

Kanthal® Super Electric heating elements



Products and accessories

KANTHAL

Kanthal® Super Electric heating elements

Kanthal is a world-renowned brand within the field of electric heating technology. The Kanthal products offer possibilities for increased and quality improved production for furnaces while its long life cycle provides cost cutting due to less maintenance and service.

This handbook is an aid when installing and operating our Kanthal Super resistance elements that are designed for all types of electric heated industrial furnaces.

When we introduced the now world-famous Kanthal iron-chromium-aluminum electric resistance alloys in the early thirties this represented a considerable rise in the maximum operating temperature of metallic resistance elements.

Again, when Kanthal Super molybdenum disilicide (MoSi₂) heating elements were introduced in 1956, this represented a step upwards on the temperature scale for resistance elements.

Our aim has always been to constantly improve our materials to enable their use at still higher temperatures. Through intense research work, we have been able to raise this temperature from 1650°C (3000°F) element temperature in 1956, to 1850°C (3360°F) today.

Kanthal Super elements have proved to be very useful not only at high furnace temperatures, but also at lower temperatures, particularly in the field of heat treatment of metallic products in controlled atmospheres and melting of glass.

The fields of possible applications are virtually unlimited and have yet to be fully explored. With the increasing interest in electric heating, we can expect many new designs and applications in the future.

In addition to information on the properties of our Kanthal Super material this handbook will also provide data on our standard elements and instructions for element installation, operation, etc. Further, advice is given on furnace designs, and examples of actual Kanthal Super element installations are shown in the installation section.

The information provided in this handbook enables you to calculate and install the Kanthal Super elements and operate your furnaces. Following the instructions you will get an efficient and economical installation of our equipment in your heat treatment operations.

To get in contact with your local representative for further information, please visit www.kanthal.com or show this QR-code to your smartphone.



SPECIAL FEATURES

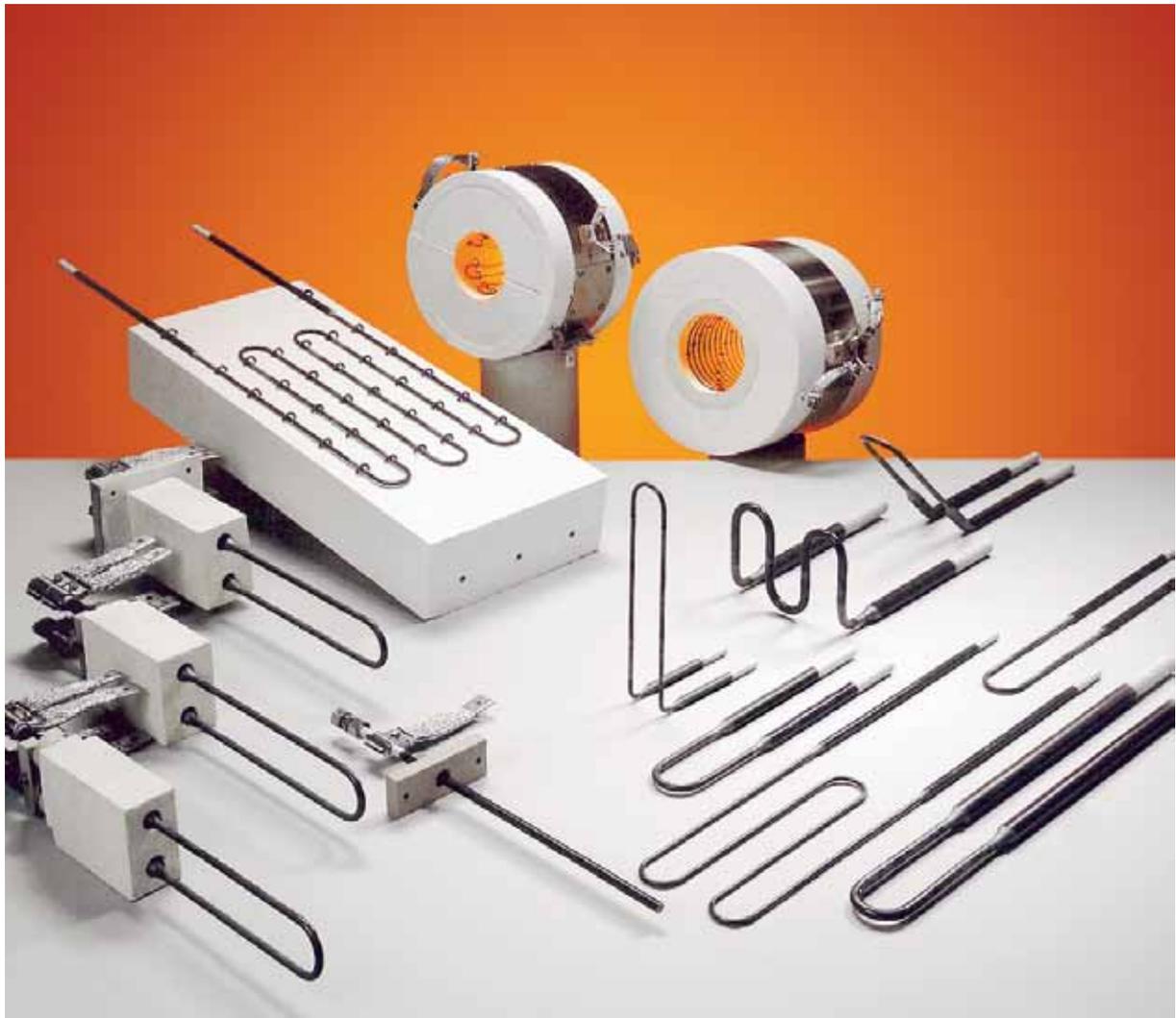
- Kanthal Super heating elements may be used in an oxidizing atmosphere up to an element temperature of 1850°C (3360°F)
- Long life combined with ease of replacing failed elements contributes to a high degree of utilization of the furnace and low maintenance costs
- New and old elements can be connected in series
- High power concentration may be applied
- Can be used continuously or intermittently
- Fast ramping

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Products and accessories



Range of Kanthal® Super 6/12, 9/18, 12/24 elements and Superthal™ heating modules.

This is Kanthal® Super

Kanthal Super is a dense cermet material consisting of molybdenum disilicide (MoSi_2) and an oxide component, mainly a glass phase.

Kanthal Super heating elements have the ability to withstand oxidation at high temperatures. This is due to the formation of a thin and adhesive protective layer of quartz glass on the surface. When MoSi_2 reacts with oxygen in the atmosphere, the layer of quartz glass is formed and under this a thin layer of molybdenum silicide with a lower silicon content Mo_5Si_3 .

When Kanthal Super elements are operated at temperatures around 1200°C (2190°F) the material becomes ductile, whilst at lower temperatures the material is more brittle.

The silica layer possesses the capacity to clean itself from adhering impurities. If the impurities react with silica, the melting point will be lowered. The contaminated layer then flows down the element and drops off. A new silica layer is, however, spontaneously rebuilt.

GRADES FOR DEMANDING APPLICATIONS

Kanthal program of MoSi_2 heating element includes several grades with specific features for use in demanding applications and atmospheres.

Kanthal Super 1700

Kanthal Super is a unique material combining the best properties of metallic and ceramic materials. Like metallic materials it has good heat and electrical conductivity and like ceramics it withstands corrosion and oxidation and has low thermal expansion. Maximum temperature 1700°C (3090°F).

Kanthal Super 1800

Same core characteristics as Kanthal Super 1700. Maximum temperature 1800°C (3270°F).

Kanthal Super 1900

Same core characteristics as Kanthal Super 1700, but has higher purity and a surface with better adhesion. Maximum temperature 1850°C (3360°F).

Kanthal Super ER

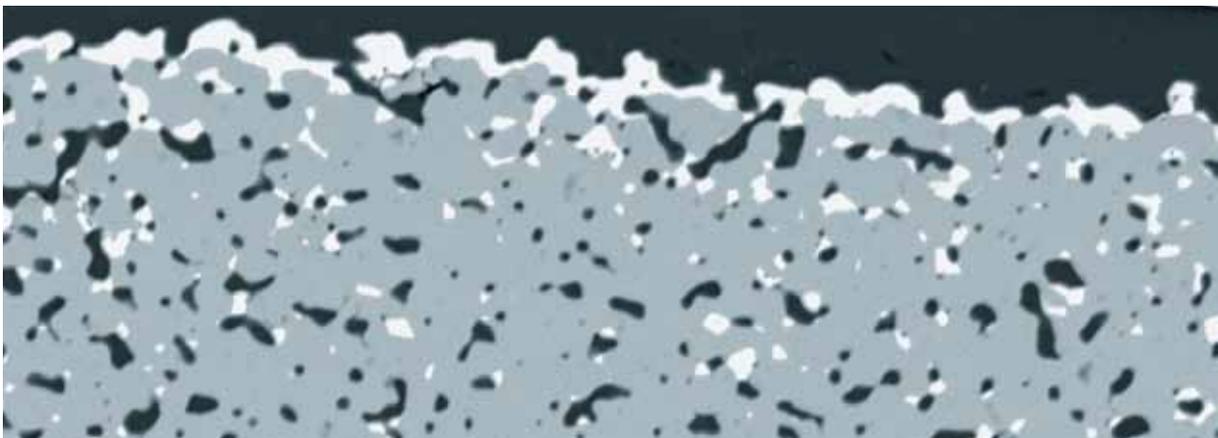
Kanthal Super ER is a new electric heating element with the unique ability to operate up to 1580°C (2875°F) directly in a wide range of furnace atmospheres from very dry reducing to oxidizing. With Kanthal Super ER heating elements it is possible, in just one furnace, to operate firing cycles where the atmosphere condition can be altered during the cycle between oxidizing, inert, carburizing, nitriding, reducing and rough vacuum.

Kanthal Super RA

Kanthal Super RA offers a long lifetime at high temperature in all reducing and oxygen deficient atmospheres. Specially designed for working in nitrogen atmosphere. Maximum temperature 1700°C (3090°F).

Kanthal Super HT

Kanthal Super HT is designed for a longer lifetime of small dimension elements in temperature cycling conditions. The hot strength and form stability is improved. The maximum operating temperature is 1830°C (3330°F), and the element is suitable for furnace temperatures between 1500 – 1750°C (2730 – 3180°F) approximately.



Microstructure of a Kanthal Super element. Grey = MoSi_2 , white = Mo_5Si_3 , dark = SiO_2 .

Properties

Kanthal Super is a unique material combining the best properties of metallic and ceramic materials.

Like metallic materials it has good heat and electric conductivity and like ceramics it withstands corrosion and oxidation and has a low thermal expansion.

It is not affected by thermal shock and is strong enough to withstand many years of service as a heating element.

RESISTIVITY

The resistivity of Kanthal Super increases sharply with temperature. This means that when the elements are connected to a constant voltage, the power will be higher at lower temperatures and will be gradually reduced with increasing temperature, thus shortening the time for the furnace to reach operating temperature. Furthermore, as the power of the elements decreases, the danger of overheating will be reduced.

The resistance of Kanthal Super elements does not change due to ageing even after having been in operation for a long time at high temperatures. There is only a slight reduction ($\approx 5\%$) during the first period of time.

Due to these properties a failed element can easily be replaced without the performance of other elements connected in series being influenced.

See page 8, diagram “Resistivity for Kanthal Super”.

Maximum element temperature for Kanthal Super

	Kanthal® Super ER	Kanthal Super 1700	Kanthal Super RA	Kanthal Super 1800	Kanthal Super HT	Kanthal Super 1900
Max. element temperature	1580°C (2875°F)	1700°C (3090°F)	1700°C (3090°F)	1800°C (3270°F)	1830°C (3330°F)	1850°C (3360°F)

The mechanical and physical properties of Kanthal Super

	Kanthal® Super ER	Kanthal Super HT	Other Kanthal Super
Tensile strength at 1550°C (2820°F)	–	100 MPa $\pm 25\%$	100 MPa $\pm 25\%$
Bending strength at 20°C (68°F)	450 MPa $\pm 10\%$	350–400 MPa $\pm 10\%$	450 MPa $\pm 10\%$
Compression strength at 20°C (68°F)	1400–1500 MPa	1400–1500 MPa	1400–1500 MPa
Fracture toughness, KIC, at 20°C (68°F)	3–4 MPam ^{1/2}	4 MPam ^{1/2}	3–4 MPam ^{1/2}
Hardness, HV, at 20°C (68°F)	9 GPa	8 GPa	9 GPa
Density	5.6 g/cm ³ 0.20 lb/in ³	7.0 g/cm ³ 0.25 lb/in ³	6.5 g/cm ³ 0.23 lb/in ³
Porosity	< 5%	< 1%	< 1%
Thermal conductivity 20–600°C (68–1110°F) 600–1200°C (1110–2190°F)	30 Wm ⁻¹ K ⁻¹ 15 Wm ⁻¹ K ⁻¹	30 Wm ⁻¹ K ⁻¹ 15 Wm ⁻¹ K ⁻¹	30 Wm ⁻¹ K ⁻¹ 15 Wm ⁻¹ K ⁻¹
Coefficient of linear expansion	7–8 $\times 10^{-6}$ K ⁻¹	7–8 $\times 10^{-6}$ K ⁻¹	7–8 $\times 10^{-6}$ K ⁻¹
Specific heat capacity at 20°C (68°F)	0.42 kJ kg ⁻¹ K ⁻¹	0.42 kJ kg ⁻¹ K ⁻¹	0.42 kJ kg ⁻¹ K ⁻¹
Emissivity	0.75–0.85	0.70–0.80	0.70–0.80
Resistivity as a function of temperature	See page 8, diagram “Resistivity for Kanthal Super”		

CHEMICAL RESISTANCE

Atmospheres

Kanthal® Super can be used in most furnace atmospheres. Most favorable are oxidizing atmospheres such as air, carbon dioxide and water vapor, but Kanthal Super elements are also operating successfully in neutral, reducing and carburizing atmospheres.

