

# Electrosurgical Units (ESU)

Veronica H.

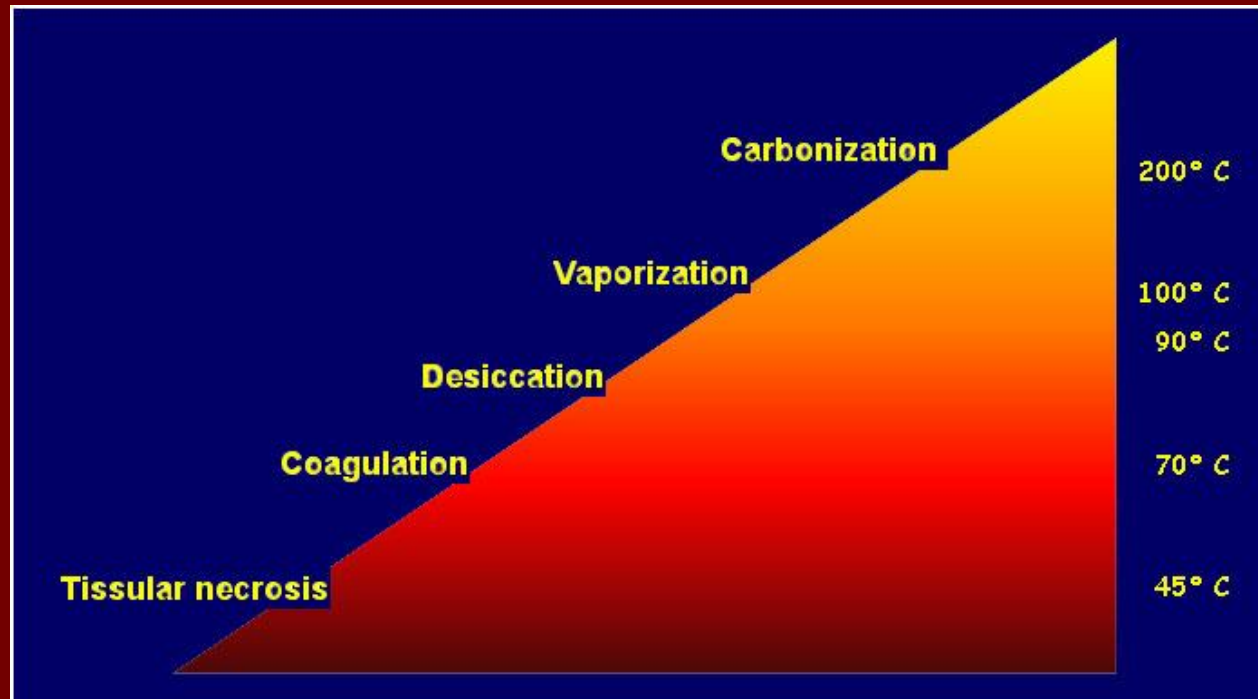


# What Electrosurgery Is...

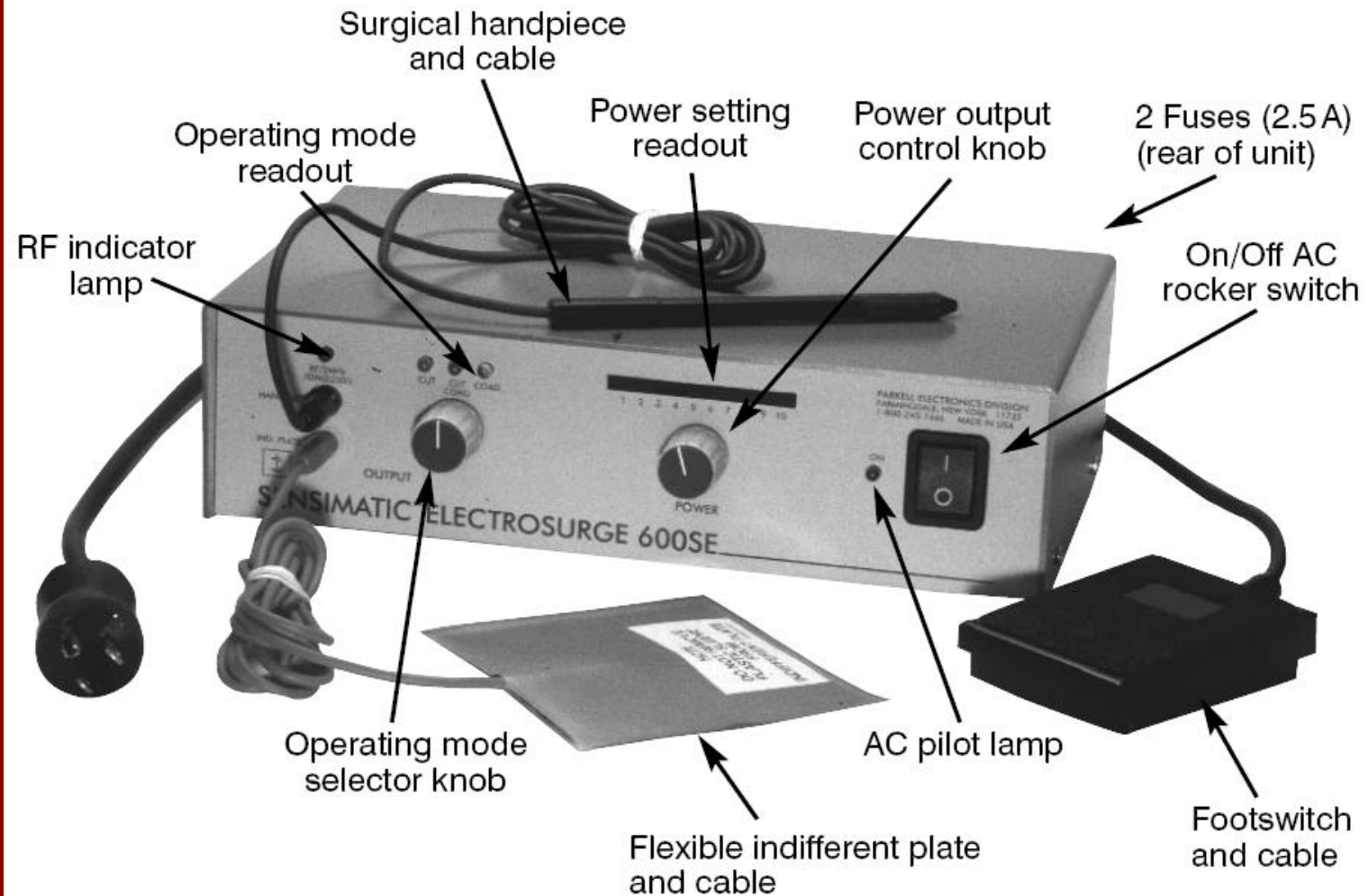
- Electrosurgery is the use of high frequency electrical energy in the radio transmission frequency (RF) band applied directly to tissue for cutting and destroying tissue and stopping blood flow.
- Electrosurgery is used on nearly every soft tissue in the human body. The energy introduced by electrosurgery reacts with water molecules within the cells of the tissue being treated. During surgery the tissue and blood vessels are cut, which causes bleeding. To prevent too much blood loss and to keep the operating field free of excess blood, electrosurgical units are used.
- Different modes of operation can be set. The monopolar mode (single electrode) is used for cutting and coagulation, the bipolar mode (forceps like electrode) is used mainly for destroying tissue.
- Electrosurgery is not the same as electrocautery. Electrocautery uses direct current to heat electrodes that are used to produce coagulation.

# What Electrosurgery Does...

- An electric current with a frequency of about 500kHz is used to cut and coagulate tissue. This process involves applying an RF (Radio Frequency) spark between a probe and the tissue. The electric current through the tissue heats up the tissue and evaporates the water in the cell destroying it. This achieves special surgical effects namely cutting, coagulation and desiccation. The voltage on the electrode is between 1000 – 10,000 V p-p. These units **should not** be used on a person with a pacemaker.



