WINCO® OPERATING INSTRUCTIONS & PARTS MANUAL

TWO-BEARING GENERATOR

0782/263/15C

READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL OR SERVICE THE WINCO TWO-BEARING GENERATOR. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE!

RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

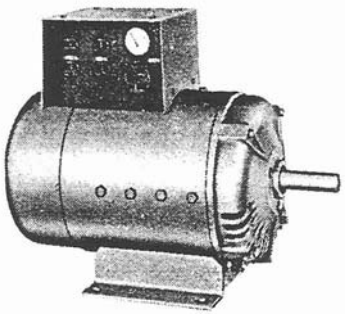

Figure 1

Testing Policy

Before any generator is shipped from the factory it is fully checked for performance. The generator is loaded to its full capacity, and the voltage, current, and frequency are carefully checked. A test card with this data is filed by unit serial number for permanent record of performance.

Rated output of generators is based on factory tests of typical units, and is subject to and limited by the ambient operating temperature. The generator will not provide full power output unless driven by a prime mover of adequate horsepower. The prime mover (engine or other input power source) horsepower is also affected by temperature as well as a number of other factors such as fuel, altitude and all other conditions specified by the prime mover manufacturer.

Description

The **WINCO** generator is a 3600 RPM two bearing, belt driven, brush type, revolving armature design. The generator is self excited and inherently regulated to +/− (plus or minus) 7% — no load to full rated load. It can be operated under any load within its rating without being damaged. The frequency regulation is determined by the sensitivity of the customer supplied prime movers' governor. It is desirable to maintain this speed to within 3 cycles variation (61.5 Hz — 58.5 Hz) no load to full rated load (3690 RPM — 3510 RPM).

Unpacking

When unpacking the generator, be sure to inspect it carefully for freight loss or damage. If loss or damage is noted at the time of delivery, require that the person making the delivery make note of the loss or damage on the freight bill, or affix his signature under the consigner's memo of the loss or damage. Contact the carrier for claim procedures.

When loss or damage is noted after delivery, segregate the damaged material and contact the carrier for claim procedures.

"Concealed damage" is understood to mean damage to the contents of a package which is not in evidence at the time of delivery by the carrier, but which is discovered later. The carrier or carriers are responsible for merchandise lost or damaged in transit. The title of goods rests with the consignee when generators are shipped FOB factory. And only the consignee can legally file claims.

1. Carefully open carton.
2. After inspecting the generator for external physical damage, check for the owner's manual (operating instructions, wiring diagram, parts list and warranty) inside the carton.
3. Remove generator hold down bolts.
4. Unit can now be lifted from shipping base.

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Specifications

WATTS	VOLTS	AMPS	HZ	PH	RPM	INSULATION
4,000	120/240	16.7	60	1	3600	CLASS B
8,000	120/240	33.3	60	1	3600	CLASS B
20,000	120/240	83.3	60	1	3600	CLASS F

General Safety Information

DEFINITION OF CAUTIONS & WARNINGS

CAUTION: Possible damage to equipment. Notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.

WARNING: PERSONAL DANGER. NOTES INDICATE ANY CONDITION OR PRACTICE, WHICH IF NOT STRICTLY OBSERVED, COULD RESULT IN PERSONAL INJURY OR POSSIBLE LOSS OF LIFE.

DESPITE THE SAFE DESIGN OF THIS GENERATOR, OPERATING IT IMPRUDENTLY, NEGLECTING ITS MAINTENANCE, OR BEING CARELESS WITH IT CAN CAUSE SERIOUS INJURY OR DEATH. THIS GENERATOR IS POWERFUL ENOUGH TO DELIVER A FATAL ELECTRIC SHOCK. ALLOW ONLY A RESPONSIBLE AND CAPABLE PERSON TO OPERATE THIS GENERATOR.

1. For permanent wiring or wiring into existing electrical service or system, the installation must comply with all national, state and local codes.
2. Do not allow anyone to operate the generator without proper instruction.
3. Avoid touching live terminals or receptacles.
4. Be extremely careful if operating this generator in rain or snow.
5. This generator must be properly grounded.
6. Hot prime mover (engine) parts, moving drive parts, and generator output, all can seriously injure the generator operator. The operator must use caution and remain alert when using this generator.
7. Keep all safety guards and drive shields in position and tightly secured while equipment is operating.
8. When operating this generator, do not wear neckties, loose articles of clothing or anything else that can be caught in moving parts.
9. Provide adequate ventilation for prime mover exhaust and fuel vapors that may leak through fittings or damaged pipes. Be sure generator itself is well ventilated for maximum performance and life.
10. The generator manufacturer recommends that only qualified electrical technicians be allowed to service (install, maintain, repair, or replace parts) this generator, and that only factory approved repair parts be used in it.
11. Do not work on this generator (or other potentially hazardous equipment) when fatigued.
12. Use extreme caution when working on electrical components. High generator output voltage can cause serious injury or death.
13. Keep the generator and the area around it clean. Remove all material that can create slippery conditions, such as grease, water, ice and snow. Also remove oily rags and other flammable material from the area.
14. Keep a fire extinguisher near the generator. Extinguishers rated ABC by the NFPA are appropriate for this use. Consult the local fire department if you have questions regarding fire extinguisher ratings. Keep the extinguisher properly maintained and be familiar with its proper use.

CAUTION: Any generator which is installed for standby or emergency power must be equipped with a suitable double-throw switch for use when the power line fails. The switch transfers the load from the power line to the generator.

When the transfer switch is thrown to the "power line," the standby generator is not connected to either the load or the power line. When the switch is thrown to the "standby" side, the generator is connected to the load but the load is disconnected from the power line. Consequently, no electricity produced by the generator can feed back to the power line where it would be hazardous to line repairmen. Failure to use a transfer switch could result in generator damage when the power line is re-energized.

Assembly

CAUTION: Before proceeding with the installation, be sure that you have completely read and understood the assembly and installation instructions.

An engine with adequate horsepower and a close regulating (fixed speed) governor is required for satisfactory operation of any alternating current generator.

Only 1.4 horsepower is required to produce each 1000 watts of generator output power assuming 100% efficiency of both the engine and the generator. However, due to engine and generator efficiencies of 80 to 90%, the loss of power due to engine driving accessories such as cooling fans, battery charging alternators, etc., friction losses and slippage in the drive pullies and belts, the general conservative rule of thumb allowing approximately two (2) horsepower for every 1000 watts of generator output is much more realistic.

For example, a 4,000 watt generator output will require an 8 or 9 H.P. engine. A 20,000 watt generator requires approximately 35 to 40 horsepower for full output, good speed, voltage regulation, and satisfactory load performance (for example starting large motors).

When determining the prime mover/generator pulley ratio to drive the generator at the correct operating speed, bear in mind that the power rating of most prime movers (usually an engine) varies with the speed — that is, it produces more power at higher speeds, less when slowed. The prime mover must be run fast enough to reach the desired horsepower for good generator set operation.

