



易卡朋

工业电机及发电机用碳刷

Carbon Brush for Industrial Motors and Power Generators



四川易卡朋科技有限公司
Sichuan ECC Sciotech Co., Ltd

易卡朋科技简介

四川易卡朋科技有限公司（原成都易卡朋电碳有限公司）成立于2016年，是一家专业从事电碳产品研发与制造的国家高新技术企业，在成都、雅安、自贡分别建成了研发和生产基地。同时与德国SGL、GERKEN以及PANTRAC公司建立了长期友好的战略合作联盟，按照欧洲标准和国家铁路标准生产，方便快捷地为国内外客户提供国际一流的高品质电碳产品。

主要产品：

*碳滑板、导电靴：用于高铁动车、电力机车、地铁、市域轻轨等轨道交通领域所用受电弓碳滑板、包括用于第三轨、单轨、无轨电车、无人驾驶轻轨以及行车等

*接地电刷：用于高铁动车、电力机车的接地装置中

*轮缘润滑器、轮缘润滑块：用于高铁动车、电力机车的轮缘润滑系统

*风电碳刷、刷架：风力发电机碳刷、接地碳刷、防雷碳刷、变桨碳刷

*工业电机碳刷、刷架：用于火电、水电以及核电等行业

*导电触头、导电滑块：用于工业自动化装备系统

2016年9月，公司获得了ISO9001:2008质量体系认证

2020年6月，取得环境管理体系ISO14001:2015认证取得职业健康安全管理体系ISO45001:2018认证

请浏览我们的网址www.ecc-carbon.com

Company profile of ECC

Sichuan ECC Carbon (formerly Chengdu ECC Carbon) was established in 2016, is a national high-tech enterprise specializing in the research and development and manufacture of electric carbon products, and has built R&D and production bases in Chengdu, Ya'an and Zigong respectively. At the same time, it has established a long-term friendly strategic cooperation alliance with German SGL, GERKEN and PANTRAC companies, and produces according to European standards and national railway standards, so as to provide world-class high-quality electric carbon products for domestic and foreign customers conveniently and quickly.

Main products:

- various carbon brushes for industrial DC motors and power generators for wind turbine, thermal power, hydroelectric and nuclear power
- carbon current collectors for pantograph of rail transportation including the conductive shoes be used for the 3rd rail, mono-rail, trolley bus, compute driving light rail and cane
- carbon brushes for grounding device of EMU, electric locomotive and subway
- carbon contacts for industrial assembly line
- Lubrication bars for wheel flange

ECC have been certified with ISO 9001 :2008 since Sept. 2016. ISO1400: 2015, ISO45001: 2018 since Sept. 2020

Kindly view our web page at www.ecc-carbon.com



电刷——电机里十分重要的传输电流的功能部件

Carbon Brushes-Very Important Functional Parts of Carrying Current in Electrical Machines

“碳刷”这一名称来源于人们用碳石墨材料取代了铜丝束的铜刷，在电气工业发展初期它被用作具有弹性的接触导电部件。碳刷虽已被用了几十年，但即使是在今天的微电子时代，它仍然是直流电机或是滑环电机领域不可或缺的硬件。

碳刷（Carbon Brush）也叫电刷，作为一种滑动接触部件，它的主要作用是在与金属对磨面的滑动接触的同时，导入或是导出电流。它不象金属对金属滑动接触导电时那样，两者摩擦增大的同时，会导致温升进而将接触部位烧结在一起。而碳刷则不会，因为碳和金属是两种不同的元素且碳刷具有很好的传热，导电和润滑的性能。碳刷是电动机或发电机或其他旋转机械的固定部分和转动部分之间传递能量或信号的重要组成部分，外型一般是方块状，放置在金属刷架里，上面有弹簧把它紧压在整流子或是滑环上，电机转动的时候，将电能通过换相器输送给线圈。碳刷是易磨损的部件，应定期维护更换，并清理积碳。



电刷的生产工艺和技术可为电刷带来丰富的物理特性以及应用的可能性。按照德国DIN IEC 60276 标准，我们把我们的碳刷分成5大类：

- 电化石墨电刷
- 金属石墨电刷
- 树脂粘结石墨电刷
- 碳石墨电刷
- 天然石墨电刷

The production parameters permit a wide variation of the physical characteristics and the application possibilities. Following DIN IEC 60276 we subdivide our carbon brush grades into 5 main groups:

- Electrographite brushes
- Metal graphite brushes
- Resin bonded graphite brushes
- Carbon graphite brushes
- Graphite brushes

碳刷、材料及其附件的德国标准

German Standards for carbon brushes, material and accessories

以下是工业电刷和机车牵引碳刷最重要的德国标准。

Below are given the most important standards for industrial and traction carbon brushes.

- DIN IEC 60136-3 电机用电刷与刷握的几何尺寸
Dimensions of brushes and brush-holders for electrical machinery.
- DIN EN 60276 碳刷、刷握、整流子以及滑环的定义和术语
Definitions and nomenclature for carbon brushes, brush-holders, commutators and sliprings.
- DIN IEC 60413 电机用电刷材料的物理性能的测试方法
Test procedures for determining physical properties of brush materials used for electrical machines.
- DIN IEC 60467 电机用电刷物理性能的测试方法
Test procedures for determining physical properties of carbon brushes for electrical machines.
- DIN 43021 牵引电机用碳刷、几何尺寸和公差
Carbon brushes for traction motors. Dimensions and tolerances.
- DIN 46224 碳刷刷辫的填塞
Stamped cable sockets for flexibles of carbon brushes.
- DIN IEC 60760 平插式接头
Flat plug contacts.
- DIN 46438 铜刷辫
Copper flexibles.

碳刷的尺寸与设计

Dimensions and Design of Carbon Brushes

t=切向 整流子或者滑环转动方向的电刷尺寸
tangential Brush dimension in direction of rotation of commutator or slipring

a=轴向 平行于转动轴的电刷尺寸
axial Brush dimension parallel to the axis of rotation

r=径向 垂直于转动轴的电刷尺寸
radial Brush dimension perpendicular to the axis of rotation

按照DIN IEC 60136-3标准，碳刷的尺寸是按 $t \times a \times r$ 规定的顺序标注的。为了避免误解，我们建议按此顺序确定电刷尺寸。

刷辫的截面积按照以上标准以及DIN 46438执行。

刷辫的长度(l)为电刷顶部到末端中心的距离（见示意图）。

在订购特殊接头（如插口接头）电刷时，刷辫的长度就要按该示意图标明。

DIN 46224标准提供了电刷接头的基本类型以及标准尺寸的参考值。

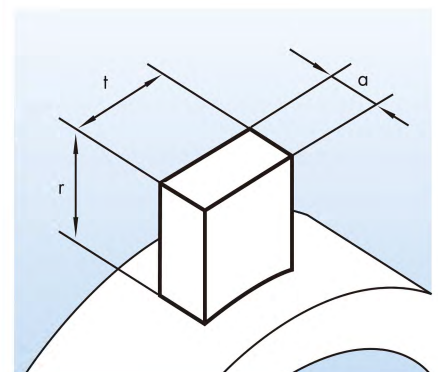
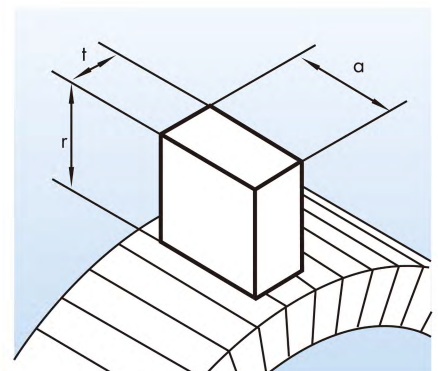
Dimensions of carbon brushes are specified according to DIN 43000-1 and DIN IEC 60136-3 in the sequence $T \times a \times r$. In order to avoid misinterpretation we suggest to specify the dimensions in this sequence.

The cross section of the flexible is determined according to DIN 46438 and DIN 43003-1.

The length (l) of the flexible is the distance between the top of the brush and the center of the terminal (see sketch).

When ordering brushes with special terminals (e.g. plug-contact) the length (l) of the flexible should be measured in accordance to the sketch.

In standard DIN 46224 are given recommendations for basic types and standards for dimensioning of plug types.



