

Kanthal® Super Electric heating elements



Installation

KANTHAL

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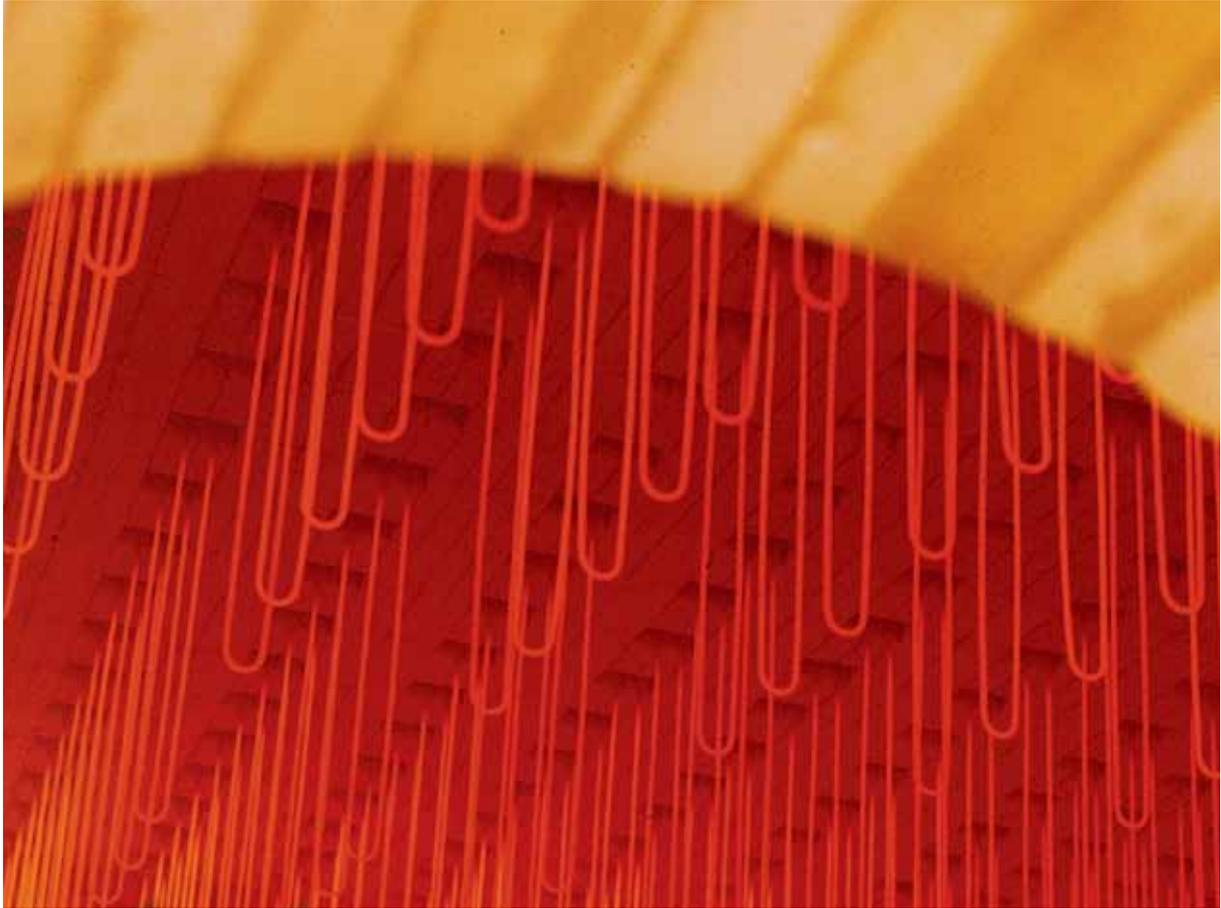
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Installation



Two-shank Kanthal Super elements installed across the width of the furnace.

VERTICALLY MOUNTED ELEMENTS

The exceptional properties of Kanthal® Super elements can best be utilized when the elements freely radiate in the furnace chamber.

U-shaped elements fitted through the furnace roof and vertically suspended in the furnace should be considered as the standard design for a Kanthal Super furnace (fig. 1, page 2). The elements are normally placed along the side walls, but in wide furnaces it may be necessary to place elements across the width of the furnace to provide the power required.

Certain furnace designs do not permit elements to be fitted through the roof. The internal height of the furnace may be such that more than one level of elements must be installed. In these cases elements with bent terminals or heating zones are available (fig. 2–4, pages 2 and 3).

HORIZONTALLY MOUNTED ELEMENTS

In some types of furnaces where the roof height is low, horizontally installed Kanthal Super elements may be the most economical and efficient alternative.

As Kanthal Super elements start to soften at temperatures around 1200°C (2190°F), they must generally be supported when used horizontally. This limits their maximum operating temperature because of possible reactions with the supporting material. If a reaction occurs between the silica layer on the element and the supporting brick, the element may adhere to the brick and fracture when cooling down. Even when suitable dense bricks of sillimanite or mullite type are used, the maximum element temperature must not exceed 1600°C (2910°F). Sillimanite or mullite grains (≈ 3 mm/0.12 in) can be used on the supporting surface where applicable.

