ERBOTOM T 175 E

Electrosurgical Unit

SERVICE MANUAL

ERBE Elektromedizin GmbH
Waldhörnlestr. 17
72072 Tübingen
Germany

Phone (70 71) 7 00 10
FAX: Sales (70 71) 70 01 88
FAX: Service (70 71) 70 01 89

ERBE ELEKTROMEDIZIN GmbH

Waldhörnlestr. 17
D-7400 Tübingen
P.O.Box 1420

Phone ..... (7071) 7001-0
Telex ..... 7 262 839 d
FAX ..... (7071) 70 01 79

ERBE U.S.A. Inc.

3800 Camp Creek Parkway
Bldg. 2600, Suite 120
Atlanta, GA 30331

Phone: 404-349-0900
FAX: 404-691-2843

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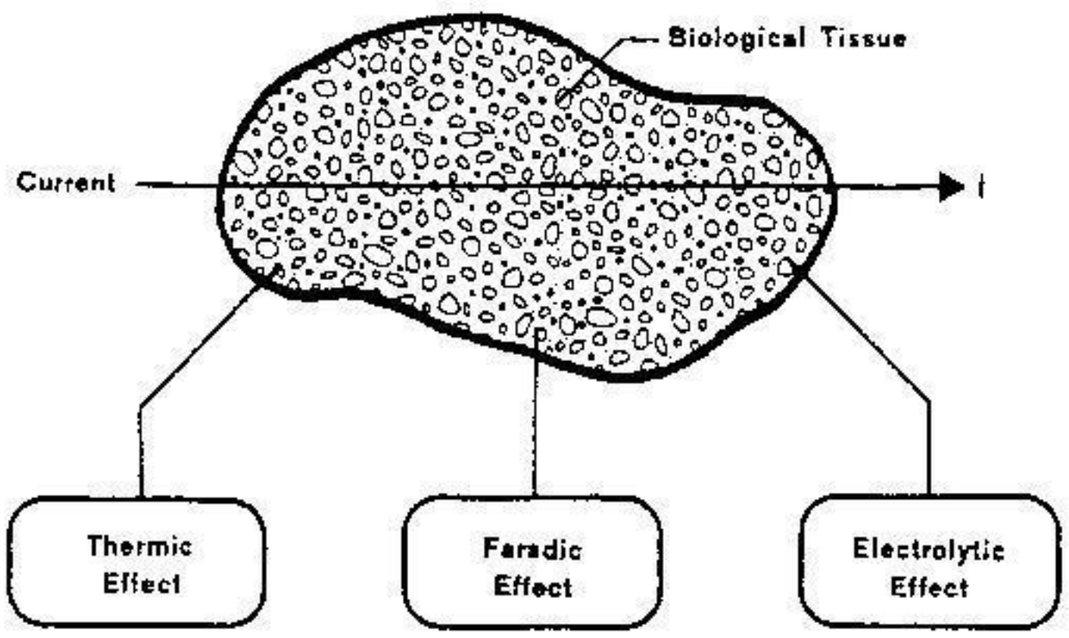
INTRODUCTION

CAUTION
This unit has hazardous electrical outputs. This equipment is for use only by qualified medical personnel.

Principles of Electrosurgery

When electric current flows through biological tissue the following effects can be observed:



The Thermal Effect
The tissue is heated by the electric current, in which the heating is dependent on the specific resistance of the tissue as well as on the current density and duration of application.

The Faradic Effect
Electrically sensitive cells, such as nerve and muscle cells, are stimulated by electric current. This effect, called faradic effect, is undesirable when performing radio-frequency surgery and a way of avoiding it has been devised. When an alternating current of sufficiently high frequency is used for electrosurgery, the faradic effect no longer occurs. This is the reason that an alternating current with a frequency of at least 300 000 Hz is used in what is henceforth referred to as high-frequency-surgery.

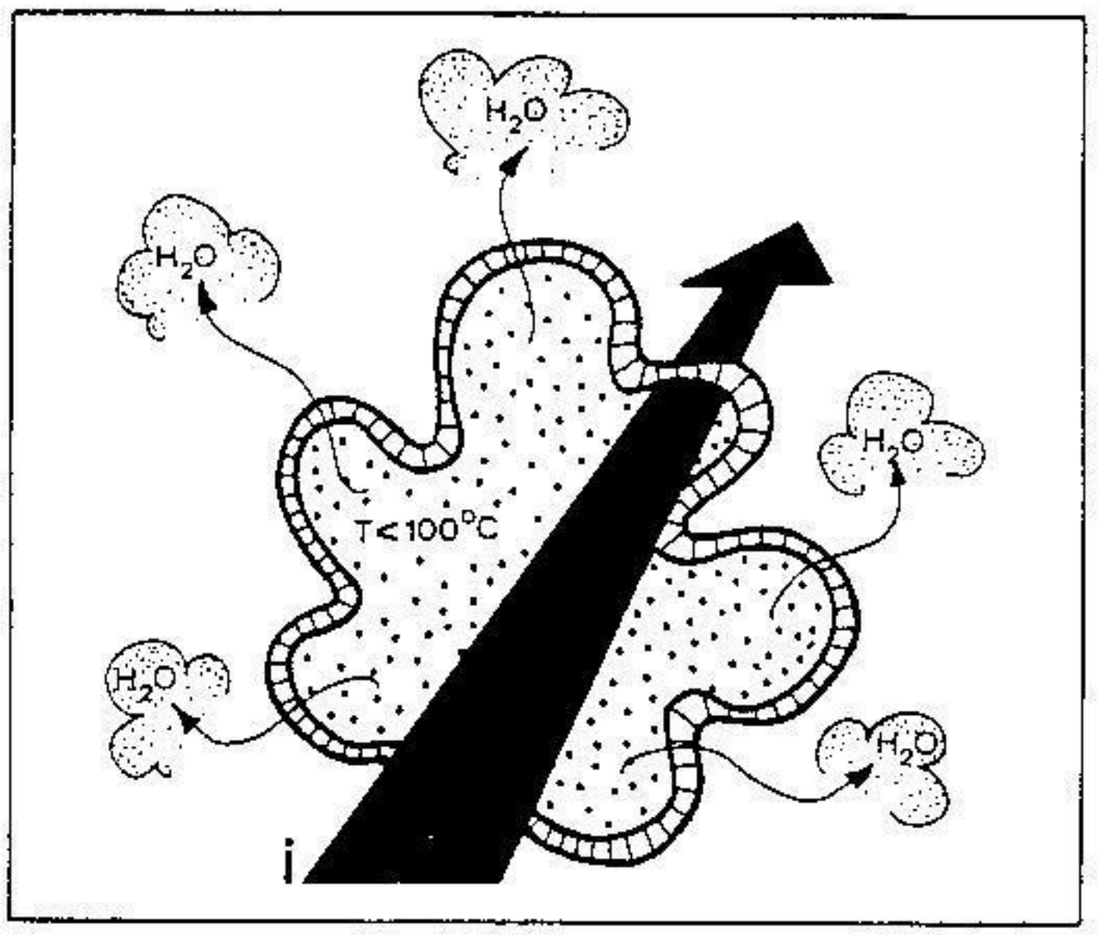
The Electrolytic Effect
Electric current causes ion shifts to occur in biological tissue. With direct current, positively charged ions would be shifted to the negative pole, the cathode, and the negatively charged ions to the positive pole, the anode, and their increased concentration at these points would cause electrolytic damage to the tissue.

When using alternating current of sufficiently high-frequency, the direction of movement of the ions is repeatedly reversed in accordance with the frequency of the current, so that the ions virtually oscillate to and fro at the frequency of the electric current. This is also a reason for the use of high-frequency alternating current in electrosurgery.

Use of the Thermal Effect in Electrosurgery
There are four different possibilities to apply the thermal effect of high-frequency current flowing through the tissue in electrosurgery:

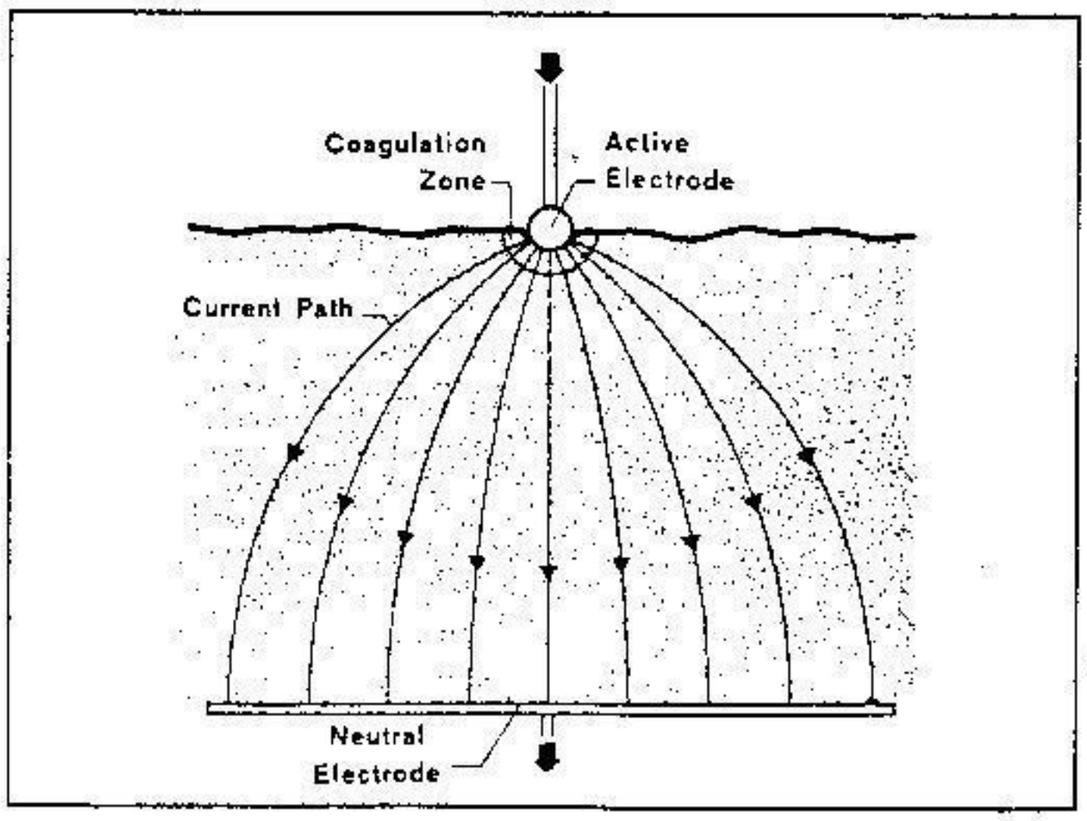
Electrosurgical Desiccation
Bipolar Coagulation
Electrosurgical Fulguration
Electrosurgical Cutting

Electrosurgical Desiccation is known as a technique in which the active electrode is held in surface contact with, or inserted into, the tissue, for the purpose of dehydration or deliberate destruction of the tissue.

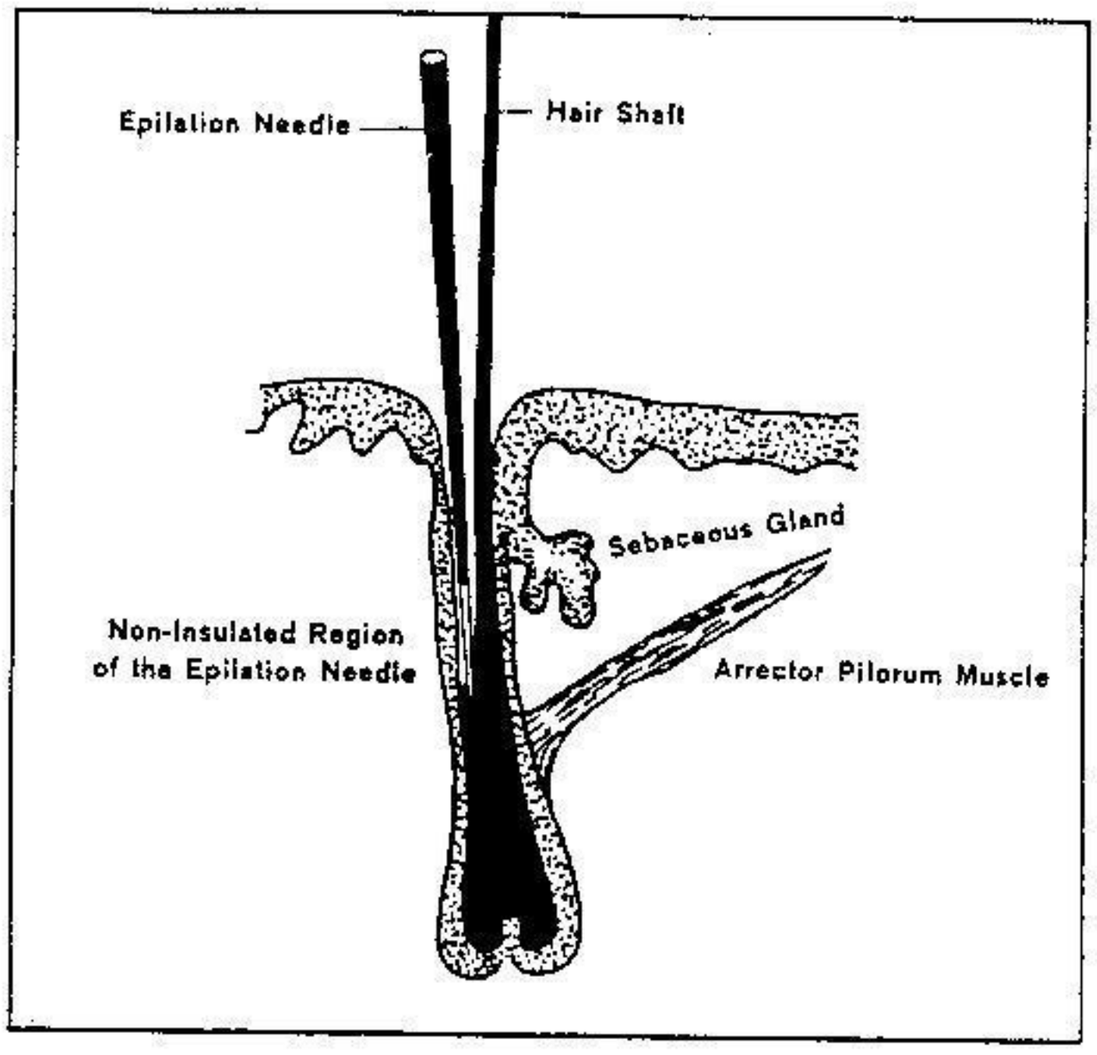


When the high frequency current i is flowing through the tissue, the cells becomes hot ($T < 100^{\circ}$ C) and the water (H_2O) is slowly driven out of the cells of the tissue and the cells plasma coagulates.

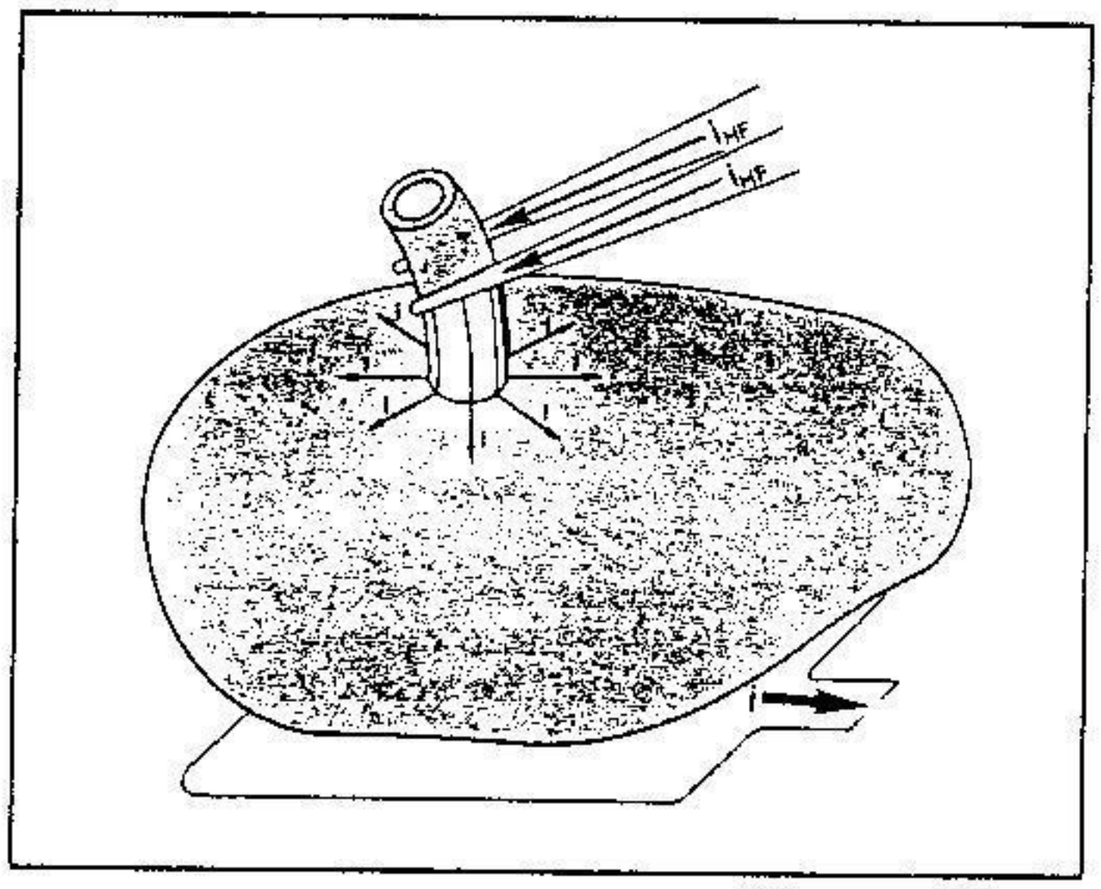
Electrosurgical Desiccation can be made monopolar with a special monopolar active coagulation electrode, i. e. a ball electrode, a surface electrode which is held in surface contact with the tissue.



Electrosurgical Desiccation can be made monopolar with a needle electrode which is inserted into the tissue during desiccation.



Electrosurgical Desiccation can be made also with monopolar coagulation forceps or by touching a clamp forcep with the monopolar active cutting electrode, so that the high frequency current I flows through the tissue.

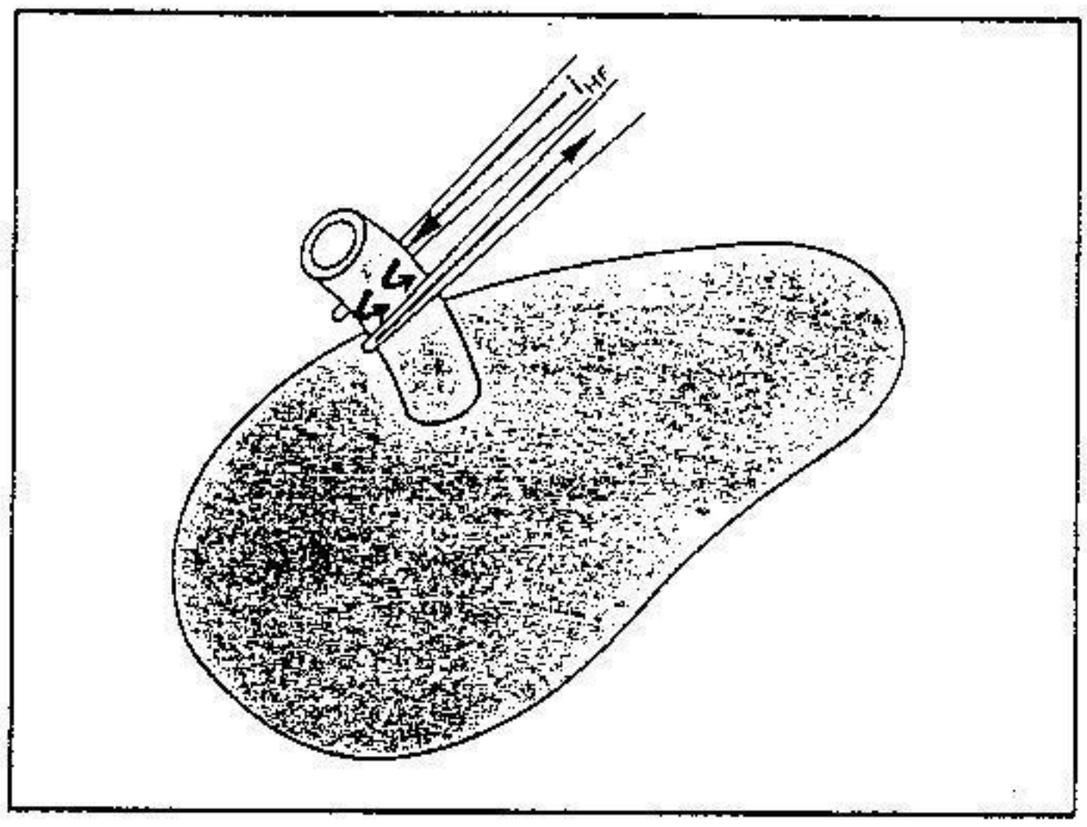


For monopolar electrosurgical desiccation a patient plate (also known as neutral, dispersive, indifferent or return electrode), is used to provide a return path for the high frequency current without physiological or physical effects are essential.