电刷的尺寸及设计

Dimensions and Design of Carbon Brushes

单体电刷 Solid brushes

这是一款最简单的电刷类型，它通常用于无电气和/或机械整流问题的电机上。（见右图1）

The simplest type of brush used on machines without electrical and/or mechanical problems.

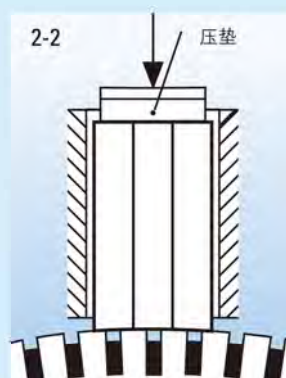
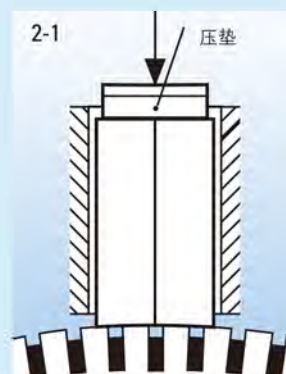
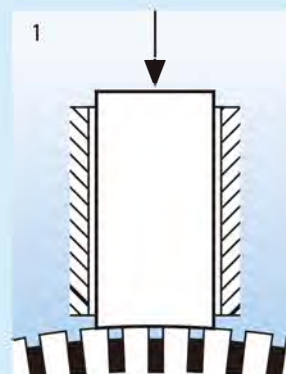
分瓣电刷 Split brushes

单体电刷通常相对较重和比较具有刚性，将其切割成两瓣或三瓣组合成一体，从而形成一个更好的电气机械接触环境。首先电刷的分体会使电刷表面和整流子之间形成大量的电气接触点，电刷刷体之间额外的接触电阻也会增加电刷横向电流的电阻。分割电刷的刷体具有更小的加速力，从而使刷体获得更好的动态性能。（见右图2-1）

分瓣电刷尤其是在往复运行电机上，显示出更为满意的使用效果，这是因其能更快适应工作运行的表面。此外，刷体顶端的橡胶压垫或以上二者的共同作用能让刷体所受的压力均匀分配以及具有更好的减震能力。（见右图2-2）刷体的切向尺寸由于机械原因不能小于4毫米。

The solid brushes which are relatively heavy and rigid are cut into 2 or 3 parts of equal size in order to create better electrical and mechanical contact conditions. First, the cutting of the brush leads to a large number of electrical contact points between the brush surface and the commutator; it also increases the resistance in the transverse circuit of the brush because of the additional contact resistance between the brush parts. The cutting of the brush causes smaller acceleration forces over the brush parts which enables better dynamic properties. Split brushes give satisfactory results mainly on machines with reversing operations, since there is a faster adaptation to the running surface.

In addition tops made of rubber, laminate, or both cause a uniform pressure distribution as well as a bigger damping ability. The tangential dimension of the brush parts has to be not less than 4 mm for mechanical reasons.



电刷的尺寸及设计

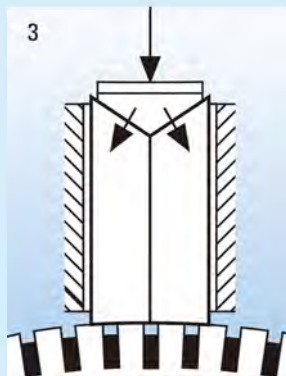
Dimensions and Design of Carbon Brushes

扩展电刷 Spread brushes

是一种特殊类型的分瓣电刷，其两瓣顶部被倒成一定角度的斜面。顶部的压力通过压垫与倾面传到电刷，通常压垫是由碳刷本体材料或是具有减震效果的绝缘材料制成。（见左图3）

The spread brush is a special type of split brush the top of which are chamfered at a certain angle towards their dividing line. Pressure to the brush is applied Via a top piece with accordingly chamfered bottom face.

The top pieces are generally made from brush or insulation material that has a cushioning effect.

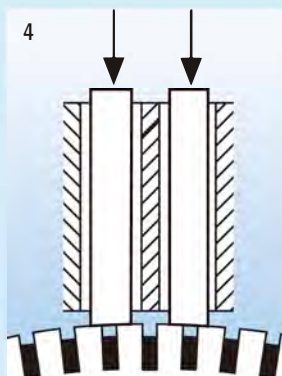


串联电刷 Tandem brushes

串联电刷是一种特殊的配对电刷，每个电刷在串联刷握内形成一个自身的匣子，并被分隔的压力指施压于整流子。这样会使电刷具有对称的压力和均匀的电流分布。（见左图4）

Tandem brushes are special pairs of brushes, where each brush has its own box within the tandem brush holder, pressed against the commutator by separate pressure fingers.

The result is a symetrical brush pressure and current distribution.



电刷的尺寸及设计

Dimensions and Design of Carbon Brushes

三明治电刷 Sandwich brushes

把分瓣电刷的各个刷体粘结组合在一起就称为三明治电刷。粘结层可以是绝缘材料。从机械上看，这也是一种整体电刷，只是由于增加了粘结层会使电刷对整流子具有更好的抛光效应；而从电气上看，电刷自身也增加了截面电阻。使用不同的单片电刷材料，就能调节整体碳刷的整流性能。（见左图5）

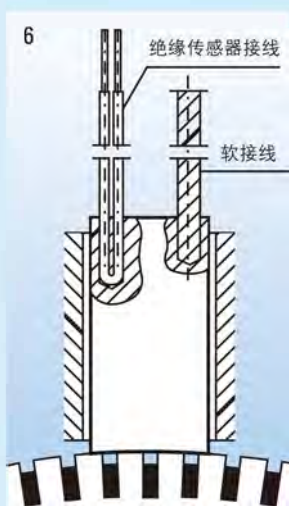
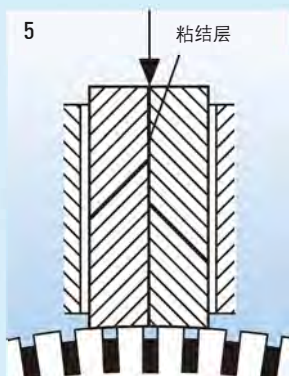
When the segments of split brushes are bonded together they are called sandwich brushes. The bonding layer can be of an insulating material. From a mechanical point of view this is now a block brush with an additional polishing effect caused by the bonding layer. From an electrical point of view the brush has an increased cross resistance. By using different rush materials for the single wafers it is possible to influence the commutation properties of the carbon brush.

带磨损传感器的碳刷 Carbon brushes with wear sensor

带磨损传感器的碳刷在达到磨损极限时会自动给出报警信号，这能减少维护监控。一个绝缘的信号线粘结在碳刷体内。当碳刷因磨损而磨穿接触绝缘体时，传感器就会发出警告提示。该报警信号可以进行电气评估，并给出声光记录。（见左图6）

Carbon brushes with wear sensors signal when the wear limit is reached and enable a lower maintenance supervision. An insulated sensor cable is glued in the carbon brush and the warning occurs when the insulation of the contact is worn down through the wear of the carbon brush.

The warning is electrically evaluated and optically and acoustically recorded.



碳刷的安装与操作指南



整流子与滑环的加工

Commutator and slipring machining

一个新的或者修复的整流子，其不圆度不应超出0.02mm。相邻整流片之间的凸起误差不超过0.002mm。不容许有平面点出现。根据使用条件和电刷材料的不同，通常情况下如果长波不圆度超过0.3mm、短波不圆度超过0.15mm时，电机转子就需要进行维修。左图下。

在扇形铜片与云母直接构成的整流子上需要硬质电刷，其结果是增加了整流子的磨损，为了延长其使用寿命，有必要下切整流片。

新的整流子的表面粗糙度应为Rz 4–8 μm

A new or reconditioned commutator should have an out of roundness of not more than 0.02 mm and lamination protrusions between neighbouring laminates over 0.002 mm and the flat points must be eliminated. In dependence on the application conditions and the carbon brush material, the rotors should be reconditioned in case of longwave unroundness of more than 0.30 mm and short-wave unroundness of more than 0,15 mm. Commutators with flush mica requires very hard brush material with the consequence of high commutator wear For a better lifetime it is necessary to undercut the insulation (see sketches).

