OPERATING & SERVICE MANUAL

MODEL 774

Electrosurgery Unit

ALWAYS CHECK TO SEE IF THERE IS AN ADDENDUM TO THE CONTENTS OF THIS MANUAL

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(818) 575-8144, TLX 4720899 Birtcher Elm

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INTRODUCTION

Congratualtions on the purchase of your new Birtcher Model 774 Electrosurgery Unit. The 774 is a versatile, solid state electrosurgery unit. The 774 features isolated output of both the high power (major surgery output) and the independent Bipolar output.

For the operator, the dials on the front panel are color coded for mode selection and level setting. The output activation may be by hand switch or footswitch. Only one output will be active at a time. The patient plate has an alarm for faulty cable indication.

Output characteristics in Cut and Coag are tailored for good surgical results. Coag is a classical damped sine wave. The controlled continuous radio frequency (RF) output gives excellent cutting results in surgical irrigating liquids for the T.U.R. procedure. The Coagulation output achieves pinpoint coagulation.

The Birtcher Model 774 has an independent Bipolar output. This output (22 watts) has a separate dial for setting power output level which is independent from any panel control in the major surgery unit. The Bipolar output may be activated by an independent footswitch operation or special switching forceps.

A certain amount of specific understanding is required for the intended use of electrosurgery. The operation, limitations and precautions for use are discussed in the Operating Section 2. Section 3 gives general principles and some specific uses and precautions needed for safe, effective use of the electrosurgery unit. Detailed technical information, troubleshooting, maintenance, calibration and repair of this unit are in the last five sections of this manual.

BIRTCHER

July 1, 1987

BIRTCHER CORPORATION WARRANTY

Birtcher Corporation (Manufacturer) warrants all products to be free from defects in material and workmanship under normal operation and use. The warranty period for major equipment is twelve (12) months to the dealer's original customer. All accessories are warranted for ninety (90) days. There is no warranty on expendable, single-use items.

Manufacturer does not warrant any product which has been damaged as the result of accident, abuse, misuse or negligence.

This warranty is limited to the repair or replacement, at the Manufacturer's option, of any product, or part thereof, which has been returned to the Manufacturer within the specified warranty period, and which after examination shall disclose to Manufacturer's satisfaction that the product is defective. Transportation of the product to the Factory must be prepaid; the product, after repair or replacement, will be returned at the expense of the dealer or end-user.

The warranty does not apply to any product, or integral part thereof, which has been altered or serviced by other than the Manufacturer.

RETURN GOODS POLICY

No equipment, supplies or material may be returned to our Factory for reason of warranty repair, non-warranty repair, etc, **without prior authorization.** A Return Goods Authorization (RGA) number and label will be issued by our Customer Service Department. This label **must be affixed externally to the carton(s)** being returned.

Please call Birtcher's Customer Service Department for a Return Goods Authorization number and label for each transaction. (800)423-4889 - In California (818)575-8144

Special Notice....Any merchandise returned to Birtcher Corporation **without a Return Goods Authorization label affixed externally** to the shipping carton **will not be accepted** by our Receiving Department....**The merchandise will be returned to the sender.**

The Warranty and Return Goods Policy stated herein supersede all others either expressed or implied and shall be governed and executed under the laws of California, U.S.A.

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SECTION 1

GENERAL INFORMATION

1.1 DESCRIPTION

The Birtcher Model 774 electrosurgery instrument is a radio frequency (RF) generator at .5 megacycles.

The three (3) output power levels in watts are displayed digitally. Controls for setting output modes and selecting type of output and power levels are available to the operator on the front panel of the unit.

The Coagulation output is a classical damped RF output which is accompanied by an audio tone and color coded panel light (blue).

The Cut output is a continuous RF output accompanied by an audio tone that is lower in pitch than the Coag tone and color coded panel light (yellow).

Three (3) additional Cut modes have the damped Coag output blending successively into the cut signal for additional hemostasis. Blend modes are designated low, medium, and high.

The output is isolated and has a patient plate cable fault indication system accompanied by an audio tone which logically disables the instrument in case of a cable disconnection.

Output of the Model 774 may be activated by a footswitch or hand activated by an electrosurgical pencil or forceps.

The Bipolar is an independent, low power (22 watts) coagulation unit. The output is a damped RF signal. The Bipolar output may be activated by a footswitch or by special hand switching forceps. The activation is accompanied by an audio tone which is higher in pitch than the Cut or Coag tones.

1.2 EQUIPMENT LIMITATIONS AND PRECAUTIONS

Operator Precaution

The safe and effective use of electrosurgery is dependent, to a large part, upon factors which are under the control of the operator and not entirely controllable by the design of the unit. Instructions should be understood and personally experienced before procedural use in order to enhance safety and effectiveness.

Duty Cycle

Under normal operation, the duty cycle is 50% at 200 W, any load (10 seconds ON, 10 seconds OFF. Under heavy operation, the duty cycle is 33% at full (maximum) power, 500 ohms load (5 seconds ON, 10 seconds OFF).

Patient Plate

The use, preparation and proper placement of the patient plate is a key element in the safe and effective use of electrosurgery, particularly in the prevention of burns.

Apparent low power output or failure of the electrosurgical equipment to function correctly at otherwise normal settings may indicate faulty application of the patient plate or failure of an electrical lead. Do not increase power output before checking for obvious defects or misapplication.

Stray Electrical Current

The Model 774's active output current is not ground seeking. However, accidentally keying the unit ON without proper placement of the active electrode may cause the current to seek a return through the nearest (indirect) path back to the patient plate. Therefore, accidental burns to the operator are possible from the active electrode if it is carelessly handled by personnel or if placed on the patient when not in use.

Monitoring Electrodes

The risk of burns at the site of monitoring electrodes on a patient undergoing electrosurgery are reduced when the monitoring electrodes are placed as far as possible from the electrosurgical site and the patient plate. Protective impendances incorporated into the monitoring leads may further reduce the risks of such burns. Needles should not be used during such procedures.

Interference With Other Devices

Use of electrosurgery can result in the possibility of interference with other devices, particularly **cardiac pacemakers.** Precautions should be taken to assure that the patient's well being is maintained in the event of such interference.

Restriction Of Flammable Materials In Surgical Site

The risk of ignition of flammable materials, gases or liquids is an inherent hazard in the use of electrosurgery which cannot be entirely eliminated by device design. Careful attention must be given to controlling the flammable gases and liquids produced within the body cavity by natural processes, and to restricting other materials, including surgical drapes, from entering the electrosurgery site.

WARNING

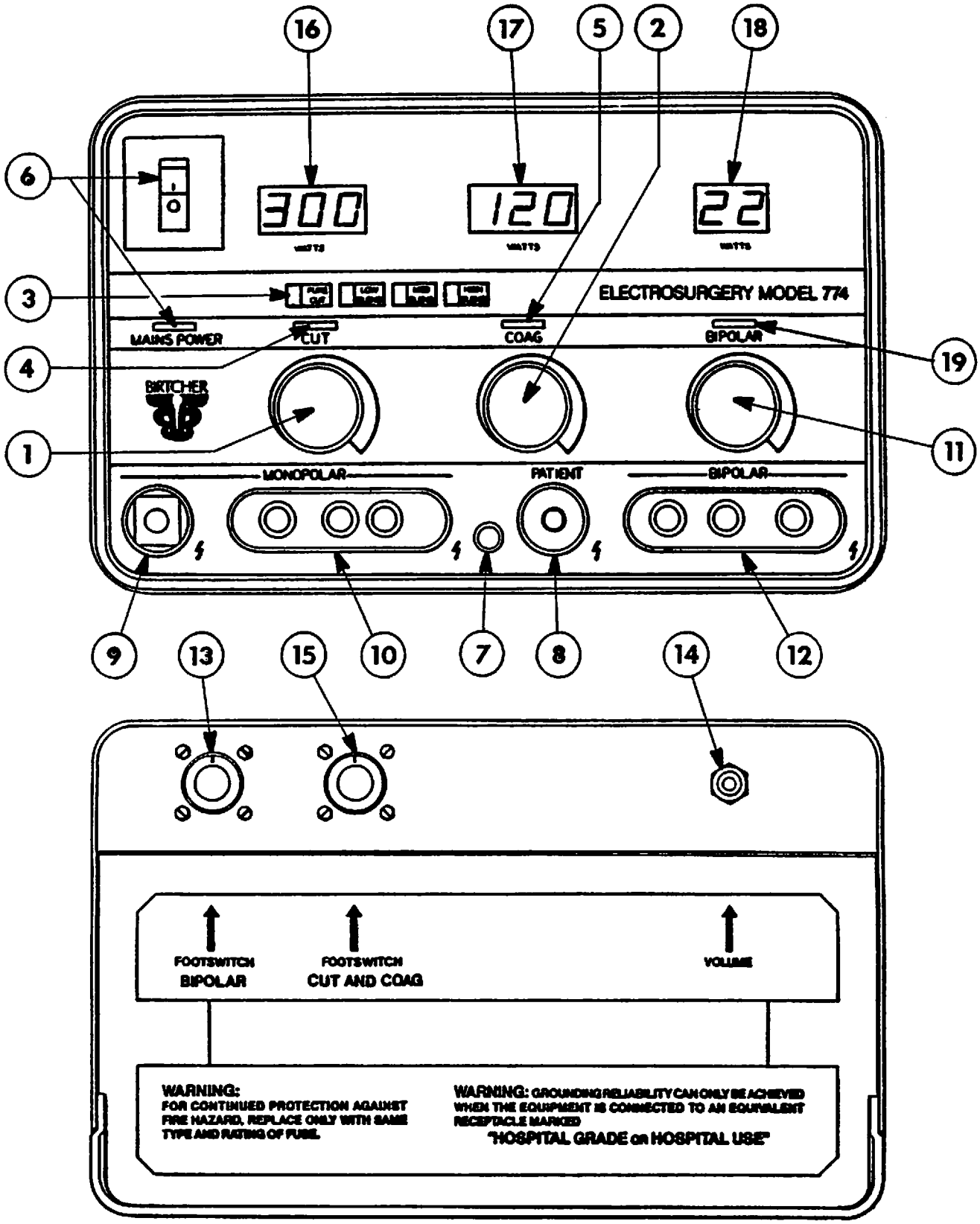
Electrosurgery is not an recommended modality for circumcision procedures.

