CM2 Type Vacuum On-Load Tap Changer Operation Instructions

HM 0.460.5701

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1 General

CM2 on load tap changer (Hereafter, referred to as OLTC) applies to power and rectification transformers with highest voltage of 72.5kV, 126kV,170kV and 252kV, maximum rated through current of 600A for three phases and 1500A for single phases, to change the taps under load for the purpose of voltage regulation. Three phase OLTCs are used at the neutral point of Y connection, and single phase OLTC can be used for any connections.

CM2 OLTC is a typical OLTC of combined structure, consisting of diverter switch and tap selector.

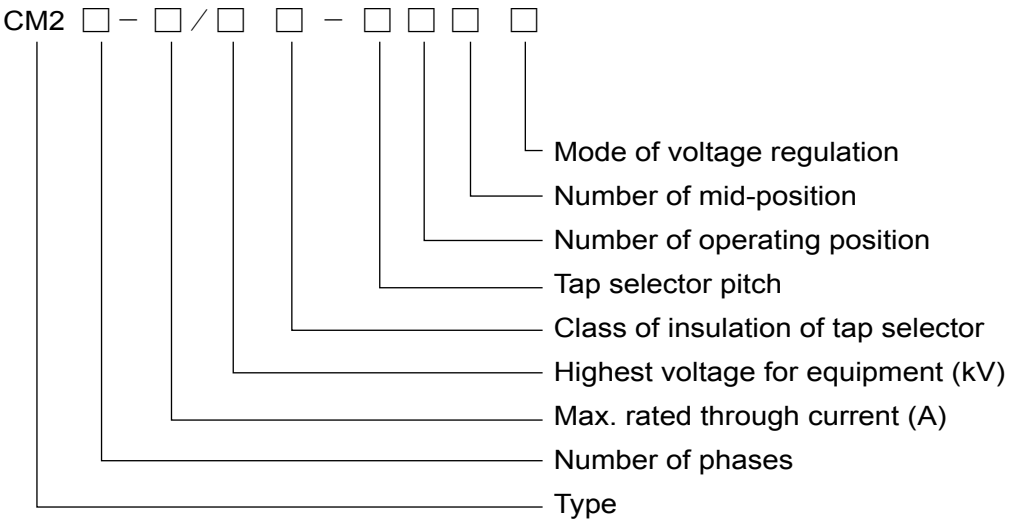
CM2 on load tap changer is to be mounted to the transformer tank cover by its tap changer head which serves also for connecting to the motor driver CMA7 or SHM-III via the worm gear box and bevel gear box to drive tap change operation.

When CM2 OLTC is used without a change-over selector, the maximum operating positions available will be 18, and 35 positions with a change-over selector. (special design is excluded).

Fig.1 Outline view of CM OLTC

This operation instructions includes all the necessary information for the installation and operation of CM2 OLTC. CM2 vacuum OLTC has the same overall dimension as CM type OLTC.

1.1 Type designation



1.1.1 Designation 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, 14131W 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, 14131G 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 different insulation grades. The symbol for insulation distance is shown in Fig.3.

1.3 The operating condition of OLTC

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

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

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

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

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

1.4 Technical data of CM2 OLTC

See table 1.

1.5 Mode of voltage regulation

There are 3 modes of voltage regulation of CM2 OLTC, namely linear voltage regulation, reversing voltage regulation, coarse and fine voltage regulation. See Fig 2 for the mode of connections.

1.6 Temperature rise of OLTC contacts and active parts

Under max. rated through current of OLTC, the temperature rise for each of the long term current-carrying contacts and the active parts should not exceed 20K against oil.

1.7 Temperature rise of transition resistor

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 against oil.

1.8 Short circuit current test

The long term current-carrying contacts of OLTC shall withstand the short circuit current test as shown in Table 1.

1.9 OLTC step capacity and electrical life

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 less than 600,000 operations.

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

1.11 The mechanical life of OLTC should not be less than 1,500,000 operations.

Table 1 Technical data of series CM2 on load tap changer

Item	Specification		CM2 I 500 CM2 III 500	CM2 I 600 CM2 III 600	CM2 I 800	CM2 I 1200	CM2 I 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 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		See details in Figure 2				
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	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%				
12	Motor drive unit		CMA7 or SHM-III				

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

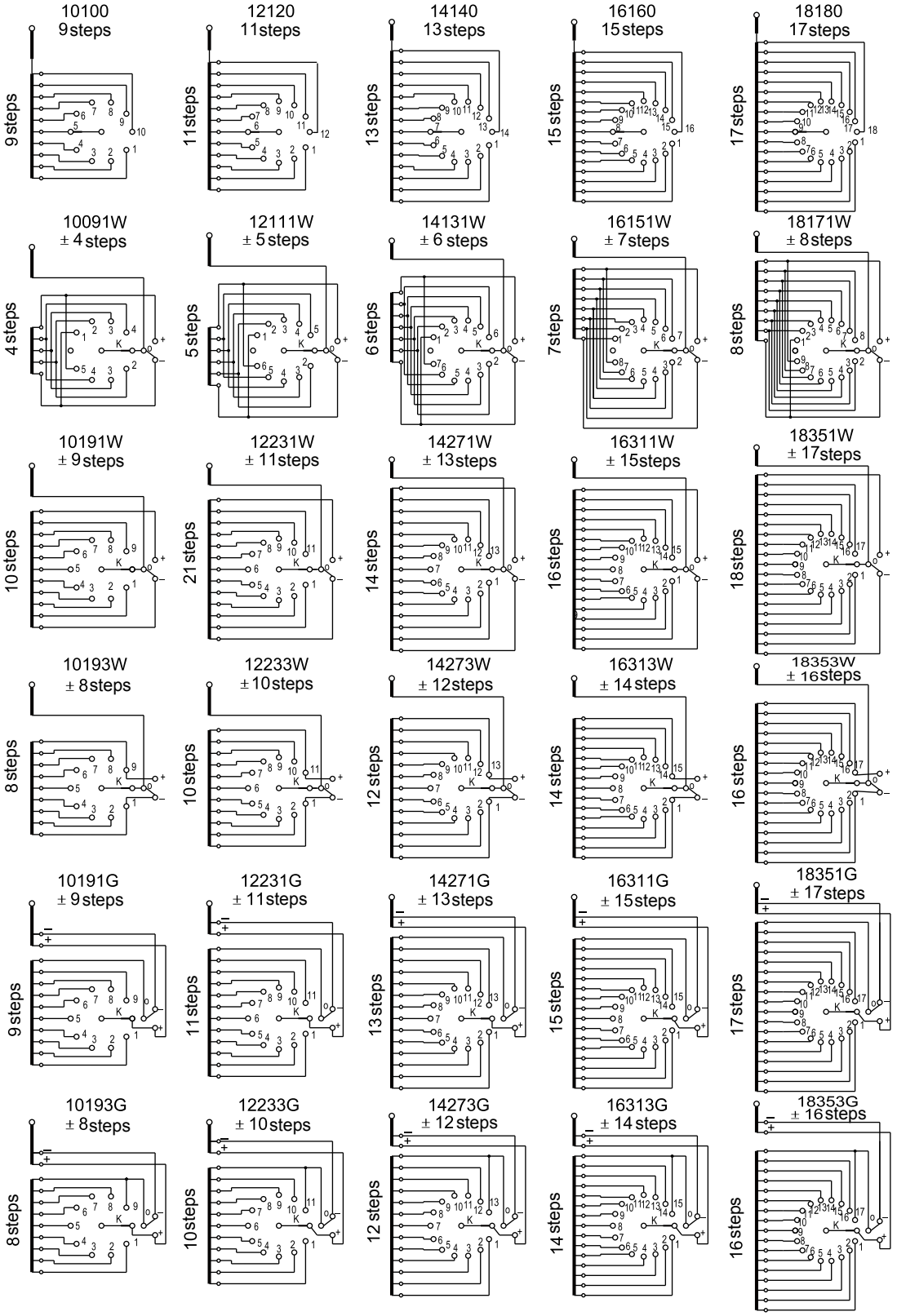
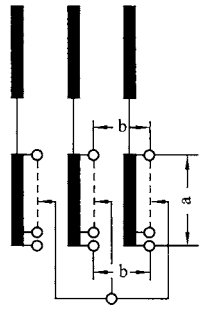
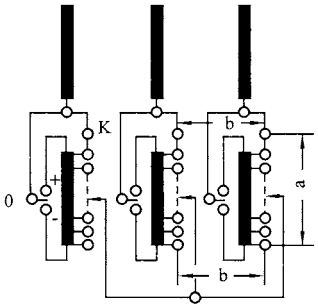