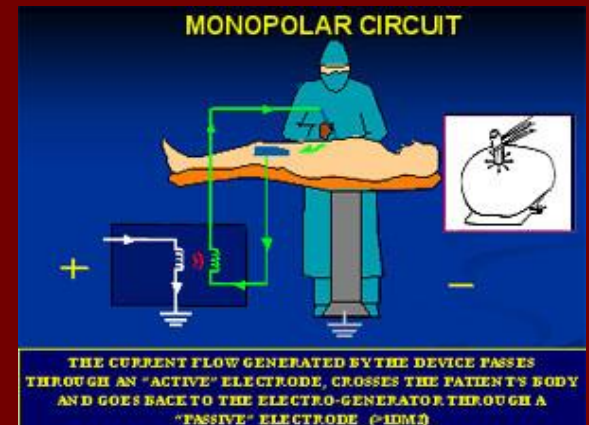
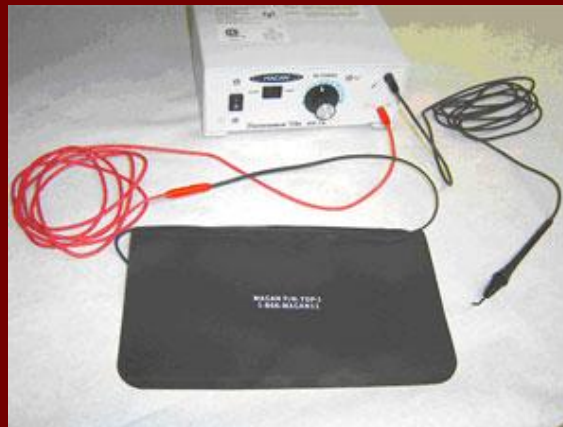
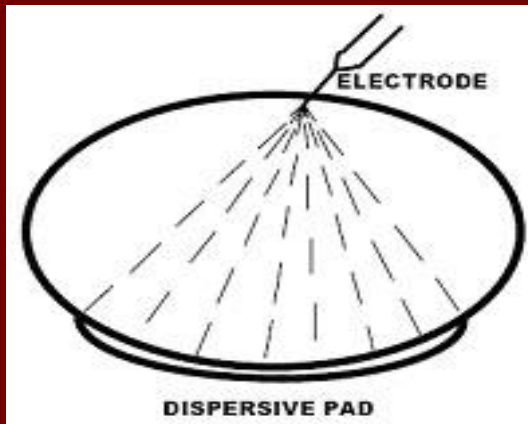
# ESU Parts



# Monopolar

[http://www.valleylab.com/education/poes/poes\\_03.html](http://www.valleylab.com/education/poes/poes_03.html)

- In "monopolar" electrosurgery, one electrode is "active" and is used to introduce current into tissue. The other electrode is the "dispersive" or "return" electrode and is in the form of a large flexible pad. (Contrary to the below picture, this pad should not be placed on bare skin). "Dispersive" connection to the patient is by means of capacitive coupling which works through normal street clothing without direct skin contact so that the patient reclines against the dispersive pad (or "plate") completing the electrical circuit.
- The "active" electrode is much smaller in surface area than the "dispersive" electrode so that current is highly concentrated in the area being treated. Current is distributed over the very large area of the "dispersive" pad to spread the current over a larger area and prevent tissue damage or significant heat build-up on the patient.

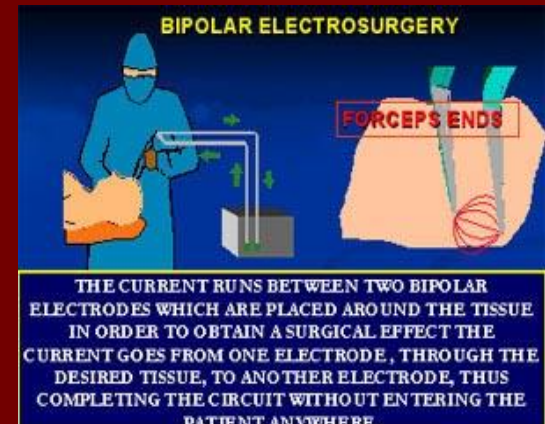
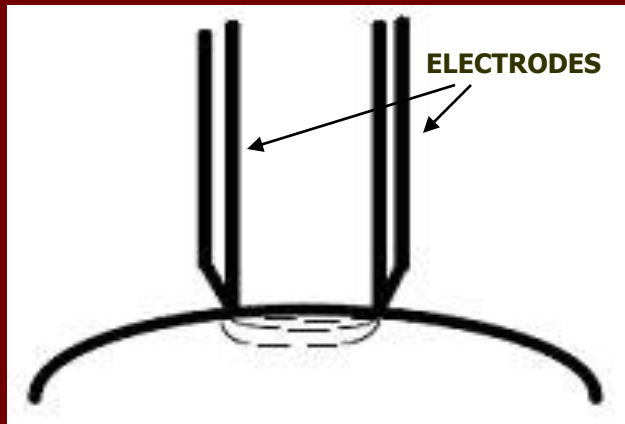




# Bipolar

[http://www.valleylab.com/education/poes/poes\\_05.html](http://www.valleylab.com/education/poes/poes_05.html)

