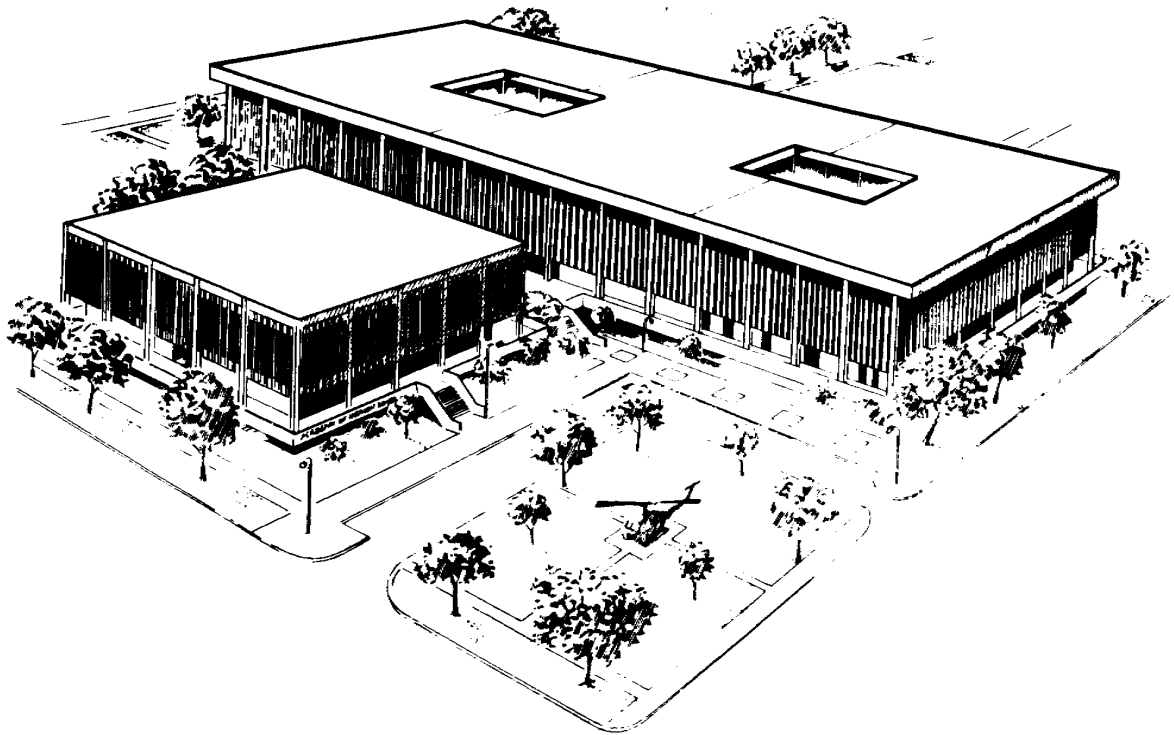


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**U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL  
FORT SAM HOUSTON, TEXAS 78234-6100**

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# **ELECTROSURGICAL APPARATUS**

**SUBCOURSE MD0363    EDITION 100**

## **DEVELOPMENT**

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## **CLARIFICATION OF TERMINOLOGY**

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

## **USE OF PROPRIETARY NAMES**

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## TABLE OF CONTENTS

<u>Lesson</u>		<u>Paragraphs</u>
	INTRODUCTION	
1	PREVENTIVE MAINTENANCE CHECKS AND SERVICES AND VERIFICATION/CALIBRATION	
	Section I. Preventive Maintenance Checks and Services .....	1-1 -- 1-7
	Section II. Verification/ Calibration .....	1-8 -- 1-10
	Exercises	
2	MALFUNCTIONS AND DEFECTIVE MODULES	
	Section I. Isolate Malfunctions to Module Level in Electrosurgical Apparatus .....	2-1 -- 2-2
	Section II. Remove and Replace Defective Modules of Electrosurgical Apparatus .....	2-3 -- 2-6
	Exercises	
	APPENDIX, HYFREACATOR TROUBLESHOOTING GUIDELINE	

**CORRESPONDENCE COURSE OF  
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL**

**SUBCOURSE MD0363**

**ELECTROSURGICAL APPARATUS**

**INTRODUCTION**

An electrosurgical apparatus generates high frequency current. The hyfrecator is one example of electrosurgical apparatus which generates current used for desiccation, fulguration, and coagulation procedures which do not require cutting. Although used as early as 1900, the hyfrecator did not become popular until 1937 when low-cost modality became available. Literally hundreds of techniques have been developed using the hyfrecator. This subcourse discusses the Birtcher hyfrecator and procedures that you, as a medical equipment repairer, need to use to keep it functioning at maximum efficiency. The procedures covered here are: performing preventive maintenance checks and services (PMCS); calibrating/verifying; isolating malfunctions to the module level; and removing and replacing defective modules of the electrosurgical apparatus, the hyfrecator.

Subcourse Components:

This subcourse consists of two lessons and an appendix.

Lesson 1, Preventive Maintenance Checks and Services and Verification/Calibration.

Lesson 2, Malfunctions and Defective Modules.

Appendix, Hyfrecator Troubleshooting Guideline.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

**Credit Awarded:**

Upon successful completion of the examination for this subcourse, you will be awarded 5 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site <http://atrrs.army.mil> and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: <http://www.usapa.army.mil/pdffiles/p350-59.pdf>.

## LESSON ASSIGNMENT

### LESSON 1

Preventive Maintenance Checks and Services and Verification/Calibration.

### TEXT ASSIGNMENT

Paragraphs 1-1 through 1-10.

### TASKS TAUGHT

Perform preventive maintenance checks and services on the electrosurgical apparatus.

Perform calibration/verification of the electrosurgical apparatus.

### LESSON OBJECTIVES

When you have completed this lesson, you should be able to:

- 1-1. Identify the function of electrosurgical apparatus controls and indicators.
- 1-2. Identify the three technique configurations.
- 1-3. Identify all safety precautions.
- 1-4. Identify the steps for quarterly preventive maintenance checks and services.
- 1-5. Identify the procedures for verifying calibration of the electrosurgical device.
- 1-6. Identify the procedures for calibrating the electrosurgical apparatus.
- 1-7. Identify the apparatus specifications.

### SUGGESTION

Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

## LESSON 1

### PREVENTIVE MAINTENANCE CHECKS AND SERVICES AND CALIBRATION/VERIFICATION

#### Section I. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

##### 1-1. GENERAL

You must ensure the Birtcher Hyfrecator continues to function efficiently. This lesson introduces the general operation of the hyfrecator, its controls and configurations, the safety precautions you need to follow, and the procedures you use for quarterly PMCS and calibration/verification.

##### 1-2. TERMINOLOGY

Terminology describing the application of high frequency currents may create some confusion. The following definitions will help you understand the terms.

a. **Monoterminal, Monopolar, or Oudin Current.** A high-frequency, high-voltage current discharging from one outlet or terminal to the patient is variously described as monoterminal, monopolar, or as an Oudin current.

b. **Bipolar, Bi-terminal, or Bi-active.** Current traveling from a high-frequency oscillator through an active cable, an electrode, a small area of tissue, and through another electrode and cable.

c. **Application.**

(1) Monoterminal application of the high frequency current may have an effect upon tissue varying from very light and superficial dehydration to relatively deep penetration and destruction.

(2) Bipolar application may create an effect in tissue varying from insufficient to very heavy coagulation.

(3) Either application carried to extreme intensity or long duration will cause carbonization or charring.

##### 1-3. CONTROLS AND STATUS INDICATORS

Review the functions of the following controls and status indicators to ensure that you understand their purpose and how they function. The number at the end of each control or indicator refers to the item in figure 1-1.