NOTE: To avoid cutting when desiccation is made with a cutting electrode (knife, wire-snare, band-snare, TUR-snare or needle electrode) pulse modulated high frequency current is required which is known as Electrosurgical Coagulation Current.

BIPOLAR COAGULATION

Electrosurgical Desiccation can also be made in the bipolar technique. For this bipolar technique special bipolar forceps are required.

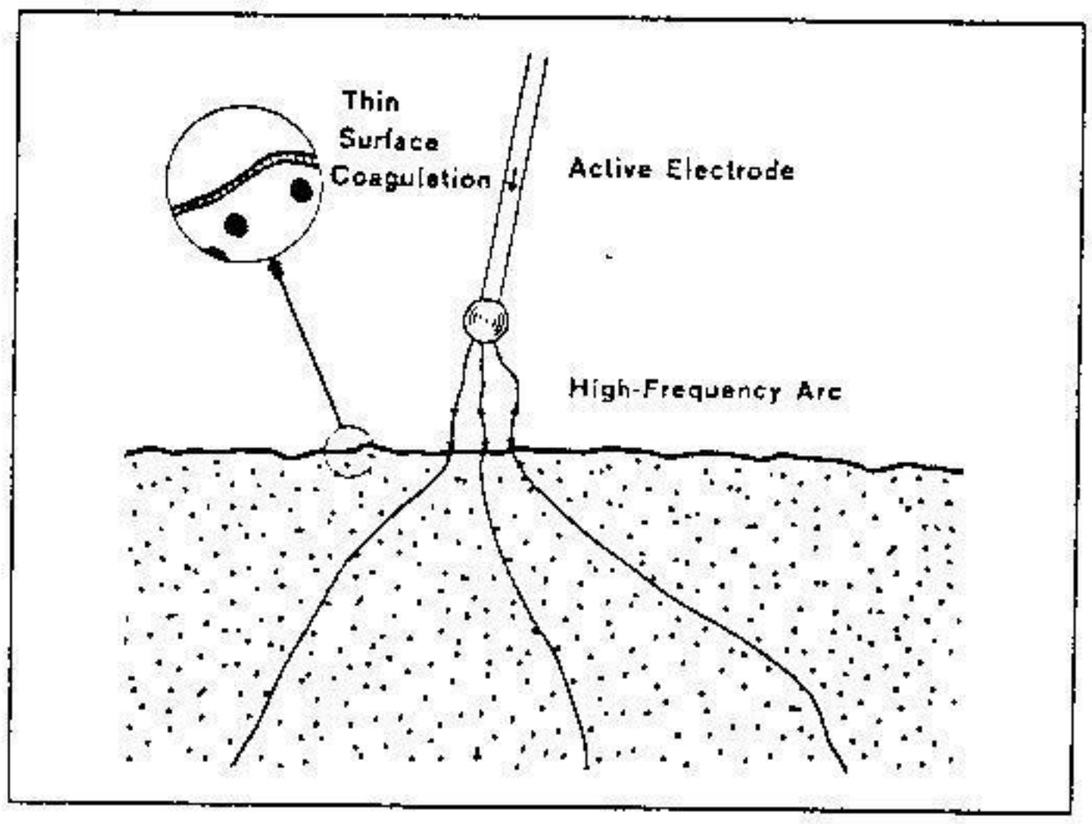


Bipolar Coagulation Using Bipolar Coagulation Forceps. The RF current i_{RF} flows into one blade of the coagulation forceps, then flows through the tissue to be coagulated into the other blade of the coagulation forceps and back to the current source, the electrosurgical unit. Bipolar coagulation produces defined localizable coagulation zones.

NOTE: No patient plate is used and isolation from earth at operating frequency is necessary for bipolar operation.

ELECTROSURGICAL FULGURATION

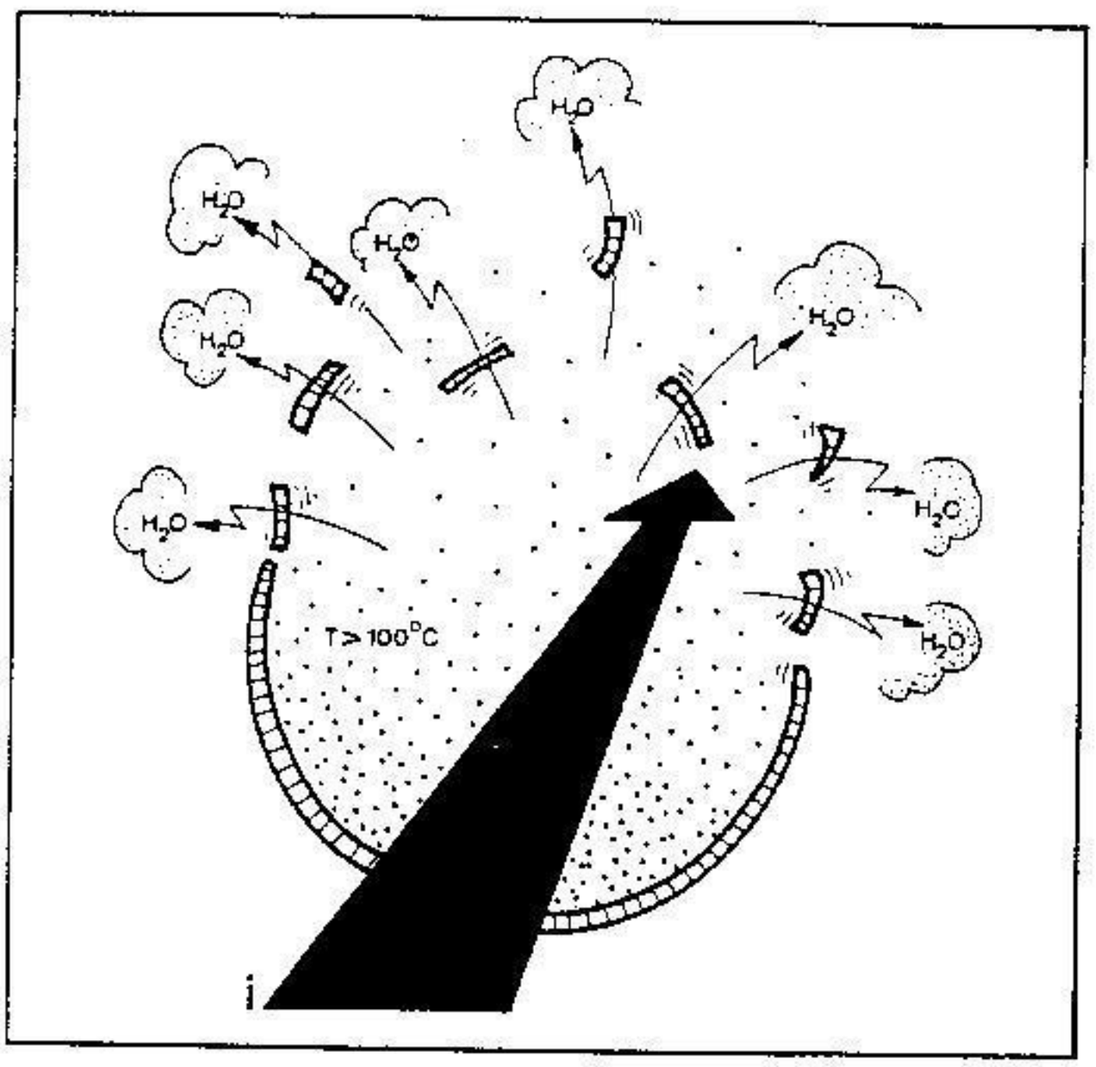
is known as the coagulation of the surface of tissue or blood by means of high frequency current sparks from the monopolar active electrode against the surface of the tissue. In contrast to electrosurgical desiccation, the active electrode is not in contact with the tissue.



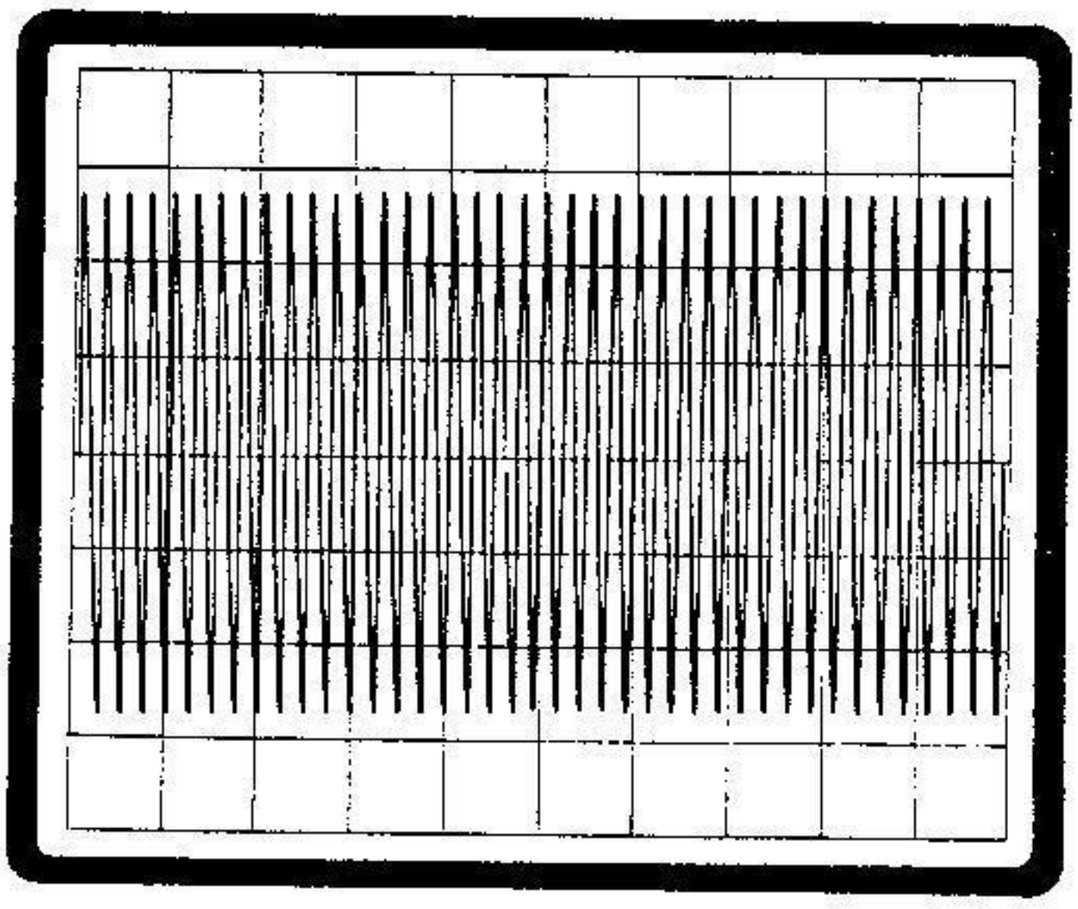
Fulguration is capable of surface coagulation.

ELECTROSURGICAL CUTTING

In electrosurgical cutting the objective is to heat the tissue so rapidly that cells explode into steam leaving a cavity in the cell matrix. The heat is dissipated in the



steam and therefore it does not conduct through the tissue or dry out adjacent cells. When the electrode is moved and fresh tissue is contacted, new cells are exploded and the incision is made.



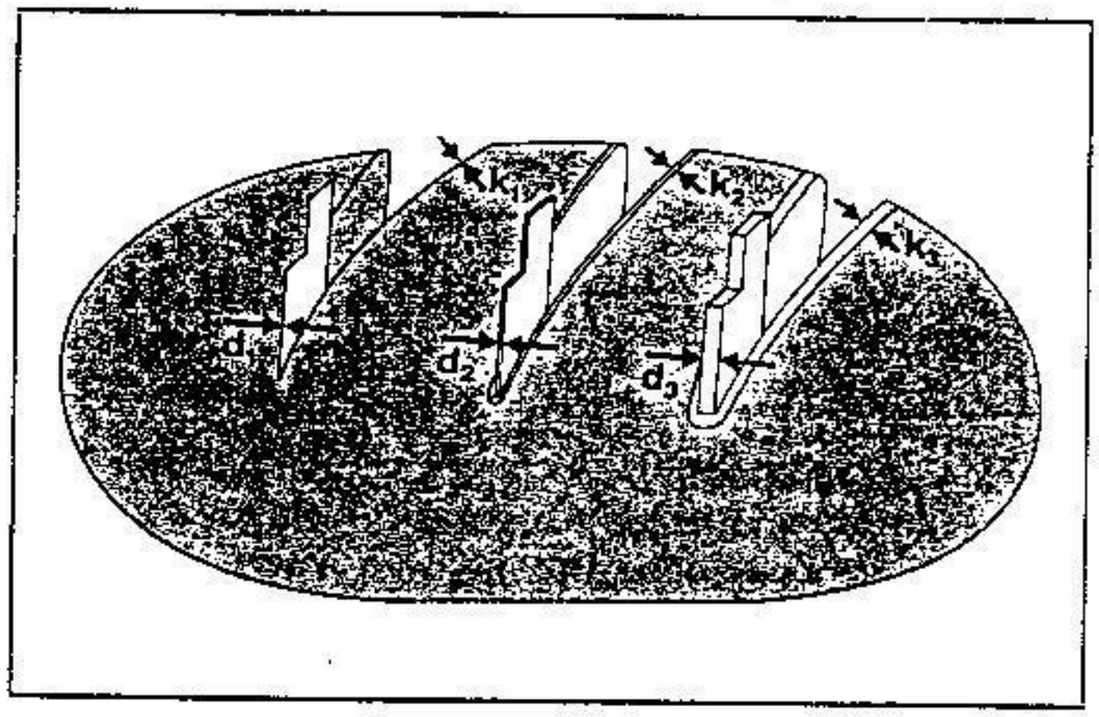
The general characteristic of the high frequency current for cutting is that it is continuous sinewave.

For Some surgical procedures pure cutting, for other cutting with more or less hemostasis is desired by the surgeon. There are different possiblities for the surgeon to influence the degree of hemostasis during cutting tissue:

- **THE SHAPE OF THE CUT ELECTRODE USED**
- **THE SPEED AT WHICH THE INCISION ELECTRODE IS USED TO CUT THROUGH THE TISSUE**
- **THE INTENSITY OF THE HF-CURRENT OR HF-POWER**
- **THE TISSUE PROPERTIES**
- **THE CHARACTERISTIC OF THE HF CURRENT WAVEFORM**

THE SHAPE d OF THE INCISION ELECTRODE USED

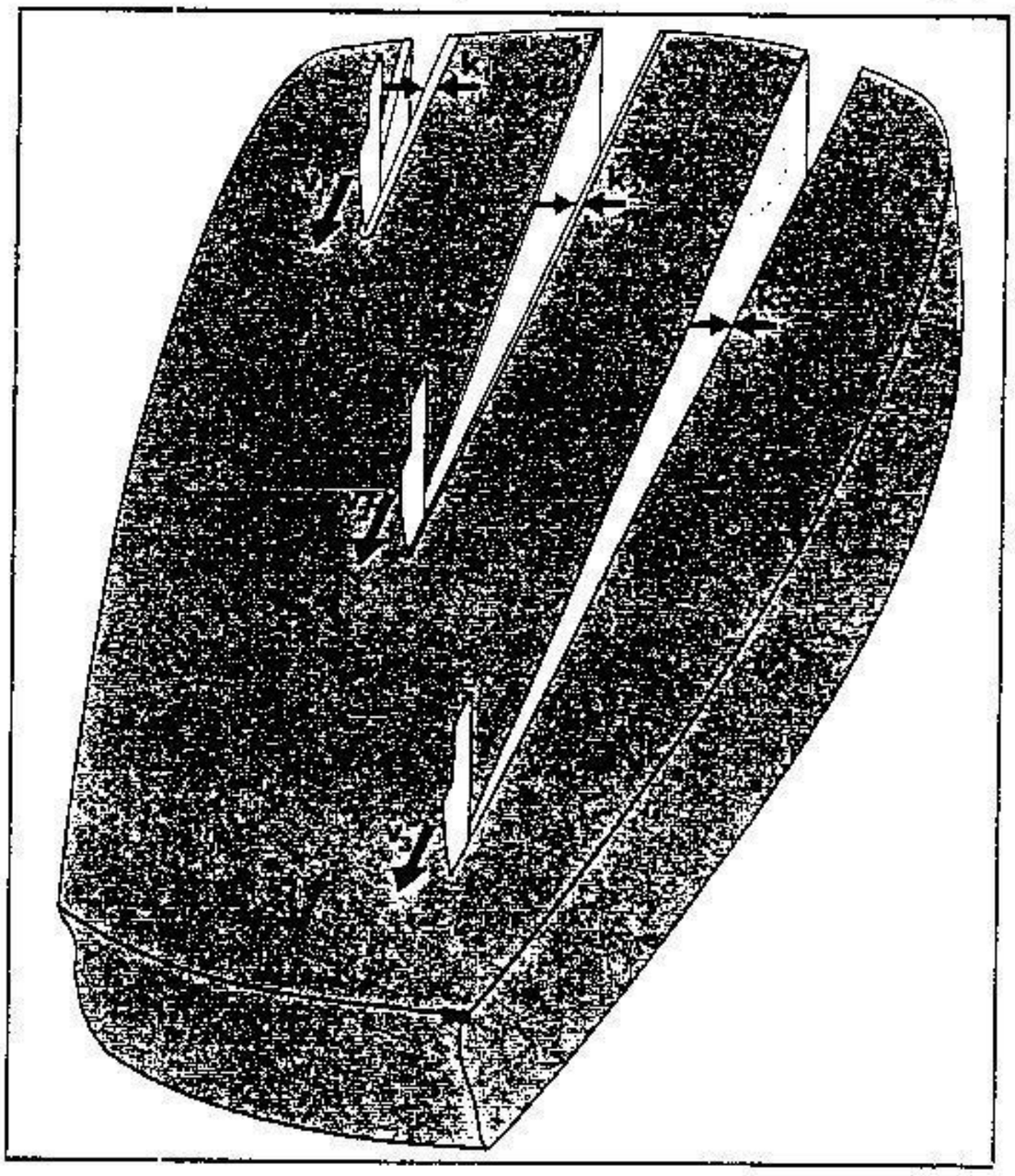
The thinner the incision electrode is, the less is the coagulation k at the surface of incision. A lancet-shaped incision electrode, for example, produces greater coagulation of the incision surfaces than a thinner incision



electrode. Examples of coagulation incision electrodes are: lancet electrode and needle electrode.
Examples of less-coagulating or non-coagulating incision electrodes are: tape loops or thin wire loop electrodes.

