



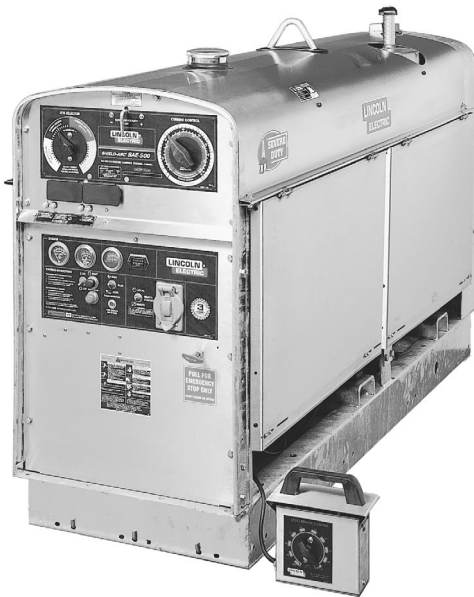
**NOTE:** This manual will cover most of the troubleshooting and repair procedures for the code numbers listed. Some variances may exist when troubleshooting/repairing later code numbers.

## SAE-500® SEVERE DUTY

For use with machines having Code Numbers:

**11477, 12241, 12242, 12515**

# SERVICE MANUAL



**Need Help? Call 1.888.935.3877**  
to talk to a Service Representative

**Hours of Operation:**  
8:00 AM to 6:00 PM (ET) Mon. thru Fri.

**After hours?**  
Use "Ask the Experts" at [lincolnelectric.com](http://lincolnelectric.com)  
A Lincoln Service Representative will contact you  
no later than the following business day.

**For Service outside the USA:**  
Email: [globalservice@lincolnelectric.com](mailto:globalservice@lincolnelectric.com)

## ⚠ WARNING

### ⚠ CALIFORNIA PROPOSITION 65 WARNINGS ⚠

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

The Above For Diesel Engines

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

The Above For Gasoline Engines

**ARC WELDING can be hazardous. PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. KEEP CHILDREN AWAY. PACEMAKER WEARERS SHOULD CONSULT WITH THEIR DOCTOR BEFORE OPERATING.**

Read and understand the following safety highlights. For additional safety information, it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1" from the American Welding Society, P.O. Box 351040, Miami, Florida 33135 or CSA Standard W117.2-1974. A Free copy of "Arc Welding Safety" booklet E205 is available from the Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio 44117-1199.

**BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.**



### FOR ENGINE powered equipment.

1.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.



1.b. Operate engines in open, well-ventilated areas or vent the engine exhaust fumes outdoors.



1.c. Do not add the fuel near an open flame welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.

1.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.

1.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.



1.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.

1.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.



1.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.



### ELECTRIC AND MAGNETIC FIELDS may be dangerous

2.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines

2.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

2.c. Exposure to EMF fields in welding may have other health effects which are now not known.

2.d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

2.d.1. Route the electrode and work cables together - Secure them with tape when possible.

2.d.2. Never coil the electrode lead around your body.

2.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.

2.d.4. Connect the work cable to the workpiece as close as possible to the area being welded.

2.d.5. Do not work next to welding power source.

SAE-500® SEVERE DUTY





### ELECTRIC SHOCK can kill.

3.a. The electrode and work (or ground) circuits are electrically “hot” when the welder is on. Do not touch these “hot” parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.

3.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground.

**In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:**

- Semiautomatic DC Constant Voltage (Wire) Welder.
- DC Manual (Stick) Welder.
- AC Welder with Reduced Voltage Control.

3.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically “hot”.

3.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.

3.e. Ground the work or metal to be welded to a good electrical (earth) ground.

3.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.

3.g. Never dip the electrode in water for cooling.

3.h. Never simultaneously touch electrically “hot” parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.

3.i. When working above floor level, use a safety belt to protect yourself from a fall should you get a shock.

3.j. Also see Items 6.c. and 8.



### ARC RAYS can burn.

4.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Headshield and filter lens should conform to ANSI Z87.1 standards.

4.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.

4.c. Protect other nearby personnel with suitable, non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.



### FUMES AND GASES can be dangerous.

5.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. **When welding with electrodes which require special ventilation such as stainless or hard facing (see instructions on container or MSDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and within applicable OSHA PEL and ACGIH TLV limits using local exhaust or mechanical ventilation. In confined spaces or in some circumstances, outdoors, a respirator may be required. Additional precautions are also required when welding on galvanized steel.**

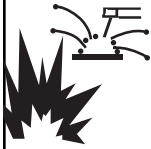
5.b. The operation of welding fume control equipment is affected by various factors including proper use and positioning of the equipment, maintenance of the equipment and the specific welding procedure and application involved. Worker exposure level should be checked upon installation and periodically thereafter to be certain it is within applicable OSHA PEL and ACGIH TLV limits.

5.c. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.

5.d. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.

5.e. Read and understand the manufacturer’s instructions for this equipment and the consumables to be used, including the material safety data sheet (MSDS) and follow your employer’s safety practices. MSDS forms are available from your welding distributor or from the manufacturer.

5.f. Also see item 1.b.



## WELDING and CUTTING SPARKS can cause fire or explosion.

6.a. Remove fire hazards from the welding area. If this is not possible, cover them to prevent the welding sparks from starting a fire. Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Avoid welding near hydraulic lines. Have a fire extinguisher readily available.

- 6.b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to "Safety in Welding and Cutting" (ANSI Standard Z49.1) and the operating information for the equipment being used.
- 6.c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.
- 6.d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapors from substances inside. They can cause an explosion even though they have been "cleaned". For information, purchase "Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances", AWS F4.1 from the American Welding Society (see address above).
- 6.e. Vent hollow castings or containers before heating, cutting or welding. They may explode.
- 6.f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.
- 6.g. Connect the work cable to the work as close to the welding area as practical. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.
- 6.h. Also see item 1.c.
- 6.i. Read and follow NFPA 51B "Standard for Fire Prevention During Welding, Cutting and Other Hot Work", available from NFPA, 1 Batterymarch Park, PO box 9101, Quincy, Ma 022690-9101.
- 6.j. Do not use a welding power source for pipe thawing.



## CYLINDER may explode if damaged.

- 7.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.
- 7.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.
- 7.c. Cylinders should be located:
  - Away from areas where they may be struck or subjected to physical damage.
  - A safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.
- 7.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.
- 7.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.
- 7.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.
- 7.g. Read and follow the instructions on compressed gas cylinders, associated equipment, and CGA publication P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders," available from the Compressed Gas Association 1235 Jefferson Davis Highway, Arlington, VA 22202.



## FOR ELECTRICALLY powered equipment.

- 8.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.
- 8.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.
- 8.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

Refer to <http://www.lincolnelectric.com/safety> for additional safety information.

## PRÉCAUTIONS DE SÛRETÉ

Pour votre propre protection lire et observer toutes les instructions et les précautions de sûreté spécifiques qui paraissent dans ce manuel aussi bien que les précautions de sûreté générales suivantes:

### Sûreté Pour Soudage A L'Arc

1. Protégez-vous contre la secousse électrique:
  - a. Les circuits à l'électrode et à la pièce sont sous tension quand la machine à souder est en marche. Eviter toujours tout contact entre les parties sous tension et la peau nue ou les vêtements mouillés. Porter des gants secs et sans trous pour isoler les mains.
  - b. Faire très attention de bien s'isoler de la masse quand on soude dans des endroits humides, ou sur un plancher métallique ou des grilles métalliques, principalement dans les positions assis ou couché pour lesquelles une grande partie du corps peut être en contact avec la masse.
  - c. Maintenir le porte-électrode, la pince de masse, le câble de soudage et la machine à souder en bon et sûr état de fonctionnement.
  - d. Ne jamais plonger le porte-électrode dans l'eau pour le refroidir.
  - e. Ne jamais toucher simultanément les parties sous tension des porte-électrodes connectés à deux machines à souder parce que la tension entre les deux pinces peut être le total de la tension à vide des deux machines.
  - f. Si on utilise la machine à souder comme une source de courant pour soudage semi-automatique, ces précautions pour le porte-électrode s'appliquent aussi au pistolet de soudage.
2. Dans le cas de travail au dessus du niveau du sol, se protéger contre les chutes dans le cas où on reçoit un choc. Ne jamais enrouler le câble-électrode autour de n'importe quelle partie du corps.
3. Un coup d'arc peut être plus sévère qu'un coup de soliel, donc:
  - a. Utiliser un bon masque avec un verre filtrant approprié ainsi qu'un verre blanc afin de se protéger les yeux du rayonnement de l'arc et des projections quand on soude ou quand on regarde l'arc.
  - b. Porter des vêtements convenables afin de protéger la peau de soudeur et des aides contre le rayonnement de l'arc.
  - c. Protéger l'autre personnel travaillant à proximité au soudage à l'aide d'écrans appropriés et non-inflammables.
4. Des gouttes de laitier en fusion sont émises de l'arc de soudage. Se protéger avec des vêtements de protection libres de l'huile, tels que les gants en cuir, chemise épaisse, pantalons sans revers, et chaussures montantes.
5. Toujours porter des lunettes de sécurité dans la zone de soudage. Utiliser des lunettes avec écrans latéraux dans les zones où l'on pique le laitier.

6. Eloigner les matériaux inflammables ou les recouvrir afin de prévenir tout risque d'incendie dû aux étincelles.
7. Quand on ne soude pas, poser la pince à un endroit isolé de la masse. Un court-circuit accidentel peut provoquer un échauffement et un risque d'incendie.
8. S'assurer que la masse est connectée le plus près possible de la zone de travail qu'il est pratique de le faire. Si on place la masse sur la charpente de la construction ou d'autres endroits éloignés de la zone de travail, on augmente le risque de voir passer le courant de soudage par les chaînes de levage, câbles de grue, ou autres circuits. Cela peut provoquer des risques d'incendie ou d'échauffement des chaînes et des câbles jusqu'à ce qu'ils se rompent.
9. Assurer une ventilation suffisante dans la zone de soudage. Ceci est particulièrement important pour le soudage de tôles galvanisées plombées, ou cadmiées ou tout autre métal qui produit des fumées toxiques.
10. Ne pas souder en présence de vapeurs de chlore provenant d'opérations de dégraissage, nettoyage ou pistolage. La chaleur ou les rayons de l'arc peuvent réagir avec les vapeurs du solvant pour produire du phosgène (gas fortement toxique) ou autres produits irritants.
11. Pour obtenir de plus amples renseignements sur la sûreté, voir le code "Code for safety in welding and cutting" CSA Standard W 117.2-1974.

## PRÉCAUTIONS DE SÛRETÉ POUR LES MACHINES À SOUDER À TRANSFORMATEUR ET À REDRESSEUR

1. Relier à la terre le châssis du poste conformément au code de l'électricité et aux recommandations du fabricant. Le dispositif de montage ou la pièce à souder doit être branché à une bonne mise à la terre.
2. Autant que possible, l'installation et l'entretien du poste seront effectués par un électricien qualifié.
3. Avant de faire des travaux à l'intérieur de poste, la débrancher à l'interrupteur à la boîte de fusibles.
4. Garder tous les couvercles et dispositifs de sûreté à leur place.

## Electromagnetic Compatibility (EMC)

### Conformance

Products displaying the CE mark are in conformity with European Community Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (89/336/EEC). It was manufactured in conformity with a national standard that implements a harmonized standard: **EN 60974-10** Electromagnetic Compatibility (EMC) Product Standard for Arc Welding Equipment. It is for use with other Lincoln Electric equipment. It is designed for industrial and professional use.

### Introduction

All electrical equipment generates small amounts of electromagnetic emission. Electrical emission may be transmitted through power lines or radiated through space, similar to a radio transmitter. When emissions are received by other equipment, electrical interference may result. Electrical emissions may affect many kinds of electrical equipment; other nearby welding equipment, radio and TV reception, numerical controlled machines, telephone systems, computers, etc. Be aware that interference may result and extra precautions may be required when a welding power source is used in a domestic establishment.

### Installation and Use

The user is responsible for installing and using the welding equipment according to the manufacturer's instructions. If electromagnetic disturbances are detected then it shall be the responsibility of the user of the welding equipment to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing (grounding) the welding circuit, see Note. In other cases it could involve construction of an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

**Note:** The welding circuit may or may not be earthed for safety reasons according to national codes. Changing the earthing arrangements should only be authorized by a person who is competent to access whether the changes will increase the risk of injury, e.g., by allowing parallel welding current return paths which may damage the earth circuits of other equipment.

### Assessment of Area

Before installing welding equipment the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

- a) other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the welding equipment;
- b) radio and television transmitters and receivers;
- c) computer and other control equipment;
- d) safety critical equipment, e.g., guarding of industrial equipment;
- e) the health of the people around, e.g., the use of pacemakers and hearing aids;
- f) equipment used for calibration or measurement
- g) the immunity of other equipment in the environment. The user shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures;
- h) the time of day that welding or other activities are to be carried out.

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## Electromagnetic Compatibility (EMC)

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

### Methods of Reducing Emissions

#### Mains Supply

Welding equipment should be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the mains supply. Consideration should be given to shielding the supply cable of permanently installed welding equipment, in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the welding power source so that good electrical contact is maintained between the conduit and the welding power source enclosure.

#### Maintenance of the Welding Equipment

The welding equipment should be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the welding equipment is in operation. The welding equipment should not be modified in any way except for those changes and adjustments covered in the manufacturer's instructions. In particular, the spark gaps of arc striking and stabilizing devices should be adjusted and maintained according to the manufacturer's recommendations.

#### Welding Cables

The welding cables should be kept as short as possible and should be positioned close together, running at or close to floor level.

#### Equipotential Bonding

Bonding of all metallic components in the welding installation and adjacent to it should be considered. However, metallic components bonded to the work piece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode at the same time. The operator should be insulated from all such bonded metallic components.

#### Earthing of the Workpiece

Where the workpiece is not bonded to earth for electrical safety, not connected to earth because of its size and position, e.g., ships hull or building steelwork, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitance, selected according to national regulations.

#### Screening and Shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire welding installation may be considered for special applications. <sup>1</sup>

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<sup>1</sup> Portions of the preceding text are contained in EN 60974-10: "Electromagnetic Compatibility (EMC) product standard for arc welding equipment."

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SAE-500® SEVERE DUTY





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## TECHNICAL SPECIFICATIONS - SAE-500® SEVERE DUTY (K1278-12)

INPUT - DIESEL ENGINE					
Make/Model	Description	Speed (RPM)	Displacement	Starting System	Capacities
Kubota V3600-T-E3B Diesel Engine EPA Tier 4i Compliant	4 cylinder 57.8 HP @ 1800 RPM	High Idle 1800 Low Idle 1100 Full Load 1725	220.9 cu. in (3.62 L)	12VDC batteries (2) & Starter	Fuel: 29 gal. 109.8 L
			<b>Bore x Stroke</b>  3.86" x 4.72" (98.0 mm x 120.0mm)		Oil: 13.95 Qts. 13.2 L  Coolant: 3.4 gal. 12.8 L
RATED OUTPUT - WELDER					
Duty Cycle <sup>(1)</sup>		Welding Output		Volts at Rated Amps	
60% (NEMA)		500 amps		40 volts	
100% (NEMA)		400 amps		36 volts	
100% (Lincoln Plus)		400 amps		40 volts	
OUTPUT - WELDER AND GENERATOR					
Welding Range		Open Circuit Voltage		Auxiliary Power	
80 - 575 Amps		97 Max. OCV @ 1800 RPM		115/230 VAC 3000 Watts, 60 Hz. 100% Duty Cycle	
PHYSICAL DIMENSIONS					
HEIGHT	WIDTH	DEPTH		WEIGHT	
50.13 in. 1273.3 mm	28.00 in. 711.2 mm	83.00 in. 2108.2 mm		2048 lbs. 929 kg	

<sup>(1)</sup> Based on a 10 minute period.

SAE-500® SEVERE DUTY



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Read this entire installation section before you start installation.

## SAFETY PRECAUTIONS

### ⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read all operating and maintenance manuals supplied with your machine. They include important safety precautions, detailed engine starting, operating and maintenance instructions and parts lists.



**ELECTRIC SHOCK** can kill.

- Do not touch electrically live parts such as output terminals or internal wiring.
- Insulate yourself from the work and ground.
- Always wear dry insulating gloves.



**ENGINE EXHAUST** can kill.

- Use in open, well ventilated areas or vent exhaust outside
- Do not stack anything near the engine.



**MOVING PARTS** can injure.

- Do not operate with doors open or guards off.
- Stop engine before servicing.
- Keep away from moving parts

Only qualified personnel should install, use or service this equipment

## LOCATION/VENTILATION

The welder should be located to provide an unrestricted flow of clean, cool air to the cooling air inlets and to avoid restricting the cooling air outlets. Also, locate the welder so that the engine exhaust fumes are properly vented to an outside area.

### ⚠ CAUTION

DO NOT MOUNT OVER COMBUSTIBLE SURFACES.

Where there is a combustible surface directly under stationary or fixed electrical equipment, that surface shall be covered with a steel plate at least .06" (1.6mm) thick, which shall extend not less than 5.90" (150mm) beyond the equipment on all sides.

## STACKING

These machines cannot be stacked.

## ANGLE OF OPERATION

To achieve optimum engine performance the machine should be run in a level position. The maximum angle of operation for the Kubota engine is 20 degrees continuous in all directions and 30 degrees intermittent (less than 10 minutes). If the engine is to be operated at an angle, provisions must be made for checking and maintaining the oil level at the normal (FULL) oil capacity in the engine crankcase. When operating the welder at an angle, the effective fuel capacity will be slightly less than the specified 29 gallons.

## LIFTING

The equipment lift bail should be used to lift the machine.

### ⚠ WARNING



**FALLING  
EQUIPMENT  
CAN CAUSE  
INJURY**

- Lift only with equipment of adequate lifting capacity.
- Be sure machine is stable when lifting.
- Do not lift this machine using lift bail if it is equipped with a heavy accessory such as trailer or gas cylinder.
- Do not lift machine if lift bail is damaged.
- Do not operate machine while suspended from lift bail.

## HIGH ALTITUDE OPERATION

At higher altitudes, output derating may be necessary. For maximum rating, derate the welder output 5% for every 500 meters (1640 ft.) above 400 meters (1312 ft.).

Contact a Kubota Service Representative for any engine adjustments that may be required for high altitude operation.

## TOWING

The recommended trailers for use with this equipment for in-plant and yard towing by a vehicle<sup>(1)</sup> are Lincoln's K2641-1 (4) wheel steerable trailer and K2637-1 (2) wheel trailer. If the user adapts a non-Lincoln trailer, he must assume responsibility that the method of attachment and usage does not result in a safety hazard nor damage the welding equipment. Some of the factors to be considered are as follows:

1. Design capacity of trailer vs. weight of Lincoln equipment and likely additional attachments.
2. Proper support of, and attachment to, the base of the welding equipment so that there will be no undue stress to the trailer's framework.
3. Proper placement of the equipment on the trailer to insure stability side to side and front to back when being moved and when standing by itself.
4. Typical conditions of use, such as travel speed, roughness of surface on which the trailer will be operated, and environmental conditions.
5. Proper preventative maintenance of trailer.
6. Conformance with federal, state and local laws.

## VEHICLE MOUNTING

### WARNING

Improperly mounted concentrated loads may cause unstable vehicle handling and tires or other components to fail.

- Only transport this equipment on serviceable vehicles which are rated and designed for such loads.
- Distribute, balance and secure loads so vehicle is stable under conditions of use.
- Do not exceed maximum rated loads for components such as suspension, axles and tires.
- Mount equipment base to metal bed or frame of vehicle.
- Follow vehicle manufacturer's instruction.

## PRE-OPERATION ENGINE SERVICE

READ the engine operating and maintenance instructions supplied with this machine.

### ENGINE OIL



The engine is shipped with the engine crankcase filled with high quality SAE 10W-30 oil (API class CD or better). Check the oil level before starting the engine. If it is not up to the full mark on the dip stick, add oil as required. Check the oil level every four hours of running time during the first 35 running hours. Refer to the engine Operator's Manual for specific oil recommendations and break-in information. The oil change interval is dependent on the quality of the oil and the operating environment. Refer to the engine Operator's Manual for the proper service and maintenance intervals.

### FUEL USE DIESEL FUEL ONLY



#### WARNING



- Stop engine while fueling.
- Do not smoke when fueling.
- Keep sparks and flame away from tank.
- Do not leave unattended while fueling.

- Wipe up spilled fuel and allow fumes to clear before starting engine.
- Do not overfill tank, fuel expansion may cause overflow.

### DIESEL FUEL ONLY

Low Sulphur fuel or ultra low sulphur fuel in USA and CANADA only.

- Fill the fuel tank with clean, fresh diesel fuel. The capacity of the fuel tank is approximately 29 Gal. (109.8 liters). See engine Operator's Manual for specific fuel recommendations. Running out of fuel may require bleeding the fuel injection pump. NOTE: Before starting the engine, open the fuel shutoff valve (pointer to be in line with hose).

**NOTE:** Before starting the engine, be sure the fuel shutoff valve is open on the fuel sedimenter .

## ENGINE BREAK-IN

Lincoln Electric selects high quality, heavy-duty industrial engines for the portable welding machines we offer. While it is normal to see a small amount of crankcase oil consumption during initial operation, excessive oil use, wetstacking (oil or tar like substance at the exhaust port), or excessive smoke is not normal.

Larger machines with a capacity of 350 amperes and higher, which are operated at low or no-load conditions for extended periods of time are especially susceptible to the conditions described above. To accomplish successful engine break-in, most diesel-powered equipment needs only to be run at a reasonably heavy load within the rating of the welder for some period of time during the engine's early life. However, if the welder is subjected to extensive light loading, occasional moderate to heavy loading of the engine may sometimes be necessary. Caution must be observed in correctly loading a diesel/generator unit.

1. Connect the welder output studs to a suitable resistive load bank. Note that any attempt to short the output studs by connecting the welding leads together, direct shorting of the output studs, or connecting the output leads to a length of steel will result in catastrophic damage to the generator and voids the warranty.
2. Set the welder controls for an output current and voltage within the welder rating and duty cycle. Note that any attempt to exceed the welder rating or duty cycle for any period of time will result in catastrophic damage to the generator and voids the warranty.
3. Periodically shut off the engine and check the crankcase oil level.

## ENGINE COOLING SYSTEM

The cooling system has been filled at the factory with a 50-50 mixture of ethylene glycol antifreeze and water. Check the radiator level and add a 50-50 solution as needed. (See Engine Manual or antifreeze container for alternate antifreeze recommendation.)

## BATTERY CONNECTION

**WARNING:** Use caution as the electrolyte is a strong acid that can burn skin and damage eyes.

Remove and discard the insulating caps from the negative battery terminals. Attach and tighten negative battery cable terminals.

**NOTE:** This machine is furnished with wet charged batteries; if unused for several months, the batteries may require a booster charge. Be careful to charge the batteries with the correct polarity. Make sure that the batteries are level while charging.

### WARNING



**GASES FROM BATTERY can explode.**

- Keep sparks, flame and cigarettes away from battery.

To prevent **EXPLOSION** when:

- **INSTALLING A NEW BATTERY** — disconnect negative cable from old battery first and connect to new battery last.
- **CONNECTING A BATTERY CHARGER** — remove battery from welder by disconnecting negative cable first, then positive cable and battery clamp. When reinstalling, connect negative cable last. Keep well ventilated.
- **USING A BOOSTER** — connect positive lead to battery first then connect negative lead to negative battery lead at the lower control panel support.



**BATTERY ACID can burn eyes and skin.**

- Wear gloves and eye protection and be careful when working near battery.
- Follow instructions printed on battery.

**IMPORTANT:** To prevent **ELECTRICAL DAMAGE** WHEN:

- a) Installing new batteries.
- b) Using a booster.

Use correct polarity — **Negative Ground**.

To prevent **BATTERY BUCKLING**, tighten nuts on batteries only until snug. **DO NOT OVERTIGHTEN**.

## SPARK ARRESTOR

**⚠ WARNING**

- Spark Arrestor and Muffler may be hot!
- Allow engine to cool before servicing spark arrestor!
- Do not operate engine while servicing spark arrestor!

Some federal, state or local laws may require that diesel engines be equipped with exhaust spark arrestors when they are operated in certain locations where unarrested sparks may present a fire hazard.

The muffler included with this welder has been modified and now qualifies as a spark arrestor. Spark arresting mufflers will have a clean out service plug and will have "US FOREST SERVICE APPROVED" stamped on the muffler shell. Any spark arrestor must be serviced and properly maintained.

**⚠ CAUTION**

**An incorrect spark arrestor may lead to damage to the engine or adversely affect performance.**

## WELDING OUTPUT CABLES

With the engine off, connect the electrode and work cables to the studs provided. These connections should be checked periodically and tightened if necessary.

Listed in Table A.1 are copper cable sizes recommended for the rated current and duty cycle. Lengths stipulated are the distance from the welder to work and back to the welder again. Cable sizes are increased for greater lengths primarily for the purpose of minimizing cable voltage drop.

**Table A.1 Combined Length of Electrode and Work Cables.**

	TOTAL COMBINED LENGTH OF ELECTRODE AND WORK CABLES		
AMPS @60% Duty Cycle	Up to 100 FT. (Up to 30m)	100-200 FT. (30m-61m)	200-250 FT. (61m-76m)
400	2/0 AWG	3/0 AWG	4/0 AWG

## MACHINE GROUNDING




Because this portable engine driven welder creates its own power, it is not necessary to connect its frame to an earth ground, unless the machine is connected to premises wiring (home, shop, etc.).

To prevent dangerous electric shock, other equipment powered by this engine driven welder must:

- be grounded to the frame of the welder using a grounded type plug,
- or
- be double insulated.

When this welder is mounted on a truck or trailer, its frame must be securely connected to the metal frame of the vehicle. When this engine driven welder is connected to premises wiring such as that in a home or shop, its frame must be connected to the system earth ground. See the article on grounding in the latest U.S. National Electrical Code and the local code.

In general, if the machine is to be grounded, it should be connected with a #8 or larger copper wire to a solid earth ground such as a metal water pipe going into the ground for at least ten feet and having no insulated joints, or to the metal framework of a building which has been effectively grounded. The U.S. National Electrical Code lists a number of alternate means of grounding electrical equipment. A machine grounding stud marked with the  symbol is provided on the welding generator frame foot.

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Return to Master TOC

**Operation** ..... **B-1**

    Safety Instructions ..... B-2

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    Design Features and Advantages ..... B-3

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    Engine Controls: Function/Operation ..... B-4

    Air Intake Shut-Off ..... B-4

    Welder Controls: Function/Operation ..... B-5

    Remote Control ..... B-5

    Auxiliary Power Controls ..... B-5

    Engine Operation ..... B-6

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        Typical Fuel Consumption ..... B-7

## OPERATING INSTRUCTIONS

Read and understand this entire section before operating your equipment.

### SAFETY INSTRUCTIONS

#### ⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read all operating and maintenance manuals supplied with your machine. They include important safety precautions, detailed engine starting, operating and maintenance instructions and parts lists.



#### ELECTRIC SHOCK can kill.

- Do not touch electrically live parts or electrodes with your skin or wet clothing.
- Insulate yourself from the work and ground.
- Always wear dry insulating gloves.
- Do not use AC welder if your clothing, gloves or work area is damp or if working on, under or inside workpiece.



#### Use the following equipment:

- Semiautomatic DC constant voltage (wire) welder.
- DC manual (stick) welder.
- AC welder with reduced voltage control.



#### ARC RAYS can injure eyes and burn skin.

- Wear eye, ear, and body protection.

- Only qualified personnel should install, use or service this equipment.
- Consult instruction manual before operating.

Before operating, read and understand the manufacturer's instructions for this equipment and the consumables to be used including the Material Safety Data Sheet (MSDS) and follow your employer's safety practices.



#### FUMES AND GASES can be dangerous to your health.

- Keep your head out of fumes.
- Use enough ventilation or exhaust at the arc, or both, to keep the fumes and gases from your breathing zone and general area.



#### WELDING SPARKS can cause fire or explosion.

- Do not weld near flammable material.
- Do not weld on containers that have held flammable material.



#### MOVING PARTS can injure.

- Keep away from moving parts
- Do not operate with doors open or guards off.
- Stop engine before servicing.



#### ENGINE EXHAUST can kill.

- Use in open, well ventilated areas or vent exhaust outside.

### ADDITIONAL SAFETY PRECAUTIONS

Always operate the welder with the hinged doors closed as these provide maximum protection from moving parts and insure proper cooling air flow.

Read carefully the Safety Precautions page in the Instruction Manual before operating this machine. Always follow these and any other safety procedures included in this manual and in the engine and compressor instruction manuals.

### GENERAL DESCRIPTION

The SAE-500™ SEVERE DUTY™ is a diesel engine driven welding power source. The machine uses a DC generator for DC stick electrode welding and an AC exciter for 115/230 VAC auxiliary power. As a generator it can supply up to 3,000 watts of 115/230 volt AC power. As a welder it provides up to 575 amps of DC constant current output.

The engine is a 57.8 Hp (43.1kw), 4-cylinder water cooled diesel made by Kubota.

### RECOMMENDED APPLICATIONS

#### WELDER

The SAE-500™ SEVERE DUTY™ provides excellent constant current DC welding output for stick (SMAW) welding.

#### AUXILIARY POWER

The SAE-500™ SEVERE DUTY™ provides 3 KW of 115/230 VAC output for auxiliary power and emergency standby power.

SAE-500® SEVERE DUTY





**DESIGN FEATURES AND ADVANTAGES****FOR STICK WELDING**

- Excellent DC constant current output for stick welding applications.
- Continuous adjustment of both voltage and current for unsurpassed welds on demanding jobs.
- Remote control capability standard.

**FOR AUXILIARY POWER**

- 3,000 watts of 115/230 VAC, 60 Hz auxiliary power.
- One 20 amp 115 VAC duplex receptacle for up to 26 amps of 115 VAC power.
- One 15 amp, 230 VAC duplex receptacle for up to 13 amps of 230 VAC power.
- Weld and AC auxiliary power at the same time (within the limits shown on the chart below).

Welding Current, Amps @ NEMA Arc Volts	Using Only 115V Circuit, Amps	Using Only 230V Circuit, Amps	Total Aux. kVA
0	26	13	3.0
100	19.5	9.75	2.25
200	13	6.5	1.5
300	6.5	3.25	0.75
400	0	0	0
500	0	0	0

**OTHER FEATURES**

- Kubota 4-cylinder, water cooled diesel engine. Designed for long life, easy maintenance and excellent fuel economy.
- Engine protection system shuts the engine down for low engine oil pressure or high coolant temperature.
- Electronic Engine Idler. Engine automatically goes to low idle in 10 to 14 seconds after welding or use of auxiliary power stops. Includes high idle switch.
- Gauges for engine oil pressure, coolant temperature and battery charging ammeter.
- Engine hour meter standard.
- Extended range 29 gallon (109.8 L) fuel tank.

**DUTY CYCLE**

Duty cycle is the percentage of time the load is being applied in a 10 minute period. For example a 60% duty cycle, represents 6 minutes of load and 4 minutes of no load in a 10 minute period.


## ENGINE CONTROLS



### IGNITION SWITCH

When placed in the "ON" position, this switch energizes the fuel solenoid. When placed in the "OFF" position, the flow of fuel to the injection pump is stopped to shut down the engine.