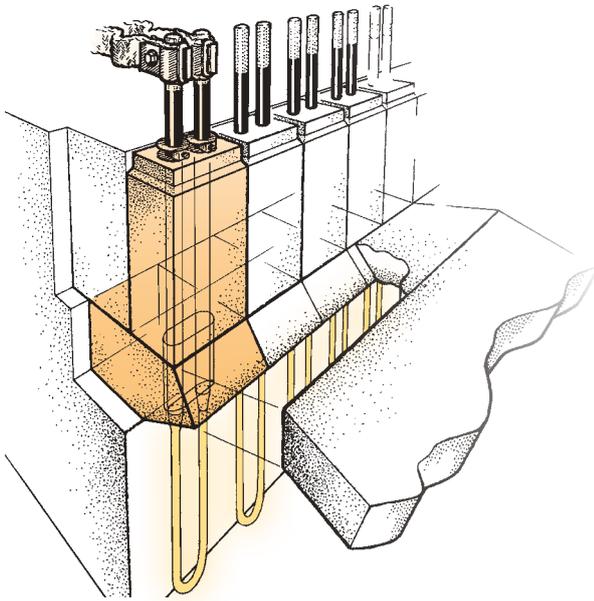


Fig. 1 Kanthal Super element installation with standard passage bricks in a brick lined furnace.

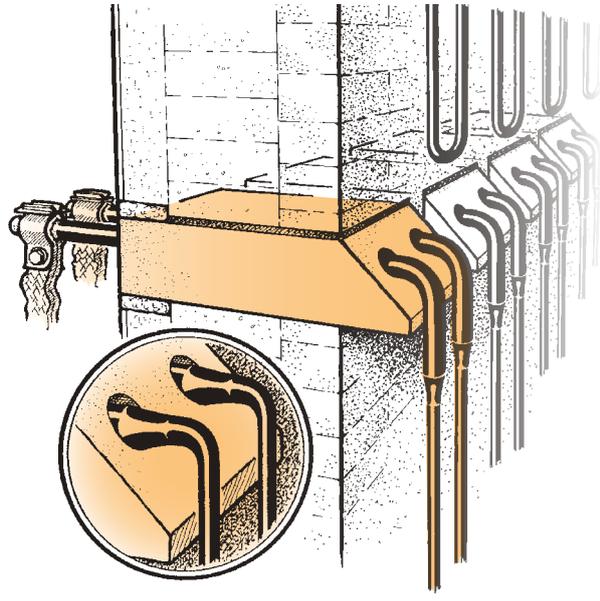


Fig. 2 Kanthal Super elements, with terminals bent 90°, installed in a brick lined furnace.

BRICK LINED FURNACES

To facilitate the installation of Kanthal® Super elements in brick lined furnaces, passage bricks are used. They are installed in openings in the roof or side wall (fig. 1 and 2). The passage bricks mounted through the roof often rests on a skew brick, which has oval holes for the elements. The passage bricks are made of heavy duty insulating firebrick of a quality matched to the furnace temperature.

CERAMIC FIBER LINED FURNACES

In fiber lined industrial furnaces, e.g. forging furnaces, if passage plugs of fiber or refractory bricks are used, then the complete element assembly also needs to be supported by the furnace roof or side walls, fig. 3–6, pages 3 and 4.

In small fiber lined furnaces, e.g. laboratory furnaces, it may be sufficient to introduce the Kanthal Super elements through slots in the insulation and fill the space around and between the terminals with loose ceramic fiber (fig. 7, page 4).

In furnaces for temperatures above 1700°C (3090°F), it is important to relieve the hot face lining of the roof from the weight of the element assembly. It is recommended to use a divided passage plug of ceramic fiber (fig. 8, page 5) or a passage plug supported by the cold side of the roof (fig. 9, page 5).

The weight of the element sets is carried by the outer lining. Especially useful in furnaces for very high temperatures.

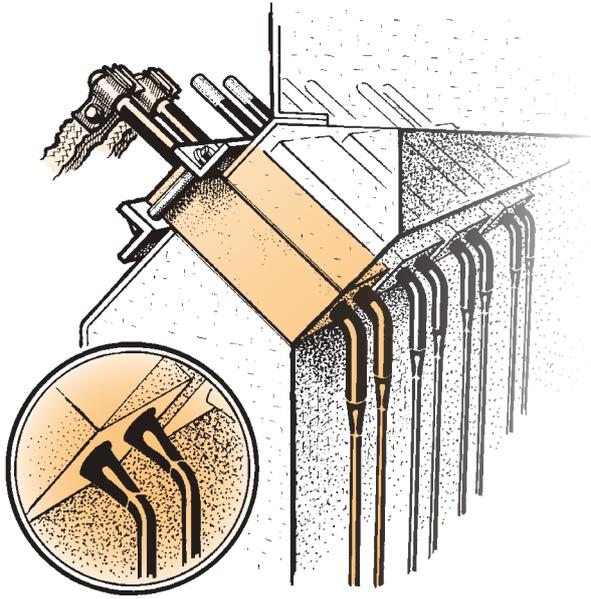


Fig. 3 Kanthal Super elements, with terminals bent 45°, installed in ceramic fiber insulated furnace.

