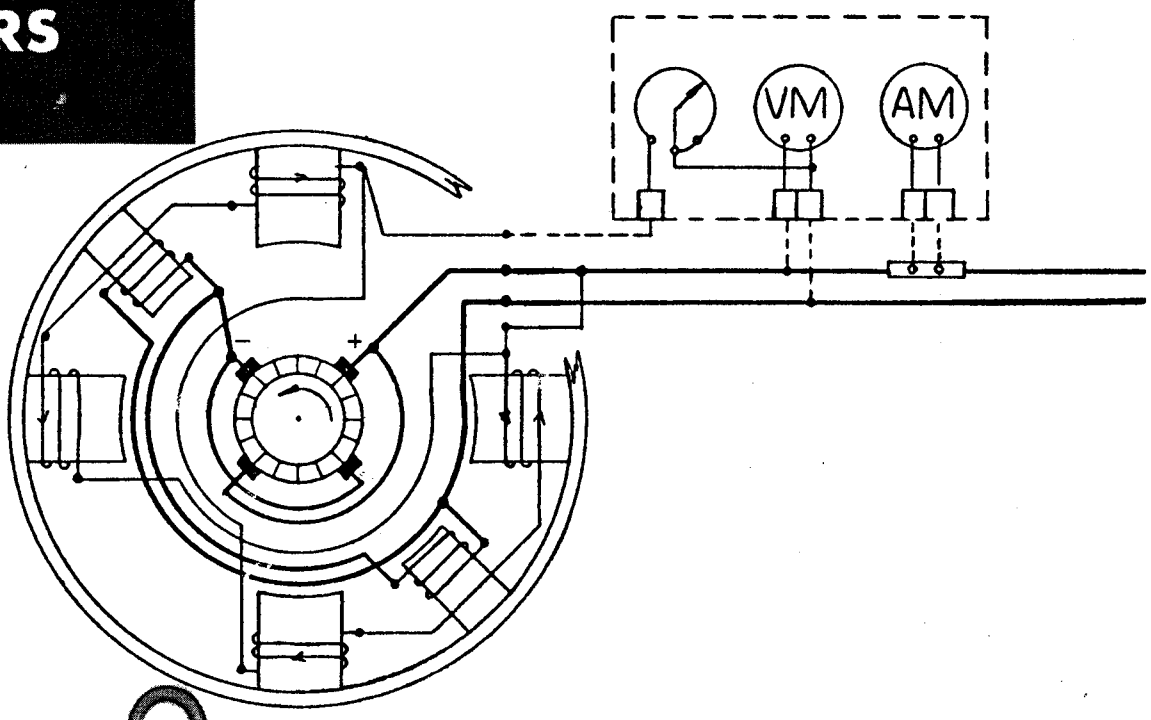
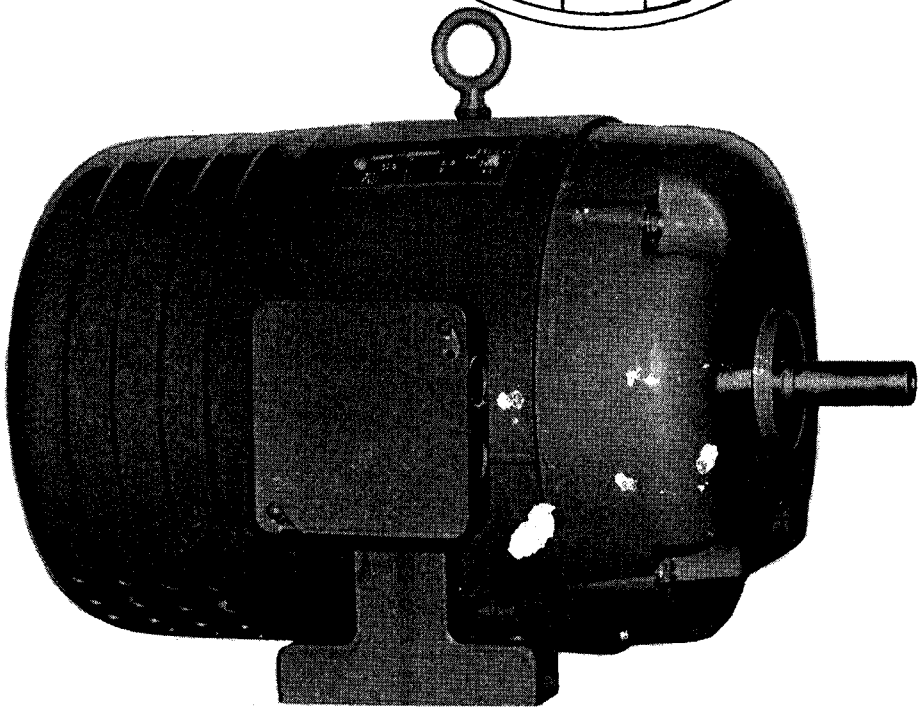
KATO

DIRECT CURRENT GENERATORS





Installation -Operation and Maintenance Manual

KATO Engineering Co.
MANKATO, MINNESOTA

•GENERATORS •MOTORS •CONVERTERS •CONTROLS

Custom Engineered To Provide Your Specific Power Needs

IDENTIFY YOUR GENERATOR
BY THE FOLLOWING NUMBERS:

Serial Number 77439

Model 25-48000-2421

Type 1964 3

The KATO drawings listed below are included to aid in installing, operating and maintaining your generator. Keep them with this instruction manual at all times.

Wiring Connection Drawing: _____

_____ _____ _____

Parts Drawing: 106-00009

The purpose of this manual is to provide the user of KATO DIRECT CURRENT GENERATORS with the information required to install, operate and maintain the generator.

Your KATO generator is a carefully designed rugged machine. Only components which have proven best in reliability and performance are used. Each generator has been completely tested and inspected before shipment from the KATO factory.

Treat your generator with normal care while installing, operating and maintaining the unit and it will provide many years of very good service.

INSTRUCTIONS NO. DC-166
Publication Date - November 1966

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SECTION 1 INSTALLATION

1-1. RECEIVING GENERATOR. Remove the generator from the crating. Throughly inspect the machine to make certain damage has not occurred in transit, and to make sure that all parts, accessories, etc., are in proper condition and position.

1-2. Inspect The Generator By: Removing the endbell covers and cooling fan screen. Inspect the inside of the generator for loose material and damage of parts. Inspect to see that the brushes are seated and centered on the commutator and that brush holder ring and brush holders are not loose. On two-bearing generators turn the shaft by hand to make certain it rotates freely without binding. Inspect for rubbing or insufficient clearance of rotating parts.

1-3. If damage is noted or material missing, notify the transportation company immediately and file a claim.

1-4. HANDLING UNCRATED GENERATOR. The generator can be moved for short distances with either slings and a hoist, or a fork lift.

1-5. Handle The Generator With A Fork Lift By: Placing the fork lift tines under the generator base. Make certain the generator is fully onto the tines and that the fork lift is centered.

NOTE

Lift the generator slightly and tilt the tines up before moving the generator. Make certain the fork lift tines are located so that one tine is on each side of the center of balance of the generator.

1-6. Handle The Generator With Slings By: Attaching cables or chain slings to the generator lifting eyes and using a hoist or crane to move the machine. The slings and hoist should have a proof rating of not less than 1½ times the weight of the generator. Refer to the bill of lading for the weight of the generator.

NOTE

Before lifting the generator, take a slight strain on the cables and adjust so the lifting hook is directly over the center of balance. When moving in an area in which machines, supplies, etc., are located, to prevent the generator from striking solid objects or personnel, use guide lines attached to the ends of the generator.

WARNING

Do not move motor-generator sets mounted on a common base, except common frame motor-generator sets, with slings attached to the motor and/or generator lifting eyes. Move common base motor-generator sets by placing slings under the base or with a fork lift.

1-7. LOCATION. Locate the generator where there will be a minimum of excess moisture, dust, or corrosive fumes being drawn into it. Moisture condenses on generator parts and electical controls, causing corrosion which can seriously effect operation and efficiency. Dust and dirt cause needless wear on all moving parts.

1-8. Location-Indoors. When the generator is located in an enclosed area, make certain that sufficent room is left on all sides of the machine so that the flow of coolant air to the machine and discharge of heated air from the machine is not obstructed. Leave enough room so that the generator or generator components can be removed without moving the prime mover.

1-9. Location-Outdoors. When possible provide an enclosure to protect the generator from severe conditions, such as dust and moisture, Use strip heaters or circulating air heaters to protect the unit in very damp or cold climates.

1-10. FOUNDATION. The generator may be placed on any material which will adequately support the weight of the generator, prime mover, and when used, base. Bearing loads of structural materials can be obtained from Engineering Handbooks, and for soil from state or local agencies. Level and align the generator as described in the applicable mounting and alignment instructions.

1-11. Concrete Foundation. A reinforced concrete foundation provides the best surface for installation of machinery. The foundation should be as level as possible to insure level installation of the generator with a minimum of shims being required. Install mounting bolts in the foundation to secure the generator and prime mover in place. Location of the mounting bolts should be ascertained from the certified drawings of the generator and prime mover (motor or engine).

1-12. Floor Or Steel Structures. Determine that the bearing load of the material will adequately support the weight of the unit, generator, motor and base. Install mounting bolts as described in paragraph 1-11.

1-13. Soil. Determine the bearing load of the soil. Level the area and provide adequate drainage away from the generator set. Place the generator and prime mover on concrete blocks, or steel or wooden skids.

1-14. MOUNTING. The generator and prime mover must be correctly mounted and aligned or excessive vibration and loads will result which will seriously shorten the life of bearings and couplings. Mounting and alignment procedures are contained in paragraphs 1-15 through 1-26.

1-15. MOUNTING COMMON FRAME MOTOR-GENERATOR SETS. Place the unit on a flat surface as described in paragraphs 1-10 through 1-13. Install shims under the generator set mounting pads, or use adjustable base feet to level the unit. Refer to paragraphs 1-16 and 1-17.

1-16. Vibration Dampeners. The use of vibration dampeners will reduce vibration transferred to or from the generator set. Use Kato Base Feet, vibration dampeners manufactured by others, or install rubber cushions between the generator set and foundation to eliminate or at least reduce transfer of vibration.

1-17. Install Common Frame Generator Sets That Have Kato Base Feet By: Installing the unit on a level foundation and adjusting the base feet to level the unit. Use pipe spacers to prevent bolting the unit down too tightly which would eliminate the effect of the rubber cushions. Refer to Figure 1-1.

1-18. MOUNTING TWO BEARING GENERATORS. This unit, generator and motor, must be securely mounted on and to a base, bed plate, or a platform which is rigid enough to prevent any vibration of the unit or transfer of vibration to the unit. Use vibration dampeners or rubber cushions between the base or platform and the foundation to eliminate or at least reduce transfer of vibration. Install the unit on the base, level, and align as described in paragraphs 1-19 through 1-26.

1-19. Install Unit On Base By: Placing the generator and the motor on the base. Start and snug the bolts which secure the generator to the base. See paragraphs 1-20 through 1-26. Level the unit as described in paragraph 1-20 before aligning the set.

1-20. Leveling. Place the motor, generator and base when used on as flat a surface as possible. Use a spirt level and check motor, generator, and/or base mounting pads at 90 degrees in two directions. Install shims between the base and foundation to level mounting pads, or adjust base feet when used. Install rubber cushions between base mounting pads and the foundation, or use vibration dampeners as described in paragraphs 1-16 or 1-17 to reduce transfer of vibration. Bolt the unit to the foundation before checking for alignment or tightening motor and generator to base mounting bolts.

NOTE

Leveling is intended to define relative position of the mounting pads, not inclination from the horizontal plane. Most generators and motors may be installed at an inclination of up to 15 degrees without effecting operation or moisture protection features of the machine.