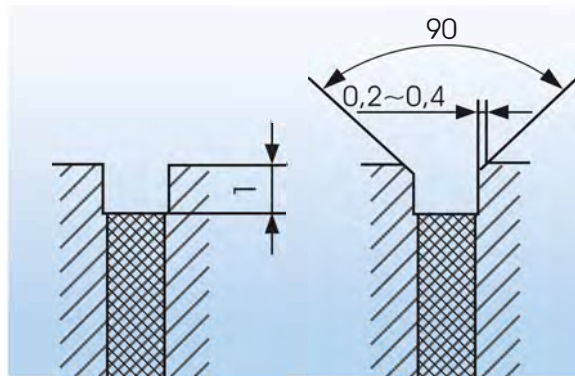
A new commutator should have a surface of roughness Rz between 4 and 8 μm.

以下是正确的电流传输与无火花整流所具备的条件：

- 整流子的同圆度好
- 无整流片的凸起
- 整流子上无平面斑点
- 整流子绝缘体有正确的对称底切以及整流片的倒角
- 整流子或者滑环表面有很轻微的粗糙度
- 电刷所受的弹簧压力均匀
- 电刷与整流子或者滑环表面的位置配合好

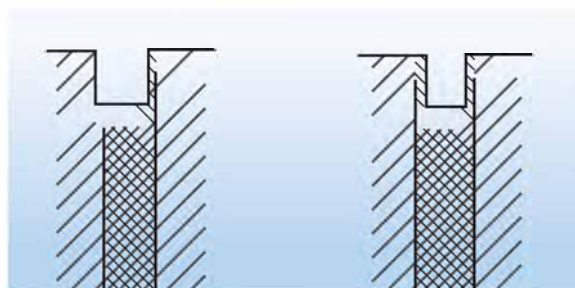
Here are the required conditions for perfect current carrying and for black commutation:

- good roundness of the commutator
- no lamination protrusions
- no flat points on the commutator
- a symmetrical undercutting of the commutator insulation, and chamfered laminate edges
- very slight roughness of the commutator or slipring surface
- uniform brush pressure
- good seating of the brushes to the commutator / slipring surface.



下切至正确的宽度和深度
Undercut to the correct width and depth

正确下切和倒角
Undercut and bevelled correctly



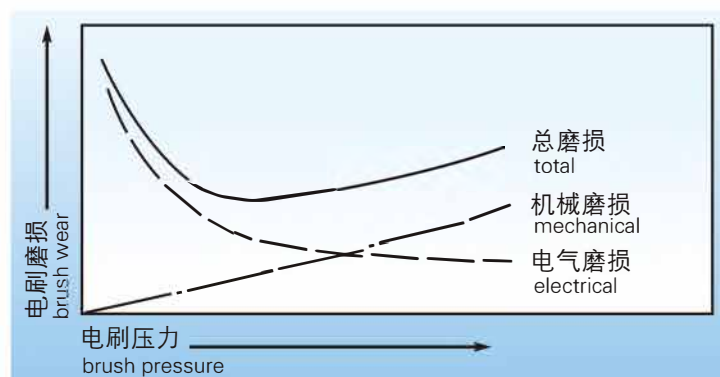
下切太薄（错误）
Too thin an undercut (wrong)

下切不够（错误）
Offset undercut (wrong)

电刷压力 Brush pressure

电刷压力必须调整到适合其运行的条件，也必须在电气和机械磨损之间取得平衡。

The brush pressure must be set to the operating conditions. It must also represent a compromise between the mechanical and electrical wear.



电刷压力推荐值 Recommendations for brush pressure

电机类型 Type of machine		电刷压力 (kpa) Brush pressure in kpa	
		安装 Mounting	
		固定电机 stable	移动电机 swing frame
1500 rpm 以下直流电机	DC machines up to 1500 r.p.m	15–20	20–30
1500 rpm 以上直流电机	DC machines over 1500 r.p.m	20–25	25–35
三相整流电机	Three-phase commutator machines	18–20	25–30
滑环电机	Slipring motors	20–25	25–35
汽轮发电机	Turbo generators	15–25	–
牵引电机	Traction motors	–	30–50

电刷压力的公差应限制在 $\pm 10\%$

The tolerance of the brush pressure should be limited to $\pm 10\%$



电刷的装入

Bedding in of carbon brushes

电刷嵌入后，电刷与滑环或整流子就形成了交界面。以下是常用的几种嵌入技术：

1. 电刷安放在刷握内，用磨条带（推荐用粒度80–100目的砂纸）在电刷和整流子或滑环之间擦拭。磨条带沿切向方向拉擦，当电刷的工作面获得了象整流子或者滑环表面的形状后，磨条带按照电机转动方向拉动，从而完成磨弧。为了退出磨条，电刷必须抬起来，这样才能保证今后电机运行时电刷在刷握里保持相同的位置。

2. 磨条带安放在整流子或者滑环上，并用胶带固定。然后把电刷放在刷握里，在启动电机转子，沿工作方向转动（尤其是小型电机）。（下图左）

3. 电机全部安装好碳刷后，开动起来空转（尽量低速转动）。把磨石压在整流子上碳刷的前面，产生浮石粉尘，直达电刷，并研磨电刷的工作面。这种研磨方法尤其适用于大型直流电机。当电刷与整流子或者滑环的接触面达到70%时，电刷的装配就算完成了。此后再把碳刷从刷握里取出来，用无油压缩空气清洁电机。（下图左）

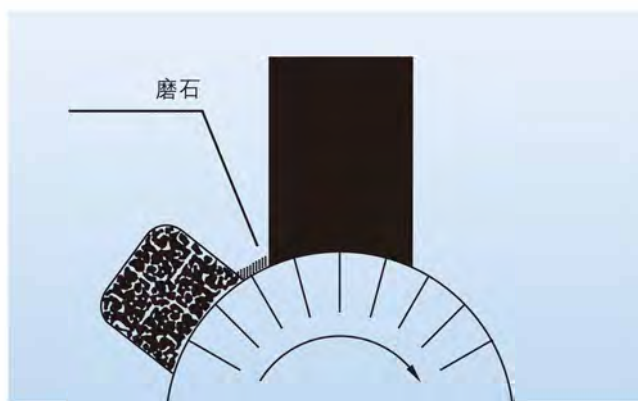
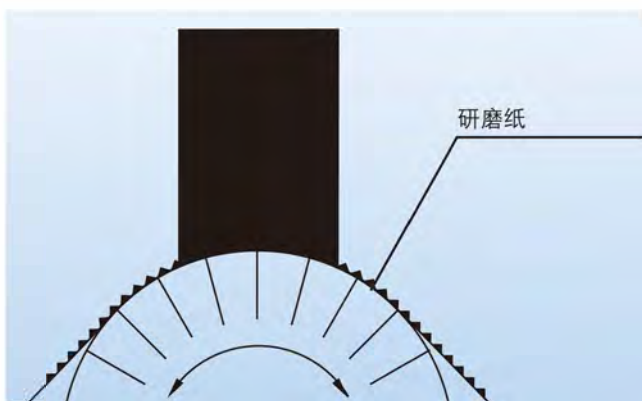
The interface of brushes to the slipring or commutator surface occurs with the bedding in of the brushes. Herewith are several techniques used:

1. The carbon brushes are placed in the brush holder. A strip of abrasive linen (for instance a granulation 80–100) is pushed between the brush and the surface of the commutator or slipring: This strip is drawn in a tangential direction.

After that the running surface has approximately taken the shape of the commutator or slipring's surface the contact means is drawn in the direction of rotation of the machine to finish the grinding. In order to withdraw the abrasive linen, the brushes have to be raised. In this way, it is guaranteed that the brushes take the same position in the brush holder as in the future operation of the machine.

2. A strip of abrasive linen is fitted around the commutator or slipring, and fixed with adhesive tape. Then the brushes are placed in the holder and the rotor of the machine is turned over in the operating direction.

3. The machine is completely equipped with carbon brushes and it is put into operation in idle running (possibly with a reduced speed of rotation). A pumice stone is pressed in front of the brushes on the commutator. The dust of the pumice stone which results reaches the brushes and grinds them in. This method of grinding is particularly suited to large DC machines. The bedding in can be finished when about 70 % of the running surface has contact with the commutator/slipring. After the bedding in the carbon brushes have to be taken away from the holder and the machine has to be cleaned by means of oilfree compressed air.

