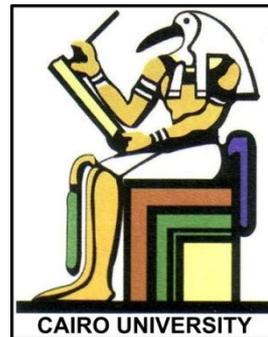


Medical Equipment I - 2009

Part II: Electrosurgical Unit

Professor Yasser M. Kadah

Web: <http://ymk.k-space.org/courses.htm>



Theory of Operation

- In principle, electrosurgery is based on the rapid resistive heating of tissue
 - Monopolar or bipolar modes



Effects of Heat on Tissues

- Up to to 45°C: Reversible cytochemical changes occur
- Above 45°C: Irreversible changes leading to cell death
 - Between 45°C and 60°C: Coagulation
 - Between 60°C and 100°C: Desiccation
 - Beyond 100°C: Carbonization
- Tissue damage depends not only on temperature but also on length of exposure to heat

[ESU Typical Power Settings]

Table 81.1 Typical ESU Power Settings for Various Surgical Procedures

Power-Level Range	Procedures
Low power	
<30 W cut	Neurosurgery
<30 W coag	Dermatology
	Plastic surgery
	Oral surgery
	Laparoscopic sterilization
	Vasectomy
Medium power	
30 W–150 W cut	General surgery
30 W–70 W coag	Laparotomies
	Head and neck surgery (ENT)
	Major orthopedic surgery
	Major vascular surgery
	Routine thoracic surgery
	Polypectomy
High power	
>150 W cut	Transurethral resection procedures (TURPs)
>70 W coag	Thoracotomies
	Ablative cancer surgery
	Mastectomies

[Term Definitions]

- Active electrode
 - Electrode used for achieving desired surgical effect.
- Coagulation
 - Solidification of proteins accompanied by tissue whitening.
- Desiccation
 - Drying of tissue due to the evaporation of intracellular fluids.

[Term Definitions]

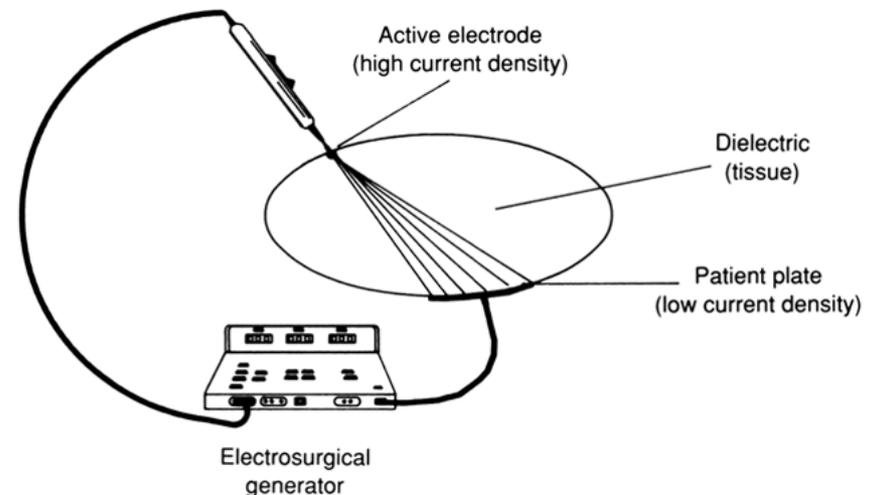
- Dispersive electrode
 - Return electrode at which no electrosurgical effect is intended.
- Fulguration /Spray
 - Random discharge of sparks between active electrode and tissue surface in order to achieve coagulation and/or desiccation.