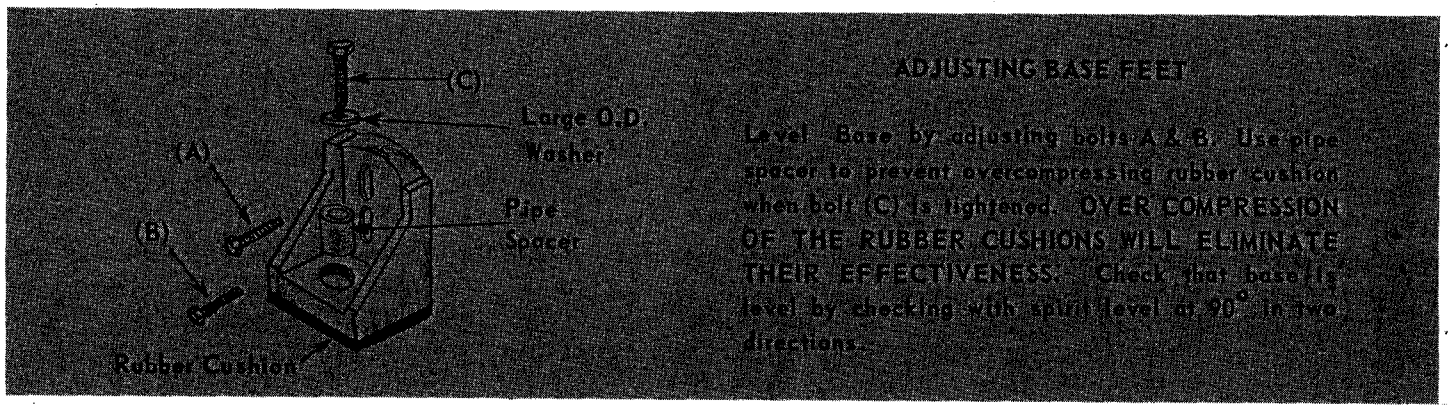

Figure 1-1. Base Feet Installation

1-21. ALIGNMENT. Trouble-free and efficient operation of the generator and motor will depend upon the correct alignment of the motor and generator shafts.

Misalignment may be the cause of:

A) Vibration.

B) Noisy Operation.

C) Excessive coupling wear, or when used belt or gear wear.

D) Premature bearing failure.

Factors which may chance the alignment of the unit are:

A) Distortion of the base.

B) Settling of the foundation.

C) Settling of the building.

D) Shifting of the motor and generator on the foundation.

1-22. ALIGNING TWO BEARING GENERATOR WITH MOTOR. The procedures described in paragraphs 1-23 through 1-25 are for aligning close coupled motor-generator sets which have flexible couplings of the tapered grid or the jaw type. Follow the coupling manufacturer's specified tolerances when less than described in paragraphs 1-23 and 1-24.

1-23. CHECKING FOR ANGULAR MISALIGNMENT. Scribe a reference mark on the coupling hub at the button or finger of the indicator to mark its position on the hub. Rotate both shafts simultaneously, keeping the finger or button of the indicator at the reference marks on the coupling hub. Note the reading on the indicator dial at each one-quarter revolution.

ANGULAR MISALIGNMENT OF THE SHAFTS MUST NOT EXCEED .001 INCH FOR EACH INCH OF RADIUS OF THE COUPLING HUB, TOTAL INDICATOR READING.

Loosen motor or generator mounting bolts. Place slotted shim under rear mounting pad of either the motor or generator. Re-check alignment. Install or remove shims from under the mounting pads until aligned.

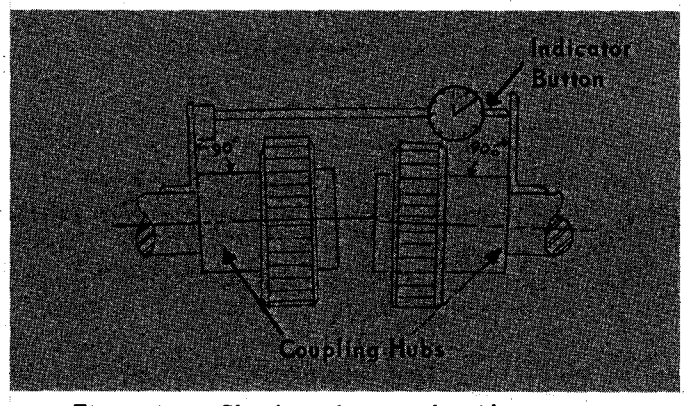

Figure 1-2. Checking for Angular Alignment.

1-24. CHECKING FOR PARALLEL SHAFTS (RUN-OUT ALIGNMENT). Scribe a reference mark on the ground or machined diameter of the coupling hub at the finger or button of the indicator. Rotate both shafts simultaneously, keeping the button or finger of the indicator at the reference mark on the hub. Note the reading on the indicator dial at each one-quarter revolution.

TOTAL RUN-OUT BETWEEN HUBS SHOULD NOT EXCEED .002 OF AN INCH.

Install or remove shims from under each of the motor or generator mounting pads. Re-check alignment. Add or remove shims until shafts are parallel. **Tighten motor and generator mounting bolts following angular and run-out alignment. Check base mounting bolts for tightness. Re-check alignment before assembling the coupling.**

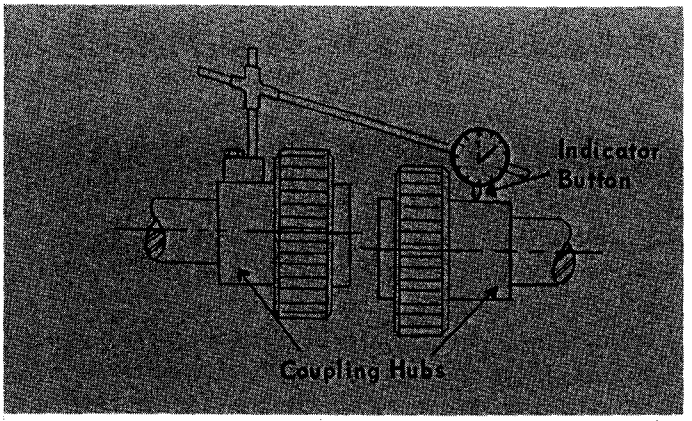

Figure 1-3. Checking Run-Out Alignment

1-25. CHECKING ALIGNMENT OF MOTOR-GENERATOR SETS PURCHASED MOUNTED ON A COMMON BASE. Motor-generator sets purchased from the factory mounted on a base have been precision aligned and vibration tested. Experience has shown that bases no matter how deep in section and rigid may be twisted during transportation due to high torsional loads placed upon the units during handling. These units should be checked for alignment before being placed in operation. The procedures described in paragraph 1-26 should be followed when the generator set is moved to a new location.

1-26. CHECKING ALIGNMENT OF MOTOR-GENERATOR SETS WITH FLEXIBLE COUPLED SHAFTS FOLLOWING MOVEMENT OF UNIT TO A NEW LOCATION. When flexible coupled motor-generator sets are moved to a new location the following procedures should be followed;

a. Level and secure base to foundation as described in paragraphs 1-19 and 1-20.
b. Remove coupling guard and with coupling installed as shown in figure 1-4a check angular alignment of shafts. Check angular alignment by following the procedures outlined in paragraph 1-23.
c. Check parallel alignment of shafts with the coupling installed as shown in figure 1-4b. Check parallel alignment by following the procedures outlined in paragraph 1-24.

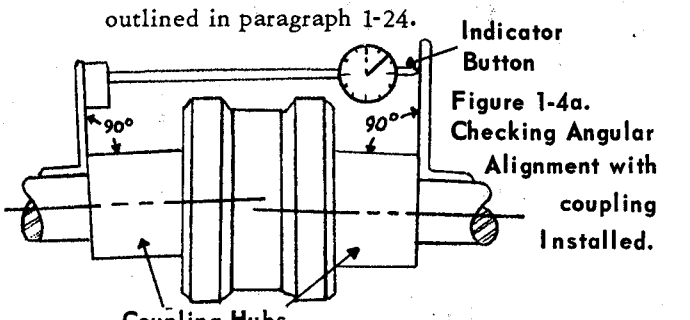

Figure 1-4a. Checking Angular Alignment with coupling Installed.

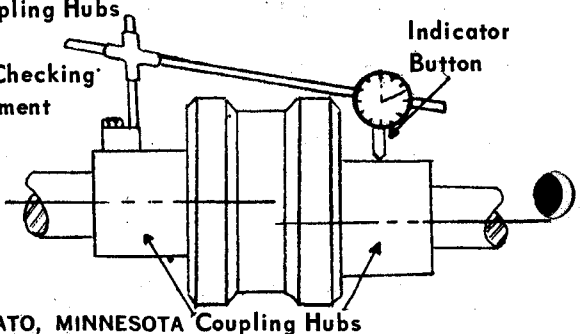

Figure 1-4b. Checking Run-Out Alignment with Coupling Installed.

1-27. INSTALLING SINGLE BEARING GENERATORS. Single bearing generators must be properly installed to the engine. Incorrect installation will result in:

A) Excessive bending of the coupling plates.

B) Bending load on the shaft.

C) High bearing loads.

D) Insufficient clearance or improper alignment of generator rotating and stationary parts.

Incorrect installation will result in:

A) Damage to generator rotating and stationary parts.

B) Premature bearing failure.

C) Vibration.

1-28. Installing Generator On Engine. The engine and generator should be mounted on a rigid common base. Install the generator onto the engine and the engine driven generator set on the base as described in paragraphs 1-29 through 1-32.

1-29. Checking Angular Alignment Of Engine Flywheel. Mount a dial indicator with the base on the flywheel housing and the indicator finger or button on the drive plate recess of the flywheel as shown in Figure 1-5. Rotate the flywheel one revolution. Note indicator reading at each one-quarter revolution.

MAXIMUM INDICATOR READING .005 INCH, TOTAL INDICATOR READING.

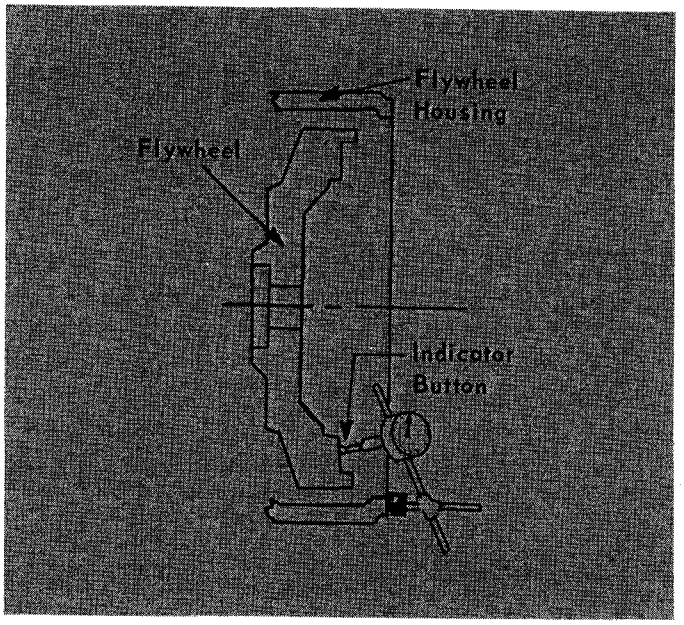

Figure 1-5. Checking Flywheel

1-30. Checking Engine Flywheel Housing Face. Mount a dial indicator with the base on the engine shaft face or the flywheel and the indicator button or finger on the machined face of the flywheel housing as shown in Figure 1-6. Rotate the flywheel one revolution. Note indicator reading at each one-quarter revolution, minimum.

MAXIMUM INDICATOR READING .005 INCH, TOTAL INDICATOR READING.

NOTE

Shims can be placed between the engine flywheel housing face and the generator adapter endbell to correct flywheel housing face tolerances to within maximum acceptable limits, providing following correction, parallel misalignment of drive plates and flywheel drive plate recess does not exceed .005 inch. See paragraph 1-31.

