Specification Guide For Carbon Brushes

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The Carbon Brush
… a brief discussion

A carbon brush functions as an electrical contact between a stationary and a moving electrical circuit. A carbon brush is always part of an electrical and mechanical system; it is a conductor of current in the electrical system and it is subjected to mechanical forces from contact with a moving surface.

One end of a brush consists of carbon/graphite composition, which is unique in that it is adequately conductive to perform electrically and has lubricating characteristics to maintain low friction for satisfactory mechanical performance. The other end of the brush usually consists of a terminal or cap to make a stationary electrical connection.

Identifying the specification for a carbon brush is a major challenge for users and manufacturers of carbon brushes. This guide includes the elements necessary to provide a description of a brush, as noted in the contents. By furnishing the information as requested on page 16-17, we will have the opportunity to supply the best brush design for your application.

It is hoped that through the use of this specification guide your requirements can be coordinated with the extensive processing and production capabilities at Helwig Carbon to result in carbon brushes which offer the very best performance.

When ordering a replacement brush, you may want to consider sending us the brush you are replacing. From its wear patterns, we may even be able to recommend a better, longer lasting brush. In any case, Helwig Carbon Products is committed to providing solutions for your business. Please contact us today.

Parts of a Carbon Brush

…vocabulary listing

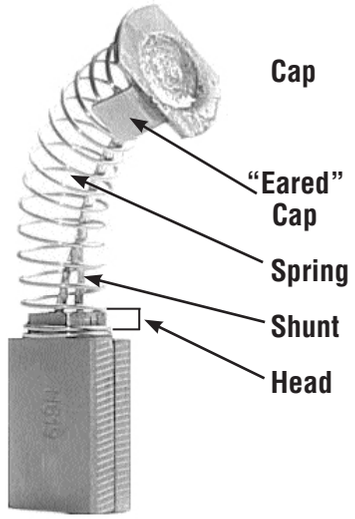
Bevel: The brush is cut on a slant on the top or bottom and it is the angle other than a right angle on the top or bottom of brush. Bevels generally range from 0-45 degrees (see page 15).

Brush face: The surface of the carbon brush which touches the commutator or ring. The condition of the brush face can be a good indicator of brush performance.

Cap: The metal top of a brush connected to the block of carbon with a wire or spring. The cap provides the stationary electrical contact. Used primarily in small fractional horsepower motors.

Carbon brush: An electrical contact consisting of a block of carbon/graphite material which rides on the contact surface with a wire leading to a terminal or cap making stationary electrical connection.

Fractional Horsepower Brush



Concave: Curved bottom surface of the brush designed to meet the curvature of the contact surface. Also referred to as concave radius. (see page 15)

Grade: The final composition of the raw material. Manufacturers give each unique composition a designation called a brush "grade" (see pages 22-24)

Head: Upper part of the carbon shaped to hold the end of the spring in place. Commonly used on brushes with springs and caps.

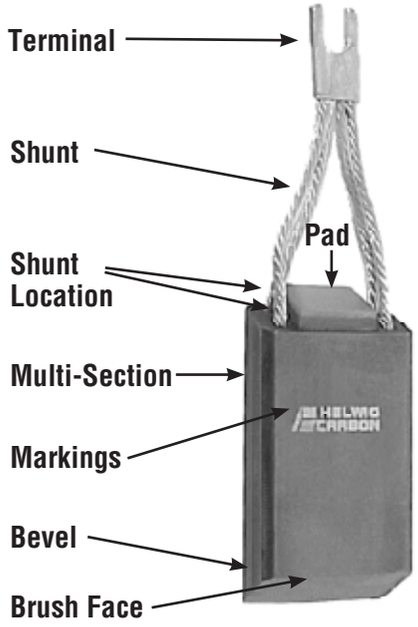
HQD: Helwig quick disconnect terminals. Electrical connection that doesn't require nut and bolt to hold terminal in place. (see page 14)

Multi-flex: Multi-section brush where two or more wafers come together to form the whole brush. The wires from the various wafers generally meet in one terminal. These brushes are often held together with a rubber pad.

Red Top or Pad: Combination of hard plastic and rubber square glued to the top of the carbon brush. Pads hold the multiple brush sections together, and insulate spring from carrying current and absorb excess vibration. The spring or spring finger will make contact with the brush on the pad surface.

Rivet connection: The wire is attached mechanically to the carbon with a rivet. The wire is generally wound around the rivet and up through holes in the carbon material.

Industrial Size Brush



Shunt: Wire leading from the block of carbon to the terminal. This is where the current flows.

Shunt locations: Where the wire enters the carbon brush. These locations are numbered in relation to viewing the front of the brush (see page 12).

Sleeving: Covering over the shunt wires. Some have a painted cloth appearance and others resemble a soft flexible rubber tubing.

Slot: Groove on the top of the brush often used to stabilize the spring (see page 11). Face slot – cuts in the brush face.

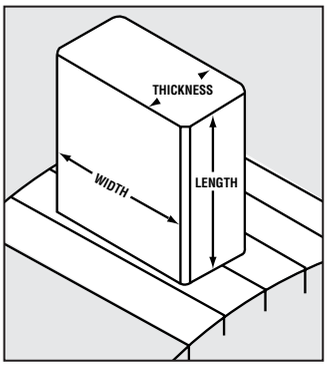
Tamped connection: The wire is embedded directly into the carbon brush.

Terminal: A device at the end of the wire of a carbon brush that makes a convenient stationary electrical connection. (see page 14)

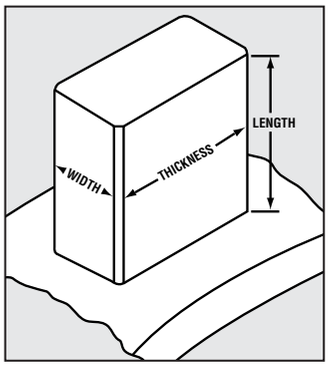
Carbon Dimensions

Brush sizes are designated as: **Thickness x Width x Length** of the carbon.
If the brush design includes a Red Top, the length measurement should include the pad. On brushes with bevels, the length is measured on the long side. Brushes with a head on top include length of head.

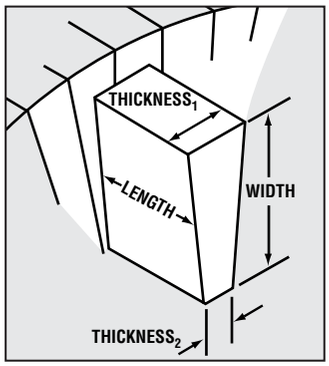
When specifying dimensions, submit information on brush length even if it is worn length, as a reference.



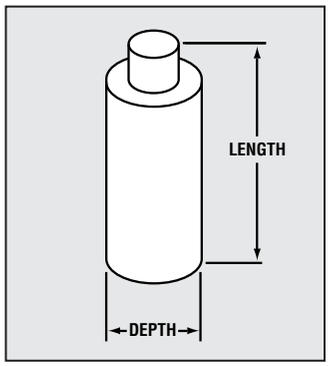
Commutator Brush



Slip Ring Brush



Wedge-Shaped Brush



Cylindrical Brush

Brush Tolerances

Unless otherwise stated on the order or the drawing, the following tolerances apply.

Carbons and Metal Graphites under 50% Metal

Thickness		Width		Length		Diameter	
Under .125"	+.000-.002	***Under .125"***	+.000 -.002	***Under .375"***	+.005 -.005	***Under .125"***	+.000 -.002
.125" to 1.250	+.000-.004	***.125" to .750"***	+.000 -.004	***.375" to 1.000"***	+.010 -.010	***.125" & Over***	+.000 -.004
1.250 and Over	-.002-.006	***Over .750"***	+.000 -.015	***1.000" & Over***	+.032 -.032		
Under 3.2mm	+.000-.050	***Under 3.2mm***	+.000 -.050	***Under 9.5mm***	+.130 -.130	***Under 3.2mm***	+.000 -.050
3.2mm to 32mm	+.000-.100	***3.2 to 19.0mm***	+.000 -.100	***9.5 to 25.4mm***	+.250 -.250	***3.2mm & Over***	+.000 -.100
32mm and Over	-.050-.150	***Over .19.0mm***	+.000 -.380	***25.4mm & Over***	+.810 -.810		

Metal Graphites over 50% Metal

Thickness		Width		Length		Diameter	
Under .125"	+.000 -.002	***Under .125"***	+.000 -.002	***Under .375"***	+.005 -.005	***Under .125"***	+.000 -.002
.125" to .500"	+.000 -.004	***.125" to .500"***	+.000 -.004	***.375" to 1.000"***	+.010 -.010	***.125" & Over***	+.000 -.004
Over .500"	-.007 -.011	***Over .500"***	-.007 -.020	***1.000" & Over***	+.032 -.032		
Under 3.2mm	+.000 -.050	***Under 3.2mm***	+.000 -.050	***Under 9.5mm***	+.130 -.130	***Under 3.2mm***	+.000 -.050
3.2mm & Over	+.000 -.100	***3.2 to 19.0mm***	+.000 -.100	***9.5 to 25.4mm***	+.250 -.250	***3.2mm & Over***	+.000 -.100
12.7mm & Over	-.178 -.280	***Over 12.7mm***	-.178 -.510	***25.4mm & Over***	+.810 -.810		

Style Configurations

Shuntless

The configuration of the carbon along with the method and location of the shunt connection determines the brush style. Due to the difficulty in describing the many different styles, refer to the style numbers located under each photograph. **If the required style is not shown, please submit a drawing, sketch or sample.**