The diagram below indicates the maximum recommended element temperatures in some common types of furnace atmospheres and gases.

Air

At low temperatures, an oxidation of molybdenum and silicon on the surface of the elements can occur at temperatures around 500°C (930°F). The oxidation product is a yellowish powder, MoO₃, and has normally no detrimental effect on the performance of Kanthal Super elements.

Water vapor and carbon dioxide

Water vapor and carbon dioxide in any amount in the atmosphere have an oxidizing effect. The presence of water vapor in a controlled atmosphere increases the maximum permissible operating temperature.

Sulphur dioxide

This gas sometimes occurs as an impurity in the atmosphere. It normally has no harmful effect on Kanthal Super elements.

Endogas

A typical gas composition is: 20% CO, 40% H₂ and balance N₂. Since hydrogen is present in this gas composition, the dew point and gas velocity are important for determining the maximum temperature. A heating solution with Kanthal Super ER is recommended.

Carburizing atmosphere

Kanthal Super elements are widely used in carburizing furnaces. The elements are not attacked by the atmosphere which normally consists of an endogas or nitrogen with controlled additions of a carburizing gas such as propane or methanol.

In this type of furnace, the element temperature is normally kept below 1400°C (2550°F). If carbon is built up in the furnace because of high carbon potential, it can lead to element failure. Regular removal of the carbon by firing the furnace under oxidizing conditions is recommended.

Nitrogen atmosphere

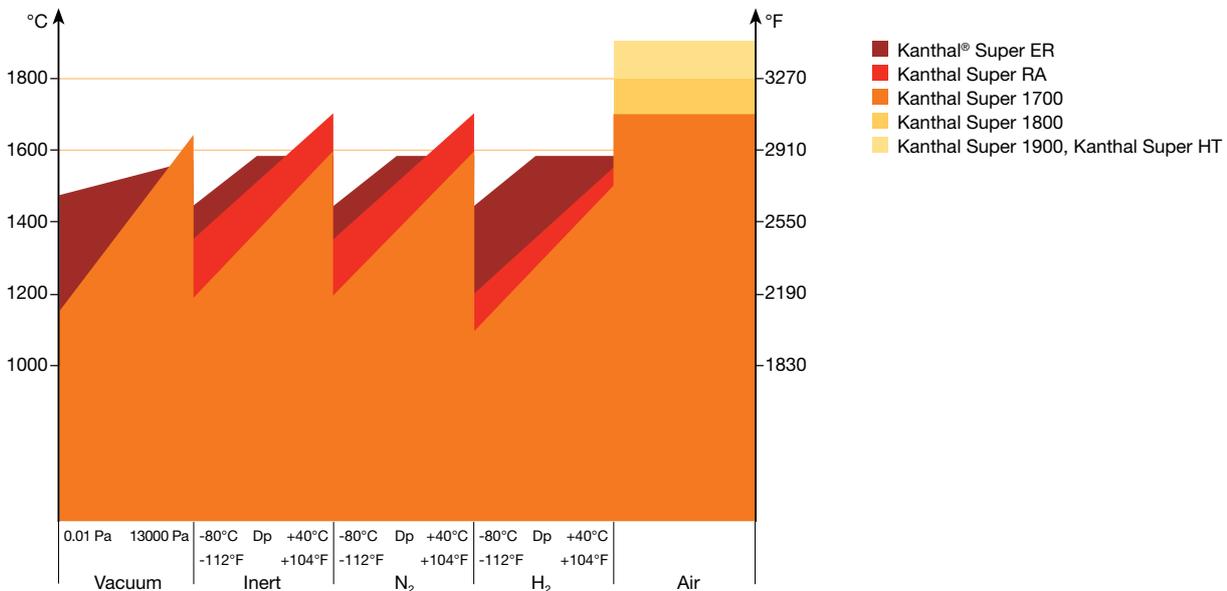
Nitrogen is used for different purposes such as:

- Nitration of ceramics (reaction)
- Protective gas
- Balancing furnace atmospheres

In the element temperature range of 1250–1550°C (2280–2820°F), nitration of ceramics usually occurs. At such temperatures, when the protective glaze is consumed, silicon in the silicide of the element may react with nitrogen forming silicon nitride (Si₃N₄), which could damage the element by scaling. The elements to be used for this purpose should be specially heat treated by Kanthal in order to reduce nitrogen penetration into the material. This treatment is always advisable when operating in nitrogen and when the dew point is low.

With operation below 1250°C (2280°F) element temperature the reaction is minor. Above 1500°C (2820°F) up to 1700–1800°C (3090–3270°F) the performance of the element very much depends on dew point and time at temperature. In cyclic conditions where the time at temperature is short, the oxide layer on elements can be restored by operating for a short time in air.

Maximum recommended element temperature in different atmospheres



When operating for extended periods at temperature (continuous furnaces), the actual formation of a thin layer of Si_3N_4 at the surface of the elements, offers the best protection against further gaseous reaction. When special heat treatment is recommended, it can usually be performed in the furnace where the elements are installed, by operating them in air above 1550°C (2820°F) element temperature for a couple of hours.

A heating solution with Kanthal Super RA is recommended when running a continuous operation. When running continuous or cyclic operations, a heating solution with Kanthal Super ER is recommended.

Noble gases, argon and helium

These gases are inert and do not react chemically with Kanthal Super. However, if there is a gas flow around the elements, it will disturb the chemical equilibrium existing around the elements. At high temperatures the glaze is consumed. When using these gases, a regeneration of the glaze is recommended before the old glaze has disappeared completely. A heating solution with Kanthal Super ER is recommended.

Hydrogen

In dry hydrogen the silica layer is reduced and MoSi_2 disintegrates by forming gaseous silicon and silicides with lower silicon content. This reaction is dependent on temperature and the reduction potential of the hydrogen gas. By increasing the dew point the maximum permissible element temperature can be increased (see page 6, diagram "Maximum element temperature in hydrogen atmospheres"). Installation of the elements in niches can reduce the gas flow around the elements, and this can help to reduce the chemical attacks. A heating solution with Kanthal Super ER is recommended in dry hydrogen atmosphere.

Nitrogen and hydrogen

The mixture of these gases should be considered as hydrogen. Although nitrogen reduces the reactivity of hydrogen, the effect of hydrogen is considerable, especially with extended periods in operation. The dew point of the gas mixture and the gas velocity are always very important (see page 6, diagram "Maximum element temperature in hydrogen atmospheres"). Special heat treatment will improve the performance. A heating solution with Kanthal Super ER is recommended.

Fluorine and chlorine

These halogens attack Kanthal Super strongly, even oxidized elements, already at temperatures below 600°C (1110°F). Both fluorine and chlorine can be formed by dissociation of organic compounds, which may often enter the furnace together with unclean products.

Vacuum

Kanthal Super elements are not suitable for operation in a high vacuum at high temperatures due to silica vaporization. (Page 6, diagram "Maximum element temperature in vacuum") shows the maximum permissible

element temperatures at different air pressures. A heating solution with Kanthal Super ER is recommended.

Metals

All metals in direct contact with Kanthal Super react with MoSi_2 , forming silicides. At higher furnace temperatures, vapors from molten metal, (zinc, copper, bronze) may also attack the elements. Dust from metal oxides in the furnace atmosphere reacts with the glaze. It is also important that the elements are protected from splashes of molten metal. Any metal or alloy with a melting point lower than approximately 1300°C (2370°F) may be melted in a Kanthal Super furnace if necessary precautions are taken. In small crucible furnaces where the elements are protected from metal fumes approx. 1550°C (2820°F) is possible.

Alkali

Compounds such as K_2O and Na_2O in the furnace atmosphere will act as a fluxing agent on the silica layer and attack the elements. Their salts also attack elements which may occur in glass melting furnaces.

The choice of lining material for furnaces operating at temperatures above $1550\text{--}1600^\circ\text{C}$ ($2820\text{--}2910^\circ\text{F}$) in particular is very important. Castables always contain alkalis. Due to how these are chemically bound in the castable they could be more or less aggressive to the Kanthal Super elements.

Avoid castables containing alkali above $1550\text{--}1600^\circ\text{C}$ ($2820\text{--}2910^\circ\text{F}$) furnace temperature.

Ceramics

As the operating temperature of Kanthal Super elements is normally rather high, reactions can easily take place between the silica layer on the element surface and most salts and oxides. This is of particular importance when the elements are supported by ceramics. The ceramics in these cases must consist of stable compounds, silicates, which do not react with silica. Suitable ceramics are sillimanite and mullite. At element temperatures exceeding 1600°C (2910°F) reactions can nevertheless occur. This element temperature should not be exceeded when the element rests on a ceramic support.

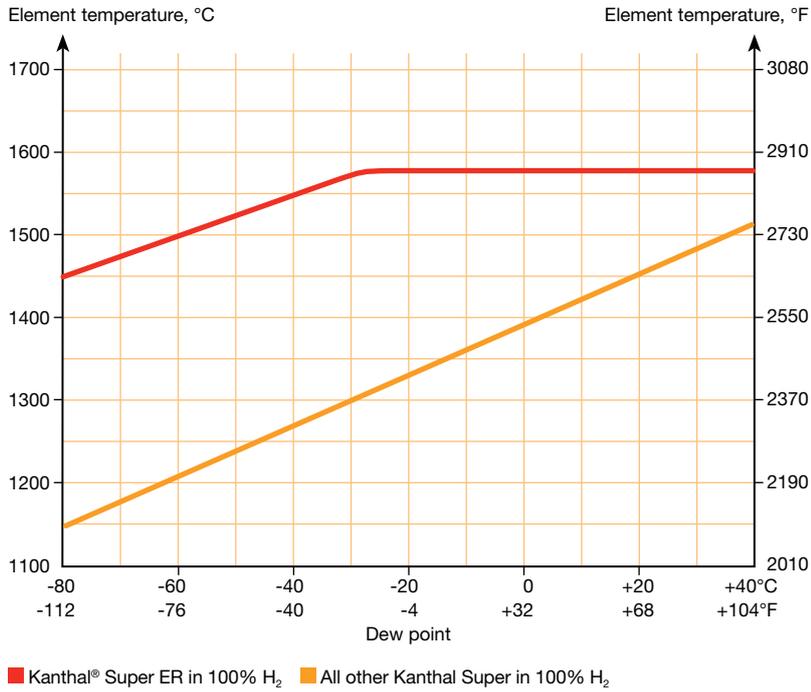
Firing of ceramics

Green ceramics (before firing) contain binders or similar, which during firing fume off, developing residual products. These residual products must be removed in order to minimize the contamination of furnace atmosphere and walls. At higher element temperatures, these residual products may attack the elements.

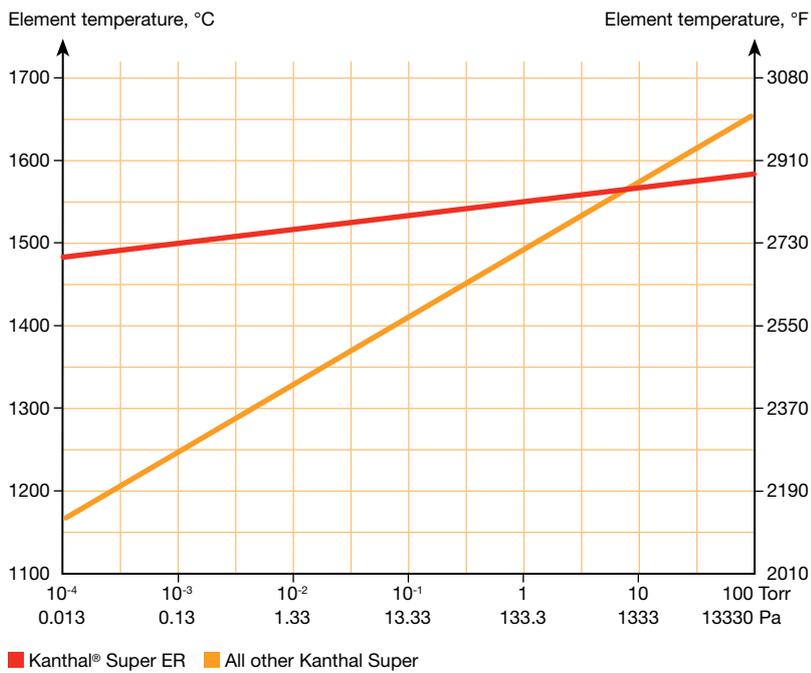
Glass

The atmosphere in a glass furnace normally has a slightly fluxing effect on the silica layer, thus lowering the viscosity and causing the glaze to flow slowly down the element. However, this normally has no detrimental effect on the life of the element.