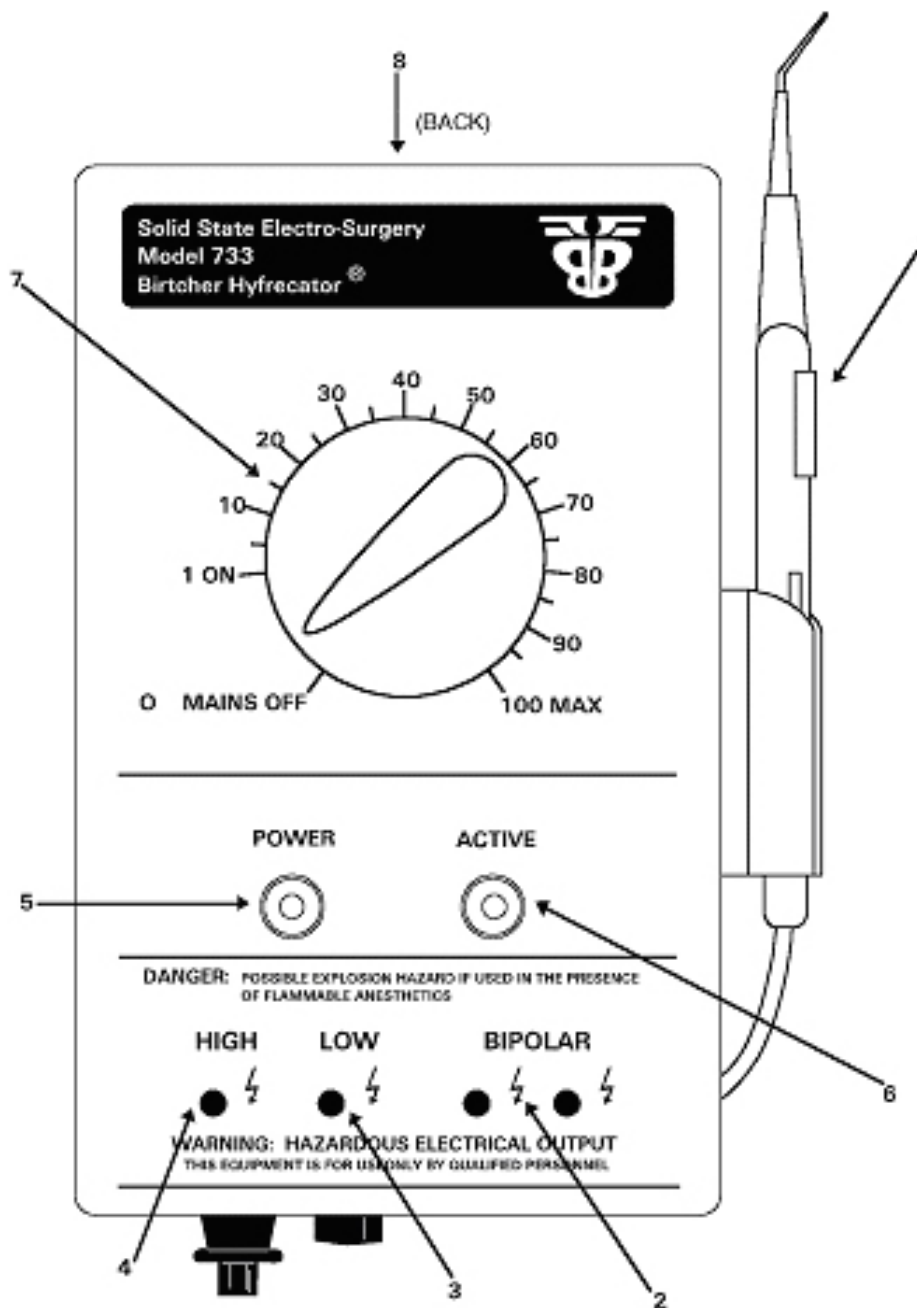


Figure 1-1. Birtcher hyfrecaTOR.

a. **Foot Switching Model 733FS.** This model includes a 711-A handle. The 790 foot switch is supplied as an accessory. (See figure 1-1).

b. **Hand Switching Model 733SW.** The 733SW is a hand switching model. The 711-SW switching handle is supplied as an accessory.



c. **Switching Handle (1).** Both the 711-SW handle and the 711-B needle electrode are shown.

d. **BIPOLAR Outlets (2).** You use the BIPOLAR outlets for bipolar (bi-active or bi-terminal) coagulation techniques. The BIPOLAR outlets are of equal power. The 789 set is available with two tips, one for each BIPOLAR outlet. Single needle techniques require that an indifferent plate electrode (Birtcher 706) be plugged into one of the BIPOLAR outlets and the tip for the electrode handle be plugged into the other.

e. **LOW Outlet (3).** The LOW outlet is a single active terminal. You use it for light desiccation and fulguration techniques requiring low intensity, or monoterminial current.

f. **HIGH Outlet (4).** The HIGH outlet is a single active terminal. You use it for heavier desiccation and fulguration techniques requiring higher intensity or monoterminial techniques.

g. **ON/OFF Pilot Light (5).** The ON/OFF pilot light lights only when you turn the control dial (item 7) clockwise from the OFF to ON position.

h. **ACTIVE Circuit Pilot Light (6).** The ACTIVE pilot light lights only when you activate the foot switch or hand switch.

i. **Control Dial (7).** You use the control dial to select current intensity from "0" (MAINS OFF) to "100" (MAX).

j. **Audio Adjust (8).** You use the audio adjust dial to control the buzzer level volume.

#### 1-4. TECHNIQUE CONFIGURATIONS

a. **Monoterminial Configurations.** For monoterminial fulguration and desiccation procedures, use either the HIGH or LOW terminal outputs only. Grounding is achieved by the third wire in the line cord. You can use the 741 sets in this configuration.

b. **Monopolar Configurations.** This technique delivers power for coagulation from one terminal of an ungrounded BIPOLAR output of a return through the indifferent plate. You may use the 771A, 711E, and 779-3 handles, the 741 set, or forceps in this configuration.

c. **Bipolar Configurations.** Bipolar electrodes actually determine the path of the therapeutic current in the area to be coagulated. Bipolar coagulation does not allow the current to flow through the surrounding organs or tissue. You may also use the 782 and 789 sets in this configuration in place of the forceps as shown in figure 1-2.

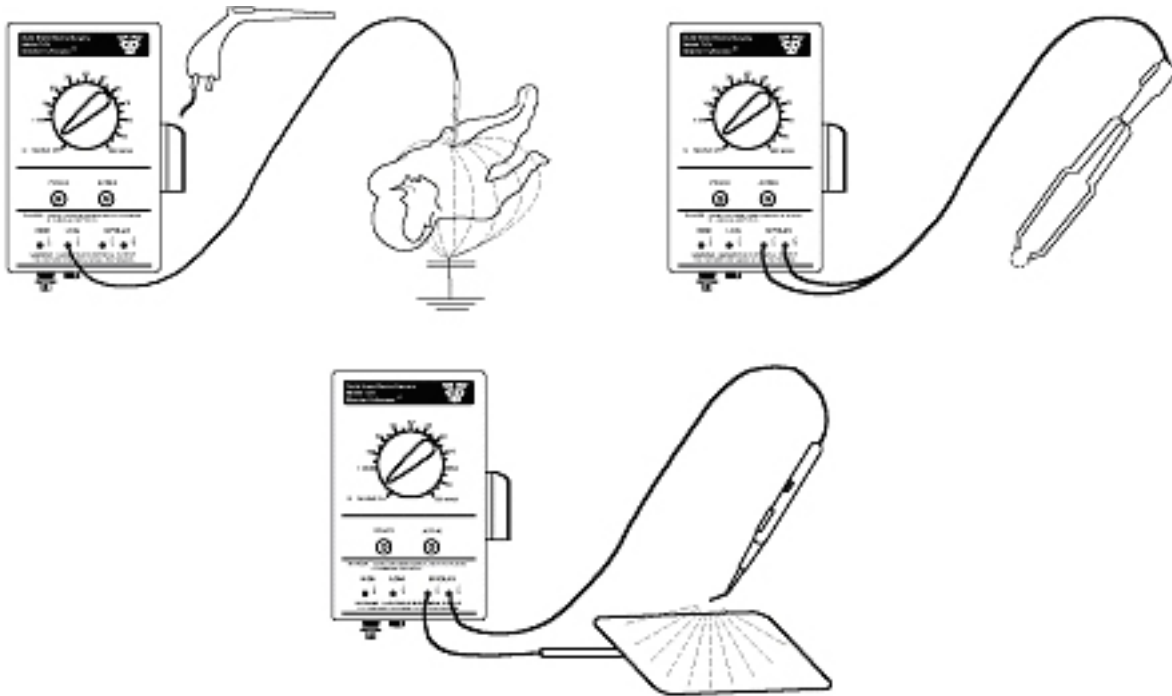


Figure 1-2. Electro-surgical apparatus wands.