P20


P24


P26


P27


P28


P29

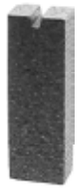

P50


P51


P52


P53


P56


P57

Tamped with Spring


Q100


Q101


Q102


Q103A


Q104


Q104A


Q105


2Q105


2Q105A


Q106


Q107


Q108


Q109


Q110


Q111


Q112


Q113


Q114


Q115


Q116


Q117

Tamped Single Shunt

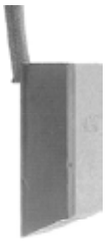

Q20


Q20P


Q21


Q22


Q23


Q24


Q24A


Q25


Q26


Q26P


Q27


Q27A


Q28


Q29


Q31


Q32


Q33


Q34


Q35


Q36


Q37A


Q38


Q38P


Q39


Q40


Q41


Q42


Q43


Q44


Q45


Q46


Q47


Q48A

Tamped Single Shunt *(continued)*


Q49


Q50


Q51


Q52


Q53

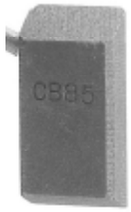

Q54


Q55


Q56


Q57


Q80


Q81


Q82


Q83


Q84


Q85


Q86


Q87


Q91


Q92


Q93


Q94


Q94A


Q94B


Q95


Q96

Tamped Multiple Shunts


Q58

Q58A


Q59


Q60


Q61


Q62


Q63


Q65


Q66P


Q67


Q68


Q68A


Q68P


Q69


Q70


Q71


Q76


Q77


Q78


Q78P


Q79

Q98

Q99

Tamped Multi-Section


2Q20


2Q21


2Q22


2Q23


2Q24


2Q30


2Q31


2Q31A


2Q31B


2Q32


2Q33


2Q34


2Q35


2Q36


2Q37


2Q38


2Q39


2Q40


2Q42


2Q44


2Q45


2Q50


2Q51


2Q51A


2Q51B


2Q52


2Q53


2Q54


2Q54A


2Q55


3Q20


3Q21


3Q22


3Q23


3Q24


3Q25

Tamped Paired Brushes


M21


M23


M24


M25


M27


M28


M28A


M29


M30


M31


M32


M33

Riveted Paired Brushes


M40


M42


M43

Riveted Single Shunt Position


R21


R22


R22B


R23


R24


R27


R28


R29


R30


R31


R32


R33


R34


R35


R36


R37


R38


R39


R70


R71


R72


R73


R74


R74P


R75


R76

Riveted Multiple Shunt Position


R41


R45


R48


R49


R50


R51


R52


R53P


R54


R54A


R54P


R55


R56


R42A

Riveted Multi-Section


2R21


2R22


2R22P


2R25


2R26

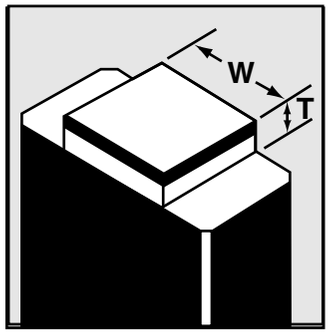

2R28


2R28P

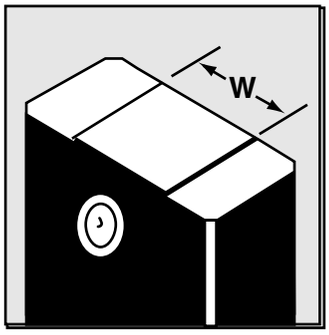

2R29

Special Features

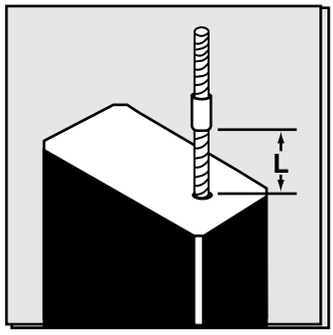
Red Top



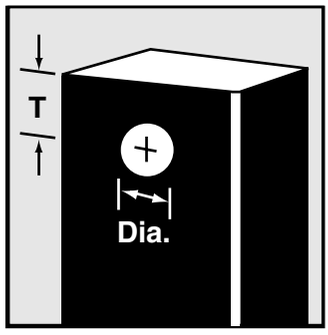
Metal Hammer Plate



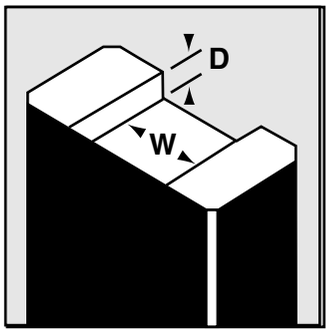
Wearband



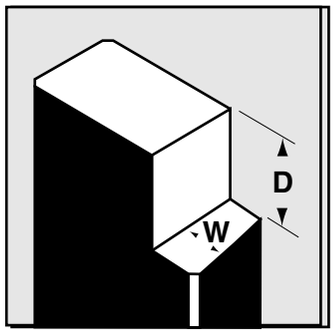
Holes



Slots

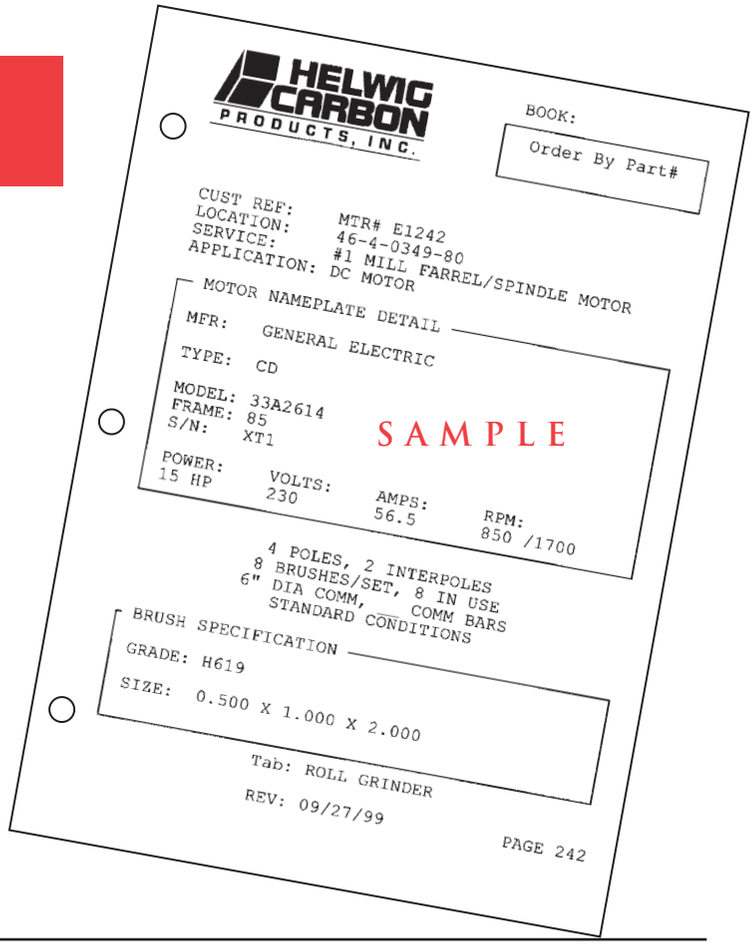


Shoulders



Free Brush Identification Service

Helwig offers a free service to identify and catalog the exact type of every carbon brush used in your facility as well as the precise specifications you will need to reorder the brushes. Our trained sales and service representatives will tour your facility and review each application, compiling a complete record of the brush applications in use there along with the operating conditions. You will receive a binder filled with this information and your Helwig representative will maintain one as well. Not only can it help you organize your storeroom, but it makes finding and reordering the best brush for the job as easy as possible. It also ensures that you are using the right brushes for the operating conditions of the unit.


HELWIG CARBON PRODUCTS, INC.

BOOK: Order By Part#

CUST REF:
LOCATION: MTR# E1242
SERVICE: 46-4-0349-80
APPLICATION: #1 MILL FARREL/SPINDLE MOTOR
DC MOTOR

MOTOR NAMEPLATE DETAIL
MFR: GENERAL ELECTRIC
TYPE: CD
MODEL: 33A2614
FRAME: 85
S/N: XT1
SAMPLE
POWER: 15 HP
VOLTS: 230
AMPS: 56.5
RPM: 850 /1700

4 POLES, 2 INTERPOLES
8 BRUSHES/SET, 8 IN USE
6" DIA COMM, COMM BARS
STANDARD CONDITIONS

BRUSH SPECIFICATION
GRADE: H619
SIZE: 0.500 X 1.000 X 2.000

Tab: ROLL GRINDER
REV: 09/27/99

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Shunt Locations

Shunt locations are given numerical designation according to the position at which the wire protrudes from the carbon. In addition to location, the number of wires in each position should be specified.

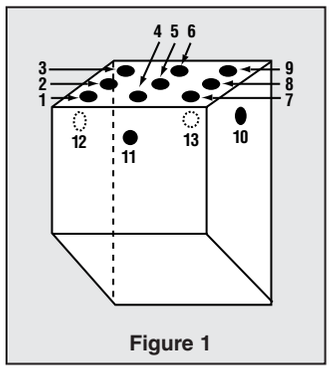


Figure 1

Beveled Brushes (Figure 1) the short face is to be held toward the observer.

Rectangular or Square Brushes with no bevel (not illustrated) the wide face or width of the brush is to be held toward the observer.

