Carbon brushes for fractional and subfractional horsepower motors

Automatic cut-off designs

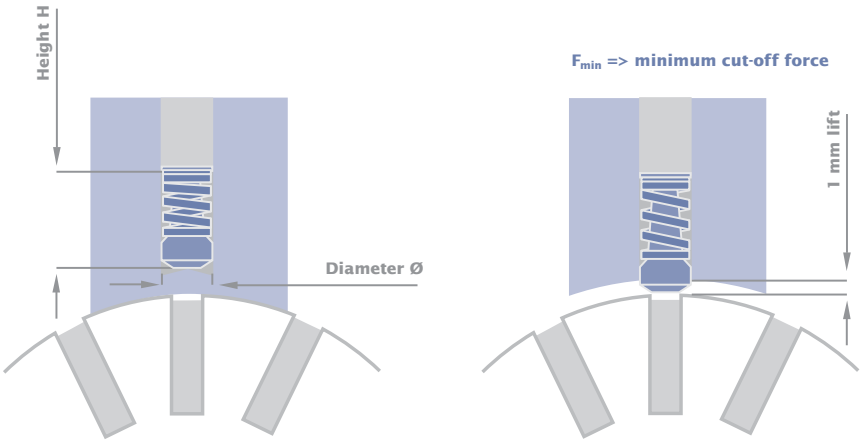
Some machines, such as hand-held power tools, garden pumps, household appliances used commercially and motors for special washing machines, are powered by fractional horsepower motors. With these motors it should be possible to wear out a series of carbon brushes before having to rework the surface of the commutator.

For carbon brushes replacing the original ones to have good brush lifetime, the commutator must still have satisfactory concentricity and be free of major surface marks. This is only the case if at its wear limit the particular carbon brush has not excessively roughened the commutator or has not burned it out-of-roundness due to increasing brush sparking.

This is achieved by installing a so-called cut-off device in the carbon brushes

- When reaching the wear limit, an insulating pin raises the remaining carbon brush body, and the conducting electrical contact between carbon brush and commutator is broken.
- The so-called cut-off element consists of a specially formed insulating pin seated in a guide bore of the carbon brush and is subjected to a strongly pre-loaded spring.

We offer 10 designs depending on the dimensions and the pressure conditions of the brush.



System No.	Diameter Ø [mm]	Height H [mm]	Installation depth [mm]	F_{min} [N] at 1 mm lift	Application
02330	2	3.8	6	1.4	Small-power motor, general purpose
02505	2	3.8	6.5	2.3	Small-power motor, general purpose
02466	2.3	4.3	7	3.1	Small-power motor, general purpose
02373	2.3	6.5	9.5	4.0	Washing machines
02503	2.5	5.3	8	4.0	Small-power motor, general purpose
02337	2.9	5	8	5.0	Small-power motor, general purpose
02329	2.9	5.5	8	5.0	Small-power motor, general purpose
02502	2.9	6	10	5.4	Small-power motor, general purpose
02485	2.9	6	10	7.5	Large hammer drills
02490	2.9	8	12.5	5.4	Washing machines

All specifications are based on measurements with new carbon brushes under ideal conditions. The numbers are approximate values without guarantee of correctness.

Cut-Off Devices – Types and Dimensions

The lift-off forces listed in the table are approximate values for the cut-off devices – at a lift of the carbon brush from the commutator of 1 mm. Variables affecting these values are: carbon brush material, brush friction in the holder and the pressure exerted by the carbon brush. The choice of the appropriate cut-off device depends on:

- Pressure exerted by the carbon brush at the wear end
- Carbon brush design and
- Segment slot width of the commutator

Depending on the material, all cut-off devices emerge 0.3 mm to 0.8 mm earlier from the carbon brush than the theoretical value indicated in the drawing.

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Design characteristics of cut-off mechanisms

The basic characteristics of these ten cut-off mechanisms are shown in Figures 1 to 8. Carbon brushes are differentiated according to whether the current is conducted via a flexible conductor or only via the compression spring. Figure 1 shows a carbon brush with conducting spring.

Figure 2 shows the only design of a carbon brush in which a flexible current conductor is tamped in above the cut-off device. This design is only used for motors with low power. It increases the installation depth of the cut-off device by 1.5 mm.

