SURGISTAT
SERVICE MANUAL

Notice: This manual and the equipment it describes are for use only by qualified medical professionals trained in the particular technique and surgical procedure to be performed.

VALLEYLAB PART NUMBER 945 100 102
EFFECTIVE DATE: July, 1988

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SECTION 1

INTRODUCTION

This Service Manual covers the installation and basic operating instructions for the Valleylab Model SurgiStat Electrosurgical Generator. Also included are sections covering the Technical Specifications, Circuit Descriptions, and the Testing and Troubleshooting of the Generator. Detailed instruction in the use of electrosurgery is beyond the scope of this manual and the reader is directed to the SurgiStat Operation Manual provided by Valleylab.

Valleylab, its dealers and representatives reserve the right to make changes in equipment built and/or sold by them at any time without incurring any obligation to make the same or similar changes on equipment previously built and/or sold by them.

SECTION 2

INSTALLATION

PROPER GROUNDING PRECAUTIONS

One of the most important considerations in assuring patient safety while using electrical equipment is that of providing proper grounding. The ground wire in the power cable is connected to the generator chassis and insures that no dangerous currents will flow from the cabinet of the unit in the event of an internal electrical failure. It is the responsibility of the user to assure proper grounding of the power outlets furnishing power to the unit. Undesirable 60 Hz leakage currents are also affected by the polarization of the input 60 Hz power to the unit and it is the responsibility of the user to insure that proper polarity is observed. Frequent checking is urged, both visually and with electrical testing equipment, of all electrical cables and wires associated with this instrument.

INSTALLATION

The Valleylab SurgiStat Electrosurgical Generator is normally supplied for operation on 90-130 VOLTS AC, 60 Hz (180 to 260 VAC operation is available).* Generators are normally shipped with a standard hospital-grade 3-prong connector. This connector meets all requirements for safe grounding. Other types of Explosion-Proof connectors commonly used in hospitals are available as options. Under continuous use for extended periods of time it is normal for the top and rear panel to feel warm to touch.

WARNING!!

By definition, electrosurgical cutting and coagulation takes place by current sparking through or to tissue. Electrosurgical procedures, therefore, are inherently NOT explosion proof and should NEVER be used in the presence of flammable objects or liquids.

SECTION 3

OPERATING CONTROLS

FRONT VIEW (FIGURE 1)

1. Power On Switch. Push switch to activate generator. Indicator illuminates GREEN when SurgiStat is ON.

2. Coag Indicator. Indicator illuminates BLUE when coagulation current is selected by activating an accessory.

3. Cut Indicator. Indicator illuminates YELLOW when cutting current is selected by activating an accessory.

4. Coag Level Dial. Dial rotates clockwise to increase the coagulation current intensity.

5. Cut Level Dial. Dial rotates clockwise to increase the cut current intensity.

6. Active Receptacle. Three position-coded receptacles accept the three-pin Handswitching accessories or the two-prong plug of the switching forceps cord.

7. Accessory Receptacle. Either of the two rectangular active receptacles will accept most standard accessories of other manufacture, or will accept adapter plugs for those accessories which will not fit directly. The SurgiStat is then activated by the footswitch.

8. Patient Return Electrode Receptacle. This 2-pin receptacle accepts the return electrode connector used in monopolar procedures. The receptacle will accept both REM™ (dual-section) and standard patient electrode connectors. A return electrode monitor alert will flash the red LED and sound the audio alarm.

REAR VIEW (FIGURE 2)

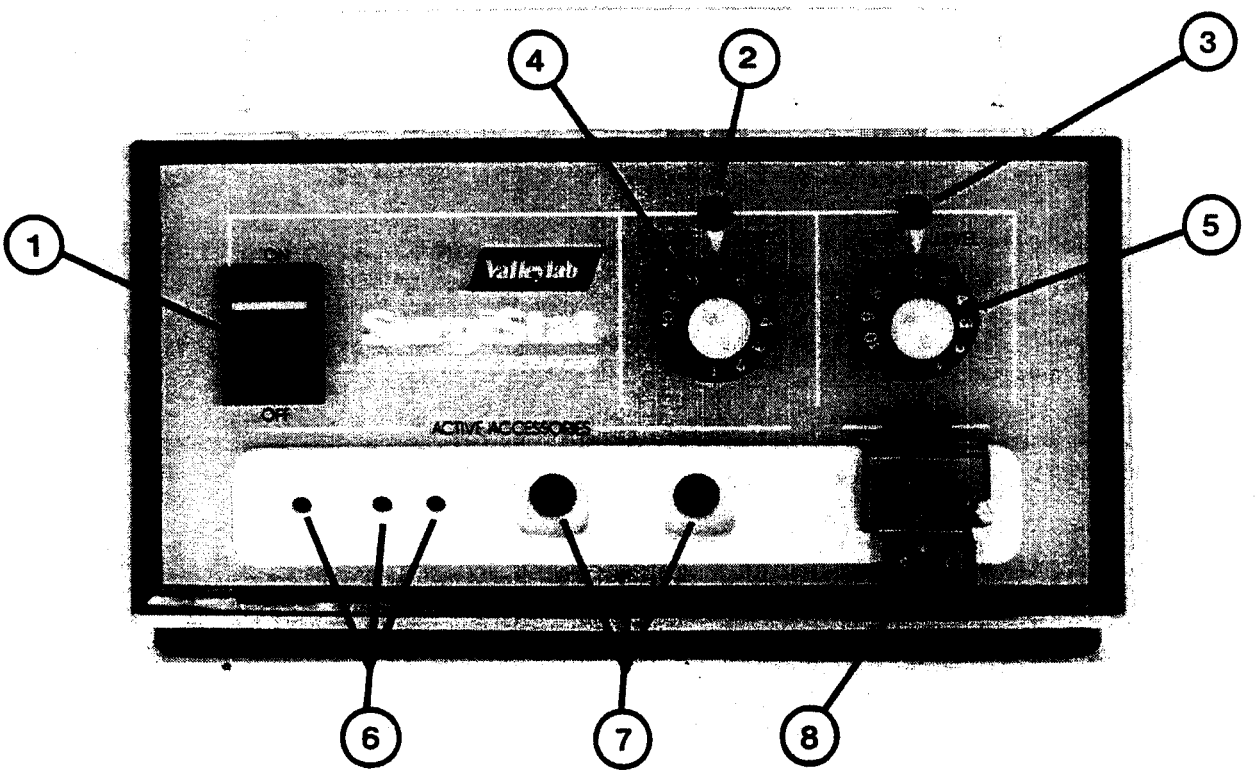
9. Circuit Breaker. Interrupts the A.C. current flow in case of internal failure or momentary overload. Push button to reset.

10. Footswitch Connection. Footswitch E6006 attaches to the rear panel of the SurgiStat with an Amphenol, three-prong connector. An adapter is available to connect an E6008 footswitch if desired.

11. Power Cord. Three-prong plug on the power cord connects to properly grounded wall receptacle providing 115 VAC, 60 Hz power. The plug is a U.L. approved hospital-grade model. Specific models of explosion-proof plugs are available through special order. Extension cords, three-prong to two-prong adapters, and extra length power cords should NOT be used. For units operating from 230 VAC, 50 Hz input, your Valleylab representative will install the appropriate plug.

12. Audio Volume Dial. Dial controls the audio volume for CUT and COAG keying tones.

Figure 1 Front Panel Operating Controls



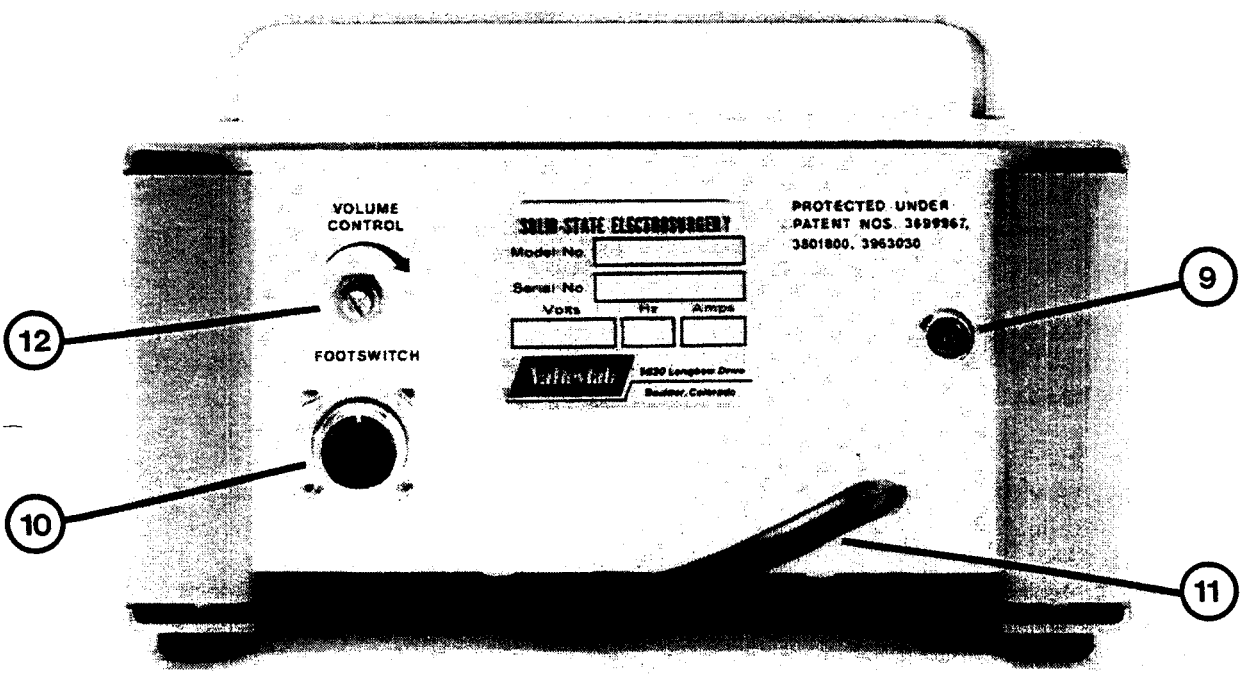


Figure 2 Rear Panel Operating Controls

SECTION 4

TECHNICAL SPECIFICATIONS

Output Waveform:

Blended Cut: 300kHz ± 25kHz damped sinusoid with 50K ± 5kHz repetition.

Coag: 1MHz ± 25kHz damped sinusoid with 50kHz ± 5kHz repetition.

Output Characteristics: (Control setting of 10)

Mode	Nominal Open Circuit P-P Voltage	Nominal Power (Watts) (500 ohm load)	500 ohm load Crest Factor (Typical)
Blended Cut	2400 ± 400	60 + 5, - 0	3.25
Coag	4200 ± 400	25 + 2, - 0	8.0

Output Power Control:

CUT and COAG output current is essentially linear with control rotation from settings of (1) to (10).

Duty: Maximum setting: 50%, 3 minutes on, 3 minutes off.

Return Electrode Monitor

Acceptance Range: dual pad - 5-135 ohms, single pad - below 5 ohms
Measurement Current: 140 kHz; 3mA, 1.5 VAC max.

Output Isolations - 115V Operation
Line frequency source leakage current: less than or equal to 0.2 uA
Line frequency sink leakage current: less than or equal to 100 uA
RF patient leakage: less than or equal to 150 mA rms
Line ground leakage current (60 Hertz):
Unit OFF: less than or equal to 10 uA
Unit ON: less than or equal to 50 uA

Cooling:
Convection

Indicators:
Blue Coag D.S.I.
Yellow Cut L.E.D.
Flashing Red REM™ Alert

Audio Volume:
Variable CUT and COAG keying tones. Variable REM™ alert volume, will not totally silence.

Input power: (Control setting 10, output short circuit)

90-130 VAC, 60 Hz, 3A C.B.	180-260 VAC, 50 Hz, 1.5A C.B.
Idle: 150 mA Max	Idle: 75 mA Max
Cut: 2.0A Max	Cut: 1.0A Max
Coag: 1.0A Max	Coag: .50A Max

Input voltage range is selected through internal connections.
Approved Hospital-Duty power plug is standard.

Line regulation:

Line variations of 100 volts to 130 volts or 200 volts to 260 volts
Cut: Output power 40 watts at 115 volts variation less than $\pm$ 4 watts
Coag: Output power 15 watts at 115 volts variation less than $\pm$ 1 watt

Size:

5.05 inches high (6.30 including handle) (12.8 (16) centimeters)
9.50 inches wide (24.1 centimeters)
8.5 inches deep (21.6 centimeters)

Weight:

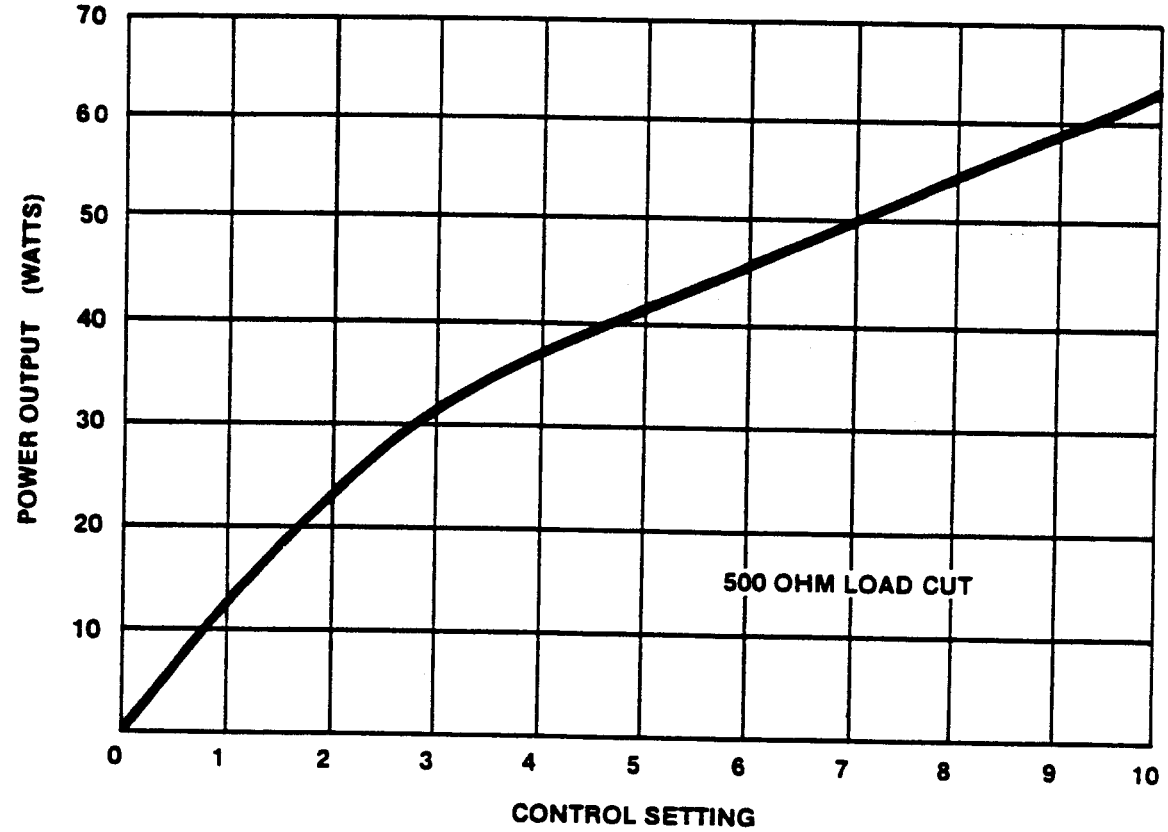
13 pounds (5.85 Kilograms)

NOTE:

Line frequency sink current is that current which flows from an external voltage source of 117 VAC, 60 Hz applied to all front panel terminals in parallel. 100K ohms in series with 117 VAC source for safety.

The SurgiStat output is classified by C.S.A. Electromedical Standard C22.2 No. 125 as Risk Class 2. Risk Class 2 applies to patient related equipment having patient applied parts which may or may not be isolated.

Specifications subject to change without notice.