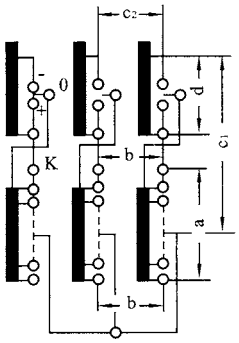
Fig.2 Basic Circuit Diagram



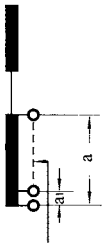
10 10 0 … 18 18 0



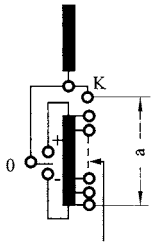
10 09 1W … 18 17 1W
10 19 1W … 18 35 1W
10 19 3W … 18 35 3W



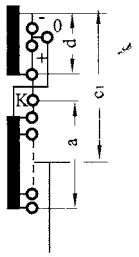
10 19 1G … 18 35 1G
10 19 3G … 18 35 3G



10 10 0 … 18 18 0



10 09 1W … 18 17 1W
10 19 1W … 18 35 1W
10 19 3W … 18 35 3W

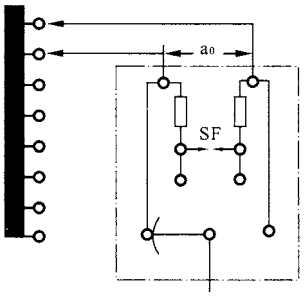


10 19 1G … 18 35 1G
10 19 3G … 18 35 3G

a. Linear regulation

b. Reverse regulation

c. Coarse & fine regulation



a —— Between start and end of a fine tap winding
b —— Between any two taps of different tap windings
a0 —— Between tany adjacent taps of diverter switch
a1 —— Between any selected and preselected taps of tap selector
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
SF —— Spark gap

Explanation of insulation distance symbol:

Fig 3 Basic connection mode of tap winding

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	
	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	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 respond 100%

2. Structure of OLTC

This product is an in-tank and combined structure on-load tap changer, consisting of diverter switch (insert and oil compartment), and tap selector (with or without change-over selector), see Fig.1.

2.1 Diverter switch insert

Diverter switch insert consists of driving unit, insulation shaft, energy accumulating mechanism, switching mechanism (contact system) and transition resistor. The energy accumulating 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.4.

2.1.1 Insulation rotating shaft

Insulation 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 compression spring, guide rail, chuck, cam wheel and bracket, as shown in Fig.5. 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

Fig.4 Diverter switch unit

Fig.5 Energy accumulating unit

the rotating force to the shaft sleeve of the cam wheel, thus making the diverter switch to operate.

2.1.3 Contact mechanism

2.1.3.1 Dual-resistor transition, "1-2-1" flag cycle, and four steps for output voltage variation

2.1.3.2 Adopt vacuum interrupter to extinguish arc, which won't cause insulation oil carbonized, hence, no need to replace contacts, therefore, greatly extending OLTC life span, The vacuum interrupter is exclusively supplied by EATON company. See Fig.6

2.1.3.3 Tap changer long-term current will be carried by main contacts, which is designed as clamping compact structure.

2.1.3.4 Take-off contact is designed to be drawn out, which facilitate easy lifting out for inspection and maintenance.

2.2 Diverter switch oil compartment

Diverter switch oil compartment is composed of four parts: head flange, top cover, insulation cylinder and bottom of the cylinder. See Fig.7.

2.2.1 Head flange

Head flange is made of aluminum alloy by low pressure steel mold die-casting. and riveted to the insulation cylinder. It is divided into standard tank 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. Pipe R is connected to conservator via tap changer protective relay. Oil suction pipe S is used to suck the oil from the bottom of the oil compartment for oil replacement or filtration in the diverter switch. It connects to an

Fig.6

Fig.7 Diverter switch oil compartment

insulation oil pipe through tap changer head flange.

This oil suction pipe extends straight down to the bottom of the oil compartment. The oil filling pipe Q acts as oil return pipe for the diverter switch.
Another through pipe E acts as the vent pipe for transformer oil overflow. Pipe R can be interchangeable with pipe Q.(See Appendix 1)

All pipes angle can be turned accordingly and fixed securely.

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 worm gear box, inspection window for tap position and bleeding screw. See Fig.8. O ring is employed for sealing against leakage of tap changer.

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 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.9.

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.10.

Fig.8 Top cover

Fig.9 Bottom of compartment

2.3.1 Step-by-step drive mechanism (also referred to as Geneva wheel mechanism)
It consists of two Geneva wheels and crank pin.

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 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 out 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 a "Ш" structure with upper and lower clamping piece . It is driven by the Geneva wheel mechanism through the driving shaft, which makes it rotate 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, four-pint touch is always maintained as shown in Fig.11, realizing adjustment-free and efficient cooling.

2.3.3 Change-over selector
Change-over selector is classified into reversing regulation and coarse & fine regulation.

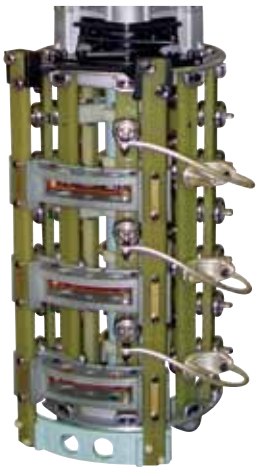


Fig.10 Tap selector (with change-over selector)

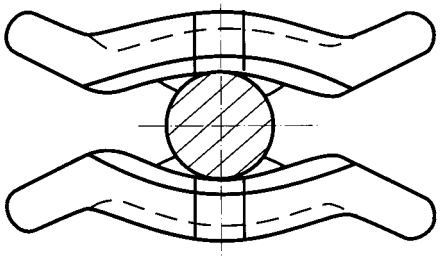


Fig.11 Touch of tap selector contact

3. Operating principle

On load tap changer employs resistor transition principle. It can change the taps of transformer tap winding under load, the switching operation of tap changer is realized in alternative combinations of two switching procedures, which means odd and even numbered moving contacts of tap selector select taps alternatively combining with switching of diverter switch, The sequence of tap change is shown in Fig.12 and 13. The bold line represents the path of the current.

