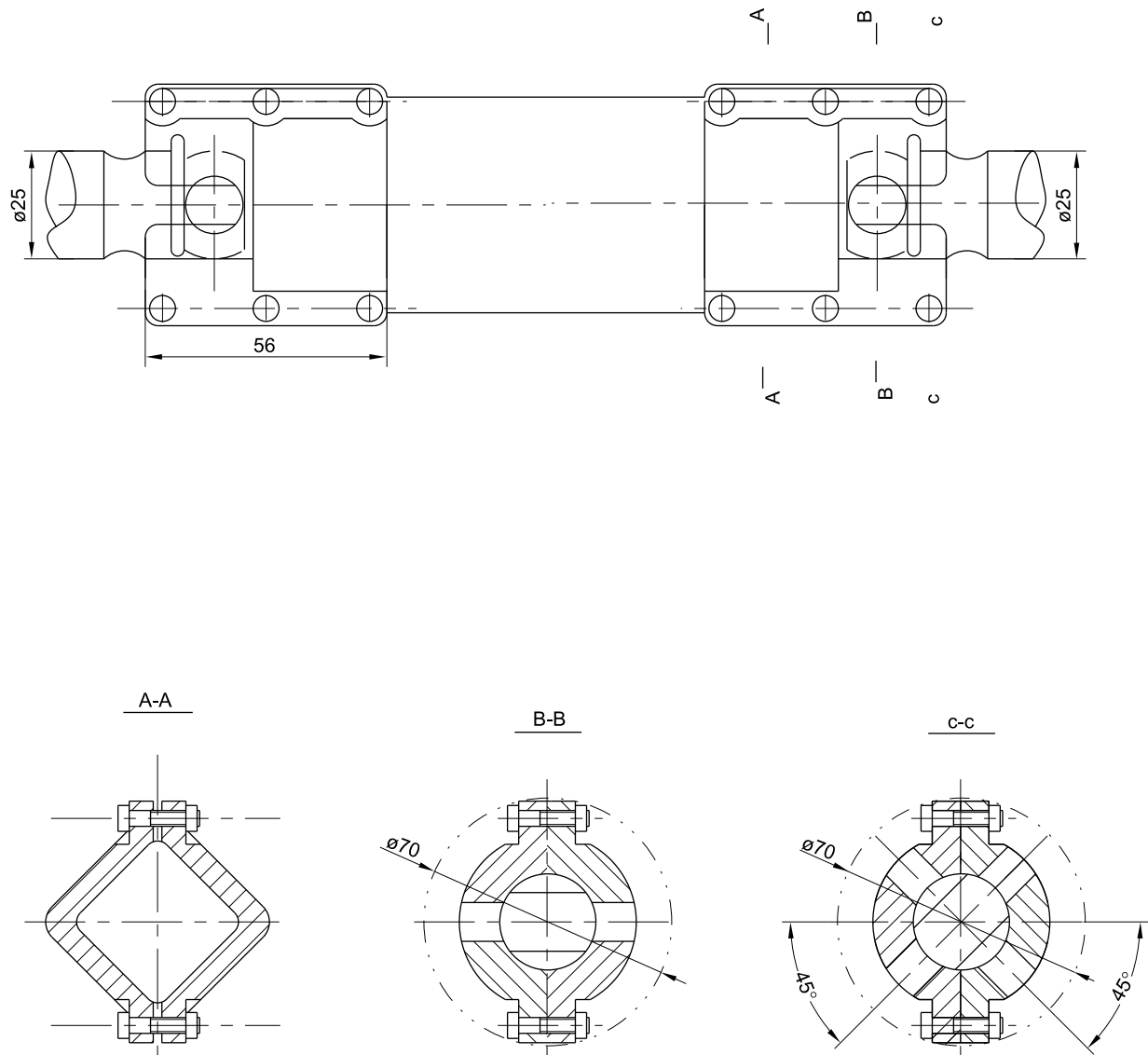
Unit: mm

Appendix 6 Dimension of lifting plate for bell type



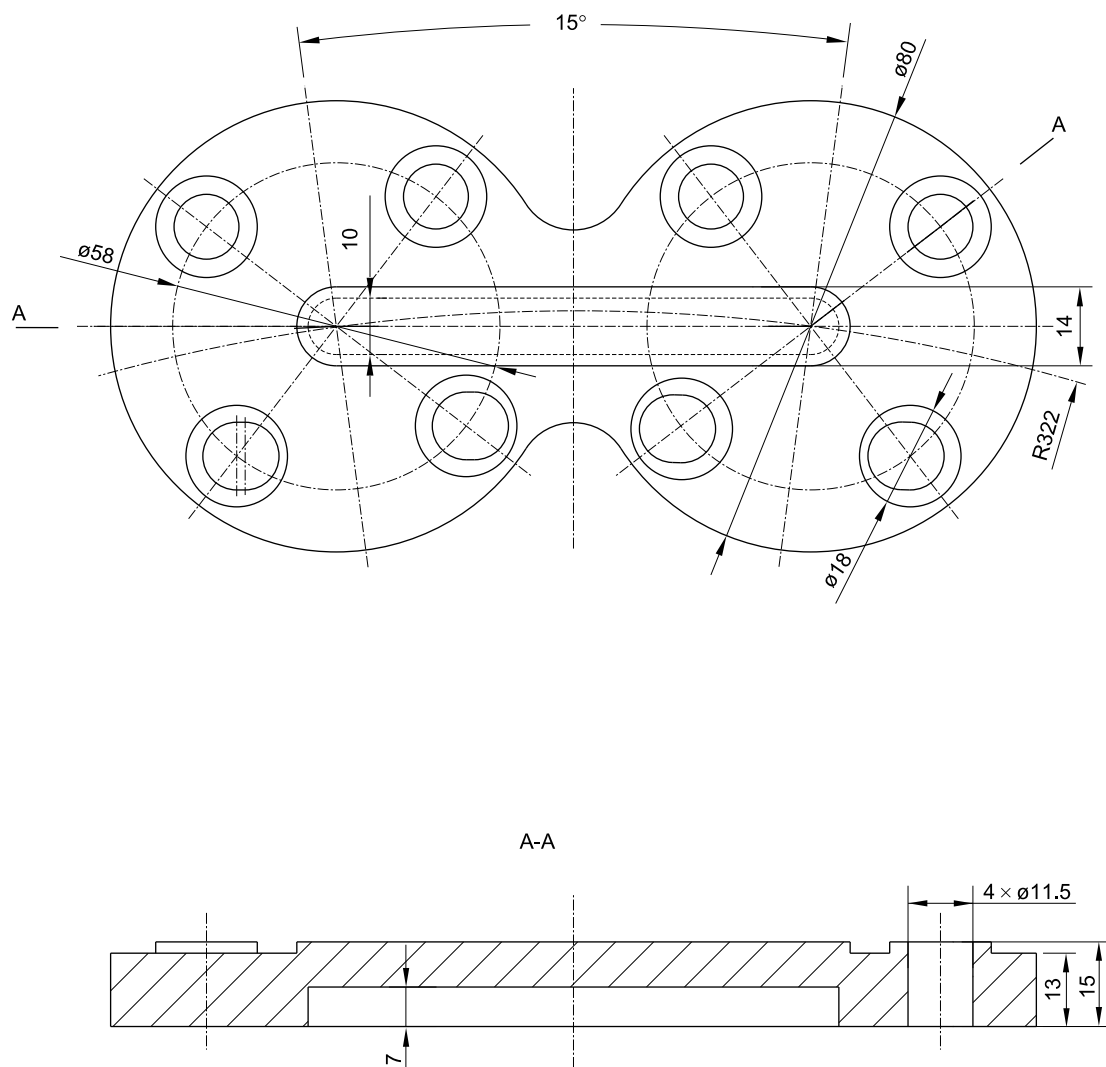
Unit: mm

Appendix 7 Diagram for the installation of horizontal and vertical drive



Unit: mm

