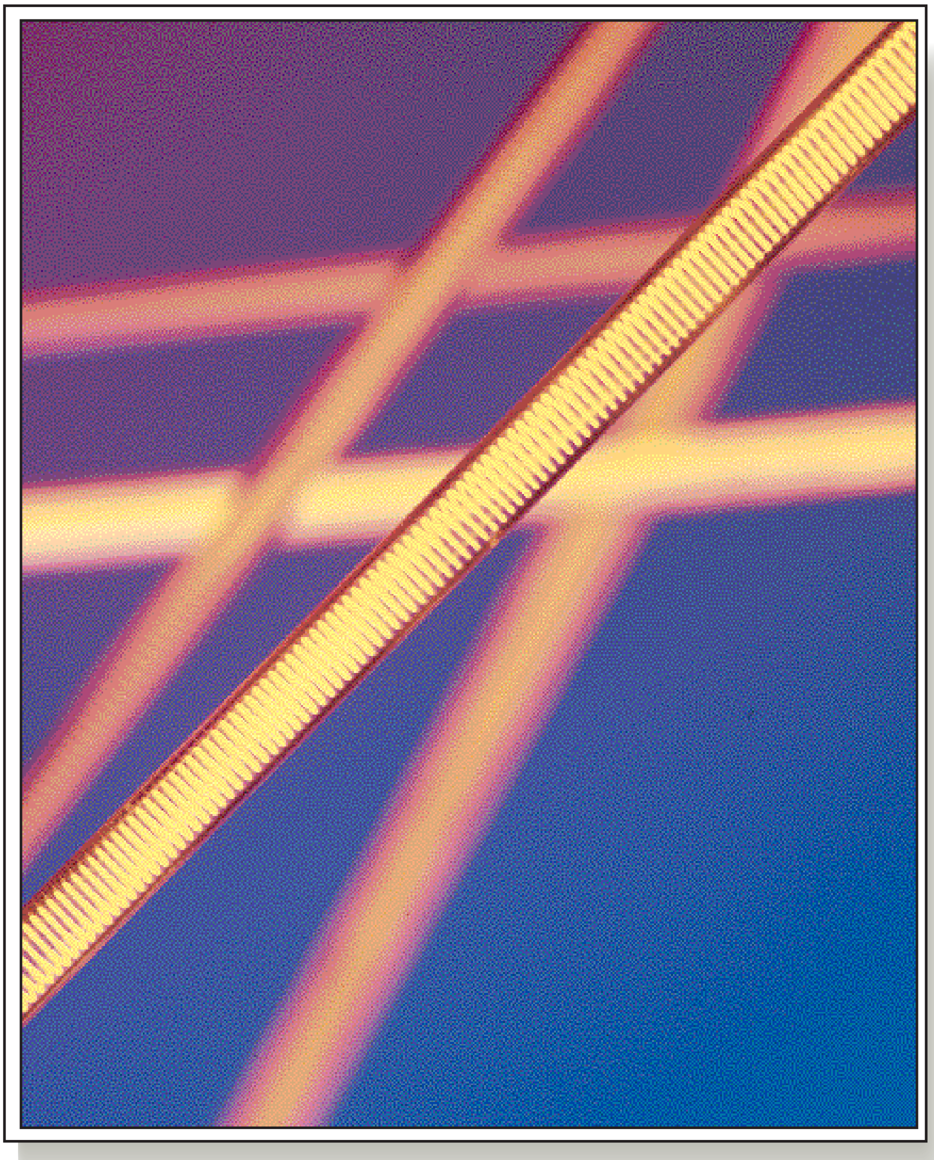
KANTHAL

Appliance Heating Alloys

Handbook



KANTHAL®

Catalogue 1-A-2-3 02. 97 5000

Set in DTP by Design & Media, Hallstahammar

Contents

Appliance Heating Alloys from Kanthal

This booklet contains basic technical data for our resistance heating alloys KANTHAL and NIKROTHAL for the appliance industry.

We have also included some design and application guidelines, in order to make it easier for you to select the right alloy.

More detailed information is given by the nearest Kanthal office or in the complete Kanthal Handbook ”Resistance Heating Alloys for Appliances and Heaters”. Kanthal also produces Fine Wire in very small diameters and products for the Furnace industry.

We have substantial technical resources at all our offices around the world and we are glad to help you in different technical questions, or to try out completely new solutions at our central laboratories. Kanthal is never far away! Kanthal produces ferritic alloys under the trade names KANTHAL and ALKROTHAL, austenitic alloys under the trade name NIKROTHAL and two grades of nickel-iron alloys for resistance heating purposes.

Resistance Heating Alloys

Ferritic Alloys (FeCrAl)

Up to 1425°C (*2595°F*). **KANTHAL APM** is a powder metallurgical alloy. It has a very good strength, giving good form stability of the heating elements with less need for element support. It has low tendency to ageing, low resistance change and long element life. KANTHAL APM has an excellent surface oxide, which gives good protection in corrosive atmospheres as well as in atmospheres with high carbon potential, and no scaling.

Up to 1400°C (*2550°F*). **KANTHAL A-1** is usually specified for high temperature furnaces in the heat treating, ceramics, glass, steel and electronics industries.

Up to 1350°C (*2460°F*). **KANTHAL A** is used for applications where its high resistivity and good oxidation resistance are particularly important.

Up to 1300°C (*2370°F*). **KANTHAL AF** is especially recommended where good form stability properties are required. For maximum life above 1300°C *(2370°F)* wire temperature KANTHAL A-1 is recommended since it provides superior oxidation resistance.

Up to 1300°C (*2370°F*). **KANTHAL AE** is developed to meet the extreme demands in fast response elements in glass top hobs and quartz tube heaters. It has exceptional form stability and life in spirals with large coil to wire diameter ratio.

Up to 1300°C (*2370°F*). **KANTHAL D.** Employed chiefly in appliances, its high resistivity and low density, combined with better heat resistance than austenitic alloys, make it suitable for most applications.

Up to 1100°C (*2010°F*). **ALKROTHAL** is typically specified for rheostats, braking resistors, etc. It is also used as a heating wire for low temperatures, such as heating cables.

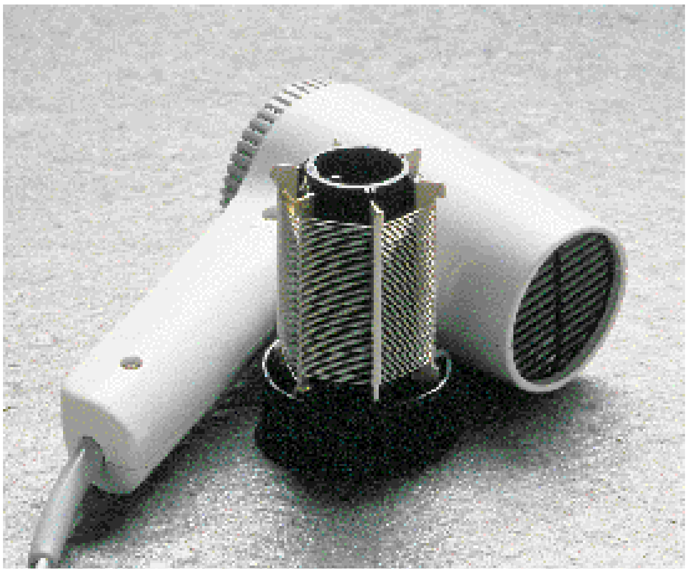


Fig.1 Portable hair dryer with straight KANTHAL AF heating element wound on mica support.

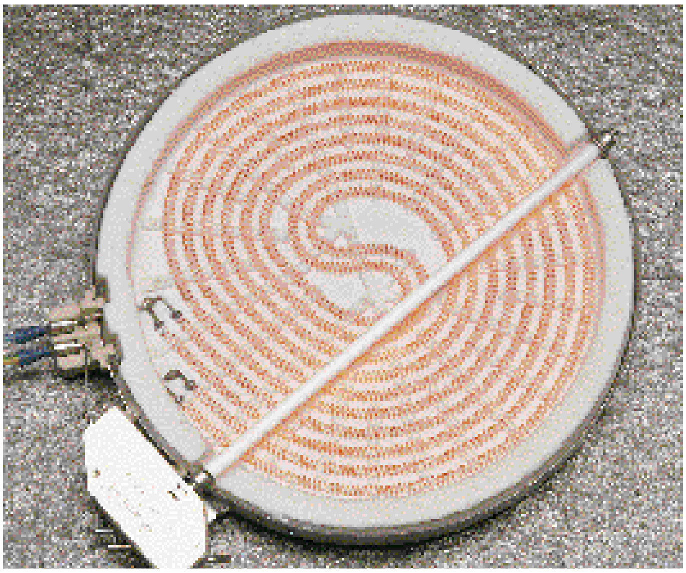


Fig. 2 Coils of KANTHAL AE wire on ceramic fibre base for glass hot plates.

Austenitic Alloys (NiCr, NiCrFe)

Up to 1200°C (*2190°F*). **NIKROTHAL 80** is the premium-quality austenitic alloy. Because of its good workability and high-temperature strength, NIKROTHAL 80 is widely used for heavy-duty applications in the electric appliance industry.

Up to 1250°C (*2280°F*). **NIKROTHAL 70** is used for electrical heating elements in industrial furnaces. It is particularly well suited for reducing atmospheres, as it is not subject to "green rot".

Up to 1150°C (*2100°F*). **NIKROTHAL 60** has good corrosion resistance, good oxidation properties and very good form stability. The corrosion stability is good except in sulphur containing atmospheres. Typical applications for NIKROTHAL 60 are in tubular heating elements and as suspended coils.

Up to 1100°C (*2010°F*). **NIKROTHAL 40** is used as electric heating element material in domestic appliances and other electric heating equipment.

Up to 1050°C (*1920°F*). **NIKROTHAL 20** is used principally for terminals and for other components exposed to elevated temperature. (Produced on volume based request.)

KANTHAL/NiFe

Up to 600°C (*1110°F*). **KANTHAL 70** and **52** are alloys with low resistivity and high temperature coefficient of resistance. The positive temperature coefficient results in reduced power in the heating elements as temperature increases.

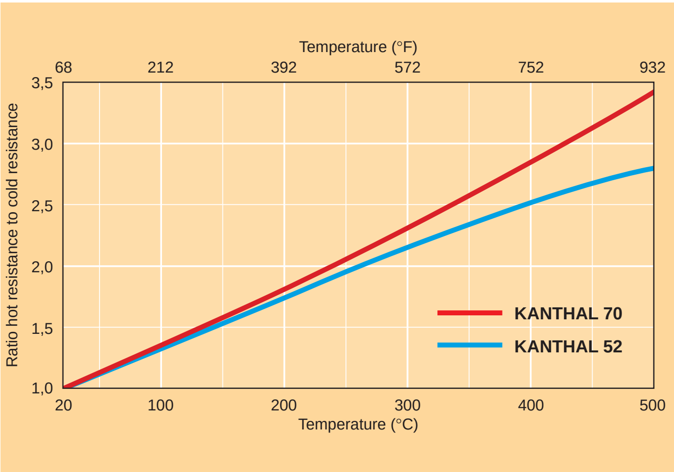


Fig. 3 Ratio of resistance at a given wire temperature to resistance at 20°C/68°F, C_t, vs wire temperature.

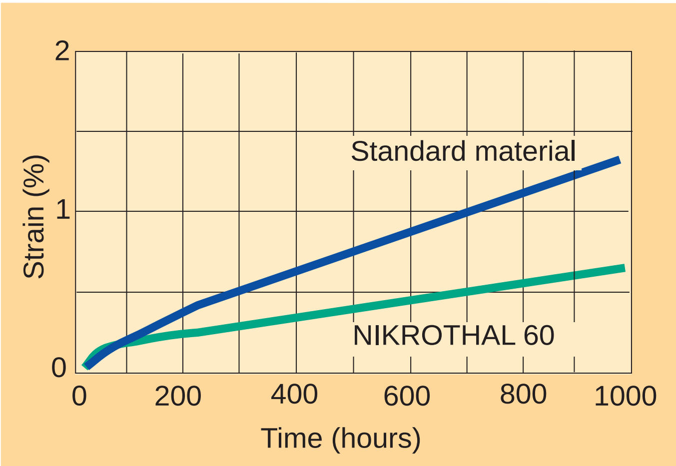


Fig. 4 Deformation vs time for NIKROTHAL 60 compared to standard material. Test performed on Ø 4 mm wire. Stress 1.5 MPa (218 psi).

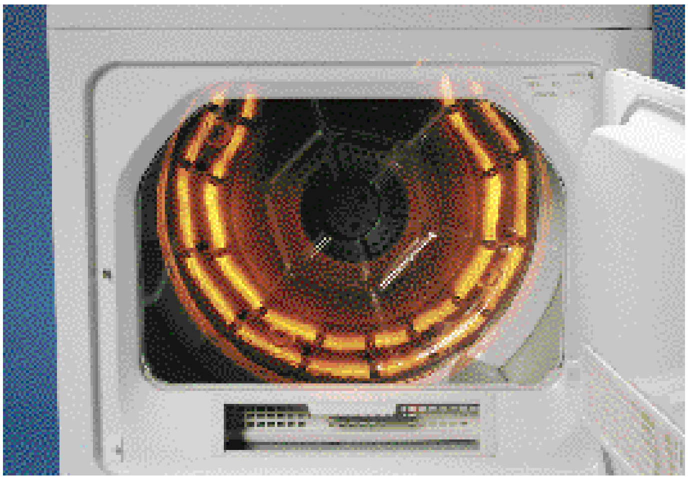


Fig. 5 NIKROTHAL 60 with outstanding combination of oxidation resistance and form stability. An example of typical application: Suspended coils in clothes drier.

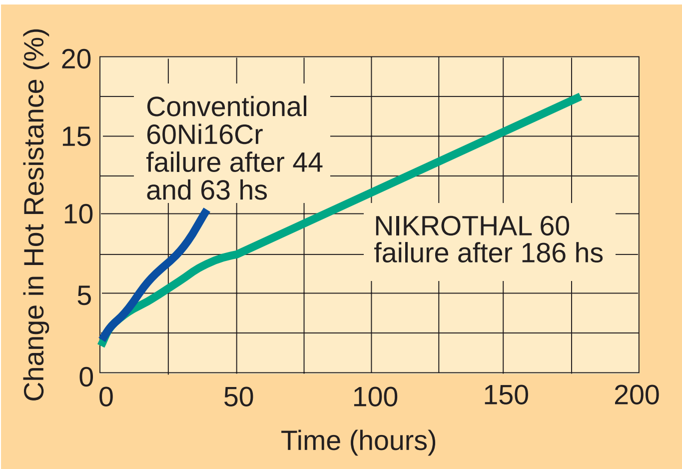


Fig. 6 Life and change in hot resistance for 60Ni, 16 Cr alloys. Constant power 200W. Cycling, 2 minutes on and 2 minutes off.