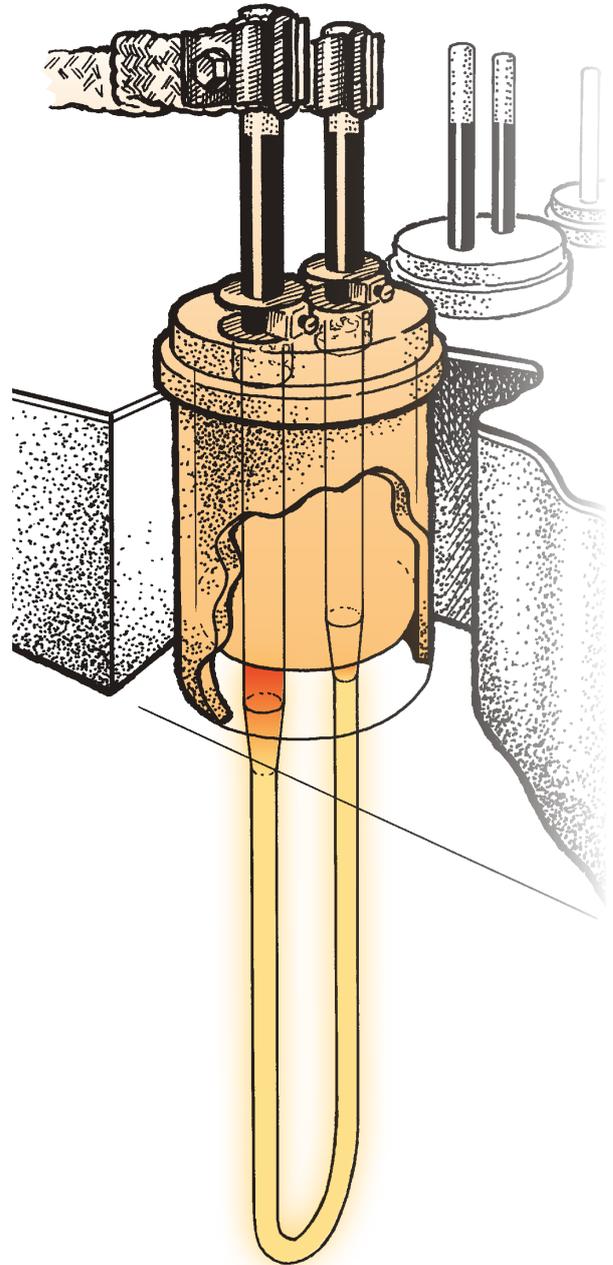


Fig. 5 Kanthal Super elements in ceramic fiber lined furnaces. The passage plugs with a flange are made of ceramic fiber and fitted into ceramic fiber sleeves.

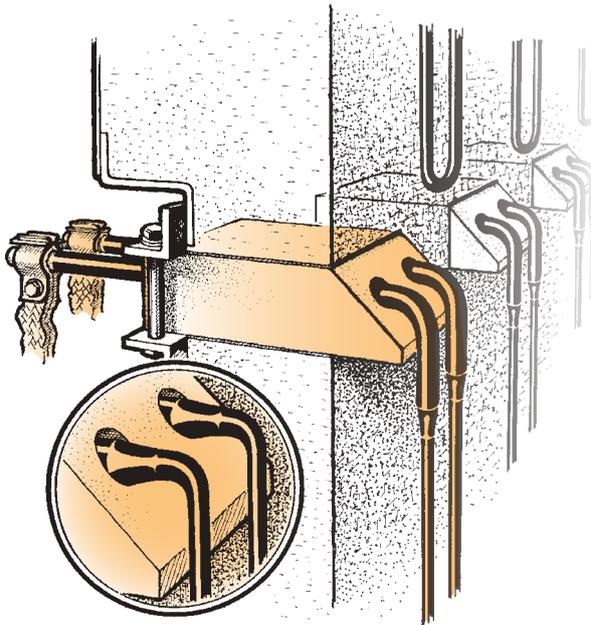


Fig. 4 Kanthal Super elements, with terminals bent 90°, installed through a furnace wall in a fiber lined furnace.

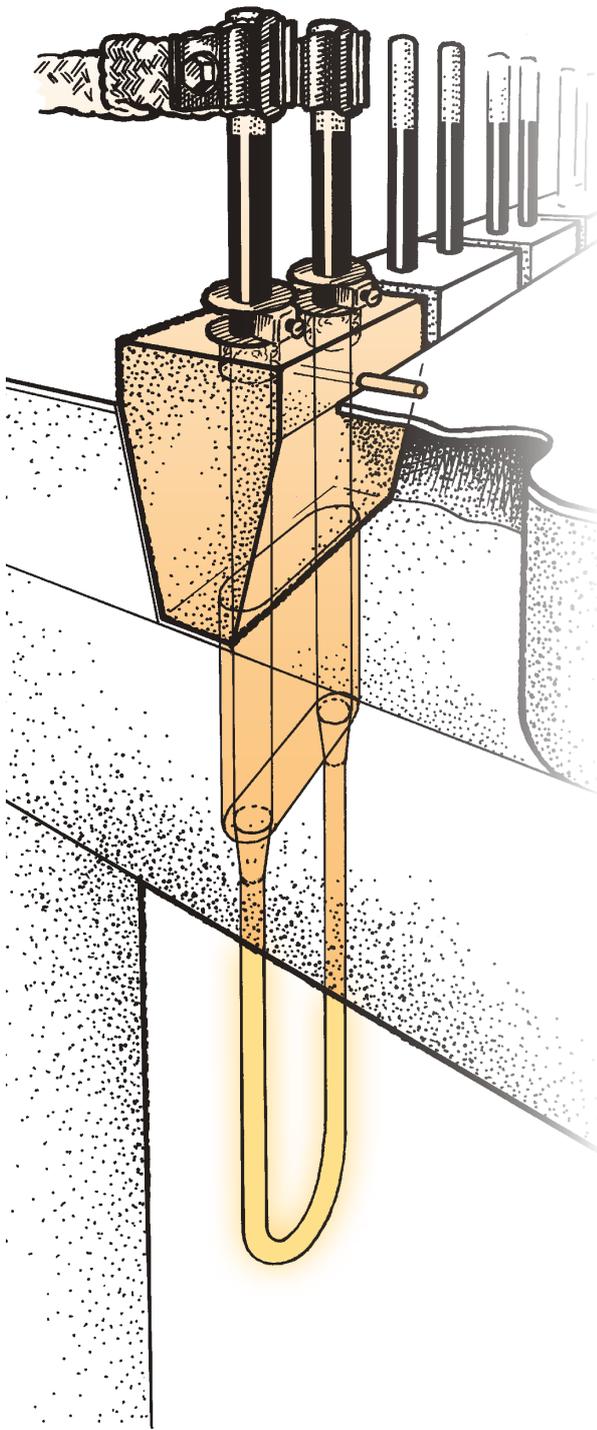


Fig. 6 Kanthal® Super elements in ceramic fiber lined furnaces. The passage plugs made of a heavy duty insulating firebrick are suspended by the cold side of the roof.