Appendix 8 Structure diagram of bypass pipe

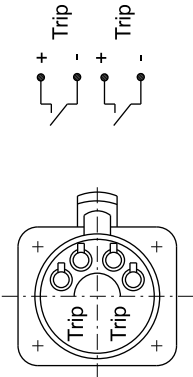
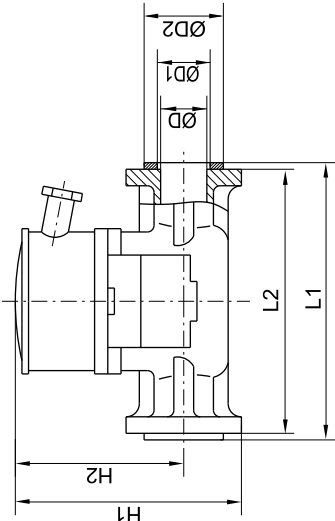


Unit: mm

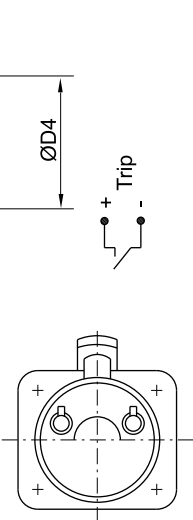
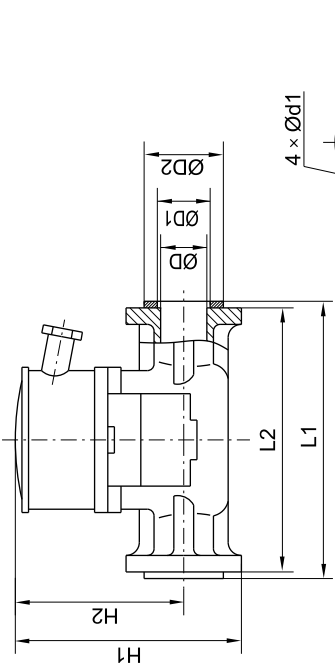
Appendix 9 Overall dimension of protective