Physical and Mechanical Properties
KANTHAL Alloys

Heating Alloys	APM	A-1	A	AF	AE
Max continuous operating temperature (element temperature in air), °C *°F*	1425…*2595*	1400…*2550*	1350…*2460*	1300…*2370*	1300…*2370*
Nominal composition, % Cr Al Fe	22 5.8 Balance		 5.3		
Density, g/cm^3 *lb/in^3*	7.10…*0.256*		7.15…*0.258*		
Electrical resistivity at 20 °C, Ω mm^{2}m^{-1} *at 68 °F, Ω/cmf*	1.45…*872*		1.39…*836*		
Temperature factor of the resistivity, C_t 250 °C *480 °F* 500 °C *930 °F* 800 °C *1470 °F* 1000 °C *1830 °F* 1200 °C *2190 °F*	 1.00 1.01 1.03 1.04 1.04		 1.01 1.03 1.05 1.06 1.06		
Coefficient of thermal expansion, K^{-1} 20-100°C *68-210°F* 20- 250 °C *68- 480 °F* 20- 500 °C *68- 930 °F* 20- 750 °C *68-1380 °F* 20-1000 °C *68-1830 °F*	 – $11 \cdot 10^{-6}$ $12 \cdot 10^{-6}$ $14 \cdot 10^{-6}$ $15 \cdot 10^{-6}$				
Thermal conductivity at 50 °C, W m^{-1} K^{-1} *122 °F, Btu in ft^{-2}h^{-1}°F^{-1}*	11…*76*				
Specific heat capacity, kJ kg^{-1}K^{-1}, 20 °C *Btu lb^{-1}°F^{-1}, 68 °F*	0.46 *0.110*				
Melting point (approx.), °C *°F*	1500…*2730*				
Mechanical properties *(approx.) Tensile strength, N mm^{-2} *psi*	680…*98600***	760…*110200*	725…*105200*	700…*101500*	720…*104400*
Yield point, N mm^{-2} *psi*	470…*68200***	545…*79000*	550…*798000*	500…*72500*	520…*75400*
Hardness, Hv	230	240	230		
Elongation at rupture, %	20**	20	22	23	20
Tensile strength at 900 °C, N mm^{-2} *at 1650 °F, psi.* Deformation rate 6.2 x 10^{-2}min^{-1}	40 *5800*	34 *4900*		37 *5400*	34 *4900*
Creep strength*** at 800 °C, N mm^{-2} *at 1470 °F, psi* at 1000 °C, N mm^{-2} *at 1830 °F, psi* at 1100 °C, N mm^{-2} *at 2010 °F, psi* at 1200 °C, N mm^{-2} *at 2190 °F, psi*	 8.2….*1190* – – –	 1.2….*170* 0.5…*70* – –		 – – 0.7…*100* 0.3…*40*	 1.2…*170* – – –
Magnetic properties	Magnetic (Curie point approx. 600 °C *1100 °F)*				
Emissivity, fully oxidized condition	0.70				

* The values given apply for sizes of approx. 1.0 mm diameter *0.04 in.*
**4.0 mm *0.16 in.* Finer gauges have higher strength and hardness values while the corresponding values are lower for heavier gauges.
***Calculated from observed elongation in a Kanthal standard furnace test. 1 % elongation after 1000 hours.

Heating Alloys	D	ALKROTHAL	K 70	K 52
Max continuous operating temperature (element temperature in air), °C *°F*	1300… *2370*	1100…*2010*	600…*1110*	600…*1110*
Nominal composition, % Cr Al Fe Ni	22 4.8 Bal –	15 4.3 Bal –	– – Bal 70	– – Bal 52
Density, g/cm^3 *lb/in^3*	7.25…*0.262*	7.28…*0.263*	8.45…*0.305*	8.20…*0.296*
Electrical resistivity at 20 °C, Ω mm^{2}m^{-1} *at 68 °F, Ω/cmf*	1.35…*812*	1.25…*755*	0.21…*126*	0.37….*223*
Temperature factor of the resistivity, C_t 250 °C *480 °F* 500 °C *930 °F* 800 °C *1470 °F* 1000 °C *1830 °F* 1200 °C *2190 °F*	 1.01 1.03 1.06 1.07 1.08	 1.03 1.05 1.10 1.11 –	 2.05 3.40 – – –	 1.93 2.77 – – –
Coefficient of thermal expansion, K^{-1} 20-100°C *68-210°F* 20- 250 °C *68- 480 °F* 20- 500 °C *68- 930 °F* 20- 750 °C *68-1380 °F* 20-1000 °C *68-1830 °F*	 – $11 \cdot 10^{-6}$ $12 \cdot 10^{-6}$ $14 \cdot 10^{-6}$ $15 \cdot 10^{-6}$		 $15 \cdot 10^{-6}$ – – – –	 $10 \cdot 10^{-6}$ – – – –
Thermal conductivity at 50 °C, W m^{-1} K^{-1} *122 °F, Btu in ft^{-2}h^{-1}°F*	11…*76*	16…*110*	16…*110*	17…*120*
Specific heat capacity, kJ kg^{-1}K^{-1}, 20 °C *Btu lb^{-1}°F^{-1}, 68 °F*	0.46 *0.110*		0.52 *0.120*	0.50 *0.120*
Melting point (approx.), °C *°F*	1500…*2730*		1430…*2610*	1435…*2620*
Mechanical properties* (approx.) Tensile strength, N mm^{-2} *psi*	670…97200	630…91400	640…92800	610…88500
Yield point, N mm^{-2} *psi*	485…*70300*	455…*66000*	340…*49300*	
Hardness, Hv	230	220	–	–
Elongation at rupture, %	23	22	30	
Tensile strength at 900 °C, N mm^{-2} *at 1650 °F, psi.* Deformation rate 6.2 x 10^{-2} min^{-1}	34 *4900*	30 *4300*	– –	– –
Creep strength*** at 800 °C, N mm^{-2} *at 1470 °F, psi* at 1000 °C, N mm^{-2} *at 1830 °F, psi* at 1100 °C, N mm^{-2} *at 2010 °F, psi* at 1200 °C, N mm^{-2} *at 2190 °F, psi*	 1.2…*170* 0.5…*70* – –	 1…*140* – –	 – – – –	 – – – –
Magnetic properties	Magnetic (Curie point approx. 600 °C *1100 °F)*		Magnetic up to °C/°F (Curie point) 610…*1130*	 530…*990*
Emissivity, fully oxidized condition	0.70		–	

* The values given apply for sizes of approx. 1.0 mm diameter *0.04 in.*
**4.0 mm *0.16 in.* Finer gauges have higher strength and hardness values while the corresponding values are lower for heavier gauges.
***Calculated from observed elongation in a Kanthal standard furnace test. 1 % elongation after 1000 hours.

Physical and Mechanical Properties

NIKROTHAL Alloys

Heating Alloys	N 80	N 70	N 60	N 40	N 20
Max continuous operating temperature (element temperature in air), °C *°F*	1200…*2190*	1250….*2280*	1150…*2100*	1100…*2010*	1050…*1920*
Nominal composition, % Cr Al Fe Ni	20 – – 80	30 – – 70	16 – Bal 60	20 – Bal 35	24 – Bal 20
Density, g/cm^3 *lb/in^3*	8.30…*0.300*	8.10….*0.293*	8.20…*0.296*	7.90…*0.285*	7.80…*0.281*
Electrical resistivity at 20 °C, Ω mm^{2}m^{-1} *at 68 °F, Ω/cmf*	1.09….*655*	1.18…*709*	1.11…*668*	1.04…*626*	0.95…*572*
Temperature factor of the resistivity, C_t 250 °C *480 °F* 500 °C *930 °F* 800 °C *1470 °F* 1000 °C *1830 °F* 1200 °C *2190 °F*	 1.03 1.04 1.04 1.05 1.07	 1.03 1.05 1.04 1.05 1.06	 1.05 1.08 1.10 1.11 –	 1.08 1.15 1.21 1.23 –	 1.12 1.21 1.28 1.32 –
Coefficient of thermal expansion, K^{-1} 20-100°C *68-210°F* 20- 250 °C *68- 480 °F* 20- 500 °C *68- 930 °F* 20- 750 °C *68-1380 °F* 20-1000 °C *68-1830 °F*	 – $15{\cdot}10^{-6}$ $16{\cdot}10^{-6}$ $17{\cdot}10^{-6}$ $18{\cdot}10^{-6}$	 – $14{\cdot}10^{-6}$ $15{\cdot}10^{-6}$ $16{\cdot}10^{-6}$ $17{\cdot}10^{-6}$		 – $16{\cdot}10^{-6}$ $17{\cdot}10^{-6}$ $18{\cdot}10^{-6}$ $19{\cdot}10^{-6}$	
Thermal conductivity at 50 °C, W m^{-1} K^{-1} *122 °F, Btu in ft^{-2}h^{-1}°F^{-1}*	15….*104*	14…*97*	13…*90*		
Specific heat capacity, kJ kg^{-1}K^{-1}, 20 °C *Btu lb^{-1}°F^{-1}, 68 °*	0.46 *0.110*			0.50 *0.119*	
Melting point (approx.), °C *°F*	1400…*2550*	1380…*2515*	1390…*2535*		1380…*2515*
Mechanical properties* (approx.) Tensile strength, N mm^{-2} *psi*	810…*117500*	820…*118900*	730…*105900*	675…*97900*	
Yield point, N mm^{-2} *psi*	420…*60900*	430…*62400*	370…*53700*	340…*49300*	335…*48600*
Hardness, Hv	180	185	180		160
Elongation at rupture, %	30		35		30
Tensile strength at 900 °C, N mm^{-2} *at 1650 °F, psi.* Deformation rate 6.2 x 10^{-2} min^{-1}	100 *14500*	120 *17400*	100 *14500*	120 *17400*	
Creep strength*** at 800 °C, N mm^{-2} *at 1470 °F, psi* at 1000 °C, N mm^{-2} *at 1830 °F, psi* at 1100 °C, N mm^{-2} *at 2010 °F, psi* at 1200 °C, N mm^{-2} *at 2190 °F, psi*	 15 4 – –	 – – – –	 15 4 – –	 20 4 – –	
Magnetic properties	Non-magnetic		Slightly magnetic	Non-magnetic	
Emissivity, fully oxidized condition	0.88				

* The values given apply for sizes of approx. 1.0 mm diameter *0.04 in.*
**4.0 mm *0.16 in.* Finer gauges have higher strength and hardness values while the corresponding values are lower for heavier gauges.
***Calculated from observed elongation in a Kanthal standard furnace test. 1 % elongation after 1000 hours.

KANTHAL or NIKROTHAL?

KANTHAL Advantages

Higher maximum temperature in air. KANTHAL A-1 has a maximum temperature of 1400°C *(2550°F)*; NIKROTHAL 80 has a maximum temperature of 1200°C *(2190°F)*.

Longer life. KANTHAL elements have a life 2-4 times the life of NIKROTHAL when operated in air at the same temperature.

Higher surface load. Higher maximum temperature and longer life allow a higher surface load to be applied on KANTHAL elements.

Better oxidation properties. The aluminium oxide (Al_2O_3) formed on KANTHAL alloys adheres better and is therefore less contaminating. It is also a better diffusion barrier, better electrical insulator and more resistant to carburizing atmospheres than the chromium oxide (Cr_2O_3) formed on NIKROTHAL alloys.

Lower density. The density of the KANTHAL alloys is lower than that of the NIKROTHAL alloys. This means that a greater number of equivalent elements can be made from the same weight material.

Higher resistivity. The higher resistivity of KANTHAL alloys makes it possible to choose a material with larger cross-section, which improves the life of the element. This is particularly important for fine wire. When the same cross-section can be used, considerable weight savings are obtained. Further, the resistivity of KANTHAL alloys is less affected by cold-working and heat treatment than is the case for NIKROTHAL 80.

Higher yield strength. The higher yield strength of KANTHAL alloys means less change in cross-section when coiling wire.

Better resistance to sulphur. In atmospheres containing sulphuric compounds and in the presence of contaminations containing sulphur on the wire surface, KANTHAL alloys have better corrosion resistance in hot state. NiCr alloys are heavily attacked under such conditions.

NIKROTHAL Advantages

Higher hot and creep strength. NIKROTHAL alloys have higher hot and creep strength than KANTHAL alloys. KANTHAL APM, AF and AE are better in this respect than the other KANTHAL grades and have a very good form stability, however, not as good as that of NIKROTHAL.

Better ductility after use. NIKROTHAL alloys remain ductile after long use.

Higher emissivity. Fully oxidized NIKROTHAL alloys have a higher emissivity than KANTHAL alloys. Thus, at the same surface load the element temperature of NIKROTHAL is somewhat lower.

Non-magnetic. In certain low-temperature applications a non-magnetic material is preferred. NIKROTHAL alloys are non-magnetic (except NIKROTHAL 60 at low temperatures). KANTHAL alloys are non-magnetic above 600°C (*1100°F*).

Better wet corrosion resistance. NIKROTHAL alloys generally have better corrosion resistance at room temperature than nonoxidized KANTHAL alloys. (Exceptions: atmospheres containing sulphur and certain controlled atmospheres.)

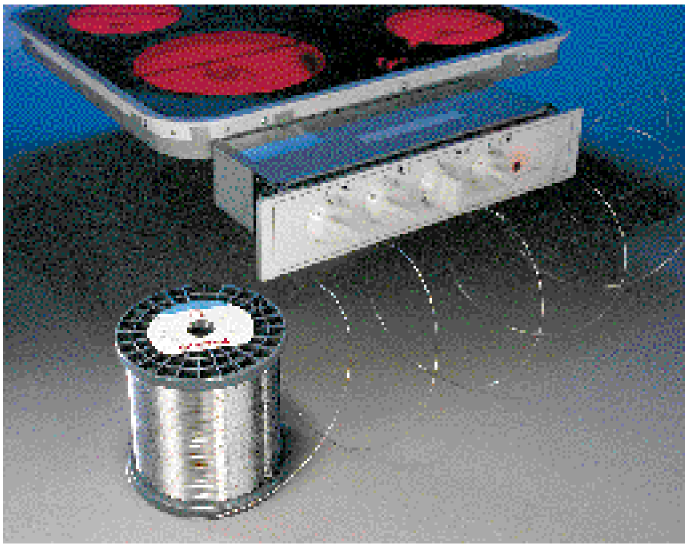


Fig. 7 KANTHAL AE heating wire in fast response elements for ceramic glass top hobs and quartz tube heaters.

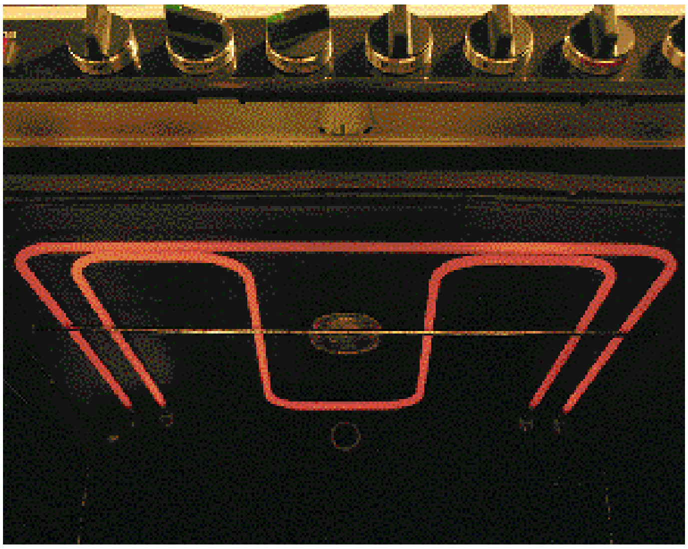


Fig. 8 NIKROTHAL 80 is widely used for heavy-duty applications because of its good workability and high temperature strength.

Weight Savings with KANTHAL alloys

The lower density and higher resistivity of KANTHAL alloys means that for a given power, less material is needed when using KANTHAL instead of NIKROTHAL alloys. The result is that in a great number of applications, substantial savings in weight and element costs can be achieved.

In converting from NiCr to KANTHAL alloys, either the wire diameter can be kept constant while changing the surface load, or the surface load can be held constant while changing the wire diameter. In both cases, the KANTHAL alloy will weigh less than the NiCr alloy.

Conversion			Weight saving (%) Equal wire diameter	Weight saving (%) Equal surface load
NiCr 80/20	→	KANTHAL D	31	6
NiCrFe 60/15	→	KANTHAL D	25	7
NiCrFe 35/20	→	KANTHAL D	20	4

Table 1 Weight savings with KANTHAL alloys at 700 °C (1290 °F)

Example: Aluminium-sheathed tubular element for coffee maker.

Voltage:	220 V
Rating:	650 W
Heated tube length:	339 mm *(13.3 in)*
Coil diameter:	2.6 mm *(0.102 in)*

Element Data	NiCrFe 60/15		KANTHAL D	
Cold resistance, R_{20}	85.8		90.0	
Wire diameter, mm *(in)*	0.22	*(0.009)*	0.22	*(0.009)*
Surface load, W/cm^2 *(W/in^2)*	32.0	*(206.4)*	37.1	*(239.3)*
Wire weight, g *(oz)*	0.916	*(0.032)*	0.700	*(0.025)*
No of elements from 1kg	1091		1429	

Weight saving: $\frac{0.916 - 0.700}{0.916} = 23.7\%$ $\qquad$ $\frac{0.032 - 0.025}{0.032} = 23.7\%$

Fig. 9 Kanthal AB, Hallstahammar, Sweden

Operating Life

When heated, resistance heating alloys form an oxide layer on their surface, which slows down further oxidation of the material. To accomplish this function the oxide layer must be dense and resist the diffusion of gases as well as metal ions. It must also be thin and adhere to the metal under temperature fluctuations.
The protective oxide layer on KANTHAL alloys formed at temperatures above 1000°C *(1830°F)* consists mainly of alumina (Al_2O_3). The colour is light grey, while at lower temperatures under 1000°C, *(1830°F)* the oxide colour becomes darker. The alumina layer has excellent electrical insulating properties and good chemical resistance to most compounds.
The oxide formed on NIKROTHAL alloys consists mainly of chromium oxide (Cr_2O_3). The colour is dark and the electrical insulating properties inferior to those of alumina.

