

I. & M. REQUIREMENTS SPECIFICATION
BELL TELEPHONE LABORATORIES, INC.
SYSTEMS DEVELOPMENT DEPARTMENT, NEW YORK

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INSTALLATION AND MAINTENANCE REQUIREMENTS
FOR "M" TYPE CHARGING GENERATORS
PER KS-5009

REASON FOR ISSUE

This specification is issued to replace specification X-72026-01, Issue 1 on account of a general revision and includes the following changes:

1. To change the requirements on "Brush Fitting".
2. To change the requirements on "Commutation and Brush Setting".
3. To change and add Maintenance Methods.
4. To add information on commutator stones.
5. To make the specification conform to latest routines.
6. To add a figure showing the correct direction to shift brushes for various loads.
7. To add a figure showing the staggering of brushes.

SECTION 1 - GENERAL

- 1.1 This specification covers the engineering requirements for the testing and maintenance of "M" type charging generators.
- 1.2 Section II of this specification gives the requirements both for operating tests and for the inspection of mechanical adjustments which shall be used to determine whether a charging generator is in proper condition for delivery to the customer and for service. These are called "Test Requirements". The "Test Requirements" must be met not only at the time of delivery to the customer but at all times when operating in service.
- 1.3 Section III of this specification is intended for maintenance purposes only. This section gives the approved maintenance methods and materials for use in making adjustments to meet the "Test Requirements" and will be called "Adjustments".
- 1.4 The following is a list of gauges, tools, materials and lubricating oils specified in Section III for use in inspecting and adjusting the charging generators and associated equipments.

Gauges

Balance, spring, 0-6 lbs. by 2 oz. graduations or equivalent
 Gauge, feeler, 9 leaves, .0015" to .015" or equivalent
 Test Indicator (Surface Gauge), Starrett No. 196 or equivalent
 Thermometer, 0-200° C in 5° graduations
 Brush Jig (Furnished with the generator)

Tools

Monkey Wrench, 8" or 10"
 Screw-driver, 8" or 10"
 Ideal Commutator Stone, "Medium" grade
 Ideal Commutator Stone, "Finish" grade
 Ideal Commutator Stone, "Polish" grade
 Wood Chisel, carpenter's, 1-1/4"
 Chain Hoist, Yale and Towne, one ton or equivalent

Materials

Vaseline
 Cheesecloth, Canton Flannel, or equivalent
 Sandpaper, No. 0, 00, 1/2 or 1, and 1-1/2 or 2
 Garnet Paper, No. 1-1/2 or 2
 Measure, 1 qt. (funnel attached) or other receptacle for oiling
 Rope Sling, 1" diam. rope or equivalent
 Pail or other receptacle for oil
 Sealing Compound, General Electric Company #880
 Sterling Armature Insulating Finishing Varnish "Extra Black"
 Flood and Conklins Black Enamel
 Kerosene
 Cord
 Felt, or the equivalent
 LePage's Glue
 Wooden Block
 Fibre Sheet, 1/16" thick
 Canvas
 Burlap
 Waterproof Paper

Lubricating Oils

One of the following:

Western Electric KS-2245
 Gargoyle Vaculine Oil "C"
 Texas Regal Oil "A"
 Standard Renown Dynamo Oil
 Gulf No. 2 Dynamo Oil
 Sinclair Speed Engine and Dynamo Oil
 Squires Brand Royal Dynamo Oil

- 1.5 The following figures are attached to and form a part of this specification:

Figure 1 - Setting of "M" Type Generator Brushes
 Figure 2 - Neutral Point - Shifting of Brushes - "M" Type Charging Generators
 Figure 3 - Staggering of Brushes - "M" Type Charging Generators

SECTION II - TEST REQUIREMENTS

2.01 Air Gap

The clearance between the generator armature and pole faces shall be at least 0.010".

shall be between 1/32" and 1/8" thick, shall have no frayed or rough edges, and shall be in line within one-quarter the width of a commutator segment. Brushes when refitted shall be cut to the proper jig associated with the machine. Dimensions of brushes shall be in accordance with Figure 1.

2.02 Lubrication

Lubricating oil shall show not more than three-quarters the height nor less than one-half the height in each oil gauge glass with the machine stopped. If metal oil gauge cups are used, the gauge cups shall be kept between one-half and three-quarters full (visual check) with the machine stopped. With the machine running the oil level will be slightly lower. Bearings shall have the oil renewed before the machine is placed in service and at eighteen month intervals.

2.055

The minimum number of segments a telephone gauze brush shall span after it is cut and trimmed can be found from the following table: These values may be exceeded materially as long as the commutation and the heating of the commutator and brushes is satisfactory.

Type and Size	Range of Speed in rpm	**Minimum No. of Segments Covered by a Brush in Accordance with Figure 1
4-P-M1	1700-1950 (.78 kw)	3-1/2
4-P-M1	1700-1950 (.825 and 1.125 kw)	2-1/2
4-P-M2	1700-1950	3-1/2
4-P-M3	1100-1200	3
6-P-M4	1100-1200	2
6-P-M5	1100-1200	2
4-P-M5-1/2	1100-1200	*
4-P-M6	1100-1200	5-1/2
4-P-M7	850-900	5
6-P-M8	850-900	4
6-P-M9	475-600	7
6-P-M10	850-900	5-1/2
8-P-M15	500-600	5-1/2

2.03 Oil Gauges

Oil gauges shall be free from leaks. Gauge glasses when used shall be free from cracks.

2.04 Brush Holders

The brush holders shall be set as shown in Figure 1 so that with the brush holders in the latched back position the heel of the brush is not less than 1" nor more than 1 1/2" from the commutator.

2.05 Brush Fitting

2.051 Telephone gauze brushes shall not be worn down to a length less than D + E (See Figure 1).

*Six segments for M-5-1/2 generators with the 268 bar commutators and three segments for the M-5-1/2 generators with 132 bar commutators.

2.052 For all machines except the M-9 and M-15 sizes, the rows of brushes shall be spaced approximately equally around the circumference of the commutator, the variation not to exceed one-quarter the width of a commutator bar. For M-9 and M-15 machines the spacing shall be as near this limit as is consistent with good commutation.

**The brush spans apply to all type "M" generators whether 30, 33, 45 or 65 volt unless the name plate is marked "Special".

2.06 Brush Pressure

The pressure of telephone gauze brushes shall be within the limits given on Figure 1.

2.053 On all machines where possible the brushes shall be staggered on pairs of studs as shown on Figure 3. When a groove is not present near the inner edge of the commutator, the inside brushes shall be spaced so that no part of the brush or brush holder shall be closer to the commutator tangs or armature windings than 1/8" when the armature is in its extreme position of end play toward the commutator end.