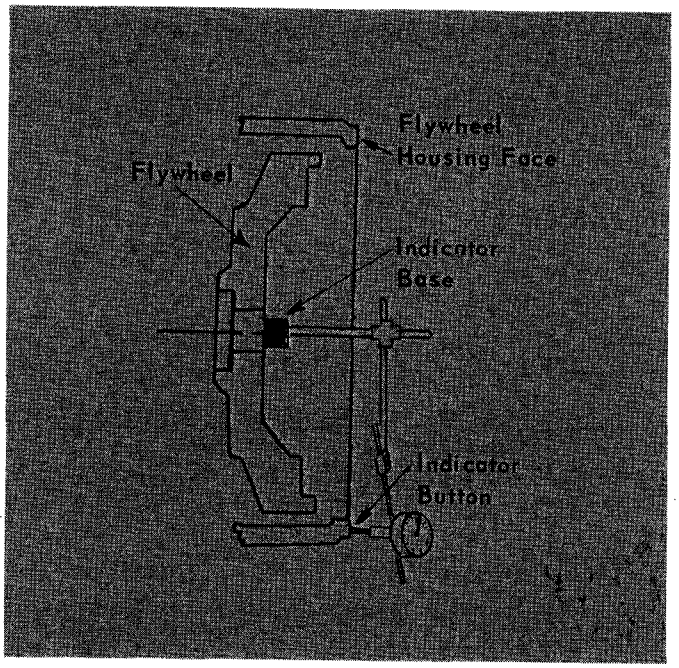

Figure 1-6. Checking Flywheel Housing

1-31. Checking Generator Mounting And Engine Flywheel Assembly Dimensions. The dimensions discribed in the following steps must be checked before installing the generator to the engine. Refer to Figure 1-7.

A) Before checking dimensions, remove the commutator endbell cover and fan screen. Remove the fan from the fan hub and when adjustable baffles are used, loosen baffles and move baffles away from the fan.

B) Visually inspect for satisfactory alignment of the generator stator and rotor. Dimension (C) should be approximately the same as (D). Use a light and mirror to check alignment.

C) Inspect to see that brushes are clear of the commutator riser (⅛ inch minimum clearance). Inspect to see that brushes are centered on the commutator. If brushes are not raised, raise brushes and lock away from the commutator by placing the brush tension arms against the side of the brushes.

D) When B) or C) above is not satisfactory, check that shaft has not moved during shipment by checking shaft end clearance. Generators are shipped from the factory with 1/32 to 1/16 inch shaft endplay. Reposition shaft to provide endplay of from 1/32 to 1/16 inch. Recheck position of rotor and brushes.

E) Measure from the engine flywheel drive plate recess to the flywheel housing face. Dimension (B).

F) Measure from the drive plate to the generator adapter endbell face. Dimension (A).

G) If dimension (A) is more than dimension (B) either loose generator drive hub and more hub until dimension (A) is equal to dimension (B) remove spacers from between drive disks and hub or remove endbell and remove shins from generator bearing well.

H) If dimension (B) is more than dimension (A), install spacers between the generator hub and the drive plates.

I) When dimensions are satisfactory to this point, install the generator to the engine as described in paragraph 1-32.

NOTE

Fan and Drive Hub design may be slightly different than shown in Figure 1-7. Remove fan screen and observe fan and drive hub design. Loosen bolts as necessary to accomplish step A), paragraph 1-31.

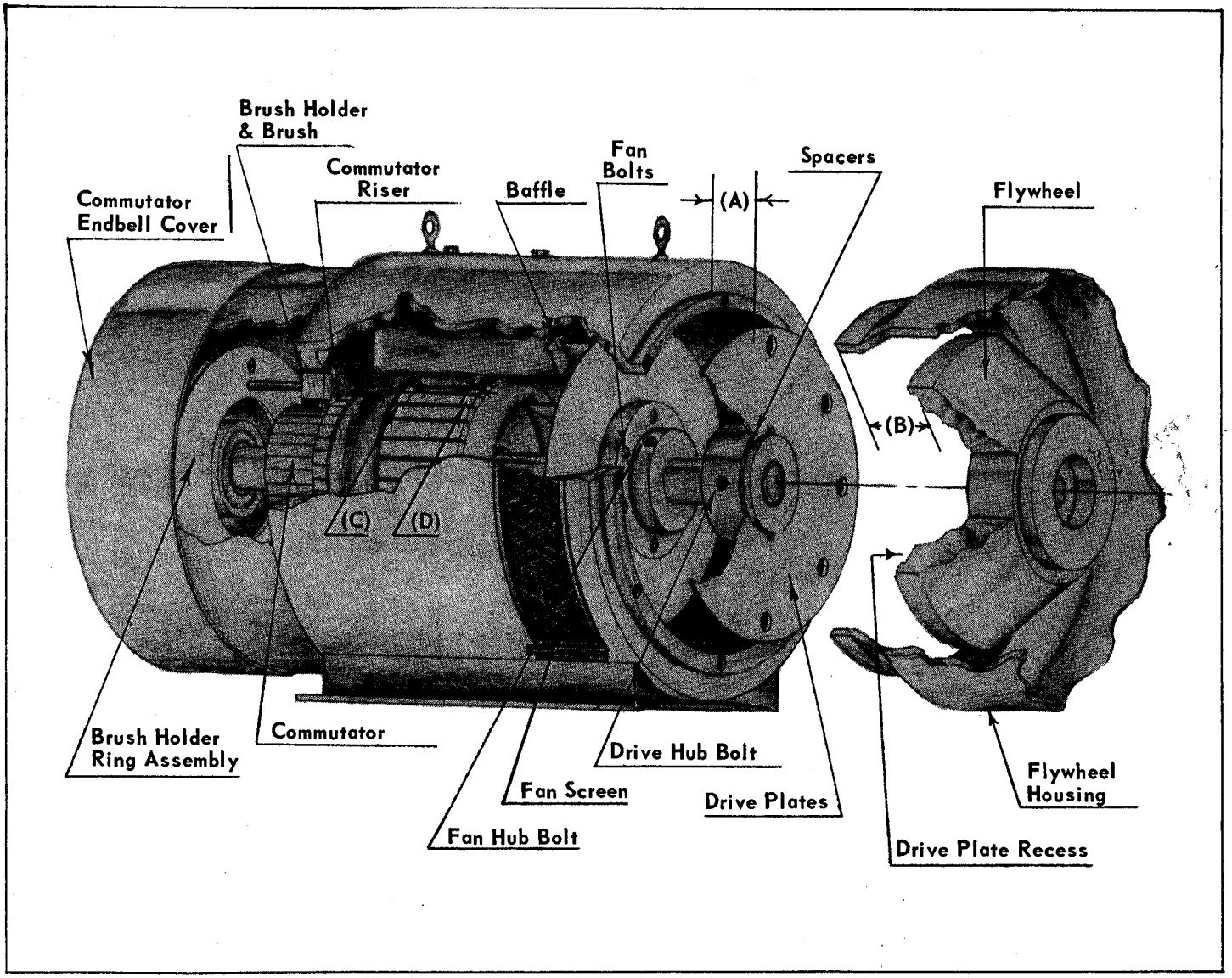

Figure 1-7. Aligning Engine and Generator

1-32. Installing Single Bearing Generator To Engine. Install the generator to the engine after alignment of generator parts and the engine flywheel dimensions have been checked as described in paragraphs 1-29 through 1-31. Install the generator to the engine as follows:

A) Raise brushes in brush holders away from the commutator.

B) Mount the engine and generator base on the foundation. Secure the base to the foundation. See paragraph 1-28.

C) Install the generator and the engine on the base.

D) Install shims between the generator mounting pads and the base and the engine mounting pads and the base. Add or remove shims until the center line of the engine shaft and generator shaft are in the same plane.

MAXIMUM PARALLEL MISALIGNMENT OF SHAFTS SHOULD NOT EXCEED - .001 INCH.

E) Install and tighten generator drive plate to engine flywheel bolts. Make certain drive plates are seated in the flywheel drive disk recess and bolts are tightened evenly.

F) Install and tighten engine flywheel housing to generator adapter endbell bolts.

G) Tighten bolts to secure the generator mounting pads to the base. Tighten bolts to secure the engine mounting pads to the base.

H) Lower brushes in brush holders. Check alignment of brushes with the commutator. Check brush holder distance from the commutator riser (⅛ inch minimum).

I) When installation is satisfactory to this point, reinstall fan, tighten fan hub bolts and drive hub mounting bolts. When generator has adjustable baffles, position baffle so that it is approximately ½ inch from the fan and tighten baffle bolts.

J) Install covers and screens.

1-33. DRIVES. Satisfactory generator operation will depend upon intelligent selection of drive couplings. In general, solid couplings (non-flexible) are not recommended except when the generator and motor frames are directly connected and belt drives, especially V-Belt should not be used when belt speed exceeds 5000 feet per minute. Improper coupling either due to misalignment or excessive tension will result in excessive wear of the coupling and the motor and generator bearings.

1-34. V-Belt. Use only matched belt sets. Avoid minimum pitch sheaves and belts. Follow the V-Belt manufacturer's specifications or NEMA limits for sheave pitch. Make certain the shaft axis of the motor and generator are parallel. Belts must enter and leave sheaves with no side bending. Tighten just enough to prevent slippage at full load. Never grease or use belt dressing on belts.

1-35. Flat Belt. Select belts and pulleys of ample width. Ample width will reduce amount of belt tension required to prevent slippage at full load. Lower belt tension reduces bearing loads and belt wear.

Position the pulleys so crowns are in the same plane. Make certain motors and generator shafts are parallel. Observe belt manufacturer's or NEMA limits for pulley sizes. Do not use flat belts with vertical shafts.

1-36. Flexible Couplings. Install and service flexible couplings as specified in the coupling manufacturer's instructions. Misalignment should not exceed those specified in paragraphs 1-23 and 1-24. When the coupling manufacturer's specifications are less than specified in this instruction, follow the coupling manufacturer's recommendations.

1-37. Gear. Accurate alignment and rigid mounting are essential for satisfactory operation with gear drives. Pitch diameter and width should not be outside recommended NEMA limits. Avoid coupling which will impose excessive thrust on bearings.

In all cases, gear teeth must be centered with each other. Gear faces must be parallel, and correct shaft center distance maintained. Gear teeth must fully engage to a depth giving approximately .002 inch minimum back lash. Avoid engagement of gear teeth so deep that they will bind or deflect.

Test for proper alignment by rotating shafts by hand. Check for backlash through at least one revolution of the shafts. Check basklash and gear face parallelism after tightening mounting bolts.

1-38. HOOKUP. Before connecting the generator to the electrical power load, check nameplate for the electrical characteristics and connect the generator exactly as shown in the connection diagram. Refer to National Electrical Code or applicable local regulations for minimum specifications for wire size, conduit and protective devices.

1-39. PROTECTIVE DEVICES. The generator set must be protected with protective devices. The minimum requirements should be as follows:

A) Circuit breakers, fuses, or switches in the incoming power lines and generator output lines. Installation must comply with National Electrical code or when more stringent local regulations.

B) Engine driven sets should be protected with adequate engine governors and protection for excessive overspeed.

SECTION 2 OPERATION

2-1. INITIAL START. Before placing the generator set in operation, make certain it has been correctly installed. Inspect for satisfactory alignment of internal parts. Check that load lines are of sufficient size and that the regulating equipment is properly adjusted for starting of the set. Place the unit in operation as described in steps A) through H).

A). Connect a DC voltmeter across the generator output leads.

B) Set the field rheostat (variable resistor) to the full resistance (full counter clockwise position).

C) Check incoming lines to motor for correct voltage and frequency (when an AC motor is used as the drive unit for generator).

D) Start unit. Stop immediately. Check for correct rotation as speed decellerates. Re-connect any two incoming lines to motor except neutral to reverse rotation.

E) Start and stop the unit several times, allowing sufficient time between starts for cooling. Observe any unusual or excessive noise or vibration as speed decellerates.

F) When satisfactory operation is observed to this point, connect load and start unit. If load line polarity is wrong, re-connect load lines.

G) Adjust the field rheostat until the desired output voltage is obtained.

H) With full load applied run unit for approximately ½ hour minimum. Observe any unusual noise, voltage deviations, or vibration. Observe unit for any signs of overheating.