The oxide layer on NIKROTHAL alloys spalls and evaporates more easily than the tighter oxide layer that is formed on the KANTHAL alloys.
Results of several life tests are given in Table 2 for KANTHAL and NIKROTHAL alloys. In the table, the durability of KANTHAL A-1 wire at 1200°C *(2190°F)* is set at 100%, and the durability of the other alloys is related to that figure.
Numerous practical applications also show a much longer life of KANTHAL elements than of elements equipped with NiCr(Fe) wire.

	1100°C *(2010°F)*	**1200°C *(2190°F)***	**1300°C *(2370°F)***
KANTHAL A-1	340	**100**	30
KANTHAL AF	465	120	30
KANTHAL AE	550	120	30
KANTHAL D	250	75	25
NIKROTHAL 80	120	25	–
NIKROTHAL 70	150	30	–
NIKROTHAL 60	95	25	–
NIKROTHAL 40	40	15	–

Table 2 Relative Durability Values in %, KANTHAL and NIKROTHAL Alloys (ASTM-test wire 0.7 mm (0.028 in))

Maximum temperature per Wire Size

The maximum permissible temperature depends on both the wire diameter and the atmosphere. Hence, the maximum temperatures given are only valid for heavy gauges of wire and strip. As a rule, elements that operate at the maximum recommended temperatures should have a wire diameter of not less than 3 mm (*0.12 in)* or a strip thickness of at least 2 mm *(0.08 in)*.

Diameter, mm *(in)*:	**0.15-0.40 *(0.0059-0.0157)***		**0.41-0.95 *(0.0061-0.0374)***		**1.0-3.0 *(0.039-0.118)***	
	°C	***(°F)***	**°C**	***(°F)***	**°C**	***(°F)***
KANTHAL AF	900-1100	*(1650-2010)*	1100-1225	*(2010-2240)*	1225-1275	*(2240-2330)*
KANTHAL A	925-1050	*(1700-1920)*	1050-1175	*(1920-2150)*	1175-1250	*(2150-2300)*
KANTHAL AE	950-1150	*(1740-2100)*	1150-1225	*(2100-2240)*	1225-1250	*(2240-2300)*
KANTHAL D	925-1025	*(1700-1880)*	1025-1100	*(1880-2010)*	1100-1200	*(2010-2190)*
NIKROTHAL 80	925-1000	*(1700-1830)*	1000-1075	*(1830-1970)*	1075-1150	*(1970-2100)*
NIKROTHAL 60	900-950	*(1650-1740)*	950-1000	*(1740-1830)*	1000-1075	*(1830-1970)*
NIKROTHAL 40	900-950	*(1650-1740)*	950-1000	*(1740-1830)*	1000-1050	*(1830-1920)*

Table 3 Maximum Permissible Temperature as a Function of Wire Size

Corrosion Resistance

Corrosive or potentially corrosive constituents can considerably shorten wire life. Corrosion can be caused by perspiring hands, mounting or supporting materials or other contamination.

Steam. Steam may shorten the wire life.

Halogens. Halogens (fluorine, chlorine, bromine and iodine) severely attack all high-temperature alloys at fairly low temperatures.

Sulphur. In sulphurous atmospheres KANTHAL alloys have considerably better durability than nickel-base alloys. KANTHAL is particularly stable in oxidizing gases containing sulphur, while reducing gases with a sulphur content diminish its service life.
NIKROTHAL alloys are sensitive to sulphur.

Salts and oxides. The salts of alkaline metals, boron compounds, etc. in high concentrations are harmful to heating alloys.

Metals. Some molten metals, such as zinc, brass, aluminium and copper, react with the resistance alloys. The elements should therefore be protected from splashes of molten metals.

Ceramic support material. Special attention must be paid to the ceramic supports that come in direct contact with the heating wire. Firebricks for wire support should have an alumina content of at least 45%. In high-temperature applications, the use of sillimanite and high-alumina firebricks is often recommended. The free silica (uncombined quartz) content should be held low. Iron oxide lowers the melting point of the ceramics.

Water glass as a binder in cements must be avoided.

Embedding compounds. Most embedding compounds including ceramic fibres are suitable for KANTHAL and NIKROTHAL if composed of alumina, alumina-silicate, magnesia or zirconia.

Elements in Electric Appliances

Embedded Elements

The wire in the embedded element type is completely surrounded by solid or granular insulating material.

The Supported Element Type

The wire, normally in spiral form, is placed on the surface, in a groove or a hole of the electrical insulating material. KANTHAL AE, KANTHAL AF and NIKROTHAL 80 are generally the best materials.
In order to avoid deformation in horizontal coils, the wire temperature should not exceed the values given in Figure 10.

Metal Sheathed Tubular Elements

KANTHAL D is generally the best heating wire for tube temperatures below 700 °C *(1290 °F)* and NIKROTHAL 80 for temperatures above.
Using KANTHAL instead of NiCr gives the following advantages:

- Reduced wire weight by 20-30 % at the same wire dimension
- More even temperature along the element and lower maximum wire temperature. This means that the element can be charged higher for a short time – important at dry boiling
- Closer tolerances of rating. Rating and temperature remains more constant since the resistivity in hot state does not change as much as for NiCr
- Longer life at high surface loads. The element life is also easier predicted
- Elements of wire type KANTHAL is easier to manufacture when high resistance per length is needed, since a heavier wire can be used
- Less sensitive to corrosion attacks

The Suspended Element Type

The wire is suspended freely between insulated points and is subjected to the mechanical stress caused by its own weight, its own spring force and in some cases also from the forces of an external spring.
NIKROTHAL 80, NIKROTHAL 60, KANTHAL D and KANTHAL AF are the best materials.

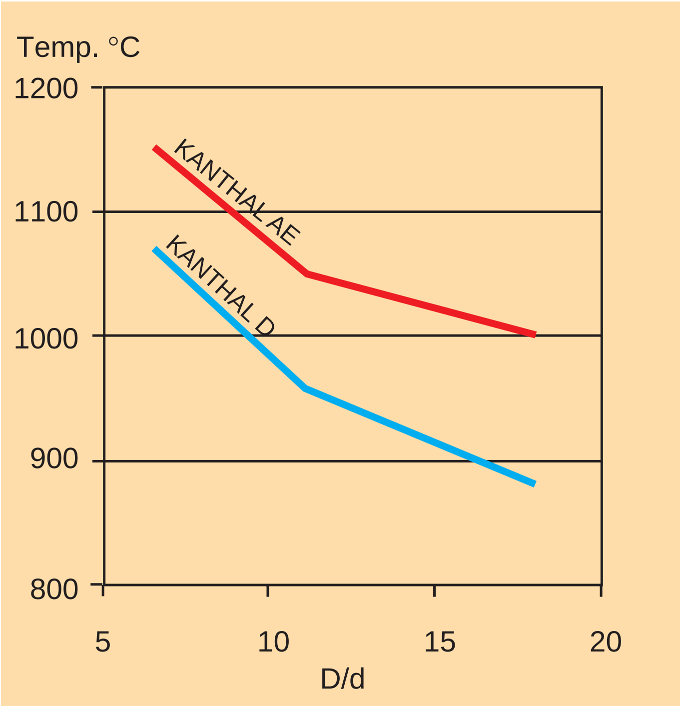


Fig. 10 Permissible D/d ratios as a function of wire temperature.

Embedded Elements

Metal Sheathed Tubular Elements

Characteristics

The heating coil is insulated from the encasing metallic tube by granular material (MgO). The tube is compressed to a round, oval or triangular shape. Terminals may be at either end or at one end of the element.

Recommended Alloy

KANTHAL D in elements with sheath temperature <700°C *(<1290°F)*.
NIKROTHAL 80 in elements with sheath temperature >700°C *(>1290°F)*.

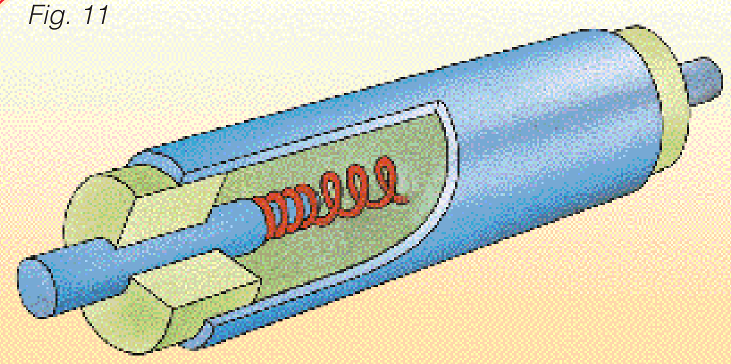
Surface Load

Wire: Normally 2-4 times the element surface load.
Element: 2-25 W/cm² *(13-161 W/in²)*.

Typical Applications

Cooking: Hot plates, domestic ovens, grills, toaster ovens, frying pans, deep fryers, rice cookers.
Water and beverage: Boilers, immersion heaters, teapots, coffee makers, dishwashers, washing machines.
Space heating: Radiators, storage heaters.
Others: Irons, air heaters, oil heaters, glow plugs.

Fig. 11



Elements Embedded in Ceramics

Characteristics

Heating coil is embedded in green ceramics and fired to solidify ceramics or cemented in grooves in ceramic bodies.

Recommended Alloy

KANTHAL A for high temperature firing.
KANTHAL D for other applications.

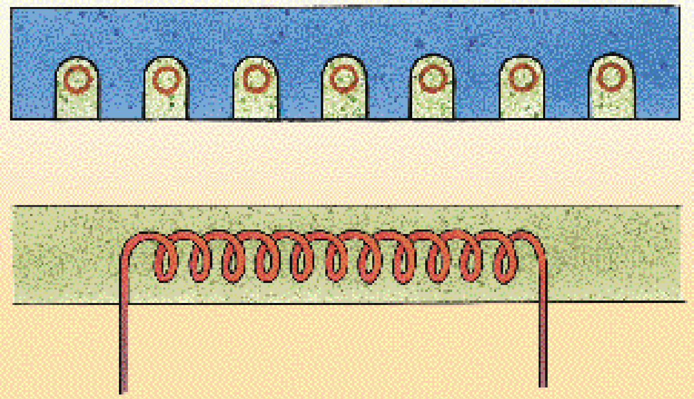
Surface Load

Wire: 5-10 W/cm² *(30-60 W/in²)*.

Typical Applications

Panel heaters, infrared heaters, warming plates, irons, ceramic pots.

Fig. 12



Coils in grooved Metal Plates

Characteristics

Heating coil and insulating powder are pressed into grooves of a metal plate.

Recommended Alloy

KANTHAL D.

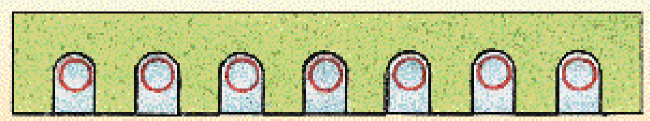
Surface Load

Wire: 4-20 W/cm² *(25-130 W/in²)*.

Typical Applications

Cast iron plates; also, irons, warming plates, kettles, domestic ovens.

Fig. 13



Cartridge Elements, Powder filled

Characteristics
Straight wire or coil is wound on a threaded ceramic body and insulated by granular insulating material (MgO) from enveloping metal tube. Terminals are at one end of the element. Elements are compressed when high-loaded.

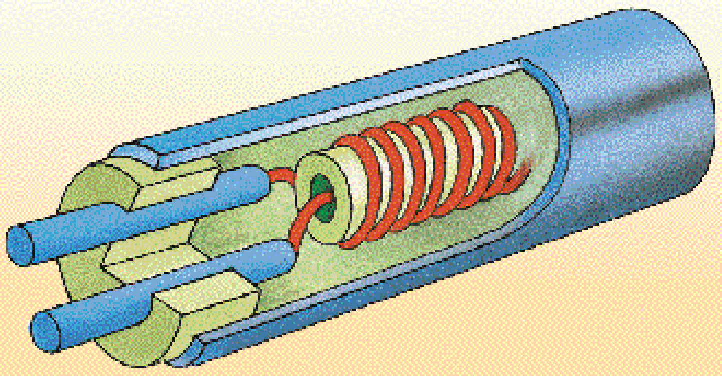
Recommended Alloy
NIKROTHAL 80 in straight wire elements. KANTHAL D in coiled wire elements.

Surface Load
On tube: 10-25 W/cm² *(65-160 W/in²)* for elements with straight wire.

Other types: about 5 W/cm² *(30 W/in²)*.

Typical Applications
Metal dies, plates, etc., refrigerators.

Fig. 14



Heating Cables and Rope Heaters

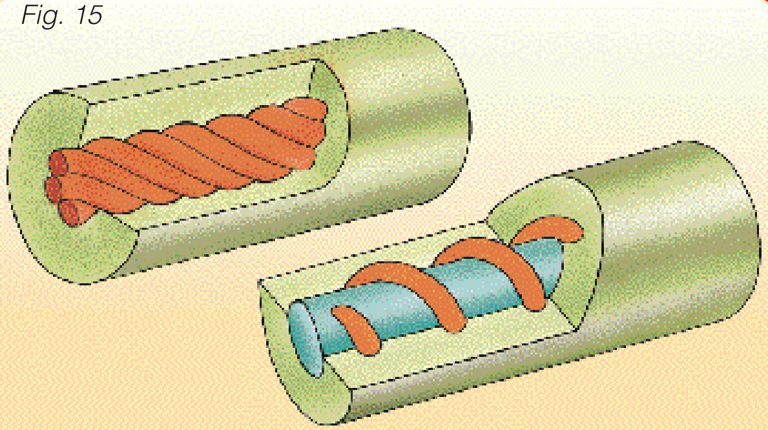
Characteristics
Wire is wound on a fibreglass core and insulated with PVC (max. 105°C *(220°F)* or silicon rubber (max. 150°C *(300°F)*. Fibreglass insulation permits higher temperatures. Heating cable with straight or stranded wire, sometimes enclosed in aluminium tube.

Recommended Alloy
KANTHAL D, NIKROTHAL 40. NIKROTHAL 80 (CuNi alloys).

Surface Load
Wire: <1 W/cm² *(<6 W/in²)* on wire for PVC and silicon rubber.
2-5 W/cm² *(13-30 W/in²)* for fibreglass insulation.

Typical Applications
Defrosting and de-icing elements, electric blankets and pads, car seats, baseboard heaters, floor heating.

Fig. 15



Micanite Elements

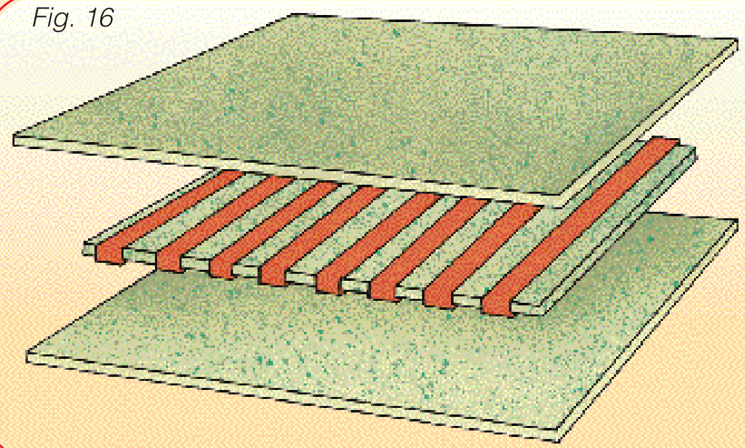
Characteristics
Resistance ribbon or wire is wound on micanite sheet or tube and insulated by mica–micanite. Elements are often encapsulated in steel sheaths.

Recommended Alloy
KANTHAL D.
NIKROTHAL 80.

