GENERATORS — TYPE "M"
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers "M" type charging generators, KS-5009 and repaired generators KS-5221.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Reference shall be made to Section 020-010-711 covering General Requirements and Definitions for additional information necessary for the proper application of the requirements listed herein.

1.04 Requirements and associated procedures marked with a number sign (#) need not be checked for by the installer unless it is thought that the requirement is not being met or performance indicates that such a check is advisable.

1.05 Requirements marked with an asterisk (*) need not be checked for during maintenance unless the apparatus or part is made accessible for other reasons or its performance indicates that such a check is advisable.

1.06 ***Successful commutation*** for the purpose of this section may be said to have been obtained if neither the brushes nor the commutator is injured in an acceptance test or any normal service to the extent that abnormal maintenance is required. The presence of some visible sparking is not necessarily evidence of unsuccessful commutation.

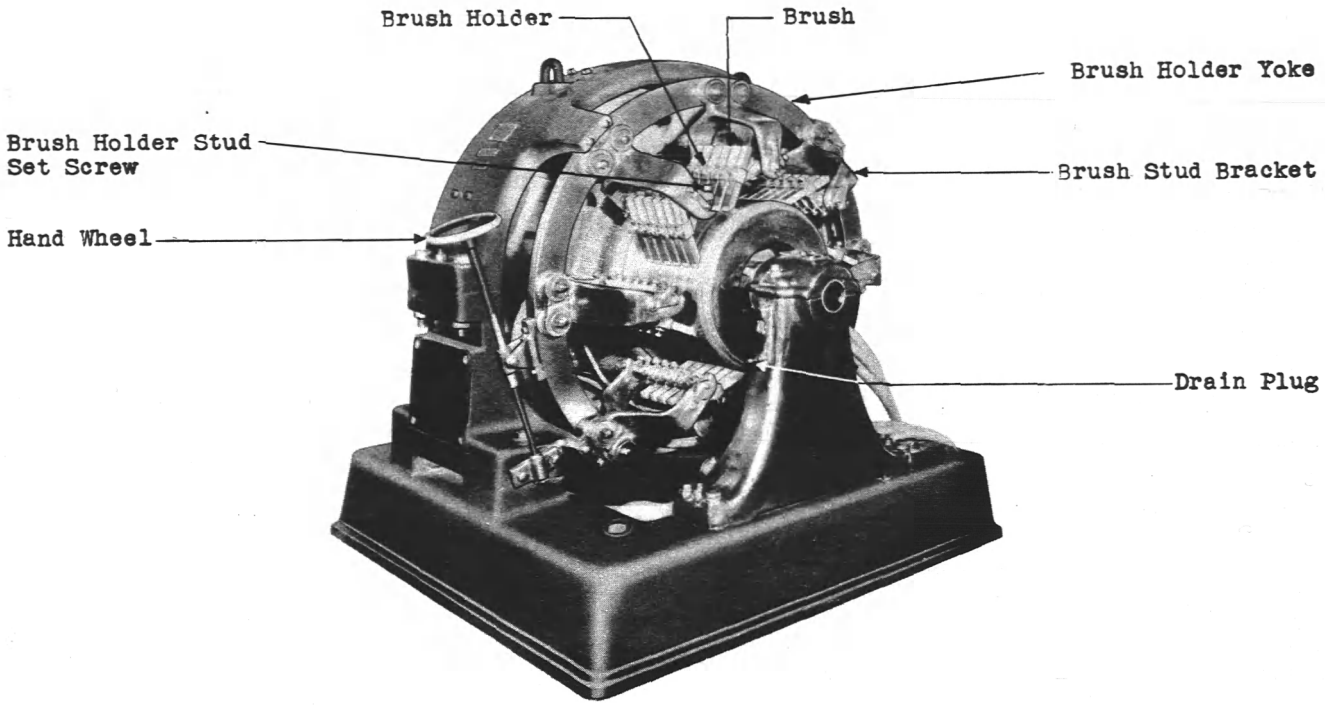

Fig. 1 – M-15 Generator

2. REQUIREMENTS

2.01 *Lubrication*

(a) Bearings shall be adequately lubricated with 220-260 S 100 oil. The amount of lubricant used at any one time shall not be sufficient to cause it to run or creep out of the bearing housing.

(b) The oil in each gauge shall be kept at such a level that the gauge shall be

Maximum — 3/4 full
Minimum — 1/2 full

Gauge by sight.

(c) The bearings shall be cleaned and have the lubricating oil replaced with fresh oil every 2 years. Dirt shall be flushed out of the bearing chamber with lubricating oil. The bearing should also be flushed with lubricating oil if it shows a tendency to overheat.

(d) Oil gauges shall be free from leaks and glass gauges where provided shall be free from cracks.

(e) During operation, it is recommended that commutators not provided with automatic lubrication be lubricated at intervals of one hour. This interval may be extended if periodic inspections are such as to insure that successful commutation will be had during the extended interval.

(f) It is recommended that the commutator, commutator tangs, brushes and brush holders be cleaned at least once a day when the machine is to be operated. Occasional cleaning of the insulators between brush stud brackets and brush yoke may also be necessary. The commutator may be cleaned with the machine in operation but all other parts should be cleaned only with the machine stopped.