Active Output - Resectoscopes, Endoscopes, Etc.

A fault, causing the active output to short to the case or the capacitive coupling, puts the scope and other instruments in the category explained under Stray Electrical Current. Therefore, the Resectoscope insulating eye piece and similar instrument-supplied safety devices should always be used for purposes of protection.

SECTION 2

OPERATING INSTRUCTIONS



OPERATING CONTROLS AND INDICATORS

FIGURE 1

SECTION 2

OPERATING INSTRUCTIONS

2.1 DESCRIPTION OF OPERATING CONTROLS AND INDICATORS

INDEX	NAME	DESCRIPTION
1	Cut power Control	Permits selection of cutting power level from 0-300 watts.
2	Coag Power Control	Permits selection of coag power level from 0-120 watts.
3	Pure Cut-Blend Four Position Touch Key Pad	Selection of pure cut, yellow light illuminated; or low, medium, high blend, white light illuminated; (coag added to the cut wave form).
4	Cut Indicator (Yellow)	Is illuminated when cut mode or cut-blend, is activated, accompanied by an audio tone.
5	Coag Indicator (Blue)	Is illuminated when coag mode is activated, accompanied by an audio tone.
6	Power On/Off Switch & Circuit Breaker	Two position rocker switch for control of input power to unit with a green glow indicator.
7	Cable Fault Indicator (Red)	Illuminates when a lead breaks in the patient plate cable (with a written display above jack). Unit is simultaneously disabled and accompanied by an audio tone. Push to reset normal operation.
8	Patient	For connection of receptacle from Patient Plate. Provides return path for active output current.
9	Active Accessories	One active receptacle to accept #12 tip.

INDEX	NAME	DESCRIPTION
10	Active Switching	Three recessed banana pin connectors for use with disposable or permanent hand control.
11	Bipolar	Permits selection of coag power level from 0-22 watts.
12	Bipolar Connector	Three recessed banana pin receptacles for use with switching accessories, bipolar or monopolar electrodes.
13	Footswitch (Bipolar Module)	Four pin receptacle for connection of the bipolar footswitch.
14	Audio Volume	Controls the audio levels for the cut, coag, cut-blend, and bipolar coagulation modes and for the cable fault.
15	Footswitch	Four pin receptacle for connection of the major surgery footswitch.
16	L.E.D. Display	Display of cut power 0-300 watts.
17	L.E.D. Display	Display of coag power 0-120 watts.
18	L.E.D. Display	Display of bipolar power 0-22 watts.
19	Bipolar Indicator (White)	Is illuminated when bipolar mode is activated, accompanied by an audio tone.

2.2 ELECTROSURGERY ACCESSORIES

Standard Accessories

Accessories included with the Model 774 Electrosurgery Unit are as follows:

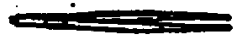
Qty	Part Number	Description
2	730	Disposable Dispersive Pads
1	674-40	Adapter
2	718 VDS	Hand Switching E/S Pencils

Optional Accessories

Model 3282 Kit Includes:

Qty	Part Number	Description
1	795-12	Handle and cord
1	747	Patient Plate
1	394	Kontax II Gel
1	774-19	Footswitch - Two Pedals

For additional Optional Accessories, see page 2-4.

BASIC FORCEPS & CORDS		BIRTCHER CATALOG NUMBER				
		Monopolar		Bipolar		Microbipolar
Description		smooth tips	serrated tips	smooth tips	serrated tips	
ADSON FORCEP 5 inches (12.5 cm)		1209-4-M	1209-7-M	1209-4-B	1209-7-B	—
		-	-	1209-10	1209-13	—
STRAIGHT CUSHING FORCEP 7 inches (17.5 cm)		1209-5-M	1209-8-M	1209-5-B	1209-8-B	—
		-	-	1209-11	1209-14	—
BAYONET CUSHING FORCEP 7½ inches (19.0 cm)		1209-6-M	1209-9-M	1209-6-B	1209-9-B	—
		-	-	1209-12	1209-15	—
JEWELERS FORCEPS 4 inches (10.0 cm)		—		—		1209-1-B
STRAIGHT GERALD FORCEP 7 inches (17.5 cm)		—		—		1209-2-B
HARDY BAYONET FORCEP 8½ inches (21.0 cm)		—		—		1209-3-B
REPLACEMENT CORD AUTOCLAVABLE 12 feet long		*1209-17		1209-16 1209-18 (Independent)		-

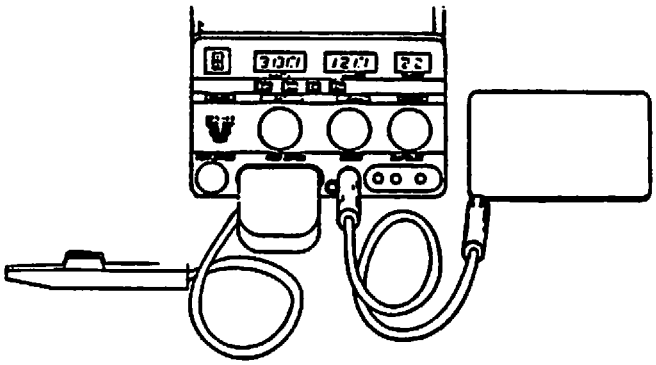
* NOTE: When ordering monopolar replacement cords, specify make and model of electrosurgical generator for correct tip connector.

GENERAL ELECTROSURGERY GENERATOR OUTPUT CONNECTIONS

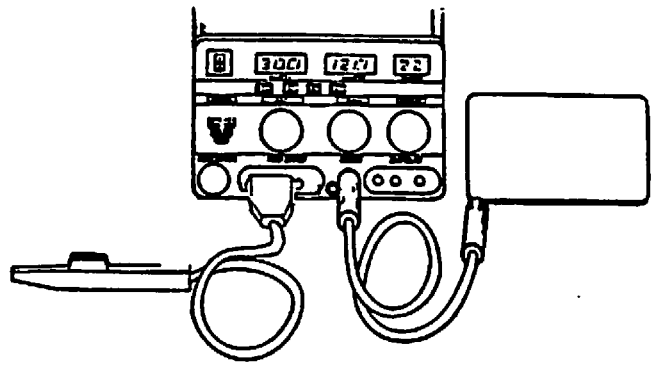
Refer to Section 2.4

The following diagrams are meant to give a general connection layout for various types of electrosurgery accessories. Complete details regarding electrosurgery accessories can be obtained from the Distributor or from the Manufacturer.

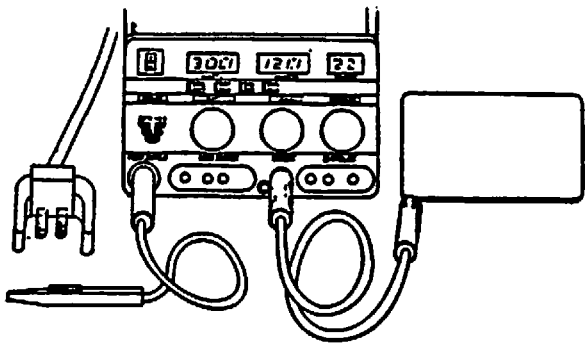
MONOPOLAR HAND-SWITCHING



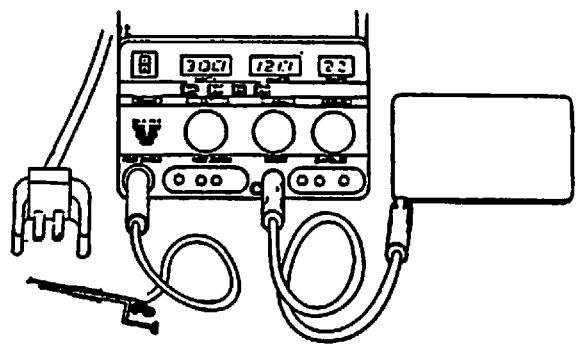
MONOPOLAR FORCEPS SWITCHING



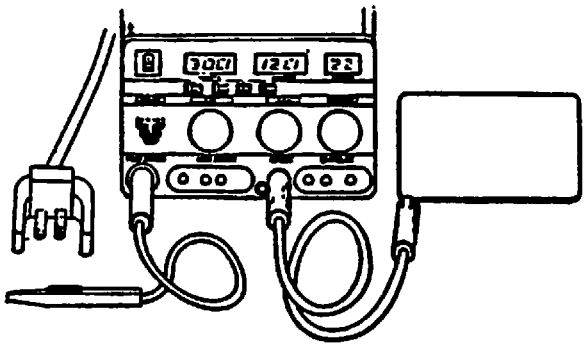
MONOPOLAR FOOT-SWITCHING



MONOPOLAR LAPAROSCOPE
FOOT-SWITCHING



MONOPOLAR FORCEPS
FOOT-SWITCHING



MONOPOLAR RESECTOSCOPE
FOOT-SWITCHING

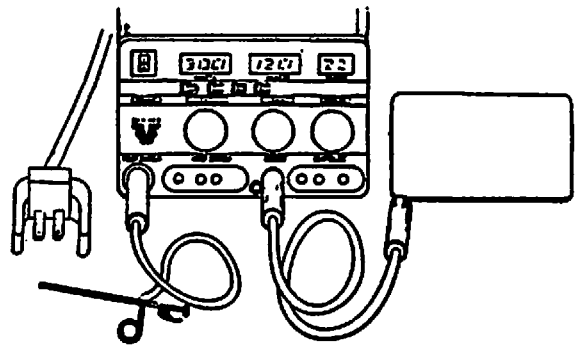
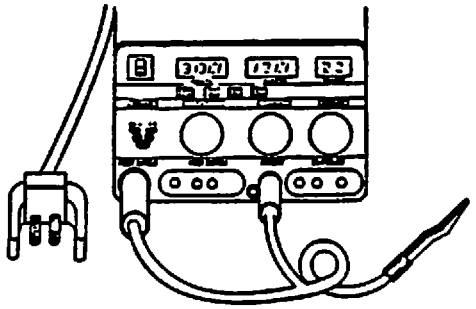


