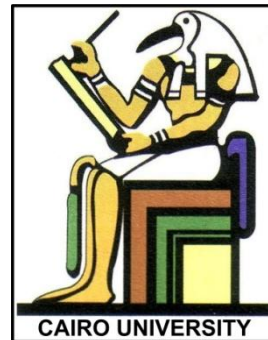


# Medical Equipment I - 2009

## 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 ]

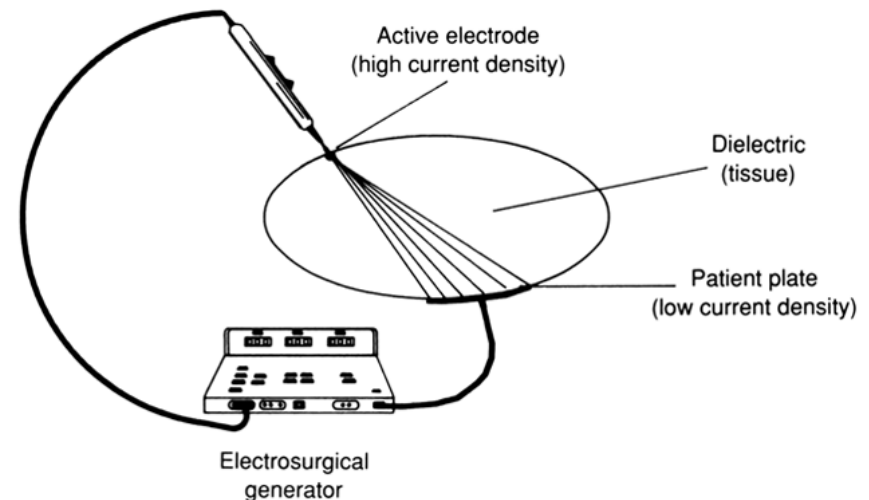
- Dispersive electrode
  - Return electrode at which no electrosurgical effect is intended.
- Fulguration /Spray
  - Random discharge of sparks between active electrode and tissue surface in order to achieve coagulation and/or desiccation.

# 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**

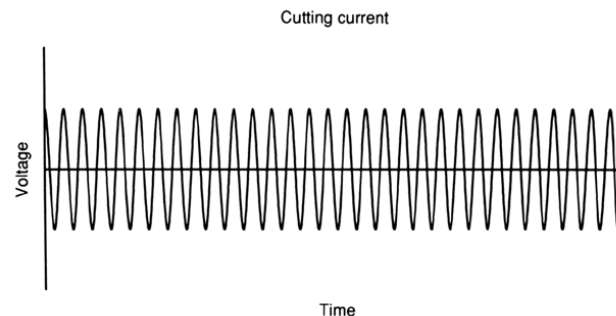
$$T - T_0 = \frac{1}{\sigma \rho c} J^2 t$$

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



# [ Cutting Mode ]

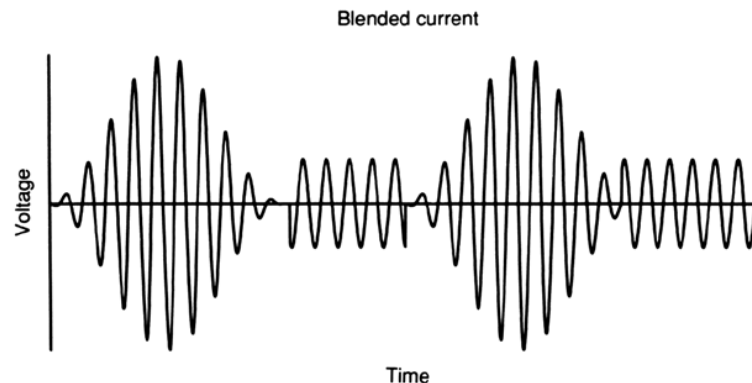
- A continuous sinusoidal waveform cuts tissue with very little hemostasis.
  - This waveform is simply called *cut* or *pure cut*.
- Electric current concentrates at one spot
  - Sudden increase in temperature at this location
  - Rapid rise in temperature then vaporizes intracellular fluids, increases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