### "IDLER" SWITCH

The idler switch has two positions, "HIGH" and "AUTO".

When in "HIGH" (  ) position, the engine will run continuously at high idle.

When in "AUTO" (  /  ) idle position, the idler operates as follows:

#### a. Welding

When the electrode touches the work, the welding arc is initiated and the engine accelerates to full speed.

After welding ceases (and no auxiliary power is being drawn), the engine will return to low idle after approximately 10 to 14 seconds.

#### b. Auxiliary Power

With the engine running at low idle and auxiliary power for lights or tools is drawn (approximately 100-150 watts or greater) from the receptacles, the engine will accelerate to high speed. If no power is being drawn from the receptacles ( and not welding) for 10-14 seconds, the idler reduces the engine speed to low idle.

### ENGINE TEMPERATURE GAUGE

Displays the coolant temperature in the engine block.

### ENGINE OIL PRESSURE GAUGE

Displays the oil pressure to the engine. When the engine starts running, watch for the oil pressure to build up. If no pressure shows within 30 seconds, stop the engine and consult the engine instruction manual.

### BATTERY CHARGING AMMETER

Displays the current going from the charging alternator into the batteries. It is normal for charging current to be high (above 15 amps) after starting or when the batteries are 'low' on charge.

### ENGINE HOUR METER

The engine hour meter records the total running time on the engine in hours. It can be used to keep a record of maintenance on the engine and or welder.

## ENGINE PROTECTION SYSTEM

The engine protection system shuts down the engine under high coolant temperature or low engine oil pressure conditions by allowing the fuel solenoid valve to close.

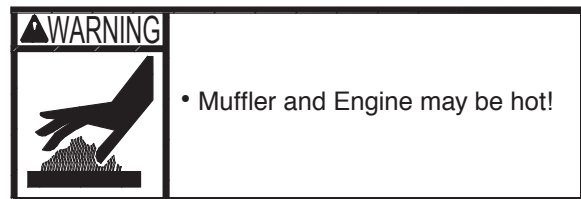
### AIR INTAKE SHUT-OFF

The air intake shut-off is a automatic/manually device which blocks all intake air from entering the engine.

The automatic feature of the shut-off will engage should excessive over speeding occur. The valve is calibrated at the factory to shutdown within the safety limits of the engine.

To manually shut down the engine, simply pull the emergency stop handle on the lower control panel.

The air intake shut-off device will reset automatically, generally within one minute.



**IMPORTANT:** Before restarting engine, verify that the air intake shut-off is in the open position. **DO NOT ATTEMPT TO START ENGINE WITH THE AIR INTAKE SHUT-OFF IN THE CLOSED POSITION.** This may cause severe damage to the engine.

## WELDER CONTROLS

### POLARITY SWITCH

Turn the Arc Polarity switch to electrode positive or electrode negative as required for each particular application.

### CONTROL OF WELDING CURRENT

#### Purpose of Controls

The continuous “Current Control” is the main current adjuster. The “Job Selector” is both a fine current adjuster and the continuous Open Circuit Voltage adjuster. Open Circuit Voltage (OCV) controls the arc characteristics.

#### “Job Selector”

The “Job Selector” dial is divided into four colored sections providing OCV ranges as follows:

Color	Title	OCV Range
White	Large Electrodes	High OCV
Black	Normal Welding	Medium OCV
Red	Overhead & Vertical	Low OCV
Grey	Special Applications	Extra-Low OCV

The “Job Selector” is usually set in the black range because it provides a soft “Buttering” arc desired for most welding. Some operators prefer to set the “Job Selector” in the red range for a snappy “Digging” arc when welding vertical up or overhead.

#### “Current Control”

### ⚠ CAUTION

Do not adjust the “Current Control” while welding because this can damage the control.

The “Current Control” dial is calibrated in amperes on three separate colored dials corresponding to the white, black and red ranges of the “Job Selector” dial. For example: when the “Job Selector” is set on the black range, the approximate welding current is indicated on the black scale of the “Current Control” dial.

#### How to Set the Controls

Assume you want a normal soft arc and about 135 amps, using a 5/32” (4.0 mm) electrode:

1. Set the “Job Selector” at the center of the black range.
2. Set the “Current Control” to read 135 amps on the black dial.
3. Start to weld.

4. If you want a little more current, turn the “Job Selector” up (counterclockwise) to increase current. If you want a little less current, turn the “Job Selector” down (clockwise) to decrease current.
5. If dialing the desired current with the “Job Selector” moves the setting outside the black range causing undesirable arc characteristics, turn the “Job Selector” back to the center of the black range. Then turn the “Current Control” up or down a little as needed. Readjust the “Job Selector” for the exact characteristics and current desired.

### REMOTE CONTROL

A receptacle and “Local/Remote” control switch on the lower front control panel and a remote control box with 100 ft. (30.5 m) of cord for adjusting the OCV at the welding site are standard. Putting the switch in the “REMOTE” position allows fine current control at the remote control box while placing the switch in the “LOCAL” position allows fine current control at the “Job Selector” on the machine.

### AUXILIARY POWER CONTROLS

Note: GFCI receptacles are an option and if installed, see the “MAINTENANCE SECTION” for detailed information on testing and resetting the GFCI receptacle.

#### 115 VAC Receptacle

One 20 amp, 115 VAC duplex receptacle provides 115 VAC for auxiliary power. A total of 26 amps can be drawn from this receptacle.

#### 230 VAC Receptacle

One 15 amp, 230 VAC duplex receptacle provides 230 VAC for auxiliary power. A total of 13 amps can be drawn from this receptacle.

#### Circuit Breakers

The circuit breakers provide separate overload current protection for each half of the 115 V duplex receptacle. The circuit breakers provide overload current protection in both current carrying wires of the 230 V duplex receptacle.

#### Ground Stud

Provides a connection point for connecting the machine to earth ground. For the safest grounding procedure refer to **Machine Grounding** in the **INSTALLATION** section of this manual.

## ENGINE OPERATION

### ⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read the engine manufacturer's manual supplied with your welder. It includes important safety precautions, detailed engine starting, operating and maintenance instructions, and parts lists.



#### ELECTRIC SHOCK can kill.

- Do not touch electrically live parts or electrode with skin or wet clothing.
- Insulate yourself from work and ground
- Always wear dry insulating gloves.



#### ENGINE EXHAUST can kill.

- Use in open, well ventilated areas or vent exhaust outside.



#### MOVING PARTS can injure.

- Do not operate with doors open or guards off.
- Stop engine before servicing.
- Keep away from moving parts.

See additional warning information at the front of this operator's manual.

For added safety always operate the welder with the doors closed. Further, leaving the doors open changes the designed air flow and may cause engine, generator overheating.

### ⚠ CAUTION

Do not adjust the high idle engine speed (rpm) above the factory setting specification as this will void warranty.

## STARTING INSTRUCTIONS

Be sure all Pre-Operation Maintenance has been performed. (See **INSTALLATION** section of this manual).

1. Turn the "IDLER" switch to "HIGH".
2. Turn the "IGNITION" switch to "ON".
3. Press the Glow Plug button for 15-20 seconds.
4. Press the Glow Plug and the Start button at the same time. When the engine starts running, release both buttons. If the engine fails to start in 60 seconds, wait 30 seconds and repeat the above procedure. Do not allow the starter motor to run continuously for more than 20 seconds.

5. Observe the oil pressure. If no pressure shows within 20 seconds, stop the engine and consult the engine operating manual. To stop the engine, turn the "IGNITION" switch to "OFF".
6. If the engine protection warning light comes on during cranking or after start up, the "IGNITION" switch must be turned "OFF" to reset the engine protection system.
7. Allow the engine to run at high idle speed for several minutes to warm the engine. Stop the engine and recheck the oil level, after allowing sufficient time for the oil to drain into the pan. If the level is down, fill it to the full mark again. The engine controls were properly set at the factory and should require no adjusting when received.

## COLD WEATHER STARTING:

### ⚠ WARNING

Under **NO** conditions should ether or other starting fluids be used!

With a fully charged battery and the proper weight oil, the engine should start satisfactorily even down to about -5°F (-20°C), it maybe desirable to install cold-starting aides.

Note: Extreme cold weather starting may require longer glow plug operation.

## STOPPING THE ENGINE

1. **Important:**  
Run the engine under low idle for 5 minutes before shutting it off after a full load operation.  
**Note:** Failure to do so may lead to turbo charger trouble.
2. Turn the "IGNITION" switch to "OFF"

At the end of each day's welding, check the crankcase oil level, drain accumulated dirt and water from the water separator and refill the fuel tank to minimize moisture condensation in the tank. Also, running out of fuel tends to draw dirt into the fuel system.

When hauling the welder between job sites, close the fuel shut-off valve.

If the fuel supply is cut off or runs out while the fuel pump is operating, air may be entrapped in the fuel distribution system. If this happens, bleeding of the fuel system may be necessary. Use qualified personnel to do this per the instructions in the **MAINTENANCE** section of this manual.

## TYPICAL FUEL CONSUMPTION

The typical fuel consumption of the SAE-500 for various operating scenarios is shown below:

Low Idle - No Load 1100 RPM	0.31 gal./ hr. ( 1.17 L./hr.)
High Idle - No Load 1800 RPM	0.69 gal./hr. ( 2.61 L./hr.)
Welding Load 400 Amps, 40 Volts	2.00 gal./hr. ( 7.57 L./hr.)
Welding Load 500 Amps, 40 Volts	2.45 gal./hr. ( 9.27 L./hr.)
Auxiliary Power 3000VA	0.65 gal./hr. ( 2.46 L./hr.)

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SAE-500® SEVERE DUTY



**Accessories** .....C-1

Optional Field Installed Accessories .....C-2

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## OPTIONAL FIELD INSTALLED ACCESSORIES

**K802-D Power Plug Kit** - Kit includes male plugs for 20 Amp receptacle.

**K2641-1 Trailer** - A 4-wheel steerable trailer for in-plant and yard towing with E78-14 load range (B) tubeless tires. Mounts directly to welder base. (Not for use on the highway.) Comes standard with a Duo-Hitch™, a 2" Ball and Lunette Eye combination Hitch.

**K2637-1 Trailer** - A 2-wheel trailer designed for road<sup>(1)</sup>, off road, in-plant and yard towing. Trailer mounts directly to welder base. Comes standard with a Duo-Hitch™, a 2" Ball and Lunette Eye combination Hitch.

### Order:

K2637-1 Trailer

K2639-1 Fender & Light Kit.

K2640-1 Cable Storage Rack

<sup>1</sup>For highway use, consult applicable federal, state and local laws regarding possible requirements for brakes, lights, fenders, etc.

**K704 Standard Accessory Kit** - Includes electrode and work cables, headshield, work clamp and electrode holder.

### K1690-1 GFCI RECEPTACLE KIT

Includes one UL approved 120V ground fault circuit interrupter duplex type receptacle with cover and installation instructions. Replaces the factory installed 120V duplex receptacle. Each receptacle of the GFCI Duplex is rated at 20 Amps, the maximum total current from the GFCI Duplex is limited to the 20 Amps. Two kits are required. See the **MAINTENANCE** section for detailed information on testing and resetting the GFCI receptacle.



**Maintenance** .....D-1

    Service Instructions .....D-2

    Routine Maintenance, Periodic Maintenance .....D-3

    Engine Oil Change, Engine Air Filter .....D-3

    Bearing, Commutator and Brush Maintenance .....D-4

    Cooling System, Fuel Filter .....D-4

    Water Separator, Secondary Fuel Filter and Engine Components .....D-4/D-5

    GFCI Receptacle Testing and Resetting Procedure .....D-5

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# Service Instructions

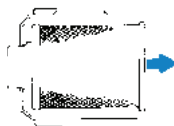
## Single- and Two-Stage Engine Air Cleaners

### 1 Remove the Filter



Rotate the filter while pulling straight out.

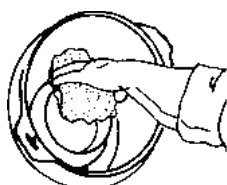
Unfasten or unlatch the service cover. Because the filter fits tightly over the outlet tube to create the critical seal, there will be some initial resistance, similar to breaking the seal on a jar. Gently move the end of the filter back and forth to break the seal then rotate while pulling straight out. Avoid knocking the filter against the housing.



If your air cleaner has a safety filter, replace it every third primary filter change. Remove the safety filter as you would the primary filter. Make sure you cover the air cleaner outlet tube to avoid any unfiltered contaminant dropping into the engine.

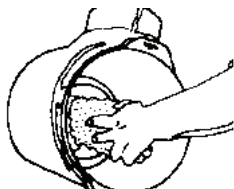
### 2 Clean Both Surfaces of the Outlet Tube and Check the Vacuator™ Valve

Use a clean cloth to wipe the filter sealing surface and the inside of the outlet tube. Contaminant on the sealing surface could hinder an effective seal and cause leakage. Make sure that all contaminant is removed before the new filter is inserted. Dirt accidentally transferred to the inside of the outlet tube will reach the engine and cause wear. Engine manufacturers say that it takes only a few grams of dirt to "dust" an engine! Be careful not to damage the sealing area on the tube.



Outer edge of the outlet tube

Wipe both sides of the outlet tube clean.



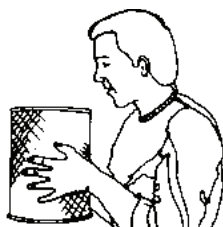
Inner edge of the outlet tube

**If your air cleaner is equipped with a Vacuator Valve** Visually check and physically squeeze to make sure the valve is flexible and not inverted, damaged or plugged.



### 3 Inspect the Old Filter for Leak Clues

Visually inspect the old filter for any signs of leaks. A streak of dust on the clean side of the filter is a telltale sign. Remove any cause of leaks before installing new filter.



### 4 Inspect the New Filter for Damage

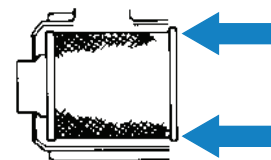
Inspect the new filter carefully, paying attention to the inside of the open end, which is the sealing area. NEVER install a damaged filter. A new Donaldson radial seal filter may have a dry lubricant on the seal to aid installation.



### 5 Insert the New Radial Seal Filter Properly

If you're servicing the safety filter, this should be seated into position before installing the primary filter.

Insert the new filter carefully. Seat the filter by hand, making certain it is completely into the air cleaner housing before securing the cover in place.



The critical sealing area will stretch slightly, adjust itself and distribute the sealing pressure evenly. To complete a tight seal, apply pressure by hand at the outer rim of the filter, not the flexible center. (Avoid pushing on the center of the urethane end cap.) No cover pressure is required to hold the seal. NEVER use the service cover to push the filter into place! Using the cover to push the filter in could cause damage to the housing, cover fasteners and will void the warranty.

If the service cover hits the filter before it is fully in place, remove the cover and push the filter (by hand) further into the air cleaner and try again. The cover should go on with no extra force.

Once the filter is in place, secure the service cover.



#### Caution

**NEVER use the service cover to push the filter into place! Using the cover to push the filter in could cause damage to the housing, cover fasteners and will void the warranty.**



### 6 Check Connectors for Tight Fit

Make sure that all mounting bands, clamps, bolts, and connections in the entire air cleaner system are tight. Check for holes in piping and repair if needed. Any leaks in your intake piping will send dust directly to the engine!

## ⚠ WARNING



### ELECTRIC SHOCK can kill.

- Do not touch electrically live parts such as output terminals or internal wiring



### ENGINE EXHAUST can kill.

- Use in open, well ventilated areas or vent exhaust outside



### MOVING PARTS can injure.

- Do not operate with doors open or guards off
- Stop engine before servicing
- Keep away from moving parts

- Remove guards only when necessary and replace when work requiring removal is complete.
- Only qualified personnel should install, use, or service this equipment.

## ROUTINE MAINTENANCE

At the end of each day's welding, refill the fuel tank to minimize moisture condensation in the tank. Also, running out of fuel tends to draw dirt into the fuel system. Check the engine crankcase oil level.

If the fuel supply runs out while the fuel pump is operating, air may be entrapped in the fuel distribution system. If this happens, bleeding of the fuel system may be necessary. See the engine instruction manual.

## PERIODIC MAINTENANCE

1. Blow out the welder and controls with an air hose at least once every two months. In particularly dirty locations, this cleaning may be necessary once a week. Use low pressure air to avoid driving dirt into the insulation.
2. The current control reactor brushes are self-lubricating and should not be greased. Keep the contacts clean. This control should be moved from maximum to minimum daily to prevent the controls from sticking.
3. See the engine Instruction Manual for periodic engine maintenance information. Change the oil filter in accordance with the instructions in the engine operating manual. When the oil filter is changed add one quart of oil to the crankcase to replace the oil held in the filter during operation.

4. Belts tend to loosen after the first 30 or 40 hours of operation. Check the cooling fan belt and tighten if necessary. DO NOT OVER TIGHTEN.

## ENGINE OIL CHANGE

The SAE-500™ SEVERE DUTY™ is equipped with a convenient oil drain system. Drain the oil when the engine is warm to assure rapid and complete draining.

- Remove the oil filler cap and dipstick.
- To open drain valve, push handle away from valve and turn 90°.
- Drain oil into a suitable container.
- To close drain valve, turn handle 90° till handle snaps in the closed position.
- Refill engine with the recommended oil to the appropriate level. Replace dipstick and tighten the oil filler cap securely.

Change the crankcase oil at regular intervals using the proper grade of oil as recommended in the Engine Operating Manual. Wash your hands with soap and water after handling used oil. Please dispose of used motor oil in a manner that is compatible with the environment. We suggest you take it in a sealed container to your local service station or recycling center for reclamation. Do not throw it in the trash, pour it on the ground or down a drain.

## ENGINE AIR FILTER

The engine air filter element is a dry cartridge type. It is located above the engine. It can be cleaned and re-used; however, damaged elements should not be washed or re-used. Remove loose dirt from element with compressed air or water hose directed from inside out. Compressed Air: 100 psi maximum. The filter should never be removed while the engine is running.

## BEARING MAINTENANCE

This welder is equipped with a double-shielded ball bearing having sufficient grease to last indefinitely under normal service. Where the welder is used constantly or in excessively dirty locations, it may be necessary to add one-half ounce of grease per year. A pad of grease one inch wide, one inch long and one inch high weighs approximately one-half ounce. Over greasing is far worse than insufficient greasing.

When greasing the bearings, keep all dirt out of the area. Wipe the fittings completely clean and use clean equipment. More bearing failures are caused by dirt introduced during greasing than from insufficient greasing.

## COMMUTATOR AND BRUSH MAINTENANCE

### WARNING



**Uncovered rotating equipment can be dangerous. Use care so your hands, hair, clothing or tools do not catch in the rotating parts. Protect yourself from particles that may be thrown out by the rotating armature when stoning the commutator.**

The generator brushes are properly adjusted when the welder is shipped. They require no particular attention. **DO NOT SHIFT THE BRUSHES** or adjust the rocker setting.

Shifting of the brushes may result in:

- Change in machine output
- Commutator Damage
- Excessive brush wear

Periodically inspect the commutator, slip rings and brushes by removing the covers. **DO NOT** remove or replace these covers while the machine is running. Commutators and slip rings require little attention. However, if they are black or appear uneven, have them cleaned by an experienced maintenance man using fine sandpaper or a commutator stone. Never use emery cloth or paper for this purpose.

**NOTE:** If the welder is used in dirty or dusty locations, or if the welder is not used for prolonged periods of time, it may be necessary to clean the commutator and slip rings more often.

Replace brushes when they wear within 1/4" of the pig-tail. A complete set of replacement brushes should be kept on hand. Lincoln brushes have a curved face to fit the commutator. Have an experienced maintenance man seat these brushes by lightly stoning the commutator as the armature rotates at full speed until contact is made across the full face of the brushes. After stoning, blow out the dust with low pressure air.

To seat the slip ring brushes, position the brushes in place. Then slide one end of a piece of fine sandpaper between slip rings and brushes with the coarse side against the brushes. Pull the sandpaper around the circumference of the rings, in direction of rotation only - until brushes seat properly. In addition, stone slip ring with a fine stone. Brushes must be seated 100%.

Arcing or excessive exciter brush wear indicates a possible misaligned shaft. Have an authorized Field Service Shop check and realign the shaft.

## COOLING SYSTEM

The SAE-500™ SEVERE DUTY™ is equipped with a pressure radiator. Keep the radiator cap tight to prevent loss of coolant. Clean and flush the cooling system periodically to prevent clogging the passage and overheating the engine. When antifreeze is needed, always use the permanent type.

## FUEL FILTERS

### WARNING

**When working on the fuel system**



- Keep ungrounded lights away, do not smoke !
- Do not spill fuel !

The SAE-500™ SEVERE DUTY™ is equipped with a **Fuel Pre-Filter/Water Separator Assembly** is mounted to the engine block just below the oil filter.

The Secondary Fuel Filter is mounted directly to the engine just above the oil filter.

## FUEL PRE-FILTER/WATER SEPARATOR ASSEMBLY

The pre-filter is a 30 micron screen designed to protect against gross fuel contamination of the water separator element and the Secondary Fuel Filter.

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The water separator element is a two stage filter with a special filtration/water separating media, and an expanded water reservoir providing maximum protection against water in the fuel. The recommended change interval for the water separator element is 1,000 hours. The procedure for changing the element is as follows:

**Note :** Consult your engine operation manual for information on air bleeding the entire fuel system.

#### ENGINE MAINTENANCE COMPONENTS

ITEM	MAKE	PART NUMBER
Engine Air Filter	Donaldson	P822768
Fan Belt	Kubota	1G517-97011
Fuel Filter Element	Racor	R60P
Engine Oil Filter	Kubota	1C020-32435

#### GFCI RECEPTACLE TESTING AND RESET- TING PROCEDURE

The GFCI receptacle should be properly tested at least once every month or whenever it is tripped. To properly test and reset the GFCI receptacle:

- If the receptacle has tripped, first carefully remove any load and check it for damage.
- If the equipment has been shut down, it must be restarted.
- The equipment needs to be operating at high idle speed and any necessary adjustments made on the control panel so that the equipment is providing at least 80 volts to the receptacle input terminals.
- The circuit breaker for this receptacle must not be tripped. Reset if necessary.
- Push the "Reset" button located on the GFCI receptacle. This will assure normal GFCI operation.
- Plug a night-light (with an "ON/OFF" switch) or other product (such as a lamp) into the GFCI receptacle and turn the product "ON".
- Push the "Test" button located on the GFCI receptacle. The night-light or other product should go "OFF".
- Push the "Reset" button, again. The light or other product should go "ON" again.

If the light or other product remains "ON" when the "Test" button is pushed, the GFCI is not working properly or has been incorrectly installed (miswired). If your GFCI is not working properly, contact a qualified, certified electrician who can assess the situation, rewire the GFCI if necessary or replace the device.

#### REPLACEMENT SERVICE ITEMS

ITEM	MAKE	PART NUMBER	SERVICE INTERVAL
AIR CLEANER ELEMENT	DONALDSON	P822768	CLEAN AS NEEDED. REPLACE EVERY 200 HOURS.
OIL FILTER CARTRIDGE	KUBOTA	1C020-32433	FIRST CHANGE AT 50 HOURS. THEN REPLACE EVERY 500 HOURS.
FAN BELT	KUBOTA	1G517-97011	INSPECT EVERY 500 HOURS. REPLACE EVERY 2 YEARS.
FUEL FILTER ELEMENT	KUBOTA	16631-43562	REPLACE EVERY 500 HOURS
FUEL WATER SEPERATOR/FUEL SEDIMENTER	KUBOTA RACOR	15831-43353 R60P	DRAIN WATER DAILY OR EVERY 8 HOURS. REPLACE ELEMENT EVERY 500 HOURS.
BATTERY	————	BCI GROUP 24	INSPECT EVERY 1 OR 2 MONTHS
ENGINE OIL CHANGE	SEE MANUAL	————	FIRST CHANGE AT 50 HOURS, THEN EVERY 250 HOURS OR 12 MONTHS, WHICHVER IS LESS. CHECK DAILY

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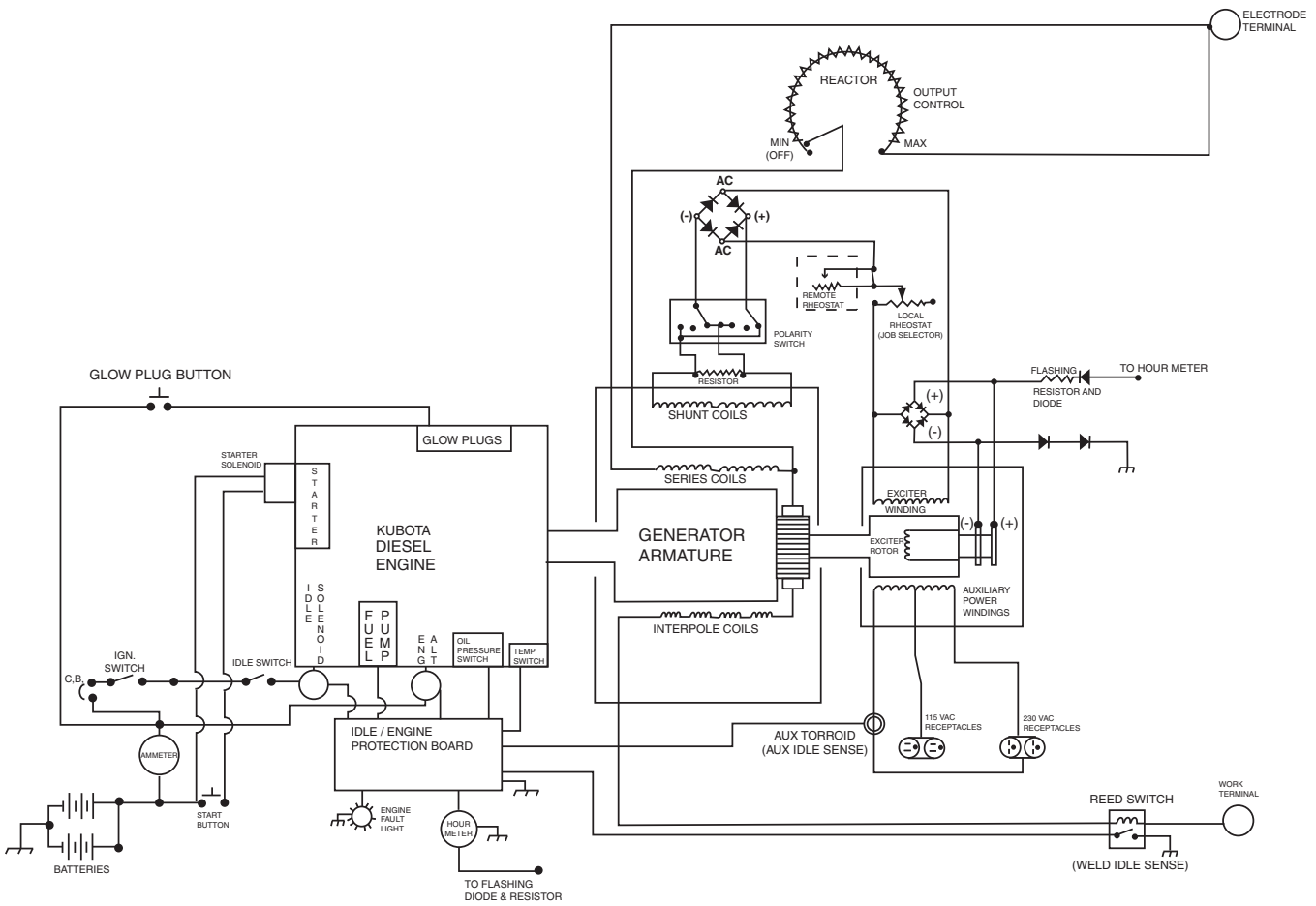
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Automatic Engine Idle System .....E-3

Exciter / Auxiliary Alternator Operation .....E-4

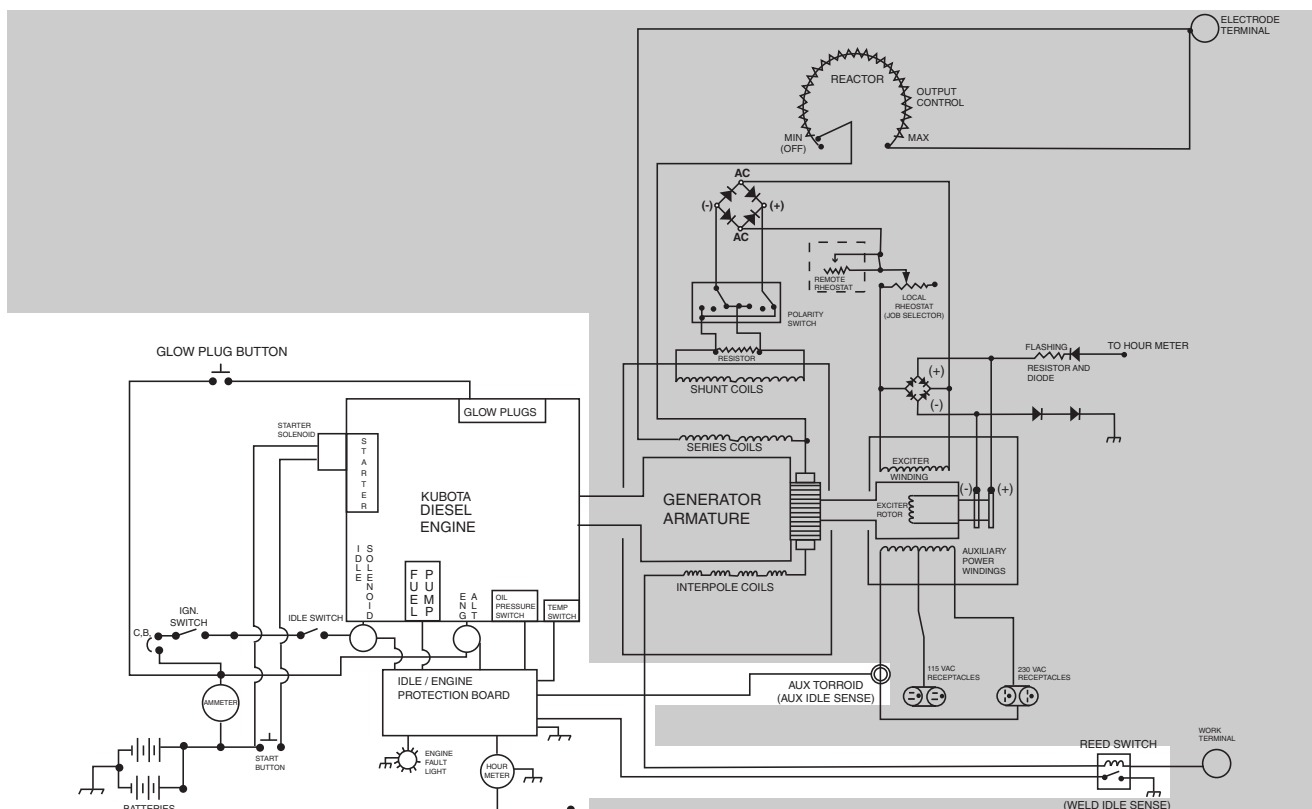
FIGURE E.1 BLOCK LOGIC DIAGRAM



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FIGURE E.2 - ENGINE STARTING AND PROTECTION



## ENGINE STARTING AND PROTECTION

Turning on the ignition switch supplies 12VDC power to idler/engine protection PC board. During the first minute after the switch is placed in the on position, power is supplied to the fuel pump, the hour meter, and flashing circuits for the engine alternator and the exciter alternator. The engine should be started during this first minute.

