

# **Capacitor contactors**

## **for on-load switching**

**List 616E**

**Edition from 01.08.2001**

---

## General

Induction furnaces for the heating and melting of metals possess a deleterious power factor. In order to charge the supply mains only with active power, static capacitors are used to compensate for the reactive current which arises in the furnaces coil. In order to adjust to the varying requirements of the furnaces coil for the reactive current, a number of the capacitors are made switchable via the contactor.

## Switching-on of capacitors

Due the low actual resistance of the capacitor connection lead, the switching-on of a capacitor directly to a live parallel capacitor bank is effected by means of an equalizing current with a natural frequency of

$$\omega_e = \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$$

which corresponds very nearly to the resonant frequency.

The highest current peaks are caused when switching at the maximum of the steady capacitor voltage occurs and thus at the zero-axis crossing of the current precipitation at 90°. Under normal conditions this is always the case, because shortly before the switching-on contactor touches the contact piece, a sparking-over occurs and initiates the switching-on process.

The initial amplitude of the equalising current must not exceed a value of 50 times the rated current of the contactor in order not to over-exert the welding strength of the capacitor contactor contacts nor the dynamic loading capacity of the capacitors. A simplified calculation of the overcurrent factor (o.f.) for 50 Hz capacitors is made possible by the following formula:

$$üf = \frac{1}{\sqrt{\omega L \cdot \omega C}}$$

o.f. = in this o.f. represents many times the rated capacitor current

$$\omega L = 2\pi f \cdot L$$

$$\omega C = \frac{P_c}{U^2}$$

$P_c$  = output of the switched capacitor (Var)

$U$  = operating voltage (V)

$L$  = effective inductivity of the circuit

$F$  = frequency of the supply mains

It can be seen from the above formula that with the switching-on of capacitors of smaller output and higher voltage, the overcurrent factor increases and can even reach 100 times the rated current. In these cases a capacitor contactor must be selected that is of sufficient thermal design with regard to its making and/or breaking capacity.

With higher operating frequencies, the overcurrent factors become smaller as a function of the square root of the frequency ratio. A reduction of the starting current will be achieved by the application of series resistances which are bridged by a lagging contact from the same contactor. These series resistors (see List 506) are so designed that during the first and the second stage of the switch-on process, maximum overcurrent factors of 6 to 8 times the rated current of the capacitor occur.

### Switching-off of capacitors

With the switching-off of one capacitor the quenching of the arc will follow at the slightest opening of the contactor. The dielectric consolidation of the switching path must, however, follow so quickly that the returning voltage will not cause arcing-through or arcing back. With higher operating voltages, 2 or 3 switching contacts are therefore connected in series.

### Discharge

The capacitor, after having been switched off, must be discharged as quickly as possible, so that when it is switched on again, it is not subjected to even higher overcurrents. The discharging provided by us via resistors (see List 506) with discharge contactors makes an exact calculation possible in accordance with the following formula of the remaining residual voltage at the time "t":

$$U_{Rest} = U_n \cdot 1,1 \cdot \sqrt{2} \cdot \varepsilon^{-\frac{t}{T}}$$

in this the following means :

- U<sub>N</sub> = rated voltage (+ 10% overvoltage)
- t = time (s)
- T = time constants = R C
- R = value of the discharge resistor (Ohm)
- C = capacity of the capacitor (F)

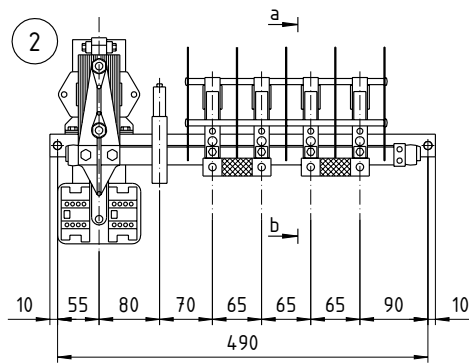
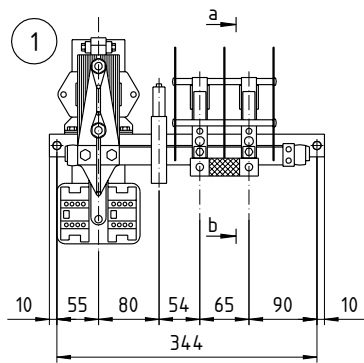
### Coil power consumption