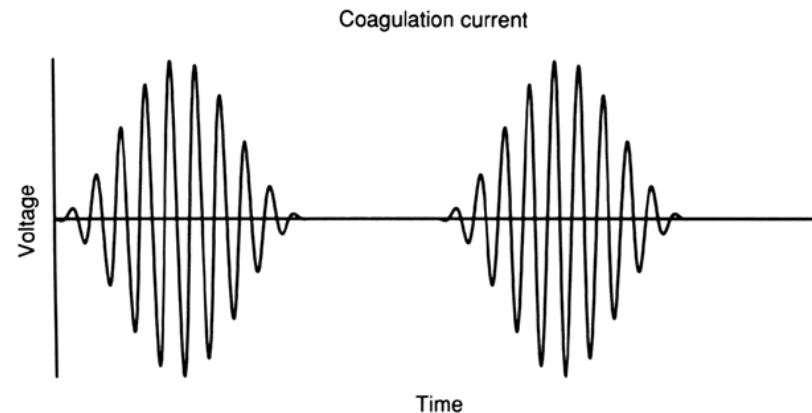
# Blended Cutting Mode

- 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*

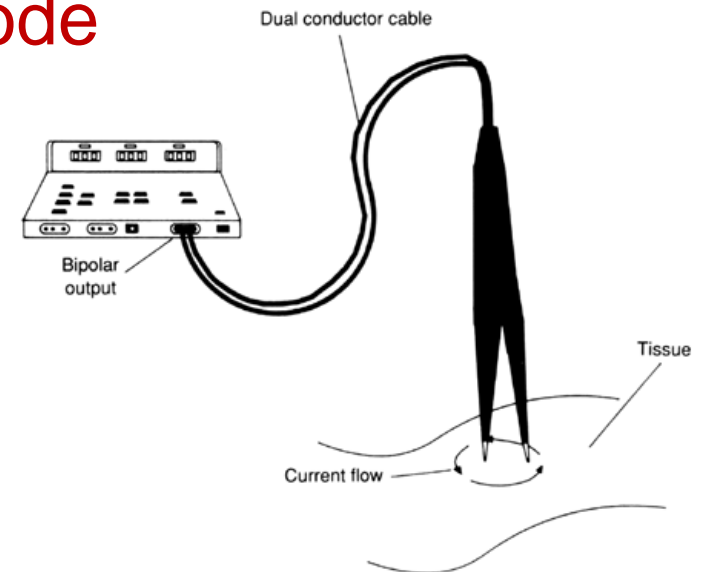
# [ ESU Output Characteristics ]