THE SPEED v AT WHICH THE INCISION ELECTRODE IS USED TO CUT THROUGH THE TISSUE

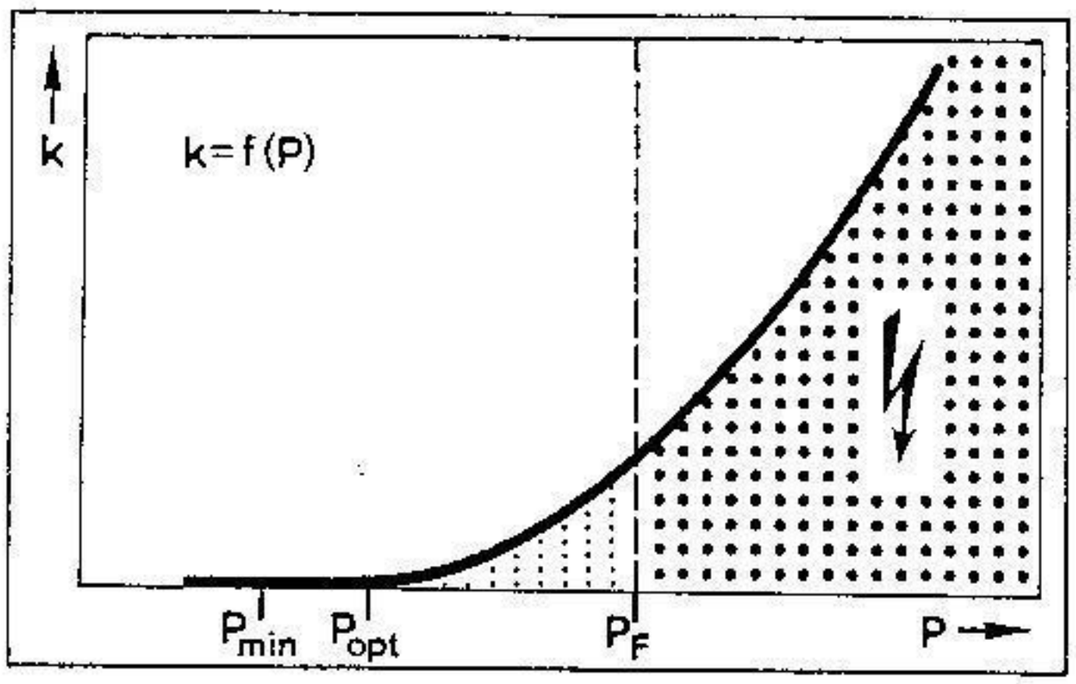
The degree of coagulation k of the incision surfaces is also dependent on the speed v with which the incision



is made. The slower the incision electrode is directed through the tissue, the greater is the degree of coagulation of the surfaces of the section.

THE INTENSITY P OF THE HF-CURRENT OR HF-POWER

When the intensity P is too low, $P_{min} < P_{opt}$, the incision can only be made slowly. Coagulation of the surfaces of incision is then relatively pronounced. When the



intensity is too great $P > P_F$, sparks occur between incision electrode and tissue which, as a result of their high temperature, coagulate the incision surfaces to the point of burning. The optimum intensity P_{opt} is that at which the degree of coagulation is at a minimum.

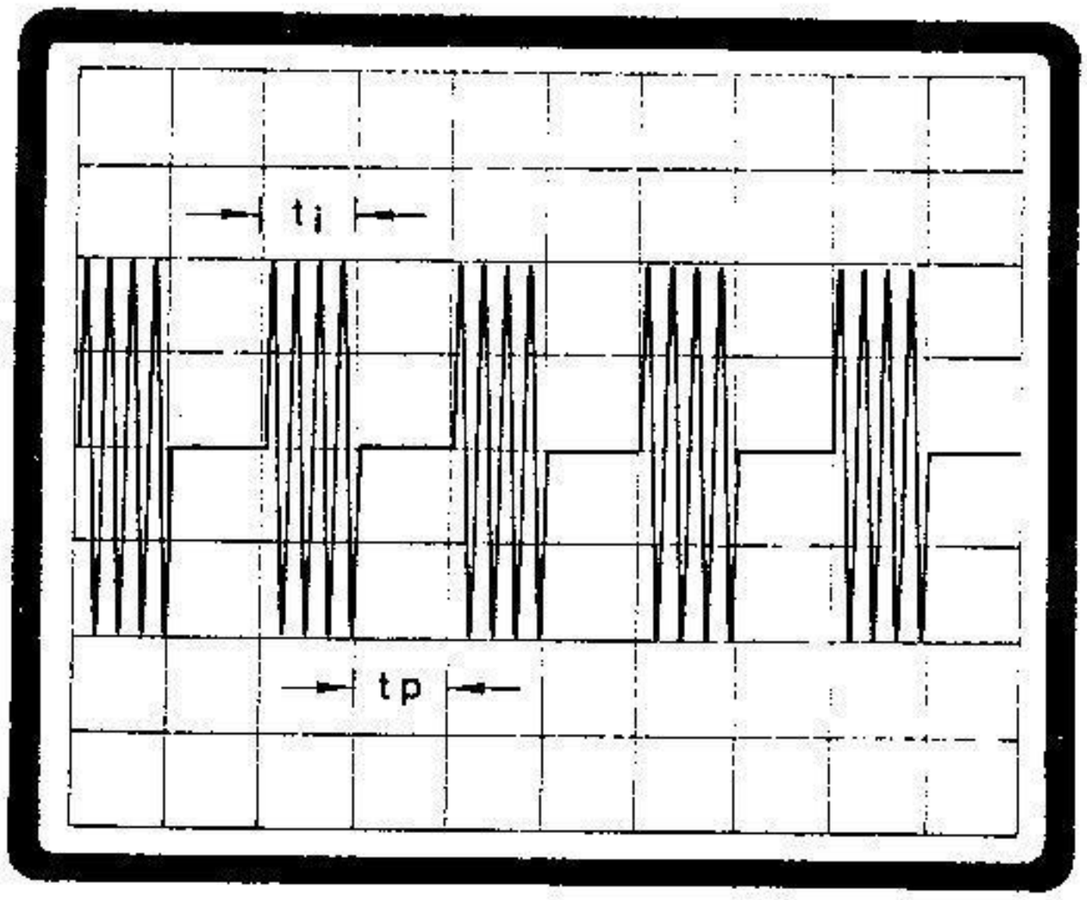
THE CHARACTERISTIC C OF THE HF CURRENT WAVEFORM

The degree of coagulation k of the surfaces of the section during incision can be influenced by modulating the amplitude of the RF current. The degree of coagulation increases with the degree of modulation. The degree of modulation can be mathematically described by the crest factor C. Here, the crest factor C is the ratio of the peak value of the current I_p (= maximum amplitude) to the root-mean-square value of the current I_{rms}.

$$C = \frac{I_p}{I_{rms}}$$

Blended Cut Principle

As one might expect, the BLEND is a cutting waveform with moderate hemostatic effect. That is, the walls of the incision made with the BLEND current will be well coagulated, depending on the duration of the pauses t_p between the COAG bursts t_i which can be chosen by means of the CUT HEMOSTASIS DEGREE ADJUSTMENT on the T 400 C surgical equipment.

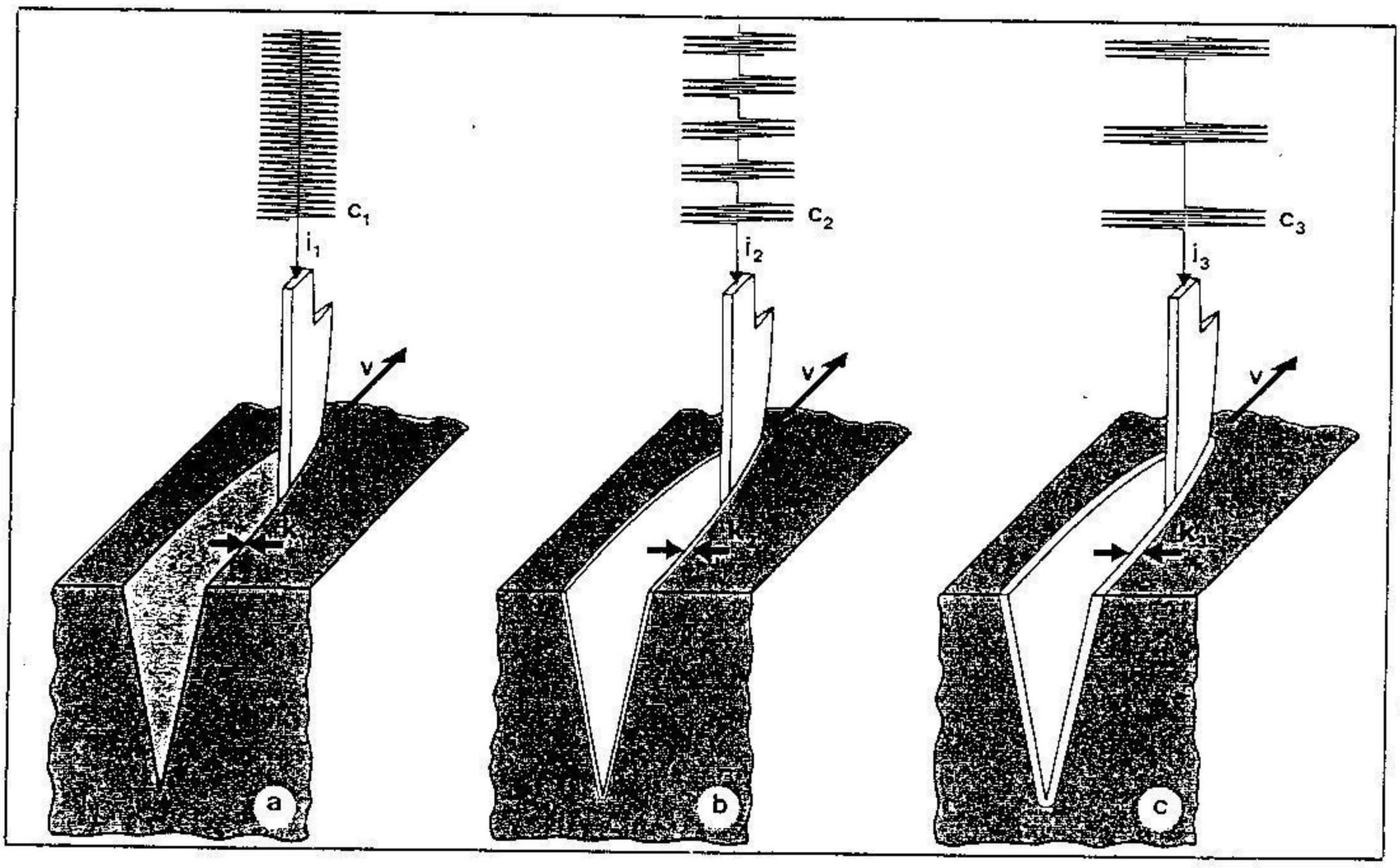


The essential characteristic of a blended cut waveform is that it is a pulse modulated RF-current.

THE TISSUE PROPERTIES

In the case of tissue with a high water content, the coagulation of the incision surfaces is less than with drier tissue.

By a combination of these five parameters, the surgeon can vary the degree of hemostasis during cutting tissue between wide limits.



DESCRIPTION OF THE ERBOTOM T 175 E UNIT

The ERBOTOM T 175 E high-frequency electrosurgical unit is equipped with two independent high-frequency generators. One generator can produce up to 175 Watts RF power for monopolar techniques such as cutting with knife or wire electrodes, coagulation with ball electrodes etc. The other generator produces up to 50 Watts RF power for bipolar techniques such as bipolar coagulations with bipolar forceps, laparoscopic tubal sterilizations etc.

The provision of independent RF generators for monopolar and bipolar outputs offers the following advantages:

- The adjustment of the outputs is totally independent.
- RF power is supplied only to the active electrode which is actuated, preventing accidental injuries that otherwise might be caused by unused electrodes.
- The bipolar output can be used without connecting the dispersive electrode (patient plate) to the unit. The safety circuit of the patient plate is operational only when utilizing the monopolar output.
- The independent bipolar generator allows bipolar operation without generating more RF power than necessary. The unit is not heated unnecessarily, no unneeded large amount of disturbance power is generated, and the danger of applying an erroneously high dosage is minimized.

For monopolar techniques, two different currents can be preset on the unit. One current for cutting with a variable degree of HEAMOSTASIS to arrest minor blood flow and oozing from small vessels. A second, independent current allows COAGULATION of larger vessels by means of clamp or coagulation electrodes.

High-frequency current may be activated by means of:

- hand control with one or two push-buttons,
- footswitch with one or two pedals also
- the bipolar generator can be activated by footswitch or by using the automatic switching on system. This system switches on the high-frequency current automatically after the forceps and the tissue have been in contact continuously for 2 seconds as adjusted on the unit, but this delay time period can also be preset from zero to five seconds. This allows the surgeon time to position the forceps and prepare the tissue before coagulation is initiated. The automatic control system operates with coagulation forceps of every shape and manufacture.

The output characteristics of the ERBOTOM T 175 E allow the generated RF power to achieve maximum effectivity at the active electrode while maintaining great flexibility (automatic power matching to the contact surface between tissue and active electrode).

The safety circuit of the patient plate automatically monitors the continuity of the electrical connection between the patient plate and the unit whenever the monopolar output is in use. To prevent accidental injuries, any interruption of the continuity cuts off the monopolar power output and signals this fault visually by a red pilot lamp and audibly via a distinct tone.

The patient plate of the ERBOTOM T 175 E can be conductively grounded, earth referenced via a capacitor or can be a floating output.

Haemostasis during cutting is smoothly adjustable. With coagulation during cutting it is possible to stop bleeding from small vessels immediately.

The ERBOTOM T 175 E produces two different tones adjustable in volume to synchronize with the RF power output for cutting and coagulation. This provides great assistance to the surgeon during an operation when he is unable to observe the unit.

3 INSPECTION AND INSTALLATION

Introduction

This section of the manual contains inspection and installation procedures for the Model T 175 electrosurgical unit. In addition, packing and claims procedures are discussed in the event damage occurs during shipment.

Initial Inspection

The T 400 unit was carefully inspected, mechanically and electrically, prior to shipment.
On receipt, inspect it for any mechanical damage which may have occured during shipment and test the electrical performance.
Check for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to the recommended claims procedure. Retain the packaging material for future use.
Check the electrical performance of the T 175 unit as soon a possible after receipt. The performance test is contained in Section 5 of this manual. This test will verify that the T 175 unit is operating to the specifications listed in the table under „TECHNICAL DATA".
The initial performance and accuracy of this T 175 unit are certified as stated in the warranty on the inside rear cover of this manual.
If the T 175 unit does not operate as specified, refer to the recommended claim procedure.

Claims

If physical damage is found or if the T 175 unit is not within specifications when received, notify the carrier and the nearest ERBE representative, immediately. The ERBE representative, will arrange for repair or replacement of the T 175 unit without waiting for a claim to the settled with the carrier.
The warranty statement for this ERBE T 175 high frequency electrosurgical unit is on the inside rear cover of this manual. Contact the nearest ERBE Sales/Service office for information and assistance with warranty claims.

Repacking for Shipment

If the T 175 unit is to be shipped to a ERBE Sales/Service office, attach a tag to it showing owners name, address, T 175 unit model number and serial number, and a description of the service required.
Use the original shipping carton and packing materials for reshipment. If they are not available, repackage the T 175 unit with the following materials:

a) A double, wall carton (Carton Test Strength 350 lb)

b) Heavy paper or sheets of cardboard to protect the frontpanel of the unit.

c) At least 4 inches of tightly-packed, industry-approved, shock-absorbing material such as extrafirm polyurethane foam.

d) Heavy-duty shipping tape to secure outside of carton.

Power Requirements

Input line power is supplied by a detachable three-conductor cord. This cord has an approved hospital-duty plug for wall outlet connection, providing an electrical ground. Electrosurgical unit power output is via a rear panel IEC connector. Because of the danger of electric shock, extension cords, three-prong to two-prong adapters, or extra length power cords shall not be used.

CAUTION

Before applying power to the unit check the rear-panel label. If there is a difference between the line voltage and the voltage marked on the label, the voltage selector on the power supply inside the T 175 unit must be changed to the correct line voltage.

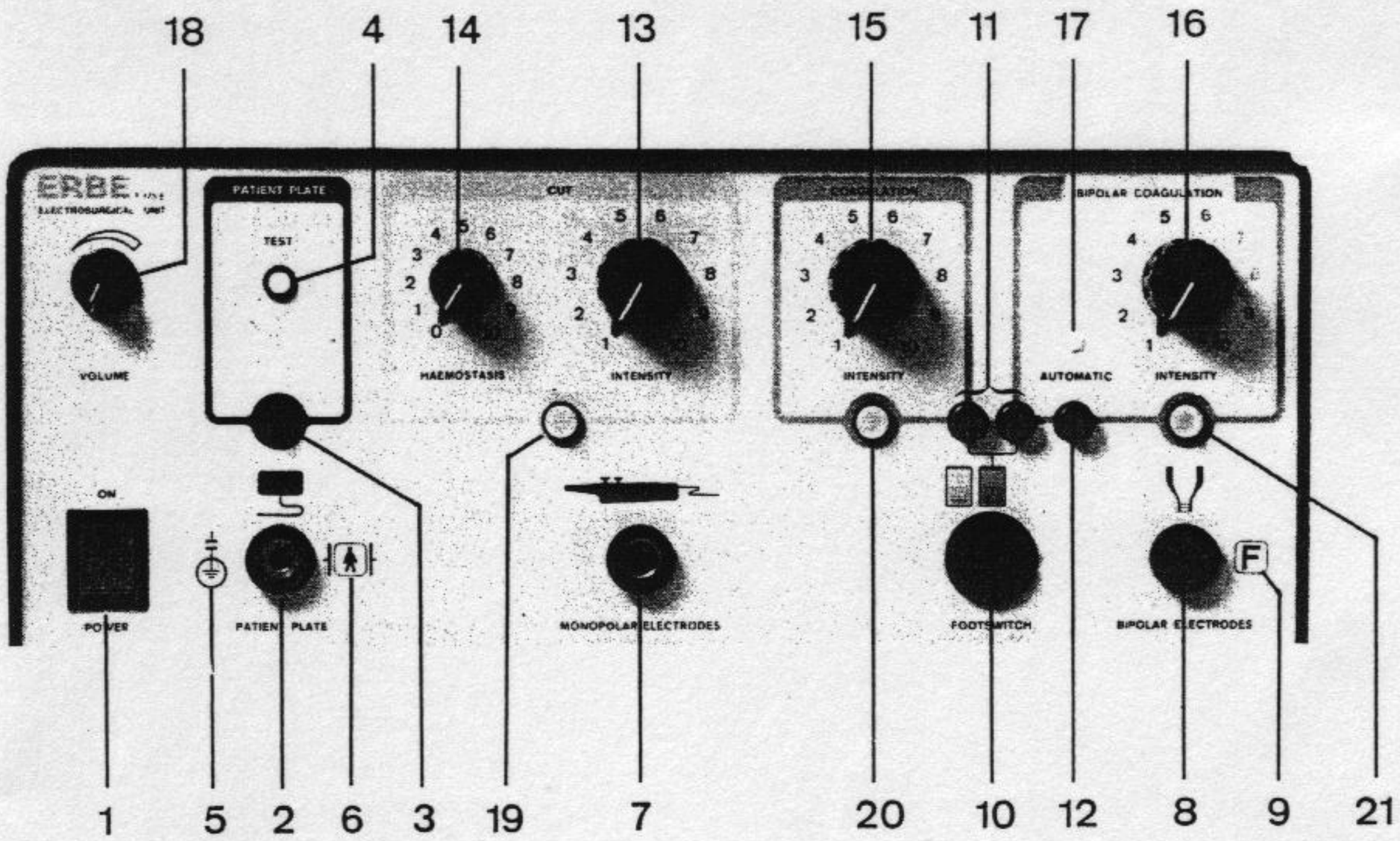
The following line voltages can be used for operating the T 175:

LINE VOLTAGE TABLE

Line Voltage Volts	Line Frequency Hz
100	50 to 60
110	50 to 60
120	50 to 60
200	50 to 60
210	50 to 60
220	50 to 60
230	50 to 60
240	50 to 60

The line power transformer Tr_1 2 (toroidal coil transformer) has four primary windings. The line voltage selection can be made by changing the bridge wires on the multipoint connector terminal St3, according to the following Line Voltage Selector Diagram.

