COMMUTATORS AND COLLECTOR RINGS
RESURFACING
MAINTENANCE PROCEDURES

CONTENTS PAGE

1. GENERAL

1.01 This section covers suggestions for procedures and equipment for maintaining commutator and collector ring surfaces in a satisfactory condition on telephone power plant machines.

1.02 This section is reissued to specify flint paper as the approved abrasive for resurfacing commutators; to specify "untreated" canvas as a wiping and burnishing agent; to remove the use of oil on abrasive paper for sanding high mica; and to add information regarding the removal of carbon brushes.

1.03 The term "commutator" is used extensively in this section but the suggestions for commutators should be used for collector rings, interrupter rings, etc, as far as they apply.

1.04 No attempt is made to recommend specific tools. The advantages and disadvantages of various tools are set forth with the idea that this information, together with the advertising of commercial manufacturers and the experience of the individual companies, will permit a reasonable choice of tool. Some of the tools made by Ideal Industries Inc are now listed in the tool sections and the general line of tools made by this company may well be considered when making a choice.

1.05 ***Grooving or Threading:*** The terms grooving and threading are used differently by different maintenance men. Fig. 1 illustrates the terms as used in this section. Grooves or threads may or may not be harmful. No action is required if the groove is polished both on the top and bottom, and the commutation is satisfactory. Threads with raw copper, with sharp tops and bottoms, not polished, are usually harmful and should be corrected. In such cases the surface of the brush will not be smooth and shiny, but may be burned blue and will have light grooves and evidence of small copper particles. It is this "copper picking" that wears the threads and, if not corrected, it will get progressively worse. Some machines are more susceptible than others to threading.

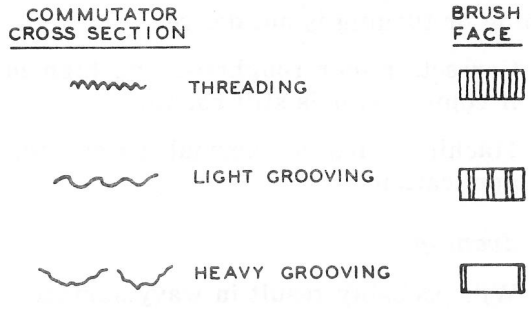


Fig. 1 – Types of Grooving and Threading

2. SELECTION OF METHOD FOR COMMUTATOR RESURFACING

2.01 ***Methods Available:*** When the commutator or collector ring has been allowed to deteriorate too far, the only proper corrective measure is to resurface it. Each of the following methods used commercially has advantages.

Abrasive Paper

Advantages

(1) Convenient.

(2) It removes dirt or deposits not removable with canvas or a solvent.

(3) Corrects minor roughness and high mica, if commutator is still round.

(4) Machine runs at normal speed during application.

Disadvantages

(5) Has tendency to round edges of bar on undercut commutators, especially if a wood block is not used with the abrasive paper.

(6) Might flatten the center of bar on commutators not having undercut mica.

(7) Will not correct flat spots, high bars, or eccentricity.

(8) Destroys commutating film. Other methods do this also but they are not usually applied as frequently as abrasive paper.

Hand Stoning

Advantages

(1) Convenient.

(2) Used where abrasive paper is not enough and set-up labor required for machine stoning or turning is not desired.

(3) Corrects minor roughness and high mica if commutator is still round.

(4) Machine runs at normal speed during application.

Disadvantages

(5) Will probably result in wavy surface.

(6) Will not take out flats or eccentricity.

(7) Is dusty.

(8) Is slow for any appreciable cutting.

Turning

Advantages

(1) Removes roughness, high mica, flats, and eccentricity.

(2) Leaves surface parallel to shaft.

(3) Produces no dust.

(4) Quicker than machine stoning.

(5) Removes less metal than a good job of stoning.

Disadvantages

(6) Requires reducing speed of most machines if turning is to be done in the machine bearings.

(7) Requires very rigid mounting of tool.

Machine Stoning

Advantages

(1) Corrects roughness and high mica.

(2) Machine runs at normal speed.

(3) Easier than turning if brush holder mountings can be used.

Disadvantages

(4) Does poor and incomplete job of removing flats or eccentricity.

(5) Is dusty.

(6) Is slow.

(7) Very hard to leave surface parallel to shaft, particularly near the risers.

(8) Requires rigid mounting of stone.

