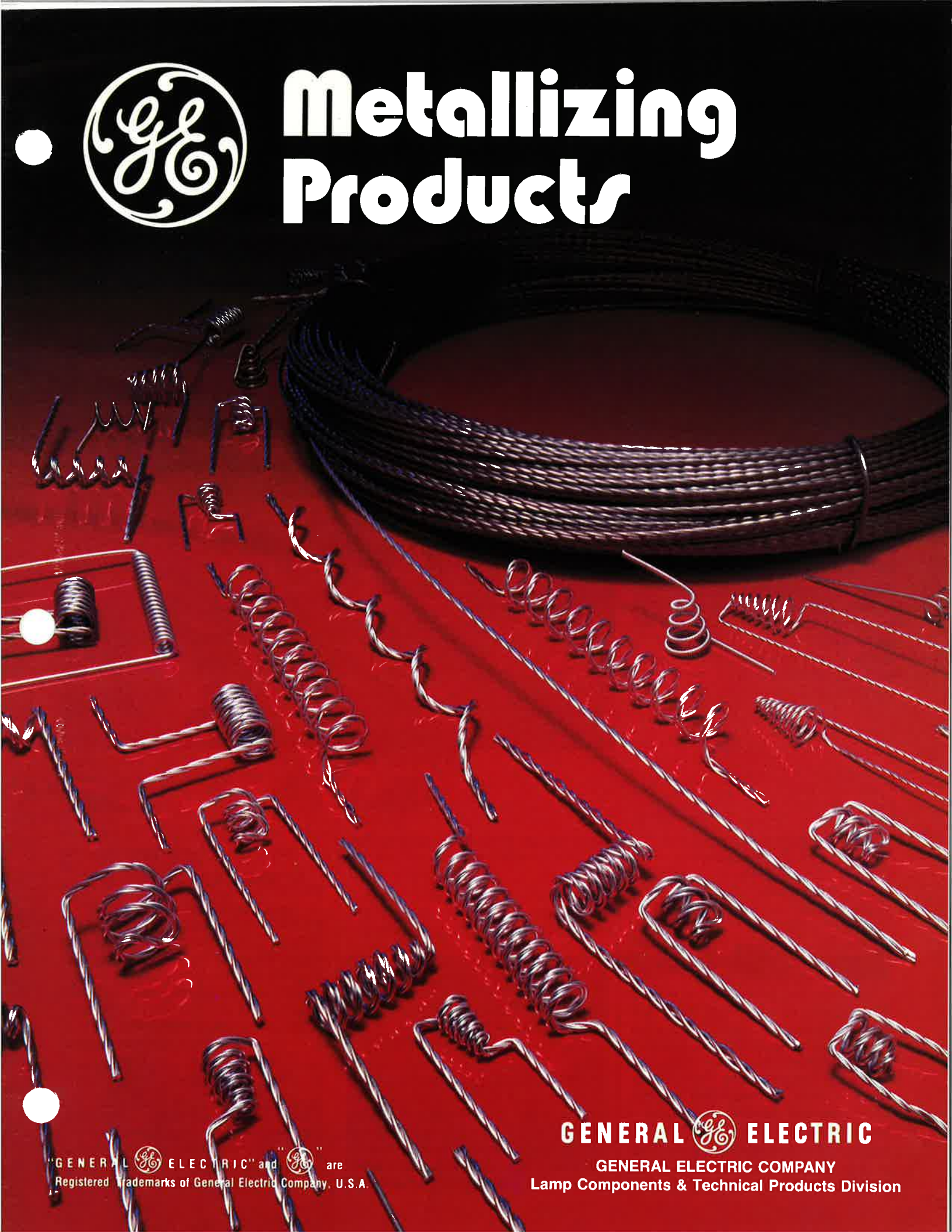
Metallizing Products



"GENERAL ELECTRIC" and "GE" are Registered Trademarks of General Electric Company, U.S.A.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY
Lamp Components & Technical Products Division

The evaporation of metal in a vacuum has expanded into many new applications in recent years. The process provides a lustrous metallic finish to hundreds of plastic parts such as knobs, bottle caps, switch plates, lamp reflectors, automotive dashboard trim, hobby kit parts, and many others. More specialized uses include deposition of metal on glass containers and in the processing of semiconductor devices.