After one minute, the PC board will begin to monitor the oil pressure switch, cooling system temp switch, and the engine alternator. If a fault is detected in any of these systems, the engine fault light will come on and the engine will be shut down by shutting off the power to the fuel pump. These systems signal a fault by connecting the sense lead to chassis ground.

If the engine fault light turns on, the engine protection system must be reset by turning the run/stop switch off, then on again before attempting to restart the engine.

The machine is equipped with a glow plug starting system that is used for cold weather starting. Pressing the Glow Plug button activates this system. See the machine nameplate and engine manual for operating instructions and service information.

Pressing the start button activates the starter motor which cranks the engine. The start button is a momentary contact switch that routes power from the battery to the starting terminal of the starter solenoid. The starter will crank the engine even if the ignition switch is in the off position.

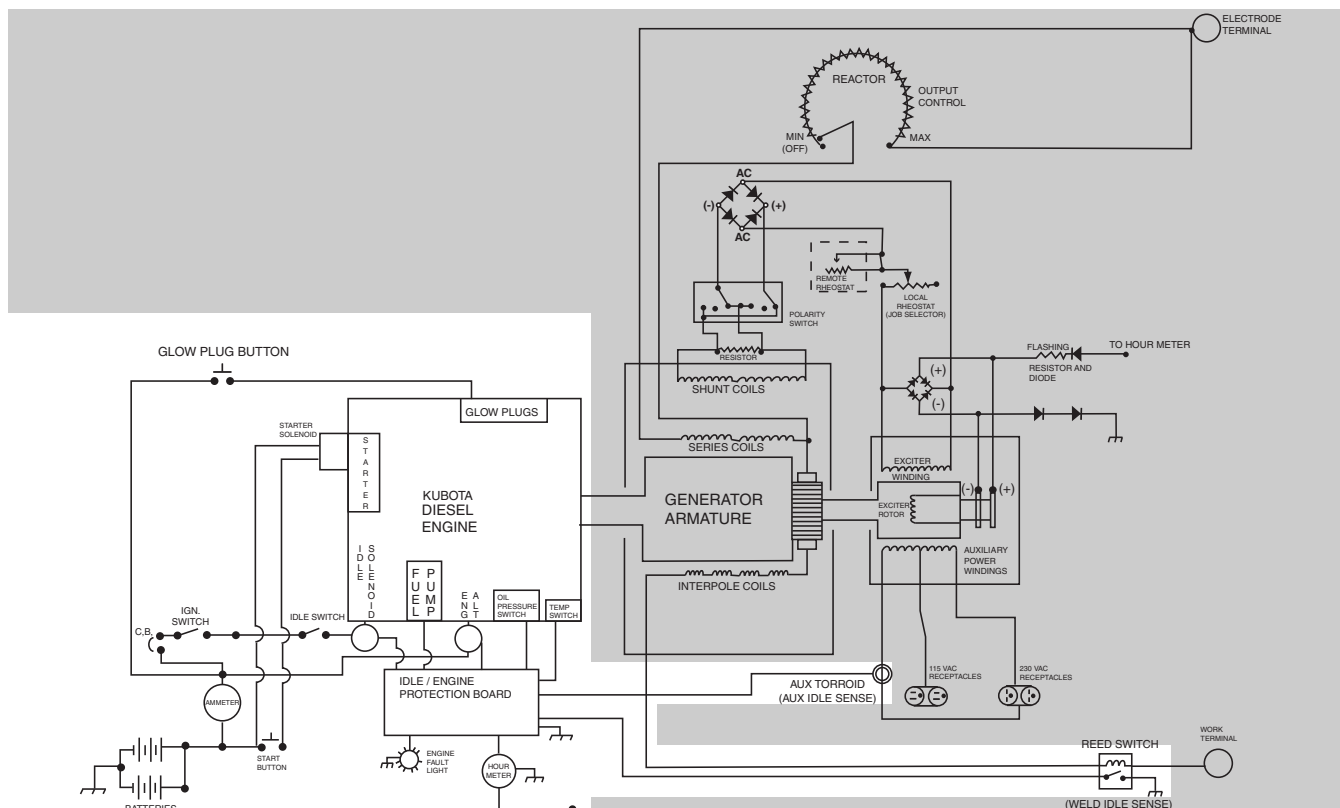
NOTE: Unshaded areas of Block Logic Diagram are the subject of discussion

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FIGURE E.3 - AUTOMATIC ENGINE IDLE SYSTEM



## AUTOMATIC ENGINE IDLE SYSTEM

The automatic idle system reduces the engine RPM when there is no electrical demand on the machine. When an arc is struck, or a load of 100 Watts or greater is applied to the auxiliary output, the engine speed will immediately increase to high RPM. When the load is released, the engine continues to run at high RPM for about 12 seconds. If a load is re-applied during this time, the machine will continue to operate at high RPM. If no load is applied, the engine RPM is reduced to idle speed.

The automatic idle system functions by energizing a solenoid, which pulls the engine speed control to a preset low idle RPM position. When this solenoid is de-energized, the engine speed is controlled by the governor which maintains the engine RPM at the specified high RPM setting. The solenoid is supplied with +12VDC power whenever the idle switch is in the auto position. It is activated when circuitry on the Idler/engine shutdown PC board completes the solenoid's path to chassis ground.

The automatic idle circuitry on the PC board uses a magnetic reed switch to sense weld current and a toroidal current transformer to sense auxiliary current. When weld current flows the reed switch closes, connecting the sense lead to chassis ground. When sufficient AC current flows, the toroidal current transformer sends a signal to the PC board.

When the idle switch is in the "high" position, power to the solenoid is shut off deactivating it and causing the engine to operate at high rpm. The idle circuitry on the PC board continues to sense if there is a load on any of the outputs, and continues to open and close the solenoid's ground path.

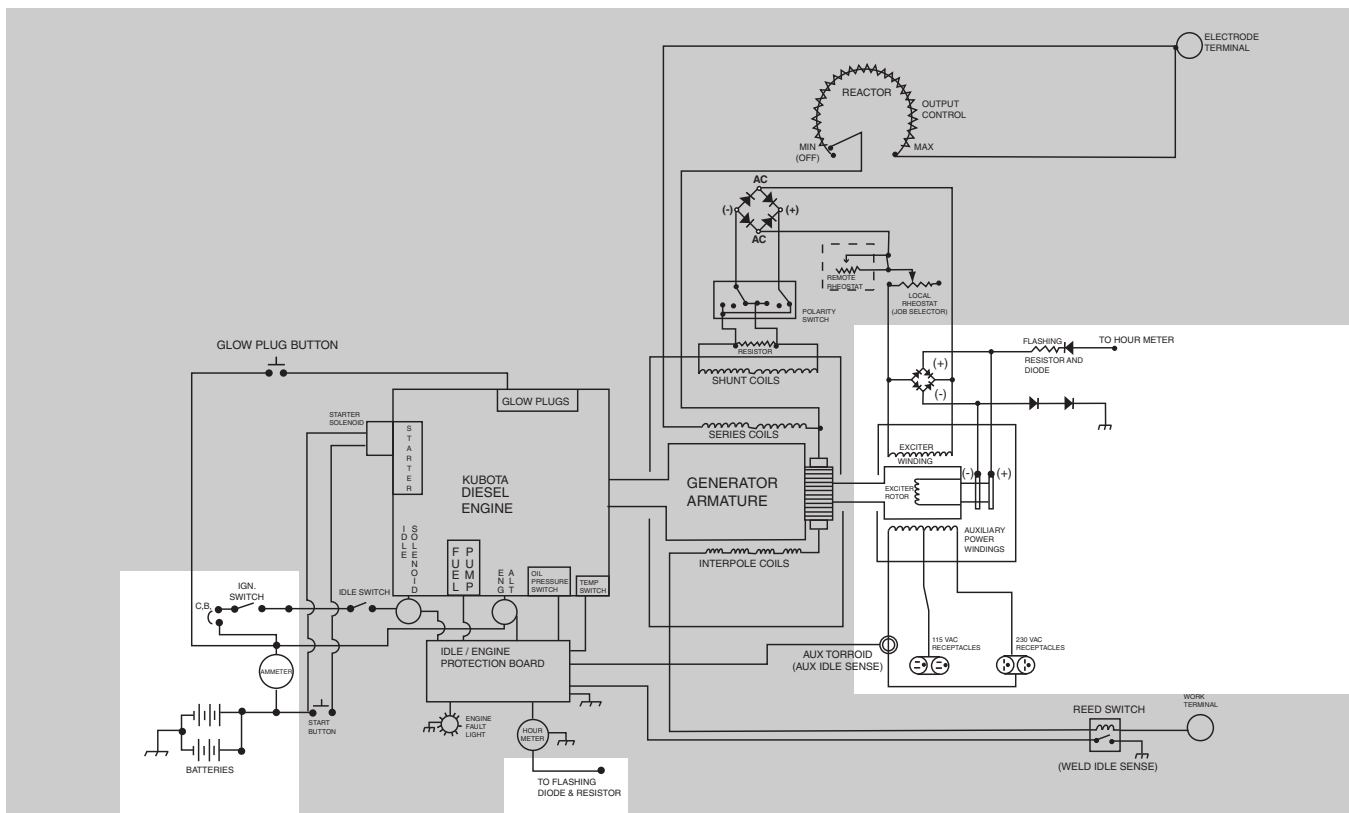
If the machine had been operating at low idle and the idle switch is moved from auto to high, the engine RPM will increase immediately. If the switch is moved from high to auto, the engine RPM may be reduced immediately or it could take up to 12 seconds for the idle circuitry on the PC board to activate and engage the solenoid.

NOTE: Unshaded areas of Block Logic Diagram are the subject of discussion

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FIGURE E.4 - EXCITER / AUXILIARY ALTERNATOR OPERATION



## EXCITER/AUXILIARY ALTERNATOR OPERATION

The exciter alternator is the smaller power generator that is located at the end of the main welding generator. It provides power to energize the rotor, the shunt fields of the main welding generator and about 3 KVA of 120/230 volts, 60 Hz. for auxiliary power.

### Flashing:

The exciter alternator requires that DC power be applied to the slip rings to start the power generation process. This DC power is often referred to as "Flashing" voltage, and originates at the battery. This voltage is applied through the Idler/Engine Protection PC Board, whenever the fuel solenoid is open and the hour meter is running.

The flashing current passes through a blocking diode and current limiting resistor before being applied to the rotor field winding through the positive brush and slip ring. The current then passes out of the negative slip ring and brush, through two diodes, and back to the battery through a chassis ground connection.

### Building output:

The flashing current produces a weak magnetic field in the rotor, which is coupled to the now running engine. This rotating magnetic field begins to generate AC output from all of the stator windings. Output from the exciter winding is rectified by a diode bridge, and then fed back into the rotating field winding, through the brushes, making the magnetic field stronger. This stronger magnetic field then produces higher voltage from the stator windings, which feeds back to the rotor, making its magnetic field even stronger.

This process of strengthening the magnetic field through feedback from the exciter winding continues to increase the output of the alternator until the design voltage is reached.

The field voltage is now considerably higher than the flashing voltage that was used to start the generating process. The diode in the flashing circuit now blocks that higher field voltage from intruding into the 12VDC battery system and the machine chassis.

*(continued on next page)*

NOTE: Unshaded areas of Block Logic Diagram are the subject of discussion

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## EXCITER/AUXILIARY ALTERNATOR OPERATION (Continued)

### AC Auxiliary Output:

The exciter alternator is now producing sufficient AC power from both the exciter winding and the 115/230 VAC auxiliary power winding. This 115/230 VAC, 60 Hz. auxiliary power is made available for use through the receptacles on the front panel of the machine, after passing through circuit breakers and the automatic idle system's current sensor.

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## HOW TO USE TROUBLESHOOTING GUIDE

**⚠ WARNING**

Service and Repair should only be performed by Lincoln Electric Factory Trained Personnel. Unauthorized repairs performed on this equipment may result in danger to the technician and machine operator and will invalidate your factory warranty. For your safety and to avoid Electrical Shock, please observe all safety notes and precautions detailed throughout this manual.

This Troubleshooting Guide is provided to help you locate and repair possible machine malfunctions. Simply follow the three-step procedure listed below.

**Step 1. LOCATE PROBLEM (SYMPTOM).**

Look under the column labeled "PROBLEM (SYMPTOMS)". This column describes possible symptoms that the machine may exhibit. Find the listing that best describes the symptom that the machine is exhibiting. Symptoms are grouped into the following categories: Output Problems.

**Step 2. PERFORM EXTERNAL TESTS.**

The second column labeled "POSSIBLE AREAS OF MISADJUSTMENT(S)" lists the obvious external possibilities that may contribute to the machine symptom. Perform these tests/checks in the order listed. In general, these tests can be conducted without removing the case wrap-around cover.

**Step 3. RECOMMENDED COURSE OF ACTION**

The last column labeled "Recommended Course of Action" lists the most likely components that may have failed in your machine. It also specifies the appropriate test procedure to verify that the subject component is either good or bad. If there are a number of possible components, check the components in the order listed to eliminate one possibility at a time until you locate the cause of your problem.

All of the referenced test procedures referred to in the Troubleshooting Guide are described in detail at the end of this chapter. Refer to the Troubleshooting and Repair Table of Contents to locate each specific Test Procedure. All of the specified test points, components, terminal strips, etc. can be found on the referenced electrical wiring diagrams and schematics. Refer to the Electrical Diagrams Section Table of Contents to locate the appropriate diagram.

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

## PC BOARD TROUBLESHOOTING PROCEDURES

**WARNING**

**ELECTRIC SHOCK  
can kill.**

- Have an electrician install and service this equipment. Turn the input power OFF at the fuse box before working on equipment. Do not touch electrically hot parts.

**CAUTION**

Sometimes machine failures appear to be due to PC board failures. These problems can sometimes be traced to poor electrical connections. To avoid problems when troubleshooting and replacing PC boards, please use the following procedure:

1. Determine to the best of your technical ability that the PC board is the most likely component causing the failure symptom.
2. Check for loose connections at the PC board to assure that the PC board is properly connected.
3. If the problem persists, replace the suspect PC board using standard practices to avoid static electrical damage and electrical shock. Read the warning inside the static resistant bag and perform the following procedures:

**PC board can be damaged by static electricity.**

- Remove your body's static charge before opening the static-shielding bag. Wear an anti-static wrist strap. For safety, use a 1 Meg ohm resistive cord connected to a grounded part of the equipment frame.

- If you don't have a wrist strap, touch an un-painted, grounded, part of the equipment frame. Keep touching the frame to prevent static build-up. Be sure not to touch any electrically live parts at the same time.

- Tools which come in contact with the PC board must be either conductive, anti-static or static-dissipative.

- Remove the PC board from the static-shielding bag and place it directly into the equipment. Don't set the PC board on or near paper, plastic or cloth which could have a static charge. If the PC board can't be installed immediately, put it back in the static-shielding bag.

- If the PC board uses protective shorting jumpers, don't remove them until installation is complete.

- If you return a PC board to The Lincoln Electric Company for credit, it must be in the static-shielding bag. This will prevent further damage and allow proper failure analysis.

4. Test the machine to determine if the failure symptom has been corrected by the replacement PC board.

**NOTE:** It is desirable to have a spare (known good) PC board available for PC board troubleshooting.

**NOTE:** Allow the machine to heat up so that all electrical components can reach their operating temperature.

5. Remove the replacement PC board and substitute it with the original PC board to recreate the original problem.

- a. If the original problem does not reappear by substituting the original board, then the PC board was not the problem. Continue to look for bad connections in the control wiring harness, junction blocks, and terminal strips.

- b. If the original problem is recreated by the substitution of the original board, then the PC board was the problem. Reinstall the replacement PC board and test the machine.

6. Always indicate that this procedure was followed when warranty reports are to be submitted.

**NOTE:** Following this procedure and writing on the warranty report, "INSTALLED AND SWITCHED PC BOARDS TO VERIFY PROBLEM," will help avoid denial of legitimate PC board warranty claims.

Observe Safety Guidelines detailed in the beginning of this manual.

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
Both the weld and auxiliary output voltages are low	<p>Make sure the engine is operating at the correct high idle speed.</p> <p>Make sure that no load is connected to either the weld or auxiliary outputs.</p>	<p>Perform the <i>Engine RPM Adjustment Test</i>.</p> <p>Perform the <i>Brush and Slip Ring Service Procedure</i>.</p> <p>Perform the <i>Exciter Rotor Voltage Test</i>.</p> <p>Perform <i>Exciter Rotor Resistance and Ground Test</i>.</p>
There is no, or very low weld output, and no auxiliary output.	<p>Check that the electrode polarity switch is not in the off position, and that the remote/local switch is in the local control position. Check that the auxiliary power circuit breakers and GFCIs (if so equipped) are not tripped.</p> <p>NOTE: GFCIs will not reliably reset, unless engine is operating at high idle RPM.</p> <p>Check all leads and cables for damaged or poor connections.</p>	<p>Perform the <i>Brush and Slip Ring Service Procedure</i>.</p> <p>Perform the <i>Exciter Rotor Voltage Test</i>.</p> <p>Perform the <i>Exciter Rotor Resistance and Ground Test</i>.</p>
There is no, or very low weld output voltage. The auxiliary output is normal.	<p>Check the polarity switch; make sure it is not in the off position.</p> <p>Check that the remote/local switch is positioned correctly.</p> <p>If a remote current control is being used, try switching to local control. The remote current control may be faulty.</p> <p>Check all leads and cables for damaged or poor connections.</p>	<p>Perform the <i>Shunt Field Coil Resistance and Ground Test</i>.</p> <p>Perform the <i>Shunt Field Circuit Voltage Test</i>.</p> <p>Perform the <i>Welding Generator Brush and Commutator Inspection and Service Procedure</i>.</p> <p>Check for damaged or poor connections at the brush holders, series and interpole coils, weld output control unit, weld output terminals, and all the conductors connecting these components.</p> <p>The Armature may be faulty.</p>

### ⚠ CAUTION

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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Observe Safety Guidelines detailed in the beginning of this manual.

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>There is no auxiliary voltage, weld output is normal.</p>	<p>Check that the auxiliary power circuit breakers are not tripped.</p> <p>If the machine is equipped with a ground fault circuit interrupter (GFCI), it may be tripped or defective.</p> <p>NOTE: GFCIs will not reliably reset, unless engine is operating at high idle RPM.</p> <p>Check all leads and cables for damaged or poor connections.</p>	<p>Check for auxiliary voltage at the receptacle input terminals, if normal voltage is present, replace receptacle.</p> <p>Check for auxiliary voltage at the connections closest to the exciter stator windings. See wiring diagram.</p> <ul style="list-style-type: none"> <li>• If normal voltage is present, check the wiring and circuit breakers between the test points and the receptacle. Repair or replace any defective parts or wiring.</li> <li>• If normal voltage is not present, check for damaged conductors between the test points and the winding. If the conductors are good, the stator is defective.</li> </ul>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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Observe Safety Guidelines detailed in the beginning of this manual.

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The weld output varies abnormally. Auxiliary voltage is normal.</p>	<p>Check welding cables for damaged or poor connections.</p> <p>Welding cable may be excessively long, too small, or coiled. Try using a set of short test cables of adequate size.</p> <p>If a remote current control is being used, try switching to local control. The remote current control may be faulty.</p> <p>The engine may not be maintaining steady RPM. Make sure there is an adequate supply of clean, fresh fuel. Replace fuel filters if necessary. Have engine serviced by a qualified engine technician.</p>	<p>Check and, if necessary, perform the <b>Brush and Slip Ring Service Procedure</b>.</p> <p>Perform the <b>Welding Generator Brush and Commutator Inspection and Service Procedure</b>.</p> <p>Perform the <b>Engine RPM Adjustment Test</b>.</p> <p>Check all the large weld current carrying leads inside the machine for damaged conductors, insulation and poor connections.</p> <p>Perform the <b>Output Control Unit Inspection and Service Procedure</b>.</p> <p>Check the wiring that connects the exciter, diode bridges, rheostat, remote/local switch, polarity switch, and the shunt coils. Check for damaged conductors, insulation and connections.</p> <p>Check Job Selector rheostat, replace if necessary.</p> <p>Check remote/local switch. Replace if necessary</p>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The weld output varies abnormally. Auxiliary voltage is normal. (continued)</p>		<p>Examine polarity switch for poor electrical connections and damaged or burned contacts. Replace if necessary. If polarity switch contacts have excessive arc damage, check the 500 Ohm resistor.</p> <p>Perform the <i>Exciter Rotor Resistance and Ground Test</i>.</p> <p>Perform the <i>Shunt Field Coil Resistance and Ground Test</i>.</p> <p>Check the Generator brush rocker position; perform the <i>Rocker Adjustment Procedure</i> if necessary.</p>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The weld output is considerably less than indicated on the dials. Auxiliary voltage is normal.</p>	<p>Check welding cables for damaged or poor connections.</p> <p>Welding cable may be excessively long, too small, or coiled. Try using a set of short test cables of adequate size.</p> <p>If a remote current control is being used, try switching to local control. The remote current control may be faulty.</p> <p>The engine RPM may low. Make sure there is an adequate supply of clean, fresh fuel. Replace fuel filters if necessary. Have engine serviced by a qualified engine technician.</p>	<p>Perform the <i>Engine RPM Adjustment Test</i>.</p> <p>Perform the <i>Welding Generator Brush and Commutator Inspection and Service Procedure</i>.</p> <p>Perform the <i>Brush and Slip Ring Service Procedure</i>.</p> <p>Perform the <i>Shunt Field Coil Resistance and Ground Test</i>.</p> <p>Perform the <i>“Dead Short”, “First Step”, and “Open Reactor” Tests</i>. If necessary, perform the <i>Output Control Unit Inspection and Service Procedure</i>.</p> <p>Perform the <i>Exciter Rotor Resistance and Ground Test</i>.</p> <p>Check all the large weld current carrying leads inside the machine for damaged conductors, damaged insulation, and poor connections.</p> <p>Check the wiring that connects the exciter, diode bridges, rheostat, remote/local switch, polarity switch, and the shunt coils. Check for damaged conductors, insulation, and connections.</p> <p>Check Job Selector rheostat, replace if necessary.</p> <p>Check remote/local switch. Replace if necessary.</p>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The weld output is considerably less than indicated on the dials. Auxiliary voltage is normal.</p> <p>(continued)</p>		<p>Examine polarity switch for poor electrical connections and damaged or burned contacts. Replace if necessary. If polarity switch contacts have excessive arc damage, check the 500 Ohm resistor.</p> <p>Verify that the rocker is positioned correctly, according to the factory drill mark. If necessary, perform the <b>Rocker Adjustment Procedure</b>.</p>
<p>The weld output is considerably higher than indicated on the dials. Auxiliary voltage is normal.</p>	<p>If a remote current control is being used, try switching to local control. The remote current control may be faulty.</p>	<p>Verify that the rocker is positioned correctly, according to the factory drill mark.</p> <p>Perform the <b>Dead Short, First Step, and Open Reactor Tests</b>.</p> <p>Perform the <b>Exciter Rotor Resistance and Ground Test</b>.</p> <p>Perform the <b>Shunt Field Coil Resistance and Ground Test</b>.</p> <p>Perform the <b>Rocker Adjustment Procedure</b>.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The welding arc is loud and spatters excessively.</p>	<p>The weld current or voltage settings may be incorrect.</p> <p>The polarity may be incorrect for the process in use. Make sure that the actual polarity of the output studs is what the Polarity Switch indicates.</p> <p>If a remote current control is being used, try switching to local control. The remote current control may be faulty.</p>	<p>The engine RPM may be incorrect; perform the <b>Engine RPM Adjustment Test</b>.</p> <p>Perform the <b>Brush and Slip Ring Service Procedure</b>.</p> <p>Perform the <b>Welding generator Brush and Commutator Inspection and Service Procedure</b>.</p> <p>Perform the <b>Dead Short, First Step, and Open Reactor Tests</b>.</p> <p>Perform the <b>Exciter Rotor Resistance and Ground Test</b>.</p> <p>Perform the <b>Shunt Field Coil Resistance and Ground Test</b>.</p> <p>Check that the rocker is aligned to the factory drill mark, and perform the <b>Rocker Adjustment Procedure</b> if necessary.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The welding arc frequently “pops out”. Welding seems otherwise normal and auxiliary output voltage appears normal.</p>	<p>The Job selector rheostat may be set too low.</p> <p>If a remote control is being used, try switching to local control. The remote control unit may be faulty.</p> <p>Check welding cables for damaged or poor connections.</p> <p>Welding cable may be excessively long, too small, or coiled. Try using a set of short test cables of adequate size.</p>	<p>The engine RPM may be incorrect; perform the <b>Engine RPM Adjustment Test</b>.</p> <p>Perform the <b>Brush and Slip Ring Service Procedure</b>.</p> <p>Perform the <b>Welding Generator Brush and Commutator Inspection and Service Procedure</b>.</p> <p>Perform the <b>Output control unit Inspection and Service Procedure</b>.</p> <p>Perform the <b>Exciter Rotor Voltage Test</b>.</p> <p>Perform the <b>Shunt Field Circuit Voltage Test</b>.</p> <p>Check that the rocker is aligned to the factory drill mark, and perform the <b>Rocker Adjustment Procedure</b> if necessary.</p>
<p>The engine will not crank when the start button is pressed.</p>	<p>The batteries may be discharged. Check, and if necessary, charge or replace the batteries.</p> <p>The battery cables or battery connections may be loose or corroded. Service the battery terminals.</p>	<p>Check for battery voltage where lead 52 connects to the starter solenoid, while holding in the start button.</p> <ul style="list-style-type: none"> <li>If no voltage is present, check the connections and wiring connecting the starter solenoid, the ammeter, and the start push button switch. (See the wiring diagram) If the wiring and connections are good, replace the push button switch.</li> </ul>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The engine will not crank when the start button is pressed.</p> <p>(continued)</p>		<ul style="list-style-type: none"> <li>If voltage is present, check that the negative battery terminal is properly connected to the engine block. If the battery is properly connected, the starter/solenoid is defective and should be serviced or replaced.</li> </ul>
<p>The engine cranks when the start button is pressed, but will not start.</p>	<p>Make sure the run/stop switch is in the run position.</p> <p>The run/stop switch may have been left in the run position for more that 30 seconds (60 seconds for some models). Move switch to the stop position, then after a few seconds, move it back to the run position.</p> <p>If the machine is being used in a cold climate, the thermostart or glow plug system may need to be used. See the welder operators' manual and the engine operator's manual for detailed instructions.</p> <p>Check that there is an adequate supply of fresh clean fuel, and that the fuel shut-off valve is open.</p> <p>Check and if necessary, replace the fuel filter.</p> <p>There may be air in the fuel system. See the engine manufacturer's manual and bleed all air from the fuel system.</p>	<p>Perform the <b><i>Engine Fuel System Voltage Tests</i></b>.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The engine starts normally, but shuts down after running for several seconds.</p>	<p>The oil pressure may be low. Check the oil level and add oil as needed. If necessary, contact the engine manufacturer, or a qualified engine specialist to determine the cause of the low oil pressure condition, and make any required adjustments or repairs.</p> <p>The engine alternator belt may be loose or broken. Replace the belt and/or adjust the belt tension.</p> <p>The engine may be overheated. Contact the engine manufacturer, or a qualified engine specialist to determine the cause of the overheat condition, and make any required adjustments or repairs.</p>	<p>The idle/engine protection PC board, alternator, oil pressure switch, or engine coolant temperature switch may be faulty. Perform the <b>Engine Protection System Test</b>.</p>
<p>The engine will not develop full power.</p>	<p>Check that there is an adequate supply of fresh clean fuel, and that the fuel shut-off valve is fully open.</p> <p>Check the fuel and air filters, replace if necessary.</p>	<p>Perform the <b>Engine RPM Adjustment Test</b>.</p> <p>There may be internal problems with the engine. Contact the engine manufacturer or a qualified engine repair technician.</p>
<p>The engine will not shut down when the run/stop switch is moved to the stop position.</p>		<p>Check the voltage at the primary fuel solenoid. If the voltage drops to zero when the switch is turned off, and the engine continues to run, there is likely a failure in the fuel system. Contact the engine manufacturer or a qualified engine technician.</p> <p>If the voltage remains at the solenoid after the switch is moved to the stop position, the run/stop switch has most likely failed.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The battery does not stay charged.</p>	<p>The battery may be faulty. Recharge and test the battery. Replace it if necessary.</p> <p>The engine alternator drive belt may be loose. Replace and/or adjust the belt tension.</p>	<p>Perform the <i>Engine Alternator Test</i>.</p>
<p>The machine will not idle down to low RPM when weld and auxiliary loads are removed.</p> <p>The machine has normal weld and auxiliary output. The engine starts and shuts down normally.</p>	<p>Make sure the idle switch is in the "AUTO IDLE" position.</p> <p>Make sure there is no external load on the weld terminals or the auxiliary power receptacles. Disconnect the weld cables and unplug anything that may be connected to the auxiliary receptacles.</p> <p>Check for mechanical restrictions in the idler solenoid linkage.</p>	<p>The idle solenoid linkage may be bent or out of adjustment. Check that the linkage moves freely and that the plunger does not bind in any way.</p> <p>Check that the solenoid can freely pull in and solidly seat against its internal stop.</p> <p>Perform the <i>Engine RPM Adjustment Test</i>.</p> <p>The idle solenoid may have failed. Disconnect the solenoid leads and check the resistance of the solenoid coil.</p> <p>The solenoid resistance from the black lead to the white lead should measure about 0.4 Ohms. The resistance from the black lead to the red lead should be about 15 Ohms.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The machine will not idle down to low RPM when weld and auxiliary loads are removed.</p> <p>The machine has normal weld and auxiliary output. The engine starts and shuts down normally.</p> <p>(continued)</p>		<p>Check the solenoid for a grounded coil; the resistance between chassis ground and either solenoid lead wire should be 500k Ohms (500,000 Ohms) minimum.</p> <p>Apply battery voltage directly to the solenoid leads and verify that it is operating normally.</p> <p>Apply battery voltage, for only an instant, to the black and white leads. The solenoid should pull in immediately.</p> <p><b>WARNING:</b> Do not allow the black and white leads to remain connected to battery. Serious damage can result.</p> <p>Apply battery voltage to the black and red leads. Manually move the plunger into the solenoid. The plunger should hold tightly against the internal stop and remain in that position until the voltage is removed.</p> <p>The 2-CR Reed relay may be faulty. The reed relay should be electrically open if no current is flowing in the weld circuit. If there is continuity through the reed relay when the machine is off, it is defective and should be replaced.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The machine will not idle down to low RPM when weld and auxiliary loads are removed.</p> <p>The machine has normal weld and auxiliary output. The engine starts and shuts down normally.</p> <p>(continued)</p>		<p>There may be voltage in the toroidal current sensor circuit. Unplug the current sensor from the PC board. Unplug J32.</p> <p>If the machine idles down after the sensor is unplugged, check the wiring between the PC board and toroidal current sensor for damaged insulation and electrical contact with other electrically live components. (See the wiring diagram) If the wiring is good, there is likely a load on the auxiliary circuit. Check all wiring and components in the AC auxiliary circuit. (See wiring diagram)</p> <p>If the machine still will not idle down, check all wiring connected to the solenoid. See the wiring diagram. Look for damaged wiring, poor connections, dirty or corroded terminals, etc. If all of the wiring is good, replace the PC board.</p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The engine goes to low idle, but will not stay at low idle.</p> <p>The machine has normal weld and auxiliary output. The engine starts and shuts down normally.</p>	<p>Make sure there are no external loads on the weld terminals or the auxiliary power receptacles. Disconnect the weld cables and unplug anything that may be connected to the auxiliary receptacles.</p>	<p>The low idle RPM may be too low. Perform the <b>Engine RPM Adjustment Test</b>.</p> <p>The idle solenoid linkage may be out of adjustment. Check that the linkage moves freely and that the plunger is not binding in any way. Check that the solenoid can freely pull in and solidly seat against its internal stop.</p> <p>The idle solenoid may have failed. Disconnect the solenoid leads and check the resistance of the solenoid coil. It should be about .4 Ohms at 77 Deg. F (25 Deg. C) from the black lead to the white lead and 15 Ohms from the black to red lead. Check the solenoid for a grounded coil; the resistance between chassis ground and either solenoid lead wire should be 500k Ohms (500,000 Ohms) minimum.</p> <p>There may be a poor or intermittent connection in the solenoid wiring, or a component may be opening while under load. Check the idle switch and the wiring between the switch, the solenoid, and the PC Board. Repair or replace any poor connections, damaged wiring, or faulty components. (See wiring diagram)</p> <p>The idle/engine protection PC board may be faulty.</p>