2.02 ***Choosing a Method for Resurfacing:*** The use of abrasive paper offers a satisfactory method of resurfacing a commutator which is dirty or on which the mica is just beginning to get high. Hand stoning will remove high mica and even flats of small size; however, the most satisfactory method of resurfacing a commutator which is eccentric or badly worn is grinding or turning with a tool having a rigid support.

The following general observations, in addition to those listed heretofore, may be useful when choosing a method.

(1) In general, it is economical to remove the armature of small machines and have the commutator turned in a machine shop. For this purpose, the dividing line between "large" and "small" machines is highly variable. Such things as transportation, nearness to a shop, ability of available personnel, availability of proper tools, considerations of proper reserve machine capacity, etc, should be considered in choosing a method. If practicable, removal of the armature for turning is preferable, particularly on small machines; however, if the bearings are in good condition, turning in the bearings has the advantage of resurfacing under actual service alignment conditions.

(2) Usually a commutator previously resurfaced because of general wear has developed enough eccentricity to warrant turning.

(3) Eccentric commutators and those having flat spots or high bars can rarely be resurfaced satisfactorily except by rest-mounted stones or turning. Occasionally, a very slight flat spot may be removed with a stone or with abrasive paper.

(4) If the mounting for a rest-mounted stone is available, it usually can be adapted for a turning tool, and turning does a better job.

(5) If much grinding is to be done, the dust inevitably thrown into the air is such that hooding of the machine and the provision of some exhauster arrangement is almost necessary, both from the standpoint of personnel safety and the operation of adjacent apparatus.

(6) The transportation of proper tools, together with the set-up and tear-down labor, clean up afterward, etc, often counterbalance the labor of removing, transporting, and reinstalling the armature. Usually it is more economical to remove armatures except for the largest machines.

(7) When turning in the bearings, it is necessary that bearings be in good condition.

Caution: Do not turn or grind into the section of the commutator where leads are attached.

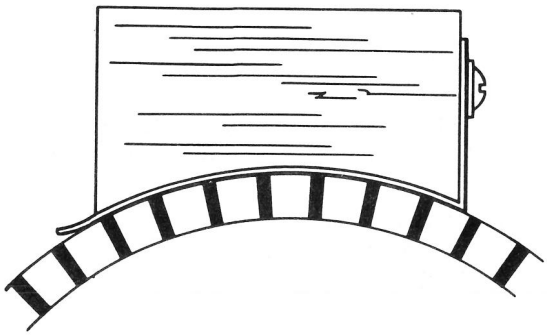
3. RESURFACING WITH ABRASIVE PAPER

3.01 Flint paper as specified in Section 065-370-101 is the approved abrasive paper for commutator resurfacing. Garnet paper or abrasive paper other than flint paper should never be used because the abrasive particles become imbedded in the brush surfaces and cause grooves to form on the commutator surfaces. Emery cloth or paper should never be used because the abrasive is conductive and may short the bars in addition to imbedding abrasive particles in the brush and commutator surfaces.

3.02 Flint paper may be used at any speed but normal speed is considered best. Wire gauze brushes should be removed. Carbon brushes should be removed, if possible, so that the abrasive will not mar the brush surface. In many cases the removal of carbon brushes is impracticable, either because the brushes are required to operate the machine or they are required to maintain service. Carbon brushes should never be removed from a running machine if it involves a personnel hazard. Brushes not removed will have to be reseated.

3.03 Flint paper may be used to remove dirt and deposits and some roughness. It may also be used successfully to eliminate flats and high mica if applied in the early stages and if the commutator is not eccentric. Flats which cover a large area on the commutator will appear to be eliminated by sanding, but will actually be broadened out.

3.04 In most cases, fine and then extra-fine flint paper should be used for resurfacing. Extra-fine flint paper applied longer will leave a smoother surface. It is good practice to apply the flint paper with a wood block, the face of which has been formed to approximately the same radius as the commutator (see Fig. 2). Movement of the flint paper should be slow to avoid diagonal scratches. If flint paper in roll form is available, a strip may be cut long enough to go about three quarters of the way around the commutator, plus some excess length so that when threaded under the brush holders, the two ends may be held in the hands. Then, while the machine is running, exert a very small pressure on the strip and move slowly back and forth over the commutator face.