**TABLE 81.3** Typical Output Characteristics of ESUs

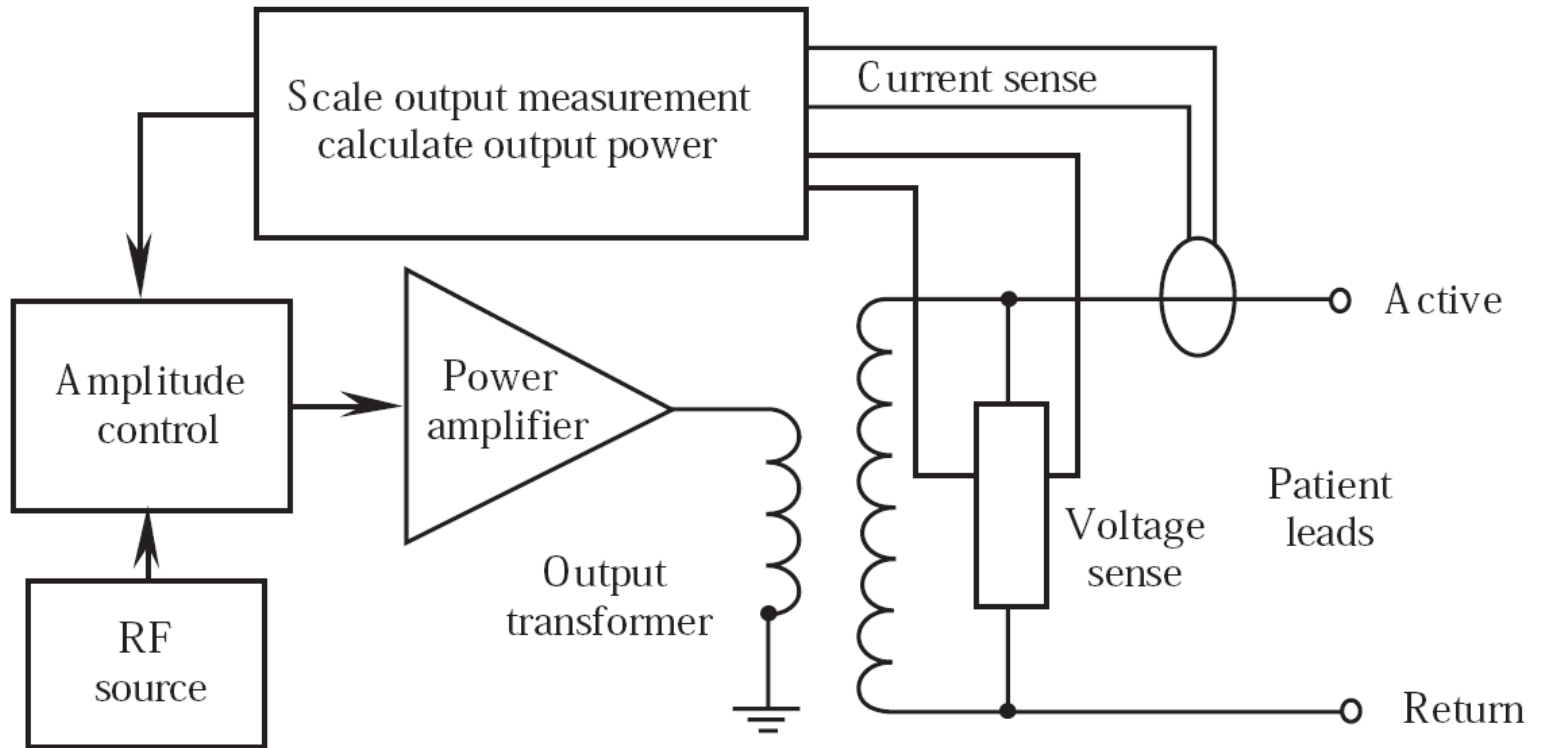
	Output Voltage Range Open Circuit, $V_{\text{peak-peak}}$ , V	Output Power Range, W	Frequency, kHz	Crest Factor $\left(\frac{V_{\text{peak}}}{V_{\text{rms}}}\right)$	Duty Cycle
Monopolar modes					
Cut	200–5000	1–400	300–1750	1.4–2.1	100%
Blend	1500–5800	1–300	300–1750	2.1–6.0	25–80%
Desiccate	400–6500	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 ]

