TECHNICAL DATA

TYPE CV2 VACUUM ON-LOAD TAP CHANGER

FOR OIL-IMMERSED TRANSFORMER

HM0.154.4101

SHANGHAI HUAMING POWER EQUIPMENT CO., LTD.

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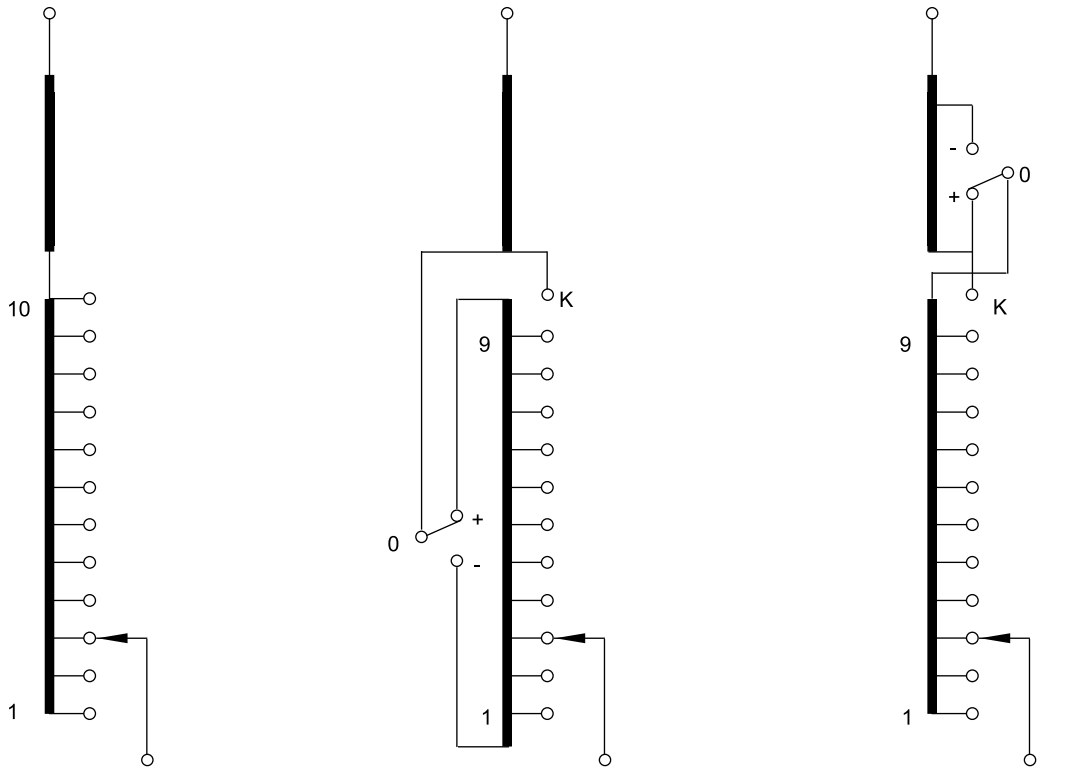
1. General

Type CV2 vacuum on-load tap changer (herein referred as tap changer) is of compound structure, applicable to oil-immersed power transformers with highest equipment voltage from 40.5 to 145kV, maximum through-current up to 500A and frequency of 50Hz ~ 60Hz. It is used to change the transformer winding taps on load.

Tap changer is to be mounted on transformer tank top by means of a top flange.

Tap changer is operated by a motor drive unit. Tap changer and motor drive unit are connected by a top gearbox, driving shaft and a bevel gear box. Tap changer provides both local and remote operation modes.

Tap changer connection includes neutral point connection for three-phase, delta connection for three-phase and any connection for single phase. Its basic connection diagram is shown in Fig. 1 below:



a) Linear regulation b) Reversing regulation c) Coarse/fine regulation

Fig.1 Basic Connection Diagram of Tap Winding

2. Technical specifications

Type CV2 on-load tap changer complies with IEC 60214-1:2003 standard. Tap changer technical data is listed in Table 1 below.

Table 1 Type CV2 Series of On-Load Tap Changer Technical Data

1	Max. rated through current(A)		250			350			500			
2	No. of phases		1	3	3	1	3	3	1	3	3	
3	Connection method		-	Y	D	-	Y	D	-	Y	D	
4	Max. rated step voltage	10 &12 contacts	2000			2000~1500*			1500~1000*			
5	Rated step capacity (kVA)	10 &12 contacts	500			525			525			
6	Short-circuit current test (kA)	Thermal (3s)	4.5			4.5			7.5			
		Dynamic (Peak)	11.25			11.25			18.75			
7	Max. operating positions		12 for linear			12 for linear			10 for linear			
			23 for reversing or coarse/fine			23 for reversing or coarse/fine			19 for reversing or coarse/fine			
8	Insulation to ground (kV)	Highest voltage for equipment Um	40.5			72.5		126	145			
		Rated separate source AC withstand voltage(kV/50Hz,1min)	85			140		230	275			
		Rated lightning impulse withstand voltage (kV,1.2/50μs)	225			325		550	650			
9	Internal Insulation Level		Refer to section 4.6									
10	Mechanical Life		1,500,000 operations									
11	Electrical Life		600,000 operations									
12	Oil compartment	Service pressure	0.03MPa									
		Leakage test	No leakage under 0.08 MPa for 24 hours									
		Over pressure protection	Rupture disc bursts at 300±20% KPa									
		Protective relay	QJ4-25, Set oil flow speed at 1.0m/s ±10%									
13	Equipped with motor drive unit		SHM-III or CMA7									
14	Tap changer model		CV2 III -250	CV2 I -250		CV2 III-350		CV2 I-350	CV2 III-500		CV2 I-500	
	Net weight (kg) without oil		120	90		140		100	160		140	
15	Oil filling volume (dm^3)		170	130		185		140	200		180	

*** Please refer to Fig.5 on page 6**

3. Type designation

3.1. Type designation

Due to the different combinations of no. of phases, maximum rated through current, highest equipment voltage and connections, type CV2 comes with various models. Hence, the type designation shall provide all the above technical parameter and below is its detailed explanation.

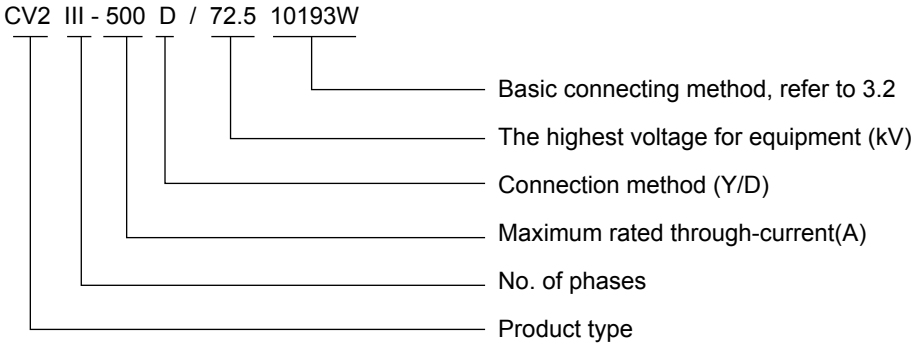


Fig. 2 Tap Changer Model Explanation

3.2. Selector switch basic connection method

Because of voltage regulation range difference and winding connection variations, selector switch has a number of different specifications. Selector switch specification is decided by no. of inherent contacts, no. of operating positions, no. of mid positions and type of change-over selector. Please refer to Fig. 3 for indications of different selector switch parameters.

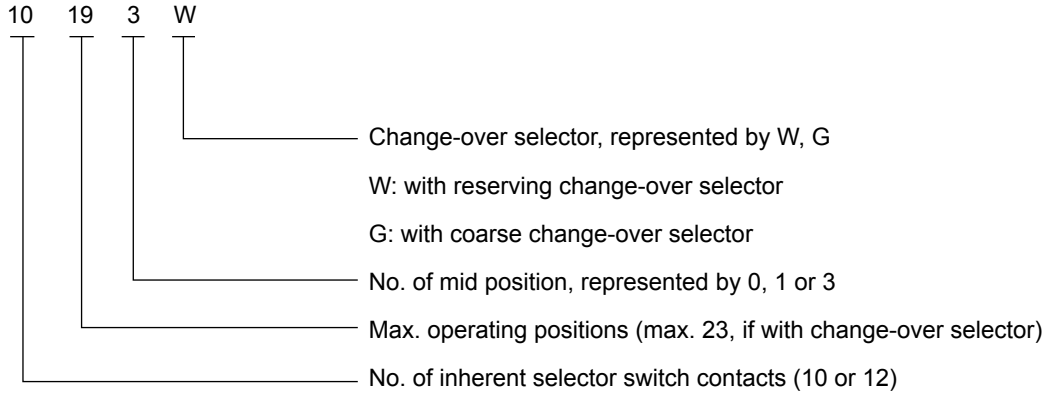


Fig. 3. Selector Switch Basic Connection Method Explanation

3.3. Selector switch basic connection diagram

Different transformer tapping corresponds to different selector switch basic connection diagrams. Fig. 4 shows common basic connection diagrams. Special requirement can also be specially designed.