CAUTION
The fuse Si 1 in the external fuseholder at the rear-panel protects the unit against excessive input current. When changing line voltage, this fuse must be changed in accordance to the rating shown in the above Line Voltage table.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ERBE
PATIENT PLATE
TEST
CUT
BIPOLAR COAGULATION
VOLUME
HAEMOSTASIS
INTENSITY
INTENSITY
AUTOMATIC
INTENSITY
ON
POWER
PATIENT PLATE
MONOPOLAR ELECTRODES
FOOTSWITCH
BIPOLAR ELECTRODES
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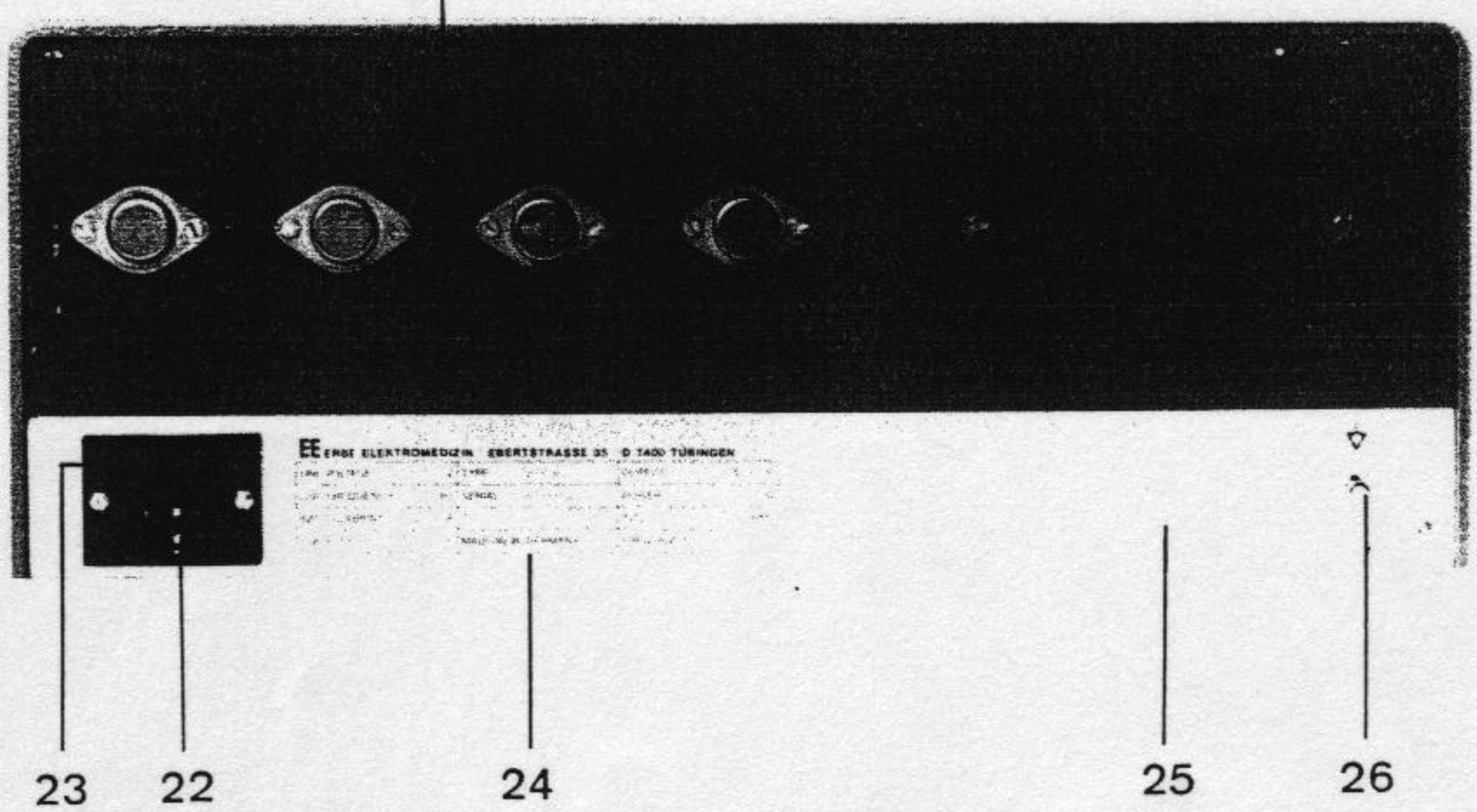
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EE ERBE ELEKTROMEDIZIN EBERTSTRASSE 35 D 7400 TÜBINGEN
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(1) Power Supply Switch. After switching on the power supply switch the ERBOTOM T 175 E is immediately ready to operate.

ATTENTION: The ERBOTOM T 175 E should only be operated from a properly installed socket which has protective plug reception.

The pilot lamp in the power supply switch indicates that the ERBOTOM T 175 E is ready for use. If this pilot lamp goes out even though the power supply switch is switched on, there is either no supply voltage or the power line fuse 23 in the unit is defective.

(2) Connection for the patient plate. The ERBOTOM T 175 E is equipped with a safety circuit which monitors continuity of the connection between the unit and the patient plate. If this connection is interrupted, the monopolar RF generator for incisions and coagulation cannot be switched on.

The bipolar RF generator, however, can be used independently of whether the patient plate is connected to the unit or not.

(3) This red pilot lamp lights up and an audible alarm signal sounds when the attempt is made to switch on the monopolar RF generator for incisions or coagulation by means of the push-button or footswitch, when the connection between the unit and the patient plate is interrupted.

(4) Test button. A check on the connection between the unit and the patient plate can be made at any time by pressing this button. If there is a fault, it is signalled by the red pilot lamp 3 and an audible alarm signal.

The function of the safety circuit can also be checked by pressing this TEST button. If the plug of the patient plate is not inserted into socket 2, the red pilot lamp 3 must light up and the audible signal must sound when the TEST button is depressed.

(5) The standard ground connection for the patient plate of the ERBOTOM T 175 E is via a capacitor (ground wire potential), which conforms to design type BF according to IEC 601-1 requirements.

(6) This symbol indicates that the patient circuit of the ERBOTOM T 175 E is defibrillation-safe, which means that the patient plate of the ERBOTOM T 175 E can remain applied to the patient during defibrillation.

(7) Connection for monopolar active electrodes. Monopolar active electrodes for incisions and coagulation are connected to this socket. When electrode holders with two buttons are used, this connection can be used to switch on both the RF current for incisions and the RF current for coagulation.

(8) Connection for bipolar electrodes. The ERBOTOM T 175 E unit is equipped with an RF generator specially developed for bipolar coagulation and which can be used completely independently of the RF generator for monopolar application. The RF power of this generator can be continuously and finely adjusted up to a maximum of 50 Watts.

Compared with units in which the RF power for bipolar coagulation is derived from the same RF generator which provides the RF power for monopolar applications, this separate RF generator for bipolar coagulation has the following advantages:

During bipolar coagulation, the monopolar outputs including the connection of the patient plate remain completely free of RF power. This ensures the prevention of monopolar fault currents from or to the bipolar electrode.

Bipolar coagulations can be carried out irrespective of whether a patient plate is connected to the unit and the patient or not. Appropriate triggering of the automatic safety circuit for the patient plate only occurs when the monopolar generator is in use.

Where monopolar as well as bipolar electrodes are connected to the unit at the same time, the particular electrode not used is completely without power. This prevents the danger of any unused electrode from accidentally touching and respectively injuring or damaging patients, personnel or materials. The bipolar generator can be actuated either by footswitch (when the right-hand blue button 11 is depressed) or completely automatically via the bipolar elctrode (when the gray button 12 is depressed). For automatic actuation, any bipolar electrode can be used - irrespective of shape or manufacture.

Automatic actuation of the bipolar generator is initiated when both surfaces of the bipolar electrode simultaneously touch the tissue to be coagulated. According to requirements, a time delay from 0 to 5 seconds between the touching of the tissue and the switching on of the coagulation current can be set. This provides the surgeon with the facility of using the bipolar coagulation electrode, bipolar tweezers or forceps, for holding or freely preparing the tissue to be coagulated prior to coagulation without the tissue being immediately coagulated. The bipolar coagulation current is only actuated when the tissue is touched with the bipolar coagulation forceps continuously for the entire delay period set. Direct contacts of less time than the set time delay can be repeated as often as required without the bipolar coagulation current is being switched on.

(9) This symbol means, the bipolar output is insulated against ground i.e. floating.

(10) Connection for footswitch. The footswitch with two pedals is connected to this socket. The left-hand yellow pedal will switch on the RF current for incisions, while the right-hand blue pedal will switch on the RF current either for monopolar or bipolar coagulation depending on whether the left-hand blue button or the right-hand blue button 11 is depressed.

(11) Selector buttons. When the left-hand blue button is depressed the blue footswitch pedal will switch on the current for monopolar coagulation.

When the right-hand blue button is depressed the blue footswitch pedal will switch on the current for bipolar coagulation.

(12) When this button is depressed the bipolar coagulation current is automatically switched on when, for example, both tips of the bipolar coagulation forceps simultaneously and continuously touch the tissue to be coagulated.

When this button is depressed a small pilot lamp (17) above the button lights up to indicate that the automatic bipolar actuation is ready to operate.

(13) Adjusting the power for incisions. Via this control the intensity of the RF current or RF power for incisions can be adjusted continuously. The RF current for incisions may be set for low-coagulation, smooth incisions as well as for coagulated incisions which arrest the blood flow at the incision surfaces.

When ball or plate electrodes are in use, the degree of coagulation has to be set at 0, since the intensity of coogulation depends in this case on the average RF power, the shape of the electrode and duration of current flow.

(14) Adjusting the degree of coagulation. The degree of coagulation of the incision surfaces can be influenced by modulating the amplitude of the RF current (see page 6).

(15) Adjusting the RF power for coagulation of larger bleeding vessels during cutting is possible since the RF power for incisions can be directly switched over to coagulation either by using the hand control or the footswitch without even having to change the electrode. Thus when touching the bleeding vessels with the electrode for incisions and shortly switching on the RF current for coagulation the bleeding vessels will be coagulated.

(16) Adjusting the RF power for bipolar coagulation continuously and finely up to maximum of 50 Watts.

(17) This pilot lamp lights up when the automatic bipolar actuation is ready to operate.

(18) Volume control. During actuation of the monopolar and bipolar generators, the ERBOTOM T 175 E emits an audible signal in order to indicate that RF power is actuated. The loudness of the signal can be individually adjusted by means of this control.

(19) This pilot lamp lights up when the RF current for incisions is switched on.

(20) This pilot lamp lights up when the RF current for coagulation is activated.

(21) This pilot lamp lights up when the RF generator for bipolar coagulation is ready to operate.

(22) Power connection. The ERBOTOM T 175 E must only be connected to a properly earthed socket supplying the voltage stated on the equipment name plate.

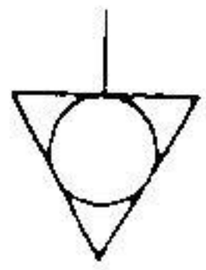
Connection to the power supply must only be made by means of power cable supplied by the manufacturer of the equipment or cable of corresponding quality. This also applies to any extension cables and distribution sockets which might be used.

(23) Power-line fuses. The ERBOTOM T 175 E is protected with two power-line fuses of 4 A, medium-delayed action, 5 x 20 mm. If either one or both fuses blow, a technician authorized by us should inspect the equipment before new fuses are fitted.

(24) Name plate. In the case of complaints, requests for servicing etc., please quote the type number and serial number stated on the plate.

(25) Red spot. WARNING: This unit must not be operated in areas where there is an explosion hazard. During electrosurgery, sparks between the active electrode and the tissue are unavoidable. These sparks can ignite flammable or even explosive agents.

(26) Potential equalization. If this electrosurgical unit is used for cardiac or brain surgery, the unit should be connected to the potential equalization busbar of the operating theater by means of the potential equalization cable supplied. The connection should be identified with the following symbol:



(27) The heat sink on the rear panel should not be covered up during operation otherwise overheating may occur.

Therefore, when setting up the unit care should be taken to leave the heat sink uncovered so the air can freely circulate.

5 Performance Tests

This section provides a performance test procedure to ensure that the Model T 175 is operating within specifications and a procedure for adjustement and calibration. Physical location of the adjustments is shown in a photograph at the beginning of this section.
This performance check may also be used as part of an incoming quality assurance inspection, as a periodic operational check or to verify operation after repair or adjustments have been made.

Preliminary Set-up

- Connect either a double footswitch to socket 10 or a surgical hand control with two pushbuttons to socket 7
- Connect a patient plate to socket 2.
- Turn all power output controls 14, 15, 13 and 16 to minimum RF-output power, INTENSITY = 1.
- Turn the audible control knob 18 to VOLUME = MAXIMUM.
- Switch on the power switch 1.
  Only the lamp in the power switch lights.

Power Output Control

WARNING!
Don't touch the active electrode because there will be a small amount of RF power in the lowest position of the RF output controls.

- Push either the yellow footswitch or the yellow pushbotton on the handcontrol.
- The pilot lamp 19 will light and a continuous tone will indicate that the cutting generator is switched on.
- With volume control 18 this sound level can be adjusted to an acceptable level.
- Push either the blue footswitch or the blue pushbotton of the handcontrol.
- lamp 11 will light and a modulated tone will indicate that the coagulating current is switched on. The sound level can be adjusted with the volume control knob 18.
  If both pushbottons are pushed at the same time, the cutting power is switched on, lamp 19 lights up and the continuous sound is generated.
- with boths pedals of the footswitch depressed no output is available.

Monitoring Circuit Control

- Push either the yellow footswitch or the yellow pushbotton on the handcontrol, lamp 14 lights.
- Pull the patient plate connector out of socket 2 and the lamp 14 will be extinguished. At the same time lamp 3 will light and an interrupted sound will be generated.
- This sound is always at the maximum level and cannot be adjusted outside the unit.
- Reconnect the patient plate into socket 2 while continuously depressing the yellow switch. Nothing will happen.
  This is for safety reasons, should a bad contact occur in the sentry circuit.
- Release the yellow switch for a short moment and push it again.
- The „incorrected sentry circuit" lamp 3 will be extinguished and lamp 19 will light and the „cutting" sound will be produced.
- The same procedure is applicable for the blue coagulation switch.

Bipolar Function

For this procedure the patient plate is not functional and shall therefore not be used. Because of the low maximum RF-output of 50 watts, this bipolar generator is made complete floating without the disadvantages of the „high" RF leakage currents of a floating high power surgical generator.

- Pull out the patient plate
- Connect a cable and forcep to socket 8

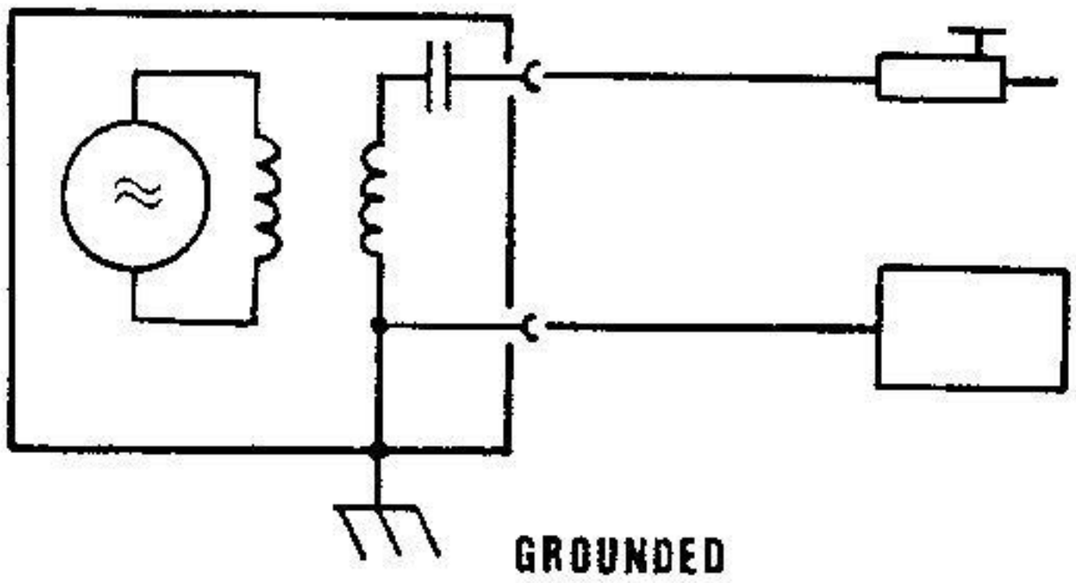
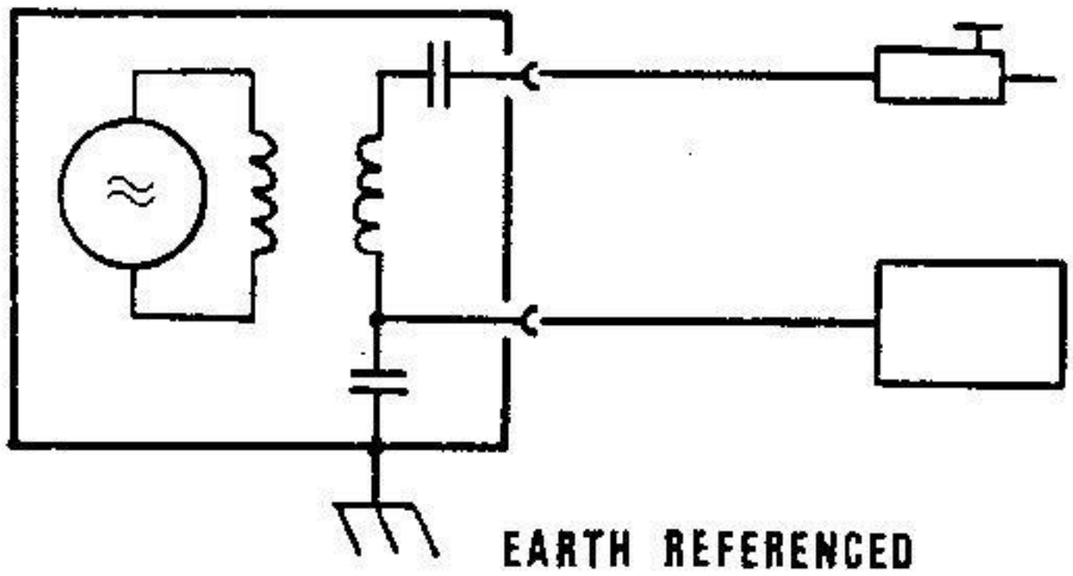
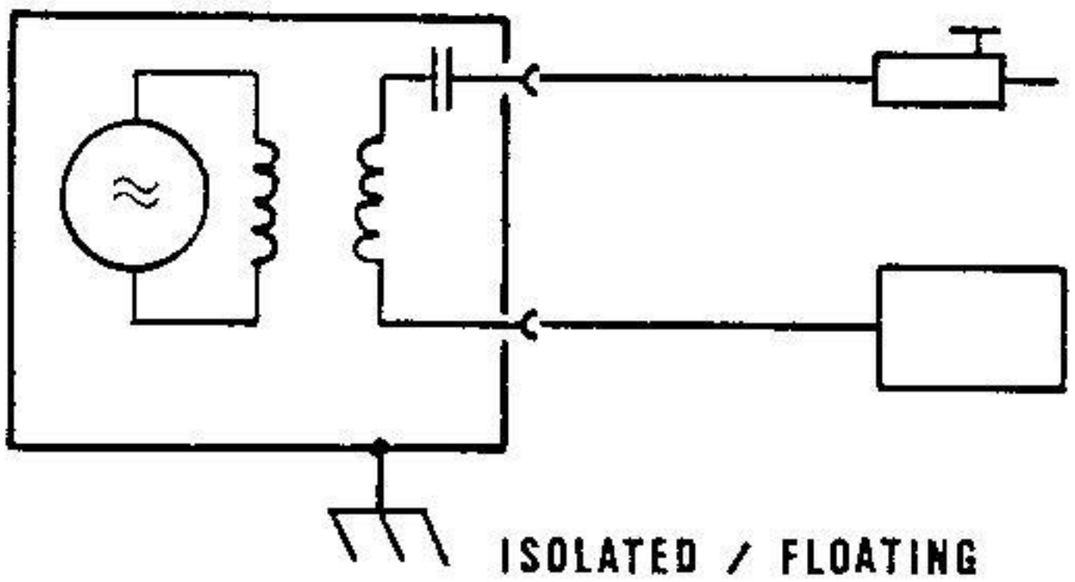
WARNING!
Before switching on the RF power please check if the power output control 16 is set to its lowest level and no body is touching the forceps.

Press the forcep tips together and after about 2 seconds lamp 21 lights and a continuous tone can be heard. This tone can be adjusted by volume control 18. This so-called „preparation time" of 2 seconds may be adjusted for longer or shorter time periods by trimpot Tp3 on PCB EE 151.4.

This timing circuit starts from 0 any time the tips of the forceps are closed, which means that the generator will be switched on after the tips have been continuously closed for 2 seconds.

By connecting the footswitch to socket 10 and depressing the grey pushbutton 11, this timing circuit is switched off and the RF bipolar generator will be switched on immediately after the footswitch is depressed.