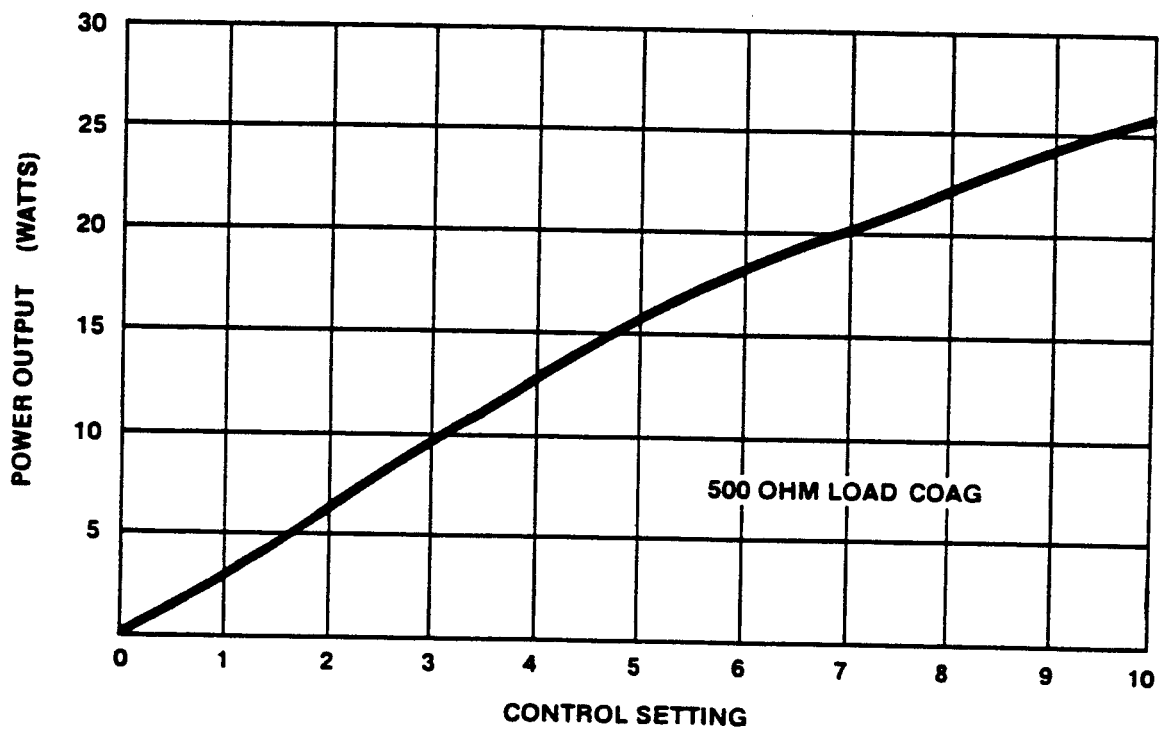
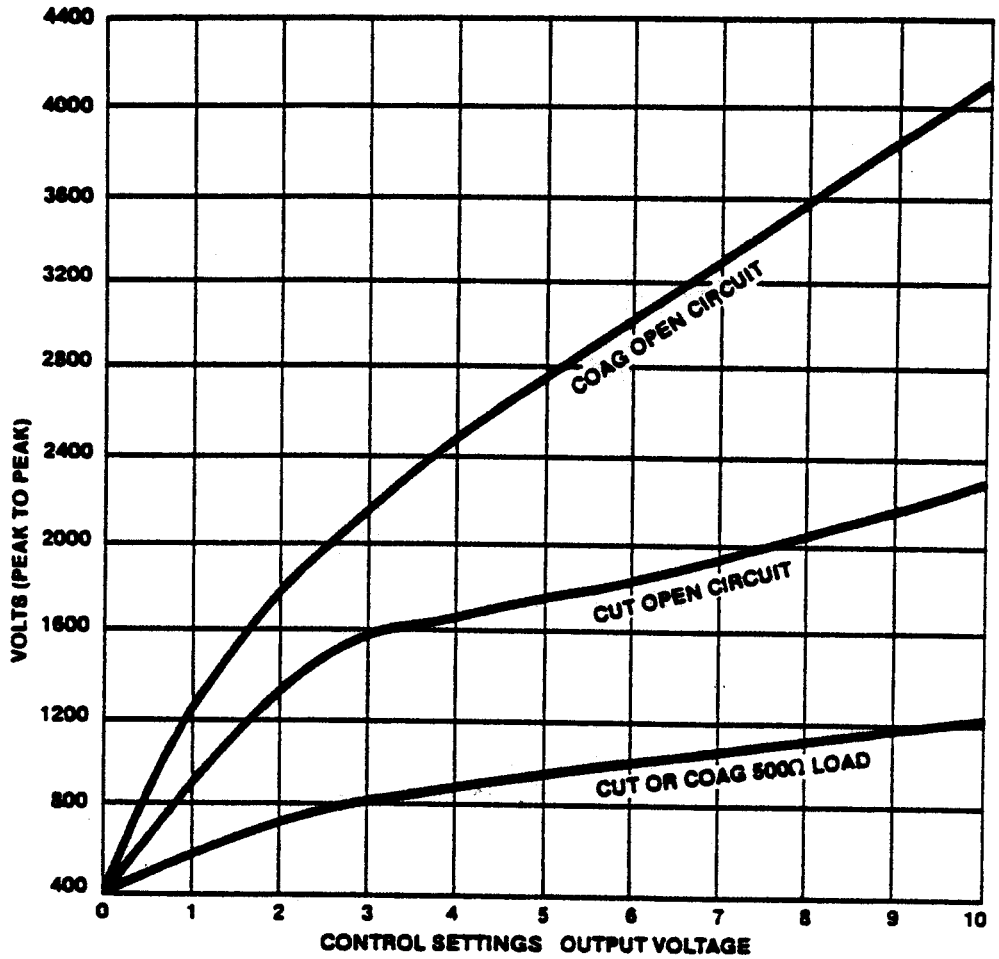


FIGURE 3 POWER OUTPUT



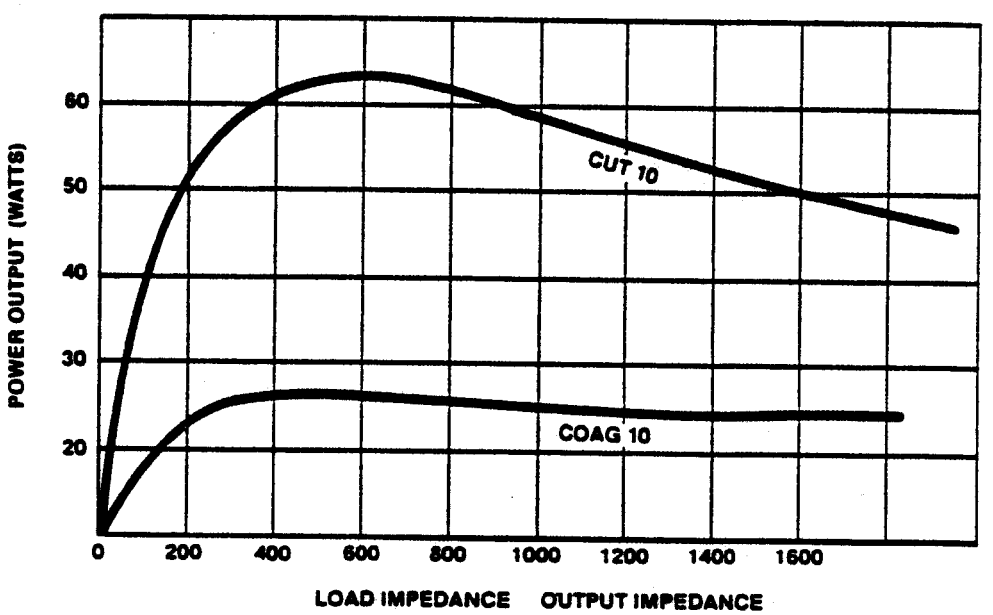


FIGURE 4 OUTPUT IMPEDANCE

SECTION 5

CIRCUIT DESCRIPTION

POWER SUPPLY

These components are located on the chassis and on the master printed circuit assemblies A single unregulated D.C. voltage is obtained by the diode bridge formed by CR109-CR112 which is filtered by C301. This voltage is used directly in the high power path through the output stage. A comparatively small amount of power is used by the control circuitry, and this is processed by U10, a 12 V regulator. A fused resistor, R116 protects the system against a shorted U10. Power and signal common throughout the system is the most negative voltage, the low side of C301. REM™ circuitry is powered via CR113 and J101; it is regulated by VR1.

OUTPUT STAGE

Parts of this circuitry are located both on the master and the output printed circuit assemblies. This circuitry generates the output waveforms. Drivers are located on the master board, and the power handling components on the output board and chassis.
Q301 is the output device. Its drive circuits are arranged so that large currents can be conducted to and from Q301 with extremely short (50 ns) risetimes. Q113 upon T/ON signal applies a voltage across an RF network which supplies turn on current drive and charges C116. During T/OFF current is conducted through the BE junction of Q301 and the collector Q106 while C116 is being discharged.
T201, the output transformer, is connected between the collector of Q301 and the power supply, +35V. During the time Q301 is conducting, current increases in the primary of T201, and when Q301 turns off, the energy stored in T201 core is discharged into the circuit capacitance and ultimately the load. A relay (K201) provides differing values of primary inductance and capacitance for the Cut and Coag functions. Small values of inductance and capacitance are used in the Coag function, providing a short energy burst at the output terminals. The relay switching of T201 primary creates a high turns ratio for Coag, and thus the open circuit voltage tends to be high. The cutting function uses large inductance and capacitance and a lower turns ratio than Coag. Thus, compared to the Coag function, the voltage and frequencies are lower, but the total power is higher due to the large inductance. Current which flows through T201 primary also flows through the parallel combination of R144 and R158-R162, and a voltage is developed across these resistors. A comparator transistor Q107 switches on when this voltage minus the offset across Q115, exceeds a programmed voltage across R131. This behavior results in a pulse at common base transistor Q108 collector. The programmed voltage is dependent upon a control setting on R302, or R303, and the mode of operation.

KEYING CIRCUITRY

This circuitry is located both on the master and output printed circuit assemblies. The purpose of this network is to respond to user control, either through the footswitch or handswitching accessories, and to provide an appropriate logic level in either the CTE or CGE (U2 pin 10 or U1 pin 10). Since there are multiple keying sources, there is the possibility of keying ambiguity. This possibility is circumvented by a path through U1 pin 4 which forces CTE to be low if CGE is high. Footswitch and handswitch inputs are combined at U1 pins 1, 2, 8, and 9. Because of accessory cord capacitance, the keying information from the handswitch accessory is referred to the active output electrically. The information is decoupled by the IsoBloc circuit which uses photo-optical couplers, PI1 and PI2 to transfer the small electrical signals from the active switching terminals to a ground referenced signal. An oscillator passes a small amount of power through T202 which is then rectified and the D.C. voltage across C207 is switched across the photo-diodes of either PI1 or PI2 upon the closure of either switch in the active switching accessory. Infra-red light impinging on either photo-transistor will cause a voltage to change across either R207 or R208 and then U1 pins 2 or 8. Keying is prevented during a REM™ alert by Q116 and Q117.

CONTROL CIRCUITRY

Components in this section are located on the master printed circuit assembly. The control circuitry adjusts the driving pulse width so that the output power will match the control setting. A wide pulse at Q108 signifies that the output stage is overdriven in pulse width. No pulse is related to power below that intended for the control setting, and a narrow pulse results from the correct driving pulse width and power output.
Basic timing signals are generated by an oscillator (U8) on pins 3 and 6. These are the A and T waveforms, respectively, on the timing diagram. T/ON (the output transistor turn on signal) exists for a position of the linear upward-sloping ramp of the T waveform, the duration depending on the value of V2. T/OFF usually occupies most of the falling region of the T waveform. $(A \cdot B)$, $(A \cdot B)$ signals are derived and fed into a latch U6 pin 6,9 and U5 pin 10 so that the T/OFF signal may be extended to the left when necessary. This happens if shorter pulse widths are suddenly required to produce a given output stage peak current, under suddenly changing conditions. For example, short circuiting the active to patient, normal loop setting time would produce unacceptable output stage current overshoot. Advanced turn off is accomplished by feeding the current comparator signal directly to U6 pins 5,8 from U2 pin 6.

A second more accurate control path exists and is used whenever the pulse width needed to maintain a specified peak current is not rapidly decreasing. Due to control circuit behavior the threshold level on U7 pin 6 tends to ramp downward and then increase the T/ON pulse width when there are no current comparator pulses. The voltage tends to ramp upward when pulses are present. A narrow current comparator is greatly extended by the latch formed by U5 pins 3,4 and U4 pins 1,2,13 with R123 and C107. This extended (approximately 300 usec) pulse opens the channel formed by U4 pins 10,11 and allows R118 to pull voltage on C106 upward, decreasing the pulse width at U7 pin 1.

If no current comparator pulses are present, R123 charges C107 past the threshold of U4 pin 12, and U4 pins 10,11 are connected through a relatively low resistance channel pulling the C106 voltage low and increasing the U7 pin 1 pulse width. If neither the CUT nor the COAG function is activated, U4 pin 11 is high and no pulse can be generated by U7 pin 1. The turn on signal is formed by that portion of the U7 pin 1 pulse before the falling edge of waveform A if there is not advanced turn off as previously described. The control paths are common to the Cut and Coag functions. However, due to different inductances of the output transformer in the two modes, maximum pulse widths are 4 usec in Coag and about 12 usec in Cut.

AUDIO WARNING DEVICE

U9, which is located on the master board, and associated circuitry drives an audio speaker located in the footswitch assembly. An adjustable volume tone is produced whenever the SurgiStat is keyed. Separate tones are produced for both Cut and Coag. U9 is a timing integrated circuit in an astable mode and whose frequency of oscillation is set by the network formed by C103, R154, R120 and R119. The output of U9 at pin 3 is connected to a volume control (R301) and then to the audio speaker. The speaker is driven by T101 and U101 during a REM™ alert.

REM™ Circuitry

Return electrode monitor circuitry is located on the REM™ board. The patient plate pad to pad impedance is measured across E1 and E2. RF return current flows through E1, E2 thru C21, C22 to E3. There are two ranges: 5135 ohms, dualpad, selected when J102-2, J102-3 are shorted by the adapter microswitch contacts; and below 5 ohms. The impedance measurement uses oscillator U4 tuned by L1 to drive T2. The primary voltage is detected synchronously by U6 with low pass filtering by C13, C12. Alarm detection limits are set by R20, R15 and sensed by U4/ 5,6,7 and U2/5,6,7. Q1 is turned off by an alarm to permit keying via Q116 and Q117. U1 is turned on by an alarm and amplifies the audio tone produced by U5/3,11 to produce an alert beep. U2/2,3,1 provides a regulated reference voltage.