Unit: mm

Type QJ6-25 Buchholz relay

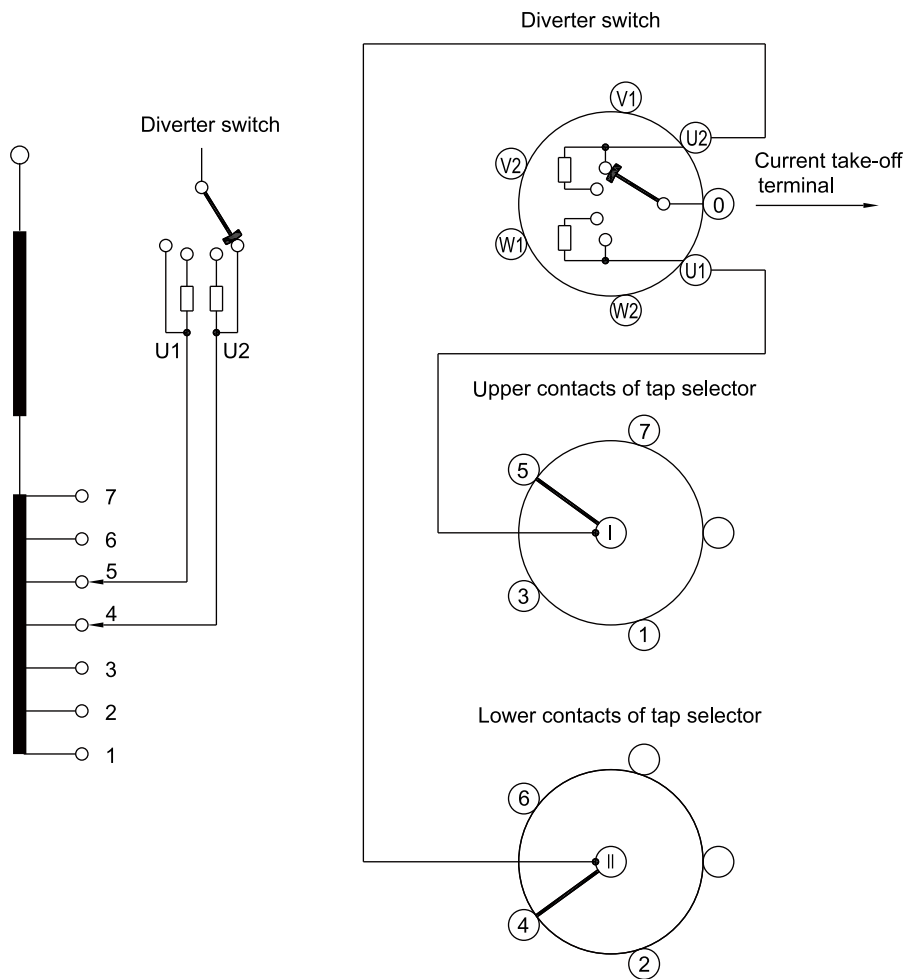


Type QJ4G-25 Buchholz relay



Model	D	D1	D2	D3	D4	d1	H1	H2	L1	L2	Remark
QJ4G-25	25	35	65	85	115	14	195	133	208	200	With one pair of trip signal
QJ6-25	25	35	65	85	115	14	215	153	208	200	With two pairs of trip signals

Appendix 10 CM(10070) operating position table and connection diagram



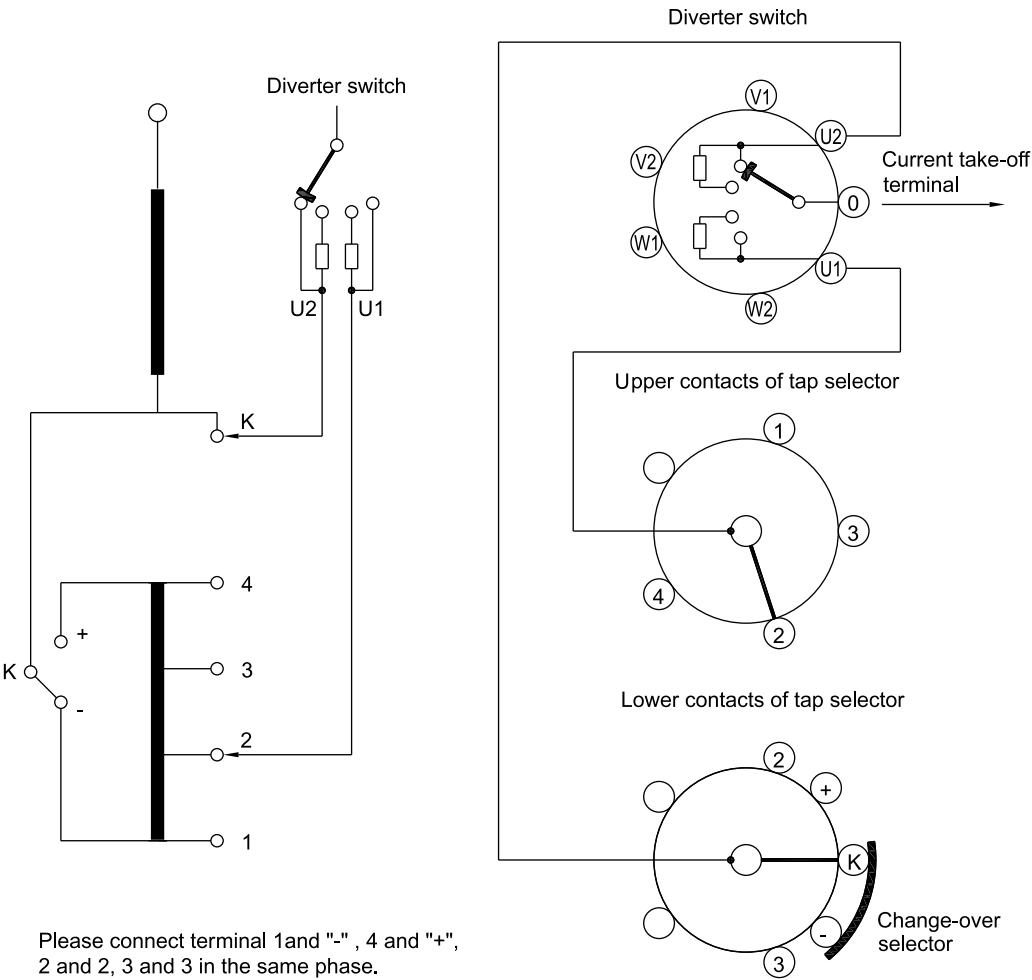
Operation position number	7
Different voltage number	7
Set position ●	4