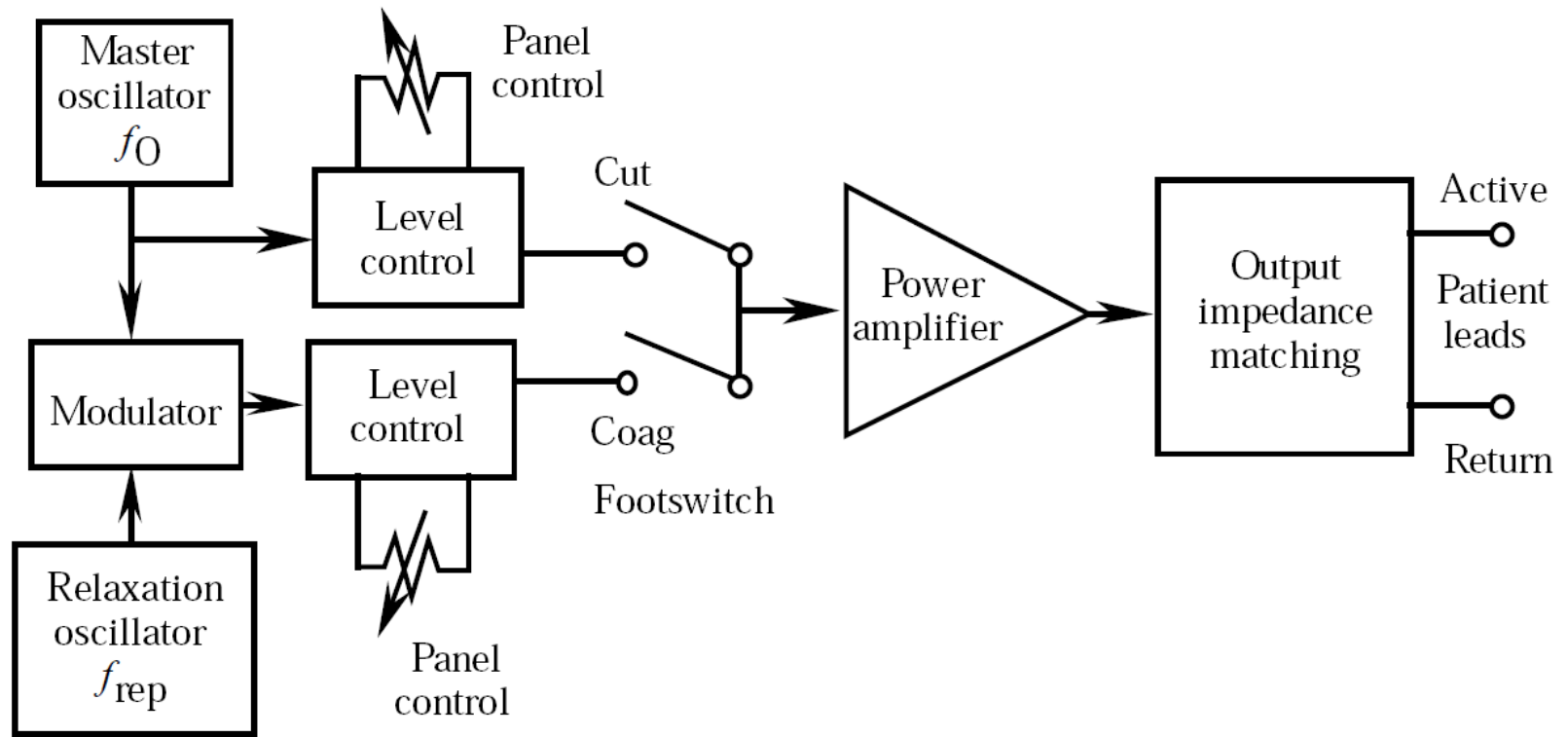
- Bipolar mode concentrates current flow between the two electrodes
  - Requiring considerably less power for achieving the same coagulation effect than the monopolar mode