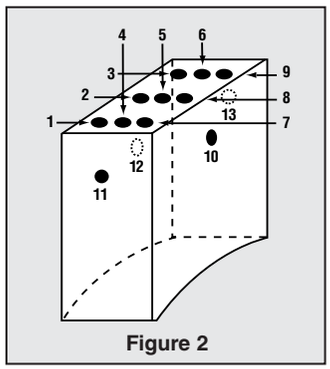


Figure 2

Spring Ring Brushes (Figure 2) the narrow face is to be held toward the observer. The number is to begin at the left hand side of top face nearest the observer.

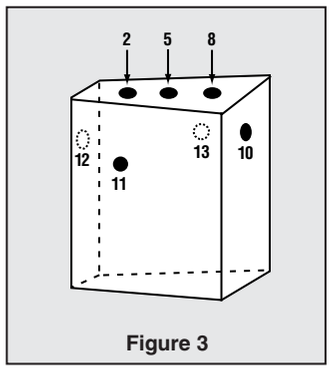


Figure 3

Wedge-Shaped Brushes (Figure 3) the brush is to be held as shown with the narrow edge to the left. The shunt locations take the number 2-5-8, beginning at the left and corresponding with those of the top face center row in Figure 1.

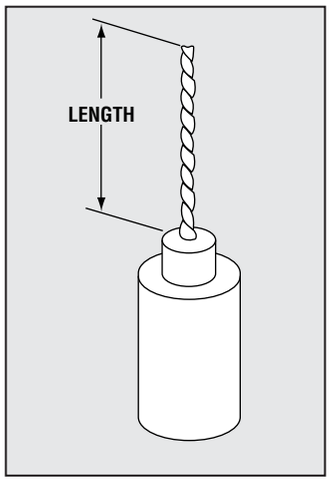
Shunt Wire Size and Rating

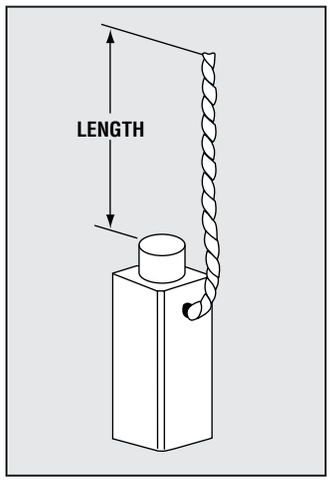
The choice of shunt size is based on the amp capacity of the carbon brush. However, there are limitations in shunt size according to the type of shunt connection, tamped or riveted, and the size and shape of the carbon.

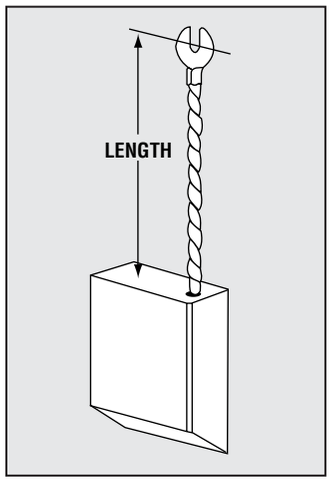
Helwig Wire #	Nearest AWG Size of Cable	Approx. Diameter of Cable		No. of Strands	No. Wires Per Strand	Actual Dia. of Individual Wires in Inches	Actual Area of Cable Circular Mils	Ampere Rating	
		Inches	(MM)					Continuous	3 Minutes or Less
#S	29	0.016	0.41	3	11	0.002	129.1	2	4
#T	26	0.022	0.56	3	22	0.002	258.1	3.5	7
#LO	25	0.022	0.56	3	11	0.003	326.3	4	8
#W	22	0.030	0.76	3	22	0.003	652.6	7	14
#1	20	0.040	1.02	7	47	0.002	1287.0	10	20
#2	18	0.052	1.32	7	63	0.002	1725.0	12	24
#3	16	0.067	1.70	7	24	0.004	2625.0	20	40
#4	14	0.086	2.18	7	24	0.005	4200.0	30	60
#5	12	0.102	2.59	7	37	0.005	6475.0	40	80
#6	10	0.130	3.30	7	59	0.005	10325.0	50	100
#7	9	0.140	3.56	7	75	0.005	13125.0	60	120
#8	8	0.166	4.22	7	95	0.005	16625.0	70	140
#9	7	0.188	4.78	7	119	0.005	20825.0	85	170
#10	6	0.204	5.18	7	150	0.005	26250.0	100	200

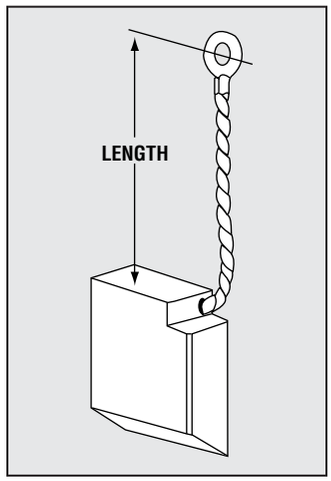
Shunt Length

The length of the shunt is measured from the top of the carbon or top of the pad on Red Top brushes to the center of the terminal or cap where connection is to be made.









The nominal lengths and tolerances of shunts shall be:

Length		Tolerances			
		Plus		Minus	
Inches	(MM)*	Inches	(MM)*	Inches	(MM)*
0.625	15.9	0.125	3.2	0.000	0.00
1.0	25.4	0.125	3.2	0.000	0.00
1.25	31.8	0.125	3.2	0.000	0.00
1.5	38.1	0.125	3.2	0.000	0.00
2.0	50.8	0.125	3.2	0.000	0.00
2.5	63.5	0.25	6.4	0.000	0.00
3.0	76.2	0.25	6.4	0.000	0.00
3.5	88.9	0.25	6.4	0.000	0.00
4.0	102.0	0.25	6.4	0.000	0.00
4.5	114.0	0.25	6.4	0.000	0.00
5.0	127.0	0.375	9.5	0.000	0.00
5.5	140.0	0.375	9.5	0.000	0.00
6.0	152.0	0.375	9.5	0.000	0.00
6.5	165.0	0.375	9.5	0.000	0.00
7.5	190.0	0.375	9.5	0.000	0.00

*These values represent conversion to SI units and are not necessarily the same as the values specified by the International Electrotechnical Commission.

Diameter Gauge


3/8"


11/32"


5/16"

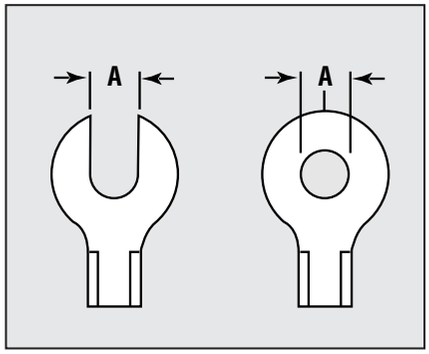

9/32"


1/4"

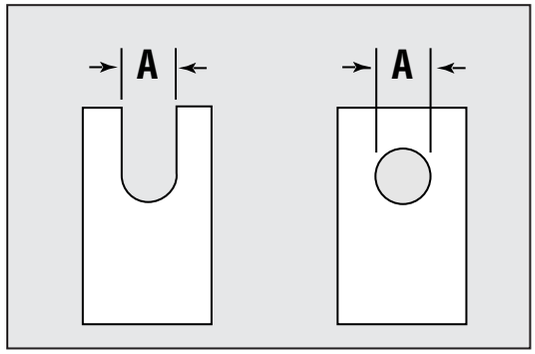

3/16"

There is an ever-increasing variety of caps and terminals used on brushes. Some of the most common are shown below.

In order to determine terminals and caps not shown here, it is recommended that a detailed drawing or sample be submitted to assure correct fit.

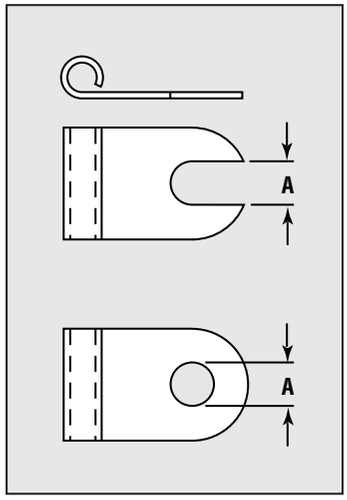


Stamped

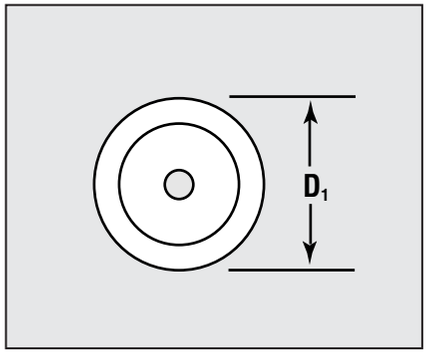


Pressed Tube

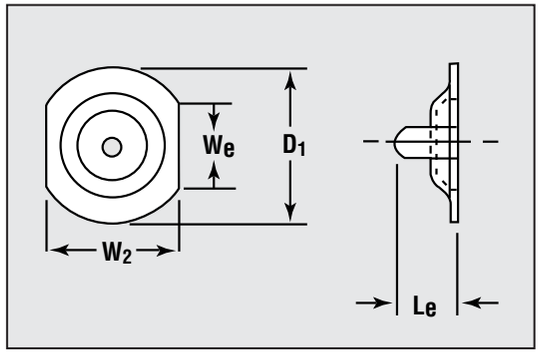
Dimension "A" (the width of the slot or the diameter of the hole) must be given. Also, stamped and pressed tube terminals may be bent at 30, 45, 60 or 90 degrees.