**NOTE:** The 711-SW switching handle may be used in the monoterminial and monopolar techniques only. You may use the non-switching handles and surgical sets in all of the above configurations. They require the 790-4 foot switch.

## 1-5. OPERATION

a. **Power.** Plug the line cord into a suitable 3-prong grounded alternating current (ac) power receptacle of the proper voltage and frequency. Primarily you will use a 110 volts alternating current (vac) unit; however, 220vac models are available.

### b. Outlets.

(1) For desiccation and fulguration with monoterminial current, plug the cord tip of the electrode handle into either the LOW or HIGH outlet, depending on the power required.

(2) BIPOLAR outlets are used for bipolar (bi-active or bi-terminal) techniques only with both tips plugged into the two BIPOLAR outlets.

(3) When employing an indifferent plate in conjunction with a single active electrode, the indifferent plate electrode (Birtcher 706) is plugged into one of the BIPOLAR outlets with the tip for the single electrode handle plugged into the other. Bipolar forceps also utilize the BIPOLAR outlets.

c. **Intensity Selection.** Turning the control dial clockwise (from 0 - 100) turns on the unit and increases the power available at all outlets when you depress the foot switch or switching handle. Unless you have sufficient experience to be familiar with the proper setting for each technique, it is recommended that you make the initial selection at a lower setting. Then, gradually increase the power until you reach the desired level.

NOTE: The dial settings on the Model 733 hyfrecator are for reference only and do **NOT** represent actual output. The actual output with respect to a dial setting will vary and will be different from that of older models.

## 1-6. SAFETY PRECAUTIONS

The output of the hyfrecator can exceed 7,000 volts (v). As you can receive severe burns, you must follow all safety precautions.

- a. If you do not remove fuse F1, turn down the power to a safe level. If F1 is removed, the unit does not energize.
- b. Put the foot switch in an area where it cannot be accidentally stepped on.
- c. If you are not using the hand piece, disconnect it from the front of the unit.
- d. Keep your work area clean, orderly, and uncluttered.
- e. Do not place books and diagrams on top of the hand piece. The weight could easily depress the hand switch.
- f. Turn off the power to connect or disconnect the foot switch cables.
- g. Do not exceed the limits of the system. According to Birtcher, the Model 733 Electrosurgical Unit has a 25 percent duty cycle at 30 watts (w) with 500 ohm load (10 seconds on, 30 seconds off).
- h. Calibrate the unit after repair using an accurate and calibrated electrical test set.
- i. Read the Model 733 Operating and Service Manual before operating or performing maintenance on this unit.

## 1-7. QUARTERLY PREVENTIVE MAINTENANCE

Preventive Maintenance Checks and Services is performed on a quarterly basis. It consists of cleaning, a visual inspection, and an operational checkout.

- a. **Cleaning.** The case is made of a durable cyclac plastic. However, do not use harsh chemicals. Use soap and water and a cloth or sponge to clean the case.

**b. Visual Inspection.**

- (1) Inspect the unit casing for cracks and breaks (figure 1-1).
- (2) Inspect the power cord for the following:
  - (a) Serviceability.
  - (b) Proper strain relief at the housing connection.
  - (c) Cracked or damaged plug.
- (3) Inspect the output wand to ensure that there are no frays or cracks present (figure 1-2).

**c. Operational Checkout.** The operator performs the following inspections and tests daily, or at each shift change.

- (1) Place the unit on a nonconductive, clean, dry surface.
- (2) Securely place the needle electrode into the front of the hand switch.
- (3) Connect the hand switch control cord to the keyed receptacle on the bottom of the unit.
- (4) Place a wet sponge in an open nonconductive container.
- (5) Plug the unit power cord into a 110vac, grounded, power source.
- (6) Place the output power cord in the LOW output receptacle.
- (7) Hold the needle electrode two to three millimeters away from the sponge. Do not touch the sponge. Activate the unit by depressing the button on the hand switch.
- (8) Vary the control dial setting and ensure the spark intensifies at higher settings.
- (9) Repeat steps 6, 7, and 8 using the HIGH output receptacle.

## Section II. VERIFICATION AND CALIBRATION

### 1-8. VERIFYING PERFORMANCE PROCEDURES

In addition to the operational checkout, performance of the apparatus must be verified by authorized personnel semi-annually. You use a radio frequency (RF) watt (w) meter capable of a 30w reading and 500 ohms load (electrosurgical tester) for testing.

#### a. Verify the BIPOLAR Output Power.

- (1) Set the RF watt meter to a 500 ohm load.
- (2) Attach the hand piece to the RF watt meter.
- (3) Plug the hand piece into the BIPOLAR outlet.
- (4) Turn on the hyfrecator and the RF watt meter.
- (5) Adjust the control dial to maximum current intensity.
- (6) Verify that the RF watt meter reads  $30 \pm 2$  watts and that both BIPOLAR outlets are of equal power.
- (7) Turn off both units.
- (8) If the output is correct, go on to verify the HIGH output power (see paragraph 1-8b). If the output is incorrect, calibrate (see paragraph 1-9).

#### b. Verify the HIGH Output Power.

- (1) Set the RF watt meter to a 500 ohm load.
- (2) Attach the hand piece to the RF watt meter.
- (3) Plug the hand piece into the HIGH outlet.
- (4) Turn on the hyfrecator and the RF watt meter.
- (5) Adjust the control dial to maximum current intensity.
- (6) Verify that the RF watt meter reads 18 to 28 watts.
- (7) Turn off both units.
- (8) If the output is correct, go on to verify the LOW output power (see paragraph 1-8c). If the output is incorrect, calibrate (see paragraph 1-9).

**c. Verify the LOW Output Power.**

- (1) Set the RF watt meter to a 500 ohm load.
- (2) Attach the hand piece to the RF watt meter.
- (3) Plug the hand piece into the LOW outlet.
- (4) Turn on the hyfrecator and the RF watt meter.
- (5) Adjust the control dial to maximum current intensity.
- (6) Verify that the RF watt meter reads 15 to 25 watts.
- (7) Turn off both units.
- (8) If the output is correct, safety test according to manufacturer's specifications (see paragraph 1-10) and return the unit to service. If the output is incorrect, calibrate. See paragraph 1-9a through c.

**1-9. CALIBRATION**

If any of the readings found during verification do not match the manufacturer's specifications, you must calibrate the BIPOLAR output and re-verify all three output readings. Use the following procedures.

- a. Before turning on the unit, do the following:
  - (1) Turn the R8 potentiometer completely clockwise. Refer to figure 1-3.
  - (2) Connect the BIPOLAR outputs to the electrosurgical tester.
- b. Turn the unit on.
  - (1) Set the intensity knob (maximum setting).
  - (2) Activate the unit and slowly adjust the R8 potentiometer counterclockwise for an output of 30w.
  - (3) Slowly turn the intensity knob back to zero. The output should decrease evenly. If the output does not decrease evenly turn OFF the unit and repeat the complete procedure by starting again at paragraph 1-9a.
  - (4) Verify BIPOLAR, HIGH, and LOW output per paragraphs 1-8a through c.