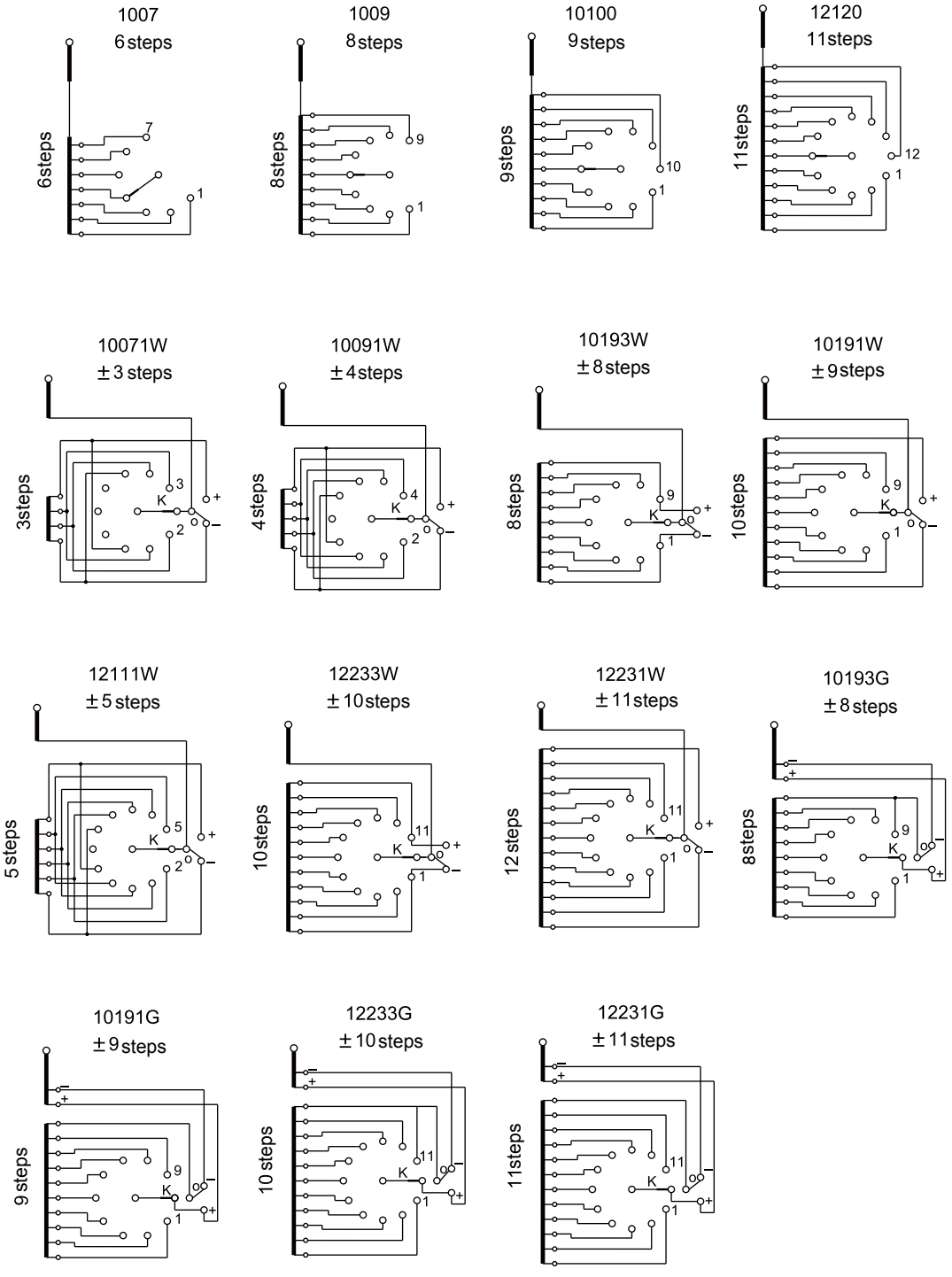


Fig. 4 CV2 OLTC Basic Connection Diagrams

4. Terms and definitions

4.1. Rated through-current (I_u), rated step voltage (U_i) and step capacity (P_{StN})

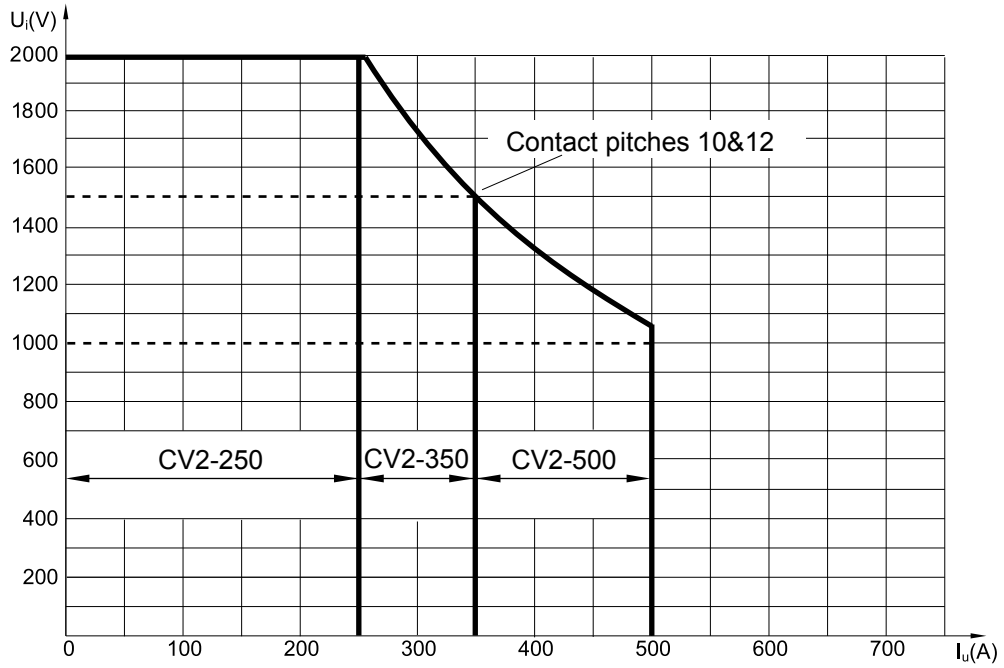


Fig. 5 Rated Switching Capacity of Three-phase CV2 OLTC

According to the above figure, the permissible max. rated through-current and related step voltage can be found for different tap changer ratings. The step voltage is limited by load current and step switching capacity.

4.2. Breaking capacity

Breaking capacity PStmax is the maximum switching capacity under safe switching load. According to stipulations of IEC60214-1:2003, breaking capacity shall be at least two times of rated switching capacity PStn, that is to break two times of maximum rated through-current (I_{um}) at related rated step voltage (U_i).

4.3. Short-circuit current test

According to IEC 60214-1: 2003, all contacts continuously carrying the current shall be able to withstand 2s (±10%) short circuit test current without melting, deformation or mechanical damage. Meanwhile the starting peak current value shall be 2.5 (±5%) times of the root means square value of rated short circuit test current. Refer the short circuit test current values to Table 1 Type CV2 Series of On-Load Tap Changer Technical Data.

4.4. Service condition of tap changer

4.4.1. 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.

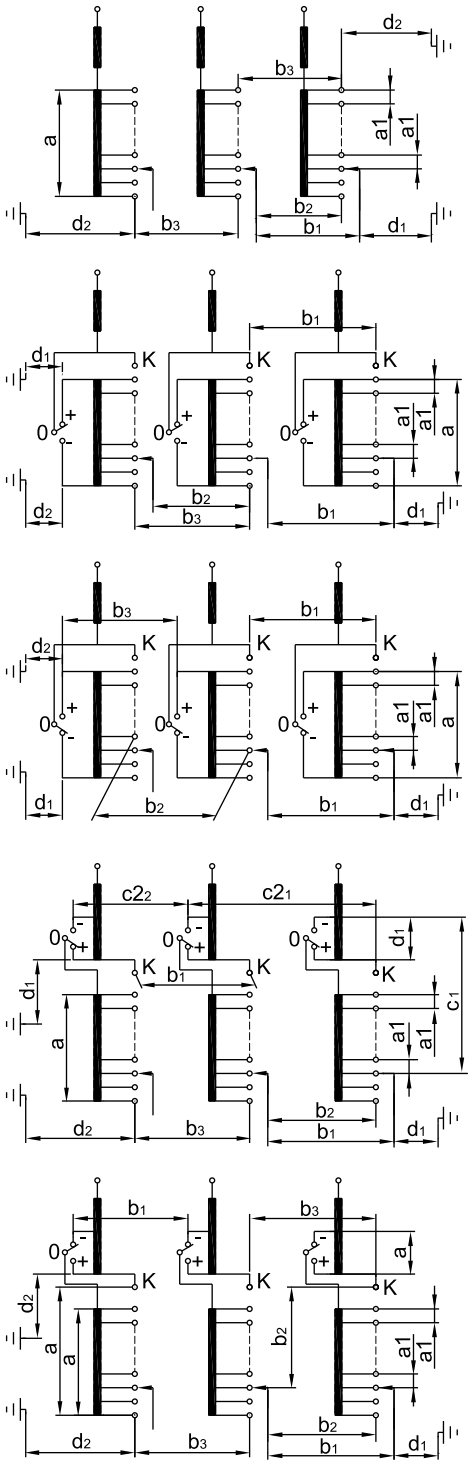
4.4.2. To meet the ordering requirements and comply with the operating environment, if the requested service temperature is out of the range of -25℃ to 40℃ , the material and accessories of the OLTC will be specially designed and selected.

4.4.3. Perpendicular deflection between ground and tap changer after being mounting on transformer shall be less than 2%.

4.4.4. There shall be no serious dust, explosive gas or corrosive gas on service site

Remark: Please contact us if special application required.

4.5. Voltage gradient of selector switch part



a1: Between any service contact and pre-service contact of the selector switch

a: between start and end of a fine tap winding; also between start and end of coarse tap winding. Note: when the tap is on the coarse/fine change-over selector: For impulse voltage, insulation between end of coarse tap winding which is connected to K contact of selector switch and end of fine tap winding of the same phase shall comply the permissible value of (a).

b: between any tapping of different fine tap windings, or between ends of different coarse windings. This distance is between the start (or end) contacts of tap winding or between the contacts of selector switch. For delta connection, the permissible voltage between contact s changes with the location of change-over selector and selector switch, therefore this insulation must company with different values of b1, b2, b3.
b1: Between selected contacts of different phases
b2: Between selected contact of one phase and unselected contact of another phase
b3: Between unselected contacts of different phases

d: Selector switch contact or change-over selector (+) contact to earth. For delta connection, two values are adopted d1: When on the (+) position of change-over selector, between terminal and earth, or between change-over (+) contact and earth
d2: When on the (-) position of the change-over selector, between unselected contacts of selector switch, or between (+) contact and earth.

c1: Between one (-) contact of change-over selector and terminal of same phase.
c2: Between (-) contacts of different phases, or between one (-) contact of change-over selector and one (+) contact of change-over selector of another phase. For delta connection, different values are adopted as below.
$c2_1$: Between one (-) contact of change-over selector and one (+) contact of change-over selector of another phase.
$c2_2$: Between (-) contacts of different phases.

Fig. 6 Voltage Gradient of the Tap Changer.

4.6. Internal insulation level of tap changer

Tap changer internal insulation level (Table 2) relates to basic regulation method (Fig. 6). It must be checked when selecting the tap changer to ensure the internal insulation of tap changer meets the insulation requirement.

Table 2 Tap Changer Internal Insulation Level

		Imposed voltage and duration	CV2 III -D			CV2 III -Y	
a	10 contact pitch	kV 1.2/50 μs	200			200	
		kV 50Hz 1min	50			50	
	12 contact pitch	kV 1.2/50 μs	180			180	
		kV 50Hz 1min	50			50	
a1	10 contact pitch	kV 1.2/50 μs	200			200	
		kV 50Hz 1min	50			50	
	12 contact pitch	kV 1.2/50 μs	180			180	
		kV 50Hz 1min	50			50	
b			b1	b2	b3		
	Um=40.5kV	kV 1.2/50 μs	200	250	300	200	
		kV 50Hz 1min	70	80	90	50	
	Um=72.5kV	kV 1.2/50 μs	350	490	520	200	
		kV 50Hz 1min	140	165	180	60	
	Um=126kV	kV 1.2/50 μs	550	570	600	200	
		kV 50Hz 1min	230	240	250	85	
	Um=145kV	kV 1.2/50 μs	650	730	800	200	
		kV 50Hz 1min	275	285	300	85	
c2			$C2_1$	$C2_2$			
	Um=40.5kV	kV 1.2/50 μs	250	300		200	
		kV 50Hz 1min	80	90		50	
	Um=72.5kV	kV 1.2/50 μs	490	520		200	
		kV 50Hz 1min	165	180		60	
	Um=126kV	kV 1.2/50 μs	570	600		200	
		kV 50Hz 1min	240	250		85	
	Um=145kV	kV 1.2/50 μs	730	800		200	
		kV 50Hz 1min	285	300		85	
d			d_1	d_2		d_1	d_2
	Um=40.5kV	kV 1.2/50 μs	200	350		200	300
		kV 50Hz 1min	70	90		70	90
	Um=72.5kV	kV 1.2/50 μs	350	490		350	490
		kV 50Hz 1min	140	165		140	165
	Um=126kV	kV 1.2/50 μs	550	570		550	570
		kV 50Hz 1min	230	240		230	240
	Um=145kV	kV 1.2/50 μs	650	730		650	730
		kV 50Hz 1min	275	285		275	285
c1	Um=40.5kV	kV 1.2/50 μs	400			400	
		kV 50Hz 1min	100			100	
	Um=72.5kV	kV 1.2/50 μs	400			400	
		kV 50Hz 1min	100			100	
	Um=126kV	kV 1.2/50 μs	400			400	
		kV 50Hz 1min	100			100	
	Um=145kV	kV 1.2/50 μs	400			400	
		kV 50Hz 1min	100			100	

4.7. Tap changer insulation level to earth

Tap changer insulation level to earth is the insulation between tap changer potential part and grounding part. It is determined by dielectric tests according to IEC-60214-1-2003. The demand of which correlates to the transformer tap winding location, regulation range & regulation method, winding connection & arrangement and rated voltage of transformer winding. It is decided by the insulation to earth of transformer tap winding.

