Technical Support

Commutators – Surface Maintenance

INTRODUCTION

The primary object of maintaining or reconditioning a commutator is to remove those irregularities which lead to impaired brush efficiency, and reduced brush and commutator life. This section concentrates on the maintenance of a proper commutating surface, on the assumption that external mechanical or electrical causes of commutator deterioration (e.g. armature out of balance) have been located and rectified by the machine user or original manufacturer. If movement of the commutator bars under normal running conditions is suspected, a specialist Repairer should be consulted in order to replace or re-season the commutator before any reconditioning of the surface takes place. Regular use of a profiling device such as the MMS6000 will help to confirm whether there is a problem with movement/distortion of commutator bars.

After confirming that the commutator is stable the next step is the truing-up operation. The frequency at which this is necessary depends entirely upon the state of the surface, its cleanliness and the commutator running conditions (notably, the rotational speed). On slow running machines, maintenance in many cases is often needed only very infrequently; even the higher speed machine can remain in service for some years before formal reconditioning is desirable. It all depends on how regularly and conscientiously cleaning is carried out. If smut and soot are allowed to build up in the mica recesses, or risers eventually the machine will fail as a result of low IR or flashover. Flashovers are also most likely to occur when the mica insulation is bridged by such debris. The early running-in period of a set of new brushes is particularly productive in loose carbon particles and soot and regular checking and cleaning is a ‘must’ during this time – a small, clean paint brush is simple and effective for this purpose.

Another point to be noted is that the colour of the skin or film on the commutator cannot be taken as an indication that the commutator needs reconditioning; it can vary over a wide range of shades from dark to light and in degrees of uniformity. The shade of colour is often related to the atmospheric conditions. If this shade remains constant and even, there is no cause for alarm and the performance of the machine should be considered as satisfactory.

Furthermore, sequential bar marking should not be considered as a fault unless the surface of the affected bar becomes rough. This type of marking is due to the use of a number of coils in the one slot and to the magnetic coupling between these coils during commutation. The greatest amount of energy is reversed in the last coil in each slot to undergo commutation and consequently the film on the corresponding bar tends to build up to a greater thickness with a darker shade of colour than the preceding bars.

In the main, slight grooves running concentrically around the circumference of the commutator are not harmful and, in themselves, do not necessitate any truing-up action. Axial errors, and steps however are another matter. Even an irregularity as small as 0.025mm (0.001”) can disturb the brushes sufficiently to result in chipping and arcing as the brushes re-seat on the commutator surface. It should be understood that the natures of the materials in the brushes and commutator are such that even these small irregularities cannot be absorbed without detracting from brush efficiency.

A commutator surface can be reconditioned in any one of seven ways, although other methods have been used in emergencies. The recognised and approved techniques are listed below in order of preference:

1. Turning with a diamond tipped tool
2. Turning with a tungsten carbide tipped tool
3. Grinding with a rotating wheel
4. Turning with a tool of normal high-speed steel
5. Grinding with a ‘fixed’ stone mounted in a tool rest
6. Grinding with a handstone
7. Scouring with abrasive cloth

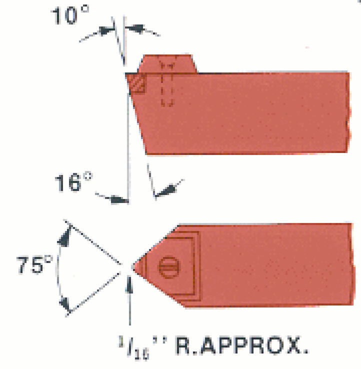
Whichever of these methods is adopted, the commutator should be trued whilst running at full speed in its own bearings if possible. This is especially important when the machine operates at high speed. Before any machining is attempted the depth of undercut on the micas must be checked and compared with the amount of material required to true the commutator up. If the undercuts will be removed completely by the turning operation then it is imperative that the micas are undercut before any turning is done; in this way the existing undercuts can be used as a guide for the undercutting tool.