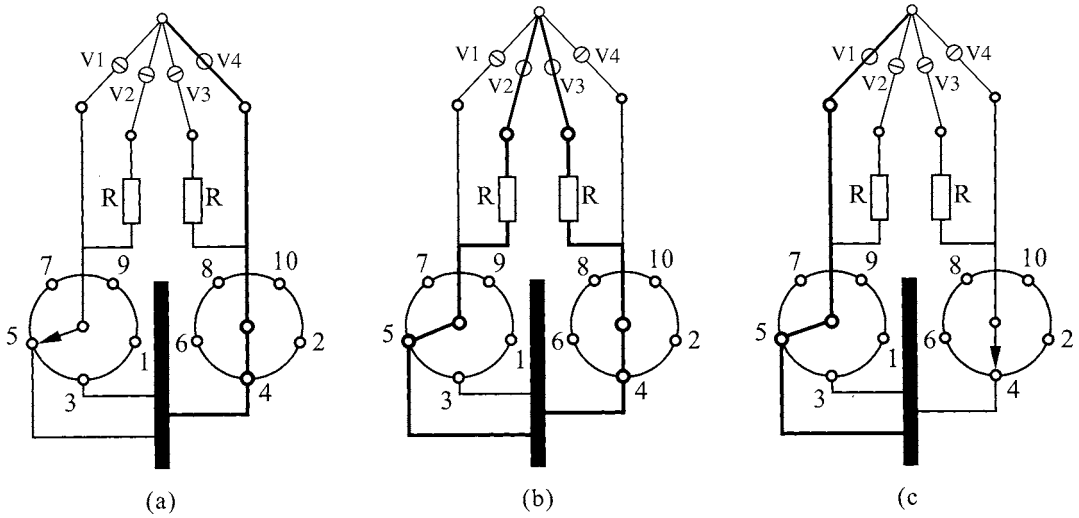


Fig.12 Switching sequence from tap position 4 → 5

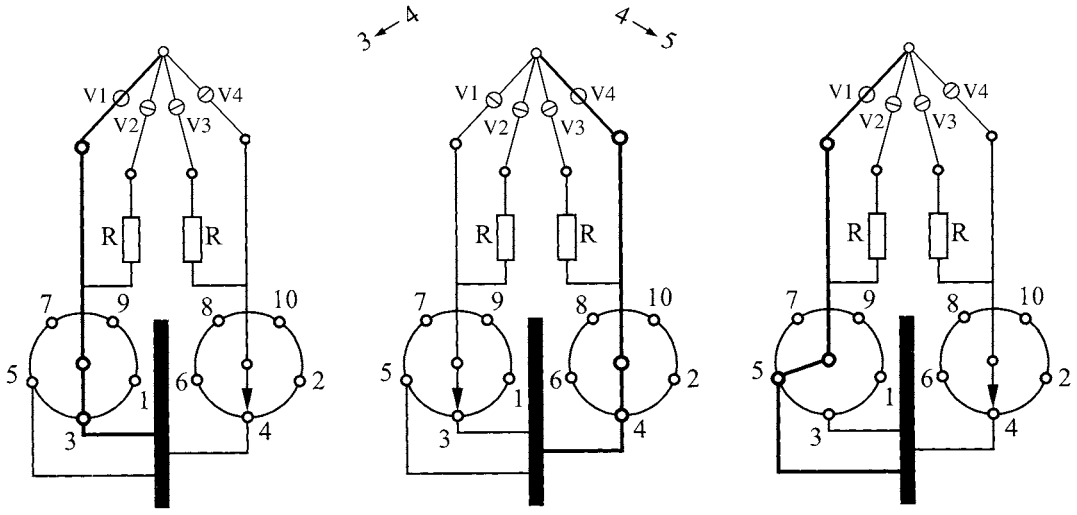


Fig.13 Switching sequence from tap position 4 → 3 or 4 → 5

3.1 Mechanical operation principle of the tap changer

Tap change operation begins with the electric motor of the motor drive unit. The driving force is transferred to the worm gear box on the top cover of the tap changer through driving shaft and belt pulley box,then the force is actuated to the energy accumulating mechanism and the shaft which passes through the diverter switch sown 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.

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 1-8.

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 2).

Stud bolts are 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 on standard-tank type transformer cover.

The detailed installation procedures are as followings:

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 before delivery.

4.1.3.5 Lift up the diverter switch and put it on the tap selector. Make sure 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 assembled tap changer and carefully insert it into the transformer through the mounting hole on the transformer tank cover. Make sure 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 changer 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.14)

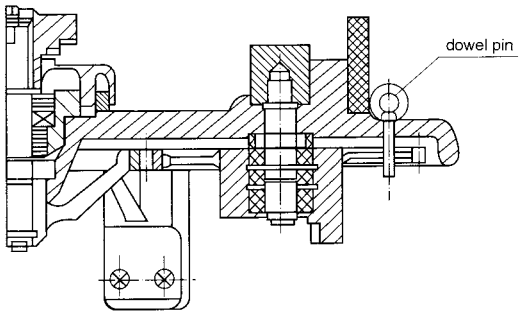


Fig.14 Diverter switch set positioning pin

4.1.4 Installation of OLTC on the bell-type transformer cover
The bell-type OLTC has been specially designed with a tap changer head which can be dismantled (see appendix 2). 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 is installed on that flange; the second is the head flange secured on the bell-type transformer 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 cover are as followings:

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

a. Remove the top cover of the tap changer. Take care the O-ring on cover.

b. Remove the position indicator,keep the spring washers for reassembling.

c. 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 insert, Pay close attention not to damage it. Keep the switch properly 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.

a. Remove the connecting screws between the diverter switch and the tap selector.

b. From the sliding connector of the stepped Geneva wheel mechanism of the tap selector remove the red painted dowel pin.

Do not move the connector's crank pin.

c. With the lifting plate (see Appendix 5) 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.

d. Tighten 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.

e. Fix the connecting leads with M10 hexagonal screw. Be sure to directly stick the leads level with contacts on insulation cylinder. Don't clip the screen cap between them (See Fig.15 and 16).

f. From the intermediate gear connector at the oil compartment bottom remove the red-painted dowel pin (see Fig.14).