Table 3 OLTC Insulation Level To Earth (unit: kV)

Highest voltage for equipment Um	Rated separate source AC withstand voltage (kV/50Hz, 1min)	Rated lightning impulse withstand voltage (kV, 1.2/50μs)
40.5	85	225
72.5	140	325
126	230	550
145	275	650

4.8. Tap changer mounting method

Type CV2 tap changer is mounted to transformer tank top by a head flange. Hence, transformer shall provide a mounting flange, the dimension of which shall refer to the drawing of Appendix 5. For bell type transformer, the supporting flange of the tap changer is only for temporary support during the transformer conductor connection. After putting the bell tank, tap changer shall be fixed to the mounting flange of the transformer.

5. Special design

Potential connection of the tap winding

For transformers with high voltage rating and big regulation range, during the operation of the change over selector, the tap winding is disconnected momentarily from the main winding and in a so-called "suspension" status. At that moment, the tap winding takes a new potential which is determined together by the coupling capacitance to ground Ce and coupling capacitance to the adjacent winding Cw. (refer details to Fig.8). Usually this potential is different from the previous potential of the tap winding before the operation. The difference between the two is called bias voltage. This bias voltage turns out to be the recovery voltage on the gap of the change-over selector. When the bias voltage exceeds a certain critical value, the change-over selector would discharge electricity and produce considerable amount of gas. This could be a serious problem. Therefore, potential connection of the tap winding must be considered when this bias voltage exceeds certain value (for type CV2 OLTC, it is 15kV), in order to avoid the discharge during the operation of the change-over selector.

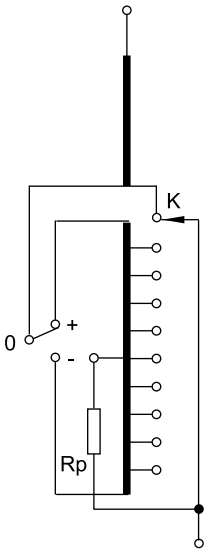


Fig. 7 Permanent Connection of the Tie-in Resistor Rp

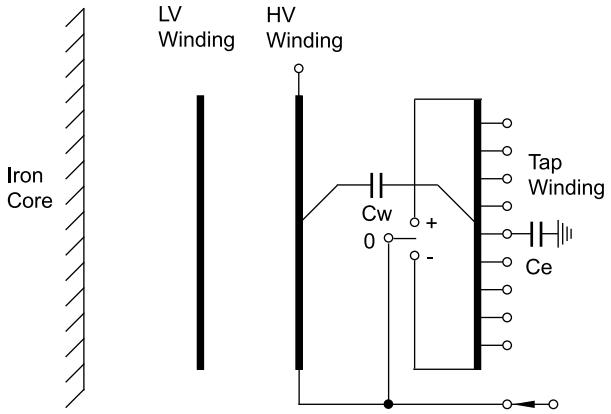


Fig. 8 Winding Arrangement of Reversing Regulation of Double Winding Transformer

For the convenience of Huaming to define the load of the change-over selector and size & quantity of the tie-in resistor, please provide the following transformer data when selecting tap changer:

a) All transformer performance data: rated capacity, rated voltage, regulation range, connection of winding and insulation level, etc.;

b) Relative arrangement of winding: relative location between tap winding and adjacent winding or winding part;

c) Operating A.C.voltage across windings or layers of windings adjacent to the tap windings

d) Capacitance between tap winding and part of adjacent winding(Cw)

e) Capacitance of the tap winding to ground or grounded adjacent windings (if exist) (Ce)

f) Voltage stress across half the tap winding at lightning impulse voltage test

g) A.C. voltage across half the tap winding under operation and test conditions.(is normally derived from order specification sheet for tap changer)

6. Motor drive unit

Type CV2 tap changer is driven by motor drive unit either SHM-III or CMA7. Its technical data is shown below in Table 4.

Table 4 Motor Drive Unit Technical Data

Motor drive unit		SHM-III		CMA7	
Motor	Rated power (W)	750	1100	750	1100
	Rated voltage (V)	380,3AC/N		380/3AC	
	Rated current (A)	2.1	2.8	2.0	2.8
	Rate frequency(Hz)	50 or 60		50 or 60	
	Rotate speed (r.p.m.)	1400		1400	
Rated torque on drive shaft (Nm)		45	66	18	26
Revolution of the drive shaft per switching operation		33		33	
Revolution of the hand crank per switching operation		33		33	
Running time per switching operation (S)		5.6		About 5	
Max. operation positions		35		107	
Voltage for control circuit and heater circuit (V)		220/AC		220/AC	
Heater power (W)		50		50	
A.C. voltage test to ground (kV/50Hz, 1min)		2		2	
Approx. weight (kg)		73		90	
Protective degree		IP66		IP56	
Mechanical endurance (operations)		Not less than 2,000,000		Not less than 800,000	

Note: Please specify if special voltage required for motor, and control & heater circuit.

7. Operation controllers

7.1 HMK8 controller

HMK8 controller is the device for remote control of SHM-III motor drive unit; it realizes OLTC switching operation through SHM-III. HMK8 can display the OLTC switching operation status and tap positions.

HMK8 has BCD code position signal output (contact capacity:AC250V/5A or DC30V/5A) and remote control signal input (non potential contact), it can also communicate with host computer via RS485 interface to realize remote supervising of OLTC position.

HMK8 main technical data is as below, refer to HMK8 manual for more details.
Working voltage: 380V, 3AC/N
Power frequency: 50Hz/60Hz
Maximum operation positions: 35
Environment temperature: -10℃ to 40℃ Indoor

7.2 HMC-3C position indicator

HMC-3C OLTC position indicator is a support fitting for CMA7 and CMA9 motor drive unit, it can be used to indicate the OLTC position, and has the function of "1→ N", "STOP", "N→ 1" control as well as remote control indicator lamp, its input is decimal code and output is BCD code.

Working voltage: 220V AC

Power frequency: 50Hz

Maximum operation positions: 107

Environment temperature: -10℃ to 40℃ Indoor

7.3 Automatic voltage regulator ET-SZ6 and HMK-2A

Automatic voltage regulator ET-SZ6 and HMK-2A is adopted for OLTC automatic voltage regulation, ET-SZ6 can be used for parallel operation in model of master and slave, please refer to relevant manual for details.

8. Accessories

8.1. Bevel gearbox

Bevel gearbox is used for the inter-connection of tap changer horizontal shaft and motor drive vertical shaft, in order to transfer the motor drive driving torque to the tap changer. Its overall dimension is shown in Appendix 15.

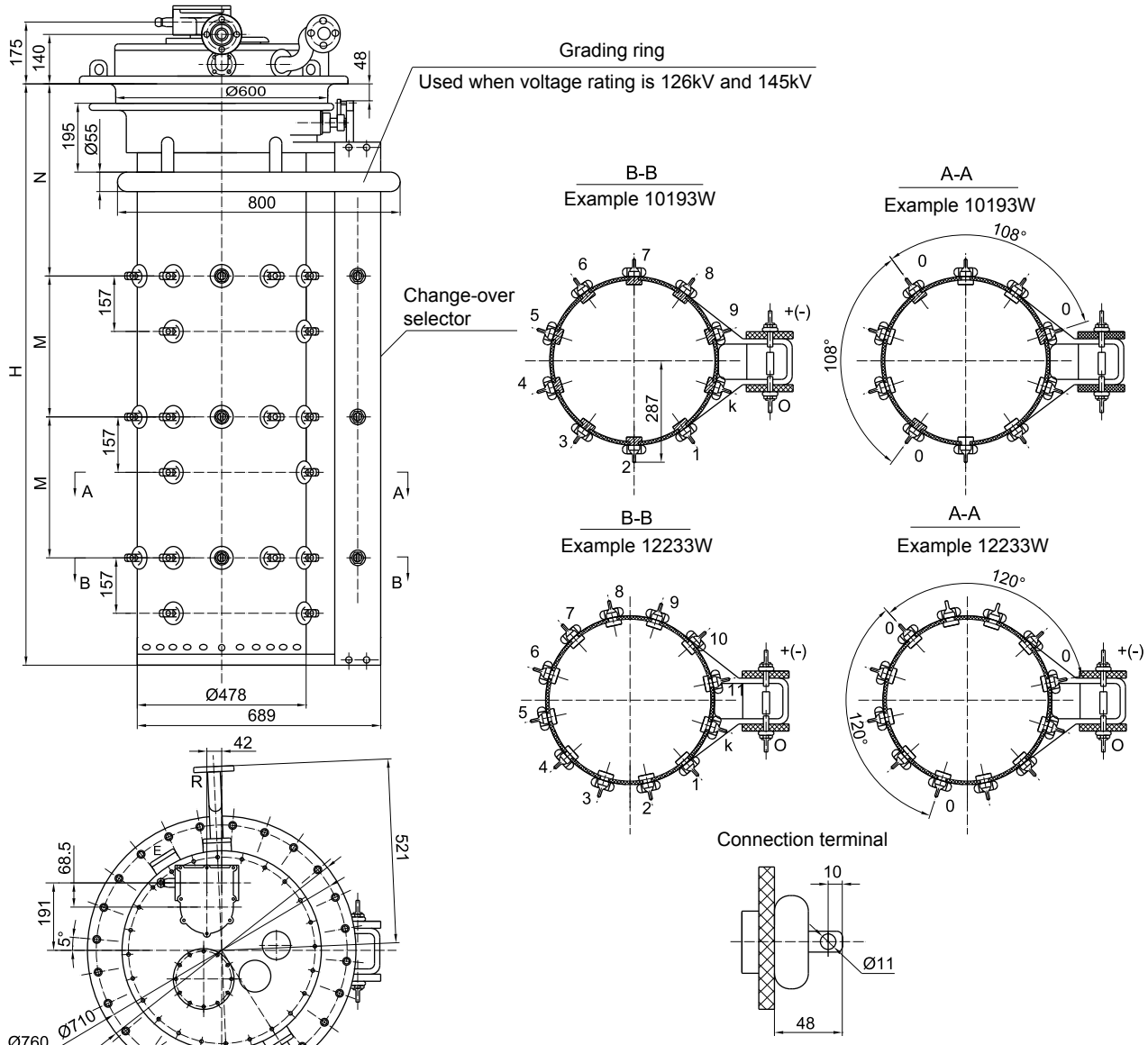
8.2. Protective relay

Protective relay is a protection device of the on-load tap changer. In case the tap changer has an internal failure, decomposing the oil into gases or creating oil surge,the protective relay contact acts, and switches on to the tripping circuit of the transformer circuit breaker, the transformer will trip at once.