2.07 Commutator

The surface of the commutator shall be clean and free from scoring, pitting or other deformation of the surface or structure other than that due to normal wear. The commutator shall have no high, low or loose commutator segments or flat spots. The total variation due to eccentricity and irregularities of the commutator shall not exceed 0.003" when the armature is rotated in its own bearings. If the commutation is unsatisfactory, the commutator shall be resurfaced so that the total variation of the commutator shall not exceed 0.002". Commutator diameters for the various machines shall not be less than those given below.

2.054 Telephone gauze brushes shall be fitted so that the brush touches the commutator over its full arc and so that at least three-quarters of the contact surface of each brush bears on the commutator. The brush toes

<u>Size of Generator</u>	<u>Minimum Permissible Commutator Diameter in Inches</u>
M-1	4
M-2	5 21/32
M-3	7 1/16
M-4	8 7/8
M-5	9
M-5-1/2 (both sizes)	9
M-6	7 9/16
M-7	9 1/8
M-8	11 13/16
M-9	16 1/2
M-10	11 7/8
M-15	17 5/8

2.08 Voltage

The generator voltage shall be capable of adjustment within one of the following limits according to the rating of the machine.

<u>Generator Rating</u>	<u>Voltage Range</u>
30 volt	20-30 volts
33 volt	22-33 volts
45 volt	32-45 volts
65 volt	44-65 volts

2.09 Noise and Vibration

The noise and vibration of the generator shall not be excessive from no load to full load.

2.10 Commutation

The commutation of the generator at any load between no load and full ampere load, at any voltage within the rated voltage range shall be sparkless.

2.11 End Play

There shall be end play in each direction from the running position of the

armature. Any endwise movement of the armature while running shall not cause knocking in the bearing. The end play shall not exceed 1/4" and shall not interfere with the proper operation of the machine under any load condition.

2.12 Machine Temperatures

Temperatures of the machine as taken by thermometer shall not rise more than the values listed below above a room temperature not exceeding 40° C.:

Bearings	- 40° C.
Commutator and Brushes	- 55° C.
Windings	- 50° C.

REQUIREMENTS TO BE MET AT TIME OF INSTALLATION ONLY

The following additional requirements shall be met at the time the generator is turned over to the Telephone Company.

2.13 Finish

The finish of a new machine shall be in good condition.

2.14 Test Run

A two hour preliminary run with the generator at a voltage within the limits specified in the job specification and at various available loads between one tenth full ampere load and full ampere load shall be made. At the satisfactory completion of the preliminary run and immediately thereafter a one half hour run at the available office load not exceeding full ampere load shall be made.

2.15 Brush Length

Brushes shall be at least 1 1/2" longer than the dimension D + E (Shown on Figure 1).

SECTION III - ADJUSTMENTS3.001 General

The following paragraphs of this section describe in detail the adjustments necessary to meet the test requirements of the correspondingly numbered paragraphs of Section II.

It is recommended that routine maintenance adjustments be made in the sequence presented in this specification in order to prevent interference of one adjustment with another. Where the job specification differs from this specification, the job specification shall take precedence. Unless otherwise specified all adjustments shall be made with the machine stopped.

3.01 Air-Gap

3.011 The air-gap shall be considered as the clearance between the pole faces and the rotating element. Measure the gap between the armature and each pole face with a feeler gauge. Checks should be taken with the armature in at least four different positions approximately 90° apart. If the clearance is less than that specified, new bearings should be installed as found necessary. For all direct connected generators except the M-15 which has split bearings, when a bearing at the coupling end is to be removed, it will be necessary first to move the generator on the sub-base so that the coupling end of the shaft is clear and then remove the coupling half which is keyed on the shaft. If the set is belted it will be necessary with the exception of M-15 generators to remove the pulley before removing the bearing at the pulley end. When removing the bearing at the commutator end of the generator the commutator and as much of the armature as is exposed should be wrapped with canvas for protection. After draining the oil from the bearing chambers into a pail or other receptacle the bearings may be removed as follows:

3.012 On generators having a bearing housing in two halves, remove the two holding down screws, the rocker arm (if this is mounted on the bearing) and the upper half of the bearing housing. The generator shaft should then be raised just far enough to take the weight of the armature off of the bearing taking care not to injure the commutator or armature windings in so doing. This may be done by a rope sling looped around the generator shaft, the rope sling being hooked into a block and tackle or chain hoist. If more convenient a bar may be placed underneath the shaft as near the bearing as possible and the shaft raised with the aid of blocks and jacks. The armatures of smaller generators may be lifted by hand with or without a rope sling instead of using a chain hoist, block and tackle or equivalent. Great care should be taken not to rest any of the weight of the armature on the commutator bars. Thin fibre sheets

should be used between the sling and the commutator to protect the end of the commutator. Do not allow the rope to touch the armature windings.

3.013

M-7 generators and smaller These generators may have their bearings removed after going through the procedure outlined in paragraph 3.011 and 3.012 by taking off the bearing housing end plates which are held to the bearing housings by four screws, and sliding the bearing out of the bearing housing taking care to lift the oil rings free from their slots in the bearing. The bearing housings are not split and the bearings are in a single piece which in a good many cases fit tightly. It will be necessary to remove the housing to take out the bearing, taking care, however, to mark the housing so that the housing may be replaced in exactly the same position in order not to alter the amount of armature end play. The housing may be removed by unscrewing the cap screw which is under the bearing housing and inside the bearing pedestal, and which secures the bearing housing in place on the pedestal. If the bearing is at the commutator end the two rocker arm clamping screws should be removed and the rocker arm taken off before attempting to remove the bearing housing.

3.014

M-8 and M-10 generators (except some obsolete types) On generators of these types the bearing housings consist of two pieces, the upper half being clamped to the lower half by two bolts. The bearing, however, is a single piece. To remove the bearing after going through the procedure given in paragraphs 3.011 and 3.012, the lower half of the bearing housing together with the bearing should first be loosened by unscrewing the two cap screws under the bearing housing and inside the bearing pedestal which secure the housing to the pedestal. After doing this the bearing and the lower half of the bearing housing may be removed from the shaft and the bearing taken from the housing.

3.015

M-15 generators The upper half of the bearing housing may first be removed by unscrewing the holding down bolts and then the bearing which is in two halves on this size of generator may be removed. It is not necessary to move the pedestal to remove the bearing. The lower bearing half may be removed after the upper half by first removing the weight of the armature from the bearing and revolving the lower bearing half around the shaft until it is on the upper side.