→ **Fig. 2 – Flint Paper Attached to Wood Block**

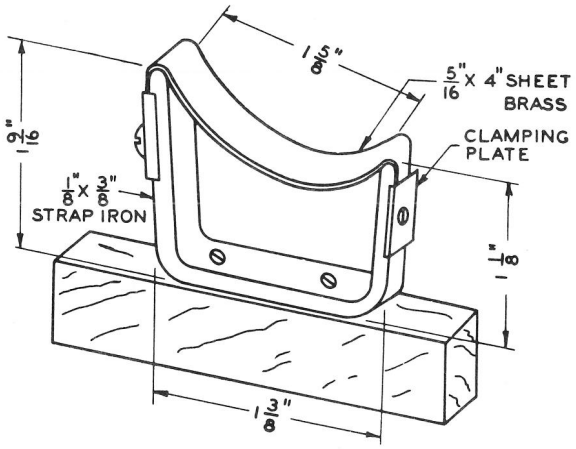


Fig. 3 – Metal Holder for Abrasive Paper Used by One of the Associated Companies for QD-15 → Ringing Machines (Strips of Flint Paper Are Clamped Under the Clamping Plate)

→**3.05** Flint paper often leaves the bars improperly rounded. On an unslotted commutator, the copper may be sanded away faster than the mica and the bar may be left with a flat →center. Wherever high mica is present, the whole →slot should be slightly undercut.

3.06 For small commutators where the armature has been removed, flint paper may be → used very effectively by wrapping it around the commutator, holding the two ends between the thumb and forefinger and rotating the armature. This rotation should be in one direction only.

→**3.07** After using flint paper, the commutator, brush holders, and windings, etc, should be cleaned thoroughly with a brush and compressed air, if available, to remove all abrasive particles. When using compressed air, be careful not to disturb insulation or blow dust into bearings.

Caution: The use of a respirator (see Section 074-755-101) is recommended during extensive sanding operations.

4. RESURFACING WITH HAND STONES

4.01 Hand stones may be used for the same work for which abrasive paper is used. Since they are not flexible, they are somewhat more effective in removing flats and are not as likely to leave the bars improperly rounded.

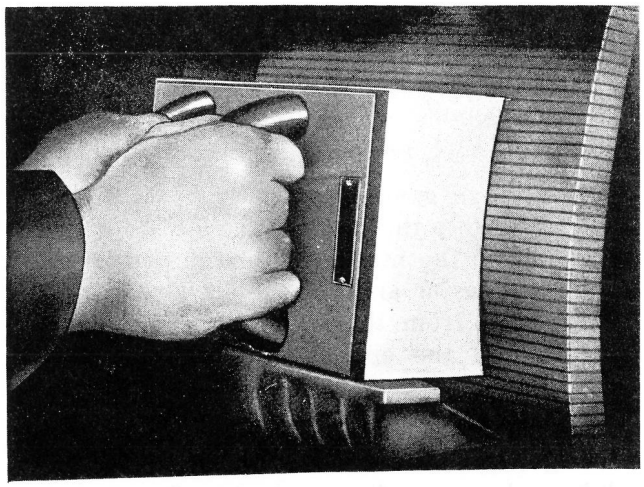


Fig. 4 – Using a Large Hand Stone

4.02 A large variety of stones is available. Section 074-785-101 lists some made by the Ideal Industries Inc, but this company and also several other companies make other shapes and have several types of handles. The following will assist in choosing a stone.

(a) ***Grade:*** A coarse grade may be used for fast cutting where a fair amount of copper is to be removed, but, for general use, high mica, small burns, etc, a medium grade is best. A finish grade should be used after the medium. The finish grade is also best if periodic application is made and for correcting small burns, ridges, etc, immediately after their appearance. Cleaning stones are also available and may be found useful in some cases.

(b) ***Size:*** The larger the stone, the better. It should have a span considerably greater than any flat spot. A length about three quarters of the length of the bar and a width as great as will conveniently go between the brush rigging is desirable. For collector rings, the length should be an inch or so greater than the width of the ring and the width two or three times the longest flat spot. The thickness may be as desired. There is more use and less waste in thick stones.

(c) ***Handles:*** Straight or vertical handles may be used on small stones for small motors with comparatively inaccessible commutators. For larger stones, "U" or "Saw" handles are used. The saw handle should only be used perpendicular to the brush arm because of the tendency to apply uneven pressure on different edges of the stone. It is harder to apply even pressure with two handles than with one.

(d) ***Shape:*** Stones for collector rings should be already formed to the approximate radius of the ring. For commutators, this is also best but the usual practice is to use flat surface stones and wear them in on the machines.