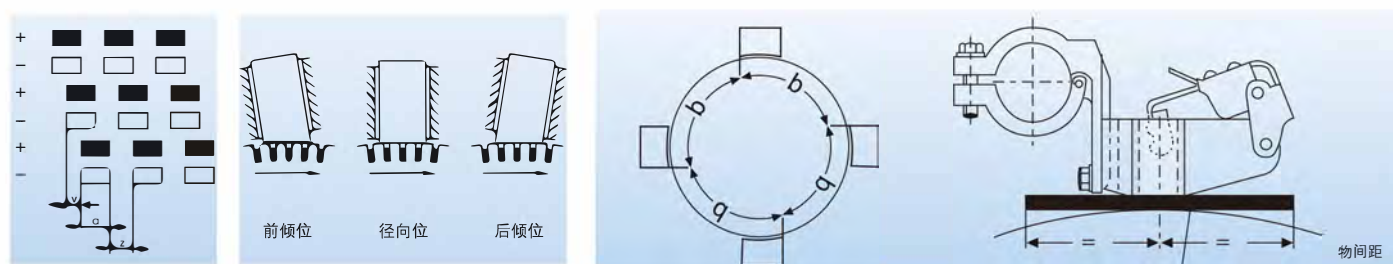


注意：粉尘千万不得进入线圈或者电机轴承。碳刷也必须用清洁布擦干净（无油或者油脂）。为了防止侵入粉尘，还得用毛刷清洁它们的工作表面。

Attention: the dust must not reach the coil or the machine bearing. The carbon brushes have to be cleaned with a clean rag (without oil or fat) and their running surface have to be cleaned by means of a glass brush in order to avoid infiltrated grains.

刷握与电刷的安装

Mounting of brush holders and brushes



为了确保电刷的正常运行，按照电枢与线圈的设计，刷握和电刷必须精确地安放在整流子上，比如不同极性电刷之间的距离必须相等。为了确保这一点，把一条纸带放在电刷下整流子上，这样不同极性电刷的印记就可以正确测量。纸带就可以用做以后检查各个电刷位置的记录。不同极性电刷之间的距离即使相差小到0.5mm，也会造成整流与电流均匀分布的困难。

整流子与刷盒底端之间的距离设定在1.5–2.0 mm之间。若整流子做了维修，那么刷握也要重新排定，并保持其底端与整流子表面的这个间距。刷握的排定要用定距块一同完成。

如果刷握底端正与整流子表面之间的距离太大，电刷会以更大的角度倾斜，从而导致电刷在运行时出现震动。直流电机上应将正负极的电刷安装在相同的轨迹上，以确保产生的绿铜不会受到在正负极上电刷的不良影响。在有更多极性的电机上，电刷应沿整流子轴线方向上错列安放，以便让整个整流子保持均匀的磨损。

如果整流子足够长，最好的错列安放如下：

上左图

$$v = z = a / (p - 1)$$

v = 间隔

z = 同极电刷之间的距离

a = 电刷的轴向尺寸

p = 电刷极对数量，即电机极性数量的一半

电刷在整流子的装配无论是在径向上还是按一定角度上都必须精确，按照整流子转动的方向，后者又被称为曳尾位或反向位。曳尾位或反向位也可起到减少震动的作用。

(上中图)

To ensure correct operation of brushes, the holders and brushes must be fitted exactly geometrically on the commutator in accordance with the design of armature and windings, for instance the distance between brushes of different polarities must be equal. To make certain that this is the case, a strip of paper is put around the commutator under the brushes, and the distance between the impressions of the brushes of each pole can then be measured correctly. This strip of paper can be used as a record for checking the positions at a later stage. A variation of as little as 0.5 mm between the brushes of different polarities can cause considerable problems with regard to commutation and current distribution.

The distance between the commutator and the lower edge of the brush box should be set at between 1.5 and 2.0 mm. If the commutator has been remachined, the brush holders will have to be reset to maintain this distance. The setting of the brush holders should be done with a distance piece.

If the distance between the brush holder and commutator is too high, this can lead to brush vibration because the brush will be tilted at a greater angle. On DC machines brushes should be installed in the same track for each pole pair. This ensures that the patina being built is not adversely affected by the brushes on the plus and on the minus poles. On machines with high number of poles, the brushes will be staggered across the commutator axially so that there is even wear across the commutator. If the commutator is long enough, the best stagger arrangement would be as follows:

$$v = z = a / (p - 1)$$

v Stagger

z Distance between brush pair of same polarity

a Axial brush dimension

p Number of brush pole pairs, i.e. half the number of poles of the machines.

The fitting of brushes on the commutator must be carried out either exactly radial or at a certain angle, which is then called either a trailing or a reaction position, according to the direction in which the commutator rotates.

The trailing and reaction position are used in order to reduce vibrations.

电刷使用效果的评估

Assessment of Performance of Carbon Brushes

电刷工作面外观 Appearance of the brush sliding face

以下照片显示了电刷工作面的典型情形。为方便起见，我们建议你选用S1，S3等电刷。S1，S3和S5是令人满意的碳刷工作面，表明其没有机械或电气问题。视电刷的材料而定，显示出密实，疏松，光亮，暗淡或是略显粗糙。如果空气中出现粉尘则电刷工作面会出现如S5所示的细纹。

The following pictures show typical brush-sliding faces. For easy identification we suggest you to use the symbols S1, S3 etc. S1, S3 and S5 are satisfactory sliding faces, indicating that there are no mechanical or electrical problems. Depending on the carbon material the sliding surface appears dense or porous, and shiny, dull or matt. If there is dust in the circulating air fine hairlining may occur as shown in S5.



S1 密实，光亮的工作面
运转正常

S1 Dense, shining sliding face
Normal operation



S3 轻度疏松的工作面
运转正常

S3 Slight porous sliding face
Normal operation



S5 细纹工作面
运转正常，受少量粉尘影响

S5 Fine hairlining
Normal operation, slight dust influence



S7 带纹路面
原因：负载不足，受粉尘或油脂的影响

S7 Hairlining
Causes: Underloaded, influence of dust, oil or grease



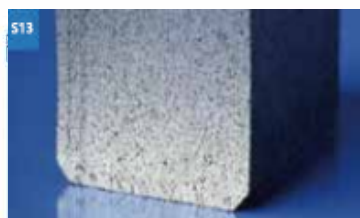
S9 带纹路与沟槽面
原因：如S7，但后果更严重

S9 Tracking with hairlining and grooves
Causes: Like S7, but stronger



S11 叠痕，整流困难
原因：中性区或整流极位置不正确引起整流困难

S11 Ghostmarks, difficult commutation
Causes: Commutation problems, e.g. false or incorrect position of the neutral zone or interpole



S13 滑入或滑离边缘烧蚀
原因：整流困难，火花大，整流子失圆或刷握弹簧压力不够造成电刷与整流子的断续接触。

S13 Burning edge of the leaving or trailing edge
Causes: Difficult commutation, heavy sparking, interruption of contact due to out of round of commutator or insufficient brush holder spring pressure



S15 蚀痕工作面
原因：电气过载，接触断续

S15 Eroded brush face
Causes: Electrical overload, interruption of contact



S17 分层工作面
原因：绕线故障引起整流时电压冲击，从而烧蚀工作面

S17 Lamination of sliding face
Causes: Burned segments of the sliding face caused by a winding fault giving voltage surge during commutation



S19 分瓣电刷出现双重工作面
原因：双向电机上电刷出现倾斜

S19 Double facing here for a twin brush
Causes: Tilting of the brush in dual direction machine



S21 出现滑垢
原因：铜霄粘连，常接着发生拉铜现象

S21 Copper nests
Causes: Pick up of copper particals, often following copper drag



S23 刷体破损
原因：整流片突起，整流子严重失圆，轻载或空载引起电刷震颤

S23 Broken edges
Causes: High raised lamination, commutator seriously out of round, brush chatter by low load and idle running

整流子的外观

Commutator appearance

除了整流子的物理外观表象外，对于碳刷的良好运行，整流子的表面和其氧化膜同样重要。在合适的运行环境下每个碳刷都会形成各具特色的氧化膜。氧化膜主要包括铜氧化物，石墨沉积物以及吸附的潮气，其外观对于评估整套整流子的运行特性是非常重要的。

下图为整流子表面的典型外观。这些照片成为碳刷生产厂家和用户判断碳刷运行的准则。

In addition to the physical appearance of the surface of the commutator, the skin or patina is of equal importance for the good running of the carbon brushes. Each carbon brush builds a characteristic patina which is affected by operating and ambient conditions. The patina consists mainly of copper oxides, graphite deposits and absorbed water, and its appearance is of importance for the assessment of the running behaviour of the commutation set.