Each of the seven specified methods is discussed in turn below.

DIAMOND TURNING

The worst irregularities should first be removed at slow speed with a tungsten carbide tool so that the diamond does not have to cope with serious flats, grooves, etc. The cutting tip of the diamond should have an angle of approximately 75° and a top radius of about 1.58mm(1/16"). The form and cutting angles should be ground as shown in fig. 1. During diamond turning, the depth of cut must never exceed 0.013mm (0.0005").

Fig. 1.



It is possible and practicable to diamond-turn any commutator at full speed. Speeds up to 45 m/s (9000ft/min) have been handled – providing that the tool rest is rigidly supported in a position that permits a reasonably small overhang of the tool, which must be radially disposed in relation to the commutator centre but not necessarily horizontal. With large commutators, the traverse should be motorised but, in any case, the feed should not be more than 0.13mm (0.005") per revolution, otherwise there may be a spiral groove tendency. No vibration should be present, particularly when turning is being carried out at high rotational speeds.

NOTE:
The highly polished – almost burnished – finish produced by diamond turning is not a suitable surface for brush operation and should be broken by abrasive paper or cloth. (on flush mica commutators this will also level or somewhat undercut the micas, which are normally left very slightly proud after diamond turning (Fig 3))

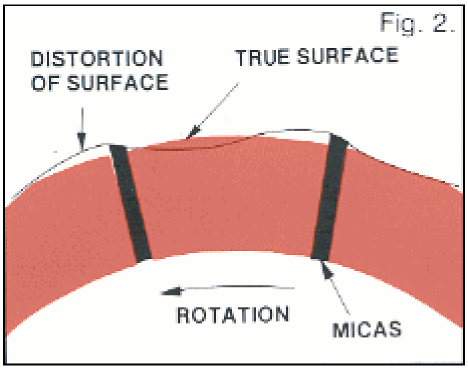
TUNGSTEN CARBIDE TURNING

The general rules for diamond turning apply equally when tungsten carbide tools are used, although normally the cutting speed in the case of the latter is limited to about 6000 ft/min (30 m/s). Heavier cuts are occasionally made, but there is always a risk that the commutator bar surfaces

will suffer the sort of distortion shown in Fig 2.

GRINDING WITH ROTATING WHEEL

In this method of resurfacing, the cutting speed should be kept to about 26 m/s (5000 ft/min) by the use of a grinding wheel of 230 to 250 mm (9 to 10") diameter rotating at a speed of not more than 3000rev/min. A medium hard shellac-bonded carbide wheel is commonly used.



HIGH-SPEED STEEL TOOL TURNING

Although a high-speed steel tool can be employed at relatively slow speeds, it should, in fact, be used only when one or other of the preceding methods is neither suitable nor available. The tool shape and clearances must be the same as those shown in Fig.1.

'FIXED' STONE GRINDING

The grit and hardness of the 'fixed' stone must be selected according to the amount of copper that has to be removed. During each traverse, the stone may have to be fed towards the commutator slightly in order to make allowance for stone wear.

HANDSTONE GRINDING

As long as the stone is large enough to cover an arc of about 45° and is radiused correctly, it is possible with this method to remove fairly substantial irregularities without giving rise to eccentricity. However, care is essential. On more than one occasion, commutators have been damaged very badly indeed by indifferent use of handstones. Sometimes small irregularities are removed with these stones during normal running of the machine, but this practice definitely cannot be recommended since it has a detrimental effect on the life of the brushes in use at the time.

On all occasions when handstone grinding is employed, a fine stone must invariably be used for the final cut.

ABRASIVE CLOTH

For this method of commutator resurfacing, only silicon carbide cloth should be used. As far as possible, emery must be avoided. Normally, the use of silicon carbide cloth is restricted to cleaning-up operations (i.e. the removal of the skin, gas films, glazing, etc.), although slight irregularities or traces of burning can also be eliminated without affecting the truth of the surface. The strip of cloth or paper must be long enough to lap at least 150° of the commutator surface and be firmly held at each end.

