KS-19231 L1 AND L2 RECTIFIER

OPERATING METHODS

1. GENERAL

1.01 The KS-19231 L1 rectifier is intended to be used to supply power to the Automatic Test Line for Wide Area Data Systems, the X66780 B1 Single Sideband Radio Telephone Terminal, the COPAN Project, and the 101 ESS PBX. ▶The KS-19231 L2 rectifier is intended to be used to supply power to the 306 Switching System.◀

1.02 This section is reissued to incorporate information for the KS-19231 L2 rectifier. This issue does affect the Equipment Test List.

1.03 The KS-19231 L1 rectifier provides nominal 20 or 24 volts dc at 7.5 amperes when connected to a single-phase source of either nominal 117 or 230 volts ac (±10 percent) at 50 or 60 Hz (±2 percent). ▶The KS-19231 L2 rectifier provides nominal 24, 28, or 30 volts dc at 4.0 amperes when connected to a single-phase source of nominal 117, 208, or 230 volts ac (±10 percent) at 50 or 60 Hz (±2 percent).◀ A manual switch is provided for obtaining either a 20- or 24-volt nominal output for the KS-19231 L1 rectifier. ▶The KS-19231 L2 rectifier is provided with taps on screw-type terminals for obtaining a 24-, 28-, or 30-volt nominal output. A limited range continuous output voltage adjustment control is provided for both the KS-19231 L1 (see Fig. 1) and KS-19231 L2 rectifiers.◀

1.04 The KS-19231 L1 rectifier is designed to mount in a standard 19-inch relay rack. ▶The KS-19231 L2 rectifier is designed to mount in a standard 23-inch relay rack.◀ Test jacks for measuring the output voltage, an output voltage adjustment potentiometer, an input protection working fuse, and spare fuse are accessible without removal of the rectifier cover.

1.05 Removal of the cover will expose screw-type terminals for input and output power connections. The input connections are for either nominal 117 or 230 volts for the KS-19231 L1 rectifier or ▶for nominal 117, 208, or 230 volts for the KS-19231 L2 rectifier.◀ Unless otherwise specified, the rectifier unit is shipped with connections for a 117-volt, 60-Hz input. ▶The output of the KS-19231 L2 rectifier is connected for a 28-volt output.◀

Caution: The voltages in these units exceed 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur. Disconnect the alternating current supply before working on the unit except when necessary to make tests.