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 followings:

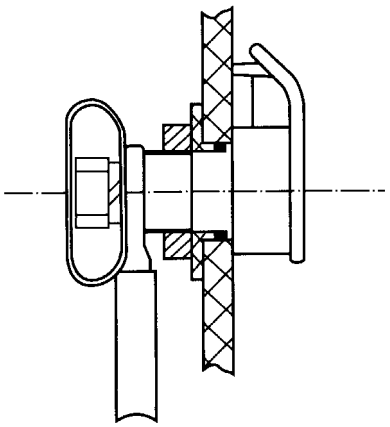


Fig.15 Sketch of connection between tap selector lead and diverter switch

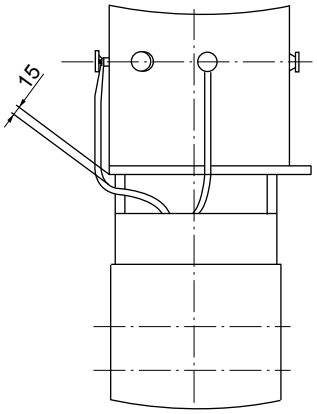


Fig.16 To ensure electrical insulation performance of switch, the distance between connecting lead and cylinder bottom metal parts must be over 15mm

a. Pre-matching of intermediate flange and head flange (alignment of " △ " on both flanges). For the installation and connection, 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 manufacturer, 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:

Pre-install OLTC tap changer head flange onto installation flange in transformer cover, 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 pinpointing the installation position of tap changer on supporting structure.

b. Adjust 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 clearance 5~20mm between intermediate flange and head flange (see Appendix 3).

When the pre-installation of tap changer on the supporting structure of transformer has been confirmed correct, connect the leads wire between tap changer and tap winding as per the section 5.2 of this manual.

After the tap leads wire has been connected, pre-install 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 be ensured that the position of two flanges are correct when assembling the tap changer transformer.

4.2 The connection of leads between tap winding and tap changer

4.2.1 Tap selector and connection leads

The tap windings should be connected according to the connection 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 terminal,the connectors of the tap winding can be installed directly on this bolt. Corona rings are employed and locked by M10 nuts.

After tightening the connecting bolts, turn up the washer of the screen cap for 90°, thus lock the nut from loosening.

The positive and negative (±) 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 should be paid to the leads connection between the tap selector and the tapped winding:

4.2.1.1 The terminal leads should not apply any force to the tap selector

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

b. The connecting leads between the end clamping of tap selector's terminal and the transformer lead should not be too short, and it should be flexible, it is suggested that leads not be coated with insulation paint so as to avoid the hardening of the coated paint after drying which makes the insulating bar to deform under force.

c. The end of the leads 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 leads of the tap selector should be led out from the exterior of the cage. Never allow the leads passing through the interior of the cage.

e. The terminal leads 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 leads 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 leads connection, Therefore, special care should be given to the degree of tightness of the connecting leads. 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 wired and after that the temporary pad will be removed. Check for the degree of tightness of the leads 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

4.2.2 The connecting leads of the tap changer

4.2.2.1 Three phase tap changer
For three phase 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 leads-out of the tap changer is connected to the conducting ring. On this ring, there are three ø12.5 through holes, screws passing through these holes and connect with the leads-out and are locked by the corona rings together with the M10 nuts. After tightening up the nuts, the lock washer of the corona rings will 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 gear box 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 change 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 by 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.

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

Preliminary drying:
Drying is carried out in circulating air, max. temperature is 110℃ , 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 the 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℃ , the duration of heating is 3-4 hours.

Drying:
Raise the temperature of kerosene vapor with a temperature of 10℃ /h. Max. temperature is 125℃ . 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 tap changer:
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. If any fastener is found loose, it must be retightened and locked against loose.

4.4.2.2 Oil filling
The head cover of the tap changer is again closed. Tighten the 24 bolts M10. Take care the correct position of the O-ring. Both the transformer and the 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, the 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 at 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 depends on the installation demand. Those pipes will rotate by loosing the clamping rings on them. So it is very easy to install the connection pipes.

4.5.1 Pipe connection for protective relay

Protective relay can be installed on the pipe connection between the head of the tap changer and the oil conservator, and should be as close as possible to the head of the tap changer. Normally it is connected directly to the flange of the elbow pipe R. The arrow mark should point to oil conservator.

4.5.2 Oil suction pipe connection

The tap changer is equipped with an oil suction connection pipe. It is used to suck 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 the pipe is also connected with the lower end filled with an oil drain valve so that 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 the same as that of the tap changer.

4.6.2 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

4.7.1 The overall and mounting dimension of bevel gear box, see Appendix 3.
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 gear box on the tap changer head, swivel the gear box 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 gear of the tap changer and the bevel gear. 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 gear 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 required 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 upon request.

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 run 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 as in both directions of rotation.

Generally, the verification of the connection of the tap changer to the motor drive unit has been done in the factory. 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 procedures:

4.8.1 Rotate the handle in 1 → N 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 N → 1 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≠K and m-K>1, then the difference of turns shall be compensated.

Loose 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. See Fig.17.

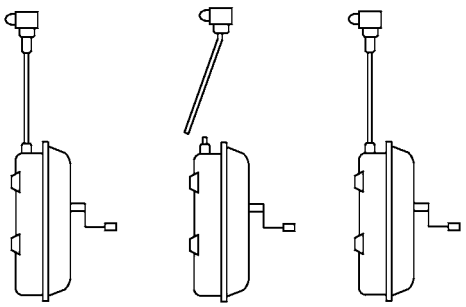


Fig.17

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 CM2 tap changer and Type SHM-III 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.

Loose the connection between the vertical driving shaft and the motor drive unit. Turn the handle in the direction 10 → 11 for one turn. Then connect them again.

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

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

b. Make 1/2(m-k) turns in the direction of increment of turns when loose the connection.

c. Connect again and verify until m=k.

4.9 Operation test of the tap changer

4.9.1 Mechanical operation test

Before voltage is applied to the transformer, 5 complete cycles of mechanical operation test (no less than 200 operations) must be performed. There should be no damage to the tap changer and motor drive unit. The position indications of the tap changer, the motor drive unit and the remote tap position indicators 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 operation test of the tap changer. Before oil filling, loose the bleeding screw on the suction pipe and the top cover of the tap changer.

Use a spanner to pry up vent oil overflowing on the top cover of the tap changer. (See Fig.18)

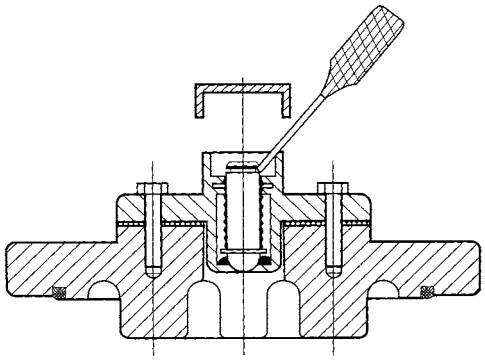


Fig.18 Schematic diagram of exhaust on top cover when filling tap changer with oil

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 drive unit shell should be connected to the cover of transformer tank.

Grounding screws for protective relay shall be connected to the transformer cover.

4.9.4 Transformer electrical test

After completing 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 setting position before 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 the safety of transportation (for example, to provide the temporary supporting). If the tap changer is immersed type, it is not necessary to remove it for transportation. If there is trouble which requires to dismantle the motor drive unit, it 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 re-installed according to above mentioned.