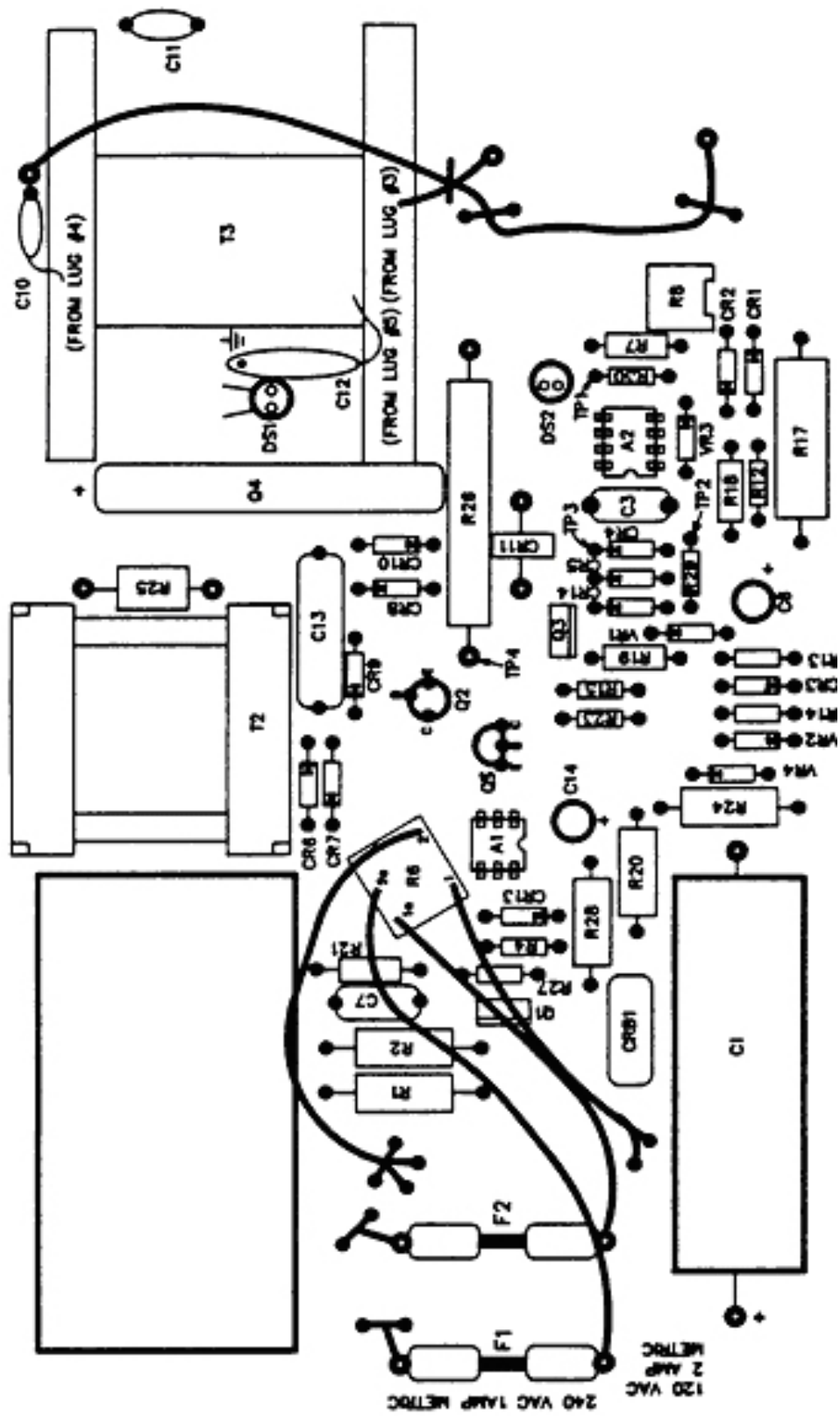


Figure 1-3. Circuit board layout.

c. When the unit is calibrated and safety tested to manufacturer's specifications (see paragraph 1-10), return it to service.

### 1-10. SPECIFICATIONS

In addition to the above calibration settings, you also need to verify the following Birtcher Hyfrecator specifications. Use the procedures in the manufacturer's operations and service manual to ensure the unit is safe to operate. Refer to figure 1-4.

CHARACTERISTIC	SPECIFICATION
Leakage	With third wire (ground) open: 50 microamperes maximum.
Power Input Requirements	733 SW and 733 FS, 120vac, 50-60 Hz (Hertz), 125w. 733 ASW and 733 AFS, 240vac, 50-60 Hz), 125w.
Output Wave Shape	Damped Sinusoidal. Damped to the point of being effectively one pulse under load. Open circuit voltage BIPOLAR 1500vp-p (voltage peak to peak) maximum. High 7000vp-p maximum.
Regulation	+ 30 percent full power, 500 ohm load, line voltage 100-130vac.
Duty Cycle	Normal type procedure: rated at 25 percent with 10 seconds on, 30 seconds off.

Figure 1-4. Birtcher hyfrecator specifications.

**Continue with Exercises**



## EXERCISES, LESSON 1

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the question or best completes the sentence.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced with the solution.

1. You turned the control dial from the OFF to ON position. Which indicator lights up on the Birtcher Hyfrecator?
  - a. Circuit pilot light.
  - b. ON/OFF pilot light.
  - c. Low battery light.
  - d. Control light.
  
2. Which technique configuration do you use to deliver power for coagulation from one terminal of an ungrounded BIPOLAR output of a return through the indifferent plate?
  - a. Monoterminal configuration.
  - b. Monopolar configuration.
  - c. Tripolar configuration.
  - d. Bipolar configuration.
  
3. Unless you perform general safety precautions, you can receive severe burns from the Birtcher Hyfrecator because its output can exceed:
  - a. 4,000v.
  - b. 5,000v.
  - c. 6,000v.
  - d. 7,000v.

4. You are following general safety precautions while working on the hyfrecator. If you do not remove the F1 fuse, you:
  - a. Connect the hand piece.
  - b. Depress the hand switch.
  - c. Connect the foot switch cables.
  - d. Turn down the power to a safe level.
  
5. Which of the following do you perform as part of the quarterly PMCS procedures?
  - a. Remove the printed circuit board.
  - b. Measure for voltage integrity.
  - c. Remove the operative assembly.
  - d. Perform an operational checkout.
  
6. You are performing an operational checkout. You should hold the needle electrode two to three millimeters away from which item?
  - a. Wet sponge.
  - b. Hand switch.
  - c. Switch control cord.
  - d. LOW output receptacle.
  
7. The specification for both BIPOLAR outputs is:
  - a.  $20 \pm 2$  watts (500 ohm load).
  - b.  $30 \pm 2$  watts (500 ohm load).
  - c.  $30 \pm 4$  watts (500 ohm load).
  - d.  $40 \pm 2$  watts (500 ohm load).

8. You are calibrating the BIPOLAR outputs. Before turning the unit on:
  - a. Slowly adjust the R8 potentiometer counterclockwise for an output of 30 watts.
  - b. Connect the BIPOLAR outputs to the electrosurgical tester.
  - c. Slowly turn the intensity knob back to zero.
  - d. Set the intensity knob (maximum setting).

**Check Your Answers on Next Page**

## **SOLUTIONS TO EXERCISES, LESSON 1**

1. b (para 1-3g)
2. b (para 1-4b)
3. d (para 1-6)
4. d (para 1-6a)
5. d (para 1-7)
6. a (para 1-7c(7))
7. b (para 1-8a(6))
8. b (para 1-9a(2))

**End of Lesson 1**

## LESSON ASSIGNMENT

### LESSON 2

Malfunctions and Defective Modules.

### TEXT ASSIGNMENT

Paragraphs 2-1 through 2-6.

### TASKS TAUGHT

Isolate malfunctions to module level in the electrosurgical apparatus.

Remove and replace defective modules of the electrosurgical apparatus.

### LESSON OBJECTIVES

When you have completed this lesson, you should be able to:

- 2-1. Identify the functions of the electrosurgical apparatus circuit.
- 2-2. Identify the equipment used to troubleshooting malfunctions.
- 2-3. Identify the procedures to use when troubleshooting a malfunction.
- 2-4. Identify the procedures for removing and replacing a defective buzzer, a faulty hand piece, and a malfunctioning printed circuit board.

### SUGGESTION

Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

## LESSON 2

### MALFUNCTIONS AND DEFECTIVE MODULES

#### Section I. ISOLATE MALFUNCTIONS TO MODULE LEVEL IN ELECTROSURGICAL APPARATUS

##### 2-1. THE CIRCUIT

Knowing the functions of the circuit will help you isolate the causes of malfunctions.

a. **General.** A2 is a multivibrator (mv) with a hysteresis voltage of 10v and 3v shown at TP2. Refer to figure 2-1.

(1) TP1 is the wave shape of the charge and discharge of the capacitor at the inverting input of A2 resulting in the switching of the mv. TP1, charging time going positive ("on" time of the output transistor) and discharge time going negative ("off" time of the output transistor) is varied by the front panel power level control knob. During the "on" time, TP3 is high and Q4 output is saturated on.

(2) The current through the output transformer primary inductance increases linearly by  $I = ET/L$  (current = voltage X time/inductance) and the energy stored at any time is  $J = 1/2 LI^2$  (joule = 1/2 inductance X current squared). The power of  $P = 1/2 LI^2 \times$  Rate of Storage and Discharge (power = 1/2 inductance X current squared X rate of storage and discharge). When Q4 is turned off, the energy in T3 primary resonates with C13 producing a damped signal wave into an output load.