**⚠ CAUTION**

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact the Lincoln Electric Service Department for technical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The engine will not go to high idle when the idle switch is moved to the "High" position. The idle system functions normally while welding or using auxiliary power. The engine starts and shuts down normally.</p>		<p>The idle switch may be defective, or there may be a faulty connection between the PC board, the idle switch, and the chassis ground connection.</p>
<p>The engine will not go to high idle when striking an arc or when using auxiliary power. The engine goes to high idle, and the weld and auxiliary power are normal when the idle switch is in the "High Idle" position. The engine starts, runs, and shuts down normally.</p>	<p>Check that the welding cables and the auxiliary power lead connections are tight and in good condition.</p>	<p>The Idle/Engine Protection PC board is probably faulty.</p>
<p>The engine will not go to high idle when striking an arc. The automatic idle system functions normally when using auxiliary power. Weld and auxiliary power are normal when the idle switch is in the "High Idle" position. The engine starts, runs, and shuts down normally.</p>	<p>Check that the welding cables, electrode holder, and work clamp are tight and in good condition.</p> <p>This may be normal operation if the machine has a Constant Voltage adapter, and is operating in CV mode. See the operator's manual for the Constant Voltage Adapter.</p>	<p>The 2 CR Reed Relay, or the wiring that connects it to the PC board and chassis ground may be faulty. The Reed relay should close when sufficient current is drawn from the weld output terminals.</p> <p>The Idle/Engine Protection PC board may be faulty.</p>

**⚠ CAUTION**

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
<p>The engine will not go to high idle when using auxiliary power. The automatic idle system functions normally when welding. Weld and auxiliary power is normal when the idle switch is in the "High Idle" position. The engine starts, runs, and shuts down normally.</p>	<p>The load applied to the auxiliary receptacles may be too low. A load of 100 Watts minimum is required for the idle system to operate reliably.</p> <p>Check that any power cords are in good condition and properly connected.</p> <p>Verify that any devices operating from the auxiliary AC power are operating correctly and are in good condition. Try plugging the device into another source of AC power to be sure it is functioning properly.</p> <p>Some devices may test the input power for correct voltage and frequency before they will operate. If such a device is being used, the idle switch will need to be placed in the "High" position. The current drawn by many of these devices, when testing the power, is too low to reliably activate the automatic idle system.</p>	<p>The Toroidal Current Transformer or the wiring connecting it to the idler/engine protection PC board may be faulty. Check the resistance of the toroidal current transformer. The resistance should measure 10 to 14 Ohms.</p> <p>The Idler/Engine Protection PC board may be faulty.</p>

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**ENGINE RPM ADJUSTMENT TEST****⚠ WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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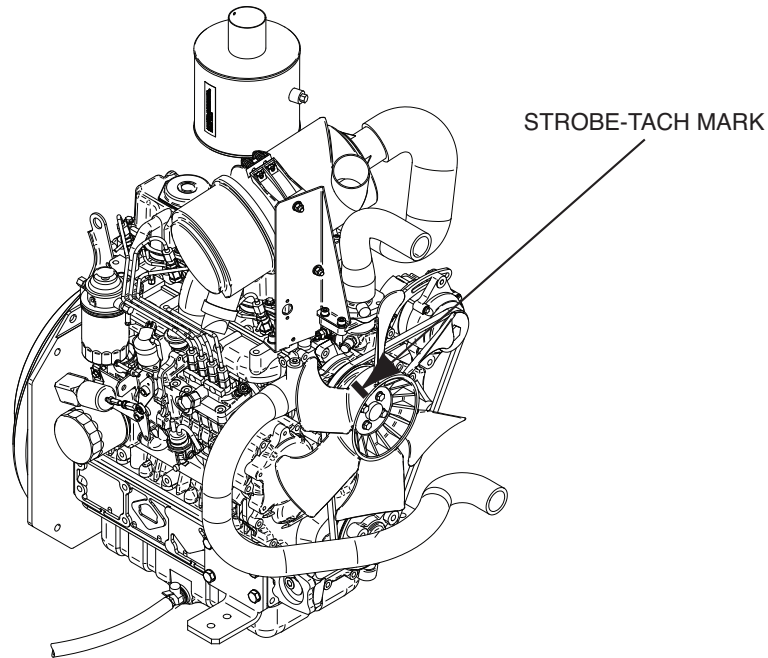
**TEST DESCRIPTION**

This test will determine if the engine is operating at the correct RPM, for both high and low idle positions.

**MATERIALS NEEDED**

Miscellaneous hand tools  
Strobe Tachometer, Frequency Counter or Multimeter  
Bright colored marking pencil or marker

FIGURE F.1 – ENGINE COMPONENTS



### PROCEDURE

1. Turn the engine off
2. Open the left side door, on the engine end of the machine.

#### WARNING



Secure the door in the open position using the door restraint system. If the machine does not have a door restraint system, remove the door or securely restrain it to prevent it from falling closed.

3. Check that the linkage attaching the solenoid to the engine speed control lever is properly aligned and in good condition. It is more important that the solenoid linkage be more precisely aligned when in the high speed (de-energized position). See Figures F.1 and F.2.

#### WARNING



**MOVING PARTS** can injure.

- Do not operate with doors open or guards off.
- Stop engine before servicing.
- Keep away from moving parts

### Strobe-Tach Method:

1. Place a highly visible mark on the engine crankshaft pulley, or another rotating component connected to the engine crankshaft. See Figure F.1.
2. Connect the strobe-tach according to the manufacturer's instructions.
3. Start the engine and place the idle switch in the "HIGH IDLE" position. Apply a resistive load operating the machine at 100% output (400 amps @ 40 volts) for about 30 minutes to get the machine up to operating temperature and the RPM to stabilize.

#### CAUTION

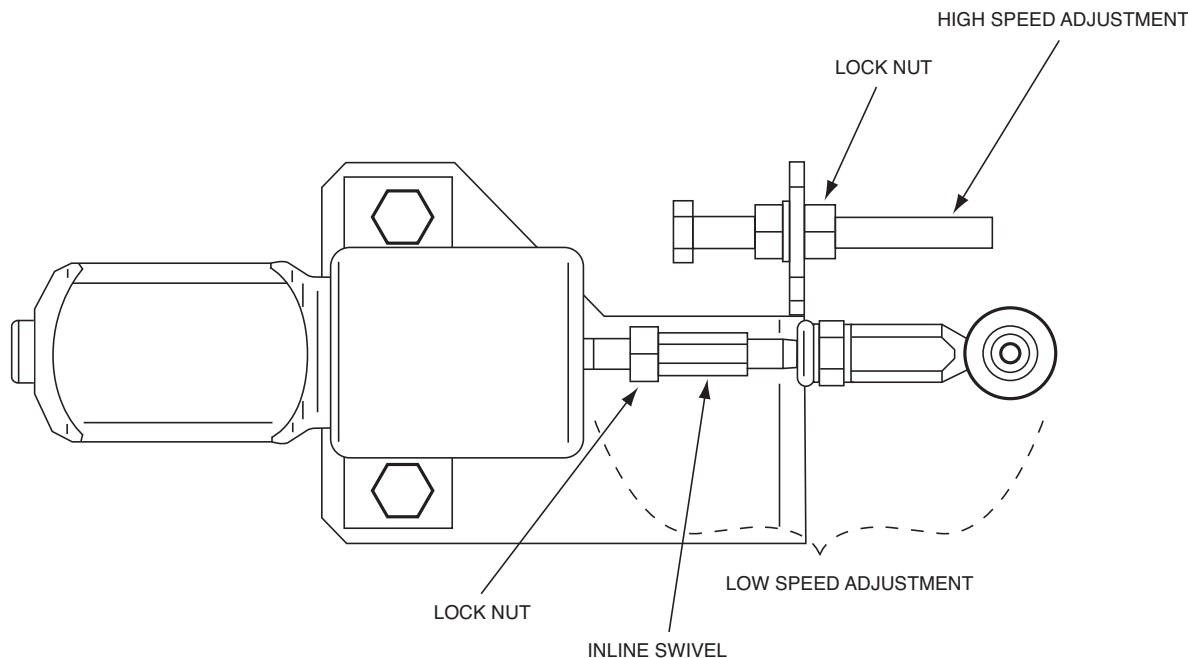
**Do Not Short the Output Studs Together as a means of loading the machine. Serious damage can result that will not be covered by Warranty.**

4. Direct the strobe-tach light on the highly visible mark that had been applied earlier and synchronize the light with the rotating mark. See the strobe-tach manufacturer's instructions.

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### FIGURE F.2 – HIGH AND LOW IDLE ADJUSTMENTS



### Strobe-Tach Method (continued)

5. The tach should read between 1780 and 1810 RPM
6. Move the idle switch to the “AUTO IDLE” position and wait for the idle solenoid to energize, and the engine RPM to drop and stabilize at the low idle RPM.
7. Synchronize the strobe-tach to read the low idle RPM.
8. The tach should read between 1000 and 1150 RPM.
9. If either of the readings is incorrect, proceed to the **Engine Rpm Adjustment Procedure** later in this section.

### Frequency counter method:

**NOTE:** A dedicated frequency counter can be used for this test, but many high quality digital multimeters also have this function, and can be easily utilized. See the manufacturer’s instructions for your frequency counter or multimeter.

1. Set your frequency counter per the meter manufacturer’s instructions, and plug the probes into one of the 120VAC auxiliary receptacles.

2. Start the engine and place the idle switch in the “HIGH IDLE” position. Apply a resistive load of about 300 amps long enough to get the machine up to operating temperature and the RPM to stabilize.

### ⚠ CAUTION

**Do Not Short the Output Studs Together as a means of loading the machine. Serious damage can result that will not be covered by Warranty**

The frequency should read between 59.3 and 60.3 Hz.

Move the idle switch to the “AUTO IDLE” position and wait for the idle solenoid to energize, and the engine RPM to drop and stabilize at the low idle RPM.

The frequency should read between 33.3 and 38.3Hz.

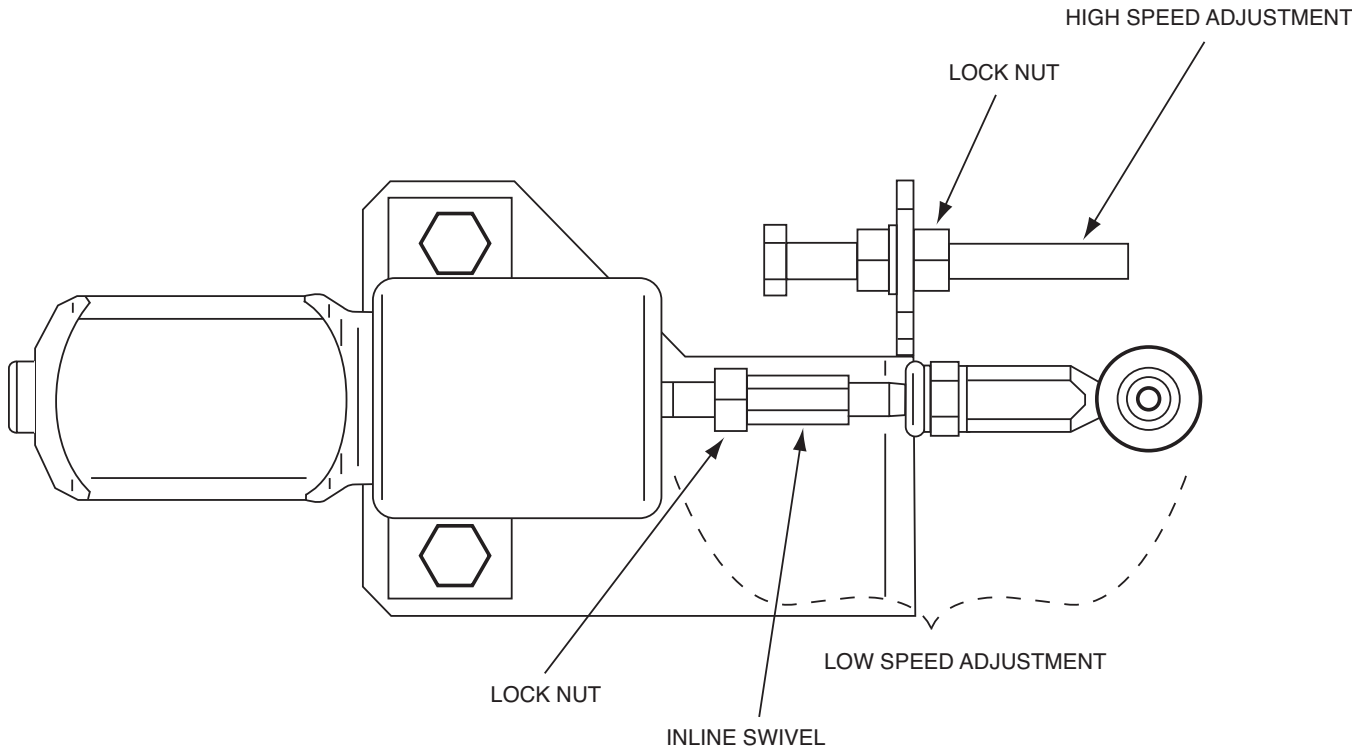
If either of the readings is incorrect, proceed to the **Engine Rpm Adjustment Procedure** later in this section.

**NOTE:** For the **SAE-500® SEVERE DUTY**, and any other Lincoln Electric 1800 RPM (4 Pole) machine, that has 60 Hz AC auxiliary power; the engine RPM can be determined by multiplying the frequency of the auxiliary power output, in Hz. By 30. (Example: 60 Hz. \* 30 = 1800 RPM)

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### FIGURE F.3 – HIGH AND LOW IDLE ADJUSTMENTS



#### High Idle Adjustment:

NOTE: High idle RPM is set at the factory and should not be changed, unless it is out of factory specifications.

1. Locate (high speed adjustment screw) lower adjustment screw on idler bracket.
2. With 7/16" wrench loosen lock nut (next to bracket) and turn adjusting screw in to lower speed and out to increase speed.
3. Tighten lock nut.
4. Check speed for 1800 RPM.
5. Readjust if necessary.

#### Low Idle Adjustment:

1. Hold in-line swivel with 5/16 wrench.
2. Loosen lock nut on solenoid shaft with 7/16 wrench.
3. Turn out to lower speed, in to increase low idle speed.
4. Lock down lock nut and check engine speed for 1100 RPM.
5. Readjust if necessary.

## BRUSH AND SLIP RING SERVICE PROCEDURE (Exciter / Auxiliary Power Alternator)

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

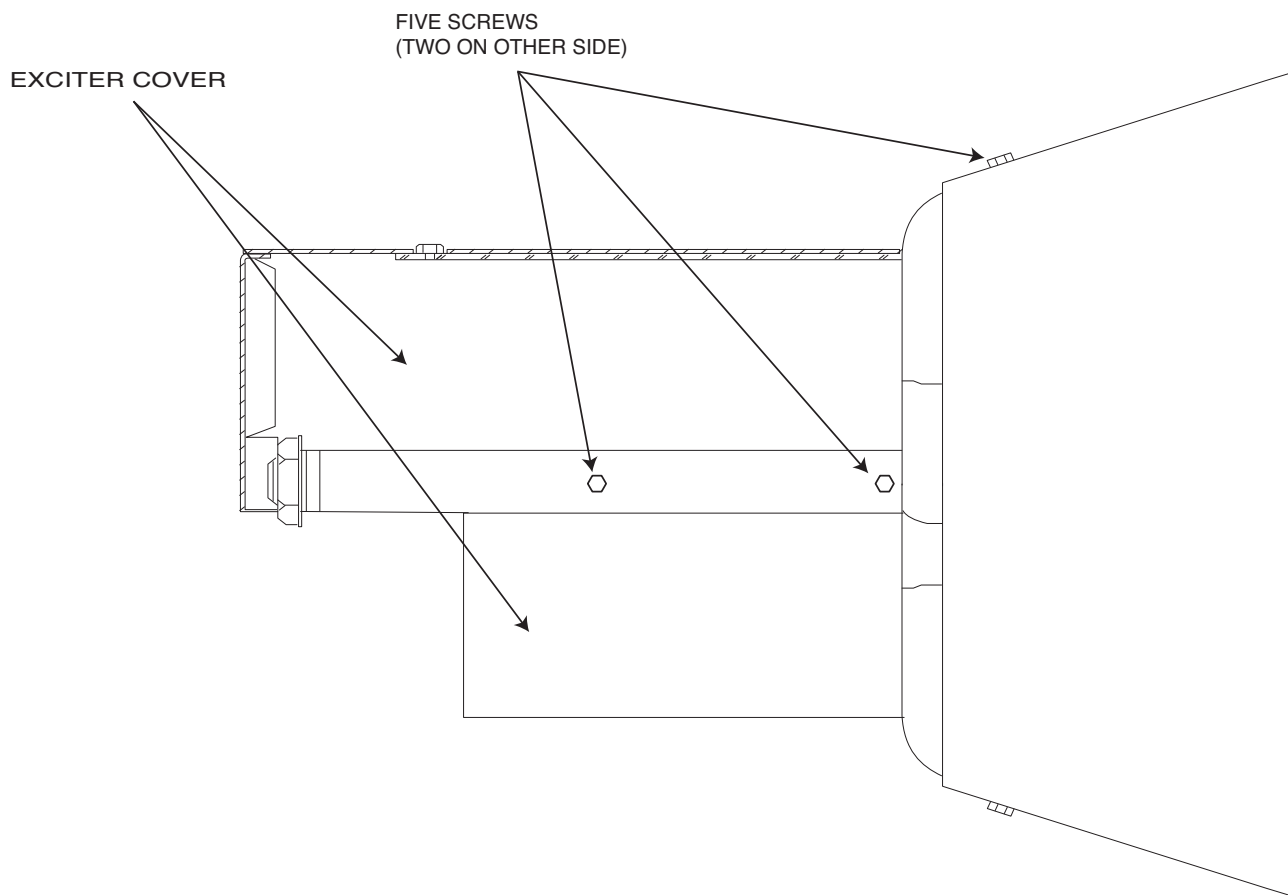
This procedure provides guidance in testing and maintaining the brush and slip ring system of the Exciter / auxiliary power alternator.

### MATERIALS NEEDED

- 500 or 600 grit cloth.
- 180 grit sand paper
- 220 or 320 grit commutator stone (Optional)

## BRUSH AND SLIP RING SERVICE PROCEDURE (Exciter / Auxiliary Power Alternator) (continued)

### FIGURE F.4 – EXCITER SCREW LOCATIONS



### PROCEDURE

1. Open either, or both of the doors on the control panel end of the SAE-500 machine.



### WARNING

Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

2. Remove the covers from the exciter / auxiliary power alternator by removing the screws securing it. See Figure F.4.

3. Examine brushes, slip rings, and brush holder.

- Brushes should be clean and free from oil or grease.
- The brushes should be of sufficient length and have adequate spring tension.
- Brushes should be making good, continuous contact with the slip rings, and should be riding near the center of the slip rings. (The brush holder bracket may need to be slightly bent to achieve acceptable alignment.)

(Generally, the brushes should be replaced if either brush has less than 1/4" remaining before it reaches the end of its travel.)

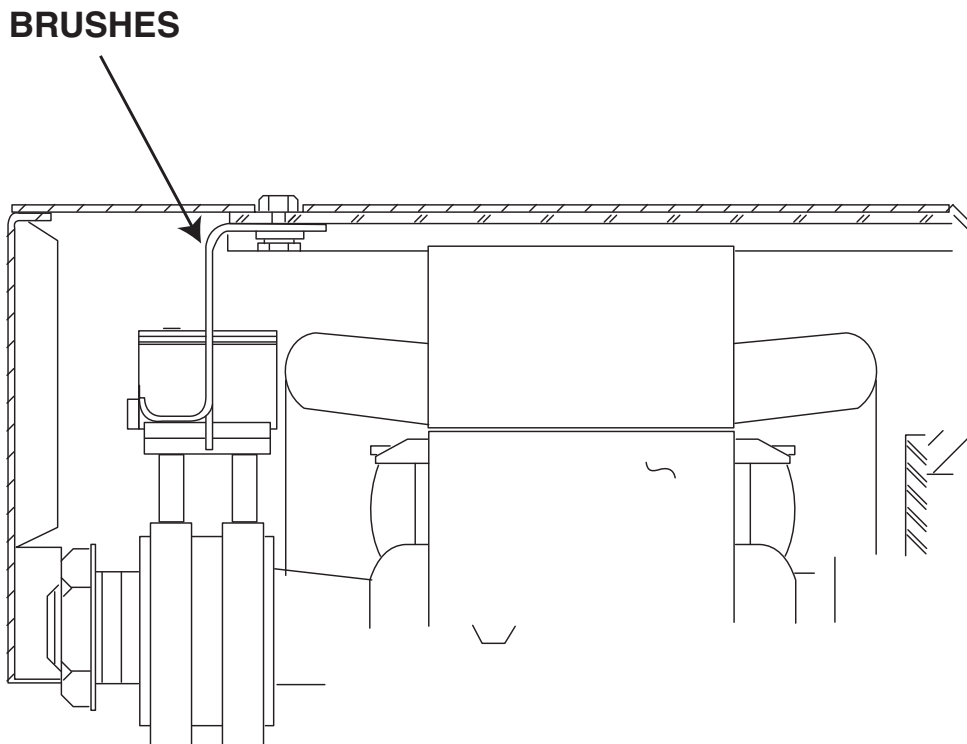
4. If the slip rings are very dark in color, display evidence of excessive arcing, or have worn prematurely, these may be signs of a grounded or shorted rotor. Perform the **Exciter Rotor Resistance and Ground Test**.

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## BRUSH AND SLIP RING SERVICE PROCEDURE (Exciter / Auxiliary Power Alternator) (continued)

### FIGURE F.5 – BRUSH LOCATIONS



5. Check for evidence of sticking brushes. Sticking brushes will normally result in the slip rings being pitted and discolored from excessive arcing. Another sign of sticking brushes is instability or loss of both weld and auxiliary output, but the machine may begin to work properly, for a short time, after being jarred or moved.
6. If there is any evidence that the brushes may have been sticking in the brush holders, a new brush holder and brush assembly should be installed.

#### Cleaning slip rings:

In the event that the slip rings have become dirty, discolored or mildly pitted, it will be necessary to clean them, using very fine (500 or 600 grit) cloth, or a 220 or 320 grit commutator stone.

#### **⚠ CAUTION**

Commutator stones should only be used by experienced technicians who have the knowledge and equipment necessary to use them safely.

#### Seating brushes:

If brushes have been replaced, repositioned, or are not making full contact with the slip rings, it will be necessary to re-seat them. This can be done by placing a strip of 180 grit sandpaper between the slip rings and the brushes, with the abrasive side against the brushes. Pull the sandpaper strip around the circumference of the slip rings in the direction of rotor rotation only. Repeat this procedure until the surface of each brush is in full contact with its matching slip ring.

Use low pressure compressed air to thoroughly blow the carbon, commutator stone, and sandpaper dust from the machine before operating.

Securely connect the leads to the brush terminals (see wiring Diagram) and replace the alternator cover if testing and service is complete.

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Return to Master TOC      Return to Master TOC      Return to Master TOC

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**EXCITER ROTOR VOLTAGE TEST****⚠ WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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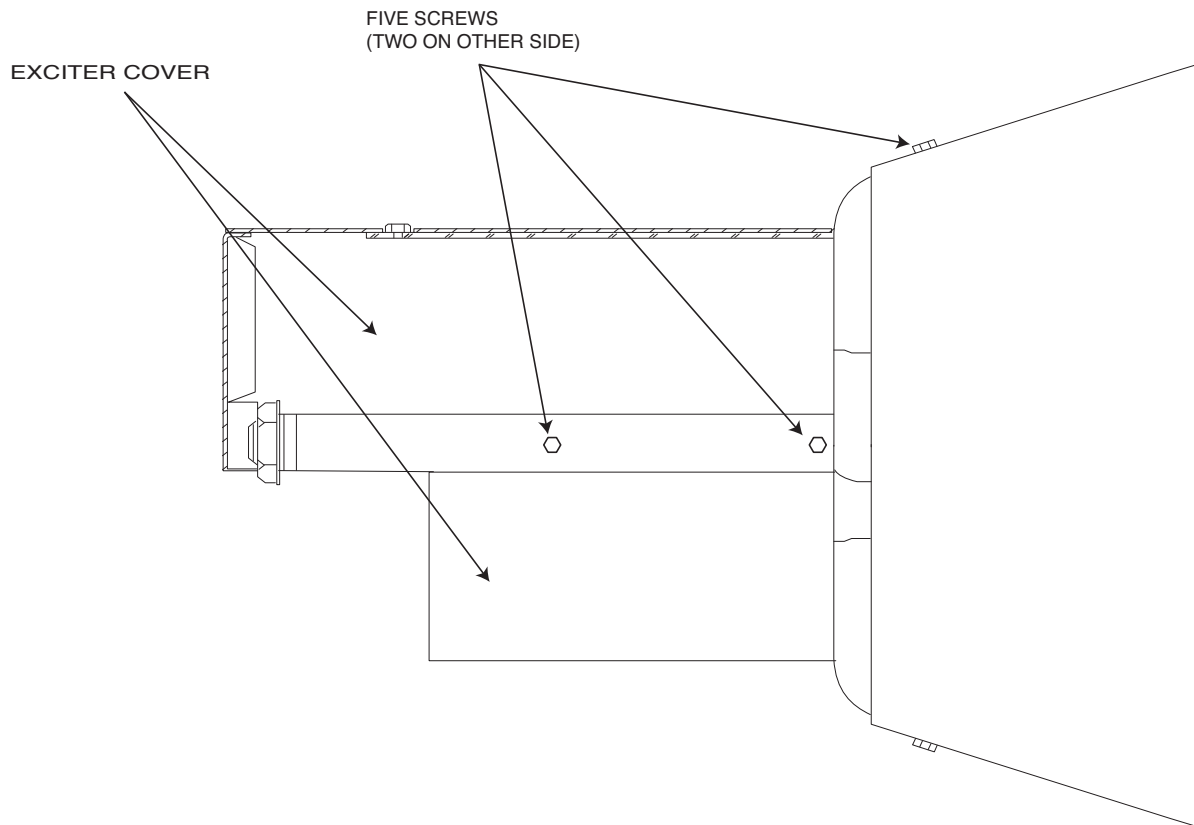
**TEST DESCRIPTION**

This test will determine if the exciter rotor winding is operating at normal voltage.

**MATERIALS NEEDED**

- Miscellaneous hand tools
- Voltmeter
- Wiring diagram

### FIGURE F.6 – EXCITER COVER SCREW LOCATIONS



### PROCEDURE

1. Turn engine off.
2. Make sure that the battery is fully charged and in good condition, and the battery connections are clean and tight.

The Engine and generator should be at normal operating temperature for this test. If the machine is cold, the voltage readings may be slightly higher than specified.

3. Open either, or both of the doors on the control panel end of the SAE-500 machine.

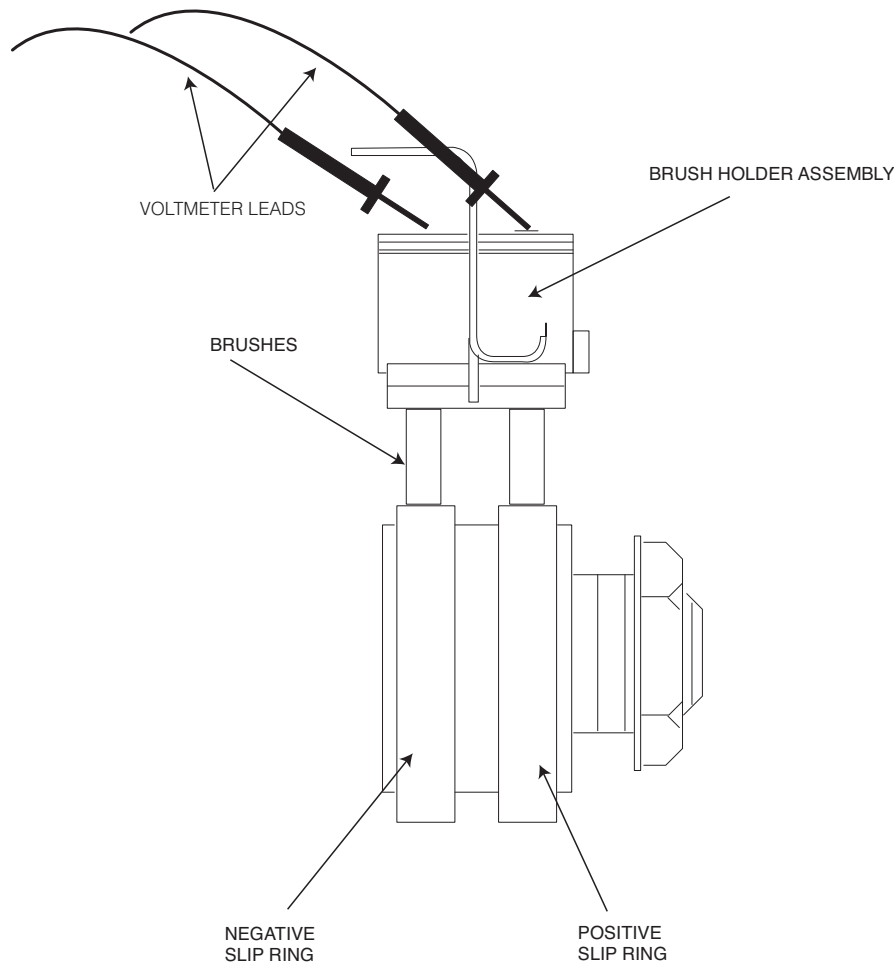
### ! WARNING



**Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.**

4. Remove the covers from the exciter/auxiliary power alternator by removing the screws securing it. See Figure F.6.

**FIGURE F.7 – EXCITER ROTOR VOLTAGE TEST**



5. Connect the volt meter probes to the brush terminals. See the wiring diagram and Figure F.7

**NOTE:** On this machine, and all other Lincoln Electric DC generator machines, the black exciter lead is positive, and the red lead is negative.