1.06 Routine checks should be made when they will cause the least service reaction.

1.07 The abbreviations cw and ccw refer to clockwise and counterclockwise, respectively.

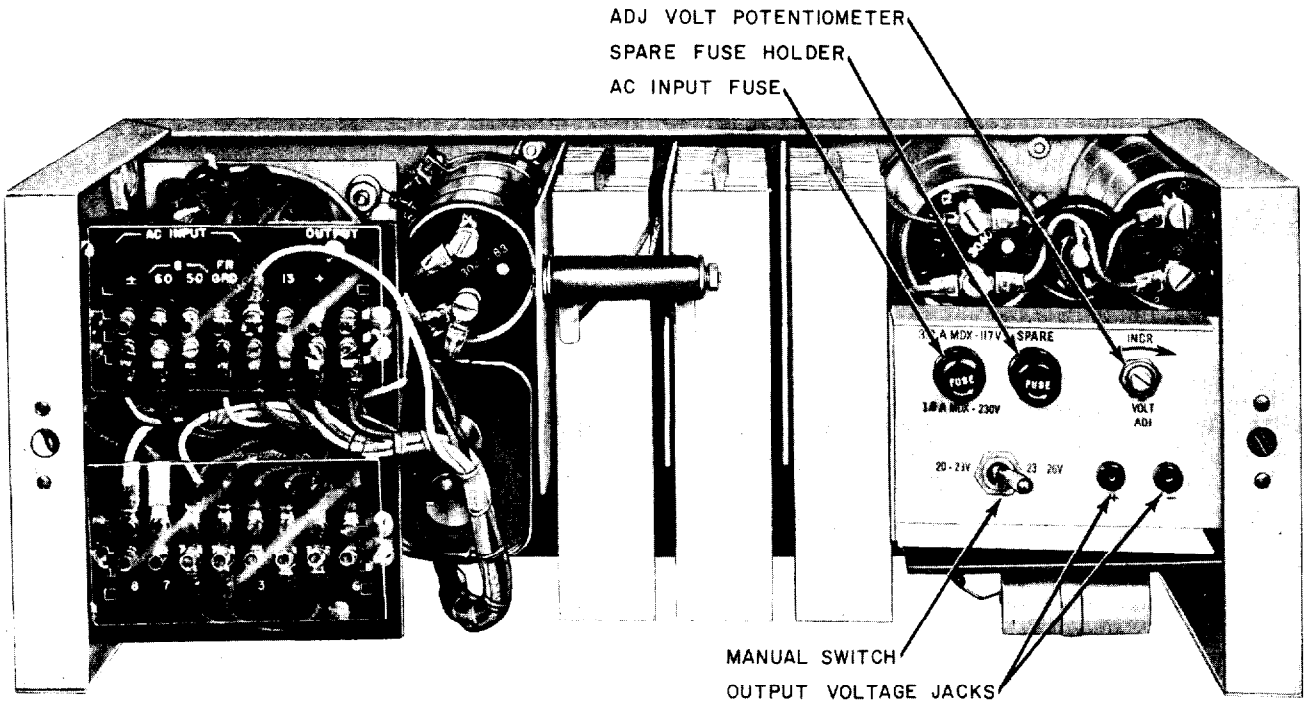


Fig. 1—KS-19231 L1 Rectifier (Cover Removed)