Metallizing Products From GE

Filaments of stranded tungsten wire are key elements in the vacuum metallizing process that is used to give a functional or decorative coating to many parts.

A major manufacturer of tungsten wire, General Electric Company supplies a number of specialized products to the metallizing industry. These include standard and made-to-order coils, as well as stranded wire and bare tungsten wire.

Type MW-G Wire

Performance of a tungsten filament in vacuum metallizing depends to a great extent upon the chemical, physical and mechanical properties of the coil, and upon its cleanliness. To meet optimum criteria in metallizing applications, General Electric developed a special tungsten wire, MW-G.

Potassium is controlled to a lower level in this product than in lamp grade tungsten wire produced by General Electric. Overall purity is typically 99.95 percent tungsten based on trace analysis and calculated on a gas-free basis.

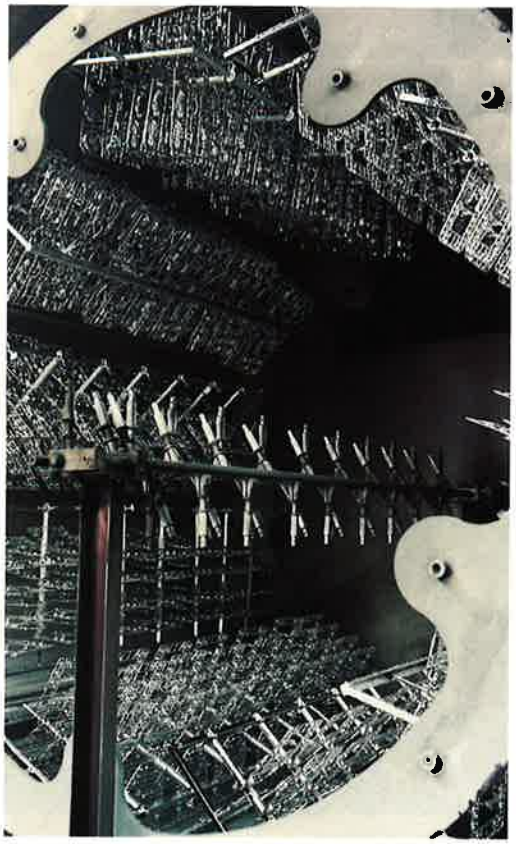
The high degree of purity and cleanliness achieved with this material helps provide more uniform results in metallizing. It contributes to longer average coil life and improved wetting characteristics. For coil manufacturers, MW-G also offers good formability.

TYPICAL CHEMICAL ANALYSIS OF TUNGSTEN METALLIZING WIRE

SPECTROGRAPHIC ANALYSIS (PPM)

Al	10	Mo	50-100
Ca	15	Ni	⟨ 10
Cr	⟨ 10	Si	20
Cu	10	Nb	⟨ 20
Fe	15	All Others (Each)	⟨ 10

Atomic Absorption (PPM)		Other Analyses (PPM)	
K	65	C	10
Na	⟨ 10	O	20
		N	5
		H	5



Loading of the vertical coil is done by dropping an aluminum cane into the coil body, a much faster operation than pinching on small clips. A special modification of electrode posts is needed for using vertical coils, as indicated in the right hand photo.

Fast Loading Coil

General Electric designed its vertical coil to speed the loading of evaporant materials and to control many of the variables which contribute to shortened filament life.

A single large cane of aluminum suspended inside the coil eliminates the time-consuming task of loading small clips and reduces the chance of coil breakage during loading.

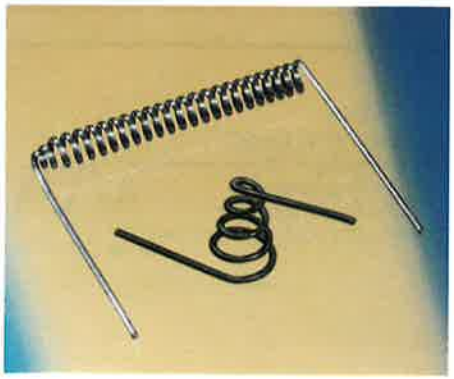
The vertical shape does away with the low spots that are present on horizontally mounted coils, thus reducing the balling and dripping problem that can occur in high load situations. Gravity feed helps provide more uniform wetting of the coil, thus contributing to lower incidence of balling.