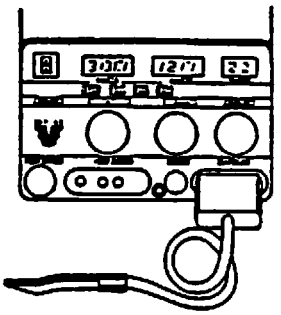
FIGURE 4

GENERAL ELECTROSURGERY GENERATOR OUTPUT CONNECTIONS (continued)

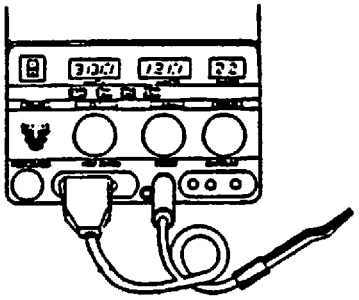
BIPOLAR FORCEPS
FOOT-SWITCHING



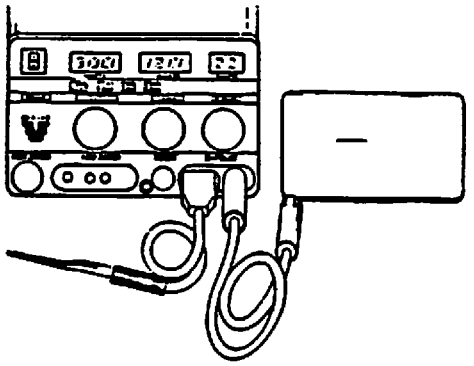
MICRO BIPOLAR SWITCHING



BIPOLAR SWITCHING



MICRO BIPOLAR MONOPOLAR
HAND-SWITCHING



MICRO BIPOLAR MONOPOLAR
FOOT-SWITCHING

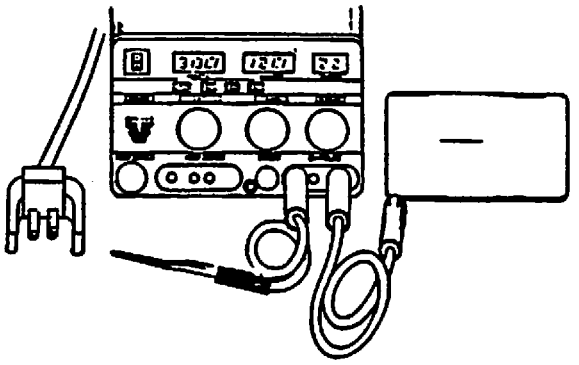


FIGURE 4

CAUTION

DANGER: RISK OF EXPLOSION. DO NOT USE IN THE PRESENCE OF FLAMMABLE ANESTHETICS.

WARNING: HAZARDOUS ELECTRICAL OUTPUT. THIS EQUIPMENT IS FOR USE ONLY BY QUALIFIED PERSONNEL.

CAUTION: THIS EQUIPMENT HAS AN OUTPUT WHICH IS CAPABLE OF CAUSING A PHYSIOLOGICAL EFFECT.

CAUTION: TO REDUCE THE RISK OF ELECTRICAL SHOCK, DO NOT REMOVE COVER. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

CAUTION: BEFORE EQUIPMENT USE, CONSULT THE OPERATOR'S MANUAL.

CAUTION: FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN OR OTHER HEALTH PRACTITIONER LICENSED BY THE STATE.

ATTENTION

DANGER: RISQUE D'EXPLOSION. NE PAS EMPLOYER EN PRÉSENCE D'ANESTHÉSIQUE INFLAMMABLES.

ATTENTION: PUISSANCE ÉLECTRIQUE HASARDOUSE. CET ÉQUIPEMENT DOIT ÊTRE UTILISER UNIQUEMENT PAR LE PERSONNEL QUALIFIÉ.

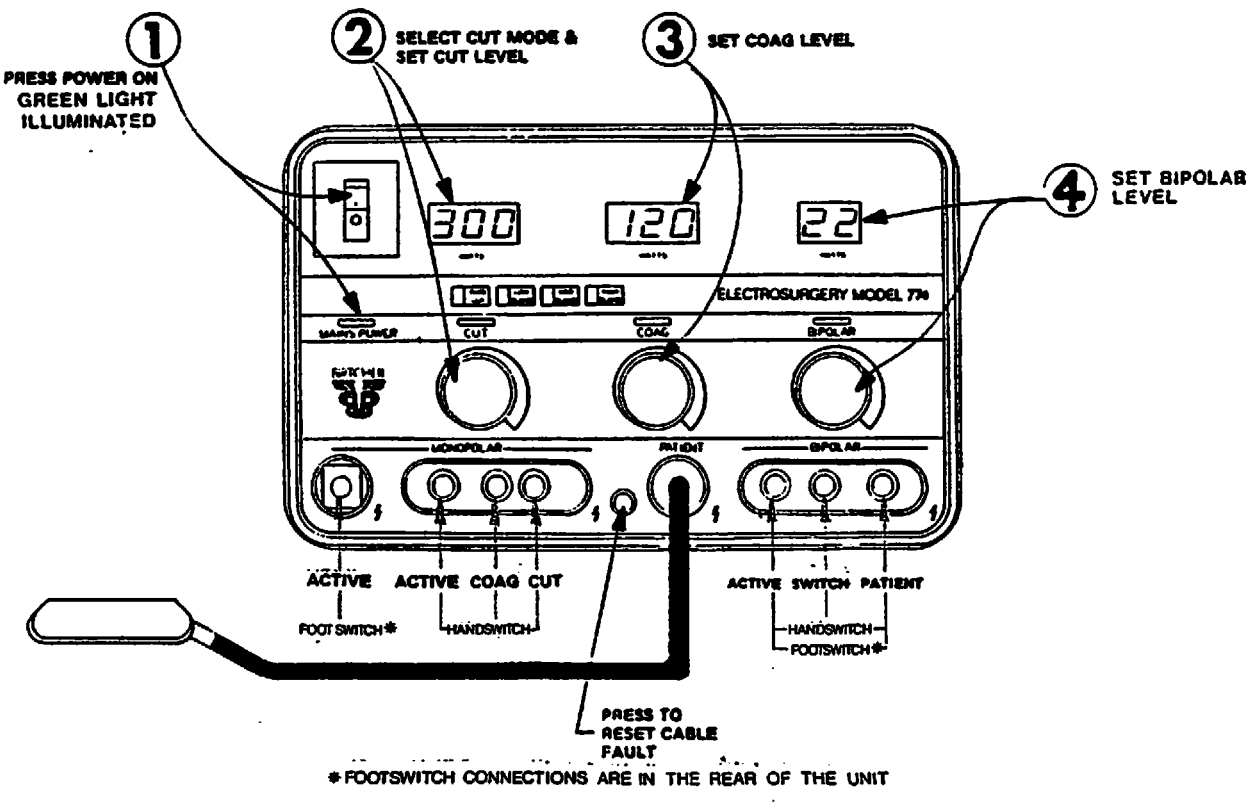
ATTENTION: CET ÉQUIPEMENT A UNE PUISSANCE DE SORTIE SUSCEPTIBLE D'ENTRAÎNER DES EFFETS PHYSIOLOGIQUES.

ATTENTION: POUR RÉDUIRE LE RISQUE D'UN CHOC ÉLECTRIQUE, NE PAS ENLEVER LA COUVERTURE NI DU FRONT. SE RÉFÉRER AUX PERSONNEL DE SERVICE QUALIFIÉS.

ATTENTION: AVANT L'USAGE D'ÉQUIPEMENT, CONSULTER LE MANUEL DE FONCTIONEMENT.

ATTENTION: LA LOI FÉDÉRALE RESTRIENT CET APPAREIL ÊTRE VENDU PAR OU À L'ORDRE D'UN MÉDECIN OU AUTRE PRATICIEN LICENSIÉ PAR L'ÉTAT.

INITIAL OPERATION - FIGURE #5



2.3 INITIAL CHECK OUT

After unpacking, check the shipment for completeness of accessories. Then verify, by inspection, that no physical damage has occurred during shipment. Carefully inspect all accessories, cords, instrument case and panels. For complete technical tests refer to Section 7. This section gives the Bio-Medical Engineer complete performance test information. See Duty Cycle limitation in Section 1.2, page 1-1.

2.4 INITIAL OPERATION

The top cover of the Birtcher Model 774 describes the basic operation and cautions.

1. Turn on power.

2. Select Cut mode and set Cut level.

3. Set Coag level.

Detailed information for accessory connections is shown in Figure 4, pages 2-5 to 2-7. Accessories available for use with Model 774 are shown in Section 2.2, pages 2-3 & 2-4.

Output Settings

If exact settings are not known, a good philosophy is to start low and increase the output until the desired electrosurgery effect is achieved.