3.016

Bearings should be replaced so that the hole for the clamping screw or clamping pin and the slots for the oil rings are on the upper side. Care should be taken when replacing bearings not to injure the oil rings. Replace the clamping screws or pin, depending on which is

furnished, and make sure that all bolts and nuts are set up tight. When replacing end plates on bearing housing halves, use No. 880 Sealing Compound to make the joints oil-tight and allow the joints to set at least an hour before placing oil in the bearing chamber. If it is necessary to move the bearing housing on the pedestal, care should be taken to replace it in its original position so that the end play of the armature is the same as before. New bearings should bring the armature into a central location in the frame so that the air-gap is approximately uniform at all poles.

3.02 Lubrication

3.021 Fill all oil gauges to the specified level with the generator stopped. Never put in too much oil as it will work along the shaft into the machine windings and cause the insulation to deteriorate rapidly. The oil should rise in the sight gauge as the bearing is filled. If after a reasonable amount of oil has been placed in the bearing and the oil level in the gauge does not rise, it is an indication that the passage to the gauge is blocked and should be cleared. A fine copper wire should be used to remove any slight obstruction. The oil recommended for best results is the Western Electric Company's KS-2245 lubricating oil but any of the light mineral dynamo oils listed in paragraph 1.4 or an oil having a viscosity between 140 and 225 seconds, Saybolt Universal at 100° F may be used for bearing lubrication. To prevent oil creeping along the shaft which is usually due to dirt or lint acting as a wick wipe off the shaft using cheesecloth. Under no consideration should the machines be wiped off or cleaned while running. Commutators should be lubricated as outlined in paragraph 3.07.

3.022 At the specified interval remove the drain plugs and drain the old oil into a pail or other receptacle. Examine the oil for evidence of grit or other foreign matter. If grit is present flush the bearing with fresh clean oil. Be sure the oil rings are clean and in good condition. Clean the drain plugs and associated threads in the casting. Replace the drain plugs sealing them with No. 880 sealing compound and allow to dry for at least an hour after which the bearing should be filled with one of the oils specified. If the machines are installed in places exposed to dust, it will be advisable to reduce this cleaning interval.

3.023 The oil rings of generator bearings should be replaced when bent or damaged in any way which might cause the

rings to stop turning or fail to deliver oil to the bearing. To remove the oil rings, it will be necessary to take out the bearings as outlined in paragraph 3.01 except in the case of an M-15 generator which has split oil rings. Oil well covers should be kept closed at all times except when inspecting or oiling the bearings.

3.03 Oil Gauges

3.031 If the oil gauges leak at the joint between the glass and the washer the glass should be removed. Drain off the oil. Unscrew the cap or holding ring which bears on the top of the glass and lift the glass out. The cork washer under the glass should then be renewed, making sure that it has a clean surface to rest on. Leaks may be caused by nicks at the bottom of the glass. The glass and cap or holding ring should be carefully replaced, screwing in the cap or holding ring firmly enough to force the glass into good contact with the cork washer.

3.032 If the oil gauges leak at the joint where the gauge is screwed into the machine casting, the gauge should be removed, the screw threads on the gauge and in the casting cleaned and the gauge replaced using No. 880 sealing compound for an effective seal. Allow the sealing compound to set for at least an hour after replacing the gauge before refilling the chamber with oil.

3.04 Brush Holders

Place the brush and holder in the latched back position. Loosen the brush holder clamping screw and turn the brush holder on the stud until the heel of the brush is the specified distance from the commutator. Clamp the brush holder in this position. After an adjustment, check the requirements as given in paragraph 2.05. In cleaning, brush holders shall not be polished as the polishing paste works under the brush holder stud and eventually reduces the electrical contact between the brush holder and the stud. This may also cause the holder to bind on the stud.

3.05 Brush Fitting

3.051 When the brushes wear below the specified limits, they shall be replaced.

3.052 The spacing of the rows of brushes may be determined by measuring off a piece of paper, the length of the circumference of the commutator, dividing the length of the paper into as many equal sections as there are studs and suitably marking each division. Lay the paper out around the commutator underneath the brushes and bring the toes of

the brushes on each stud in line with one of the marks. To assist in setting the brushes at a future date, punch marks may be placed on the ends of the commutator bars directly beneath the toes of the brushes on each stud. The dimension "D" (See Figure 1) may be varied slightly to meet the spacing requirements and commutator wear. Any change in the brush position will require refitting of the brush.

For M-9 and M-15 machines the factory setting of the brush stud brackets should not be changed in an endeavor to meet the spacing requirements. If it is found necessary to remove the brushes and brush stud brackets carefully mark each brush and the position of each eccentric bushing in the brush stud bracket, before removing, in order that they may be replaced in the same position.

Where the factory setting has been disturbed, the brushes on the generator should be reset as follows. If scribe marks are present on the brush stud bracket and rocker arm, the brackets should be set on these marks and fastened in position. If no marks are present, set all the brushes within the limits and as outlined for other sizes of "M" type generators. If sparking still occurs under the brushes on any stud, stop the machine, loosen the clamping bolts which hold the bracket to the rocker arm, rotate the eccentric bushings around these bolts to move the brush position on the commutator either forward or backward until the best commutation is obtained. Clamp the brackets firmly in position by tightening the clamping bolts. When this position has been obtained the bracket and rocker arm should be marked with scribe marks to indicate the proper operating position for future reference. At least three marks should be made for each bracket preferably at the ends, near each mounting screw and at the side between the two mounting screws.

- 3.053 The position of the brushes on the stud may be shifted by loosening the clamping screw and sliding the brush holders backward or forward along the stud to stagger the brushes as shown on Figure 3. After an adjustment has been made, be sure that the clamping screw is tightened securely.
- 3.054 When it becomes necessary to replace or refit a telephone gauze brush the brush should be clamped in the brush filing jig furnished (when specified) with each generator. With a sharp wood chisel trim the brush to the curvature of the jig. Trim the toes of the brush to the specified thickness, replace the brush in the brush holder,

in accordance with Figure 1 and line it up on the brush stud. Smooth any rough edges and sand in the contact surface. "Sanding in" may be accomplished in the following manner:

Place all the brushes in the latched back position. Cut a piece of garnet paper or sandpaper No. 1/2, 1, 1 1/2 or 2 the width of the commutator and having a length sufficient to go around the commutator and overlap a distance of approximately 2". The garnet or sandpaper should be drawn tightly around the commutator with the sand side out. Where the paper laps the sand should be removed from the under portion and the overlapped end should point opposite to the direction of rotation. If possible the overlapping parts of the paper should be thinned so that the joint is no thicker than the rest of the surface. Apply LePage's glue to the lap and commutator for a distance of approximately 3" in each direction from the joined end of the lap and at intervals around the commutator. The paper should be held securely in place by cord wrapped over the paper until the glue is thoroughly dry. An alternative method is to cut the paper to such a length that when wrapped tightly around the commutator the ends will form a butt joint with not more than 1/8" space between them. With the armature rotating at normal speed, one brush at a time in its holder should be pressed lightly against the sandpaper at intervals until it is sanded over its entire contact area. This brush should then be latched back and another brush sanded in a similar manner. This procedure should be followed until all brushes on the machine have the proper fit. The brushes should then be given a final finish with No. 0 or No. 00 sandpaper. After sanding, clean the machine by blowing out as much dirt and metallic dust as possible and wipe with a clean cheesecloth. Clean the brushes with a cloth moistened with kerosene. Remove the sandpaper and glue from the surface of the commutator by using a cloth moistened with warm water. Be careful not to get moisture into the windings and be sure the commutator is thoroughly cleaned. After removing the sandpaper, the brushes should be shifted forward in their holders a slight amount to compensate for the removal of the sandpaper. The brushes should then be lowered on the commutator and the machine operated at rated speed for four or five hours without excitation. This operation of the machine is necessary to obtain a good commutating surface. During the operation of the machine the commutator should be kept well lubricated.

3.055 Check brush dimensions with Figure 1

and make any necessary adjustments.

3.06 Brush Pressure

Brush pressure may be determined by looping a piece of light cord under the center of the face of the brush parallel to the commutator segments and exerting a radial pull (See Figure 1) by means of a spring balance hooked into the looped cord. The total brush pressure is the reading of the balance in ounces just as the brush starts to move away from the commutator. The movement of the brush may be determined by placing a piece of paper under the brush and exerting a slight tension on the paper. When the paper slides out from under the brush the balance should be read for brush pressure. The correct brush pressure may be obtained by adjusting the adjusting nut on the brush holder (See Figure 1) as required. It is desirable to make the brush pressure on all brushes of the same generator as nearly uniform as possible.

3.07 Commutator

3.071 The commutator should never be polished but should be allowed to acquire an even bronze color. It should be cleaned by rubbing with a clean dry cheesecloth. If the commutator becomes smutted, clean with cheesecloth slightly moistened with kerosene. Raise the brushes during this operation.

3.072 To maintain good commutation, a lubricating mixture consisting of 50% vaseline and 50% dynamo oil should be used, adding more vaseline to the mixture if cases are found where the brushes tend to cut or scrape the commutators and thinning the mixture with oil if gumming of the commutator occurs. The mixture should be thoroughly stirred each time before using and should be applied to the commutator often enough and in just sufficient quantities to maintain efficient commutation with minimum wear. Cheesecloth or Canton flannel folded with the hard side out, slightly moistened with the above mixture should be used for lubricating the commutator. In general, the frequency of lubrication required will be at about one hour intervals. This may vary somewhat for different operating conditions but it is essential that the lubricant be applied at regular intervals to insure a continuous even film on the commutator. The use of kerosene as part of a commutator lubricant is not recommended due to the possibility of the brushes cutting the commutator if this is used. Each time the machine is shut down the commutator and the contact surfaces of the brushes should be cleaned using kerosene. Do not leave the brushes saturated with kerosene as this will cut the lubricant.

When a machine is shut down the brushes should be left in the latched back position. After starting the machine wipe off the commutator before lowering the brushes.

3.073

A certain amount of grooving of the commutator will take place due to normal wear between the brushes and the commutator and will not ordinarily prevent satisfactory operation. This wear should not be confused with scratching of the commutator. When the commutator surface shows signs of scratching the brushes should be carefully cleaned with kerosene to remove any grit which may have become imbedded in the brush bearing surface. If this fails to prevent further scratching, the brush should be replaced or the lubricating routine changed. If trouble of this kind is not remedied at once the commutator may be badly injured within a short time. In general, if the commutator is properly lubricated it will operate for several weeks before roughness appears. If it is necessary to remove any roughness on the commutator surface use No. 00 or No. 0 sandpaper. Never use a file, emery cloth or paste on a commutator for this purpose.

3.074

A scored or ridged commutator may be smoothed by means of "Ideal" commutator stones as follows: Lift the brushes from the commutator surface and cover the brushes and brush holders with paper or canvas to protect against the grit and dust of the stoning process, or remove the brushes from the brush holders. Clean the commutator surface with cheesecloth moistened with kerosene.

For the protection of the operator it is suggested that a moistened gauze mask be placed over the nose and mouth during the stoning process. A "Medium" grade of stone should be held firmly by means of the handle in such a manner that the length of the stone is at right angles to the commutator bars. The position of the operator in relation to the direction of armature rotation will depend upon local conditions and the convenience of the operator. The stone shall be moved slowly back and forth across the surface in a direction parallel to the commutator segments with an even pressure and with the machine running at normal speed. When the major grooves or ridges have been removed, a "Finish" stone should be used and this followed with a "Polish" stone. If the commutator requires but little cutting the operation may be started with a "Finish" stone, omitting the use of the "Medium" stone. After the resurfacing is completed blow out the windings with air, clean the commutator and brushes with cheesecloth moistened with kerosene and apply lubricant to the commutator before

lowering the brushes.

The following sizes of stones are suggested as suitable for use on "M" type charging generators: 3.0771

Type of Generator	Size in Inches of "Ideal" Stones		
	Length	Width	Thickness
M-1 and M-2	3	1	3
M-3 and M-4	3	1 1/2	3
M-5	5	2 1/2	4
M-5 1/2	4 1/2	4	4
M-6	5	4	4
M-7	6	6	4
M-8 and M-9	7	6	4
M-10	8	6	4
M-15	8 1/2	6	4

Handles are furnished attached to the stones.

3.075 Scored or ridged commutators may also be smoothed by using No. 00 or No. 0 sandpaper folded sand side out on a wooden block which is carefully shaped to fit the curvature of the commutator. Before commencing the smoothing operation all brushes should be latched back and the commutator should be cleaned. The brushes and brush holders should be covered with paper or canvas to protect against the grit and dust of the sanding process. For the protection of the operator it is suggested that a moistened gauze mask be placed over the nose and mouth during the sanding process. By pressing down on the wooden block and moving it constantly back and forth in a direction parallel to the commutator segments while the machine is running the commutator is smoothed down. After sanding blow out the windings with air, clean the commutator and the brushes with cheesecloth moistened with kerosene and apply lubricant to the commutator before lowering the brushes.