At higher currents and the small transition losses necessary in this case between flexible conductor and carbon brush, designs according to Figures 3 and 4 should be chosen. A minimum carbon brush cross section of 5 mm x 8 mm is required in this case. Depending on the dimensions of the carbon brushes, ten different cut-off mechanisms can be installed in these designs. The design according to Figure 3 is intended for tubular brush-holders, and that according to Figure 4 for flange and box-type brush holders.

Minimum Dimensions

For spatial reasons such designs can technically only be implemented at specific minimum carbon brush dimensions. Such considerations should therefore only start at carbon brush cross sections of 5 mm x 6 mm and up – given an equally adequate radial brush length.

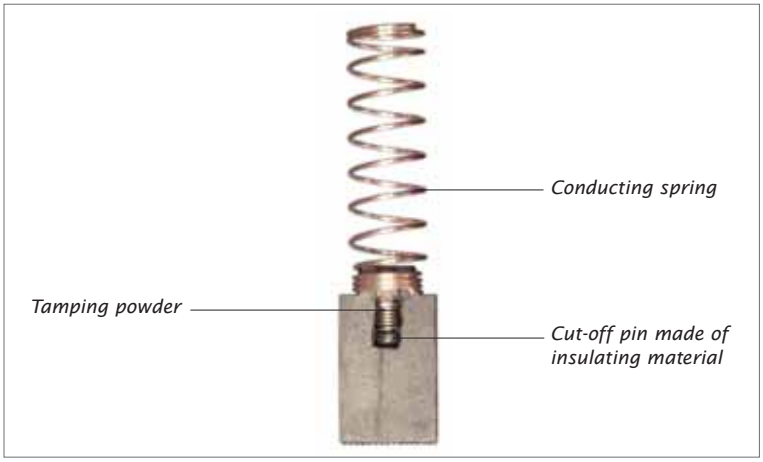

Figure 1: Carbon brush with conducting spring and cut-off mechanism.

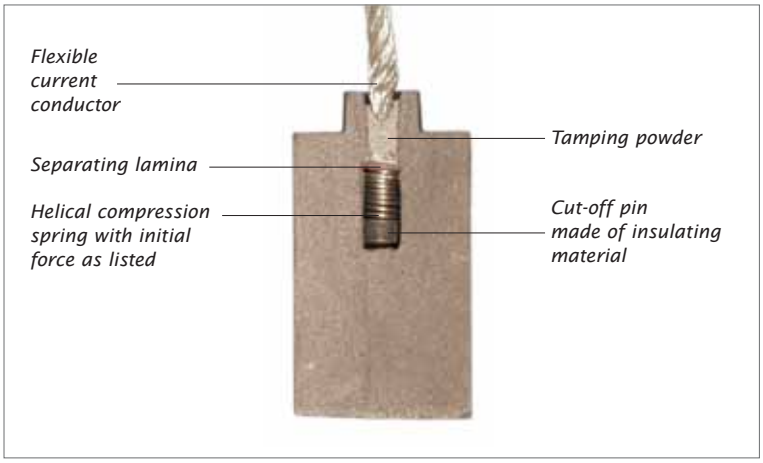

Figure 2: Carbon brush with the flexible current conductor tamped in above the cut-off device

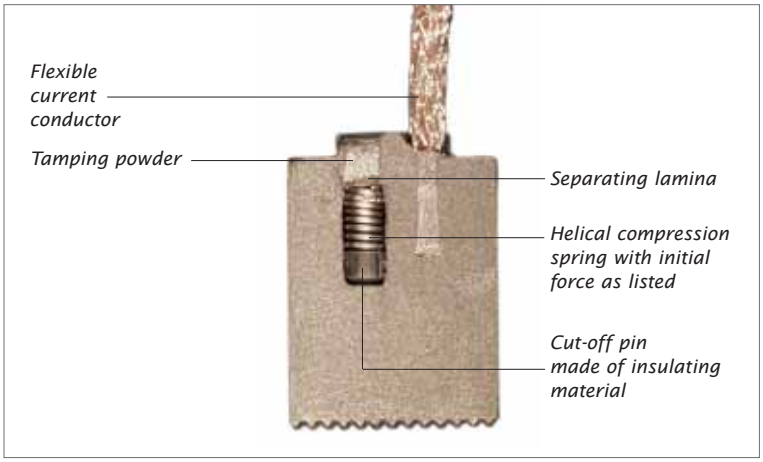

Figure 3: Carbon brush for higher currents – suitable for tubular brush-holders. All ten cut-off mechanisms are possible

Automatic cut-off designs

Special design for washing machines

Figure 5 shows the special design for washing machine motors.