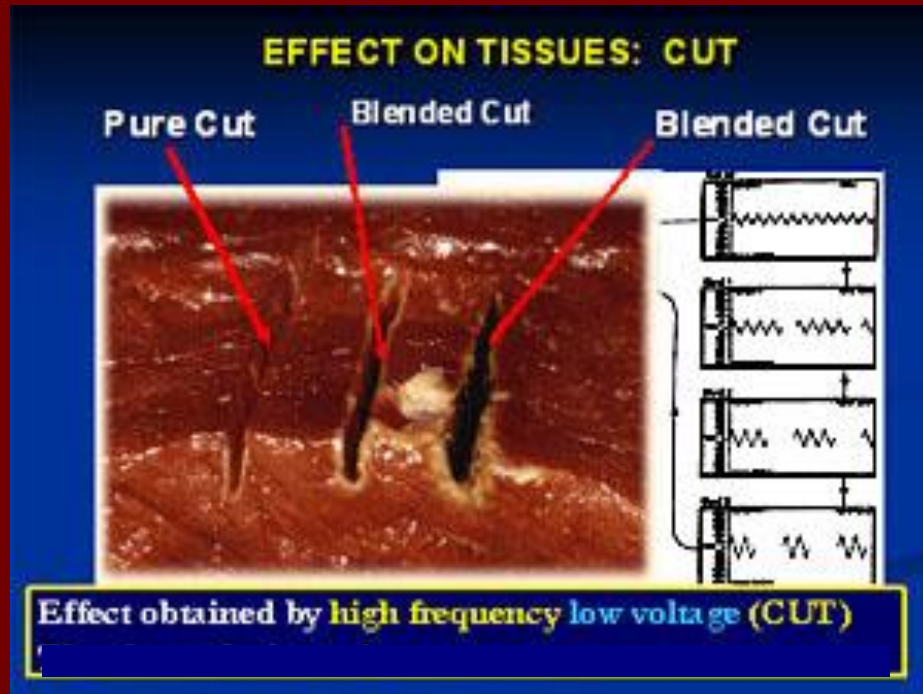
- In "bipolar" electrosurgery, both electrodes are the same or similar size and are mounted on a common hand piece. Current flows from the generator to the instrument, typically forceps, through one tine of the forceps, the active electrode, through the patient tissue, to the other tine, the return electrode, and returns to the generator to complete the circuit. No separate dispersive plate or pad is used.
- This technique is used when current is restrained to the immediate volume of tissue being treated and does not diffuse through the body. Bipolar forceps are insulated from each other. Bipolar accessories are not safe with ground referenced generators.



# Mode of Operation: Cut

- “Cut” uses a spark, in addition to the heat of the current passing through the tissue, to rapidly vaporize the tissue, creating a cutting effect.

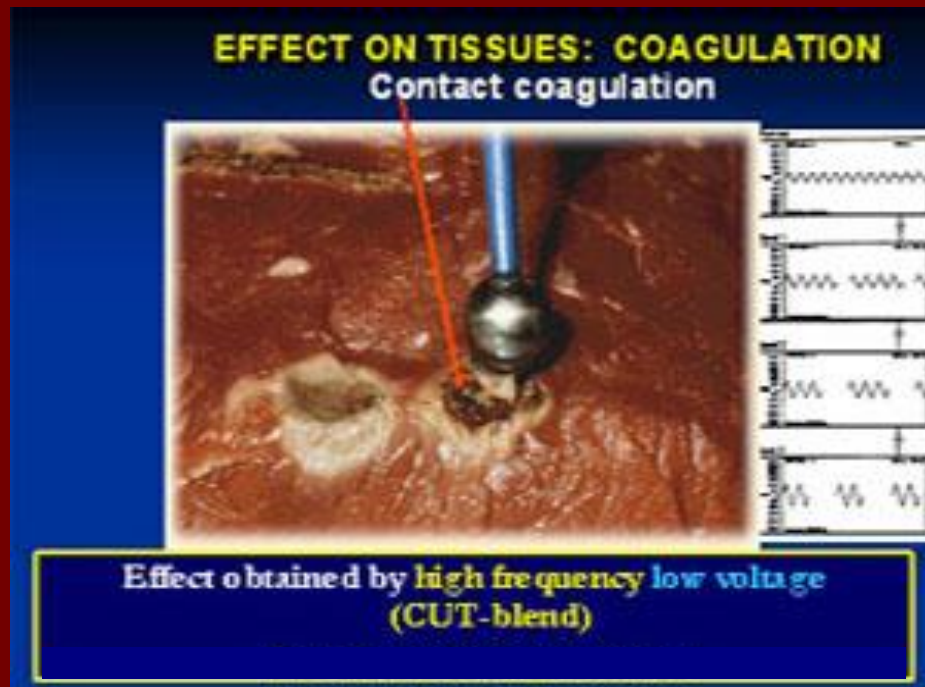
[http://www.valleylab.com/education/poes/poes\\_08.html](http://www.valleylab.com/education/poes/poes_08.html)



# Mode of Operation: Coagulation

- “Coagulation” or “Fulgeration” is used for maximum haemostasis, or stopping the flow of blood. It uses intermittent short bursts of high voltage to coagulate and char tissues without cutting.