Maximum element temperature in hydrogen atmospheres



Maximum element temperatures in vacuum



Performance

TEMPERATURE DEPENDENCE OF RESISTIVITY

The diagram on page 8 shows that the resistivity of Kanthal® Super increases sharply with temperature.

ELEMENT SURFACE LOAD

The curves shown in the diagrams on page 9, which apply to furnaces with suspended, freely radiating Kanthal Super elements show the approximate element temperature at various furnace temperatures, element surface loads and currents.

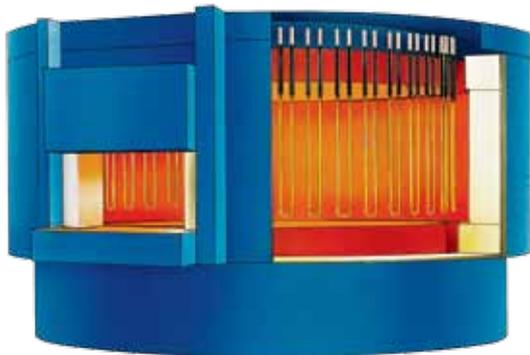
For example, at an element surface load of 14.4 W/cm^2 (92.9 W/in^2) and a furnace temperature of 1300°C (2370°F) the element temperature of Kanthal Super 1700 will be 1525°C (2780°F) with a current of 156 A for 6 mm \varnothing and 286 A for 9 mm \varnothing .

WALL LOADING

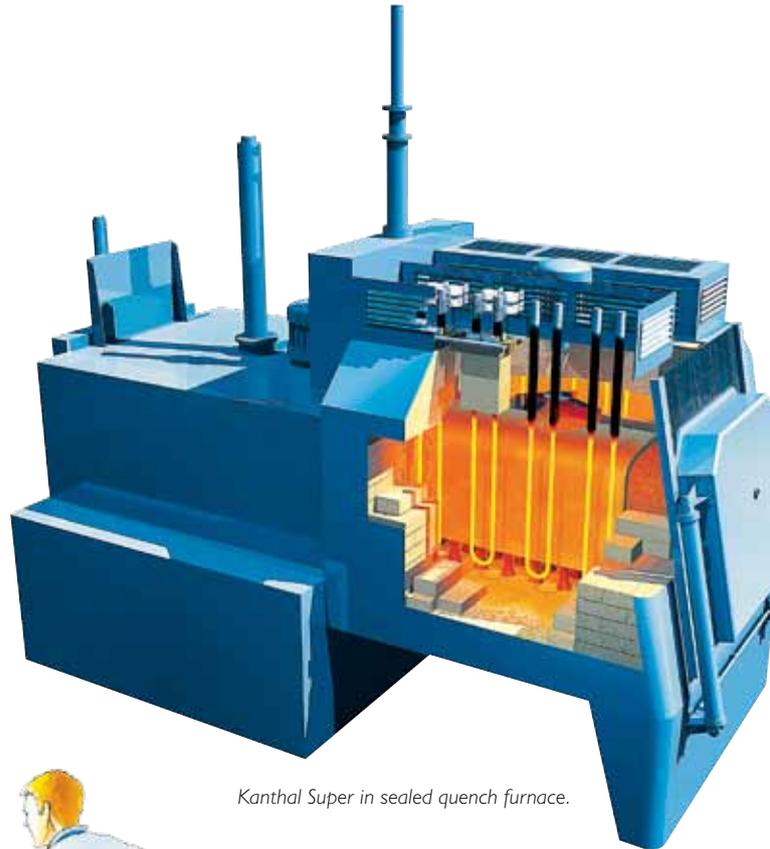
A characteristic property of furnaces equipped with Kanthal Super elements is that the surface load on the furnace walls can be much higher than with metallic elements. This is due to the high maximum operating temperature of the Kanthal Super elements. Consequently, the heating-up time can be considerably reduced.

The wall loading is also dependent on how the elements are installed: along the walls or perpendicular.

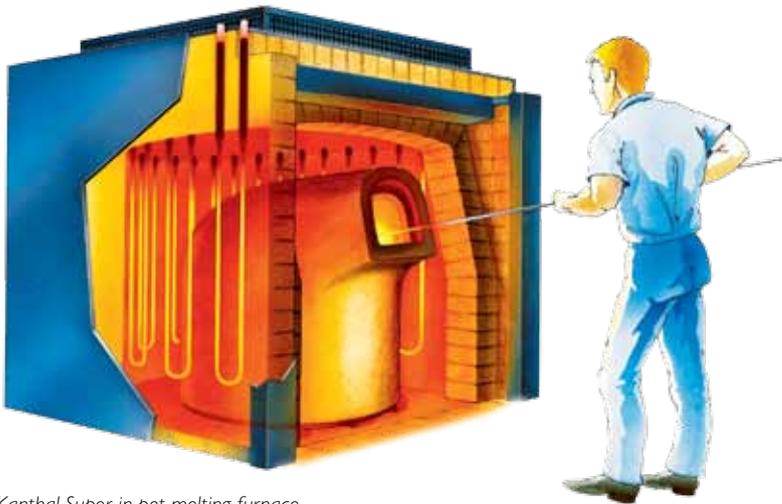
The diagrams on page 10 shows maximum recommended wall loading as a function of the furnace temperature for different element diameters and mode of installation.



Kanthal Super in rotary hearth furnace.



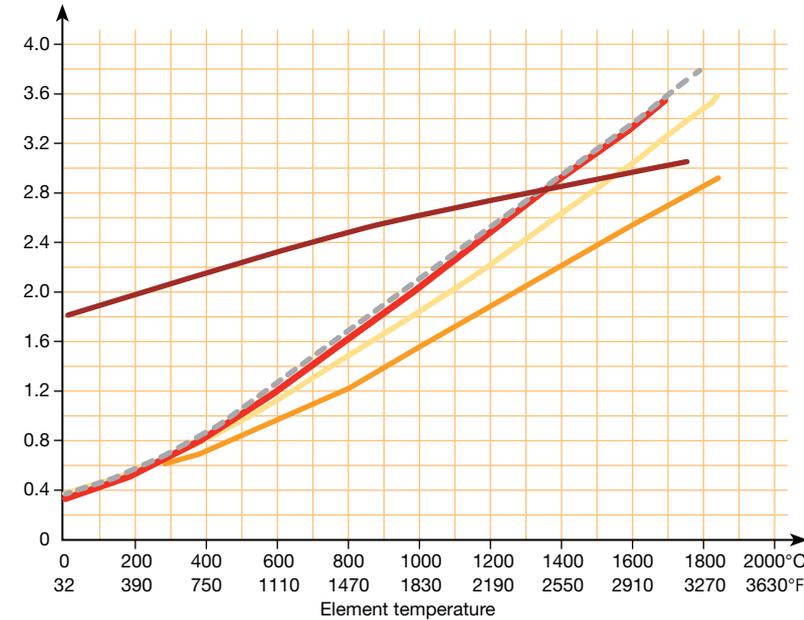
Kanthal Super in sealed quench furnace.



Kanthal Super in pot melting furnace.

Resistivity of Kanthal® Super

Resistivity, $\Omega \text{mm}^2/\text{m}$



$$r = \frac{\rho \times l \times 4}{\pi \times d^2}$$

r = resistance, Ω/m
 ρ = from diagram
 l = rod length, m
 d = diameter, mm

- Kanthal® Super ER
- Kanthal Super 1700 and RA
- Kanthal Super HT
- Kanthal Super 1800
- Kanthal Super 1900

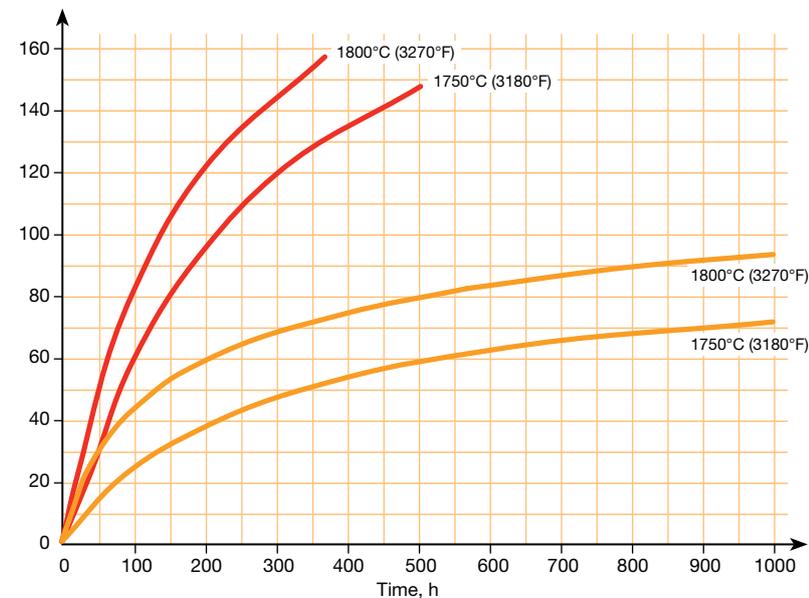
OXIDE GROWTH

For Kanthal Super grades the oxide growth at certain temperature as function of time have a parabolic growth. The growth of the oxide layer, the glaze, of Kanthal Super HT is much reduced, compared to Kanthal

Super 1800 and 1900, see diagram below. A thin oxide layer results in a much-improved service life, because the tension is reduced between the base material and the surrounding oxide, depending on the different thermal expansion coefficient.