Monopolar Mode

- In the **monopolar** mode, electrode either touches tissue or is held a few mm above it
 - **Direct current or electric discharge arc**
 - **Temperature rise from Bioheat equation**

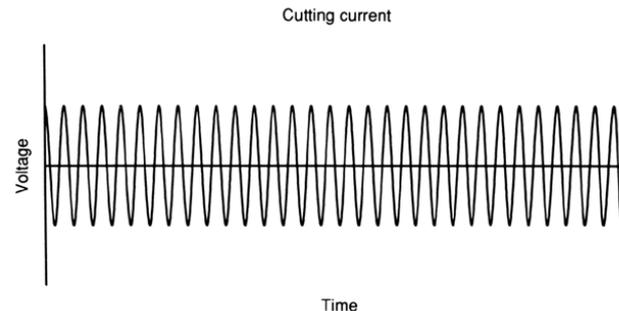
$$T - T_0 = \frac{1}{\sigma \rho c} J^2 t$$

- **Control of heating using J , A , and t**



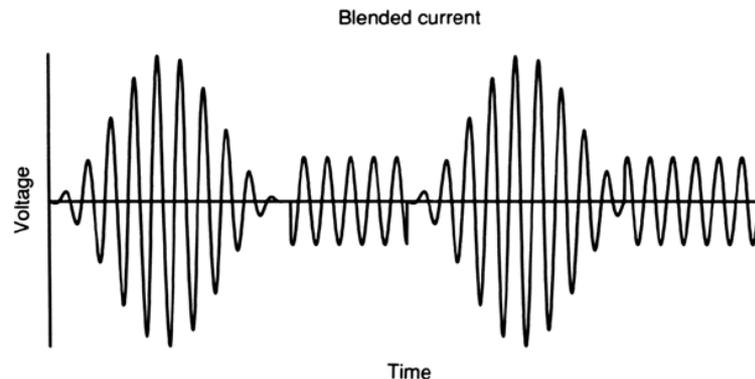
[Cutting Mode]

- A continuous sinusoidal waveform cuts tissue with very little hemostasis.
 - This waveform is simply called *cut* or *pure cut*.
- Electric current concentrates at one spot
 - Sudden increase in temperature at this location
 - Rapid rise in temperature then vaporizes intracellular fluids, increases cell pressure, and ruptures cell membrane, thereby parting tissue.



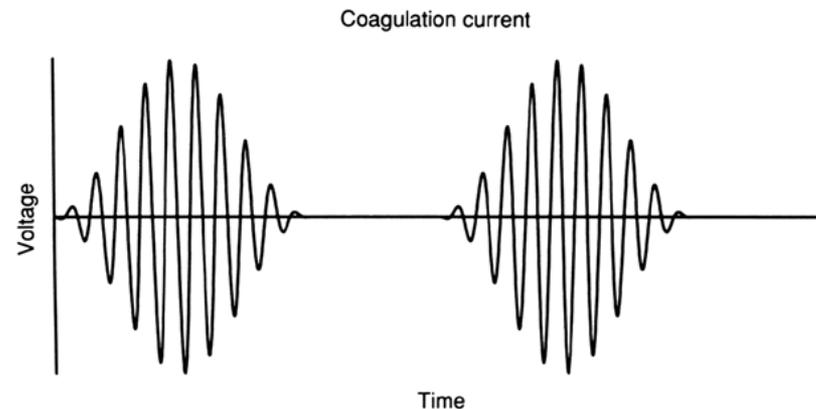
Blended Cutting Mode

- More hemostasis is achieved when cutting with an interrupted sinusoidal waveform or amplitude modulated continuous waveform.
 - Typically called *blend* or *blended cut*.
- Some ESUs offer a choice of blend waveforms to allow the surgeon to select degree of hemostasis desired.



[Coagulation Mode]

- When a continuous or interrupted waveform is used in contact with the tissue and output voltage current density is too low to sustain arcing, desiccation of the tissue will occur.
 - Distinct mode called *desiccation* or *contact coagulation*.



[Spray Mode]

- While a continuous waveform reestablishes arc at essentially same tissue location concentrating the heat there, an interrupted waveform causes arc to reestablish itself at different tissue locations.
 - Arc seems to dance from one location to another raising the temperature of the top tissue layer to coagulation levels.
 - Called *fulguration* or *spray mode*