The drive belt system must be of adequate size and must be tight enough to power the generator without slippage. Be careful not to overtighten to the extent that it puts excessive strain on the bearings — doing so can cause bearing failure and other possible damage to the generator.

The **8KS** and **20KS** models both have oversize bearings and shafts which will allow them to tolerate very high belt loads without increasing the threat of shaft or bearing failure. Alignment of the generator to the prime mover is important. Misalignment of the pullies will cause excessive belt and pulley wear and unnecessary stress on the prime mover.

The following table shows the effect of various operating speeds and electrical loads on a typical generator when matched and mounted to an adequate prime mover.

APPLIED	2-POLE	FREQUENCY	115V PLANTS	230V PLANTS
None	3690	61	129	258
Half	3600	60	120	240
Full	3510	58-1/2	115	230

Although individual units and models may vary slightly, the normal voltage and frequency of typical 60 cycle engine-driven generators described in this manual are approximately as follows when run first with no load applied, then at half the generator capacity and finally

when loaded to its full capacity as rated on the nameplate.

NOTE: Required generator speed must be maintained at 3600 +/– 90 RPM under all load conditions.

All engines have a tendency to slow down when a load is applied. The governor on the engine is designed to hold the engine speed nearly constant when the electrical load connected to the generator is increased. The engine is more heavily loaded and as a result the speed drops slightly. This slight decrease in speed, together with the natural "voltage drop" within the generator itself due to load current and heating of the windings, results in a slightly lower voltage than when the generator is running idle.

The normal slight variations in speed also directly affect the frequency of the output current. This frequency variation has no appreciable effect in the operation of most loads (such as motors, lights and most small appliances). However, timing devices and clocks will not keep perfect time unless the engine can keep the generator running at exactly 3600 RPM at all times. Since this is not usually possible, minor time errors in clocks occur.

The speed of the engine is usually adjusted so that the generator produces proper voltage. If the adjustment is made "cold," set the voltage a little higher than normal since it will drop a few volts as the generator warms up.

NOTE: When operating continuously at full load the generator shell becomes very warm. It will be uncomfortable to the touch — this is normal for any high performance inherently regulated generator.

Output voltage should be checked periodically to ensure proper operation of the generating plant and appliances.

CAUTION: Low voltage may damage any motors or appliances connected to it. Running the generator at excessively high speeds results in too high voltage which will also damage electrical devices connected to it. Excessively high speed may also cause damage to the generator armature windings.

Plans for installation should be prepared with proper attention to mechanical and electrical engineering detail to assure a satisfactory system installation. The information in this manual is offered as a guide to finalizing your installation plans. The installation sequence is summarized below.

PLAN THE INSTALLATION

Generally these two-bearing generators are used on portable equipment. For best service consider the following:

1. All electrical equipment should be protected from excessive moisture. Failure to do so will result in deterioration of the insulation and short circuits and grounds.
2. The generator should be installed in a sheltered area. If the unit must be left in the open it should always be protected with a weather cover such as a tarp or large piece of canvas after each use to keep out water and dust.

CAUTION: Always allow the generator and prime mover to cool before covering with a flammable weather covering.

Some units are installed permanently. The following is a general installation sequence for a permanently mounted generating system. Since many different prime movers could be used, the list is generalized around a typical internal combustion engine as the drive source.

PLANNING FOR PERMANENT INSTALLATIONS

1. Space required for installation and service access
2. Location — close to fuel, exhaust outlet, and electrical connections
3. Ventilation of room for prime mover (engine) and generator
4. Protect from moisture and dirt
5. For seasonal temperature variations (heat and cold)
6. Mounting of generator system
7. Prime mover hook-up: Exhaust, fuel, battery, and control (as required)

SPACE REQUIRED AND LOCATION

The space required should allow for ample working room around and in back of prime mover (engine) generator set. A general rule to follow is three (3) feet clearance. This allows service personnel to repair and remove prime mover (engine) or generator parts in the event service is needed.

The prime mover (engine) - generator should be placed near an outside wall as close to electrical service and fuel source as possible. This will reduce the cost of electrical and fuel runs. Position the unit to keep the exhaust runs as short as possible. Protection from adverse weather conditions must be provided without restricting adequate ventilation for cooling. Planning now will eliminate costly errors that will have to be corrected later at considerably higher expense.

VENTILATION OF ROOM, PRIME MOVER (ENGINE) AND GENERATOR

The prime mover is usually an internal combustion engine and probably is air-cooled. The ventilation should be a sweeping flow. When a prime mover (engine) -generator is installed in a building it should have an air inlet opening 1-1/2 times the area of the prime mover (engine) inlet screen. The hot air discharge should be above the cool air inlet, as the hotter air will rise.

NOTE: Local weather conditions should be considered when choosing the type of louver.

Exhaust gases from gasoline type engines are extremely poisonous.Whenever an engine is installed indoors, the exhaust fumes must be vented to the outside. The prime mover (engine) should be installed at least two feet from any outside wall.

WARNING: BE AWARE OF THE DANGER OF DEADLY CARBON MONOXIDE GAS.

Remember that the exhaust fumes from any gasoline (or other internal combustion type) prime mover (engine) are very poisonous if discharged in a closed room but are not dangerous when well mixed in outside air. If the engine is installed indoors, you must make provisions to carry the exhaust gases safely outdoors.

Moisture and dirt — All electrical equipment should be protected from excessive moisture. Failure to do so will result in deterioration of the insulation and short circuits and grounds.

Foreign materials such as dust, sand, lint and abrasive materials have a tendency to cause excessive wear, not only to the prime mover (engine) parts but also to the generator parts — particularly the brushes. It is therefore important that the unit be installed in a reasonably clean location for best service.

Heat and Cold — All prime movers (engine) give off considerable heat when they are running. Since most

prime movers (engine) used on these generators are air-cooled, it is important that the temperature of the room in which they are located does not exceed 105° F while operating. Automatic louvers in doors, windows and/or walls are required to assist in providing adequate air flow where natural cross ventilation is inadequate. A thermostatically controlled fan may be required to boost circulation.

Prime movers (engines) start most easily when they are not subjected to extreme cold.

MOUNTING

CAUTION: The generator must be mounted with the engine to a common rigid base to prevent stress on the engine and generator shafts and bearings due to vibration displacement. For permanent installations the engine-generator is usually mounted on a sub-frame which can be shock mounted with special neoprene pads on the main frame. The assembled generator system should be bolted solid to a solid cement pad, 4 inch minimum.

Use the following checklist to verify correct installation before starting the prime mover (engine).