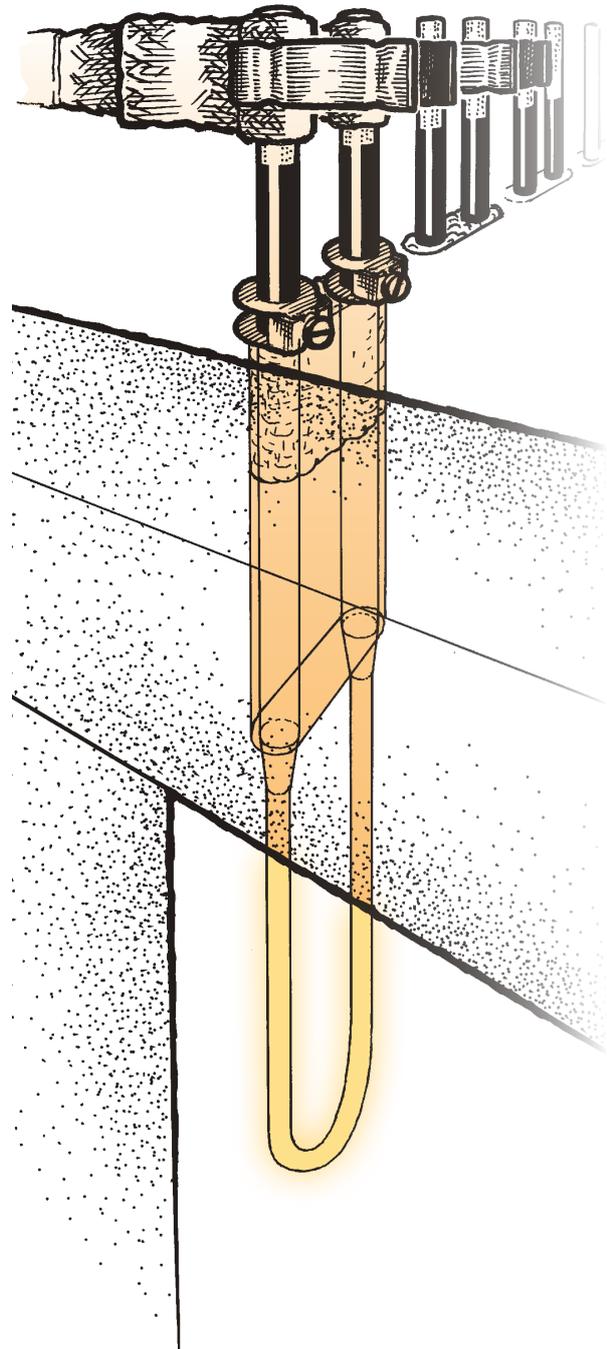


Fig. 7 Kanthal Super elements in ceramic fiber lined furnaces installed through oval slots in the roof.

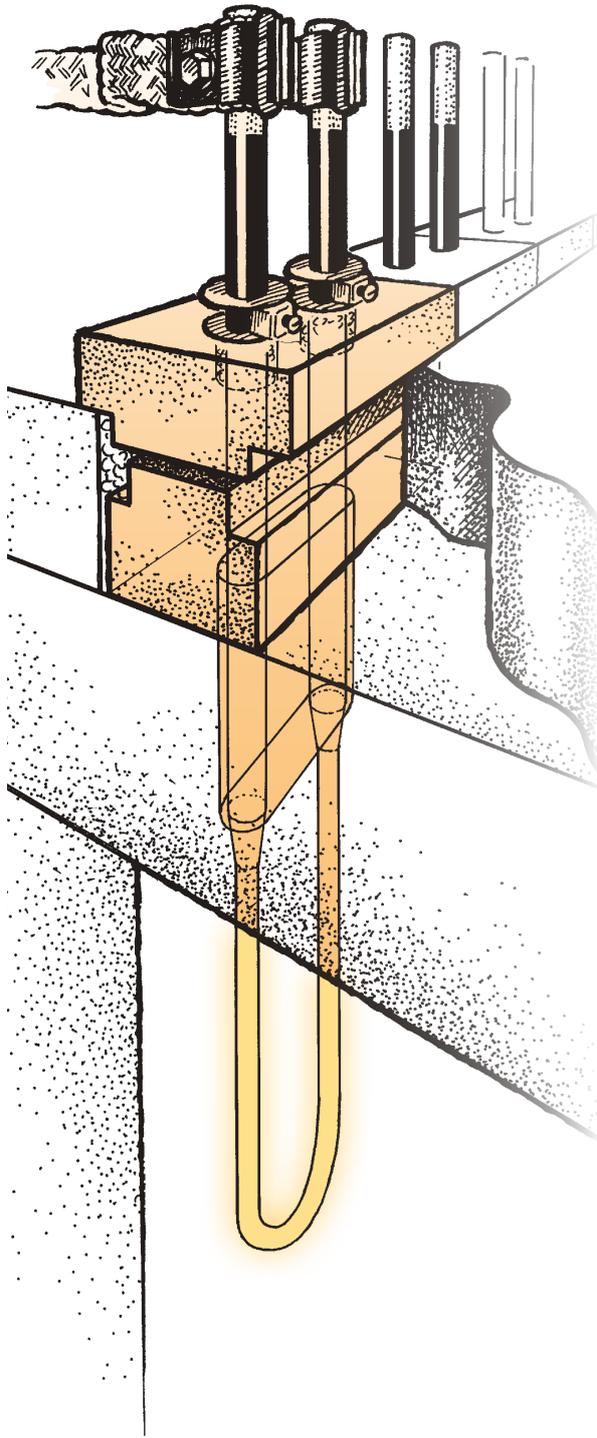


Fig. 8 Kanthal Super elements in ceramic fiber lined furnaces.
The passage plugs are divided in two pieces.