Power Turn On

Power indicator lamp glows green when power switch is turned ON. Pull out patient plate cable to check for proper operation of the cable fault light and audio tone. Reinsert patient plate cable and press cable fault switch to reset fault light, output display, and enable unit operation.

Select Cut Mode

Cut mode is comprised of Pure Cut, Low Blend, Medium Blend, and High Blend. The Cut mode is always a selected mode when power is applied and light indicator is ON.

Set Cut Level

Set Cut level dial to minimum for initial test.

Set Coag Level

Set Coag level dial to minimum for initial test.

Footswitch Or Hand Switch Activation

With either the footswitch or the Birt-A-Switch plugged into the unit, check for audio and light indication of Cut and Coag.

2.5 GENERAL CARE OF ACCESSORIES AND ELECTROSURGERY UNIT

A careful inspection of cords, handles and cord connections at regular intervals will insure best performance of your Birtcher Solid State Electrosurgery unit. Replace all worn cords. Have a Bio-Medical Engineer check snug fit of all cord connectors.

The cabinet finish on this unit is baked enamel. Blood, chemicals or other soil can and should be promptly removed with soap and water. Clean the front panel overlay with soapy water or isopropyl alcohol only.

Maintenance should be performed at six month intervals in order to insure peak operating performance of your new Model 774 electrosurgery unit. Power output and leakage tests should be checked at three month intervals in order to maintain a history of electronic output characteristics by which the unit can be measured.

If power output levels change, beyond specification, between successive intervals, adjustments should be made. Necessary adjustments are described in Section 7, Maintenance and Calibration, of this manual.

2.6 STERILIZATION

Many of the optional reusable accessories that may be used with the Model 774 may be steam sterilized or ETO gas sterilized depending on the product. Disposable accessories cannot be re-sterilized. Please consult the factory for recommended sterilization cycles for reusable accessories.

2.7. RECOMMENDED PRACTICES FOR USE OF A PERMANENT PATIENT PLATE

The following are recommended practices for the proper placement, use and surveillance of the patient plate:

1. The patient plate must be kept clean and smooth and should always be applied with a generous application of **Birtcher #394 Kontax-S Gel Conductor.**

2. Wet towels or soap lather should not be used as conductive agents because they may dry out, resulting in high frequency skin burns to the patient.

3. Never apply patient plate over heavily matted hair or over scar tissue.

4. Needles should not be used as dispersive electrodes when using electrosurgery.

SECTION 3

GENERAL PRINCIPLES OF ELECTROSURGERY

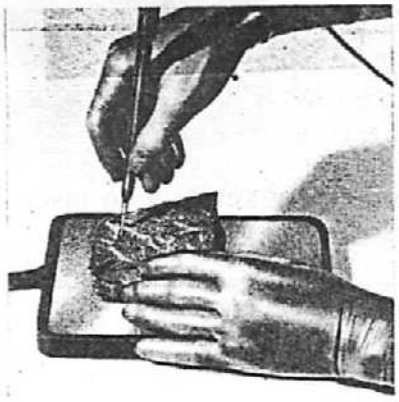
Electrosurgery is the use of radio frequency (Rf) energy to accomplish various surgery effects. The type of energy, (continuous RF, intermittent damped wave RF, or a combination of the two), accomplishes different results. Control and technique are also important.

Two (2) output controls are incorporated into the Model 774 (major surgery unit): Cut and Coag. Three (3) electrosurgery effects are controlled from the application of these two RF power outputs.

1. Electrosurgical Cutting
2. Electrosurgical Coagulation - Desiccation Type (drying and sealing)
3. Electrosurgical Coagulation - Fulguration Type (burning, charring of tissue)

3.1 ELECTROSURGERY CUTTING

For electrosurgery cutting, the continuous RF power waveform heats and explodes the tissue cells immediately in front of the guiding blade or loop. The heat results from the current through the tissue and the spark itself which may contribute the major part of the total heat. Therefore, cutting is actually achieved with the electrical current and is merely guided with a dull blade or wire loop.



CORRECT APPROACH FOR USING ELECTROSURGERY BLADE AND LOOP

The operator may experiment in cutting fat and other types of tissue, using somewhat more power for fat. Fat is the most difficult tissue to cut due to the fact that it does not carry the electrical current readily. However, fat cuts more readily in live tissue than in dead tissue.

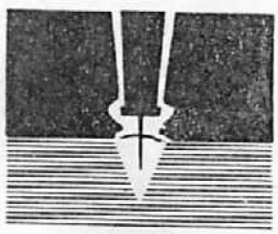
The operator should then experiment with the other shaped blades, needle points and loops. While loops of various shapes will be found particularly desirable for scalloping out pieces of tissue of various sizes and shapes, here too the operator should experiment using only a portion of the loop at first, then gradually learning to bury most of it into the tissue. Likewise, the vertical stroke should be first employed. A fair amount of power is required in cutting with the loop inasmuch as the circumference of a loop presents a considerable cutting length.

Cutting in a wet field requires more power than a dry field. When a loop is used under surgical irrigating fluids as in a T.U.R. procedure, high power is required (over 150 watts) since much of the energy is conducted away through the liquid.

3.2 ELECTROSURGERY COAGULATION - DESICCATION

The definition of desiccation comes from the Latin root, desiccare, which means to dry. For Coagulation the Model 774's electrosurgery output is a damped RF power at a low frequency repetition rate (30 KHz). Its high voltage damped output produces Coag power into various load conditions. That is, the high electrical resistance of dried tissue or low resistance of a wet field will receive a reasonable constant power as set on the coag dial. The high, but intermittent, RF power causes dehydration but does not create temperature that is high enough to produce tissue cell explosion (cutting).

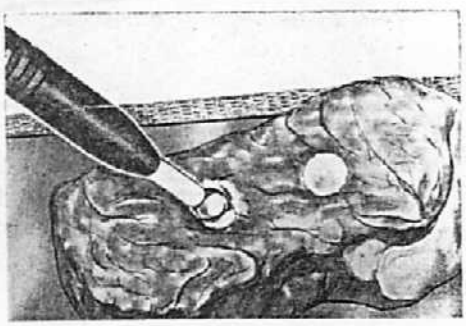
The desiccation process is caused by the heat rise of tissue at the surface contact of the active electrode due to RF current concentration and flow through tissue resistance at this point. Continual desiccation at increased intensity will result in tissue destruction and charring.



In surgery the active electrode or small needle point may actually be inserted into the tissue.

3.3 COAGULATION AROUND BALL POINT

When an electric current flows through any substance which offers resistance to its passage, heat is generated. In electro coagulation the current flows between the active electrode and the patient plate. No heat is generated at the patient plate because of the large area of its surface. Since the same volume of current concentrates around the very small surface area of the active needle or ball point, the resistance of the immediately adjacent tissue is sufficient to create adequate heat to cook the tissue.



Experience alone must be the guiding factor as to the depth of coagulation. But it must be kept in mind that a longer time factor will bring about greater and deeper coagulation than a greater amount of power for a very short period. The same experiment as referred to in the Electrosurgery Cutting Section, 3.1, may be used to test the effects of electro coagulation.

3.4 ELECTROSURGERY COAGULATION - FULGURATION

The definition of fulguration comes from the Latin root fulgor which means lightning. The active electrode is held slightly out of contact (1mm to 3mm) with the surface being treated. The resulting arcing to the surface is useful coagulation for large bleeders and tissue char.

3.5 COAGULATION USING HEMOSTAT

Electro coagulation in major surgery is very useful as a means of procuring hemostasis. Operations in which small and fair sized bleeders are encountered and in which ordinarily many hemostats or ligatures are required may be handled using the coagulation current in many cases. These small bleeders may be seized in the usual manner with the hemostat. The operator or assistant may then hold the hemostat up in such a manner that no portion of it contacts any tissue except for the actual point which is clamped to the bleeder. Then the active blade may be brought in contact with the hemostat, an inch or two above the point and the current turned on.

The current will flow down the hemostat to its point and gently coagulate the walls of the bleeder together. Surgeons have reported complete thyroidectomies, hysterectomies, mastectomies, nephrectomies, etc. without the use of ligatures.

Very small vessels which usually do not bleed after the clamp is removed can be definitely sealed with a mild current. Moderate sized vessels which ordinarily bleed after removing the clamp may be controlled by coagulation through the hemostat by using just enough current and time to slightly blanch the tissue of the vessel. Some surgeons have reported success in coagulating larger vessels but, as a general rule, it is recommended that only vessels up to 1/16 inch in diameter be controlled by this method. Conventional ligation should be used on larger vessels.

In employing this method, be sure that the operating field is sponged free of excessive fluids around the point of the hemostat, otherwise current will be dissipated through the fluids.

3.6 CUTTING WITH BLENDED COAGULATION

The Cut function includes four (4) modes: Pure Cut, low, medium, and high Blend. The Blend modes are continuous RF Cut power with the damped Coag signal blended in at a repetitive rate. The Coag signal repetitive rate varies with the mode selected and at high Blend, the signal looks similar to a standard Coag damped signal with a continuous RF Cut signal between each damped Coag energy burst. See illustrations, Section 4, paragraph 4.2. The heavier blend of Coag produces increased hemostasis during Cut.

3.7 MICRO BIPOLAR COAGULATION

The Model 774's Micro Bipolar option is an independent, low power, isolated output for electrosurgery. Its output power signal is a damped wave shape and its dial setting and output are independent of the major surgery unit. Footswitch and forcep power activation is available.

Bipolar technique is where two electrodes are employed with the current flowing between them. The two electrodes are usually in close proximity to each other, such as forceps. (See Figure #6. The forceps are inactive when the tips are open and are active when the tips are closed.) Bipolar technique does not allow Coagulation current to flow through surrounding organs or tissues.