EQUIPMENT CLASSIFICATION

	IEC 601	AS 3200	VDE 0750	
 GROUNDED	CLASS B			
 EARTH REFERENCED	CLASS BF	CLASS B		
 ISOLATED / FLOATING	CLASS C	CLASS A	F	

T 175 Patient Plate Referencing Mode

The patient plate, also known as indifferent, neutral, passive, or dispersive electrode, of the ERBE T 175 unit can be set in the following modes:

EARTH MODE, PATIENT PLATE GROUNDED

The patient plate in the earth mode protects the patient from RF potentials with respect to earth, however, it does not protect the patient from low frequency (LF) leakage currents generated by other patient connected equipment.

EARTH REFERENCED OR CAPACITIVE MODE

The patient plate in the earth referenced or capacitive mode protects the patient from rising to RF-potentials and also limits the low frequency (LF) leakage currents from other patient connected equipment to a safe level. Excessive low frequency leakage currents may be generated from other patient connected equipment if their grounding is faulty or not properly connected to the hospital grounding system.

ISOLATED OR FLOATING MODE

The patient plate in the floating mode protects the patient from low frequency leakage currents, but in some instances may allow the patient's body to rise to dangerous RF potentials.

6 SAFETY PRECAUTIONS

WARNING!
Disregard of these inst ructions may cause serious injury.

General

The equipment must not be used if any component is defective, or if the procedures described in the Schedule of Maintenance have not been carried out.

Changes and additions to the equipment may only be carried out by ERBE or by parties expressly authorized by ERBE to do so. Such changes must comply with local regulations and accepted standards of good practice.

Other technical equipment including accessories used in combination with ERBE electrosurgical apparatus require expert operation and proper care and maintenance to ensure that they are always in good working order.

Note that if the equipment is to be used with accessories other than those supplied by ERBE, it is essential to check with ERBE to ensure that the accessories are compatible with the type of equipment being used. The use of non-compatible accessories may prove extremely dangerous due to excessive current leakage, insufficient or defective insulation, disabling of the sentry circuit, or inability to sterilize the accessories efficiently.

Electrical Safety

Always switch off and disconnect the equipment from the ac power before cleaning or disinfecting. Do not allow water or other liquids to enter the equipment, as they may cause short circuits or corrosion. Remember that some disinfectants vaporize to form explosive mixtures, and that if such disinfectants are used the vapor must be allowed to disperse before the equipment is returned to use.

A regular check for electrical safety is strongly recommended at least once a year. But the surgical electrodes and leads, and connectors and all patient leads and connectors must be checked for any signs of damage before every operation, paying particular attention to the insulation. The protective earth connection shall be checked every three months.

The equipment may only be used in rooms with provisions for compliance with national and/or international legislation and recommendations concerning electrical safety.

WARNING!
This equipment is not suitable for use in the presence of flammable anaesthesia gases.

7 OPERATION

Safety Procedures During Surgery

During electrosurgery, the surgeon should be aware at all times, of changes in the high frequency current flow. The following points are of great importance:
If the output power decreases during a surgical procedur do not increase the RF-power settings without checking the contact area between the patient plate and the patient. Decreasing of the output-power may indicate a questionable contact between the patient plate and the patient.
After repositioning of the patient, check the contact area between the patient plate and the patient before applying the RF-current. This is important if the patient plate is not affixed or complete adhered to the patient.
A periodical check on the position of the patient plate is strongly recommended.
Attention should be called to the danger of ignition of endogenous gases.
Any fluid under the patient or in body cavities such as the umbilicus and the vagina, should be wiped off before the electrosurgery is used.
For coagulation procedures on small cross sectional areas, the use of the bipolar technique is recommended.

WARNING!

When the high frequency surgical apparatus is in the floating mode (neutral electrode neither direct nor via a capacitor connected to earth) the arcing of the active electrode to earth creates an extremely dangerous situation. At the moment of arcing in the floating mode, the patient, all patient connected equipment, and the neutral electrode, become the active electrode of an earthed output system. The patient and any staff in contact with the patent run the risk of burns from any point touching earth.

The electrode holder should never be rested on the patient, when not in use. Inadvertant operation of the footswitch, can also cause very severe burns on the place where the active electrode is touching the patient.

ECG Interference During Electrosurgical Procedures

Any time there is sparking to the tissue, either during electrosurgical cutting or coagulation, some interference with ECG monitors can be expected. The ECG monitors are sensitive to very low level, low frequency voltages on the order of millivolts. Electrosurgery exposes the patient to voltages thousands of times greater, but primary at radio frequencies. In order to have a minimum of interference, first the ECG monitor must reject all the high radio frequencies. With respect to this, ECG monitors with a high rejection factor to radio frequencies should be used. Unfortunately, sparking produces low frequencies in the physiological ECG bandwidth as well, therefore some ECG interference is invitable. Another source for ECG interference can be magnetic fields originating from the different power supplies in the operating theatre and/or the supply cables or interference signals from other equipment in use during electrosurgical procedures.

Measures Which can be Taken to Minimize Interferences on ECG Monitors

- ECG electrodes should not be placed on fatty, bony and hairy areas. Hairy areas should be shaved before application.
- Silver/silver-chloride electrodes are recommended to provide a constant low impedance between skin and the electrodes.
- The skin on which the electrodes will be attached, should be roughened before application ensuring optimal contact.
- For a maximum suppression of the electrosurgical frequencies, RF suppression filters should be inserted in the ECG leads. These filters or chokes should be mounted as near to the ECG electrodes as possible to minimize the risk of burns.
- The ECG electrodes should be placed as far away as possible from the operation site and from the neutral electrosurgical electrode.
- The red and yellow ECG electrodes should, if possible, be placed equidistant from the black ECG electrode, from the operation site and from the neutral electrosurgical electrode.
- The ECG electrodes should be placed as close together as possible for a reasonable signal.
- To minimize „antenna effects" caused by ECG leads, tape the leads together as close to the electrode as possible. Use short, shielded leads to help minimize „antenna effect".
- The distance between the ECG and electrosurgical leads should be as great as possible. Perpendicular positioning of these leads will give the least interference.
- The leads of the electrosurgical equipment will act as transmitters. Avoiding loops in these leads will reduce the effectiveness and hence interference.
- The earth referenced mode of operation will give less interference than the floating mode.
- The neutral electrosurgical electrode should be placed close to the incision as possible and the RF power should be set in the lowest position for the intended surgical procedures.

If all the above mentioned measures don't give the desired results the first action should be a check on the contact quality of the neutral electrosurgical electrode with the patient. A questionable contact between the plate and the patient will increase the interference problems. AC line intereference problems in the earth referenced mode of operation might be reduced by connecting the neutral ECG electrode to the neutral electrosurgical electrode.

WARNING!
Never connect the neutral ECG electrode to the neutral electrosurgical electrode in the floating mode of operation.

Interferences due to the sparks will be minimized if the vector of the ECG signal is perpendicular to the scalpel current vector. This means that at e. g. a stomack operation the neutral electrosurgical electrode should be placed on the patient's back in a vertical line directly under the incision. The ECG electrodes should be placed in equidistant positions from the incision in a horizontal field across the chest.

Cleaning, Disinfection and Sterilization

Cleaning

Always switch off and disconnect the equipment from the power supply before cleaning.
Do not allow water or other liquids to enter the equipment as they may cause short circuits and corrosion.
Enamelled parts must only be cleaned by wiping with a damp cloth and mild detergent, and rubbed down with a dry cloth.
The active electrodes must be kept clean while in use. Any blood or particles of tissue found adhering to them should be removed at once with the aid of sterile gauze or copper wool.
Normal cleaning can be done with water, but the electrodes should be stored dry.
Reusable patient plates must always be kept bright and free from grease. Blood etc. may be removed with water and a mild abrasive. The plates must be rinsed thorougly to remove all traces of abrasive. The patient plate and connecting cable must be maintained in perfect condition since bad conductivity or bad application of the plate to the patient, may cause burns.

Disinfection

Always switch off and disconnect the equipment from the power supply before disinfection.
The equipment, accessories and connecting cables can be disinfected by wiping with a cloth dampened with glutor aldehyde fluid or an equivalent solution. Do not use solvent or corrosive disinfectants.

WARNING!
The equipment must not be exposed to gaseous disinfectants.

Spray disinfectants are not recommended as the disinfectant may enter the equipment causing short circuits or corrosion. If the room in which the equipment is installed is to be disinfected by means of an atomizer the equipment should be carefully covered with plastic. The equipment should be switched off and allowed to cool down well in advance, in order to prevent convection currents drawing the disinfectant spray into the equipment.
After disinfecting the room, remove the plastic cover from the unit and wipe the unit with disinfectant. The equipment may not be used in the presence of disinfectants which vaporize to form explosive mixtures and the vapor must be allowed to disperse before the equipment is returned to use.
The method of disinfection used should comply with standard regulations and recommendations, including those concerning the prevention of explosion hazards.

Sterilization

All monopolar and bipolar handcontrols, forceps, electrodes, cables and reusable patient plates may be steam sterilized using standard practices.
It is advisable to wrap handcontrols and cables in cloth for steam sterilization, however, do not wrap too tightly or damage may occur. After sterilization, the items should be removed from the cloth immediately and dried thoroughly before reusing in another operating procedure.

Application of the Patient Plate

Essential prerequisites for satisfactory electrosurgery are that the patient plate, including cable and plug, is in perfect condition and that the patient plate is correctly applied to the patient.

General

The entire RF current, which flows into the patient via the monopolar active electrode, must be conducted away from the patient via the patient plate in order to flow back to the surgical equipment through the patient plate cable. If fixing of the patient plate to the patient is forgotten or incorrectly applied, then the current will flow from the patient to electrically conductive objects, such as operating table, supports, parts of other equipment, damp swabs, etc., in which the current density can be so great as a result in burns to the patient where small area contact with the above mentioned objects occure.

The Following Instructions Regarding the Application of the Patient Plate Must be Observed:

The patient plate including cable and plug must always be in perfect condition. Above all, care should be taken to ensure that the surface of any reusable patient plate is clean and metallically bright.

The electrically conductive surface of the patient plate should be at least 180 cm^2 and its whole area should be fixed to the upper arm or thigh closest to the operating area of the patient.

The electrical conductivity of the skin in the area of the patient plate should be improved by cleaning away oil and grease, massaging or brushing to improve the circulation and by carefully rubbing in saline solution.

Do not attach the patient plate directly over large blood vessels close to the skin. Attach the patient plate securely, so that if the patient moves the whole fixture area is secure. Make sure that there is no excessive contusion which could lead to necrosis resulting from the lack of circulation.

During electrosurgery, the patient must not come into contact with electrically conductive objects, such as the operating table, supports, damp cloths etc. A thick, dry, electrically-insulating sheet must be placed between the patient, the operating table and the supports. During electrosurgery, these sheets must not become damp.

Areas subject to considerable secretion of sweat, body extremities lying against the trunk or skin-to-skin contacts should be separated by the application of dry cloths. Drain off urine with a catheter.

If the patient is connected to a monitoring device during electrosurgery the ECG electrodes should not be applied too close to the operating area. The distance should be at least 15 cm. Instrument leads which can conduct the RF current away from the patient must not be applied to the patient during electrosurgery.

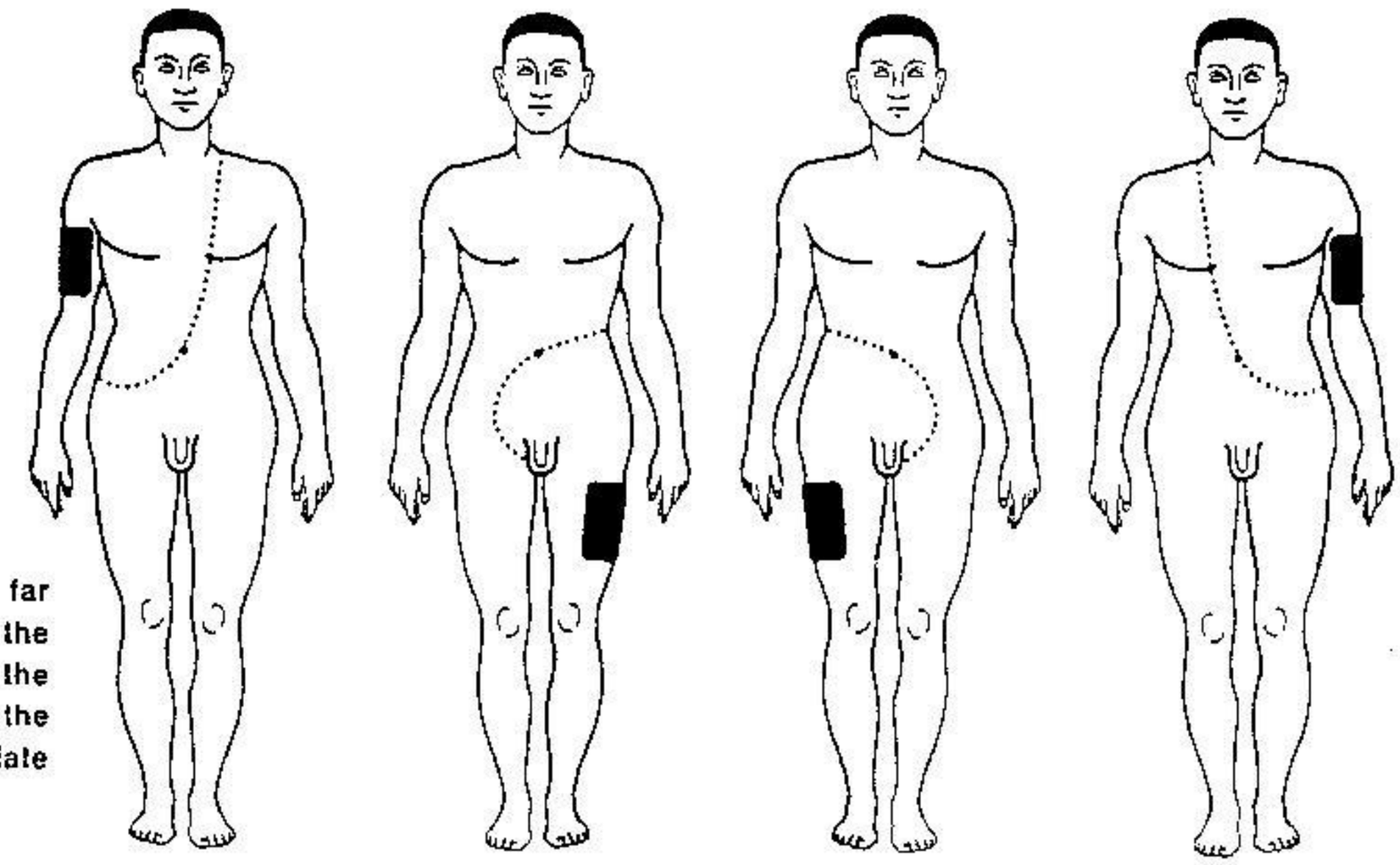
The cable between the patient plate and the surgical unit must be as short as possible.

The neutral electrode should not be applied to bony or hairy areas. Hairy areas should be shaved before application.

WARNING!
In the floating mode the neutral ECG electrode must not be connected to the neutral surgical electrode, but should be placed as far away from it as possible.

Careful consideration should be given to the positioning of the electrodes and their connections. The high frequency RF current path through the patient must be as short as possible. Therefore the patient plate should be positioned with its entire area covering the patient as close to the operating area as possible.

In the following examples the patent plate can very easily be attached to the patient.

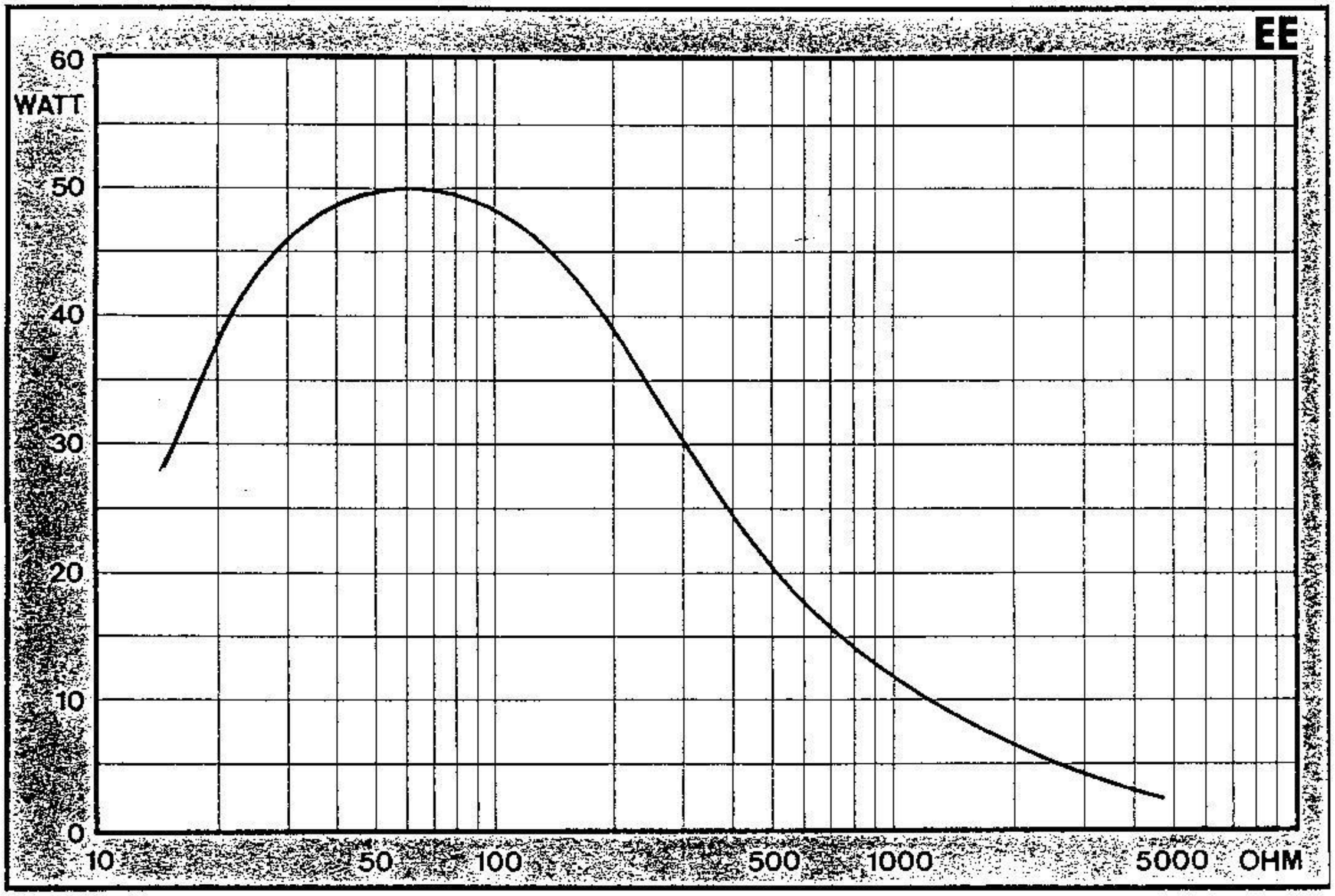


The ERBE PATIENT PLATE should as far as possible be applied in the vicinity of the operating area. The diagram shows the most suitable points of application on the upper arms or thighs for the appropriate operating areas.