(g) It is recommended that on machines having automatic lubrication, the oil wells be filled with 220-260 S 100 oil at least once a day when the machine is to be operated, this is done when the machine is stopped. This interval may be changed as local conditions require, provided that periodic inspections are such as to insure that successful commutation will be had at all times.

*2.02 *Voltage:* With a speed within the limits as given in Requirement 2.03 under all operating conditions of machine temperature and load (no load to full load), the d-c voltage at the terminals of the generator shall be capable of adjustment within the limits given in the following table. Use voltmeter.

VOLTAGE RANGE

GENERATOR RATING	VOLTAGE RANGE
30 volt	22-30 volts
33 volt	22-33 volts
45 volt	32-45 volts
65 volt	44-65 volts

*2.03 *Capacity:* At any voltage within the range specified in Requirement 2.02 and with speed within the limits outlined below the generator shall be capable of delivering continuously its rated full load current in amperes as given in the following table. Use ammeter.

AMPERE OUTPUT

TYPE	SPEED	AMPERES	RATED VOLTS
M-1	1700-1950	12	65
M-1	1700-1950	25	33
M-1	1700-1950	20	45
M-2	1700-1950	25	65
M-2	1700-1950	50	33
M-2	1700-1950	50	42
M-3	1100-1200	50	65
M-3	1100-1200	100	33
M-4	1100-1200	80	65
M-4	1100-1200	175	33
M-5	1100-1200	100	65
M-5	1100-1200	225	33
M-5-1/2	1100-1200	175	65
M-5-1/2	1100-1200	300	33
M-5-1/2	1100-1200	400	33
M-6	1100-1200	300	65
M-6	1100-1200	600	33
M-7	850-900	600	33
M-8	850-900	400	65
M-8	850-900	800	33
M-9	475-600	1000	33
M-10	850-900	500	65
M-10	850-900	1000	33
M-15	500-600	800	65
M-15	500-600	1500	33

#*2.04 *Bearings* shall be free from excessive wear. If the generator operates satisfactorily under available office load, with end play in both directions and with requirements 2.05, 2.06, 2.07, 2.17 and 2.18 met, the bearings shall be considered to be in a satisfactory condition.

#*2.05 *End play* in each direction from the running position of the armature under all conditions of load from no load to full load for machines furnished subsequent to 1926 shall be:

Maximum — 1/4 inch

This shall not permit the brushes to override the commutator groove or ends of the commutator. No limit is specified on end play on machines furnished prior to 1926. Gauge by sight.

2.06 *Freedom of Rotating Parts:* The generator armature shall turn freely in its bearings. Gauge by feel.

#*2.07 *The air gap* at all points between the armature and the pole faces shall be

Minimum — .010 inch

Use feeler gauge.

#*2.08 *Brush Holder*

(a) The brush holders shall be set so that with the brush holder in the latched back position, the distance from the heel of the brush to the commutator shall be

Minimum — 1 inch
Maximum — 1-1/2 inches

Use scale.

(b) The brush stiffener shall be so adjusted that its end shall be 1/2 inch ± 1/64 inch from the toe of the brush. Use scale.

#*2.09 *Brush length* shall be such that the distance measured from the back side of the brush holder to the end of the brush (Fig. 2) shall be

	MINIMUM
At Turnover	1-7/16 inches
During Service	1/8 inch

Use scale or gauge by eye.

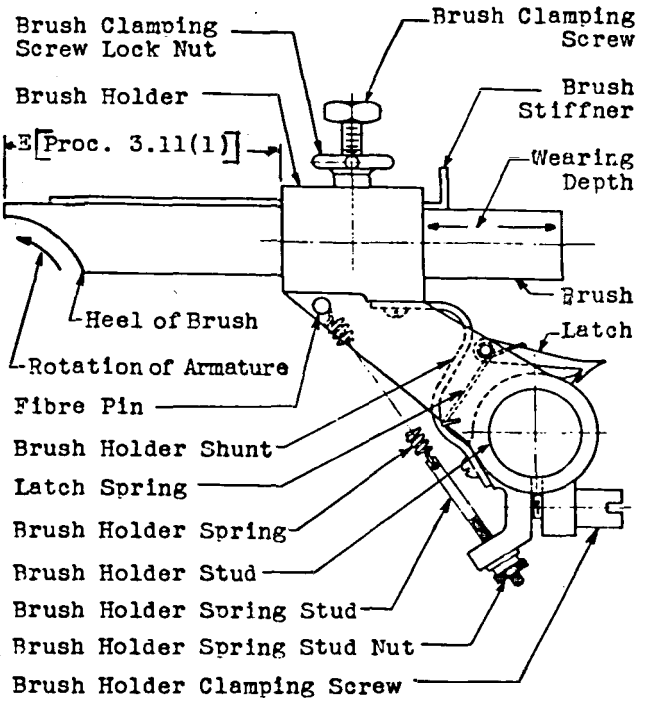

Fig. 2 – Gauze Brush Holder

#*2.10 *Brush Alignment*

(a) All brushes on the same stud shall be set as close together as possible, indicated in Figs. 3 and 4 (C) except on M-10 and M-15 generators, in which case the brushes shall be equally spaced after the dimensions X(1/2 inch) or Y(3/8 inch) indicated in Figs. 5 or 6 have been met. The spacing of brushes on all studs shall be as uniform as possible.