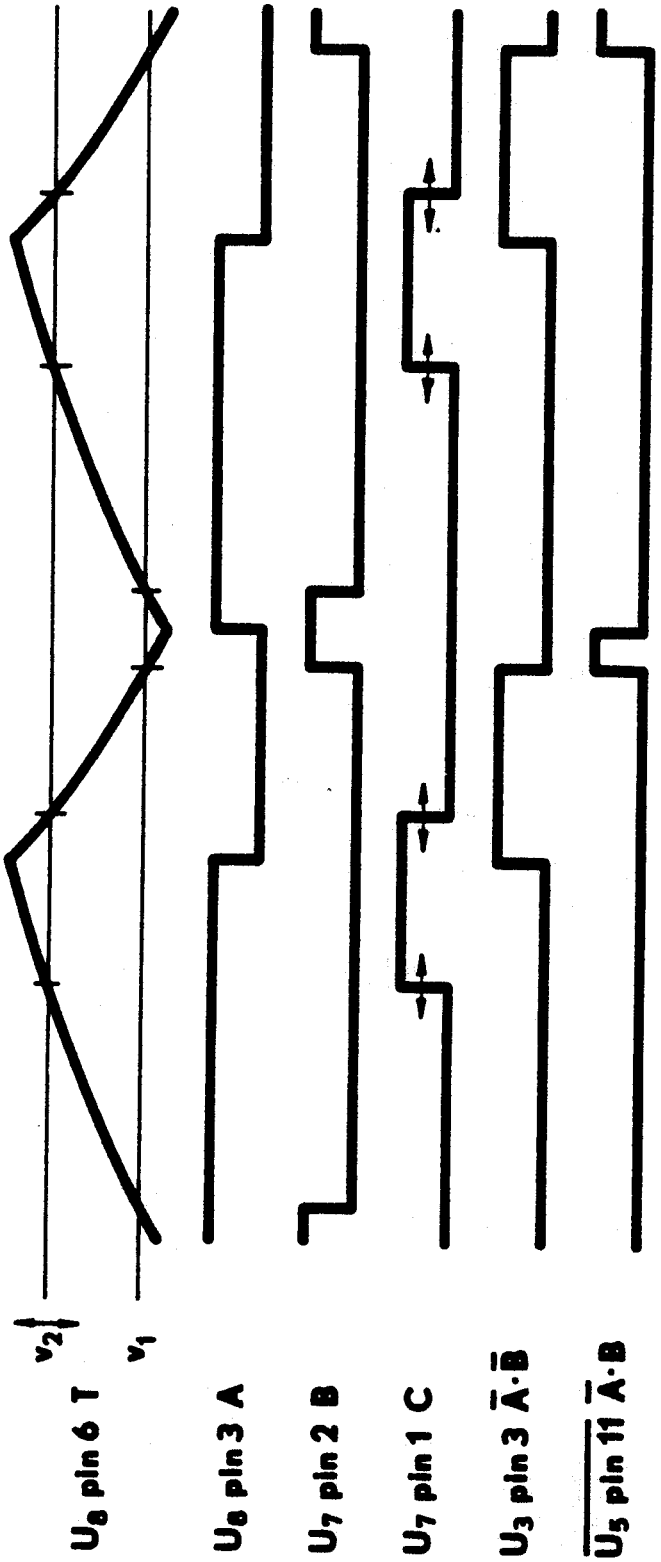


Figure 5 Timing Diagram

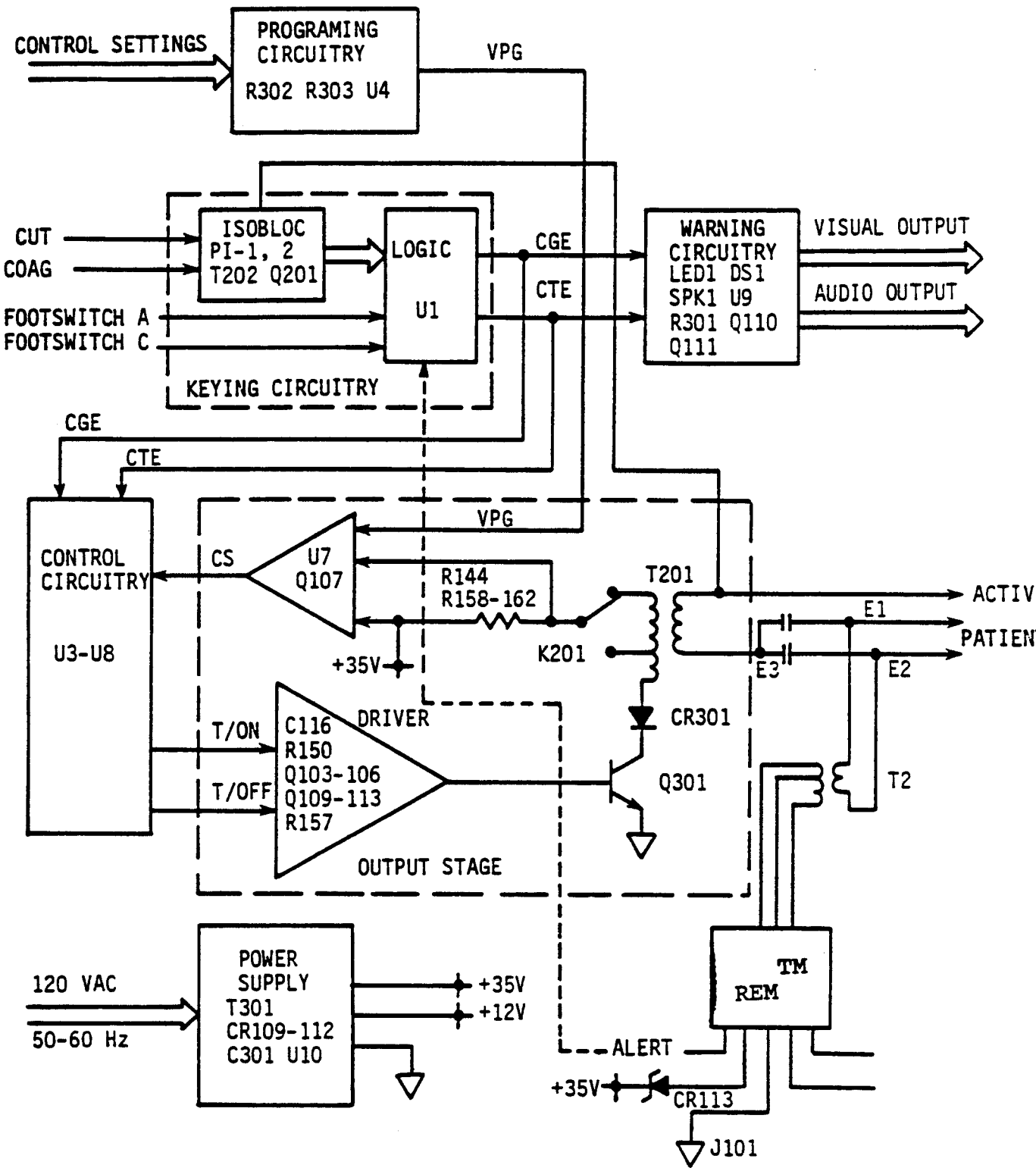


FIGURE 6

BLOCK DIAGRAM

SECTION 6

TESTING PROCEDURE

OPERATIONAL TESTING - GENERATOR OUTPUT

The purpose of the operational test is to quickly determine whether the generator is functional and is generating the necessary electrosurgical waveforms. In the Acceptance Test Procedure detailed measurement procedures will be described to accurately determine the condition of the Generator.
A significant amount of information can be obtained about the generator's output by a simple arc-test. By observation of the arc, it can be determined quickly whether the CUT or COAG outputs are present. To test the output of the generator, a functional switching pencil is required along with a ground clamp and patient plate. For this purpose a dummy electrode could be used to avoid burning surgical electrodes. While switching the pencil in the COAG mode, starting at a setting of (1), attempt to start an arc to the patient plate. At low settings a very small arc should occur, growing larger as the control level is increased. The arc appears to be a thin, feathery looking arc. At full output (10) it should be possible to sustain an arc 1/8 - 1/4" from the plate. In the CUT mode the arc is much stronger and larger with a distinct sputtering sound. At full output (10) a very strong arc should be obtained. These quick tests are, of course, very subjective but can be used to effectively evaluate a unit when one is familiar with a known good generator.

NOTE: Electrosurgical generators are not continuous-duty devices and should not be operated continuously. A 50% duty at dial settings of ten is recommended (three minutes on -- three minutes off).

OPERATIONAL TESTING - RADIO FREQUENCY LEAKAGE CURRENT

The Acceptance Test Procedure outlines the method used to accurately measure this leakage current. Because of the high crest-factors in the waveforms involved, the use of a thermo-couple type RF Ammeter is imperative to prevent errors in this measurement.
Excessive RF leakage from the Patient terminal has the effect of raising the patient to an RF potential with respect to ground. These voltages, when allowed to become too high, can cause operating room personnel to be "shocked" when lightly touching the patient. These "shocks" are, in reality, tiny pinpoint RF burns and although not dangerous to the patient or operating room personnel, are disagreeable and should be avoided.

Excessive RF leakage from the ACTIVE jack has the effect of allowing surgery to be performed without benefit of a patient plate which is also an undesirable situation. For this reason RF leakage measurements should be performed periodically to insure patient safety.

OPERATIONAL TESTING - 60Hz CURRENT LEAKAGE

There is no simple means of making these measurements. Sensitive instruments are needed to measure the low values of current involved. The 60Hz leakage is measured with the SurgiStat ON but NOT keyed. The measuring procedure is described in the detail in the Acceptance Test Procedure. Because of the potential danger to an electrically-susceptible patient in the case of excess 60 Hz leakage, generators suspected of this fault should be carefuly tested and inspected.

ACCEPTANCE TEST PROCEDURE

Equipment Needed:

Tektronix type 465 Oscilloscope
Tektronix type P6013A HV Probe
Tektronix type P6007 X 100 Probe
Tektronix type P6010 X 10 Probe
Simpson Model 1339 RMS RF Ammeter, 0-250mA
Wattmeter, 0-500 watts, 500 ohm load
General Radio Co. 0-140V AC Variac
(For 230 V SurgiStat a 0-280 VAC Variac is required.
General Radio type W20 HM).
Decade Resistance Box, General Radio Co. Type 1434-B

In testing RF type equipment, proper test procedures must be adhered to in order to have a reasonable chance of duplicating factory obtained data. Test leads must be kept to the minimum length usable as lead inductance and stray capacity can adversely affect readings. The selection of suitable "ground" points must be made with care to avoid ground-loop errors. Keep in mind that meter accuracy of many RF instruments is 5-10% of full scale. This may have a large effect upon measured values. In measuring high voltage RF waveforms, the effect of an uncompensated scope probe may cause large errors. In measuring fractional microampere leakage currents, accidental capacitive or inductive coupling may cause order-of-magnitude errors in the observed values.

CHASSIS GROUND INTEGRITY

Check for the existence of a low impedance connection between the generator chassis and the 3rd wire ground plug. To avoid any problems of contact resistance in measuring this impedance (0.1 ohm) it is recommended that 4-wire resistance measuring technique be utilized. The recommended maximum impedance of 0.1 ohm is for the standard factory installed 10 foot 18/3 AWG line cord. Use of longer cords is NOT recommended.

INITIAL FUNCTIONAL TEST

Powering the generator from a variable-voltage transformer capable of furnishing at least 3 amperes at 115 VAC, turn unit ON and key it in the CUT mode. Insure that it starts to function at 90 VAC or lower. The presence of an audible tone and appearance of the CUT and COAG lamps is indicative of proper operation for this test.

SUPPLY VOLTAGES

Turn unit ON and measure the D.C. supply voltages. Under normal line voltage, they should read:

+35, Less than +50V
+12V, +12 ± 2V

CLOCK GENERATOR TEST

Measure the signal at U8 pin 3.
The frequency should be 50 ± 5K Hz. (If not, select another value for C108)
The voltage should remain in the high state between 11 and 13 usec.

CUT MODE TEST

In this test the generator is operated into a 500 ohm load wattmeter capable of dissipating the full power of the generator (60 watts). The wattmeter is connected from the extreme left ACTIVE terminal to the PATIENT terminal and the generator is keyed ON from the footswitch jack. The PATIENT terminal may be connected to chassis ground to insure proper operation of an oscilloscope. Use a Variac or insure that the line voltage is 115 VAC.
Connect the wattmeter and set to 125W full scale. Set CUT level control to 10 and adjust R130 until either the output equals 60 +5, -0 watts or the system is continuously in the forced reset mode. (Forced reset is when the output stage switches off at a transition of the clock waveform rather than at the desired peak collector current point.)

Measure the +35V supply at maximum setting. The D.C. level measured with an average responding meter should be greater than 28.0V and the ripple should be less than 4.0 volts p-p. The lowest non-zero power which can be selected should be less than 5.0 watts. Set CUT level to (5) and see that the power output is 40 ± 5 watts. Set CUT level to (3) and see that the power output is 32 ± 5 watts. Set level to (10), remove the 500 ohm load and check open circuit voltage of generator. This should not exceed 2800 volts peak-to-peak. The output transistor collector voltage should not exceed 500V when the output is in an open circuit condition.

COAGULATION MODE TEST

Connect 500 ohm load, set COAG level to (10) and key generator in COAG. Power output should be 25 +2, -0 watts. If not, adjust R128 until the appropriate power is reached. Set COAG level to (5) and see that the power output is 15 ± 3 watts. Set COAG level to (3) and see that the power output is 10 ± 3 watts.

The lowest non-zero power which can be selected should be less than 2 watts. Remove the 500 ohm load and set the generator level to (10). Check for open circuit voltage of 4200 pp. ± 400 volts. The output transistor collector voltage should be between 350 and 500 volts when the output is in an open circuit condition.

LINE REGULATION TEST

Connect the SurgiStat to a variable voltage transformer (Variac) and set the supply voltage to 115 VAC (or 230 VAC as appropriate).
Select the CUT mode and set the generator output to 40 watts into a 500 ohm load, while keeping the supply voltage constant. Vary the supply voltage from 100 VAC to 130 VAC (or 200 VAC to 260 VAC). The output should vary less than ± 4 watts. Return supply voltage to 115 VAC and set COAG power to 20 watts. Vary supply voltage from 100 VAC to 130 VAC (or 200 VAC to 260 VAC). Output power should vary less than ± 2 watts.

NOTE: If a Variac is not available and the generator must be tested with the existing line voltage, the output power will differ from that at 115 VAC input. Intermediate output powers will be proportionally higher or lower, depending on the actual line voltage available. If the generator power output does not meet the requirements of the preceding paragraphs, it will be necessary to tune it up to the proper power levels per the Acceptance Test Procedure.

REM™ TEST

Proper REM™ calibration is necessary for maximum patient safety. Connect a decade box using a dual pad REM™ connector. Set the resistance to 10K ohms and adjust L1 for maximum voltage across TP1-TP2 on the REM™ board. Set the resistance to 5 ohms and rotate R15 until the REM™ alarm just comes on. Set the resistance to 135 ohms and adjust R20 until the alarm just comes on. Check that the acceptance range is 5 to 135 ohms for dual pads and below 5 ohms for single pads. Adjust R116 for 2.5V p-p at the speaker.

FRONT PANEL RF LEAKAGE

These readings are made with an RF ammeter from the PATIENT or ACTIVE lead to ground. Accidental connection of the meter from ACTIVE to PATIENT will result in instant destruction of the METER!
Connect a 250 mA RF RMS Ammeter from any ACTIVE jack to ground. Set CUT and COAG level to (10) and key generator with the footswitch. The RF leakage to ground should not exceed 150 mA. Connect the Ammeter from the PATIENT jack to ground and key the generator in CUT and COAG with the footswitch. The RF leakage to ground should not exceed 150mA.

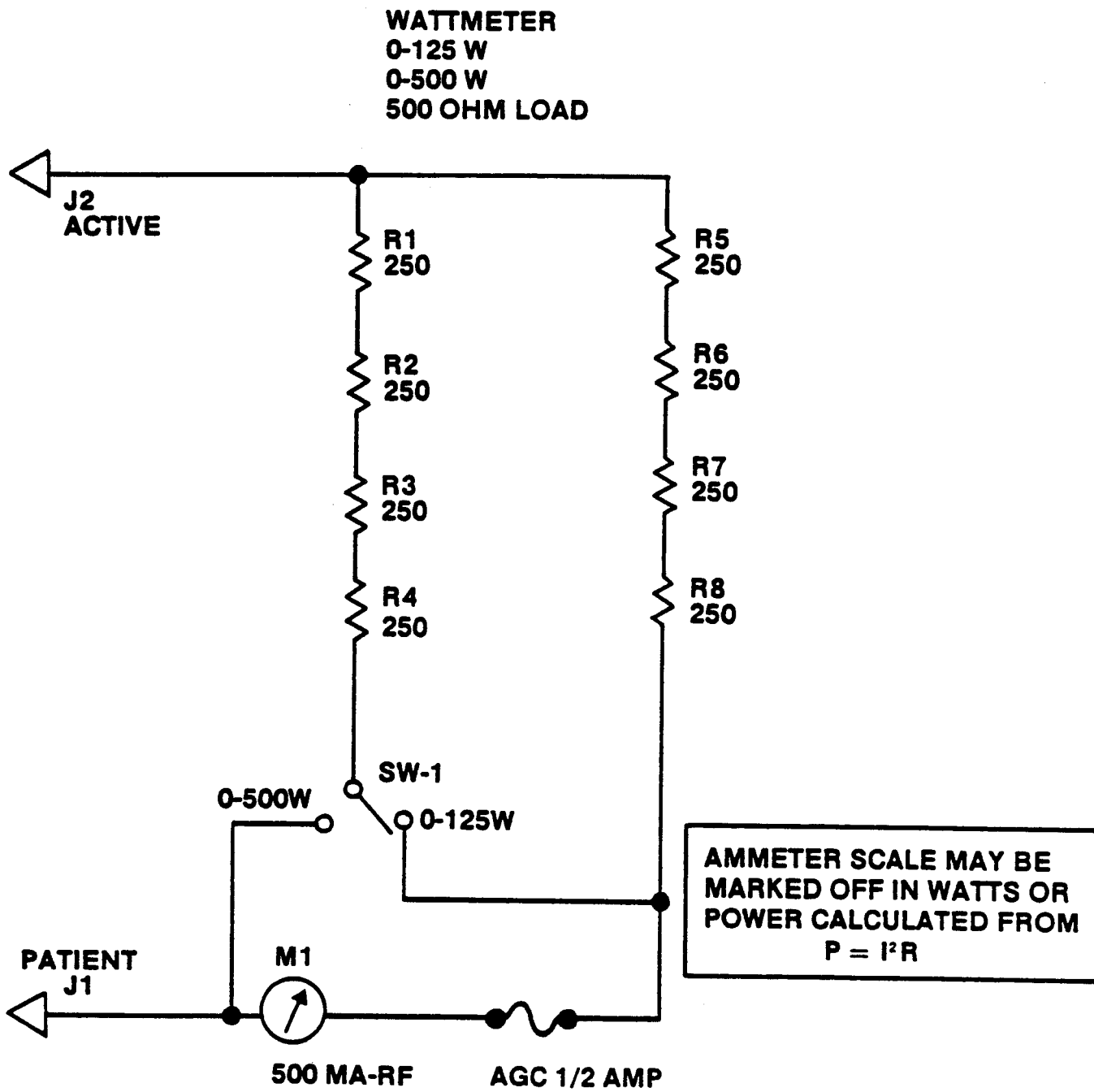
LINE FREQUENCY LEAKAGE CURRENT (60Hz)

Potentially dangerous 60 Hz line leakage currents to ground are measured in this test. Turn the SurgiStat on but do NOT key. The current is measured indirectly by observing the voltage developed across a 1K ohm resistor to ground from each front jack. A .015 uf capacitor is connected across the 1K resistor to remove any trace of high frequency noise generated by the oscillator inside the unit. It has little effect on the actual 60 Hz leakage current. Leakage current is calculated from I = E/R, where R = 1,000 ohms and E is the voltage across the resistor. The maximum acceptable voltage across the 1K resistor for 0.2 uA leakage is .0002 volts (.2 millivolts).

NOTE: Because of the extreme difference in magnitude of the 60 Hz leakage current and the RF signals (when keyed), it is very difficult to make a 60 Hz leakage measurement with the unit keyed. When keyed, there can be as much as 4600 volts peak to peak of RF as compared to 2 millivolts of 60 Hz. This ratio (23,000,000:1) of voltages would necessitate the use of sophisticated measuring techniques. In actual use, the 60 Hz leakage currents do not change significantly from the keyed to the unkeyed mode. Third wire leakage current is measured by opening the green grounding wire at the plug and connecting the 1K resistor from chassis to ground. The maximum voltage for 50 uA leakage would be 0.05V (50 millivolts). Commercially available leakage testers may be used for this test. The value of 50 uA valid for factory installed 10 foot 18/3 AWG line cords. Longer power cords or extension cords will increase the 3rd wire leakage and are NOT recommended. With the SurgiStat turned OFF the 3rd wire leakage should be less than 10 uA. The line frequency sink leakage is the current that will pass into the patient leads when a 115 volt 60 Hz potential is applied between a patient lead and the chassis. The voltage source should be a 115 volt isolation transformer with a 120K ohm current limiting resistor in the secondary. The current is calculated from the voltage measured across a 1K ohm resistor in series with the 115 volt source and the PATIENT or ACTIVE jacks. This current should be less than 100 uA.