Tap selector contact position	1	2	3	4	5	6	7
Display position	1	2	3	4	5	6	7

● ←

● Drawing is shown at the set position

Appendix 11 CM(10071W) operating position table and connection diagram

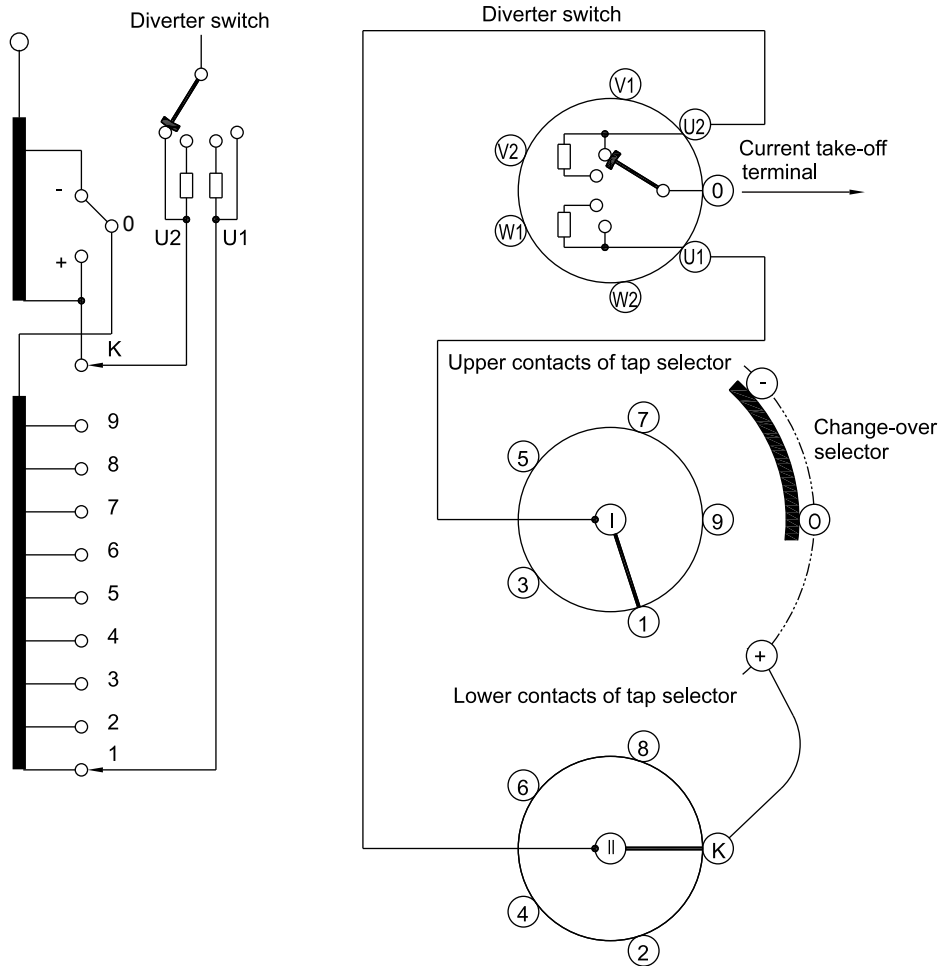


Operation position number	7
Different voltage number	7
Set position	4


Change-over selector location	<div><div></div><div>K+</div><div></div><div></div><div></div><div></div><div>K-</div><div></div></div>						
Tap changer position	1	2	3	4	5	6	7
Tap selector contact position	1	2	3	K	2	3	4
Display position	1	2	3	4	5	6	7