| contactor type                      | power consumption at alternating voltage [VA]<br>closing / holding |           |            |            |
|-------------------------------------|--|-----------|------------|------------|
|                                     | 110V 50Hz  | 110V 60Hz | 220V 50Hz  | 220V 60Hz  |
| G 125/...<br>G 200/...<br>G 320/... | 800 / 140  | 800 / 140 | 800 / 70   | 800 / 80   |
| G 500/...<br>G 800/...              | ---  | ---       | 2300 / 230 | 2600 / 250 |

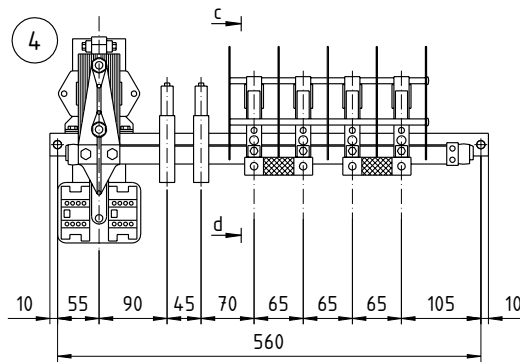
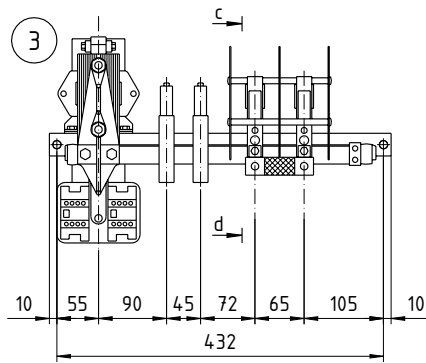
### Selection table for capacitor contactors

| Contactor type     | Admissible rated current of contactor [A] | Rated insulation voltage $U_i$ [kV] | Rated voltage [kV] | Wiring according figure | Number of discharge contacts | Dimension A [mm] | Figure | Net weight [kg] |
|--------------------|---|-------------------------------------|--------------------|-------------------------|------------------------------|------------------|--------|-----------------|
| G 125/21 sond.     | 100                                       | 2                                   | 1,5                | 5                       | 1                            | 344              | 1      | 7,2             |
| G 125/22 sond.     |   |                                     |                    | 6                       |                              | 490              | 2      | 9,5             |
| G 200/21 sond.     | 180                                       | 2                                   | 1,5                | 5                       | 1                            | 344              | 1      | 8,2             |
| G 200/22 sond.     |   |                                     |                    | 6                       |                              | 490              | 2      | 11,3            |
| G 320/21 sond.     | 300                                       | 2                                   | 1,5                | 5                       | 1                            | 344              | 1      | 9,0             |
| G 320/22 sond.     |   |                                     |                    | 6                       |                              | 490              | 2      | 12,9            |
| G 500/11           | 375                                       | 1,5                                 | 1,5                | 1                       | 1                            | 385              | 5      | 20,0            |
| G 500/12           |   |                                     |                    | 2                       |                              | 445              | 6      | 26,0            |
| G 500/13           |   |                                     |                    | 3                       |                              | 541              | 7      | 32,0            |
| G 500/14           |   |                                     |                    | 4                       |                              | 635              | 8      | 39,0            |
| G 800/11           | 500                                       | 1,5                                 | 1,5                | 1                       | 1                            | 385              | 5      | 21,0            |
| G 800/12           |   |                                     |                    | 2                       |                              | 445              | 6      | 27,5            |
| G 800/13           |   |                                     |                    | 3                       |                              | 541              | 7      | 34,0            |
| G 800/14           |   |                                     |                    | 4                       |                              | 635              | 8      | 42,0            |
| G 125/21 sond.     | 100                                       | 3                                   | 3                  | 7                       | 2                            | 432              | 3      | 7,5             |
| G 125/22 sond.     |   |                                     |                    | 8                       |                              | 560              | 4      | 12,0            |
| G 200/21 sond.     | 150                                       | 3                                   | 3                  | 7                       | 2                            | 432              | 3      | 8,5             |
| G 200/22 sond.     |   |                                     |                    | 8                       |                              | 560              | 4      | 13,6            |
| G 320/21 sond.     | 250                                       | 3                                   | 3                  | 7                       | 2                            | 432              | 3      | 9,5             |
| G 320/22 sond.     |   |                                     |                    | 8                       |                              | 560              | 4      | 16,0            |
| G 500/21 sond.     | 375                                       | 3                                   | 3                  | 7                       | 2                            | 541              | 9      | 30,0            |
| G 500/22 sond.     |   |                                     |                    | 8                       |                              | 760              | 10     | 45,0            |
| G 500/800/21 sond. | 500                                       | 3                                   | 3                  | 7                       | 2                            | 541              | 11     | 30,0            |
| G 500/800/22 sond. |   |                                     |                    | 8                       |                              | 760              | 12     | 45,0            |
| G 125/12 sond.     | 100                                       | 3                                   | 3                  | 9                       | 2                            | 490              | 13     | 9,0             |
| G 200/12 sond.     | 150                                       |                                     |                    |                         |                              | 490              | 13     | 10,0            |
| G 320/12 sond.     | 250                                       |                                     |                    |                         |                              | 490              | 13     | 10,5            |
| G 500/12 sond.     | 375                                       |                                     |                    |                         |                              | 541              | 14     | 28,0            |
| G 800/12 sond.     | 500                                       |                                     |                    |                         |                              | 541              | 14     | 30,0            |