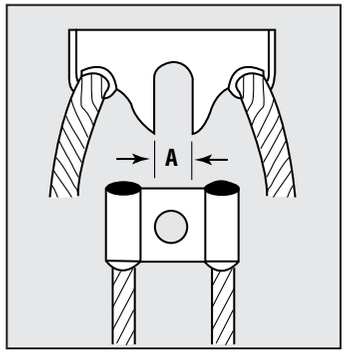
Flag



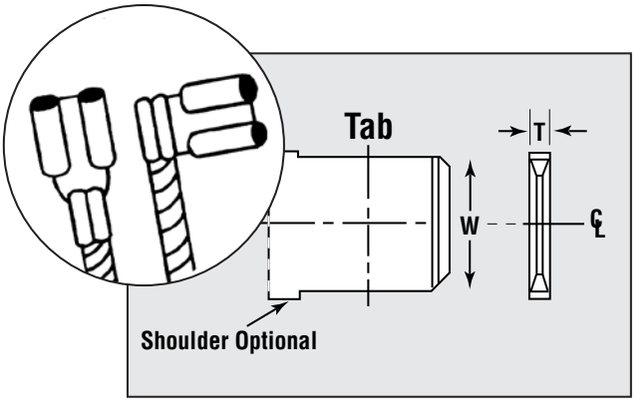
Round Cap *Specify diameter.*



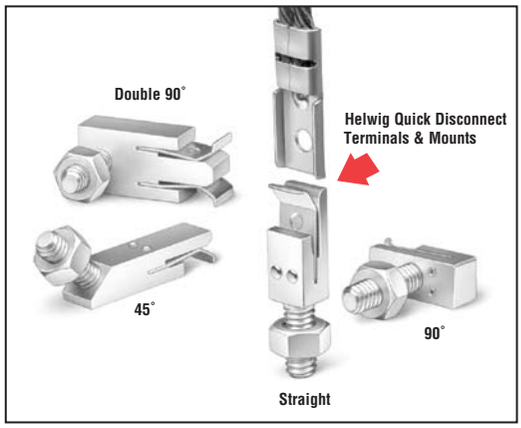
Eared Cap *Specify diameter, width across ears, width of ears and length of ears.*



Yokes

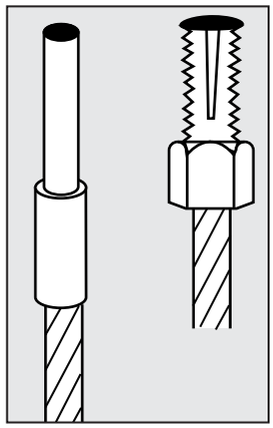


Quick-Connect terminal *Specify width and thickness of connector tab.*



Helwig Quick Disconnect

- *Easily Adaptable to Most Applications*
- *200 Amp Current Carrying Capacity*
- *Save Time, No Tools Required*
- *Field Proven*

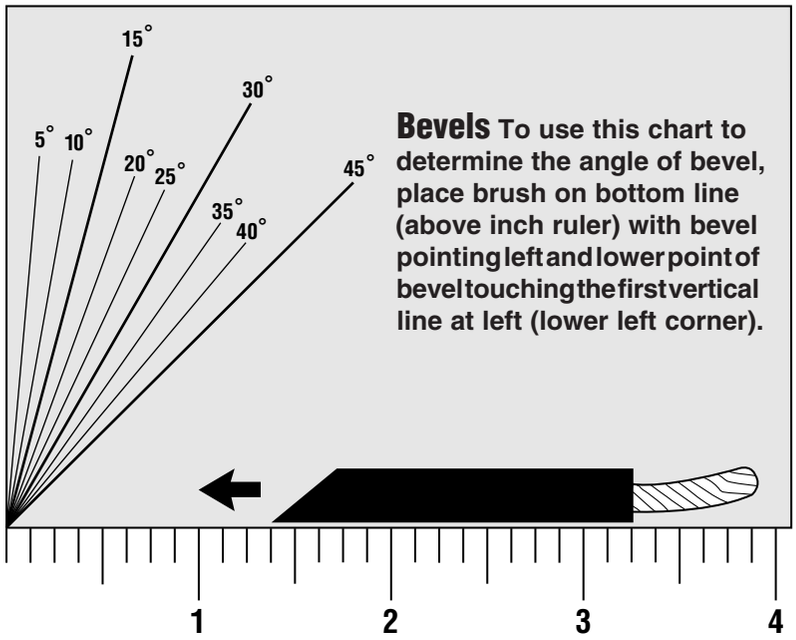


Plug *Specify diameter of plug.*

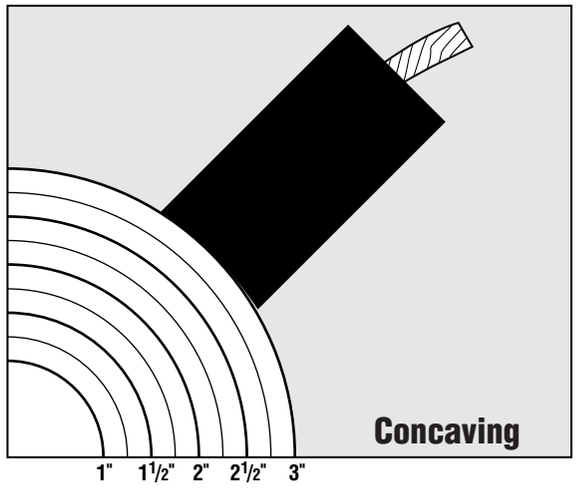
Bevels & Concave

Brushes are frequently supplied with top and/or bottom bevels in order to provide a more stable reaction of a brush within the holder. Production tolerance on a bevel is plus or minus one degree (+ / –1.0 degree).

A concave is a pre-machined radius on the wearing surface to reduce time required to seat a new brush to the commutator or ring surface.



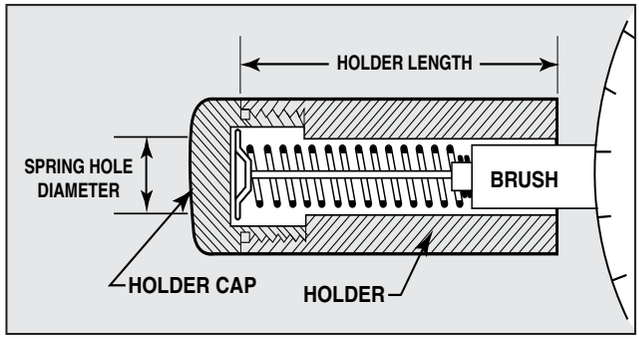
Bevels To use this chart to determine the angle of bevel, place brush on bottom line (above inch ruler) with bevel pointing left and lower point of bevel touching the first vertical line at left (lower left corner).



Specify diameter of commutator or ring surface. The brushes can then be supplied with the proper radius to maximize the contact surface of a new brush and minimize seating time.

Coil Spring Brushes

Brush designs with a coil spring held captive with the carbon require additional information in order to assure proper reproduction. The coil spring and the holder must be specified as follows:



Spring

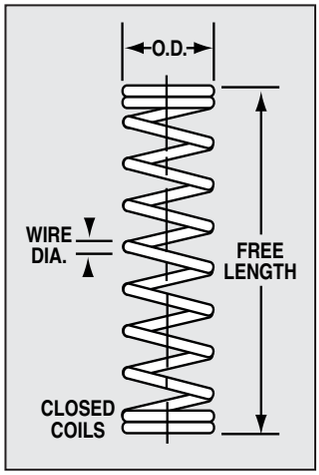
O.D. _____

Free Length _____

Wire Dia. _____

No. Active Coils _____

No. Closed Coils _____



Holder These additional dimensions from the holder will allow us to supply the optional brush design.

Spring hole diameter _____

Holder Length *(length from bottom of holder cap to bottom end of holder)*

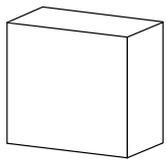
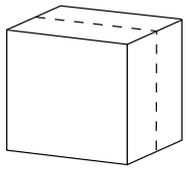
_____

Fax: 800.365.3113

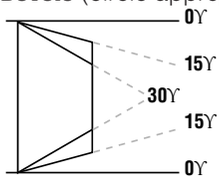
Please photocopy this form and fax us at 1-800-365-3113 or 414-354-2421.
Additional forms can be found in the pocket of this catalog OR are available on our Webpage at www.helwigcarbon.com

Markings on the Brush: _____ **Style Configuration:** (pages 3-10) _____

Size: Thickness:_____ Width: _____ Length: _____

☐ **Solid**  **or** ☐ **Multi-section** 

Bevels (circle appropriate degree)



Top Bevel: _____

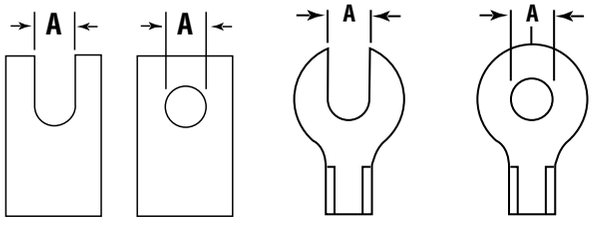
Bottom Bevel: _____

No. of Wires: 0 1 2 4 6 (circle appropriate no.)

