

CIRCUMFERENTIAL BRUSH STAGGER

TECHNICAL NOTE ■ STA BE 16-23 GB

DEFINITION

Circumferential brush staggering (*) on a commutator is a method for improving the commutating ability of a machine, mainly when on overload.

Circumferential brush stagger increases the commutator arc covered by the brushes by staggering tangentially one or more brushes on each arm.

There are 2 types of staggering:

- Dissymmetrical according to the neutral line (fig. 1b) for unidirectional machines with staggering in the direction of rotation; hence the name "advanced brushes" sometimes given to the staggered brushes.
- Symmetrical according to the neutral line (fig. 1d) for reversing machines.

These two arrangements can be obtained by "all or nothing" as shown on fig. 1b and 1c, or by progressive stagger as shown on fig. 1d.

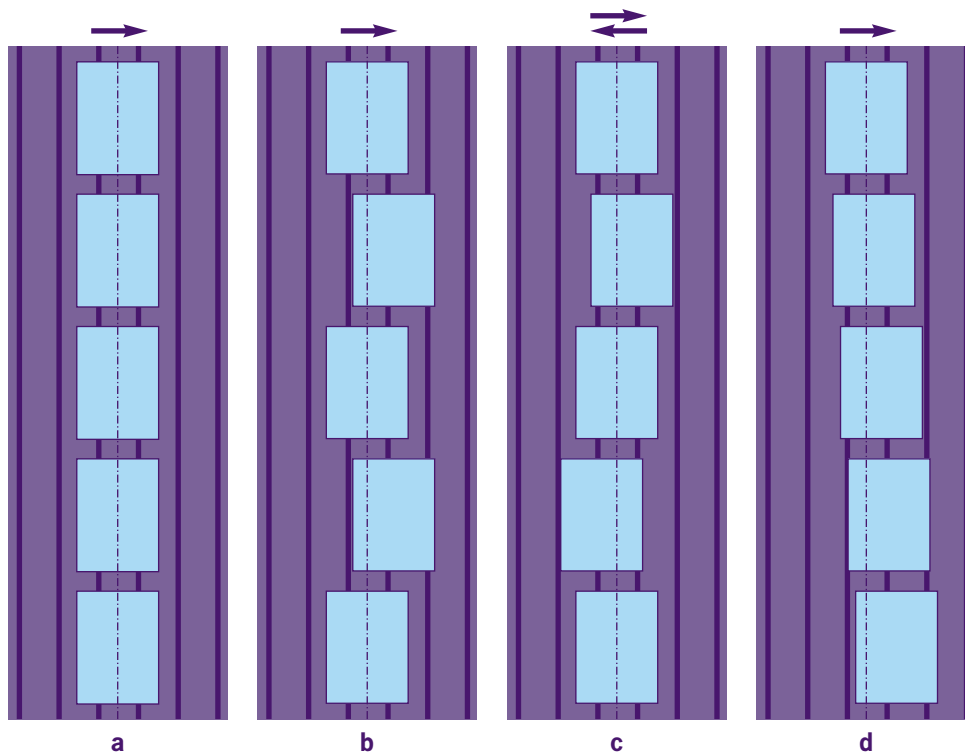


Fig. 1

(*) Do not confuse circumferential staggering with axial staggering which is used to even commutator wear (see Technical Note STA: BE 16-7).

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SCOPE

By increasing in this way the number of bars covered by the brushes, the commutating time is increased and the speed of current reversal decreased in the commutated coil. The commutating difficulties of the machine are accordingly reduced.

The effect of circumferential stagger is especially sensitive when:

- the number of commutator bars is great,
- the speed of the machine is high,
- the thickness of the brush is small ('t' dimension), i.e. the number of bars covered by a brush is smaller.