PREVENTIVE MAINTENANCE

In order to insure safe and dependable operation, the SurgiStat should be periodically checked to see that it meets minimum specifications. The printed circuit boards should be examined for any signs of corrosion on the contact fingers and should be cleaned as necessary. It is recommended that the SurgiStat be inspected at least twice a year and the Acceptance Test performed at that time to insure efficacy and continued patient safety.



PARTS LIST

R1-R8	250 OHM 50W	DALE RH-50 1%
M1	500 MA RF RMS	SIMPSON MOD 1339
SW-1	SPDT TOGGLE	ALCO MST-105D

Wattmeter Construction
Alternate for Valleylab E3000 Wattmeter

Figure 7 Wattmeter Construction

SECTION 7

TROUBLESHOOTING

TROUBLESHOOTING GUIDE

Trouble Symptom

1. Both modes inoperative.
   No power output.
   No lamps or audio.

Probable Cause
   A. Faulty power plug, cord or circuit breaker.
   B. P300 disconnected.
   C. S1 faulty.

Solution
   A. Check continuity from power plug to P300.
   B. Insure proper connection.
   C. Replace S1.

Trouble Symptom

2. Both modes inoperative.
   No power output.
   Power indicator operative but no mode lamps or audio when keyed from front panel or footswitch.

Probable Cause
   A. P301 or P104 disconnected.
   B. + 12V supply faulty.
   C. U1 faulty.
   D. Screws insuring electrical contact to C1 are loose.
   E. +35V supply faulty.

Solution
   A. Check proper connections from S1 to Master Board.
   B. Check +12V supply, U10 and fused resistor R116.
   C. Check logic functions of U2 and U1. Replace faulty component.
   D. Tighten screws.
   E. Check CR109, CR110, CR111 and CR112. Replace faulty component.

Trouble Symptom

3. One or both modes inoperative from front panel, but operate with footswitch. Audio working.

Probable Cause
   A. Q201 or CR201 faulty. See photo #11 (idle). See photo #12 (keyed).
   B. Open in Isobloc toroid winding.
   C. Improper front panel contacts.
   D. P11 or P12 faulty.

Solution

A. Check Q201 and CR201 Replace faulty component.
B. Check continuity of all windings.
C. Check continuity from front panel to Output Board.
D. If U1 pin 2 or U1 pin 8 do not go to ground when keyed, replace P11 or P12.

Trouble Symptom

4. One or both modes inoperative from footswitch but operate normally from front panel with audio tones.

Probable Cause

A. Improper connection from footswitch (A,B and C) to P102 and ground.

Solution

A. Check continuity from pin B to ground, footswitch pin A to P102, footswitch pin C to P102.

Trouble Symptom

5. Both modes inoperative from footswitch, but operate properly from front panel with no audio tones.

Probable Cause

A. P102 disconnected.

Solution

A. Check continuity of P102.

Trouble Symptom

6. Both modes operate from front panel and footswitch, but not audio.

Probable Cause

A. U9 faulty.
B. Speaker or volume control faulty.

Solution

A. Check for signal on U9 pin 3 while keyed. If none, replace U9.
B. If signal is present, replace the speaker or volume control.

Trouble Symptom

7. Both modes operate but no Cut light.

Probable Cause
- A. Cut LED 1 faulty.
- B. Q111 faulty.

Solution
- A. Replace LED 1.
- B. Replace Q111.

Trouble Symptom

8. Both modes operate but no Coag light.

Probable Cause
- A. Coag DS1 faulty.
- B. Q110 faulty.

Solution
- A. Replace DS1.
- B. Replace Q110.

Trouble Symptom

9. Coag operational, Cut light and audio ok, no output Cut.

Probable Cause
- A. P101 pin 2 stays at ground instead of varying from OV to + 12V with Cut control pot.
- B. U4 pin 3 stays at ground instead of varying from OV to +12 with Cut control pot.
- C. U4 pin 8 stays at ground instead of varying from OV to +4 with Cut control pot while keyed in Cut.

Solution
- A. Replace R302.
- B. Replace R130.
- C. Replace U4.

Trouble Symptom

10. Cut operational, Coag light and audio of, no output Coag.

Probable Cause
- A. P101 pin 1 stays at ground instead of varying from OV to +12V with Coag control pot.
- B. U4 pin 9 stays at ground instead of varying from OV to +12V with Coag pot.
- C. U4 pin 8 stays at ground instead of varying from OV to +4.5 with Coag control pot while keyed in Coag.

Solution
A. Replace R303.
B. Replace R128.
C. Replace U4.

Trouble Symptom

11. No output in Cut or Coag. Indicator lights and audio function properly.

Probable Cause
A. F1 blown and/or Q301 shorted.
B. No ramp signal on U8 pin 6, see Photo #1.
C. No clock signal on U8 pin 3, see Photo #2.
D. No CTE + GGE signal on U4 pin 11 when keyed.
E. No CTE + GGE signal on U6 pin 13 when keyed.
F. No signal on U5 pin 12, see Photo #3.
G. No clock signal on U2 pin 4.
H. No signal on U5 pin 11,9 or 6. See photo #4.
I. No signal on U3 pin 3, Photo #5.
J. No signal on U2 pin 2. See photo #6.
K. No signal on U6 pin 6. See photo #7.

Solution
If good, proceed to the next step. If not:
A. Replace F1 and/or Q301 after verifying proper T/OFF signal at pin 6. See photo #7.
B. Replace Q102.
C. Replace U8, U2, or U5.
D. If remains at +12V, replace U3.
E. If remains at ground, replace U3, Q101 and/or CR101.
F. If remains at ground, replace U7 or U5.
G. Replace U2 or U5.
H. Replace U5.
I. Replace U3 or U2.
J. Replace U2 or U6.
K. Replace U6, U5, and/or U3 if U6 pin 8 is at +12V.

NOTE: At this point, if no faulty component has been found, disconnect the base-emitter connector of Q301 and continue troubleshooting.

Probable Cause (Cont)
L. U6 pin 8 remains at ground.
M. U2 pin 7 remains at +12V.
N. U7 pin 13 remains at +12V.
O. No signal on U3 pin 11, see photo #8.
P. U4 pin 13 remains at +12V.
Q. U4 pin 12 remains at ground.
R. U7 pin 6 remains at +12V when keyed.
S. U6 pin 12 remains at ground when keyed.
T. U6 pin 10 remains at ground when keyed.
U. U2 pin 15 remains at +12V when keyed.
V. Base of Q113 remains at ground when keyed, see Photo #9.
W. Open between collector of Q301 and pins 11,12,13.

Solution (Cont)

L. Replace U6,U2 or U5 if U2 pin 7 is at ground.
M. Replace Q107, Q108, Q112 or Q115 if U7 pin 13 is at ground (with occasional pulses).
N. Replace U7.
O. Replace U3 or U6.
P. Replace U5 or U4.
Q. Replace U4.
R. Replace U4.
S. Replace U7 or U6.
T. Replace U6 or U2.
U. Replace U2 or Q103.
V. Replace Q113, Q109, CR106 or CR107.
W. Replace CR301 or K201.

Trouble Symptom

12. Temperature of Q301 raises rapidly and transistor fails in very short time.

Probable Cause

A. Turn off circuit faulty. Waveform of base of Q106 is incorrect. See photo #10.
B. No signal on U6 pin 6.

Solution

A. Verify signal on U6 pin 6 (photo #7). If good, replace Q104, Q105 or Q106.
B. Replace U6, U5 and/or U3 if U6 pin 8 is at +12V.

Trouble Symptom

13. Persistant REM™ alert prevents keying.

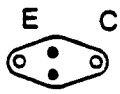
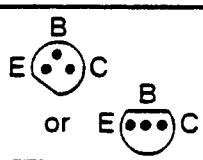
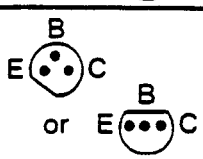
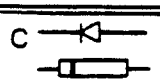
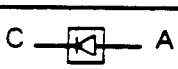
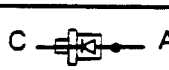
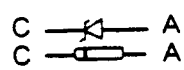
Probable Cause

A. Faulty wiring to REM™ circuit board, adapter jacks or microswitch

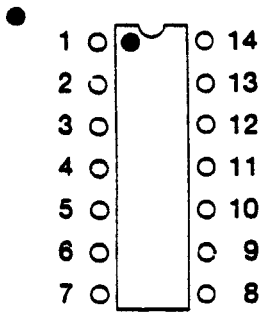
B. Improper calibration; adjust R20 to trip at 135 ohms and R15 to trip at 5 ohms with microswitch open.

C. Adjust L1 to peak voltage TP1 with E1-E2 open circuited.

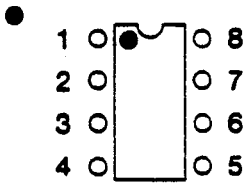
The following readings are approximate due to the different ranges and batteries of various ohmmeters. All measurements should be made with the components removed from the circuit.

TRANSISTOR	TYPE	BASE DIAGRAM (BOTTOM VIEW)	CONNECT (+) LEAD OF OHMMETER TO LEAD	CONNECT (-) LEAD OF OHMMETER TO LEAD	METER READING X1 OR X10 SCALE
Q301	FESE 178		B B E E C	C E C B B	1K TO 3K OHMS 1K TO 3K OHMS 100K TO 300K OHMS 100K TO 300K OHMS INFINITE
Q107 Q109 Q115	2N2905A 2N2907A		B B E E C	C E C B B	INFINITE 75K TO 150K OHMS INFINITE 40 TO 100 OHMS 40 TO 100 OHMS
Q101 Q110 Q103 Q111 Q104 Q114 Q105 Q201	2N3904 2N2222 2N3568		B B E E C	C E C B B	40 TO 100 OHMS 40 TO 100 OHMS 75K TO 150K OHMS 100K TO 300K OHMS INFINITE
Q102 Q108	2N3906		B B E E C	C E C B B	INFINITE 75K TO 150K OHMS INFINITE 1K TO 10K OHMS 1K TO 10K OHMS
Q106	D45C6		B B E E C	C E C B B	INFINITE 75K TO 150K OHMS INFINITE 1K TO 10K OHMS 1K TO 10K OHMS
Q113	D44C6		B B E E C	C E C B B	1K TO 10K OHMS 1K TO 10K OHMS 100K TO 250K OHMS 100K TO 250K OHMS INFINITE
U10	LM340T-12		1 1 2 2 3	3 2 1 3 1	10K TO 40K OHMS 10K TO 40K OHMS 500 TO 1.5K OHMS 5K TO 15K OHMS 500 TO 1.6K OHMS
DIODE	TYPE	DIAGRAM			
CR102 THRU CR108	1N4148		C A	A C	INFINITE OR HIGH 1K TO 10K OHMS
CR109 THRU CR112	MR751		C A	A C	INFINITE OR HIGH 1K TO 10K OHMS
CR301	MR1376		C A	A C	INFINITE OR HIGH 1K TO 10K OHMS
CR101 CR113	1N758A 1N5352		C A	A C	INFINITE OR HIGH 1K TO 10K OHMS

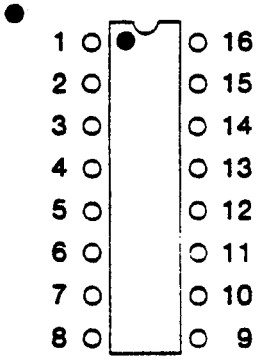
MASTER BOARD TOP VIEW (COMPONENT SIDE)
Integrated Circuit Lead Numbering
Dots on P.C. board indicate Pin #1 (All I.C.'s have the same orientation)