● Drawing is shown at the set position

Appendix 12 CM(10191G) operating position table and connection diagram

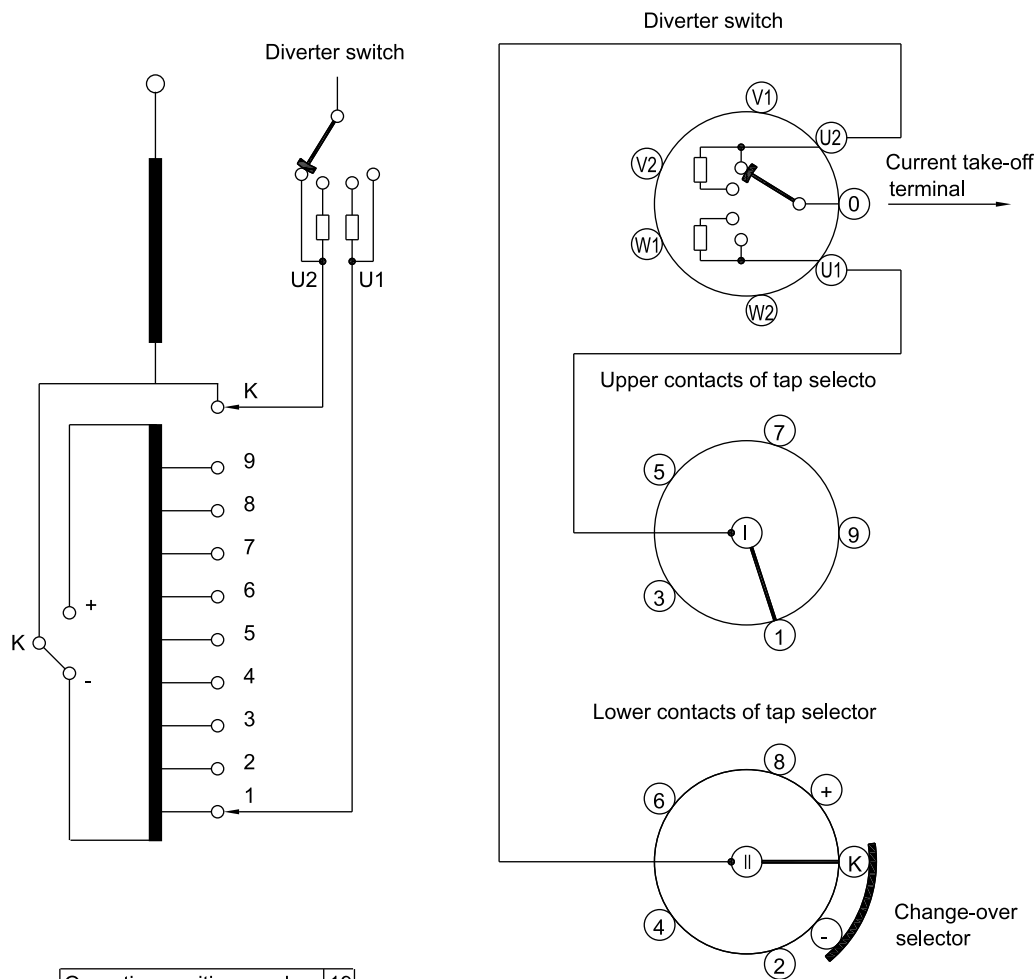


Operation position number	19
Different voltage number	19
Set position ●	10

Change-over selector location																			
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

● Drawing is shown at the set position

Appendix 13 CM(10191W) operating position table and connection diagram

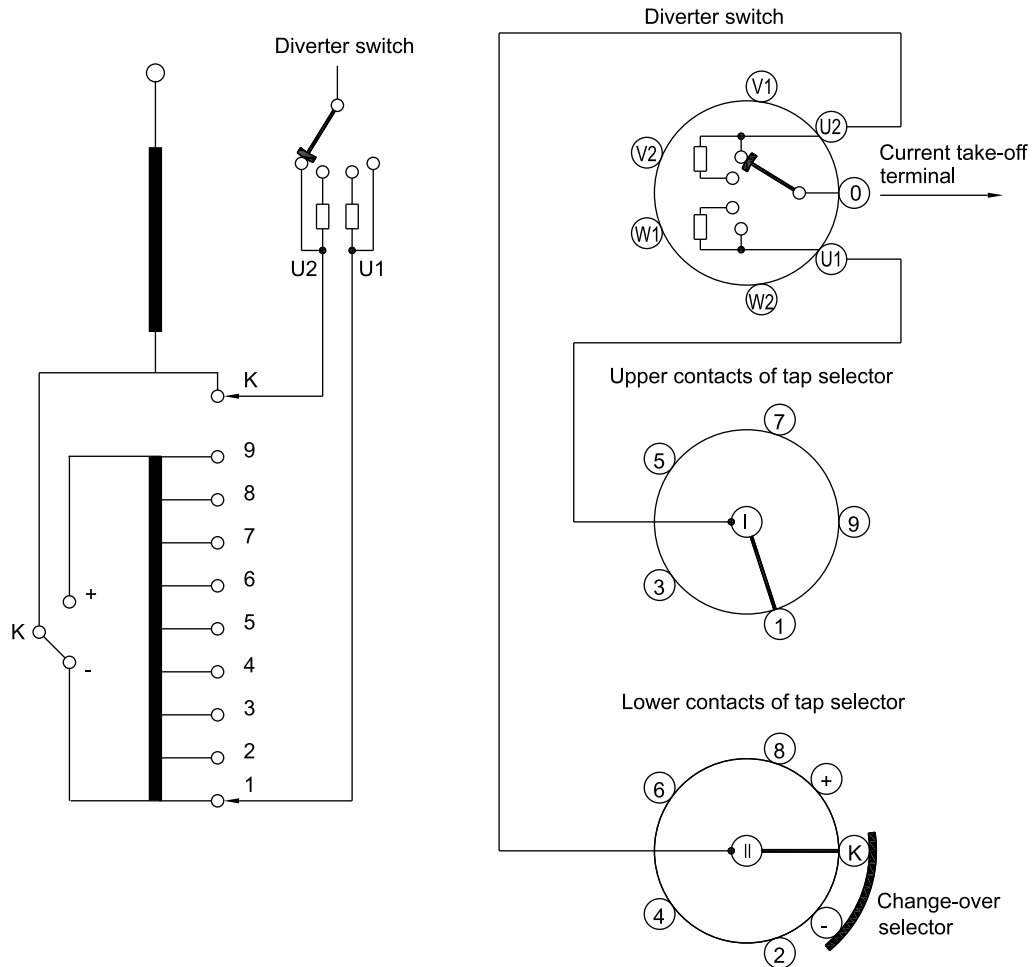


Operation position number	19
Different voltage number	19
Set position ●	10

Change-over selector location	<div><div></div><div>K+</div><div></div><div>K-</div><div></div></div>																		
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