The compact size of the vertical coil means more of them can be used for big jobs. Most vertical coils come as four-strand assemblies: three strands of tungsten wrapped around an aluminum core, but they are also available in an open or closed strand design without the aluminum core.

Other Coils

Two product offerings of special interest are the overwrap strand and the single strand coil.

The overwrap strand, shown in the shape of a basket coil, has proven superior in aluminizing lamp reflectors.



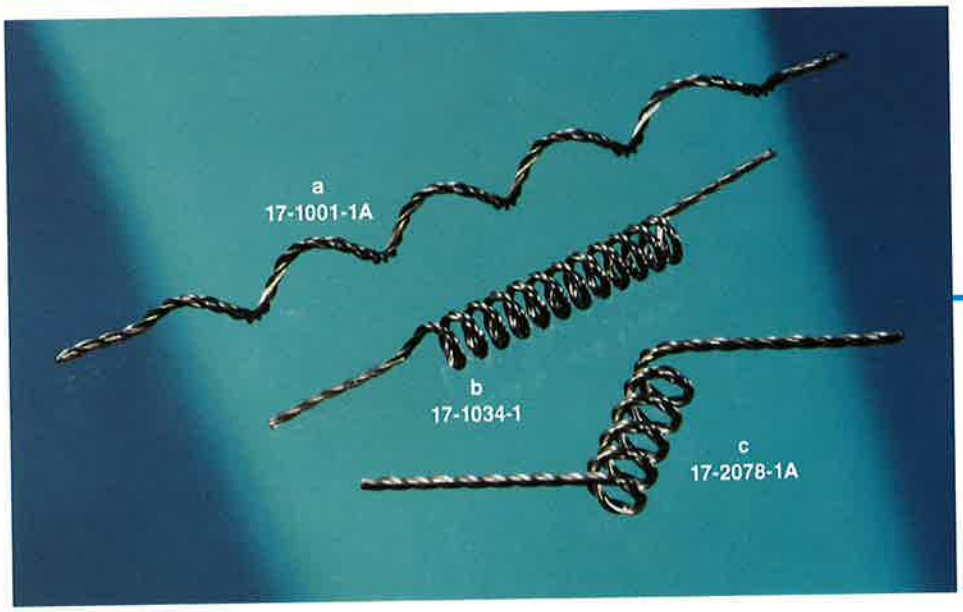
General Electric's innovative fabrication techniques make this material available in a variety of coil designs with a uniformly wound, tight overwrap to assure consistent quality. Major benefits are improved wettability through better distribution of evaporant, resulting in reduced balling. These factors contribute to longer coil life and improved part coverage.

The single strand coil is not new, but it has been successful in evaporation of chromium for metallizing mirrors and reflectors.

Types of Coils

While most applications call for a custom designed filament, GE offers a limited number of standard types which can be readily adapted to existing equipment. In general, coils for vacuum metallizing are classified in two application categories.

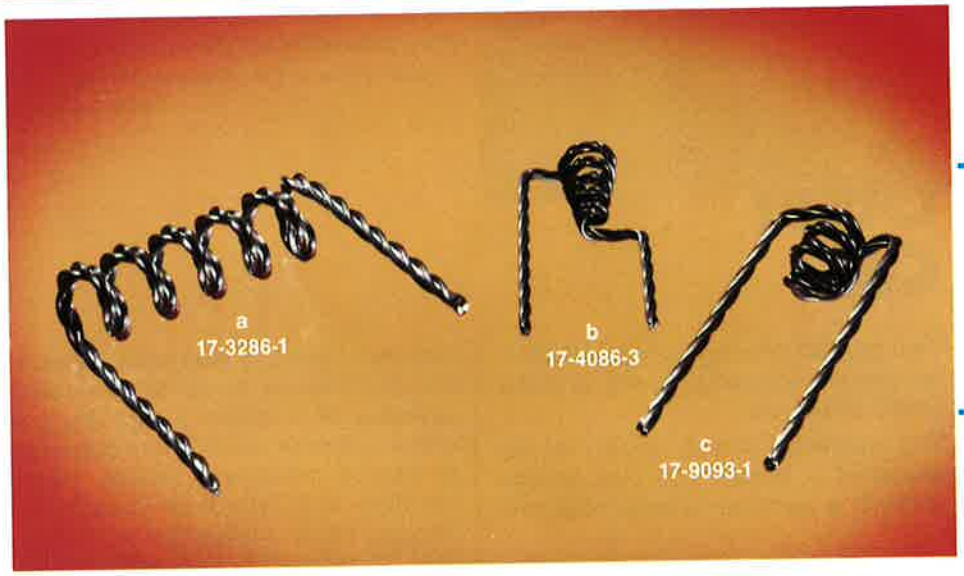
FOR CHAMBER AND BELL JAR METALLIZING (legs parallel and extending in opposite directions)