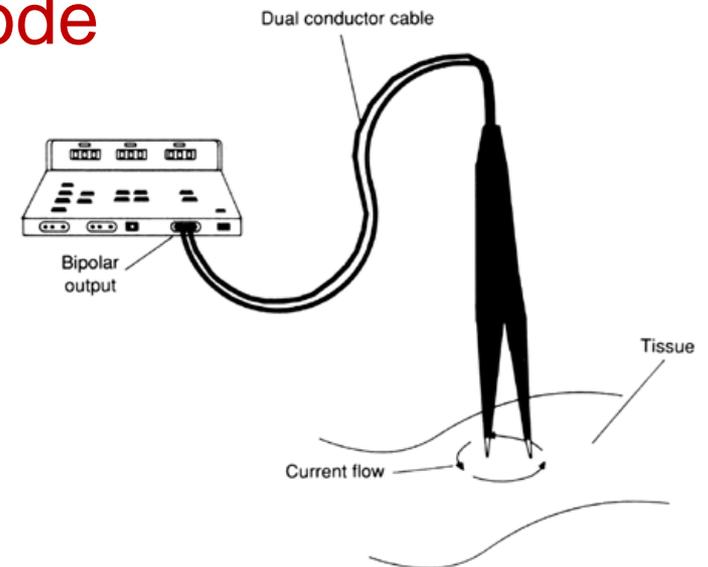
[ESU Output Characteristics]

TABLE 81.3 Typical Output Characteristics of ESUs

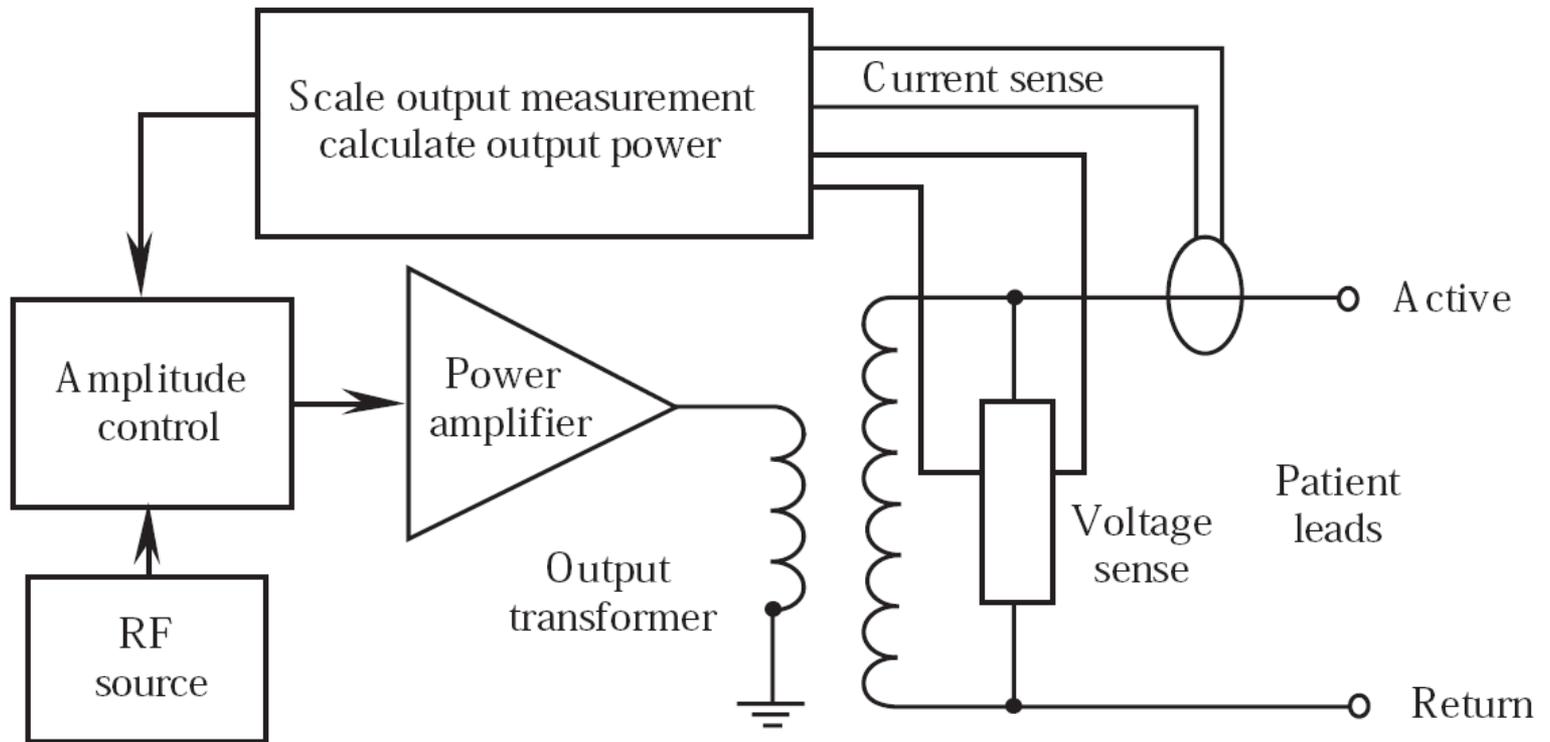
	Output Voltage Range Open Circuit, $V_{\text{peak-peak}}$, V	Output Power Range, W	Frequency, kHz	Crest Factor $\left(\frac{V_{\text{peak}}}{V_{\text{rms}}}\right)$	Duty Cycle
Monopolar modes					
Cut	200–5000	1–400	300–1750	1.4–2.1	100%
Blend	1500–5800	1–300	300–1750	2.1–6.0	25–80%
Desiccate	400–6500	1–200	240–800	3.5–6.0	50–100%
Fulgurate/spray	6000–12000	1–200	300–800	6.0–20.0	10–70%
Bipolar mode					
Coagulate/desiccate	200–1000	1–70	300–1050	1.6–12.0	25–100%