Note: See that appreciable clearance is maintained between brush holders.

(b) On all machines where possible the brushes shall be staggered on pairs of studs as shown in Figs. 3, 4, 5 and 6. With the armature in the extreme position of end play toward the commutator end, the inside brushes shall be so placed that no part of the brush or brush holder shall be closer than 1/8 inch to the commutator groove, commutator tangs or armature winding [(A) Figs. 3 to 6 incl.] Gauge by sight.

(c) With the armature in the extreme position of end play toward the coupling end, the outer brushes shall be so placed that no part

of the brush or brush holder shall be closer than 1/8 inch to the edge of the commutator [(B) Figs. 3 to 6 incl.]. Gauge by sight.

(d) The minimum number of segments a brush shall span shall be determined 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	NUMBER OF COMMUTATOR SEGMENTS	△MINIMUM NUMBER OF SEGMENTS COVERED BY A BRUSH
M-1 (.78 kw)	121	3-1/2
M-1 (.825 and) (1.125 kw)	121	2-1/2
M-2	113	2-1/2
M-2	129	3-1/2
M-3	148	3
M-4	170	2
M-5	170	2
M-5-1/2	132	3
M-5-1/2	268	6
M-6	144	5-1/2
M-7	170	5
M-8	171	5
M-8	216	4
M-9	320	6
M-10	216	5-1/2
M-15	320	5-1/2

△ The brush spans apply to all type "M" generators whether 30, 33, 45 or 65 volt unless the nameplate indicates otherwise.

#*2.11 ***Brush Spacing:*** 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 segment. For M-9 and M-15 machines the spacing shall be as near this limit as is consistent with good commutation.

#2.12 ***Brush Fit***

(a) 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.

(b) The thickness of the brush toes shall be

Minimum — 1/32 inch
Maximum — 1/8 inch

and 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.

#*2.13 ***Brush Pressure***

(a) The total brush pressure on the commutator for each gauze type brush on type M-1 to M-5 inclusive shall be

Minimum — 8 ounces or 225 grams
Maximum — 12 ounces or 340 grams

Use spring balance or gram gauge.

(b) The total brush pressure on the commutator for each gauze type brush on types M-5 1/2 to M-15 inclusive shall be

Minimum — 12 ounces or 340 grams
Maximum — 16 ounces or 450 grams

Use spring balance or gram gauge.

(c) Brush pressure on individual brushes shall be set at a value within the limits given in (a) or (b) which will give the best commutation.

(d) Brush pressure of all similar brushes on the same machine shall be as nearly uniform as possible.

#*2.14 ***Brush Holder Yoke***

(a) The brush holder yoke shall be set so that the painted marks on the yoke and frame are in line. Gauge by sight.

#*2.15 ***Commutator***

(a) The commutator and associated tangs shall be clean and commutating surfaces free from scoring, pitting or other deformation of the surface or structure save that caused by normal wear.

(b) The commutator shall have no high, low or loose segments or flat spots. The eccentricity of the commutator shall not be enough to cause poor commutation or poor operation of the machine.

(c) The minimum permissible commutator diameter shall be

FRAME	DIAMETER INCHES NOMINAL	MINIMUM
M-1	5	4
M-2	6-1/2	5-3/4
M-3	8-1/2	7-1/8
M-4	10-1/2	9
M-5	10-1/2	9-1/8
M-5-1/2	10-1/2	9-1/8
M-6	8-3/4	7-1/2
M-7	10-1/2	9-1/8
M-8	13	11-7/8
M-9	18	16-1/2
M-10	13	11-15/16
M-15	19	17-11/16

#2.16 *Commutation:* Without altering the position of the brushes, the generator shall commutate successfully when the commutator is lubricated as in requirement 2.01, at any current between 1/10 of full ampere load and full ampere load; at any voltage within the limits specified in requirement 2.02; and with the machine at any temperature within the limits specified in requirement 2.18. Gauge by sight.

2.17 *Noise and Vibration:* The noise and vibration of the set under any normal operating condition shall not be excessive at any load from 1/10 of full ampere load to full ampere load. Gauge by sound and feel.

#*2.18 *Temperature*

(a) When in continuous operation within normal voltage and current limits the temperature of any part of the machine as measured by feel shall not be excessive. If the fingers can be held on the bearing housing, frame or part under discussion the machine temperature may be assumed to be within specified limits.

(b) If the temperature is thought to be excessive measure by thermometer. The temperature of the various parts shall not exceed the following.