2-2. NORMAL START. Start the motor or engine in accordance with the operating instructions for the unit. When previously correctly adjusted, no adjustment fo the generator control devices is required.

2-3. OPERATION UNDER SPECIFIC CONDITIONS. Refer to operating conditions, paragraph 3-2, before placing the generator set in operation. When the generator set is operated under severe conditions, follow the prestart procedures recommended for the specific condition.

2-4. PRE-START PROCEDURES FOR GENERATORS OPERATING IN SEVERE ENVIRONMENTAL CONDITIONS. When the generator is being placed in operation after being subjected to severe conditions the procedures listed below are recommended. Refer to paragraph 3-2 for discription of operating conditions.

A) Extreme Dust: If possible, fabricate an enclosure to protect the generator from the extreme condition. Clean outside of unit, air intake and exhaust screens and ports. Use clean filtered compressed air at a pressure of from 25 to 40 psi, a vacuum cleaner, or wipe with cloth saturated in an approved detergent or cleaning solvent. Inspect inside of unit. Check for accumulations of dirt on widings, air passages, brushes, brush holders, commutator and sliprings. Use a vacuum cleaner or compressed air at a pressure of 25 to 40 psi to remove dirt from windings and air passages. Remove thick stubborn accumlations of dirt from windings with Naptha. Use a clean lint free cloth to remove accumulations of dirt from brushes, brush holders sliprings and commutator. Remove dirt from controls with a vacuum cleaner or compressed air at a pressure of from 25 to 40 psi.

WARNING

EXERCISE EXTREME CARE WHEN USING NAPTHA. USE ONLY IN A WELL VENTILATED FLAME AND SPARK FREE AREA. WHEN USING SOLVENTS OBSERVE THE PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OF THE SOLVENT.

B) Extreme Moisture: If possible, use Strip or space heaters to protect unit from extreme moisture. If the unit is being placed in operation after being subjected to extreme moisture inspect inside of unit for accumulation of moisture. Use clean filtered compressed air at a pressure of from 25 to 40 psi to blow moisture from inside of generator. Dry sliprings, commutator and brushes with a clean lint free cloth. As an additional precaution, check winding insulation resistance and dry out windings if resistance is low.

C) Extreme Cold and/or Snow: If possible, fabricate an enclosure to protect unit from the elements. Use strip or space heaters. If the unit has been subjected to extreme cold allow unit to warm slowly to prevent condensation. If the unit has been subjected to snow or ice follow the procedures outlined for units subjected to extreme moisture.

SECTION 3 MAINTENANCE

3-1. GENERAL. A routine, regular service and maintenance program is the best assurance of trouble free, long life operation of rotating electrical and control equipment. Only trained personnel who know the equipment should perform any adjustment or repairs. A regular inspection and maintenance program consisting of the following items should be established.

A) Inspect unit for accumulation of oil, dust, water, or chemicals. Clean exterior. When excessive accumulation of foreign material is apparent on exterior of generator, remove endbell cover, inspect and clean interior with low pressure (25 to 40 psig) air. It is especially important that air intake and exhaust openings are free of foreign material. Additional procedures are listed in paragraph 2-4.

B) Inspect control devices for accumulation of dust, moisture, oils or other foreign material.

WARNING

Disconnect incoming power to motor, disconnect generator from load and control devices from their power source before performing any maintenance of the generator, motor or control equipment. Automatic starting devices, when used, must be disconnected from their power source.

3-2. OPERATING CONDITIONS. Operating conditions are described for standard, severe and extremely bad conditions the time between regular preventive maintenance service of the machine should be shortened and all possible precautions taken to eliminate adverse effect of severe conditions on the machine. Generators operating under extremely bad conditions must be specially designed for the operating conditions. When the generator is to be operated in extremely bad conditions, give Kato Engineering Company a complete description of the operating conditions prior to purchase of the generator.

A) Standard Conditions: Approximately 8 hours per day, steady load, clean 104° F maximum ambient temperature.

B) Severe Conditions: Approximately 24 hour per day, shock or vibration, dust and dirt, excessive moisture. 104° F maximum ambient for machines with class A insulation and 40°C temperature rise rating 122°F maximum ambient temperature for machines with class B insulation. Intermittent operation at low (0° F to 30° F) ambient temperature, ice and snow.

C) Extremely Bad Conditions: Heavy shock or vibration, extreme dust or moisture, corrosive chemicals. Ambient temperature over 122° F. Extremely low ambient temperature (-30° F to -65° F).

3-3. THREE MONTH OR 250 HOUR MAINTENANCE SCHEDULE. The following chart is enclosed as a guide for establishing a maintenance program for generators operating under standard conditions. The specific operating conditions should be analized by the user of the equipment and the maintenance schedule established accordingly.

Three Month Or 250 Hour Maintenance Schedule
1. Inspect lead wires and control devices wiring for cracked insulation and loose terminals.
2. Inspect control equipment for loose mounting hardware.
3. Clean outside of generator and ventilating screens.
4. When dust or moisture is excessive, clean and/or dry inside of generator.
5. Inspect control devices for accumulation of dust, moisture and other foreign matter.
6. Inspect brushes, brush holders and commutator.
7. With unit running, check control devices and meters for correct adjustment and operation.
8. Allow unit to run at least ½ hour. Observe any unusual noise or vibration. Refer to trouble-shooting chart for possible causes of noise and vibration.

3-4. WINDINGS - PROTECTIONS. Generators operating intermittently in very damp locations should be protected with space heaters. Generators being placed in operation after being subjected to very low temperatures should be slowly warmed to prevent excessive condensation. Insulation resistance should be checked before placing the generator in operation if the unit was subjected to an extremely damp and/or cold environment for an extended period.

3-5. INSULATION RESISTANCE TEST. A hand cranked megger of not over 500 volts is a convenient and safe method. An excepted standard for measuring resistance of stator windings at 75° C. measured at 500 volts DC after one minute should not be less than:

$$\text{Resistance in megohms} = \frac{\text{Rated Voltage of Machine} + 1000}{1000}$$

The above formula is satisfactory for most checks. For more information see "Recommended Practice for Insulation Resistance Testing DC Rotating Machinery", AIEE Standards.

3-6. DRYING WINDINGS. If the insulation fails to meet the above standards, the generator may be dried out by heat from a warm air oven, heat lamps or strip heaters. The temperature should not exceed 75° C. (167° F.)

WARNING

When oven drying, use a forced air circulation oven, not a radiant type. Radiant type oven would overheat some generator parts before remote parts reached a satisfactory temperature.

3-7. MAINTENANCE OF BRUSHES, BRUSH HOLDERS AND COMMUTATORS. Brushes, brush holders and commutators should be inspected and cleaned periodically. Dirty commutators and brushes, brushes which are not properly "seated", or pitted commutators will cause excessive brush sparking and poor commutation.

Brushes can be raised in their holders for inspection or sanding of the commutator as shown in Figure 3-1. Figure 3-2 shows the brushes lowered in their holders.

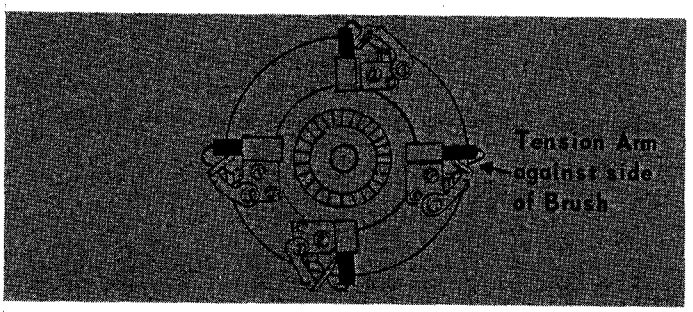

Figure 3-1. Brushes Raised In Holders

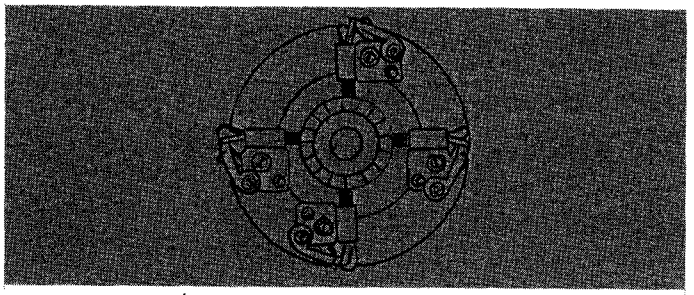

Figure 3-2. Brushes Lowered In Holders

3-8. REPLACING BRUSHES. Replace brushes when worn excessively. Make certain brush is replaced before tension arm rests on brush holder. When replacing brushes, it is most important that they are properly "seated" to the contour of the commutator and free to move in the brush holders.

NOTE

Always order replacement brushes of the same size and of an equivalent grade or type as were installed at the factory. Order by part number including the type and serial number of the generator.

3-9. Seating Brushes. To properly seat brushes, lift all the brushes in their holders. Insert a strip of (No. 000) sandpaper between the brush and the commutator with the abrasive side toward the brush. Lower one of the brushes in the holder. With the brush in the holder and under pressure draw the sandpaper in the direction of rotation of the generator, keeping the sandpaper close to the contour of the commutator. Lift the brush to release pressure before returning the sandpaper for the next stroke. Sand until at least 80% of the brush surface is in contact with the commutator. Sand each of the remaining brushes one at a time as described above. Check for proper "seating" by running the machine at no load, minimum excitation and observe the area of bare commutator polished by the brushes. Reseating of brushes is required when brushes are replaced, commutator is resurfaced, or when excessive brush sparking was evident.

WARNING

NEVER USE EMERY CLOTH TO SEAT BRUSHES.

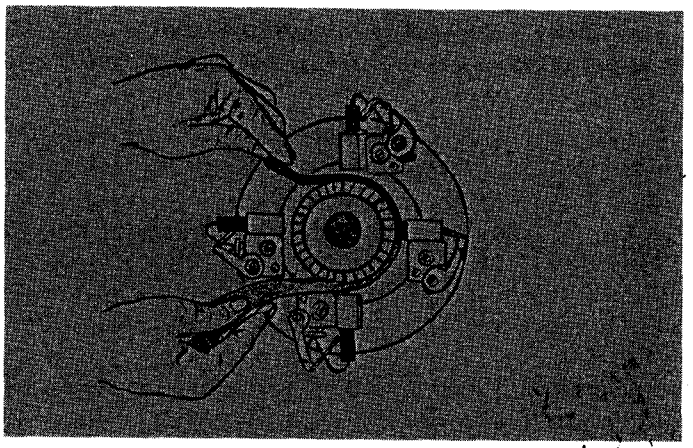

Figure 3-3. Sanding Brushes

3-10. Commutator. Under normal operating conditions, the commutator should rarely need attention. It should be kept free of dirt and oil. Should it become slightly rough or grooved, it may be polished with (No. 000) sandpaper or a polishing stone. DO NOT USE EMERY. When defects cannot be removed in this manner the generator rotor (armature) must be removed and the commutator turned.

3-11. Sanding Commutator. Lift all brushes in their holders, install a strip of sandpaper with the abrasive side against the commutator. Using a hardwood block as shown in Figure 3-4, press against the sandpaper surface. Use a hardwood block which has the same contour as the commutator surface. Run the commutator at high speed while moving the block back and forth along the commutator surface parallel to the shaft.

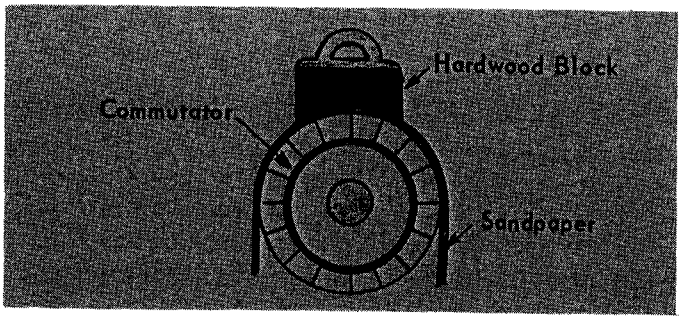

Figure 3-4. Sanding Commutator

3-12. Turning Commutators. When the commutator is too deeply grooved or pitted to be cleaned with sandpaper, the armature must be mounted in a lathe and the commutator turned down. Install the armature assembly drive end of the shaft in a four-jaw chuck. Use a center on the commutator end. Make certain the shaft center is clean. Check that shaft is centered by installing a dial indicator as shown in Figure E-5. Rotate shaft one revolution.