3.0772

3.076 If a commutator becomes more than slightly rough or eccentric, or develops flat spots, it should be refaced by a commutator turning device or in a lathe as sanding or stoning in these cases is likely to make conditions worse rather than better. If commutation trouble is encountered which is believed to be due to excessive eccentricity, the eccentricity may be checked, by means of a test indicator, (surface gauge), and if found to be greater than permitted the commutator should be refaced by machining in a lathe or by a commutator turning device. After the commutator is resurfaced by any of the above means the brushes should also be refitted.

3.0773

3.077 In case the commutator is found to have a high, low or loose commutator segment, the commutator should be baked, tightened and trued. To repair or replace a commutator it will be

3.0774

necessary to remove the armature which may be done in the following manner.

Mark the position of the coupling on the shaft and remove the coupling half or pulley, shifting the position of the generator on the sub-base, if necessary. Insert thin fibre sheets between the pole faces and armature and also between the rope slings (if used) and the ends of the commutator and the armature windings to prevent injury. Using rope slings and a block and tackle or chain hoist, if necessary, remove the bearing housings and rocker arm as described under paragraph 3.01. Support the weight of the armature taken by rope slings at either end of the shaft. Slide the armature toward the commutator end of the generator until one of the rope slings comes up against the magnet frame. Rest the armature carefully on pieces of fibre inserted between the pole pieces and the armature and bring the sling used at the coupling end to the other side of the magnet frame and loop it back thru the magnet frame and under the shaft again. Take up the weight carefully and work the armature clear of the magnet frame. A spreader should be inserted between the two slings whenever possible to keep the slings from bearing against the commutator or end turns of the armature winding.

M-15 generator armatures may be removed by removing the upper half of the field magnet frame as well as the upper bearing caps and bearings and hoisting the armature out by means of a chain, hoist or block and tackle hooked into two rope slings looped under each end of the shaft, with a spreader holding the two slings apart, so that they will not bear against the commutator or end turns of the armature winding.

Whenever an armature is removed from a machine the greatest care should be taken to rest it on wooden blocks placed under the shaft and never allow the weight to rest on the surface windings of the armature except temporarily just after removing from the machine when it may be rested on burlap bagging or equivalent material. Great care should be taken to avoid scratching the journals of the shaft as this will cause cutting in the bearings and heating. If roughened the journals should be smoothed with No. 00 sandpaper and dynamo oil, using a circular motion around the shaft.

When shipping an armature the shaft should be covered with

vaseline, the armature wrapped with waterproof paper and carefully boxed, the weight resting on the shaft bearing on "V" shaped blocks with holding down blocks bearing on the top and both sides of the shaft so as to make movement of the armature within the box impossible. The shafts should be completely enclosed in the box and blocked to prevent the armature from shifting in an endwise direction. All blocks should have a clearance of from 1 1/2" to 2 1/2" from the commutator or armature winding and a space of at least 1 1/2" should be left between the armature and the sides of the box.

tightened when the adjustment has been made.

3.10 Commutation

3.101 For the successful commutation of "M" type charging sets the requirements of paragraph 2.01, and 2.04 to 2.07 inclusive shall be met.

3.102 The factory marking will usually give the best commutation and least noise over the greater part of the permissible load and voltage ranges. The rocker arm should be shifted if necessary to give sparkless commutation for the local load conditions. This position will be indicated by producing the least noise in the connected circuits. To move a rocker arm loosen the clamping stud (if provided) and shift the position of the rocker arm by means of the handwheel which is provided for this purpose on the larger generators or by hand for the smaller generators. Be sure to tighten the clamping stud after an adjustment.

3.0775 Armatures may be replaced in a similar manner going thru the steps given above in the reverse order.

3.08 Voltage

The voltage may be read on the associated voltmeter on the power board. The voltage may be controlled by the generator field rheostat. Cutting in resistance decreases the voltage while cutting out resistance increases the voltage. If the polarity of a machine becomes reversed or the field loses its residual magnetism, this may be corrected as follows: Stop the machine. Raise all brushes. Close the generator line switch and hold the generator circuit breaker in for a few seconds and repeat as necessary until the generator field is magnetized correctly.

65 volt machines when furnished for emergency charging of a 24 volt battery are capable of regulation in the 22-33 volt range as well as in the 44-65 volt range.

3.103 For a given ampere load, the electrical neutral, shifts in the direction of rotation when the generator voltage is reduced from maximum rated voltage to a voltage less than maximum. For a given voltage, the electrical neutral, shifts against the direction of rotation as the load is decreased. These conditions are illustrated by the arrows in Figure 2. These arrows indicate only relative positions, because the distances thru which the neutral moves will vary not only with the size of generator but also with individual machines of the same size.

3.09 Noise and Vibration

3.091 Noise and vibration in the generator may be caused by worn generator bearings or poor alignment of the generator with the driving motor or gas engine. Replacement of bearings if required should be done in accordance with the instructions given in paragraph 3.01. On direct connected sets the generator should be set up so that its shaft will be level and in line with the driving motor or gas engine shaft. Metal shims may be used where necessary. The M-15 generator bearing pedestals are dowelled in place. For belt driven sets the generator should be set up so that its shaft is parallel with the shaft of the driving member.

3.092 If the set is resting on car springs and vibration occurs after it has been leveled, the car springs can be adjusted by loosening the lock nut on the adjusting screw and turning the screw in or out as is found to be best by experiment. The lock nut should be

As an illustration, assume that a 33 volt generator is to be operated usually between 1/4 and 3/4 ampere load at 25 volts. By referring to Fig. 2 the neutral for full load 25 volts would bring the movable neutral mark to the right of the fixed neutral mark. However, as the generator is to be used at an average of 1/2 load the neutral will be to the left of the 25 volt full load position. After locating the correct neutral for this load it will seldom be necessary to shift the brushes for normal load variations.

3.11 End Play

The amount of end play in the generator may be altered, by loosening the hexagon headed cap screws inside the bearing pedestal which secure the bearing housing in place on the pedestal and moving the bearing housing in or out as necessary, taking care to tighten the screws again. This will break the finish at the joint between the bearing housing and pedestal and hence should be avoided if possible. An exception to the above is the M-15 generator in which the pedestal and

bearing housing form one piece which is doweled in place at the factory after proper adjustment has been made. A machine may appear to lack end play from the running position if the machine is not level. Oscillation or endwise movement while running may be caused by the rotor of the generator or motor not being in the magnetic center of the respective magnetic field.

