VOLTAGE REGULATOR — GENERAL ELECTRIC CO.
KS-5580 — ELECTRONIC TYPE GVD
OPERATING METHODS

1. GENERAL

1.01 This section describes the operation of the KS-5580 electronic type regulator used for controlling the output of a 130-160-volt d-c battery-charging engine-generator such as the KS-5525—5kva set used in the 420B power plant.

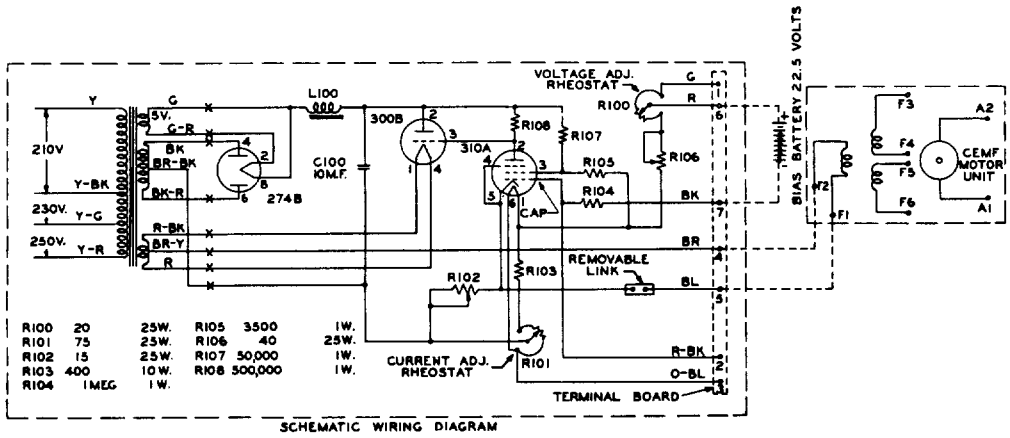
1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 The regulator consists of a regulated tube rectifier and a cemf motor having two main shunt field windings and one differential shunt field winding. The differential shunt field winding (F1-F2) is connected across the output of the rectifier and the main shunt field windings (F3-F4, F5-F6) are arranged for excitation by the charging generator output. The differential field opposes the main shunt fields. The armature of the motor is connected in the field circuit of the charging generator and the cemf of the motor armature opposes the voltage applied to the generator shunt field circuit. Thus an increase in the rectifier output increases the differential shunt field (known as the buck field) which tends to neutralize the field set up by the current from the generator. This reduces the cemf of the motor which increases the output of the generator by increasing its field strength. A decrease in the rectifier output is reflected to the generator with an opposite effect and reduces the generator output.

1.04 The rectifier consists of a transformer, one double-anode 274B rectifier vacuum tube arranged for full-wave rectification, one 310A amplifier vacuum tube, one 300B series vacuum tube, resistors, and rheostats. An a-c source of 210-250 volts, 60 cycles nominal is required for the input to the transformer.

Current Regulation

1.05 When the charging generator is delivering its full output the associated charge circuit transfers the regulator circuit to current regulation. Under this condition, the associated circuit provides a voltage across terminal strip punchings 2 and 3 to maintain a constant charging current. This voltage (see associated charge circuit) usually consists of a 3-volt grid battery opposed by the drop across an ammeter shunt and variable resistor in the negative charging lead. Thus if the generator output



SCHEMATIC WIRING DIAGRAM

tends to diminish, the grid bias on the regulator amplifier tube increases and reduces the plate current. This increases the voltage drop across the amplifier tube which decreases the negative grid bias on the series tube, decreases its resistance, and raises the output voltage of the rectifier. This increases the output of the generator (par. 1.03) to bring the charging current back to the regulated value. An increase in charging current would have the opposite effect.

Voltage Regulation

1.06 When the battery voltage is raised to the regulated value, the associated charge circuit transfers the regulator to voltage regulation. Under this condition, a potentiometer consisting of resistor R103, rheostats R100 and R101, and variable resistor R106, is connected across the terminal strip punchings 1 and 3 which are connected through an external resistor across the output of the charging generator. A positive voltage from the movable contact of rheostat R100 is opposed by the negative voltage of the grid battery connected across terminal strip punchings 6 and 7. The resultant negative voltage is furnished to the grid of the amplifier tube through current limiting resistor R104. Thus a decrease in output voltage of the generator will lower the positive voltage at the movable contact of rheostat R100 and increase the grid bias on the amplifier tube which will increase the output voltage of the generator (par. 1.04) and return it to the regulated value.