[Bipolar Mode]

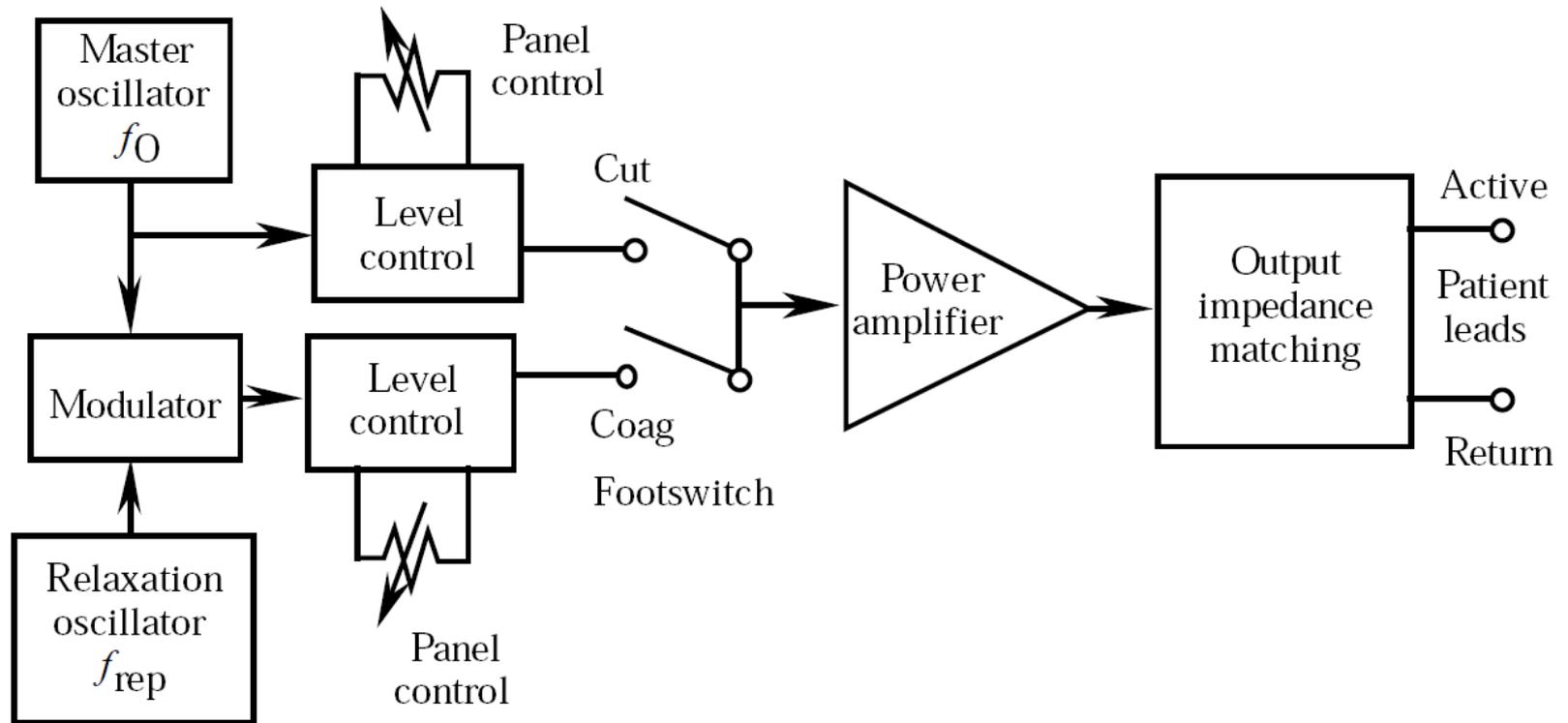
- Bipolar mode concentrates current flow between the two electrodes
 - Requiring considerably less power for achieving the same coagulation effect than the monopolar mode