	MAXIMUM
Bearings	80C (176F)
Windings and Frame	90C (194F)

3. ADJUSTING PROCEDURES

3.001 *List of Tools, Gauges and Materials* (Equivalents may be substituted if desired)

TOOLS

Bellows, Hand, 10 inch
Chisel, Wood, 1-1/4 inch (R1454)
Hoist, Chain, 1 Ton (R1496)
Screwdriver, 4 inch, Regular
Wrench, Adjustable, 8 inch
Wrenches, Hexagonal, Flat, with following openings as required: 1/4, 5/16, 3/8, 1/2, 9/16, 3/4, 7/8, 31/32, 1-1/16, 1-7/16, 1-5/8, 1-13/16 inch

GAUGES

Balance, Spring, 0-6 lbs.
Brush Jig (furnished with machine)
Gauge, Gram, Tension, 79B
Gauge, Nest, Thickness, KS-6909 (or 85B Gauge)
Indicator, Speed, Jones 5B or Lyons type A
Scale, 6 inch
Thermometer, (R1032), Detail 1
Voltmeter, Portable, DC, Weston Model 280
3-60-150 volt scale
300-600 volt scale (with multiplier)

MATERIALS

Abrasive Cloth or Paper, 100 grade or 150 grade
Cloth, Cleaning, KS-14666
Compound, Sealing, KS-6824
Cord
Felt Pad (for temperature)
Fibre Sheet, 1/16 inch thick
Indicator, Test, Starrett No. 196A
LePage's Glue
Measure, 1 qt. (funnel attached)
Oil, 220-260 S 100
Pail or equivalent receptacle for oil
Petrolatum
Petroleum Spirits
Rope Sling, 1 inch diameter rope or equivalent
Sandpaper 4/0
Waste, Wool Yarn
Woden Blocks
Wooden Wedges
Water-proof Paper

3.01 ***Lubrication*** (Reqt 2.01)

(1) To add oil to a bearing pour oil slowly into the bearing chamber until the proper level is indicated in the oil gauge. The oil should be added with the generator stopped except in the case of hot bearings. The oil should be added slowly to permit the level to rise in the gauge at the same rate as in the bearing chamber. If the oil does not rise in the gauge, it is an indication that the passage to the gauge is blocked and should be cleaned. A small bare copper wire will be found advantageous in cleaning the passage. A quart measure with funnel attached may be found very convenient for adding the oil.

(2) After a new machine has operated a week, shut the machine down. Remove the drain plug in the bottom of the bearing chamber and drain the old oil into a pail or other receptacle. Pour a small quantity of fresh oil through the bearings to wash out all sediment. Clean the drain plug and associated threads in the casting, coat with KS-6824 sealing compound, and replace. Refill the bearing chamber to the proper level with 220-260 S 100 oil as outlined in (1).

(3) To replace the oil in a bearing, draw off the oil and flush the bearing as outlined in (2).

(4) If the oil ring is bent or damaged, it should be replaced.

(5) If an oil gauge leaks, the oil should be drained from the bearing chamber into a pail or other receptacle by removing the drain plug at the bottom of the bearing chamber. If the leak occurs at the point 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 coated with KS-6824 sealing compound and the gauge replaced. After the gauge has been replaced, clean the drain plug and the associated threads in the casting and coat the plug with KS-6824 sealing compound and replace. Refill the bearing chamber to the proper level with fresh oil as outlined in (1).

(6) Lubricate the commutator as outlined in procedure 3.15. Automatic lubrication is obtained by the use of lubricating-type gauze brushes on the top stud of the generator. The amount of flow of 220-260 S 100 oil from the oil chamber in the brush may be altered by changing the size of the hole in the bottom of the oil well. If necessary to change the size of the hole, it should be increased or decreased one drill size only at a time. A smaller opening may be made by filling the hole with solder and redrilling with a smaller drill. Where new brushes having oil wells are installed for the first time, they should be dipped in 220-260 S 100 oil for about half their length for a period of time sufficient to saturate the brushes. After being saturated they should be allowed to stand on end and drain for a few hours before being placed in the brush holder.

Note: When new lubricating brushes are installed, the flow of oil may be excessive at first, but may be expected to decrease during the first month of operation. Make no changes in the size of the hole at the bottom of the oil well during this period.

(7) The oil flow may usually be considered satisfactory if a trace of oil is visible on the commutator while it is running at normal speed.

3.02 ***Voltage*** (Reqt 2.02)

(1) To determine the voltage use may be made of the switchboard voltmeter if one is available. Vary the voltage of the generator by manually operating the hand wheel of the associated 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 remagnetized correctly.

Note: 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.

(2) If the voltage is not within the proper limits, examine the rheostat for possible injury and replace or repair if necessary. Examine the generator windings for possible trouble or loose connections and repair if necessary. If the voltage is still outside the

limits, check the driving agent for the proper speed and correct. If the voltage remains outside the limits after the above checks, refer the matter to the supervisor as it may be necessary to replace the generator armature with a new or reconditioned one.

#3.03 *Capacity* (Reqt 2.03)

(1) To determine the current output of the generator, use may be made of the switchboard ammeter. Machines which do not meet the requirements should be repaired or replaced.

#3.04 *Bearings* (Reqt 2.04)

(1) Replace any worn bearings.

#3.05 *End Play* (Reqt 2.05)

(1) 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. If this is thought to be the cause of the trouble the matter should be referred to the supervisor as he may wish to obtain the assistance of a service expert.

3.06 *Freedom of Rotating Parts* (Reqt 2.06)

(1) Examine the generator and remove any foreign objects which might interfere with rotation. Also check to see that all mounting bolts are firm and tighten if necessary. Examine the generator for brushes binding or for worn bearings and adjust or replace if necessary.

#3.07 *Air-Gap* (Reqt 2.07)

(1) With the armature in any position, measure the air-gap between the armature and each pole-face with a thickness gauge. Particular care should be taken in measuring the air-gap between the armature and the pole-faces in the lower half of the generator frame as this is where the maximum bearing wear will be most noticeable.