3.12 Machine Temperatures

- 3.121 With a temperature of approximately 45° centigrade, the hand may still be held on a machine without discomfort. This temperature, however, is only about one half the allowed amount, which consists of the sum of the room temperature and the allowable temperature rise. Therefore, if machines become so hot that the hand cannot be held on them it is not necessarily an indication that the machine is too hot. In these cases, the temperature should be measured as described in paragraphs 3.122, 3.123, and 3.124 below.
- 3.122 The temperature of the bearings should be taken while the machine is running by either one of the two following methods:
1. Where possible place the bulb of a centigrade thermometer for at least 5 minutes in the lubricating oil of the bearing taking care that the thermometer does not strike the shaft or interfere with the oil ring in the bearing.
 2. Where impossible to use method 1, hold the bulb of a centigrade thermometer for at least 5 minutes tightly against the hottest spot on the outside of the bearing housing as near as possible to where the bearing is located, by means of a piece of felt or equivalent material covering that part of the bulb which does not touch the bearing housing.
- 3.123 The temperature of the commutator should be taken immediately after stopping the machine. The bulb of a centigrade thermometer should be held against the commutator surface by means of a piece of felt and the high-

est temperature indicated by the thermometer observed.

- 3.124 Windings, brushes and machine frame may be measured for temperature rise by holding the thermometer against the surface for 5 minutes by means of a piece of felt.

REQUIREMENTS TO BE MET AT TIME OF INSTALLATION ONLY

3.13 Finish

Care should be taken not to mar the finish of the machine. If it becomes necessary to paint the armature field coils, pole pieces or cables, Sterling Armature Insulating Finishing Varnish, "Extra Black" may be used. Surfaces which have been treated with a filler during the finishing process, such as the generator frame or sub-base may be retouched with Flood and Conklins Black Enamel.

3.14 Test Run

During the test run the generator shall be operated within the voltage and current limits as specified in the job specification. The voltage and ampere load on the machine may be read from switchboard meters. At the completion of the official run a statement to the effect that the machine has been tested and found to operate satisfactorily should be turned over to the Telephone Company, together with a copy of this test data and the factory test. The statement shall include the date upon which the oil in the bearings was last changed.

3.15 Brush Length

If the brushes are not within the specified limits they should be removed from their holders and replaced.

3.16 Renewal Parts

In general, replacement parts for the generators may be ordered by describing the part fully and giving the complete data shown on the nameplate including the serial number of the generator. Generator telephone-gauze brushes may be ordered by giving the generator size and brush dimensions as shown on Figure 1.

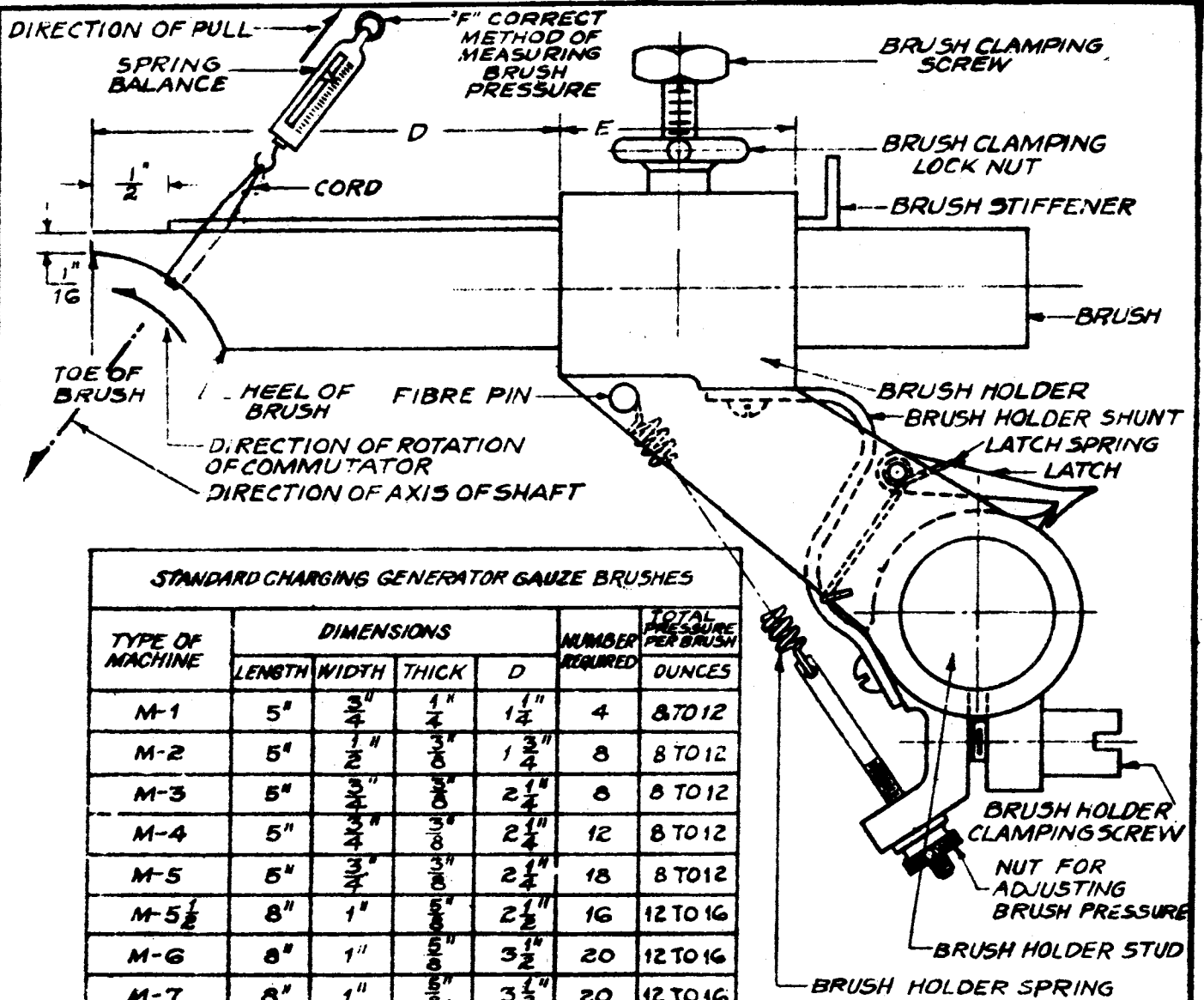
Attached:

- X-72026-01, Figure 1
- X-72026-01, Figure 2
- X-72026-01, Figure 3

DEPT. 331-C

AHR)ZL

BELL TELEPHONE LABORATORIES, INC.