The following pictures show typical appearances of commutation surfaces. The pictures are used by carbon brush manufacturers and users of brushes as a guide to assist in judging the operation of carbon brushes.



P2, P4和P6为整流子正常表面和氧化膜形成的实例。电机运行正常时，整流子表面和氧化膜是均匀的，稍微光亮，颜色从铜棕色到黑色也有可能是灰色，蓝色和红色，但重要的是表面氧化膜形成的均匀性，而不是其颜色

P2, P4 and P6 are examples of normal skin or patina formation. When a machine runs well, the patina or skin on a commutator will be even, slightly shiny and coppery brown to black in colour. There may be appearance of greyish, bluish and reddish hues, but of importance is the evenness of the skin formation and not its colour



电气、机械和气氛对氧化膜外观的影响 Electrical, mechanical and atmospheric influences on the patina appearance

P12条纹状氧化膜有宽窄不一、颜色不同的痕迹。无整流子磨损

原因：湿度高，油蒸气，腐蚀性气体，电刷的电气载荷低

P12 Streaky patina having some wide and narrow tracks of different colour. No commutator wear
Causes: High humidity, oil vapour, aggressive gases in the atmosphere, low electrical load on the brushes

P14间断的氧化膜滑痕，典型外观见P12，但整流子损坏
原因：如P12所示，但运行的时间更长，造成整流子损坏

P14 Torn patina, general appearance as in P12, but with arrow tracks and commutator wear
Causes: As in P12, but the conditions have been maintained for a longer period causing commutator damage



P16黑色的氧化膜，不均匀的色斑呈随机分布
原因：不均匀的整流子或不干净的运行条件

P16 Smutty patina, uneven skin having patchy colours and random spots
Causes: Uneven commutator or unclean operating conditions



P22黑色氧化膜，有规则或不规则的色斑出现在一个或多个整流子片上

原因：整流子同圆度不好，或因主轴调整不好或轴承损坏引起的电机振动。

P24黑色斑状氧化膜，出现典型的花边如图T12和T14所示

原因：整流子片表面突起，或成片的整流子片凸起从而引起电刷跳动

P22 Patina with dark areas, regular or irregular patches covering one or more commutator segments

Causes: Out of round commutator, vibrations of the motor caused by badly adjusted shaft or damaged bearings

P24 Dark patchy patina having definite edges as in T12 and T14
Causes: Raised segment or group of segment causing the brush to bounce



P26整流子片在中间或边缘有色斑

原因：通常是由于整流子的错误磨削或整流困难

P28汇流条中部或两侧污损

原因：同P26，整流问题

P26 Commutator segments having patches in the middle or at the edges
Causes: Often due to faulty grinding of the commutator

P28 Central or lateral bar stains. Shadows in the centre of the bar or at either edge
Causes: See P26, commutating problems



P42光亮和暗淡状条纹交替出

原因：双绕线绕过同一凹槽引起两排平行绕线上的电流分布不均匀

P46双极出现粗糙斑

原因：通常是错误焊接了竖片或者整流片连接体

P42 Alternating light and dark bar markings
Causes: Uneven current distribution over two parallel windings caused by double windings crossing in the same slot

P46 Mat patches in double pole pitches
Causes: Usually by faulty soldering of the risers or segment connections

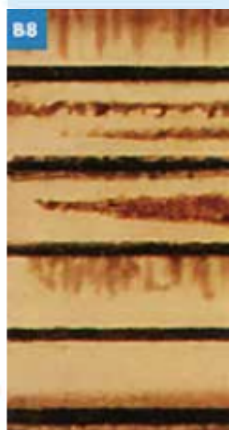
整流子的外观

Commutator appearance



B2, B6, B8 汇流条的边缘或中间出现烧蚀条纹
原因: 整流困难引起的火花

B2, B6, B8 Burning at the edge or in the middle of bar
Causes: Sparking caused by commutation problems



B10 孔状氧化膜, 光亮、密实或呈点状分布
原因: 电阻太大导致氧化膜的破坏

B10 Perforated patina, light, dense or distributed buildup spots
Causes: Patina destruction caused by too large electrical resistance



T10 汇流条沿转动方向边缘出现黑色斑
原因: 通常是由于电机无电长期停机或负载不足短时停机引起的

T10 Dark patches at edges of bars in direction of rotation
Causes: Frequently caused by long periods with the motor being stationary without power or short stationary periods under load

T12 在一汇流条的滑出端和下一汇流条的滑入端边缘出现烧蚀条纹
原因: 整流子片出现突起引起 (见L2)

T12 Burning of a trailing edge and the next leading edge of a bar
Causes: Caused by protruding segment as in L2



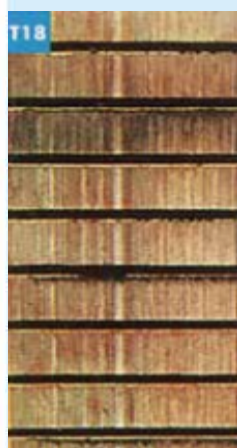
T14暗黑斑纹
原因：整流子片下切，也有可能是整流子平面点造成的

T14 Dark markings
Causes: Sign of a low segment, could also be caused by a flat spot on the commutator



T16明显的暗黑斑纹并带有整流子边缘烧蚀
原因：云母突起（见L6）

T16 Clearly defined dark markings together with segment edges burnt
Causes: Raised mica (see L6)



T18暗黑的斑纹
原因：整流子片边缘下切（见L8）

T18 Dark markings
Causes: Badly undercut segment edges (see L8)



整流子的磨损 Commutator wear

R2从整流子顶部看
原因：电刷安放正确，长期运行后造成的金属正常磨损

R2 Top view of a commutator
Causes: Trackwise normal metal abrasion after long period of operation with correctly positioned brushes

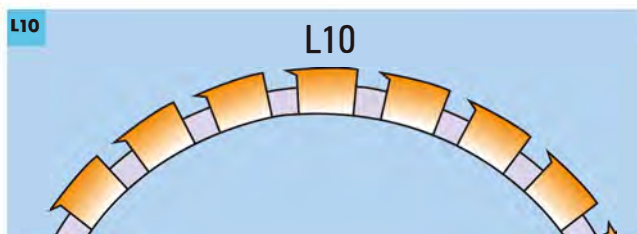
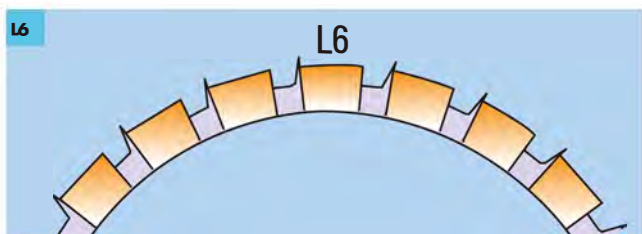
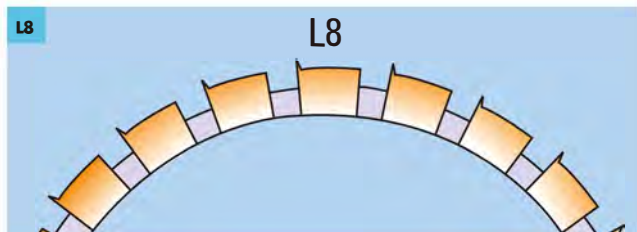
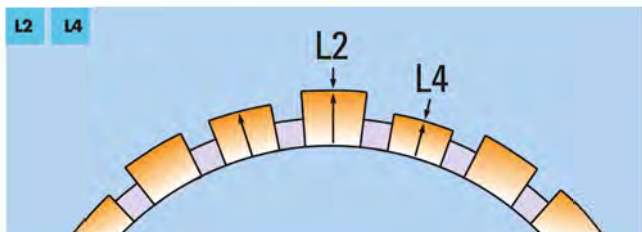


R4整流子的汇流条显示异常的金属磨损
原因：错误的电刷排位、不合适的电刷材料或者污染等引起的异常磨损

R4 Commutator bar showing abnormal metal abrasion
Causes: Abnormal abrasion is caused by incorrect brush alignment, inadequate brush material or contamination