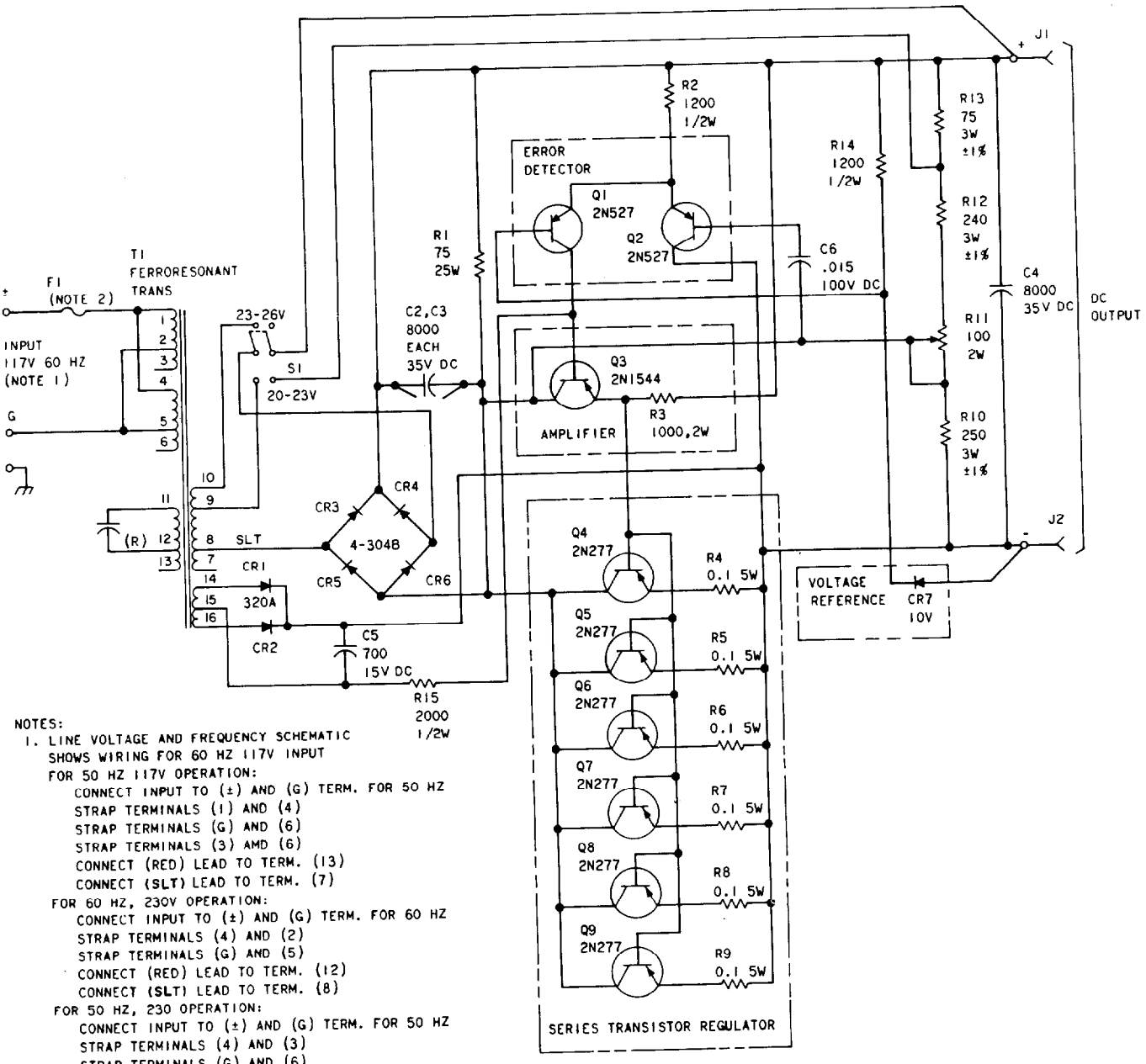
2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
—	TS-30 Torque Screwdriver with W-12 Socket Torque, Control, Inc
TEST APPARATUS	
KS-14510	Volt-Ohm-Milliammeter
—	Weston Model 281 Direct Current Ammeter, Scale 1.5-3-30 (or equivalent)

3. OPERATION

Description

3.01 The KS-19231 L1 and L2 rectifier circuits (see Fig. 2 and 3, respectively) consist of a ferroresonant regulating transformer including its associated ac capacitor. The isolated secondary winding is connected to a full-wave bridge-type silicon rectifier assembly followed by a capacitance filter and a bleeder resistance. The ferroresonant transformer provides a well regulated output voltage for wide ac line voltage variations while being essentially unregulated for load variations. The capacitors at the output of the rectifier stack are essential for satisfactory line regulation as well as for filtering the output. The output of the rectifier stack is connected to the input of a transistor series regulator.



NOTES:

1. LINE VOLTAGE AND FREQUENCY SCHEMATIC SHOWS WIRING FOR 60 HZ 117V INPUT
   FOR 50 HZ 117V OPERATION:
   - CONNECT INPUT TO (±) AND (G) TERM. FOR 50 HZ
   - STRAP TERMINALS (1) AND (4)
   - STRAP TERMINALS (G) AND (6)
   - STRAP TERMINALS (3) AMD (6)
   - CONNECT (RED) LEAD TO TERM. (13)
   - CONNECT (SLT) LEAD TO TERM. (7)

   FOR 60 HZ, 230V OPERATION:
   - CONNECT INPUT TO (±) AND (G) TERM. FOR 60 HZ
   - STRAP TERMINALS (4) AND (2)
   - STRAP TERMINALS (G) AND (5)
   - CONNECT (RED) LEAD TO TERM. (12)
   - CONNECT (SLT) LEAD TO TERM. (8)