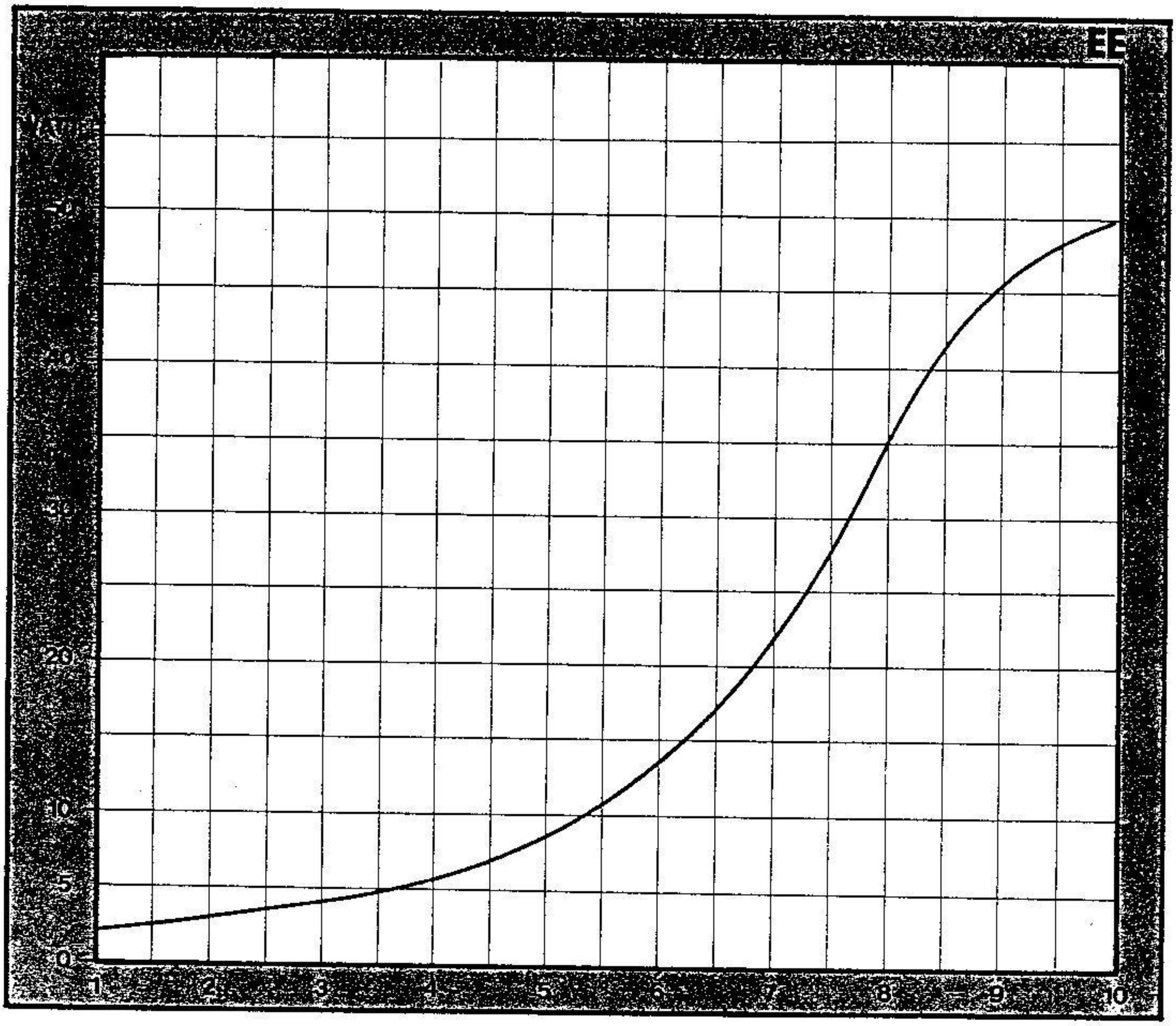
TECHNICAL SPECIFICATIONS

Mains		220 V ± 10 %, 50 Hz other voltages and frequencies on request.
Power consumption: without RF output power by 175 Watts RF output power		7 Watts 345 VA
Leakage current		0.09 mA
Protection Class		I according to IEC 601-1 requirements
RF output	monopolar cutting monopolar coagulation bipolar coagulation	175 Watts at 300 Ohms 100 Watts at 300 Ohms 50 Watts at 75 Ohms
Monopolar frequency Bipolar frequency		450 kHz 500 - 1000 kHz
Output power controls: Monopolar Bipolar Degree of coagulation Crestfactor: monopolar cutting		 continuous from 1 to 10 continuous from 1 to 10 continuous from 0 to 10 continuous from 1.4 to 9.5
Patient plate	Standard: alternatively:	grounded capacitively (type BF) grounded directly or as a floating output (type CF)
Low frequency leakage current 50 Hz		less than 2 µA
Colour indications according to IEC 601-1:	Cutting Coagulation	yellow blue
Audible signals:	Cutting Coagulation Bipolar	continuous tone modulated tone continuous tone
Visual signals:		5 pilot lamps
Cooling		no fan, cooled by natural convection
Size		W x H x D = 405 x 170 x 300 mm
Weight		11 kilograms

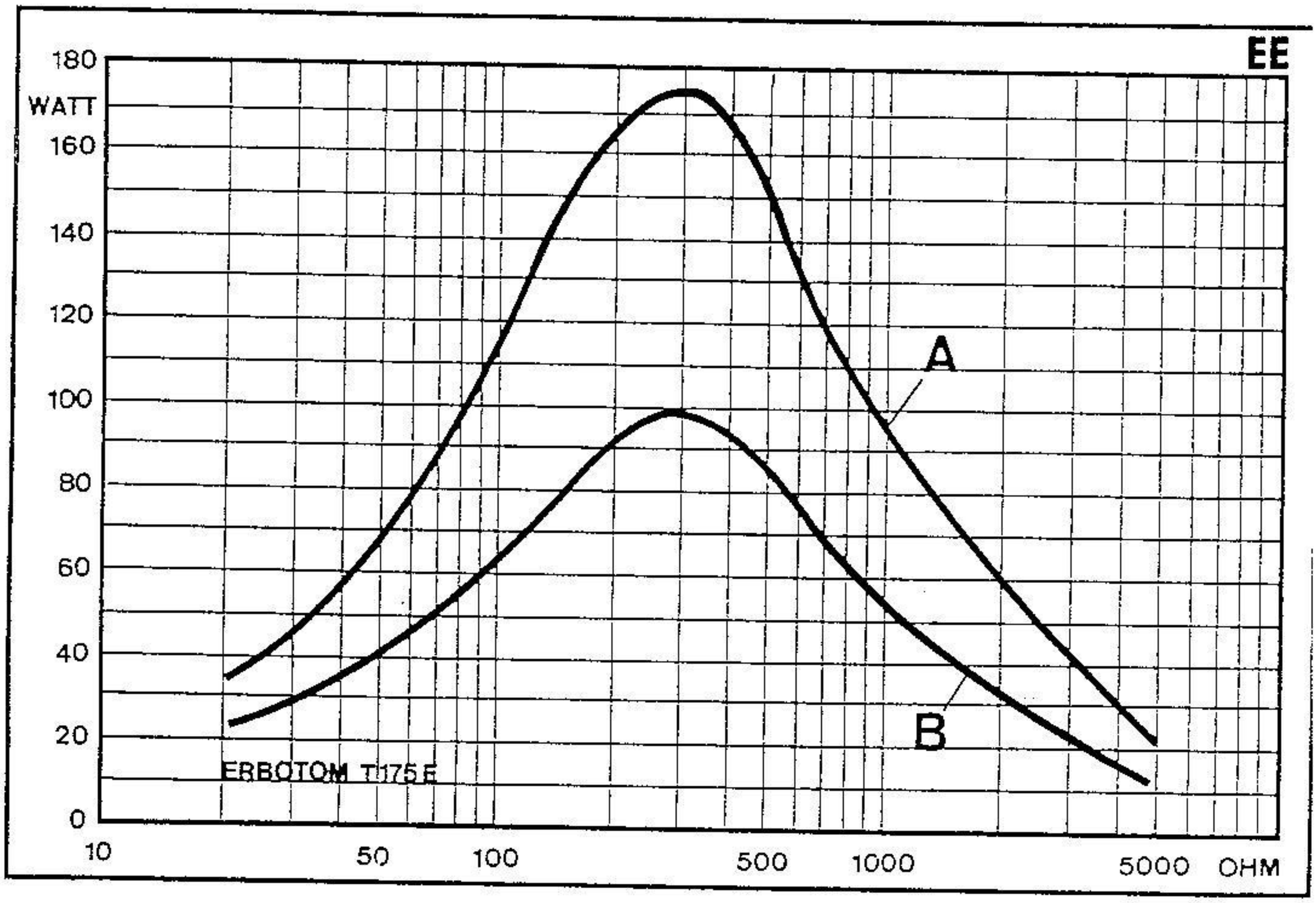
GRAPHS



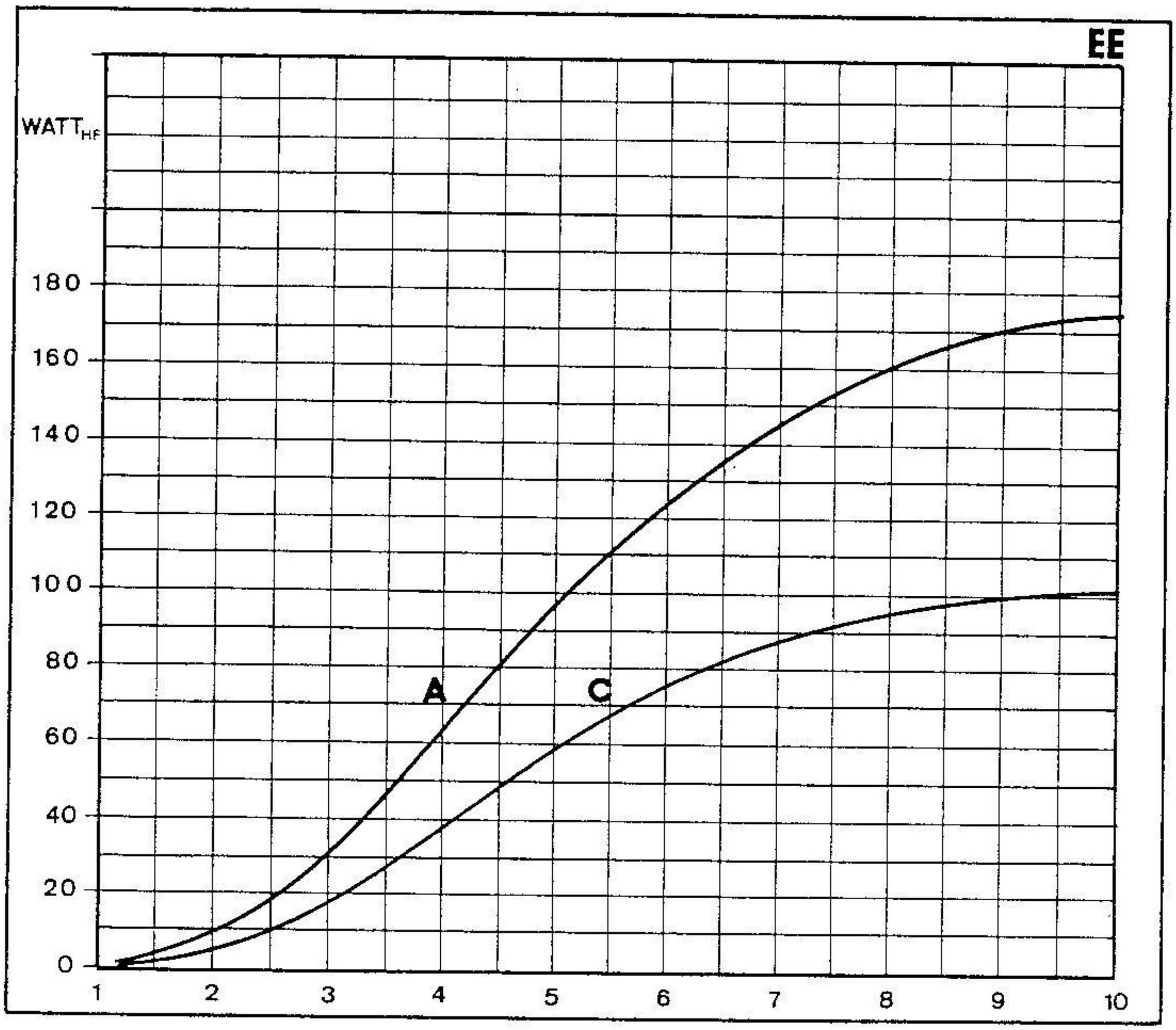
MAXIMUM BIPOLAR OUTPUT POWER VERSUS LOAD RESISTANCE.



BIPOLAR OUTPUT POWER VERSUS INTENSITY SETTING. LOAD RESISTANCE 75 OHMS.



MAXIMUM OUTPUT POWER VERSUS LOAD RESISTANCE
A = PURE CUT
B = MONOPOLAR COAGULATION



MONOPOLAR OUTPUT POWER VERSUS
CONTROL SETTING
A = CUT, C = COAGULATION

10 MAINTENANCE

CAUTION To prevent danger of severe electrical shock, do not remove the cover of the unit. Refer all servicing problems to qualified service personnel.
The procedures listed below should be carefully followed in order to ensure safe and efficient operation.

PREVENTIVE MAINTENANCE
The following routine inspections shall be carried out on the equipment and accessories in order to keep the equipment within its specification during its lifetime and to warranty safety.

Before every use the following routine inspections shall be carried out:	
Insulation	Checks for any sign of damage to the insulation of the cables, connectors and accessories.
Sentry circuit	The sentry circuit shall be tested for proper function.
Indicators	The audible and visual alarm indicators shall be tested for proper function.

Every three months or after repairs:	
Eearth conductor	An earth continuity test shall be carried out.

Every year or after repairs the following functional checks shall be made:	
Low frequency leakage current tests	Measuring leakage currents (50 or 60 Hz).
Sentry circuit test	Check for proper function.
Audible and visual alarms	Check for proper function.
Output power	Measure max. cut, coag. and bipolar RF output power.
Haemostasis control	Measure max. RF-cutting power in the positions 3 and 9.
Absence of muscular stimulation	Measure the absence of resistance between active and patient plate (R > 2 MOhms).
Control the mode of operation	Indication of the earth, earth referenced or floating mode on the frontpanel (5) has to be in accordance with the electrical connection of the patient plate.

The earth referenced or floating mode of operation	Measure the resistance between the patient plate and protective earth (R > 2 MOhms).
The earth mode of operation	Measure the resistance between the patient plate and protective earth (R < 0,1 Ohms).

Corrective Maintenance
Modifications and repairs may only be carried out by ERBE or by service organizations, expressly authorized by ERBE to do so. The latter must provide a certificate on the nature and extent of the repair, and where appropriate, any changes to ratings or working limitations. The certificate must also state the date, the work carried out, and be duly signed.

11 MODIFICATION/REPAIR CERTIFICATE

The following modifications and/or repairs have been carried out on the equipment:

As a result of the modifications, the following rated characteristics have been altered:

The modifications and/or repairs listed above have been carried out in accordance with technical requirements. The safety regulations, in particular the technical information providet by the manufacturer and the IEC regulations applicable at this time were known to me.

Name of service engineer:

Address of service engineer:

Date of repair/modification:

11 CIRCUIT DESCRIPTION

Power Supply

The power supply assembly consist of transformer Tr1 and Tr2 (toroidal type) protected against excessive primary current by fuses F1 and F3 as well as excessive coil temperature by two thermal cut off fuses Th2 and Th3 which are embeded in the two 110 V primary windings of transformer Tr2 and a separate thermal sensitive device Th1 placed on the inner circle of the toroidal coil to the transformer Tr2.

Transformer Tr1 produces 18 Vac and 27 Vac.

The 27 Vac is rectified by the bridge rectifier GI1 and stabilized to 24 V by IC1 on PCB 151.2.

Transformer Tr2 produces 115 Vac which is rectified by the bridge rectifier GI1 on PCB 151.3.

The line power transformer Tr2 (torodial coil transformer) has four primary windings. The line voltage selector diagram is shown inside the cover of the unit. The line voltage selection can be made by changing the bridge wire on multipoint connector terminal St3.

The line transformer Tr1 has only one primary 110 V winding which is parallel to the primary 110 V winding 1–2 of transformer Tr2.

With the front panel power switch Sch1 in the ON position, power is applied to the power supply and to the lamp inside of switch Sch1.

Monitor for Bipolar Coagulations
PCB EE 151.4

The bipolar generator, PCB EE 150.3, can be switched on by either footswitch or automatic control. When the bipolar generator is switched on by automatic control, a time delay is used for switching on the bipolar coagulation current. This allows the surgeon to use the forceps for tissue preparation prior to the initiation of coagulation. Coagulation begins only when the tissue has been held between the forcep tips for a continuous time interval. This time interval is the delay time which can be pre-set by adjusting trimpot TP3 on PCB 151.4 for a delay of 0 to 5 seconds, thus avoiding unintentional coagulations.

Switching of the bipolar generator by footswitch control.

ATTENTION!
For switching of the bipolar generator by footswitch, depress the grey push button 11 (Sch2 in the circuit diagram) on the front panel.

By pressing the blue pedal of the footswitch, 24V dc is supplied to contact J on PCB 151.4. Relay 1 is activated and the relay contact r1 is closed and the power regulator PCB 156.3 is activated.
The maximum and minimum RF-power can be adjusted by TP1 and TP2 on PCB 151.4. Potentiometer PC on the front panel controls the intensity of the output.

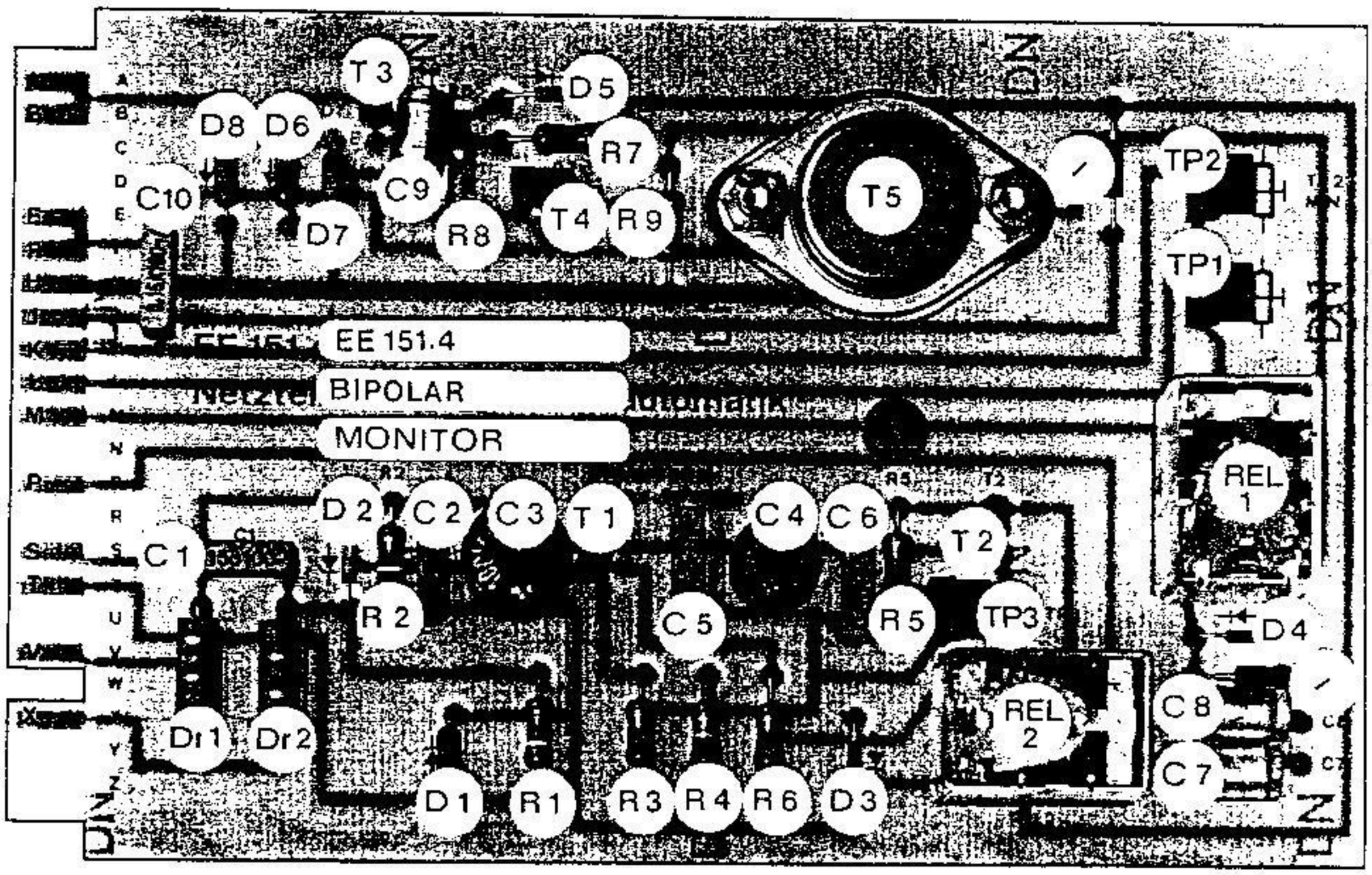
Switching of the bipolar generator by auomatic delay control.