Oxidation properties

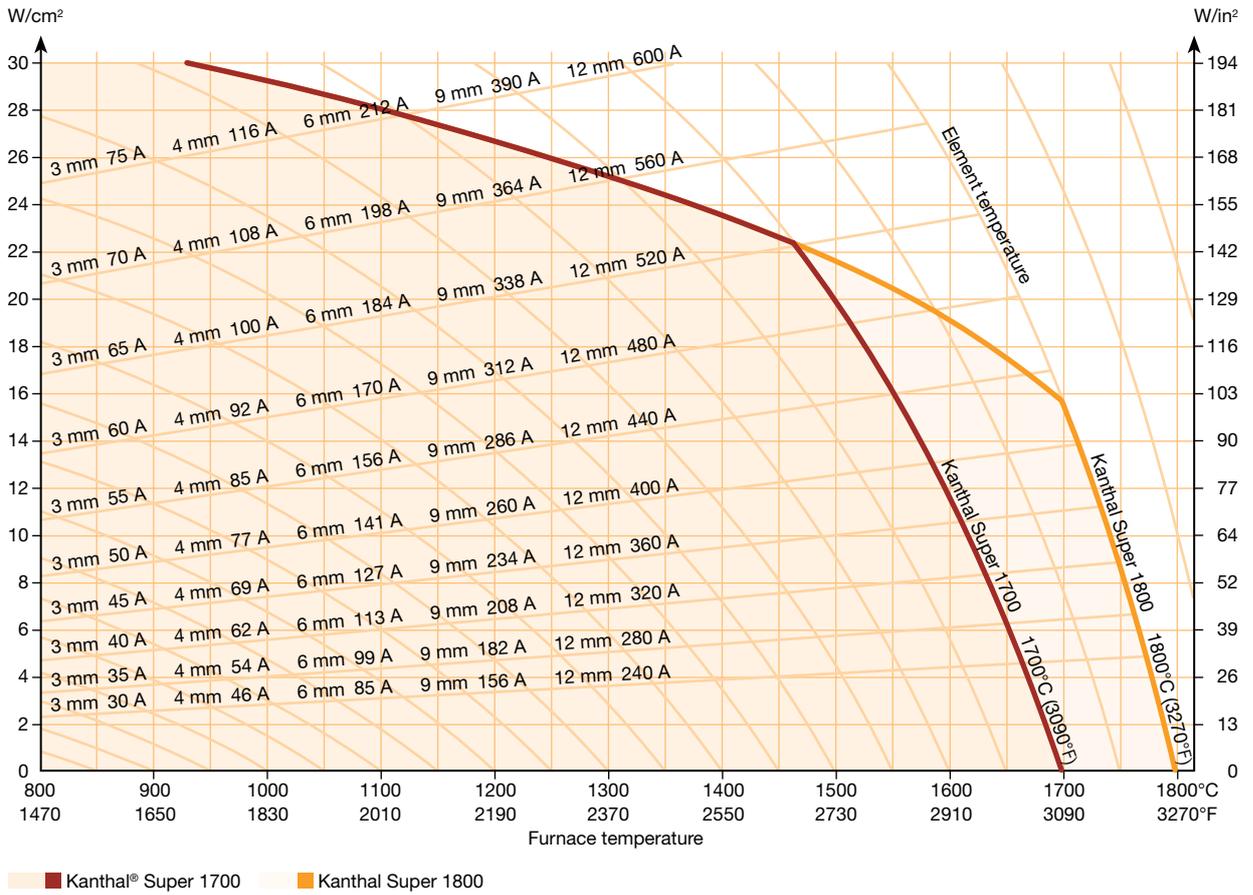
Oxide thickness, μm



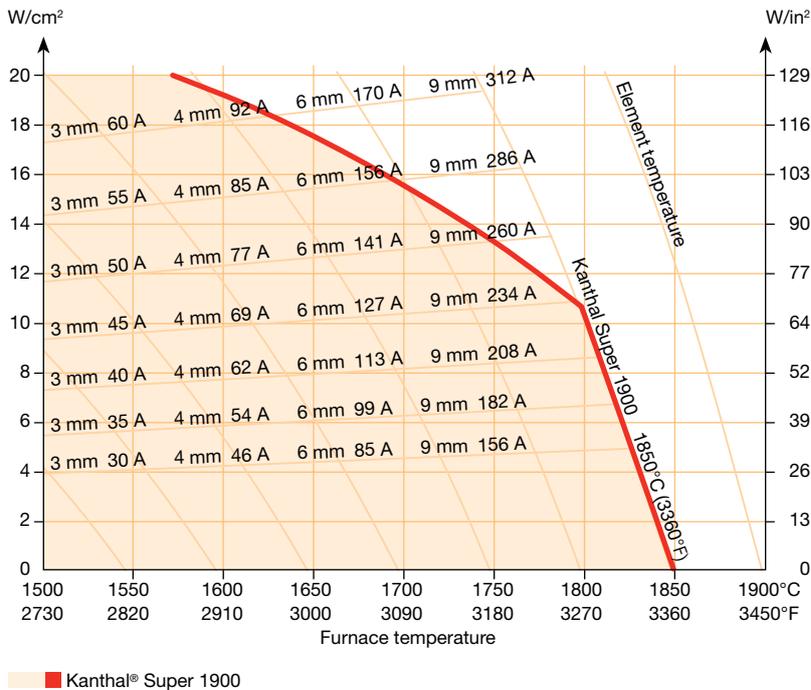
- Kanthal® Super HT
- All other Kanthal Super

TEMPERATURE LOADING DIAGRAMS

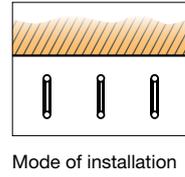
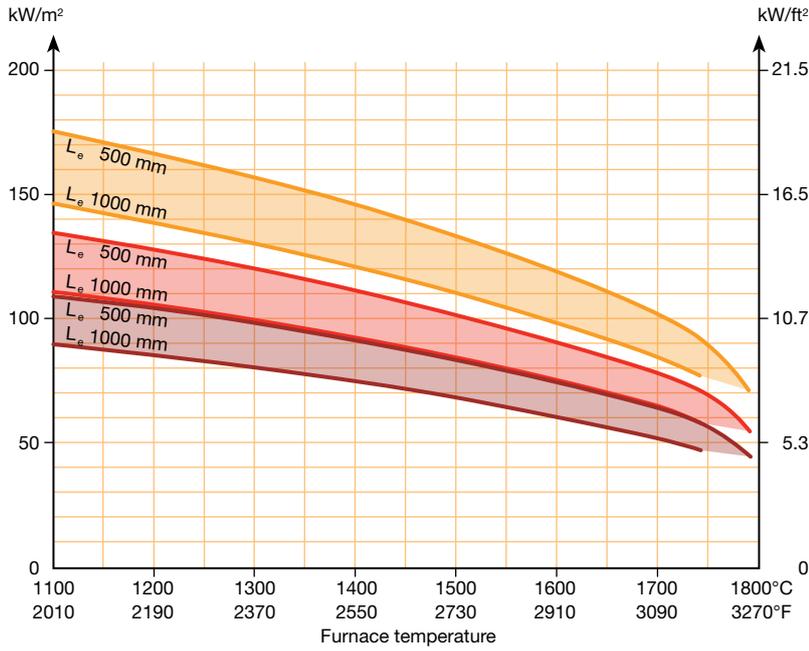
Temperature loading diagram for Kanthal Super 1700 and 1800



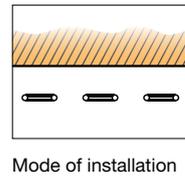
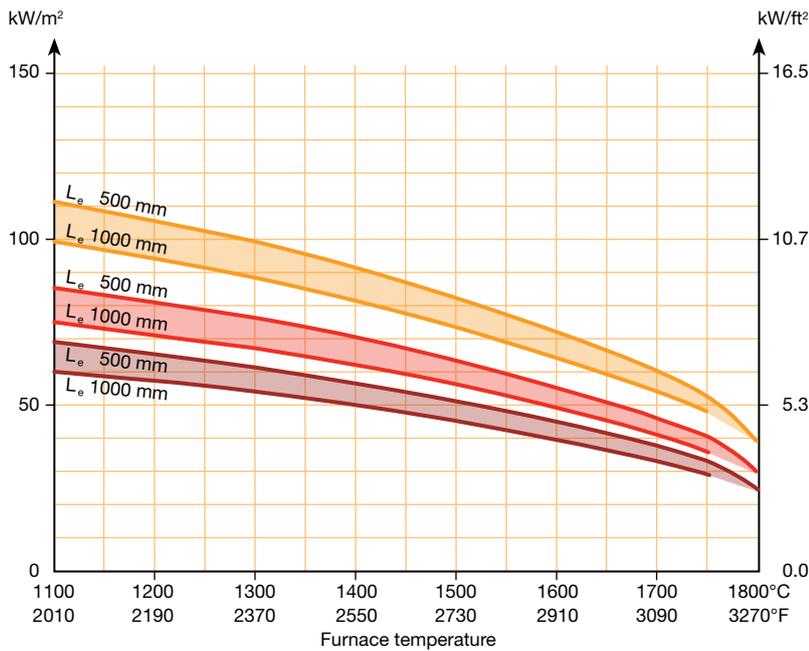
Temperature loading diagram for Kanthal Super 1900



Maximum recommended wall loading as a function of the furnace temperature for different element diameters and mode of installation



Element diameter: ■ 6/12 ■ 9/18 ■ 12/24



Element diameter: ■ 6/12 ■ 9/18 ■ 12/24

NECESSARY DISTANCES

Distance to wall

It is important that the distance between wall and heating zone of the element is large enough to avoid contact. In the case of long elements at high temperatures, electromagnetic forces and bad centering when installing the elements may cause the elements to come in contact with the walls, causing damage.

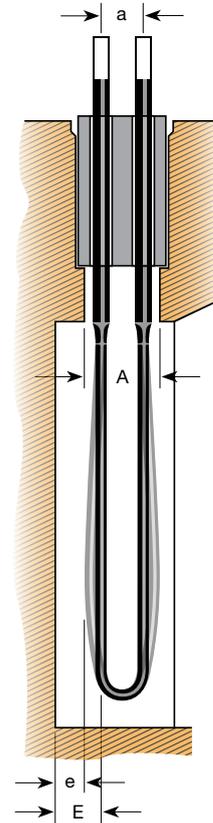
The minimum distance, e, between the heating zone of the element and the furnace walls depends on the length of the element (see the figures to the right).

When installed *along the wall* it is:

- For $L_c < 1000$ mm (39.4 in); $e = L_c/20$
- For $L_c < 300$ mm; $e = \text{min. } 15$ mm (0.6 in)
- For $L_c > 1000$ mm (39.4 in); $e = \text{min. } 50$ mm (1.97 in)

When installed *perpendicular to the wall*, the deformation due to the electromagnetic forces must also be considered. The reason is that the deformation causes reduction of the distance between part of the heating zone and the wall. After calculating the magnitude of deformation (see the figure on page 12 “Deformation of Kanthal® Super elements”), the distance E can be calculated and e is estimated in the same way as for elements installed parallel to the wall.

$$E_{\text{min}} = e + \frac{A - a}{2}$$



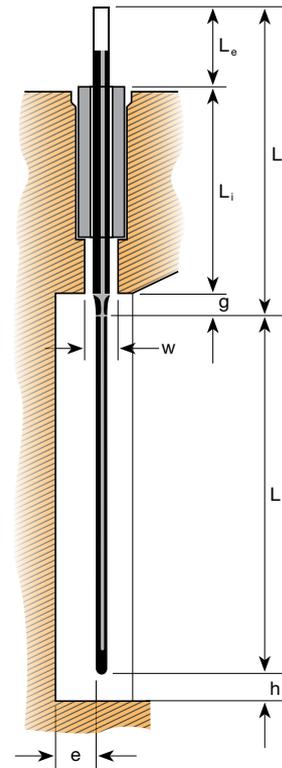
Distance to bottom

In order to prevent the elements from coming into contact with any material deposited on the bottom of the furnace and to compensate for the elongation of the elements at high temperatures, the recommended vertical distance h between the element bend and the furnace floor should be at least:

$$h \geq \frac{L_c}{20}; \text{ min. } 10 \text{ mm}$$

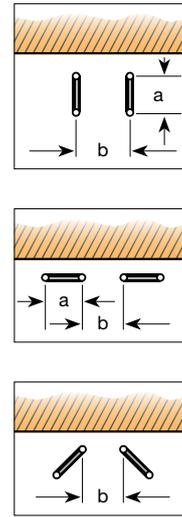
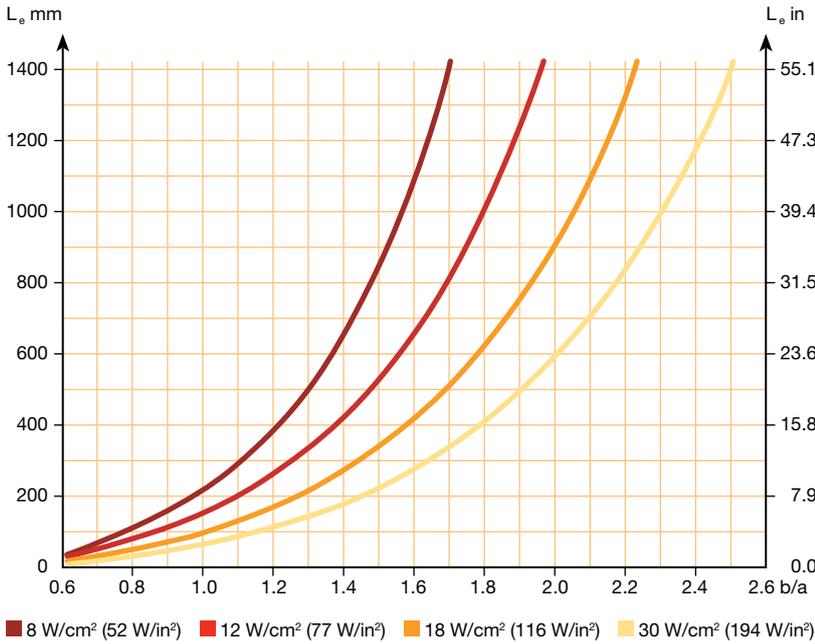
Distance between elements

Minimum distances, b, between adjacent elements are given in the figure on page 12 “Necessary distances”.

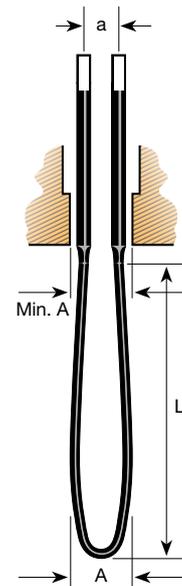
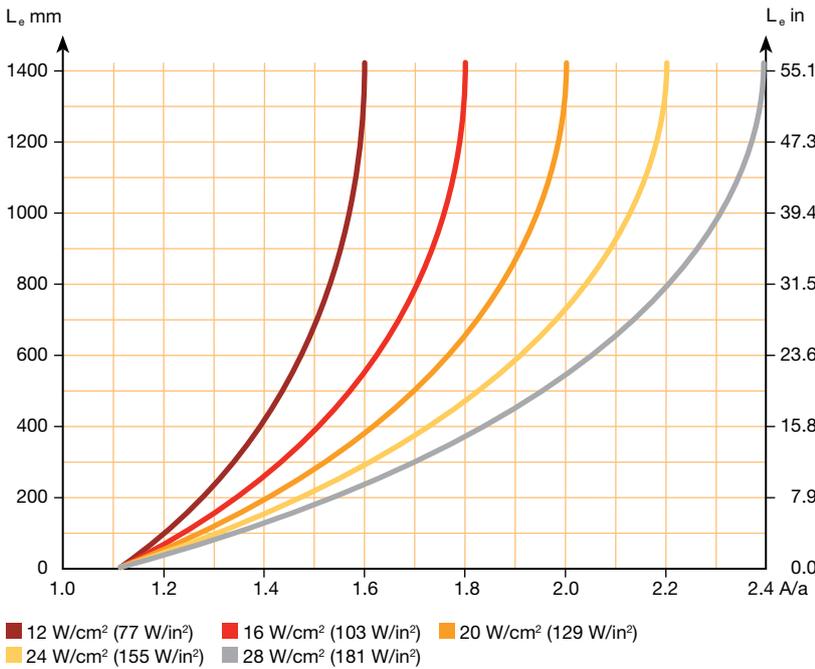


Installation parameters.