Straight cut lengths or any of the **helix** designs (17-1000 type, a & b) can be used for bell jar evaporation of materials such as aluminum or nichrome, which are available in rod or wire form

Vertical feed filaments (17-2000 type, c in photo), introduced by General Electric offer a number of advantages in decorative applications. Because gravity feed promotes more uniform wetting, the coil lasts up to 50% longer when properly mounted, and wastes

FOR TV TUBE ALUMINIZING (legs parallel and extending in the same direction) Coils for TV tube aluminizing



The **horizontal helix** design (a), 17-3000 type, is used in certain integrated

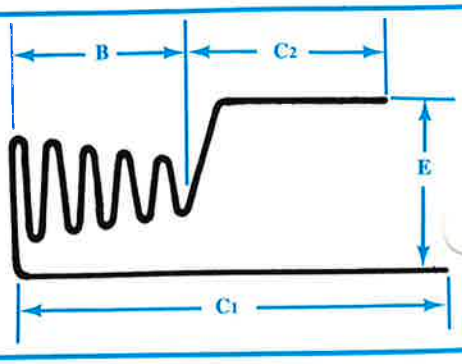
The **basket type coil** design (b), 17-4000 type, is suitable for a wide range of applications. Large coils are used for aluminizing color tubes, while smaller sizes are used for monochrome tubes and lamp reflectors. A tapered basket with a crossover leg design is recom-

The **double helix basket** design (c), 17-9000 type, has won acceptance in

*KEY TO STANDARD DIMENSIONS

Code

A—Overall Length
B—Coil Length
C—Leg Lengths
D—Inside Diameter
E—Distance Between Legs



and which "wet" the coil. Traditional design (a) is used for metallizing decorative items such as automotive parts, bottle caps, toys, jewelry, etc.

far less material. This design also does away with the time-consuming loading of multiple clips, since each flash requires only one of the longer cane type evaporants which are suspended inside the coil.

Standard Coil Number	Standard Dimensions★ (inches)				Coil Turns		Number & Size of Wires
	A	B	C	D	Total	Turns Per Inch	
17-1001-1	6	5	.500	.218	5	1	3 x .030″
17-1001-1A	6	5	.500	.218	5	1	3 x .030″ plus 1 .025″ Al Core
17-1034-1	4	2	1.000	.250	12	6	3 x .030″
17-1241-1A	6	5	.500	.135	5	1	3 x .030″ plus 1 .025″ Al Core
17-2110-1	3.125	1.530	1.735	.225/.085	13	8.49	3 x .030″
17-2033-1A	2.960	1.250	1.625	.187	5	4	3 x .030″ plus 1 .025″ Al Core
17-2078-1	3	1.250	1.500	.250	5	4	3 x .030″
17-2078-1A	3	1.250	1.500	.250	5	4	3 x .030″ plus 1 .025″ Al Core
17-2109-1	4	.875	2.178	.200	5.750	6.57	3 x .030″
17-2117-5	1.625	.630	.925 Bottom 1.062 Top	.258 Bottom .465 Top	4	6.35	1 x .035″ with .009″ overwrap
17-2019-5	2.362	.874	1.315	.187	5	6	1 x .040″

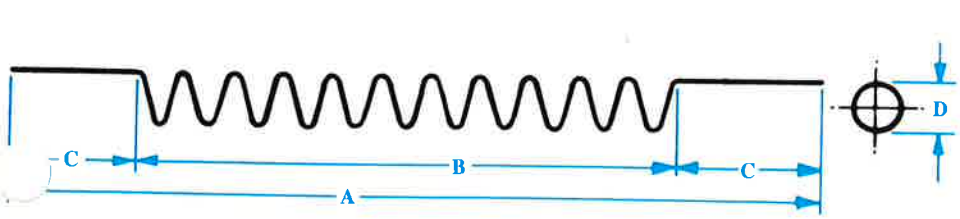
can be made in regular, open, or aluminum-core strands. However, regular strand construction is recommended.