##### b. Circuit Description.

###### (1) Functions of the level control and rate generator.

(a) Comparator amplifier A2 functions as a pulse repetition generator. Its pulse width and rate is varied with the potentiometer R6 controlling the final power output.

(b) A2 is a self-starting mv. When the power is applied, pin 7 of A2 (the collector output) is high and through CR1 and R6 charges C3 to pin 3 of A2 TP1.

(c) The non-inverting differential input pin 2 A2 is clamped to +10v through CR3 to zener VR2.

(d) When pin 3 (voltage on C3) reaches +10v, the comparator changes state, and pin 7 switches to low. Pin 2 is at the voltage division of R13 and R14 (3v). C3 discharges through CR2, R6, R8, and R7 until this voltage at pin 3 is lower than 3v and A2 changes state again. This completes the multivibrator cycle.

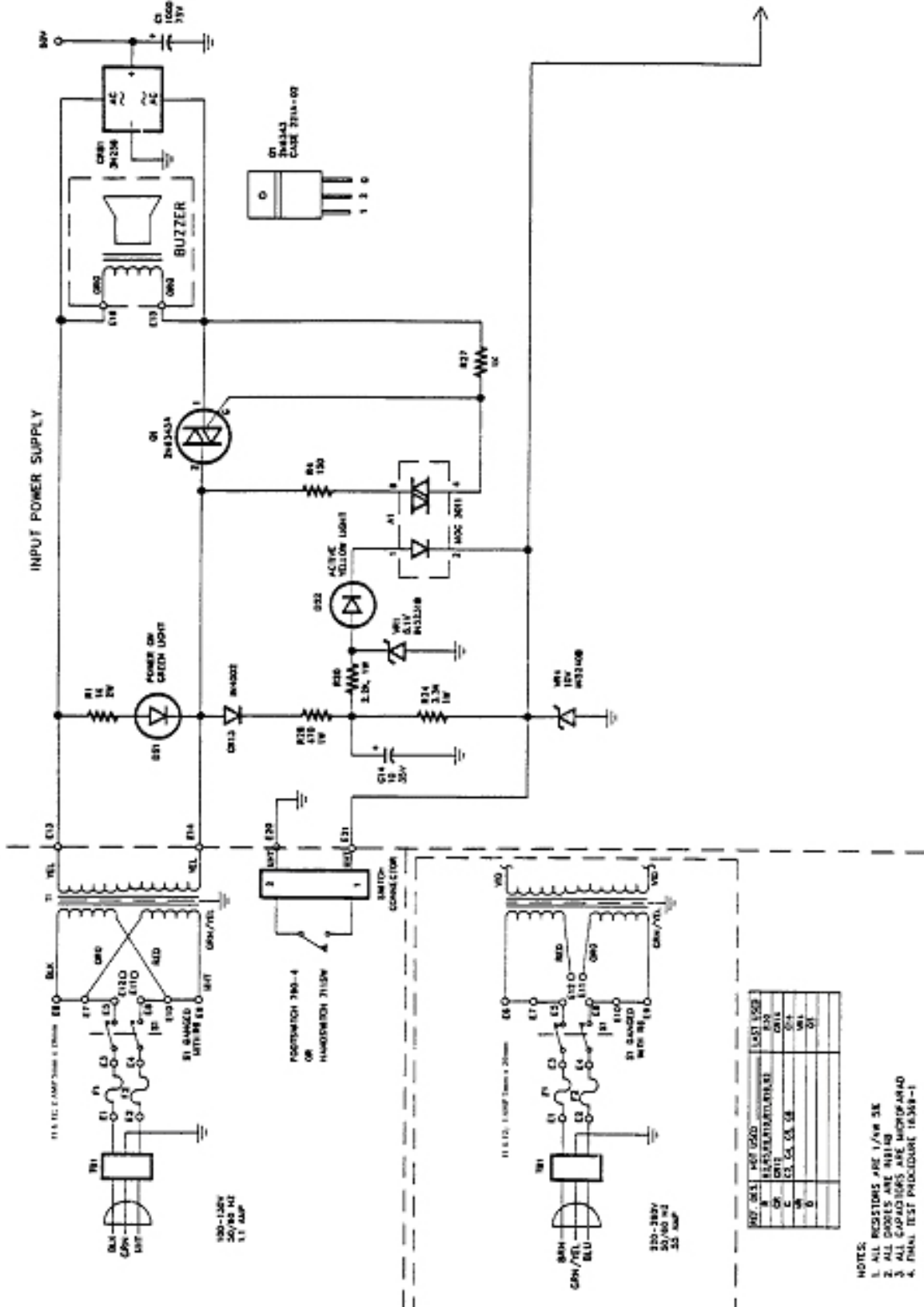


Figure 2-1. Hyfrecator Model 733 wiring diagram.

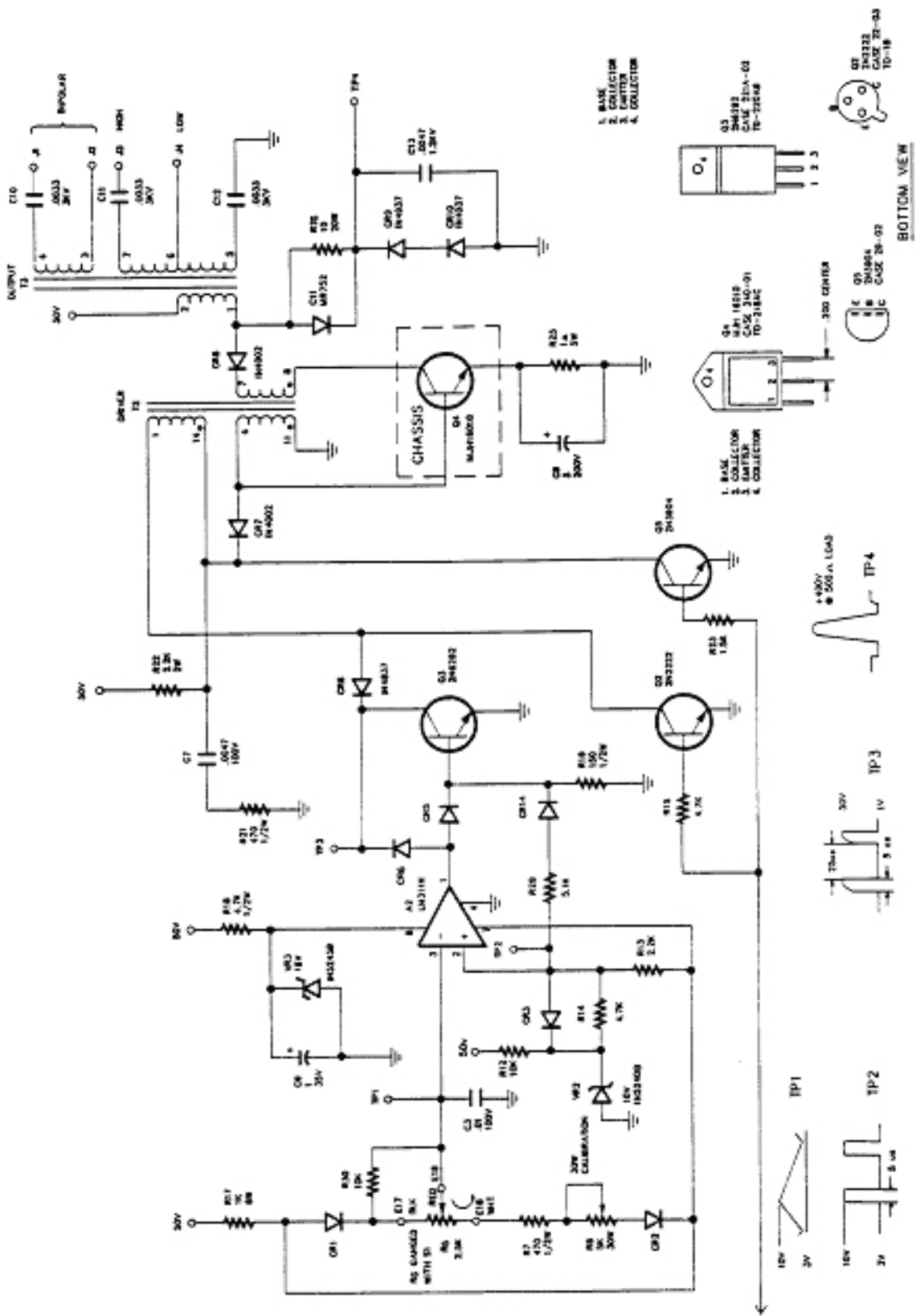


Figure 2-1. Hyfrecator Model 733 wiring diagram (concluded).