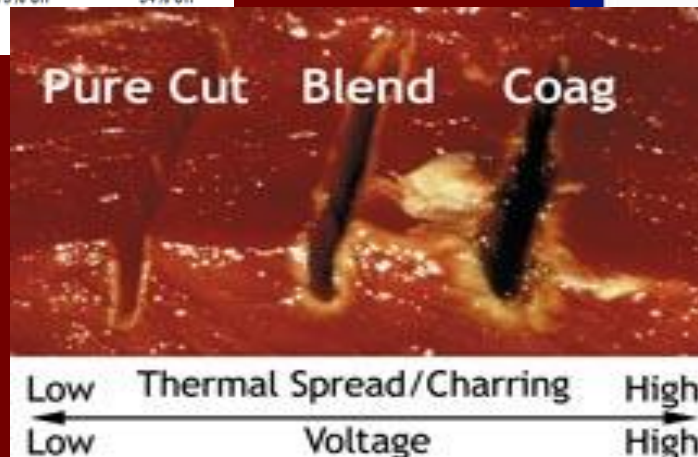
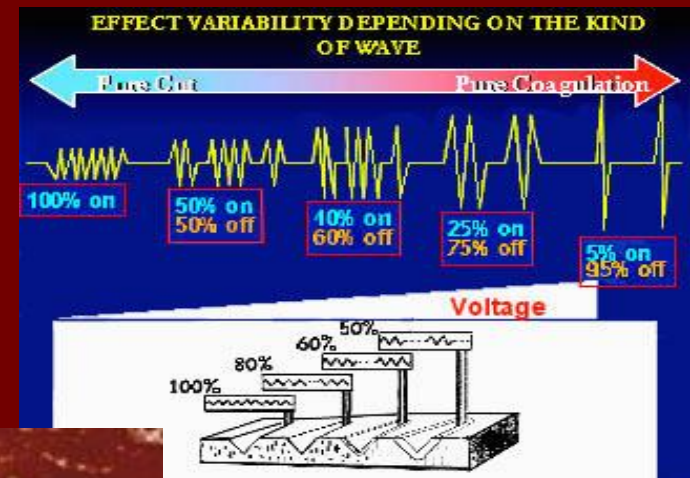
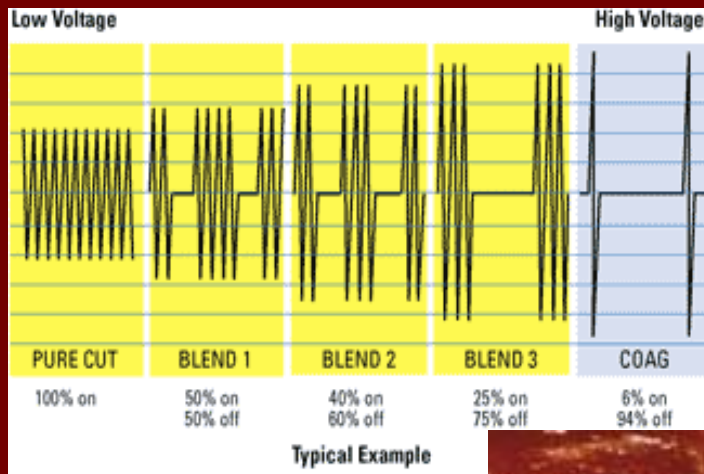
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# Mode of Operation: Blend

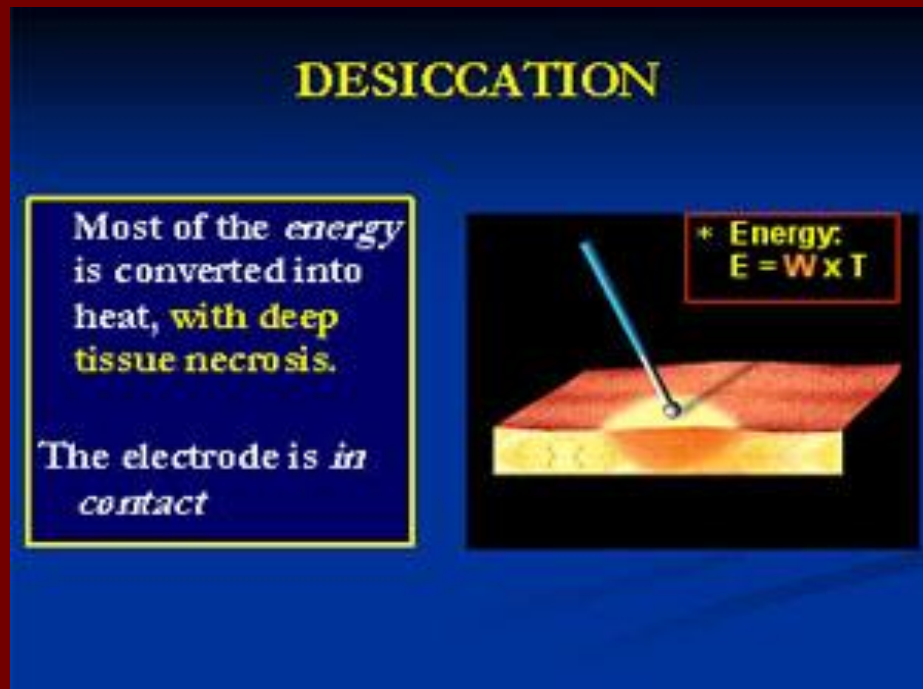
- “Blend” is not a mixture of cutting and coagulation, but a modification of the amount on time the generator is on, called the duty cycle. However, it has properties of both cut and coag.