Surface Load
Wire: 2-10 W/cm² *(13-65 W/in²)*.

Typical Applications
Irons, ironing machines, water heaters, plastic moulding dies, soldering irons.

Fig. 16



Foil Elements

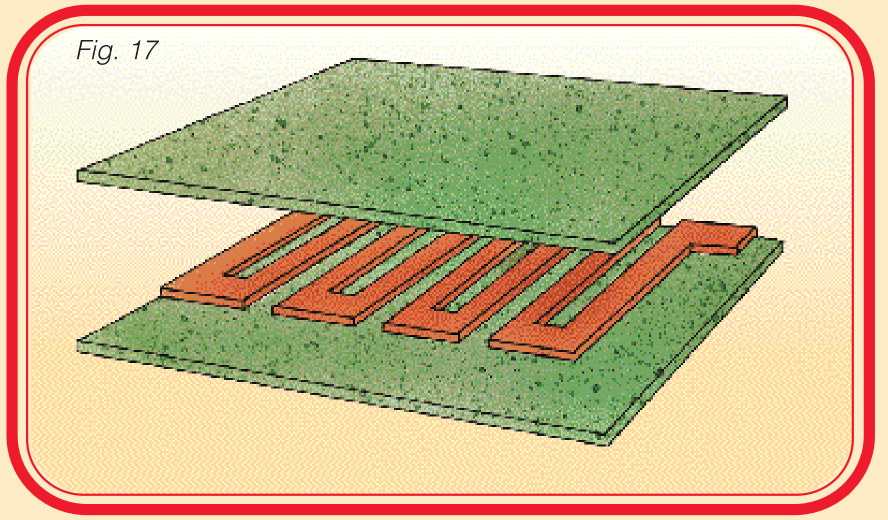
Characteristics
An etched metallic foil is sandwiched between two thin layers of insulating material.

Recommended Alloy
KANTHAL, NIKROTHAL, (Aluminium, stainless brass, PbSn, etc.).

Surface Load
Element: 1-10 W/cm² *(6.5-65 W/in²)*
0.01-40 Ω/cm².

Typical Applications
Waterbed, pickling baths car seats, antennas, operating tables, trouser presses, etc.

Fig. 17



Supported Elements

Cartridge Elements

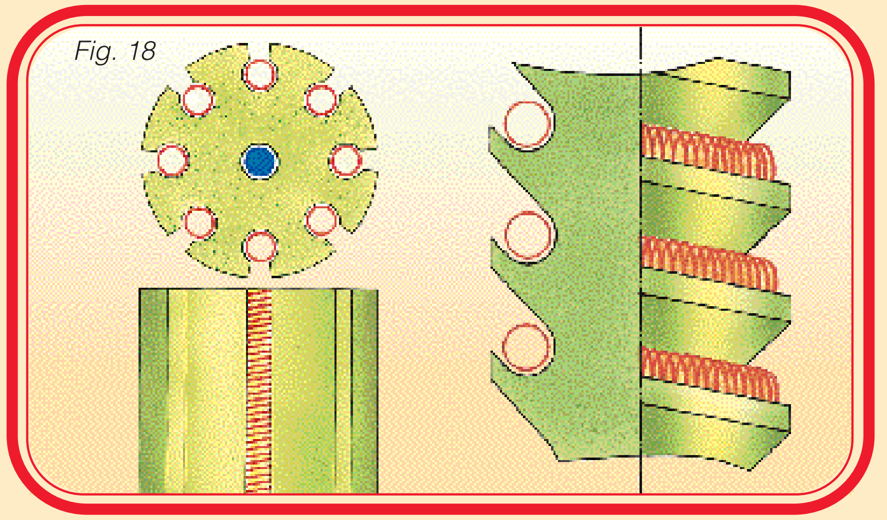
Characteristics
Most common design consists of round ceramic bodies with longitudinal holes or grooves for heating coil. Elements are often in metallic tube with terminals at one end. Often provisions are made to avoid excessive sagging of the coil when the element is operating vertically.

Recommended Alloy
KANTHAL A or D for horizontally operating coils.
NIKROTHAL 80 (usually) for long vertically situated coils when sagging is a problem.

Surface load
Wire: 3-6 W/cm² *(20 - 40 W/in²).*
Element: 2-5 W/cm² *(13 - 32 W/in²).*

Typical Applications
Liquid heating, storage heaters.

Fig. 18



Other ceramic Elements

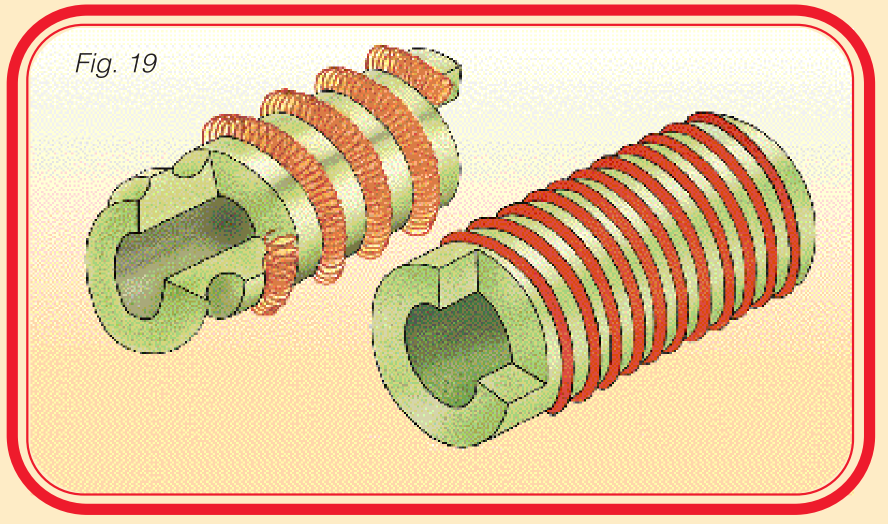
Characteristics
Coiled and straight wire is located on smooth ceramic tube or in grooves or holes of ceramic bodies of various shapes (plates, tubes, rods, cylinders, etc.).

Recommended Alloy
KANTHAL A, AF and D.
NIKROTHAL 80 (for pencil bars).

Surface Load
Wire: 3-9 W/cm² *(20-60 W/in²).*

Typical Applications
Boiling plates, air guns, hobby kilns, radiators.

Fig. 19



Quartz Tube Heaters

Characteristics

Heating coil is placed inside quartz tube. When the element is operating vertically or at an angle, the coil should be tight-wound and pre-oxidized. For horizontal use the relative pitch is 1.2-2.0.

Recommended Alloy

KANTHAL AE, AF, A and D.

Surface Load

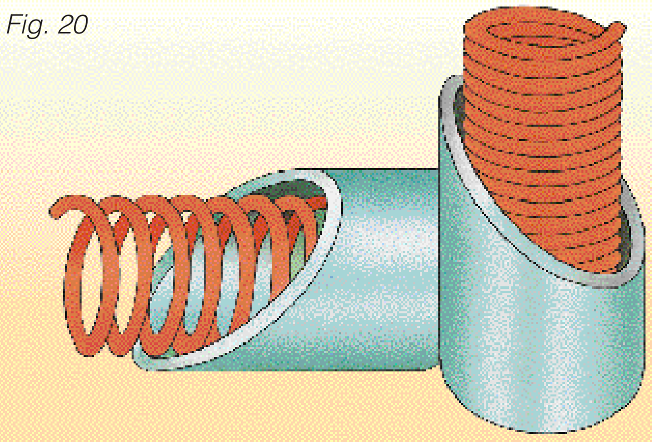
Wire: 2-8 W/cm² *(13-52 W/in²).*

Element: 4-8W/cm² *(26-52 W/in²).*

Typical Applications

Space heating; toasters,toaster ovens, grills, industrial infrared dryers etc.

Fig. 20



Coils on moulded ceramic fibre

Characteristics

Heating coil rests on moulded ceramic fibre plate, which may incorporate grooves in which coil is cemented at intervals. Coils may also be stapled to a flat surface or pressed into ribs on this surface. Corrugated strip and coiled ribbon are also used.

Recommended Alloy

KANTHAL AE or AF.

Surface Load

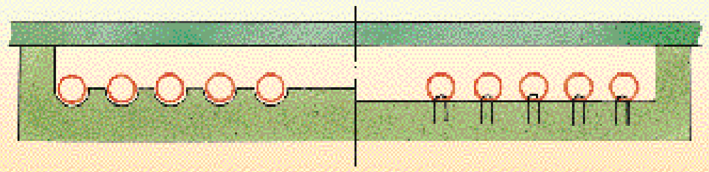
Wire: <10 W/cm² *(< 65 W/in²)* .

Ribbon: 4-6 W/cm² *(25-40 W/in²).*

Typical Applications

Boiling plates with ceramic hobs.

Fig. 21



Bead insulated coils

Characteristics

Heating coil is insulated by ceramic beads. With beads having two holes heating mats are made. Stranded wires are sometimes used. This element type is becoming less common.

Recommended Alloy

KANTHAL D, NIKROTHAL 80 (for panel heaters).

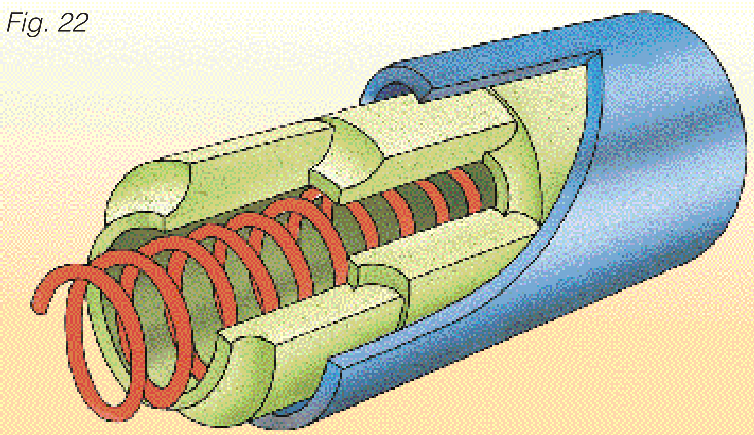
Surface Load

Wire: 1-8 W/cm² *(6.5-52 W/in²).*

Typical Applications

Panel heaters, waffle irons, domestic ovens, water heater, stress relief annealing of welded parts (mats).

Fig. 22



String Elements

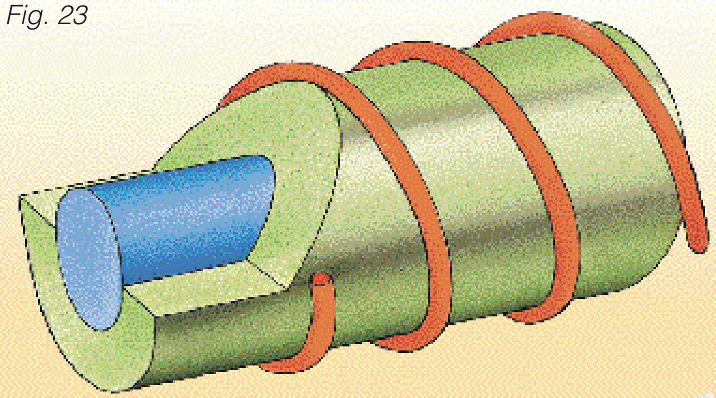
Characteristics
Insulated steel wire (approx. 2 mm *0.008 in)* is wound with a heating conductor.

Recommended Alloy
KANTHAL D.

Surface Load
Wire: <10 W/cm² *(<65 W/in²).*

Typical Applications
Stationary hair dryers.

Fig. 23



Suspended Elements

Suspended coils

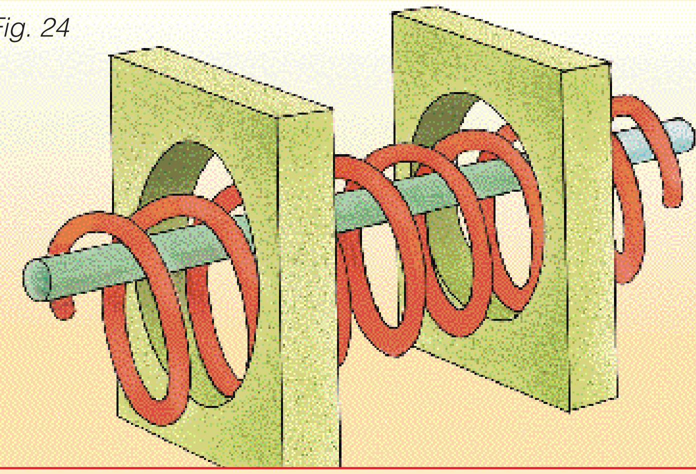
Characteristics
Wire coil is supported at intervals. Fibreglass cord is often placed inside coil to prevent the coil from falling in case of element failure.

Recommended Alloy
NIKROTHAL 80, NIKROTHAL 60, KANTHAL D and AF (mainly for wire temperatures below 600°C *(1110°F).*

Surface Load
Wire: 7-8 W/cm² *(45-50 W/in²)* forced air; 3-4 W/cm² *(20-25 W/in²)* natural convection.

Typical Applications
Air heaters such as:
laundry dryers, fan heaters, land dryers.

Fig. 24



Suspended straight wires and ribbons

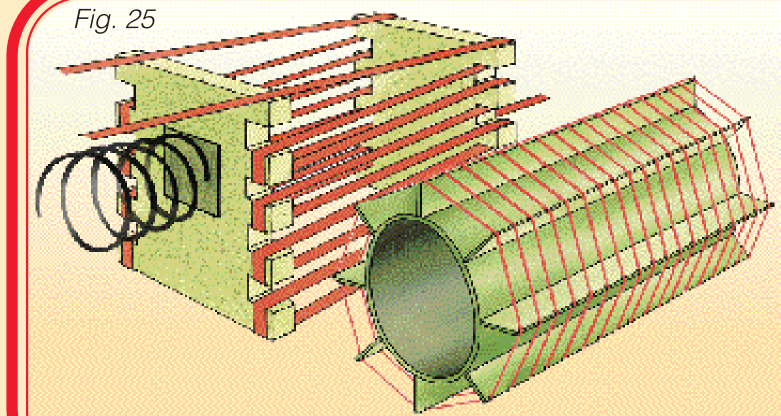
Characteristics
Wire or ribbon may have elastic or fixed suspension.
Elastic: Wire kept straight by springs when heated.
Fixed: Operating temperature is lower and low thermal expansion is advantageous.

Recommended Alloy
KANTHAL A and AF (low thermal expansion).
NIKROTHAL 80 (high hot strength).

Surface Load
Wire: 4-12 W/cm² *(25-77 W/in²).*

Typical Applications
Radiators, toasters, convection heaters.

Fig. 25



Open Micanite Elements

Characteristics
Straight or corrugated heating conductor is wound on one or both sides of a micanite sheet or separated micanite strips. Typically ribbons are used.

Recommended Alloy
NIKROTHAL 80, NIKROTHAL 60, KANTHAL D and AF.

Surface Load
Wire: 4-7 W/cm^2 *(25-45 W/in^2)* (toasters)
< 13 W/cm^2 *(<26-52 W/in^2)*
(wire-wound elements).

Typical Applications
Toasters; also, convectionheating, low-watt aquarium heaters.

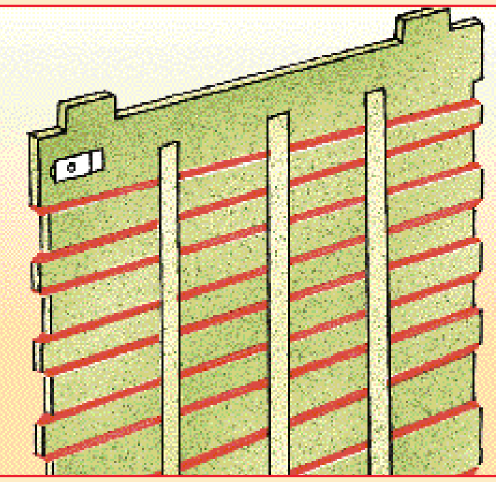


Fig. 26

Zig-zag Elements

Characteristics
Deep-corrugated ribbon is supported by micanite sheets. Also radial shape.

Recommended Alloy
KANTHAL D, AF and NIKROTHAL 40.