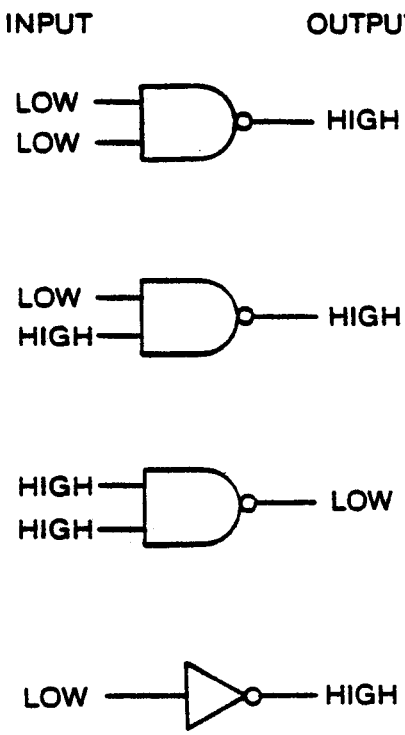
U1
U3
U4
U5
U6
U7

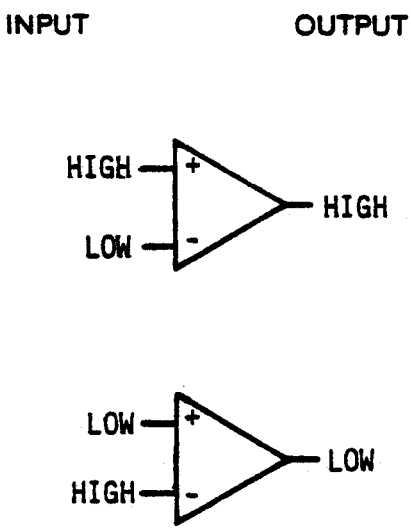


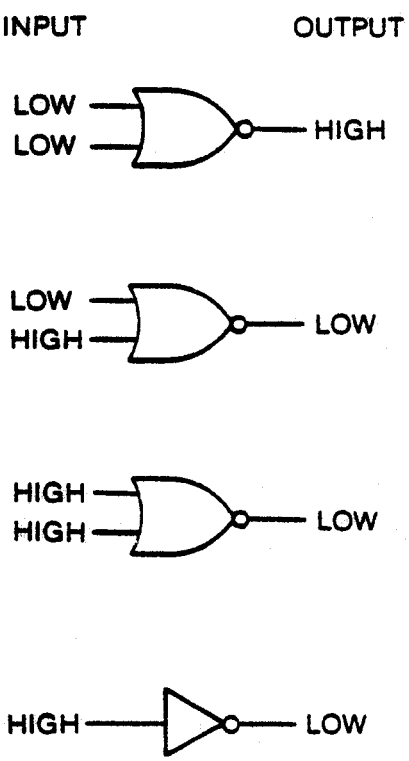
U8
U9

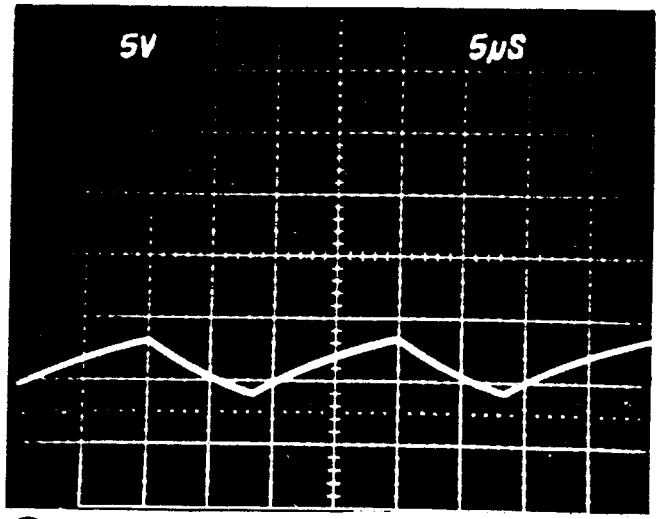


U2

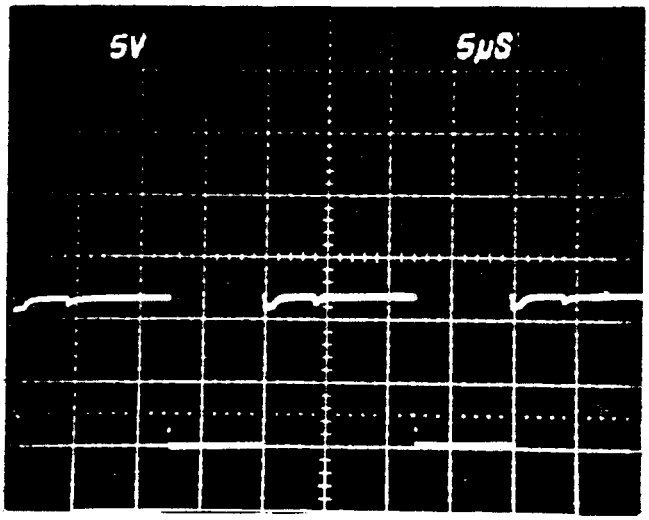




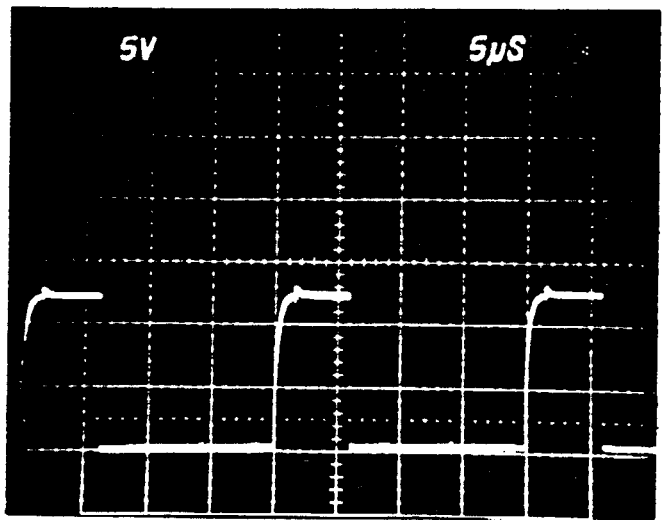




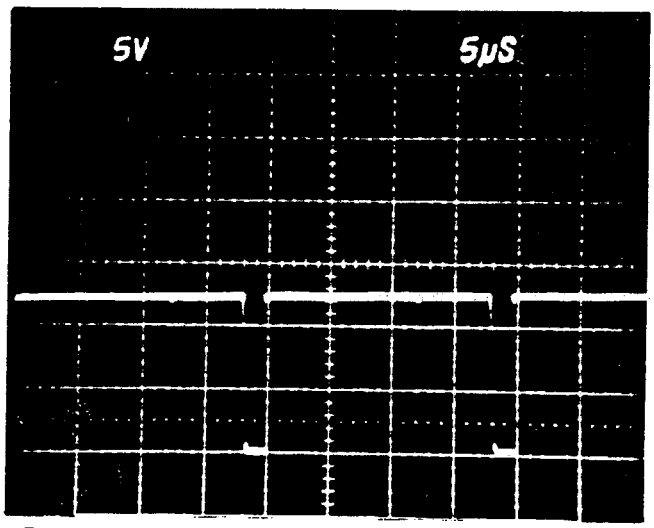
1 U8 PIN 6



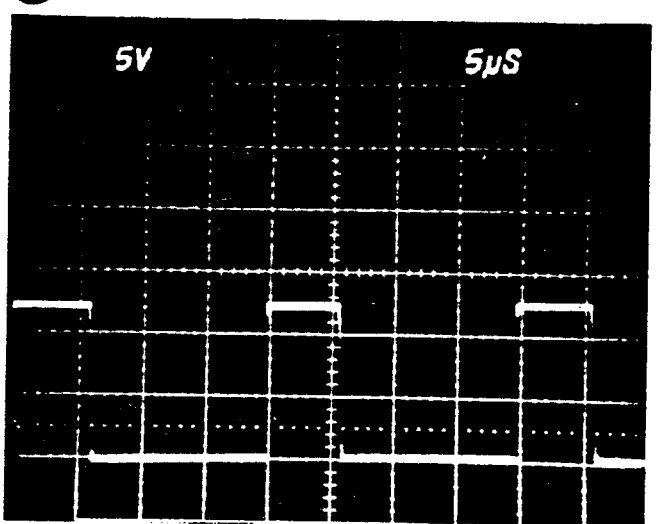
2 U8 PIN 3



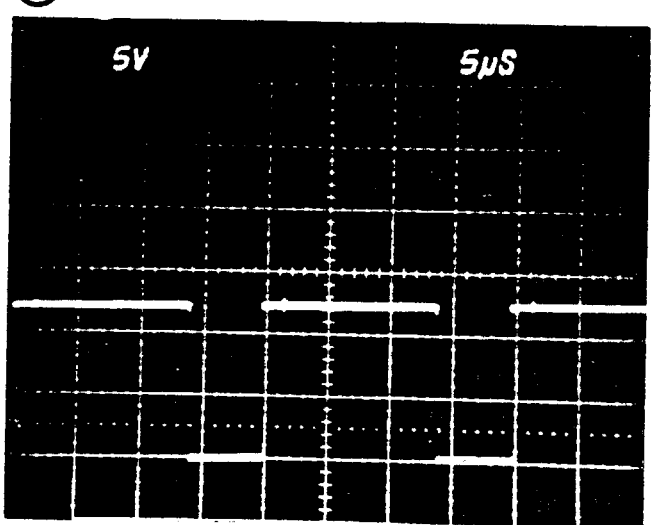
3 U5 PIN 12



4 U5 PIN 11

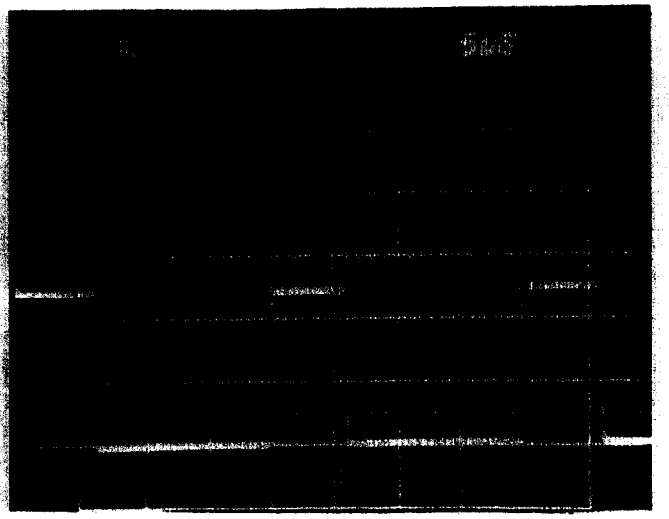


5 U3 PIN 3

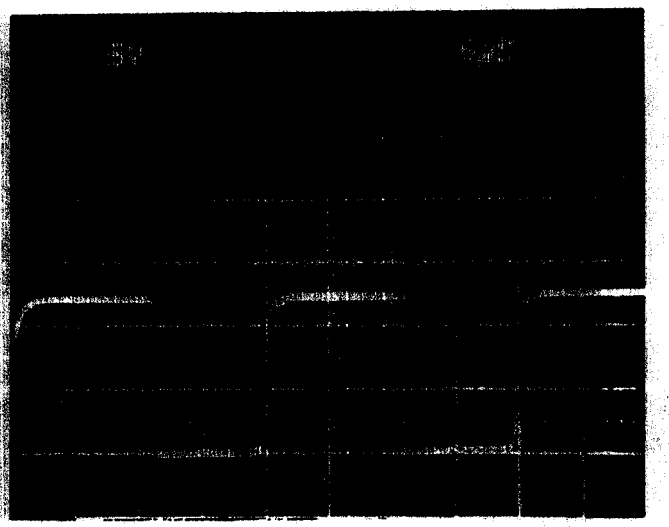


6 U2 PIN 2

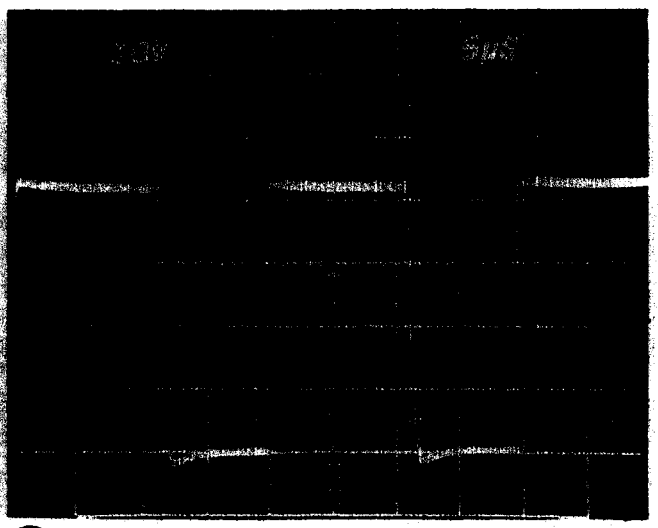
Figure 8 Waveform Charts



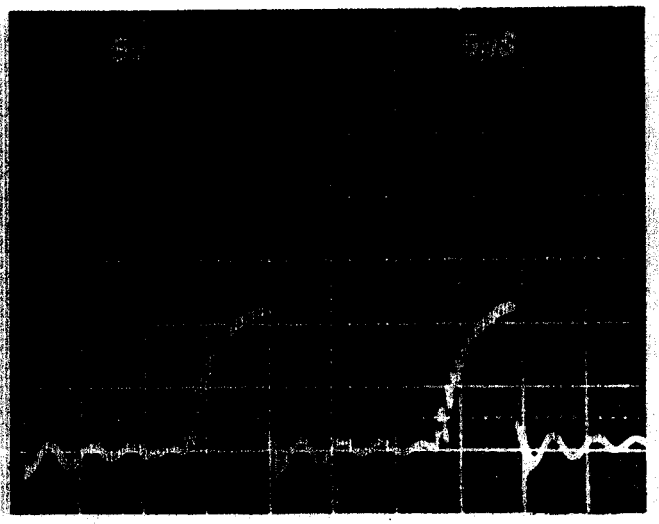
(7) U6 PIN 6



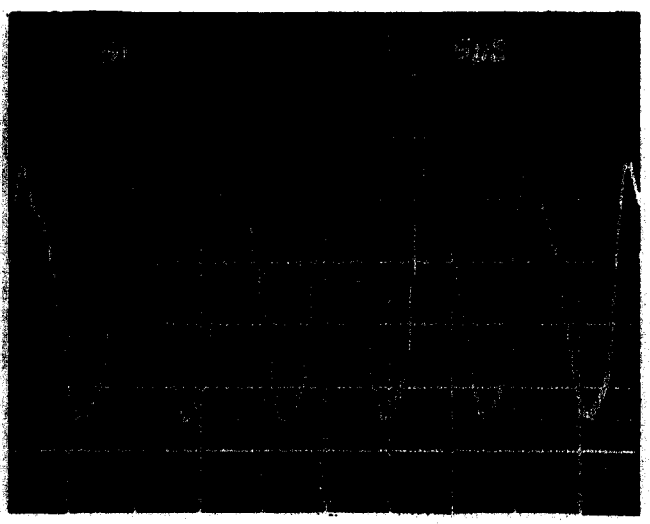
(8) U3 PIN 11



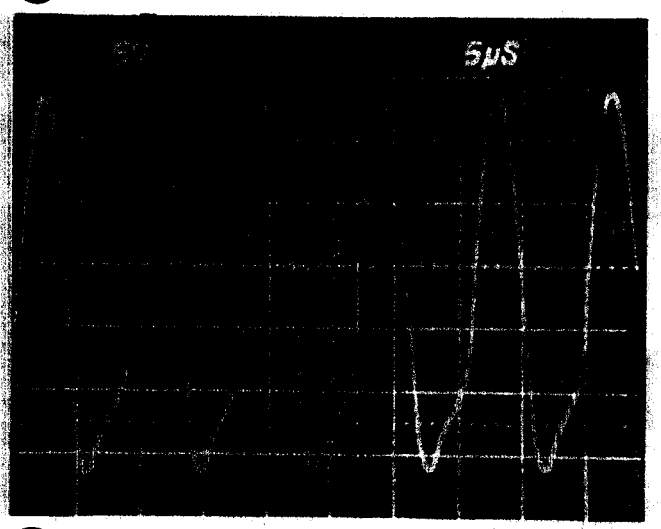
(9) BASE Q113 UNIT KEYED



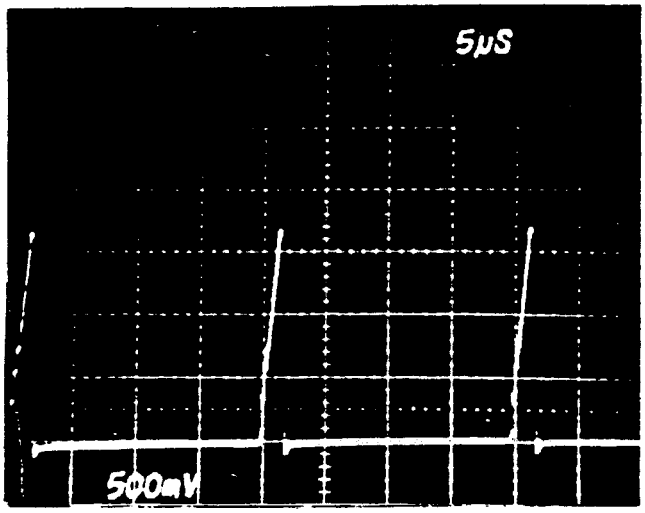
(10) BASE Q106



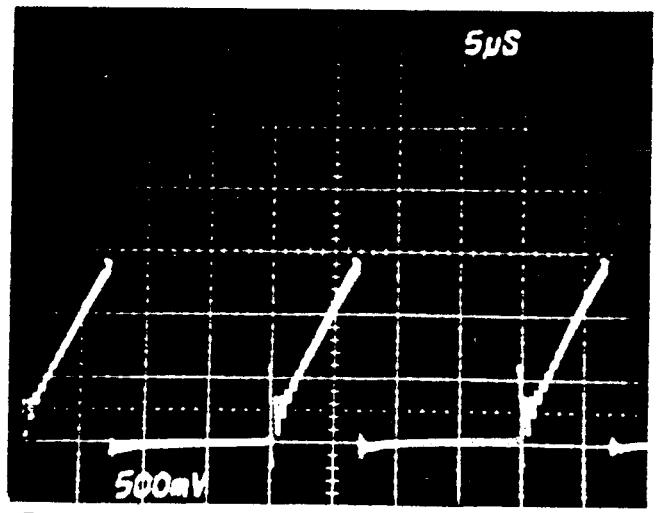
(11) COLLECTOR Q201 UNIT IDLE



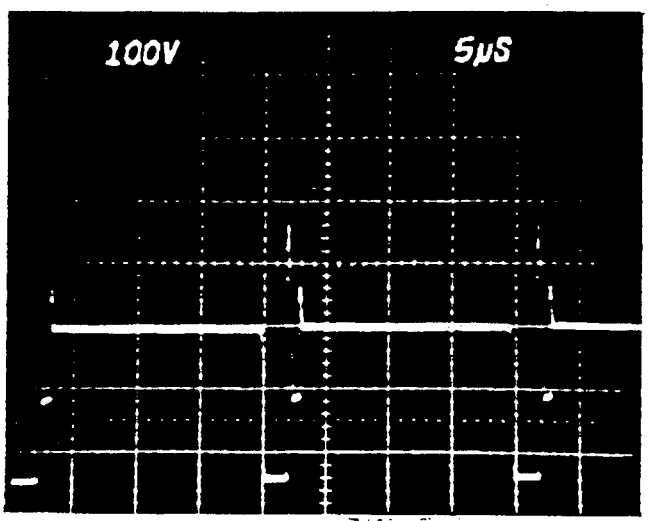
(12) COLLECTOR Q201 UNIT KEYED



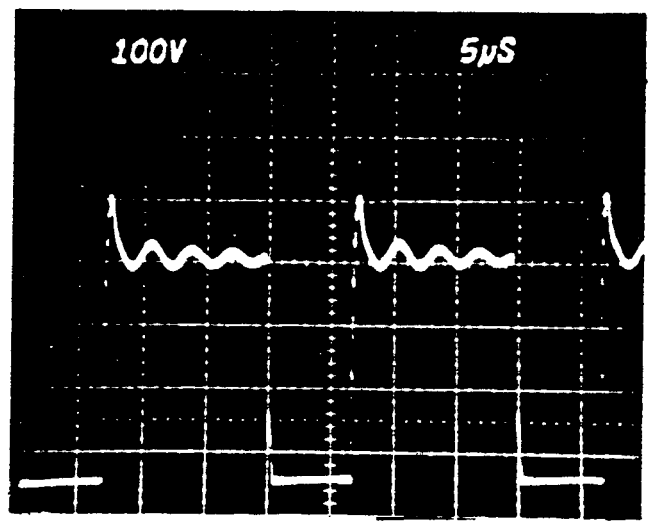
(13) Q301 COLLECTOR I, LOADED



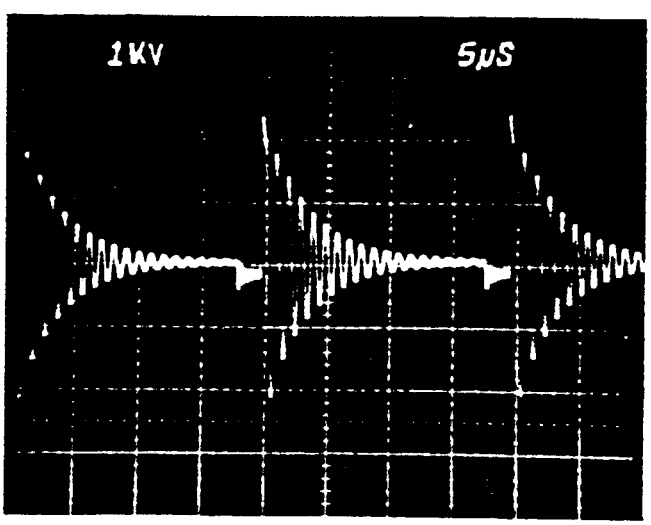
(14) Q301 COLLECTOR I, LOADED



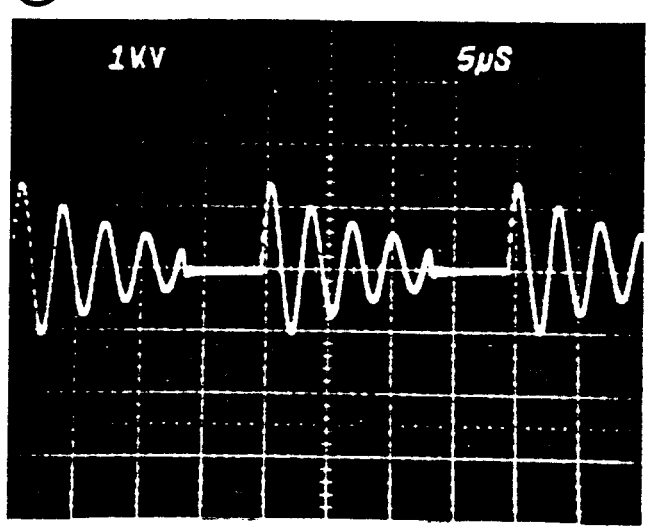
(15) Q301 COLLECTOR V, OPEN CIRCUIT



(16) Q301 COLLECTOR V, OPEN CIRCUIT



(17) OUTPUT V, OPEN CIRCUIT



(18) OUTPUT V, OPEN CIRCUIT

COAG SETTING OF "10"