Necessary distances, b , to counteract the effect of the electromagnetic force on Kanthal® Super elements



Deformation of Kanthal Super elements due to electromagnetic forces, valid for all sizes



Important installation parameters for passage brick and skew brick

Element size	3/6		4/9		6/12		9/18		12/24	
	mm	in	mm	in	mm	in	mm	in	mm	in
Hole diameter of passage brick	9	0.35	12	0.5	15	0.6	23	0.9	30	1.2
Recommended min. width of opening in skew brick, w	15	0.6	20	0.8	25	1.0	30	1.2	40	1.6

The minimum length of opening A is calculated according to the diagram above.

Elements and tubes

The most commonly used design is a two-shank U-shaped element (fig. 1, page 14). The heating zone is welded to terminals which normally have a diameter double that of the heating zone.

The two-shank element can be bent 45° or 90° either in the heating zone or in the terminals (fig. 2–5, pages 14–15).

Four-shank elements are used only horizontally (fig. 5).

Kanthal Super is also available as a Superthal™ heating unit.

TWO-SHANK ELEMENTS

Two-shank elements with straight terminals are defined by:

- The quality
- Heating zone diameter, mm (in)
- Terminal diameter, mm (in)
- Terminal length, L_u , mm (in)
- Heating zone length, L_e , mm (in)
- Center distance between shanks, a , mm (in)

Example:

Kanthal Super 1700 9/18 $L_u = 450$ mm (17.7 in)
 $L_e = 560$ mm (22 in)
 $a = 60$ mm (2.36 in)

The maximum length of the heating zone depends on the element temperature. The diagram on page 16, “Maximum recommended heating zone lengths”, shows the maximum recommended heating zone lengths for vertically suspended 6/12, 9/18 and 12/24 elements.

* Note: 3/6 and 4/9 mm Kanthal Super 1800 elements are not normally manufactured with a heating zone L_e longer than 400 mm (15.8 in).

Two-shank bent elements

Bent elements are used when the electrical connections for some reason cannot be made above the roof. When

the furnace is too high to permit installation of elements suspended from the roof, due to the limitation regarding the maximum permitted heating zone length, it may also be necessary to install elements with bent terminals or heating zones. By installing several rows of such elements it is also possible to control the power at different levels in the furnace.

The terminals are supported by brick or fiber, which normally limits the maximum temperature to 1600°C (2910°F) furnace temperature.

FOUR-SHANK ELEMENTS

Four-shank Kanthal Super 1700 elements for horizontal use

In many cases, particularly in furnaces with a low chamber height, the best choice is horizontally mounted elements.

The advantage of this shape is that fewer elements are needed than in the case of two-shank elements, with lower terminal losses, making the four-shank elements more economical. Maximum element temperature 1600°C (2910°F). Available as 6/12, 9/18 and 12/24 elements.

Four-shank elements with straight terminals (fig. 5, page 15) are defined by:

- The quality
- Heating zone diameter, mm
- Terminal diameter, mm
- Terminal length, L_u , mm (in)
- Heating zone length, L_e , mm (in)
- Heating zone length, B , mm (in)
- Center distances between shanks, a , mm (in)

Example:

Kanthal Super 1700 9/18 $L_u = 450$ mm (17.7 in)
 $L_e = 450$ mm (17.7 in)
 $B = 400$ mm (15.8 in)
 $a = 3 \times 60$ mm (3×2.36 in)

Range of Kanthal Super elements

Grade	Element size, mm heating zone diameter/terminal diameter				
	3/6	4/9	6/12	9/18	12/24
Kanthal® Super 1700	–	–	•	•	•
Kanthal Super 1800	•	•	•	•	•
Kanthal Super 1900	•	•	•	•*	–
Kanthal Super RA	–	–	•	•	•
Kanthal Super ER	•	•	•	•	–
Kanthal Super HT	•	•	•	–	–

* 9/12/18

Terminal shapes

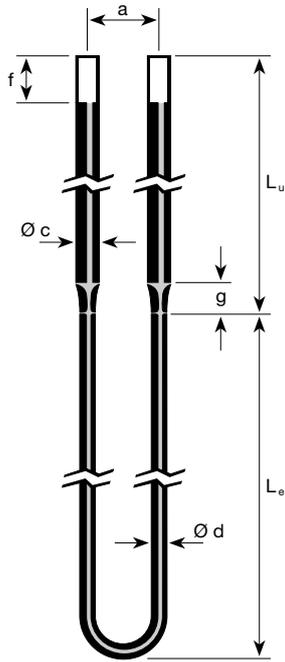


Fig. 1 Straight terminals.

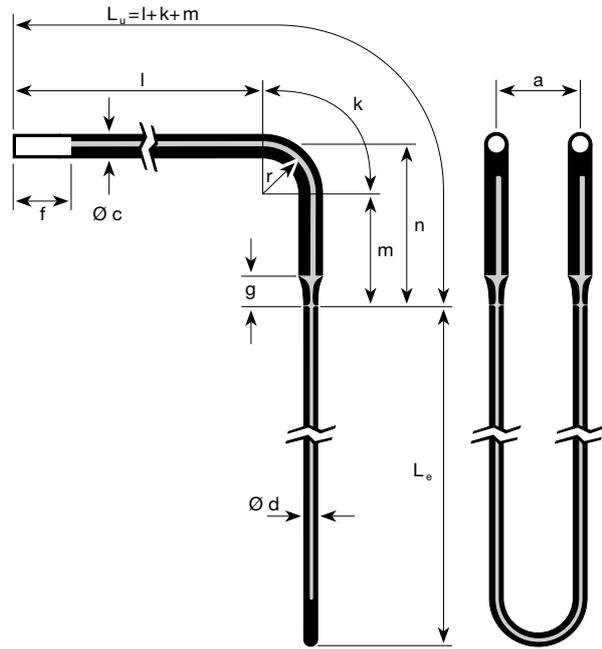


Fig. 2 Element bent 90° at the terminals.

The following parameters are valid for all Kanthal® Super elements (metric)

Element size	a, mm		c, mm	d, mm	f, mm	g, mm	k _{90°} , mm	k _{45°} , mm	m, mm	n, mm		r, mm	
	Stand.	Min.								Stand.	Min.	Stand.	Min.
3/6	25	16	6	3	25	15	19	9	30	42	30	12	
4/9	25	19	9	4	25	15	19	9	35	47	42	12	
6/12	50	26	12	6	45	25	47	24	60	90	70	30	20
9/18	60	38	18	9	75	30	71	35	90	135	100	45	30
12/24	80	54	24	12	100	40							

Dimensional tolerances ± 5% (except c and d)

The following parameters are valid for all Kanthal Super elements (imperial)

Element size	a, in		c, in	d, in	f, in	g, in	k _{90°} , in	k _{45°} , in	m, in	n, in		r, in	
	Stand.	Min.								Stand.	Min.	Stand.	Min.
3/6	0.98	0.63	0.24	0.12	0.98	0.59	0.75	0.35	1.18	1.65	1.18	0.47	
4/9	0.98	0.75	0.35	0.16	0.98	0.59	0.75	0.35	1.38	1.85	1.65	0.47	
6/12	1.97	1.02	0.47	0.24	1.77	0.98	1.85	0.94	2.36	3.55	2.76	1.18	0.79
9/18	2.36	1.50	0.71	0.35	2.95	1.18	2.80	1.38	3.71	5.31	3.94	1.77	1.18
12/24	3.15	2.13	0.95	0.47	3.94	1.57							

Dimensional tolerances ± 5% (except c and d)

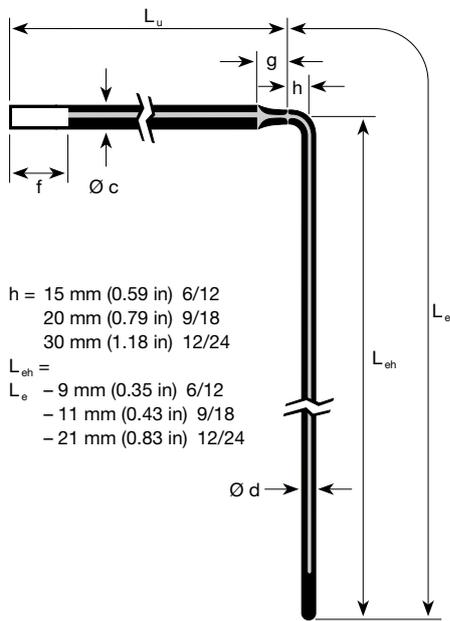


Fig. 3 Element bent 90°.

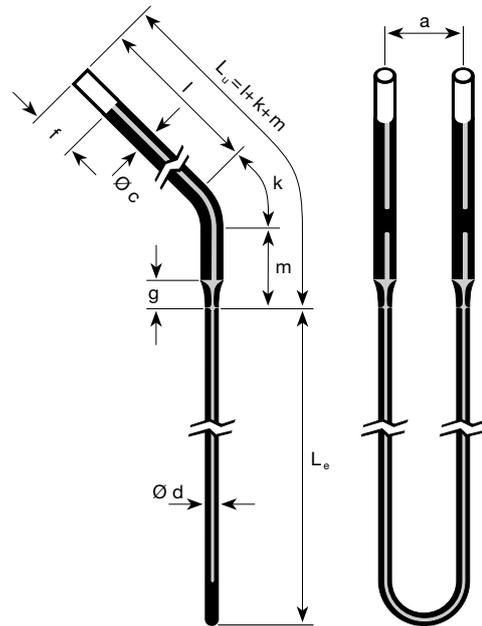


Fig. 4 Element bent 45° at the terminals.

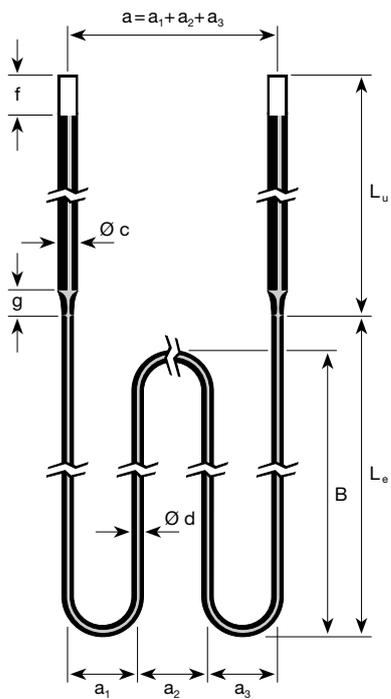
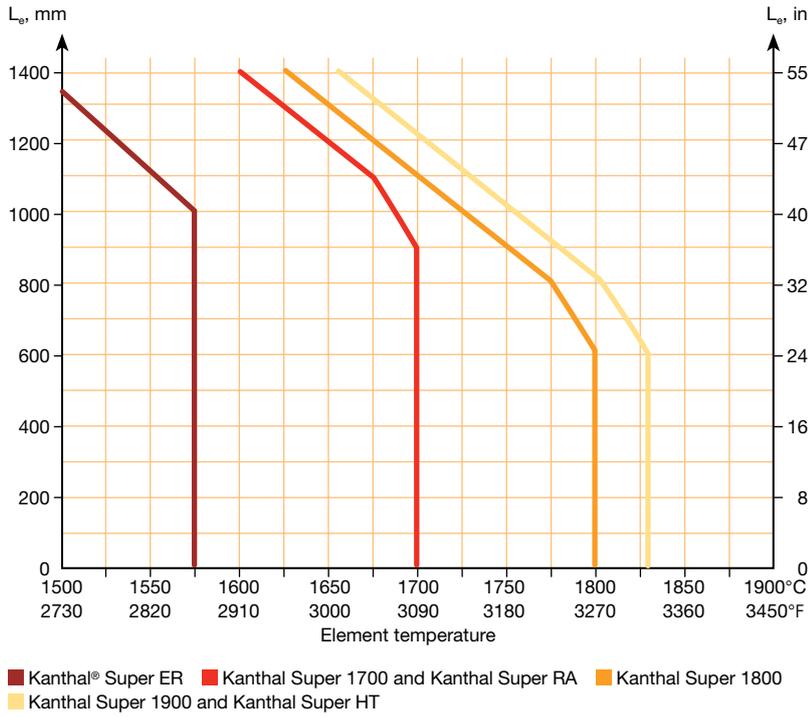


Fig. 5 Four-shank element for horizontal use.

Maximum recommended heating zone lengths for vertically suspended 6/12, 9/18 and 12/24 mm elements



TUBES

Tubes are normally manufactured in a quality corresponding to Kanthal® Super 1700. As the same material is used in the tubes as in the elements the data regarding properties previously given in the handbook is also valid for tubes. Standard sizes are manufactured as per table to the right.

Maximum lengths

For outer diameter 7–25 mm (0.28–0.98 in) maximum 2000 mm (78.7 in).