Surface Load
Wire: 9 W/cm^2 (60 W/in^2).

Typical Applications
Fan-heaters.

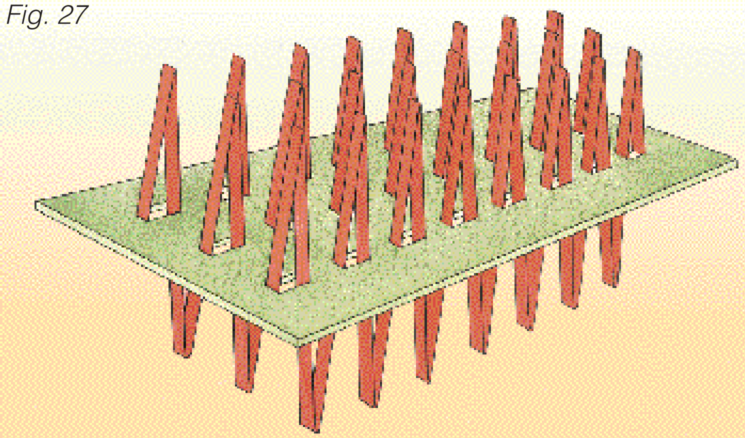


Fig. 27

Porcupine Elements

Characteristics
Heating conductor consists of hairpin-shaped wire bends protruding in all directions, with hole in centre. Element is supported by central insulated rod or insulating tube around its circumference.

Recommended Alloy
KANTHAL D, AF.
NIKROTHAL 80.

Surface Load
Wire: 4 W/cm^2 *(25 W/in^2)* natural convection,
<12 W/cm^2 *(75 W/in^2)* forced convection.

Typical Applications
Hot air guns, radiators, convectors, tumble driers, domestic ovens with forced convections. Also, regulating resistors. (However, not commonly used in domestic appliances.).

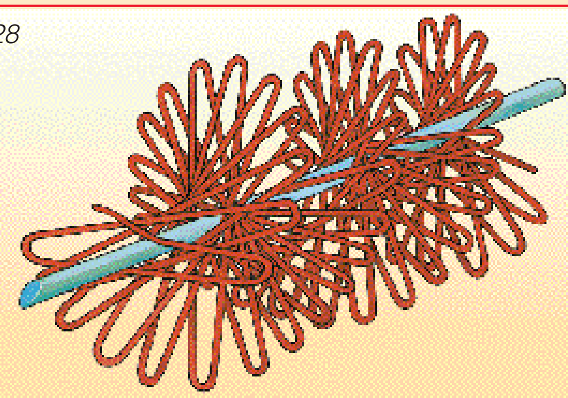


Fig. 28

Coils immersed in water

Characteristics
Wire coils operating directly in water.

Recommended Alloy
KANTHAL D and AF.
NIKROTHAL 80.

Surface Load
Wire: Depending on water velocity, 20-60 W/cm^2 *(130-390 W/in^2)* (even higher figures occur.).

Typical Applications
Instantaneous water heaters, steam generators, showers.

Fig. 29 The Scanning Electron Microscope is a powerful tool for material development and trouble shooting.

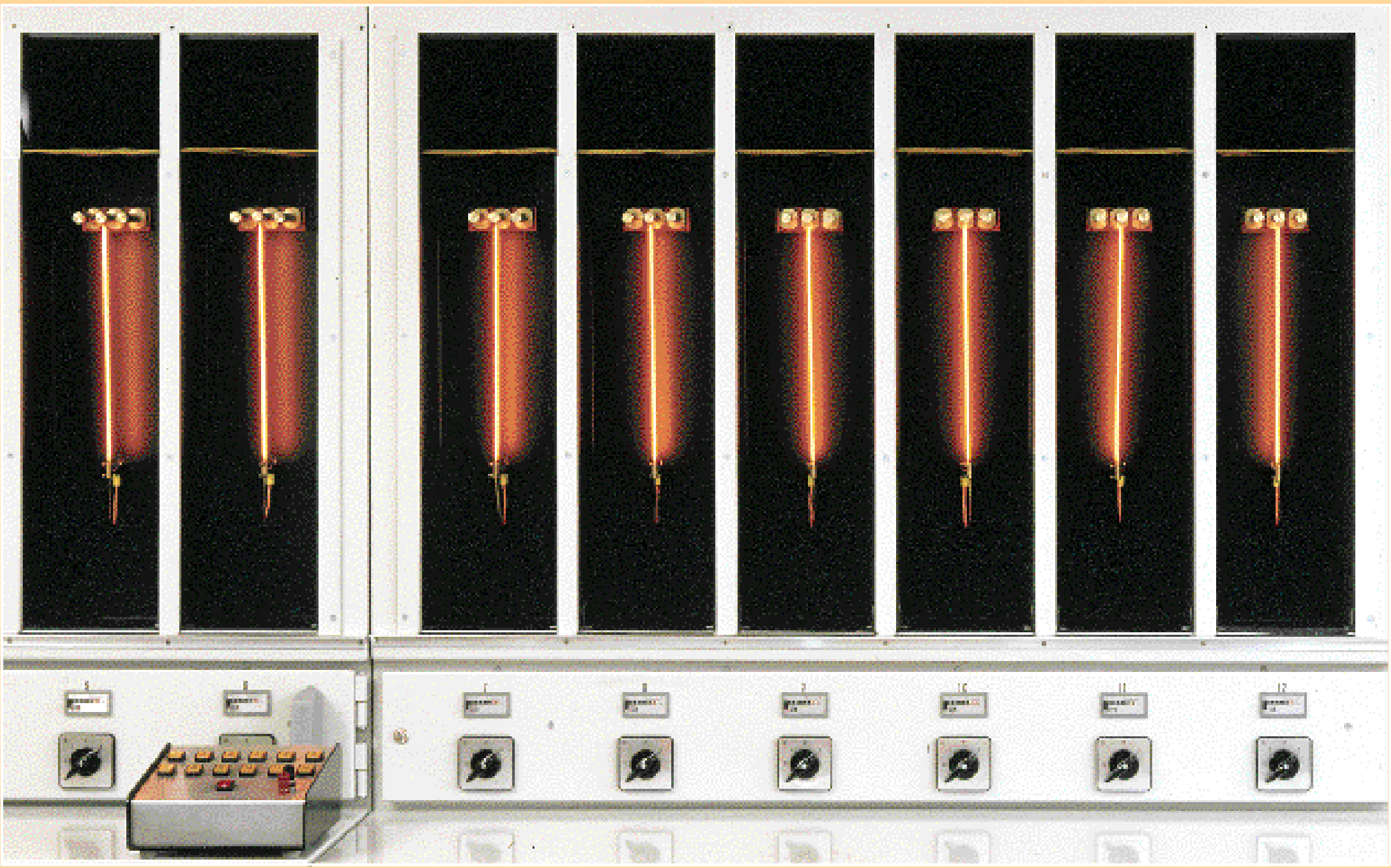


Fig. 30 Performance of resistance wire is monitored in a fully computer controlled test. The statistically analyzed results are used for quality assurance and material development.

KANTHAL A, AF, AE
Wire inch B&S

A: 0.325 – 0.002 in
AE: 0.039 – 0.008 in
AF: 0.325 – 0.004 in
Resistivity Ω/cir.mil ft 837
Density, lb/cu.in 0.258

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192	2372
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.06	1.06

Diameter B&S	Diameter inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
0	0.325	0.00792	1550	257	12.2	82.9
1	0.289	0.00999	1090	204	10.9	65.7
2	0.258	0.0126	771	161	9.71	52.1
3	0.229	0.0159	544	128	8.65	41.3
4	0.204	0.0200	384	101	7.70	32.8
5	0.182	0.0253	271	80.5	6.86	26.0
6	0.162	0.0319	192	63.8	6.11	20.6
7	0.144	0.0402	135	50.6	5.44	16.4
8	0.129	0.0506	95.7	40.2	4.84	13.0
9	0.114	0.0639	67.5	31.8	4.31	10.3
10	0.102	0.0805	47.7	25.2	3.84	8.16
11	0.0907	0.1020	33.5	20.0	3.42	6.46
12	0.0808	0.128	23.8	15.9	3.05	5.13
13	0.0720	0.161	16.8	12.6	2.71	4.07
14	0.0641	0.203	11.9	10.0	2.42	3.23
15	0.0571	0.256	8.39	7.93	2.15	2.56
16	0.0508	0.324	5.91	6.28	1.92	2.03
17	0.0453	0.407	4.19	4.99	1.71	1.61
18	0.0403	0.515	2.95	3.95	1.52	1.28
19	0.0359	0.649	2.09	3.13	1.35	1.01
20	0.0320	0.817	1.48	2.49	1.21	0.804
21	0.0285	1.03	1.04	1.98	1.07	0.638
22	0.0253	1.31	0.730	1.56	0.954	0.503
23	0.0226	1.64	0.520	1.24	0.852	0.401
24	0.0201	2.07	0.366	0.982	0.758	0.317
25	0.0179	2.61	0.259	0.779	0.675	0.252
26	0.0159	3.31	0.181	0.615	0.599	0.199
27	0.0142	4.15	0.129	0.490	0.535	0.158
28	0.0126	5.27	0.0902	0.386	0.475	0.125
29	0.0113	6.55	0.0651	0.310	0.426	0.100
30	0.0100	8.36	0.0451	0.243	0.377	0.0785
31	0.00890	10.6	0.0318	0.193	0.336	0.0622
32	0.00800	13.1	0.0231	0.156	0.302	0.0503
33	0.00710	16.6	0.0161	0.123	0.268	0.0396
34	0.00630	21.1	0.0113	0.0965	0.238	0.0312
35	0.00560	26.7	0.00792	0.0763	0.211	0.0246
36	0.00500	33.4	0.00564	0.0608	0.188	0.0196
37	0.00450	41.3	0.00411	0.0492	0.170	0.0159
38	0.00400	52.3	0.00289	0.0389	0.151	0.0126
39	0.00350	68.3	0.00193	0.0298	0.132	0.00962
40	0.00310	87.0	0.00134	0.0234	0.117	0.00755
41	0.00280	107	0.000990	0.0191	0.106	0.00616
42	0.00250	134	0.000704	0.0152	0.0942	0.00491
43	0.00220	173	0.000480	0.0118	0.0829	0.00380
44	0.00200	209	0.000361	0.00973	0.0754	0.00314
45	0.00176	270	0.000246	0.00753	0.0664	0.00243
46	0.00160	327	0.000185	0.00622	0.0603	0.00201

KANTHAL A, AF, AE

Ribbon inch

Resistivity Ω/sq.mil ft 657
Density, lb/cu.in 0.258

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in^2

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192	2372
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.06	1.06

Width in	Thickness in	Resistance at 68°F Ω/ft	in^2/Ω at 68°F	Weight lb/1000 ft	Surface area in^2/ft	Cross sectional area in^2 x 1000
1/8	0.057	0.100	43.6	20.3	4.37	6.56
	0.051	0.112	37.7	18.2	4.22	5.87
	0.045	0.127	32.2	16.0	4.08	5.18
	0.040	0.143	27.7	14.2	3.96	4.60
	0.036	0.159	24.4	12.8	3.86	4.14
	0.032	0.178	21.1	11.4	3.77	3.68
	0.029	0.197	18.8	10.3	3.70	3.34
	0.025	0.228	15.8	8.90	3.60	2.88
	0.023	0.248	14.3	8.19	3.55	2.65
	0.020	0.286	12.2	7.12	3.48	2.30
	0.018	0.317	10.8	6.41	3.43	2.07
	0.016	0.357	9.48	5.70	3.38	1.84
	0.014	0.408	8.18	4.98	3.34	1.61
	0.013	0.439	7.54	4.63	3.31	1.50
	0.011	0.519	6.29	3.92	3.26	1.27
	0.010	0.571	5.67	3.56	3.24	1.15
	0.0089	0.642	5.01	3.17	3.21	1.02
	0.0080	0.714	4.47	2.85	3.19	0.920
	0.0071	0.804	3.94	2.53	3.17	0.817
	0.0063	0.906	3.48	2.24	3.15	0.725
3/32	0.057	0.134	27.1	15.2	3.62	4.92
	0.051	0.149	23.3	13.6	3.47	4.40
	0.045	0.169	19.7	12.0	3.33	3.88
	0.040	0.190	16.9	10.7	3.21	3.45
	0.036	0.211	14.7	9.61	3.11	3.11
	0.032	0.238	12.7	8.54	3.02	2.76
	0.029	0.263	11.2	7.74	2.95	2.50
	0.025	0.305	9.36	6.68	2.85	2.16
	0.023	0.331	8.46	6.14	2.80	1.98
	0.020	0.381	7.17	5.34	2.73	1.73
	0.018	0.423	6.34	4.81	2.68	1.55
	0.016	0.476	5.54	4.27	2.63	1.38
	0.014	0.544	4.76	3.74	2.59	1.21
	0.013	0.586	4.37	3.47	2.56	1.12
	0.011	0.692	3.63	2.94	2.51	0.949
	0.010	0.761	3.27	2.67	2.49	0.863
	0.0089	0.855	2.88	2.38	2.46	0.768
	0.0080	0.952	2.57	2.14	2.44	0.690
	0.0071	1.07	2.26	1.90	2.42	0.612
	0.0063	1.21	1.99	1.68	2.40	0.543
	0.0056	1.36	1.75	1.50	2.38	0.483
	0.0050	1.52	1.56	1.34	2.37	0.431
1/16	0.032	0.357	6.35	5.70	2.27	1.84
	0.029	0.394	5.58	5.16	2.20	1.67
	0.025	0.457	4.60	4.45	2.10	1.44
	0.023	0.497	4.13	4.09	2.05	1.32
	0.020	0.571	3.47	3.56	1.98	1.15
	0.018	0.634	3.04	3.20	1.93	1.04
	0.016	0.714	2.64	2.85	1.88	0.920
	0.014	0.816	2.25	2.49	1.84	0.805
	0.013	0.879	2.06	2.31	1.81	0.748
	0.011	1.04	1.70	1.96	1.76	0.633
	0.010	1.14	1.52	1.78	1.74	0.575
	0.0089	1.28	1.34	1.58	1.71	0.512
	0.0080	1.43	1.19	1.42	1.69	0.460
	0.0071	1.61	1.04	1.26	1.67	0.408
	0.0063	1.81	0.911	1.12	1.65	0.362
	0.0056	2.04	0.801	0.997	1.63	0.322
	0.0050	2.28	0.709	0.890	1.62	0.288
	0.0045	2.54	0.634	0.801	1.61	0.259
	0.0040	2.86	0.559	0.712	1.60	0.230