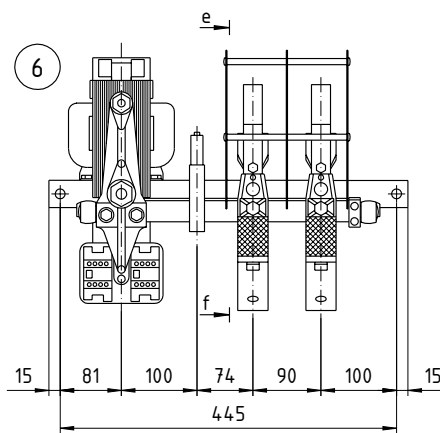
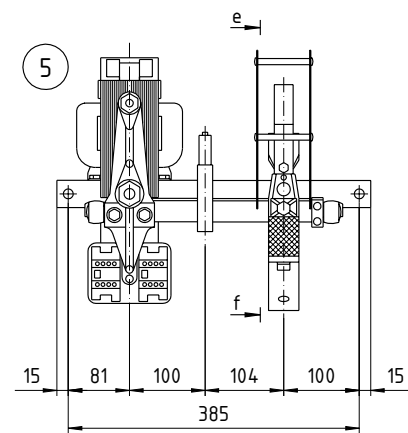
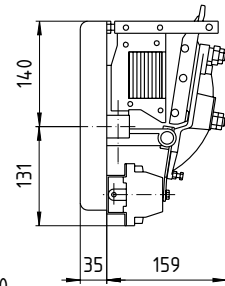
### Dimensions diagrams for capacitor contactors



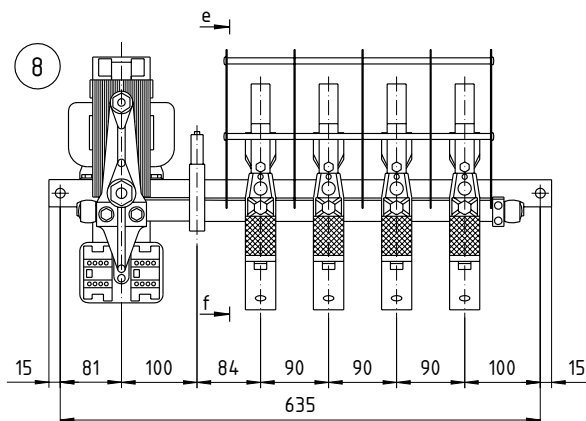
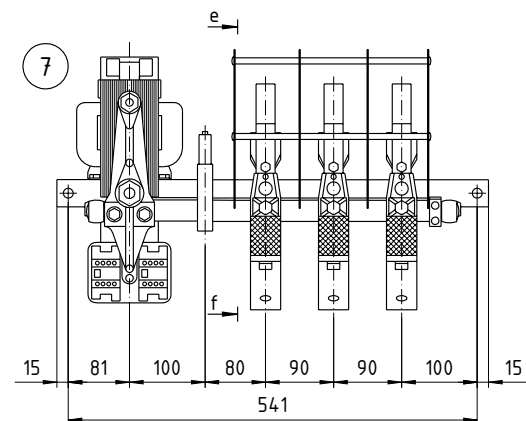
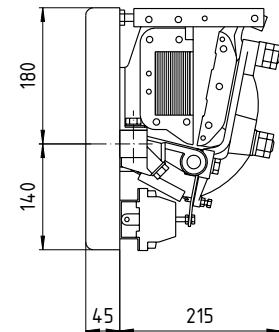
cross section see  
page 5 and 6