Protective relay is installed in the pipe which connects the tap changer head oil elbow pipe and oil conservator. The "Arrow" mark shall be directed to the side of the oil conservator when being installed. For CV2 on-load tap changer, Huaming provides two models of protective relay, namely QJ4-25 and QJ4-25A for the choice of the user. Appendix 16 shows the installation dimension of them,

9. Appendix

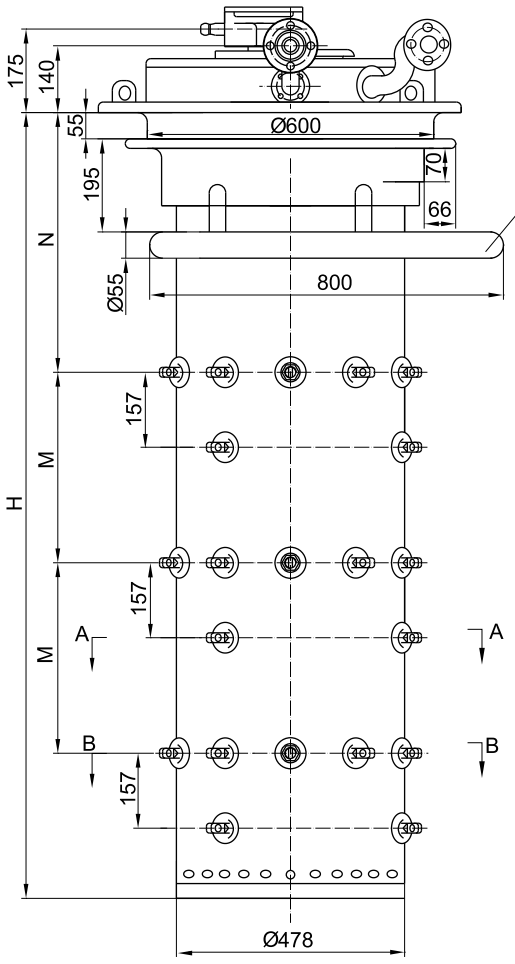
Appendix 1. CV2 III with change-over selector, overall dimensions



Model		CV2III-250/350/500Y				CV2III-250/350/500D			
The highest voltage for equipment(Um.kV)		40.5	72.5	126	145	40.5	72.5	126	145
Size(mm)	H	1646	1776	2298	2428	1866	2016	2416	2508
	N	544	594	724	774	544	594	724	774
	M	399	439	635	675	509	559	694	715

Unit: mm

Appendix 2. CV2 III without change-over selector, overall dimensions

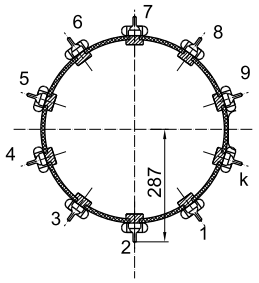


Grading ring

Used when voltage rating is 126kV and 145kV

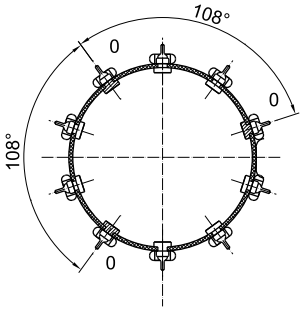
B-B

Example 10193W



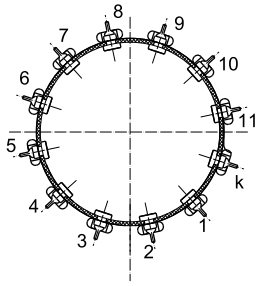
A-A

Example 10193W



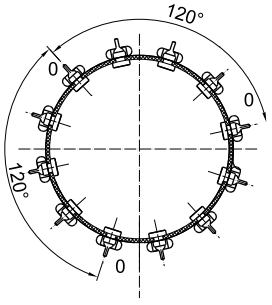
B-B

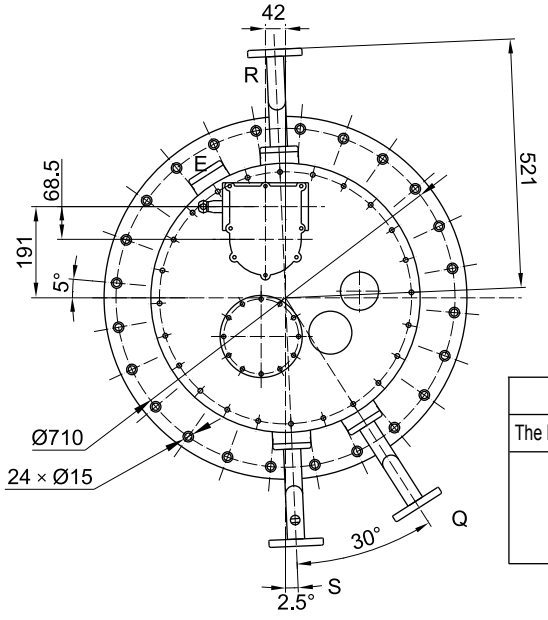
Example 12233W



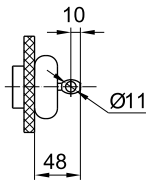
A-A

Example 12233W





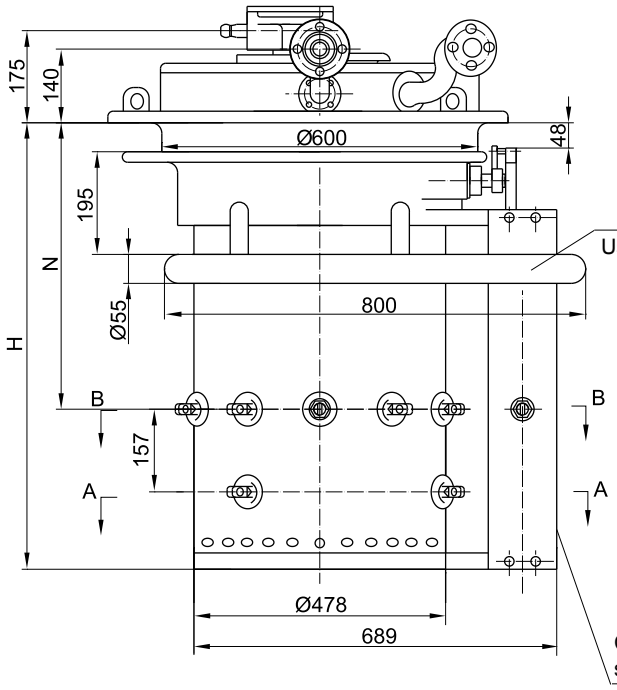
Connection terminal



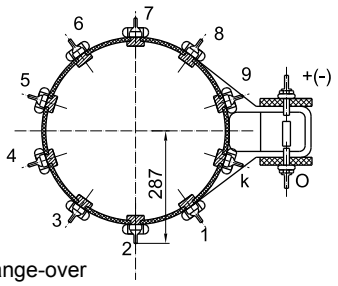
Model		CV2III-250/350/500Y				CV2III-250/350/500D			
The highest voltage for equipment(Um.kV)		40.5	72.5	126	145	40.5	72.5	126	145
Size(mm)	H	1646	1776	2298	2428	1866	2016	2416	2508
	N	544	594	724	774	544	594	724	774
	M	399	439	635	675	509	559	694	715

Unit: mm

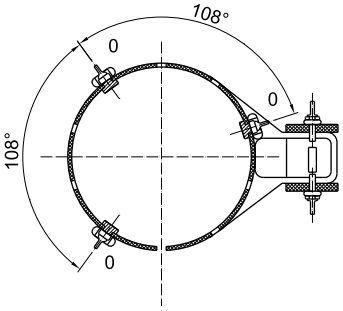
Appendix 3. CV2 I with change-over selector, overall dimensions



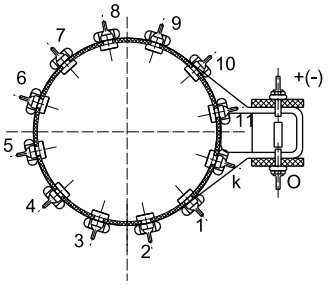
B-B
Example 10193W



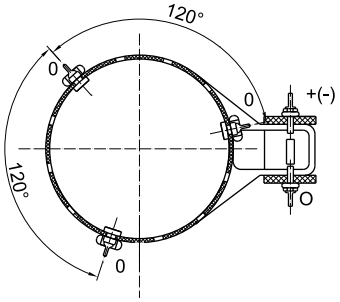
A-A
Example 10193W

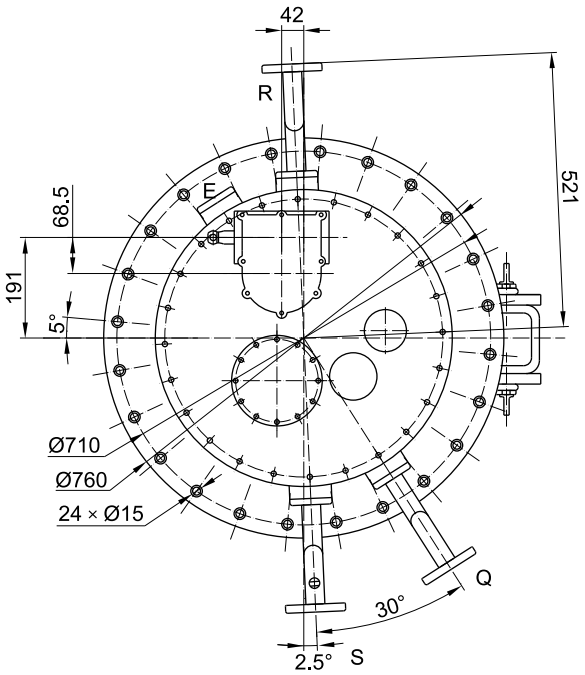


B-B
Example 12233W

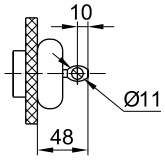


A-A
Example 12233W





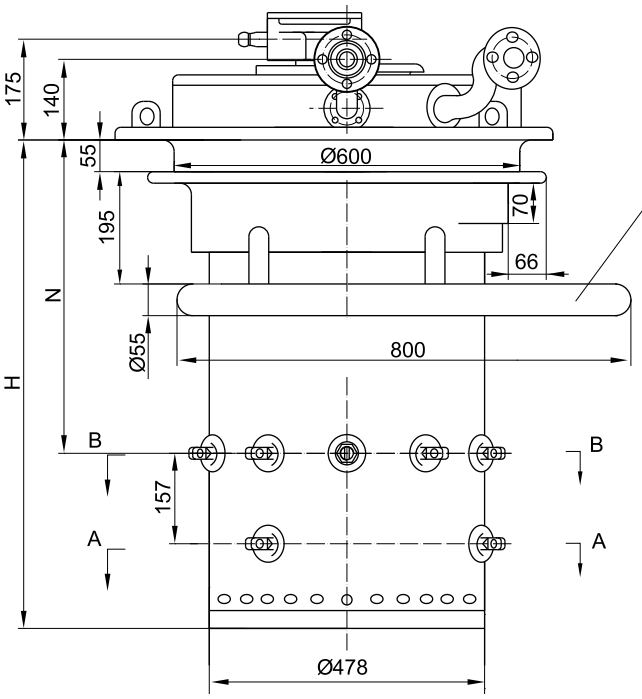
Connection terminal



Model		CV2 I-250/350/500			
The highest voltage for equipment(Um.kV)		40.5	72.5	126	145
Size(mm)	H	848	898	1028	1078
	N	544	594	724	774