1. Prime mover (engine) oil. Fill as required grade/quantity
2. Unit mounting base
3. Ventilation (louver size, inlet/outlet)
4. Clearance on all sides
5. Proper fuel line material, size and connections
6. Fuel line protected
7. Proper size and slope on exhaust line
8. Flexible exhaust connector installed
9. Condensation traps installed in fuel and exhaust lines
10. Muffler installed and properly supported. Look closely for potential fire hazards in the mounting system.
11. Exhaust line free of excessive elbows and restrictions
12. Battery of proper voltage and ampere hour rating. Check carefully for correct (usually negative ground) polarity
13. Battery connections clean and tight
14. Battery fully charged

After completing the above checklist, the prime mover (engine)-generator set is ready for the initial start-up test.

A voltmeter is installed in the control/junction box as standard equipment. In installations where engine vibration reduces readability the voltmeter can be relocated remotely by extending the wires.

WARNING: PERSONAL DANGER: EXCERCISE EXTREME CARE.

Consult a qualified electrician to ensure that the high voltage (240 volts) at the meter terminals is correctly connected and insulated for proper and safe operation.

TRANSFER SWITCH

Any generator which is installed for standby or emergency power and tied into a commercial power system (your home or business) must be equipped with a suitable double-throw power isolation switch for use when the power line fails. The switch transfers the building electrical load from the power line to the generator for this type of generator. These switches are typically of the manually operated type.

When the manual transfer switch is thrown to the "power line" the standby generator is completely isolated from the load and the power line. When the switch is thrown to the standby side the generator is connected to the load but the load is completely disconnected from the power line. Consequently, no electricity produced by the generator can feed back to the power line where it would be hazardous to line repairmen. And no power line electricity can be 'backfed' to the generator where it could cause considerable equipment damage.

There are two general classifications of transfer switch installations. Those which switch the entire electrical load from the power line to the standby generator does not have sufficient capacity to carry the entire electrical load. The user may find it necessary to turn off or disconnect some of the lights or appliances since the transfer switch carries all the current when the system is connected to the power line. The switch must have the same (ampere rating) as the main service entrance.

When a double-throw switch is connected into the circuit, the load on only one branch is transferred. The capacity of the switch need be only as large as the total of the rating of the circuits to which it is connected. For example, if the transfer switch is to switch only two 15 ampere circuits, a 30 ampere switch is large enough. Such installations have the disadvantage that only part of the electrical circuits can be used with the standby plant. With smaller generators, however, the principal advantage is that the generator is much less likely to be overloaded.

WARNING: PERSONAL HAZARD — ELECTRICAL SHOCK. ALL WIRING MUST BE DONE IN CONFORMANCE WITH THE NATIONAL CODE AND THE STATE AND LOCAL REGULATIONS.

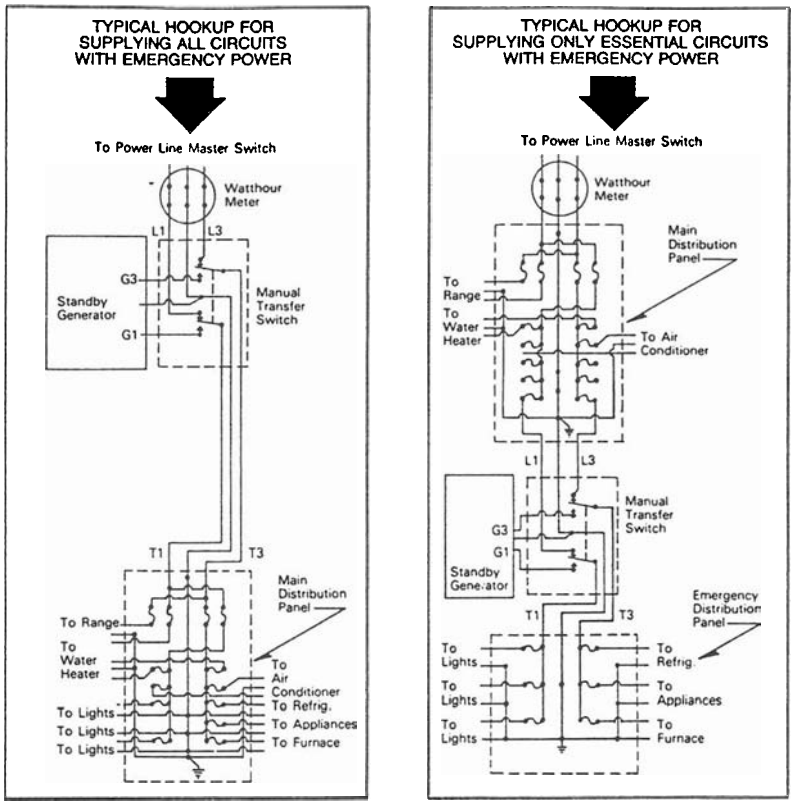

Figure 2

Operation

USE OF ELECTRIC MOTORS

Electric motors require much more current (amperes) to help start them than to run them. Certain motors, particularly inexpensive split-phase motors, are very hard to start. Typically, they require 7 to 10 times as much current to start them as to run them. Capacitor motors are easier to start but still require 3 to 5 times their running current to start. Repulsion induction motors are the easiest to start and usually require only 2 to 4 times their running current to start. Refer to the nameplate of the generator for the running current (ampere rating) and starting code of your motors.

NOTE: The starting code is an alpha character — 'A' code motors are the easiest to start; 'R', 'S', or 'T' code motors are very hard starting.

Most fractional horsepower motors take about the same amount of current to run them regardless of their type of construction (repulsion-induction (RI), capacitor (CAP), or split-phase (SP) type).

For 230 volt motors, the "running" current is half as much as the 115 volt motors of the same size. Some dual voltage 115/230 volt motors that are difficult to start on 230 volts can be sometimes started more easily when connected to operate on 115 volts. This is particularly true of "capacitor start-induction run" motors.

A self-excited generator responds differently to severe overloading than a transformer connected to a power line. To illustrate, suppose that a 230 volt 10 HP "capacitor start-induction run" motor is connected to a small transformer with a minimum rating of 5,000 watts and then to a generator of 5,000 watts capacity.

The transformer would not be able to supply enough power to bring the motor up to operating speed, but would be very severely overloaded and probably would burn out in a short time. The motor might also be damaged.

When this motor is connected to a self-excited 5,000 watt generator, the generator output voltage drops to its residual voltage level (nearly zero — typically 3 to 7 volts). The exciter voltage is also taken from the generator ouptut voltage. Since there is no exciter voltage, the generator magnetic field 'collapses'. Now there is virtually no load on the generator or engine, so no harm is done to either.

Under these conditions, the motor may revolve a few times when it is first turned on, and then stop when the generator field collapses under massive overloads. The generator is self or inherently protected and since the generator is producing nearly zero voltage, the motor or other load is not damaged in any way.

CAUTION: On the other hand, an electric motor that requires slightly more output than the generator can produce will run, but will not reach a high enough speed for the centrifugal switch to disconnect the starting winding. The generator output voltage, instead of being 115, may drop to 70 or 80 volts. Running the generator under these conditions may result in burning out the motor start winding. Exercise care the first time each new load is energized to be sure that the load is compatible and within the capacity of the generator.