4.03 Stones may be used at any speed up to normal, but normal speed is considered best.

4.04 Any oil on the stone or commutator must be removed with a solvent or with flint paper to prevent clogging the pores of the stone.

4.05 The stone should be pressed firmly but not too hard against the commutator and moved slowly from side to side to prevent diagonal scratches. Use care to prevent the stone being pulled from the hands. Reverse the stone occasionally so it will wear down evenly. Brushes should be removed and the machine cleaned as in 3.02 and 3.07.

5. RESURFACING WITH A TURNING TOOL

5.01 Turning with a lathe turning tool mounted on a 2-way movable carriage and secured to a rigidly mounted base is the method most likely to leave a true commutator surface.

5.02 The ***turning may be done in a machine shop*** or in the machine bearings, provided the proper tool can be properly mounted. Refer to 2.02 for points governing the decision as to whether turning is to be done in a shop or in the machine bearings.

5.03 ***Tightness:*** Before turning, examine the commutator just after stopping, and while still hot (preferably after a full-load run), to see that it is tight. Loose bars may be located by tapping one end with a light hammer while holding a finger on the other end. If bars on commutators with V-rings are loose, the bolts should be tightened snugly, but not sufficiently to strip threads or buckle bars. This should be done while the commutator is still hot.

5.04 Usually a ***surface speed*** of around 500 feet per minute should not be exceeded for turning. This means that a reduction of speed below normal is often necessary. If turning is done without removing the armature, the speed is usually reduced by belt driving from the coupling. A small motor with a 2- or 3-step pulley may be mounted on a base beside the set and belted to the coupling.

Note: Commutator surface speed in feet per minute may be obtained from the formula 3.1416 x diameter of the commutator in feet x rpm.

5.05 For turning, the ***tool rest must be absolutely rigid.*** In a lathe, this is inherent in the design of the tool; in the bearings, a rigid mounting must be provided and the bearings must be reasonably good. The brush holder mounting studs are used sometimes, but they are rarely rigid enough without auxiliary bracing, which is not always easy. However, there is a wide use of commercial tools designed for use on the brush holder studs or on some bracket

mounted in place of the stud and, where they are applicable, they may be used satisfactorily if small cuts are taken.

5.06 For ***end shield bearing machines,*** no tool has been developed for turning the armature in the bearings except those mentioned in 5.05. The commercial practice is to remove the armature where these tools cannot be used.

5.07 ***Before starting to turn a commutator,*** the brushes should be removed and the windings of the armature and the field should be protected with untreated canvas or cloth to keep out dust and copper chips. This may not be feasible for all windings if operation is to be at normal speed in the machine bearings.

5.08 If the machine has end play, it is necessary to remove this before turning. Usually the coupling bolts can be loosened and the coupling halves held apart by extra nuts or washers or by wooden wedges. Wedges should not be driven too tight and may be held in place by a cord. Remove these before restoring the set to service.

5.09 When turning a commutator, use a tool with a rather sharp point, ground at an angle approximately as shown in Fig. 5. It is assumed that no one would be assigned this work without some knowledge of lathe work. For example, the point of the tool should be slightly below the center of the commutator, the tool should be set at an angle that will not permit the engaging of the heel of the tool with the commutator risers when the point is run to the riser end of the bar, the adjustment should be such that the cut can extend the entire length of the bar, and the travel of the tool must be parallel with the machine shaft, etc.

5.10 In addition to such evident precautions as the use of goggles and respirators, wrap the feet and ankles with cloth to prevent copper chips getting into shoes and socks and causing irritation.

5.11 ***After turning*** is completed, the commutator should be undercut, if required, the end of the bars beveled slightly to remove sharp edges, the machine cleaned thoroughly, the armature polished as in Part 8, and the brushes refitted.

6. RESURFACING WITH MACHINE-MOUNTED STONES

6.01 The term "machine-mounted stone" is used here to refer to a stone mounted on a carriage which is movable in two directions and which, in turn, is mounted on a base secured rigidly in place beside the commutator. Such a mounting or carriage is essentially the same as that on a machine turning lathe and commercial designs usually mount the carriage on the brush holder studs or brackets as mentioned in 5.05. Fig. 6 shows a tool of this type made by Ideal Industries Inc.