整流子的外观

Commutator appearance



L2-T12 整流片凸起

L2-T12 Protruding segment

L4-T14 整流片凹下

L4-T14 Low segment

L6-T16 云母片凸起

L6-T16 Raised mica

L8-T18 整流片边缘隆起
原因：整流子片错误安装

L8-T18 Ridge on the segment edge
Causes: Faulty commutator segments

L10 拉铜
原因：各种原因引起的碰撞或震动

L10 Copper drag
Causes: Bumps or vibrations with various causes



电刷使用指南

Instructions in Case of Operating Difficulties

强烈的电刷火花 Strong brush sparking

原因 Cause	改进方法 Corrective measures
整流子或滑环不圆 Out of round commutator or slipring	车削或磨削（见安装与操作指南） Turning or grinding (see "Directions for Installation and Operation")
电刷压力不足 Insufficient brush pressure	增加电刷压力（见第9页） Increase brush pressure (see page9)
电刷被粘在刷握里 Carbon brushes are stuck in holder	仔细清除杂物以及电刷和刷握的灰尘推荐采用收尘槽设计 Carefully remove foreign bodies and dust from brush and holder. Dust grooves are recommended
整流子片间有油和污物 Oil or dirt between segments	清洁薄片，过滤冷却气体及密封轴承 Clean segments, filter cooling air, and possibly seal bearings
碳刷位不当 Carbon brushes badly bedded in	重新嵌入 Repeat bedding in
刷握远离整流子或滑环 Brush holder too far from the commutator or slipring	调整刷握底端与整流子的距离至2mm Adjust distance between holder and commutator to 2 mm
绝缘薄片凸起 Protruding insulation segments	下切绝缘片和整流片倒角 Undercut insulation and chamfer segments
电机震动或咔嗒作响 Machine vibrating or chattering	如不能减少电机震动，就增加电刷压力或采用顶部有纤维或橡胶垫的设计 If it is not possible to reduce the vibration of the machine, increase brush pressures or use a brush design fitted with fibre and rubber top
电刷桥架错位 Wrong position of brush bridge	建立中性位置并相应调整电刷臂 Establish neutral position and adjust brush arms accordingly
电刷臂安装错误 Faulty installation of brush arms	正确调整电刷臂 Adjust brush arms correctly
换向极太强或太弱 Interpole too strong or too weak	电机制造商应纠正错误，或更换电刷牌号 Machine manufacturer to correct fault, or install another brush grade to compensate
不合适的电刷牌号 Incorrect brush grade	请联系我们的技术支持部门 Contact our technical service

色斑或烧蚀痕迹 Patches or burn marks

原因 Cause	改进方法 Corrective measures
产生整流片低下（L2, L4） Producing or low segments (L2,L4)	紧固并车削整流子 Retighten and turning the commutator
绝缘云母凸起（T16, P24） Raised mica insulation (T16,P24)	车削整流子，下切云母，有可能就再紧固整流子 Turning the commutator, undercut mica and possibly retighten commutator
整流子或滑环同圆度差，平衡性差（P16） Out of round commutator or slip rings, i.e. badly out of balance (P16)	重新平衡或维修整流子或滑环 Rebalance and / or remachine commutator or slip ring
竖片焊接差（P42,P46） Bad soldering of risers (P42, P46)	重新焊接竖片 Resolder risers
电刷与静止钢滑环间出现电化沉积物（电镀元素） Electrolytic deposit from brush to steel on stationary steel slip rings (galv. Element)	若停机时间长，可在碳刷下垫上一绝缘带 In case of long standstill periods insert insulating strip under the carbon brush

电刷使用指南

Instructions in Case of Operatong Difficulties

整流子和滑环过度磨损 Excessive wear of commutator and slip rings

原因 Cause	改进方法 Corrective measures
不均匀的电流分布引起刷轨过载 Overload on brush track due to uneven current distribution	调整电刷压力，可用抛光效果更好的电刷 Adjust brush pressures to the correct level. Possibly use brushes with a higher polishing effect
工作环境灰尘大 (P14) Dusty environment (P14)	安装滤清器引入清洁的空气 Blow in clean air by installing a filter
有腐蚀性气体或蒸汽 (P12) Aggressive gases or vapors P12)	引入清洁空气，用刷子去除也可用抛光效果更好的电刷 Blow in clean air and use brushes with a stronger polishing effect
电刷低载引起拉槽 (P14) Grooving caused by low electrical load on brushes (P14)	减少每极电刷数量或更换电刷牌号 Reduce number of brushes per pole or change brush grade
整流子或滑环的油膜引起拉槽 Grooving causes by oil film on commutator or Slip rings	密封轴承，避免油蒸气 Seal bearings and avoid oil vapor
直流电用于滑环时会有阳极性的材料损失 Material loss by anodic when using slip rings with DC current	经常更换滑环极性 Change polarity of slip rings time to time
拉铜 (L10) Copper drag (L10)	造成的原因很多，请向我们的技术人员咨询 Because of complex nature of the cause, please contact our technical service
产生平面斑点 Development of flat spots	安装启动电流极限 Install starting current limits

不均匀的电刷磨损 Uneven brush wear

原因 Cause	改进方法 Corrective measures
不均匀的电流分布 Uneven current distribution	调整电刷压力到正确水平 Adjust brush pressure to correct level
刷辫与刷体的连接差 Bad connection of tail to brush	更换碳刷 Change carbon brushes
电刷牌号混淆 Mixed brush grades	只用一种牌号的电刷 Use only one brush grade
电刷在刷握里粘住 Brushes stuck in holder	清洁刷握，电刷并检查公差，电刷采用收尘槽设计 Clean holder and check tolerances, use dust grooves eventually