Width in	Thickness in	Resistance at 68°F Ω/ft	in^2/Ω at 68°F	Weight lb/1000 ft	Surface area in^2/ft	Cross sectional area in^2 x 1000
3/64	0.029	0.525	3.47	3.87	1.82	1.25
	0.025	0.609	2.83	3.34	1.73	1.08
	0.023	0.662	2.53	3.07	1.68	0.992
	0.020	0.761	2.11	2.67	1.61	0.863
	0.018	0.846	1.84	2.40	1.56	0.776
	0.016	0.952	1.59	2.14	1.51	0.690
	0.014	1.09	1.34	1.87	1.46	0.604
	0.013	1.17	1.23	1.74	1.44	0.561
	0.011	1.38	1.00	1.47	1.39	0.474
	0.010	1.52	0.896	1.34	1.37	0.431
	0.0089	1.71	0.782	1.19	1.34	0.384
	0.0080	1.90	0.692	1.07	1.32	0.345
	0.0071	2.14	0.604	0.948	1.30	0.306
	0.0063	2.42	0.528	0.841	1.28	0.272
	0.0056	2.72	0.463	0.748	1.26	0.242
	0.0050	3.05	0.409	0.668	1.25	0.216
	0.0045	3.38	0.364	0.601	1.23	0.194
	0.0040	3.81	0.321	0.534	1.22	0.173
	0.0035	4.35	0.278	0.467	1.21	0.151
	0.0031	4.91	0.244	0.414	1.20	0.134
1/32	0.016	1.43	0.794	1.42	1.13	0.460
	0.014	1.63	0.666	1.25	1.09	0.403
	0.013	1.76	0.604	1.16	1.06	0.374
	0.011	2.08	0.488	0.979	1.01	0.316
	0.010	2.28	0.433	0.890	0.990	0.288
	0.0089	2.57	0.375	0.792	0.964	0.256
	0.0080	2.86	0.330	0.712	0.942	0.230
	0.0071	3.22	0.286	0.632	0.920	0.204
	0.0063	3.63	0.249	0.561	0.901	0.181
	0.0056	4.08	0.217	0.498	0.884	0.161
	0.0050	4.57	0.190	0.445	0.870	0.144
	0.0045	5.08	0.169	0.401	0.858	0.129
	0.0040	5.71	0.148	0.356	0.846	0.115
	0.0035	6.53	0.128	0.312	0.834	0.101
	0.0031	7.37	0.112	0.276	0.824	0.0891
	0.0028	8.16	0.100	0.249	0.817	0.0805
	0.0025	9.14	0.0887	0.223	0.810	0.0719
	0.0022	10.4	0.0773	0.196	0.803	0.0633
1/64	0.0089	5.13	0.115	0.396	0.589	0.128
	0.0080	5.71	0.0993	0.356	0.567	0.115
	0.0071	6.43	0.0848	0.316	0.545	0.102
	0.0063	7.25	0.0726	0.280	0.526	0.0906
	0.0056	8.16	0.0624	0.249	0.509	0.0805
	0.0050	9.14	0.0542	0.223	0.495	0.0719
	0.0045	10.2	0.0476	0.200	0.483	0.0647
	0.0040	11.4	0.0412	0.178	0.471	0.0575
	0.0035	13.1	0.0352	0.156	0.459	0.0503
	0.0031	14.7	0.0305	0.138	0.449	0.0446
	0.0028	16.3	0.0271	0.125	0.442	0.0403
	0.0025	18.3	0.0238	0.111	0.435	0.0359
	0.0022	20.8	0.0206	0.0979	0.428	0.0316

KANTHAL D

Wire inch B&S

0.325–0.0008 in
Resistivity Ω/cir.mil ft 812
Density, lb/cu.in 0.262

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192	2372
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.07	1.08	1.08

Diameter B&S	Diameter inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
0	0.325	0.00769	1590	261	12.2	82.9
1	0.289	0.00970	1120	207	10.9	65.7
2	0.258	0.0122	794	164	9.71	52.1
3	0.229	0.0154	560	130	8.65	41.3
4	0.204	0.0195	396	103	7.70	32.8
5	0.182	0.0245	279	81.7	6.86	26.0
6	0.162	0.0309	197	64.8	6.11	20.6
7	0.144	0.0390	140	51.4	5.44	16.4
8	0.129	0.0492	98.5	40.8	4.84	13.0
9	0.114	0.0620	69.5	32.3	4.31	10.3
10	0.102	0.0782	49.1	25.6	3.84	8.16
11	0.0907	0.0987	34.6	20.3	3.42	6.46
12	0.0808	0.124	24.5	16.1	3.05	5.13
13	0.0720	0.157	17.3	12.8	2.71	4.07
14	0.0641	0.198	12.2	10.1	2.42	3.23
15	0.0571	0.249	8.64	8.05	2.15	2.56
16	0.0508	0.315	6.09	6.37	1.92	2.03
17	0.0453	0.396	4.32	5.07	1.71	1.61
18	0.0403	0.500	3.04	4.01	1.52	1.28
19	0.0359	0.630	2.15	3.18	1.35	1.01
20	0.0320	0.793	1.52	2.53	1.21	0.804
21	0.0285	1.00	1.07	2.01	1.07	0.638
22	0.0253	1.27	0.752	1.58	0.954	0.503
23	0.0226	1.59	0.536	1.26	0.852	0.401
24	0.0201	2.01	0.377	1.00	0.758	0.317
25	0.0179	2.53	0.266	0.791	0.675	0.252
26	0.0159	3.21	0.187	0.624	0.599	0.199
27	0.0142	4.03	0.133	0.498	0.535	0.158
28	0.0126	5.11	0.0929	0.392	0.475	0.125
29	0.0113	6.36	0.0670	0.315	0.426	0.100
30	0.0100	8.12	0.0464	0.247	0.377	0.0785
31	0.00890	10.3	0.0327	0.196	0.336	0.0622
32	0.00800	12.7	0.0238	0.158	0.302	0.0503
33	0.00710	16.1	0.0166	0.124	0.268	0.0396
34	0.00630	20.5	0.0116	0.0980	0.238	0.0312
35	0.00560	25.9	0.00815	0.0774	0.211	0.0246
36	0.00500	32.5	0.00580	0.0617	0.188	0.0196
37	0.00450	40.1	0.00423	0.0500	0.170	0.0159
38	0.00400	50.8	0.00297	0.0395	0.151	0.0126
39	0.00350	66.3	0.00199	0.0302	0.132	0.00962
40	0.00310	84.5	0.00138	0.0237	0.117	0.00755
41	0.00280	104	0.00102	0.0194	0.106	0.00616
42	0.00250	130	0.000725	0.0154	0.0942	0.00491
43	0.00220	168	0.000494	0.0120	0.0829	0.00380
44	0.00200	203	0.000371	0.00988	0.0754	0.00314
45	0.00176	262	0.000253	0.00765	0.0664	0.00243
46	0.00160	317	0.000190	0.00632	0.0603	0.00201
47	0.00140	414	0.000127	0.00484	0.0528	0.00154
48	0.00124	528	0.0000885	0.00380	0.0467	0.00121

KANTHAL D, DT
Ribbon inch

Resistivity Ω/sq.mil ft KANTHAL D 638
KANTHAL DT 648

Density, lb/cu.in 0.262

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192	2372
C_t	1.00	1.00	1.01	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.07	1.08	1.08

Width in	Thickness in	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
1/8	0.057	0.0973	44.9	20.6	4.37	6.56
	0.051	0.109	38.8	18.4	4.22	5.87
	0.045	0.123	33.1	16.3	4.08	5.18
	0.040	0.139	28.6	14.5	3.96	4.60
	0.036	0.154	25.1	13.0	3.86	4.14
	0.032	0.173	21.7	11.6	3.77	3.68
	0.029	0.191	19.3	10.5	3.70	3.34
	0.025	0.222	16.2	9.04	3.60	2.88
	0.023	0.241	14.7	8.32	3.55	2.65
	0.020	0.277	12.5	7.23	3.48	2.30
	0.018	0.308	11.1	6.51	3.43	2.07
	0.016	0.347	9.76	5.78	3.38	1.84
	0.014	0.396	8.42	5.06	3.34	1.61
	0.013	0.427	7.76	4.70	3.31	1.50
	0.011	0.504	6.47	3.98	3.26	1.27
	0.010	0.555	5.84	3.62	3.24	1.15
	0.0089	0.623	5.16	3.22	3.21	1.02
	0.0080	0.693	4.60	2.89	3.19	0.920
	0.0071	0.781	4.06	2.57	3.17	0.817
	0.0063	0.880	3.58	2.28	3.15	0.725
3/32	0.057	0.130	27.9	15.5	3.62	4.92
	0.051	0.145	24.0	13.8	3.47	4.40
	0.045	0.164	20.3	12.2	3.33	3.88
	0.040	0.185	17.4	10.8	3.21	3.45
	0.036	0.205	15.2	9.76	3.11	3.11
	0.032	0.231	13.1	8.68	3.02	2.76
	0.029	0.255	11.6	7.86	2.95	2.50
	0.025	0.296	9.64	6.78	2.85	2.16
	0.023	0.322	8.72	6.24	2.80	1.98
	0.020	0.370	7.38	5.42	2.73	1.73
	0.018	0.411	6.53	4.88	2.68	1.55
	0.016	0.462	5.70	4.34	2.63	1.38
	0.014	0.528	4.90	3.80	2.59	1.21
	0.013	0.569	4.50	3.53	2.56	1.12
	0.011	0.672	3.74	2.98	2.51	0.949
	0.010	0.739	3.37	2.71	2.49	0.863
	0.0089	0.831	2.97	2.41	2.46	0.768
	0.0080	0.924	2.64	2.17	2.44	0.690
	0.0071	1.04	2.32	1.93	2.42	0.612
	0.0063	1.17	2.05	1.71	2.40	0.543
	0.0056	1.32	1.81	1.52	2.38	0.483
	0.0050	1.48	1.60	1.36	2.37	0.431
1/16	0.032	0.347	6.54	5.78	2.27	1.84
	0.029	0.382	5.74	5.24	2.20	1.67
	0.025	0.444	4.73	4.52	2.10	1.44
	0.023	0.482	4.25	4.16	2.05	1.32
	0.020	0.555	3.57	3.62	1.98	1.15
	0.018	0.616	3.14	3.25	1.93	1.04
	0.016	0.693	2.72	2.89	1.88	0.920
	0.014	0.792	2.32	2.53	1.84	0.805
	0.013	0.853	2.12	2.35	1.81	0.748
	0.011	1.01	1.75	1.99	1.76	0.633
	0.010	1.11	1.57	1.81	1.74	0.575
	0.0089	1.25	1.37	1.61	1.71	0.512
	0.0080	1.39	1.22	1.45	1.69	0.460
	0.0071	1.56	1.07	1.28	1.67	0.408
	0.0063	1.76	0.938	1.14	1.65	0.362
	0.0056	1.98	0.825	1.01	1.63	0.322
	0.0050	2.22	0.730	0.904	1.62	0.288
	0.0045	2.46	0.652	0.814	1.61	0.259
	0.0040	2.77	0.576	0.723	1.60	0.230

Width in	Thickness in	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
3/64	0.029	0.510	3.57	3.93	1.82	1.25
	0.025	0.592	2.92	3.39	1.73	1.08
	0.023	0.643	2.61	3.12	1.68	0.992
	0.020	0.739	2.17	2.71	1.61	0.863
	0.018	0.822	1.90	2.44	1.56	0.776
	0.016	0.924	1.63	2.17	1.51	0.690
	0.014	1.06	1.38	1.90	1.46	0.604
	0.013	1.14	1.26	1.76	1.44	0.561
	0.011	1.34	1.03	1.49	1.39	0.474
	0.010	1.48	0.923	1.36	1.37	0.431
	0.0089	1.66	0.806	1.21	1.34	0.384
	0.0080	1.85	0.712	1.08	1.32	0.345
	0.0071	2.08	0.622	0.963	1.30	0.306
	0.0063	2.35	0.544	0.854	1.28	0.272
	0.0056	2.64	0.477	0.759	1.26	0.242
	0.0050	2.96	0.421	0.678	1.25	0.216
	0.0045	3.29	0.375	0.610	1.23	0.194
	0.0040	3.70	0.330	0.542	1.22	0.173
	0.0035	4.23	0.286	0.475	1.21	0.151
	0.0031	4.77	0.251	0.420	1.20	0.134
1/32	0.016	1.39	0.818	1.45	1.13	0.460
	0.014	1.58	0.685	1.27	1.09	0.403
	0.013	1.71	0.622	1.18	1.06	0.374
	0.011	2.02	0.503	0.994	1.01	0.316
	0.010	2.22	0.446	0.904	0.990	0.288
	0.0089	2.49	0.387	0.804	0.964	0.256
	0.0080	2.77	0.340	0.723	0.942	0.230
	0.0071	3.12	0.295	0.642	0.920	0.204
	0.0063	3.52	0.256	0.569	0.901	0.181
	0.0056	3.96	0.223	0.506	0.884	0.161
	0.0050	4.44	0.196	0.452	0.870	0.144
	0.0045	4.93	0.174	0.407	0.858	0.129
	0.0040	5.55	0.153	0.362	0.846	0.115
	0.0035	6.34	0.132	0.316	0.834	0.101
	0.0031	7.16	0.115	0.280	0.824	0.0891
	0.0028	7.92	0.103	0.253	0.817	0.0805
	0.0025	8.87	0.0913	0.226	0.810	0.0719
	0.0022	10.1	0.0796	0.199	0.803	0.0633
1/64	0.0089	4.99	0.118	0.402	0.589	0.128
	0.0080	5.55	0.102	0.362	0.567	0.115
	0.0071	6.25	0.0873	0.321	0.545	0.102
	0.0063	7.04	0.0747	0.285	0.526	0.0906
	0.0056	7.92	0.0643	0.253	0.509	0.0805
	0.0050	8.87	0.0558	0.226	0.495	0.0719
	0.0045	9.86	0.0490	0.203	0.483	0.0647
	0.0040	11.1	0.0425	0.181	0.471	0.0575
	0.0035	12.7	0.0362	0.158	0.459	0.0503
	0.0031	14.3	0.0314	0.140	0.449	0.0446
	0.0028	15.8	0.0279	0.127	0.442	0.0403
	0.0025	17.7	0.0245	0.113	0.435	0.0359
	0.0022	20.2	0.0212	0.0994	0.428	0.0316

ALKROTHAL 14
Wire inch B&S

0.258–0.0040 in
Resistivity Ω/cir.mil ft 755
Density, lb/cu.in 0.263

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012
C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.08	1.09	1.10	1.11	1.11	1.12

Diameter B&S	Diameter inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
2	0.258	0.0113	857	164	9.71	52.1
3	0.229	0.0143	605	130	8.65	41.3
4	0.204	0.0180	427	103	7.70	32.7
5	0.182	0.0227	302	82.0	6.86	26.0
6	0.162	0.0287	213	65.1	6.11	20.6
7	0.144	0.0361	151	51.6	5.44	16.4
8	0.129	0.0455	106	40.9	4.84	13.0
9	0.114	0.0575	75.1	32.4	4.31	10.3
10	0.102	0.0724	53.0	25.7	3.84	8.16
11	0.0907	0.0914	37.4	20.4	3.42	6.46
12	0.0808	0.115	26.4	16.2	3.05	5.13
13	0.0720	0.145	18.7	12.8	2.71	4.07
14	0.0641	0.183	13.2	10.2	2.42	3.23
15	0.0571	0.231	9.33	8.08	2.15	2.56
16	0.0508	0.291	6.57	6.40	1.92	2.03
17	0.0453	0.366	4.66	5.09	1.71	1.61
18	0.0403	0.463	3.28	4.03	1.52	1.28
19	0.0359	0.583	2.32	3.19	1.35	1.01
20	0.0320	0.734	1.64	2.54	1.21	0.804
21	0.0285	0.926	1.16	2.01	1.07	0.638
22	0.0253	1.17	0.812	1.59	0.954	0.503
23	0.0226	1.47	0.579	1.27	0.852	0.401
24	0.0201	1.86	0.407	1.00	0.758	0.317
25	0.0179	2.35	0.288	0.794	0.675	0.252
26	0.0159	2.97	0.202	0.627	0.599	0.199
27	0.0142	3.73	0.144	0.500	0.535	0.158
28	0.0126	4.74	0.100	0.394	0.475	0.125
29	0.0113	5.89	0.0723	0.317	0.426	0.100
30	0.0100	7.52	0.0501	0.248	0.377	0.0785
31	0.00890	9.49	0.0353	0.196	0.336	0.0622
32	0.00800	11.7	0.0257	0.159	0.302	0.0503
33	0.00710	14.9	0.0179	0.125	0.268	0.0396
34	0.00630	18.9	0.0125	0.098	0.238	0.0312
35	0.00560	24.0	0.00880	0.0777	0.211	0.0246
36	0.00500	30.1	0.00627	0.0620	0.188	0.0196
37	0.00450	37.1	0.00457	0.0502	0.170	0.0159
38	0.00400	47.0	0.00321	0.0397	0.151	0.0126

ALKROTHAL 14

Ribbon inch

Resistivity Ω/sq.mil ft 591
Density, lb/cu.in 0.263

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012
C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.08	1.09	1.10	1.11	1.11	1.12