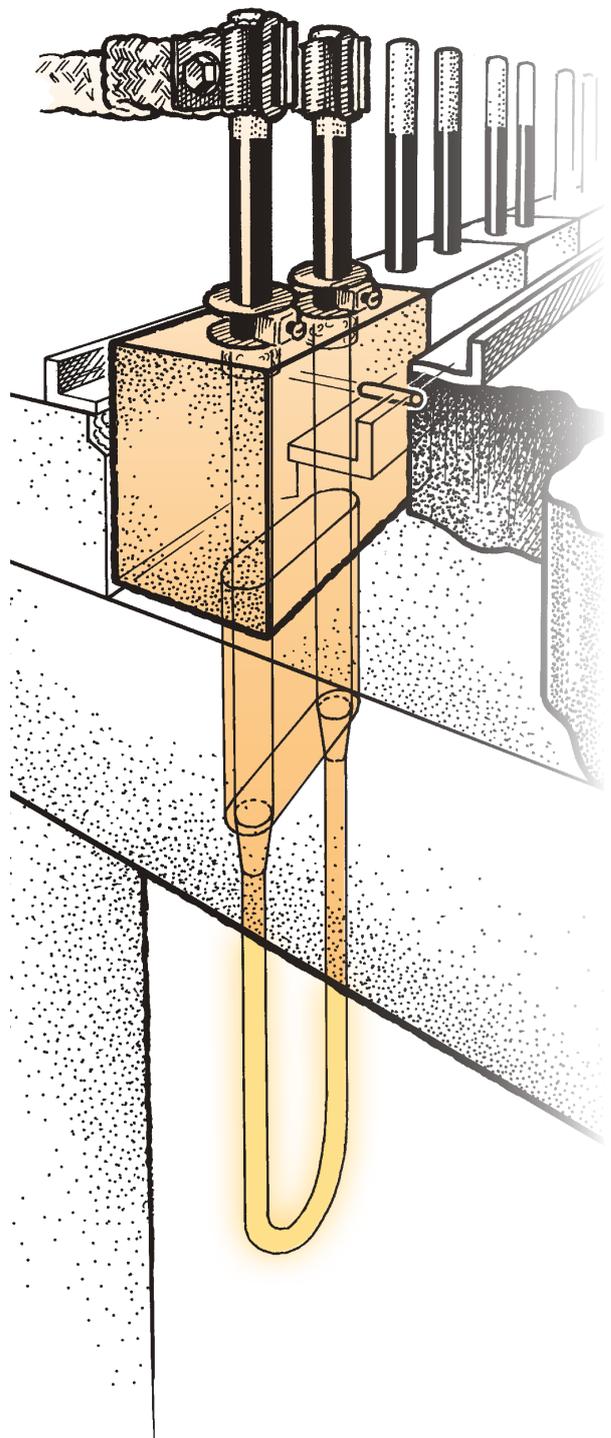


Fig. 9 Kanthal Super elements in ceramic fiber lined furnaces.
The passage plugs and elements are supported by the cold side of the roof.

ELEMENT HOLDERS AND ANCHOR SYSTEMS

Single-shank holders

Single-shank holders can be used for all kinds of Kanthal® Super qualities. It is essential that the terminals are able to move freely and independently of each other, otherwise mechanical stresses may cause the element to break.

This is important at very high temperatures.

Two-shank holders

Two-shank holders are used when the elements need to be anchored to the passage brick.



Single-shank holders.



Two-shank holders.

Standard anchor system

When Kanthal Super elements are used in an air atmosphere the standard anchor system is recommended in brick lined furnaces.

A fastening yoke holds the anchor pin, which is secured in the passage brick by a locking pin.



Element holder and anchor system, standard design.

“Air cooled” anchor system

By using the “air cooled” design it is possible to blow cooling air down along the terminals. In furnaces where impurities in the form of dust or fumes occur, e.g. glass melting furnaces, it is essential that such substances be prevented from depositing and condensing in the holes of the passage bricks; otherwise, corrosion may occur on the element terminals. The element may also be jammed in the hole, thus preventing free movement and possibly leading to element breakage. This is particularly important in glass melting furnaces, since glass fumes readily condense, resulting in damage to Kanthal Super elements.

Normal overpressure of the air is 200–700 Pa at a flow rate of 3–4 liters/minute for each element.

Sealed anchor system

Kanthal Super elements are often used in furnaces with controlled atmospheres. When the elements operate directly in the atmosphere, it is essential that the terminals be sealed. A lead-through, which is sealed and bolted to the shell of the furnace, is shown in the figure below.



Element holder and anchor system , air cooled design.



Element holder and anchor system, sealed design.

CONTACTS

Each contact consists of a double-folded aluminum braid, which is secured around the aluminized end of the terminal by means of a spring or screw clamp.

The busbar end of the braid is reinforced with an aluminum sleeve.

The standard sizes and types available are shown in *Part I: Products and accessories*, pages 18–28.

It is essential that *no mechanical stresses should be transmitted to the elements through the aluminum braids*. The length of the braid should therefore be longer than the straight distance between the element and the busbar. When tightening the bolts at the element terminal, it is important that the terminal should not be twisted or bent.

In order to avoid breakage of the elements, *direct connection of element to element is not recommended*. They should be connected to busbars or with individual braids which are bolted together. See image below.

The aluminum braids should not be connected to copper busbars. Stainless steel screws and aluminum busbars are recommended.