Unit: mm

Appendix 4. CV2 I without change-over selector, overall dimensions

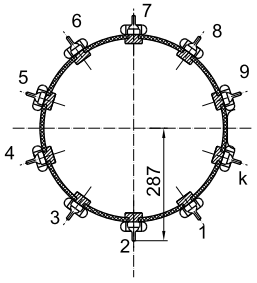


Grading ring

Used when voltage rating is 126kV and 145kV

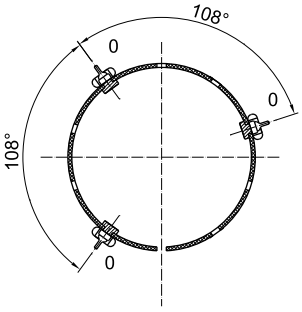
B-B

Example 10193W



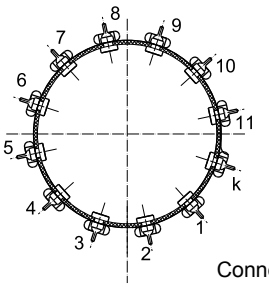
A-A

Example 10193W



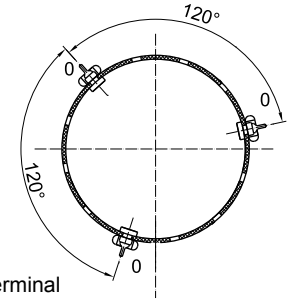
B-B

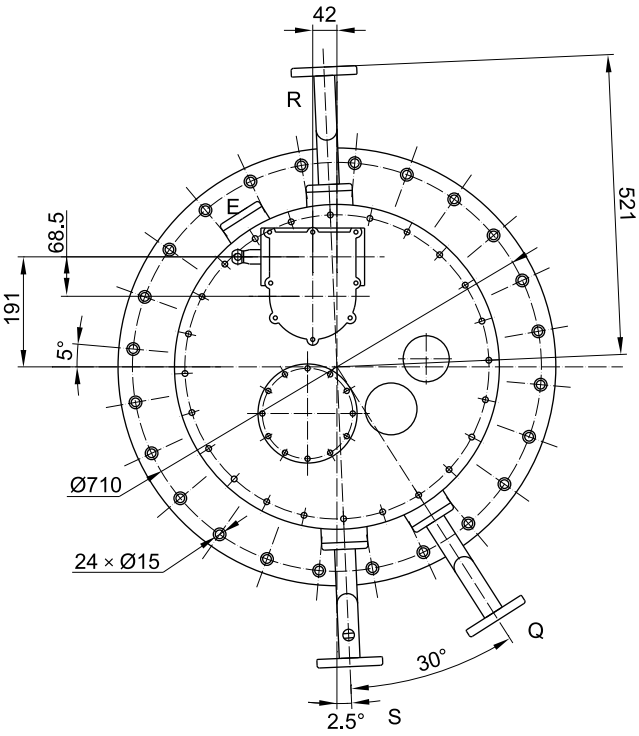
Example 12233W



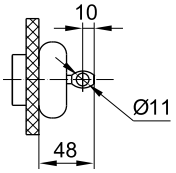
A-A

Example 12233W





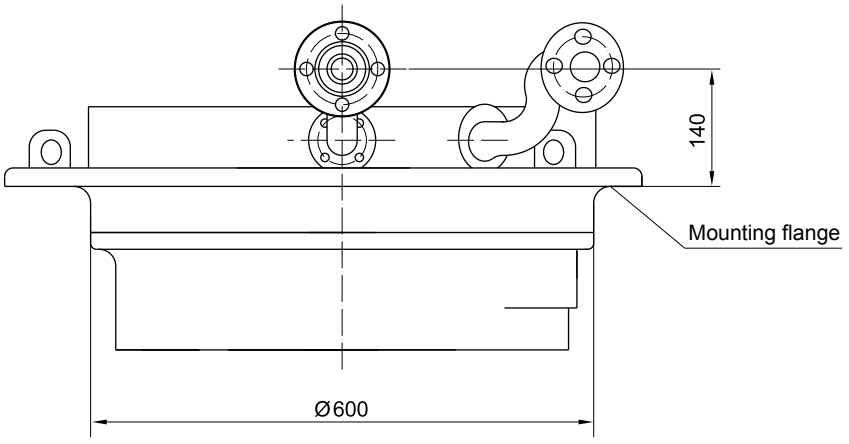
Connection terminal

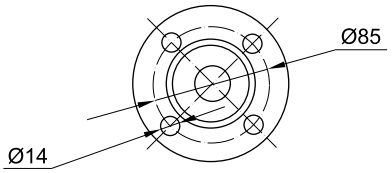


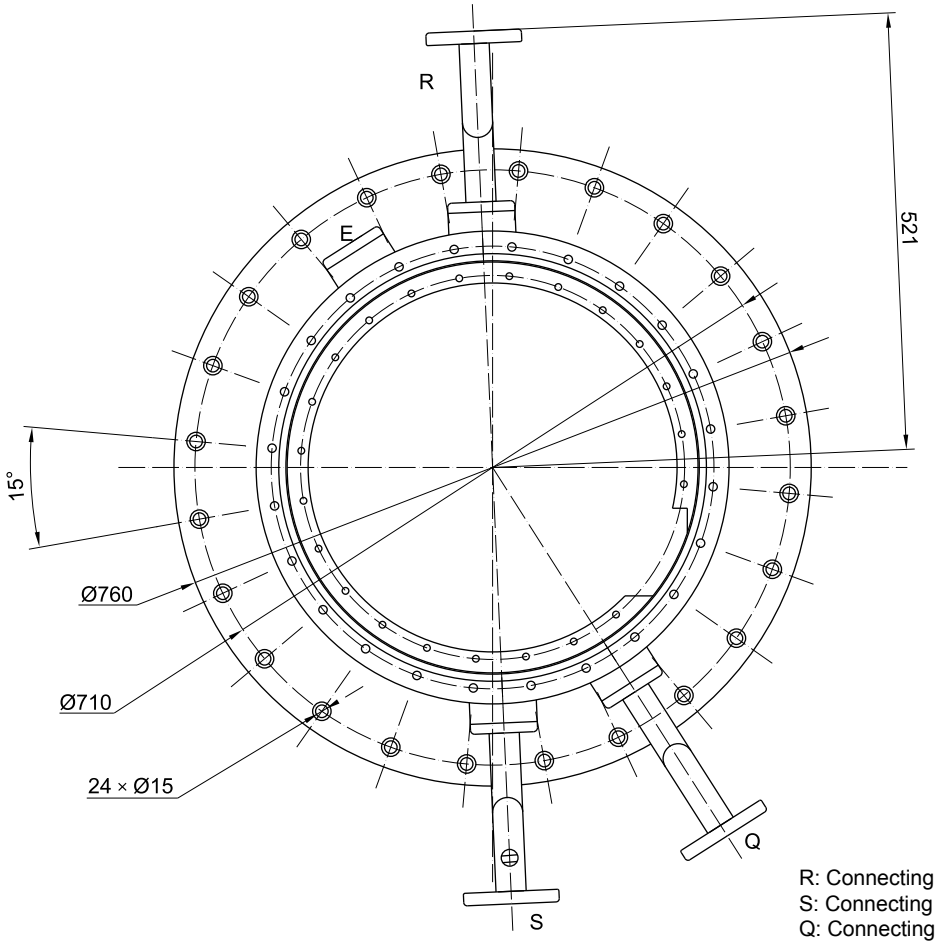
Model		CV2 I-250/350/500			
The highest voltage for equipment(Um.kV)		40.5	72.5	126	145
Size(mm)	H	848	898	1028	1078
	N	544	594	724	774

Unit: mm

Appendix 5. CV2 OLTC head flange for standard tank, overall dimensions



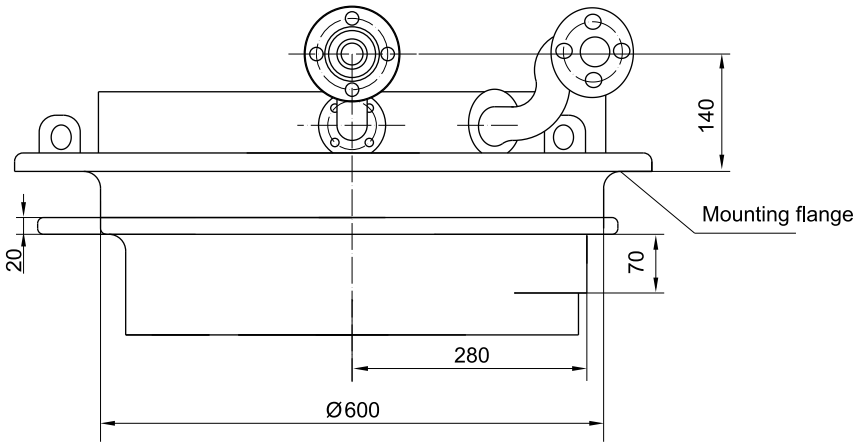


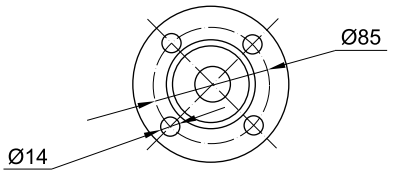


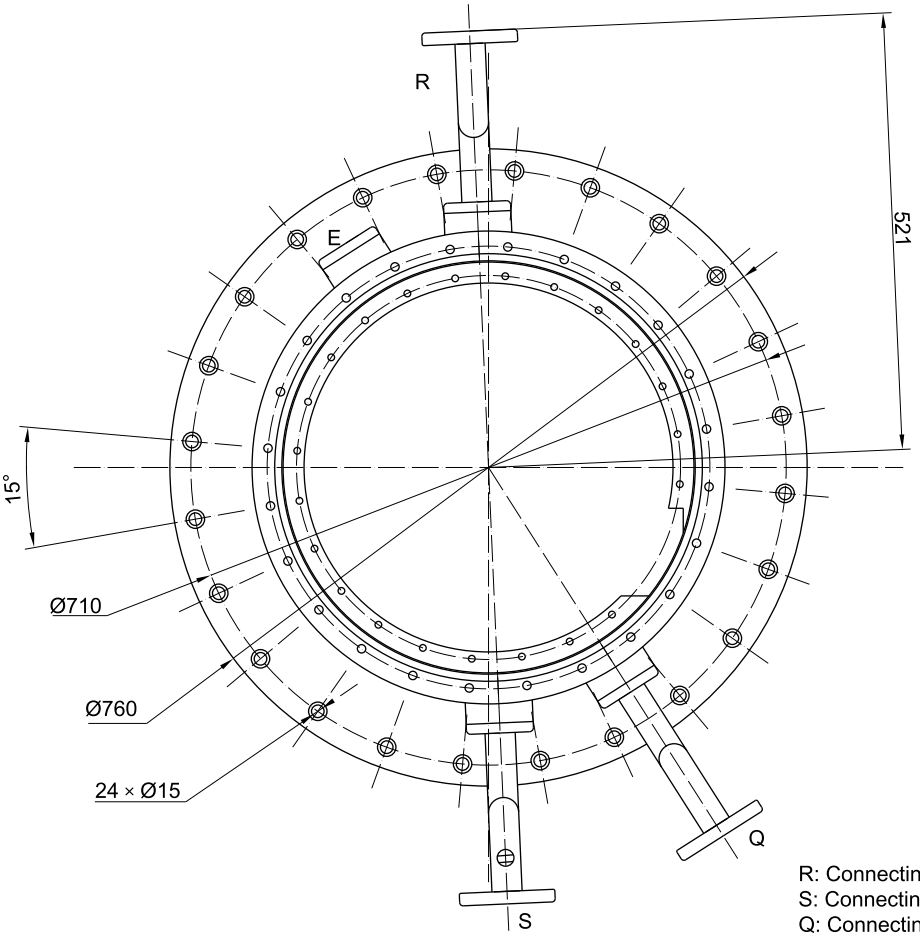
R: Connecting flange for protective relay
S: Connecting flange for suction pipe
Q: Connecting flange for oil return

