



English version



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Technology of components used in heating.

Chapter 39

Table of different connection methods of heating elements

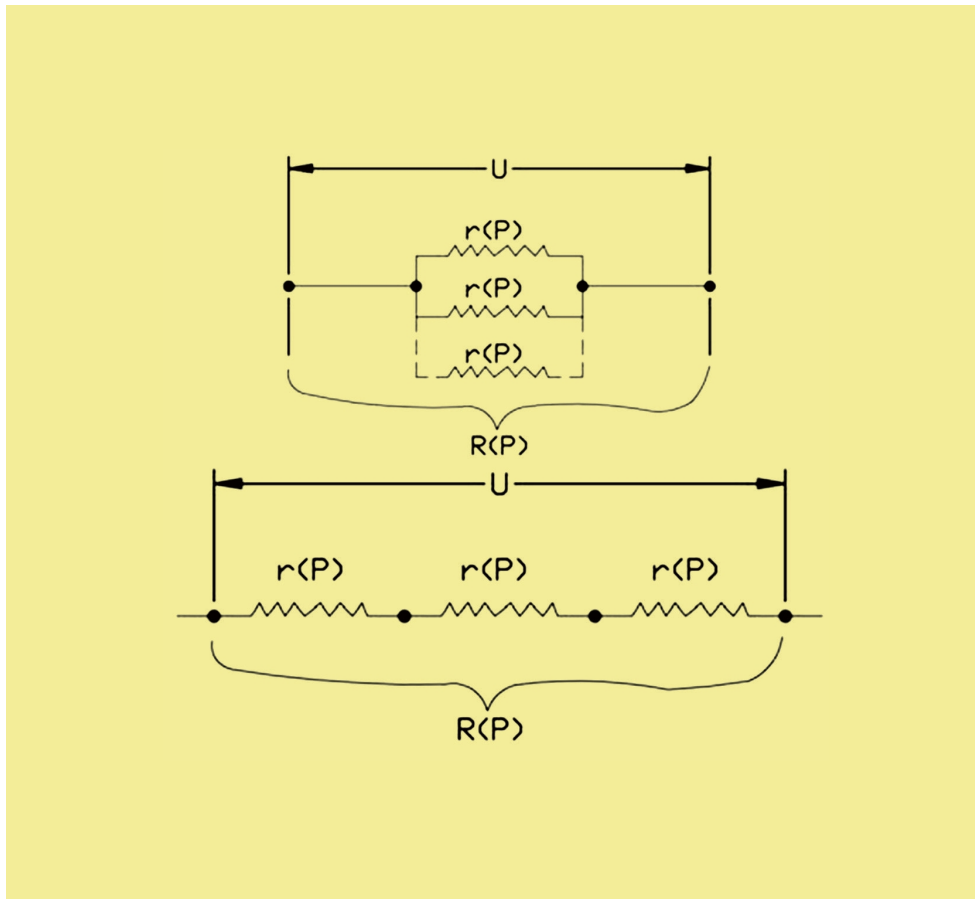
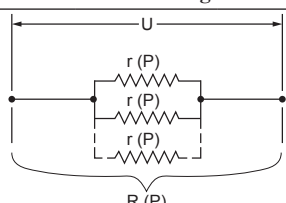
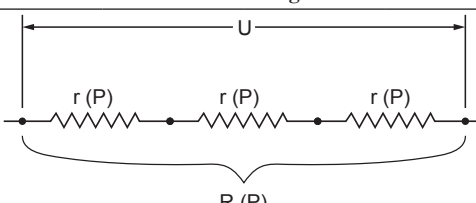


Table of different connection methods of heating elements

Power formula P = Power in watts U = Voltage I = Current in amperes	P = UI	OHM'S law U = Voltage R = Resistance in ohms I = Current in amperes	U = RI
$I = P/U \quad U = P/I \quad I = U/R \quad R = U/I \quad P = U^2/R \quad R = U^2/P$			

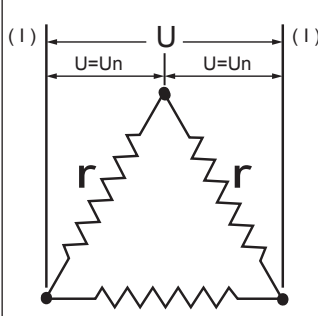
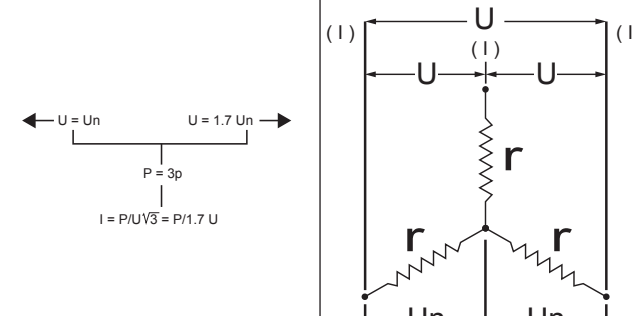
Heating elements connections

(Heating elements resistance "r" of unit power "p" with nominal voltage "U")

Parallel wiring			Serial wiring			
						
Quantity of elements (n)	Total resistance (R)	Total power (P)	Quantity of heating elements (n)	Total resistance (R)	Total power (P)	Heating element Watt density (w/cm ²)
2	$R = r/2$	$P = 2p$	2	$R = 2r$	$P = p/2$	Divided by 4
3	$R = r/3$	$P = 3p$	3	$R = 3r$	$P = p/3$	Divided by 9
X	$R = r/x$	$P = xp$	X	$R = Xr$	$P = p/x$	Divided by x ²

NOTE: Watt density (W/cm²) for each element is unchanged

Delta and star element connections

Delta connection					Star connection				
									
Delta (triangle) connection: The voltage measured at the heating elements terminal is the same than the power supply nominal voltage: U= Un					The voltage measured at the heating elements terminal is the power supply nominal voltage divided by √3: U= 1.737 (if U= 400V, Un=230V)				
Supply voltage (U)	230V, 3 phases	230V, 3 phases	400V, 3 phases	400V, 3 phases	Supply voltage (U)	230V, 3 phases	230V, 3 phases	400V, 3 phases	400V, 3 phases
Heating elements nominal voltage (Un)	230V	400V	230V	400V	Heating elements nominal voltage (Un)	230V	400V	230V	400V
Watt density (W /cm ²)	No change in watt density.	Watt density is divided by 3.	Watt density is multiplied by 6.	No change in watt density.	Watt density (W /cm ²)	Watt density is divided by 3.	Watt density is divided by 9.	No change in watt density.	Watt density is divided by 3.
Total power (P)	Total power is divided by 3 time nominal power of one heating element (P= 3 p).	Total power is divided by 9. It is 1/3 of nominal power of one heating element (P= p/3).	Total power is 9 time nominal power of one heating element (P= 9 p)	Total power is 3 time nominal power of one heating element (P= 3 p)	Total power (P)	Total power is 1/3 of total possible power: it is the same than one heating element (P=p)	Total power is 1/9 of total possible power. 1/3 nominal power of one heating element (P= p/3)	Total power is 3 time nominal power of one heating element (P= 3 p)	Total power is 1/3 of total possible power: it is the same than one heating element (P=p)
Comments	Solution without any technical problem .	This configuration can be used as the low power step in a Star/ Delta connection system.	Never use Fire hazard!	This is the most common configuration.	Comments	Not recommended	Not recommended	This is the most standard connection, allows the same heaters to be used with 400V star connection or 230V delta connection without power change	Not recommended