# Mode of Operation: Dessiccation

- “Desiccation” is used for destroying tissue. The cells dry out and form a coagulum rather than vaporizing and exploding.

[http://www.valleylab.com/education/poes/poes\\_10.html](http://www.valleylab.com/education/poes/poes_10.html)



# Uses of Medical Electrosurgery

- A routine part of laparoscopic (aided by lighted tube) and open surgeries
- Safe around pregnant patients or doctors
- Bloodless biopsy
- Surgeries with antisepsis and hemostasis
- Plastic Surgery (used in 85% of surgeries) and Implant surgery (Recommended for first stage surgery only, since touching implant with electrode is extremely dangerous. Use in later stages should be avoided.)
- Gynecology, urology
- Destroy cancer cells

## HISTORY of ELECTROSURGERY

- 3000 B.C.: Egyptians used heat to treat tumours
- Beginning of XIX century: Discovery of electricity properties (Electrocautery)
- 1875: Bottini used galvanocautery for a prostatectomy
- 1889: Sir Henry Thompson built the first high frequency generator
- 1890: the action of high frequency alternating current on human tissues was demonstrated
- 1893: Paul Oudin and Telsa invented the secondary coil which, coupled with Arsonval coil, increased voltage and decreased current

## HISTORY of ELECTROSURGERY

- 1900: A. Riviere used Arsonval device to destroy a skin cancerous lesion
- 1907: Prof. Pozzi showed the effectiveness of scintillation on the growth of deep and surface malignant tumours
- 1909: Nagelschmidt used the therapeutic effects of tissue heating and called this technique "diathermy"
- 1910: Electrosurgery was recognized as a surgical tool to be included in surgical instruments
- 1926: Harvey Cushing e W.T. Bovie built the first electrosurgical generator supplying sufficient haemostatic effect and quick cut for neurosurgery.

# Uses of Dental Electrosurgery

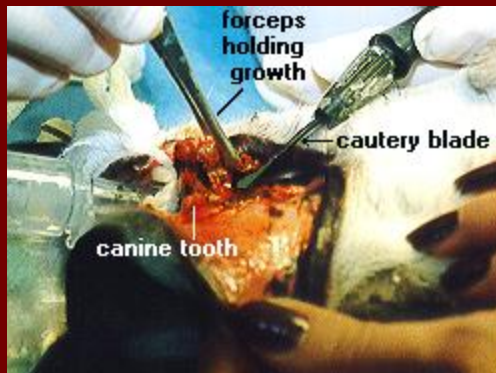
- Root canal sterilization
- Tissue sculpting in a manner far superior to laser
- Prosthodontics
- Accelerating desensitizing agents and whitening agents (in spot whitening)
- Mouth tissue incisions
- Gingival curettage (tissue removal)
- General bleeding control during surgery