Because the heavy surge of current required for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds of time. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

GENERAL INFORMATION

The main components of the generator are field frame, field coils, armature, brushes, brush holder assembly and brackets, armature, generator cooling fan and control box.

GENERATOR MAINTENANCE

BRUSHES

Under ordinary circumstances brushes will operate for thousands of hours without requiring replacement. They should be inspected after the first 1000 hours of operation, and after every 500 hours of operation thereafter. Remove brushes one at a time and check for length. Be sure that each moves freely in the brush holder. Brushes should be replaced when worn down to 3/8". Always replace brushes in complete sets, never singly. When replacing brushes be careful to reconnect the lead wire properly. Poor contact or "skipping" between brush and slip ring can be caused by oil and grit, flint, or other hard contaminant substances on the brushes, or by the brush not being properly shaped to fit the slip rings.

Remedy these defects by cleaning the rings and brushes and then fitting the brushes to the slip-ring curvature. Place #00 sandpaper under the brushes with the abrasive side to the brushes, and work it back and forth until the brushes are the same shape as the slip-rings.

SLIP RINGS

The continuous copper rings located at the end of the armature are the power collector rings or 'slip rings' for proper generator output. The surface of these slip rings must have a highly polished finish. Under sustained use, it is advisable to check and occasionally polish the ring surfaces with a crocus cloth to maintain the finish under normal conditions. This should not be required more than once each thousand hours of operation.

ELECTRICAL TESTING

Testing generator field for opens and grounds.

1. Disconnect field leads from rectifier.
2. Set multimeter to read resistance, and connect the meter leads to the field leads. If field is open, meter will read infinite resistance (very high ohms). Repair or replace field if it is open. Typical resistance for these fields vary from 7 to 20 ohms.
3. Leaving one meter lead connected to the field, connect the other meter lead to the field shell. If meter indicates continuity (any reading — should be infinite resistance), the field is grounded and should be repaired or replaced. To determine which of the fields is grounded, cut the connector between the two coils and retest to determine which coil has the low resistance path.

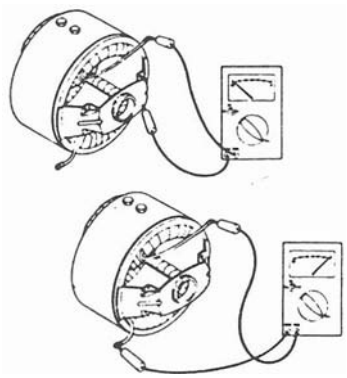

Figure 3

TESTING ARMATURE FOR OPENS AND GROUNDS

1. Separate brush rack assembly from generator armature (slip rings) — or — remove all brushes
2. Ground test — set multimeter to read high resistance (meg-ohms).

   Holding one meter lead against a clean spot on the armature shaft, touch the other lead to each of the slip rings (one at a time) while observing the meter. If meter indicates continuity (any reading lower than one meg-ohm), the armature is grounded. Dirt between the slip rings and on the insulator surface can cause grounding. If grounding was indicated, carefully clean all dirt off the slip rings and their insulators and then recheck it. Replace the armature if it is grounded and unrepairable.

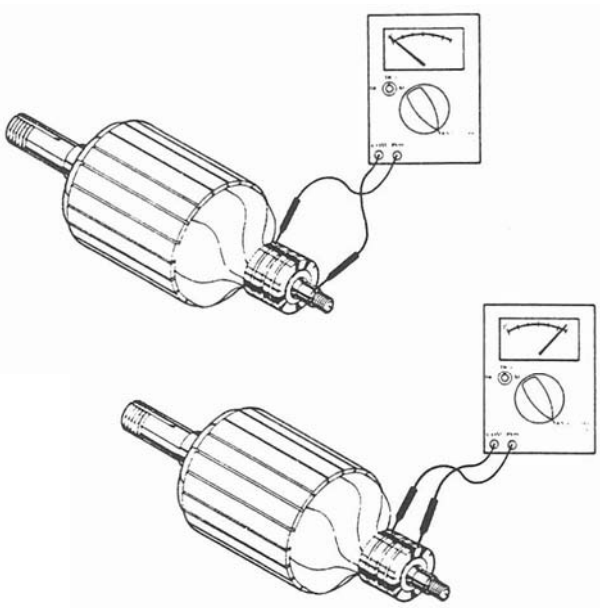

Figure 4

3. Testing for opens

   Set meter to read low resistance (R × 1 ohms). Holding one meter lead on surface of slip ring No. 1, touch other meter lead to surface of slip ring No. 2 while observing the meter. Meter should indicate continuity (low resistance — less than 0 & 1 ohm is typical). If the meter indicates open circuit (infinite resistance) part of armature winding is open. This may be caused by a repairable defect in the connection at the slip ring, however generally an open armature will have to be replaced.

   Check for open between each pair of slip rings in same manner as was done above between rings 1 and 2.

TESTING RECTIFIERS

The field excitation is supplied through a bridge rectifier. Model **4KS** uses a half wave type. This type of rectifier has three terminals — two AC and a DC positive. Models **8KS** and **20KS** use a full wave type. This type of rectifier has four terminals — two AC, a DC positive (+), and a DC negative (−).

A rectifier may be tested in the following manner:

1. Disconnect all leads from rectifier.
2. Connect the red ohmmeter lead to the positive DC (+) terminal.

3. Connect the black lead to each of the AC terminals in turn. Either a high or low resistance reading will be obtained.
4. Reverse the meter leads, (black lead to the DC pos (+) and red to the AC terminals, each in turn. An opposite reading should be observed.
5. Now check each of the AC terminals referenced from the negative terminal, using the same procedures described above.
6. Check each terminal to the case. An open circuit (very high resistance) reading should be observed. If a battery-powered test light is used, follow the same procedures described above. A good diode element will allow current to pass to the light in the test lamp when the leads are connected in the forward direction.
7. If the rectifier fails any of the above tests, it should be considered defective and replaced.

CONDENSER TESTING

Condensers are built into the generator circuit to minimize radio interference during operation. If a condenser shorts out, it will also short out the generator output. To determine whether a condenser is shorted, stop the generator and disconnect the condenser lead wire from the brush holder.

Using a multimeter on the R × 100 scale, check the resistance of the condenser. Normal response is a sharp swing of the meter towards low resistance and then a steady rise towards high resistance (open circuit). If the capacitor is shorted it will show as a constant low resistance.

Otherwise, restart the generator without the capacitor connected to recheck the generator for output. If the generator then provides power, the condenser was at fault and should be replaced. (If the generator did not provide power after, the problem was not caused by that condenser, reconnect the lead wire).

If these tests have not located the trouble, remove the armature and have it tested for opens, shorts, and grounds on a growler.