易卡朋电碳碳刷主要牌号及技术参数

Carbon brush grades and typical properties used in ECC

类别 Category	材质型号 Material Grade	电阻率 S.E.R $\mu\Omega\text{m}$	密度 Density g/cm^3	抗折强度 Flexural Strength Mpa	洛氏硬度 Rockwell Hardness HRB	电流密度 Current Density A/cm^2	圆周速度 Peripheral Speed m/s	主要用途 Main Applications
天然石墨 Natural Graphite	ECN28	22	1.28	5.2	N/A	10	80	集电性能优异，用于高速汽轮发电机 Excellent current collecting property. For high speed turbomotor
	ECN31	23	1.31	5	N/A	10	70	集电性能优异，用于中速汽轮发电机 Excellent current collecting property. For medium speed turbomotor
	ECN35	21	1.35	5	N/A	8	70	集电性能优异，用于中速汽轮发电机 Excellent current collecting property. For medium speed turbomotor
	ECN39	20	1.39	5.5	N/A	8	70	集电性能优异，用于低速水轮发电机 Excellent current collecting property. For low speed hydro-generator
	ECN45	18	1.45	10	N/A	11	60	直流发电机、同步发电机集电环 DC generator and Synchronos generator's collecting ring
树脂石墨 Resin bonded graphite	ECR12	120	1.78	34	85 (10/60)	10	35	直流和交流变速电机 DC and AC variable speed motor
	ECR21	210	1.70	32	82 (10/60)	8	35	直流和交流变速电机 DC and AC variable speed motor
	ECR48	480	1.66	18	80 (10/40)	6	40	直流和交流变速电机 DC and AC variable speed motor
	ECR120	1200	1.58	23	84 (10/40)	5	40	起动力矩大的交流电机 big starting torque AC motor
电化石墨 Electro-graphite	ECE10	10	1.62	10	100 (10/20)	12	50	80-120V直流发电机、直流电焊机 80-120V DC generator, DC electric welding machine
	ECE17	13	1.58	8	103 (10/20)	12	50	高速汽轮发电机集电环、小型直流电机 High speed turbomotor's collecting ring, Small DC generator
	ECE20	20	1.56	11	90 (10/60)	10	45	汽轮发电机励磁机和牵引直流电机 Turbomotor's exciter, DC traction motor
	ECE25	16	1.61	13	75 (10/60)	12	40	有换向要求和有机机械振动的牵引直流电机 The reversing required and vibrating DC traction motor
	ECE21	28	1.62	20	85 (10/60)	10	40	120-400V直流电机 120-400V DC motor
	ECE30	40	1.58	21	87 (10/60)	10	35	牵引电机、汽轮发电机的高速励磁机、轧钢电动机、交流整流子电动机和其它换向困难的直流电机 Traction motor, Turbomotor's exciter, Steel rolling motor, AC commutator machine, Other DC motor
	ECE31	50	1.62	20	92 (10/100)	12	50	牵引电机、汽轮发电机的高速励磁机、轧钢电动机、交流整流子电动机和其它换向困难的直流电机 Traction motor, Turbomotor's exciter, Steel rolling motor, AC commutator machine, Other DC motor
	ECE35	54	1.67	24	85 (10/100)	12	45	牵引电机、汽轮发电机的高速励磁机、轧钢电动机、交流整流子电动机和其它换向困难的直流电机 Traction motor, Turbomotor's exciter, Steel rolling motor, AC commutator machine, Other DC motor
	ECE36	59	1.7	26	90 (10/100)	12	40	牵引电机、汽轮发电机的高速励磁机、轧钢电动机、交流整流子电动机和其它换向困难的直流电机 Traction motor, Turbomotor's exciter, Steel rolling motor, AC commutator machine, Other DC motor
	ECE37	62	1.57	23	90 (10/100)	12	45	牵引电机、汽轮发电机的高速励磁机、轧钢电动机、交流整流子电动机和其它换向困难的直流电机 Traction motor, Turbomotor's exciter, Steel rolling motor, AC commutator machine, Other DC motor
浸渍电化石墨 Impregnated electro-graphite	ECE31R	48	1.65	25	90 (10/100)	12	50	换向优异、成膜性好，适用于各型机车、船舶等牵引电机 Excellent reversing, Good film-forming, Applicable for all kinds of engines and haulage machine
	ECE35R	52	1.73	31	100 (10/100)	12	45	换向优异、成膜性好，适用于各型机车、船舶等牵引电机 Excellent reversing, Good film-forming, Applicable for all kinds of engines and haulage machine
	ECE36R	56	1.62	20	86 (10/100)	12	40	换向优异、成膜性好，适用于各型机车、船舶等牵引电机 Excellent reversing, Good film-forming, Applicable for all kinds of engines and haulage machine
	ECE37R	60	1.75	35	103 (10/100)	12	40	机车、矿山牵引电机 Engine, Mine traction motor
金属石墨 Metal graphite	ECC45	2.5	2.8	28	70 (10/60)	13	40	风力发电机、异步电动机集电环，低电压直流电机 Wind driven generator, Asynchronous motor's collecting ring, Low voltage DC motor
	ECC50	1.5	3.1	30	75 (10/60)	15	35	风力发电机、异步电动机集电环，低电压直流电机 Wind driven generator, Asynchronous motor's collecting ring, Low voltage DC motor
	ECC55	1.0	3.2	32	78 (10/60)	15	35	风力发电机、异步电动机集电环，低电压直流电机 Wind driven generator, Asynchronous motor's collecting ring, Low voltage DC motor
	ECC65	0.4	3.9	45	80 (10/60)	18	30	低电压直流发电机和变速电机集电环、接地环 Low voltage DC generator, variable speed motor's collecting ring, grounding ring
	ECC75	0.2	4.2	50	80 (10/60)	20	30	低电压直流发电机和变速电机集电环、接地环 Low voltage DC generator, variable speed motor's collecting ring, grounding ring
	ECC90	0.08	5.8	65	65 (10/60)	22	25	工业触点、滑块、接地装置和电镀生产线 Contact for industries, Sliding block, Grounding device, production line for electric plating
	ECS50	2.6	3	24	80 (10/60)	15	40	交流微型电机 Mini AC motor
	ECS65	0.8	3.6	30	85 (10/60)	18	30	交流微型电机 Mini AC motor
	ECS85	0.1	6	45	90 (10/60)	20	-	信号装置触点 Contact of signal device
浸金属石墨 Metal impregnated graphite	ECE10C	6	2.2	30	70 (10/60)	15	40	交流滑环电机、接地环 AC slip ring motor, grounding ring
	ECE17C	4	2.5	35	75 (10/60)	15	40	交流滑环电机、接地环 AC slip ring motor, grounding ring
	ECE37C	6	2.4	32	80 (10/60)	15	35	交流滑环电机、接地环 AC slip ring motor, grounding ring
	ECE17S	8	2.1	25	65 (10/60)	14	45	腐蚀性环境交流滑环电机 AC slip ring motor used in corrosion condition.

易卡朋公司采用的电刷牌号及其技术参数

Carbon Brush Grades and Typical Properties

电刷类别 Group	电刷牌号 Grade	电阻率 S.E.R $\mu \Omega m$	密度 Density g/cm ³	抗折强度 Flexural strength MPa	洛氏硬度 Hardness Rockwell B	电流密度 Current density A/cm ²	圆周速度 Peripheral speed m/s
电化石墨类 Electrographite	RE12	50	1.52	17	85HR10/60	12	50
	RE28	42	1.63	21	70HR10/100	12	50
	RE54	18	1.58	28	65HR10/60	12	50
	RE59	49	1.67	24	75HR10/150	12	56
	RE60	50	1.67	20	70HR10/150	12	56
	RE75	25	1.56	21	58HR10/60	12	50
	RE76	25	1.57	25	68HR10/60	12	50
	RE80	15	1.50	9	30HR10/40	10	50
	RE92*	16	1.53	14	55HR10/40	12	50
	RE95	15	1.56	14	57HR10/40	12	50
	RE98	61	1.41	12	50HR10/60	12	60
	RE140	90	1.68	25	95HR10/150	10	50
	RE170	74	1.68	27	92HR10/150	10	50
	E33	57	1.62	22	105HR10/100	12	60
	E34	32	1.66	26	90HR10/100	12	60
天然石墨类 Natural graphite	RE50	9	1.40	7	—	10	80
	RE66	23	1.23	6	—	10	80
金属石墨类 Metal graphite	RC53	1.3	3.2	30	84HR10/60	12	40
	RC67	0.4	3.8	35	85HR10/60	14	35
	RC73	0.20	4.2	44	85HR10/60	15	30
	RC87	0.10	5.2	55	60HR10/60	18	25
	RC90	0.09	5.3	36	74HR10/40	22	25
	RC95	0.12	6.2	115	75HR10/60	25	20
	RS70	0.8	4.3	30	90HR10/60	—	20
树脂粘结石墨类 Resin bonded graphite	RX88	140	1.68	32	85HR10/60	10	35
	RX91	330	1.41	18	80HR10/40	10	40
硬碳类 Hard carbon	RH67	46	1.60	45	(5/150)103	8	—
	RH67 M5	6.5	2.58	80	(5/150)120	12	—

1) 通过浸渍处理可以改善电刷的使用性能，这是有字母和数字加在其基本牌号之后如RE 59 N1

2) RE92*是闻名于世的电刷牌号，现已被RE95代替

1) It is possible to improve the running properties of the grades by impregnation; in that case, numbers or letters are added to the basic grades, e.g. RE 59 N1.

2) RE92* Which is the famous grade in the world has been replaced by RE95.