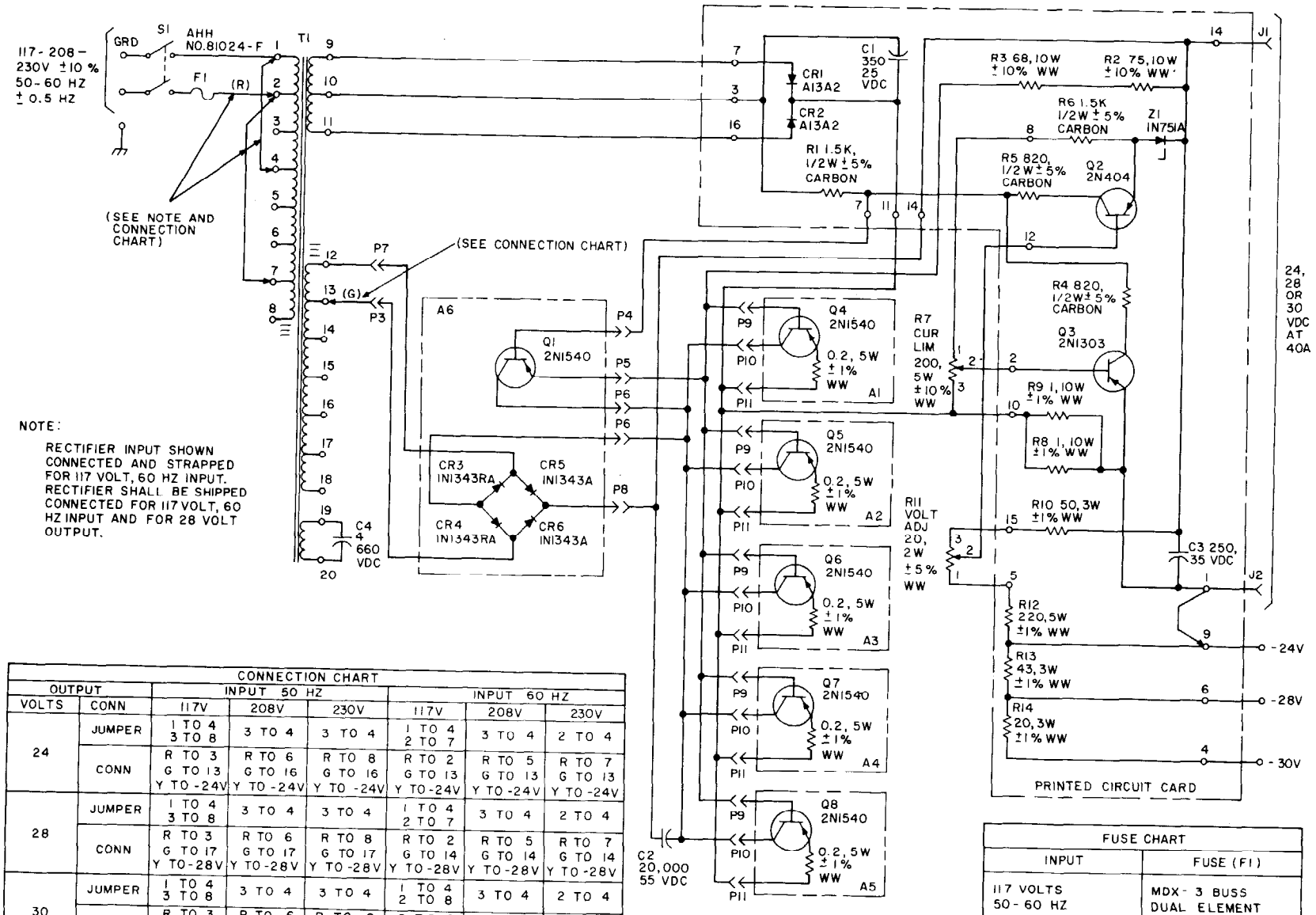
   FOR 50 HZ, 230 OPERATION:
   - CONNECT INPUT TO (±) AND (G) TERM. FOR 50 HZ
   - STRAP TERMINALS (4) AND (3)
   - STRAP TERMINALS (G) AND (6)
   - CONNECT (RED) LEAD TO TERM. (13)
   - CONNECT (SLT) LEAD TO TERM. (7)
2. FUSING FOR 117V OPERATION:
   USE BUSSMAN 3.2A MDX, LITTLEFUSE NO. 31303.2
   OR APPROVED EQUIV.
   FOR 230V OPERATION:
   USE BUSSMAN 1.6A MDC, LITTLEFUSE NO. 31301.6
   OR APPROVED EQUIV.
3. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, AND ARE ±5% TOLERANCE; CAPACITANCE VALUES ARE IN MICROFARADS.