If the transformer is transported or stored without the conservator, then the bypass pipe (see Appendix 9) 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 Appendix1), 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 be 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 onsite and before putting it into operation.

4.11 Operation on-site

When the transformer is installed on site, the installed position of the tap changer and the tightness of the connecting leads 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 4.9, and in the same time, check the proper function of the protective relay.

The protective relay should be connected to the tripping circuit of the circuit breaker, in case the relay trips, it will instantly cut off the transformer circuit.

“Transformer Off” test button on the top of gas relay can be used to test the function of the 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 on the tap changer top cover will expel a slight amount of oil. When the tap changer is in good conditions, then it can be put into operation.

5. Operation supervision

Please pay particular attentions as below:
Tap changer head cover, protective relay and motor drive unit should take a frequent supervision.
Check if any leakage happen on tap changer head cover, protective relay and all pipe connections, as well as the case of motor drive unit; check if all electrical parts in motor drive unit are all in good conditions.

If Bucholz relay is activated, should take a thorough inspection on transformer and OLTC, in this case, the diverter switch need to be lifted out.

Before putting into operation again, check if transformer or OLTC has any defect. No operation is allowed before checking the transformer.

If any severe failure occurs on OLTC and motor drive unit, and it is not easy to fix at-site, or protective relay activates, please contact our service team.
We recommend periodic inspection for OLTC to keep a reliable performance.

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 (QJ series)

6.2.4 Driving shaft and bevel 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℃ and +40℃ . There should be no corrosive gas.

Note: The six leads on the tap selector may be loose due to transportation, therefore, when the leads connected to the diverter switch, tighten it if it is loose.

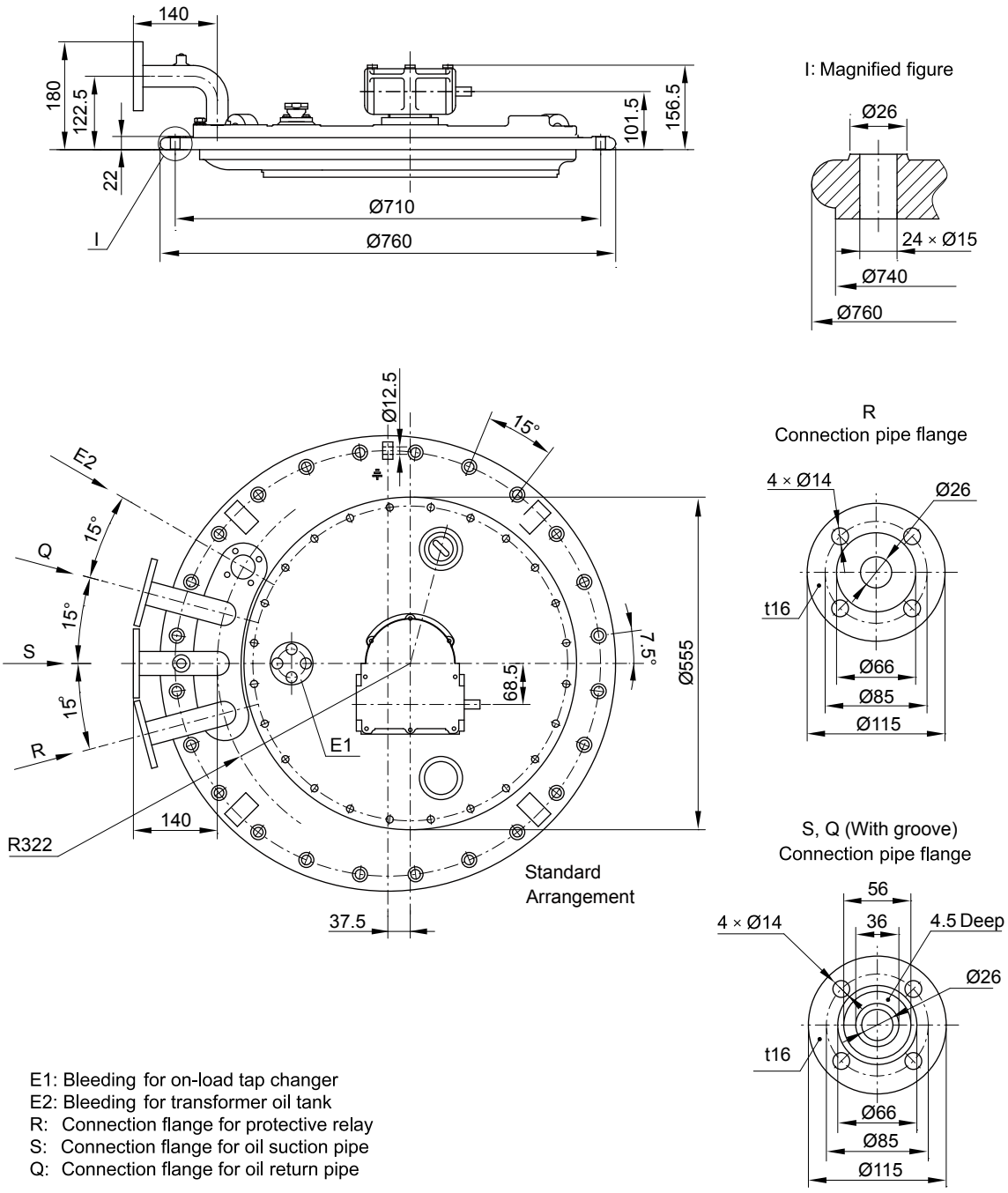
7. Maintenance and repair

Maintenance period:

It is free maintenance for 300,000 operations.

8. Appendix

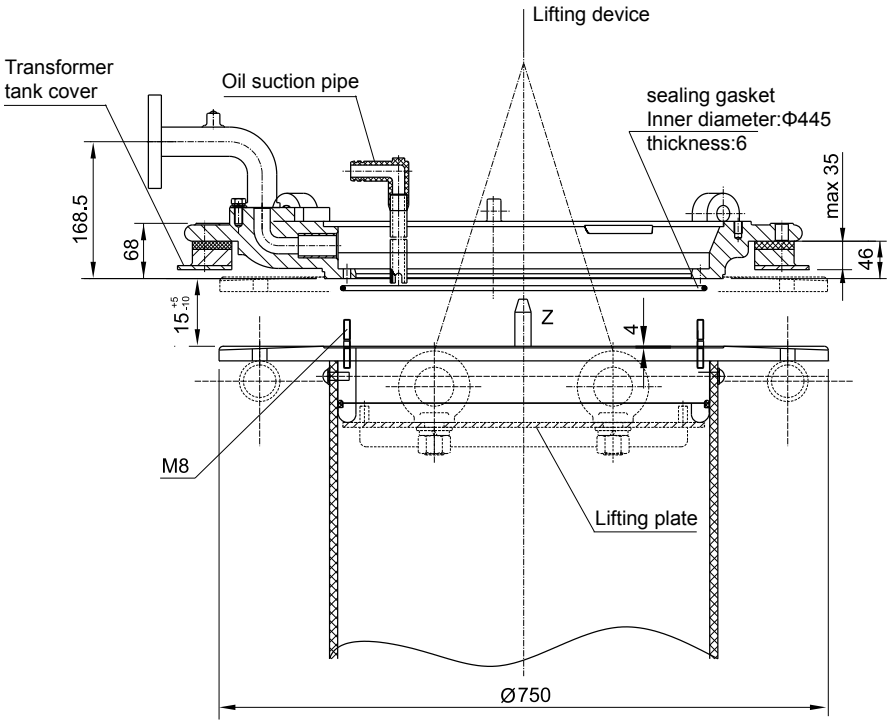
Appendix 1 CM2 OLTC head flange, overall dimensions