Pressure with the fingers on the working part of the cloth is to be avoided as it gives a rounded segment top.

Whatever the reconditioning technique, a final surface finish should be obtained, after the micas have been recessed, with 150 – 200 silicon carbide paper or cloth or its equivalent.

COMMUTATOR SKIN

As a general rule it is best to allow a natural build-up of skin by deposit from the brushes on the commutator, after the surface has been given a final finish. Ideally not smoother than 25 micro inches (6 x 10 –4mm or 635 Nanometers) the brush must be allowed to develop their own natural graphite skin without aid for a separate source. However, it must be admitted that in exceptionally difficult local conditions it may be necessary to depart from this rule.

RECESSING

After a commutator has been turned, and before it is given its final finish with Silicon Carbide paper, the micas must be checked and recessed if necessary. This is an operation that must be carried out most carefully and every precaution must be taken against damaging the freshly turned surface. The depth of recess should not exceed the width, and the walls of the segments must be completely free from every trace of mica; a thin sliver is at times more troublesome that a flush mica. Although many tools and methods have been proposed for this operation, perhaps the most useful tool is a short piece of hacksaw blade gripped in a file handle. A hook-type scraper is valuable for clearing the walls of the segments.

When the mica has been cleanly undercut, the edges of the segments must be bevelled by about one-half millimetre at 45°. Although a triangular file is often used for this, the quickest and most effective tool is a small scraper shaped to a 90° V-form with a slight rake. Drawn along the edges of the recess with the tip of the vee inwards, this tool effectively bevels the two adjacent segment edges at the same time. Care must be taken to avoid gouging the commutator surface.

With all recessing and bevelling finished, the recesses must be cleaned thoroughly with a stiff brush and fibre scrapers or some comparable implements. The final finish should be done. It is essential that any copper debris is removed completely from the micas, armature assembly and stator field system by brushing and vacuuming as necessary.

This publication deals largely with undercut commutators, since flush mica is not encountered these days except in fractional horsepower and special purpose machines, the commutators of which are generally turned on a lathe between centres. In point of fact, technically there is no such thing as flush mica. If such a commutator is turned with a diamond tool, the mica is left about 0.005 mm (0.0002”) proud (Fig.3a). If, on the other hand, it is turned with a tungsten carbide tool, the mica tends to become recessed (Fig. 3c). The same result is obtained if the surface is given a finish with an abrasive material such as silicon carbide paper.

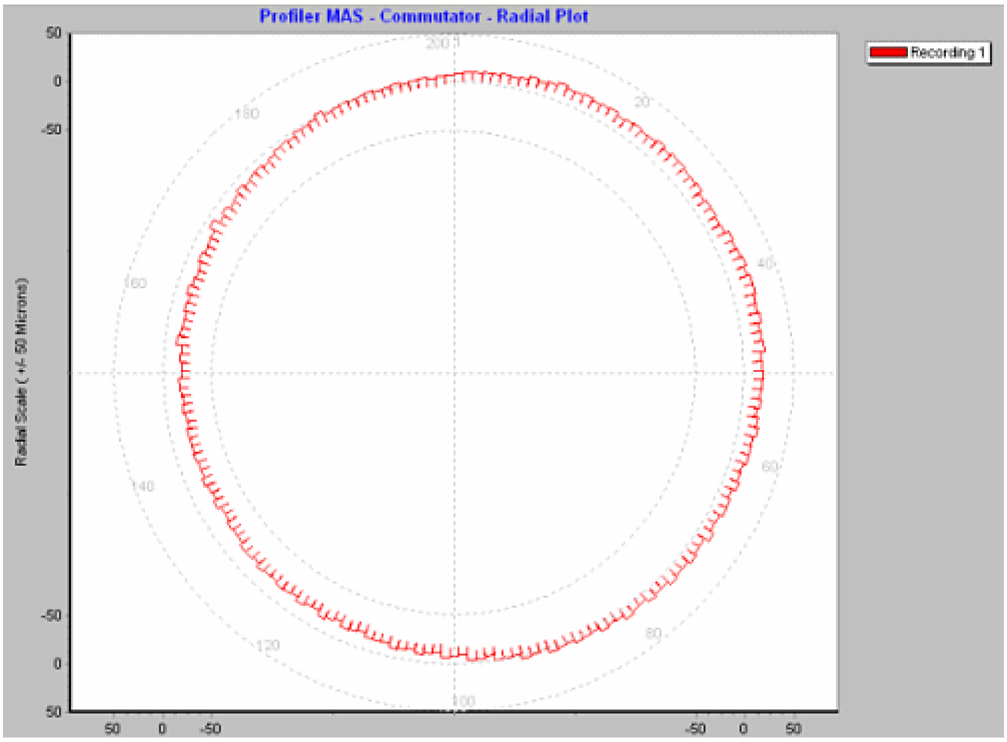
Obviously it is unwise to run brushes on a flush mica commutator that has been diamond turned without first relieving the proud mica by a finishing operation with silicon carbide paper.