Wire Length: _____ ☐ **Bare wire** ☐ **Tinned wire** ☐ **Sleeving**

☐ **Rubber Pad** ☐ **Metal Hammer Plate**

Terminal (circle one)



☐ **Bent terminal** ☐ **45°** ☐ **60°** ☐ **90°**

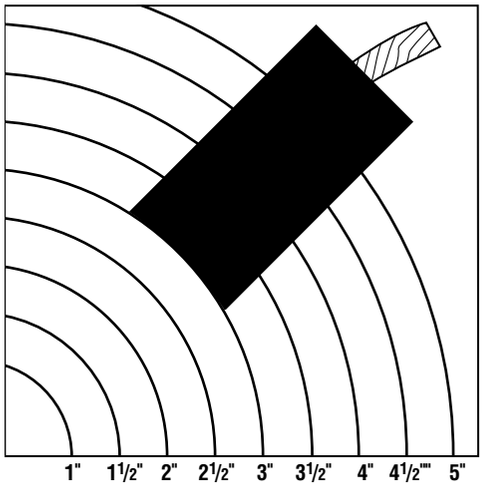
Diameter of Hole or Slot
(circle appropriate diameter)

6 **7** **8** **9** **10** **11**

Terminal Openings (_____ x 1/32 inches)

Helwig Quick Disconnect Terminals & Mounts

Concave (radius) _____
Or circle below



Billing Information:

Company: _____ Attn: _____

Account number (if known): _____ Phone: _____

Fax: _____ E-mail: _____

Address: _____

City: _____ State: _____ Zip: _____

Shipping (if different from billing information):

_____

_____

_____

Additional Brush information:

_____

_____

_____

Ordering Information:

P.O. or RFW: _____ Ordered by: _____

Quantity: _____

Phone 1-800-962-4851

Need Help with Brush Problems?

Please photocopy this form and fax us at 1-800-365-3113 or 414-354-2421.
Additional forms can be found in the pocket of this catalog OR are available on our Webpage at www.helwigcarbon.com

Motor/Generator Name Plate:

Volts _____ Amps _____ # of Holders _____ # of Brushes Being Used_____

# of Slip Rings & Material _____ Metered Running Amps _____

Diameter of Commutator/Ring _____ Motor Manufacturer _____

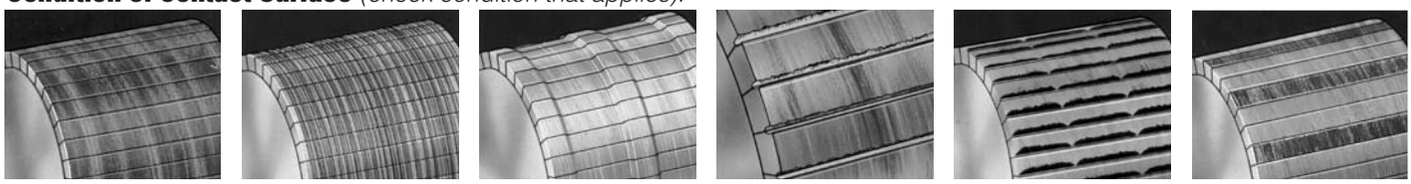
RPM/Nameplate RPM _____ Running RPM _____

Frame or model # _____ Thickness & width of brush _____

Environment *(Please check those that apply):*

☐ Hot ☐ Dry ☐ Dust ☐ Cement ☐ Grease ☐ Solvents ☐ Fresh filter air ☐ Silicone vapors
☐ Cold ☐ Wet ☐ Grit ☐ Lint ☐ Oil ☐ Acids ☐ Unfiltered air ☐ Smoke ☐ Plastics

Condition of Contact Surface *(check condition that applies):*



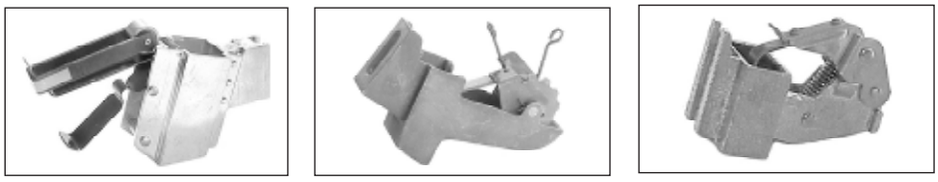
☐ Streaking ☐ Threading ☐ Grooving ☐

Arcing? ☐ Yes ☐ No Brush bounce? ☐ Yes ☐ No

Last time spring clips were changed? _____ ☐ Pad on brush

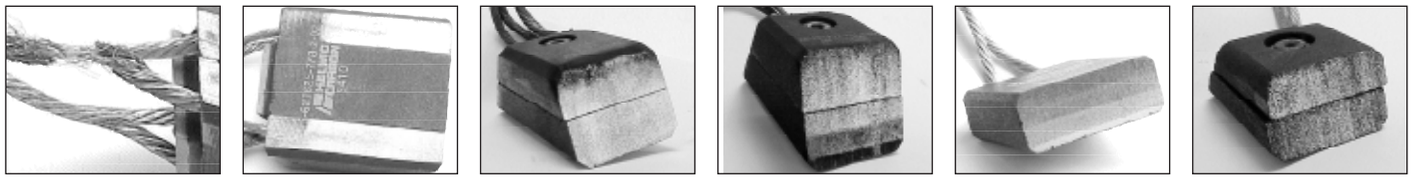
Spring force reading? _____ ☐ Metal hammer plate

Type of brush holder:



☐ Constant force ☐ Coil spring ☐ Other spring finger type ☐ Other

Condition of the Brush *(check those that apply):*



☐ ☐ ☐ ☐ ☐ ☐

Condition of Shunts:

☐ Frayed ☐ Discolored ☐ Pulled out of carbon ☐ Good condition ☐ Tinned ☐ Sleeving

Contact information:

Name:_____ Company name: _____

Best time to reach you: _____ Fax # _____ Phone # _____

Pager # _____ E-mail _____

Commutator

…Problems and solutions

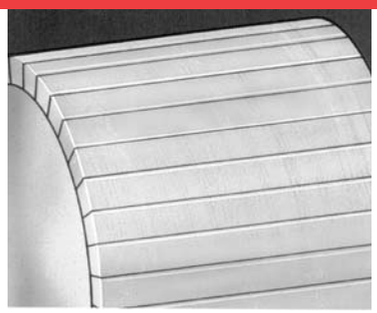
The purpose of this guide is to promote awareness of undesirable carbon brush operation. Early recognition and corrective action can help avoid costly unscheduled down time.

The commutator film condition is a primary indicator of the performance of any motor or generator. A consistent color over the entire commutator in the brown tones from light tan to dark brown indicates a satisfactory film condition.

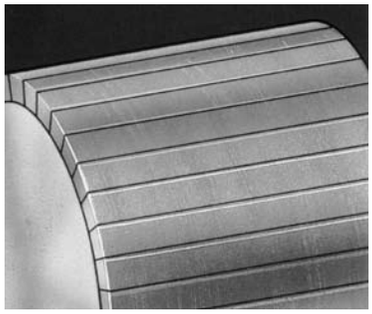
In these cases, sufficient film exists for low friction operation, while there is not excessive film to restrict proper flow of current.

Inconsistent film color and deformation of the commutator surface are warning signs for developing trouble conditions with fast brush and commutator wear.

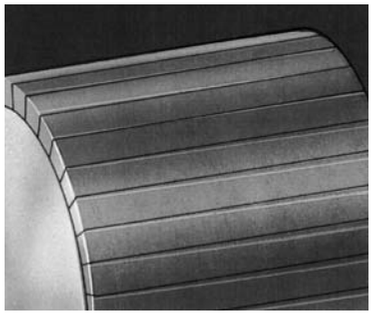
Satisfactory Surfaces



Light Film: Indicates good brush performance. Light load, low humidity, brush grades with low filming rates, or film reducing contamination can cause lighter color.



Medium Film: Is the ideal commutator condition for maximum brush and commutator life.



Heavy Film: Results from high load, high humidity or heavy filming rate grades. Colors not in the brown tones indicate contamination resulting in high friction and high resistance.

Fast Wear: Accelerated brush wear due to a variety of conditions causing excessive dusting or arcing.

Cause – All of the definitions listed below will contribute to fast wear. Also, roughness or irregularity of the commutator surface such as high bars, mica or burrs, or an out-of-round contact surface condition will cause radial movement and resulting arcing and chatter.

Recommendations – Check that commutator is in good condition, that spring pressure is adequate at the face of the brush, and that the proper number of brushes are in use based on operating current densities.

Light Load: Low current density for the grade in use or inadequate filming or high friction conditions.

Cause – Equipment is set for the maximum loads and the product dictates operation at less than nameplate resulting in light load, high friction, brush dust, and eventual threading.

Recommendations – Increase current density by removing brushes or consider light load filming grade.

Threading: The copper transfer from the rotating surface to the brush face and the resulting wear on the contact surface from metal to metal abrasion.

Cause – Often due to low current density and inadequate spring pressure. May also be worsened by contamination.

Recommendations – Verify actual operating loads and spring pressure to be sure they are in the proper range for the grade in use. If possible, eliminate any contamination present.

Grooving: The result of abrasiveness or excessive electrical wear of contact surface or ring surface.

Cause – Most commonly due to poor electrical contact resulting in arcing and electrical machining of the commutator. Can also be due to mechanical wear or overly abrasive grade. Inadequate spring pressure, low current densities, or excessive current are also possible causes.

Recommendations – Check the contact surface that roundness is within .002” with less than .0003” variation from bar to bar. Vibration should be less than 6 mils. Check current density and spring pressure.

Arcing: Arcing and burning at the brush face.

Cause – Due to poor electrical contact, inadequate spring pressure (see chart), rough commutator, or ring deposits or burrs in brush holder.

Recommendations – Contact surface should be round within .002". Check spring pressure to ensure that it is 4-6 psi for industrial DC applications and remove any deposits in holders.