When using Kanthal® Super elements the current is high. Consequently, the transition resistance between contact and terminal must be kept low. The voltage drop across the contact should not exceed 0.01 V. Aluminum oxidizes easily, and the alumina layer built up on the surface is a good insulator. Furthermore, the creep strength of aluminum is low and the temperature at *the contacts should not exceed 300°C (570°F)*. When screw clamps are used, it is essential that the bolts be fully tightened.

The contacts are designed for a continuous current of:

Element size:	3/6	4/9	6/12	9/18	12/24
Current, A	75	115	200	365	560

In order to avoid overheating of the contacts due to radiation and conduction through the terminals, the minimum length of the terminal protruding from the passage brick, L_c , should be as shown in the table on page 9.



Kanthal Super elements connected to busbars.

If a contact becomes damaged, it should be replaced. If the aluminized layer on the terminal is damaged, it should be removed by careful grinding with emery cloth. Then a new contact should be fitted.

An excessive temperature in the busbar housing may cause overheating of the contacts. This may be due to insufficient ventilation. If natural convection is not sufficient, forced convection is recommended.

A common cause of overheating of the contacts is poor sealing between the terminals and the passage brick, and between the passage brick and the roof, resulting in a “chimney” effect. This not only causes overheating of the contacts but also increases the temperature of the terminal, which leads to excessive heat generation in the roof.

Sealing, therefore, must be carefully carried out using high duty ceramic fiber. In the standard passage bricks

there are recesses around the terminals as well as a shoulder around the top to facilitate efficient sealing.

Should overheating of the contacts be caused by poor insulation of the roof, forced air cooling of the contacts will be necessary if it is not possible to improve the insulation.

Terminal length

When determining the terminal length L_u , it is necessary to know the distance from the hot face of the furnace roof to the cold face of the passage brick, L_i or passage plug.

The tapered part of the terminal must come fully below the hot face of the lining.

The following table gives information about the length of taper g , and the minimum length of terminal protruding above the passage brick $L_{c\ min}$.

Terminal length

Element size	3/6		4/9		6/12		9/18		12/24	
	mm	in								
Length of taper	16.5 ±1.0	0.6 ±0.04	17.5 ±1.0	0.7 ±0.04	20.5 ±0.5	0.8 ±0.05	25.5 ±1.5	1.0 ±0.05	35.5 ±1.5	1.4 ±0.05
$L_{c\ min}^*$	50	2	50	2	75	3	125	5	150	6

* For holders of “air cooled” and sealed design $L_{c\ min}$ for 6/12 is 100 mm (4 in) and 9/18 140 mm (5.5 in).

Fixed contacts Kanthal Super

Sandvik has been developing a fixed contact as an alternative to the standard bolted on contacts. These can be utilized, where the temperature of different reasons is high.

Fixed contacts are designed to assure safe and reliable electrical connections. The fixed contact consists of an aluminum braid with a cable clip attached to one end and a metallic sleeve attached to the other. The metallic sleeve is soldered to the terminal end.

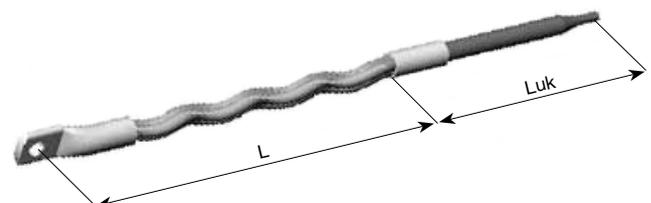
The fixed contacts can withstand temperatures up to 400°C (750°F) which is 100°C (180°F) higher than what is recommended for standard contacts.

Fixed contacts are available for all terminal diameters and the length of the braid can be adapted to the cus-

tomers demand. The length should be long enough to enable a good installation with some slack of the braid, usually longer than 100 mm (3.94 in). It is important that no mechanical stresses should be transmitted to the elements through the alumina braids.

The braid fibers diameter is 0.16 mm (0.006 in) to get the correct stiffness of the braid.

It is not possible to install the element with fixed contacts through bricks or fiber with normal hole diameter. The insulation needs either to have larger holes, with increased risk of heat leakage or be parted into two half's with slots for the element.



ASSEMBLING OF KANTHAL® SUPER ELEMENT



1. Kanthal Super elements should not be unpacked until the furnace and the busbars are ready. Pages 10–11 show the practice employed when assembling vertically suspended Kanthal Super elements with passage bricks.



2. When unpacking, care should be taken to avoid any bending or twisting.

3. The element is placed horizontally on a table and the terminals are carefully inserted in the holes in the passage brick ensuring that the correct length of terminals are protruding from the top of the brick.



4. After packing heavy-duty ceramic fiber loosely into the recesses of the terminal holes...



5. ...single- or two-shank element holders should be fixed to the terminals.



6. When determining the position of the element holder, it is of the utmost importance to ensure that the tapered transition between terminal and heating zone comes fully below the hot face of the furnace lining. If not, there is a risk that the part of the heating zone which is inside the lining may become overheated. When connecting the installed elements, the aluminum braids should first be bolted to the elements and then to the busbars.



7. Before inserting the element assembly...

...it is necessary to check the size of the corresponding holes in the roof. When fastening the contact bolts the elements must not be bent or twisted. Finally, check that the installed elements can move freely!

Furnace operation

INITIAL START-UP PROCEDURE RECOMMENDATIONS

- Review the installation instructions of the furnace to verify that it is in operating condition.
- Become familiar with the various adjustments on the controller or programmer before operating the furnace for the first time.
- Do not leave the furnace unattended during the initial break-in period.
- Check the current limit of the power controller. Generally the current limit is pre adjusted before shipping.
- Note that fibrous insulation is fragile and that the Kanthal® Super heating elements are also subject to breakage if handled improperly. Take special care with all furnace components at all times.