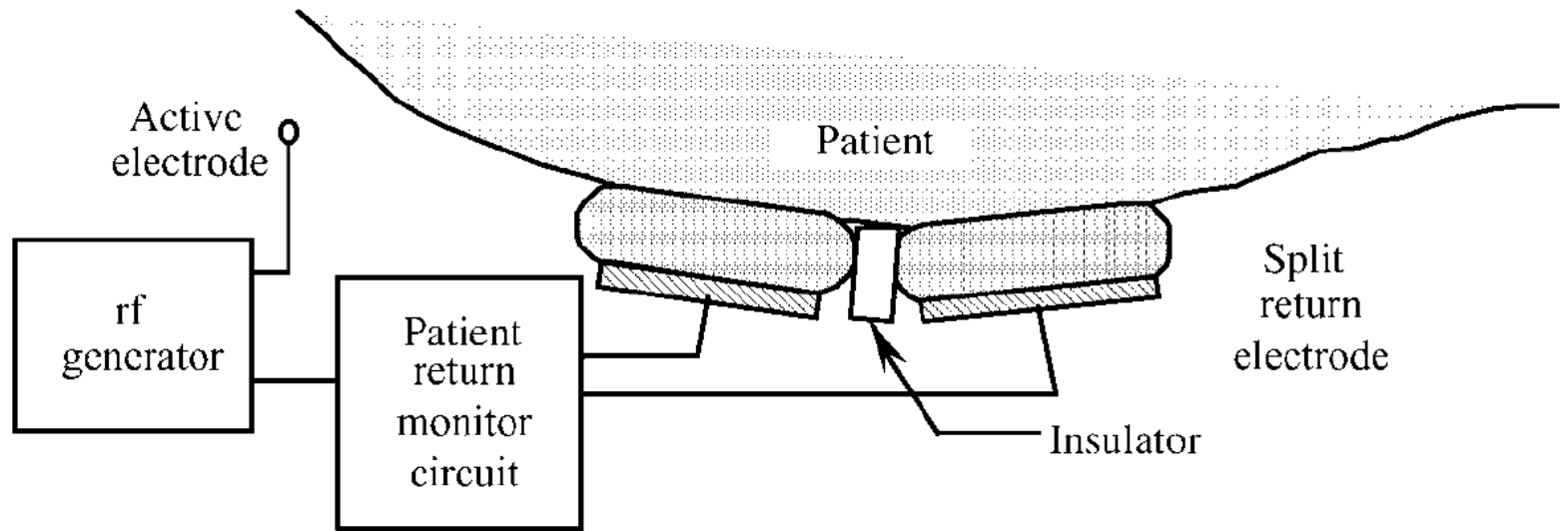
# [ ESU Design ]



# ESU Design

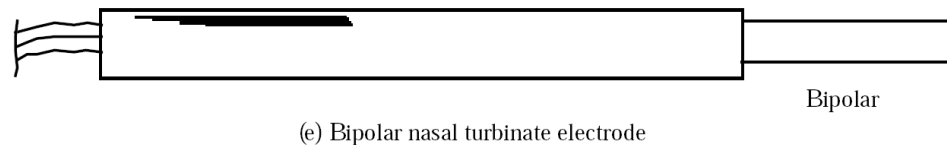
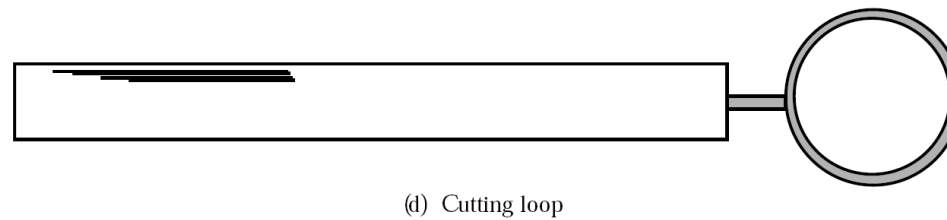
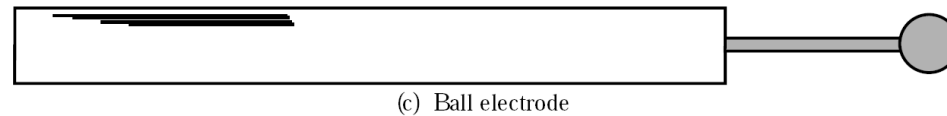
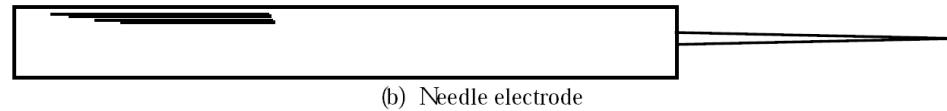
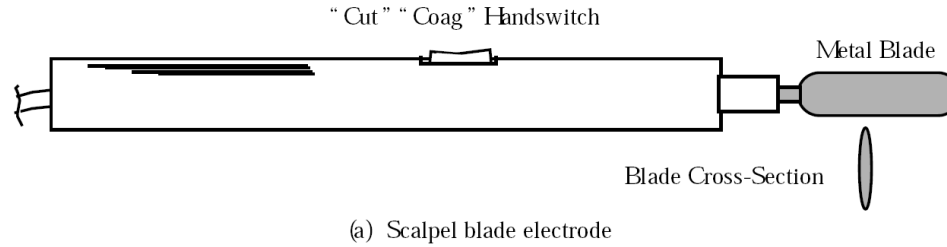