Chipping: Brushes chipping or breaking at the face.

Cause – Roughness or irregularity of commutator surface, high bars, mica or burrs can break the entering edge of the brush, and cause brush bounce or chatter.

Recommendations – Check contact surface condition to be sure it is within tolerance, check spring pressure, and running loads.

Spring Pressure

The most common cause of unsatisfactory film condition is inadequate spring pressure. For reference, the chart below indicates the recommended ranges of spring pressure for various applications and the method for calculating spring pressure from the measured spring force.

Recommended Range of Spring Pressures

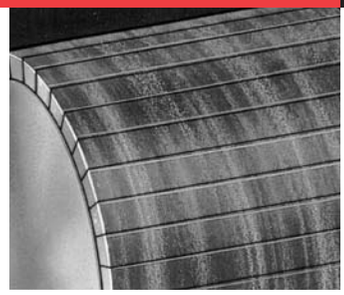
Industrial D.C. Applications	4-6 P.S.I.
WRIM & Sync. Rings	3.5 – 4.5 P.S.I.
High Speed Turbine Rings, Soft Graphite Grades	2.5 – 3.5 P.S.I.
Metal Graphite Brushes	4.5 – 5.5 P.S.I.
FHP Brushes	4-7 P.S.I.
Traction Brushes	5-8 P.S.I.

For brushes with top and bottom angles greater than 25 degrees, add an extra .5 — 1 P.S.I.

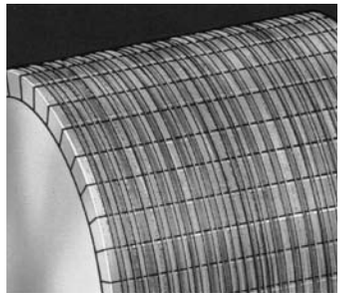
$$\text{Spring (P.S.I.) Pressure} = \frac{\text{Measured Force (lbs.)}}{\text{Brush Thickness (in)} \times \text{Brush Width (in)}}$$

Warning Signs

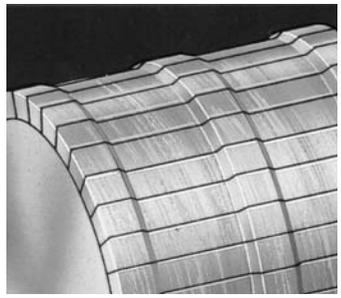
Streaking: Results from metal transfer to the brush face. Light loads and/or light spring pressure are most common causes. Contamination can also be a contributing factor.



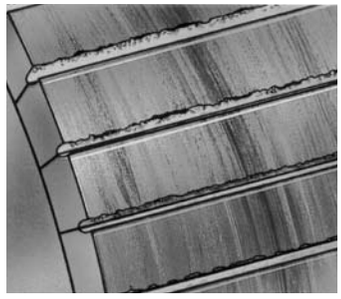
Threading: A further development of the streaking condition as the metal transferred becomes work-hardened and machines into the commutator surface. With increased loads and increased spring pressure, this condition can be avoided.



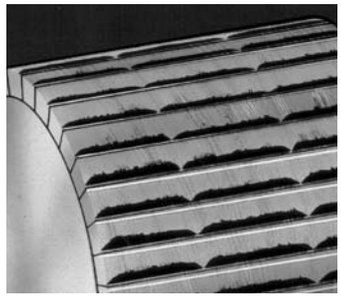
Grooving: May result from an overly abrasive brush grade. The more common cause is poor electrical contact resulting in arcing and the electrical machining of the commutator surface. Increased spring pressure reduces this electrical wear.



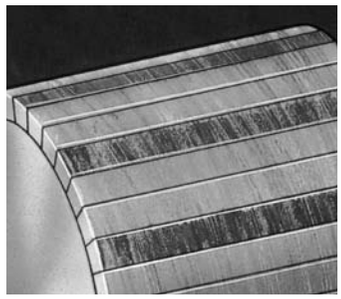
Copper Drag: Develops as the commutator surface becomes overheated and softened. Vibration or an abrasive grade causes the copper to be pulled across the slots. Increased spring pressure will reduce commutator temperature.



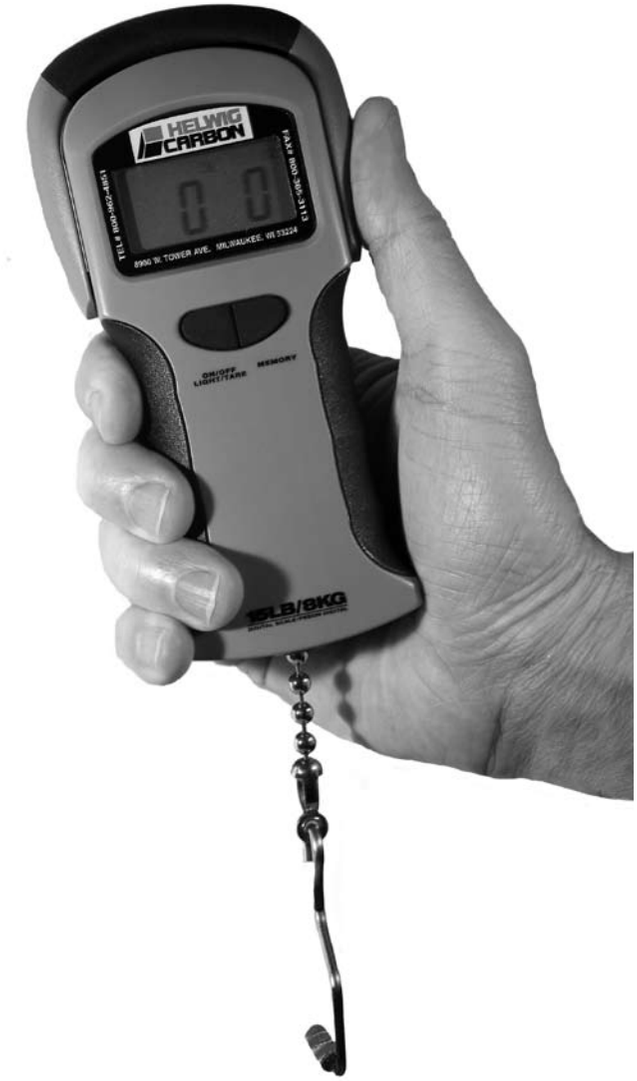
Bar Edge Burning: Results from poor commutation. Check that brush grade has adequate voltage drop, that the brushes are properly set on neutral and that the interpole strength is correct.



Slot Bar Marking: Results from a fault in the armature windings. The pattern relates to the number of conductors per slot.



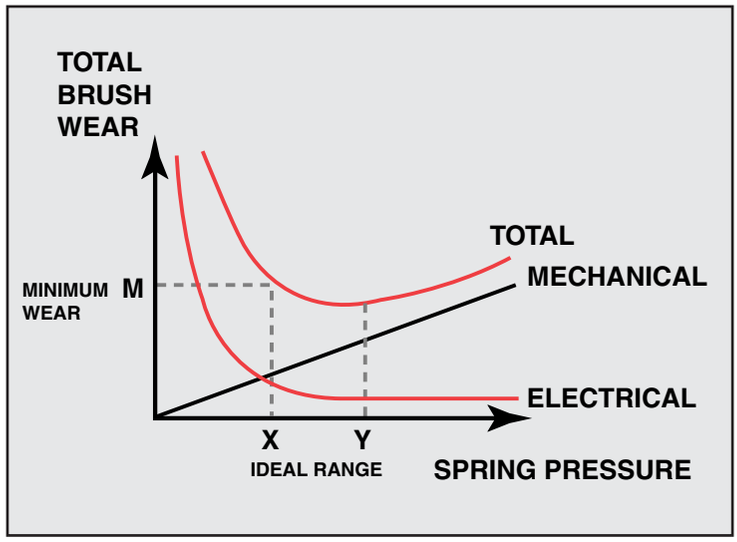
Spring Pressure



Helwig's Electronic Digital Scale is the convenient way to measure spring force. Simply attach the interchangeable strap or roller to the spring assembly and pull the scale taut. The spring force is clearly displayed. The battery operated Digital Scale accurately reads force measurements of both spiral torsion springs and constant force springs up to 10 lbs. (+ or - 2 oz). Detect improper spring forces before excessive brush and commutator wear causes costly downtime. Refer to the recommended range of spring pressures on page 19.

Brushes wear due to the combination of mechanical wear resulting from friction and electrical wear resulting from excessive resistance at the contact surface (arcing). The total brush wear is the summation of mechanical and electrical wear. The amount of spring pressure has a very significant effect on the brush performance and the corresponding wear rate. At low spring pressure there is more electrical wear. At high spring pressure there is more mechanical wear. There is minimum total wear when the spring pressure is in the range from X to Y as shown is the graph below.

$$\text{Spring Pressure} = \frac{\text{Measured spring force}}{\text{Brush thickness} \times \text{Brush width}}$$



Loss of Spring Force on Beveled Brushes

Angle Degrees	Loss in Downward Force
5	0.4%
10	1.5%
15	3.4%
20	6.0%
25	9.4%
30	13.4%
35	18.1%
40	23.4%
45	29.3%

Grade Listing

…determining the best grade

The greatest challenge in carbon brushes is to supply a grade which will offer the best performance for the manner in which the motor or generator is operating. Consideration must be given to the actual running loads, the duty cycle, the voltage, the peripheral speeds and the environment.