STARTING UP A NEWLY-BUILT FURNACE

When starting up a furnace for the first time or after it has been relined, it is necessary to dry it out so that the lining is not damaged. This is especially important when the furnace is brick lined. As far as the Kanthal Super elements are concerned, the quicker the furnace can be brought up to full operating temperature, the better. The elements may also be attacked by gases and dust given off from the lining during the first firing of a furnace. It is therefore very important to ventilate the furnace thoroughly during the drying-out process.

We recommend the following procedure as suitable for starting most Kanthal Super furnaces.

Step-down transformer and on/off control

Open the furnace door slightly and switch on the starting voltage (1/3 or 1/4 of operating voltage) for the first drying-out period at 100–200°C (210–390°F).

Switch over to an intermediate voltage (2/3 or 1/2 of operating voltage). This must be done quickly in order to avoid too much reduction in element temperature and the resulting high current surges which may cause damage.

Allow the furnace door to remain slightly open for ventilation to continue while the furnace temperature rises gradually to 800°C (1470°F). When the furnace has reached this temperature, close the furnace door and allow the furnace to run up to full temperature at operating voltage.

Thyristor control

When thyristor control is used, the remarks regarding operating voltage do not apply. It is advisable to reduce the current limit during the drying-out period. Otherwise, the same considerations apply as with a furnace with step-down transformer and on/off control.

For Kanthal Super elements it is advantageous if they are allowed to work at an element temperature of at least 1500°C (2730°F) for one half to one hour as part of the initial start-up procedure.

Naturally, these basic instructions are not applicable to all furnaces. On large furnaces it is often advisable to dry out the brickwork by means of a separate source of heat before installing the Kanthal Super elements.

REPLACEMENT OF ELEMENTS

One of the greatest advantages of Kanthal Super elements is that a defective element can easily be replaced without the furnace having to be cooled down. Vertically mounted elements are replaced as follows:

After having located the defective element, unbolt the contacts from the busbars and remove the ceramic fiber around the upper part of the passage brick, after which the element and the passage brick may be lifted out. A previously assembled unit consisting of a new element complete with passage brick and element holders now should be inserted through the hole in the furnace roof.

The contacts which have been removed from the damaged element can be used again providing that they are undamaged. If the contact surfaces are oxidized or damaged to such an extent that they cannot be restored to a serviceable condition, they should be replaced.

TEMPERATURE CONTROL

The type of thermocouple used for temperature control depends on the furnace temperature. Type K has good stability to 1200°C (2190°F) and can be used in many heat treating furnaces. Temperature measuring above 1200°C (2190°F) is usually performed with thermocouples made of platinum-platinum/rhodium.

Thermocouples age faster the higher the furnace temperature is. In Pt-Pt/Rh thermocouples there is a structural change in the platinum and diffusion of rhodium occurs at the junction. Problems with temperature corrosion and overheated Kanthal Super elements are often related to ageing thermocouples.

By alloying the platinum with rhodium the usable temperature increases. A high content of rhodium in both shanks gives the highest permissible furnace temperature. When the rhodium content is increased, the EMF (electromotive force) decreases and this affects the accuracy of the measurement. When thermocouples are utilized at the maximum classifying temperatures, it is important to check the EMF frequently in order to avoid increased furnace temperature due to the ageing. In high temperature furnaces with Kanthal Super 1900 elements operating at furnace temperatures above 1750°C (3180°F), using Pt/20% Rh - Pt/40% Rh, it has been found that the EMF can have decreased significantly after only 4–5 hours at furnace temperature. By the time this has occurred, the thermocouple has become more stable and the change is slower with time. This thermocouple has a low thermoelectric output and small changes can lead to large variations in the furnace temperature and element temperature with subsequent element problems.

For high temperature furnaces we recommend two thermocouple positions close to each other in the roof. One thermocouple for the controller and the SCR, the other to check the operating thermocouple and the actual furnace temperature. It is important that the thermocouple for checking is exposed to the furnace temperature only when the checks are being carried out.