Kanthal Super bubble tubes

The standard Kanthal Super bubbler tube has an ID of 3 mm (0.12 in) and OD 12 mm (0.47 in). Some glass works inquire smaller end holes for generation of smaller air bubbles.

Kanthal can now supply 12/3 tubes with a 5 mm (0.20 in) welded end cap with a min 0.7 mm (0.03 in) hole made by water jet.

Kanthal Super typical tube sizes

Outside diameter ± 5%		Inside diameter ± 5%	
mm	in	mm	in
12	0.47	3	0.12
12	0.47	6	0.24
22	0.87	13	0.51
25	0.98	15	0.59

Examples of applications for Kanthal Super tubes



Bubbler tubes for glass melting.



Protection tubes for thermocouples.

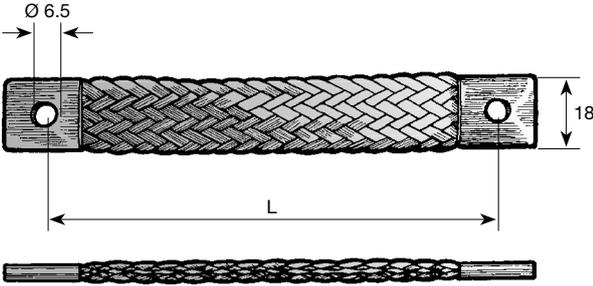


Tubes for electrodes for glass melting.

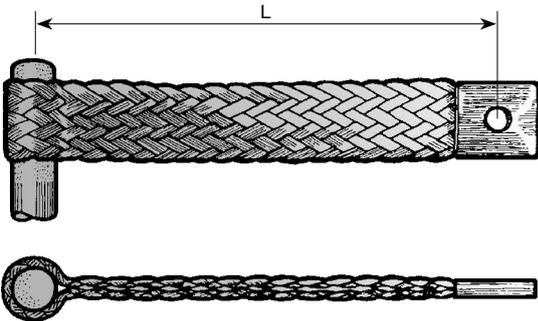
Accessories

ELEMENT SIZE 3/6 MM AND 4/9 MM
Contact straps

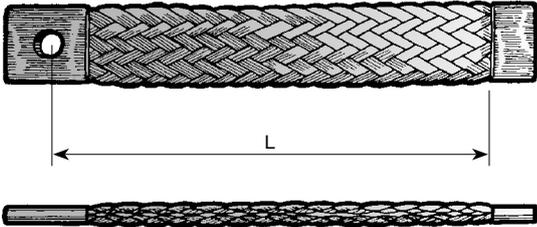
Type 5826
Lengths (L): 100, 150, 200



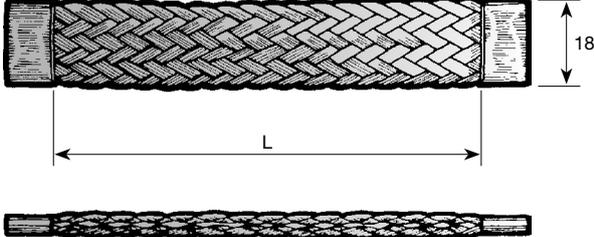
Type 5827
Lengths (L): 75, 100, 150, 200



Type 5828
Lengths (L): 75, 100, 150, 200



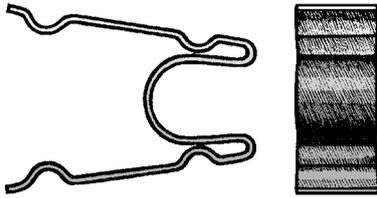
Type 5829
Lengths (L): 75, 100, 150, 200
Spring clips to be used at both ends.



Spring clips

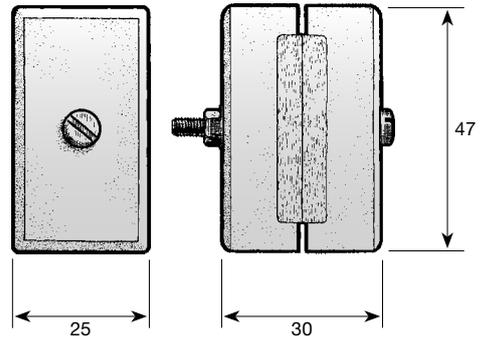
Type 10434
for element size 3/6 mm

Type 10435
for element size 4/9 mm



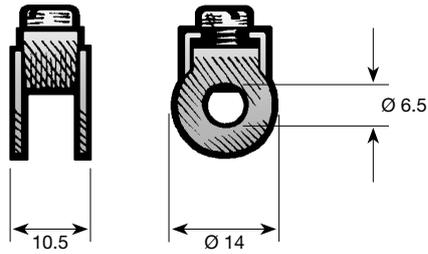
Element holder

Type 5830

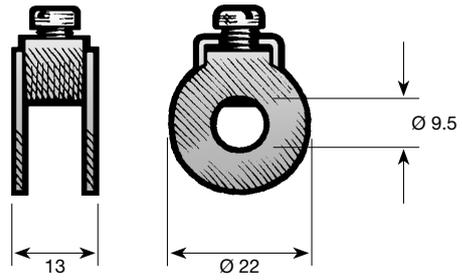


Single-shank holders

Type 10421
for element size 3/6 mm



Type 10424
for element size 4/9 mm

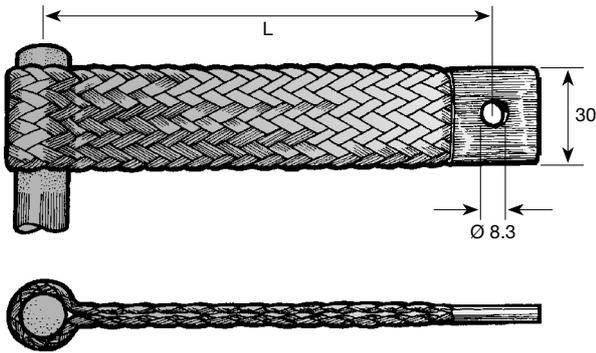


ELEMENT SIZE 6/12 MM

Contact straps

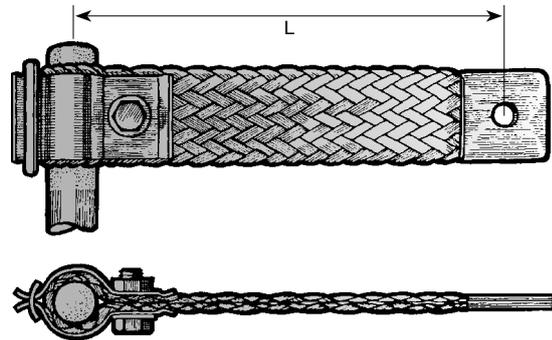
Type 5766

Lengths (L): 80, 100, 150, 200, 250, 300



Type 3579

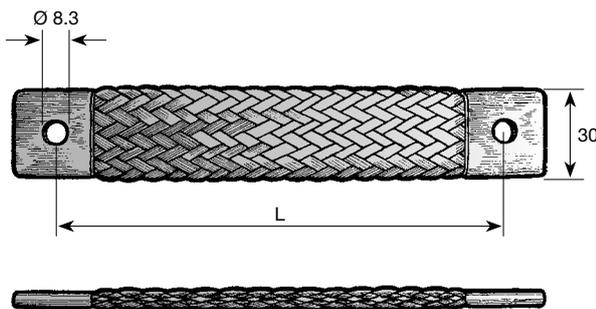
Lengths (L): 80, 100, 150, 200, 250, 300