Note: A KS-6909 thickness gauge will usually be sufficient. Where it is thought that measuring the air-gap around the edges of the pole pieces does not give a true picture of the clearance or where an 85B gauge is available, the latter may be found more desirable.

Rotate the armature approximately a quarter of a turn and repeat the above. Checks should be made with the armature in at least four different positions.

(2) If the air-gap is to small, new bearings should be installed.

#3.08 *Brush Holder* (Reqt 2.08)

(1) To adjust the brush holder for the gauze type brush, 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 requirement 2.12. 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.

#3.09 *Brush Length* (Reqt 2.09)

(1) Replace any short brushes.

#3.10 *Brush Alignment* (Reqt 2.10)

(1) To align a gauze type brush follow the procedure as outlined in 3.12.

(2) The dimension (D) Fig. 4 is measured after setting the brushes on the first two pairs of studs. The brushes on the third pair of studs shall be set half way between those on the first two pairs of studs.

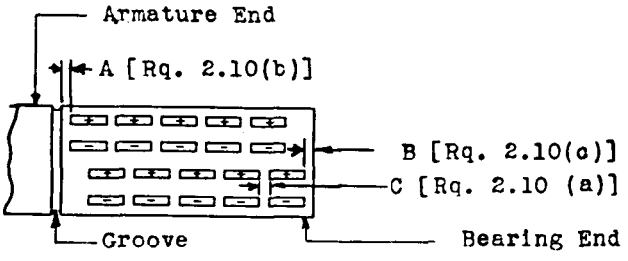

Fig. 3 – Commutator With 4 Brush Studs

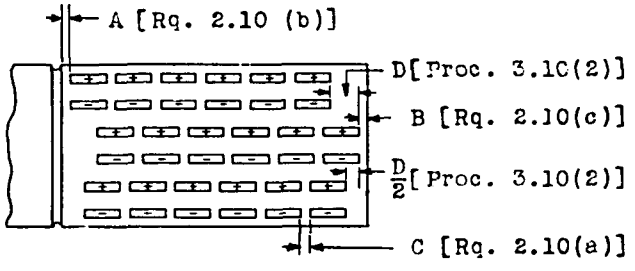

Fig. 4 – Commutator With 6 Brush Studs

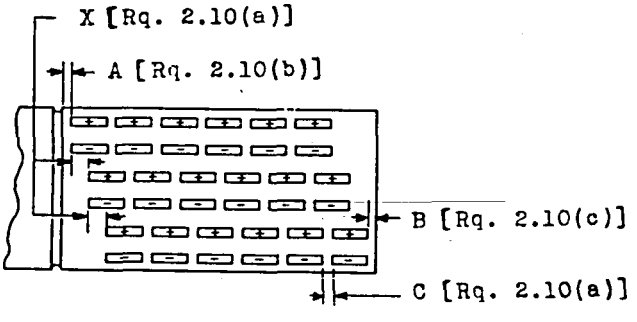

Fig. 5 – M-10 Generator

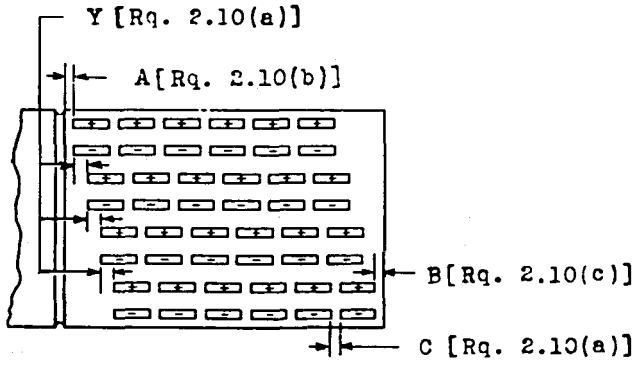

Fig. 6 – M-15 Generator

#3.11 *Brush Spacing* (Reqt 2.11)

(1) To space a gauze brush proceed as follows: 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 brush and bring the toes of the brushes on each stud in lines 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 "E" given in the table below may be varied slightly to meet the spacing requirements and commutator wear. Any change in the brush position will require refitting of the brush.

TYPE	FIG. 2-E INCHES
M-1 (.78 kw)	1-1/4
M-1 (.825 & 1.125 kw)	1-1/4
M-2	1-3/4
M-3	2-1/4
M-4	2-1/4
M-5	2-1/4
M-5-1/2	2-1/2
M-6	3-1/2
M-7	3-1/2
M-8	2-3/4
M-9	2-3/4
M-10	2-5/8
M-15	3-1/2

(2) For M-9 to M-15 machines inclusive, the factory setting of the brush stud brackets should not be changed if 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 removal, in order that they may be replaced in the same position.

(3) 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 brush holder yoke, the brackets should be set on these marks and fastened in position. If no marks are present, set all the brushes within

the limits 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 brackets to the brush holder yoke, 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 yoke 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.

(4) 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 Figs. 3 to 6. After an adjustment has been made, be sure that the clampng screw is tightened securely.