# [ Patient Return Monitor ]



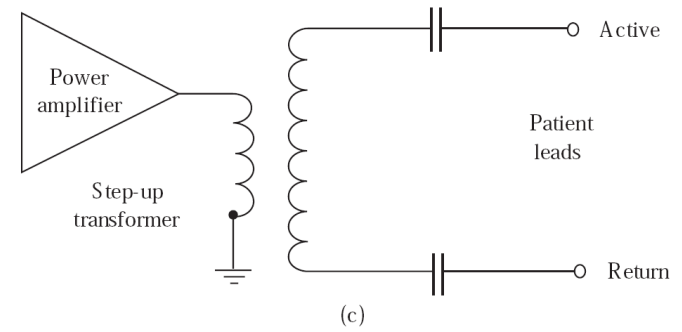
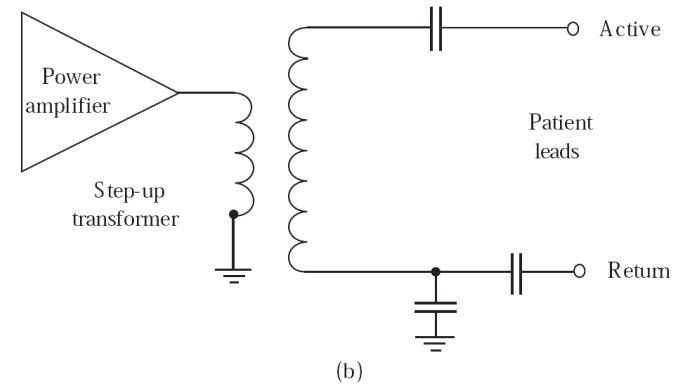
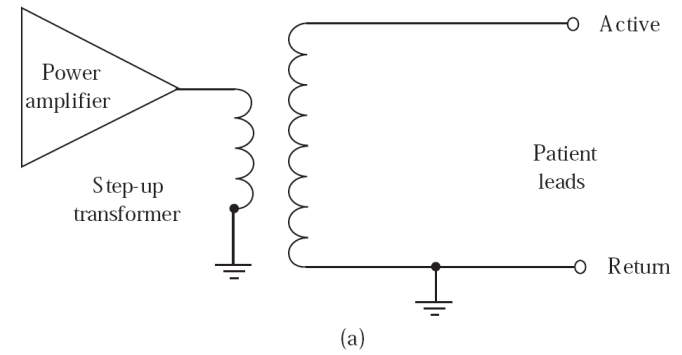