6. Set the RUN/STOP switch to “RUN” and the IDLE switch to “HIGH”. Do not start the engine at this time.
7. Within 30 seconds of switching the run/stop switch to the run position, read the “flashing” voltage across the brush connections. The meter should read approximately 2 to 4 VDC. (Check this voltage)

If this voltage reading is correct, start the engine and continue the testing.

If this voltage is not within these limits, perform the Flashing Voltage Tests.

**NOTE:** If more than 30 seconds (One minute for some models) has passed, the engine fault lamp will turn on and the fuel solenoid and flashing voltage will be turned off. Before the engine can be started, the engine protection system will need to be reset by switching the run/stop switch off, then on again.

8. Start the engine and allow the RPM to stabilize for about 15 to 30 seconds.

The meter should read 124 to 132 VDC\*.

(continued on following page)

## EXCITER ROTOR VOLTAGE TEST (continued)

9. Set the RUN/STOP switch to "STOP"

If the meter reading is normal, this test is complete.

If the voltage measures zero or very near zero, the rotor may be shorting or grounding while spinning. Perform the **Exciter Rotor Resistance and Ground Test**.

If voltage is higher than specified, the engine RPM may be too high, or there may be voltage intrusion from one of the higher voltage stator windings to the stator exciter winding. Perform the **Engine RPM Adjustment Test**, and the **Exciter Stator Short Circuit and Ground Test**.

If the voltage is lower than 124, but higher than 14, the engine RPM may be too low, or there may be problems in the windings or other exciter circuit components or connections. Perform the **Engine RPM Adjustment Test**, and then perform the testing described below, under the heading "If the voltage measures about 2 to 4 VDC"

If the meter reading indicates battery voltage, about 12 to 14 VDC, The rotor may be opening while spinning, or the brushes may be faulty or not making proper contact with the slip rings while the rotor is spinning. **Perform the Rotor Resistance Test**, and the **Brush and Slip Ring Service Procedure**.

If the voltage measures about 2 to 4 VDC, the generator is not building-up to normal output even though the flashing circuit appears to be functioning normally. This condition could be caused by one of several failed components or connections. Continue with the following tests.

10. Check the D1 field bridge rectifier.
11. Check the wiring and terminals connecting the D1 bridge rectifier to the Exciter stator winding. See the wiring diagram.
12. Perform the **Exciter Stator Short Circuit and Ground Test**.

When the Stator Short Circuit and Ground Tests have been completed, reconnect the leads to the AC terminals of the D1 field bridge rectifier.

Be sure that there are no loads of any kind across any of the stator windings. The exciter winding should be the only stator winding connected at this time. Examine stator wiring for damage, pinched leads, chafed insulation, etc. If necessary, disconnect and insulate the stator output leads as close to the stator winding as possible. If any leads were disconnected, secure them so they cannot be damaged by moving parts. See wiring diagram.

13. Re-start the machine and measure the rotor voltage.

If the rotor voltage continues to read significantly lower than 124VDC, the Stator is probably defective and should be replaced.

**NOTE:** The field bridge rectifier may appear to function normally when tested independently, but may malfunction when placed under the stress of normal operation. For this reason, it is recommended that the bridge rectifier be replaced with a known good component before replacing the stator.

\* Voltages shown in this document are for a machine operating at normal temperature. Voltage readings may be slightly higher if the machine is cold.

## EXCITER ROTOR RESISTANCE AND GROUND TEST (Exciter / Auxiliary Power Alternator)

### **WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

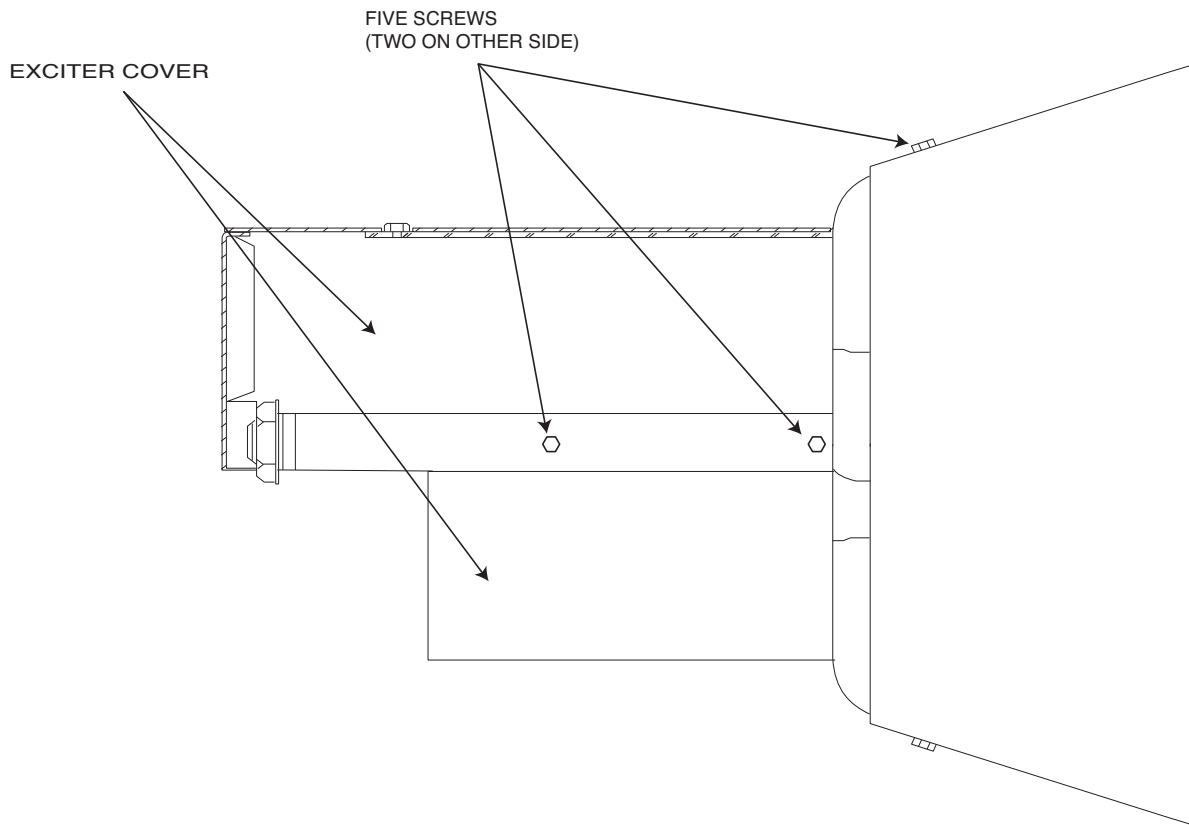
This test will determine if the exciter / auxiliary power alternator rotor winding is open, shorted, or grounded.

### MATERIALS NEEDED

- Miscellaneous hand tools
- Ohmmeter (Analog type meter required for dynamic resistance test.)
- Wiring diagram

## EXCITER ROTOR RESISTANCE AND GROUND TEST (Exciter / Auxiliary Power Alternator) (continued)

FIGURE F.8 – EXCITER COVER SCREW LOCATIONS



### PROCEDURE

#### “Static” Tests:

1. Turn the engine off.
2. Open either, or both of the doors on the control panel end of the SAE-500 machine.
3. Remove the cover from the exciter / auxiliary power alternator by removing the screws securing it. See Figure F.8.
4. Locate and label the leads connected to the rotor brush holder assembly. Remove the leads to electrically isolate the rotor windings.

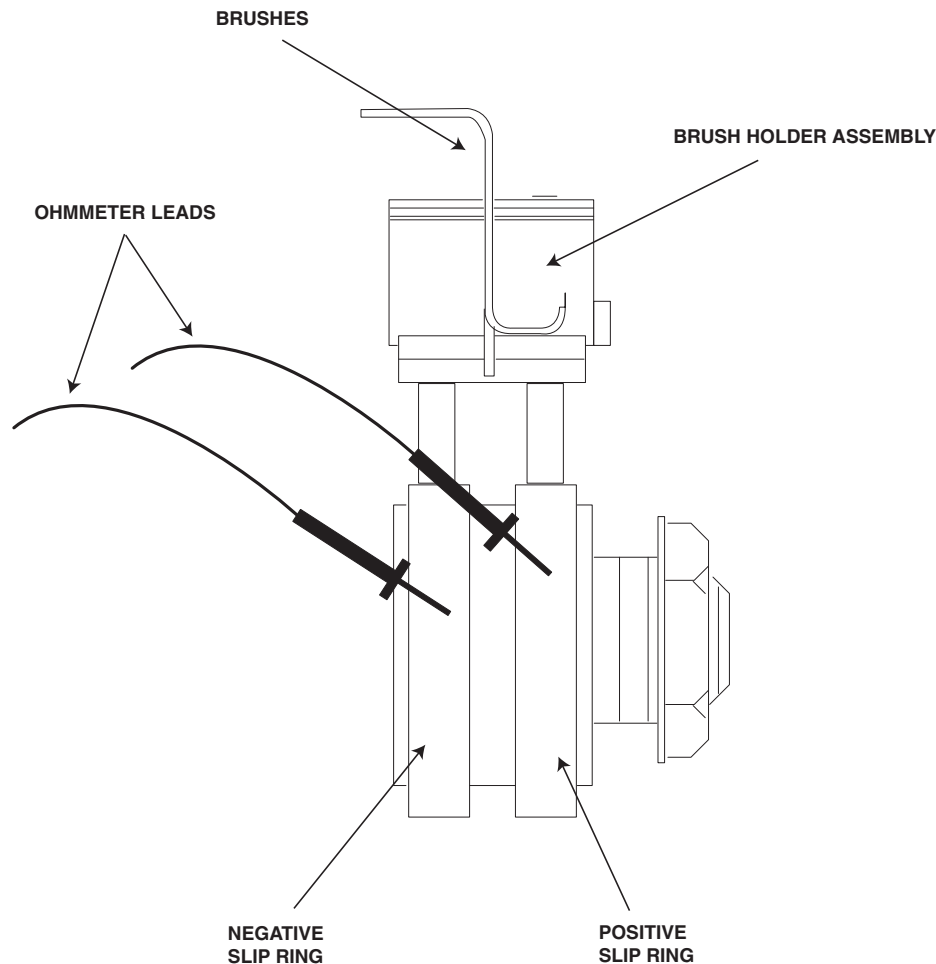
#### WARNING



Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

## EXCITER ROTOR RESISTANCE AND GROUND TEST (Exciter / Auxiliary Power Alternator) (continued)

### FIGURE F.9 – SLIP RING LOCATIONS



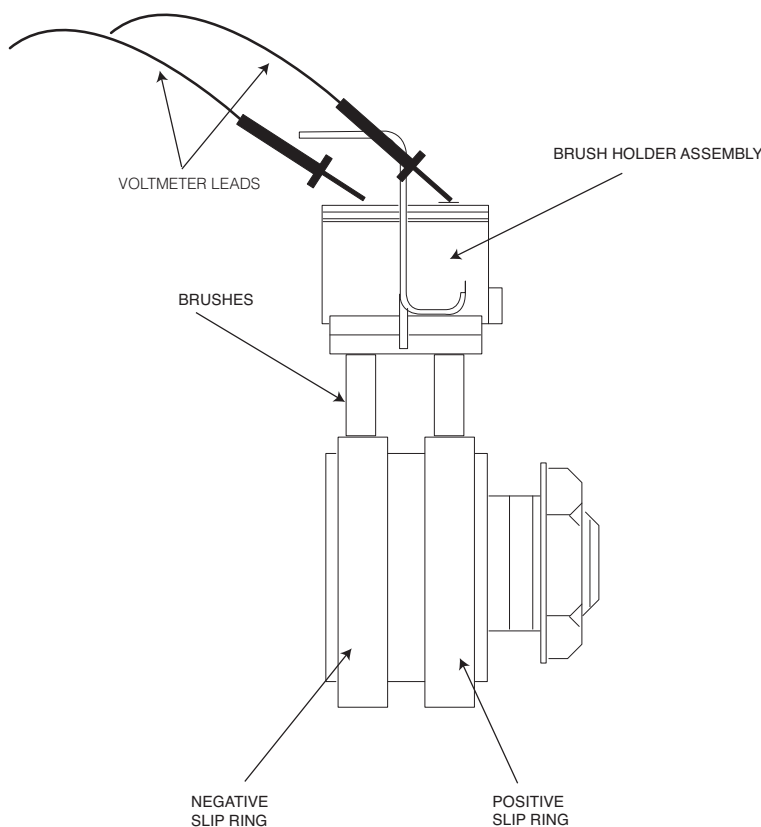
5. Using the ohmmeter, check the rotor winding resistance across the slip rings. Normal resistance is approximately 41.5\* ohms, at 77°F. (25° C.) See Figure F.9.
  
6. Measure the resistance to ground. Place one meter probe on either of the slip rings. Place the other probe on any good, unpainted chassis ground. The resistance should be very high, at least 500,000 (500k) ohms.

If the resistance measurements are not as specified the rotor may be faulty and should be replaced.

If these resistance values are normal, continue testing, using the dynamic rotor resistance and ground test.

## EXCITER ROTOR RESISTANCE AND GROUND TEST (Exciter / Auxiliary Power Alternator) (continued)

### FIGURE F.10 – SLIP RING LOCATIONS



#### “Dynamic” Tests:

(Also referred to as flying resistance test)

This test checks for faults in the rotor winding, while these windings are being stressed by the mechanical forces encountered during normal operation.

**NOTE:** This test is best performed with a good quality analog type ohmmeter. Many digital meters will not provide stable or accurate resistance readings while the rotor is spinning.

This test requires that the brushes and slip rings are clean, in good condition, and are properly seated.

Perform the **Brush and Slip Ring Service Procedure**.

1. Insulate the lead wires that had been disconnected from the brushes during the static rotor resistance test. Position and secure them so they cannot become damaged by the spinning rotor.

It is recommended that the ohmmeter leads be securely attached to the brush terminals, using clips or terminals BEFORE starting the engine.

See Figure F.10.

2. Start the engine and run it at high idle speed (1800 RPM). The resistance should read approximately 42 ohms\* at 77 deg. F. (25 deg. C).
3. Shut off engine, and move one of the ohmmeter leads to a good clean chassis ground connection.
4. Restart the engine and run it at high idle speed (1800 RPM). The resistance should be very high, at least 500,000 (500k) ohms.
5. If the resistance readings differ significantly from the values indicated, re-check the brushes and the brush spring tension. If the brushes and slip rings are good, replace the rotor.
6. Securely connect the leads to the brush terminals (see wiring Diagram) and replace the alternator covers if testing and service is complete.

**\*NOTE:** The resistance of the copper windings will change with temperature. Higher temperatures will produce higher resistance, and lower temperatures will produce lower resistance.

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## FLASHING VOLTAGE TEST (Engine not running)

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

This test will aid the technician in checking the exciter rotor flashing voltage with the engine stopped.

### MATERIALS NEEDED

- Miscellaneous Hand Tools
- Voltmeter
- Wiring Diagram

## FLASHING VOLTAGE TEST (Engine not running) (continued)

FIGURE F.11 – EXCITER COVER SCREW LOCATIONS

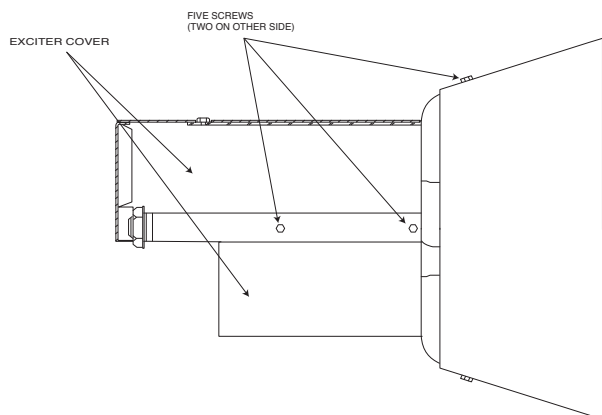
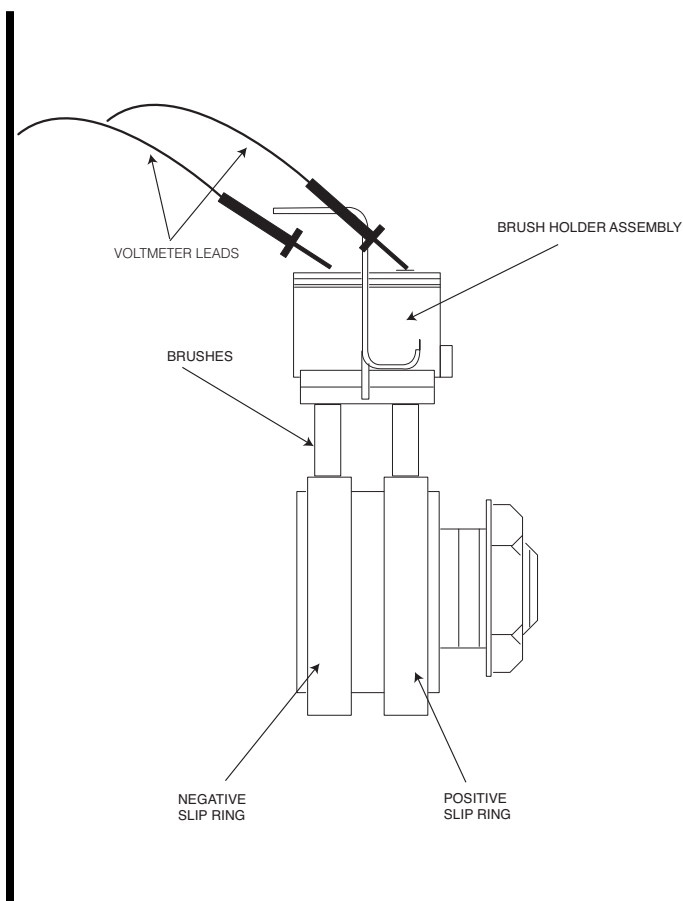


FIGURE F.12 – FLASHING VOLTAGE TEST



### PROCEDURE

1. Open either, or both of the doors on the control panel end of the SAE-500 machine.

#### **⚠ WARNING**



**Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.**

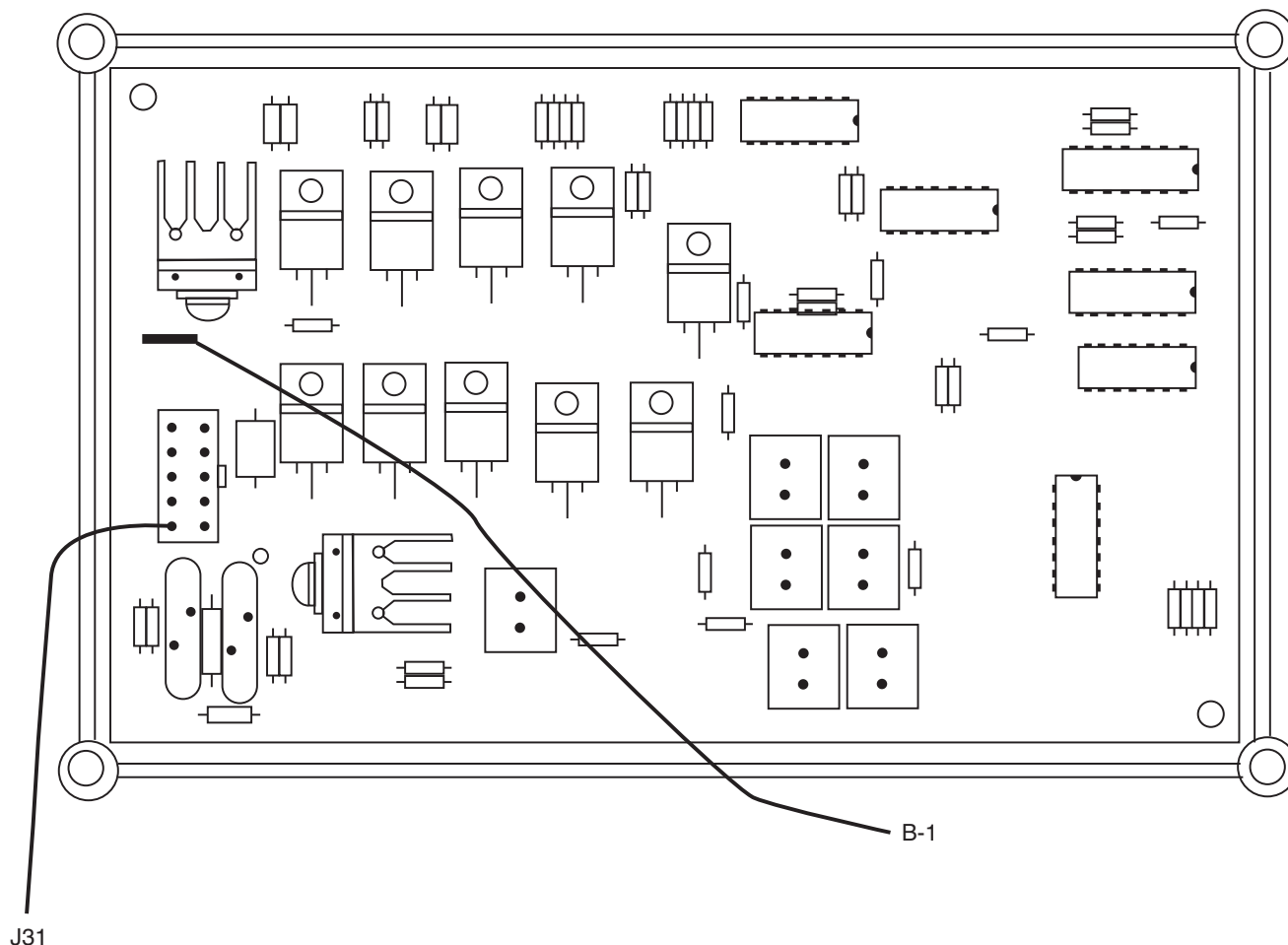
2. Remove the covers from the exciter/auxiliary power alternator by removing the screws. See Figure F.11.
3. Make sure that the battery is fully charged and in good condition, and the battery connections are clean and tight.

4. Connect the volt meter probes to the brush terminals. See the wiring diagram and Figure F.12.
5. Set the RUN/STOP switch to "RUN". Do not start the engine at this time.
6. Within 30 seconds of switching the run/stop switch to the run position, read the "flashing" voltage across the brush connections. The meter should read approximately 2 to 4 VDC.

**NOTE:** If the flashing voltage reading is not taken within 30 seconds, (60 seconds with some models) after moving the run/stop switch to the run position, move the run/stop to "stop" then back to "run". This resets the Idler/engine protection PC board.

## FLASHING VOLTAGE TEST (Engine not running) (continued)

FIGURE F.14 – IDLER/ENGINE PROTECTION PC BOARD



7. If this voltage reading is correct, the test is complete.

If the voltage is significantly higher than expected:

There may be an open rotor winding or faulty brushes or slip rings. Perform the **Brush and Slip Ring Service Procedure**, and the **Exciter Rotor Resistance and Ground Test**.

If the voltage measures zero or significantly lower than specified (Be sure that the voltage reading was taken within 30 seconds after the run/stop switch was moved to the run position. Reset the switch and retest if necessary.)

This condition could be caused by a poor connection or a defective component in the flashing circuit. Other possible causes include a shorted rotor winding, a shorted field bridge rectifier, or a failed Idler/Engine protection PC board. Continue with the tests below.

8. Perform the **Exciter Rotor Resistance and Ground Test**.
9. Test or replace the D1 field bridge rectifier.

## FLASHING VOLTAGE TEST (Engine not running) (continued)

10. Connect positive voltmeter probe to the Idler / Engine protection PC board, (J31 pin 10 for codes 11199 and 11408). Connect the negative probe to a good chassis ground connection or the negative battery terminal.
11. Move the run/stop switch to “run” and read the voltage within 30 seconds of switching to “run”.

### If battery voltage is detected:

Test the flashing diode and resistor assembly, and the two diode and leads connecting the negative side of the D1 bridge rectifier to chassis ground. Also check all of the wiring and connections between the Idle / Engine Protection PC board, and the positive brush terminal. See the wiring diagram.

If battery voltage is not present, move the positive probe to (J31, pin 1 for Codes 11199 and 11408), and check the voltage.

If no voltage is present, check the run/stop switch, the circuit breaker, and all connections between the battery, engine starter solenoid, ammeter, run/stop switch, idler switch, circuit breaker, and the idler/engine protection PC board. See the wiring diagram.

If battery voltage is present at, (J31-pin 1), check that the Idler/Engine protection PC board is properly grounded. Wire GND-A connects terminal B1 to chassis.

12. If the idler/engine protection PC board is getting power, and has a good chassis ground connection, but is not producing flashing voltage during the first 30 seconds after power-up. Replace the Idler/Engine Protection PC board

When testing is complete, replace all covers and close the doors.

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**EXCITER STATOR SHORT CIRCUIT & GROUND TEST****⚠ WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

**TEST DESCRIPTION**

This test will determine if there are undesirable electrical connections between the exciter stator windings and chassis ground, or between individual windings within the exciter stator.

This test should be performed if flashing voltage is present at the rotor slip rings, rotor resistance, the D1 field bridge rectifier, and all associated wiring are proven to be good, but the exciter stator output voltage fails to build-up to normal levels, or is too high in one or more of the windings.

**MATERIALS NEEDED**

Miscellaneous hand tools  
Ohm Meter

## EXCITER STATOR SHORT CIRCUIT & GROUND TEST (continued)

### PROCEDURE

1. Open either, or both of the doors on the control panel end of the SAE-500 machine.

### WARNING



Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

2. Make sure that nothing is plugged into the auxiliary receptacles.
3. Disconnect and isolate the ground lead connected to the neutral side of the 115 VAC auxiliary receptacle. See the wiring diagram.
4. Disconnect and isolate the exciter winding leads. (leads 203A and 602C.) See the wiring diagram.

5. Using an ohmmeter; check the resistance between the following points. Resistance should read very high, 500,000 (500k) ohms minimum.

- From chassis ground and one of the exciter winding leads.
- From chassis ground and one of the neutral terminals of the 115 VAC receptacle. (The neutral terminal is the larger of the two slots).
- From one of the neutral terminals of the 115 VAC receptacle to one of the exciter leads.

If any of these readings are less than 500,000 (500k) ohms, be certain that the windings are completely dry and check for grounded components or wiring that remain connected to the stator, such as circuit breakers, receptacles, etc. See wiring diagram. If necessary, disconnect and isolate the stator leads as close to the stator winding as possible.

If the low resistance to ground, or between individual stator windings is determined to be within the stator, the stator is defective and should be replaced.

## WELDING GENERATOR BRUSH AND COMMUTATOR INSPECTION AND SERVICE

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

### TEST DESCRIPTION

This procedure provides guidelines for checking and servicing the welding generator commutator and brushes.

### MATERIALS NEEDED

Miscellaneous hand tools  
120-150 grit commutator stone  
220-320 grit commutator stone

**IMPORTANT:** Do not use emery cloth or paper to clean the commutator. Use only sand paper or a commutator stone.

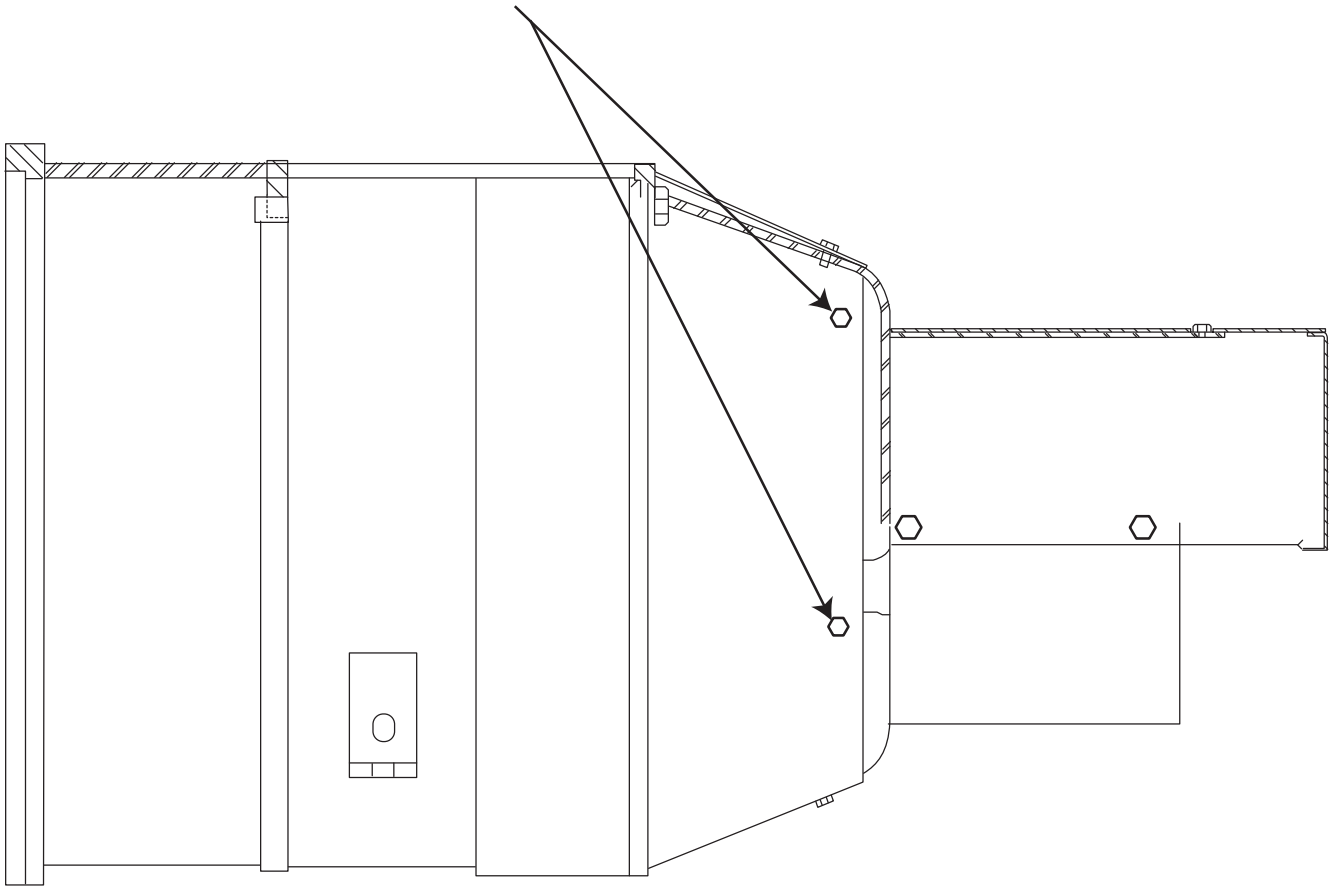
### CAUTION

Stoning the commutator involves pressing an abrasive stone against a spinning commutator. This procedure can be hazardous if done without proper training, tools and protective equipment. Consult the commutator stone manufacturer's instructions before attempting this procedure.