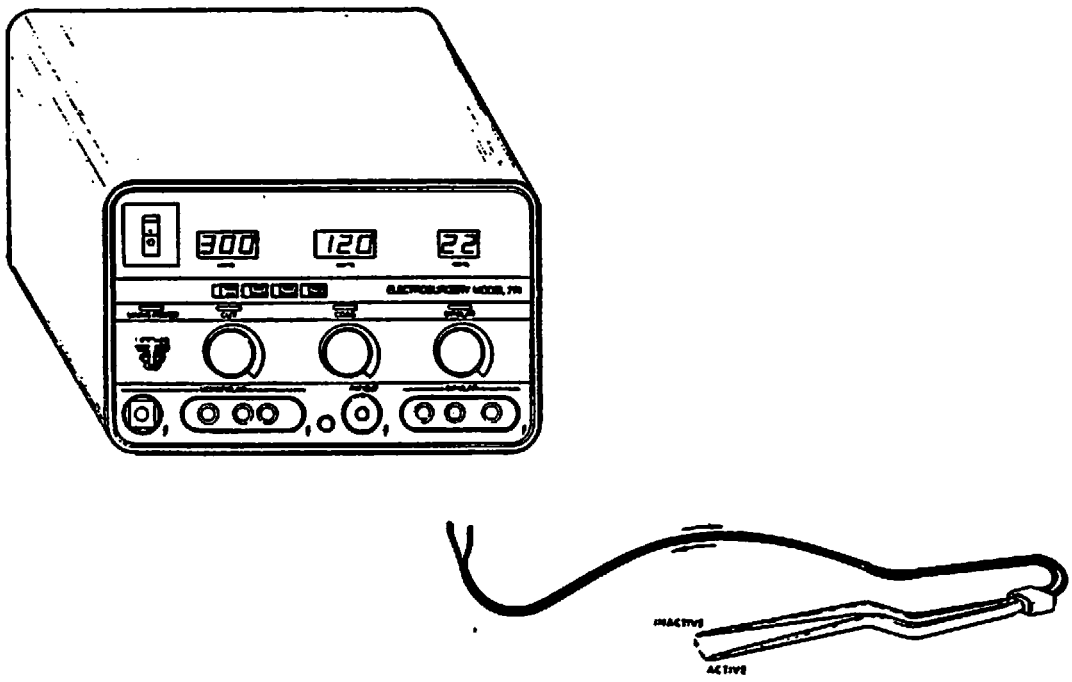


FIGURE 6

SECTION 4

EQUIPMENT FUNCTIONAL DESCRIPTION

4.1 BLOCK DIAGRAM DESCRIPTION

The block diagram (Figure 7) is drawn to correspond to the same layout as the schematic diagram. Arrows on signal lines show general signal control flow.

Logic Control

The logic control receives a "Turn On" signal from the footswitch or the Birt-A-Switch (switch isolator circuit) which then activates either Cut or Coag depending upon which one the operator has switched. The logic supplies proper repitition rates and turns on timing and blend mixing. The dispersive (patient plate) alarm defeats all logic when the patient plate dispersive circuit is not complete.

Cut Control

The Cut control is composed of two major circuits: The Cut amplitude control and the zero angle control which controls the driver.

The Cut amplitude, which is set by the operator and the output RF feedback to the circuit, is part of the Cut amplitude control. It works in conjunction with the zero angle control circuitry for Class C type output drive.

Driver

Both Cut and Coag signals are sent to the same driver. The driver then drives the output stage to a continuous RF power output for either Cut or Coagulation damped RF power energy bursts. In the Blend mode, the signals are successively mixed. The cut output is accompanied by an audio tone and a yellow light indicator. The Coag output is accompanied by an audio tone and a blue light indicator.

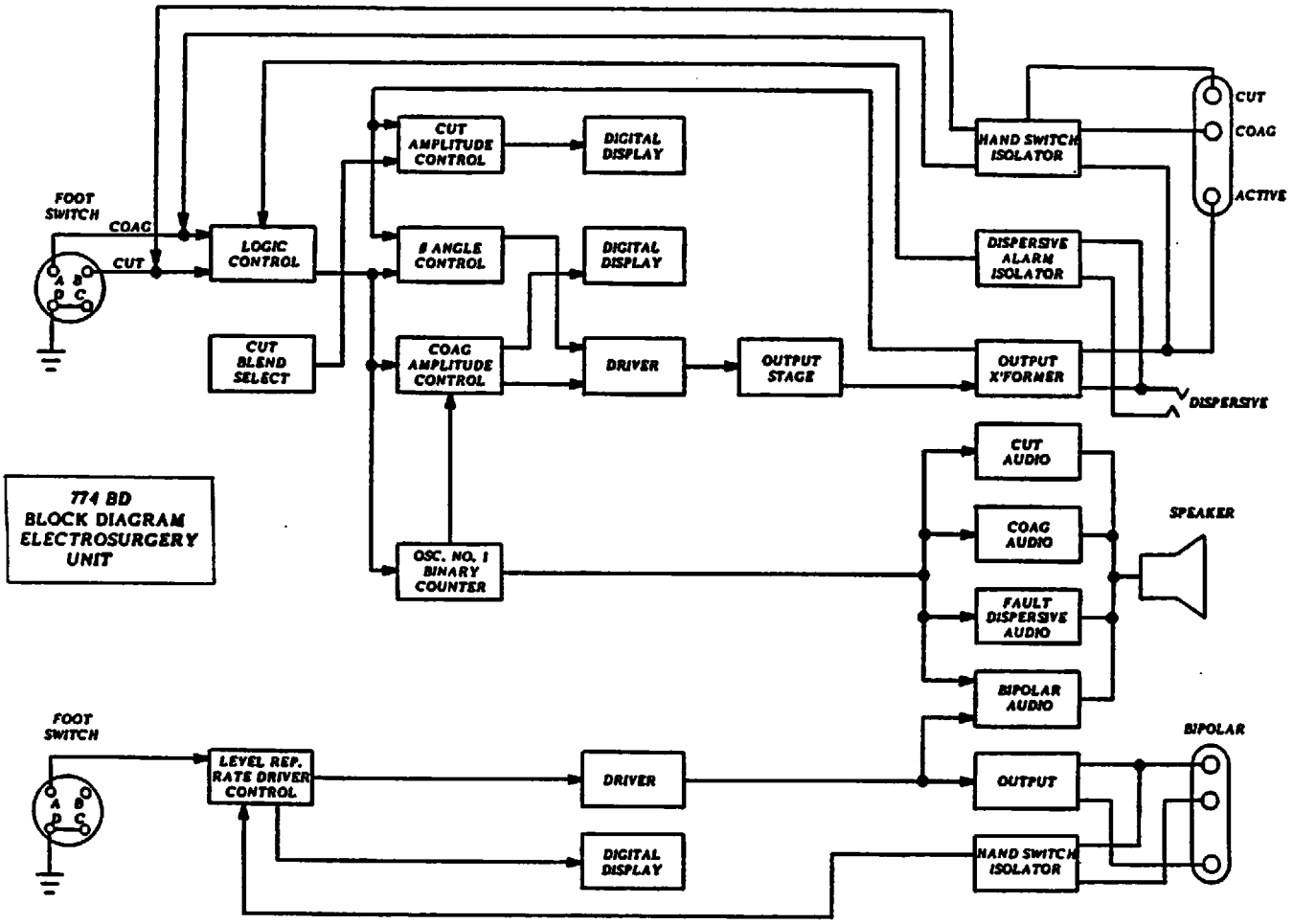
Output And Isolation

The output transistors drive an RF tuned output isolation transformer. Both hand switch contacts and the dispersive patient plate are connected to this isolated output. These isolation circuits enable the electrical operation to be referenced back to ground without defeating the output isolation.

Bipolar

In the Bipolar circuit, an I.C. comparator amplifier doubles as the repetition rate generator and level control. This generator drives a drive transistor which, in turn, drives the output transistor. The isolated output has a switch isolator for forcep power output activation switching. Audio tone and a blue light accompany power output activation. Footswitch activation is also available.

FIGURE # 7


774 BD
BLOCK DIAGRAM
ELECTROSURGERY
UNIT
FOOT SWITCH
COAG
CUT
LOGIC CONTROL
CUT BLEND SELECT
CUT AMPLITUDE CONTROL
DIGITAL DISPLAY
θ ANGLE CONTROL
DIGITAL DISPLAY
COAG AMPLITUDE CONTROL
DRIVER
OUTPUT STAGE
OSC. NO. 1 BINARY COUNTER
HAND SWITCH ISOLATOR
DISPERSIVE ALARM ISOLATOR
OUTPUT X'FORMER
CUT
COAG
ACTIVE
DISPERSIVE
CUT AUDIO
COAG AUDIO
FAULT DISPERSIVE AUDIO
BIPOLAR AUDIO
SPEAKER
FOOT SWITCH
LEVEL REP. RATE DRIVER CONTROL
DRIVER
DIGITAL DISPLAY
OUTPUT
HAND SWITCH ISOLATOR
BIPOLAR

4.2 MODE - OUTPUT WAVESHAPES

1

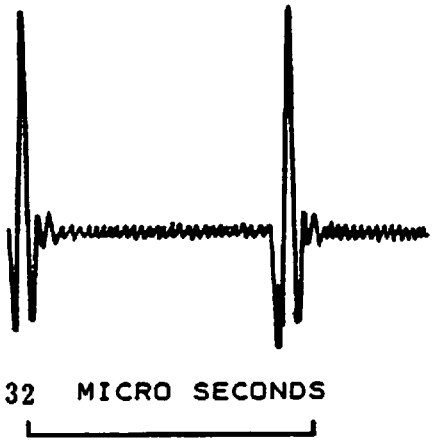
15V

TP2 Coag repitition rate logic drive to Coag amplitude control amplifier A4.