Portable Test Instruments

1.07 The following portable test d-c instruments, or their equivalents, are suggested for the readings called for under the reference paragraphs. Where the suggested ranges are not readily available, any range that gives a reading in the upper two thirds of the scale may be used.

REFERENCE PARAGRAPH	WESTON MODEL	INSTRUMENT	OHMS PER VOLT	RANGE	CORD TERMINATION
2.02(b)	280	Voltmeter	Any	30V	Clips
2.02(d)	280	Milliammeter	—	75ma.	Spades
2.05	280	Voltmeter	1000	5 and 50V	Picks

2. OPERATION

Preparing to Start

2.01 When putting a regulator in service initially, check that:

(a) Tubes are in the correct sockets.

(b) Correct primary transformer taps are connected.

(c) Proper grid batteries are connected.

(d) VOLTAGE ADJUSTMENT rheostat R100 and CURRENT ADJUSTMENT rheostat R101 are in their maximum counterclockwise position.

2.02 Make the initial adjustment of rheostats and variable resistors as follows:

(a) Start the engine. With MAN-AUTO switch of associated charge circuit in the MAN position, adjust the generator field rheostat at no load (generator disconnected from battery) so that the voltmeter on the engine control panel reads the desired regulated voltage (160 volts for 420B power plant).

(b) Connect a portable voltmeter (see 1.07) across the heater (1 and 6) of the 310A tube. With the associated charge circuit relays in the voltage regulation position, adjust rheostat or variable resistor in the associated circuit which is in series with the VOLTAGE ADJUSTMENT rheostat R100, until the voltmeter reads 10.3 volts with the generator output voltage at the desired value.

(c) With the generator field rheostat in the position (resistance all out) for automatic operation (generator still disconnected from battery and MAN-AUTO switch of charge circuit still in MAN position), adjust the VOLTAGE ADJUSTMENT rheostat to obtain the regulated value. If the rheostat is not then near the maximum counterclockwise position with a new grid battery, loosen the clamp and move the slider of variable resistor R106 as necessary. Tighten the clamp. Readjust external resistors as covered in (b) above to hold the filament at 10.3 volts.

(d) Connect a d-c milliammeter (see 1.07) in series with motor winding F1-F2 by removing the ammeter link. Connect the gener-

ator to the battery. With the associated circuit relays in the current regulation position and the generator output held manually at the desired charging rate (30 amperes for the 420B power plant), adjust the R101 rheostat until the milliammeter reads 0.055 ampere for list 1 regulators, or 0.044 ampere for list 2 regulators. In case the rectifier starts to hunt it may be necessary to loosen the clamp on resistor R102 and move its slider to cut out part or all of its resistance to clear the trouble. Check this adjustment as the generator voltage approaches the regulated voltage.

Note: In the 420B power plant, drawing SD-80910-01, this adjustment assumes that the series resistance which affects grid bias has been set initially in accordance with the following change being made in the CD sheet. "Adjust the resistance CR2 to the maximum resistance position. Manually hold the generator output at 30 amperes. Read the voltage from the + terminal of the AMR relay shunt to the generator side of the CR1 resistance. If the voltage is less than 3 volts, do not change the CR2 resistance. If the voltage is more than 3 volts, adjust resistance CR2 to give 3 ±0.05 volts. From then on adjustments should be made on the regulator in accordance with the BSP."

(e) With the charge circuit MAN-AUTO switch in the MAN position, generator field rheostat readjusted to the position for automatic operation (resistance all out), and the associated charge circuit relays still on current regulation, again adjust the CURRENT ADJUSTMENT rheostat R101 to obtain the desired charging rate when voltage is near the regulated voltage.

(f) When the charging circuit transfers to voltage regulation, check the voltage and if necessary, adjust the VOLTAGE ADJUSTMENT rheostat R100.