STANDARD CHARGING GENERATOR GAUZE BRUSHES

TYPE OF MACHINE	DIMENSIONS				NUMBER REQUIRED	TOTAL PRESSURE PER BRUSH OUNCES
	LENGTH	WIDTH	THICK	D		
M-1	5"	$\frac{3}{4}$ "	$\frac{1}{4}$ "	$\frac{1}{2}$ "	4	8 TO 12
M-2	5"	$\frac{1}{2}$ "	$\frac{3}{8}$ "	$1\frac{3}{4}$ "	8	8 TO 12
M-3	5"	$\frac{3}{4}$ "	$\frac{5}{16}$ "	$2\frac{1}{4}$ "	8	8 TO 12
M-4	5"	$\frac{3}{4}$ "	$\frac{3}{8}$ "	$2\frac{1}{4}$ "	12	8 TO 12
M-5	5"	$\frac{3}{4}$ "	$\frac{5}{16}$ "	$2\frac{1}{4}$ "	18	8 TO 12
M-5 $\frac{1}{2}$	8"	1"	$\frac{5}{16}$ "	$2\frac{1}{2}$ "	16	12 TO 16
M-6	8"	1"	$\frac{5}{16}$ "	$3\frac{1}{2}$ "	20	12 TO 16
M-7	8"	1"	$\frac{5}{16}$ "	$3\frac{1}{2}$ "	20	12 TO 16
M-8	8"	1"	$\frac{5}{16}$ "	$2\frac{3}{4}$ "	36	12 TO 16
M-10	8"	1"	$\frac{3}{4}$ "	$2\frac{5}{8}$ "	36	12 TO 16
M-15	8"	1"	$\frac{9}{16}$ "	$3\frac{1}{2}$ "	48	12 TO 16

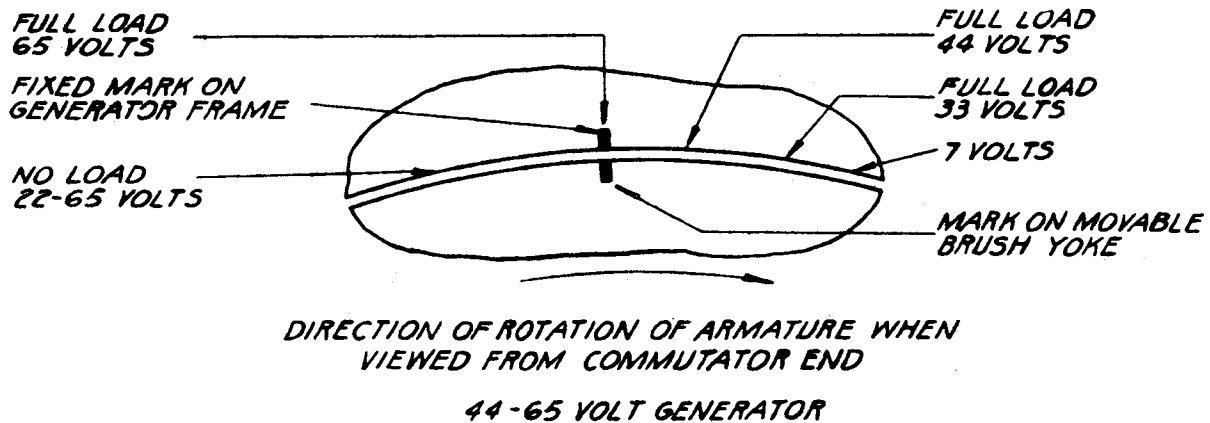
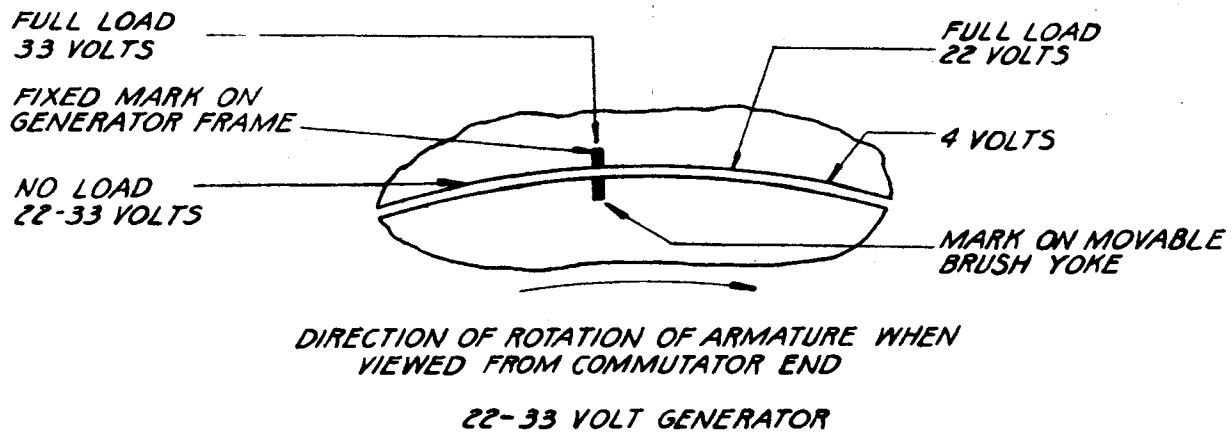
NOTES:

- 1- ALL BRUSHES MADE OF TELEPHONE GAUZE
- 2- FOR CORRECT READING OF BRUSH PRESSURE THE CORD MUST BE LOOPED HALF WAY BETWEEN HEEL AND TOE OF BRUSH AND PULL EXERTED AT "F" IN A RADIAL DIRECTION FROM THE AXIS OF THE COMMUTATOR AS SHOWN ABOVE.
- 3- IN TABLE, DIMENSION "D" SHALL BE INCREASED TO COMPENSATE FOR COMMUTATOR WEAR TO MAINTAIN THE MINIMUM NUMBER OF SEGMENTS UNDER THE BRUSH (SEE PARAGRAPH 2.055)

SETTING OF "M" TYPE GENERATOR BRUSHES

BELL TELEPHONE LABORATORIES, INC.