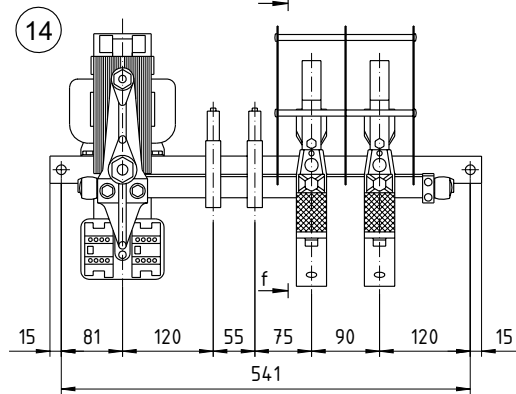
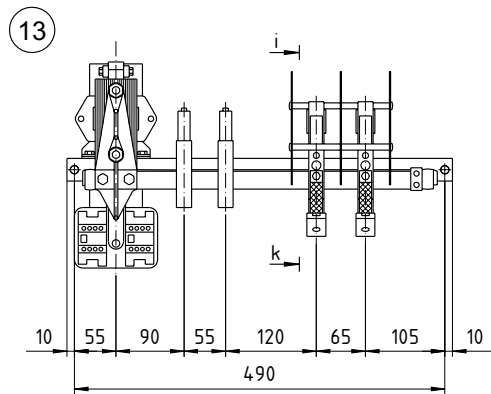
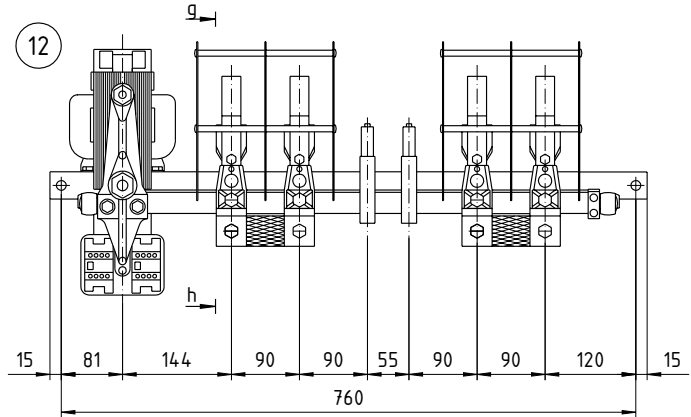
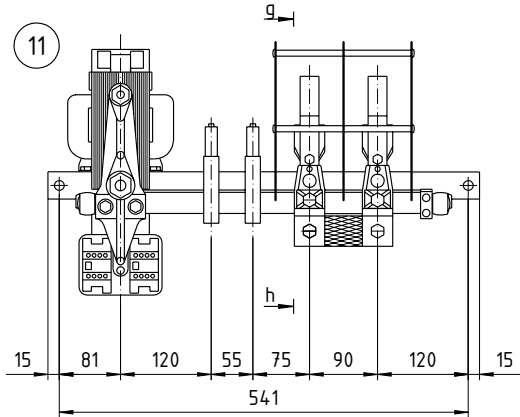
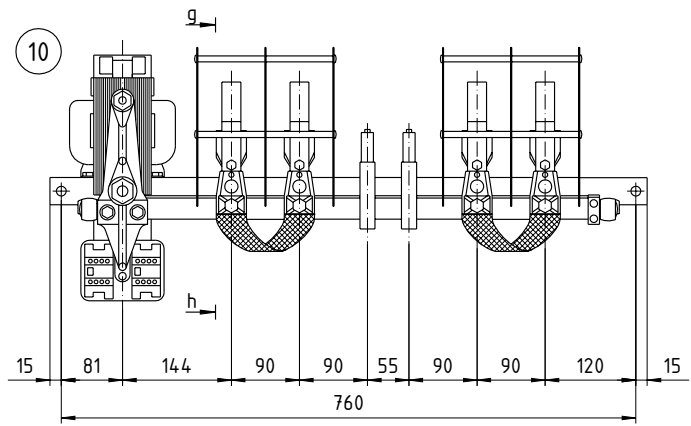
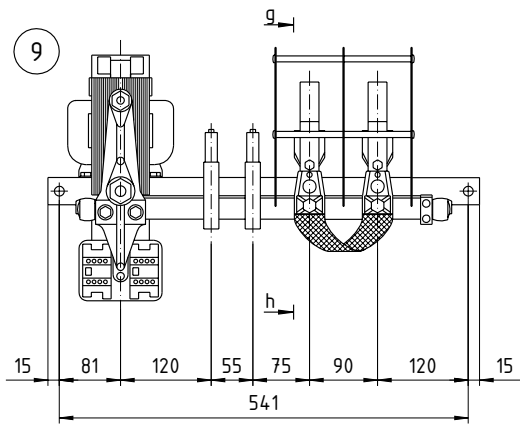
side view fig. 1-4  
(shown without switching pole)