7 Amps PP

Coag drive to output transistor at current test loop.

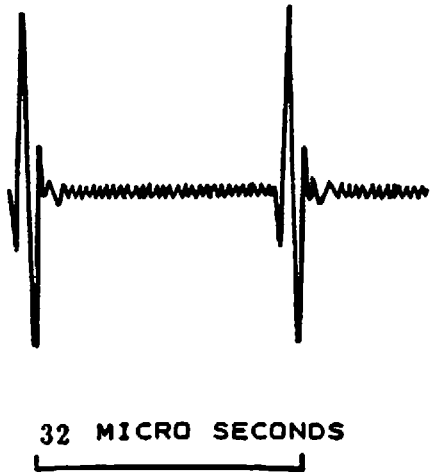
2



375 VPP

TP10 Coag, resonate tank voltage at the collector of the output stage 75 watts into 300 Ohms load.

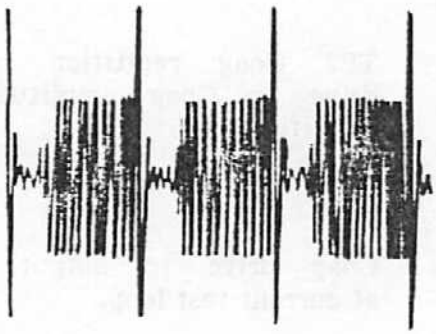
3



1600 VPP

Output, active to patient plate. 75 Watts into 300 Ohms load; loaded 1600 VPP; unloaded 3000 VPP; Coag.

4

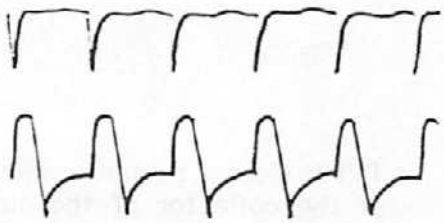


32 MICRO SECONDS

800 VPP

Output, active to patient plate. 175 Watts into 300 Ohms; Blend.

5



32 MICRO SECONDS

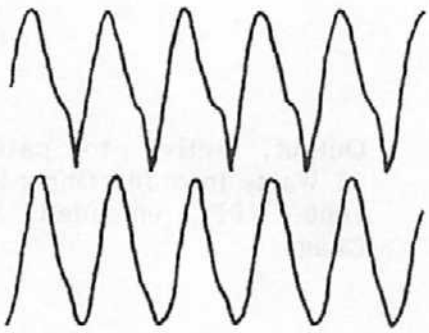
15 V

TP4 Ø control pulse for Cut.

5 Amps PP

Current drive to output transistor; (current loop). Drive for 200 Watts of Cut.

6



2 MICRO SECONDS

200 VPP

TP10 Cut; resonate tank at output stage collectors at 200 Watts into 300 Ohms.

700 VPP

Cut output 200 Watts at 300 Ohms load.

When this voltage is equal to the voltage at input Pin 3 of A4, set by the Coag power control knob R62, A4 resets. The output of A4 goes positive. Q18 & Q20 turn ON back biasing the output transistors to about -7 volts. The output transistors turn OFF. The output transformer now has a damped wave shape output because of its self-inductance of the transformer and the capacitor C40, causing a series resonant circuit. This energy oscillates and is a damped wave output into the output load. Different power levels are accomplished by the voltage setting of the Coag power control knob. Different levels of stored energy accomplishes output power control.

Cut Power Generation

Cut power is a continuous wave radio frequency (RF) output. The output power generator may generally be described as a Class C, RF power generator. However, this is not completely descriptive. Aspects of Class D and Class E amplification are present in a configuration that can tolerate open and short circuits and operate at high loaded efficiencies. During part of the cycle, the output transistors conduct. The rest of the cycle is self-resonant at the natural frequency of the output transformer and its capacitors. When Cut circuitry is enabled TP3 is high. The Cut output will function as follow:

1. A2 output goes negative and positive because A2 changes state by itself for this first cycle (as a self oscillator). CR31, R50, R52, and C11 are the components controlling this multivibrator action.

2. The negative swing of A2 couples thru CR34, C12, CR36 to A3, Pin 2 causing A3 comparator amplifier output to switch to ground.

3. Q18 & Q20 are turned OFF and Q19 is turned ON driving the output transistor ON by the current thru R151 until the output of A3 returns to a high state. This time (phase angle θ output conduction time) is controlled by the output voltage of A1. This voltage sets and clamps a voltage on C13 in the A3 feedback CR38, R58 and C13 to the inverting input of A3, Pin 3. This voltage level regulates θ, the output-turn-on conduction time.

   The output of A1 is the control signal to regulate the Cut amplitude level. It is set by the Cut amplitude control and is the Cut amplitude feedback regulator. The output feedback to A1 is from T3 the output transformer thru C7, R35, CR26 to Pin 2, A1. The non-inverting input from the Cut level control knob and the amplifier senses the RF output amplitude which feeds back to the inverting differential input which makes a differential measurement of the two and adjusts A1 output to control the RF output amplitude.

4. A3 returns to the high state by its own feedback, R58 discharging C13. (This on-to-off time is the phase anlge θ output conduction time.)

5. A3, returning to the high state, turns OFF the drivers and output transistors. The output tank T3, C40 oscillates positive and back negative (the first cycle of the RF continuous wave).

SECTION 5

SCHEMATIC DESCRIPTION AND SPECIFICATIONS

5.1 SCHEMATIC DESCRIPTION

Circuit Description - Reference 774 Schematic

The 774 electrosurgery unit is composed of the following major circuit sections. Each is explained in circuit detail operations.

1. Coag power generation
2. Cut power generation
3. Control logic Cut, Coag, and Blend
4. Hand chuck isolation switch
5. Dispersive alarm isolator
6. Audio tones
7. Power supply
8. Micro Bipolar

Sound Signals

Pulses from U3 binary counter gate A7 or A8 when U1, Pin 10 or Pin 11 are gated driving SP1 and DS302 or DS306 for Cut, Blend and Coag.

Coagulation Power Generation

Coag power is generated by the operation of four basic circuit sections.

1. A4 control comparator amplifier
2. Z302 - Z303, DP303 - DP305 digital display
3. Q18 thru Q20 power output driver
4. Power output transistors Q13 thru Q17

A4 is triggered on at the Coag repetition rate. This is by logic control from TP2, via clock pulses from U3. The output of A4 switches to ground, Q18 is turned OFF and Q19 turns ON driving the output transistors Q13 thru Q17 ON. Current increases in the output transformer inductance T3. At the same time Q10 turns OFF charging C18 thru R76. This voltage is fed back to Pin 2 on A4 comparator.

6. This output wave shape from the T3, C40 RF output tank is fed back to the control circuitry at two points: The conduction (θ) angle control comparator A2 and the Cut amplitude control differential amplifier A1.

7. The positive-going RF signal thru C59, R43, R44, and CR30 charges C11 positive. When the output signal oscillates negative, Pin 2 of A2 switches the output negative and A3 is pulsed negative continuing the RF CW cycle as explained from Step 2.

8. A1 amplifier measures the difference between the Cut amplitude set level and the actual RF peak to peak output. The set level is at Pin 3, and the measured RF level is to Pin 2. Peak to peak thru CR26 is stored at C8. Low voltage here in respect to Pin 3 level set voltage, causes the output of A1 to go high with an increase voltage storage on C13. This increases the phase angle on time of A3 and the conductions time of the output stage. The result is a higher output RF peak voltage. If the RF output is unloaded and becomes higher, the reverse occurs. Output tank regulation is thus accomplished with output transistor conduction time control.

Pure Cut, Low, Medium, Or High Blend

Logic selection of pure Cut, low, med, or high Blend is activated by selecting one of four touch key pads. Selecting the Touch/Entry key for pure Cut enables U4 Section A to select Y inputs for decoded binary output of U5. A logic "1" at Pin 17 reverse-biases CR98 turning ON Q9 and illuminating DS301. Selecting a Touch/Entry key for low, med, or high Blend enables U4 analog switch to select the correct Y inputs for decoded binary outputs of U5 Pins 14, 15, or 16.

Cut Enable - Pure

With the pure Cut light illuminated, the junction of R20, CR10, TP3 is high whenever the input to U1 (12-13) is low. That is, when the Cut footswitch or the hand chuck isolator switch input is active (low), the Cut cable line at TP3 is high and Cut RF circuitry is enabled.

Coag Enable

Activating the footswitch or hand chuck isolator circuit causes the input of Gate U1 (8) to go low and U1 (10), the output of this gate, to go high and U2 (4) produces a square wave and a negative output. This signal couples thru C16, CR43 to A4, starting a Coag signal generation (see Coagulation Power Generation, Page 5-1). The output of U1 (10) gates R62 and turns the control level pot ON at this time.

Blend

Blend (heavy) is a Coag signal at normal rate with RF Cut signal between the high energy damped sinusoids of Coag. (Lower repetition rate of Coag is used in moderate and low Blend modes.) In the Blend mode, the Cut level front panel knob controls power level and the Cut gate U1 (11) initiates control. The output

of U2 (4) and gate CR 12 thru CR13 initiates Cut Coag timing for each Blend mode. See the timing diagram on the schematic. This output drive U2 (4) and the output gates CR12, CR13 for a Cut Blend enable or U2 (3) for a Coag of Blend enable.

Hand Chuck Control - Isolator Switch

This circuitry provides electrical isolation and allows Cut or Coag control from an electrosurgery switching blade chuck.