LIMITATIONS

From this point of view we must bear in mind that:

the minimum arc of commutator which has to be covered by the brush for a satisfactory commutation, must obey the relation:

$$T - e > K(L + e)$$

Where:

T = arc covered by the brush,

L = width of a bar,

e = width of interbar insulation (mica),

k = number of coils per armature slot,

If the brushes are radial with thickness t and without stagger, then

$$T = t$$

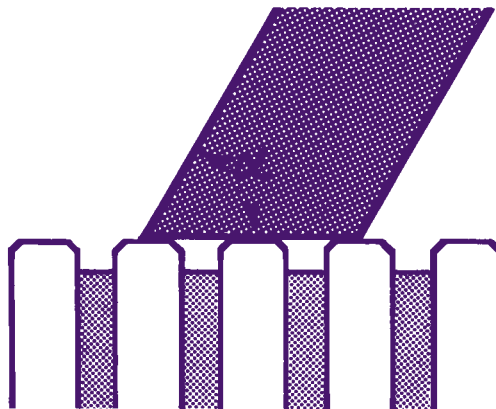


Fig. 2

If the brush is inclined with an angle α at the contact face (fig. 2)

$$T = t : \text{Sen } \alpha$$

The maximum arc of a commutator that may be covered by an arm of staggered brushes is limited by the zone of action of the auxiliary poles and by circulating currents developed between bars by the brushes.

The calculation can give an approximate value but it is only by adjustment on test bed that the coverage can be specified with accuracy.

In practice, staggering can go from 3 to 10 mm.

(Note that the number of covered bars must not be a whole number in order to eliminate the risk of resonance linked with the procession of bars under the brush).

SPECIAL APPLICATIONS

Circumferential stagger is sometimes introduced in the two following special cases:

- DC low voltage generators having difficult commutation.

These old machines have long arms which are necessarily still fitted with metallic brushes having a low contact drop and consequent poor commutating ability.

To avoid this difficulty one brush per arm can be staggered forward (fig. 3) and forced to accept the commutation sparking energy of the whole arm. If such brush is of good commutation quality, i.e. chosen is an appropriate EG grade, this transfer of commutation can be achieved without damage to the staggered brush.

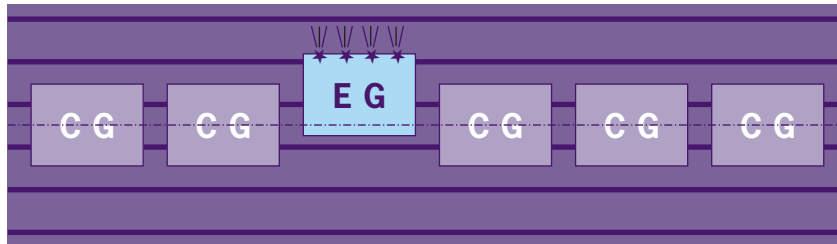


Fig. 3

- DC machines with two brushes per arm always under loaded.

Clearly it is wrong to remove one brush per arm to increase the current density in the remaining brush. Two brushes of sensibly reduced section must be adopted and staggered each side of the neutral line in order to keep the same coverage of commutator as existed with the original larger section brushes (fig. 4).

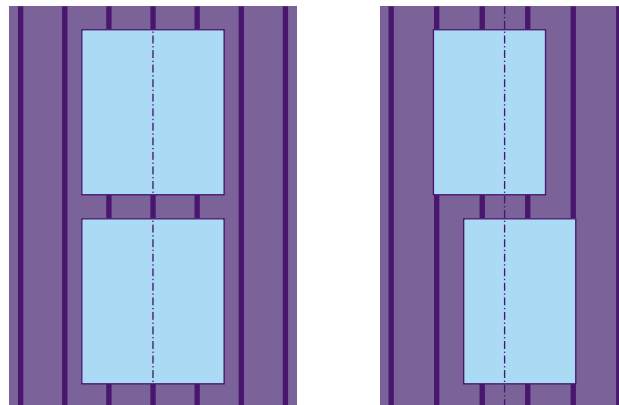


Fig. 4





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