● Drawing is shown at the set position

Appendix 14 CM(10193W) operating position table and connection diagram



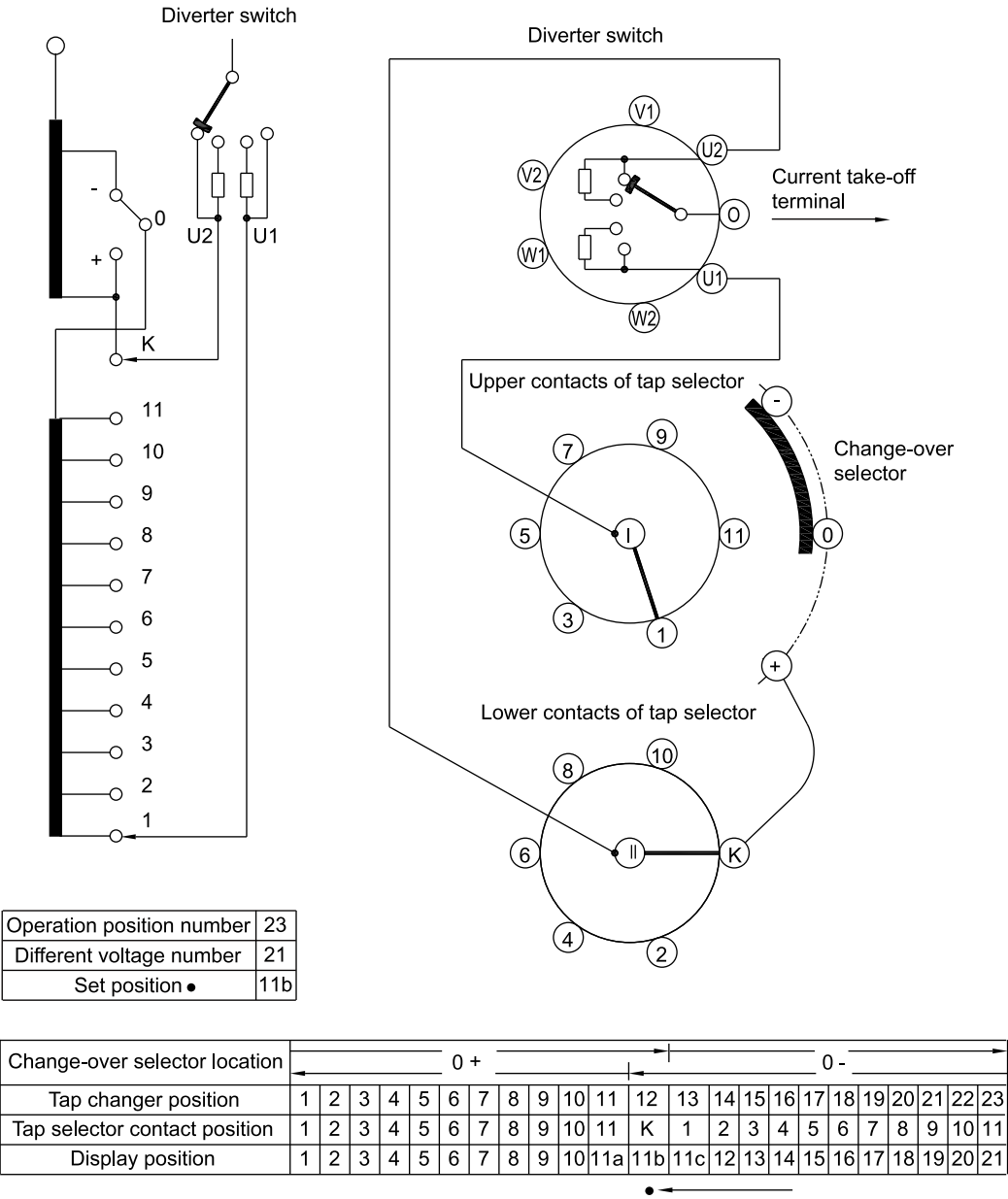
III 350/500/600

Operation position number	19
Different voltage number	17
Set position ●	9b

Change-over selector location	← K+ →										← K- →								
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17