Width in	Thickness in	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
1/8	0.057	0.0901	48.5	20.7	4.37	6.56
	0.051	0.101	42.0	18.5	4.22	5.87
	0.045	0.114	35.8	16.3	4.08	5.18
	0.040	0.128	30.8	14.5	3.96	4.60
	0.036	0.143	27.1	13.1	3.86	4.14
	0.032	0.160	23.5	11.6	3.77	3.68
	0.029	0.177	20.9	10.5	3.70	3.34
	0.025	0.205	17.5	9.07	3.60	2.88
	0.023	0.223	15.9	8.35	3.55	2.65
	0.020	0.257	13.6	7.26	3.48	2.30
	0.018	0.285	12.0	6.53	3.43	2.07
	0.016	0.321	10.5	5.81	3.38	1.84
	0.014	0.367	9.09	5.08	3.34	1.61
	0.013	0.395	8.38	4.72	3.31	1.50
	0.011	0.467	6.99	3.99	3.26	1.27
	0.010	0.514	6.31	3.63	3.24	1.15
	0.0089	0.577	5.57	3.23	3.21	1.02
	0.0080	0.642	4.97	2.90	3.19	0.920
	0.0071	0.723	4.38	2.58	3.17	0.817
	0.0063	0.815	3.87	2.29	3.15	0.725
3/32	0.057	0.120	30.1	15.5	3.62	4.92
	0.051	0.134	25.9	13.9	3.47	4.40
	0.045	0.152	21.9	12.2	3.33	3.88
	0.040	0.171	18.8	10.9	3.21	3.45
	0.036	0.190	16.4	9.80	3.11	3.11
	0.032	0.214	14.1	8.71	3.02	2.76
	0.029	0.236	12.5	7.89	2.95	2.50
	0.025	0.274	10.4	6.81	2.85	2.16
	0.023	0.298	9.41	6.26	2.80	1.98
	0.020	0.342	7.97	5.44	2.73	1.73
	0.018	0.380	7.05	4.90	2.68	1.55
	0.016	0.428	6.16	4.36	2.63	1.38
	0.014	0.489	5.29	3.81	2.59	1.21
	0.013	0.527	4.86	3.54	2.56	1.12
	0.011	0.622	4.04	2.99	2.51	0.949
	0.010	0.685	3.64	2.72	2.49	0.863
	0.0089	0.769	3.20	2.42	2.46	0.768
	0.0080	0.856	2.85	2.18	2.44	0.690
	0.0071	0.964	2.51	1.93	2.42	0.612
	0.0063	1.09	2.21	1.71	2.40	0.543
	0.0056	1.22	1.95	1.52	2.38	0.483
	0.0050	1.37	1.73	1.36	2.37	0.431
1/16	0.032	0.321	7.07	5.81	2.27	1.84
	0.029	0.354	6.20	5.26	2.20	1.67
	0.025	0.411	5.11	4.54	2.10	1.44
	0.023	0.447	4.60	4.17	2.05	1.32
	0.020	0.514	3.86	3.63	1.98	1.15
	0.018	0.571	3.39	3.27	1.93	1.04
	0.016	0.642	2.94	2.90	1.88	0.920
	0.014	0.734	2.50	2.54	1.84	0.805
	0.013	0.790	2.29	2.36	1.81	0.748
	0.011	0.934	1.89	2.00	1.76	0.633
	0.010	1.03	1.69	1.81	1.74	0.575
	0.0089	1.15	1.48	1.62	1.71	0.512
	0.0080	1.28	1.32	1.45	1.69	0.460
	0.0071	1.45	1.15	1.29	1.67	0.408
	0.0063	1.63	1.01	1.14	1.65	0.362
	0.0056	1.83	0.891	1.02	1.63	0.322
	0.0050	2.05	0.789	0.907	1.62	0.288
	0.0045	2.28	0.705	0.817	1.61	0.259
	0.0040	2.57	0.622	0.726	1.60	0.230

Width in	Thickness in	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
3/64	0.029	0.472	3.86	3.95	1.82	1.25
	0.025	0.548	3.15	3.40	1.73	1.08
	0.023	0.595	2.82	3.13	1.68	0.992
	0.020	0.685	2.34	2.72	1.61	0.863
	0.018	0.761	2.05	2.45	1.56	0.776
	0.016	0.856	1.76	2.18	1.51	0.690
	0.014	0.978	1.49	1.91	1.46	0.604
	0.013	1.05	1.36	1.77	1.44	0.561
	0.011	1.24	1.12	1.50	1.39	0.474
	0.010	1.37	0.997	1.36	1.37	0.431
	0.0089	1.54	0.870	1.21	1.34	0.384
	0.0080	1.71	0.769	1.09	1.32	0.345
	0.0071	1.93	0.672	0.966	1.30	0.306
	0.0063	2.17	0.587	0.857	1.28	0.272
	0.0056	2.45	0.515	0.762	1.26	0.242
	0.0050	2.74	0.455	0.681	1.25	0.216
	0.0045	3.04	0.405	0.612	1.23	0.194
	0.0040	3.42	0.357	0.544	1.22	0.173
	0.0035	3.91	0.309	0.476	1.21	0.151
	0.0031	4.42	0.272	0.422	1.20	0.134
1/32	0.016	1.28	0.883	1.45	1.13	0.460
	0.014	1.47	0.740	1.27	1.09	0.403
	0.013	1.58	0.672	1.18	1.06	0.374
	0.011	1.87	0.543	0.998	1.01	0.316
	0.010	2.05	0.482	0.907	0.990	0.288
	0.0089	2.31	0.418	0.808	0.964	0.256
	0.0080	2.57	0.367	0.726	0.942	0.230
	0.0071	2.89	0.318	0.644	0.920	0.204
	0.0063	3.26	0.276	0.572	0.901	0.181
	0.0056	3.67	0.241	0.508	0.884	0.161
	0.0050	4.11	0.212	0.454	0.870	0.144
	0.0045	4.56	0.188	0.408	0.858	0.129
	0.0040	5.14	0.165	0.363	0.846	0.115
	0.0035	5.87	0.142	0.318	0.834	0.101
	0.0031	6.63	0.124	0.281	0.824	0.0891
	0.0028	7.34	0.111	0.254	0.817	0.0805
	0.0025	8.22	0.0986	0.227	0.810	0.0719
	0.0022	9.34	0.0860	0.200	0.803	0.0633
1/64	0.0089	4.62	0.128	0.404	0.589	0.128
	0.0080	5.14	0.110	0.363	0.567	0.115
	0.0071	5.79	0.0943	0.322	0.545	0.102
	0.0063	6.52	0.0807	0.286	0.526	0.0906
	0.0056	7.34	0.0694	0.254	0.509	0.0805
	0.0050	8.22	0.0602	0.227	0.495	0.0719
	0.0045	9.13	0.0529	0.204	0.483	0.0647
	0.0040	10.3	0.0459	0.181	0.471	0.0575
	0.0035	11.7	0.0391	0.159	0.459	0.0503
	0.0031	13.3	0.0339	0.141	0.449	0.0446
	0.0028	14.7	0.0301	0.127	0.442	0.0403
	0.0025	16.4	0.0265	0.113	0.435	0.0359
	0.0022	18.7	0.0229	0.0998	0.428	0.0316

KANTHAL 70, 52
Wire inch B&S

0.0720–0.0040 in

Resistivity Ω/cir.mil ft	KANTHAL 52	223
	KANTHAL 70	126
Density, lb/cu.in	KANTHAL 52	0.296
	KANTHAL 70	0.305

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	302	392	482	572	662	752	842	932
KANTHAL 70, C_t	1.00	135	1.57	1.80	2.05	2.30	2.56	2.82	3.10	3.40
KANTHAL 52, C_t	1.00	1.33	1.53	1.73	1.93	2.13	2.32	2.49	2.64	2.77

KANTHAL 70

Diameter B&S	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
13	0.0720	0.0243	111	14.9	2.71	4.07
14	0.0641	0.0307	78.8	11.8	2.42	3.23
15	0.0571	0.0386	55.7	9.37	2.15	2.56
16	0.0508	0.0488	39.2	7.42	1.92	2.03
17	0.0453	0.0614	27.8	5.90	1.71	1.61
18	0.0403	0.0776	19.6	4.67	1.52	1.28
19	0.0359	0.0978	13.8	3.70	1.35	1.01
20	0.0320	0.123	9.80	2.94	1.21	0.804
21	0.0285	0.155	6.93	2.33	1.07	0.638
22	0.0253	0.197	4.85	1.84	0.954	0.503
23	0.0226	0.247	3.45	1.47	0.852	0.401
24	0.0201	0.312	2.43	1.16	0.758	0.317
25	0.0179	0.393	1.72	0.921	0.675	0.252
26	0.0159	0.498	1.20	0.727	0.599	0.199
27	0.0142	0.625	0.857	0.580	0.535	0.158
28	0.0126	0.794	0.599	0.456	0.475	0.125
29	0.0113	0.987	0.432	0.367	0.426	0.100
30	0.0100	1.26	0.299	0.287	0.377	0.0785
31	0.0089	1.59	0.211	0.228	0.336	0.0622
32	0.0080	1.97	0.153	0.184	0.302	0.0503
33	0.0071	2.50	0.107	0.145	0.268	0.0396
34	0.0063	3.17	0.0748	0.114	0.238	0.0312
35	0.0056	4.02	0.0525	0.0901	0.211	0.0246
36	0.0050	5.04	0.0374	0.0719	0.188	0.0196
37	0.0045	6.22	0.0273	0.0582	0.170	0.0159
38	0.0040	7.88	0.0191	0.0460	0.151	0.0126

KANTHAL 52

Diameter B&S	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
13	0.0720	0.0431	63.0	14.4	2.71	4.07
14	0.0641	0.0543	44.5	11.5	2.42	3.23
15	0.0571	0.0684	31.5	9.10	2.15	2.56
16	0.0508	0.0864	22.2	7.20	1.92	2.03
17	0.0453	0.109	15.7	5.72	1.71	1.61
18	0.0403	0.137	11.1	4.53	1.52	1.28
19	0.0359	0.173	7.82	3.60	1.35	1.01
20	0.0320	0.218	5.54	2.86	1.21	0.804
21	0.0285	0.275	3.91	2.27	1.07	0.638
22	0.0253	0.348	2.74	1.79	0.954	0.503
23	0.0226	0.437	1.95	1.42	0.852	0.401
24	0.0201	0.552	1.37	1.13	0.758	0.317
25	0.0179	0.696	0.970	0.894	0.675	0.252
26	0.0159	0.882	0.680	0.705	0.599	0.199
27	0.0142	1.11	0.484	0.563	0.535	0.158
28	0.0126	1.40	0.338	0.443	0.475	0.125
29	0.0113	1.75	0.244	0.356	0.426	0.100
30	0.0100	2.23	0.169	0.279	0.377	0.0785
31	0.0089	2.80	0.120	0.222	0.337	0.0626
32	0.0080	3.53	0.085	0.176	0.300	0.0496
33	0.0071	4.42	0.061	0.141	0.268	0.0396
34	0.0063	5.60	0.0425	0.111	0.238	0.0313
35	0.0056	7.06	0.0300	0.0881	0.212	0.0248
36	0.0050	8.92	0.0211	0.0697	0.188	0.0196
37	0.0045	11.3	0.0149	0.0552	0.168	0.0156
38	0.0040	14.1	0.0106	0.0440	0.150	0.0124

NIKROTHAL 80, 70
Wire inch B&S

NIKROTHAL 80 0.325–0.00078 in
NIKROTHAL 70 0.39–0.0195 in
Resistivity Ω/cir.mil ft NIKROTHAL 80 655
NIKROTHAL 70 709
Density, lb/cu.in NIKROTHAL 80 0.300 NIKROTHAL 70 0.293

$in^2/\Omega = \frac{I^2 C_t}{p}$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192
NIKROTHAL 80 C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.04	1.04	1.04	1.04	1.05	1.06	1.07
NIKROTHAL 70 C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.05	1.04	1.04	1.04	1.05	1.05	1.06

To get NIKROTHAL 70, multiply the figures in the table with:

Diameter B&S	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
		1.083	**0.924**	**0.976**		
0	0.325	0.00621	1970	298	12.2	82.9
1	0.289	0.00783	1390	237	10.9	65.7
2	0.258	0.00988	983	188	9.71	52.1
3	0.229	0.0125	694	149	8.65	41.3
4	0.204	0.0157	490	118	7.70	32.8
5	0.182	0.0198	346	93.6	6.86	26.0
6	0.162	0.0250	244	74.2	6.11	20.6
7	0.144	0.0315	173	58.9	5.44	16.4
8	0.129	0.0397	122	46.7	4.84	13.0
9	0.114	0.0501	86.1	37.0	4.31	10.3
10	0.102	0.0631	60.8	29.4	3.84	8.16
11	0.0907	0.0797	42.9	23.3	3.42	6.46
12	0.0808	0.100	30.3	18.5	3.05	5.13
13	0.0720	0.126	21.5	14.7	2.71	4.07
14	0.0641	0.160	15.1	11.6	2.42	3.23
15	0.0571	0.201	10.7	9.22	2.15	2.56
16	0.0508	0.254	7.54	7.30	1.92	2.03
17	0.0453	0.320	5.34	5.80	1.71	1.61
18	0.0403	0.404	3.76	4.59	1.52	1.28
19	0.0359	0.509	2.66	3.64	1.35	1.01
20	0.0320	0.640	1.88	2.90	1.21	0.804
21	0.0285	0.807	1.33	2.30	1.07	0.638
22	0.0253	1.02	0.931	1.81	0.954	0.503
23	0.0226	1.28	0.664	1.44	0.852	0.401
24	0.0201	1.62	0.467	1.14	0.758	0.317
25	0.0179	2.05	0.330	0.906	0.675	0.252
26	0.0159	2.59	0.231	0.715	0.599	0.199
27	0.0142	3.25	0.165	0.570	0.535	0.158
28	0.0126	4.13	0.115	0.449	0.475	0.125
29	0.0113	5.13	0.0830	0.361	0.426	0.100
30	0.0100	6.56	0.0575	0.283	0.377	0.0785
31	0.00890	8.28	0.0405	0.224	0.336	0.0622
32	0.00800	10.2	0.0294	0.181	0.302	0.0503
33	0.00710	13.0	0.0206	0.143	0.268	0.0396
34	0.00630	16.5	0.0144	0.112	0.238	0.0312
35	0.00560	20.9	0.0101	0.0887	0.211	0.0246
36	0.00500	26.2	0.00719	0.0707	0.188	0.0196
37	0.00450	32.4	0.00524	0.0573	0.170	0.0159
38	0.00400	41.0	0.00368	0.0452	0.151	0.0126
39	0.00350	53.5	0.00247	0.0346	0.132	0.00962
40	0.00310	68.2	0.00171	0.0272	0.117	0.00755
41	0.00280	83.6	0.00126	0.0222	0.106	0.00616
42	0.00250	105	0.000898	0.0177	0.0942	0.00491
43	0.00220	135	0.000612	0.0137	0.0829	0.00380
44	0.00200	164	0.000460	0.0113	0.0754	0.00314
45	0.00176	212	0.000313	0.00876	0.0664	0.00243
46	0.00160	256	0.000236	0.00724	0.0603	0.00201
47	0.00140	335	0.000158	0.00554	0.0528	0.00154
48	0.00124	426	0.000110	0.00435	0.0467	0.00121

NIKROTHAL 60
Wire inch B&S

0.258–0.0020 in
Resistivity Ω/cir.mil ft 668
Density, lb/cu.in 0.296

$$in^2/\Omega = \frac{I^2C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192
C_t	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.13