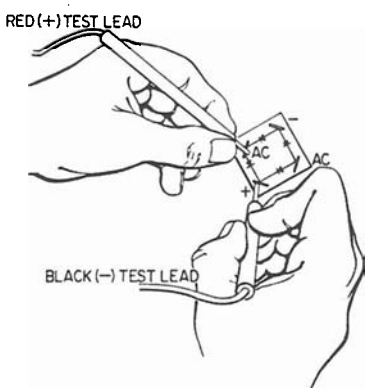

Figure 5

Trouble Shooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
No output or low output voltage	1. Open or shorted armature	1. Replace armature.
	2. Open or shorted field coil(s)	2. Replace field coil(s).
	3. Generator operating below correct RPM speed	3. Generator must be operated at 3600 RPM, +/– 90 RPM for proper output voltage.
	4. Generator overloaded	4. Reduce load to generator nameplate.
	5. Short circuit in the load	5. Disconnect the load. Check voltage at receptacle. Check motors, appliances and load leads for short circuits. Repair short.
	6. Loose (or broken) wires or connections in the control box	6. Remove panel cover and check all wiring and connections. Tighten and/or repair where necessary.
	7. Defective rectifier	7. Test rectifier. Replace if defective.
	8. Dirty slip rings	8. Clean and polish. Use 00 sandpaper and crocus cloth, never emery paper.
	9. Brushes binding in holders	9. Check brushes for swelling. Replace defective brushes. Clean brush holders.
	10. Loss of residual magnetism	10. Check output voltage with sensitive meter. If very low (eg. 1/2 volt) flash fields with 12 VDC battery.
Output voltage too high	1. Engine speed too high	1. See engine manual.
Generator overheating	1. Generator overloaded	1. Reduce load.
	2. Armature rubbing pole shoes	2. Check bearing condition. Check field shell bearing bracket alignment.
	3. Poor ventilation	3. Clear inlet and outlet air vents of debris. If unit is housed, ensure at least 2 ft. clearance on all sides and that inlet and outlet vents are of adequate size.
	4. Short circuit in fields	4. Repair or replace — open or shorted fields should be replaced. Grounded fields may be repaired by insulating at the point where the ground occurs.
	5. Short turns in armature	5. Replace arm.
Sparking at the brushes	1. Generator overloaded	1. Reduce load.
	2. Brushes not seated properly	2. Contour brushes (see maintenance).
	3. Slip rings rough or eccentric	3. Redress slip rings (see maintenance).
	4. Brushes sticking in brush holder	4. Remove brushes and inspect and correct problem.
	5. Brushes worn down shorter than 3/8 inch	5. Replace brush. Note: Always replace brushes a full set at a time.