Unit: mm

Appendix 6. CV2 OLTC head flange for bell-type, overall dimensions



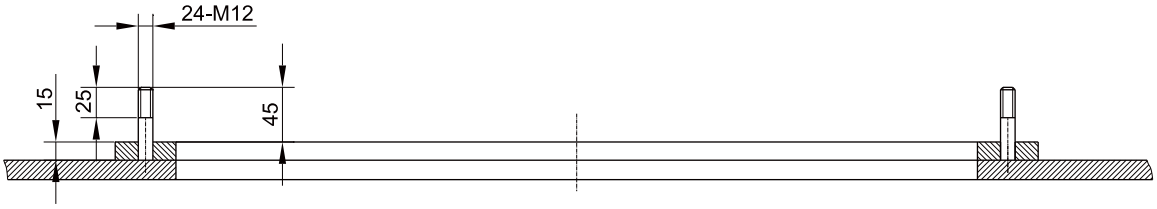


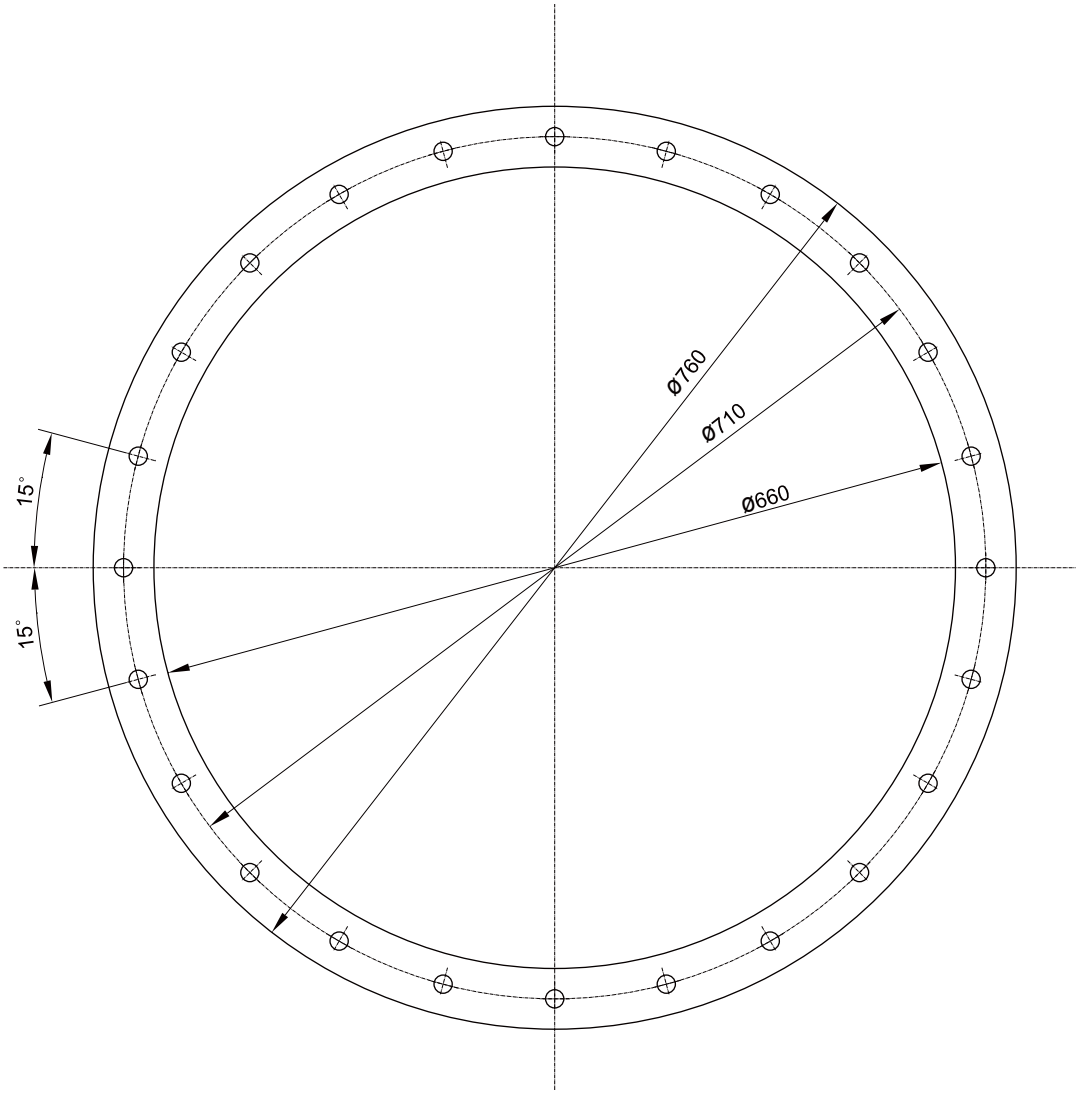


R: Connecting flange for protective relay
S: Connecting flange for suction pipe
Q: Connecting flange for oil return

Unit: mm

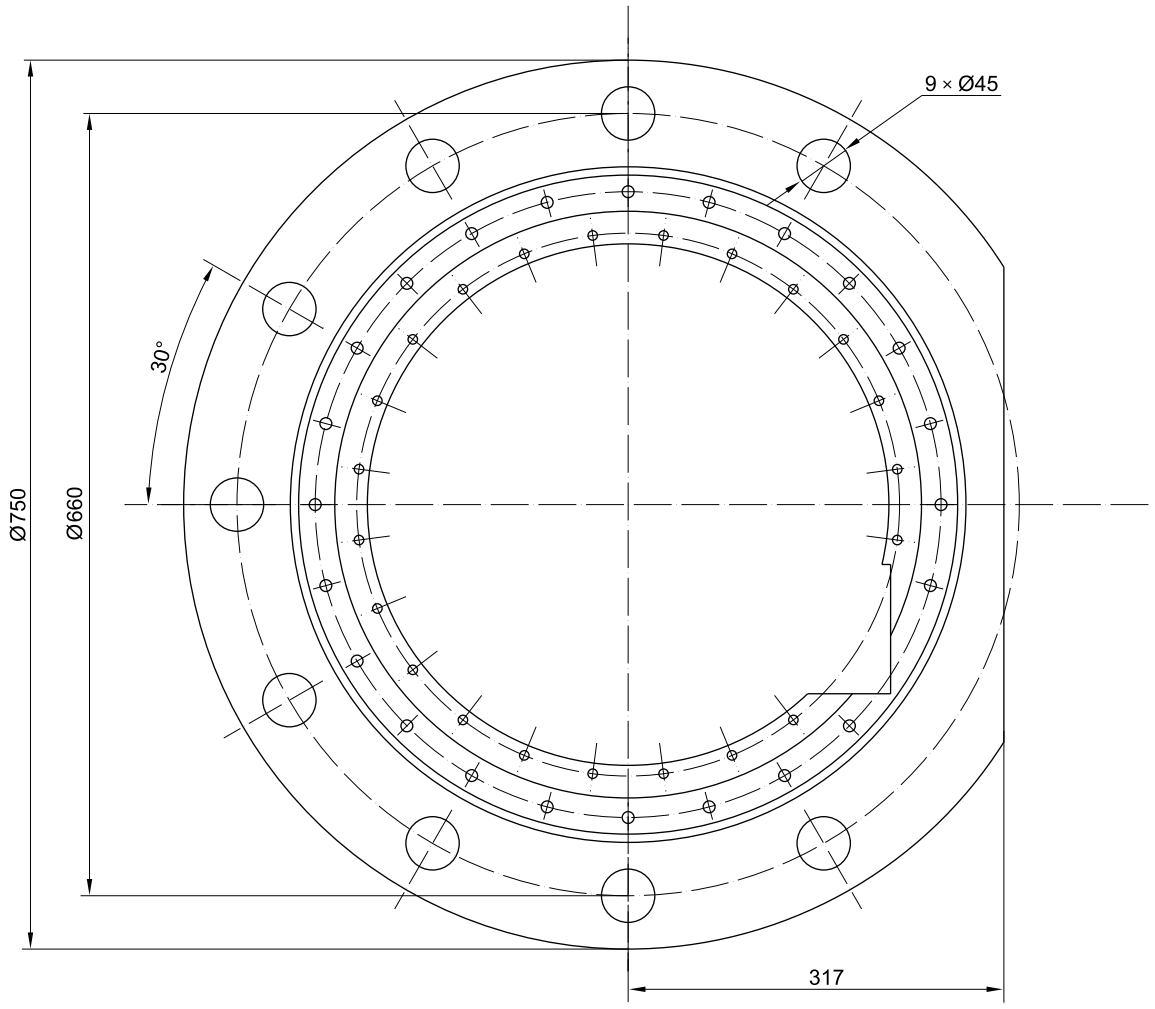
Appendix 7. Transformer connection flange for CV2 OLTC, overall dimensions





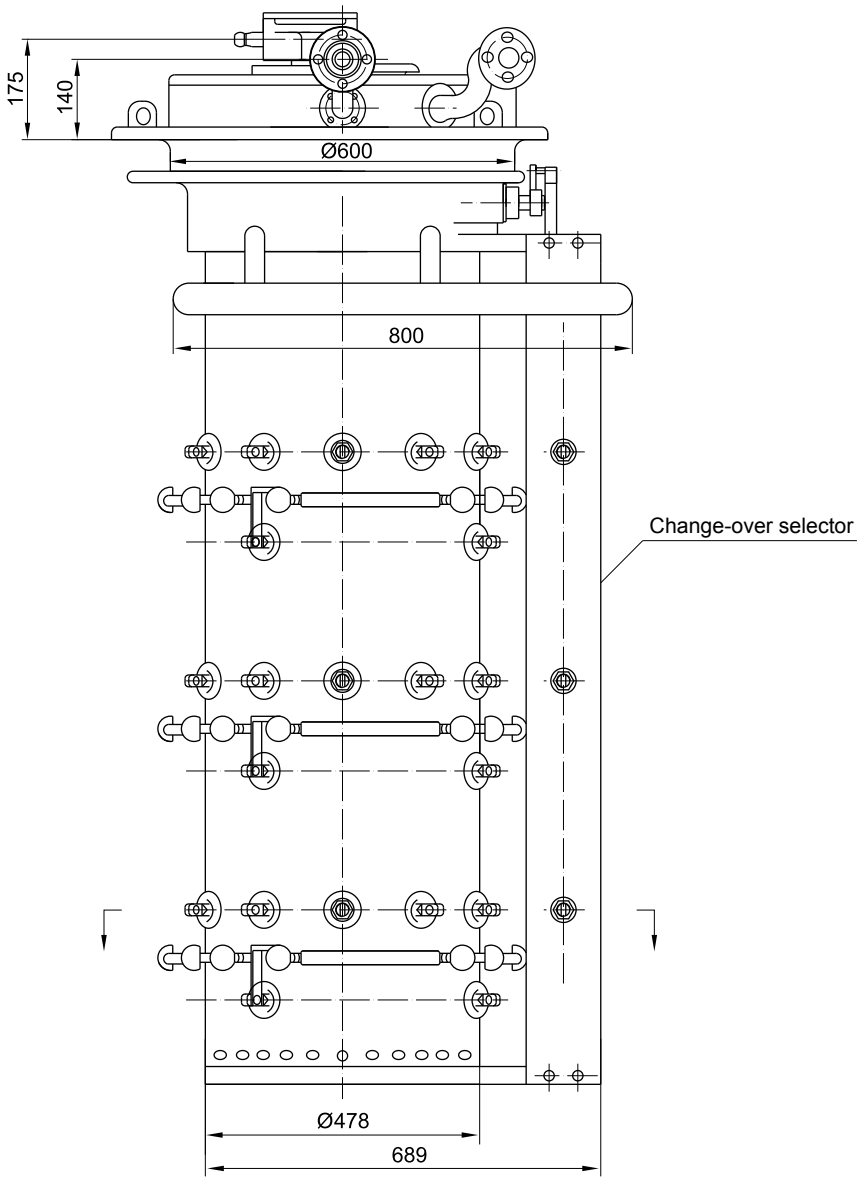
Unit: mm

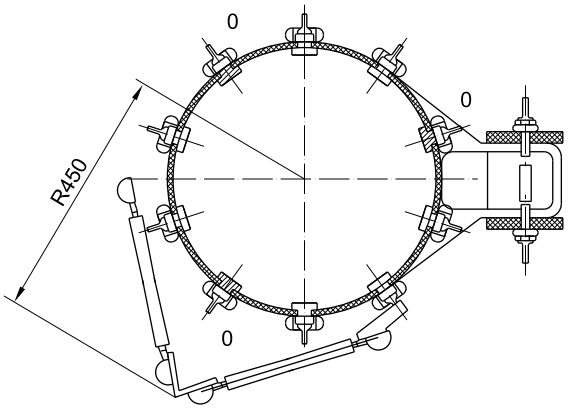
Appendix 8. Bell-type CV2 OLTC supporting flange, overall dimensions