ATTENTION!
For switching of the bipolar generator by automatic control, depress the blue push button 12 (Sch2 in the circuit diagram) on the front panel. (The circuit diagram shows Sch2 in automatic mode condition).

Transistor T1 is normally conductive, however when the forcep tips are both in continuous contact with tissue, the base of T1 becomes 0 voltage and T1 is shut off. This allows capacitor C4 to be charged through resistor R4. After the delay time, transistor T2 becomes conductive and activates the relay Rel 2 which closes contact r2 allowing 24V to activate Rel 1 and thus the bipolar generator is activated for use.

Delay time may be adjusted from 0 to 5 seconds with trim potentiometer TP3.

Transistor T5 on PCB 151.4 isolates the bipolar generator from the power supply PCB 156.3 and prevents the bipolar from being supplied power when monopolar generator is activated.



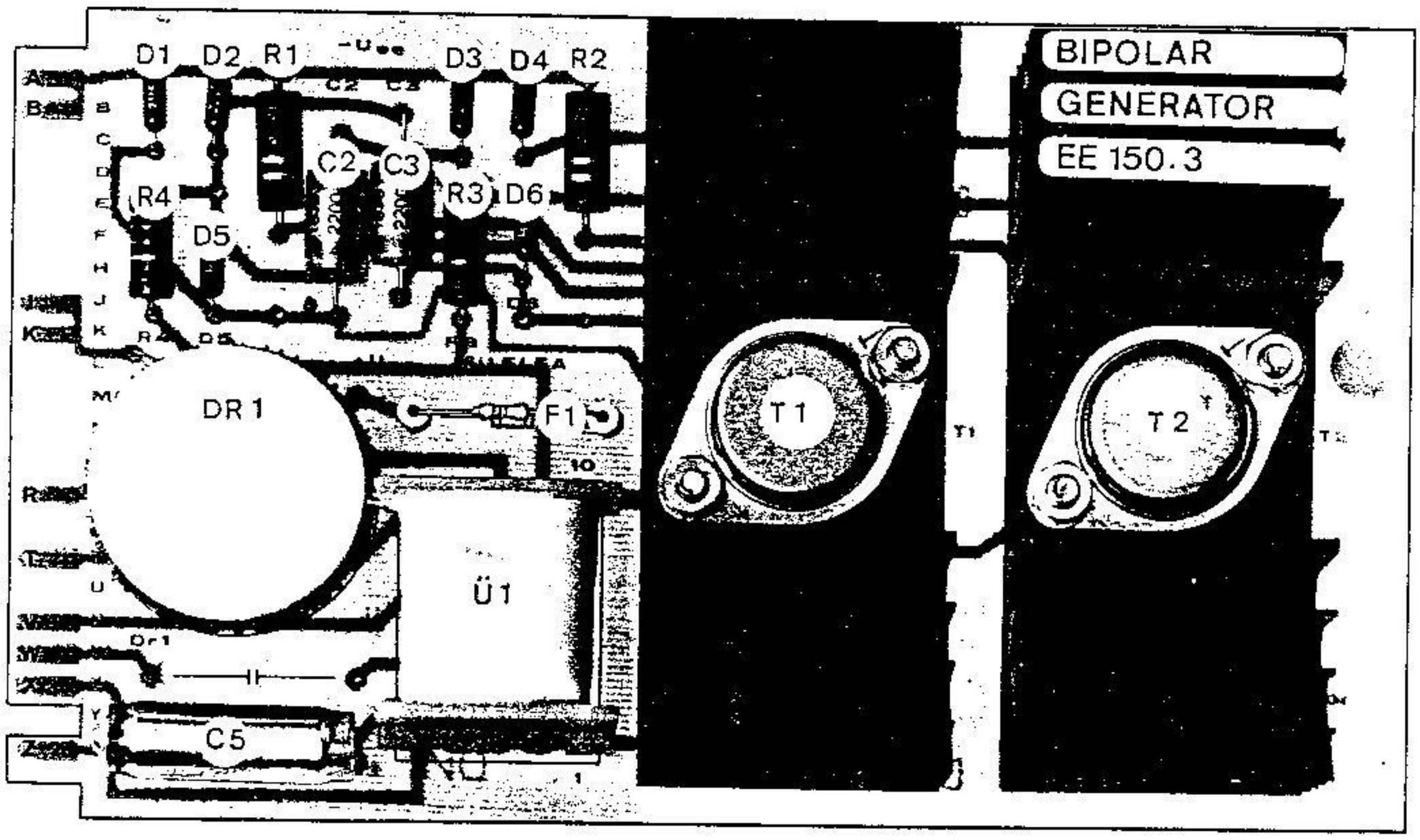
RF-Generator for Bipolar Coagulations PCB EE 150.3

The T 175 ELECTROSURGICAL UNIT is provided with a special RF-generator for bipolar coagulations. It consists of the RF-generator on PCB EE 150.3 and the bipolar monitor for automatic activation of the bipolar RF-generator. The bipolar RF-generator is supplied from the power regulator PCB EE 151.3.

The bipolar monitor PCB 151.4 is supplied with 18 Vac from the transformer Tr1 of the power supply.

The RF-generator for bipolar coagulations, PCB EE 150.3 consists of the power transistors T1 and T2 which are operating push-pull. The frequency of this selfoscillating generator results from the combination of the capacitance of the cpacitors C2 and C3 as well as the inductance of the primary winding of the RF-transformer U1. Because there is an influence from the secondary loading of the RF-transformer U1 to the inductance of the primary winding, the frequency of this generator varies from approximately 1000 kHz in matched loading to 500 kHz in open circuit condition.

The fuse F1 on PCB 150.3 protects the power supply from excessive current when one of the transistors T1 or T2 or one of the diodes D1 or D4 becomes shorted circuit. Capacitor C5 avoids unwanted neuromuscular stimulations.



Logic
PCB EE 151.2

The task of the logic-PCB 151.2 is to coordinate the different functions of the unit:

Cut-Logic
Monopolar Coag.-Logic
Bipolar Coag.-Logic
Priorities
Visual and Audible Signals

Cut-Logic
If activated by footswitch, + 24 V is supplied to contact V on PCB 151.2 and if activated by handcontrol, + 24 V is supplied to the same both contacts V and T. This +24V is fed through diodes D5, D6 to IC2, which turns on transistor T1 and energizes relay Rel A. Transistor T3 does not conduct in this state, because it is shorted by T4 through diode D4. When Rel A is energized, contact rA1 activates the power supply PCB 156.3 and contact rA2 switches on modulation for hemostasis.

Monopolar Coag.-Logic
When channel B is activated by footswitch or handcontrol the +24V is supplied to contact T of PCB 151.2. Therefore transistor T3 is switched on conductive through D6, D7, IC2 and R6. That energizes relay B. It's contact rB1 activates the power supply PCB 156.3 and contact rB2 activates the modulator on PCB 156.5.

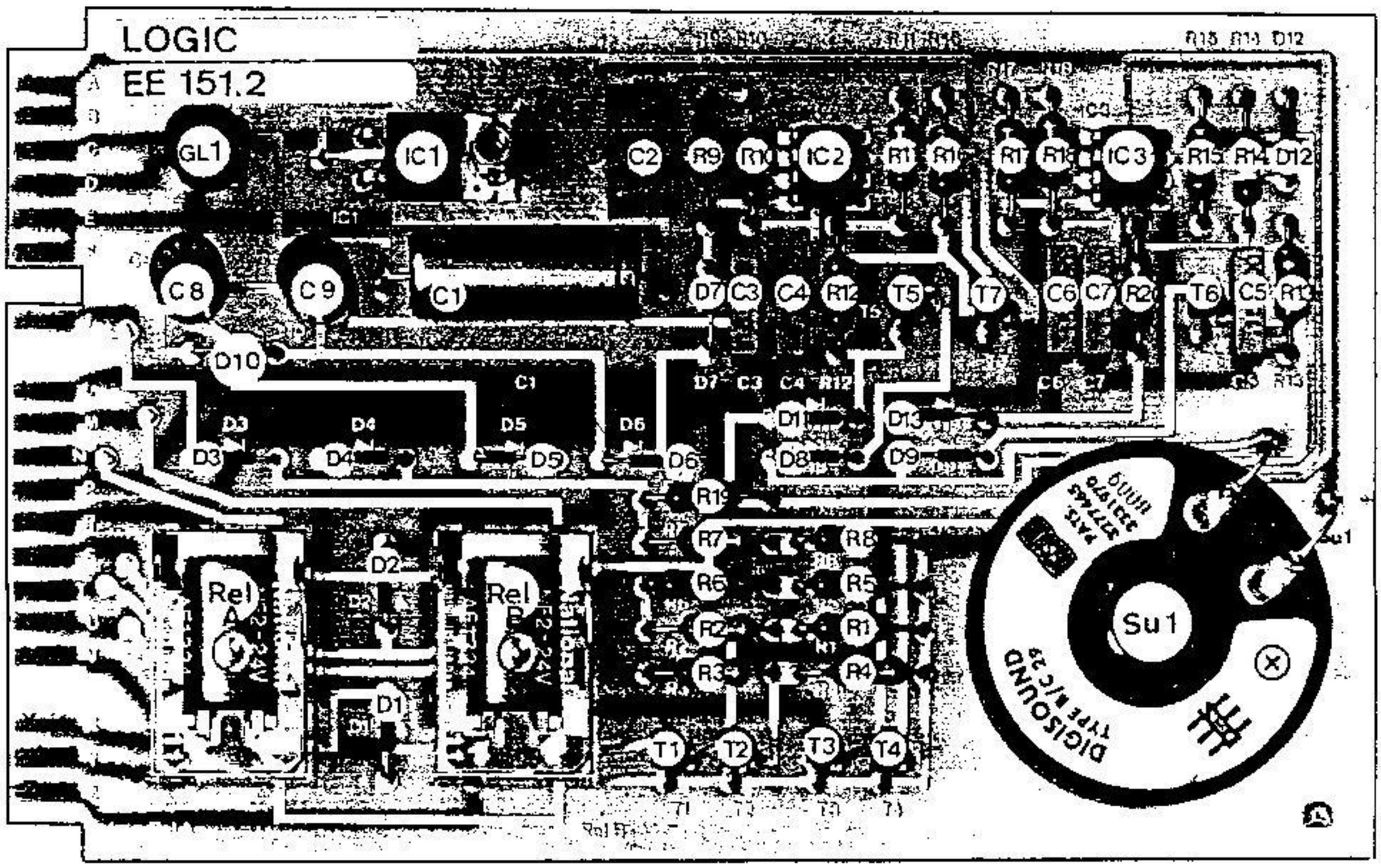
Bipolar Coag.-Logic
When the bipolar generator is activated, it must be shure that the monopolar generator can not be activated simultaneously. If the bipolar generator is activated either by footswitch or by automatically the +24V is fed to contact J on PCB 151.2 and 151.4 with the result that realy Rel1 on PCB 151.4 activates the power supply over it's contact r1. To ensure, that bipolar coagulation current has priority relay A and relay B are blocked through R3, T2 and D3, R7, T4 on PCB 151.2.

Priorities
To prevent multi-activation of the different functions the logic on PCB 151.2 has to coordinate priorities.
First priority is patient plate alarm.
Second priority is bipolar coagulation.
Third priority is cut.
Fourth priority is monopolar coag.

Visual and Audible Signals
Patient plate fault conditions are indicated at the same time by acoustic and optically signals.
The audible signal is generated by IC2, which delivers an output signal from output 3 over R11 to T5 which activates Su1 giving an interrupted audible signal. IC2 is activated by Ty1 on PCB 156.5 through D3 on PCB 156.3. The voltage at contact P on PCB 151.2 is at ground so that IC2 is started and activation of the monopolar generator is prevented, because the bases of T1 and T3 are also at ground. Because lamp LaNE is also connected to Ty1 on PCB 156.5 it illuminates in a patient plate fault condition.

ATTENTION!
When there is a fault associated with the patient plate, audible and visual alarm signals are only given when an attempt is made to operate the monopolar generator.

The lamps LaA and LaB are in parallel with relays Rel A and Rel B and illuminate when the corresponding relay is activated. The lamp LaC, which indicates bipolar current, is directly activated from the footswitch socket through contact J on PCB 151.2.
The audible signal for cut is activated through T6 which is activated through D4, R19 and R14. This audible signal is a continuous tone.
The audible signal for monopolar coagulation is a modulated tone. It is activated through D10, T7, IC3, R15, D12 and T6 which is modulated by IC3.
The audible signal for bipolar coagulation is identical the audible cut signal. It is activated through D13, R20 and T6.



12 CALIBRATIONS AND ADJUSTMENTS

This section provides the procedure for calibrations and adjustments to bring the model T 175 E electrosurgical unit within the specifications. The recommended test equipment is listed below.

Recommended Test Equipment

1 Digital voltmeter, with more than 1 MOhms input impedance.

1 RF-power-meter,model 1200, Dempsey or ERBE electrosurgical power meter.

The following adjustments can be done:

AB-Monitor function

Bipolar output power

Bipolar automatic delay time

Monopolar cut output power

Monopolar coag. output power

AB-Monitor Adjustment (PCB 151.5)

- Connect a handcontrol with two push buttons to socket 7 (in circuit diagram Bu2).

- Disconnect patient plate during AB-monitor adjustment to avoid RF-power interference which can disturb the digital voltmeter. Take no notice of the patient plate audible alarm during depressing the push buttons of the handcontrol.

- Connect a digital voltmeter to collector of T12 on PCB 151.5 and ground. Set the digital voltmeter to ac voltage.

- Depress yellow push button (cut) on the handcontrol and adjust approx. 6 Vac_{eff} +/- 0,2 V on trimming potentiometer TP2 on PCB 151.5.

- Connect the patient plate to socket 2 (in circuit diagram Bu1).

- Check if cut is activated when the yellow push button is depressed and coag. is activated when the blue push button on the handcontrol is depressed.

- If cut and coag. are activated confusedly also relay RelA and RelB rattle, adjust TP2 so that activation of cut and coag. is definite.

- When the adjustment is carried out correctly, pilot lamp 19 (in circuit diagram LaA) must be on when the yellow push button on the handcontrol is depressed. Pilot lamp 20 (in circuit diagram LaB) must be on when the blue push button on the handcontrol is depressed.

Bipolar Output Power (PCB 151.4)

- Connect bipolar forceps to socket 8 (in circuit diagram 8u4).
- Connect the RF-power meter to the two tips of the forceps.
- Depress the blue push button 11 on the front panel of the T 175 E unit.
- Set the RF-power meter to 125 Ohms load resistance (heavy load) and low power range (high sense).
- Set the bipolar intensity control to step 10.
- Adjust the bipolar RF-output power to 50 + 2 Watts by trimming potentiometer TP1 ($C_{MAX.}$) on PCB 151.4.
- Set the bipolar intensity control to step 1.
- Adjust the bipolar RF-output power to 2,5 +/- 1 Watts by trimming potentiometer TP2 ($C_{MIN.}$) on PCB 151.4.
- Check if the bipolar RF-output power increases with bipolar intensity control setting.

Bipolar Automatic Delay Time (PCB 151.4)

The automatic delay time is defined as the time between touching the tissue with both tips of the bipolar foreceps and the automatic activation of the rf-coagulation current.

- Depress push button 12 on the front panel of the T 175 E unit.
- Connect bipolar forceps to socket 8 (in circuit diagram 8u4)
- Connect the two tips of the bipolar forceps to the RF-power meter and check if the required automatic delay time is provided.
- The automatic delay time can be adjusted in the range from 1 to 5 seconds by trimming potentiometer TP3 on pcb 151.4. The standard automatic delay time is 2 seconds.
- If no delay time is required, the capacitor C4 on pcb 151.4 must be replaced with a 22 µF/40 V capacitor.

Monopolar Cut Output Power (PCB 151.3)

- Connect the patient plate to socket 2 (in circuit diagram Bu1) on the T 175 E front panel to the patient plate input socket of the RF-power meter.
- Connect a handcontrol with two push buttons to socket 7 (in circuit diagram Bu2) and connect the active input socket of the RF-power meter to the active electrode which is in the handcontrol.
- Set the RF-power meter to 500 Ohms load resistance (normal load) and high power range (normal sense). When the ERBE RF-power meter is used set it to 250 Watts power range.
- Set hemostasis control 14 on the T 175 E front panel to zero.
- Set cut intensity control 13 on the T 175 E front panel to 10.
- Depress the yellow push button on the handcontrol or the yellow pedal of the footswitch to activate cut power (channel A).
- Adjust the maximum cut power by trimming potentiometer TP2 ($A+B_{MAX.}$) on PCB 151.3, which should be 175 +/- 20 Watts.
- Set cut intensity control to step 1.
- Set RF-power meter to high sense (ERBE power meter 60 Watts).
- Adjust the minimum cut output power to 2,5 + 3/- 1 Watts by trimming potentiometer TP3 ($A_{MIN.}$) on PCB 151.3.
- Check if cut output power increases with the cut intensity setting.

Monopolar Coag. Output Power (PCB 151.3 and PCB 151.5)

NOTE: Before coag. output power adjustment is carried out the cut output power must be correctly adjusted.

- Connect patient plate to socket 2 (in the circuit diagram Bu1) and the patient plate input socket of the RF-power meter.
- Connect a handcontrol with two push buttons to socket 7 (in the circuit diagram Bu2) and to the active input socket of the RF-power meter with the active electrode, which is in the handcontrol.
- Set the RF-power meter to 500 Ohms "normal load" and "normal sense".
- The maximum monopolar coag. output power (monopolar coag. intensity control at step 10) should be approx. 100 +/- 20 Watts. This depends on the pulse/pause ratio of the modulation (PCB 151.5).
- Set coag. intensity control on the front panel of the T 175 E unit to step 1.
- Set RF-power meter to high sense (ERBE power meter to 60 Watts).
- Depress the blue push button on the handcontrol or the blue pedal of the footswitch to activate the monopolar coag. power (channel B).
- Adjust the minimum monopolar coag. output power by trimming potentiometer TP1 ($B_{MIN.}$) on PCB 151.3 to 2,5 + 2/- 1 Watts.
- Check if the monopolar coag. power increases with monopolar coag. intensity setting.