## WELDING GENERATOR BRUSH AND COMMUTATOR INSPECTION AND SERVICE (continued)

FIGURE F.15 – GENERATOR COVER SCREW LOCATIONS

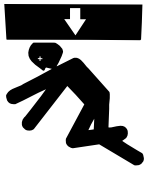
GENERATOR COVER  
FOUR SCREWS TOTAL



### PROCEDURE

1. Shut off the engine.
2. Open either, or both of the doors on the control panel end of the SAE-500 machine.
3. Disconnect the negative battery cable.
4. Remove the sheet metal covers protecting the welder generator brushes. See Figure F.15.

### WARNING



Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

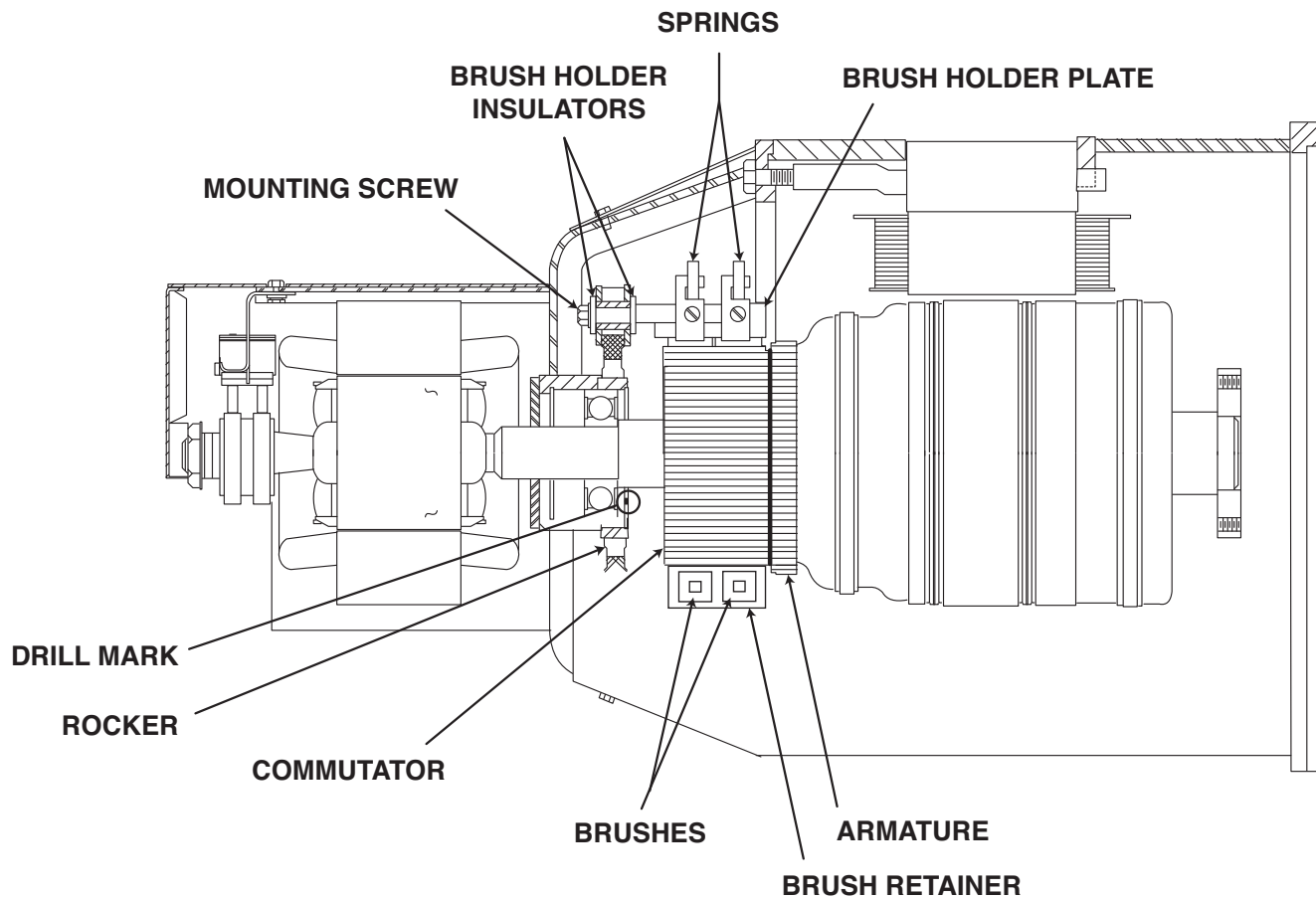
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## WELDING GENERATOR BRUSH AND COMMUTATOR INSPECTION AND SERVICE (continued)

FIGURE F.16 – GENERATOR COMPONENTS



5. Examine the Commutator.

### Normal appearance:

The commutator should appear smooth, and have an even brown color where the brushes ride.

### Blackened Commutator:

A commutator that appears to have an even black color all around may indicate a grounded armature, shorted weld circuit, a serious overload condition, or out-of-adjustment rocker. It could also indicate the use of poor quality brushes, or brushes that have been contaminated with oil or some other foreign substance.

- Check the rocker position. Be certain that it is aligned with or very close to the factory drill mark. See Figure 16. **IMPORTANT:** If the rocker position requires adjustment, do not over tighten the rocker clamping screw. This screw should be tightened to a torque of 70 to 75 Inch-Lbs. Over tightening can destroy the rocker.

- Perform the ***Weld Circuit Ground and Short Circuit Test***.
- If the weld circuit is not grounded or shorted, and poor brush quality or contamination is suspected, replace the brushes and seat them with a commutator stone or sand paper.
- If brush quality or contamination is not suspected, clean the commutator by lightly stoning the surface.

### **⚠ CAUTION**

**Stoning the commutator involves pressing an abrasive stone against a spinning commutator. This procedure can be hazardous if done without proper training, tools and protective equipment. Consult the commutator stone manufacturer's instructions before attempting this procedure.**

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## WELDING GENERATOR BRUSH AND COMMUTATOR INSPECTION AND SERVICE (continued)

### Pitted and Arc Damaged Commutator:

If pitting and arc damage to the commutator is evident, the machine may have been used with badly worn brushes. The brush spring tension may have been too low, or the brushes may have been sticking in the holders. An out-of-adjustment rocker or a serious overload may also cause this condition.

- Examine the inside of the brush covers and other parts that are close to the commutator. If there is a significant amount of solder and debris that has been thrown from the commutator, the armature will need to be replaced and the stator coils must be carefully examined and tested for damage.
- Perform the ***Weld Circuit Ground and Short Circuit Test***.
- If the brushes are worn out, replace them and re-surface or clean the commutator as needed. If re-cutting is required, the minimum diameter of the commutator is 6.895 in. If the brush springs appear weak, discolored or damaged in any way, replace them as well. The brush holder plates and retainers should be clean, smooth, and undamaged so the brushes can move freely as they wear.
- Check the rocker position. Be certain that it is aligned with or very close to the factory drill mark. See ***Figure F.16***. IMPORTANT: If the rocker position requires adjustment, do not over tighten the rocker clamping screw. This screw should be tightened to a torque of 70 to 75 Inch-Lbs. Over tightening can destroy the rocker.

### Uneven Commutator appearance:

If the commutator appears to have some normal colored bars and some blackened bars, the armature may be shorted.

- If excessive sparking is observed and/or the weld output is abnormal, the armature should be replaced.
- If the commutator has uneven color, but there is no sign of serious generator performance problems, the commutator may only need to be cleaned by lightly stoning the surface. See caution note on commutator stone usage.

### Examine the brushes:

The brushes and springs should all be in place and not be excessively worn. Brushes should be replaced if they are worn to within  $\frac{1}{4}$ " of the pigtail lead.

The pigtail lead of each brush should be positioned so it allows free movement of the brush while it wears.

The brushes should be seated so that the face of each brush makes 95% minimum contact with the commutator. Lightly stone the commutator to seat the brushes. See caution note on commutator stone usage.

### Examine the brush holders:

The brush holder insulators must be clean and in good condition and all of the hardware must be in place. See ***Figure F.16***. Replace any insulators that are cracked or damaged in any way.

When installing the brush holders, they should be rotated toward the brush retainer (clockwise rotation when facing the brush holder mounting screw.) until they stop. The edge of the brush holder plate should be parallel with the surface of the commutator and positioned .030 to .090 from the surface of the commutator. The brush holder mounting screw should be tightened to a torque of 24 to 28 Ft Lbs.

The brush holder plate and retainer assembly must be clean and smooth; nothing should prevent free movement of the brushes. All electrical connections to the brush holders must be clean, and tight. The recommended torque for 5/16-18 brush holder connection screws is 8 Ft.-Lbs.

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## WELD CIRCUIT GROUND AND SHORT CIRCUIT TEST

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

This procedure checks for grounded components in the weld circuit. It also checks for a short circuit condition between the positive and negative components of the weld circuit. This test cannot detect a short circuit within the armature or a turn to turn short circuit within a coil or coil set.

**IMPORTANT:** The machine must be clean and completely dry before this test is done.

### MATERIALS NEEDED

- Miscellaneous hand tools
- Ohm meter or Multimeter
- Wiring diagram

## WELD CIRCUIT GROUND AND SHORT CIRCUIT TEST (continued)

### PROCEDURE

1. Turn the engine off.

#### Weld circuit ground test:

1. Rotate the output control to the minimum output position.
2. Measure the resistance between either of the two weld output terminals and a clean chassis ground connection.
3. The resistance measurement should be very high 500,000 (500k) Ohms minimum.

#### If the resistance is lower than 500k Ohms:

4. Move the output control away from the minimum position and recheck the resistance. If the resistance is now 500k Ohms or greater; check for a damaged or missing insulator bushing at the output control unit.
5. If the resistance is still less than 500k Ohms, Remove the welding generator brushes, or pull them away from the commutator and isolate them so they cannot come in contact with anything except the brush holder where they are attached.
6. Check the resistance between chassis ground and each output terminal, and between chassis ground and the commutator.

If the commutator has low resistance to chassis ground, the armature is defective.

7. If the resistance measured at the "WORK" terminal is low, carefully examine the interpole coils, and the heavy leads, and the brush holders connected to the interpole coils. Check for damaged, dirty or missing brush holder insulators. Check for a damaged or dirty weld output "WORK" terminal.
8. If the resistance measured at the "ELECTRODE" terminal is low, examine the output control unit, the series coils, and the heavy leads and brush holders connected to them. Check for damaged, dirty or missing brush holder insulators. Check for a damaged or dirty weld output "ELECTRODE" terminal. If necessary, disconnect the output control unit and test it separately. See the **Output Control Unit (Variable Reactor) Inspection and Service Procedure**.
9. Test for a short circuit condition between the electrode and work circuits.
10. With the brushes still isolated as described above, check the resistance between the two weld terminals. The resistance should be very high, 500,000 (500k) Ohms minimum.
11. If the resistance measurement is too low, check the heavy weld current carrying leads and connections for damaged insulation or dirt buildup between the electrode (Series Coils) and work (Interpole Coils) circuits. If the low resistance point is between the stator coils, the coils will require replacement or repair.

## SHUNT FIELD COIL RESISTANCE AND GROUND TEST

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

---

### TEST DESCRIPTION

This procedure will determine if the welding generator shunt field coils are open, shorted or grounded

**IMPORTANT:** The machine should be clean and windings must be completely dry before this test is done.

### MATERIALS NEEDED

- Miscellaneous hand tools
- Ohm meter or Multimeter
- Wiring diagram

## SHUNT FIELD COIL RESISTANCE AND GROUND TEST (continued)

### PROCEDURE

1. Turn the engine off.
2. Open both of the doors on the control panel end of the SAE-500 machine. The roof may also need to be removed on some models.



### WARNING



Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

### Shunt Coil Resistance Test:

3. Place the polarity switch in the "OFF" position. Locate the 500 Ohm/50 Watt resistor located on the back of the control panel, just below the 115 VAC duplex receptacle. Leave all of the leads connected to the resistor, and measure the resistance across it. The resistance should measure approximately 36.5\* ohms at 77°F. (25° C.)

If the resistance reading is correct, proceed to the Shunt coil ground test.

- If the resistance reading is slightly high, about 40\* Ohms, The 500 Ohm resistor may be open.
- If the resistance is significantly higher than 40\* Ohms, check the wiring between the test points and the shunt coils. Check the lead connecting the two shunt coils together inside the generator frame. See the wiring diagram and the internal generator diagram. If these wires and connections are undamaged, one of the coils is likely open. Replace the shunt field coil set.
- If the resistance is significantly lower than 36.5\* Ohms at 77°F. (25° C.), check the wiring between the test points and the coils for damaged insulation, pinched wires, etc. If the wires and insulation are in good condition, disconnect at least one of the shunt coil wires from the resistor and test the resistance of just the shunt coil set. See the wiring diagram and internal generator diagram. If the resistance is still significantly lower than 40 Ohms, one of the coils is likely shorted. Replace the shunt coil set.

### Shunt Coil Ground Test:

4. Place the polarity switch in the "OFF" position. Locate the 500 Ohm resistor located on the back of the control panel, just below the 115 VAC duplex receptacle. Leave all of the leads connected to the resistor, and measure the resistance between either of the resistor terminals and a good clean chassis ground. The resistance should be very high, 500,000 (500k) Ohms minimum.

- If the resistance is too low, disconnect the shunt coil leads from the resistor and position them so they cannot make electrical contact with anything. See the wiring diagram. Test the resistance between either of the shunt coil lead wires and a good, clean chassis ground.
- If the resistance is still lower than 500,000 (500k) Ohms, check the shunt coil leads between the test points and the coils. Also check the lead connecting the two shunt coils together inside of the generator. Look for pinched wires and damaged insulation. If the low resistance is determined to be between chassis ground and one of the shunt coils, replace the coil set.
- If the coil set tests normal when disconnected, check the resistor and polarity switch for low resistance to chassis ground. Repair or replace these parts as needed.

5. Reconnect the wires and replace any covers that have been removed.

**\*NOTE:** The resistance of the copper windings will change with temperature. Higher temperatures will produce slightly higher resistance, and lower temperatures will produce slightly lower resistance.

# TROUBLESHOOTING AND REPAIR

## SHUNT FIELD CIRCUIT VOLTAGE TEST

### **WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### **TEST DESCRIPTION**

This procedure will determine if the shunt field coils are receiving the necessary power to operate correctly.

This test should be done if there is little or no output from the welding generator, but auxiliary output is normal.

### **MATERIALS NEEDED**

- Miscellaneous hand tools
- Volt meter or Multimeter
- Wiring diagram

## SHUNT FIELD CIRCUIT VOLTAGE TEST (continued)

## PROCEDURE

1. Turn the engine off.
2. Open both of the doors on the control panel end of the SAE-500 machine. The roof may need to be removed on some models.

**WARNING**

Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

3. Place the rheostat in the maximum position and verify that the polarity switch is either the positive or negative position. It must not be in the neutral position.
4. Place the remote/local switch in the local position.
5. Place the idle switch in the high idle position, start the engine and allow it to stabilize at high idle RPM.
6. Locate the 500 Ohm/50 Watt resistor located on the back of the control panel, just below the 115 VAC duplex receptacle, and measure the voltage across it. The voltage should measure about 140 VDC.

If the measured voltage is normal, but there is still no usable output from the welding generator, perform the **Shunt Field Coil Resistance and Ground Test**.

If the correct voltage is not present at the 500 Ohm resistor, check for voltage at the positive and negative terminals of the D2 bridge rectifier.

If about 140 VDC is present at the D2 bridge rectifier, check the wiring between the rectifier, the polarity switch and the 500 Ohm resistor. If the wiring and connections are all good, the polarity switch may be faulty.

If the voltage is not present at the DC terminals of the D2 rectifier, check for approximately 125 VAC at the AC terminals of the D2 rectifier. If this AC voltage is present, replace the D2 rectifier.

If AC voltage is not present, check the remote/local switch, the P8 harness plug and receptacle. Check all the wiring and connections between the D2 and the D1 rectifiers. See the wiring diagram.

7. Check the Rheostat.



## DEAD SHORT, 1ST STEP, AND OPEN REACTOR TESTS

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

This procedure tests the operation of the Output Control Unit (Variable Reactor) and the Series Field Coils in the welding generator.

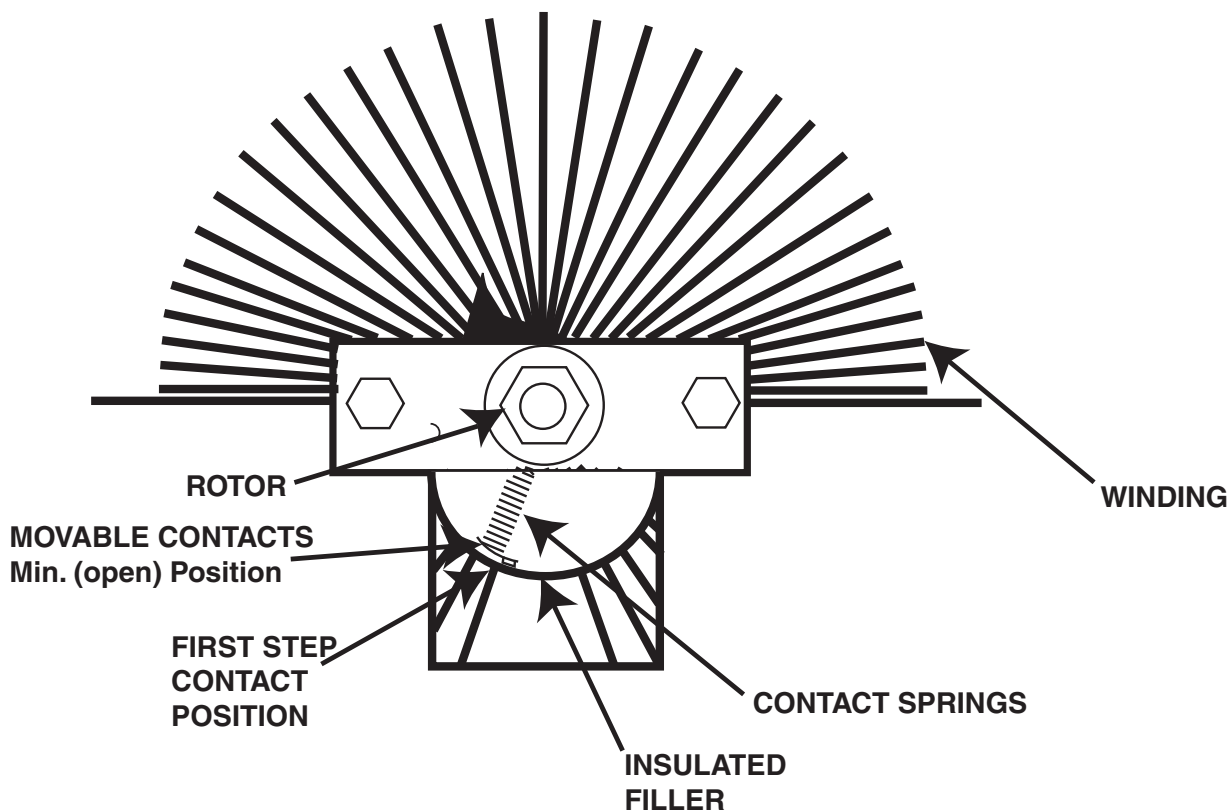
This procedure should be done if the low end weld output too low, too high, or varies abnormally, and the auxiliary output is normal.

### MATERIALS NEEDED

- Miscellaneous Hand tools
- Ohm Meter
- Resistive load Bank
- A short length of heavy cable to short the output, or load bank with shorting contactor

## DEAD SHORT, 1ST STEP, AND OPEN REACTOR TESTS (continued)

FIGURE F.17 – OUTPUT CONTROL UNIT



## PROCEDURE

1. If possible, bring the machine to normal temperature by connecting a load bank and operating the machine at 100% output (400 amps @ 40 volts) for about 30 minutes.
2. Remove the load; turn the Job Selector Rheostat to MAXIMUM, and the Current Control to MINIMUM (Contacts on the insulated steel filler or "Open Reactor").
3. Short the output terminals and check that the machine output is 135 to 165 Amps, at 0.2 to 4 Volts DC\*.

If there is no output at the Min. setting of the output control, there is probably an open circuit in the Series coils or the conductors connecting them. See the Internal generator diagram, and the wiring diagram.

A high output when the reactor is set to Min. would indicate a possible short in the series coils. See the internal generator diagram.

4. Begin rotating the output control until the output current changes, this is the first step or first turn of the reactor coil. See Figure F.17. The output should measure 200 to 300 Amps, at 0.2 to 4 Volts DC\*.

A slightly high reading in the Min. position, with no clear first step jump in output could indicate that the contacts are badly worn, and the contact fingers, rather than the contacts themselves, may be making contact with the output control winding. Perform the **Output Control Unit Inspection and Service Procedure**.

No change in the output as the output control is slowly increased to the first step would indicate an open Output Control Unit, or an open in the cables connecting to it. See the wiring diagram, and perform the **Output Control Unit Inspection and Service Procedure**.

\* These values will be accurate if machine is operating at normal temperature. If the machine is cold, the values will be higher.

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

### TEST DESCRIPTION

The rocker is the part of the welding generator that supports and positions the 4 sets of brushes. Its position can be adjusted to fine tune the weld output and influence the weld characteristics.

**IMPORTANT:** The rocker is set at the factory for the best overall performance and long generator and brush life. Altering this adjustment is normally not recommended unless one or more of the welding generator components affecting this setting have been replaced. In very unusual situations, very small adjustments of the rocker may be beneficial if the machine is operating within the specified limits, but the arc characteristics are unsatisfactory for the desired application.

### CAUTION

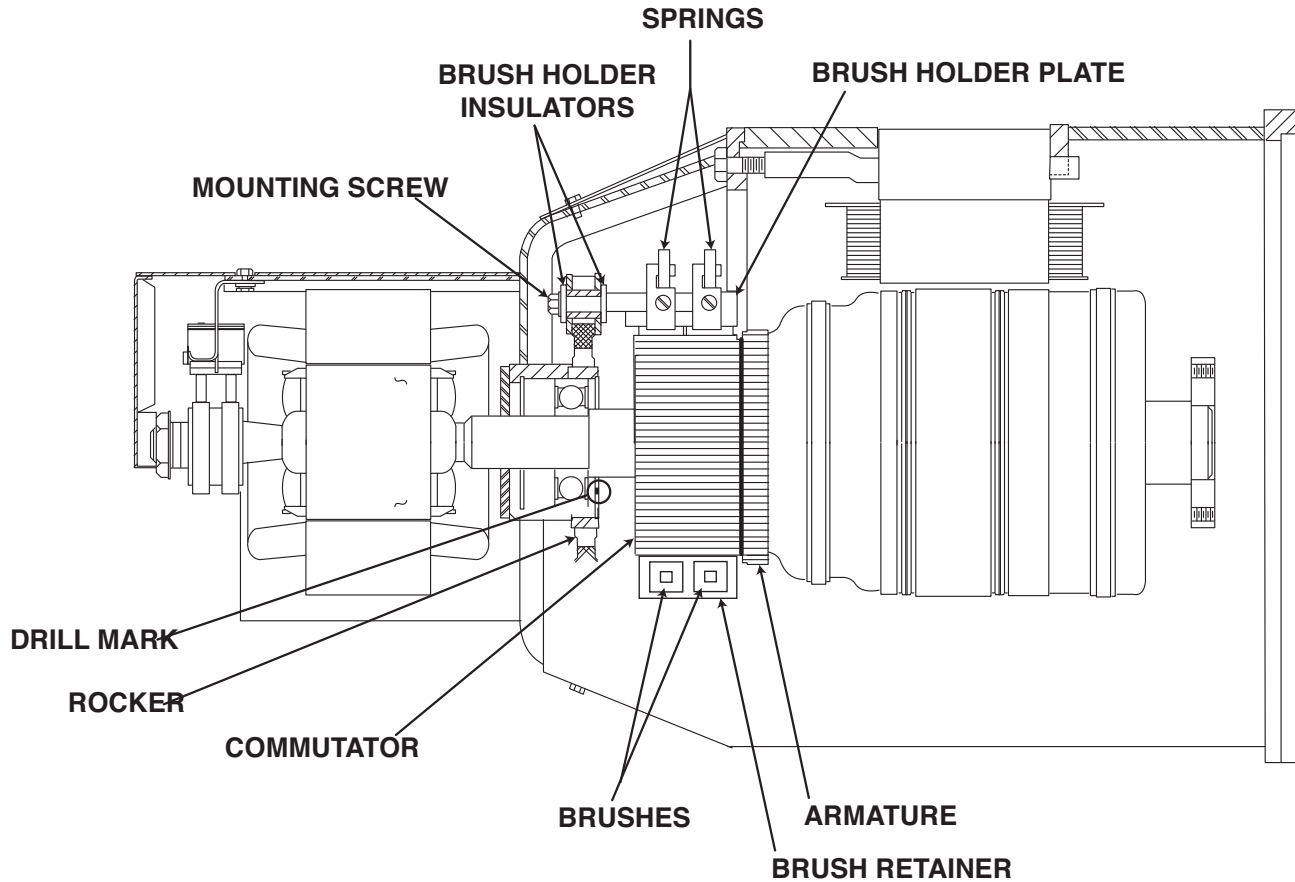
**Improper rocker adjustment can result in poor performance, reduced brush life and damage to the welding generator. This adjustment should only be attempted by an experienced professional.**

### MATERIALS NEEDED

- Resistive load bank, capable of absorbing at least a 500 Amp load.
- Volt meter
- Ammeter, able to read at least 500 Amps
- Miscellaneous hand tools
- Drill with 1/8" bit
- Tachometer or frequency meter.

## ROCKER ADJUSTMENT PROCEDURE (continued)

FIGURE F.18 – ROCKER W/MARKS

**PROCEDURE****The factory set point drill marks:**

1. When the rocker is set for the first time at the factory, a 1/8" drill is used to mark the position of both the rocker and the exciter bracket. See Figure F.18

If a machine is not operating within the specified limits, and nothing else appears to be faulty, the rocker position should be checked. If the drill marks are not aligned, the rocker and/or the exciter bracket should be reset to the original factory position.

If it has been determined that a rocker adjustment is necessary on an unaltered machine; the rocker should only be moved in very small increments, and the total movement should be no more than 1/2 the diameter of the drill mark.

**Setting the Rocker** - if the factory drill mark is missing or invalid due to component replacement.

**IMPORTANT:** The following procedures should only be attempted if all the other systems have been thoroughly checked and are functioning normally.

A tachometer will be required for this phase of the test. See the **Engine RPM Adjustment Test** for details about measuring engine RPM.

## ROCKER ADJUSTMENT PROCEDURE (continued)

## Initial rocker placement:

1. The rocker should be initially positioned so the center of brushes visually lines up with the center of the main poles. Lining up the four brush holder studs with the four exciter bracket mounting bolts is acceptable for initial placement. The rocker should be tight against the shoulder of the hub and the clamping screw should be tightened only enough to assure the rocker cannot move.

**IMPORTANT:** DO NOT OVER TIGHTEN. Over tightening the rocker clamp screw can destroy the rocker.

2. Check that the brush holders are properly installed and positioned correctly. See the **Welding generator Brush and Commutator Inspection and Service Procedure**.
3. Start the engine, place the idle switch in the high idle position, and seat the brushes using a commutator stone. See the **Welding generator Brush and Commutator Inspection and Service Procedure**.
4. Use a load bank to apply a 100% duty cycle load (400 amps @ 40 volts). Look at the brushes while the load is applied. If excessive sparking is observed, adjust the rocker position to minimize sparking. Generally, moving the rocker slightly in the direction of the armature rotation will reduce sparking.
5. Continue running the machine under load for at least 30 minutes to bring the machine up to normal operating temperature and to fully seat the brushes.

## Check for Max output.

6. Remove the load, set the output control and rheostat to maximum, re-apply the load and adjust the load bank to apply a 500 Amp load to the machine.

 **WARNING**


- Do not move the Current Control while the machine is under load.
- Electric Shock Can Kill.

7. Measure the output voltage, it should read between 45 and 51 Volts DC
8. Measure the engine RPM, it should measure between 1680 and 1795 RPM.

If the engine RPM is not within specification, Perform the **Engine RPM Adjustment Test**, if the engine high idle RPM is normal, but the load RPM is significantly less than specified above, the engine or governor may be malfunctioning. See the engine troubleshooting procedures in this manual and/or have the engine serviced or repaired by a qualified engine technician.

If the weld output voltage is lower than specified above, the rocker position will need to be adjusted. Generally, moving the rocker opposite the armature rotation direction will increase output voltage. When making this adjustment, the rocker should only be moved in very small increments. The adjustment may need to be repeated several times to achieve the desired result.

9. Remove the load and check the voltage at the output studs (OCV). The voltage should measure 93 to 99 Volts DC.

After the rocker has been adjusted and the machine is operating normally, the rocker locking screw should be tightened to 70-75 Inch-Lbs.

If new parts had been installed, the new rocker and/or exciter bracket location should be marked with a 1/8" drill mark. See **Figure F.18**.



## OUTPUT CONTROL UNIT (VARIABLE REACTOR) INSPECTION AND SERVICE PROCEDURE

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

The output control unit, also known as a variable reactor, functions like a very high current, highly specialized rheostat. It works together with the series coils in the generator to regulate the weld output and the weld output volt/amp curve. See the theory of operation section of this manual for a more complete description.

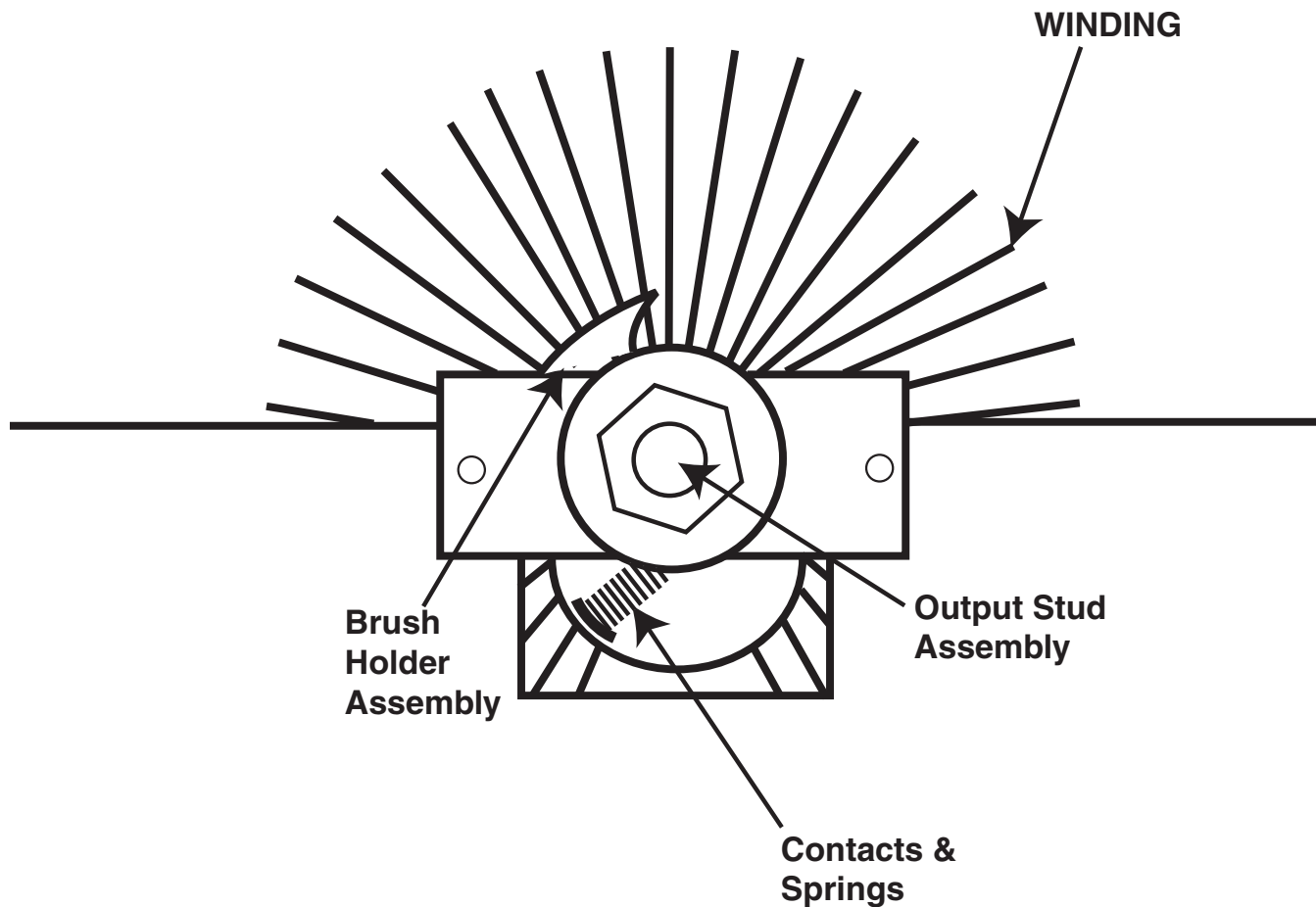
This procedure should be performed if a visual inspection of the unit indicates excessive wear, dirt, or damage. It should also be performed if the output control unit fails a ground test, or if called for in the dead short, first step, or open reactor tests. It should also be done if the weld output is low or erratic, and the auxiliary output is normal.