CUT SETTING OF "10"

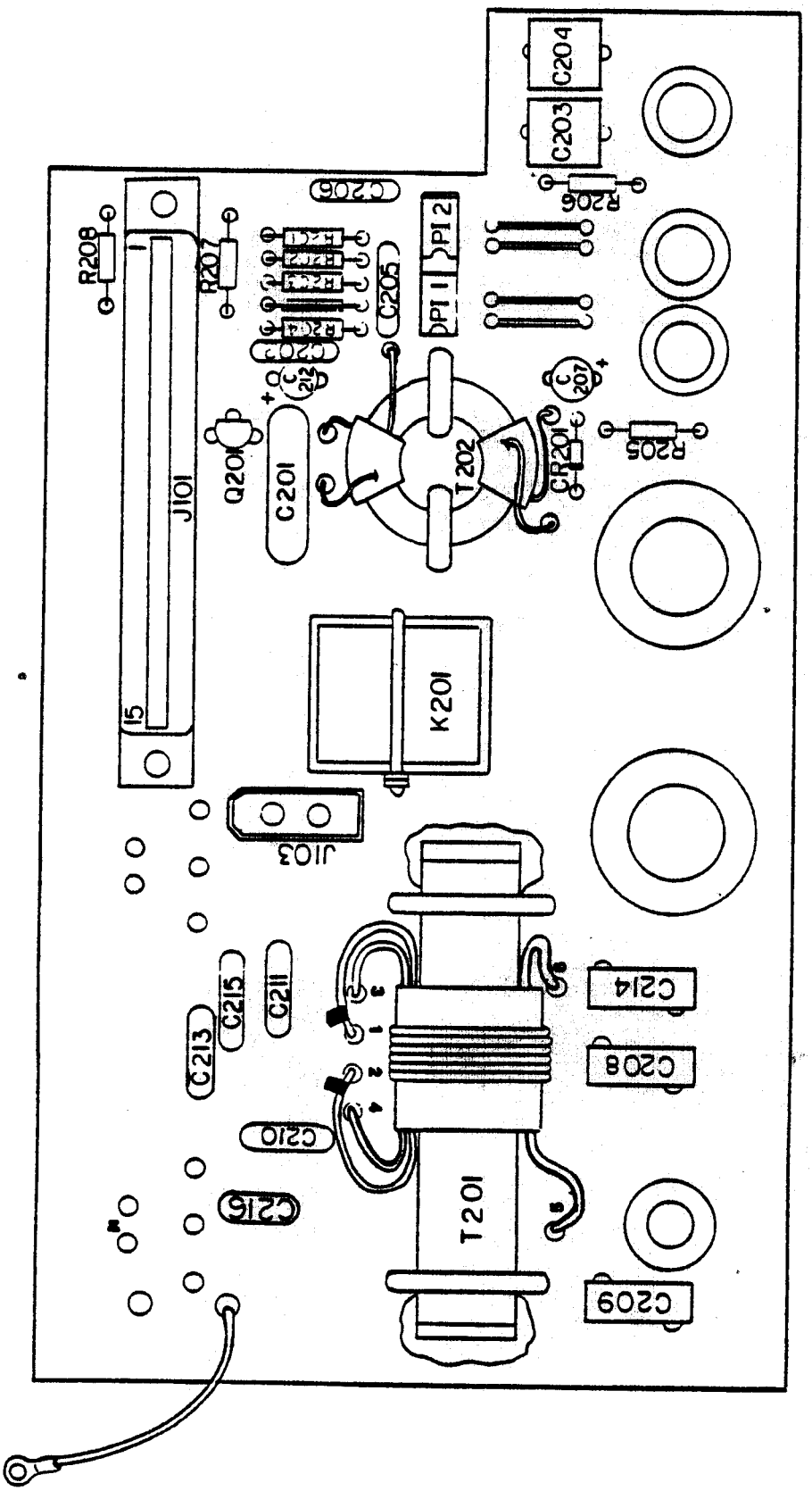


FIGURE 9

115V OUTPUT BOARD

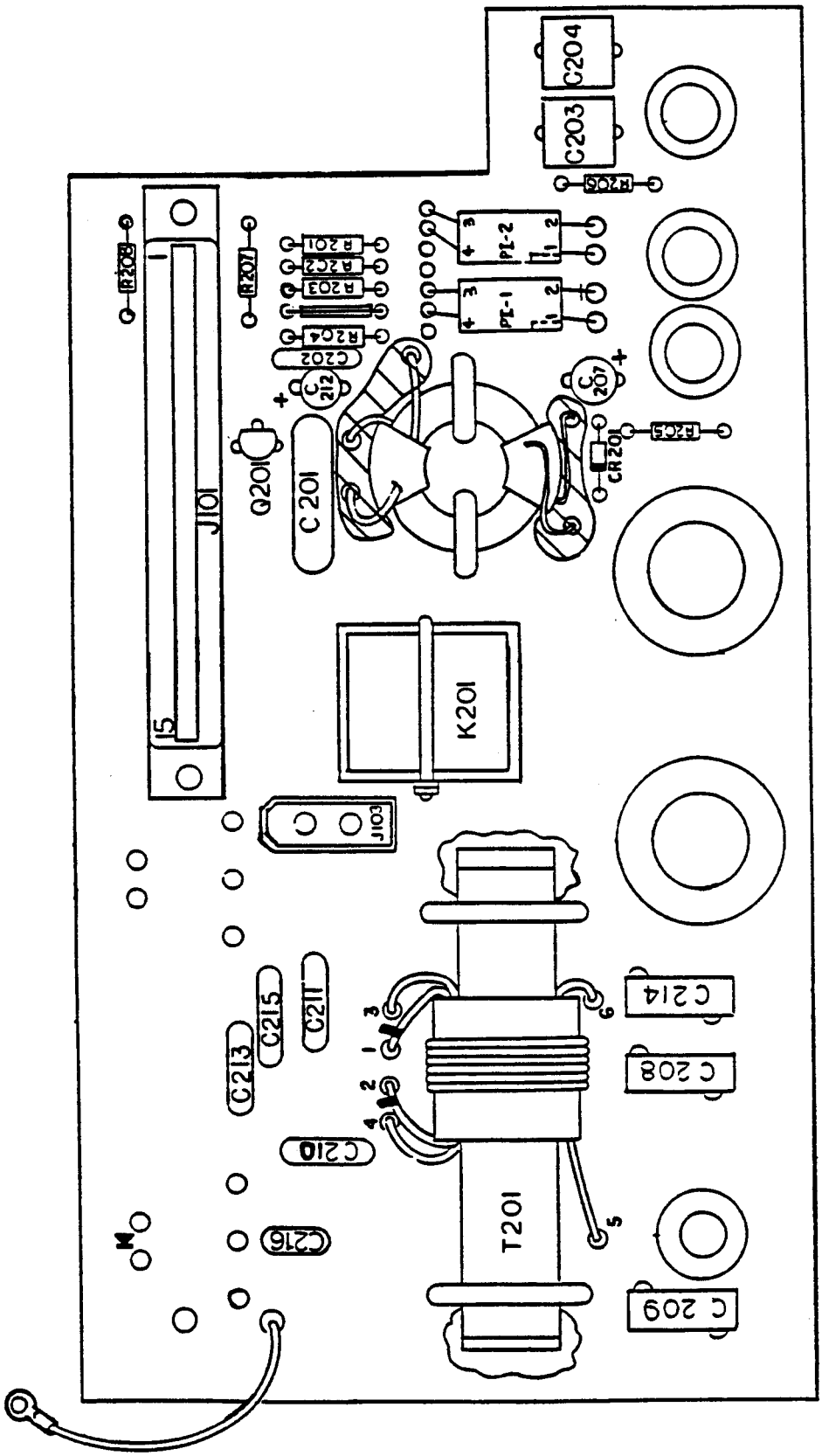


FIGURE 9 CONT.

230V OUTPUT BOARD

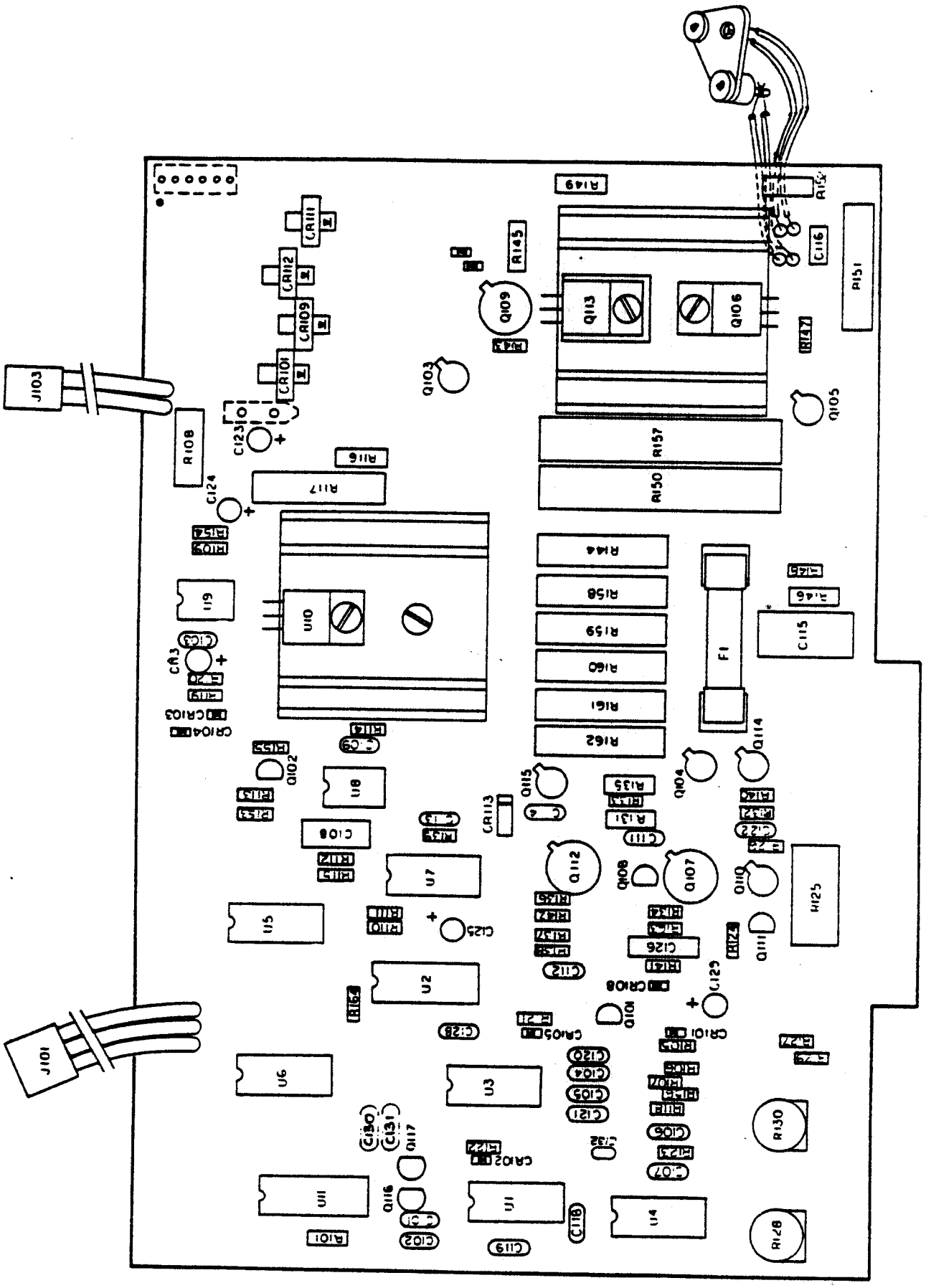


FIGURE 10

MASTER BOARD ASSY 201 089 002

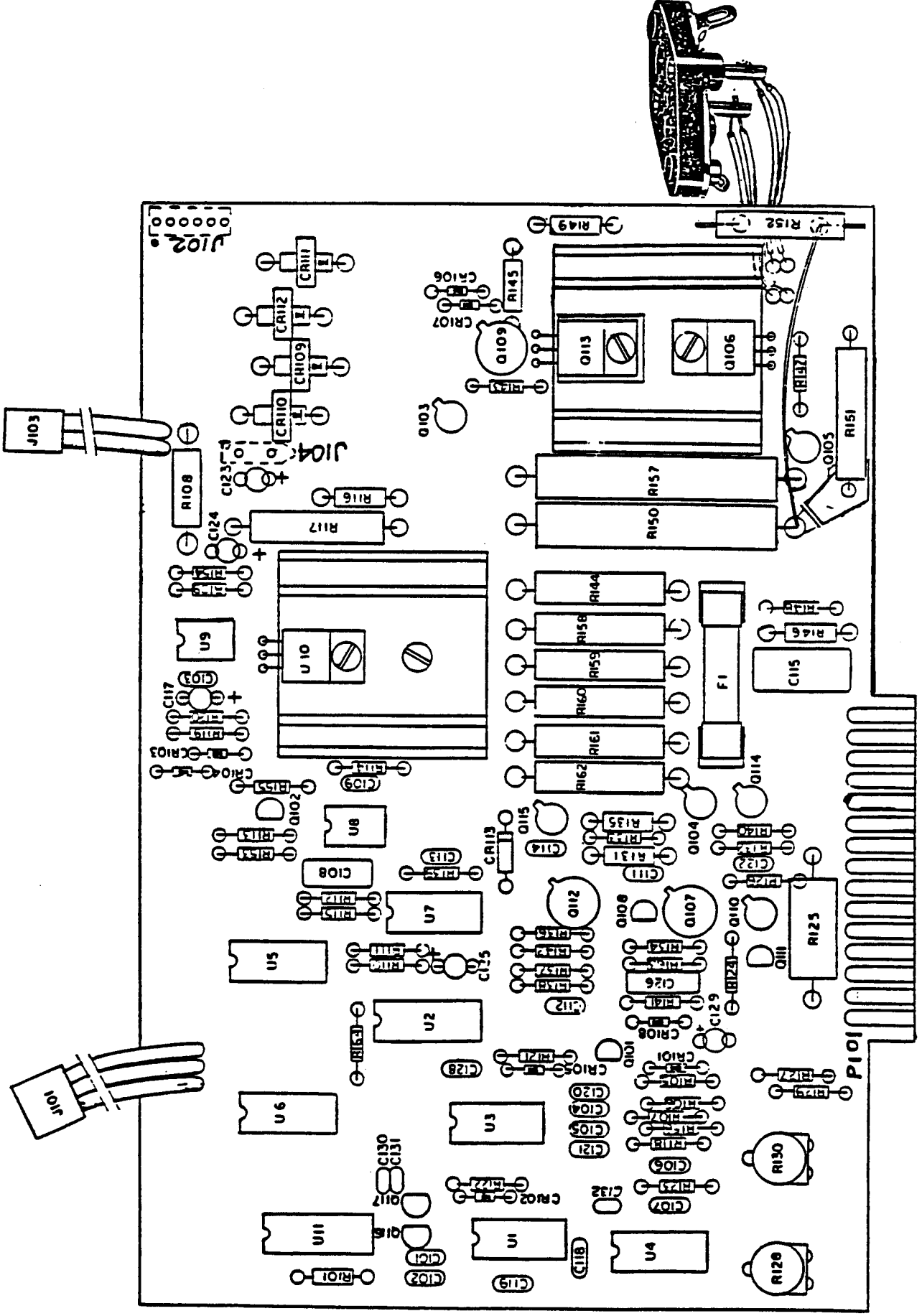


FIGURE 10 CONT.