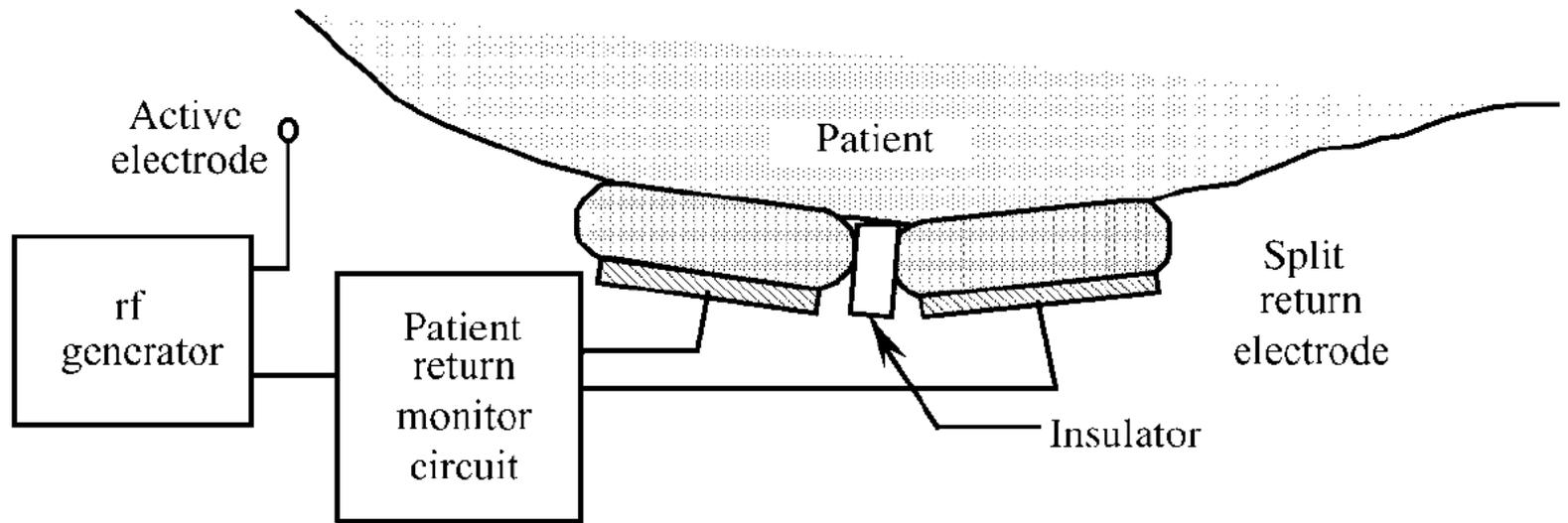
[ESU Design]