### MATERIALS NEEDED

- Miscellaneous Hand Tools
- 400 to 600 Grit sand paper
- Ohm meter

## OUTPUT CONTROL UNIT (VARIABLE REACTOR) INSPECTION AND SERVICE PROCEDURE (continued)

FIGURE F.19 – BRUSH & SPRING



### PROCEDURE

1. Turn the engine off, open the doors on the control panel end of the machine and disconnect the negative battery cable. The doors must be secured while disconnecting the battery cable.

#### WARNING



Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

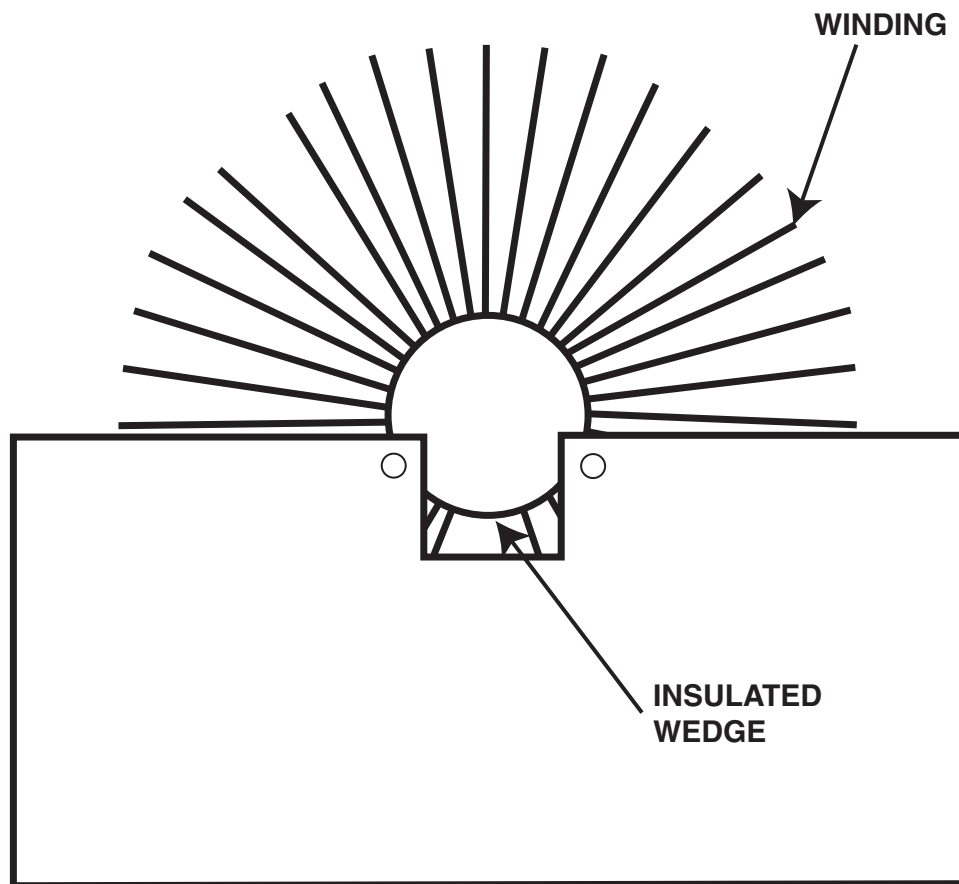
2. Remove the roof and doors.
3. Inspect the output control unit:

4. Carefully examine the unit. Check for arc damage, missing or broken springs, burned and/or badly worn contacts. Also look for missing or damaged insulators, poor lead connections, and damaged lead insulation. If there is serious damage to the inside diameter of the winding, the Output Control Unit should be replaced. See Figures F.19 and **F.20**.
5. Disassemble the continuous control unit:  
If service is necessary, remove the fuel tank and disconnect the heavy cable attached to the output stud, at the center back on the output control.
6. Remove the Output control handle.
7. Remove the two screws holding the Brush holder stud assembly. Use caution, the shaft is under spring tension. The stud assembly and the rotating brush holder/contact assembly can now be removed through the back of the unit. See Figures F.19 and **F.20**.



## OUTPUT CONTROL UNIT (VARIABLE REACTOR) INSPECTION AND SERVICE PROCEDURE (continued)

FIGURE F.20 – BRUSH & SPRING



### Servicing the continuous control unit:

8. Clean the continuous output control unit by using low pressure air to remove any excess dust and dirt. If the unit is greasy or oily, a more thorough cleaning will be required. The unit must be clean and completely dry before continuing.
9. Ground test the unit by testing the resistance between the following points:
  - Chassis ground to winding
  - Chassis ground to the insulated steel wedge (at the bottom of continuous output control inside diameter)
  - Insulated steel wedge to the winding. See Figure F.20.

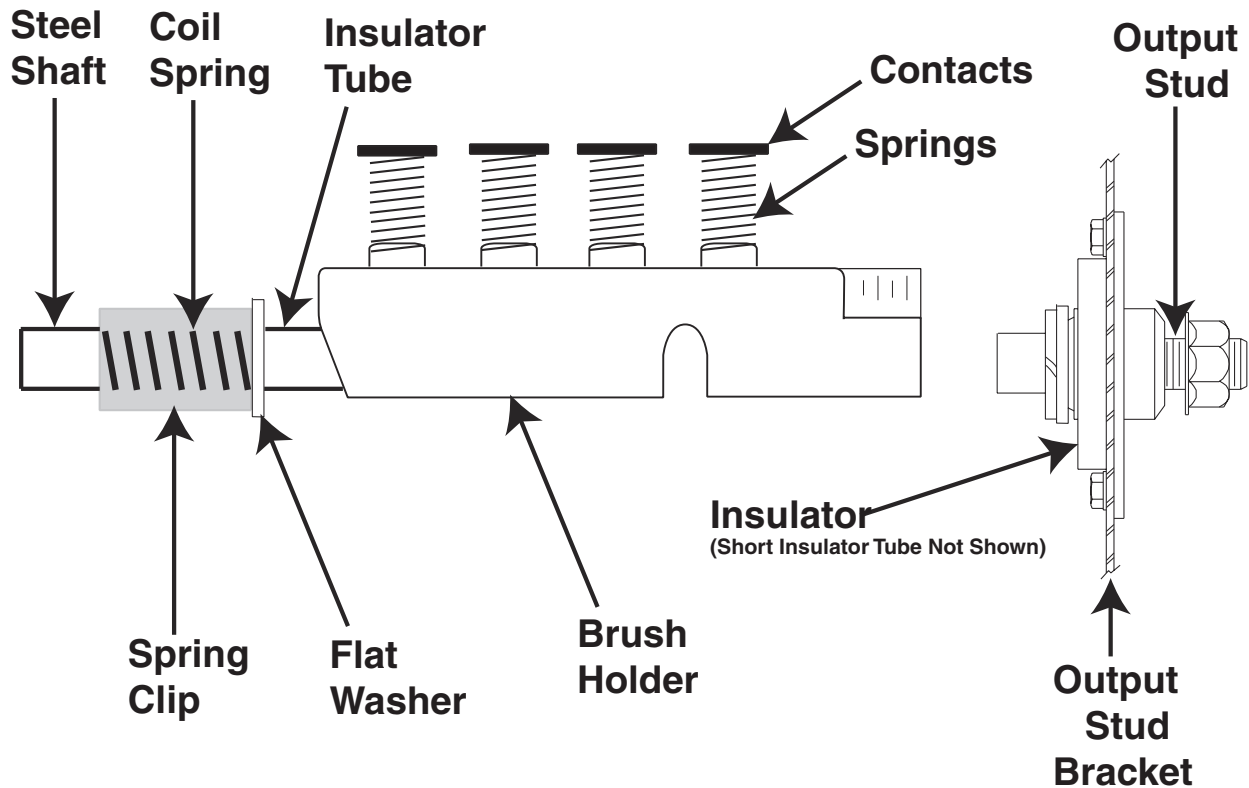
The resistance should be very high, 500,000 (500k) Ohms min.

If the resistance is too low, disconnect the remaining connection cable and look for any connection with chassis ground, including any buildup of conductive dirt contacting the winding. Repeat the above resistance tests. If the low resistance is determined to be within the continuous output control unit, it will need to be replaced.

Use very fine, 400 to 600 grit sand paper or a cylinder hone to clean away any dirt, oxidation, or minor arc pitting from the output control bore.

## OUTPUT CONTROL UNIT (VARIABLE REACTOR) INSPECTION AND SERVICE PROCEDURE (continued)

### FIGURE F.21 – INSULATOR & SPRING LOCATIONS



## PROCEDURE

### Servicing the rotating brush holder and output stud assembly:

Thoroughly clean and inspect the rotating brush holder assembly and the output stud assembly.

10. Examine the insulators on both assemblies. See Figure F.21. Replace any that are worn, damaged or missing. If the shaft insulation tube requires replacement, position the shaft and tube per Figure F.22, and torque the two 5/16-18 Hex head screws to 8 Ft-Lbs.
11. Disassemble the output stud assembly and check the insulating washers and tube. Replace them if they are damaged or worn and re-assemble the output stud assembly. See Figure F.21
12. Check for grounded output stud and brush holder assemblies by measuring the resistance as follows:
  - From the steel shaft to the rotating brush holder
  - From the copper output stud to the output stud bracket

The resistance should be very high, 500,000 (500k) Ohms min.

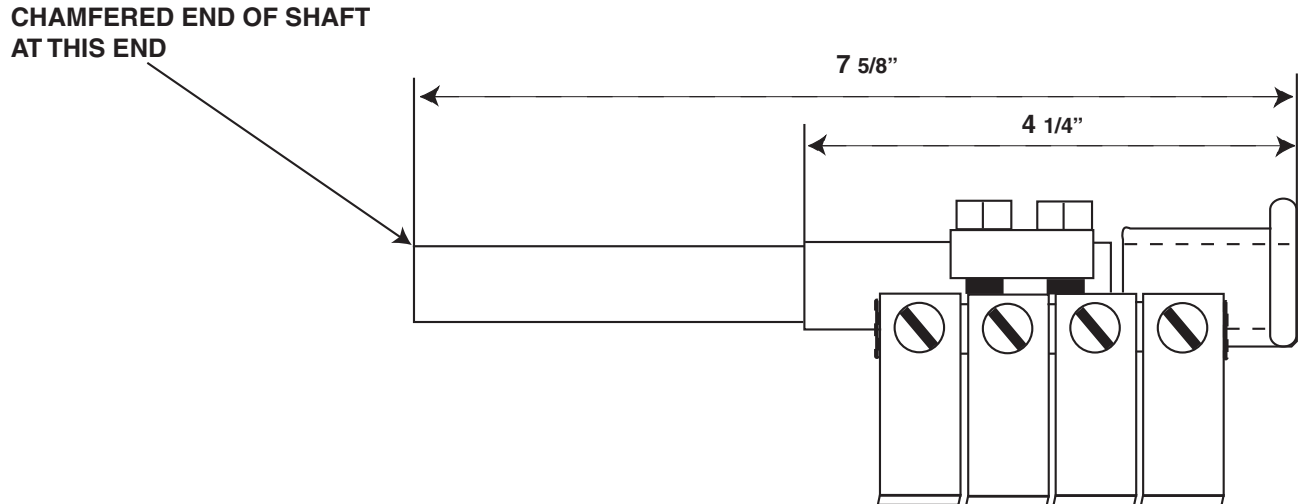
If any of the contacts on the brush holder assembly are damaged, install all new contacts and new springs.
13. Assemble the flat washer, spring clip, and coil spring to the shaft. See figure F.21
14. Apply a thin layer of grease to both the output stud and the inside of the brush holder that mates to the output stud. Grease should also be applied to the area around the hole where a shaft passes through the front panel.
15. Insert the brush holder and output stud assembly through the output control unit and through the hole in the front panel. Be sure the output stud bracket is positioned correctly. The insulated stop should be on the left when facing the back on the output control unit.

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## OUTPUT CONTROL UNIT (VARIABLE REACTOR) INSPECTION AND SERVICE PROCEDURE (continued)

FIGURE F.22 – SHAFT & TUBE



The shaft spring will need to be compressed and the bracket drawn close to the back of the output control before the screws can be started and tightened. Locking type pliers and a drift punch can be used to maneuver the bracket into position. Tighten the screws.

16. Connect any cables that had been removed. Install fuel tank, roof and doors. Reconnect the battery cable.

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# TROUBLESHOOTING AND REPAIR

## ENGINE PROTECTION SYSTEM CIRCUIT TEST

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

### TEST DESCRIPTION

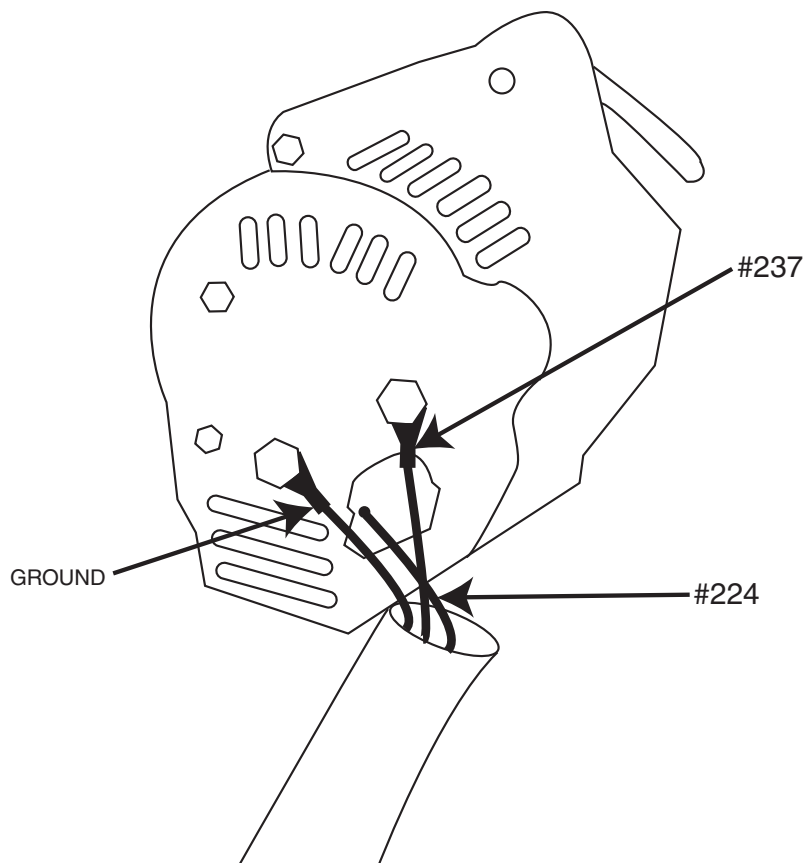
This test will help pinpoint a failure of the engine protection system and should be done if the engine fault light turns on and the engine shuts down shortly after startup, and the engine is not actually in a fault condition.

### MATERIALS NEEDED

- Miscellaneous hand tools
- Volt meter
- Wiring diagram

## ENGINE PROTECTION SYSTEM CIRCUIT TEST (continued)

FIGURE F.23 – ENGINE ALTERNATOR



## PROCEDURE

**IMPORTANT:** Before proceeding with this test, verify that the engine has normal oil pressure, is not overheated, and the alternator drive belt is in place and properly tensioned.

Open all of the doors on the SAE-500 machine.

 **WARNING**


Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

 **CAUTION**

The following procedure will temporarily disable the engine protection system. Be absolutely certain that engine temperature and oil pressure are within the normal range. If the engine is permitted to run while overheated or with low oil pressure, severe engine damage will likely result, and the engine warranty will not cover the damage. Be absolutely certain that all wires are connected when the test is completed.

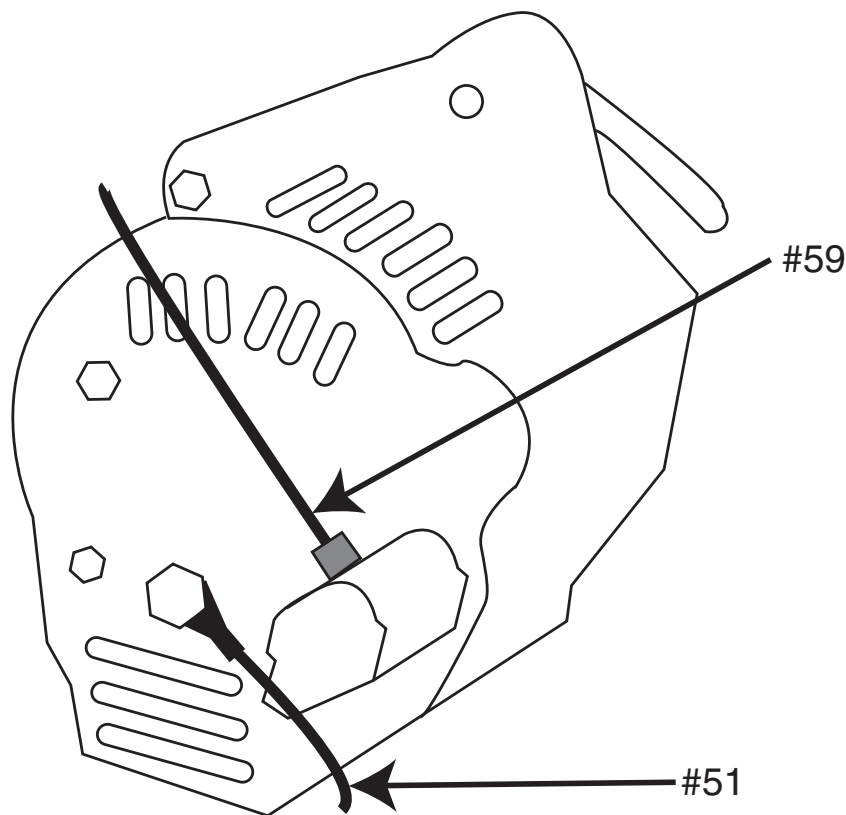
1. Disconnect the lead from the engine coolant temperature gage or switch.  
Temp switch, lead
2. Disconnect the lead from the engine oil pressure switch.  
lead #54
3. Disconnect the flash/sense lead from the engine alternator.  
lead #59

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## ENGINE PROTECTION SYSTEM CIRCUIT TEST (continued)

FIGURE F.24 – ENGINE ALTERNATOR



4. Insulate and/or position these leads so they cannot touch chassis ground, any other electrical conductor, or be damaged by any moving parts.
5. Start the engine and allow it to run.
6. If the engine still shuts down, thoroughly check the three wires that had been disconnected in steps 1 through 3. Be particularly aware of damaged insulation, or anything that may cause one of these conductors to come in contact with chassis ground.
7. If no problems are discovered with the wiring or insulation, the Idler/Engine shutdown PC board is faulty and should be replaced.
8. If the engine continues to run with these wires disconnected, one of the engine protection switches is faulty or the engine alternator is faulty.
9. Shut off the engine and reconnect any one of the three leads that had been disconnected in steps 1 through 3, then start the engine and allow it to run. If the engine shuts down, the component that had just been connected is faulty and should be repaired or replaced.
10. If the engine continues to run after reconnecting one of the wires, repeat step #9, connecting one of the two remaining wires, then repeat step #9 again connecting the last wire. Repair or replace any faulty component.

Be certain to reconnect all lead wires and close the doors when testing and service is complete.

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**ENGINE ALTERNATOR TEST****⚠ WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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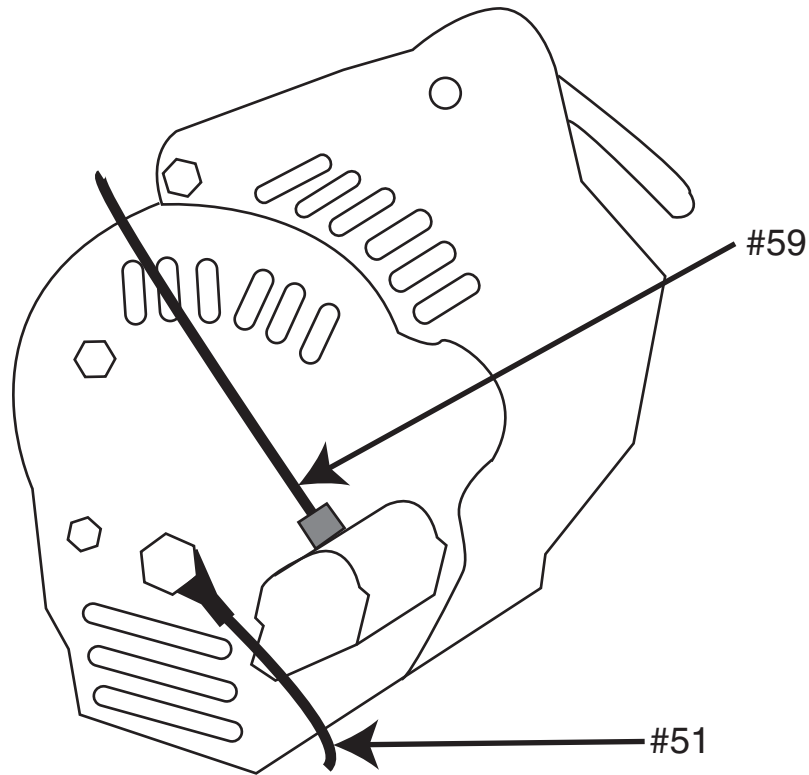
**TEST DESCRIPTION**

This test will determine if the engine alternator is operating normally.

**MATERIALS NEEDED**

Voltmeter or multi-meter  
Miscellaneous hand tools  
Wiring diagram

FIGURE F.25 – ALTERNATOR



### PROCEDURE

1. Open the right side cover, on the radiator end of the SAE-500 machine.

#### WARNING



Secure the door in the open position using the door restraint system. If the machine does not have a door restraint system, remove the door(s) or securely restrain them to prevent them from falling closed.

2. Locate the engine alternator (See Figure *Figure F.26*)
3. Check voltage as follows:

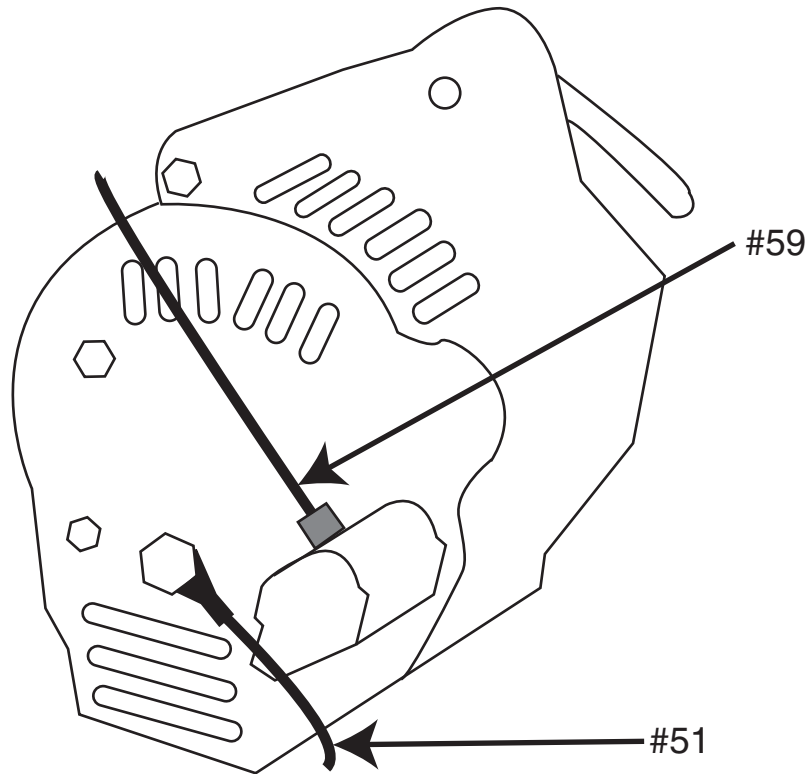
4. Run/stop switch off:

- Chassis ground to the B+ terminal of the alternator, (Lead #51) the meter should read battery voltage.
- Chassis ground to the alternator flash/sense lead, (Lead #59) the meter should read 0 volts.

- Run/stop switch on:

- Chassis ground to the flash/sense lead, (Lead #59) the meter should read 11.5 to 12.9 Volts DC during first 30 seconds of operation. (This time may be 60 seconds on some models.)

FIGURE F.26 – ALTERNATOR CODE



### PROCEDURE

Engine running:

- Chassis ground to the B+ terminal of the alternator, (Lead #51) the meter should read about 13.5 to 14.2 VDC.
- Chassis ground to the alternator flash/sense lead, (Lead #59) the meter should read about 10 Volts DC.

If the voltages are significantly different from those shown above, check the wiring connected to the alternator for faulty connections or bad insulation. If the wiring is good, the alternator is probably faulty and should be serviced or replaced.

**NOTE:** A closed temperature switch or oil pressure switch can also cause the flash/sense voltage to measure low; perform the **Engine Protection System Test** before replacing the alternator.

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# TROUBLESHOOTING AND REPAIR

## ENGINE FUEL SYSTEM VOLTAGE TESTS

### WARNING

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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### TEST DESCRIPTION

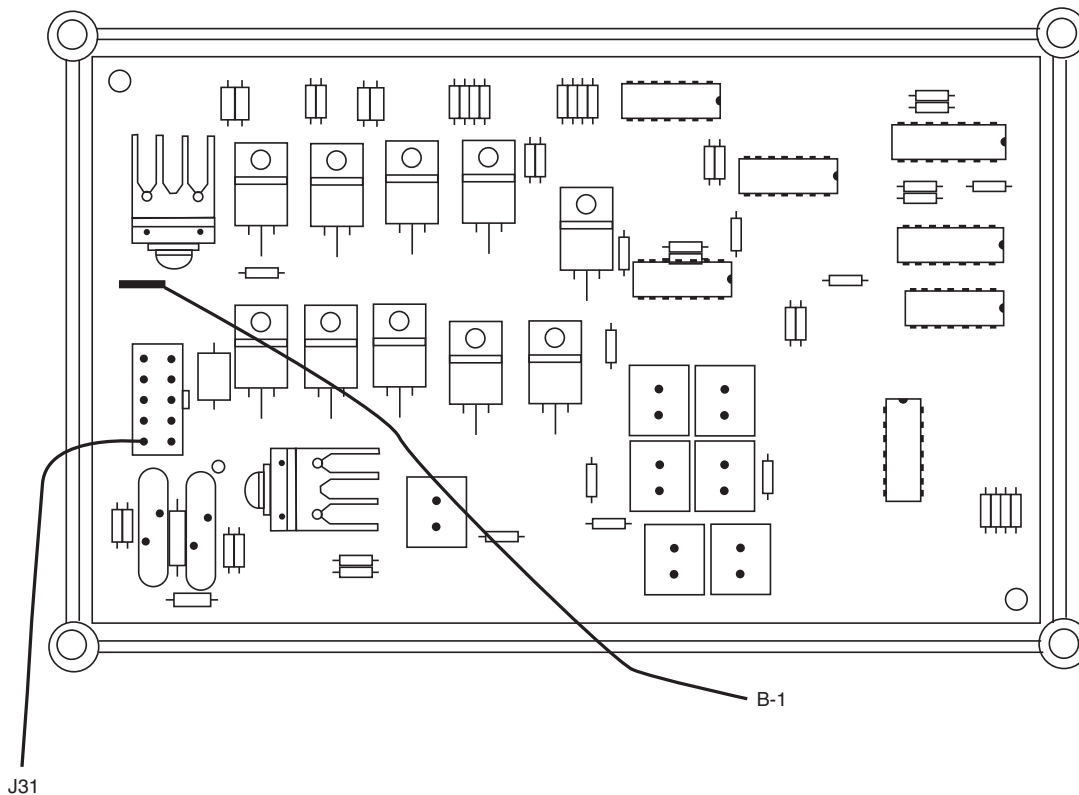
This test will determine if the fuel system is getting the electrical power needed to function correctly.

### MATERIALS NEEDED

Miscellaneous hand tools  
Multimeter, or a volt meter and ohm meter

## ENGINE FUEL SYSTEM VOLTAGE TESTS (continued)

FIGURE F.27 – PC BOARD



## PROCEDURE

1. Open the doors on the SAE-500 machine.

 **WARNING**


**Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.**

2. Check the wiring and connections on the Idle/Engine protection PC board, the engine fuel system injection pump solenoids, the fuel system temperature switch, fuel pump and chassis ground. Look for dirty, corroded, or damaged terminals, including the Molex terminals connecting the wiring to the PC board. Look for poor crimp connections and damaged wiring.
3. Make sure the batteries are in good condition, and are fully charged, then place the run/stop switch in the run position. Within 30 seconds, check for battery voltage (11 to 13 VDC), across the primary and secondary fuel solenoids, and the fuel pump. See the wiring diagram.

**NOTE:** The secondary solenoid will only have voltage if the fuel system temperature switch is closed. Consult a Perkins engine service facility for precise information about the temperature switch and other fuel system electrical components.

If battery voltage is present at the solenoids and the fuel pump (if equipped), and the starter motor is cranking the engine normally, the problem is likely in the engine. Engine problems should be diagnosed and repaired by a qualified Perkins engine technician.

If battery voltage is not present at the solenoids and fuel pump (if equipped) follow the procedures below.

**ENGINE FUEL SYSTEM VOLTAGE TESTS (continued)**

1. Place the run/stop switch in the "RUN" position and within 30 seconds, check for 11 to 13 VDC between terminal J31-9 (+) and terminal B-1 (-).
2. Check for battery voltage between terminal J31-1 (+) and terminal B-1 (-).