Turn the commutator, removing only as much material as is necessary to remove grooves or pitted areas from the commutator surface. After turning, undercut the mica segments.

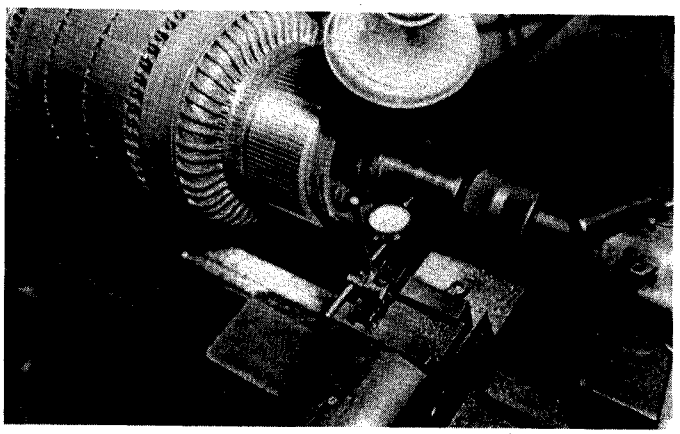

Figure 3-5. Centering Shaft In Lathe Before Turning Commutator

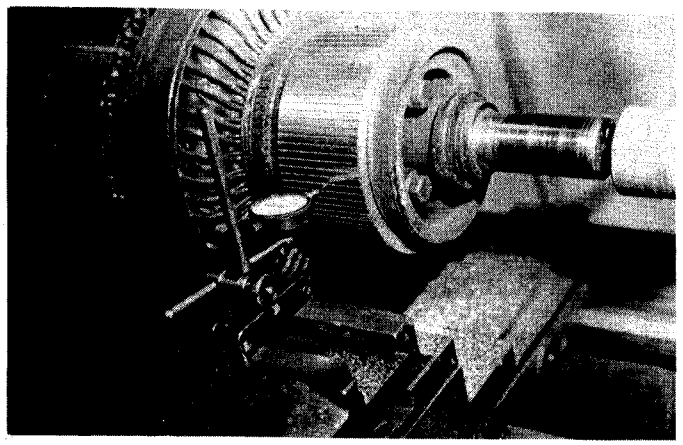

Figure 3-6. Checking Eccentricity of Commutator

3-13. Undercutting Commutator. The commutator may be undercut by using either a square or "V" undercutting tool.

When a square undercutting tool is used, it should be slightly wider than the mica and well centered so that the mica fin as shown at (C), Figure 3-7, is not left. Remove edges as shown at (A) by beveling as shown at (B).

When a "V" undercutting tool is used, the tool should be slightly wider than the mica to provide the bevel as shown at (E). The mica fin shown at (D) will result if the undercutting is not deep enough. If the tool is not well centered a fin as shown at (F) will be the result. Always make certain the undercutting tool is centered and cuts deep enough to prevent these undesirable results.

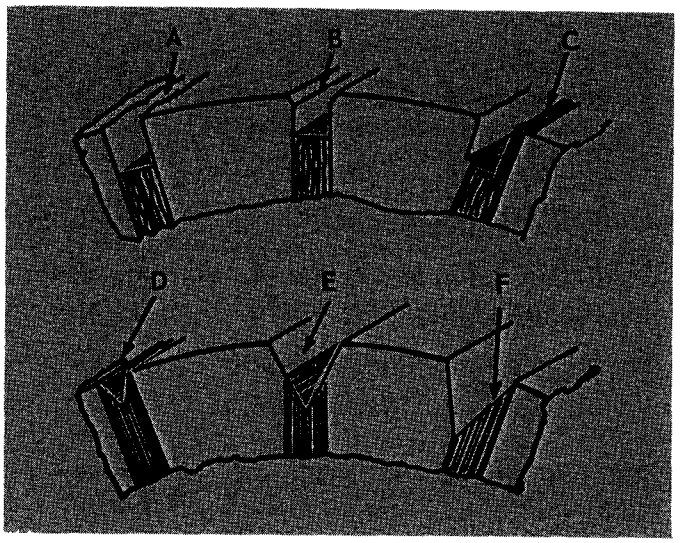

Figure 3-7.

3-14. BEARINGS. The bearings are of the factory lubricated shielded type on most KATO generators. These bearings are greased for the life of the bearing and should not be serviced. If there is an indication of bearing failure, refer to trouble shooting chart, disassemble the machine and replace the bearing. Order bearings by part number and include the model and serial number of the generator. Replace, do not regrease shielded "greased for life" bearings.

NOTE

When requested by the customer, KATO Generators may have regreasable bearings. If the type bearing (shielded greased for life regreasable) is not know, remove the endbell cover and check the bearing housing for grease fittings or plugs. The bearing housing will not be drilled for grease fittings or plugs when shielded "greased for life" bearings are used. The bearing housing will have grease fittings or plugs installed when bearings are regreasable. Write KATO Engineering Company for lubrication information when the generator has regreasable bearings.

3-15. Removing Bearing. Remove the endbell to expose bearing. See "Disassembling Generator". Using a satisfactory dye or paint, mark position of bearing on shaft as shown in Figure 3-8. Use a puller to remove the bearing from the shaft. Protect the shaft end with a cap. Make certain puller applies pressure only against the bearing inner ring. If puller will not hook bearing inner ring, fabricate a split bushing and install it between the bearing and the puller hooks.

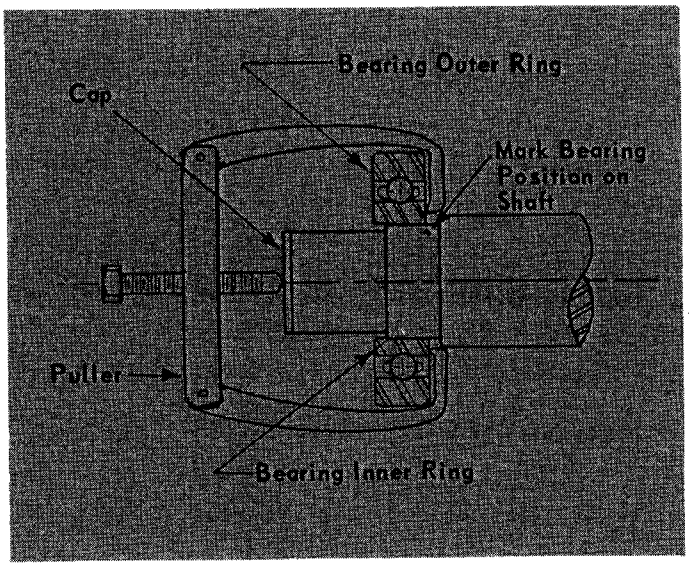

Figure 3-8. Removing Bearing From Generator Shaft

3-16. Installing Bearings. Heat the bearing to 250° F. in a clean temperature controlled circulating air oven. Start the heated bearing onto the shaft. Then use a fiber or soft metal sleeve to tap bearing into place. Make certain that pressure is applied only to the bearing inner ring. Install bearing to the same position on the shaft as the original bearing. Assemble the generator after the bearing has cooled.

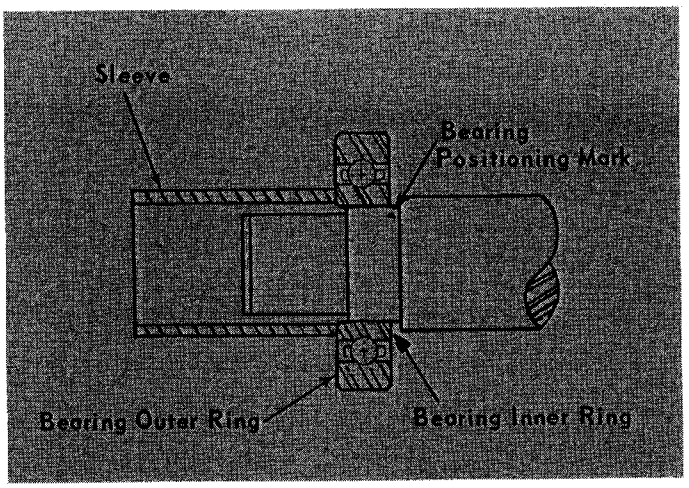

Figure 3-9. Installing Bearing On Generator Shaft

3-17. TROUBLESHOOTING. Troubleshooting is a process of recognizing malfunctions of the system, intelligently analizing the system malfunction, and making the necessary corrections to place the unit back into proper operation.

The systems operator is urged to be alert at all times for any signs of malfunctions. Any minor malfunctions should be corrected immediately to prevent serious malfunctions and down time. The troubleshooting chart lists symptoms of malfunctions which could possibly occur as well as the possible cause and remedy.

WARNING

Do not attempt to make any adjustments, replace any parts, or make any repairs for which you do not have the necessary knowledge or testing equipment. Contact KATO Engineering Company, or employ a competent electrical firm which has the knowledge and equipment.

TROUBLESHOOTING CHART

SYMPTOM	POSSIBLE CAUSES	REMEDY
No Voltage	Poor brush connection.	Replace excessively worn brushes. Clean, adjust, and seat poorly seated brushes. Make certain brushes do not bind in brushholders and that brush leadwire connections are tight.
	Grounded armature or field.	Repair or replace armature or field.
	Open field circuit in field windings.	Trace open circuit with DC test lamp. Repair or replace defective parts.
	Short circuit in line or load.	Check for short in load.

SYMPTOM	POSSIBLE CAUSES	REMEDY
Low Voltage	Excessive load.	Reduce load. Load should not exceed rated current.
	Excessive line drop.	Increase size of line wires.
	Underspeed.	Correct speed of unit driving generator.
	Shorted field windings.	Test field windings for possible short by checking resistance with an ohmeter or resistance bridge. Replace windings if defective.
	Brushes dirty or not properly seated.	Clean and seat, or replace brushes.
Fluctuating Voltage	Voltage regulator not operating properly (if used).	Regulator may be bypassed, repaired or replaced as necessary. If generator is operated without a regulator, voltage should be checked to make certain voltage is approximately the same as stamped on the nameplate.
	Poor brush contact.	Clean, adjust or replace brushes.
	Dirty pitted or grooved commutator.	Clean, sand or turn commutator.
	Loose terminal or load connections.	Check all mechanical and electrical connections.
	Generator overloaded.	Reduce load.
High Voltage	Overspeed.	Correct speed of prime mover.
	Improper adjustment of generator field resistor or regulator.	Adjust field resistor or regulator.
Overheating	Clogged ventilating screen.	Clean all air passages.
	Dry or defective bearings.	Replace defective bearings.
	Coupling misaligned or drive belt too tight.	Align generator set or adjust belt.
	Generator field coils shorted or grounded.	Test field coils for shorts with an ohmeter or resistance bridge. Replace defective field coils.
Vibration	Defective or dry bearings.	Replace defective bearings.
	Misalignment of generator and prime mover.	Align generator set.
	Generator not properly mounted.	Check mounting. Correct defective mounting.
	Transfer of vibration to generator from prime mover or other source.	Isolate from source of vibration with vibration dampeners.

3-18. DISASSEMBLING GENERATORS. Your KATO DC generator can be completely disassembled with the use of standard hand tools. Disassemble single bearing generators as described in Paragraph 3-20. Follow the steps described in paragraph 3-19 when disassembling two bearing generators.

3-19. Disassembly Procedures For KATO Two Bearing DC Generators. Refer to Figure 3-10 for Key number and Part identifications then disassemble the generator as follows;

A) Remove outlet box cover (26) and disconnect the generator output leads and field leads.