MASTER BOARD ASSY 201 089 003

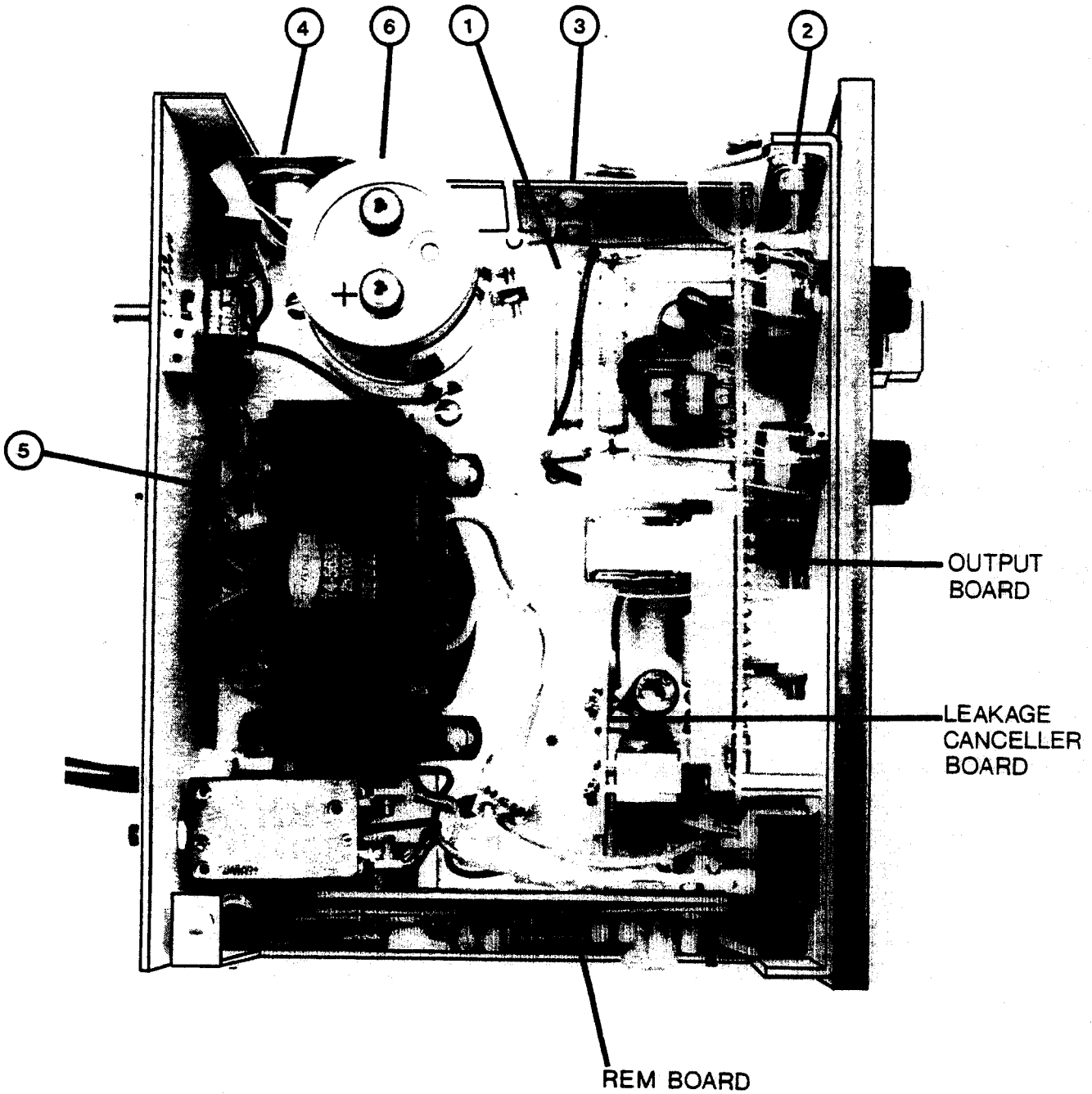


FIGURE 11

CHASSIS COMPONENTS

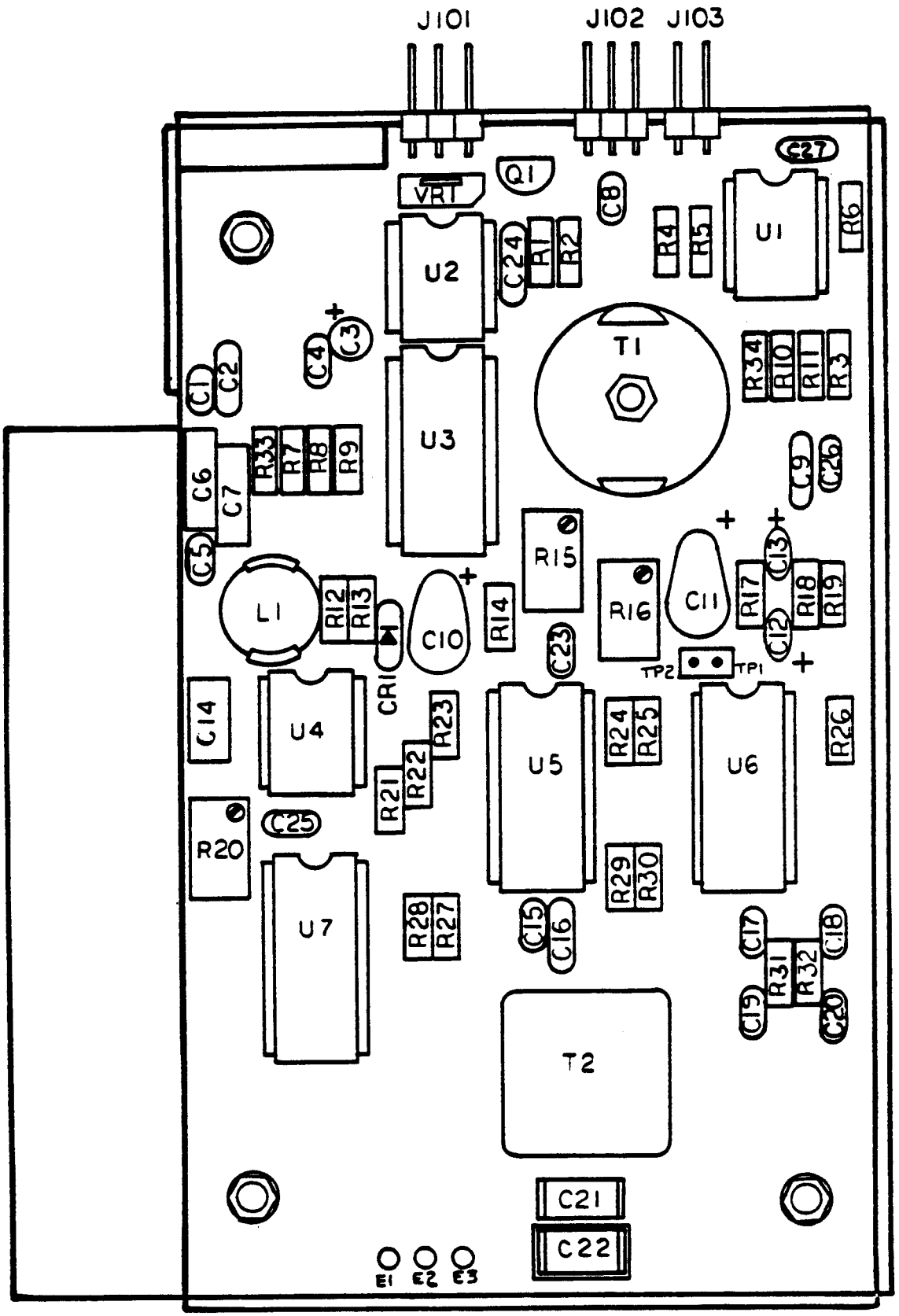


FIGURE 12

REM™ BOARD

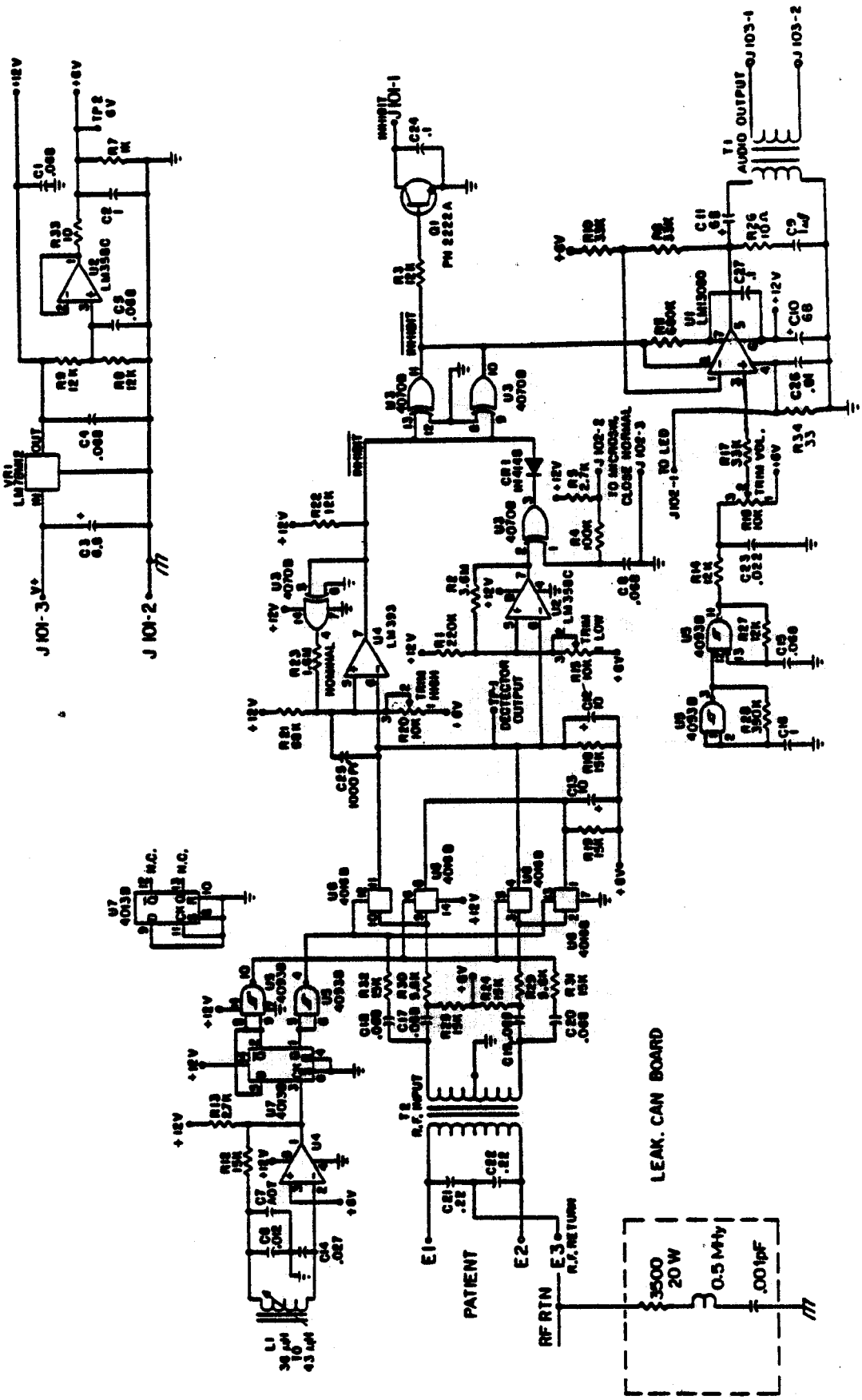


FIGURE 13

REM™ SCHEMATIC

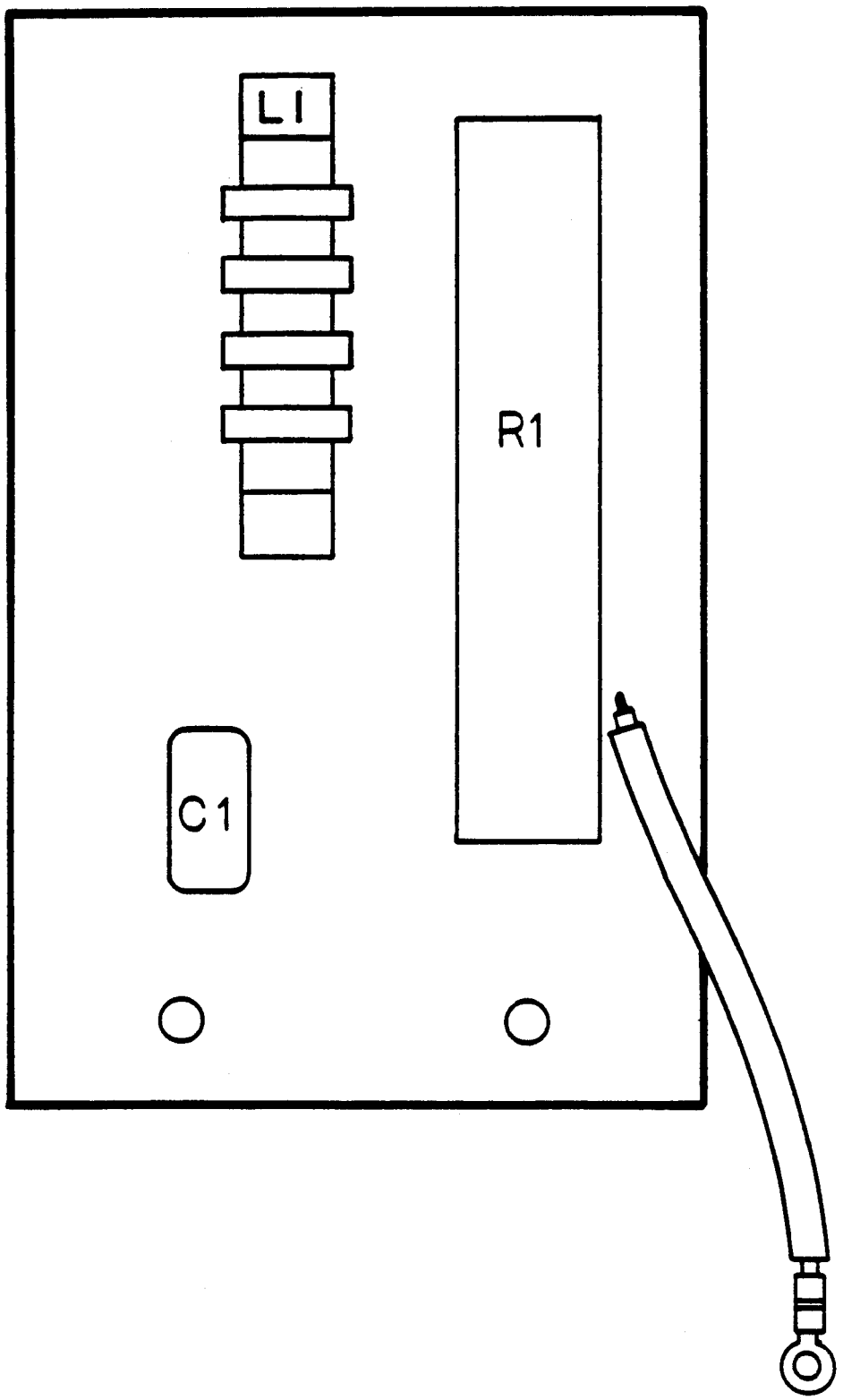


FIGURE 14

LEAKAGE CANCELLER BOARD

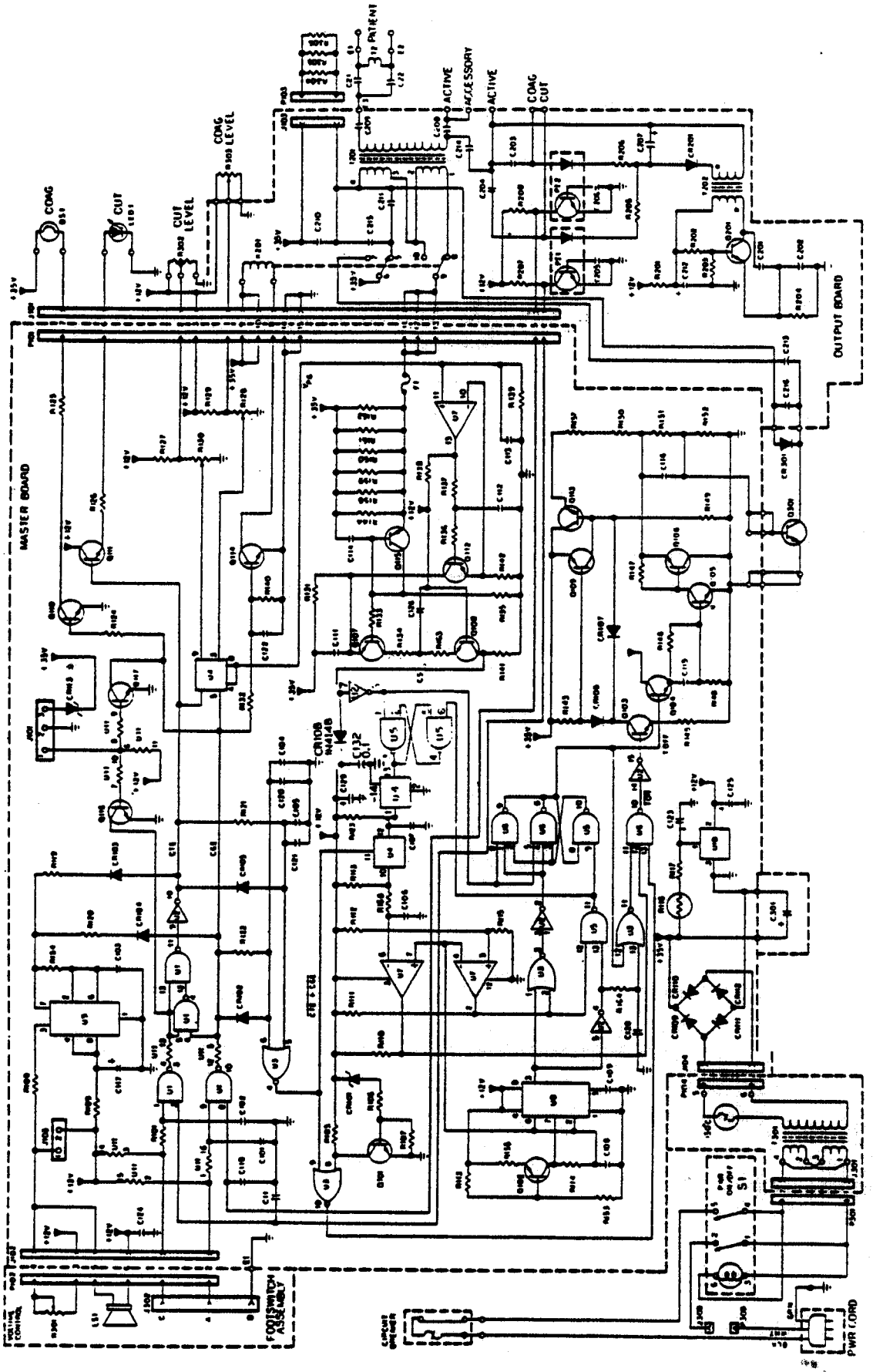


FIGURE 15

MASTER SCHEMATIC, ASSY 201 089 002

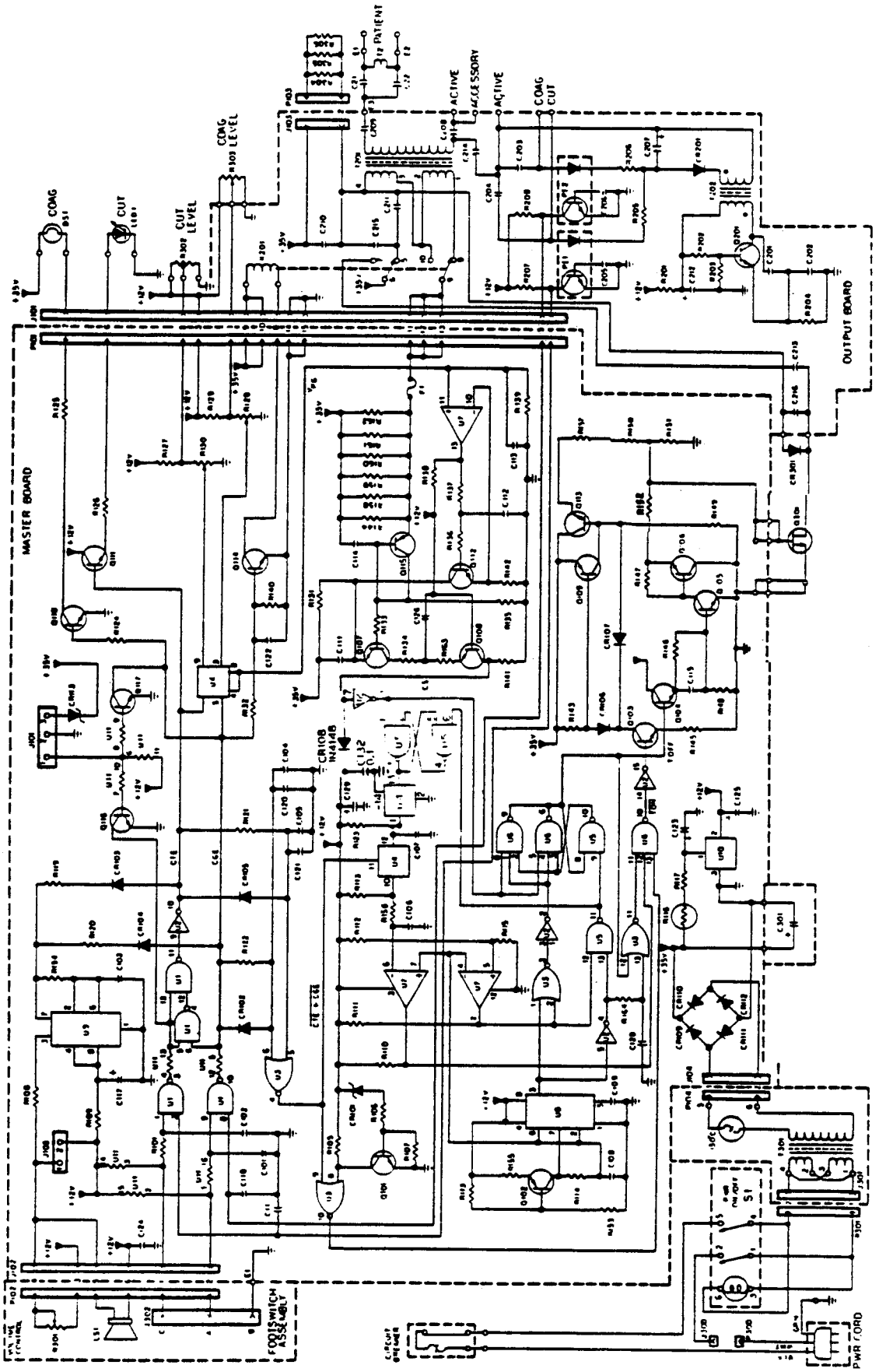


FIGURE 15 CONT.

MASTER SCHEMATIC, ASSY 201 089 003

SECTION 8

PARTS LIST

FRONT PANEL OPERATING CONTROLS (Fig. 1)

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
Item 1	POWER SWITCH ASSEMBLY	202 700 033 (115V) 202 701 073 (230V)
Item 1 (S1)	POWER SWITCH	243 030 003 (115V) 243 038 000 (230V)
Item 2 (DS1)	COAG INDICATOR	215 200 011
Item 2	BLUE LENS COVER	215 200 507
Item 3 (L1)	CUT INDICATOR, YELLOW	239 070 005
Item 4 (R303)	COAG LEVEL CONTROL, 10K	236 100 000
Item 4	KNOB	213 047 000
Item 5 (R302)	CUT LEVEL CONTROL, 10K	236 100 000
Item 5	KNOB	213 047 000
Item 6	ACTIVE & KEYING JACKS	222 548 000
Item 7	ACCESSORY JACK	222 089 000
Item 8	REM™ ADAPTER ASSEMBLY	202 701 049

REAR PANEL OPERATING CONTROLS (Fig. 2)

Item 9 (CBI)	CIRCUIT BREAKER, 3 AMP	243 100 000 (115V) 243 100 001 (230V)
Item 10	FOOTSWITCH JACK ASSEMBLY	202 700 035
Item 11	POWER CORD ASSEMBLY	202 400 092 (115V) 202 400 268 (230V)
Item 11	HOSPITAL GRADE PLUG	208 104 000 (115V) 208 177 000 (230V)
Item 12 (R301)	VOLUME CONTROL POT	236 006 000

OUTPUT BOARD — 201 090 000 G (115V)
201 090 001 E (230V)

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R201	10 ohm ± 5%, 1/4W	234 024 015
R202	2.2K ohm ± 5%, 1/4W	234 024 071
R203	1.2K ohm ± 5%, 1/4W	234 024 065
R204, 205, 206	100 ohm ± 5%, 1/4W	234 024 039
R207, 208	10K ohm ± 5%, 1/4W	234 024 087

OUTPUT BOARD (Cont'd)

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
CAPACITORS		
C201	.012uf ± 10%, 600V	204 067 001
C202	.047uf ± 15%, 50V	204 200 107
C203,204	1uf ± 5%, 100V	204 078 010
C205,206	220uf ± 10%, 600V	204 079 033 (115V)
C207,212	10uf ± 20%, 20V	204 055 010
C208,209,214	2200uf ± 20%, 6KV	204 025 044
C210	5100uf ± 5%, 500V	204 105 043
C211	7500uf ± 5%, 500V	204 080 000
C213	820uf ± 10%, 1KV	204 079 052
C215	4300uf ± 5%, 500V	204 105 041
C216	240uf ± 5%, 500V	204 105 011
SEMICONDUCTORS		
CR201	DIODE 1N4148	239 014 000
Q201	TRANSISTOR 2N3568	239 017 000
PI-1,-2	OPTOISOLATOR 4N35	239 750 002 (115V)
	OPTOISOLATOR 1264B	239 750 019 (230V)
MISCELLANEOUS		
K201	RELAY A/Z #420-56-4HUS	230 005 003
T201	OUTPUT TRANSFORMER	202 900 004
T202	TOROID ASSEMBLY	202 306 000

MASTER BOARD

201 089 002 D
201 089 003 A

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R101	2K ohm ± 5%, 1/4W	234 024 070
R105,118,121,164	33K ohm ± 5%, 1/4W	234 024 099
R106,126,136	1.0K ohm ± 5%, 1/4W	234 024 063
R107,140,141	2.2K ohm ± 5%, 1/4W	234 024 071
R108	47 ohm ± 10%, 1W	234 004 001
R109	33 ohm ± 5% , 1/4W	234 024 027
R110,111	6.8K ohm ± 5%, 1/4W	234 024 083
R112	3.6K ohm ± 5%, 1/4W	234 024 076
R113	15K ohm ± 5%, 1/4W	234 024 091
R114	4.87K ohm ± 1%, 1/8W	234 201 355
R115	2.7K ohm ± 5%, 1/4W	234 024 073
R116	20 ohm ± 10%, 1W	234 025 000
R117	100 ohm ± 5%, 5W	234 027 055
R119	82K ohm ± 5%, 1/4W	234 024 109
R120	39K ohm ± 5%, 1/4W	234 024 101
R122,123,156	330K ohm ± 5%, 1/4W	234 024 123
R124	12K ohm ± 5%, 1/4W	234 024 089
R125	430 ohm ± 5%, 5W	234 027 073
R127	1.8K ohm ± 5%, 1/4W	234 024 069
R128,130	50K ohm ± 20%, 1/2W	236 200 038
R129	3.0K ohm ± 5%, 1/4W	234 024 074
R131	220 ohm ± 5%, 1/2W	234 014 034
R132	22K ohm ± 5%, 1/4W	234 024 095
R133	270 ohm ± 5%, 1/4W	234 024 049
R134,163	240 ohm ±5%, 1/4W	234 024 048
R135	3.9K ohm ± 5%, 1/2W	234 014 011
R137,138	5.6K ohm ± 5%, 1/4W	234 024 081
R139	1MEG ohm ± 5%, 1/4W	234 024 135
R142	390 ohm ±5%, 1/4W	234 024 053
R143	100 ohm ± 5%, 1/4W	234 024 039
R144,158-162	1 ohm ± 5%, 5W	234 027 001
R145,149	560 ohm ± 5%, 1/2W	234 014 039
R146	330 ohm ± 5%, 1/2W	234 014 036
R147	56 ohm ± 5%, 1/4W	234 024 033
R148	330 ohm ± 5%, 1/4W	234 024 051
R150,157 (-002)	7.5 ohm ± 5%, 11W	234 018 007
R150,157 (-003)	15 ohm ± 5%, 11W	234 018 002
R151 (-002)	10 ohm ± 5%, 5W	234 027 027
R151 (-003)	22 ohm ± 5%, 5W	234 027 035
R152 (-002)	10 ohm ± 5%, 1/2W	234 014 068
R152 (-003)	10 ohm ± 5%, 5W	234 027 027
R153,154	10K ohm ± 5%, 1/4W	234 024 087
R155	1.1K ohm ± 5%, 1/8W	234 201 293

MASTER BOARD (Cont'd)

CAPACITORS

C101, 102, 109, 111, 112, 118, 119	0.1uf ± 20%, 100V	204 049 001
C103	.047uf ± 15%, 50V	204 200 107
C104-106, 113, 120-122	.1uf ± 20%, 25V	204 050 000
C107	.001uf ± 10%, 1KV	204 079 054
C108	2200uf ± 5%, 500V	204 105 034
C114	.0015uf ± 10%, 1KV	204 079 059
C115	5100uf ± 5%, 500V	204 105 043