(2) Functions of the driver.

(a) The collector of the power driver Q3 is in phase with the collector of the transistor (pin 7) on mv A2.

(b) Q2, Q3, and Q5 initiate the on and off drive to the power output stage Q4.

(3) Functions of the output.

(a) When Q3 is turned off by the drive from mv A2 - pin 1, the magnetic energy stored in T2 (winding pins 1 and 14) is induced into T2 (winding pins 4 and 11) switching the output transistor Q4 to on.

(b) The current through Q4 now stores the magnetic energy in T3 (winding pins 1 and 2). With Q4 on, the current increases with time. When Q4 is turned off, T3 (winding pins 1 and 2) resonates with C13.

(c) The result is a damped sinusoid wave shape. The energy is coupled by secondary windings to generate output power. The wave shape damping varies with the particular output load. With average physiological loads, one or two high amplitude cycles exist.

(4) Functions of the power supply.

(a) The power supply is an unregulated +50 volts and regulated 5, 10, and 15v by zener diodes.

(b) The secondary rectification is by a full wave bridge.

(5) Functions of the switch.

(a) The output power can be switched on and off by the foot switch or hand switch.

(b) Closing E21 to ground turns off Q2 and Q5, and increases light emitting diode (led) current to optically excite the silicon detector chip to drive the gate of triac Q1. With Q2 off, A2 functions as a multivibrator.

(6) How to generate sound. Audio is generated by pulsing the solenoid (buzzer) on and off from the ac secondary voltage.

c. **Access the Unit.** You can access the entire printed circuit board (pcb) and operative assembly by removing the back screws, 4 pcb screws, and the control knob. Refer to figure 2-2.

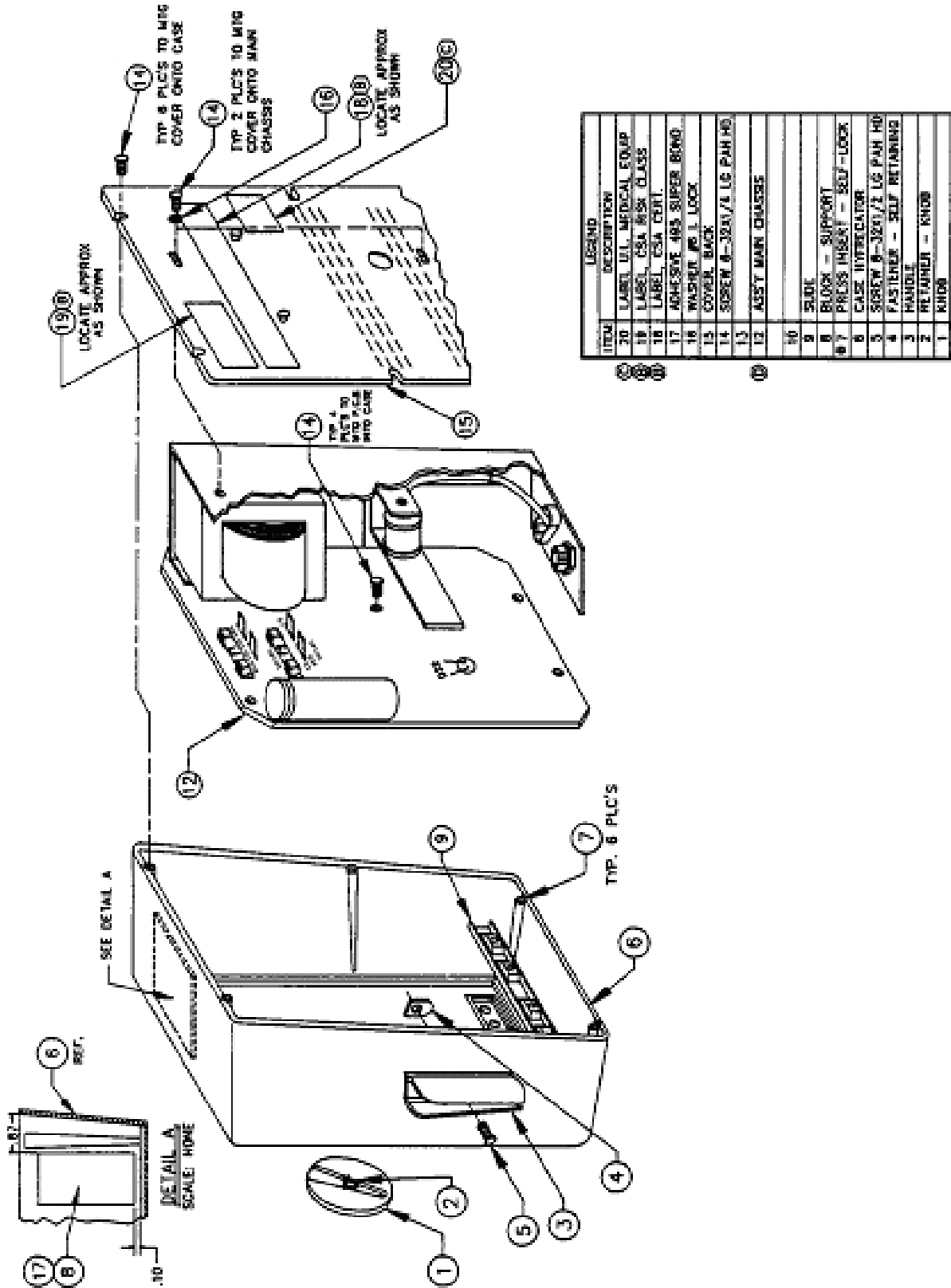


Figure 2-2. Hyfrecator final assembly (110v 50 cycle main housing assembly).

## 2-2. TROUBLESHOOTING PROCEDURES

Use the following troubleshooting techniques to identify the causes of malfunctions.

a. **Equipment.** You need the following equipment to troubleshoot the hyfrecator:

- (1) Volt-ohm meter.
- (2) Oscilloscope.
- (3) Electrosurgical test set.

b. **Troubleshooting Guideline.** Refer to the Hyfrecator Troubleshooting Guideline in the appendix. Use it to isolate malfunctions. The guideline consists of three columns:

- (1) Symptom. Lists symptom you are observing with the malfunctioning unit.
- (2) Probable Cause. Indicates, in priority order, the most likely causes for the symptom under discussion.
- (3) Corrective Action. Lists the proper corrective action to take to repair the malfunction for the probable cause indicated.

c. **Troubleshooting a Malfunctioning Printed Circuit Board .** Refer to the Hyfrecator Troubleshooting Guideline in the appendix, Symptom number six.

- (1) Remove the active Q4 devices.
  - (a) Measure for voltage integrity.
  - (b) Check test points TP1 through TP3 for correct operation. Refer to figure 1-3.
  - (c) Insert the output transistor for operation and final calibration.
- (2) Critically inspect test point TP4 for a heavily damped sinusoid. This damping occurs whether the output is loaded or open circuited. With a dial setting of half scale, and the output loaded, the first sinusoid completed is about 400v peak. The second sinusoid is about 100v peak. With an unloaded output, the damping of the wave shape goes virtually to zero volts in 5 cycles.
- (3) If the above conditions are not met on full power output (30w bipolar), check transistors Q5, Q4, and Q3 in that order for a possible shorted condition. Check CR9 and CR14 if needed.

d. **Test Points and Locations.** When testing power outputs, you should see, on an oscilloscope, the signals shown in figures 2-3 through 2-5.