#3.12 ***Brush Fit*** (Reqt 2.12)

(1) When it becomes necessary to replace or refit a gauze brush the brush should be placed in the brush filing jig furnished (when specified) with each generator and clamped firmly in the jig being careful not to clamp the brush tight enough to injure the oil well if the brush is of the lubricating type. With a ***sharp*** wood chisel trim the brush to the curvature of the jig. In trimming lubricating brushes which have already had considerable wearing length removed, it is suggested that a fine hack-saw blade be used to trim the brush instead of a chisel as with this type of brush a chisel, unless sharp and drawn across the end of the brush with a sliding motion, sometimes has a tendency to pull out the gauze in the center of the brush instead of cutting, due to the shortened length of the middle strands caused by drilling for the oil reservoir. However, in using a hack-saw blade care should be used not to damage the jig surface forming the outline for the brush curvature. After cutting to the curvature of the jig, remove the brush, trim the toe to the specified thickness, replace the brush in its holder and line it up on the brush stud in accordance with Figs. 3 to 6. Smooth any rough edges and "sand in" the contact surface.

(2) To "sand in" place all the brushes in the latched back position. Cut a strip of abrasive cloth (100 grade) or paper approximately as wide as the commutator and long enough to go around the commutator tightly and form a butt joint. The ends should not overlap or have more than 1/8 inch opening at the joint. Where strips are not available sheets may be used. Apply LePage's glue on the commutator for about 3 inches on each side of the joint and at frequent intervals around the commutator. The glue should be applied in thin strips about 2 or 3 inches wide lengthwise of the commutator (parallel to the commutator segments). Place the strip of abrasive around the commutator. Commencing at one edge wrap cord around the abrasive to hold it firmly against the commutator by rotating the armature by hand. Each turn of the cord should be about 1/4 to 3/8 inch from the preceding turn. Let the glue dry for about one half to one hour until it is firm but slightly tacky, since, if allowed to dry until brittle, it would have a tendency to flake off from the copper. Remove the cord and any excess glue at the joint so that the joint will be as smooth as possible. Start the machine in the usual manner and unlatch the brushes carefully, one at a time. Be careful not to touch the abrasive with the hand to avoid injury. Note that the brushes do not chatter and that the abrasive does not become loose. If necessary to obtain more steady brush contact on the abrasive increase the brush pressure slightly in the usual way. Continue the grinding-in process until all brushes have proper contact surface, latching back the brushes individually as they are seated.

(3) After "sanding in" clean the machine and brushes by blowing out as much dirt and metallic dust as possible and wipe with a clean cloth. Remove the paper and glue from the commutator with a cloth moistened with warm water, being careful not to get moisture into the winding. Wipe with a dry cloth. Shift the brushes forward in their holders slightly to compensate for the removal of the paper and lower them onto the commutator. Run the machine at rated speed for 4 or 5 hours at light load to obtain a good commutating sur-

face. Lubricate the commutator during this run and recheck the alignment, brush pressure, etc, as covered herein.

#3.13 *Brush Pressure* (Reqt 2.13)

(1) To measure the brush pressure on the gauze type brush proceed as follows: Loop a piece of light cord under the center of the face of the brush parallel to the commutator segments and exert a radial pull (See Fig. 7) by means of a spring balance or gram gauge hooked into the looped cord. The total brush pressure is the reading of the balance or gauge in ounces or grams 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 or gauge should be read for brush pressure. The correct brush pressure may be obtained by adjusting the adjusting nut on the brush holder (See Fig. 7) as required.

Note: Upon releasing the pressure from the scale, see that the brush is held firmly against the commutator by the force of the brush holder spring. Check the pressure again and if the scale does not record approximately the same pressure as before, it indicates binding in the holder which should be investigated.

It is desirable to make the brush pressure on all brushes of the same generator as nearly uniform as possible.

#3.14 *Brush Holder Yoke* (Reqt 2.14)

(1) On the gauze type brush adjust the brush holder yoke as outlined in procedure 3.16.

#3.15 *Commutator* (Reqt 2.15)

(1) The commutator should never be polished with Bell System Paste Metal Polish but should be allowed to acquire an even bronze color. It should be cleaned by rubbing with a clean dry twill jean or other hard non-linting cloth. If the commutator or brushes become smutted, clean with a cloth slightly moistened with petroleum spirits. Raise the brushes during this operation. Stop the machine and remove any dust or dirt from between the commutator tangs by means of air or by wiping with a cleaning cloth.