B) Remove endbell cover (1)

C) Disconnect output wires (6) and (7) at the brush holder assemblies. Lift brushes in holders and lock brushes in the raised position. Remove any clips securing wires (6) and (7) to the generator endbell (2) or frame (15).

D) Remove drive belt and sheaves or flexible coupling in accordance with the coupling or pulley manufacturers instructions.

E) Remove bolts securing generator to the base.

F) Attach slings to lifting eyes (25) and lift generator to disassembly area.

G) Remove endbell bolts (21). Remove endbell (20). check for shims in endbell bearing housing, make sure these shims, when used, are reinstalled when the generator is assembled.

H) Remove endbell bolts (3). Remove endbell (2). Check for shims in endbell bearing housing, make sure these shims, when used, are reinstalled when the generator is assembled.

I) Remove (armature rotor) assembly from fan end.

J) When necessary, remove bearings as described in paragraph 3-15.

K) Remove fan by loosening fan bolt (18). When generator has a sheet metal fan and steel fan hub instead of the cast fan and hub assembly shown, remove fan hub by loosening bolt and then heating the hub before removing hub with a puller.

L) Remove bolts (24). Remove field coil and field pole assembly (10) and (11).

M) Reverse disassembly procedures when assembling generator. Install and align the generator as described in the installation instructions.

3-20. Disassembly Procedures For KATO Single Bearing DC Generators. Refer to Figure 3-11 for Key number and part identification, then disassemble the generator as follows:

A) Remove outlet box cover (26) and disconnect the generator output leads and field wires.

B) Remove endbell cover (1).

C) Disconnect output wires (6) and (7) at the brush holder assemblies. Lift brushes in holders and lock brushes in the raised position. Remove any clips securing wires (6) and (7) to the generator endbell (2) or frame (15).

D) Remove generator from the engine by reversing installation procedures. Refer to paragraphs 1-31 and 1-32.

E) Remove bolts securing generator to the base.

F) Attach slings to lifting eyes (25) and lift generator from the base. Move generator to the disassembly area.

G) Remove endbell bolts (3) and endbell (2). Check for shims in endbell bearing housing. Make sure these shims, when used, are reinstalled when generator is assembled.

H) Remove armature (rotor) assembly from drive end.

I) Remove steel drive hub by loosening bolts (19) heating hub and removing with pullers.

J) Remove fan as described in step K), paragraph 3-18.

K) Remove bolts (24). Remove field pole and coil assembly (10) and (11).

L) Reverse disassembly procedure when assembling generator. Install and align the generator as described in paragraph 1-30 through 1-32.

3-21. Ordering Repair Parts. Order repair parts by Part number. Refer to the parts list included with this manual. Always include the serial number, model number and type number of the generator. Do not attempt to substitute parts of a similar type or grade.

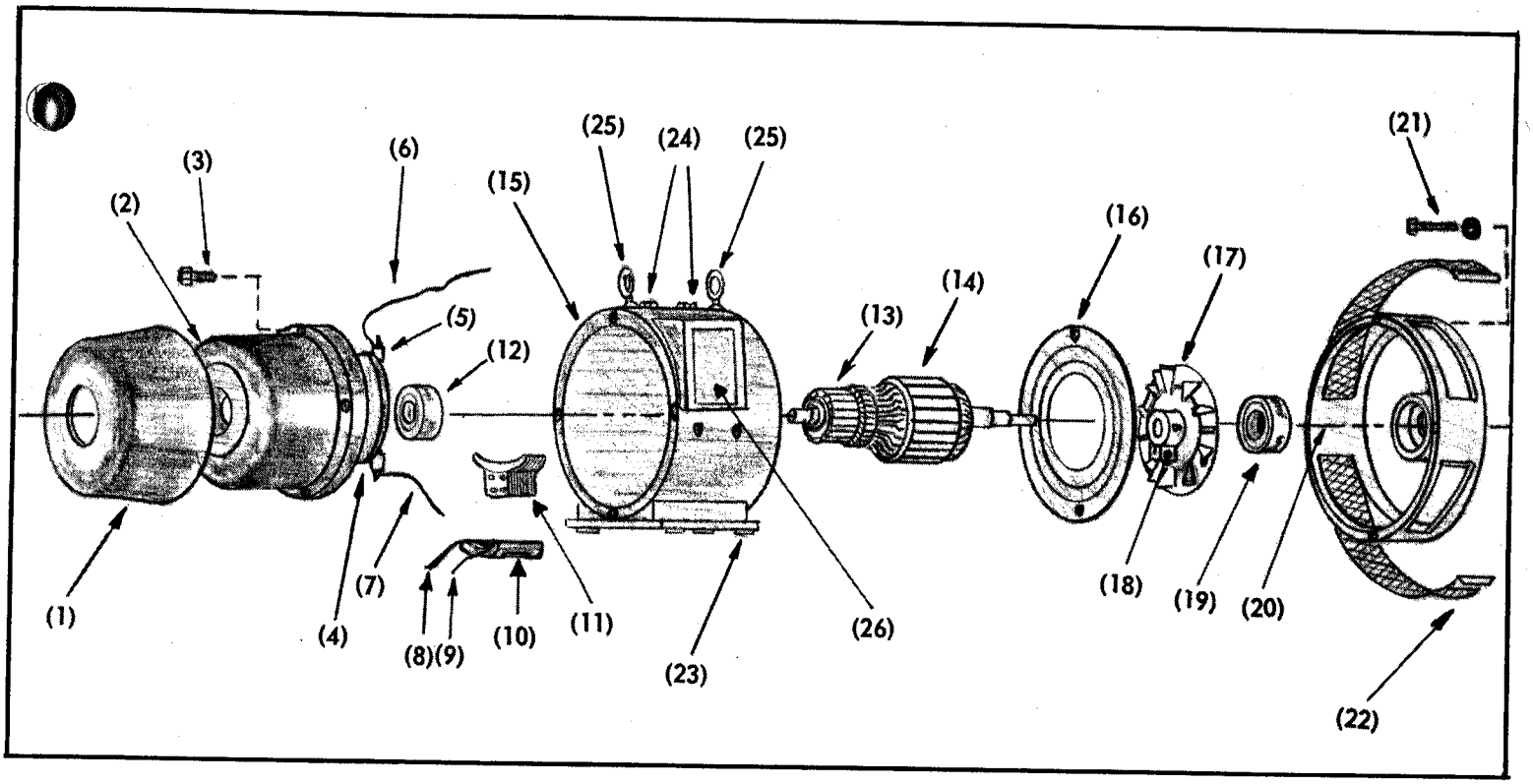

Figure 3-10. Parts Drawing, Typical Two Bearing DC Generator, Exploded Veiw

Key	Part
(1)	Endbell Cover, Commutator End
(2)	Endbell, Commutator
(3)	Bolt, Endbell, Commutator End
(4)	Brush Holder Ring Assembly
(5)	Brush Holder and Brushes
(6)	Output Lead A1
(7)	Output Lead A2
(8)	Field Coil Lead F1
(9)	Field Coil Lead F2
(10)	Field Coil
(11)	Field Pole
(12)	Bearing, Commutator End
(13)	Commutator

Key	Part
(14)	Armature (Rotor) Assembly
(15)	Generator Stator and Frame Assembly
(16)	Baffles
(17)	Fan Assembly
(18)	Bolt, Fan Hub Retaining
(19)	Bearing Drive End
(20)	Endbell, Drive End
(21)	Bolt, Endbell, Drive End
(22)	Fan Screen
(23)	Generator Mounting Pad
(24)	Bolt, Field Pole and Coil Assembly Mounting
(25)	Lifting Eye
(26)	Outlet Box Cover

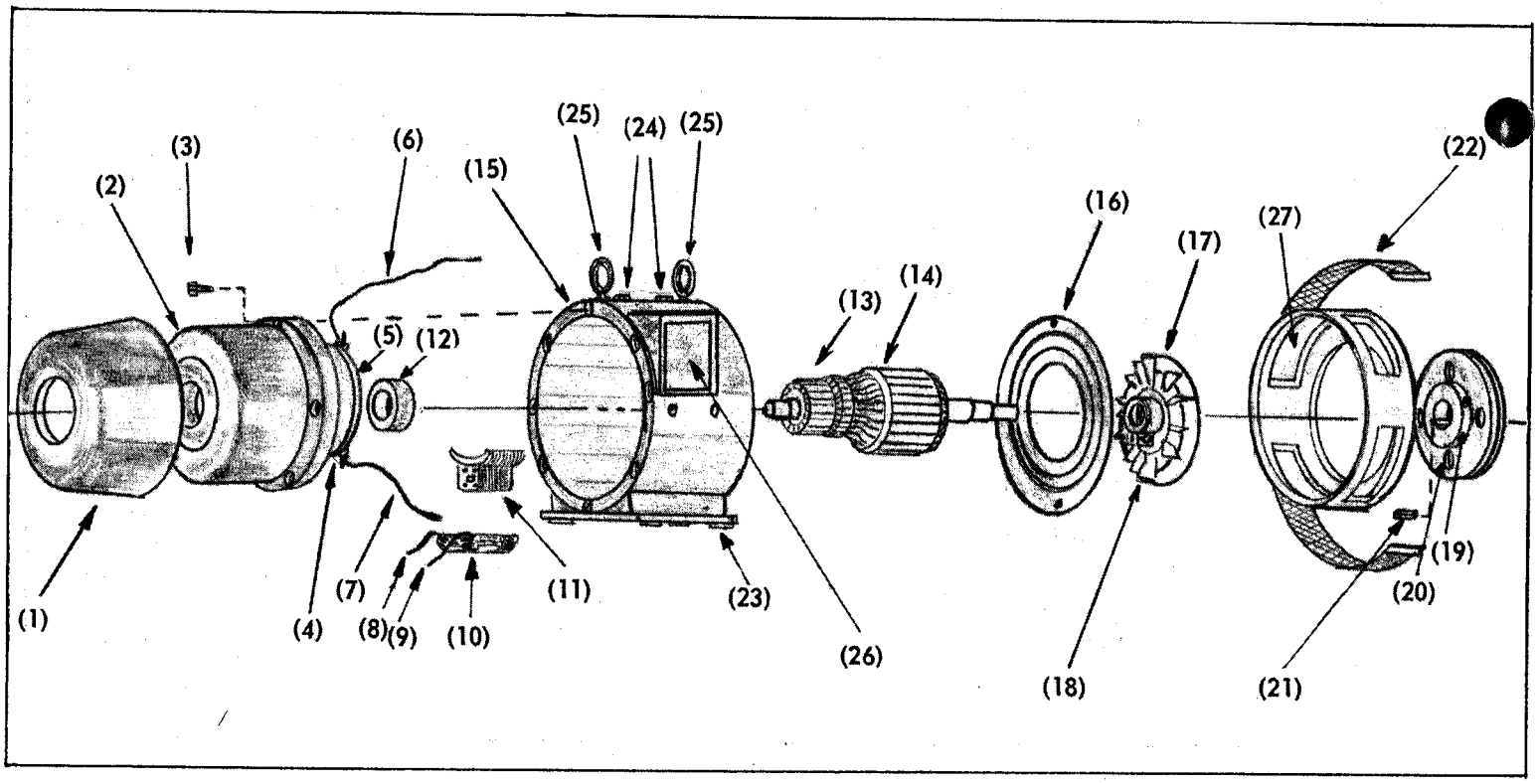

Figure 3-11. Parts Drawing, Typical Single Bearing DC Generator, Exploded Veiw

Key	Part
(1)	Endbell Cover, Commutator End
(2)	Endbell, Commutator End
(3)	Bolt, Endbell, Commutator End
(4)	Brush Holder Ring Assembly
(5)	Brush Holder and Brushes
(6)	Output Lead A1
(7)	Output Lead A2
(8)	Field Coil Lead F1
(9)	Field Coil Lead F2
(10)	Field Coil
(11)	Field Pole
(12)	Bearing, Commutator End
(13)	Commutator

Key	Part
(14)	Armature (Rotor) Assembly
(15)	Generator Stator and Frame Assembly
(16)	Baffles
(17)	Fan Assembly
(18)	Bolt, Fan Hub Retaining
(19)	Drive Hub Bolt
(20)	Drive Plates
(21)	Key, Drive Hub
(22)	Fan Screen
(23)	Generator Mounting Pad
(24)	Bolt, Field Pole and Coil Assembly Mounting
(25)	Lifting Eye
(26)	Outlet Box Cover
(27)	Adapter Endbell, Drive End

WARRANTY

Kato Engineering Company warrants that the apparatus manufactured by us will deliver its rated output, providing such apparatus is properly installed, properly cared for, operated under normal conditions and with competent supervision.