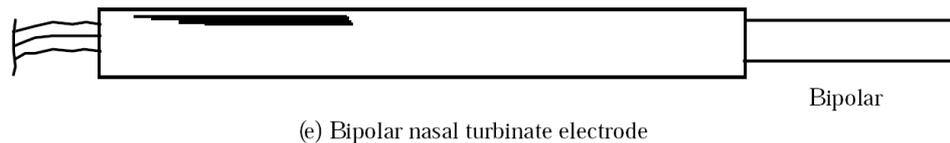
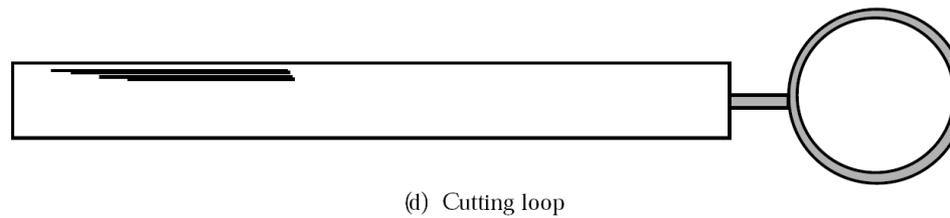
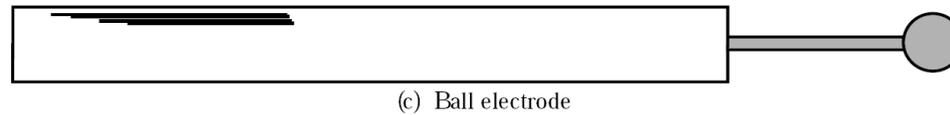
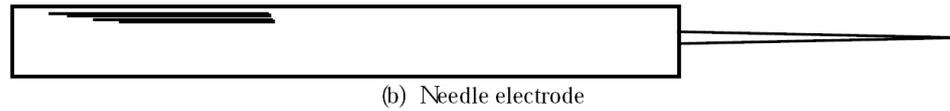
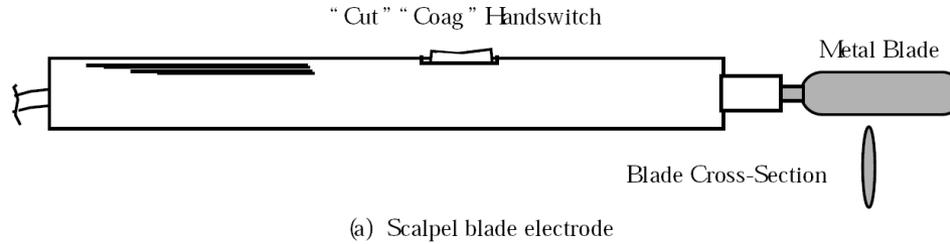
ESU Design



[Patient Return Monitor]

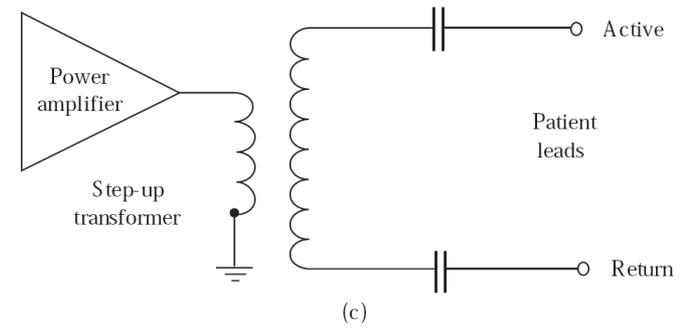
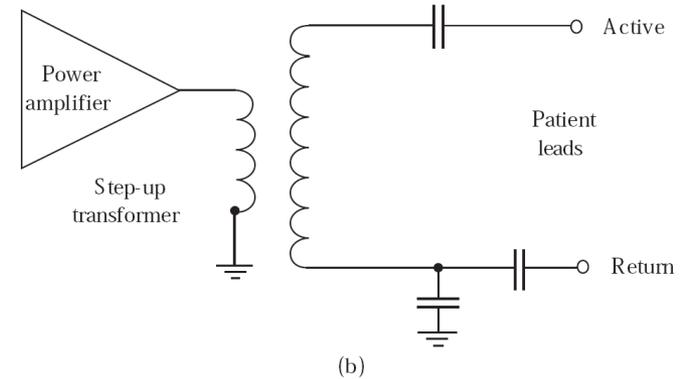
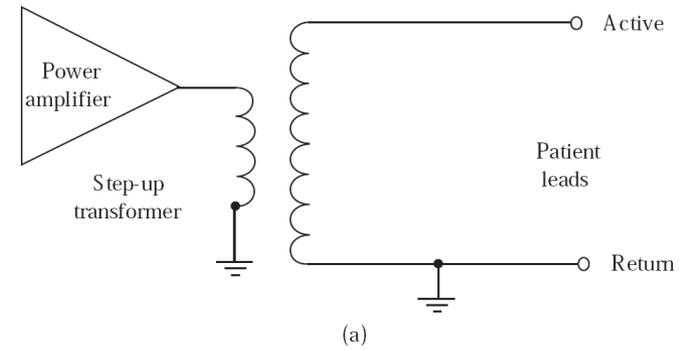