A5 is a multivibrator driving the high frequency isolation transformer T2. When neither Cut or Coag is activated, the positive pulses at T2 (J6-1) and T2 (J6-3) produces DC signals on C2 and C3, respectively, de-activating Cut and Coag gates U1 (10) and U1 (11). When Cut or Coag is activated CR68 or CR69 shorts that polarity pulse drive as indicated by the diode polarity. The absence of a positive pulse to C3 or C2 causes the respective Cut or Coag gate of U1 (10) or U1 (11) to go positive.

L.E.D. Displays

The L.E.D. display board has three 7107C MOS IC's to convert the input P.C. level to seven segment decoders to drive the L.E.D. displays. Each 7107 generates a clock pulse used to generate the negative 5 volts by CD4009 hex-invertor. Full scale reading for Cut is 300, Coag 120, and Bipolar 22 (watts).

Dispersive Plate Cable Alarm

A6 is a multivibrator driving the high frequency isolation transformer T2. If either line in the dispersive cable is open, a positive pulse at test point TP9 thru CR54 latches the U1 (4) U1 (3) flip flop causing the cable fault red light to illuminate, gating U6 Pin 9 and driving SPK 1 audio tone, which disables the control logic at U1 (13) and U1 (9). When the cable-to-plate connection is complete, this positive pulse is shorted by transformer action thru CR70.

Power Supply

When AC power is applied, Q8 is biased full ON and Q21 is OFF enabling U3. When AC power is removed, Q8 is OFF enabling U2 and Q21, resetting U3 counter which removes all drives. The power supply is conventional with a power transformer having three secondary windings, driving bridge rectifiers to produce +100V, +24V and -7V. A regulated +15V source is derived from the +24V supply.

When power is applied, Q8 is saturated, Q21 cuts OFF and the reset line of U3 Pin 12 is held low for binary counting. When power is turned OFF, Q8 is cut OFF and Q21 saturates biasing Q24 OFF, removing 5 volt supply from VR11 and supplying a logic "1" to U3 disabling the binary counter.

Fan Control (Option)

Depending on the wiring, the fan may be activated in one of the following three ways:

1. Jumper E3 to E1 to have the fan run when unit's power is ON.
2. Jumper E3 to E2 to have the fan run when unit is overheated.
3. Jumper E3 to E4 to have the fan run when unit is activated.

Circuit Description - Micro Bipolar

The Micro Bipolar consists basically of four circuit sections:

1. Isolator switch
2. Level, repetition rate, driver control
3. Output transistor
4. Audio

Isolator Switch

An explanation of circuit operation begins by depressing the Bipolar switch or the footswitch. Under this circuit condition, A201 oscillates as a multivibrator (MV) and its output is rectified at CR209. This DC voltage enables A202, the driver control comparator amplifier. This AC coupling provides for safety on any DC failure of comparator A201. If A201 shorts to +24V, to ground or fails with an open output, the Bipolar unit (fail safe) will not be turned ON.

The Bipolar switching forceps contacts short the output of T203 thru CR212. This reflects a short back to CR211 and inhibits the positive pulse at the junction of C217 and R229. This converts A201 from a long duration blocking oscillator to a MV capable of producing a power supply for enabling A202, The Bipolar driver amplifier.

Level Rep Rate Driver Control And Output

When A202 is enabled with voltage from the isolator switch circuit, A202 is biased so Q201 switches ON (low). This same action is also initiated with the footswitch. Xformer T201 now draws current, storing up energy in the primary. This portion of the cycle continues until R215 discharges C202 to a voltage more negative than Pin 2 of A202. When this occurs, the collector of Q201 switches high (OFF).

The stored energy in T201 generates a current drive in the secondary of T201 to Q203, turning it ON. Current is then drawn through R223 at a linear rate with respect to time. This produces a voltage ramp that is representative of the current through T202 and consequently the energy stored in T202. Then the voltage ramp through R208, R207, and CR202 becomes positive to Pin 2 of A202, the collector of Q201 switches ON (low), driving Q203 OFF through T201. The point on the ramp at which this occurs is modified by the settings of R202 full level adjustment and R203 the output control. With Q203 OFF, the energy stored previously in the primary of T202 is allowed to resonate with C210, producing a damped sinusoid at the output terminals and one cycle is completed.

Audio

A203 is an amplifier which drives the speaker. It is gated ON whenever the collector of Q201 switches to ground. The input pulse at Pin 3 comes from U3 Pin 15 Binary Counter of Mother Board.

5.2 SPECIFICATION

OUTPUT CHARACTERISTICS	P.P. VOLTAGE OPEN CIRCUIT	POWER WATTS 300 OHMS
CUT	1000 Max	300
COAG	4000 Max	120
BLEND	4000 Max	300

Cut Power Output L.E.D. Display — Power output ±15% at 5 watts of reading, ±7% full scale, ±.5 watt of calibration value with 300 Ohms load.

Coag Power Output L.E.D. Display — Power output ±15% at 5 watts of reading, ±4% full scale, ±.5 watt of calibration value with 300 Ohms load.

Output Wave Form

Cut — 0.5 megahertz sinusoidal 100% duty cycle.

Coag — Sinusoidal with a repetition frequency of 31.35 KHz, 6.25% duty cycle.

Blend — Coag signal is added to the Cut signal to achieve Blend. The proportion of Coag signal power is approximately 1/3 of Cut, (i.e. 100W/300W). The Blend power is controlled by the Cut control knob. The four Cut touch key pads are labelled "Pure Cut" (with zero Blend), "Low" which produces one Coag burst (25% Coag repetition rate) then Cut power resumes during the remaining time. This sequence is repeated as long as the Cut button is depressed.

Blend (continued)	"Medium" is similar to "Low" except Coag has a 50% repetition rate. "High" has 75% (32 KHz) Coag repetition rate with Cut between Coag burst.
Output Isolation	Sink current 7 microamperes with 115VAC to active or dispersive. Isolation leakage to ground, 500 Ohms load, less than .5 watt Cut, less than 2.5 watts Coag.
Leakage Current 60 Cycle	Chassis to earth ground; third wire in line cord conducts less than 50 microamperes.
Crest Factor	
Cut	1.2
Coag	5.5
Output Power Decrease Without Patient Plate Return	98%
Duty Cycle	50% normal operation at 200 watts, any load (10 seconds ON, 10 seconds OFF); 33% heavy operation at full (max.) power, 500 ohms load (5 seconds ON, 10 seconds OFF).
Cooling	Convection cooled.
Indicators	.6" 7 segment LED displays for Cut and Coag power output, 9 distinctive lights indicating operating mode.
Audio Volume	Four (4) distinctive tones for indiction of Cut, Coag, Bipolar, and fault indicator.
Input Line Voltage	Standard model is 115VAC, 60 Hz. Multivoltage is 100, 115, 127, 220, 230, and 250 at 50/60 Hz. Switch selectable is available for export sales.
Input Watts	625 watts maximum. Idle 25 watts nominal.

Patient Cable Fault Indicator	Detects one of two or both conductors for open patient cable, activates cable fault indicator tone and disables the electrosurgical currents until the reset light is depressed to enable normal operation.

Bipolar Module Specifications

Power Output LED Display	Controls Bipolar power dial; power display to 22 watts. Power is ± 15% or ± 2 watts of reading, ± 3% of full scale, ± .5 watt of calibration value with 500 ohms load.
Output Plug	Type 3: contacts, banana pin connector.
Indicators	.6" 7 segment LED display for power output, white light when coagulation is keyed ON by operator.
Output Wave Shape	30 KHz energy storage repetition rate. A damped sinusoid wave occurs when energy is discharged into a load resistance.
Output Voltage	Open circuit voltage, 1500 Vp-p.
Frequency	Open circuit frequency, 0.5 MHz.
Power Output	22 watts full scale.
Power Input	24 volts nominal @ 2 Amps, @ full power.
Output Isolation	Sink current 7 microamperes with 115VAC to active or dispersive input. Radio Frequency dispersive leakage to ground, less than 1.25 watts Coag.

Physical Specifications - Total Unit

Weight	29 pounds (13.2 Kg.)	
Size	HEIGHT	8 inches (20.3 cm.)
	WIDTH	12 inches (30.5 cm.)
	LENGTH	17 inches (43.2 cm.)

SECTION 6

TROUBLESHOOTING FOR REPAIR

6.1 GENERAL INFORMATION

Some general observations for localizing trouble areas are given in this section. An understanding of the general block diagram functions and the schematic description should be used in conjunction with this troubleshooting guide.

CAUTION - HIGH RF AND DC VOLTAGE

The entire electrosurgery circuit may be operated up to the output transistors without high voltage on the output by removing high voltage fuse F1. When all circuits are properly functioning and base drive to the output transistors checked, the overall instrument may be tested for output operation.

6.2 PROBLEM AREA CIRCUIT ISOLATION

The front panel, hand switch (Birt-A-Switch) and an RF output indicator (Wattmeter, light bulb or arc to patient plate) may be utilized to isolate some trouble before detail circuit oscilloscope troubleshooting is required.

The following trouble symptoms that the unit may indicate and the reason for these symptoms will cover most major sections of the Model 774. The tests and reasoning will indicate other more detailed testing that may be required.

Power Switch - Circuit Breaker Cannot Be Turned On

Output power transistor(s) shorted. Therefore the high voltage is shorted to ground, tripping breaker. Replace transistor(s) on assembly #3410-26.

No Power Output

Cut and Coag audio and lights key ON. The power output stage is shorted and has blown the high voltage fuse F1. All circuits through to TP7 may be normal.

No Power Output

Cut audio and light keys ON, Coag does not. Note Coag audio is driven from driver TP7. Cut audio is not. This indicates a drive problem Q18 - Q20 and the above output problems may also prevail.