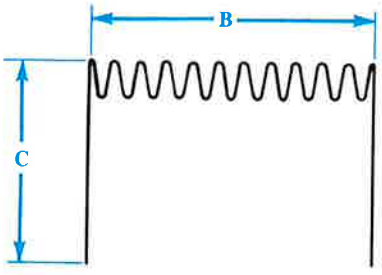
circuit applications where the leg design is preferred over other types.

mended for use with non-wetting evaporants. For gold, copper, silver, and other materials which do not wet well, tightly wound helix or basket coils minimize charge loss between the coil turns.

aluminizing both monochrome and color TV tubes.

Standard Coil Number	Standard Dimensions★ (inches)				Coil Turns		Number & Size of Wires
	B	C	D	E	Total	Turns Per Inch	
17-3121-1	1.500	1	.250	1.500	12.5	8.32	3 x .030″
17-3212-5	1.844	1.500	.126	1.844	22.5	12.2	1 x .045″
17-4078-7	.625	1.456 Top .827 Bottom	.284 Top .083 Bottom	.550	7.125	11.13	3 x .016″
17-4086-2	.500	1.187 Top .687 Bottom	.171 Top .075 Bottom	.500	5.125	10.2	3 x .025″
17-9012-1	.468	1.250	.187	.562	1.375	.250 Pitch	3 × .030″
17-9093-1	.468	1.500	.187	.562	1.375	.250 Pitch	3 × .030″
17-9095-1	.625	1.250	.234	.655	2.000	.250 Pitch	3 × .030″





Types of Strand Available

Regular Strand

This configuration is an application-proven product, particularly in television picture tube aluminizing. It is available in ready-to-use coils, straight pieces of wire cut to specific lengths, and wire in random lengths.

Open Strand

This General Electric development produces coil strands with an "open" pattern that presents up to 25% more tungsten surface area for smoother, more uniform wetting. Open strand design "holds" more evaporant because of better capillary action and reduces "balling up" of evaporant. This contributes to longer coil life. Available in ready-to-use coils only.

Overwrap Strand

The newest metallizing strand from GE is the overwrap design. The wire consists of a tungsten core over which a thin strand of tungsten is tightly wound. This design has exhibited superior performance over single strand coils in a number of applications. Major attributes are its better wettability, its tendency to control balling, and longer coil life. These benefits are realized through the added surface area provided by the extra wrap, and the tendency of the wrap to retard vertical flow of the molten metal prior to the flash. This material, which has been used successfully in the 1000 and 2000 series coils, as well as in the various basket configurations, is only available in ready made filaments.

Aluminum Core/Nichrome Core

Core strand improves wetting qualities for most metallizing applications. It consists of three tungsten wires wrapped around a central core of aluminum or nichrome wire. The core strand construction is designed to pre-wet the entire coil to achieve effective wetting of the evaporant on the first flash. After flashing, the coil takes on an open strand design.

Special Strand

Combinations of other wire materials, sizes, and cores, as well as multistrand configurations are available on request.