side view fig. 5-12  
(shown without switching pole)



### Dimensions diagrams for capacitor contactors

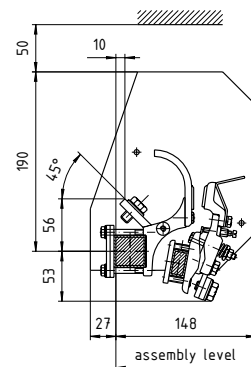
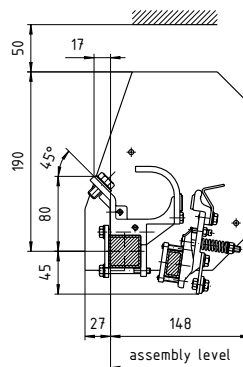
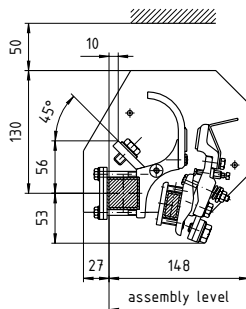
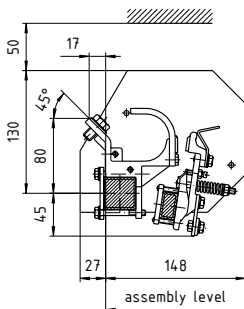


section a-b  
(G 125/... - G 200/...)

section a-b  
(G 320/...)

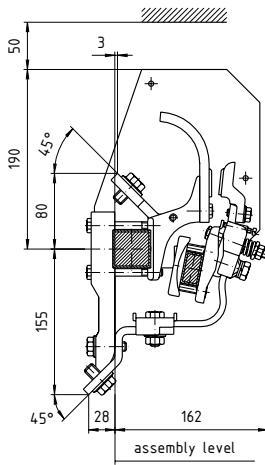
section c-d  
(G 125/... - G 200/...)

section c-d  
(G 320/...)

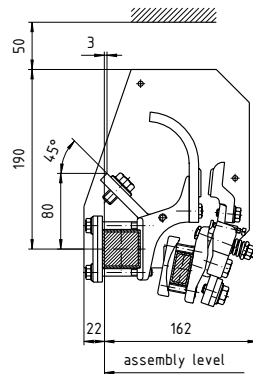


## Dimensions- and wiring diagrams for capacitor contactors

section e-f  
(G 500/... - G 800/...)