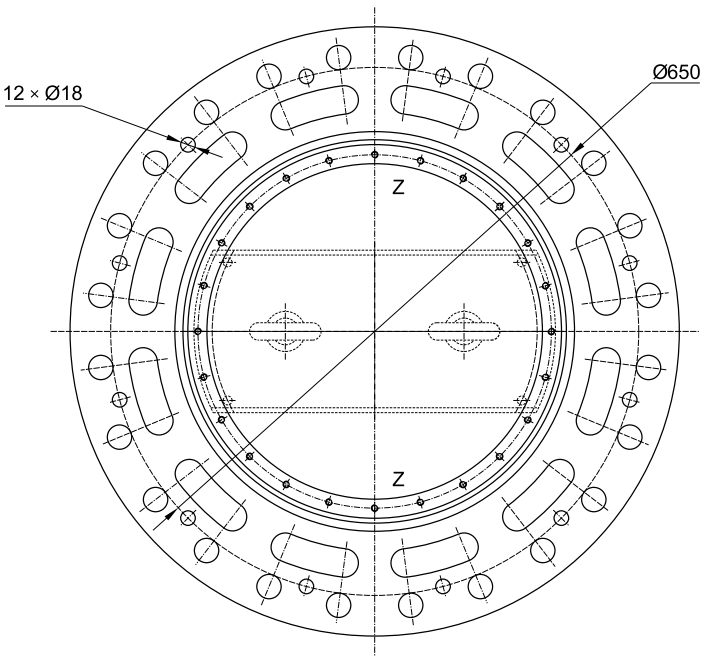


E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

Unit:mm

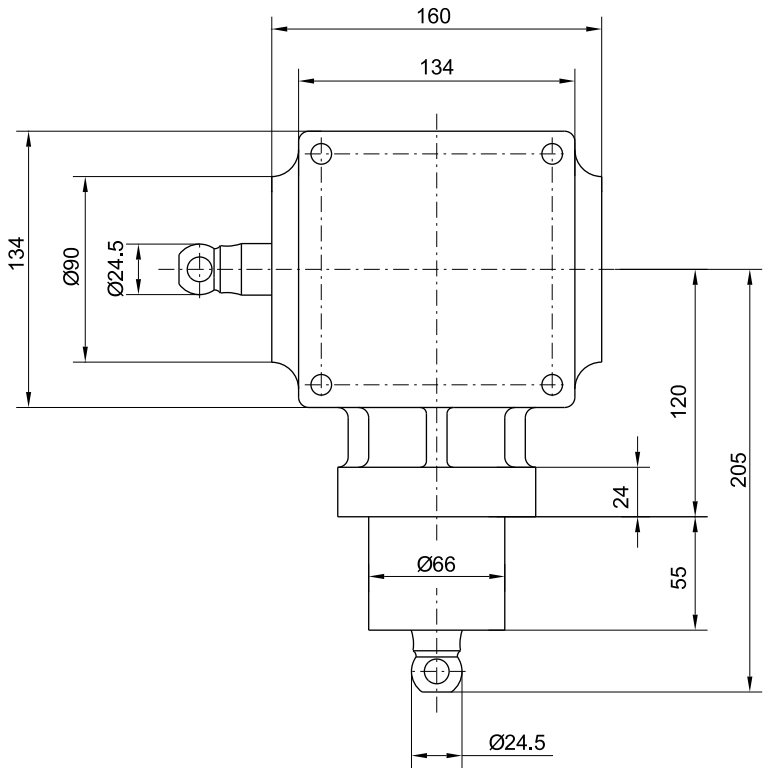
Appendix 2 CM2 OLTC head flange installation for bell-type, overall dimensions

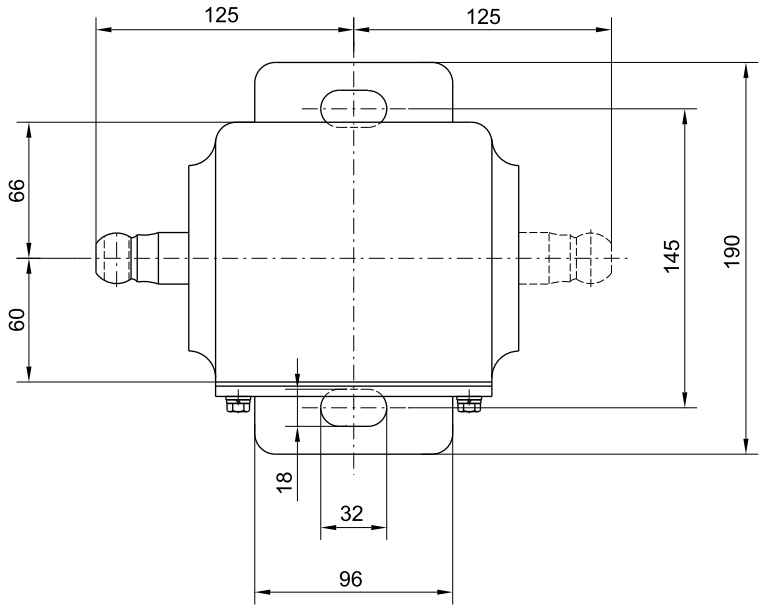




Unit:mm

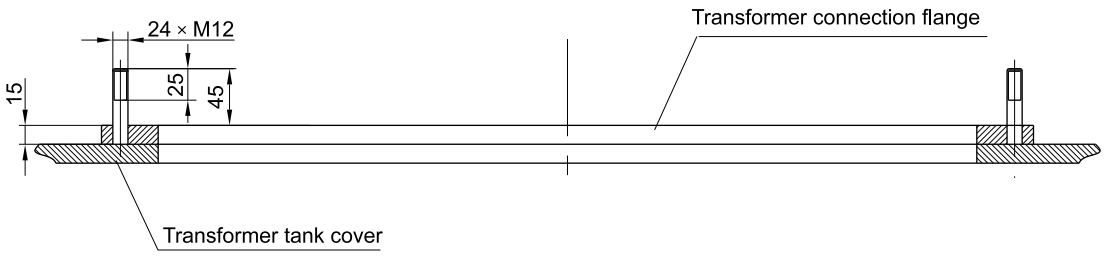
Appendix 3 The overall dimension of bevel gear