ESU Electrodes

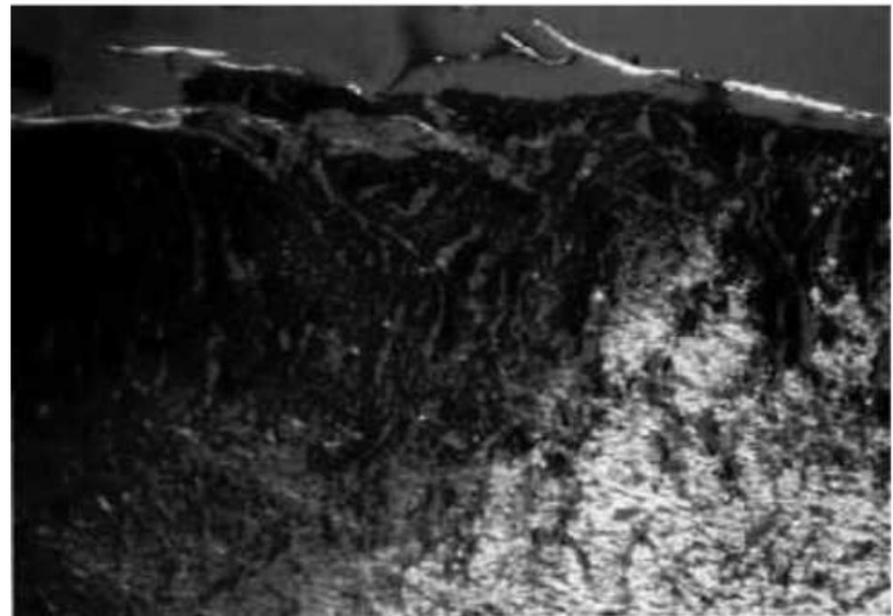
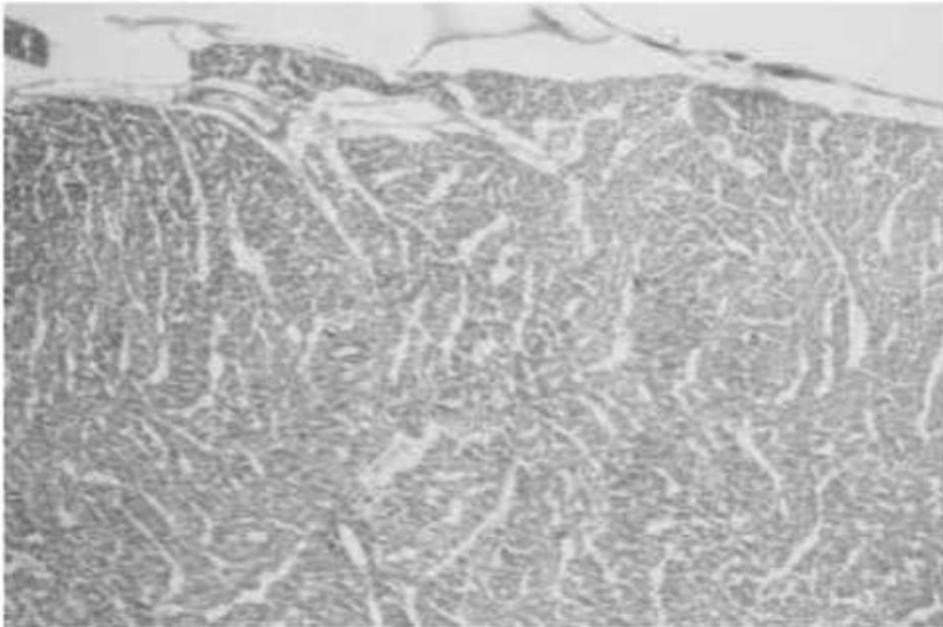
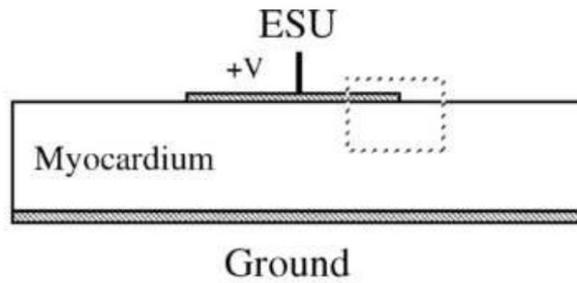