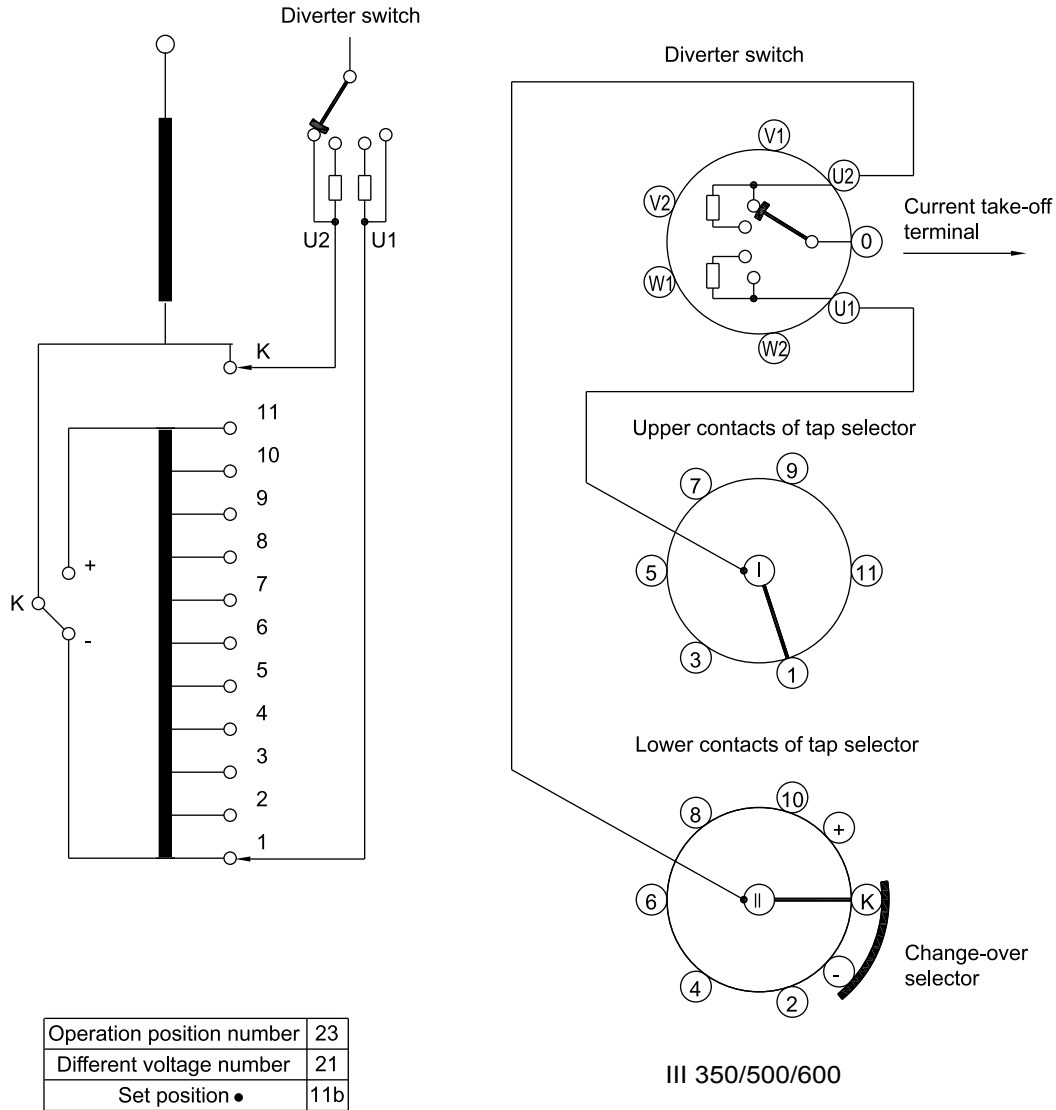
● Drawing is shown at the set position

Appendix 15 CM(12233G) operating position table and connection diagram



● Drawing is shown at the set position

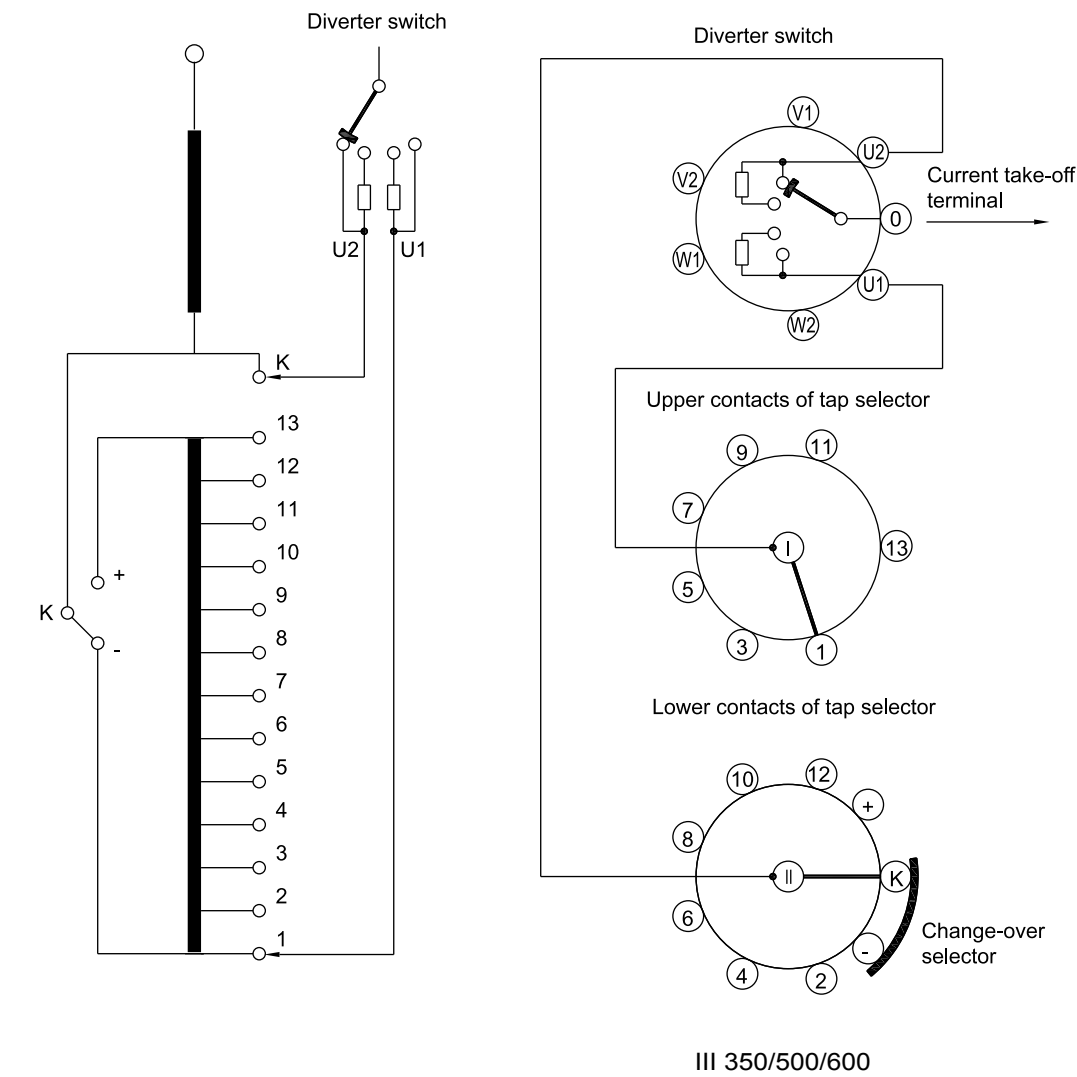
Appendix 16 CM(12233W) operating position table and connection diagram