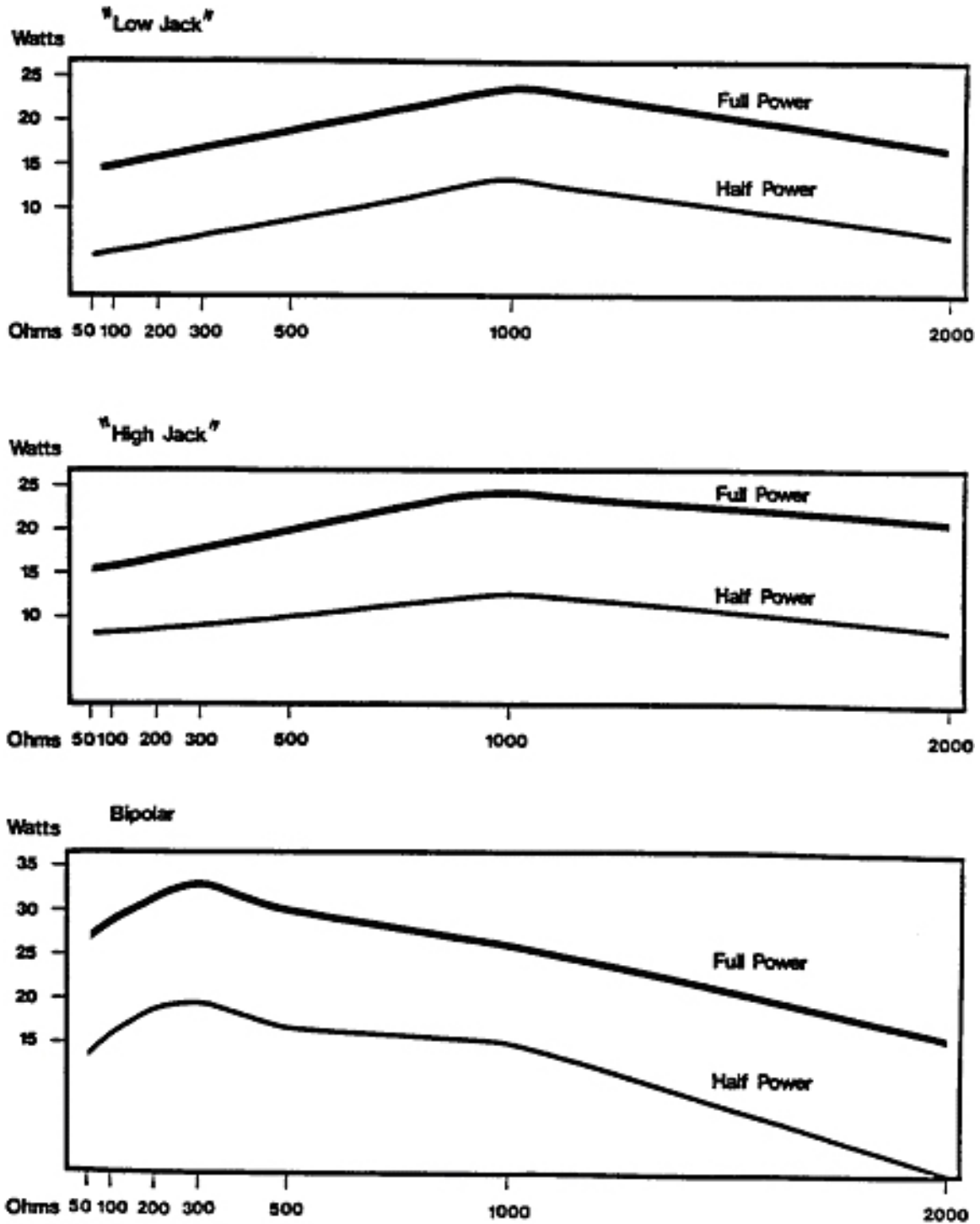


Figure 2-3. Output power load variation.

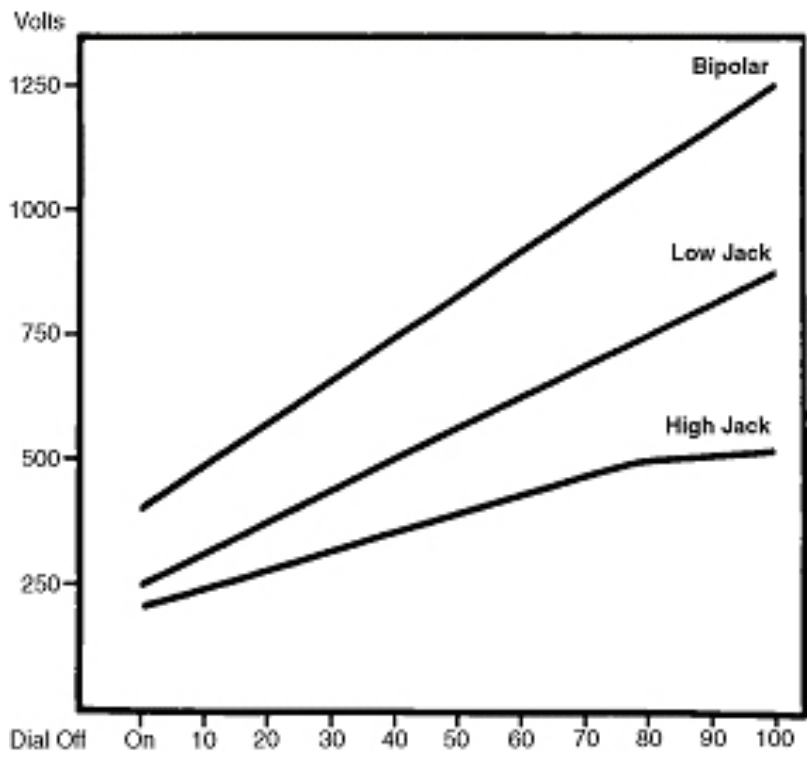


Figure 2-4. Voltage output peak to peak versus dial position at 300 ohms.

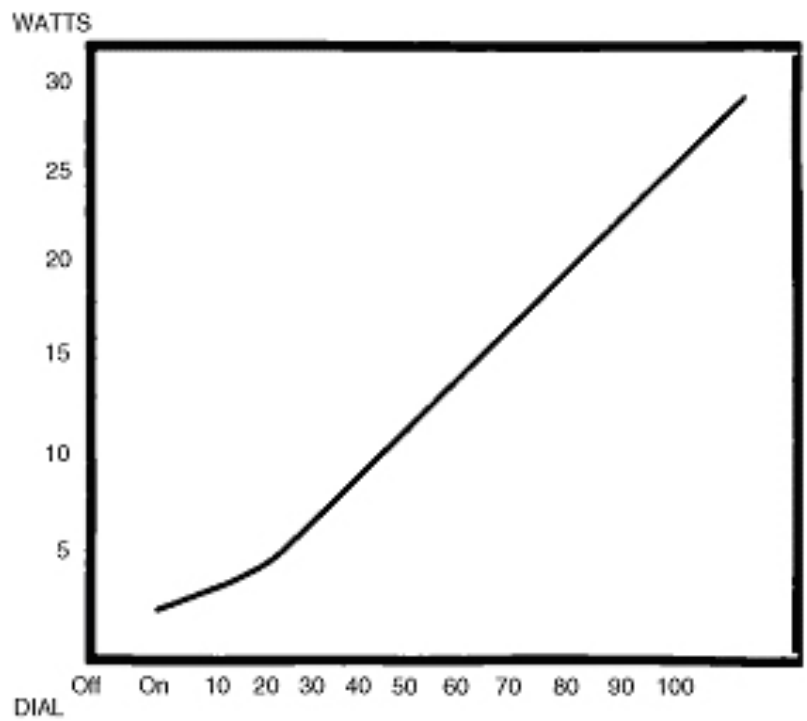


Figure 2-5. Power output (bipolar) versus dial position at 500 ohms.

## **Section II. REMOVE AND REPLACE DEFECTIVE MODULES OF ELECTROSURGICAL APPARATUS**

### **2-3. LOCATIONS OF PARTS**

The modules included in this lesson represent a portion of the total number of modules in this piece of equipment. The skills required to remove and repair or replace a portion of the modules are transferable to removing and repairing or replacing all modules. Study the location of the modules and components in figure 2-6, Main chassis assembly (110v).

### **2-4. REMOVE AND REPLACE A DEFECTIVE BUZZER**

You have isolated a malfunction to a defective buzzer. Refer to the steps below and figures 2-1 and 2-6 to replace it.