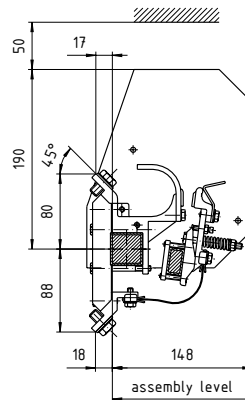


section g-h  
(G 500/... - G 800/...)

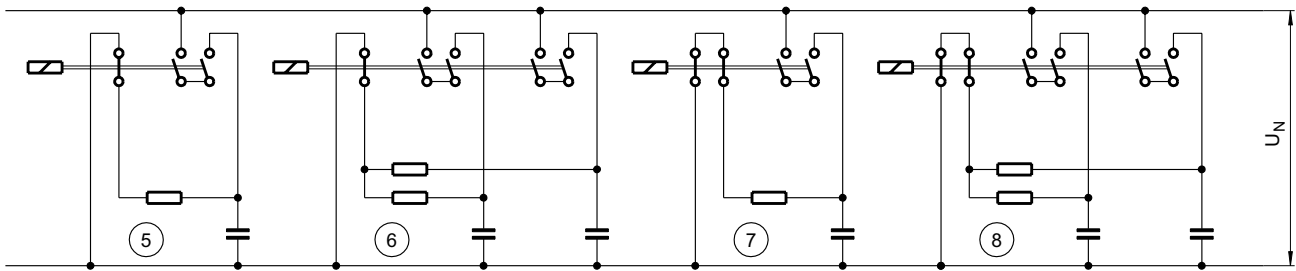
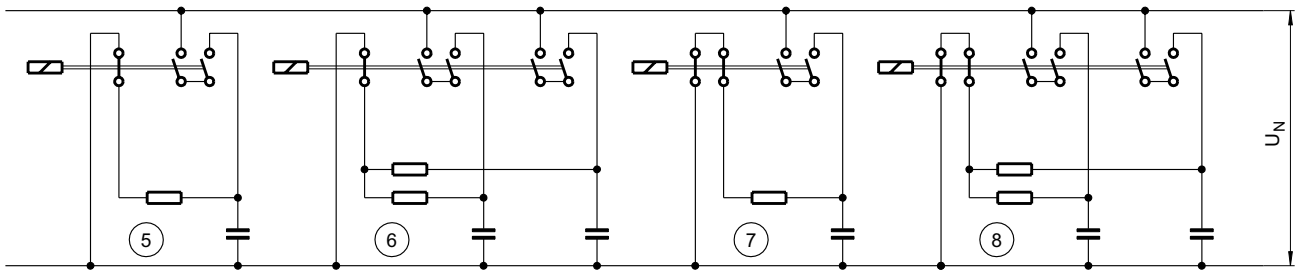
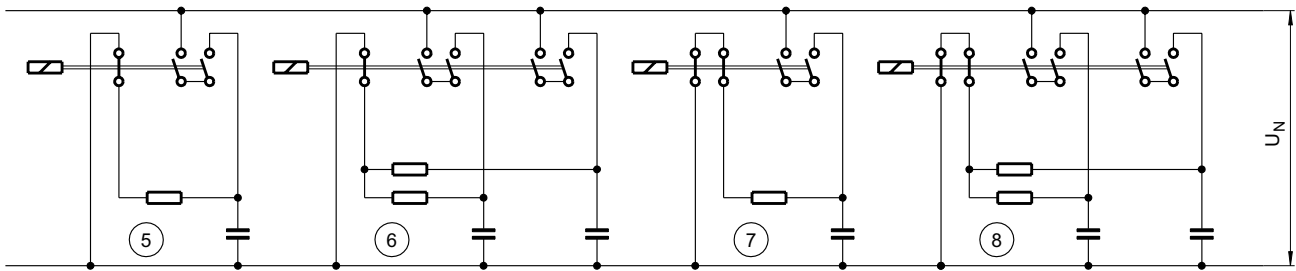
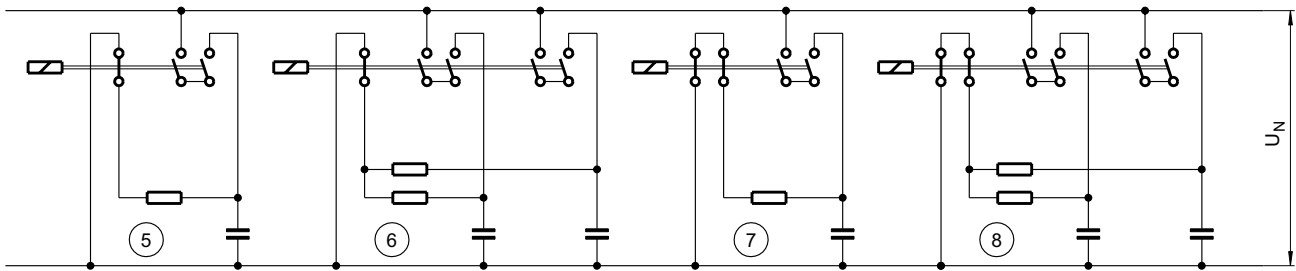