In carbon block brushes, used in DC motors, the tamped Version A is applied. In multi-layer carbon brushes, used in AC and DC motors, both versions can generally be applied.

The more complex Version B should preferably be applied in AC motors with difficulties during commutation. In this case no additional decrease of the commutation resistance circuit takes place in comparison to a multi-layer carbon brush without cut-off device.

The carbon brushes in washing machine motors are set at a specific angle of 10° to 28° to the commutator. To prevent the cut-off pin from breaking off or being lifted out, the lower cylindrical part must be lengthened compared to the standard design.

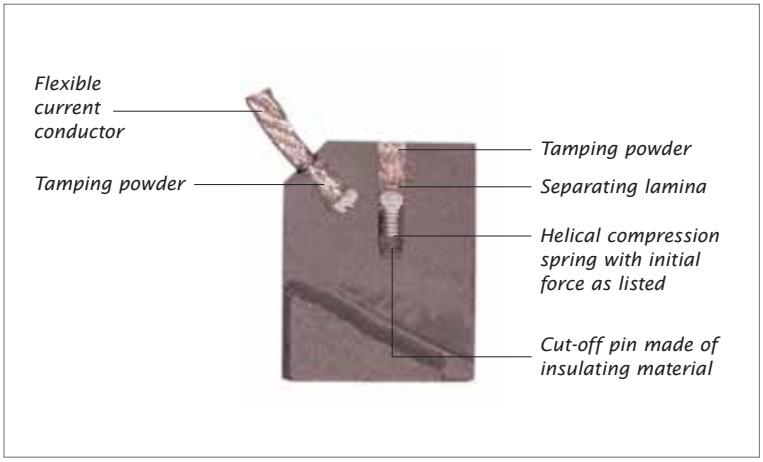

Figure 4: Carbon brush for higher currents – suitable for flange and box brush holders. All ten cut-off mechanisms are possible.

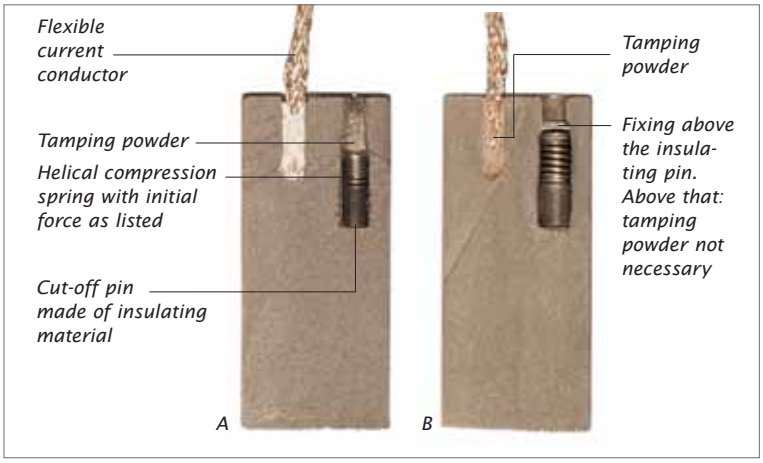

Figure 5: Special design for washing machine motors.
Version A: tamped carbon brush for DC motors.
Version B: AC motors with difficulties during commutation

Cut-off and signaling designs

Carbon brushes with cut-off and signaling device

Carbon brushes with cut-off device are a well-known standard product. Since the cut-offs of these models occur unexpectedly for the user of the device (primarily hand-held power tools), they lead to loss of working hours, because replacement carbon brushes are rarely at hand.

As a preventive measure a signaling device can additionally be installed in the carbon brush.

- The end of the flexible signaling conductor is insulated and structurally more deeply installed than the cut-off device.
- In the event the carbon brush is worn out, this end insulation is abraded when the end of the flexible signaling conductor is reached, and an electric connection between the commutator and the flexible signaling conductor is set up.
- While the motor is running, the segment voltage in this case is used for lighting a service light (LED) across appropriate electronic circuitry.

On the basis of the difference of the installation depth – between the cut-off device and the flexible signaling conductor – and knowing the specific brush wear (time), it is possible to control the useful life of the device up to the cut-off of the carbon brush. Nominal values for this application are 6 to 10 hours. This ensures that after being alerted by the signal the user can still utilize the device on site until work is completed.