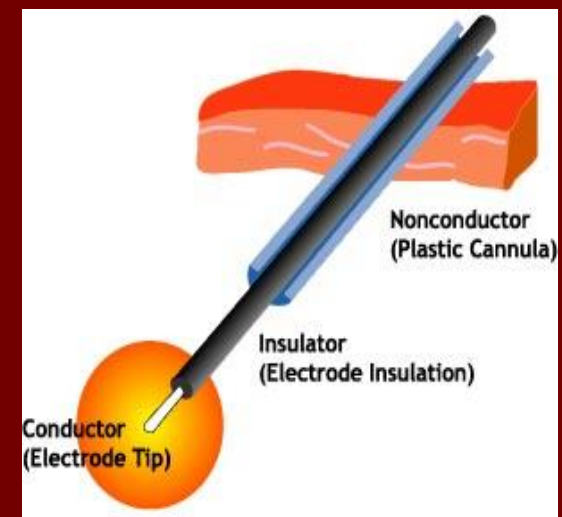
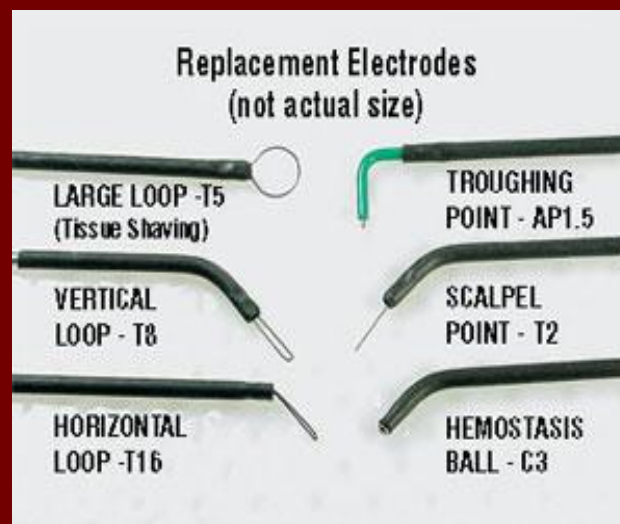
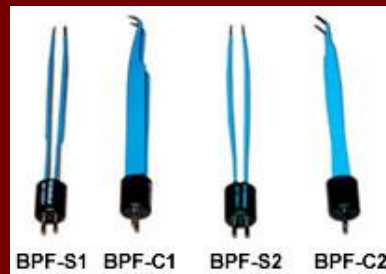
# Uses of Veterinary Electrosurgery

- Ear cropping and tail docking
- Eye lid surgery
- Epilation (hair removal)
- Gingivoplasty (surgical reshaping and recontouring of the gum tissue)
- Incision with healing on par with laser and scalpel with minimal scar formation.
- Neutering and Amputation
- De-clawing and De-barking
- Emergency trauma treatment



# Electrodes

These are also called "tips" or "electrode tips" and come in a wide variety of sizes and shapes suited to specific clinical indications for incision, excision, curettage, and coagulation. These are held in an insulated hand piece. Power should be turned off before switching tips to prevent electric shock.



# Calibration

Electrosurgical units deliver high voltage and power that can cause serious electrical burns. Be sure that all connections are secure and well insulated before performing any power output tests!!!



# Calibration Don'ts:

Never:

- Operate the unit for a prolonged period of time
  - Activate the unit with the active and dispersive electrodes connected, or short-circuited
  - Leave unit in the on mode when not taking measurements
  - Measure 60 Hz leakage current from the active electrode while the unit is activated
  - Measure current from the return electrode when the unit is activated for testing isolated output current
  - Touch, connect, or disconnect ESU lines or electrodes while testing
- Doing so may cause harm to yourself or the unit.





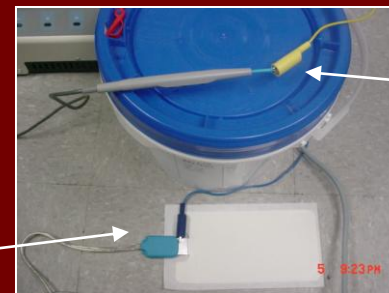
# Calibration Using Model 454A Analyzer – Connecting It

Use the test leads supplied with the analyzer to connect it to the ESU being tested. The leads are color coded. **Yellow** = **active electrode**, **Blue** = **dispersive electrode (patient pad)**, **Green** = **case external ground**.



Make sure that both electrodes are insulated from each other and other conductive surfaces. Formica or other surfaces normally considered to be insulators may be inadequate at the frequencies being measured. This applies to electrostatic pads as well.

**DISPERSIVE ELECTRODE**



**ACTIVE ELECTRODE**

# Calibration Using Model 454A Analyzer – Generator Output

From MANUAL mode, select an isolated load as specified by the ESU manufacturer. (50-1550 $\Omega$  available range on the 454A).

Activate the ESU for two seconds to take a reading. Press the HOLD key (F1) to save the parameters and then deactivate the ESU. A PRINT prompt will appear above F2 only after an output is no longer detected. Press the RELEASE key (F1) to show the data.



Parameter measurements:

- KVpp (peak-to-peak voltage in kV – closed circuit only)
- CF (Crest Factor)
- I (current in mA)
- Power (in watts)



# Calibration using Model 454A Analyzer – RF Leakage

This test can only be conducted on ESUs with isolated outputs only. Other ESUs are ground referenced or have an output balanced to ground. They do not require this test.

Select the active or dispersive electrode. Select the load value (50-1550 $\Omega$ ).