Fig. 2—KS-19231 L1 Rectifier Simplified Schematic

COMPONENT SOURCE LIST — KS-19231 L1 RECTIFIER

CIRCUIT REFERENCE	PECo PART NO.	DESCRIPTION	APPROVED SOURCE
C1	304 0711	Capacitor 15 MFD, 330 VAC	General Electric, Sprague
C2-C4	304 0683	Capacitor 8000 MFD, 35 VDC	Mallory
C5	304 0758	Capacitor 700 MFD, 15 VDC	Mallory
C6	304 0955	Capacitor .015 MFD, 100 VDC	Cornell Dubilier
CR1, CR2	337 0906	Diode 1N-1217	Westinghouse, Transitron, General Inst
CR3-CR6	337 0889	Diode 1N-1200	Westinghouse, Transitron, Automatic
CR7	337 0924	Diode Zener, 10V	Pacific, Hoffman
F1	315 0122	Fuse 3.2A	Bussman
Q1, Q2	370 0029	Transistor 2N527	General Electric, Motorola
Q3	370 0044	Transistor 2N1544	Motorola, Texas Inst
Q4-Q9	370 0024	Transistor 2N277	Delco
R1	340 2807	Resistor 75Ω, 5%, 25W	Ohmite
R2	340 0155	Resistor 1200Ω, 5%, .5W	Allen-Bradley
R3	340 0848	Resistor 1000Ω, 5%, 2W	Allen-Bradley
R4-R9	340 1669	Resistor .1Ω, 5%, 5W	*Tepro
R10	340 5005	Resistor 250Ω, 1%, 3W	*Tepro
R11	341 0424	Potentiometer 100Ω, 5%, 2W	Mallory
R12	340 5101	Resistor 240Ω, 1%, 3W	*Tepro
R13	340 5066	Resistor 75Ω, 1%, 3W	*Tepro
R14	340 0155	Resistor 1200Ω, 5%, .5W	Allen-Bradley
R15	340 0160	Resistor 2000Ω, 5%, .5W	Allen-Bradley
S1	366 0062	Switch DPDT	Cutler-Hammer
T1	611 3246	Transformer Ferroresonant	Power Equipment Co

* Temp Coeff 20PPM/°C



CONNECTION CHART

OUTPUT		INPUT 50 HZ			INPUT 60 HZ		
VOLTS	CONN	117V	208V	230V	117V	208V	230V
24	JUMPER	1 TO 4 3 TO 8	3 TO 4	3 TO 4	1 TO 4 2 TO 7	3 TO 4	2 TO 4
	CONN	R TO 3 G TO 13 Y TO -24V	R TO 6 G TO 16 Y TO -24V	R TO 8 G TO 16 Y TO -24V	R TO 2 G TO 13 Y TO -24V	R TO 5 G TO 13 Y TO -24V	R TO 7 G TO 13 Y TO -24V
28	JUMPER	1 TO 4 3 TO 8	3 TO 4	3 TO 4	1 TO 4 2 TO 7	3 TO 4	2 TO 4
	CONN	R TO 3 G TO 17 Y TO-28V	R TO 6 G TO 17 Y TO-28V	R TO 8 G TO 17 Y TO-28V	R TO 2 G TO 14 Y TO-28V	R TO 5 G TO 14 Y TO-28V	R TO 7 G TO 14 Y TO-28V
30	JUMPER	1 TO 4 3 TO 8	3 TO 4	3 TO 4	1 TO 4 2 TO 8	3 TO 4	2 TO 4
	CONN	R TO 3 G TO 18 Y TO-30V	R TO 6 G TO 18 Y TO-30V	R TO 8 G TO 18 Y TO-30V	R TO 2 G TO 15 Y TO-30V	R TO 5 G TO 15 Y TO-30V	R TO 7 G TO 15 Y TO-30V