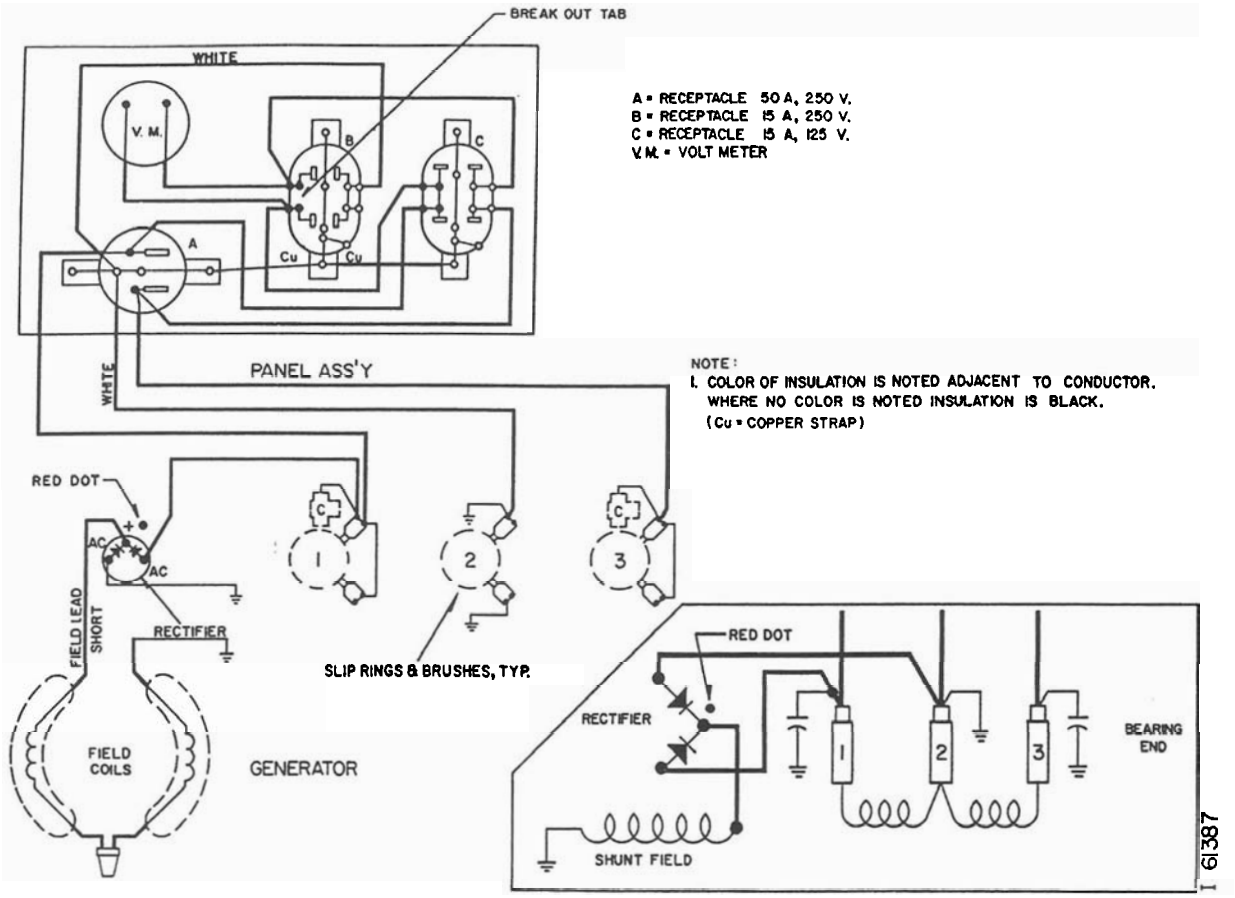

Figure 6 — Models **4, 8KS**

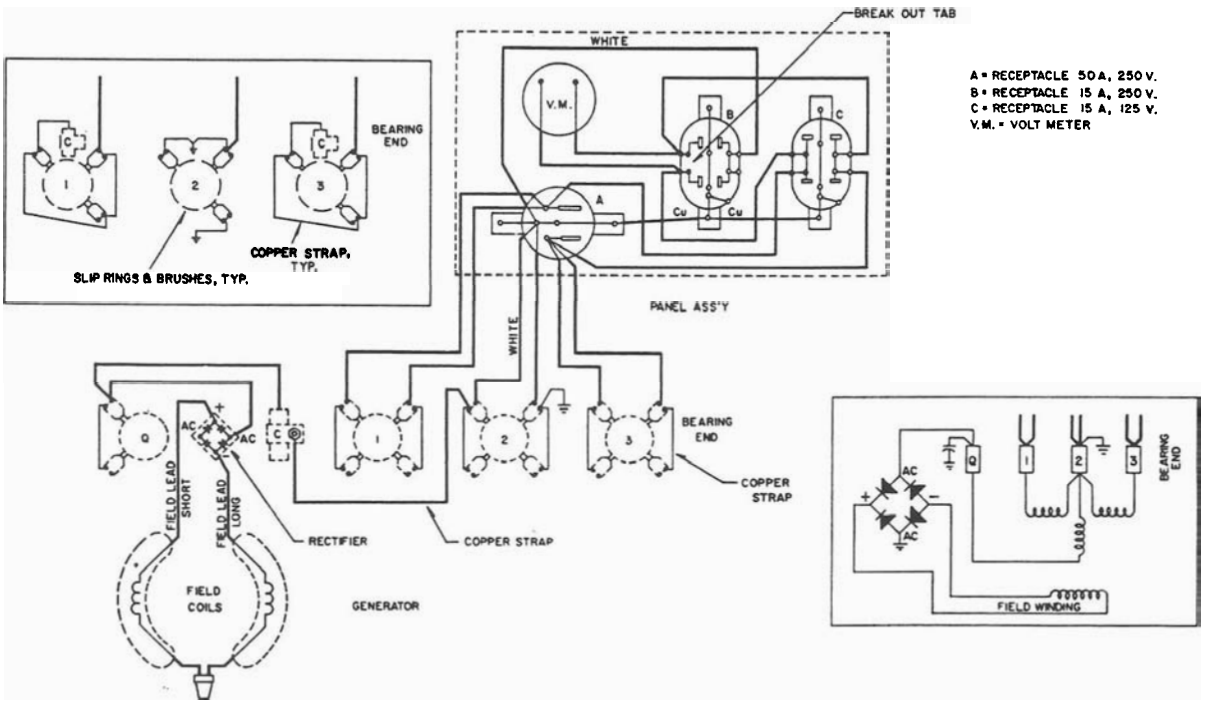

Figure 7 — Model **20KS**

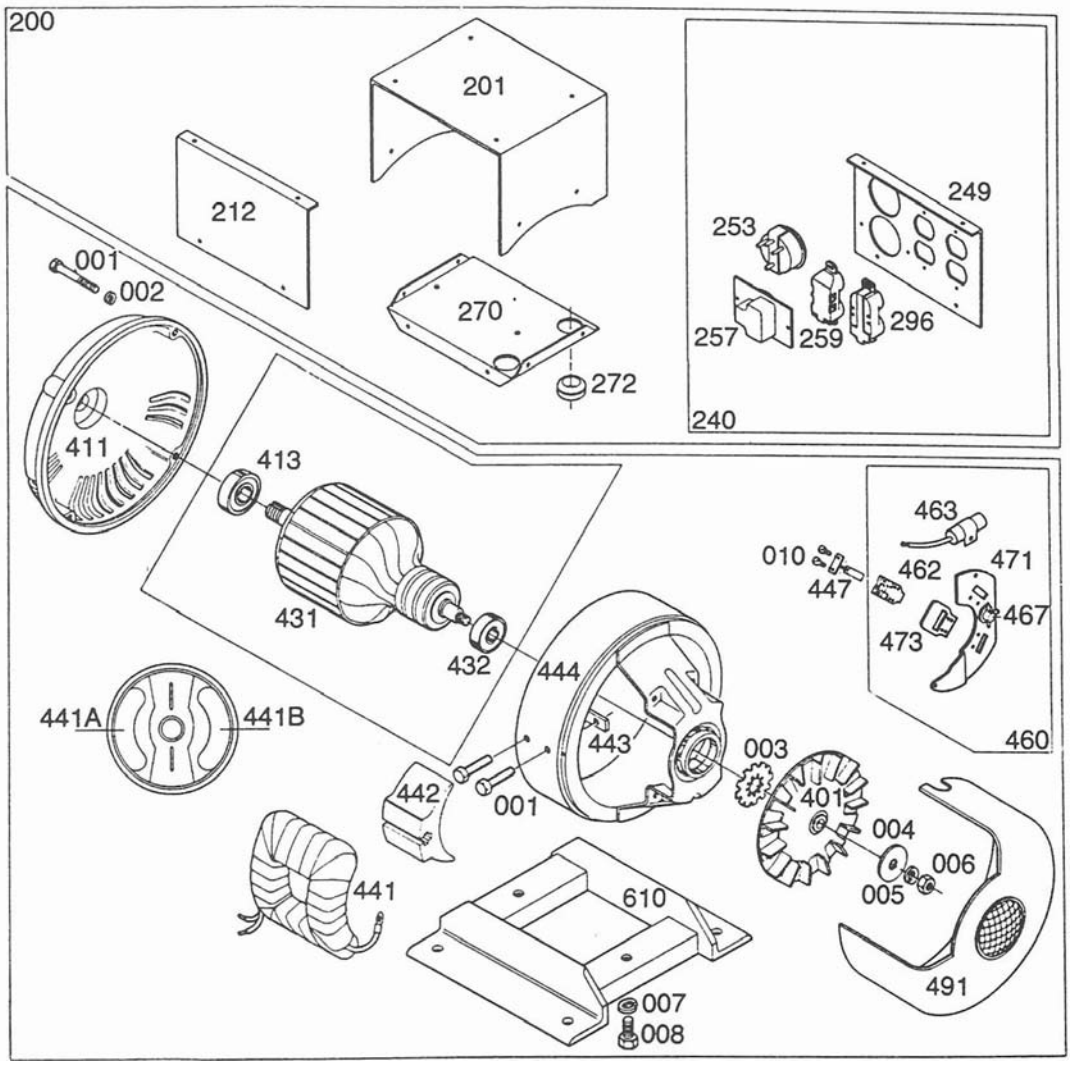

Figure 8 **4KS2G**

Replacement Parts List for 4KS2G

Ref. No.	Part No.	Qty.	Description	Ref. No.	Part No.	Qty.	Description
001	9416	8	Machine screw - 5/16-1	400	61374	1	Generator and base assy. (less box)
002	480	4	Lockwasher - 5/16 split				
003	40552	1	Lockwasher - 11/16 int.	401	23404	1	Fan assembly
004	21867	1	Washer - 1/2 flat	411	40097	1	End bracket
005	20039	1	Lockwasher - 1/2 ext.	413	8031	1	Bearing
006	9549	1	Nut - 1/2-20 × 3/8	431	61046-1	1	Armature assembly - less bearings
007	481	2	Lockwasher - 3/8 split				
008	91658-1	2	Cap screw - 3/8	432	46911	1	Bearing
010	40746	12	Machine screw - #6-32 - 5/16	441	—		See 441A and 441B
				441A	55361	1	Field coil
200	61382-5	1	Control box assy. (complete)	441B	55361-1	1	Field coil
				442	23207	2	Pole shoe
201	60940	1	Cover	443	23208	2	Pole shoe retainer
212	60938	1	Rear panel	444	59067	1	Field shell and brkt.
240	61380-1	1	Front panel assy.	447	23607	6	Brush A.C. (1/4 × 3/8)
248	24749	1	Receptacle - 120V/ 15 amp (5-15R)	460	55247	1	Brush rack assembly
				462	59690	6	Brush holder A.C.
249	60937	1	Front panel only	463	41221	3	Capacitor A.C.
253	52490	1	Voltmeter	467	91452	1	Rectifier
257	57325	1	Receptacle - 250V/ 50 amp (X-50R)	468	41387-6	3	Ground strap - copper
				473	59688	1	Barrier spacer
259	24749	1	Receptacle - 120V/ 15 amp (5-15R)	471	56960	1	Brush plate (bare)
				491	55007	1	End cover
270	60147	1	Saddle	610	24535	1	Base assembly
272	23917	1	Grommet				
296	40452	1	Receptacle - 240V/ 12 amp (6-15R)				