Activate the ESU for two seconds to take a reading. Press the HOLD key to save the parameters and then deactivate the ESU. Press the RELEASE key after the PRINT prompt to show the data.



# Calibration using Model 454A Analyzer - Ammeter

This test provides a method to measure RF Current using an external test load. This is a direct connection to the wide band current transformer. Since the impedance between the top panel and the positive and negative jacks is zero, do not connect an external RF source directly across this input without a load of adequate power.

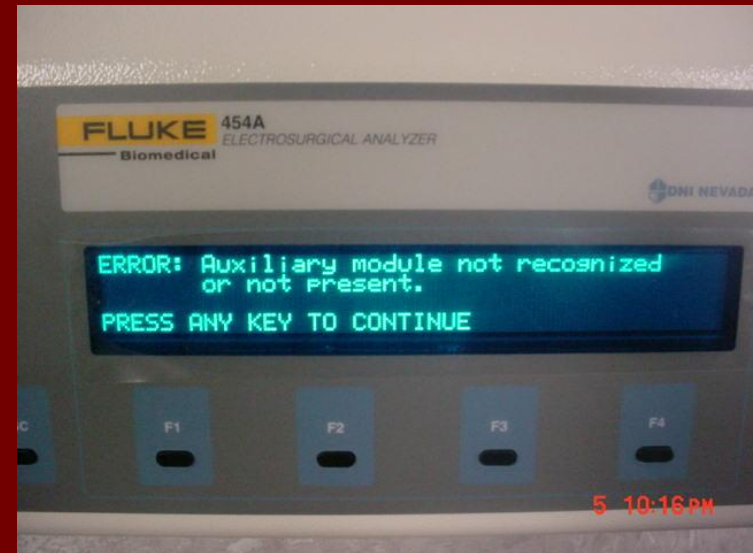
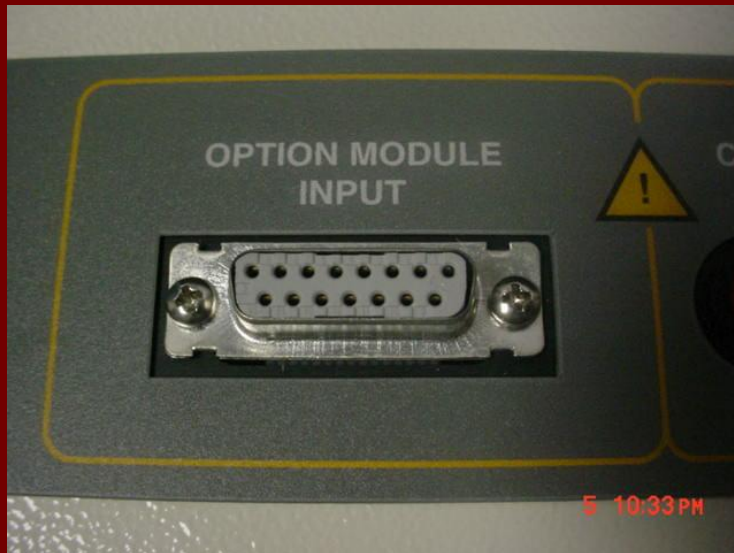
Connect an external load at the CURRENT LOOP + jack and – jack.  
Measured RMS current is displayed.





# Calibration using Model 454A Analyzer - Auxiliary

This mode enables specific manufacturer parameters using an accessory model that is attached to the 454A at the COMM port connector. This port is not a serial RS-232 port or parallel printer port. It is only compatible with DNI Nevada options.



# Sources

- Flinders Biomedical Engineering  
<http://www.fbe.org.au/Clin/BasicEquipment/ESU.htm>
- Macan Engineering & Manufacturing Company:  
<http://www.macanengineering.com/>
- Valleylab: [http://www.valleylab.com/education/poes/poes\\_01.html](http://www.valleylab.com/education/poes/poes_01.html)
- The Internet Animal Hospital Dog and Cat Health Care:  
[www.ThePetCenter.com](http://www.ThePetCenter.com)
- Health Devices Inspection and Preventative Maintenance Systems  
Procedure/Checklist 411-0595  
<http://parkell.com/NEW-pdf-files/Instructions/600SEIns.pdf>
- OBGYN.net:  
[http://www.obgyn.net/urogyn/urogyn.asp?page=/hysteroscopy/articles/troc ar\\_physical](http://www.obgyn.net/urogyn/urogyn.asp?page=/hysteroscopy/articles/troc ar_physical)
- Electrosurgery glossary:  
<http://www.corexcel.com/courses/body.electrosurgery.glossary.htm>
- DNI Nevada model 454A Electrosurgical Analyzer Operating Manual