Shipping Method

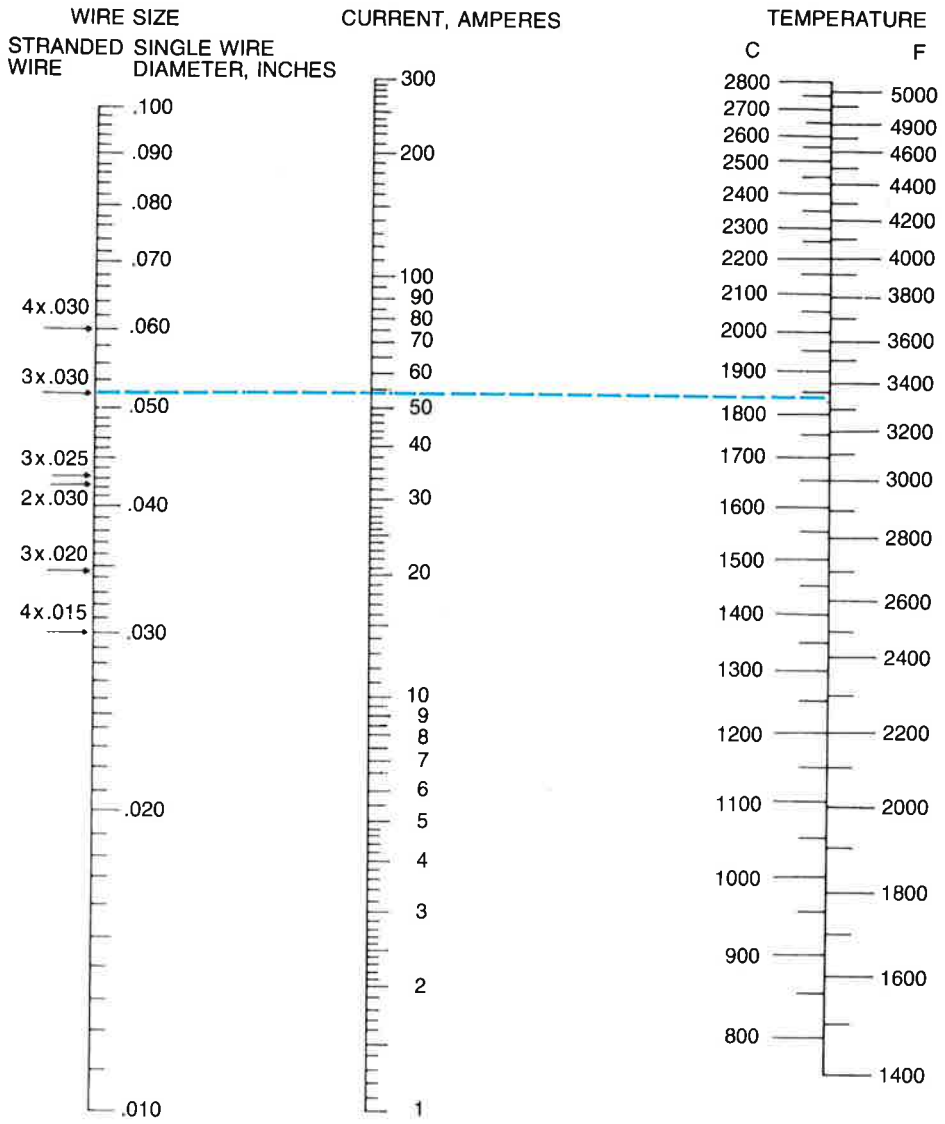
Random length strand is available on non-returnable masonite reels (15″ flanged diameter, 8″ barrel diameter, 6″ traverse and $1^1/_4$″ arbor); self-contained 8″ diameter coils below .025″ and 8″ or 16″ diameter self-contained coils for .026″ and above.

STRAND SPECIFICATION AND CONVERSION TABLE

TYPE	STANDARD SIZES				LENGTH AND WEIGHT CONVERSIONS				AVAILABILITY
	Number of Strands	Diameter of Each Strand in.	mm	Lay★ in.	cm.	Kilograms Per 1000 Meters	Kilograms Per 1000 Feet	Meters Per Kilogram	Feet Per Kilogram	
Regular	4	.015	.381	1/4	.63	9.048	2.758	110.5	362.6	Coils, cut pieces, random lengths
	3	.016	.406	1/4	.63	7.660	2.334	130.5	428.1	
	3	.020	.508	5/16	.79	11.972	3.649	83.5	274.0	
	3	.025	.635	3/8	.95	18.749	5.715	53.3	175.0	
	3	.0276	.700	3/8	.95	22.915	6.985	43.6	143.2	
	2	.030	.762	1/2	1.27	17.795	5.424	56.2	184.4	
	3	.030	.762	1/2	1.27	26.844	8.182	37.3	122.2	
	4	.030	.762	1/2	1.27	36.233	11.044	27.6	90.5	
	3	.0315	.800	1/2	1.27	29.653	9.038	33.7	110.6	
Open	3	.025	.635	3/8	.95	19.769	6.025	50.584	165.966	Coils
	3	.030	.762	1/2	1.27	27.769	8.464	36.011	118.152	
Aluminum Core	4 (3 + 1)	.030W .025Al	.762 .635	1/2	1.27	28.647	8.732	34.908	114.521	Coils, cut pieces, random lengths
Nichrome Core	4 (3 + 1)	.030W .040N	.762 1.016	1/2	1.27	35.550	10.836	28.129	92.287	
Overwrap	2 (1 + 1)	.035W .009W	.889 .228	N/A		18.413	6.041	54.309	178.179	Coils

★ "Lay" or "pitch" is the amount of advance of any point in a strand for one complete turn.
Note: Specifications are subject to manufacturing tolerances.