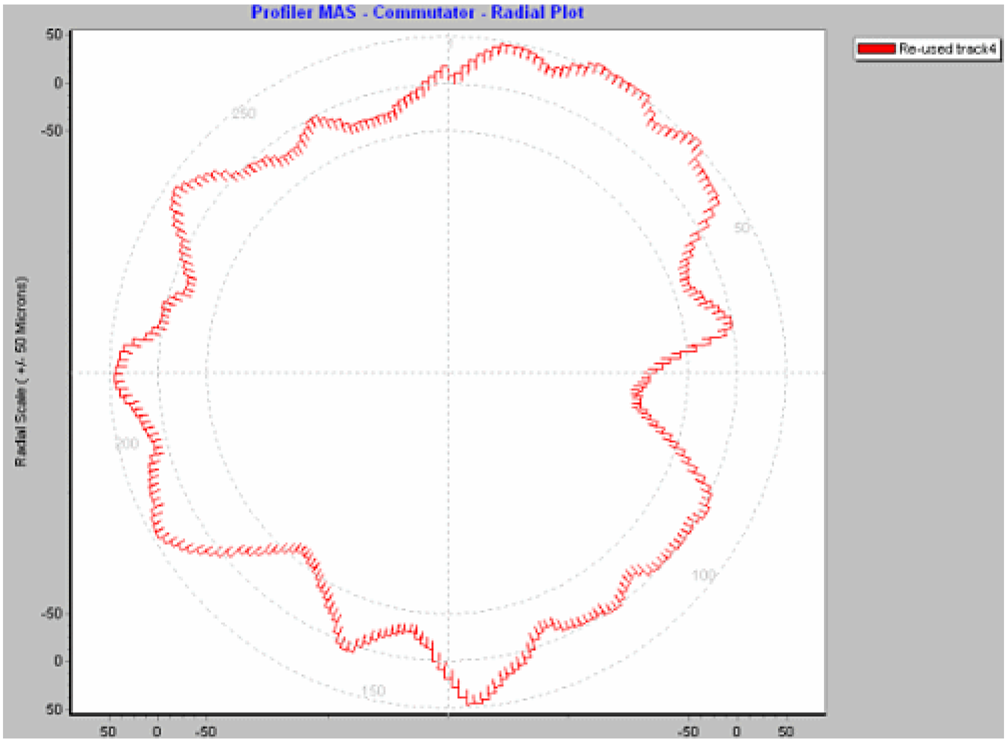
TOTAL INDICATOR READING (T.I.R.) AND SEGMENT TO SEGMENT DIFFERENCES.