6.02 Much of the general information in Part 5 applies to the use of machine-mounted stones also; for example, tightness of commu-

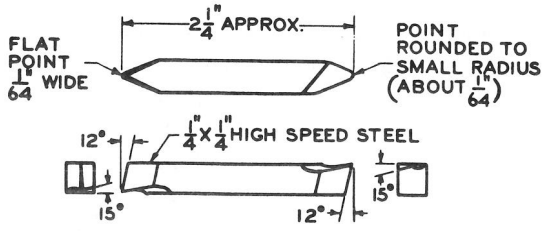


Fig. 5 – Design of One Turning Tool Found Suitable for Turning Commutators

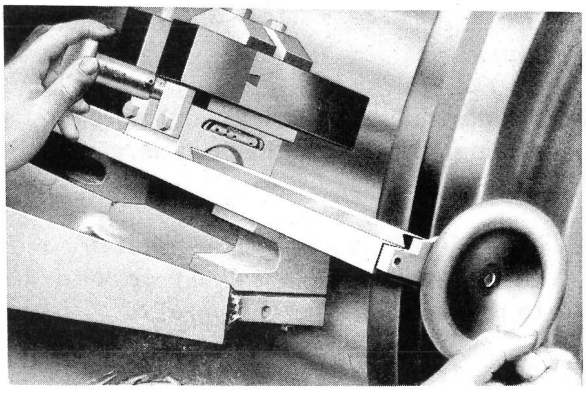


Fig. 6 – Using a Machine-Mounted Stone Mounted on a Brush Holder Stud and Braced to the Bearing Housing

tator bars, rigidity of tool support, masking windings against dust, safety precautions, cleaning, etc.

6.03 Since machine stoning requires the same type of tool mount (except for tool post) and almost as strict requirements on rigidity of tool mounting, there is little to recommend it over turning. It is easier in that normal speed can usually be used (although frequently the best cutting speed will be found at 1500 feet per minute or less), but it is definitely harder in that it is very dusty, much slower, and much less apt to leave a true surface. The following information is included, although many telephone companies have eliminated machine-mounted stones from their practice.

6.04 A medium grade stone should be used until the final cut with a finish grade.

6.05 The stone wears away as it moves across the surface and many small cuts are necessary to prevent a tapered or wavy surface. Several light finish cuts will help to obtain a surface of the same diameter at all points.

6.06 There seems no reason to use a rest-mounted stone if the armature has been removed. The advisability of turning seems evident unless the suggestions in 3.06 apply.

6.07 If much copper is to be removed, experience has shown it advisable to hood the entire machine with canvas, tarpaulins, etc, and exhaust the air with a vacuum cleaner or some such apparatus. If this is not done, the dust-filled atmosphere is harmful to attendants and apparatus.

7. COMMUTATOR UNDERCUTTING

7.01 Commutators that have had the mica undercut should be re-undercut after resurfacing unless there is still room for considerable wear. It should be noted that depth of undercut requirements apply only to new or newly undercut commutators. Shallow undercutting causes little if any trouble as long as no mica extends to the surface of the copper.

7.02 Several tools are available for undercutting.

TOOL	DESCRIPTION
Slotting File	Convenient but cuts a V slot instead of a U slot. File is useful for beveling slot after undercutting. Fig. 7 shows a type made by Ideal Industries Inc.
Motor-driven Rotating Cutter	Modern designs are effective and easily used. Cutters of variable thicknesses are available. Will not cut quite up to risers. More expensive. Fig. 8 shows a type made by Ideal Industries Inc.

Note: Due to lack of demand, the KS-5289 tool has been rated "Manufacture Discontinued."

Motor-driven Reciprocating Cutter	Not so easily used, requires very little clearance between brush arms, cuts close to risers.
Hand Slotters	Simple, convenient, and much used, but have some tendency to drag out small mica laminations and leave cracks for the accumulation of oil and dirt. May be bought commercially or made from a hack-saw blade of suitable width.
Hack-saw Blade	Much used, satisfactory if sharp and used with care. Should be clamped between wood strips to give rigidity. Fig. 9 shows a hack-saw modified for undercutting.
Grooving Tool	Mounted in the turning tool post and moved while the armature is held stationary.