Type 5768

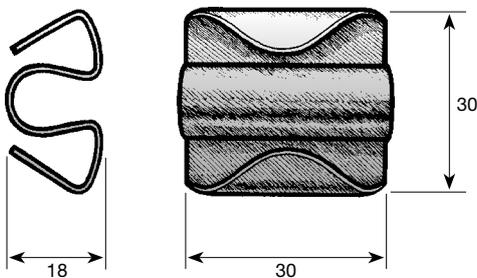
Lengths (L): 150, 200, 250, 300

Note: Two pcs per shank for 9/18



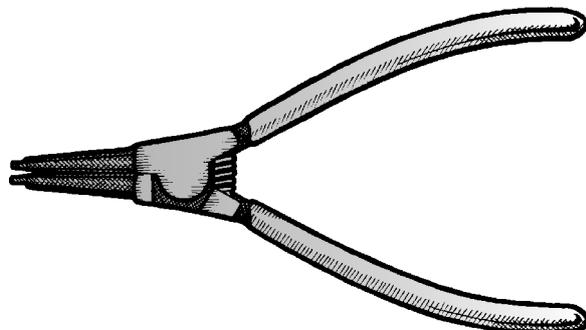
Contact clamp

Type 5758



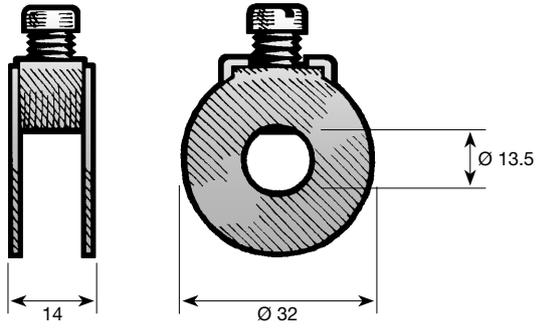
Expansion tool for clamps

Type 21690

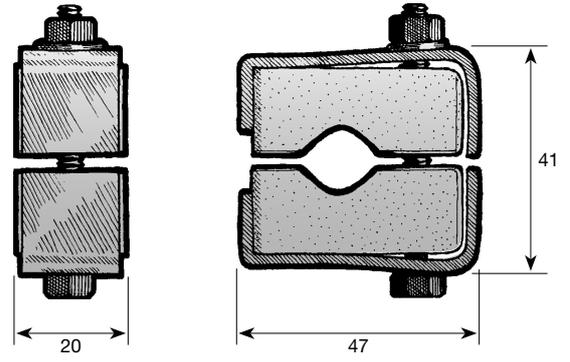


Single-shank holders

Type 6248



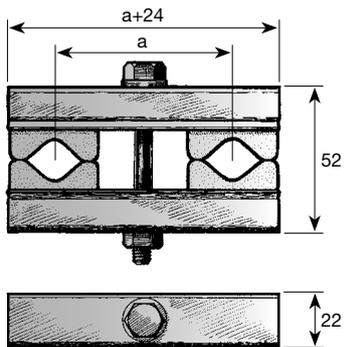
Type 5778



Two-shank holder

Type 5776

$a = 40, 45, 50, 55, 60$

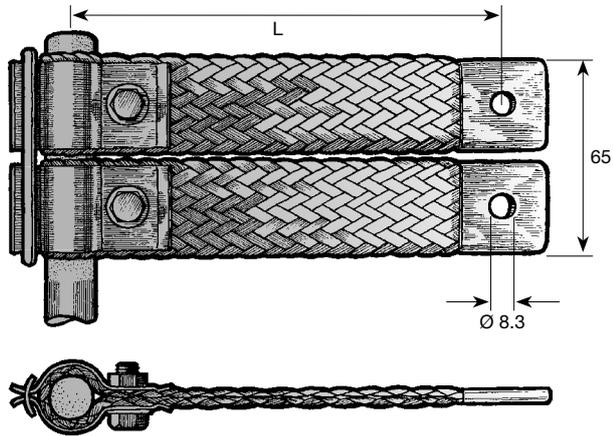


ELEMENT SIZE 9/18 MM

Contact straps

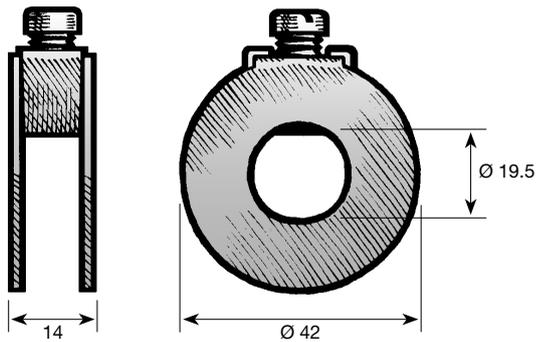
Type 3801

Lengths (L): 100, 150, 200, 250, 300

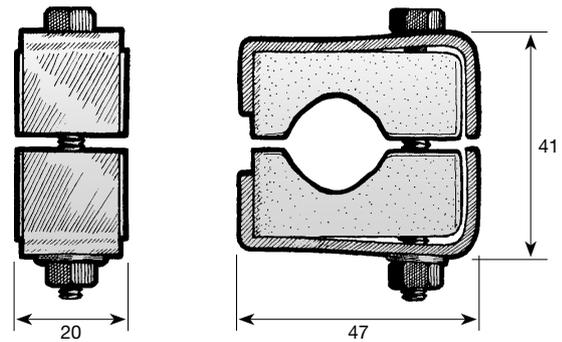


Single-shank holders

Type 6249



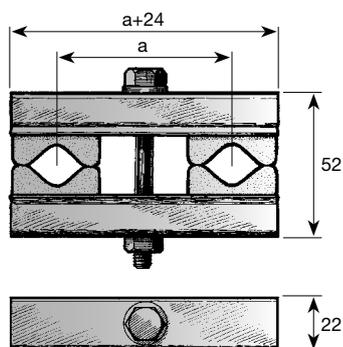
Type 5779



Two-shank holders

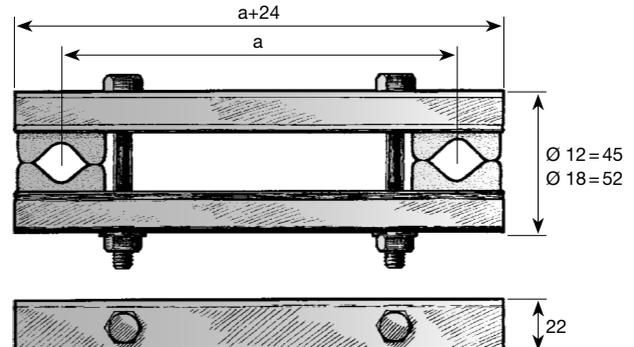
Type 5776

a = 40, 45, 50, 55, 60



Type 5777

a = 80 and 150 for element size 6/12 also



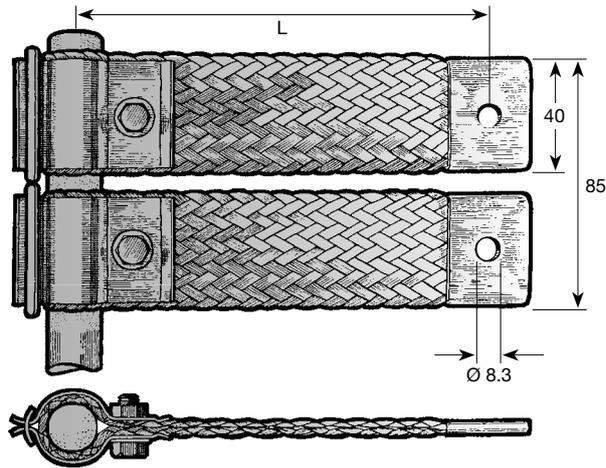
ELEMENT SIZE 12/24 MM

Contact straps

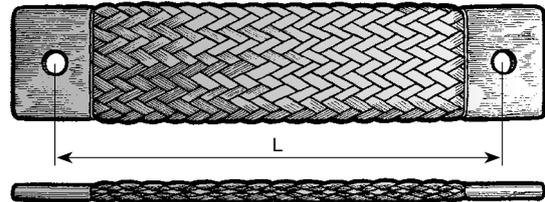
Type 10432

Lengths (L): 150, 200, 250, 300

Note: Two per shank

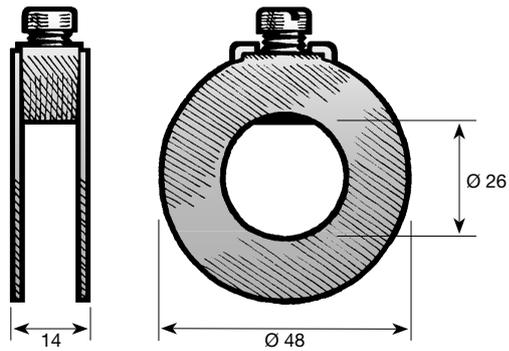


Type 10439



Single-shank holder

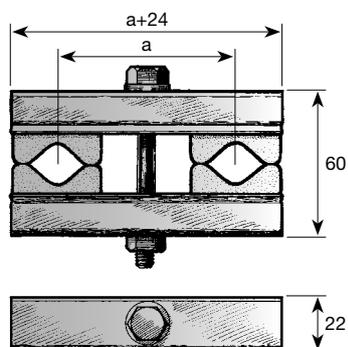
Type 10433



Two-shank holders

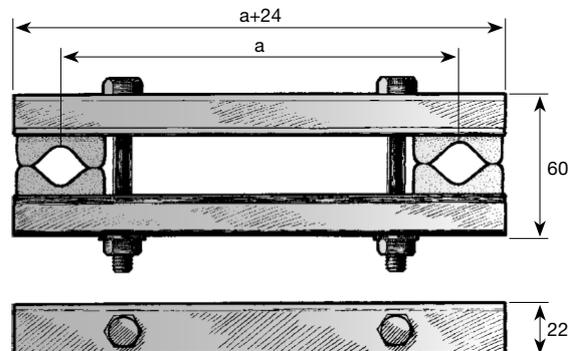
Type 10437

a = 60



Type 10438

a = 80

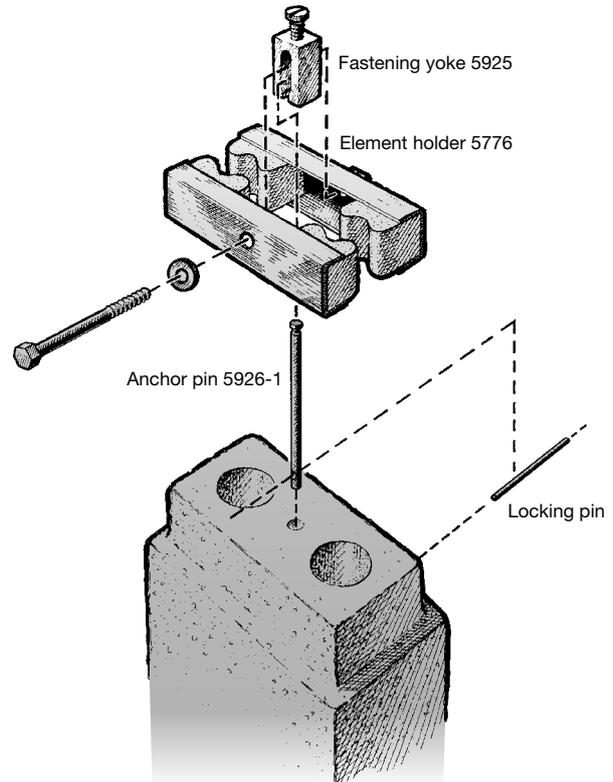


ANCHOR SYSTEMS

Standard anchor system

Type 5987

Element holder
Standard design



Air cooled anchor system

Type 5927

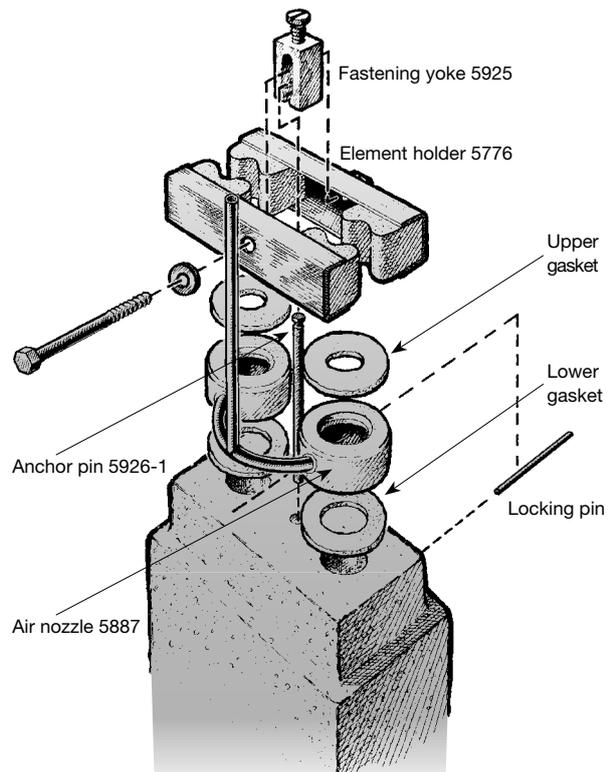
Element holder with air nozzle for
Kanthal® Super 9/18 mm a = 60

Type 6031

Element holder for Kanthal Super 6/12 mm a = 50

Type 6033

Element holder for Kanthal Super
6/12 mm a = 40



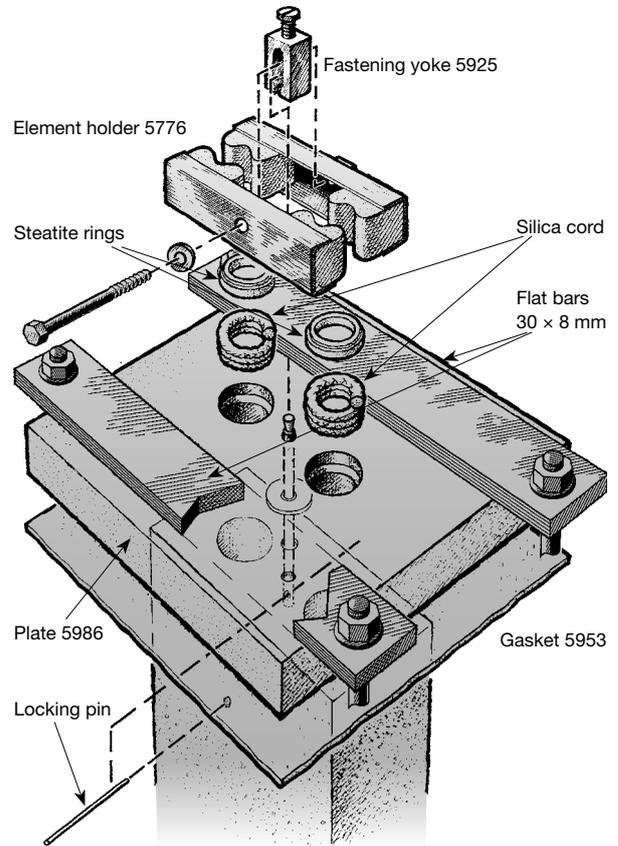
Sealed element anchor system

Type 5965

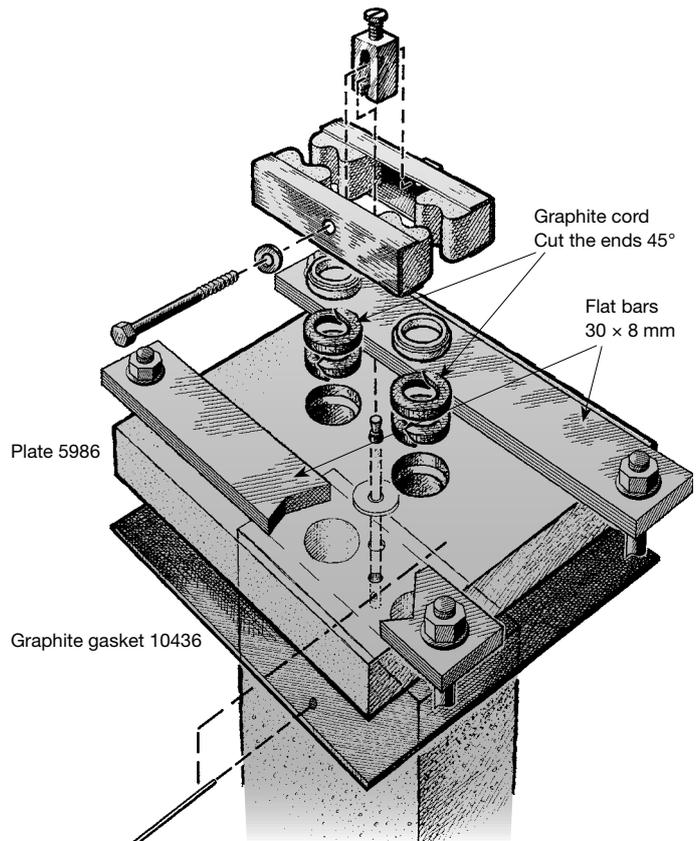
Element holder with sealed terminal lead through for Kanthal Super 9/18 mm a = 60

Type 6037

Element holder with sealed terminal lead through for Kanthal Super 6/12 mm a = 50



Graphite alternative



PASSAGE BRICKS

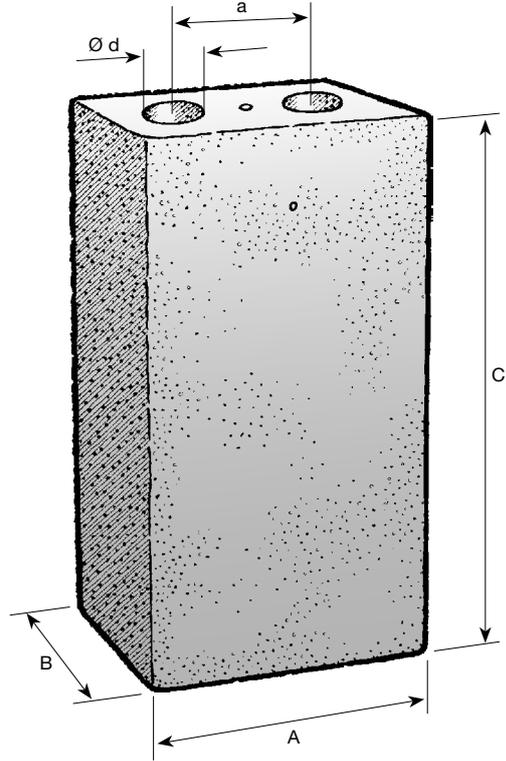
Note: Under certain conditions, long passage bricks may result in excessive temperatures on the terminals, unless special precautions are taken when designing the furnace.