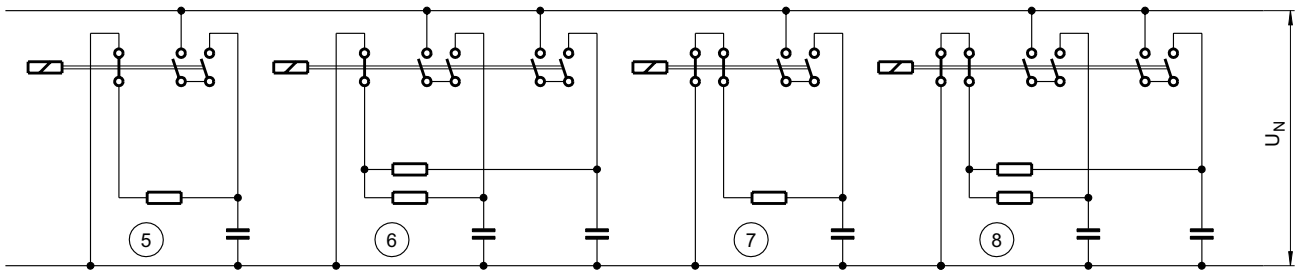
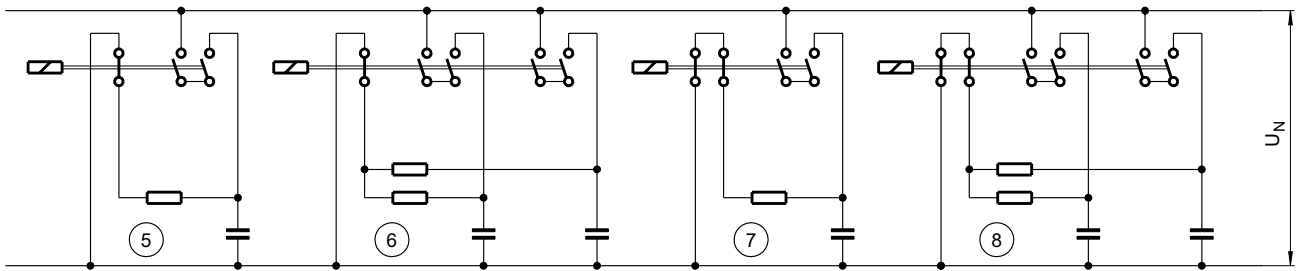
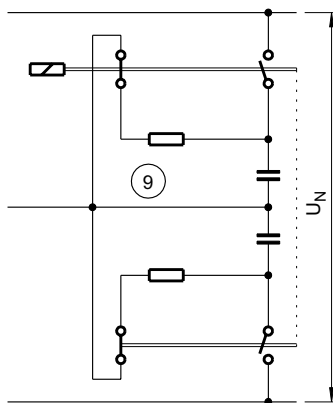
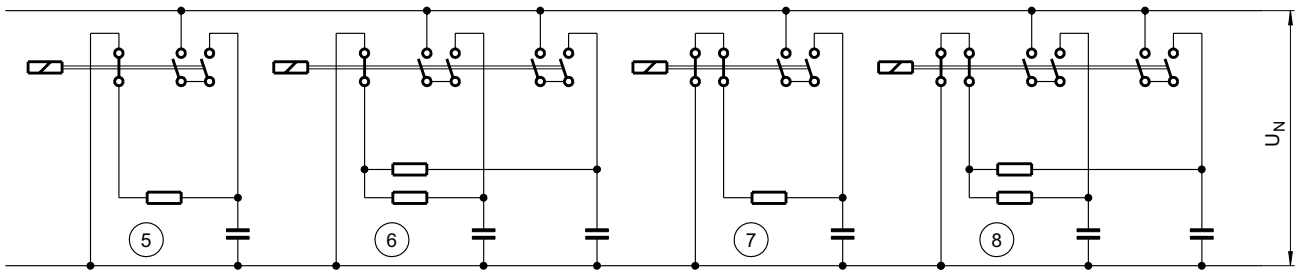
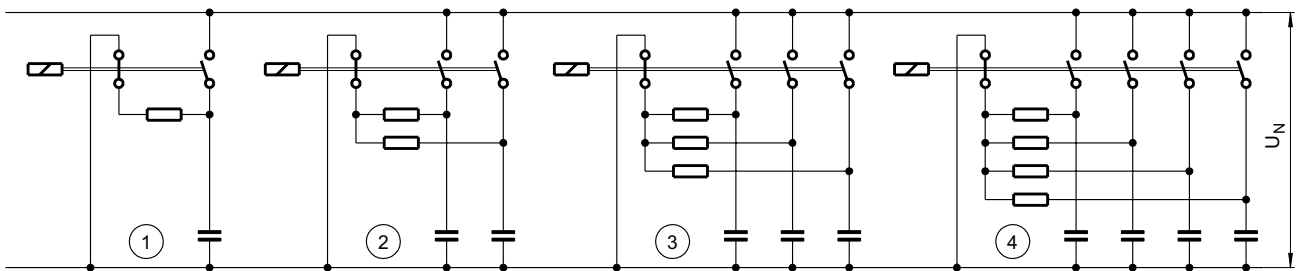
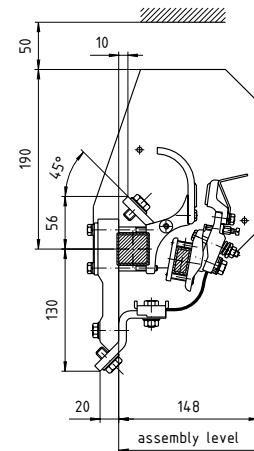