Standard platinum-platinum/rhodium thermocouples

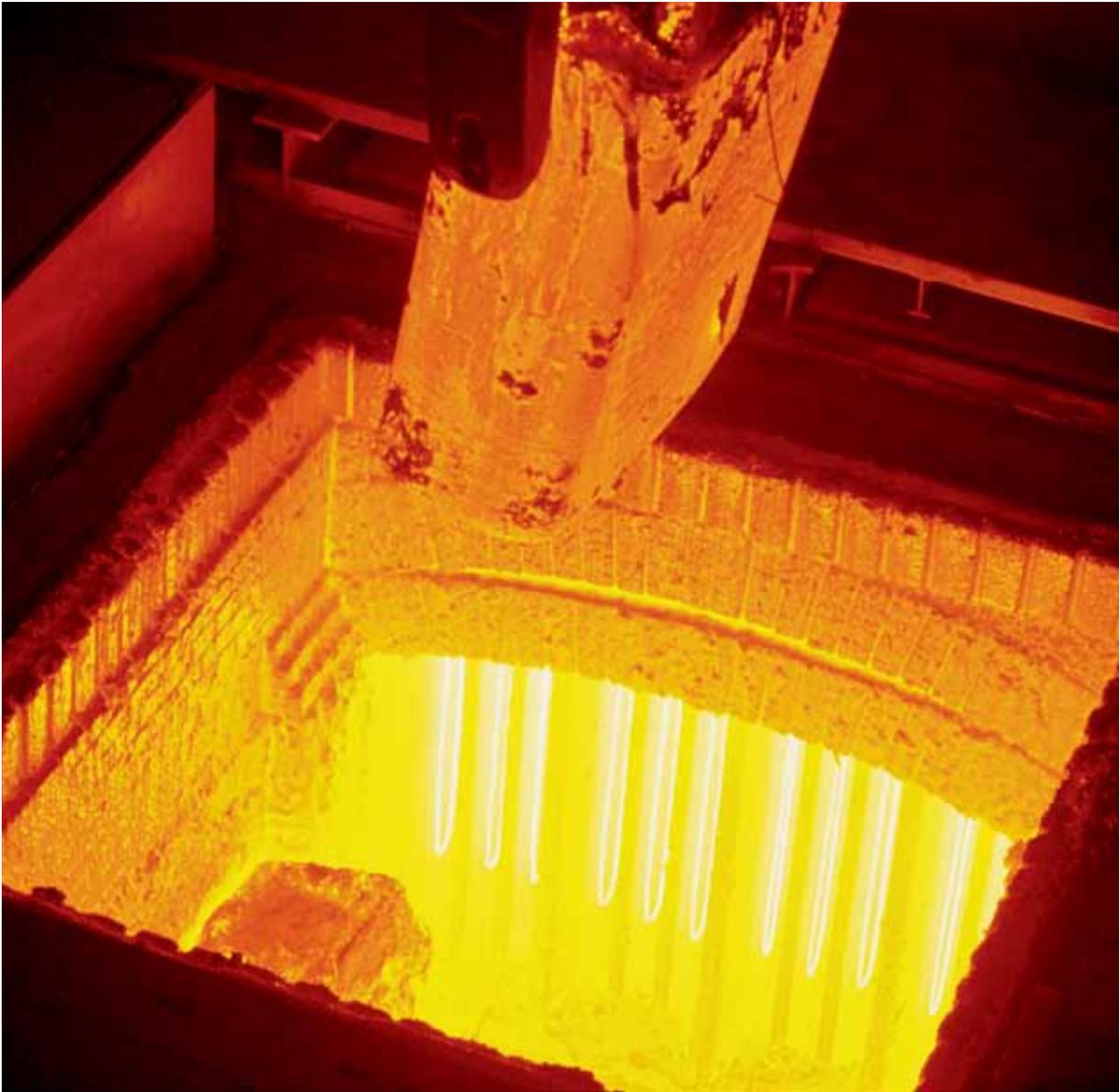
	Max. service temperature			
	Continuous		Intermittent	
	°C	°F	°C	°F
Pt/Pt 10 Rh, Type S	1400	2550	1650	3000
Pt/Pt 13 Rh, Type R	1400	2550	1650	3000
Pt 6 Rh/Pt 30 Rh, Type B	1500	2730	1800	3270
Pt 20 Rh/Pt 40 Rh	1600	2910	1800	3270

SAFETY PRECAUTIONS

Use dark glasses when observing glowing Kanthal Super elements. The eyes are subjected to great strain when observing temperatures above 1400°C (2550°F).

Kanthal Super elements which have been operating for a long time at high temperature and have then cooled down sometimes have internal stresses which cause the glaze to splinter into small fragments. There have been instances where elements which have been cold for several days have emitted a shower of fine glaze particles when touched.

Always use eye protection even when handling cooled down Kanthal Super elements.



Kanthal® Super furnace for ingot heating.

Troubleshooting

Kanthal Super is a long lasting heating element due to its low ageing rate. Installed according to our recommendations, their life is to most operator's satisfaction.

Element life is limited due to several reasons, but the major reason for failure is rarely due to material faults or workmanship.

The design of the element lead through is critical for optimum element life.

The most common reasons for element failure, which we have seen have been due to:

Careless handling

- Handling of element packages by the carriers whilst in transit.
- Handling of elements by the customer after being removed from the package.

Mechanical damage

- Breakage of elements after being installed in the furnace e.g. bumping into an element with a wrench or elbow when carrying out repair work inside a furnace. Also, breakages when elements are removed before relining a furnace.

Mechanical stress

- All roof suspended elements should be hung freely to allow unrestricted movement of the element shanks during expansion and contraction due to electromagnetic forces and thermal expansion.
- Any binding-sticking of the elements during thermal cycling can result in mechanical and thermal stresses. If this is the case, the element will typically break around the fusion welded joint between the heating zone and terminals.
- The contact straps should be long enough so that no stresses are transferred to the elements. If there is sufficient space available, it is preferable to use busbars or terminal posts for series connecting elements as the risk of damaging adjacent elements will be reduced when replacing individual elements.

Chemical attack

- Compounds and gases, which may have a detrimental effect on Kanthal Super material is covered in *Part I: Products and accessories*, pages 4–6.

Overheated elements

- When the element temperature exceeds the limit for each of the three qualities, the silica in the material starts to boil. The MoSi_2 depletes through evaporation of the silica and the hot zone shows signs of surface cracking and is pitted in appearance. The effect is the same if part of the hot zone is restricted to radiate freely. If one side of the hot zone is too close either to the furnace wall or some other restriction, this side can show signs of overheating.

Overheated contacts

Either one or a combination of the following items can cause too high a temperature on the contacts:

- Chimney effect.
- Terminal length protruding outside the furnace being too short.
- Contacts become loose.
- Poor roof insulation (insufficient thickness, quality, cracking or degradation).
- Poor ventilation over the contacts.

Chimney effect

The terminals should be sealed at the cold face with ceramic fiber to prevent convective and radiant heat losses (elements must still be able to move freely).

Terminal length too short

It is quite common to see installations where the contacts are very close to the holders.

Loose contacts

Can cause thermal shock breakages due to sparking between contact and terminal end. Symptoms: partly melted contacts, thermal cracking of terminal end due to arcing.

When low temperature oxidation (pest) occurs underneath the aluminizing, the temperature has been far too high. The effect is the same as with loose contacts.

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.

Sandvik Materials Technology

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.

Kanthal is a Sandvik owned brand, under which world class heating technology products and solutions are offered. Sandvik, Kanthal and Superthal are trademarks owned by Sandvik Intellectual Property AB.

Quality management

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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