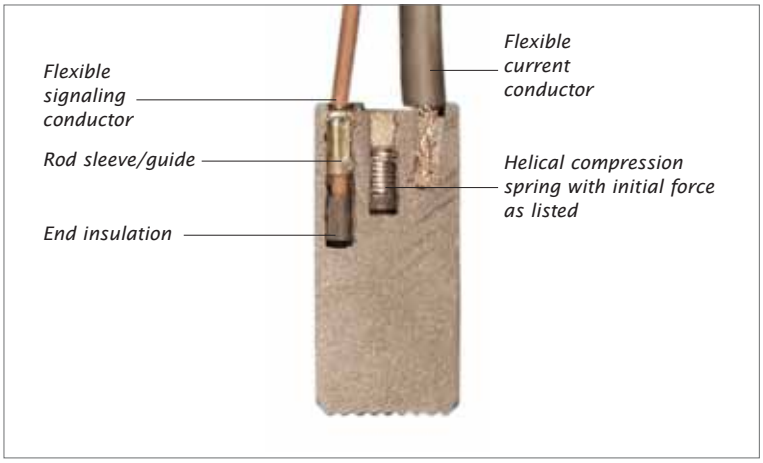

Figure 6: Carbon brush with cut-off and signaling device

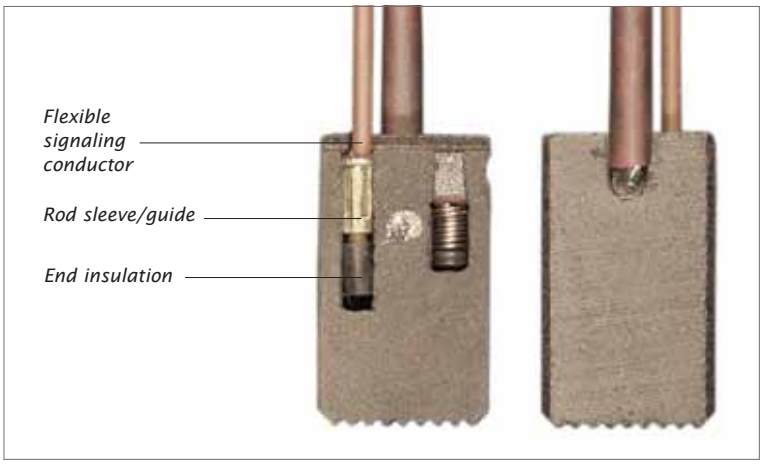

Figure 7: Carbon brush with cut-off and signaling device (front and back)

Carbon brushes with cut-off and signaling device

It then becomes possible to replace the brushes with some time flexibility. If the carbon brushes are not replaced, the cut-off device switches off in order to maintain a good commutator surface. Since the two carbon brushes in the motor can have slightly different wear, cut-off and signaling device are installed together in the carbon brush to gain more precise time control. Combining these two installations can also be utilized for scheduled service controls, such as, for example, monitoring and overhauling the gearing and other structural parts.

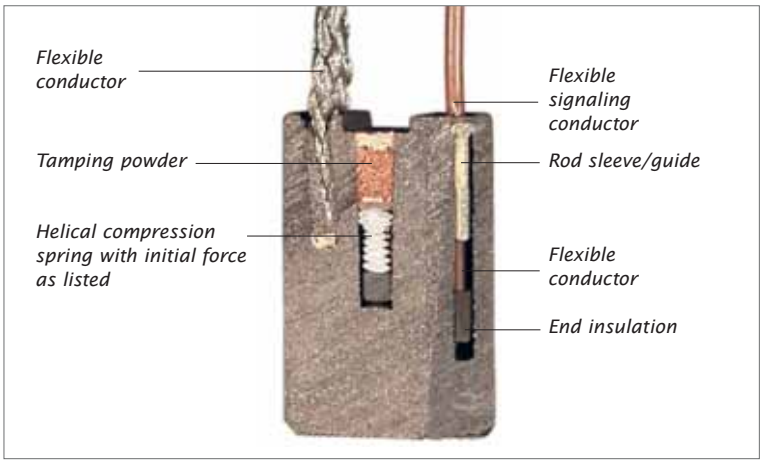

Figure 8: Carbon brush with cut-off and signaling device for higher currents

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