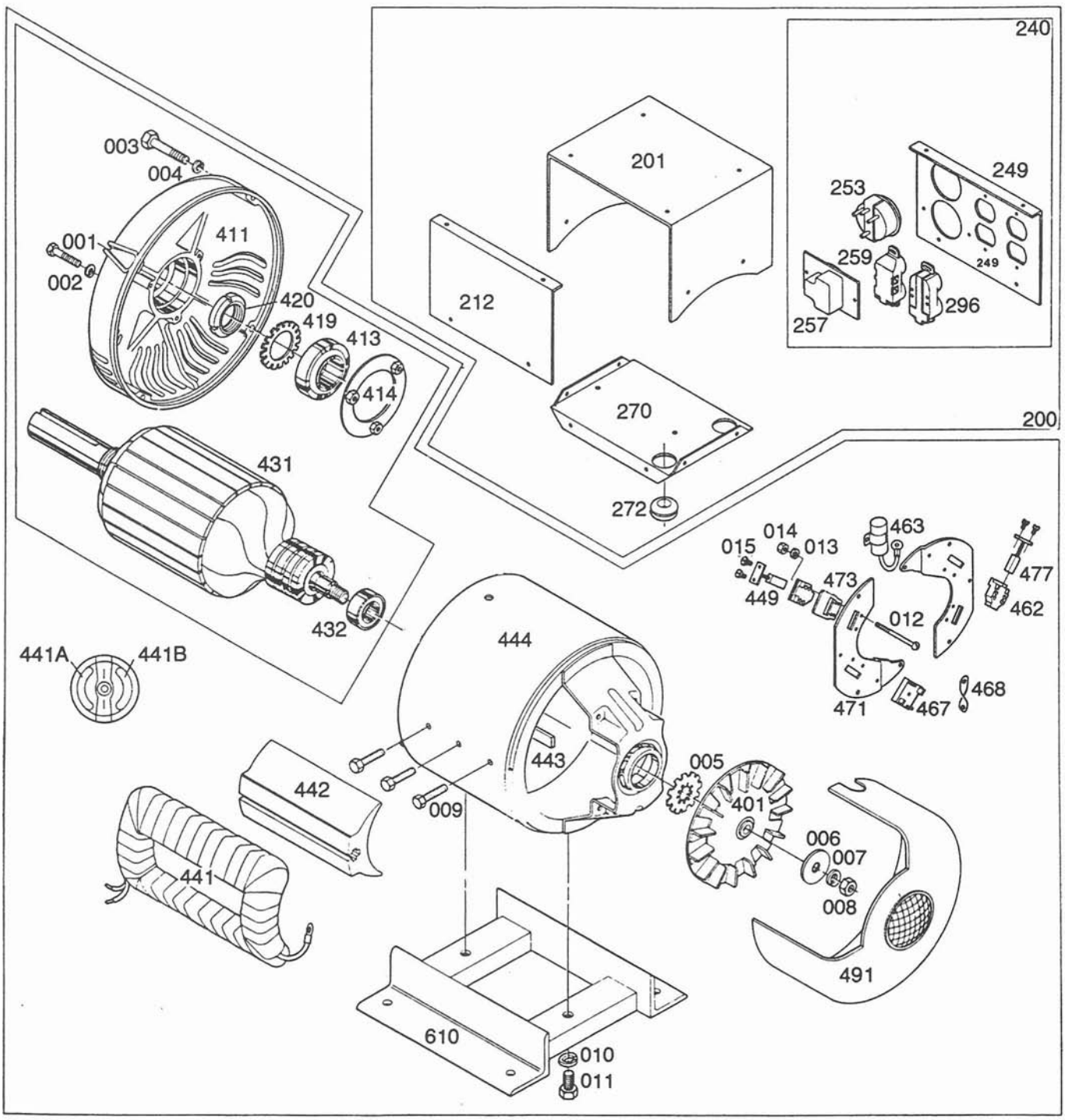

Figure 9 **8KS2**

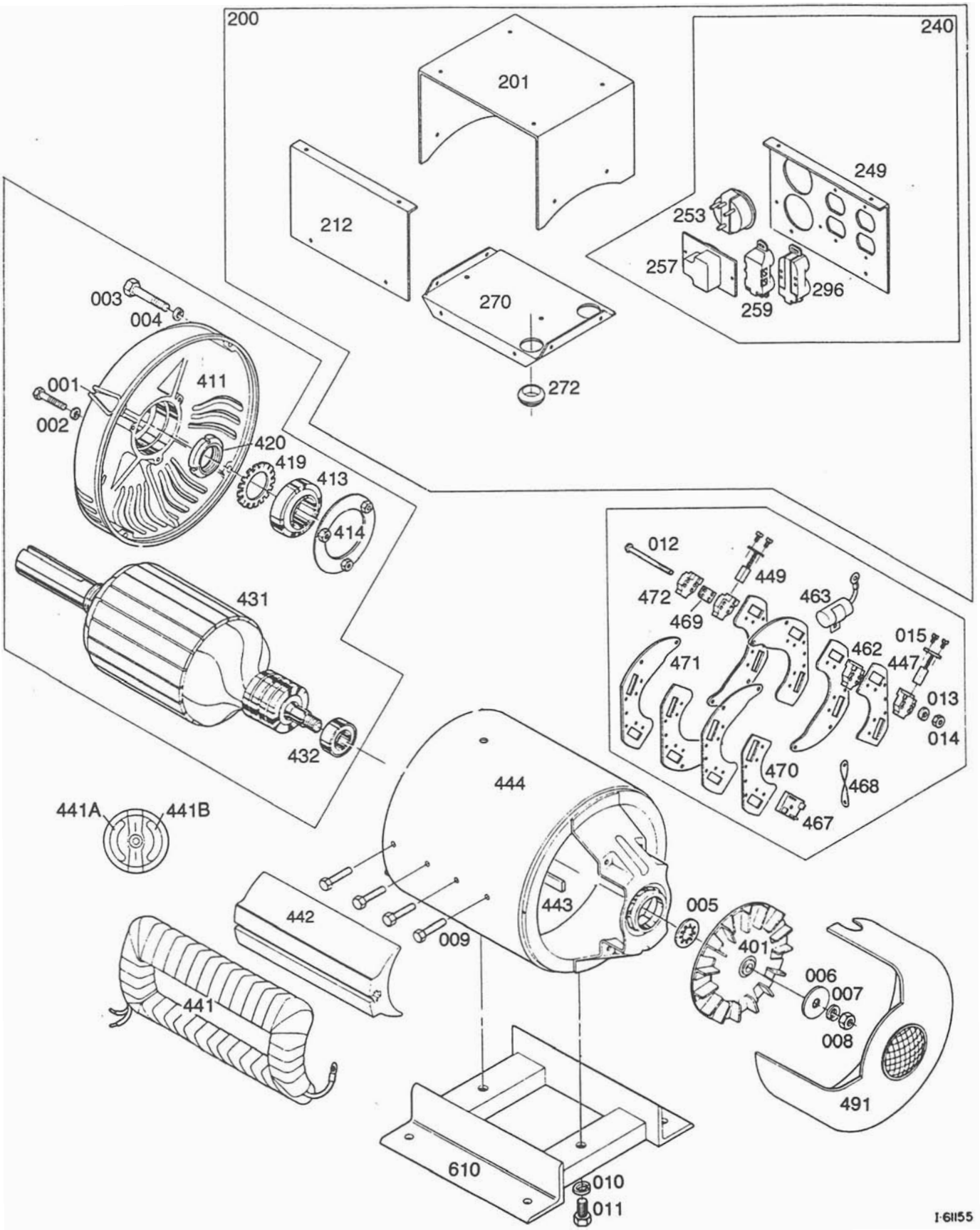

Figure 10 **20KS2G**

Replacement Parts List for 8KS2G

Ref. No.	Part No.	Qty.	Description
001	20544	3	Screw - 1/4-20 × 1-3/4
002	479	3	Lockwasher - 1/4 split
003	51101	4	Machine screw - 5/16-18 × 2-3/4
004	480	4	Lockwasher - 5/16 split
005	40552	1	Lockwasher - 11/16 int.
006	21867	1	Washer - 1/2 flat
007	20039	1	Lockwasher - 1/2 ext.
008	9549	1	Nut - 1/2-20 × 3/8
009	91658-4	6	Capscrew - 3/8-16 × 1-3/4
010	636	2	Lockwasher - 1/2 split
011	48178	2	Capscrew - 1/2-13 × 1
012	10888	6	Machine screw - #8-32 × 2-1/2
013	6376	6	Lockwasher - #8 split
014	5113	6	Nut - #8-32
015	40746	22	Machine screw - #8-32 × 5/16
200	61382-4	1	Control box assy. (complete)
201	60940	1	Cover
212	60938	1	Rear panel
240	61380-1	1	Front panel assembly
249	60937-1	1	Front panel only
253	52490	1	Voltmeter
257	57325	1	Receptacle - 250V/ 50 amp (X-50R)
259	24749	1	Receptacle - 120V/ 15 amp (5-15R)
270	60939	1	Saddle
272	23917	1	Grommet
296	40452	1	Receptacle - 250V/ 15 amp (6-15R)
401	23404	1	Fan assembly
411	51046-1	1	End bracket
413	46913	1	Bearing
414	50536	1	Retainer plate
419	50531	1	Lockwasher
420	50532	1	Lock nut
431	60980-1	1	Armature assembly — less bearings
432	50215	1	Bearing
441	—		See 441A and 441B
441A	60852	1	Field coil
441B	60852-1	1	Field coil
442	42882	2	Pole shoe
443	42883	2	Pole shoe retainer
444	60989	1	Field shell and brkt.
449	53949	2	Brush "O" (1/4 × 3/8)
462	59690	11	Brush holder A.C.
463	41221	3	Capacitor A.C.
467	91452	1	Rectifier
468	41387-6	3	Ground strap - copper
473	59688	11	Barrier spacer
471	56960	2	Brush plate (bare)
477	55536	9	Brush A.C. (1/4 × 3/8)
491	55007	1	End cover