If the correct voltage is present for tests #1 and #2, check the wiring and connections between the PC board, the primary solenoid, and the fuel pump. See wiring diagram.

If no voltage is present for tests #1 and #2, check the run/stop switch and all wiring and connections between terminal J31-1 and the positive battery terminal. Check all the wiring and connections between Terminal B-1 and the negative battery terminal. See wiring diagram.

If the correct voltage is not present for test #3, check the wiring between the engine temperature switch and run/stop switch.

If the correct voltage is present for test #2, but not for test #1, and the voltage reading was taken within 30 seconds of placing the run/stop switch in the "run" position, The PC board is faulty and should be replaced.

**NOTE:** The fuel solenoids, temperature switch and the fuel pump are part of the Perkins engine and should be tested and, if necessary, repaired or replaced by a qualified Perkins engine technician. To help in precisely identifying a fuel system failure, approximate solenoid resistance values and current draw for the fuel pump are included on the machine schematic.

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**ALTERNATOR ROTOR REMOVAL AND REPLACEMENT****⚠ WARNING**

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**TEST DESCRIPTION**

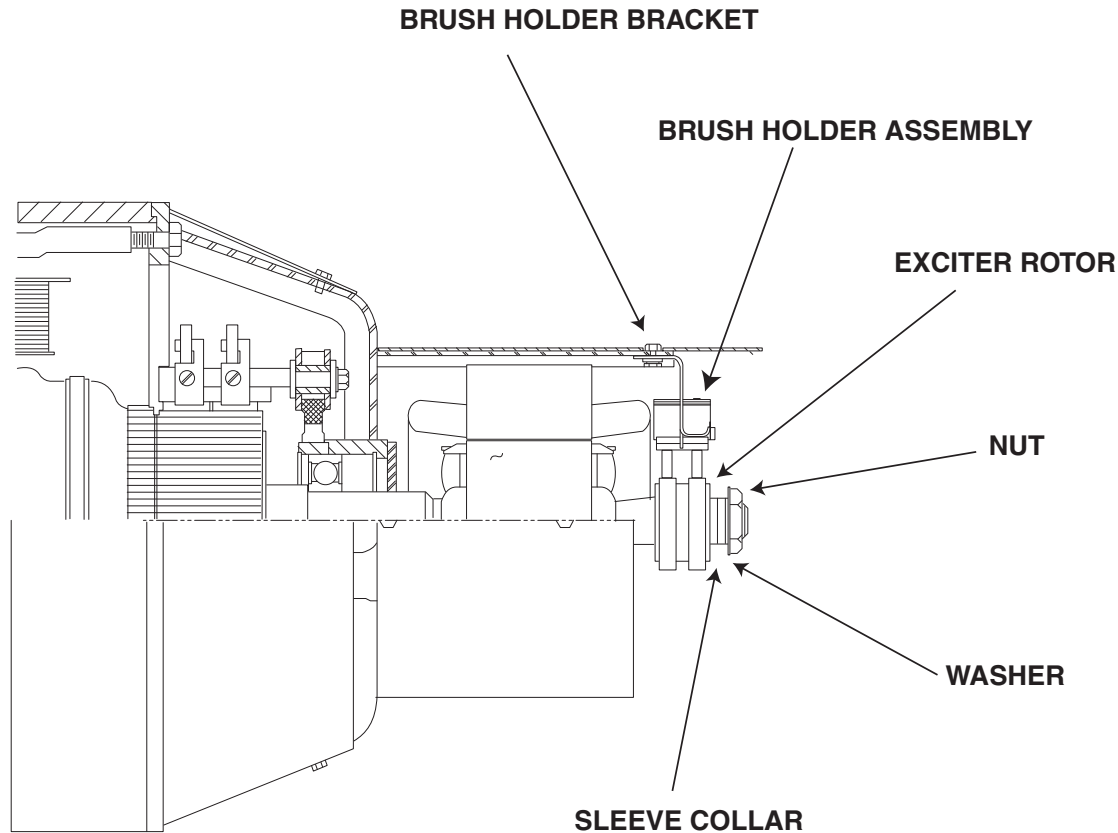
This procedure will aid the repair technician in the removal and replacement of the alternator rotor.

**MATERIALS NEEDED**

- Miscellaneous hand tools
- Small gear puller
- 1-5/8" wrench
- 180-grit sandpaper strip

## ALTERNATOR ROTOR REMOVAL AND REPLACEMENT (continued)

FIGURE F.29 – ROTOR REMOVAL

**PROCEDURE****Rotor Removal**

1. Turn off the engine.
2. Open either, or both of the doors on the control panel end of the SAE-500 machine.


**WARNING**


Secure the doors in the open position using the door restraint system. If the machine does not have a door restraint system, remove the doors or securely restrain them to prevent them from falling closed.

3. Disconnect the battery cables. Disconnect the negative cables first, and then disconnect the positive cables.
4. Remove the three nuts holding the battery retainer bracket. Remove the bracket and the batteries.

5. Remove the 5 screws securing the exciter covers, and then remove the upper and lower covers.
6. Disconnect and label the wires from the exciter brush holder. Remove the screws, and nuts holding the exciter brush holder and bracket assembly to the exciter frame, then remove the brush holder and bracket assembly. See Figure F.29
7. Bend the washer away from the rotor lock nut.
8. Using the 1-5/8" wrench to remove the nut from the end of the armature shaft, then remove the washer and sleeve collar.

**NOTE:** The sleeve collar will have to be removed with a small gear puller. Be very careful not to damage the rotor slip ring assembly.

9. Remove the rotor by pulling it off of the generator shaft. If necessary, remove the screws and nuts securing the lower front panel. This will allow the panel to be shifted enough to provide the additional clearance needed to remove the rotor.

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**ALTERNATOR ROTOR REMOVAL AND REPLACEMENT (continued)****Rotor Replacement:**

1. Clean and inspect the armature shaft, the exciter rotor and slip rings. Replace the rotor if it is damaged, or if the slip rings are excessively worn.

2. Carefully slide the rotor onto the armature shaft.

**NOTE:** It is recommended that a new sleeve collar, washer and locking nut be used when installing the exciter rotor.

3. Install the sleeve collar; if necessary, carefully tap the collar into place. Be careful that the collar is not damaged or deformed.

4. Install the washer, then the locking nut. Gently tighten the nut and check that the rotor is fully seated and turning concentric on the shaft.

5. Torque the nut to 175 Ft-Lbs.

6. Bend the washer down to lock the nut in place.

7. Check the rotor air gap. At the smallest point, the gap should be wide enough to allow a .016 thick, ½" wide feeler gage to pass between the rotor and stator.

8. Check the slip rings, brushes and brush holder assembly. These parts must be clean and undamaged.

9. Mount the brush holder bracket assembly to the exciter stator frame using the screws and nuts that had been removed earlier. The brushes should ride as close as possible to the center of each slip ring. If necessary gently bend the brush holder bracket to adjust the position.

10. Use a long strip is 180-grit sandpaper to seat the exciter brushes. Place the sandpaper strip between the slip rings and the brushes with the abrasive side against the brushes. Pull the sandpaper around the circumference of the slip rings in the direction of rotation only. Repeat this procedure until the brushes are contoured to match the radius of the slip rings.

11. Attach the wires to the brush terminals. Proper polarity is important

**NOTE:** On this machine, and all other Lincoln Electric DC generator machines, the black exciter lead is positive, and the red lead is negative.

12. If necessary, secure the lower front panel.

13. Install the exciter covers and batteries. Reconnect the battery cables; connect the positive cables first, followed by the negative cables.

14. Close the side doors if the work on the machine is finished.

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**ALTERNATOR STATOR REMOVAL AND REPLACEMENT****⚠ WARNING**

Service and repair should be performed only by Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

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**TEST DESCRIPTION**

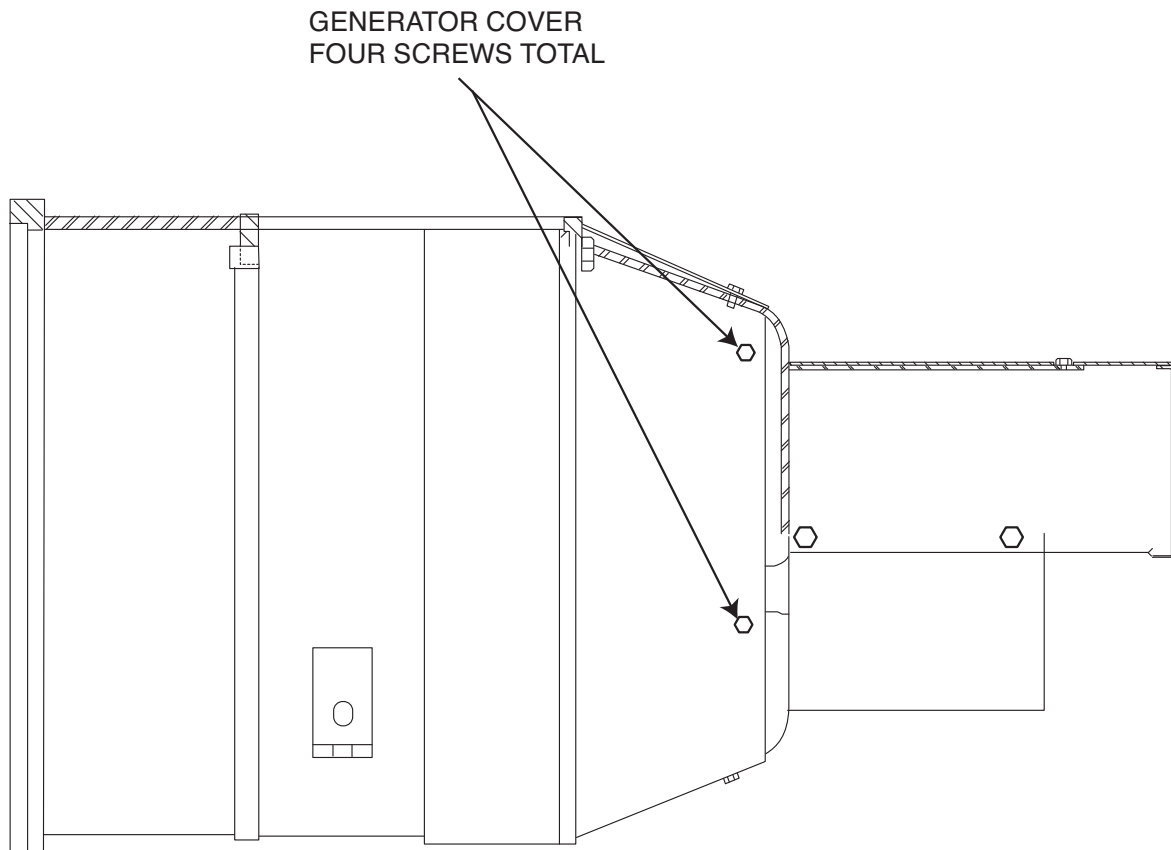
This procedure will aid the repair technician in removal and replacement of the exciter alternator stator.

**MATERIALS NEEDED**

- Miscellaneous Hand Tools
- Pry Bar
- Wiring diagram

## ALTERNATOR STATOR REMOVAL AND REPLACEMENT (continued)

FIGURE F.30 – GENERATOR COVER REMOVAL



## PROCEDURE

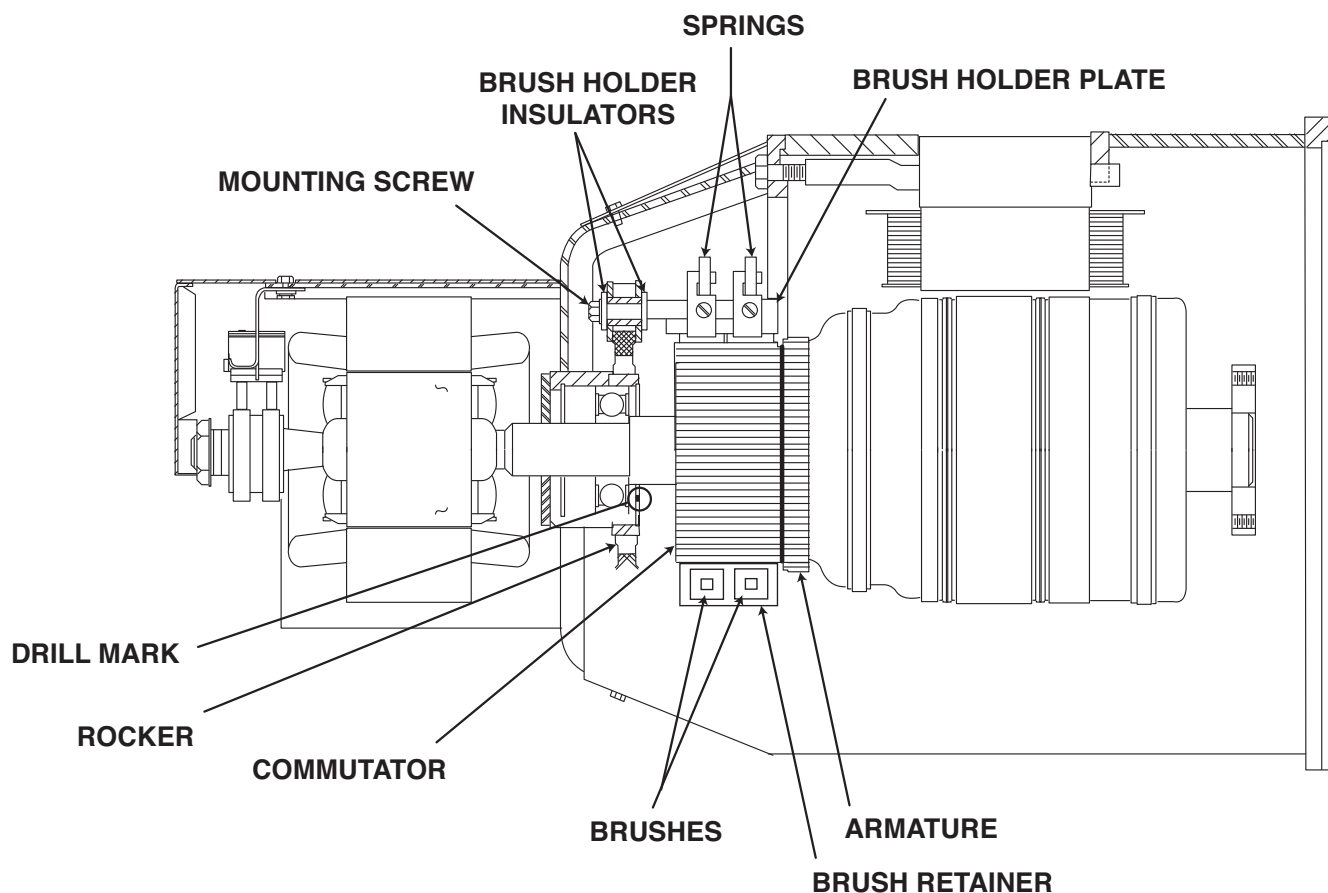
1. Turn off the engine.
2. Perform the **Alternator Rotor Removal Procedure**.
3. Remove the roof and doors.
4. Remove the four covers protecting the welding generator brushes. See Figure F.30
5. Use the wiring diagram to identify all of the wires connected to the alternator stator winding. Carefully mark these leads, for later reassembly, and then disconnect them. Cut cable ties as needed.
6. Lift the eight welding generator brushes from the commutator. Note the position of the brushes for later reassembly.
7. To assure accurate reconnection, carefully mark the heavy leads connected to the brush holders, and then disconnect them. To aid in reassembly, note the way these leads are connected, routed, and positioned.
8. The front panel of the machine can be unbolted and moved to the side to provide the clearance necessary to remove the exciter stator. This can normally be done by disconnecting only the wires and cutting only the cable ties necessary to allow the front panel to be moved. Most wiring can remain connected. Be sure to carefully mark all of the wires that were disconnected to aid in reassembly. The emergency shut down cable will also need to be removed.

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## ALTERNATOR STATOR REMOVAL AND REPLACEMENT (continued)

FIGURE F.31 – ROCKER &amp; MARK LOCATIONS



9. Drain the fuel and store it in an approved container. Disconnect the fuel line from the bottom of the tank and plug the line to avoid getting dirt or other contaminant's into the fuel system. Remove the fuel tank and the tank mounting rails.

Note the drill spots marking the position of the exciter bracket and the rocker. It is very important that these marks be precisely aligned during reassembly. See Figure F.31

**NOTE:** If these drill marks cannot be found, the positions of the rocker and exciter bracket should be clearly marked so these parts can be precisely aligned when the machine is reassembled.

10. Loosen the rocker clamping screw, but do not remove it.
11. Use a hoist, or other appropriate means to support the weight of the exciter frame assembly.
12. Remove the four screws securing the exciter end bracket to the generator frame.
13. Carefully pry the exciter stator/end bracket assembly away from the generator frame.

**NOTE:** The welding generator brush holder and rocker assembly will also be removed.

## ALTERNATOR STATOR REMOVAL AND REPLACEMENT (continued)

### Replacing the Exciter Alternator Stator:

1. During reassembly, anti-seize compound should be applied to the screw threads.
  2. Inspect the mating surfaces of the generator frame and the exciter bracket assembly. These surfaces must mate together completely so it is very important that the surfaces are completely clean and undamaged. The bearing and bearing housing should also be clean and undamaged.
- Be sure that the rocker assembly is placed on the bearing housing with the locking screw positioned on top.
3. Place some bearing grease in the bearing housing. Chevron SRI or equivalent is recommended.
  4. Mount the exciter stator/end bracket assembly to the welding generator frame. Carefully line up the drill spot between the two mating parts. Carefully and evenly tighten the four mounting bolts. See **Figure F.31**.
  5. Check the armature air gap. At the smallest point, the gap should be wide enough to allow a .030" thick 1/2" wide feeler gage to fit between the armature and stator through the entire length.
  6. Position the rocker tightly against the hub, align the drill mark and tighten the rocker lock screw to 70 to 75 Inch-Lbs. DO NOT OVERTIGHTEN.
  7. Be certain that the brush holders are properly positioned and parallel with the commutator. See the commutator and brush service procedure.
  8. Re-attach the heavy generator leads to the brush holders. Use the notes made during disassembly to assure that the leads are connected and routed correctly.
  9. If the original brushes are used, install them in the same positions that they had been. Form the braided brush leads so they will not interfere with the travel of the brushes as they wear.
  10. Reverse the removal procedure to finish reassembling the machine.
  11. Replace all the tie wraps that had been removed during disassembly.
  12. Replace and connect the batteries. Connect the positive cables first, followed by the negative cables.
  13. Connect the fuel line and fill the tank. The fuel system may require bleeding. See the engine instruction manual for more information on the fuel system bleeding procedure.
  14. Start the engine and seat the brushes using a commutator stone. See the commutator and brush service procedure.
  15. Replace the brush and exciter sheet metal covers.
  16. Replace the roof and doors.



**GENERATOR FRAME REMOVAL AND REPLACEMENT****⚠ WARNING**

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**TEST DESCRIPTION**

This procedure will aid the technician in the removal and replacement of the case sheet metal covers.

**MATERIALS NEEDED**

- 3/8" wrench
- 7/16" wrench
- 1/2" wrench
- 3/4" wrench

## GENERATOR FRAME REMOVAL AND REPLACEMENT (continued)

### PROCEDURE

#### Remove the generator frame

1. Turn off Engine.
2. Perform the **Alternator Rotor Removal Procedure**.
3. Perform the **Alternator Stator Removal Procedure**.
4. Disconnect all of the wires and cables that connect to the stator/frame assembly. Carefully mark them for reassembly.
5. Remove the mounting bolts from the generator feet.
6. Using a hoist and sling, very carefully lift the generator only enough so the generator frame will clear the welder frame and can be removed. The sling should be positioned near the center of the generator frame.  
  
Carefully watch the clearance between the engine and any other components while hoisting, especially the clearance between the engine fan, the fan shroud, and radiator. Loosen or remove the radiator if necessary.
7. Support the engine at the generator adapter plate end.
8. With the generator frame still supported by the sling, (Be certain the sling is positioned at the center of gravity of the generator frame.) and the weight of the engine resting on the supports that were placed in the previous step, remove the screws securing the generator frame to the engine adapter plate.
9. Carefully pry and wiggle the generator frame to free it from the adapter plate, and then slide the generator frame off of the armature. Adjust the height of the stator frame as needed to assure that it can slide off the armature without damage to any of the armature or stator windings.

#### Replacing the Generator Frame

1. During reassembly, anti-seize compound should be applied to the screw threads.
2. Carefully inspect the mating surfaces of the engine adapter plate and the generator frame. The mating surfaces must be clean and undamaged.
3. Lift the generator frame with the rope sling and very carefully slide it over the armature. Be very careful that the armature and stator windings are not damaged.
4. Align the bolt holes and install the screws that had been removed earlier. Carefully and evenly tighten them, making sure that the mating surfaces come together cleanly all the way around. Tighten the screws; see the torque specification page for correct torque values.
5. Remove the supports from the engine and carefully lower the generator frame. Install the rubber mounts.
6. Reverse the removal procedure to reassemble the machine. Be sure to secure all cables, and wires. Replace all cable ties that had been removed during disassembly.
7. Perform the **Alternator Stator Replacement Procedure**.
8. Perform the **Alternator Rotor Replacement Procedure**.

**GENERATOR ARMATURE REMOVAL AND REPLACEMENT****⚠ WARNING**

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If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

**TEST DESCRIPTION**

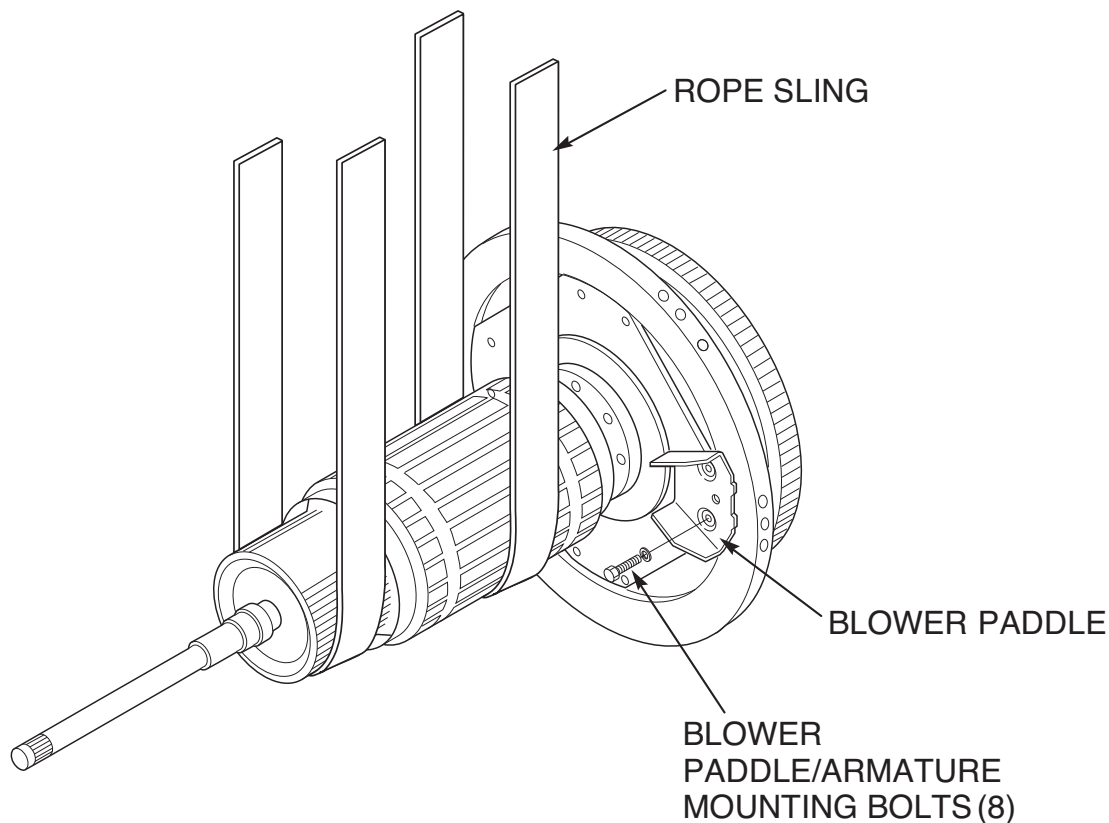
This procedure will guide the technician in removing and replacing the welding generator armature.

**MATERIALS NEEDED**

Rope sling  
Miscellaneous hand tools

## GENERATOR ARMATURE REMOVAL AND REPLACEMENT (continued)

FIGURE F.32 – SLING LIFT

**PROCEDURE****Removing the Armature**

1. Turn off the engine
2. Perform the **Alternator Rotor Removal Procedure**.
3. Perform the **Alternator Stator Removal Procedure**.
4. Perform the **Generator Frame Removal Procedure**.
5. Using the rope sling, support the armature. Position the sling at the center of gravity of the armature assembly. See Figure F.32
6. Remove the eight screws securing the blower paddle segments and the outer diameter of the flexible coupling disk to the flywheel.
7. With the armature securely supported in the sling, unlock it from the flywheel by carefully rotating it 1/8 of a turn in either direction.

**Replacing the armature**

1. Carefully inspect the mating surfaces of the flywheel and armature coupling parts. These surfaces must be clean and undamaged.
2. Support the armature in a rope sling and carefully move it into position, and align it to the flywheel.
3. Rotate the armature 1/8 of a turn, in either direction, to engage the locking mechanism and line up the bolt holes. Be certain that the coupling plate is fully and cleanly seated in the flywheel.
4. Replace the eight screws and four blower segments. Tighten the screws per the torque specification sheet.
5. Perform the **Generator Frame Replacement Procedure**.
6. Perform the **Alternator Stator Replacement Procedure**.
7. Perform the **Alternator Rotor Replacement Procedure**.

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**RETEST AFTER REPAIR**

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The machine should be retested if any parts are replaced that could affect the machine's electrical characteristics.

**Engine output:**

Perform the Engine RPM Adjustment Test

**Welder DC Output:****Maximum Output:**

Bring the machine to normal temperature by connecting a load bank and operating the machine at 100% output (400 amps @ 40 volts) for about 30 minutes.

Remove the load and set the output control and job selector rheostat to the maximum position.

**IMPORTANT: Do not move the output control while a load is applied to the weld output terminals. Damage to the output control unit may result.**

Read the open circuit voltage (OCV) at the weld output terminals. The voltage should measure 93 to 99 DC Volts.

Apply a 500 Amp load to the machine using the resistive load bank. Check the engine RPM and weld terminal voltage.

The Engine RPM should be 1680 to 1795

The weld output volts should be 45 to 51 VDC.

**AC Auxiliary Output:**

Machine should be operating at normal operating temperature.

Place the idle switch in the high idle position.

230 Volt receptacles should read 240 to 254 AC volts.

115 Volt receptacles should read 118 to 128 AC Volts.

**Field amps and volts:**

Place the Job Selector rheostat to Maximum. (The machine should still be at normal operating temperature.)

Exciter volts, Measured at slip rings: 124 to 132 DC Volts

Exciter rotor amps: 2.1 to 2.6

Shunt field amps: 2.55 to 3.2

(Measure the Shunt Field current at either the blue or brown wires between the generator and the 500 ohm resistor. See wiring diagram.)

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**Electrical Diagrams** ..... **G-1**

    Wiring Diagram (M21929) ..... G-2

    Schematic – Complete Machine (G6368) ..... G-3

    Schematic – Idler/Engine Shutdown PC Board (G4828) \* ..... G-4

**\* NOTE:** Many PC Board Assemblies are now totally encapsulated, surface mounted and or multi-layered and are therefore considered to be unserviceable. Assembly drawings of these boards are no longer provided.





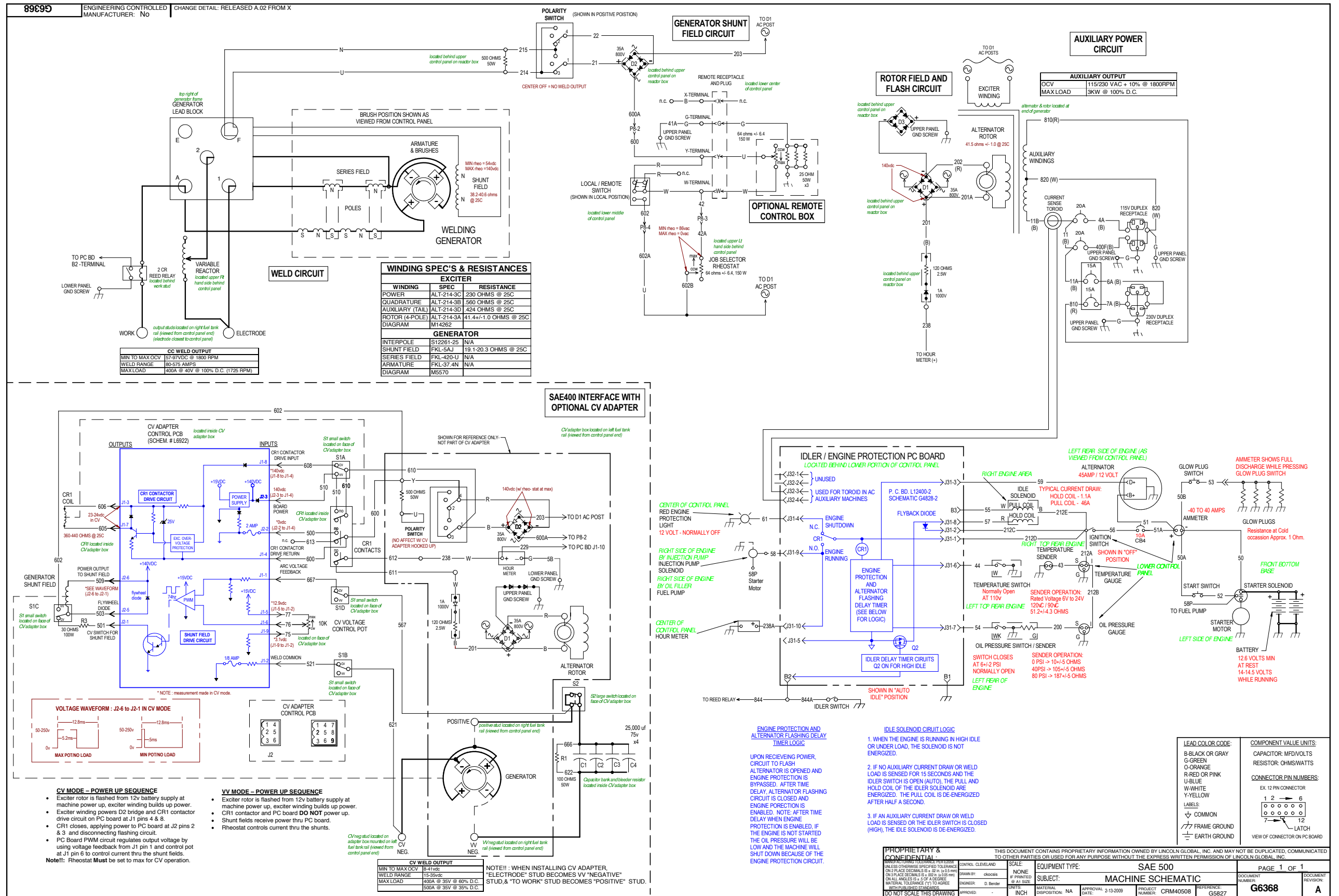
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NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.