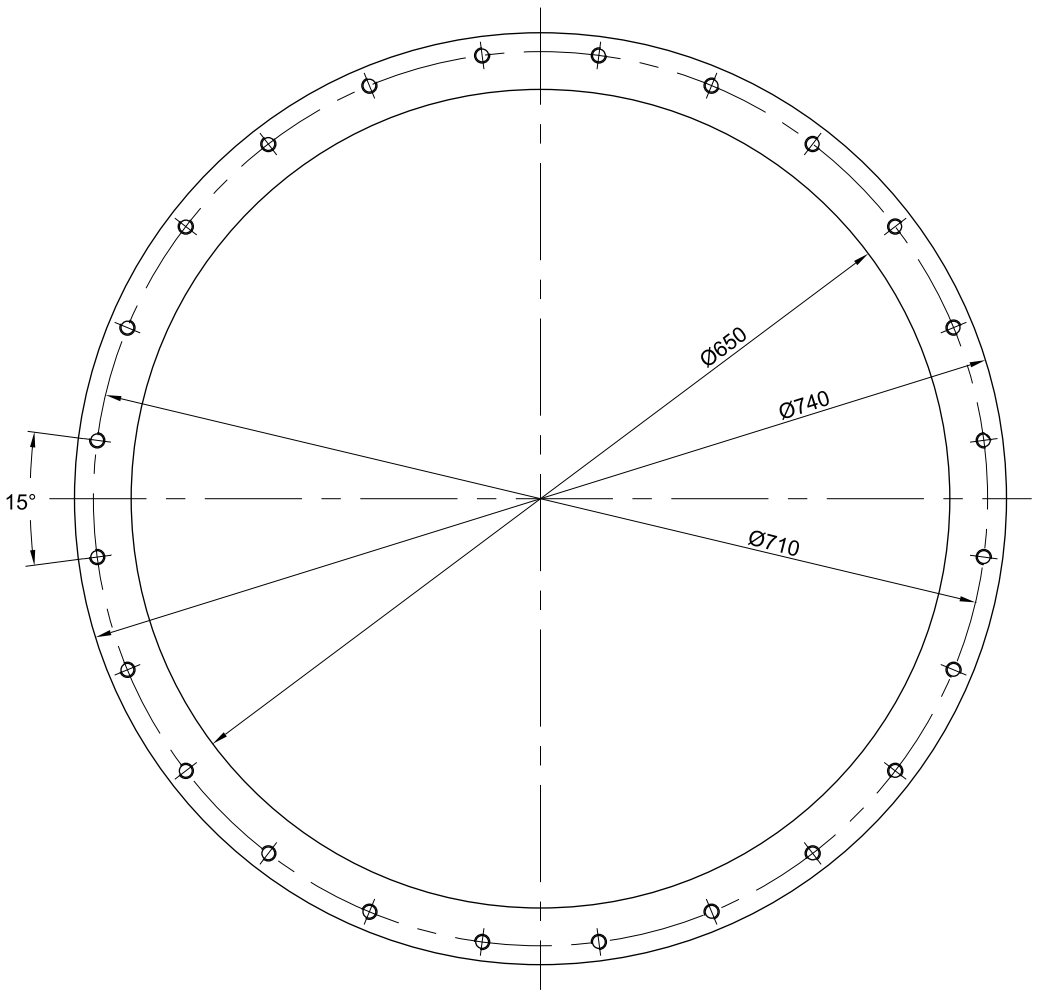




Unit:mm

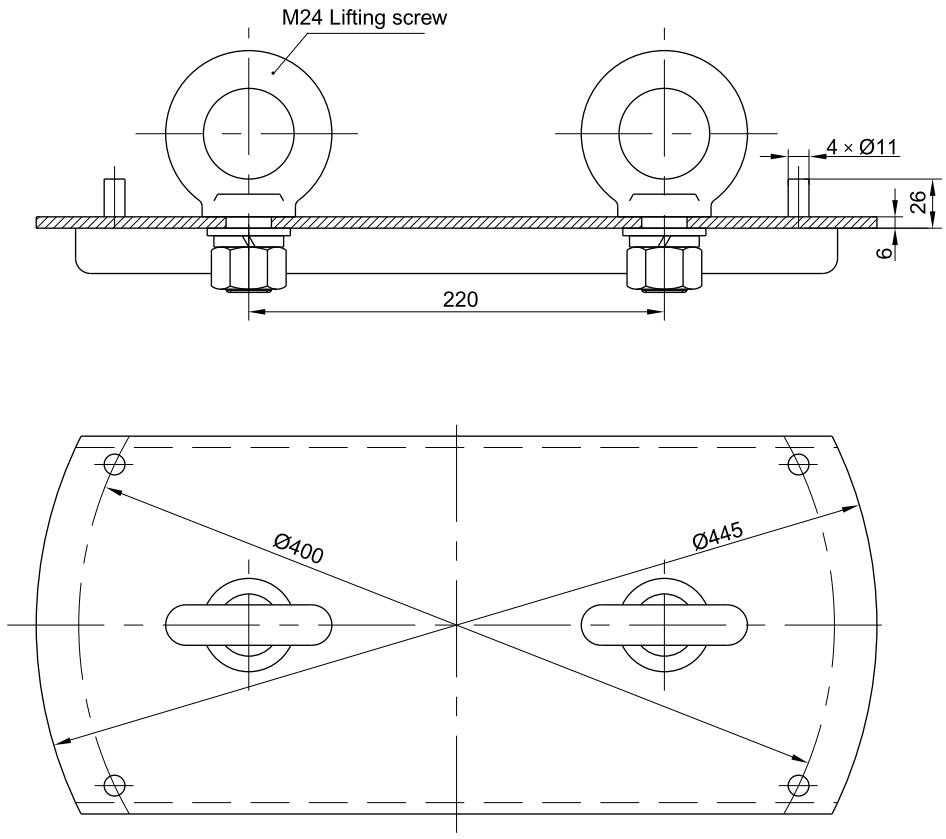
Appendix 4 Transformer connection flange for CM2 OLTC, overall dimensions