Unit: mm

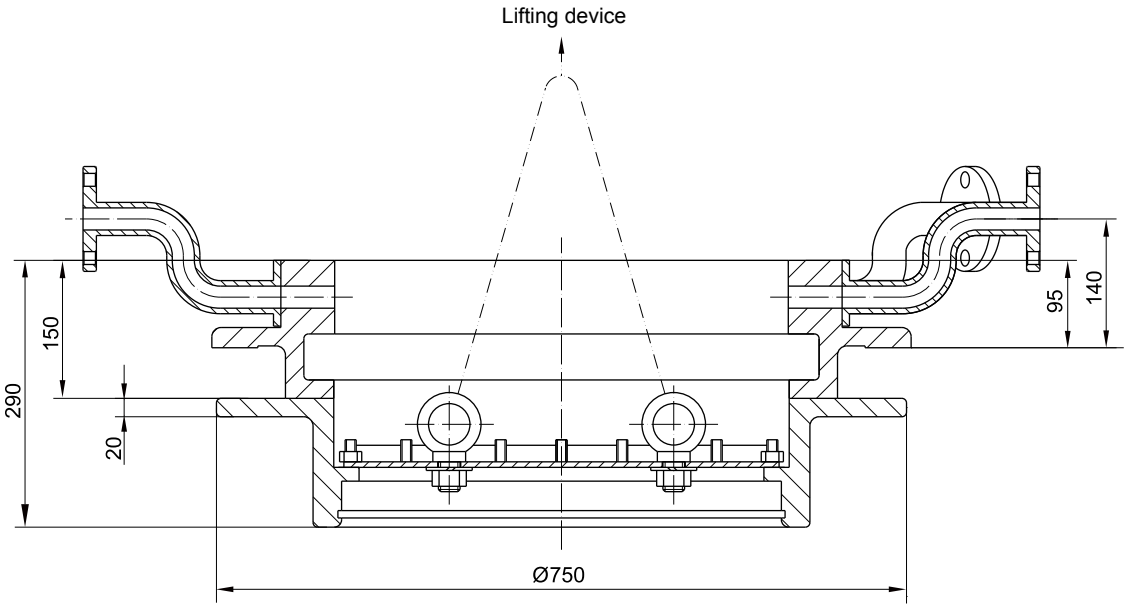
Appendix 9. Installation dimensions of tie-in resistor

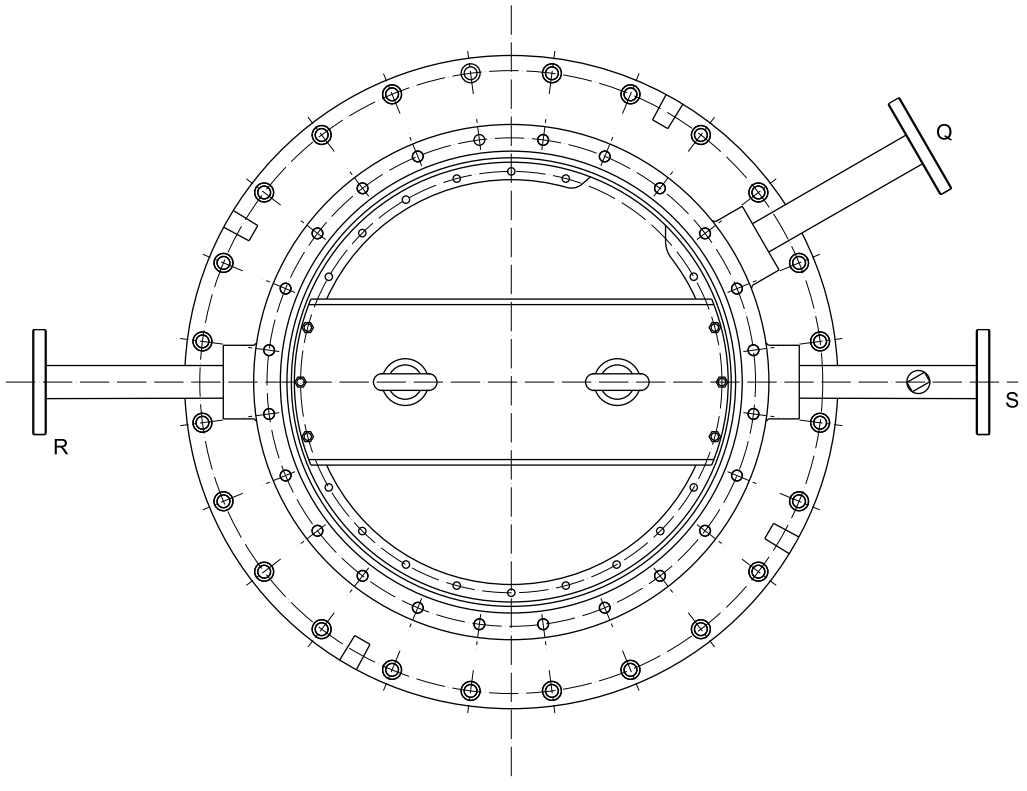




Unit: mm

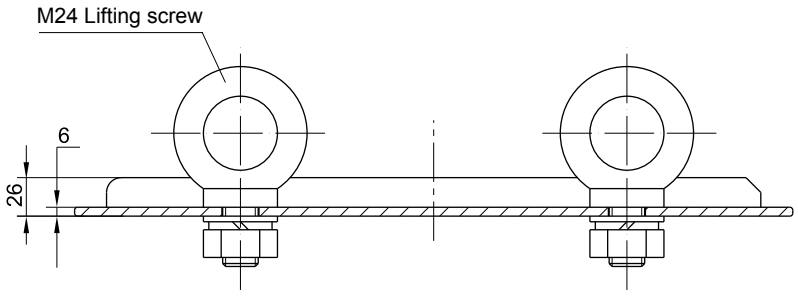
Appendix 10. Installation diagram of OLTC lifting device

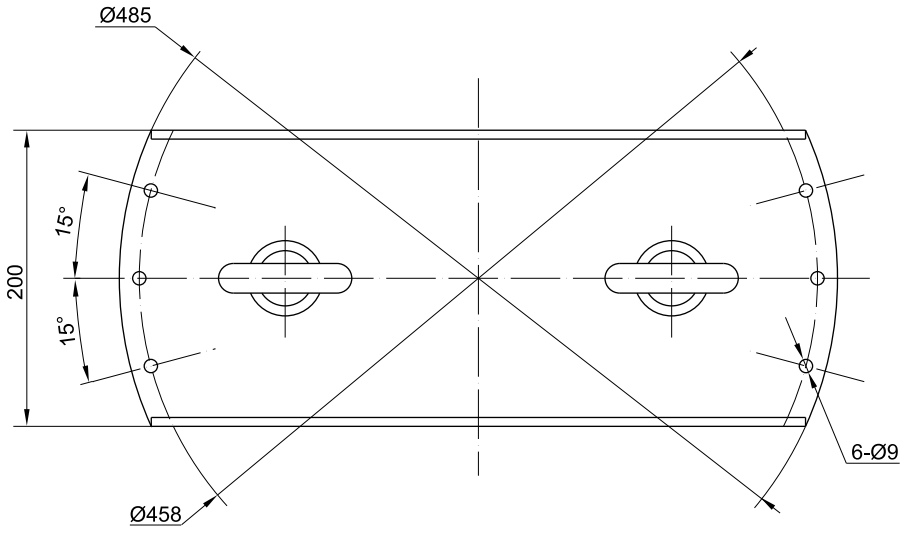




Unit: mm

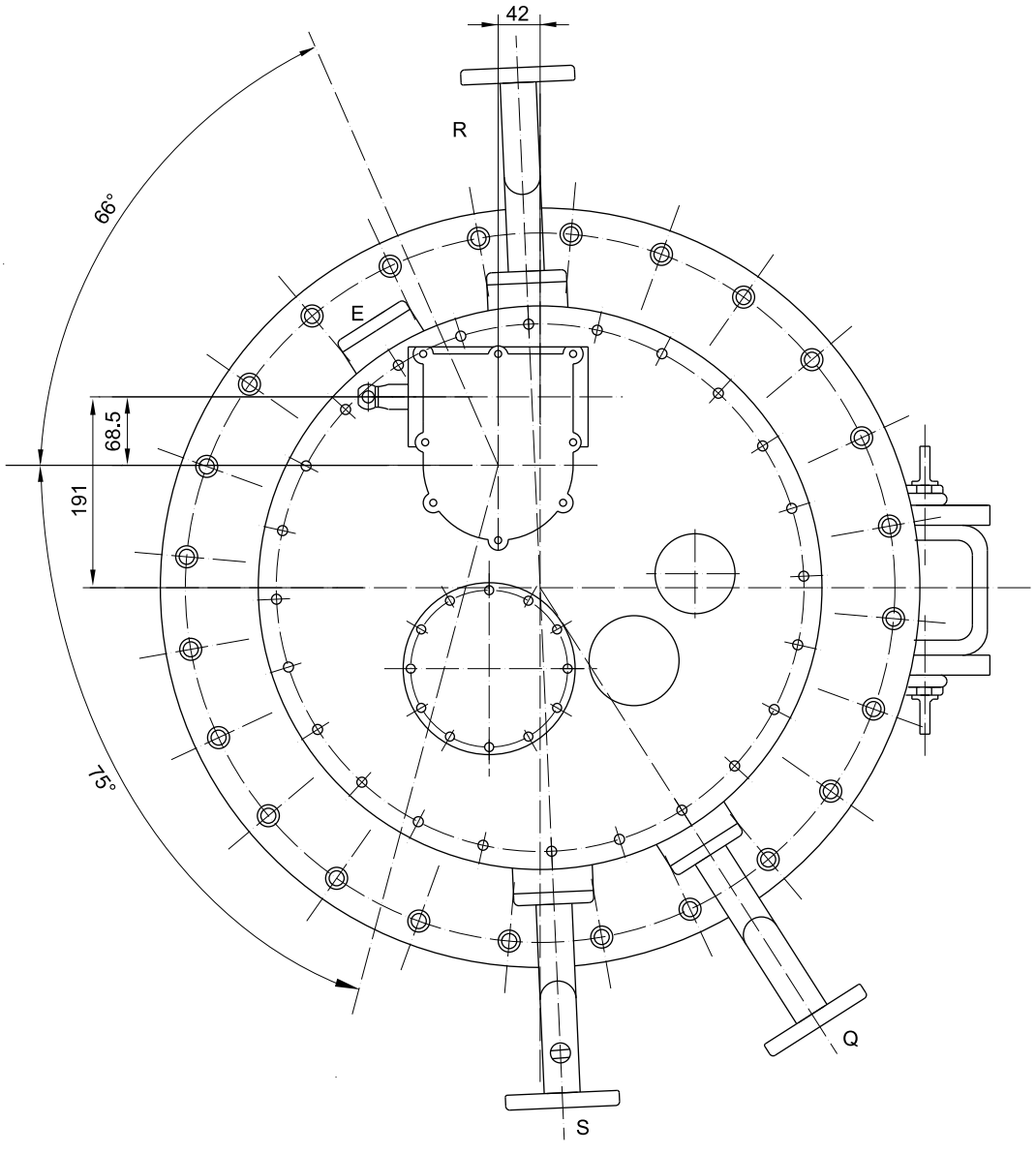
Appendix 11. Dimensions of OLTC lifting device