[Lead Isolation]

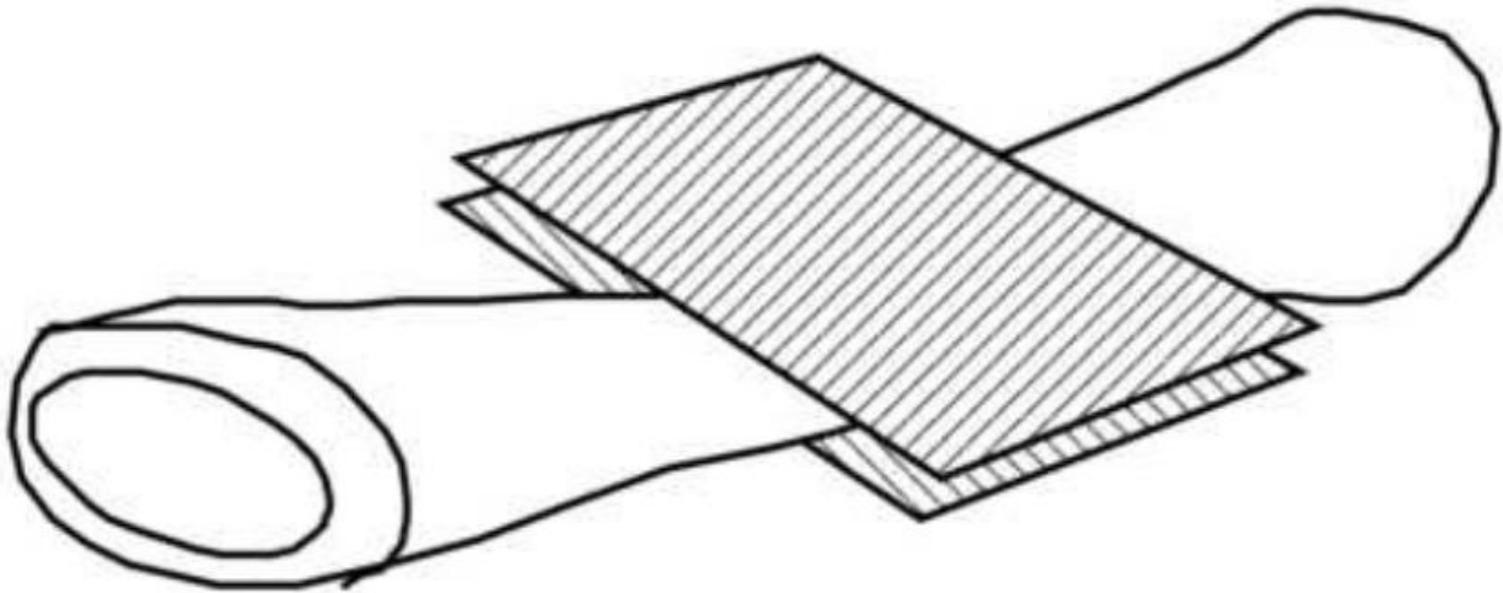
- Grounded
- Referred to ground
- Isolated
- No isolation system is ideal



[Example Application]



[Bipolar Vessel Sealing]



[ESU Hazards]

- Electric shock
- Undesired burns
- Undesired neuromuscular stimulation
- Interference with pacemakers or other devices, implant heating

[Presentation Download]

- Posted on class web site
- References also posted there
- You are required to study only what was given in the lecture

Web: <http://ymk.k-space.org/courses.htm>