FUSE CHART

INPUT	FUSE (F1)
117 VOLTS 50-60 HZ	MDX-3 BUSS DUAL ELEMENT
208-230 VOLTS 50-60 HZ	MDX-1-1/2 BUSS DUAL ELEMENT

Fig. 3—KS-19231 L2 Rectifier Simplified Schematic

COMPONENT SOURCE LIST — KS-19231 L2 RECTIFIER

CIRCUIT REFERENCE	*PART NO. (REGULUS, INC)	DESCRIPTION	APPROVED SOURCE
C1	#444012	Capacitor 350 MFD at 25 VDC	20-41631 (P R Mallory) BR-500-25 (Cornell-Dubilier) Equivalent (General Electric) 44D10092 (Sprague)
C2	#444087	Capacitor 20,000 MFD at 55 VDC	43F3760MA6 (General Electric) CGS203U060 FLIH (P R Mallory) 36D203F075DE6B (Sprague)
C3	#444130	Capacitor 250 MFD at 35 VDC	TCM (P R Mallory) BR-250-50 (Cornell-Dubilier) Equivalent (General Electric) 44D10112 (Sprague)
C4	#444113	Capacitor 4 MFD at 660 VAC	49F4388 (General Electric) Type 8066-4 (Sangamo) 200P28 (Sprague) 31A6604 (P R Mallory)
CR1, CR2	#521068	Silicon Diode 1 Ampere at 100V	A13A2 (General Electric) ZJ252A (General Electric) 1N4002 (Motorola)
CR3, CR4	#521078	Silicon Diode 6 Ampere at 150V	1N1343RA (General Electric) 1N1343RA (Westinghouse) 1N1343RA (G I)
CR5, CR6	#521077	Silicon Diode 6 Ampere at 150V	1N1343A (General Electric) 1N1343A (Westinghouse) 1N1343A (G I)
F1 Holder	#480002	Fuse Holder	HKP (Bussman) 342012 (Littlefuse)
F1	#471027	Fuse	MDX-3 (Bussman) 313003 (Littlefuse)
J1	#482005	Red Pin Jack	#279 Red (H H Smith)
J2	#482006	Black Pin Jack	#279 Black (H H Smith)
Q1, A1-5 Assembly	#581006	Transistor	2N1540 (Motorola) 2N1540 (Delco)
Q2	#581002	Transistor	2N404 (General Electric) 2N404 (Motorola) 2N404 (RCA)
Q3	#581012	Transistor	2N1303 (General Electric) 2N1303 (Motorola) 2N1303 (RCA) 2N1303 (Texas Instrument)
R1 and R6	#524035	Resistor 1.5K ohm, .5W, ±5%	Little Devil (Ohmite) Type EB (Allen-Bradley) Type GBT (IRC)

COMPONENT SOURCE LIST — KS-19231 L2 RECTIFIER (Cont)