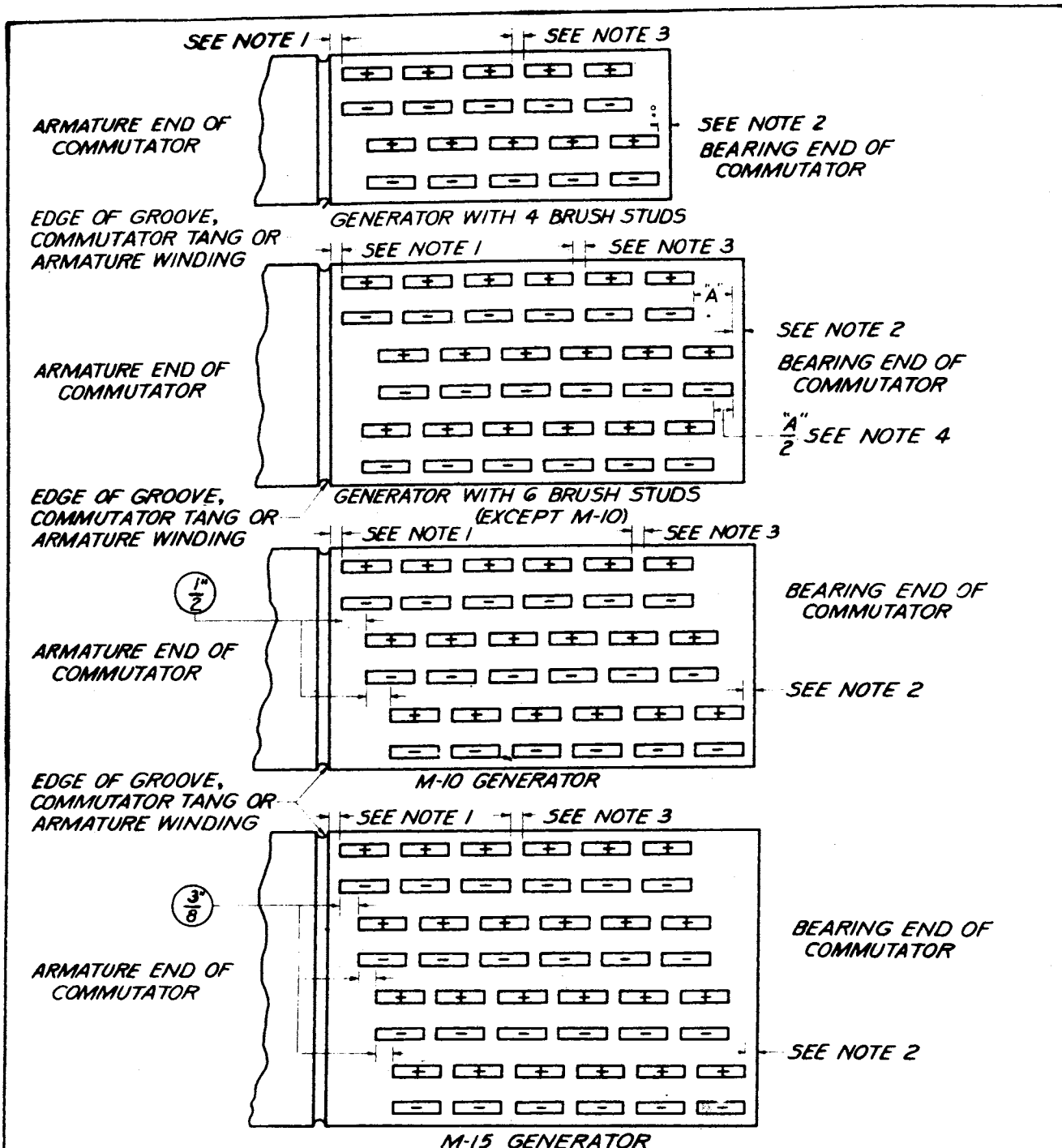
X-T2026-01 FIG.1



NOTES:

1. CORRESPONDING POSITIONS FOR GENERATORS RATED AT 20-30 VOLTS AND 32-45 VOLTS ARE SIMILAR TO THOSE INDICATED FOR THE 22-33 VOLT GENERATOR
2. DISTANCES SHOWN FOR THE VARIOUS SETTINGS ARE NOT TO SCALE.
3. ARROWS FOR VARIOUS LOAD AND VOLTAGE POSITIONS ALWAYS INDICATE POSITIONS ON THE GENERATOR FRAME TOWARD WHICH THE MARK ON THE BRUSH YOKE SHOULD BE SHIFTED.
4. FOR VOLTAGES LESS THAN MAXIMUM WITH GENERATOR CARRYING FULL LOAD, SHIFT THE BRUSHES IN THE DIRECTION OF ROTATION OF ARMATURE FROM THE FULL LOAD MAXIMUM VOLTAGE POSITION.
5. FOR LESS THAN FULL LOAD SHIFT THE BRUSHES OPPOSITE TO THE DIRECTION OF ROTATION OF THE ARMATURE FROM THE FULL LOAD POSITION OF THE BRUSHES FOR THE VOLTAGE IN USE.
6. AFTER SELECTING A NEUTRAL FOR THE OPERATING LOAD AND VOLTAGE OF THE GENERATOR IT WILL SELDOM BE NECESSARY TO SHIFT THE BRUSHES FOR NORMAL LOAD VARIATIONS.
7. FOR THE 4 VOLT OR 7 VOLT CONDITION SHIFT THE BRUSHES IN THE DIRECTION OF ROTATION OF THE ARMATURE.

**NEUTRAL POINT
SHIFTING OF BRUSHES
"M" TYPE CHARGING GENERATORS**



NOTES:

1. BETWEEN 0 " AND $\frac{1}{8}$ " WITH ARMATURE IN EXTREME POSITION OF END PLAY TOWARD COMMUTATOR END OF GENERATOR.
2. BETWEEN 0 " AND $\frac{3}{8}$ " WITH ARMATURE IN EXTREME POSITION OF END PLAY TOWARD THE COUPLING END OF THE GENERATOR.
3. ALL BRUSHES ON THE SAME STUD SHALL BE SET AS CLOSE TOGETHER AS POSSIBLE, EXCEPT ON M-10 AND M-15 GENERATORS THE GENERATOR BRUSHES SHALL BE EQUALLY SPACED AFTER THE DIMENSIONS INDICATED IN THE FIGURES FOR THESE GENERATORS HAVE BEEN MET. THE SPACING OF BRUSHES ON ALL STUDS SHALL BE AS UNIFORM AS POSSIBLE.
4. THE DIMENSION 'A' IS MEASURED AFTER SETTING THE BRUSHES ON THE FIRST TWO PAIRS OF STUDS. THE BRUSHES ON THE THIRD PAIR OF STUDS ARE SET HALF WAY BETWEEN THOSE ON THE FIRST TWO PAIRS OF STUDS.

**STAGGERING OF BRUSHES
"M" TYPE CHARGING GENERATORS**