Standard products manufactured by Kato Engineering Company are warranted to be free from defects in workmanship and material for a period of one year from the date of shipment, and any products which are defective in workmanship or material will be repaired or replaced at the option of Kato Engineering Company at no charge to the Buyer. Final determination as to whether a product is actually defective rests with Kato Engineering Company. The obligation of Kato Engineering Company hereunder shall be limited solely to repair and replacement of products that fall within the foregoing limitations, and shall be conditioned upon receipt by Kato Engineering Company of written notice within the warranty period of any alleged defects or deficiency. No products shall be returned to Kato Engineering Company without its prior consent. Products which Kato Engineering Company consents to have returned, shall be shipped F.O.B. the Company's factory. Kato Engineering Company cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective. In the case of components, parts, or units purchased by Kato Engineering Company, the obligation of Kato Engineering Company shall not exceed the settlement that it is able to obtain from the supplier thereof.

The life of the products of Kato Engineering Company depends to a large extent upon type of usage thereof, and Kato Engineering Company makes no warranty as to period of service nor as to fitness of its product for specific applications by the buyer unless Kato Engineering Company specifically agrees to otherwise in writing after the proposed usage has been made known to it. In no event will Kato Engineering Company be liable for consequential or incidental damages or for any expense incurred by Buyer due to use or sale of products sold by Kato Engineering Company.

The foregoing warranty is exclusive and in lieu of all other warranties expressed or implied, including but not limited to any warranty of merchantability or of fitness for a particular purpose.

This warranty does not apply to experimental or developmental products.

KATO ENGINEERING COMPANY
Mankato, Minnesota

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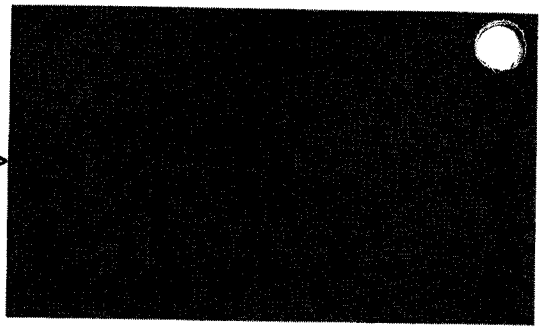
ENGINEERING
COMPANY



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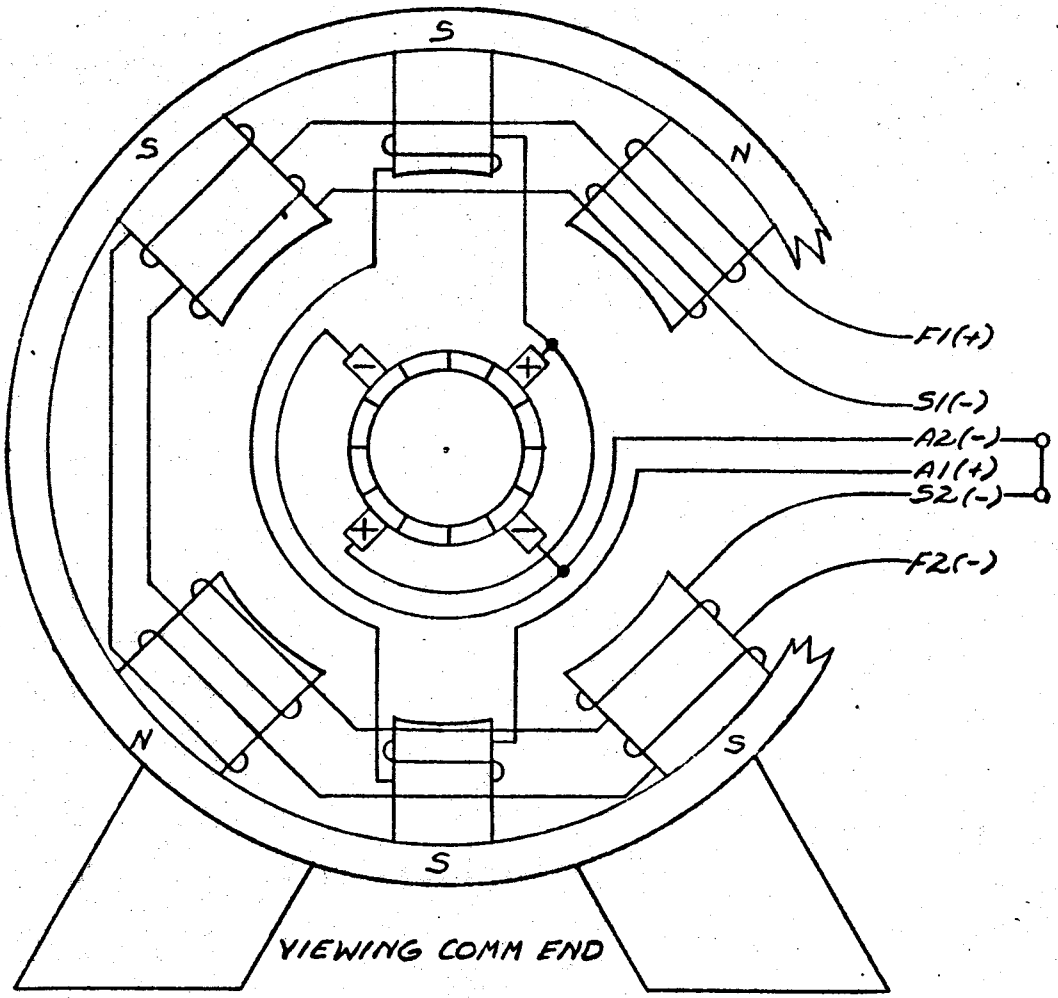
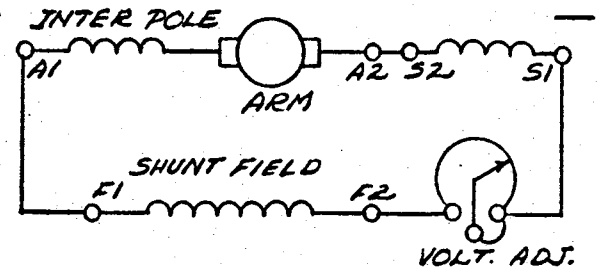


SERVICE ENGINE

CCWFCE



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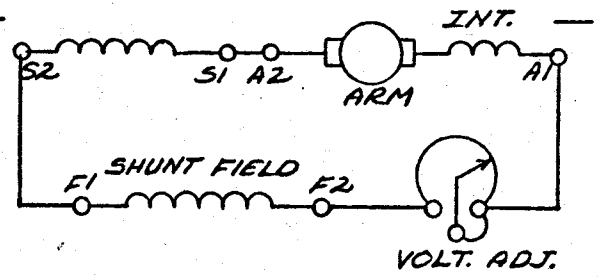


REV.	DATE	E.C.O.
A		
B		
C		

KATO ENGINEERING CO.
ELECTRICAL GENERATING EQUIPMENT
MANKATO, MINNESOTA, U.S.A.

1st S/N USED ON 73505

DRWG. NO. | SH 1 OF 1

PATD | MATL. | DR MS

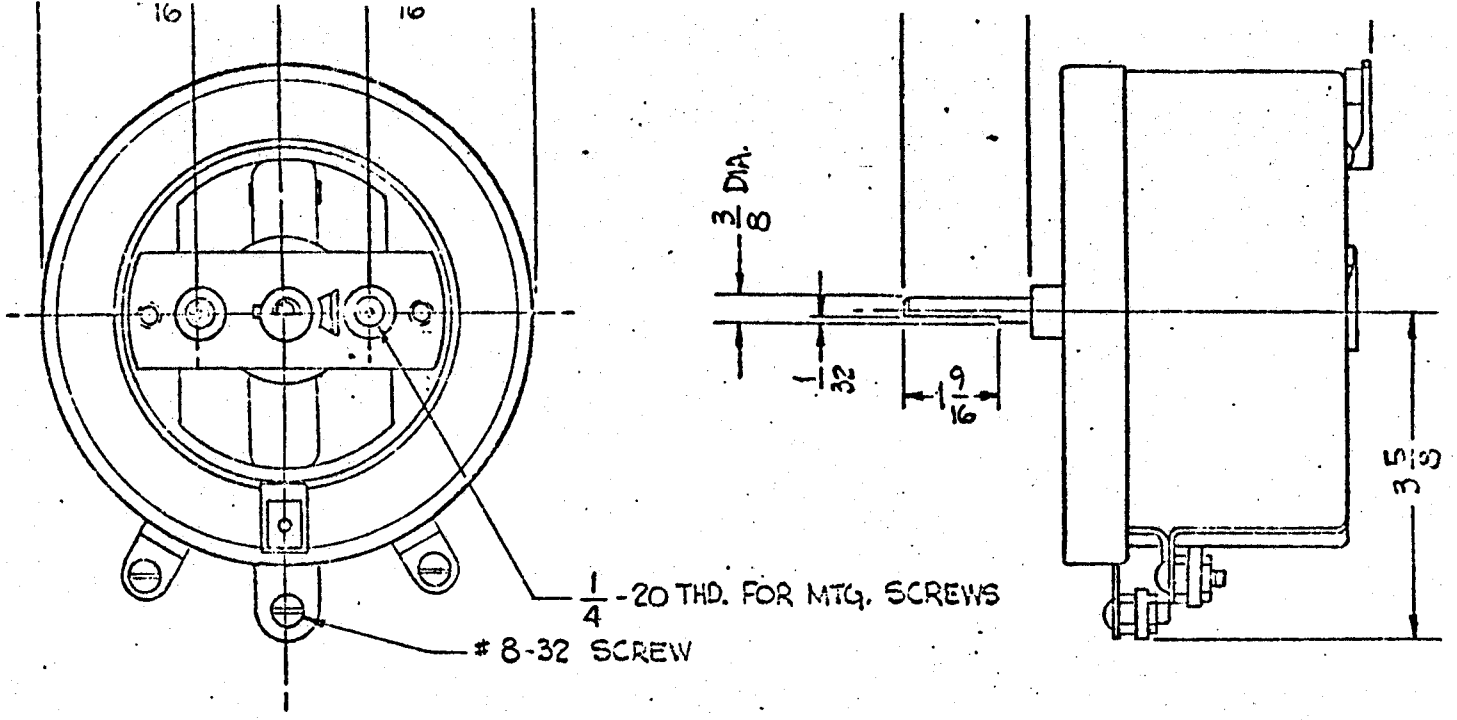
ENGR JF | CK [illegible] | DATE 12-29-75 | SCALE

CERTIFIED FOR

P.O. 111137

KATO S/N 74239

DRAWING NO. 867-33243-12



SCOPE: This drawing covers the detail requirements for a wire-wound rheostat.

REQUIREMENTS:

Mechanical:

Design and Dimensions: In accordance with drawing.
Construction: Linear taper wire wound winding.
Shaft: 3/8" diameter round
Rotation: 315°
Additional parts required: Dial plate, knob, 2 flat head screws 1" long

Electrical:

Watts: Rated 300 watts in free air.
Resistance: 0 to 320 ohms
Maximum Amps: 2.8 to .12

THIS PRINT CERTIFIED
FOR
Pettibone Michigan
CUSTOMER ORDER NO. 111137
KATO ORDER NO. 77439
DATE 12/16/77 SIGN. MR
ENGINEERING DEPT.
KATO ENGINEERING CO.