|                    |           |           |           |
|--------------------|-----------|-----------|-----------|
| area of connection |           |           |           |
| G 125              | 25x25-M10 | G 500     | 40x40-M12 |
| G 200              | 25x25-M10 | G 500/800 | 40x40-M12 |
| G 320              | 30x30-M10 | G 800     | 40x40-M12 |

section i-k  
(G 125/... - G 200/...)



section i-k  
(G 320/...)



## Manufacturing-program

|            |  |
|------------|--|
| 026/1      | pole-changing switches, change over switches, circuit breakers               |
| 145        | NF and MF high-current switches (air-cooled)                                 |
| 280        | NF and MF contactors for off-load switching                                  |
| 282        | Damping resistors  |
| 350/1      | DC- and NF-contactors for on-load switching                                  |
| 421        | Prism-contacts (air- and water-cooled)                                       |
| 427        | NF and MF high-current switches (watercooled)                                |
| 460        | insulator-supports and bus-bar-supports                                      |
| 467        | MF-contactors for on-load switching  |
| 475/1      | Prism-contacts (air-cooled)  |
| 502        | cable (air- and water-cooled)  |
| 506        | discharge- and dropping-resistors  |
| 507        | capacitor-contactor for on-load switching                                    |
| 549        | contactors with NC-contacts for on-load switching                            |
| 559        | Prism-contacts for the electrode-position                                    |
| 560        | spare parts  |
| 600        | pole-changing switches, with motor-drive (water-cooled)                      |
| 615        | NF and MF high-current circuit breaker for off-load switching (water-cooled) |
| <b>616</b> | <b><i>capacitor-contactor for on-load switching</i></b>                      |
| 617        | NF and MF high-current circuit breaker for off-load switching (air-cooled)   |
| 624        | contactors with NC-contacts off-load switching                               |
| 625        | DC-contactors with brake-contacts  |
| 641        | Air-cooled-current-carrying leads  |