The Helwig Carbon technical staff accepts responsibility for selection of the proper grade as it takes many years of experience to develop expertise in this area. The selection of an incorrect material may cause considerable damage. However, grade change should not be the initial consideration when attempting to improve performance due to the many other factors which most often have greater effect. In general, over the years, grades have been given far more credit or blame for brush performance than is deserved.

The many different grades in use today are derived through variation in manufacturing process including raw materials, molding pressures, temperature and duration of the baking process, and after-treatments. All brush grades fall within the five categories of Carbon Graphite, Graphite, Electrographite, Copper Graphite, and Silver Graphite as on the following pages.

Each material has been designed and developed to perform under certain operating conditions. There will be a best grade for each application, although several grades with similar characteristics may offer satisfactory performance.

For best results, call the Helwig Carbon technical staff for grade recommendation.

Key for Performance Characteristics

Contact Drop

VH	2.5 and Higher
H	1.9 to <2.5
M	1.3 to <1.9
L	0.7 to <1.3V
VL	Less than 0.7V

Coefficient of Friction

H	0.3 and Higher
M	0.2 to < 0.3
L	0.1 to < 0.2
VL	< 0.1

Film Code

1	Mild Abrasive = Light Film
2	No Cleaning = Filming
3	Film Forming Properties = Med – Dark Film

Contact drop, coefficient of friction and rated current are performance characteristics. Values shown are based on tests under standard conditions and are in comparison between grades. On any application, the values could vary due to the many possible changes in operating conditions.

Carbon Graphite

Carbon Graphites offer cleaning action for use at slow speeds, low current densities and medium to low voltages. These grades were developed early in the history of motors and generators and are therefore found most often on older equipment, particularly with flush mica commutators.

Grade	Resistivity		Shore	Strength		VD	CF	Film #	Rated Current	
	OHM-IN	uOHM-M	Hard	PSI	N/mm²				Amp/in²	Amp/cm²
H	0.0011000	27	55	3000	20.7	M	M	1	40	6.2
H250	0.0008000	20	60	6700	46.2	M	M	1	50	7.8
H357	0.0012000	30	50	2800	19.3	M	M	1	55	8.5
H422	0.0100000	197	50	3600	27.9	H	L	1	60	9.3
H990	0.0027000	67	70	4300	29.6	H	H	1	40	6.2
H4336	0.0010000	25	40	5000	34.5	M	M	3	80	12.4
HO15	0.0008000	20	40	4000	27.6	M	M	1	40	6.2
NH12	0.0320000	800	45	3025	20.1	H	L	1	55	8.5
NH16	0.0200000	500	25	2200	15.2	H	VL	1	55	8.5
NH4	0.0016000	40	45	2500	17.2	M	L	1	50	7.8

Graphite

Graphites are for use in special applications requiring the low friction characteristics of this material. When brushes must operate at very low current densities or very high peripheral speeds, a graphite grade should be used.

Grade	Resistivity		Shore	Strength		VD	CF	Film #	Rated Current	
	OHM-IN	uOHM-M	Hard	PSI	N/mm²				Amp/in²	Amp/cm²
H552	0.0005000	12	15	2000	13.8	L	L	2	60	9.3
H610	0.0008000	20	20	4700	32.4	M	L	2	60	9.3
H619	0.0019000	47	35	5500	37.9	VH	L	3	50	7.8
H621	0.0700000	1778	45	4500	31.0	VH	L	3	30	4.7
H646	0.0100000	250	30	5000	34.5	H	L	1	60	9.3
H649	0.0098000	245	35	2600	17.9	H	L	2	65	10.1
H651	0.0100000	250	35	4300	29.6	H	L	2	55	8.5
H700	0.0004000	10	25	2300	15.9	M	L	1	70	10.9
H702	0.0010000	25	15	700	4.8	M	M	1	60	9.3
H704	0.0006000	15	15	1000	6.9	M	L	1	60	9.3
H7240	0.1700000	4250	55	4000	27.6	VH	M	2	25	3.9
K018	0.0007	17.7	40	3000	20.6	M	L	3	80	12.4
K084	0.0012000	30	28	3000	20.7	H	L	2	80	12.4
K094	0.0600000	1400	37	2100	15.9	VH	L	3	30	4.7
K174	0.0080000	200	27	1900	13.1	H	L	3	55	8.5
K194	0.0030000	76	25	4500	31.0	H	L	3	55	8.5
K214	0.0350000	889	37	3000	20.7	VH	L	2	55	8.5
K224	0.0080000	200	30	4000	27.6	VH	VL	2	55	8.5
K244	0.0400000	1020	35	2600	18.0	VH	L	2	40	6.2
K254	0.0009000	30	40	3500	24.2	H	L	2	80	12.4
K294	0.0250000	530	35	2000	13.5	H	L	2	55	8.5

Electrographite

Electrographites are the most common grades used on modern equipment with good performance at high voltages, high current densities and high speeds. There is a wide range of characteristics within this category. Most electrographite grades are capable of handling overloads well.

Grade	Resistivity		Shore	Strength		VD	CF	Film #	Rated Current	
	OHM-IN	µOHM-M	Hard	PSI	N/mm²				Amp/in²	Amp/cm²
H170	0.0029000	74	80	3900	26.9	H	VL	2	70	10.9
H22	0.0007500	18	45	3000	25.6	M	L	2	70	10.9
H3	0.0003500	9	35	3500	24.1	M	VL	3	70	10.9
H23	0.0015000	37	70	4500	31.0	M	L	1	70	10.9
H24	0.0016000	40	55	4100	26.2	M	L	2	80	12.4
H25	0.0012000	30	65	5100	35.2	M	L	2	80	12.4
H27	0.0017000	43	65	3900	26.9	H	VL	2	80	12.4
H28	0.0018000	46	45	2600	17.9	M	VL	2	80	12.4
H34	0.0022000	55	75	4400	30.3	H	L	2	80	12.4
H35	0.0022000	55	50	2500	17.2	H	L	2	90	14.0
H36	0.0022000	55	70	3300	22.8	H	VL	3	80	12.4
H37	0.0018000	46	75	4400	30.3	H	VL	2	80	12.4
H38	0.0020000	50	80	5400	37.2	M	VL	2	80	12.4
H39	0.0016000	40	85	5400	37.2	H	VL	3	80	12.4
H41	0.0025000	62	60	3000	20.7	H	VL	3	80	12.4
H43	0.0018000	46	65	3700	25.5	M	L	2	90	14.0
H4399	0.0008000	20	45	4000	27.6	H	L	3	80	12.4
H44	0.0017000	42	85	5500	37.9	M	L	2	80	12.4
H4430	0.0022000	55	48	2500	17.2	VH	L	3	80	12.4
H45	0.0025000	62	55	3300	22.8	H	VL	3	80	12.4
H46	0.0010000	25	25	1500	10.3	M	L	2	80	12.4
H47	0.0025000	62	40	1500	10.3	H	L	2	80	12.4
H49	0.0025000	62	45	2000	13.8	H	L	2	100	15.5
H50	0.0021000	52	60	2900	20.0	M	L	2	90	14.0
H51	0.0022000	55	60	3200	22.1	M	VL	2	80	12.4
H52	0.0022000	55	60	2900	20.0	H	L	2	80	12.4
H524	0.0003800	10	35	3300	22.8	L	H	1	75	11.66
H55	0.0011000	27	50	3975	27.4	M	L	3	75	11.6
H57	0.0021000	52	50	2600	17.9	M	L	2	100	15.5
H60	0.0021	53	75	5300	36	H	VL	3	80	12.4
H61	0.0006000	15	30	1500	10.3	M	VL	2	75	11.6
H74	0.0030000	75	55	1800	12.4	H	VL	3	80	12.4
H76	0.0030000	75	65	2400	16.6	H	L	3	80	12.4
H77	0.0026000	65	40	1800	12.4	H	VL	3	80	12.4
H82	0.0016000	40	64	5000	38.6	M	L	2	80	12.4
H83	0.0017000	42	70	5000	20.7	H	L	2	80	12.4
H580	0.0003600	9	40	3700	25.5	M	L	1	100	15.5
HH	0.0006000	15	40	3000	20.7	L	L	1	75	11.6

Copper Graphite

Copper graphites have material contents of 15–95% copper or copper alloy. The added conductivity and lower voltage drop of the metals allows metal graphite brushes to perform well at very high current densities and low voltages.