For anchor systems, sealed design

Type 6038
for 6/12 mm

Type 5984
for 9/18 mm

Type no.	Grade	A	B	C	a	d	Element size
6038-1	28	115	64	229	50	15	6/12
5984-1	28	115	64	229	60	23	9/18
5984-2	28	115	76	229	60	23	9/18
5984-3	28	152	76	305	60	23	9/18



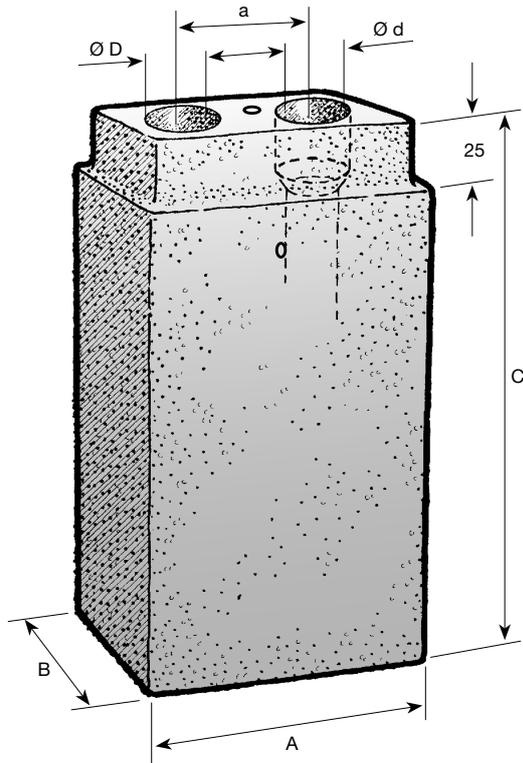
For anchor systems, typical design

Type 6036
for 6/12 mm

Type 5985
for 9/18 mm

Type 10943
for 12/24

Type no.	Grade	A	B	C	a	d	D	Element size
6036-1,-3,-6	G28,30,33	115	64	229	40	15	25	6/12
6036-9,-4,-8	G28,30,33	115	64	229	45	15	25	6/12
6036-2,-5,-7	G28,30,33	115	64	229	50	15	25	6/12
5985-1,-4,-8	G28,30,33	115	64	229	60	23	35	9/18
5985-2,-5,-10	G28,30,33	115	76	229	60	23	35	9/18
5985-3,-6,-11	G28,30,33	152	76	305	60	23	35	9/18
10943-1,-4,-7	G28,30,33	115	64	229	60	30	40	12/24
10943-2,-5,-8	G28,30,33	115	76	229	60	30	40	12/24
10943-3,-6,-9	G28,30,33	152	76	305	80	30	40	12/24

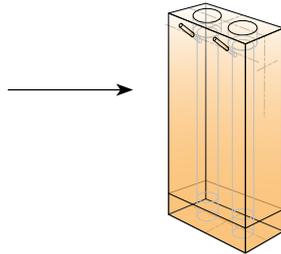


For anchor systems, air cooled design

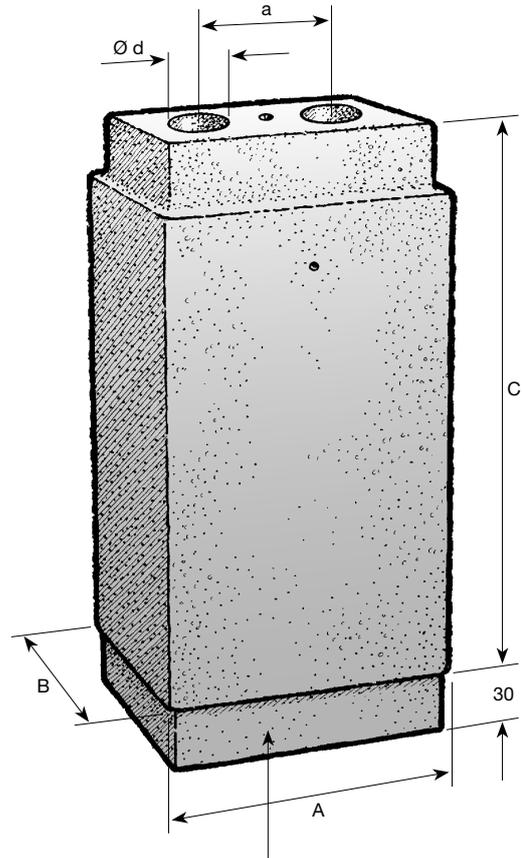
Type 6035
for 6/12 mm

Type 5930
for 9/18 mm

for 12/24 mm



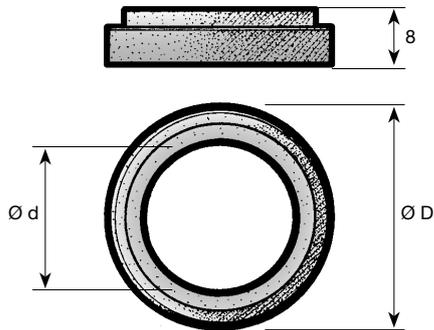
Type no.	Grade	A	B	C	a	d	D	Element size
6035-1,-3,-6	G28,30,33	115	64	229	40	15	25	6/12
6035-,-4,-7	G28,30,33	115	64	229	45	15	25	6/12
6035-2,-5,-8	G28,30,33	115	64	229	50	15	25	6/12
5930-1,-4,-7	G28,30,33	115	64	229	60	23	35	9/18
5930-2,-5,-8	G28,30,33	115	76	229	60	23	35	9/18
5930-3,-6,-9	G28,30,33	152	76	305	60	23	35	9/18



Bottom plate: Alfrax coated grade 33

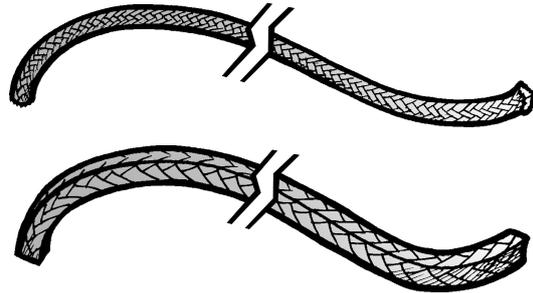
OTHER ACCESSORIES

Steatite rings



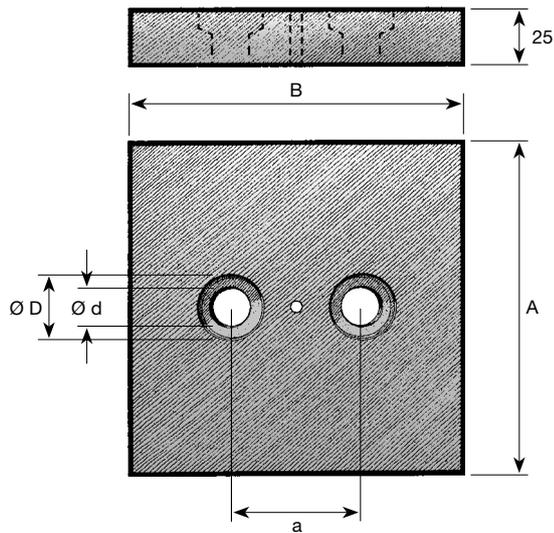
Element size	6/12	9/18
D	20	27
d	13	19

Silica cord and graphite cord



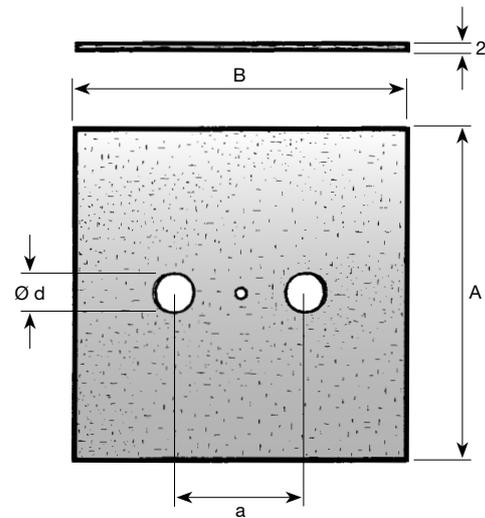
Element size	6/12	9/18
Length of silica cord	2 × 180	2 × 230
Length of graphite cord	4 × 60	4 × 80

Plates



Type	A	B	a	d	D
5986-1	150	150	60	20	28
5986-2	160	160	60	20	28
5986-3	180	180	60	20	28
5986-4	160	200	60	20	28
5986-5	130	180	60	20	28
5986-10	150	150	50	13	21

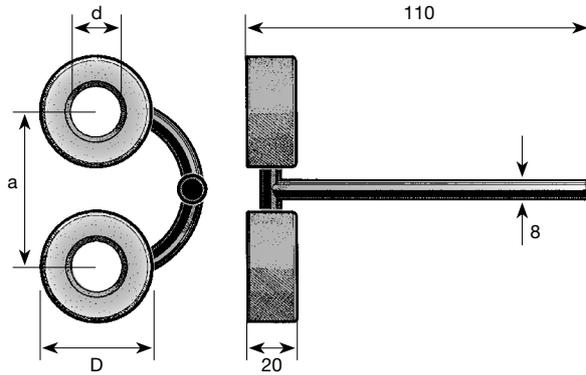
Gasket for plates



Graphite	Ceramic fiber	A	B	a	d
10436-1	5953-1	150	150	60	18
10436-2	5953-2	160	160	60	18
10436-3	5953-3	180	180	60	18
10436-4	5953-4	160	200	60	18
10436-5	5953-5	130	180	60	18
10436-10	5953-10	150	150	50	12

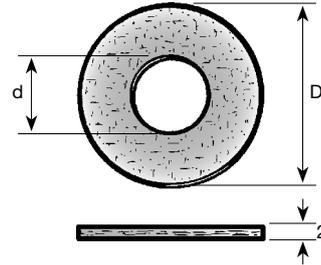
10436-1-5 d = 30 mm
10436-10 d = 24 mm

Air nozzles



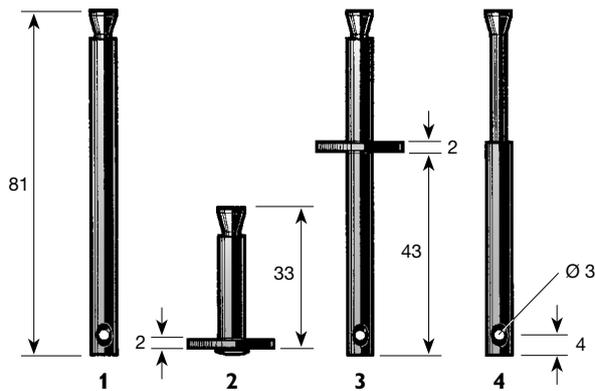
Type	Element size	a	D	d
5887-A	6/12	40	36	13.5
5887-B	6/12	50	36	13.5
5887-C	9/18	60	42	19.5

Gaskets for air nozzles



Element size	6/12		9/18	
	d	D	d	D
Upper gasket	11	32	17	38
Lower gasket	16	36	22	42

Anchor pins



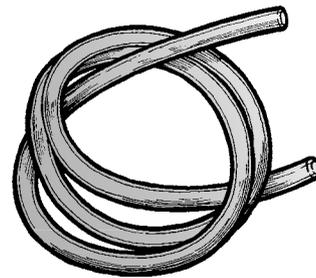
Type	Anchor system
5926-1	Standard and air cooled
5926-2	Sealed ¹⁾
5926-3	Sealed
5926-4	Air cooled ²⁾

1) Without locking pin.

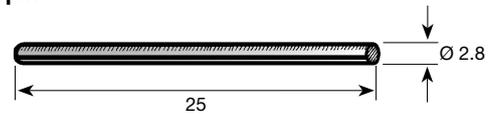
2) Element size 6/12 mm and distance between shanks (a) = 40 mm

Silicon rubber hose

For connection to air nozzles.

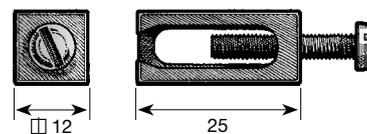


Locking pin



Fastening yoke

Type 5925



Sandvik Group

The Sandvik Group is a global high technology enterprise with 47,000 employees in 130 countries. Sandvik's operations are concentrated on five business areas in which the group holds leading global positions in selected niches: Sandvik Mining, Sandvik Machining Solutions, Sandvik Materials Technology, Sandvik Construction and Sandvik Venture.

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Sandvik Materials Technology is a world-leading developer and manufacturer of products in advanced stainless steels and special alloys for the most demanding environments, as well as products and systems for industrial heating.

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Sandvik Materials Technology has quality management systems approved by internationally recognized organizations. We hold, for example, the ASME Quality Systems Certificate as a materials organization, approval to ISO 9001, ISO/TS 16949, ISO 17025 and PED 97/23/EC. We also have product and/or shop approvals from bodies such as TÜV, JIS, DNV and Lloyd's Register.

Environment, health and safety

Environmental awareness, health and safety are integral parts of our business and are at the forefront of all activities within our operation. We hold ISO 14001 and OHSAS 18001 approvals.

Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice.

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