Diameter B&S	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
2	0.258	0.0101	965	185	9.71	52.1
3	0.229	0.0127	682	147	8.65	41.3
4	0.204	0.0160	481	116	7.70	32.8
5	0.182	0.0202	340	92.3	6.86	26.0
6	0.162	0.0254	240	73.2	6.11	20.6
7	0.144	0.0321	170	58.1	5.44	16.4
8	0.129	0.0404	120	46.1	4.84	13.0
9	0.114	0.0510	84.5	36.5	4.31	10.3
10	0.102	0.0643	59.7	29.0	3.84	8.16
11	0.0907	0.0812	42.1	22.9	3.42	6.46
12	0.0808	0.102	29.8	18.2	3.05	5.13
13	0.0720	0.129	21.0	14.4	2.71	4.07
14	0.0641	0.163	14.9	11.5	2.42	3.23
15	0.0571	0.205	10.5	9.10	2.15	2.56
16	0.0508	0.259	7.40	7.20	1.92	2.03
17	0.0453	0.325	5.25	5.72	1.71	1.61
18	0.0403	0.411	3.70	4.53	1.52	1.28
19	0.0359	0.518	2.61	3.60	1.35	1.01
20	0.0320	0.652	1.85	2.86	1.21	0.804
21	0.0285	0.822	1.31	2.27	1.07	0.638
22	0.0253	1.04	0.914	1.79	0.954	0.503
23	0.0226	1.31	0.652	1.42	0.852	0.401
24	0.0201	1.65	0.458	1.13	0.758	0.317
25	0.0179	2.08	0.324	0.894	0.675	0.252
26	0.0159	2.64	0.227	0.705	0.599	0.199
27	0.0142	3.31	0.162	0.563	0.535	0.158
28	0.0126	4.21	0.113	0.443	0.475	0.125
29	0.0113	5.23	0.0815	0.356	0.426	0.100
30	0.0100	6.68	0.0565	0.279	0.377	0.0785
31	0.00890	8.43	0.0398	0.221	0.336	0.0622
32	0.00800	10.4	0.0289	0.179	0.302	0.0503
33	0.00710	13.2	0.0202	0.141	0.268	0.0396
34	0.00630	16.8	0.0141	0.111	0.238	0.0312
35	0.00560	21.3	0.00992	0.0875	0.211	0.0246
36	0.00500	26.7	0.00706	0.0697	0.188	0.0196
37	0.00450	33.0	0.00514	0.0565	0.170	0.0159
38	0.00400	41.7	0.00361	0.0446	0.151	0.0126
39	0.00350	54.5	0.00242	0.0342	0.132	0.00962
40	0.00310	69.5	0.00168	0.0268	0.117	0.00755
41	0.00280	85.2	0.00124	0.0219	0.106	0.00616
42	0.00250	107	0.000882	0.0174	0.0942	0.00491
43	0.00220	138	0.000601	0.0135	0.0829	0.00380
44	0.00200	167	0.000452	0.0112	0.0754	0.00314

NIKROTHAL 40, 20
Wire inch B&S

0.258–0.0040 in

Resistivity Ω/cir.mil ft	NIKROTHAL 40	626
	NIKROTHAL 20	572
Density, lb/cu.in	NIKROTHAL 40	0.285
	NIKROTHAL 20	0.281

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

I = Current
C_t = Temperature factor
p = Surface load W/in²

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012
NIKROTHAL 40 C_t	1.00	1.03	1.06	1.10	1.12	1.15	1.17	1.19	1.21	1.22	1.23	1.24
NIKROTHAL 20 C_t	1.00	1.04	1.10	1.14	1.17	1.21	1.23	1.26	1.28	1.30	1.32	1.34

To get NIKROTHAL 20, multiply the figures in the table with:

Diameter B&S	Diameter inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
		0.913	**1.095**	**0.987**		
2	0.258	0.00943	1030	178	9.71	52.1
3	0.229	0.0119	727	141	8.65	41.3
4	0.204	0.0150	514	112	7.70	32.8
5	0.182	0.0189	363	88.9	6.86	26.0
6	0.162	0.0238	256	70.5	6.11	20.6
7	0.144	0.0300	181	55.9	5.44	16.4
8	0.129	0.0379	128	44.4	4.84	13.0
9	0.114	0.0478	90.2	35.2	4.31	10.3
10	0.102	0.0602	63.8	27.9	3.84	8.16
11	0.0907	0.0760	45.0	22.1	3.42	6.47
12	0.0808	0.0958	31.8	17.5	3.05	5.13
13	0.0720	0.121	22.5	13.9	2.71	4.07
14	0.0641	0.152	15.9	11.0	2.42	3.23
15	0.0571	0.192	11.2	8.76	2.15	2.56
16	0.0508	0.242	7.90	6.93	1.92	2.03
17	0.0453	0.305	5.60	5.51	1.71	1.61
18	0.0403	0.385	3.94	4.36	1.52	1.28
19	0.0359	0.485	2.79	3.46	1.35	1.01
20	0.0320	0.611	1.97	2.75	1.21	0.804
21	0.0285	0.770	1.39	2.18	1.07	0.638
22	0.0253	0.977	0.976	1.72	0.954	0.503
23	0.0226	1.22	0.696	1.37	0.852	0.401
24	0.0201	1.55	0.489	1.09	0.758	0.317
25	0.0179	1.95	0.346	0.861	0.675	0.252
26	0.0159	2.47	0.242	0.679	0.599	0.199
27	0.0142	3.10	0.173	0.542	0.535	0.158
28	0.0126	3.94	0.121	0.426	0.475	0.125
29	0.0113	4.90	0.0870	0.343	0.426	0.100
30	0.0100	6.26	0.0603	0.269	0.377	0.0785
31	0.00890	7.90	0.0425	0.213	0.336	0.0622
32	0.00800	9.78	0.0309	0.172	0.302	0.0503
33	0.00710	12.4	0.0216	0.135	0.268	0.0396
34	0.00630	15.8	0.0151	0.107	0.238	0.0312
35	0.00560	19.9	0.0106	0.0842	0.211	0.0246
36	0.00500	25.0	0.00753	0.0672	0.188	0.0196
37	0.00450	30.9	0.00549	0.0544	0.170	0.0159
38	0.00400	39.1	0.00386	0.0430	0.151	0.0126

NIKROTHAL 80, 60, 40
Ribbon inch

Resistivity Ω/sq.mil ft	
NIKROTHAL 80	514
NIKROTHAL 60	524
NIKROTHAL 40	491

Density, lb/cu.in	
NIKROTHAL 80	0.300
NIKROTHAL 60	0.296
NIKROTHAL 40	0.285

I = Current
C_t = Temperature factor
p = Surface load W/in²

$$in^2/\Omega = \frac{I^2 C_t}{p}$$

To obtain resistance at working temperature multiply by the factor C_t in the following table:

°F	68	212	392	572	752	932	1112	1292	1472	1652	1832	2012	2192
NIKROTHAL 80 C_t	1.00	1.01	1.02	1.03	1.04	1.05	1.04	1.04	1.04	1.04	1.05	1.06	1.07
NIKROTHAL 60 C_t	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.13
NIKROTHAL 40 C_t	1.00	1.03	1.06	1.10	1.12	1.15	1.17	1.19	1.21	1.22	1.23	1.24	

To get NIKROTHAL 60 and 40, multiply the figures in the table with:

N 60	**1.018**	**0.982**	**0.988**
N 40	**0.954**	**1.048**	**0.952**

Width in	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
1/8	0.057	0.0786	55.6	23.6	4.37	6.56
	0.051	0.0878	48.1	21.1	4.22	5.87
	0.045	0.100	41.0	18.6	4.08	5.18
	0.040	0.112	35.4	16.6	3.96	4.60
	0.036	0.124	31.1	14.9	3.86	4.14
	0.032	0.140	26.9	13.2	3.77	3.68
	0.029	0.154	23.9	12.0	3.70	3.34
	0.025	0.179	20.1	10.4	3.60	2.88
	0.023	0.195	18.2	9.52	3.55	2.65
	0.020	0.224	15.5	8.28	3.48	2.30
	0.018	0.249	13.8	7.45	3.43	2.07
	0.016	0.280	12.1	6.62	3.38	1.84
	0.014	0.320	10.4	5.80	3.34	1.61
	0.013	0.344	9.62	5.38	3.31	1.50
	0.011	0.407	8.02	4.55	3.26	1.27
	0.010	0.448	7.24	4.14	3.24	1.15
	0.0089	0.503	6.39	3.68	3.21	1.02
	0.0080	0.560	5.70	3.31	3.19	0.920
	0.0071	0.631	5.03	2.94	3.17	0.817
	0.0063	0.711	4.43	2.61	3.15	0.725
3/32	0.057	0.105	34.5	17.7	3.62	4.92
	0.051	0.117	29.7	ß	3.47	4.40
	0.045	0.133	25.1	14.0	3.33	3.88
	0.040	0.149	21.5	12.4	3.21	3.45
	0.036	0.166	18.8	11.2	3.11	3.11
	0.032	0.187	16.2	9.94	3.02	2.76
	0.029	0.206	14.3	9.00	2.95	2.50
	0.025	0.239	11.9	7.76	2.85	2.16
	0.023	0.260	10.8	7.14	2.80	1.98
	0.020	0.299	9.14	6.21	2.73	1.73
	0.018	0.332	8.09	5.59	2.68	1.55
	0.016	0.373	7.06	4.97	2.63	1.38
	0.014	0.426	6.06	4.35	2.59	1.21
	0.013	0.459	5.58	4.04	2.56	1.12
	0.011	0.543	4.63	3.42	2.51	0.949
	0.010	0.597	4.17	3.11	2.49	0.863
	0.0089	0.671	3.67	2.76	2.46	0.768
	0.0080	0.746	3.27	2.48	2.44	0.690
	0.0071	0.84	2.88	2.20	2.42	0.612
	0.0063	0.95	2.53	1.96	2.40	0.543
	0.0056	1.07	2.24	1.74	2.38	0.483
	0.0050	1.19	1.98	1.55	2.37	0.431
1/16	0.032	0.280	8.10	6.62	2.27	1.84
	0.029	0.309	7.11	6.00	2.20	1.67
	0.025	0.358	5.86	5.18	2.10	1.44
	0.023	0.389	5.27	4.76	2.05	1.32
	0.020	0.448	4.42	4.14	1.98	1.15
	0.018	0.498	3.88	3.73	1.93	1.04
	0.016	0.560	3.37	3.31	1.88	0.920
	0.014	0.640	2.87	2.90	1.84	0.805
	0.013	0.689	2.63	2.69	1.81	0.748
	0.011	0.814	2.17	2.28	1.76	0.633
	0.010	0.896	1.94	2.07	1.74	0.575
	0.0089	1.01	1.70	1.84	1.71	0.512
	0.0080	1.12	1.51	1.66	1.69	0.460
	0.0071	1.26	1.32	1.47	1.67	0.408
	0.0063	1.42	1.16	1.30	1.65	0.362

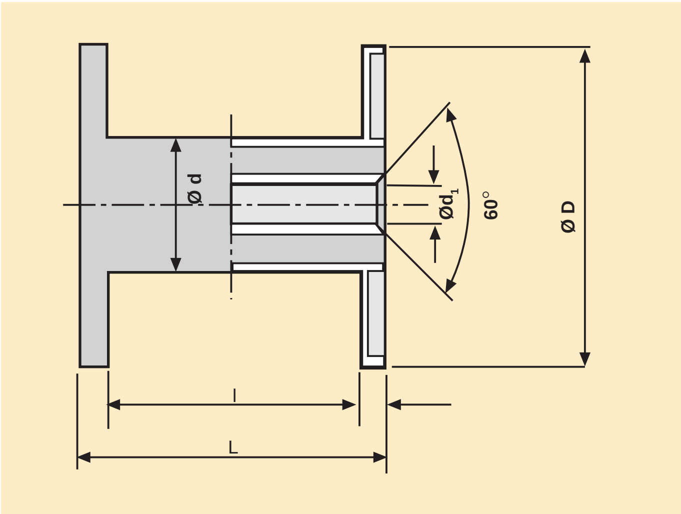
N 60	**1.018**	**0.982**	**0.988**
N 40	**0.954**	**1.048**	**0.952**

Width in	inch	Resistance at 68°F Ω/ft	in²/Ω at 68°F	Weight lb/1000 ft	Surface area in²/ft	Cross sectional area in² x 1000
	0.0056	1.60	1.02	1.16	1.63	0.322
	0.0050	1.79	0.904	1.04	1.62	0.288
	0.0045	1.99	0.808	0.932	1.61	0.259
	0.0040	2.24	0.713	0.828	1.60	0.230
3/64	0.029	0.412	4.42	4.50	1.82	1.25
	0.025	0.478	3.61	3.88	1.73	1.08
	0.023	0.519	3.23	3.57	1.68	0.992
	0.020	0.597	2.69	3.11	1.61	0.863
	0.018	0.663	2.35	2.79	1.56	0.776
	0.016	0.746	2.02	2.48	1.51	0.690
	0.014	0.853	1.71	2.17	1.46	0.604
	0.013	0.919	1.56	2.02	1.44	0.561
	0.011	1.09	1.28	1.71	1.39	0.474
	0.010	1.19	1.14	1.55	1.37	0.431
	0.0089	1.34	0.998	1.38	1.34	0.384
	0.0080	1.49	0.882	1.24	1.32	0.345
	0.0071	1.68	0.770	1.10	1.30	0.306
	0.0063	1.90	0.673	0.978	1.28	0.272
	0.0056	2.13	0.591	0.869	1.26	0.242
	0.0050	2.39	0.521	0.776	1.25	0.216
	0.0045	2.65	0.465	0.699	1.23	0.194
	0.0040	2.99	0.409	0.621	1.22	0.173
	0.0035	3.41	0.354	0.543	1.21	0.151
	0.0031	3.85	0.311	0.481	1.20	0.134
1/32	0.016	1.12	1.01	1.66	1.13	0.460
	0.014	1.28	0.849	1.45	1.09	0.403
	0.013	1.38	0.771	1.35	1.06	0.374
	0.011	1.63	0.623	1.14	1.01	0.316
	0.010	1.79	0.553	1.04	0.990	0.288
	0.0089	2.01	0.479	0.921	0.964	0.256
	0.0080	2.24	0.421	0.828	0.942	0.230
	0.0071	2.52	0.365	0.735	0.920	0.204
	0.0063	2.84	0.317	0.652	0.901	0.181
	0.0056	3.20	0.277	0.580	0.884	0.161
	0.0050	3.58	0.243	0.518	0.870	0.144
	0.0045	3.98	0.216	0.466	0.858	0.129
	0.0040	4.48	0.189	0.414	0.846	0.115
	0.0035	5.12	0.163	0.362	0.834	0.101
	0.0031	5.78	0.143	0.321	0.824	0.0891
	0.0028	6.40	0.128	0.290	0.817	0.0805
	0.0025	7.16	0.113	0.259	0.810	0.0719
	0.0022	8.14	0.0986	0.228	0.803	0.0633
1/64	0.0089	4.03	0.146	0.461	0.589	0.128
	0.0080	4.48	0.127	0.414	0.567	0.115
	0.0071	5.05	0.108	0.367	0.545	0.102
	0.0063	5.69	0.0925	0.326	0.526	0.0906
	0.0056	6.40	0.0796	0.290	0.509	0.0805
	0.0050	7.16	0.0691	0.259	0.495	0.0719
	0.0045	7.96	0.0607	0.233	0.483	0.0647
	0.0040	8.96	0.0526	0.207	0.471	0.0575
	0.0035	10.2	0.0448	0.181	0.459	0.0503
	0.0031	11.6	0.0389	0.160	0.449	0.0446
	0.0028	12.8	0.0346	0.145	0.442	0.0403
	0.0025	14.3	0.0304	0.129	0.435	0.0359
	0.0022	16.3	0.0263	0.114	0.428	0.0316

Delivery Forms for Wire and Ribbon

Wire

Wire of < 0.064 mm can be delivered on standard spools, such as shown in the figure. Only one length of wire is wound on each spool.



Types of Wire Spools.

Spool No.	Tare (lbs.)	Spool measurements (inches) flange D	barrel d	traverse l	bore d_1	Typical wire dia.	Capacity (lbs.)
1	0.126	2 1/2	1 3/4	2	5/8	< .001	1/2
2	0.140	2 1/2	1 3/4	3	5/8	.001–.0045	1
8	0.180	3	1 3/4	3	5/8	.0035–.0101	2
13	0.450	5	3	3 1/2	5/8	.0035–.0179	5
32	0.650	6	3 1/2	3 1/2	5/8	.004–.0359	10
22	5.20	12	7	6	1 1/4	> .0359	50
24	7.20	14	6 1/2	6	1 1/4	> .0359	100

Pail Pack Wire diameters .0101”–.064” can also be supplied in pail packs.
Coil Wire diameters >.064 are usually supplied in coils with inner diameter 17”–20”.

Ribbon

Ribbon is most commonly supplied on the spools list below. However, many other spools are available upon request.

Types of Ribbon Spools.

Spool No.	Tare (lbs.)	Spool measurements (inches) flange D	barrel d	traerse l	bore d_1	Capacity (lbs.)
DIN 80	0.155	3	2	2 1/2	5/8	2
DIN 100	0.28	4	2 1/2	3	5/8	3–4
DIN 125	0.43	5	3	4	5/8	7–8
No. 42	0.64	6	4	3	5/8	7
No. 32	0.65	6	3 1/2	3 1/2	5/8	10

KANTHAL

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