XLD PART NO. D-3654

KATO ENGINEERING CO. ELECTRICAL GENERATING EQUIPMENT MANKATO, MINNESOTA, U.S.A.	PATT. NO.				
	MAT'L. LISTED				
ORDER FIRST USED ON	AP'D.	DESCRIPTION	DATE	REV.	
DATE 1-17-69	SCALE NONE	CK'D. Ted	DRAWING NO. 867-33243-12	SHEET	OF
TITLE RHEOSTAT	DR. Raja				

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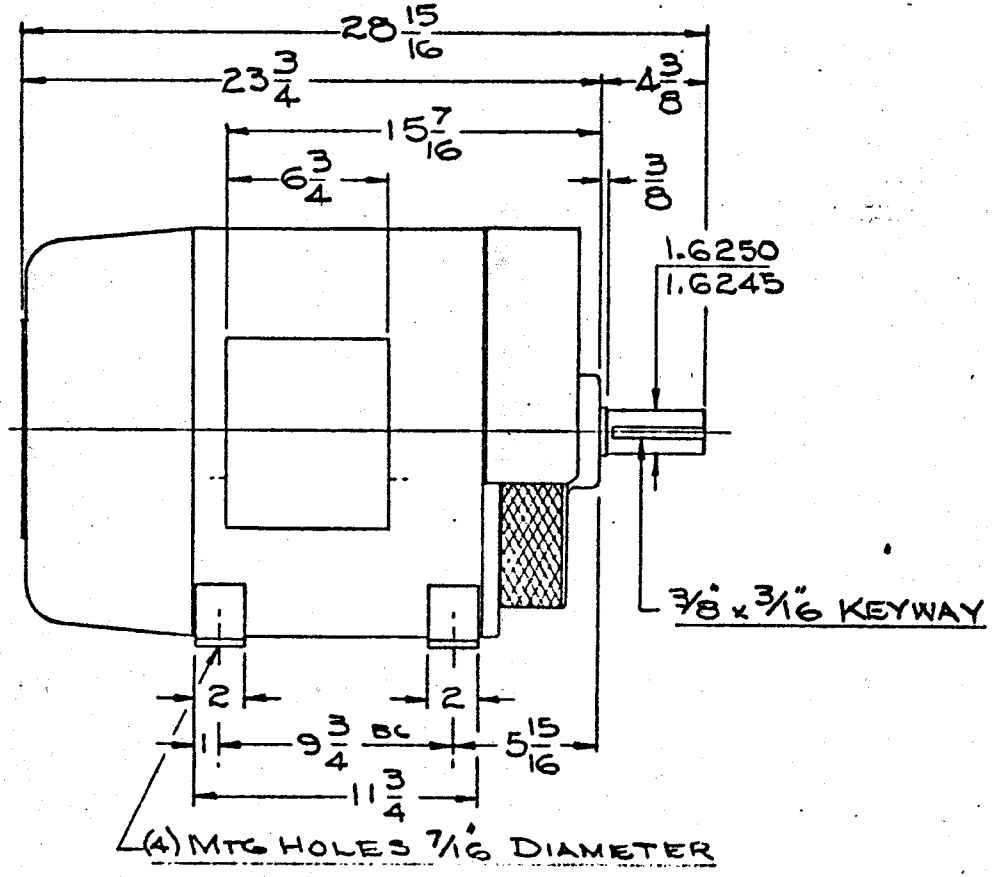

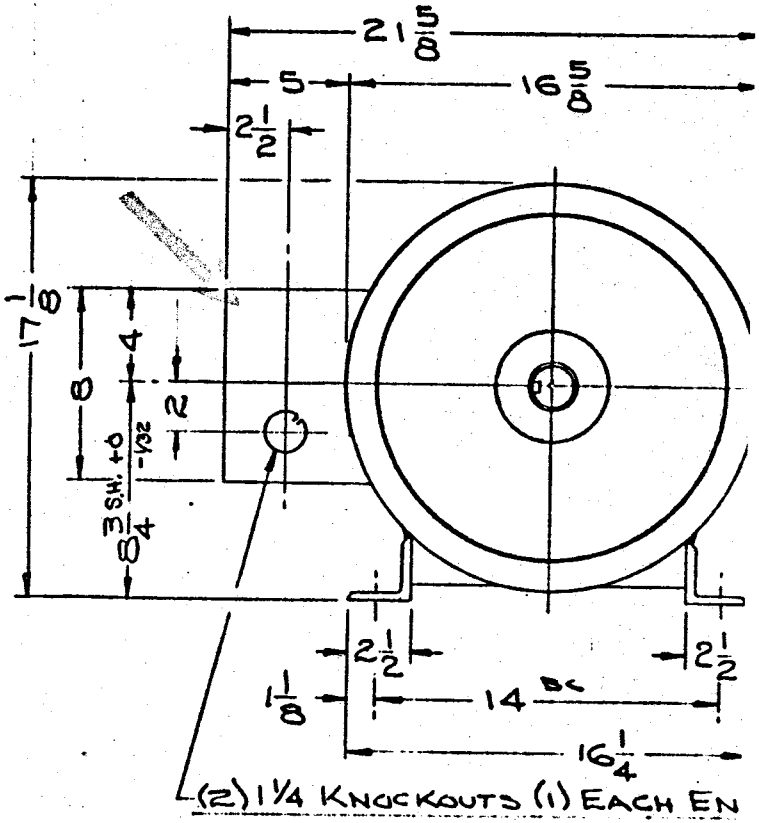

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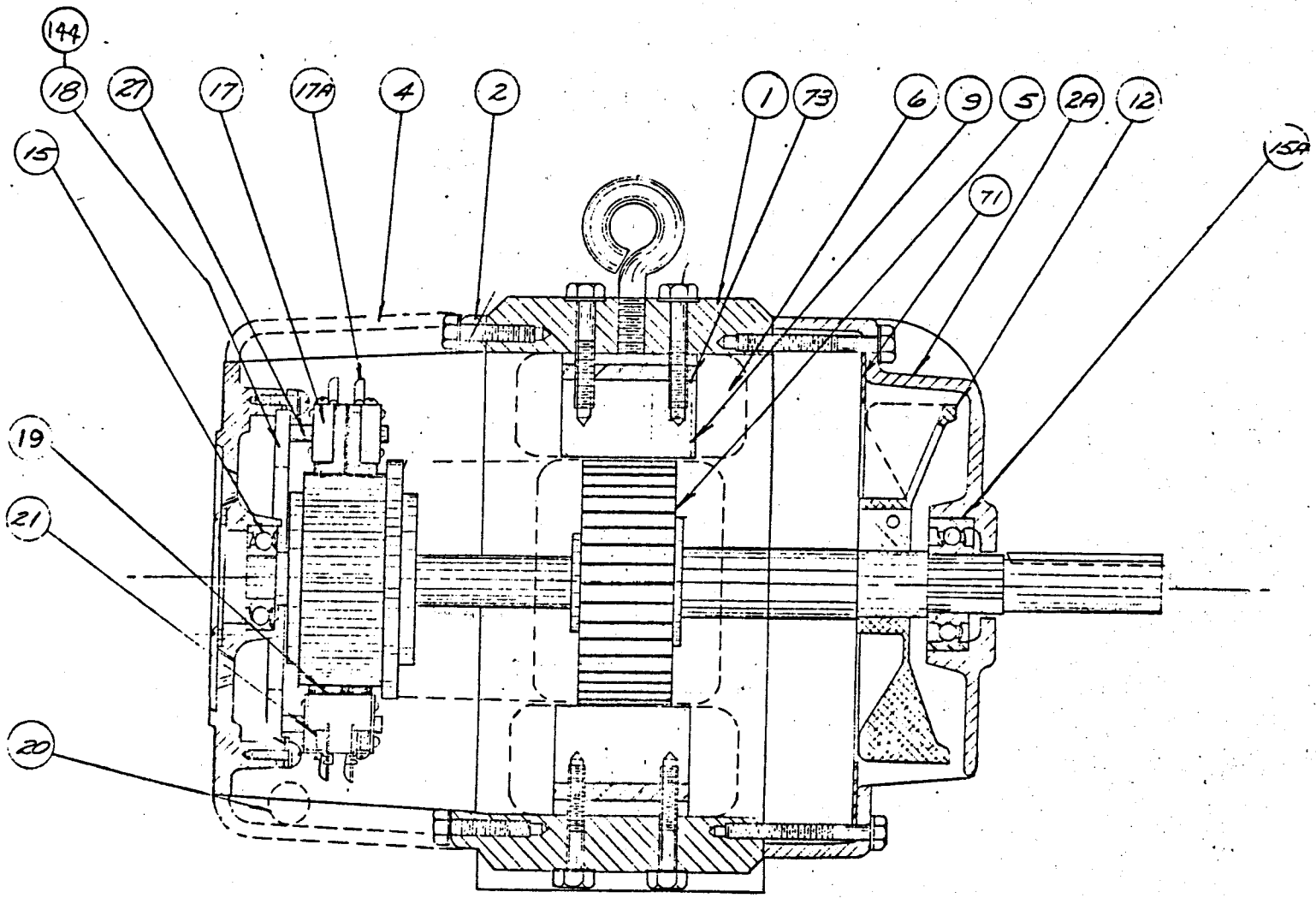
P.O.	ENGR.	DR.	CK.
KATO S/N	DATE 11-30-77	SCALE 1 : 8	1st S/N USED ON 7743
DATE / SIGN	TITLE KATO GENERATOR		DRWG. NO. 102-8006 SH. 1 OF 1

106-0000



OLD NO. A-3715

ASSEMBLY OR PART NO. 106-00009	KATO ENGINEERING CO. MANKATO, MINN.	NAME
CHANGES	DR. TR. CK.	MATERIAL
	FOR	PATTERN NO.
	ORDER NO.	SCALE DATE

BILL OF MATERIAL NO. 110-07743-90 PAGE 1 OF 1

CUSTOMER PETTIBONE MICHIGAN CORP.

O. NO. 111137

GENERATOR MODEL 25-480002421 TYPE NO. 19643

MOTOR MODEL _____ TYPE NO. _____

EQUIP. DESCRIPTION TWO BEARING D.C. GENERATOR-BRUSH TYPE

KATO SER. NO. 77439

DATE April 7, 1978

PARTS DWG. 106-00009

NOTE: When placing an order for parts, always include the model, type and serial number.

KEY NO.	KATO ENGINEERING CO. PART NO.		PART DESCRIPTION	NO. REQ'D.	
5	223-28035-73		ARMATURE ASSEMBLY	1	
	015-00066-01		COMMUTATOR BAR	1	
15	012-21072-00	*	BEARING COMM END	1	
15A	012-21092-00	*	BEARING DRIVE END	1	
12	016-00006-03		FAN ASSEMBLY	1	
144	045-00102-00		BRUSHHOLDER RING ASSEMBLY	1	
18	046-12061-50		BRUSH RING	1	
17	047-00048-00		D.C. BRUSHHOLDER	4	
19	050-12067-06	*	D.C. BRUSH	2	
17A	048-60021-00		D.C. TENSION ARM & HUB	12	
21	048-80034-00	*	D.C. TENSION SPRING	12	
20	868-35070-30	*	D.C. CONDENSER	6	
9	024-00187-75		FIELD POLE	4	
6	237-84006-77		FIELD COIL	4	
	090-00450-21		COMM POLE & COIL ASSY.	2	
1	001-80136-00		FRAME	1	
2	004-80019-00		ENDBELL COMM END	1	
2A	005-10001-00		ENDBELL DRIVE END	1	
4	009-00025-00		COVER COMM END	1	
	008-10003-01		COVER DRIVE END	1	
	008-10043-00		DRIPPROOF SHIELD	1	
	035-00001-04		INSPECTION PLATE	1	
71	020-00002-00		BAFFLE	1	
	034-10041-00		OUTLET BOX	1	
	867-33243-12	*	VOLTAGE ADJUST RHEOSTAT (320 Ohm 300W)	1	
			DRAWINGS		
	102-80063		UNIT DIMENSIONAL DRAWING		
	AK-8884		GENERATOR HOOKUP		
			*RECOMMENDED SPARES FOR ONE YEARS USAGE.		