Change-over selector location	K+											K-											
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	K	1	2	3	4	5	6	7	8	9	10	11
Display position	1	2	3	4	5	6	7	8	9	10	11a	11b	11c	12	13	14	15	16	17	18	19	20	21

• Drawing is shown at the set position

Appendix 17 CM(14273W) operating position table and connection diagram

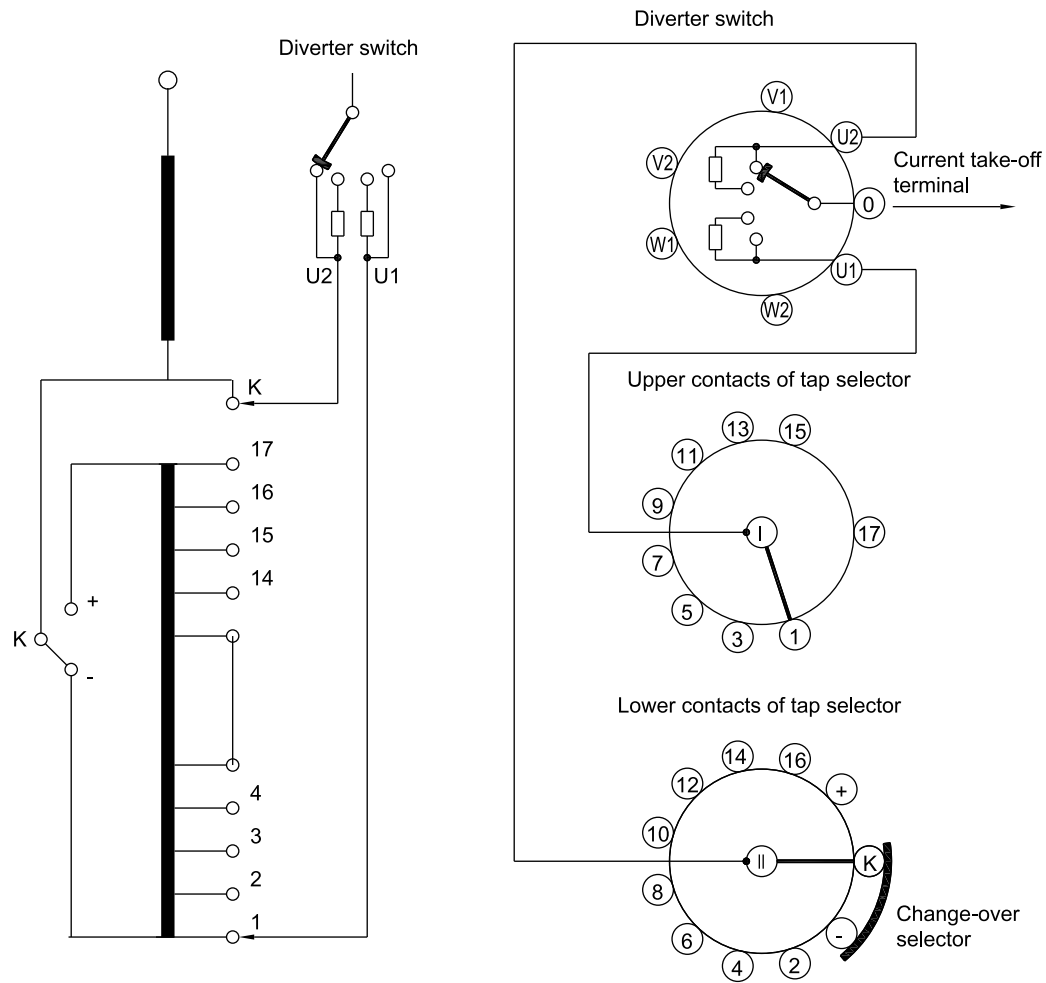


Operation position number	27
Different voltage number	25
Set position ●	13b

Change-over selector location	<div><div></div><div>K+</div><div></div><div></div><div>K-</div><div></div></div>																										
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	K	1	2	3	4	5	6	7	8	9	10	11	12	13
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13a	13b	13c	14	15	16	17	18	19	20	21	22	23	24	25

● Drawing is shown at the set position

Appendix 18 CM(18353W) operating position table and connection diagram



III 350/500/600

Operation position number	35
Different voltage number	33
Set position ●	17b

Change-over selector location	K+																	K-																	
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17a	17b	17c	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

● Drawing is shown at the set position

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