CIRCUIT REFERENCE	*PART NO. (REGULUS, INC)	DESCRIPTION	APPROVED SOURCE
R2	#524262	Resistor 75 ohm, 10W, ±5%	4787 (Ohmite) S•AL-10, 75 ohm, ±5%, (Tru-ohm) 10SX, 75 ohm, ±5%, (Ward Leonard)
R3	#524263	Resistor 68 ohm, 10W, ±5%	4785 (Ohmite) S•AL-10, 68 ohm, ±5%, (Tru-ohm) 10SX, 68 ohm, ±5%, (Ward Leonard)
R4	#524119	Resistor 150 ohm, .5W, ±5%	Little Devil (Ohmite) Type EB (Allen-Bradley) Type GBT (IRC)
R5	#524010	Resistor 820 ohm, .5W, ±5%	Little Devil (Ohmite) Type EB (Allen-Bradley) Type GBT (IRC)
R7	#517038	Pot 200 ohm, 5W, ±10%	Type WW (P R Mallory)
R8 and R9	#524264	Resistor 1 ohm, 10W, ±1%	Type 884 (Ohmite) S•AL-10, 1 ohm, ±1%, (Tru-ohm) 10SX, 1 ohm, ±1%, (Ward Leonard)
R10	#524265	Resistor 50 ohm, 3W, ±1%	Type 884 (Ohmite) S•AL-3, 50 ohm, ±1%, (Tru-ohm) 38X, 50 ohm, ±1%, (Ward Leonard)
R11	#517	Pot 20 ohm, 5W, ±10%	Type WW (P R Mallory)
R12	#524 8	Resistor 220 ohm, 5W, ±1%	Type 884 (Ohmite) S•AL-5, 220 ohm, ±1%, (Tru-ohm) 5SX, 220 ohm, ±1%, (Ward Leonard)
R13	#524266	Resistor 43 ohm, 3W, ±1%	Type 884 (Ohmite) S•AL-3, 43 ohm, ±1%, (Tru-ohm) 3SX, 43 ohm, ±1%, (Ward Leonard)
R14	#524267	Resistor 20 ohm, 3W, ±1%	Type 884 (Ohmite) S•AL-3, 20 ohm, ±1%, (Tru-ohm) 3SX, 20 ohm, ±1%, (Ward Leonard)
A1-5 Assembly	#524311	Resistor 0.2 ohm, 5W, ±1%	Type 884 (Ohmite) S•AL-5, 0.2 ohm, ±1%, (Tru-ohm) 5SX, 0.2 ohm, ±1%, (Ward Leonard) TS-3W, 0.2 ohm, ±1%, (Tepro)
T1	#181035	Ferroresonant Reactor Input: 117, 208, 230 VAC ±10% at 50 or 60 Hz Output: 24, 28, 30 VDC at 4 amperes	181033 (Regulus)
TB	#578027	Terminal Block	10-141-E (H B Jones) 210 (Marathon)
Z1	#521040	Silicon Diode (Zener) 400 MW at 5.1V	1N751A (Motorola)

* Regulus, Inc, Mt Gilead, Ohio

3.02 This regulator consists of a conventional series-type feedback amplifier, a zener diode reference, an error detector, and a parallel arrangement of transistors used as a series regulator. The series transistor circuit regulates the output by comparing the output voltage to a reference voltage and amplifying the differential. The difference or error signal is applied to the series transistors. The phasing is such as to tend to maintain the error signal at a minimum, thereby compensating for output load changes.

3.03 The output of a second secondary winding, coupled to the primary coil, is rectified and filtered to supply a bias voltage to the transistors in the control stage.

3.04 A current-limiting circuit is provided for the KS-19231 L2 rectifier to limit the output current to a value within the capabilities of the series transistors.

Preparing to Start

3.05 When putting a rectifier in service, check that:

(a) There is nothing in, on, above, or below the rectifier to interfere with operation or prevent free ventilation.

(b) The strapping on the input terminal block is proper for the input voltage service available (see Fig. 2 or 3).

(c) All external connections are made in accordance with the SD drawing covering the associated circuit of which the rectifier is a part.

(d) The proper size ac supply fuse is provided in the rectifier.

(e) Meters and test apparatus are available for checking input and output voltages.