Starting and Stopping

2.03 Starting and stopping of the regulator is controlled by the associated circuit.

Routine Checks and Adjustments

2.04 Check the settings of the VOLTAGE ADJUSTMENT [par. 2.02 (f)] and CURRENT ADJUSTMENT [par. 2.02 (e)] rheostats periodically, and when tubes or grid batteries have been replaced. Use a screwdriver for adjustment.

2.05 Replace the 3-volt and 22.5-volt grid batteries when their terminal voltages have dropped to 2.7 and 20 volts, respectively (see par. 1.06), or when it is no longer possible to raise the charging current or generator voltage to the desired value by adjusting the CURRENT ADJUSTMENT and VOLTAGE ADJUSTMENT rheostats respectively. Do not change the positions of the sliders on resistors R102 and R106 or the settings of the variable resistors in the associated circuit which affects the grid voltage applied to terminal strip punching 2. Where it is impractical to read the voltages, the grid batteries should be replaced annually.

2.06 Check periodically that the connections to the transformer primary taps suit the power service voltage.

2.07 ***CEMF Motor Brushes***

(a) Replace the brushes with new ones when the length of brush is worn to about 3/8 inch as measured from the spring shoulder to contact surface. It is desirable to have the brushes make contact over a 100 per cent arc and at least 75 per cent of the contact area.

(b) Brush pressure is considered satisfactory if, when the brush cap is removed, the brush spring extends out of the brush tube a minimum of 1/8 inch.

(c) Brushes can be removed after removing the brush caps. Note the position of the brushes in the holders so that they may be replaced in the same holder and in the same position in the holder.

2.08 ***Lubrication***

(a) The ball bearings are lubricated at the factory with a light grease. They should be relubricated every five years or whenever the motor is disassembled for other reasons. If noise or heating attributed to the bearings

indicates that such lubricants are inadequate, more frequent intervals may be used.

(b) To relubricate the bearings, disconnect the leads from the motor, and remove the motor to a bench or other convenient place. Remove the motor fan from the shaft by removing two retaining bolts. Remove the brushes [see par. 2.07 (c)]. Remove the through bolts holding the end shields in place and remove the end shields. Remove the armature. Blow out carbon dust, etc., with compressed air if available.

(c) Remove the old lubricant from the accessible part of the bearing with an orange stick or toothpick. If old lubricant is very hard, a screwdriver with a cloth over its blade may be used. Follow with a stiff brush but be sure that no bristles are left in or on the bearing. Fill the recess of the bearing with grease, 310-330 P, but to avoid overheating do not attempt to force it into the bearing interior. Do not allow grease to get on the commutator.

(d) Clean the end play washers. Wipe bearing housing with a dry, lint-free cloth or one moistened in petroleum spirits. Fill the chamber 1/3 full with grease 310-330 P. Keep dirt from entering the housings.

(e) Clean the commutator with a dry, lint-free cloth or one moistened in petroleum spirits.

(f) Assemble in the reverse order.

2.09 ***Commutator*** surfaces should be smooth and free from cuts, flats, or other unevenness other than that caused by normal wear. A highly polished commutator surface is very desirable and a dark color should not be mistaken for a burned condition. If the surface is smooth and polished and the commutation satisfactory it should be left alone. Slight sparking is not necessarily evidence of poor commutation. If slightly rough, smooth with fine sandpaper. After sanding, blow out with air and wipe with a clean cloth.

3. GENERAL TROUBLES

3.01 If any of the following troubles are indicated it is suggested that the possible causes be checked in the order listed. If cause is not found, resistance measurements and continuity tests may be necessary.

TROUBLE	POSSIBLE CAUSE
High regulated voltage or current.	VOLTAGE ADJUSTMENT rheostat R100 or CURRENT ADJUSTMENT rheostat R101 out or adjustment. 310A tube burned out. Wrong connections to transformer primary taps.
Low regulated voltage or current.	VOLTAGE ADJUSTMENT rheostat R100 or CURRENT ADJUSTMENT rheostat R101 out of adjustment. 274B or 300B tube burned out. 3-volt grid battery aged (low-current). 22.5-volt grid battery aged (low voltage). Wrong connections to transformer primary taps.
Erratic regulation.	Rectifier hunting due to wrong setting of variable resistor R102 [see par. 2.02 (d)].