Nomograph Relating Wire Size/Current/Temperature



Explanation of Nomograph

1. Current-temperature relationship may be affected by strand design. For the same current, regular strand will operate at a slightly higher temperature than open or aluminum core strand.

2. Coil configuration may also affect current-temperature relationship. For example, for the same current a coil with more turns per inch will operate at a higher temperature than one of similar design but with fewer turns per inch.

3. For sizes of stranded wire not shown on nomograph, determine the equivalent single wire diameter from the formula below:

$$D = d\sqrt{n}$$

D = equivalent single wire diameter of the stranded wire in mils.

d = actual diameter of a single wire in mils

n = number of wires in the strand

Example: What is the equivalent single wire diameter of three strands of 0.030 inch wire?

d = 30 mils

n = 3

$D = 30\sqrt{3} = 52$ mils or .052″

4. Example of how to use nomograph. Find temperature of 3 x 0.030 inch stranded wire at current of 55 amperes.

Answer: 1850°C (3362°F)

Engineering Assistance

General Electric Company recognizes that successful evaporation of metal in a vacuum requires a combination of experience and expertise.

GE's role has always been more than that of a materials and components supplier. We're involved in the most basic metallurgical studies in our continued effort to produce the optimum tungsten material. Our research has encompassed strand construction, coil design, and coil positioning within the chamber. As a result, a number of product innovations have come from GE's laboratories in recent years, and many of them have become standards of the industry.

Application engineering is another of our strengths. Whether your needs are for standard or special vacuum metallizing coils, please check with us first. Our engineering staff can help you select or "tailor make" a tungsten coil meeting your requirements.

For design assistance, provide us with complete answers to the following questions. This will enable our vacuum metallizing specialists to recommend a design for your needs. At the same time, please supply a print or sample of the coil you are using.

1. What is the type and size of your vacuum metallizing equipment?
2. What material and weight (mg) are you evaporating?
3. What are the dimensions of the evaporant you're using?
4. What is the length between your electrode holders? Are they adjustable?
5. How many strands of tungsten are you using?
6. What is your size wire?
7. What is the maximum electrical capacity at which you can operate consistently?

When describing a coil or preparing a print, include all essential details in this checklist:

A—Overall Length
B—Coil Length
C—Leg Lengths
D—Inside Diameter
E—Distance Between Legs

Indicate coil turns per inch, size of wire, number of strands and type of strand.

See "Technical Assistance" below for address or phone number to contact.

Simulated life and coating tests are run in this vacuum bell jar to generate the data which enables General Electric engineers to design coils for a variety of metallizing applications.

Special Services

As an added service to our metallizing coil customers, we will provide credit for used coils against the purchase of new coils. Please call for details and current price quotations.

Our complete troubleshooting guide "Taking the Mystery Out of Metallizing" will prove helpful in obtaining maximum results with GE coils. Your copy will be sent free upon request.

ORDERING

To order metallizing products, contact your Sales Operation representative, Sales headquarters (below), or the manufacturing plant (right).

General Electric Company
Lamp Components & Technical Products Division
Sales Operation
21800 Tungsten Road
Cleveland, Ohio 44117

Phone:
Domestic —(216) 266-2451
International —(216) 266-3295

Telex: 985569 (GECOLCS EUCD)

METALLIZING COILS

Dover Wire Plant
Phone: (216) 343-8841
Ext. 224

STRANDED WIRE

Tungsten Products Plant
Phone: (216) 266-3600

TECHNICAL ASSISTANCE

General Electric Company
Glass & Metallurgical Products Dept. — Marketing
24400 Highland Rd.
Cleveland, OH 44143
Phone: (216) 266-6669

Printed in U.S.A.

GENERAL ELECTRIC

General Catalog 7225
April, 1984
45/3M