(f) On the KS-19231 L2 rectifier, the taps on the output terminals are selected for the output voltage desired.

(g) On the KS-19231 L1 rectifier, the manual switch (S1) is in the position for the output voltage desired.

(h) The ADJ VOLT potentiometer is rotated fully ccw.

Starting

3.06 Perform the checks in 3.05 and then proceed as follows.

(1) Connect the KS-14510 volt-ohm-milliammeter, set to the 60 VOLT DC range, to the + and - test jacks.

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from the equipment being tested, or if test picks are being used, they should be removed from the equipment under test.

(2) Insert the ac fuse.

(3) Adjust the rectifier output as required. The adjustment of the ADJ VOLT potentiometer will be determined by the requirements of the associated equipment or circuit of which this rectifier is a part. Rotate the ADJ VOLT potentiometer cw to increase or ccw to decrease the output voltage.

(4) Disconnect the KS-14510 volt-ohm-milliammeter.

Normal Operation

3.07 The rectifier has no disconnecting switches and is connected to both ac power and the load when the associated fuse is in place. The rectifier output voltage is adjusted by rotating the ADJ VOLT potentiometer cw to increase or ccw to decrease the voltage as required.

Note: The KS-19231 L2 rectifier is provided with a current-limiting potentiometer (CUR LIM) which is set at 4.1 amperes and locked and sealed at the factory; it should not require adjustment.

4. ROUTINE CHECKS

4.01 The following checks should be performed.

(a) The output voltage should be checked from time to time with the KS-14510 volt-ohm-milliammeter to make certain that it is correct under typical office load.

(b) The office load should be checked from time to time with the ammeter to make sure that the load does not exceed the rating of the rectifier.

4.02 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

4.03 ◗Semiconductor devices should be maintained in accordance with Section 032-110-701.◖

4.04 ◗Keep the ventilating passages and semiconductor heat sinks clean to avoid excessive heating.◖

5. TROUBLES

5.01 In general, the components most likely to become defective with use are the electrolytic capacitors and the semiconductor devices.

5.02 When replacing a stud-mounted semiconductor device, the manufacturer-recommended tightening torque should be applied. Use the TS-30 torque screwdriver equipped with a W-12 socket, Torque Controls, Inc. Insufficient torque will result in inadequate thermal contact with the heat sink. Excessive torque may crack and destroy the semiconductor wafer in the device.

Trouble Chart

5.03 Should any of the following troubles develop, it is suggested that the possible causes be checked in the order given. If the trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals.

TROUBLE	POSSIBLE CAUSE
No output voltage	Failure or disconnection of the input power.
	Blown ac supply fuse.
	Defective T1 transformer.
	◗ Output filter capacitors shorted (C4 capacitor on KS-19231 L1 rectifier or C3 capacitor on KS-19231 L2 rectifier).
	Defective rectifying element (CR3, CR4, CR5 or CR6 diode). ◖
Low dc output voltage	Low input power voltage.
	Incorrect transformer taps.
	Excessive load on rectifier.
	Breakdown of any or all capacitors.
	Defective T1 transformer.
	◗ Defective reference voltage diode (CR7 zener diode on KS-19231 L1 rectifier or Z1 zener diode on KS-19231 L2 rectifier). ◖
High output voltage	High input power voltage.
	Incorrect transformer taps.
	Defective T1 transformer.
	◗ Defective reference voltage diode (CR7 zener diode on KS-19231 L1 rectifier or Z1 zener diode on KS-19231 L2 rectifier). ◖
◗ High ripple voltage ◖	◗ Output filter capacitor open (C4 capacitor, KS-19231 L1 rectifier or C3 capacitor, KS-19231 L2 rectifier).
	Defective rectifying element (CR3, CR4, CR5, or CR6 diode). ◖
Erratic output voltage	Fluctuating input power voltage.
	Intermittent open or short in any component.
	Defective connections.