- a. Turn off the unit.
- b. Remove power from the unit.
- c. Remove the back six screws.
- d. Remove the back cover.
  - (1) Remove the intensity knob.
  - (2) Remove the printed circuit board (PCB) assembly.
- e. Remove and replace the buzzer.
- f. Replace the back cover and screws.
- g. Perform an operational checkout (Refer to paragraphs 1-7c(1) through (9)).
- h. Return the unit to service.

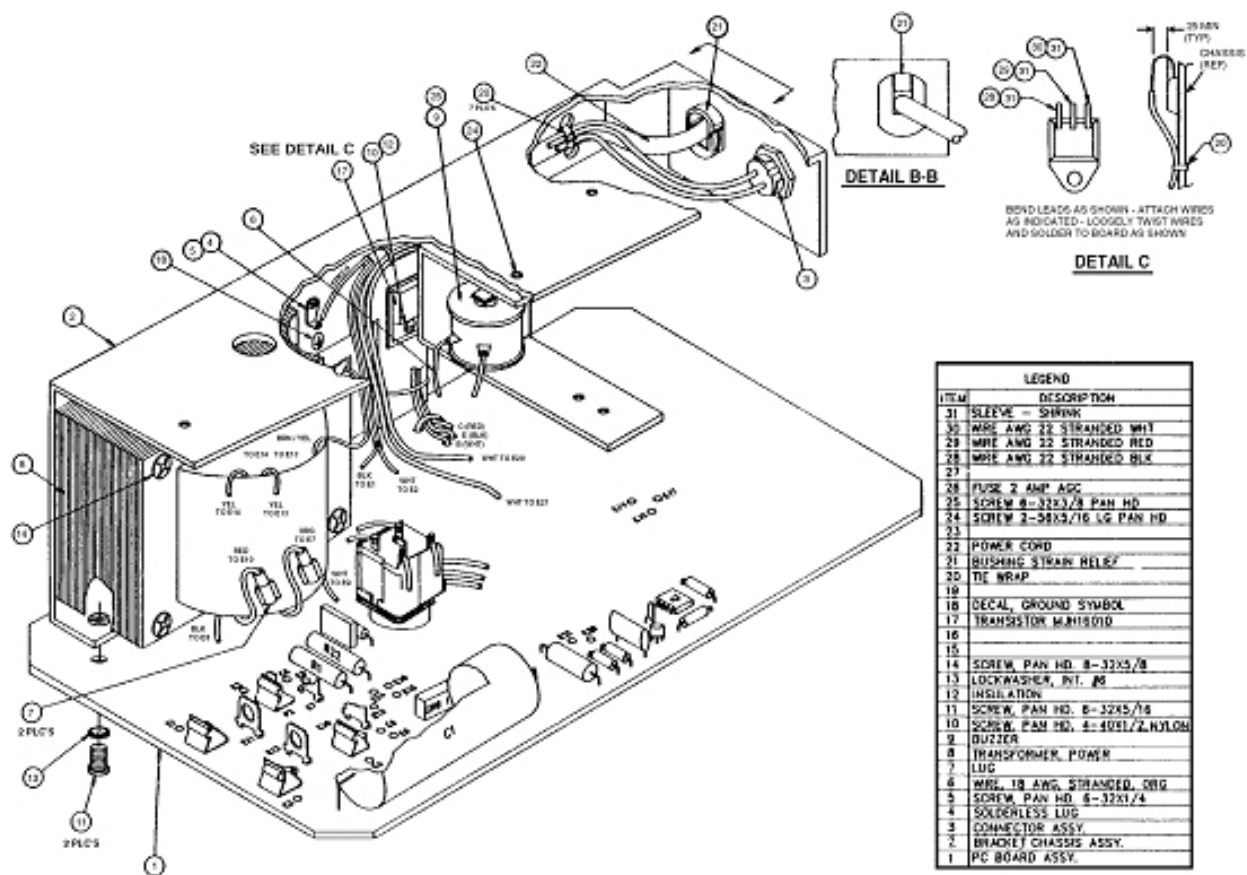


Figure 2-6. Main chassis assembly (110v).

## 2-5. REMOVE AND REPLACE FAULTY HAND PIECE

You have isolated a malfunction to a faulty hand piece. Refer to figures 1-1 and 2-1.

- Turn off the unit.
- Remove power from the unit.
- Remove the hand piece.
- Replace the hand piece with a new one.
- Restore power to the unit.
- Perform an operational checkout. Refer to paragraphs 1-7c(1) through (9).
- Return the unit to service.

## **2-6. REMOVE AND REPLACE A MALFUNCTIONING PRINTED CIRCUIT BOARD**

You have isolated a malfunctioning PCB. Refer to figures 1-3, 2-2, and 2-6.

- a. Turn off the unit.
- b. Remove power from the unit.
- c. Unplug the foot switch from the unit.
- d. Unplug the hand piece from the unit.
- e. Remove the back six screws.
- f. Remove the back cover.
- g. Remove the intensity knob.
- h. Access the PCB.
- i. Remove and replace the PCB. Mark all wires and connectors so that they can be properly reconnected (figure 2-6).
- j. Reassemble the unit.
- k. Perform an operational checkout. Refer to paragraphs 1-7c(1) through (9).
- l. Perform calibration tests (refer to paragraphs 1-9a, b), safety test to manufacturer's specifications, and return the unit to service.

**Continue with Exercises**



## EXERCISES, LESSON 2

**INSTRUCTIONS:** Answer the following exercises by marking the lettered response that best answers the question or best completes the sentence.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced with the solution.

1. The A2 multivibrator has a hysteresis voltage of:
  - a. 10v and 3v.
  - b. 10v and 5v.
  - c. 12v and 10v.
  - d. 24v and 15v.
  
2. Which circuit functions as a pulse repetition generator?
  - a. Driver.
  - b. Output.
  - c. Power supply.
  - d. Comparator amplifier A2.
  
3. Refer to the Hyfrecator Troubleshooting Guideline in the appendix. If the unit will not coagulate, and you have no ACTIVE light with either the foot switch or hand switch, which of the following is a probable cause?
  - a. DS1 is open.
  - b. Open buzzer.
  - c. Fuse F1 is open.
  - d. Bad printed circuit board.

4. You are removing and replacing a defective buzzer. After turning off the unit and removing power from the unit, the next step is which of the following?
  - a. Remove the hand piece and/or the foot switch.
  - b. Remove the back six screws.
  - c. Remove and replace the buzzer.
  - d. Replace the back cover and screws.
  
5. You have isolated a malfunction to a faulty hand piece. After turning off the unit and removing the power from the unit, you should next:
  - a. Remove the hand piece.
  - b. Restore power to the unit.
  - c. Replace the hand piece with a new one.
  - d. Perform an operational checkout.
  
6. You have isolated a malfunction to the printed circuit board. What is the last step in the removing and replacing process for the pcb?
  - a. Unplug the hand piece from the unit.
  - b. Replace the printed circuit board.
  - c. Perform operational checkout.
  - d. Perform calibration tests.

**Check Your Answers on Next Page**

## **SOLUTIONS TO EXERCISES, LESSON 2**

1. a (para 2-1a)
2. d (para 2-1b(1)(a))
3. d (Appendix, number six)
4. b (para 2-4c)
5. a (para 2-5c)
6. d (para 2-6k)

**End of Lesson 2**

## APPENDIX

### HYFRECATOR TROUBLESHOOTING GUIDELINE

<b>SYMPTOM</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
1. The unit will not energize.	Unit not plugged in. Fuse F1 or F2 open.	Plug in to 110vac grounded outlet. Replace.
2. Power on light does not energize.	DS1 is open.	Replace.
3. Unit coagulates, but the buzzer does not sound.	Open lead to buzzer. Open buzzer.	Reconnect. Replace.
4. Unit will not coagulate, buzzer and active (yellow) light operate.	Bad hand piece.	Replace.
5. Unit coagulates with hand switch, but not with foot switch.	Bad foot switch.	Replace.
6. Unit will not coagulate, no ACTIVE (yellow) light or buzzer with either foot switch or hand switch.	Bad printed circuit board or component.	Use TP1 through TP\$ to isolate faulty area, then locate and replace faulty component  OR  Replace printed circuit board.

**End of Appendix**