610	51147	1	Base assembly

Replacement Parts List for 20KS2G

Ref. No.	Part No.	Qty.	Description
001	20544	3	Screw - 1/4-20 × 1-3/4
002	479	3	Lockwasher - 1/4 split
003	51101	4	Machine screw - 5/16-18 × 2-3/4
004	480	4	Lockwasher - 5/16 split
005	40552	1	Lockwasher - 11/16 int.
006	21867	1	Washer - 1/2 flat
007	20039	1	Lockwasher - 1/2 ext.
008	9549	1	Nut - 1/2-20 × 3/8
009	43781	8	Capscrew - 7/16-20 × 1-3/4
010	636	2	Lockwasher - 1/2 split
011	48178	2	Capscrew - 1/2-13 × 1
012	10888	6	Machine screw - #8-32 × 2-1/2
013	6376	6	Lockwasher - #8 split
014	5113	6	Nut - #8-32
015	40746	28	Machine screw - #8-32 × 5/16
200	61382-4	1	Control box assy. (complete)
201	60940	1	Cover
212	60938	1	Rear panel
240	61381-1	1	Front panel assy.
249	60937-1	1	Front panel only
253	52490	1	Voltmeter
257	57325	1	Receptacle - 250 V/ 50 amp (6-50R)
259	24749	1	Receptacle - 120V/ 15 amp (5-15R)
270	60939	1	Saddle
272	23917	1	Grommet
296	40452	1	Receptacle - 250V/ 15 amp (6-15R)
401	23404	1	Fan assembly
411	50517	1	End bracket
413	46913	1	Bearing
414	50536	1	Retainer plate
419	50531	1	Lockwasher
420	50532	1	Lock nut
431	58394	1	Armature assembly — less bearings
432	50215	1	Bearing
441	—		See 441A and 441B
441A	52563	1	Field coil
441B	52563-1	1	Field coil
442	43473	2	Pole shoe
443	43474	2	Pole shoe retainer
444	60992	1	Field shell and brkt.
447	24981	12	Brush AC (3/8 × 3/8)
449	53949	2	Brush "O" (1/4 × 3/8)
462	23500-2	12	Brush holder A.C.
463	41221	3	Capacitor A.C.
467	91452	1	Rectifier
468	41387-6	1	Ground strap - copper
469	23532	14	Fiber spacer
470	52559	2	Spacer-brush holder
471	53975	6	Brush mtg. plate segment (bare)
472	23500	2	"O" ring brush holder
491	55007	1	End cover
610	51147	1	Base assembly