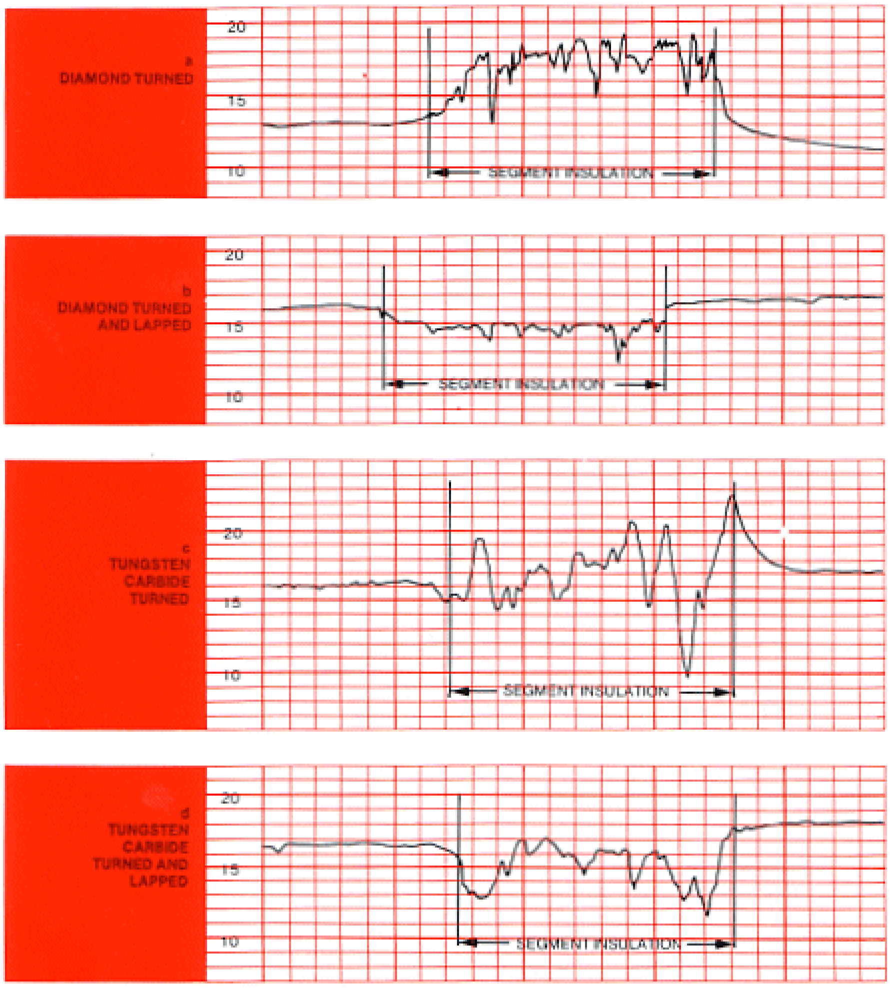
Any measurement of T.I.R. on the commutator is not very meaningful and not very important where revolutions per minute are low as the brush gear can generally cope with a fair amount of eccentricity without deterioration of the brush performance.

The prime factor is the difference in readings between adjacent segments. This difference should be as small as possible, for whereas an eccentricity of as much as 0.1 mm could be tolerated for the whole commutator, a difference of more than 0.025 mm for the readings between adjacent segments can cause sufficient disturbance to the brushes to promote serious trouble later.

In conclusion; if a machine is performing satisfactorily and the commutator is not wearing badly and progressively, LEAVE IT WELL ALONE. More troubles are born than solved by turning or reconditioning commutators because they look a little wavy, patchy or serrated and do not possess a copy-book smooth polished surface.


Profiler MAS - Commutator - Radial Plot
Recording 1
Radial Scale (+/- 50 Microns)


Profiler MAS - Commutator - Radial Plot
Re-used track4
Radial Scale (+/- 50 Microns)



Scale: Vertical 40 micro inches per division

COMPARISON OF DIFFERENT SURFACE FINISHES