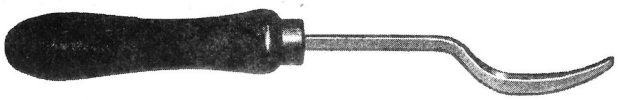


Fig. 7 – Slotting Files (They Are Available in Several Sizes and Shapes)

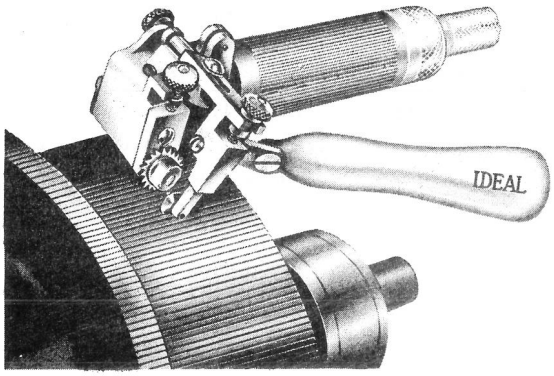


Fig. 8 – Using One Type of Motor-Driven Undercutter

Fig. 9 – Hand Slotter Made From Hack-Saw Blade Wired to a Wood Handle

7.03 No oil or other lubricant should be used in undercutting or on a commutator that has been undercut. The resulting accumulation of copper dust, carbon, etc, in the slots may cause short circuits.

7.04 Two kinds of slots are used, V shaped and U or flat bottom. The main advantage of the V slot is that it tends to throw dirt out better than the U slot. However, the combination of speed and diameter found on practically all telephone power plant machines, except low-speed interrupters, makes the U slot fairly self-cleaning and results in longer wear and easier removal of mica fins left along the sides of the bar when undercutting the U slot.

7.05 When undercutting commutators, the depth should generally be about 1/32 inch and should not be more than 3/64 inch.

7.06 After undercutting, or after resurfacing if no undercutting is to be done, the slot should be cleaned out, any mica fins removed, and the edge of the bars given about a 1/64-inch bevel to remove rough edges. A drag tool or slotting file is good for this purpose.

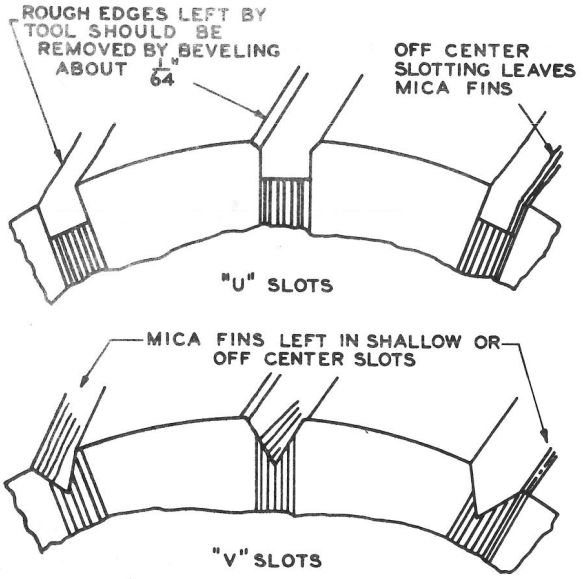


Fig. 10 – U Slots and V Slots

8. BURNISHING OR POLISHING COMMUTATORS AFTER RESURFACING

8.01 After turning or stoning a commutator, the surface should be polished with flint →paper or untreated canvas. The commutation film →may be started by the use of a flexible abrasive stick. (See Section 171-110-701.)

→**8.02** Flint paper applied as in 3.04 and 3.05 is usually sufficient, particularly for small machines. Some burnishing tools such as the Ohio Carbon Company burnishing tool or the Ideal flexible abrasives are also satisfactory.

8.03 Untreated canvas or a flexible abrasive may be used to give a more highly polished or burnished surface than flint paper will give. This may be desirable, particularly for larger machines that must immediately carry full load. Canvas may be applied with a wood block curved to the surface of the commutator. With the commutator running at as near normal speed as practicable, apply the canvas or the flexible abrasive with considerable pressure. The friction and heat will tend to burnish or "cure" or "season" the surface and, if done long enough, will result in a surface almost as good as that obtained by actual service. It is possible, however, to produce excessive temperatures and cause distortion in the commutator assembly; consequently, it is best, if possible, to have this "curing" done by someone with experience in the operation. The commutator polisher described in various machine sections including Section A401.101 is convenient for polishing and curing a newly resurfaced commutator.

8.04 After any operation affecting commutation surface or brush fit, it is very desirable that the machine be operated for several hours at light load before heavy load is applied. (Light load is preferred to no load because of the tendency of some brushes to thread, groove, or form excessive film at no load.) The brush surfaces should then be observed for several days to be sure that they are not picking up copper. The lengths of time for light load runs and for observation of brushes depend on the extent of the work done on the commutator.