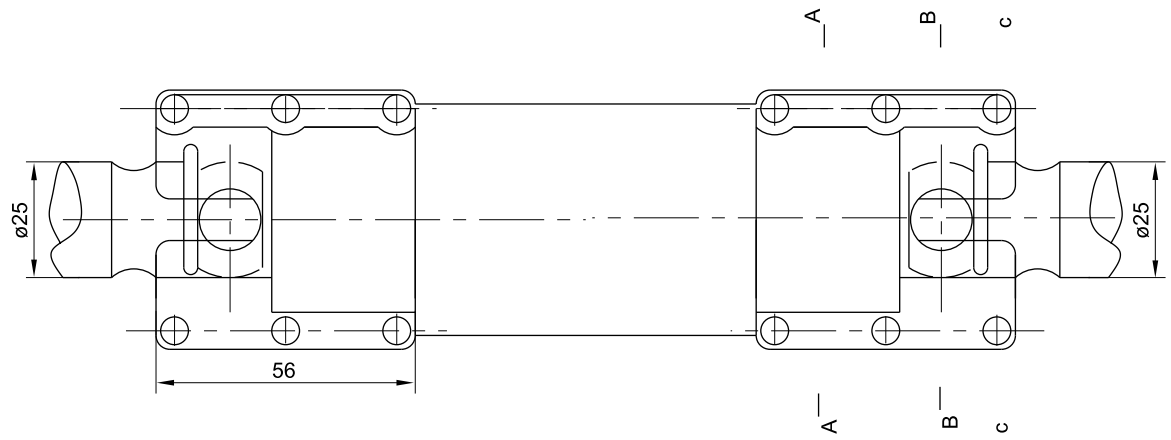
Unit:mm

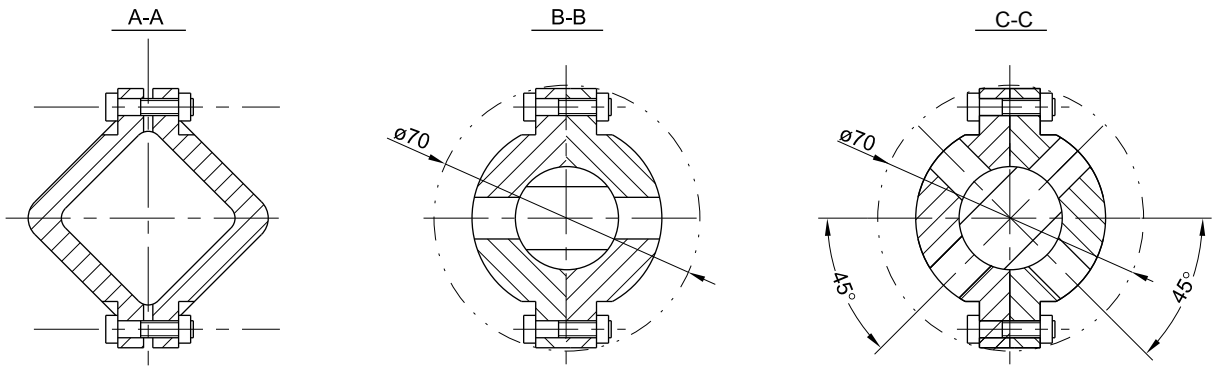
Appendix 5 Dimension of lifting plate for bell type



Unit:mm

Appendix 6 Sketch of installation of driving shafts



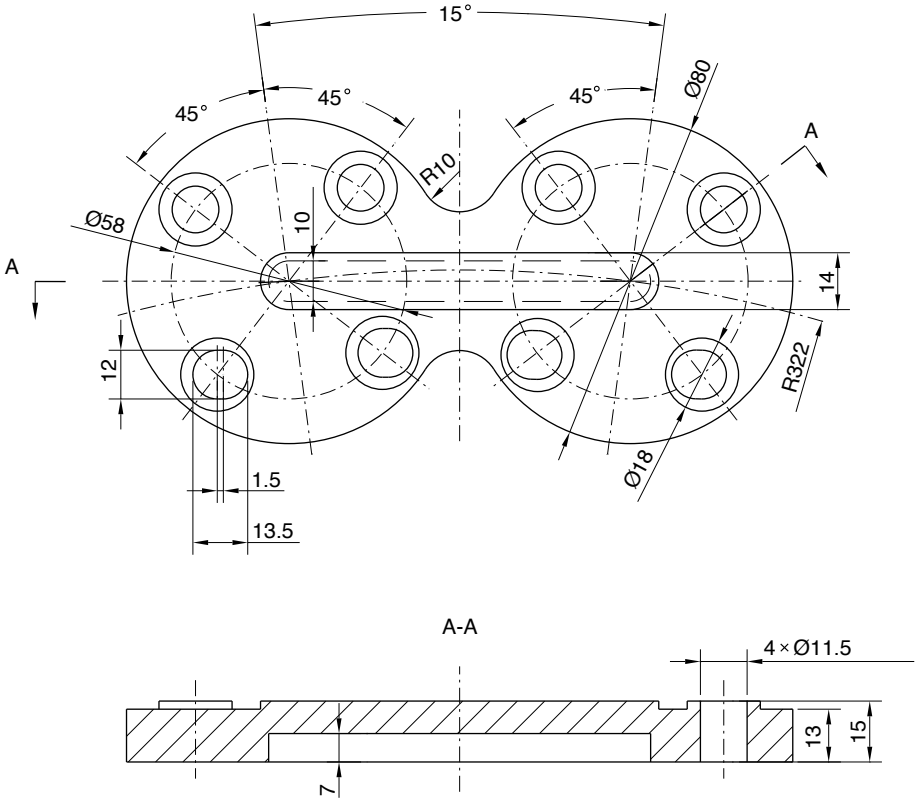


Single unit CM2

Three units gang-operated CM2

Unit:mm

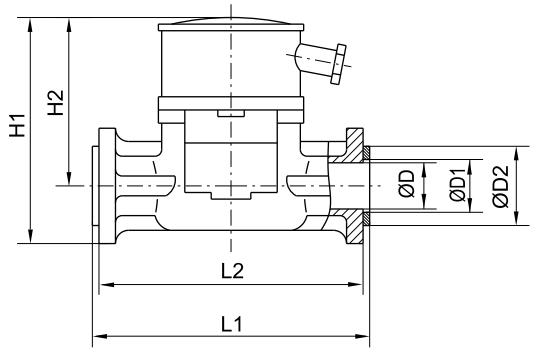
Appendix 7 Structure drawing of by-pass pipe

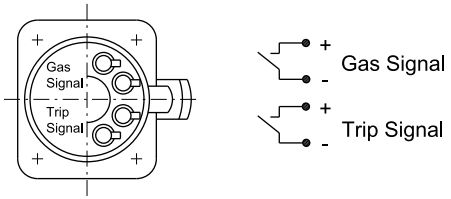


Unit:mm

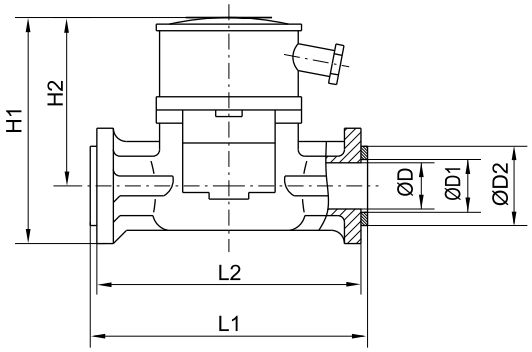
Appendix 8 Overall dimension of protective relay

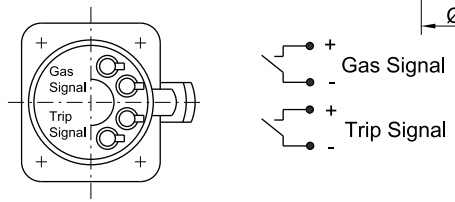
Type QJ4-25A protective relay

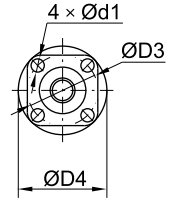




Type QJ4-25 protective relay







Model	D	D1	D2	D3	D4	d1	H1	H2	L1	L2	Note
QJ4-25A	25	35	65	85	115	14	215	153	208	200	1 pair of gas signal and 1 pair of trip signal, gas release device connected to man position
QJ4-25	25	35	65	85	115	14	215	153	208	200	1 pair of gas signal and 1 pair of trip signal

Unit:mm

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