电刷材料性能参数表

Brush Material Performance Parameters Table

电刷类别 Group	电刷牌号 Grade	密度 Density g/cm ³	电阻率 S.E.R $\mu \Omega m$	肖氏硬度 Shore Hardness	抗折强度 Flexural strength MPa	圆周速度 Peripheral speed m/s	电流密度 Current density A/cm ²	接触电压降 Voltage Drop	摩擦系数 Coeff. Friction
电化石墨类 Electrical Graphite	E3X	1.69	11	30	21.4	45	12.5	m	vl
	E22	1.66	16	45	25.5	30	10	l	h
	E24	1.57	38	60	28.3	30	10	m	l
	E25	1.68	30	65	27.6	30	10	l	l
	E27	1.54	43	70	29	33	10	h	vl
	E28	1.48	48	50	18.6	30	10	m	vl
	E31	1.6	48	70	27.6	40	12	h	vl
	E34	1.62	55	70	30.3	35	12	m	l
	E37	1.6	43	75	33.8	40	10	l	vl
	E38	1.7	46	75	37.2	35	10	m	vl
	E39	1.8	40	85	37.2	40	10	h	vl
	E40	1.45	53	40	13.8	45	12	vh	l
	E41	1.55	58	60	20.7	45	12.5	h	vl
	E44	1.72	43	80	37.9	35	10	m	l
	E45	1.55	59	55	22.8	45	12.5	m	vl
	E49	1.64	43	70	20.7	50	12.5	h	l
	E50	1.57	53	55	20	35	12	m	l
	E51	1.56	56	60	22.1	45	12.5	m	vl
	E57	1.53	54	50	17.9	45	12.5	m	l
	E58	1.65	50	65	27.6	50	12.5	h	vl
	E60	1.66	50	75	36.5	50	12.5	h	vl
	E61	1.44	15	30	11	45	12	m	l
	E63	1.58	14	30	14	45	12	m	l
	E67	1.43	66	40	11	50	12.5	m	l
	E77	1.45	66	40	12.4	50	12.5	h	vl
	4029	1.46	63	45	13.8	40	12.5	m	l
	4041	1.49	76	50	9	37	12.5	m	vl
	6677X	1.6	76	65	16.5	40	12.5	m	l
硬碳类 Carbon	H	1.64	27	55	20.7	20	6605	m	m
天然石墨 Graphite	610	1.91	20	20	32.4	30	8	m	l
	619	1.78	48	35	37.9	25	8	vh	l
	700	1.82	10	25	1515.8	35	11	h	l
	702	1.43	25	15	4.8	70	10	h	l
树脂粘结石墨 Bakelite Graphite	621	1.75	200	55	31	20	5	vh	m
	622		150	16	0	40	10	vh	l
金属石墨 Metal Graphite	B 75	4.6	0.16	20	48	30	20	vl	vl
	B 80	5.2	0.07	20	95	30	25	vl	vl
	B 86	6	0.07	30	95	30	25	vl	vl
	B 87	6.4	0.05	30	62	30	25	vl	vl
	B 98	5.8	0.01	30	67	30	25	vl	vl
风电用碳刷 Windmill Grade	CW 40	2.8	2.3	75	30	40	16	vl	vl
	CW 54	3.2	1.5	85	32	40	18	vl	vl
	CW 68	3.8	0.4	84	36	35	20	vl	vl
	CW 74	4.2	0.2	85	45	30	22	vl	vl
	AG 20	3.8	0.3	75	30	20	25	vl	vl
	AG 65	4.4	0.35	85	30	20	25	vl	vl

级别 Classification	符号 Symbol	电压降 Voltage Drop	摩擦系数 Coeff Friction
很高 Very High	vh	2.5-3	
高 High	h	2-2.5	>0.3
中等 Medium	m	1.5-2	0.2-0.3
低 Low	l	1-1.5	0.1-0.2
很低 Very Low	vl	0.5-1	<0.1

使用电刷常见问题的解决指南

Carbon Brushes Trouble Shooting Guide

电刷使用过程中常见的问题列于下表的右上方，而可能导致其问题的原因则列于下表的左面栏目中按其产生问题的频率，我们标注了“1”，“2”，“3”等，其它可能的原因我们标注了“X”

Locate trouble at top of vertical columns. Possible causes can then be located by looking down the column and reading item on horizontal rows indicated. Most frequent causes are numbered 1, 2, 3, etc. Other possible causes are marked with an “X”

产生问题的原因 Cause		产生火花或滑出边烧损 Sparking or burnt trailing edge	产生火花或滑入边烧损 Sparking or burnt leading edge	出现绿色细束状的火花 Green sparks
刷握臂位置不正确	Incorrect position of brush holder arms	1	1	1
极间空气间隙太小	Interpole air-gap too small		6	4
极间空气间隙太大	Interpole air-gap too large	5		5
极间电流太强	Interpole current too strong		2	2
极间电流太弱	Interpole current too weak	2		3
整流子表面有油渍，污物或碳粉	Oil and dirt on commutator, carbon dust			
电刷工作面有金刚砂颗粒	Grains of emery in the brush running surface			
电机过载	Overload of machine	x	x	
电机震动	Vibration of machine	4	5	
电枢绕组错误	Armature winding faulty	x	x	
定子与汇流条的接触电阻不均等	Unequal contact resistance between spindles to bus bar	x	x	
电刷粘连在刷握中	Brushes stick in the brush holders	x	x	
刷握不合格，刷握盒太大	Defective holders, brush boxes too large	x	x	
电刷接触回路缺失	Some loose brush circuit connections	x	x	
刷握离整流子太远	Brush holder too far from commutator	x	x	
空气湿度太大	Humidity of air too high	6		
空气湿度太低	Humidity of air too low			
空气中有粉尘	Dusty air			
空气中有腐蚀性的气体或酸雾	Corrosion from gas and acid fumes in the air	7		
弹簧压力不对	Incorrect spring tension	x	3	
电刷工作面打磨不够	Polishing action not sufficient	x		
电刷摩擦系数太大或相对磨面打磨太强	Brush friction too strong or polishing action too strong	x		
电刷被油脂污染	Brushes are greased	x		
不同牌号的电刷被平行使用	Different carbo grades in parallel			
电刷并联错误	Brush shunt faulty			
电刷臂的空间不均等	Unequal brush arm spacing	x	x	
云母片未下切	Mica not undercut	x		
整流子或滑环失圆	Commutator or rings untrue	3	4	
整流子的接线片未连接	Commutator lugs disconnected	x	x	
整流子的汇流条过于疏松，过高或过低	Loose, high or low commutator bars	x	x	
整流子面出现扁平	Flats on the commutator	x	x	

Green pin



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固定电机及牵引电机用电刷的推荐表

Recommended Applications of Carbon Brushes for Stationary Machines and Railway Technology

工业电机Industrial Motor	用途 Application	电刷牌号 Grades	电刷牌号 Grades	stationary machines 固定电机用电刷的推荐
至110V直流电机和叉车电机	DC machines until 110V, Fork lift motors	RE28,RE75, RE76, RC53		
大型直流电机 大于110V	Large DC machines >110V			
轧钢及矿用升降电机	Rolling mill and mine hoist motors	RE60, RE92N1 RE98N1,RE75	E45,E41,E57,4029	
控制发电机	Control generators	RE92N1,RE98N1,RE60	E45,E61	
励磁机	Exciters	RE60,RE92,RE75,RE170	E35,E61	
轧钢辅助电机	Steel mill auxiliary motors	RE12,RE75,RE92,RE54	E45,4029	
中小型直流电机	Small and medium DC machines	RE603,RE753,RE60N5, RX91, RE98, RE170	E45,E61,4029	
三相整流电机	3-phase commutator motors	RX88, RX91		
至转速40M/S的滑环	Sliprings until 40 ms ⁻¹			
青铜和紫铜滑环	Bronze and copper rings	RC53,RC67,RC71,RC87, RE54, RE92	E3	
剩磁、珠光体及球墨铸铁滑环	Remanite, perlite-and spheroidal cast iron rings	RC53, RC73,RE92,RE54,RE80	E61	
至转速80M/S滑环	Sliprings until 80 ms ⁻¹	RE50		
钢环（涡轮发电机）	Steel rings(Turbo generators)		702	
接地装置	Earthing contacts	RE50, RS70,		
铁路牵引电机Traction motors (railway)				
16 2/3赫兹交流牵引电机	16 2/3-Hz-AC traction motors	RE59, RE60N7	E31	railway technology 铁路机车用电刷的推荐
可控硅电机	Thyristor controlled motors	RE59N1, RE60N7	6677	
直流牵引电机	DC traction motors	RE59N1, RE60N7	6677,E45	
牵引电机(用于本地交通)	Traction motors (local traffic)			
无交流变换器控制的直流电机	DC without chopper control	RE59, RE59N1, RE92N1, RE76	E45,6677,E37	
有交流变换器控制的直流电机	DC with chopper control	RE140	6677,E37	
无轨电车	Trolleybus	RE59N1	E45,E37	
内燃机车	Diesel electric trains			
直流电机	DC motors	RE59N1	E37,E45,E49	
火车发电机	Train generators	RE59N1, RE60N6	E45,E49	
矿山及工业铁路用牵引电机	Traction motors for mining and industrial railways	RE75N1, RE76, RE59N1	E45,E49	
辅助电机	Auxiliary motors	RE54, RE59, RK433, RX91, RE80	E45,4029,E51	
铁路机车接地装置	Railway Earthing Devices	RC87, RC90	B80	

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