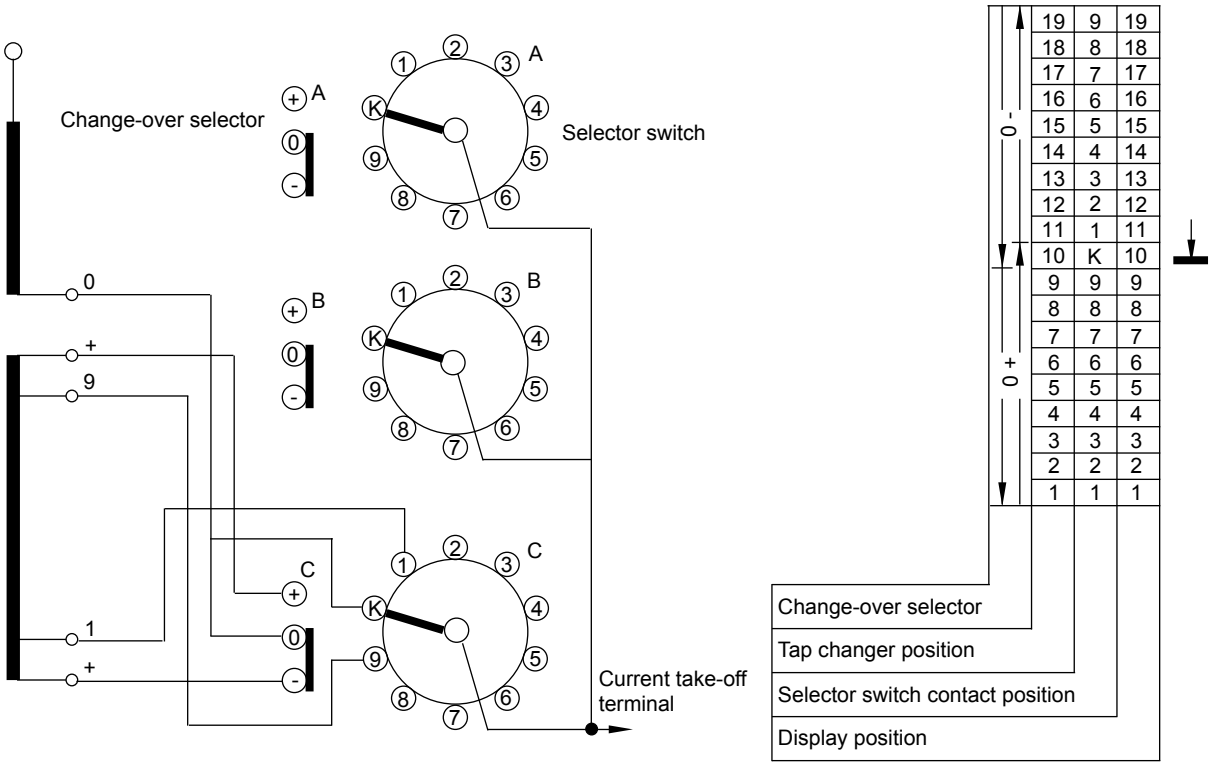
Unit: mm

Appendix 12. Swiveling range diagram of tap changer upper gearbox



Unit: mm

Appendix 13. CV2 (10191W) operating position table and connection diagram

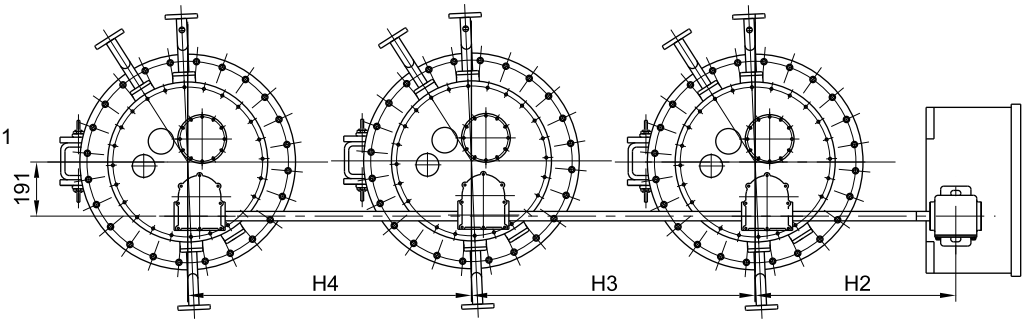


19	9	19
18	8	18
17	7	17
16	6	16
15	5	15
14	4	14
13	3	13
12	2	12
11	1	11
10	K	10
9	9	9
8	8	8
7	7	7
6	6	6
5	5	5
4	4	4
3	3	3
2	2	2
1	1	1

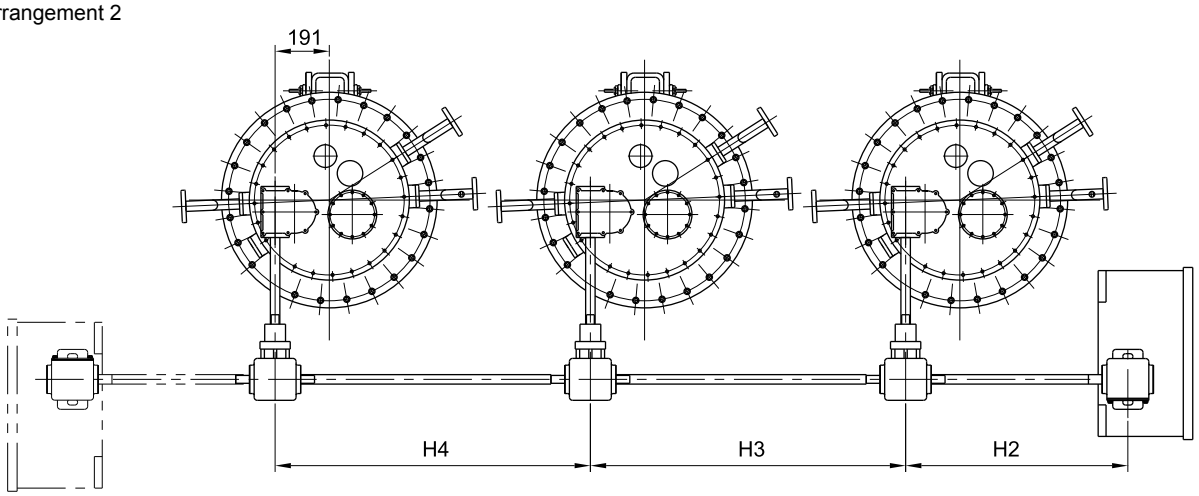
Unit: mm

Appendix 14. Three units of single phase tap changer interconnection arrangement

Arrangement 1



Arrangement 2

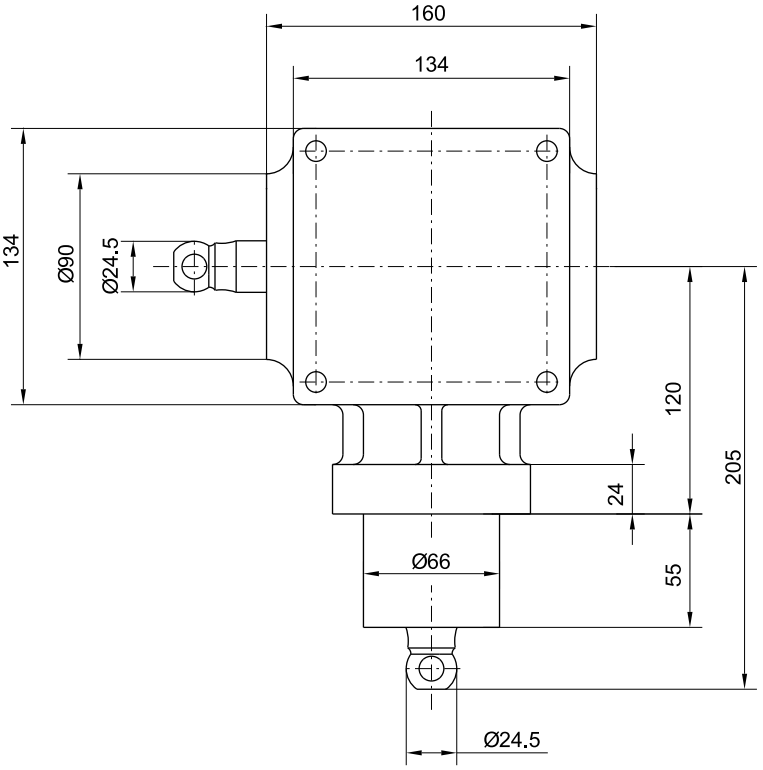


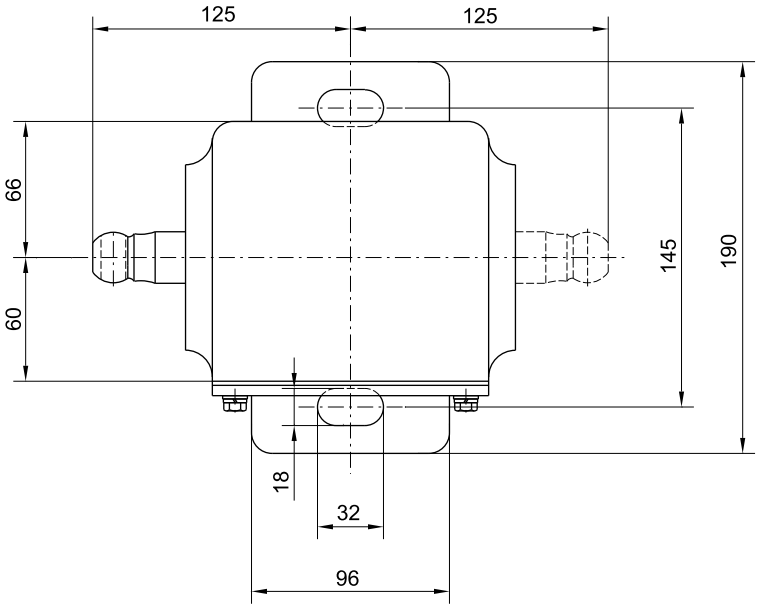
Arrangement	H2	
1	⩾ 1400	The minimum dimensions of H3 and H4 determined by the insulation distance between the phases A.B.C. (For mechanical reasons the minimum limit is 740mm)
2	⩾ 1400	

H2 may be realized as minimum dimensions, possibly increased by a certain position of the upper gear unit.

Unit: mm

Appendix 15. Overall dimensions of bevel gearbox

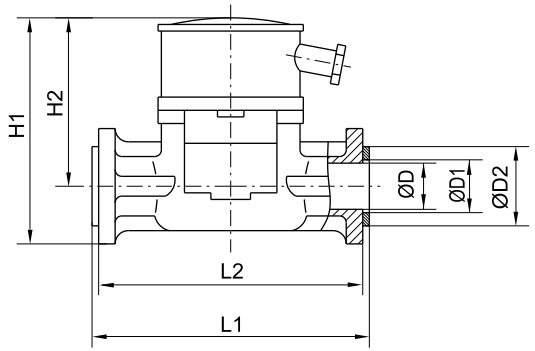


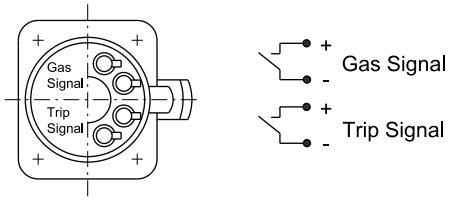


Unit: mm

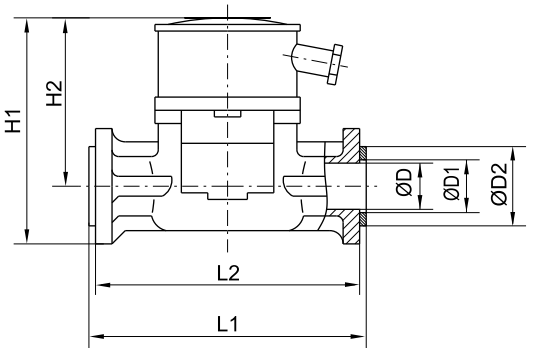
Appendix 16. Overall dimensions of protective relay

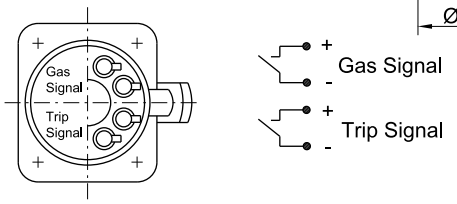
Type QJ4-25A protective relay

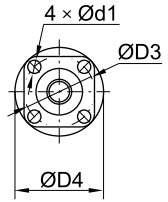




Type QJ4-25 protective relay







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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