C116 (not used on -003)	.47uf ± 5%, 100V	204 078 006
C117, 124, 125, 129	10uf ± 20%, 20V	204 055 010
C123	10uf ± 20%, 35V	204 104 048
C126	2500uf ± 5%, 500V	204 105 044
C128	47uf ± 10%, 600V	204 079 019
C130, 131	.010uf ± 15%, 100V	204 200 037
C132	0.1uf ± 20%, 50V	204 118 007

INTEGRATED CIRCUITS

U1,5	4011	210 003 000
U2	4049B	210 210 049
U3	4001B	210 210 001
U4	4016B	210 210 016
U6	4023	210 002 000
U7	LM339AN	210 300 015
U8,9	NE555N	210 006 000
U10	LM340T-12	210 021 004
U11	RESISTOR NETWORK, 2K	234 100 131

SEMICONDUCTORS

CR101	1N758A (10V ZENER)	239 600 010
CR102 thru 108	1N4148	239 014 000
CR109 thru 112	MR751	239 041 000
CR113	1N5352	239 600 628
Q101, 111, 116, 117	2N3904	239 015 000
Q102, 108	2N3906	239 047 000
Q103-105, 110, 114	2N2222A	239 100 001
Q106	D45C6	239 046 000
Q107, 109	2N2905A	239 019 000
Q112	MM3724	239 052 000
Q113	D44C6	239 051 006
Q115	2N2907A	239 016 000

MISCELLANEOUS

F1	FUSE 3AG, 10 AMP	215 005 042
Q301	SOCKET (used w/ FESE178)	208 090 000
Q301	SOCKET (used w/ 21N50)	208 500 030

CHASSIS COMPONENTS (Fig. 11)

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
Item 1	RESISTOR ASSEMBLY	202 700 064
Item 1 (R304-R306)	1.2K ohm, 11W	234 018 004
Item 2 (CR301)	POWER DIODE, SUES 708	239 042 000
Item 3 (Q301)*	POWER TRANSISTOR FESE178	239 300 008
(Q301)**	POWER TRANSISTOR 21N50	239 200 023
Item 4	SPEAKER, 8 OHM	241 003 000
Item 5	TRANSFORMER ASSY	202 900 002 (115V)
		202 900 014 (230V)
Item 5 (T301)	TRANSFORMER	251 034 000 (115V)
		251 200 002 (230V)
Item 6 (C301)	6500uf, 50V	204 075 000

* FESE178 is used with Master Board Assy 201 089 002
** 21N50 is used with Master Board Assy 201 089 003

REM™ BOARD 201 135 011 B

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
RESISTORS		
R1	220K ohm ± 5%, 1/4W	234 024 119
R2	3.6M ohm ± 5%, 1/4W	234 024 147
R3, 8, 9, 14, 22, 27	12K ohm ± 5%, 1/4W	234 024 089
R4	100K ohm ± 5%, 1/4W	234 024 111
R5, 13	2.7K ohm ± 5%, 1/4W	234 024 073
R6, 10, 17	33K ohm ± 5%, 1/4W	234 024 099
R7	1K ohm ± 5%, 1/4W	234 024 063
R11	680K ohm ± 5%, 1/4W	234 024 131
R12, 18, 19, 24, 25, 31, 32	15K ohm ± 5%, 1/4W	234 024 091
R15, 16, 20	TRIMPOT 10K ohm	236 200 079
R21	68K ohm ± 5%, 1/4W	234 024 107
R23	1.8Meg ohm ± 5%, 1/4W	234 024 141
R26, R33	10 ohm ± 5%, 1/4W	234 024 015
R28	390K ohm ± 5%, 1/4W	234 024 125
R29, 30	5.6K ohm ± 5%, 1/4W	234 024 081
R34	33 ohm ± 5%, 1/4W	234 024 027

REM™ BOARD (Cont'd)

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
CAPACITORS		
C1, 4, 5, 8, 15, 17-20	.068uf ± 15%, 50V	204 200 109
C2, 9, 16	1.0uf ± 20%, 50V	204 121 082
C3	6.8uf ± 10%, 35V	204 104 011
C6	.012uf ± 5%, 50V	204 400 100
C7	.0033uf ± 5%, 250V	204 400 077
C10, 11	68uf ± 20%, 15V	204 600 012
C12, 13	10uf ± 20%, 25V	204 102 028
C14	.027uf ± 5%, 50V	204 400 101
C21, 22	.22uf ± 10%, 250V	204 400 120
C23	.022uf ± 20%, 50V	204 121 070
C24, 27	.1 uf ± 20%, 100V	204 121 048
C25	1000uf ± 15%, 100V	204 200 025
C26	.01uf ± 20%, 100V	204 049 001
INTEGRATED CIRCUITS		
U1	LM1308ON	210 400 005
U2	LM358AN	210 300 013
U3	4070B	210 210 070
U4	LM393N	210 300 011
U5	4093B	210 250 094
U6	4016B	210 210 016
U7	4013B	210 027 001
VR1	LM78M12CP	210 300 055
TRANSFORMERS		
T1	TRANSFORMER, AUDIO OUTPUT	202 900 016
T2	TRANSFORMER, R.F. INPUT	202 900 017
L1	COIL, OSCILLATOR	202 900 020
SEMI-CONDUCTORS		
CR1	DIODE, 1N 4148	239 014 000
Q1	2222A	239 100 011

LEAKAGE CANCELLER BOARD 201 198 000 B

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
R1	3.5K ohm ± 5%, 20W	234 023 034
C1	.001 uf ± 20%, 6KV	204 025 041
L1	RF CHOKE	251 029 009

SECTION 9

WARRANTY

Valleylab, Inc. ("Manufacturer") warrants each product manufactured by it to be free from defects in material and workmanship under normal use and service. Manufacturer's obligation under this warranty is limited to the repair or replacement, at its option, of any product, or part thereof, which has been returned to it or its Distributor within the applicable time period shown below after delivery of the product to the original purchaser, and which examination discloses, to Manufacturer's satisfaction, the the product is defective. This warranty does not apply to any product, or part thereof, which has been repaired or altered outside of Manufacturer's factory in a way so as, in Manufacturer's judgement, to affect its stability or reliability, or which has been subjected to misuse, negligence or accident.

The warranty periods for Manufacturer's products are as follows:

Electrosurgical Generators	One year
Mounting fixtures, all models	One year
Footswitches, all models	One year
Return Electrodes	Shelf life only, as stated on packaging
Sterile Disposables	Sterility only, as stated on packaging

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