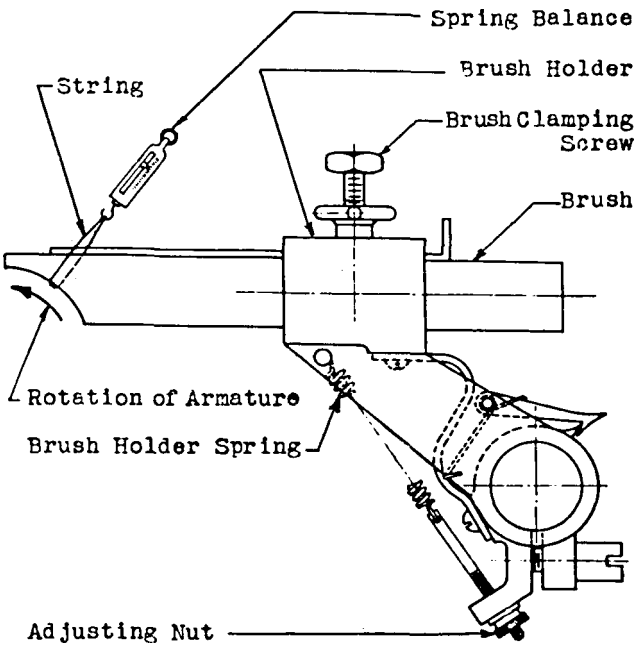

Fig. 7 – Method of Measuring Brush Pressure

(a) In carrying out the foregoing procedure, the machine should be stopped, and the brushes latch back with the machine at rest. Never raise a brush beyond the position at which the latch becomes operative. This is essential to avoid permanent stretching of the brush-holding spring. It is suggested that suitable gloves be worn to protect the hands from contact with the sharp edges of the brushes.

(2) To maintain good commutation where the gauze type brushes are used on machines not provided with automatic lubrication the commutator should be lubricated as follows:

Take a piece of twill jean cloth or other hard, non-linting cloth folded, slightly moistened with a lubricating mixture consisting of 50% petrolatum and 50% 220-260 S 100 oil and apply to the commutator. Add more petrolatum to the mixture if cases are found where the brushes tend to cut or scrape the commutators and thin 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. (Some companies

are using Socony #36 semi fluid oil for this purpose with apparent satisfaction.) 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 petroleum spirits. Do not saturate the brushes with the petroleum spirits any more than is necessary. 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) 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 petroleum spirits 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 properly lubricated it will operate for several months or even years. If it is necessary to remove any roughness of the commutator surface use No. 4/0 sandpaper. Never use a file, emery cloth or paste on a commutator for this purpose and it is desirable to sandpaper a commutator only when absolutely necessary, especially on a commutator which has acquired in operation a smooth bronzed glazed surface.

(4) Commutators which are ridged by wear of the gauze brushes but on which the surface is otherwise in good condition, should be continued in service without disturbing the commutator surface, but the brushes should be shifted so they will bear on new surfaces. This will tend to wear down the ridges on both commutator and brushes, increasing the lift of both and postponing the time when the commutator must be turned down. The reduced contact surface while the brushes are wearing in in their new locations is compensated for by a higher unit pressure on the surfaces actually in contact, so the commutation should be as satisfactory as before and experience indicates that sparking and effective heating do not develop by such procedure.

(5) Scored commutators may be smoothed when necessary by using No. 4/0 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 a cloth moistened with petroleum spirits and apply lubricant to the commutator as outlined in (2) before lowering the brushes.

Caution: When smoothing commutators, remove one or more brush-holder studs to provide space for the proper manipulation of the sandpaper or sand block.

(6) 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. Eccentricity will usually be indicated by poor commutation. However, if a test indicator is available this tool will accurately indicate the amount of eccentricity. If commutation trouble is encountered which is believed to be due to excessive eccentricity, the commutator should be refaced by a commutator turning device or removed as outlined in (8) and machined in a lathe. After the commutator is resurfaced by any of the

above means the brushes should also be refitted as outlined in procedure 3.12. Machines whose commutators are worn below minimum limits should have the armatures replaced, unless replacement of the commutator is found feasible and more economical for the particular machine.

(7) In case the commutator is found to have a high, low, or loose commutator segment, it should be heated by running for some time at full load or at a slight overload or by other means. The bolts holding the end ring should then be tightened, after which the commutator will generally have to be turned down. For turning and resurfacing information, see Section 171-110-802. If it is necessary to remove the armature for repairs, this may be done in the following manner.

(8) 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.

(9) 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:

(10) On generators having a bearing housing in two halves, remove the two holding down screws, the yoke (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.

(11) ***M-7 Generators and Smaller:*** These generators may have their bearings removed after going through procedures (9) and (10) 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 oredr 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 yoke clamping screws should be removed and the yoke taken off before attempting to remove the bearing housing.

(12) ***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 procedures given in (9) and (10) 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.

(13) ***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.

(14) 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 KS-6824 Sealing Compond to make the joints oil-tight. 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.

(15) Support the weight of the armature 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.

(16) 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.

(17) 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. 4/0 sandpaper and dynamo oil, using a circular motion around the shaft.

(18) When shipping an armature the shaft should be covered with petrolatum, the armature wrapped with water-proof 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 inches to 2-1/2 inches from the commutator or armature winding and a space of at least 1-1/2 inches should be left between the armature and the sides of the box.

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

#3.16 ***Commutation*** (Reqt 2.16)

(1) If the commutation is not satisfactory see that requirements 2.07 to 2.15, inclusive, are met.

(2) The factory marking will usually give the best commutation and least noise over the greater part of the permissible load and

voltage ranges. The yoke 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 yoke loosen the clamping stud (if provided) and shift the position of the yoke 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) 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 Figs. 8 and 9. These arrows indicate only relative positions, because the distances thru which the neutral moves will vary not only with the size of the generator but also with individual machines of the same size.