REFERENCE DESIGNATION	DESCRIPTION		MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Control Knob	diameter 15 mm, grey	Ritel		5 15 01-010
	Cover		Ritel		5 15 01-011
	Ring		Ritel		5 15 01-012
La	Pilot Lamp	Automatic 24 V	Schurter	035.0301.10	5 06 04-049
La_{NE}	Signal Lamp	Patient Plate Socket	Schurter	LFR 035.6800	5 16 10-005
	Bulb	24 V, 23 mA	Schurter	KSL 5.913.2024	5 06 04-005
	Cover	red opal	Schurter	L 035.6862	5 06 04-008
La A	Pilot Lamp	Cut Socket	Schurter	LFR 035.6800	5 16 10-005
	Bulb	24 V, 23mA	Schurter	KSL 5.913.2024	5 06 04-005
	Cover	white opal	Schurter	L 035.6861	5 06 04-009
La B	Pilot Lamp	Coagulation Socket	Schurter	LFR 035.6800	5 16 10-005
	Bulb	24 V, 23 mA	Schurter	KSL 5.913.2024	5 06 04-005
	Cover	white opal	Schurter	L 035.6861	5 06 04-009
La C	Pilot Lamp	Bipolar Coagulation Socket	Schurter	LFR 035.6800	5 16 10-005
	Bulb	24 V, 23 mA	Schurter	KSL 5.913.2024	5 06 04-005
	Cover	white opal	Schurter	L 035.6862	5 06 04-009
Sch1	Mains Switch	illuminated, 110 V, CSA-Recognized	Dreefs		5 05 02-000
C1	Capacitor	680 uF, 200 V	Adv. Electro.		5 11 00-011
Si1	Fuse	M5 A / 250 V, 5 x 20 mm	Wickmann		5 16 11-003
Si2	Fuse	M5 A / 250 V, 5 x 20 mm	Wickmann		5 16 11-003

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
Bu1	Socket	Neutral Electrode		ERBE		3 01 02-039
Bu2	Socket	Monopolar Active Electrode		ERBE		3 01 02-004
Bu3	Socket	Footswitch, 4 poles		Tuchel-Amph.		3 01 02-109
Bu4	Socket	Bipolar Electrode		ERBE		3 01 02-016
Bu5	Socket	Potential Equalization		ERBE		5 16 01-025
PA	Potentiometer	100 k	negative logarithmical	Valvo		5 10 31-003
PB	Potentiometer	100 k	negative logarithmical	Valvo		5 10 31-003
PC	Potentiometer	100 k	negative logarithmical	Valvo		5 10 31-003
PT	Potentiometer	220 R	linear	Valvo		5 10 31-001
PM	Potentiometer	22 k	linear	Valvo		5 10 31-030
	Control Knob	diameter 21 mm, grey		Ritel		5 15 01-007
	Cover			Ritel		5 15 01-008
	Arrow			Ritel		5 15 01-009
	Control Knob	diameter 28 mm, grey		Ritel		5 15 01-001
	Cover			Ritel		5 15 01-002
	Arrow			Ritel		5 15 01-003
C_{NE}	Capacitor	0.22 uF Y-Capacitor		Rifa		5 11 06-010

REFERENCE DESIGNATION	DESCRIPTION		MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
GSD	Power Socket	APP-Plug	Feller		5 16 03-000
T1-T4	Transistor	BUX 80	Valvo / Texas		5 02 00-007
	Transistor Socket		Seifert		5 16 10-008
St1	Socket	3 poles	AMP		5 16 02-014
St2	Socket	6 poles	AMP		5 16 02-016
St3	Socket	2 poles	AMP		5 16 02-013
St4	Socket	3 poles	AMP		5 16 02-014
St5	Socket	3 poles	AMP		5 16 02-014
St6	Socket	3 poles	AMP		5 16 02-014
St8	Socket	3 poles	AMP		5 16 02-014
	Socket	Mate N Lok Ms 0.3 - 0.75 mm^2	AMP		5 16 02-020
	Pushbutton	Test, white	Rafi		5 05 02-027

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 151.5	ERBE		3 01 02-037
IC1	Timer	Signetics	NE 555 V	5 00 00-000
T1	Transistor	Valvo	BC 546 B	5 02 00-001
T2	Transistor	Valvo	BC 546 B	5 02 00-001
T3	Transistor	Valvo	BC 547 B	5 02 00-002
T4	Transistor	Valvo	BUX 80	5 02 00-007
T5	Transistor	Valvo	BUX 80	5 02 00-007
T7	Transistor	Valvo	BC 546 B	5 02 00-001
T8	Transistor	Valvo	BC 557 B	5 02 01-000
T9	Transistor	Valvo	BC 557 B	5 02 01-000
T10	Transistor	Valvo	BC 557 B	5 02 01-000
T11	Transistor	Valvo	BC 557 B	5 02 01-000
T12	Transistor	Valvo	BC 546 B	5 02 00-001
Ty1	Thyristor	Teccor	EC 103 M	5 02 10-000
D1	Zener Diode	Telefunken	BZX 55 C 15	5 02 22-003
D2	Diode	Telefunken	1 N 4148	5 02 20-000
D3	Diode	Valvo	BYV 95 C	5 02 20-001
D4	Diode	Valvo	BYV 95 C	5 02 20-001
D5	Diode	Valvo	BYV 95 C	5 02 20-001

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
D6	Diode			Solitron	NS 3004	5 02 20-004
D7	Diode			Valvo	BYV 95 C	5 02 20-001
D8	Diode			Solitron	NS 3004	5 02 20-004
D9	Diode			Telefunken	1 N 4148	5 02 20-000
D10	Diode			Telefunken	1 N 4148	5 02 20-000
D11	Diode			Telefunken	1 N 4148	5 02 20-000
D12	Diode			Telefunken	1 N 4148	5 02 20-000
D13	Diode			Telefunken	1 N 4148	5 02 20-000
D14	Diode			Telefunken	1 N 4148	5 02 20-000
D15	Diode			Telefunken	1 N 4148	5 02 20-000
D16	Zener Diode			Telefunken	BZX 55 C 5 V 6	5 02 22-001
D17	Zener Diode			Telefunken	BZX 55 C 9 V 1	5 02 22-002
C1	Capacitor	470 pF	630 V	Siemens		5 11 03-002
C2	Capacitor	0.015 µF	250 V	ERO		5 11 02-012
C3	Capacitor	470 pF	630 V	Siemens		5 11 03-002
C4	Capacitor	0.15 µF	100 V	ERO		5 11 02-004
C5	Capacitor	0.15 µF	100 V	ERO		5 11 02-004
C6	Capacitor	330 pF	630 V	Siemens		5 11 03-001
C7	Capacitor	0.015 µF	250 V	ERO		5 11 02-012

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
C8	Capacitor	0.15 µF	100 V	ERO		5 11 02-004
C9	Capacitor	100 pF	630 V	Siemens		5 11 03-000
C10	Capacitor	100 pF	630 V	Siemens		5 11 03-000
C11	Capacitor	0.15 µF	100 V	ERO		5 11 02-004
C12	Capacitor	0.1 µF	400 V	Wima		5 11 03-007
C13	Capacitor	100 pF	630 V	Siemens		5 11 03-000
C14	Capacitor	0.015 µF	250 V	ERO		5 11 02-012
C15	Capacitor	0.68 µF	100 V	ERO		5 11 02-005
C16	Capacitor	0.015 µF	250 V	ERO		5 11 02-012
C17	Capacitor	1.5 µF	63 V	ERO		5 11 02-002
C18	Capacitor	0.68 µF	100 V	ERO		5 11 02-005
C19	Capacitor	0.68 µF	100 V	ERO		5 11 02-005
C20	Capacitor	1.5 µF	63 V	ERO		5 11 02-002
C21	Capacitor	0.015 µF	250 V	ERO		5 11 02-012
C22	Capacitor	1.5 µF	63 V	ERO		5 11 02-002
C25	Capacitor	3.3 nF ± 5%	2 kV	ERO		5 11 03-004

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
R1	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R2	Resistor	12 K	0.5 W	5 %			5 10 02-016
R3	Resistor	22 K	0.5 W	5 %			5 10 02-019
R4	Resistor	22 K	0.5 W	5 %			5 10 02-019
R5	Resistor	3.3 K	0.5 W	5 %			5 10 02-013
R6	Resistor	3.3 K	0.5 W	5 %			5 10 02-013
R7	Resistor	3.3 K	0.5 W	5 %			5 10 02-013
R8	Resistor	120 R	0.5 W	5 %			5 10 02-004
R9	Resistor	1 M	0.5 W	5 %			5 10 02-025
R10	Resistor	5.6 K	0.5 W	5 %			5 10 02-015
R11	Resistor	10 R	0.5 W	5 %			5 10 02-001
R12	Resistor	15 R	0.5 W	5 %			5 10 02-002
R13	Resistor	18 K	4 W	10 %	Vitrohm		5 10 08-000
R14	Resistor	1.2 R	0.5 W	5 %			5 10 02-000
R15	Resistor	10 R	0.5 W	5 %			5 10 02-001
R16	Resistor	15 R	0.5 W	5 %			5 10 02-002
R17	Resistor	1.2 R	0.5 W	5 %			5 10 02-000
R18	Resistor	1.2 R	2 W	10 %	Vitrohm		5 10 06-001
R19	Resistor	220 R	0.5 W	5 %			5 10 02-005

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
R20	Resistor	0.33 R	2 W	10 %	Vitrohm		5 10 06-000
R21	Resistor	0.33 R	2 W	10 %	Vitrohm		5 10 06-000
R22	Resistor	27 R	0.5 W	5 %			5 10 02-003
R23	Resistor	5.6 K	11 W	10 %	Vitrohm		5 10 11-000
R24	Resistor	1.2 R	2 W	10 %	Vitrohm		5 10 06-001
R26	Resistor	0.33 R	2 W	10 %	Vitrohm		5 10 06-000
R27	Resistor	0.33 R	2 W	10 %	Vitrohm		5 10 06-000
R28	Resistor	27 R	0.5 W	5 %			5 10 02-003
R29	Resistor	3.9 K	0.5 W	5 %			5 10 02-014
R30	Resistor	820 R	0.5 W	5 %			5 10 02-008
R31	Resistor	18 K	0.5 W	5 %			5 10 02-018
R33	Resistor	1 K	0.5 W	5 %			5 10 02-009
R34	Resistor	390 R	0.5 W	5 %			5 10 02-006
R35	Resistor	18 K	0.5 W	5 %			5 10 02-018
R36	Resistor	3.9 K	0.5 W	5 %			5 10 02-014
R37	Resistor	18 K	0.5 W	5 %			5 10 02-018
R38	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R39	Resistor	18 K	0.5 W	5 %			5 10 02-018
R40	Resistor	1 K	0.5 W	5 %			5 10 02-009

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
R41	Resistor	120 R	0.5 W 5 %			5 10 02-004
R42	Resistor	12 K	0.5 W 5 %			5 10 02-016
R43	Resistor	12 K	0.5 W 5 %			5 10 02-016
R44	Resistor	4.7 R	0.33 W 5 %			5 10 00-000
R45	Resistor	22 R	0.33 W 5 %			5 10 00-001
R46	Resistor	22 R	0.33 W 5 %			5 10 00-001
TP1	Trimpot	100 R		Sfernice		5 10 30-000
TP2	Trimpot	4.7 K		Sfernice		5 10 30-002
Ü1	Transformer			EE		3 01 02-030
Ü2	Transformer			EE		3 01 02-031
Ü3	Transformer			EE		3 01 02-032
Ü4	Transformer	(Monitor)		EE		3 01 01-013
Ü5	Transformer	(Monitor)		EE		3 01 01-013
St1	Plug	3 prongs		AMP		5 16 02-009
St2	Plug	6 prongs		AMP		5 16 02-012
St3	Plug	2 prongs		AMP		5 16 02-008
St4	Plug	3 prongs		AMP		5 16 02-009
St5	Plug	3 prongs		AMP		5 16 02-009
St6	Plug	3 prongs	(prong 1 removed)	AMP		5 16 02-009
St7	Plug	3 prongs	(prong 2 removed)	AMP		5 16 02-009

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTORS NAME	MANUFACTORS PART No	ERBE PART No
St8	Plug	3 prongs	(prong 3 removed)	AMP		5 16 02-009

REFERENCE DESIGNATION	DESCRIPTION			MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
Tr1	Transformer	M 55 / 110 V,	Model Export	ERBE		3 01 02-028
Tr2	Transformer	300 VA,	Model Export, pre-assembled	Talema		5 13 00-001
Si3	Fuse	0.125 A / 250 V		Wickmann		5 16 11-004

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 151.2	ERBE	0678	3 01 02-034
IC1	Voltage Regulator	Motorola	MC 7824 CT	5 00 02-000
IC2	Timer	Signetics	NE 555 V	5 00 00-000
IC3	Timer	Signetics	NE 555 V	5 00 00-000
G11	Bridge Rectifier	Telefunken	B 250 C 800 Si	5 02 24-001
T1	Transistor	Valvo	BC 547 B	5 02 00-002
T2	Transistor	Valvo	BC 547 B	5 02 00-002
T3	Transistor	Valvo	BC 547 B	5 02 00-002
T4	Transistor	Valvo	BC 547 B	5 02 00-002
T5	Transistor	Valvo	BC 547 B	5 02 00-002
T6	Transistor	Valvo	BC 547 B	5 02 00-002
T7	Transistor	Valvo	BC 547 B	5 02 00-002
D1	Diode	Telefunken	1 N 4148	5 02 20-000
D2	Diode	Telefunken	1 N 4148	5 02 20-000
D3	Diode	Telefunken	1 N 4148	5 02 20-000
D4	Diode	Telefunken	1 N 4148	5 02 20-000
D5	Diode	Telefunken	1 N 4148	5 02 20-000
D6	Diode	Telefunken	1 N 4148	5 02 20-000
D7	Zener Diode	Telefunken	BZX 55 C 5 V 6	5 02 22-001

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
D8	Diode				Telefunken	1 N 4148	5 02 20-000
D9	Diode				Telefunken	1 N 4148	5 02 20-000
D10	Zener Diode				Telefunken	BZX 55 C 15	5 02 22-003
D11	Diode				Telefunken	1 N 4148	5 02 20-000
D12	Diode				Telefunken	1 N 4148	5 02 20-000
D13	Diode				Telefunken	1 N 4148	5 02 20-000
C1	Capacitor	220 µF	40 V		ROE		5 11 00-000
C2	Capacitor	0.68 µF	63 V		ERO		5 11 02-005
C3	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C4	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C5	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C6	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C7	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C8	Capacitor	4.7 µF	63 V		ROE		5 11 00-001
C9	Capacitor	4.7 µF	63 V		ROE		5 11 00-001
R1	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R2	Resistor	12 K	0.5 W	5 %			5 10 02-016
R3	Resistor	18 K	0.5 W	5 %			5 10 02-018
R4	Resistor	1.8 K	0.5 W	5 %			5 10 02-011

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
R5	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R6	Resistor	12 K	0.5 W	5 %			5 10 02-016
R7	Resistor	18 K	0.5 W	5 %			5 10 02-018
R8	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R9	Resistor	1.5 M	0.5 W	5 %			5 10 02-026
R10	Resistor	330 K	0.5 W	5 %			5 10 02-024
R11	Resistor	18 K	0.5 W	5 %			5 10 02-018
R12	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R13	Resistor	180 R	0.5 W	5 %			5 10 02-054
R14	Resistor	390 R	0.5 W	5 %			5 10 02-006
R15	Resistor	330 R	0.5 W	5 %			5 10 02-056
R16	Resistor	6.8 K	0.5 W	5 %			5 10 02-057
R17	Resistor	18 K	0.5 W	5 %			5 10 02-018
R18	Resistor	100 K	0.5 W	5 %			5 10 02-045
R19	Resistor	820 R	0.5 W	5 %			5 10 02-008
R20	Resistor	1 K	0.5 W	5 %			5 10 02-031
RelA	Relay				SDS		5 04 00-000
RelB	Relay				SDS		5 04 00-000
Su	Buzzer	Digisound				B/C 29	5 06 10-000

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 151.3				ERBE		3 01 02-035
GI1	Bridge Rectifier				Varo	VH 247	5 02 24-002
Ty1	Thyristor				ECC	S 2010 L	5 02 10-001
Ty2	Thyristor				Teccor	EC 103 M	5 02 10-005
T1	Unijunction Transistor				Motorola	2 N 4871	5 02 02-000
D1	Zener Diode				Telefunken	BZX 55 C 5 V 6	5 02 22-001
D2	Diode				Telefunken	1 N 4148	5 02 20-000
D3	Diode				Telefunken	1 N 4148	5 02 20-000
D4	Diode				Valvo	BYV 95 C	5 02 20-001
C1	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C2	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C3	Capacitor	0.015 µF	250 V		ERO		5 11 02-012
C4	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
R1	Resistor	15 K	1 W	5 %	Vitrohm		5 10 04-000
R2	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R3	Resistor	1.8 K	0.5 W	5 %			5 10 02-011
R4	Resistor	120 R	0.5 W	5 %			5 10 02-004
R5	Resistor	0.33 R	2 W	10 %	Vitrohm		5 10 06-000
R6	Resistor	1 K	0.5 W	5 %			5 10 02-009
R7	Resistor	5.6 K	0.5 W	5 %			5 10 02-015
R8	Resistor	27 K	0.5 W	5 %			5 10 02-020

UNIT ERBOTOM T 175 E No. 1 01 02 ASSEMBLY EE 151.3 No. 3 01 02-035

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
TP1	Trimpot 100 K	Sfernice		5 10 30-004
TP2	Trimpot 47 K	Sfernice		5 10 30-003
TP3	Trimpot 100 K	Sfernice		5 10 30-004
TP5	Trimpot 2.2 K	Sfernice		5 10 30-001
	Heat Sink	Thermalloy	6106 B	3 01 02-019

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
C1	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C2	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C3	Capacitor	100 µF	40 V		ROE		5 11 00-003
C4	Capacitor	47 µF	40 V		ROE		5 11 00-002
C5	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
C6	Capacitor	0.015 µF	400 V		ERO		5 11 02-012
C7	Capacitor	1000 pF	Y		Rifa		5 11 06-012
C8	Capacitor	1000 pF	Y		Rifa		5 11 06-012
C9	Capacitor	680 pF	630 V		Siemens		5 11 03-011
C10	Capacitor	0.15 µF	100 V		ERO		5 11 02-004
R1	Resistor	150 K	0.5 W	5 %	Allen Bradley		5 10 02-069
R2	Resistor	39 K	0.5W	5 %			5 10 02-030
R3	Resistor	27 R	0.5 W	5 %			5 10 02-003
R4	Resistor	270 K	0.5 W	5 %			5 10 02-023
R5	Resistor	27 K	0.5 W	5 %			5 10 02-020
R6	Resistor	1.5 M	0.5 W	5 %			5 10 02-026
R7	Resistor	510 R	0.5 W	5 %			5 10 02-007
R8	Resistor	3.3 K	0.5 W	5 %			5 10 02-013
R9	Resistor	3.3 K	0.5 W	5 %			5 10 02-013

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 151.4	ERBE	0779	3 01 02-036
T1	Transistor	Texas	BC 517	5 02 00-003
T2	Transistor	Texas	BC 517	5 02 00-003
T3	Transistor	Texas	BF 398	5 02 01-001
T4	Transistor	Valvo	BUX 84	5 02 00-011
T5	Transistor	Valvo	BUX 80	5 02 00-007
D1	Diode	Valvo	BYV 95 C	5 02 20-001
D2	Zener Diode	Telefunken	BZX 55 C 2 V 7	5 02 22-000
D3	Diode	Telefunken	1 N 4148	5 02 20-000
D4	Diode	Telefunken	1 N 4148	5 02 20-000
D5	Zener Diode	Telefunken	BZX 55 C 5 V 6	5 02 22-001
D6	Diode	Valvo	BYV 95 C	5 02 20-001
D7	Diode	Valvo	BYV 95 C	5 02 20-001
D8	Diode	Valvo	BYV 95 C	5 02 20-001
Dr1	Inductor 680 µH			5 13 02-000
Dr2	Inductor 680 µH			5 13 02-000

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
TP1	Trimpot 47 K	Sfernice		5 10 30-003
TP2	Trimpot 100 K	Sfernice		5 10 30-004
TP3	Trimpot 47 K	Sfernice		5 10 30-003
Rel1	Relay	SDS		5 04 00-002
Rel2	Relay	SDS		5 04 00-002

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 151.6	ERBE	0779	3 01 02-038
	PCB Connector 22 poles (Socket)	Harting		5 16 02-000
	PCB Connector 31 prongs	Harting		5 16 02-002
R1	Resistor 15 k 2 W 5 %	Vitrohm		5 10 06-002
R2	Resistor 12 k 0.5 W 5 %			5 10 02-031

REFERENCE DESIGNATION	DESCRIPTION				MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Printed Circuit Board Assembly EE 150.3				ERBE	1178	3 01 01-008
T1	Transistor				Valvo	BUX 80	5 02 00-007
T2	Transistor				Valvo	BUX 80	5 02 00-007
D1	Diode				Valvo	BYV 95 C	5 02 20-001
D2	Diode				Valvo	BYV 95 C	5 02 20-001
D3	Diode				Valvo	BYV 95 C	5 02 20-001
D4	Diode				Valvo	BYV 95 C	5 02 20-001
D5	Diode				Valvo	BYV 95 C	5 02 20-001
D6	Diode				Valvo	BYV 95 C	5 02 20-001
C2	Capacitor	2200 pF	630 V		Siemens		5 11 03-003
C3	Capacitor	2200 pF	630 V		Siemens		5 11 03-003
C5	Capacitor	3300 pF	± 5 %	2 kV	ERO		5 11 03-004
R1	Resistor	1.2 R	2 W	5 %			5 10 06-001
R2	Resistor	1.2 R	2 W	5 %			5 10 06-001
R3	Resistor	8.2 K	1 W	5 %			5 10 04-005
R4	Resistor	8.2 K	1 W	5 %			5 10 04-005
Dr1	Choke				Vogt		5 13 02-001
Ü1	Transformer				EE		3 01 01-014
Si1	Fuse	F 1.6 A / 250 V			Wickmann		5 16 11-000

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
	Fuse Holder	Deutschlaender		5 16 10-003
	Heat Sink 37.5 SE T03 30° 30	Assmann	104 511	4 01 01-002

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
Sch1	Double Push Button Assembly, Isostat	EBB	4-3385	5 05 03-003
	Button blue / blue	EBB	4354-1063	5 15 01-094

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART No.	ERBE PART No.
D1	Diode	Telefunken	1 N 4148	5 02 20-000
Sch1	Single Push Button Assembly, Isostat	EBB	3-3385	5 05 03-004