Logic And Cut-Coag Control Circuitry Test

+15 power test from front panel: Pulling patient plate operates alarm. This light is illuminated from +15V supply. Failure to light: check +15V or isolator switch circuitry A6 and TP9.

Dispersive Alarm Works - No Cut Or Coag Keying Indication

Check isolator switch M.V. A5 at TP8. See schematic wave shape, M.V. OK - check footswitch input.

Cut Keys Light And Audio Sounds - No Coag

Check Coag logic through coag amplitude control only.

1. U1 (10) for ON-OFF with hand switch.

2. TP2 for a 32 micro seconds square wave which is the Coag repetition rated control signal. Check counter U3 logic U2.

3. TP6 the time duration (to 1.5 micro seconds) Coag amplitude signal to the driver.

Coag Keys Light And Audio Sounds - No Cut

Check Cut logic through Cut control only.

1. U1 (11) for ON-OFF with Cut hand switch.

2. TP3 enable Cut ON-OFF as above.

3. TP4 oscillates at 2 micro seconds, see schematic wave shape.

Micro Bipolar

The Bipolar is composed of M.V. driver and output with an isolator M.V. for turn ON keying. The audio and lamp drive are keyed from the drive output Q201. Wave shapes at key points are shown on schematic in Section 8.

L.E.D. Display - No Intensity

1. +5 volt power supply VR11.

2. -3.3 Volt power supply Z301, Z302 & Z304

SECTION 7

MAINTENANCE AND CALIBRATION

7.1 GENERAL INFORMATION

The Model 774 requires only the general maintenance of cleaning and the practice of general inspection of cord, cables and other electronic parts for good physical properties.

The calibration procedure is described in detail on the next page. Essentially the calibration procedure for the major surgery unit consists of settings as follows:

1. Low power calibration for Cut mode
2. Low power calibration for Coag mode
3. Low power calibration for Blend mode
4. High power calibration for Cut
5. High power calibration for Blend - Low
6. High power calibration for Blend - Medium
7. High power calibration for Blend - High
8. High power calibration for Coag

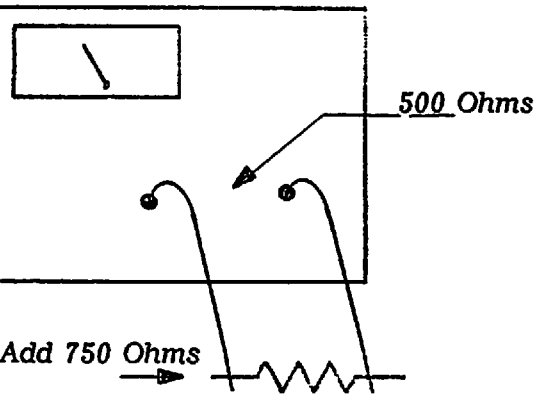
There is one calibration setting for the Bipolar unit which is explained in detail on the next page.

7.2 EQUIPMENT REQUIRED

Electrosurgery analyzer capable of 0 to 300 watts power reading at 300 Ohms. (See chart on follwoing page). NOTE: At 500 Ohms, a Dempsey, Model 443 may be used, shunting the input with a non-inductive 750 Ohms, 200 watt resistor, and using the following chart. (The resistor can be purchased from Ohmite, Type 270N vitreous enameled, Catalog Number 2410.)

7.3 CALIBRATION

500 Ohm ESU Tester



TESTER READING		*REAL POWER*
180	=	*300*
150	=	*250*
120	=	*200*
60	=	*100*
30	=	*50*
15	=	*25*

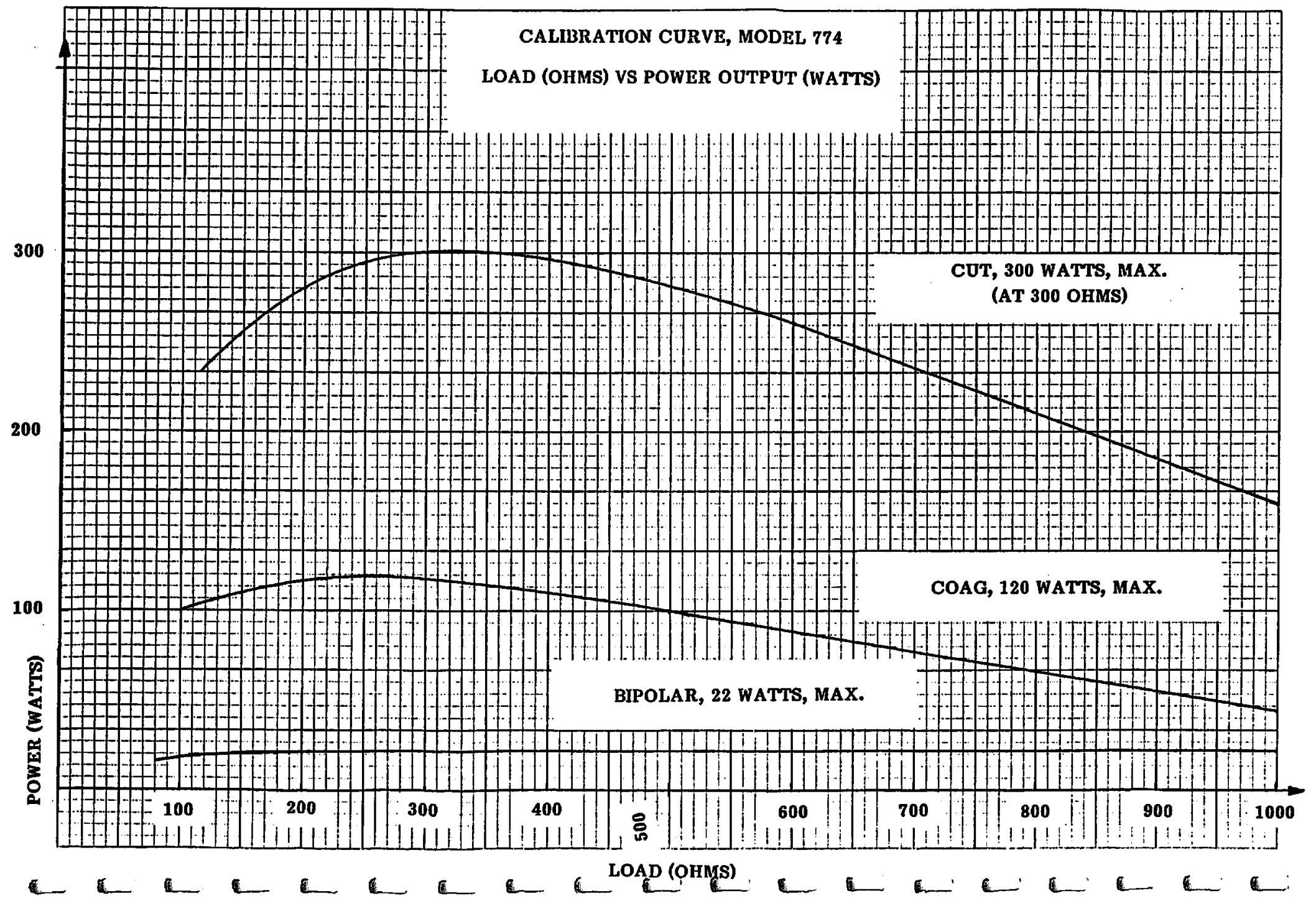
$\frac{750}{500 + 750} = \frac{750}{1250}$ = *.6 of the real power read on the tester. The remainder of the power is dissipated in the 750 Ohms, therefore reading divided by .6 = Real Power.*

For example $\frac{60}{.6}$ watts reading = 100 watts real electrosurgery output power.

CALIBRATION: Load output 300 Ohms - Active & Dispersive	*SET DIAL*	*Adjust R to watts output*
Coag - Low	*10 Watts*	*R250 10 Watts*
- High	*120 Watts*	*R77 120 Watts*
Cut - Low	*25 Watts*	*R39 25 Watts*
- High Cut	*300 Watts*	*R16 300 Watts*
- Blend, Low, Med. & High	*25 Watts*	*R173 & R176 25 Watts*
- Low Blend, High End	*300 Watts*	*R17 300 Watts*
- Med Blend, High End	*300 Watts*	*R18 300 Watts*
- High Blend, High End	*300 Watts*	*R19 300 Watts*
For above calibration potentiometers see PCB 3410-3 assembly drawing in Section 8		
MICRO BIPOLAR (Active Output Load 500 Ohms)	*22 Watts*	*R202 22 Watts*
For above calibration potentiometers see PCB 3410-4 assembly drawing in Section 8		

7.4 CALIBRATION L.E.D. DISPLAY

CUT	With the Cut knob (S3) at maximum clockwise, adjust R214 (on Mother Board) for 3.00 volts at J13-5. Adjust R303 on display assembly 3410-2 for a display of 300.
COAG	With the Coag knob (S4) at maximum clockwise, adjust R213 (on the Mother Board) for 1.20 volts at J13-7. Adjust R305 on Display Assembly 3410-2 for a display of 120.
MICRO BIPOLAR	With R3 maximum clockwise, adjust R249 on the Micro Bipolar Assembly, 3410-4, for 2.2 volts at P15-5. Adjust R307 on Display Assembly 3410-2 for a display of 22.


CALIBRATION CURVE, MODEL 774
LOAD (OHMS) VS POWER OUTPUT (WATTS)
CUT, 300 WATTS, MAX.
(AT 300 OHMS)
COAG, 120 WATTS, MAX.
BIPOLAR, 22 WATTS, MAX.
300
200
100
POWER (WATTS)
100
200
300
400
500
600
700
800
900
1000
LOAD (OHMS)