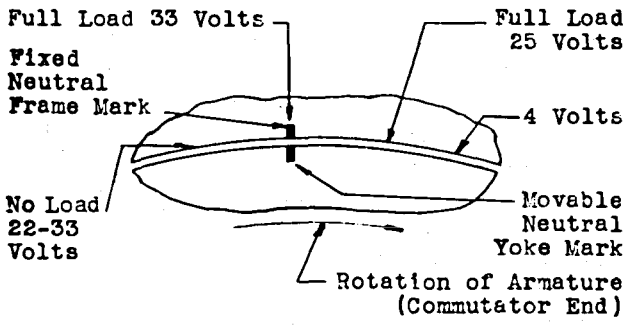

Fig. 8 – Shifting of Brushes — 22-33 Volt Generator

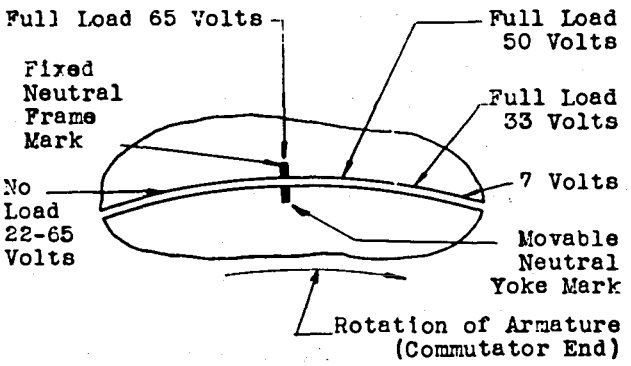

Fig. 9 – Shifting of Brushes — 44-65 Volt Generator

(4) 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. 8 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. Follow procedure 3.16 (2) if required.

(5) Corresponding positions for generators rated at 20-30 volts and 32-45 volts are similar to those indicated for the 22-33 volt generator. The distance shown for the various settings are not to scale. The 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. 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. 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. 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. For the 4 volt or 7 volt condition shift the brushes in the direction of rotation of the armature.

3.17 *Noise and Vibration* (Reqt 2.17)

(1) Where excessive noise and vibration is present, see that all holding down bolts and coupling bolts are drawn up firmly and the spring cushions, when provided are adjusted properly. The spring cushions should be so adjusted that the spring tension on all springs are approximately the same. If it is thought that the spring tension is uneven loosen the locknuts on all springs and turn the adjusting studs above the springs counterclockwise until all pressure of the spring is released and the sub-base rests on the floor or foundation. With all springs free, go around the sub-base in rotation turning each stud clockwise with the fingers until a slight tension is felt in each spring, (finger tight). After

this procedure take a wrench of proper size to fit the stud and again go around the sub-base in rotation and tighten the stud above each spring one complete turn at a time, (do not change the previous finger tight adjustment before the wrench is applied), until there is a clearance of 1/16 inch minimum between the sub-base and floor at all points. A chalk mark on the stud and sub-base will assist in making one complete turn of the stud. This will give the correct tension on each spring for the proper cushioning effect. Tighten the locknuts at the end of the adjustment.

(2) If the noise and vibration continues to be excessive after the above adjustments have been made, the trouble may be caused by worn bearings or improper alignment of the set. Worn bearings can usually be noted by lack of air-gap between the armature and bottom pole faces or by excessive play if the armature is raised by the means of a bar or lever underneath the shaft as close to the bearing housing as possible. If a bar is used care should be taken not to injure the commutator or windings.

(3) It is not practical to check the alignment of three bearing sets. Four bearing sets may have the alignment checked by means of a thickness gauge and a test indicator where available. Loosen the coupling bolts (do not remove) and measure the distance between faces of couplings with thickness gauge at four points spaced at approximately 90 degree intervals around the periphery of the coupling, marking the points where measured and noting the distances measured. Then rotate the coupling approximately 180 degrees and again measure the distance between faces at the same points. After adjusting the readings for any variation due to end play the difference between the first and second measurement at each point shall not be more than .0025". Secure a test indicator rigidly to either the motor or generator half of the coupling with its indicating point set on the opposite half of the coupling. Revolve the coupling through 360 degrees and record the total variation shown by the dial indicator. The total variation as shown by the dial should not exceed .005". Where, as in the usual case, local facilities are not available for making this latter check the matter should be referred to the supervisor.

#3.18 *Temperatures* (Reqt 2.18)

(1) The temperature of the bearings should be taken in one of two ways outlined below with the machine running. One method is to place the bulb of a thermometer in the lubricating oil of the bearing for at least 5 minutes, if the oil well opening is large enough to permit this, taking care that the thermometer does not strike the shaft or interfere with the proper operation of the oil ring. This method is to be preferred but where the bearing construction makes this method impractical the second method may be used.

(2) The second method is to hold the bulb of the thermometer against the hottest spot on the outside of the bearing housing as near as possible to where the bearing is located, covering that part of the bulb which is not in contact with the housing by a piece of felt or the equivalent and observe the highest temperature indicated.

(3) The temperature of the commutator should be taken immediately after stopping the machine. The bulb of the thermometer should be held against the commutator or ring surface by means of a piece of felt or equivalent, covering the exposed surface of the bulb not in contact with the commutator surface and the highest temperature noted.

(4) The windings, and machine frame may be measured in a similar manner. If the temperature exceeds the specified limits see that requirements 2.02 to 2.07, and 2.10 to 2.16 are met. If these requirements are met and the temperature is still outside the specified limits, refer the matter to the supervisor as it may be necessary to replace the generator.