Grade	Resistivity OHM-IN	Resistivity uOHM-M	Shore Hard	Strength PSI	Strength N/mm²	VD	CF	Film #	Rated Current Amp/in²	Rated Current Amp/cm²	Metal %
6H1	0.0002600	6.50	30	2700	18.6	M	L	1	100	15.5	30
6H2	0.0001200	3.00	30	3700	25.5	L	L	1	110	17.1	40
6H3	0.0000600	1.80	25	3200	22.1	L	L	1	120	18.6	50
6H6	0.0005000	9.70	35	2500	17.2	M	L	1	90	14	15
6H7	0.0000330	0.64	25	3400	23.4	L	L	1	130	20.2	65
6H8	0.0000130	0.33	22	4500	31.0	VL	L	1	140	21.7	75
H670	0.0001800	4.50	40	5100	35.2	L	L	2	110	17.1	40
H671	0.0002500	6.30	50	6000	41.4	L	M	1	110	17.1	30
H680	0.0000032	0.08	18	9300	64.1	L	L	1	150	23.3	87
H682	0.0000050	0.13	25	5100	35.2	L	VL	1	140	21.7	75
H692	0.0000027	0.07	18	8800	60.7	VL	L	1	160	24.8	90
H693	0.0000024	0.06	20	11500	80.0	VL	L	1	175	27.1	95
H4333	0.0001500	3.00	23	4000	27.5	VL	L	2	130	20.2	40
H4375	0.0003000	6.60	23	3000	20.7	VL	L	2	110	17.1	30
K025	0.0001400	1.80	25	3300	22.8	M	L	1	120	18.6	50
K045	0.0001100	2.80	25	4500	31.3	M	L	2	110	17.5	40
K075	0.0002600	6.60	25	4000	27.7	M	L	2	100	15.5	30
K076	0.0000200	0.50	13	13000	89.6	VL	L	1	175	27.1	91
K085	0.0001000	2.54	25	3300	22.8	M	L	1	125	19.3	50
K086	0.0000020	0.05	7	9000	62.1	VL	L	1	160	24.8	91
K106	0.0000040	0.10	8	6150	42.4	VL	L	1	150	23.3	85
K115	0.00004	1.02	10	4000	27.68	L	L	2	110	17.05	35
K126	0.0000000	1.80	7	7100	49.0	VL	M	1	200	31.0	95
K136	0.0000130	0.33	18	4800	33.1	VL	L	1	140	21.7	75
K165	0.00030	6.6	25	2500	17.2	L	L	2	110	17.1	43
K175	0.00016	4.06	45	5000	34.4	L	L	2	110	17.1	40
K176	0.000033	8.4	25	5000	34.5	L	L	1	130	20.2	65
K216	0.00010	2.54	20	4000	27.5	L	L	1	140	21.7	77.5
K236	0.0000200	0.50	20	9000	62.1	L	VL	1	150	23.3	85
K286	0.000015	3.00	5	6000	41.3	L	L	1	160	24.8	94

Silver Graphite

Silver graphites have material contents of 15–95% silver. The added conductivity and lower voltage drop of the metals allows metal graphite brushes to perform well at very high current densities and low voltages.

Grade	Resistivity OHM-IN	Resistivity uOHM-M	Shore Hard	Strength PSI	Strength N/mm²	VD	CF	Film #	Rated Current Amp/in²	Rated Current Amp/cm²	Metal %
H1260	0.0000080	0.160	20	5500	37.9	VL	L	1	160	24.8	75
H7052	0.0000022	0.055	10	6000	41.4	VL	L	1	200	31.0	91
K017	0.00005	1.27	20	3800	26.7	VL	L	2	140	21.7	50
K037	0.0000020	0.050	6	6000	41.4	VL	L	1	200	31.0	91
K047	0.0003000	7.600	25	4500	31.1	L	L	2	100	15.5	29
K087	0.00006	1.52	25	3500	24.1	VL	L	3	130	20.1	50

Fraction Conversion Chart

Fractional Inches to Decimal and Metric Equivalents

Fractions Inches	Decimal Inches	MM	Fractions Inches	Decimal Inches	MM
1/64	0.016	0.397	33/64	0.516	13.097
1/32	0.031	0.794	17/32	0.531	13.494
3/64	0.047	1.191	35/64	0.547	13.891
1/16	**0.063**	**1.588**	**9/16**	**0.563**	**14.288**
5/64	0.078	1.984	37/64	0.578	14.684
3/32	0.094	2.381	19/32	0.594	15.081
7/64	0.109	2.778	39/64	0.609	15.478
1/8	**0.125**	**3.175**	**5/8**	**0.625**	**15.875**
9/64	0.141	3.572	41/64	0.641	16.272
5/32	0.156	3.969	21/32	0.656	16.669
11/64	0.172	4.366	43/64	0.672	17.066
3/16	**0.188**	**4.763**	**11/16**	**0.688**	**17.463**
13/64	0.203	5.159	45/64	0.703	17.859
7/32	0.219	5.556	23/32	0.719	18.256
15/64	0.234	5.953	47/64	0.734	18.653
1/4	**0.250**	**6.350**	**3/4**	**0.750**	**19.050**
17/64	0.266	6.747	49/64	0.766	19.447
9/32	0.281	7.144	25/32	0.781	19.844
19/64	0.297	7.541	51/64	0.797	20.241
5/16	**0.313**	**7.938**	**13/16**	**0.813**	**20.638**
21/64	0.328	8.334	53/64	0.828	21.034
11/32	0.344	8.731	27/32	0.844	21.431
23/64	0.359	9.128	55/64	0.859	21.828
3/8	**0.375**	**9.525**	**7/8**	**0.875**	**22.225**
25/64	0.391	9.922	57/64	0.891	22.622
13/32	0.406	10.319	29/32	0.906	23.019
27/64	0.422	10.716	59/64	0.922	23.416
7/16	**0.438**	**11.113**	**15/16**	**0.938**	**23.813**
29/64	0.453	11.509	61/64	0.953	24.209
15/32	0.469	11.906	31/32	0.969	24.606
31/64	0.484	12.303	63/64	0.984	25.003
1/2	**0.500**	**12.700**	**1**	**1.000**	**25.400**

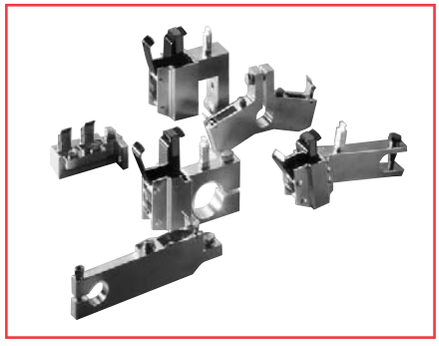
For Inch conversion multiply (mm) x .03937 = Inches

Metric Conversion Chart

Millimeter to Inch Equivalents

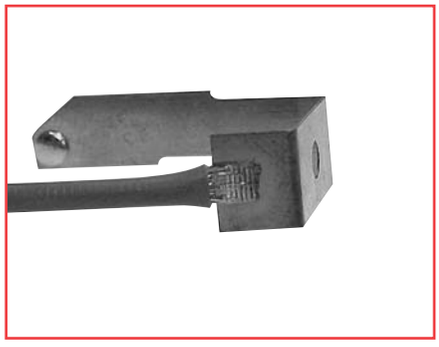
MM	Inches	MM	Inches
10	0.394	51	2.008
11	0.433	52	2.047
12	0.472	53	2.087
13	0.512	54	2.126
14	0.551	55	2.165
15	0.591	56	2.205
16	0.630	57	2.244
17	0.669	58	2.283
18	0.709	59	2.323
19	0.748	60	2.362
20	0.787	61	2.402
21	0.827	62	2.441
22	0.866	63	2.480
23	0.906	64	2.520
24	0.945	65	2.559
25	0.984	66	2.598
26	1.024	67	2.638
27	1.063	68	2.677
28	1.102	69	2.717
29	1.142	70	2.756
30	1.181	75	2.953
31	1.220	80	3.150
32	1.260	85	3.346
33	1.299	90	3.543
34	1.339	95	3.740
35	1.378	100	3.937
36	1.417	105	4.134
37	1.457	110	4.331
38	1.496	115	4.528
39	1.535	120	4.724
40	1.575	125	4.921
41	1.614	130	5.118
42	1.654	135	5.315
43	1.693	140	5.512
44	1.732	145	5.709
45	1.772	150	5.906
46	1.811	155	6.102
47	1.850	160	6.299
48	1.890	165	6.496
49	1.929	170	6.693
50	1.969	175	6.890

Carbon Brushes
Industrial, Fractional, Molded and Metric

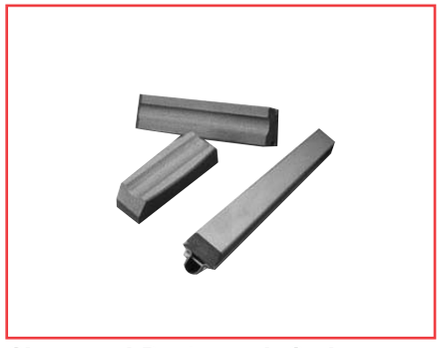


Brush Holders

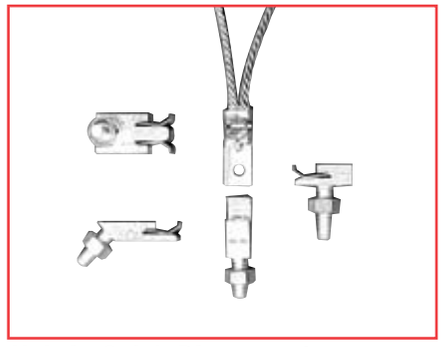
Spring Clips



Cable and Ultrasonic Welding



Shoes and Pantograph Carbons



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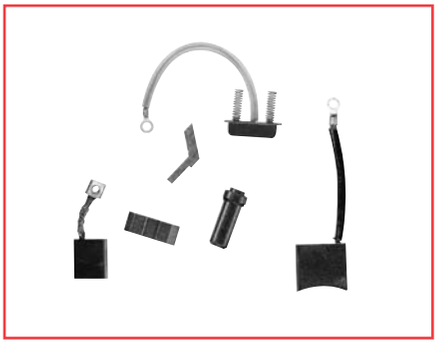

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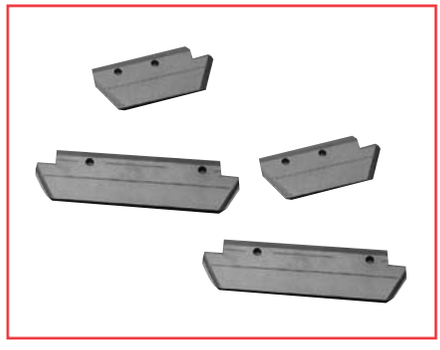

Sliding Contacts