# [ ESU Electrodes ]

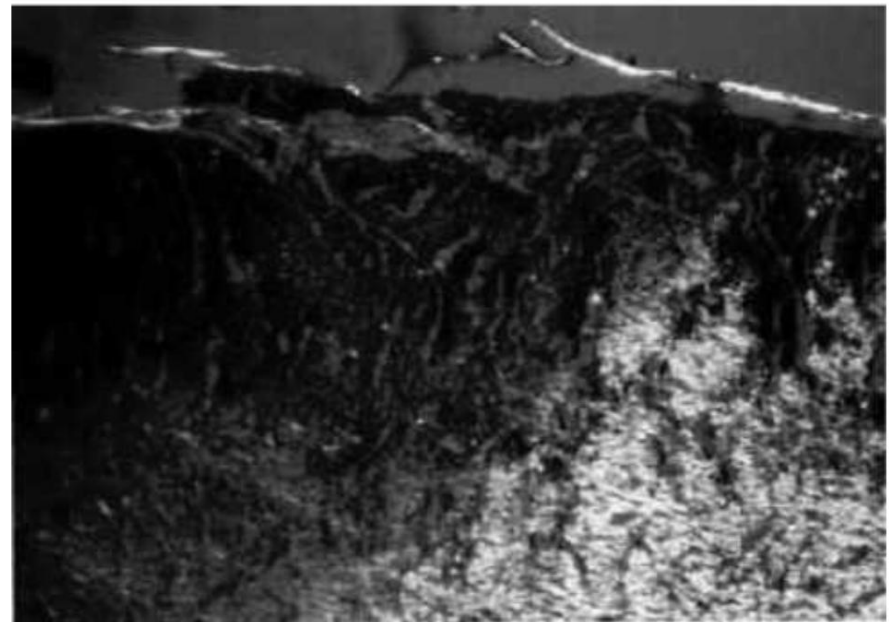
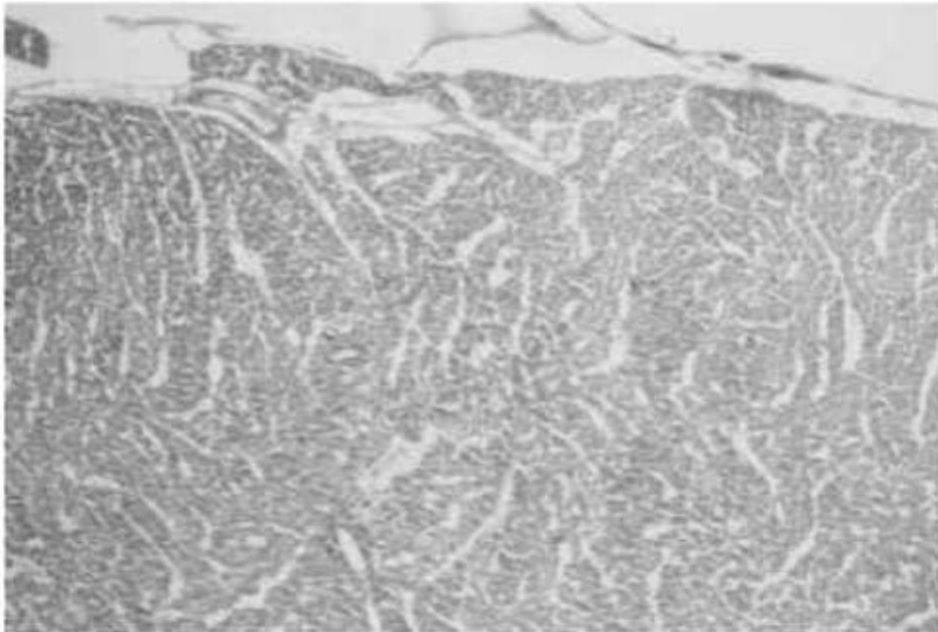
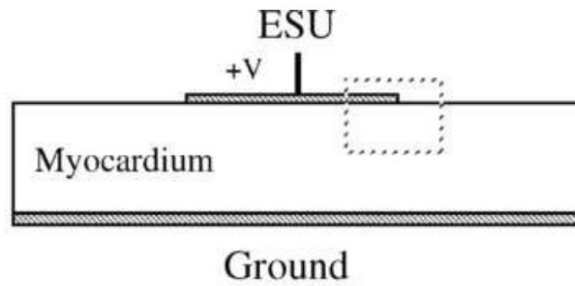


# [ Lead Isolation ]

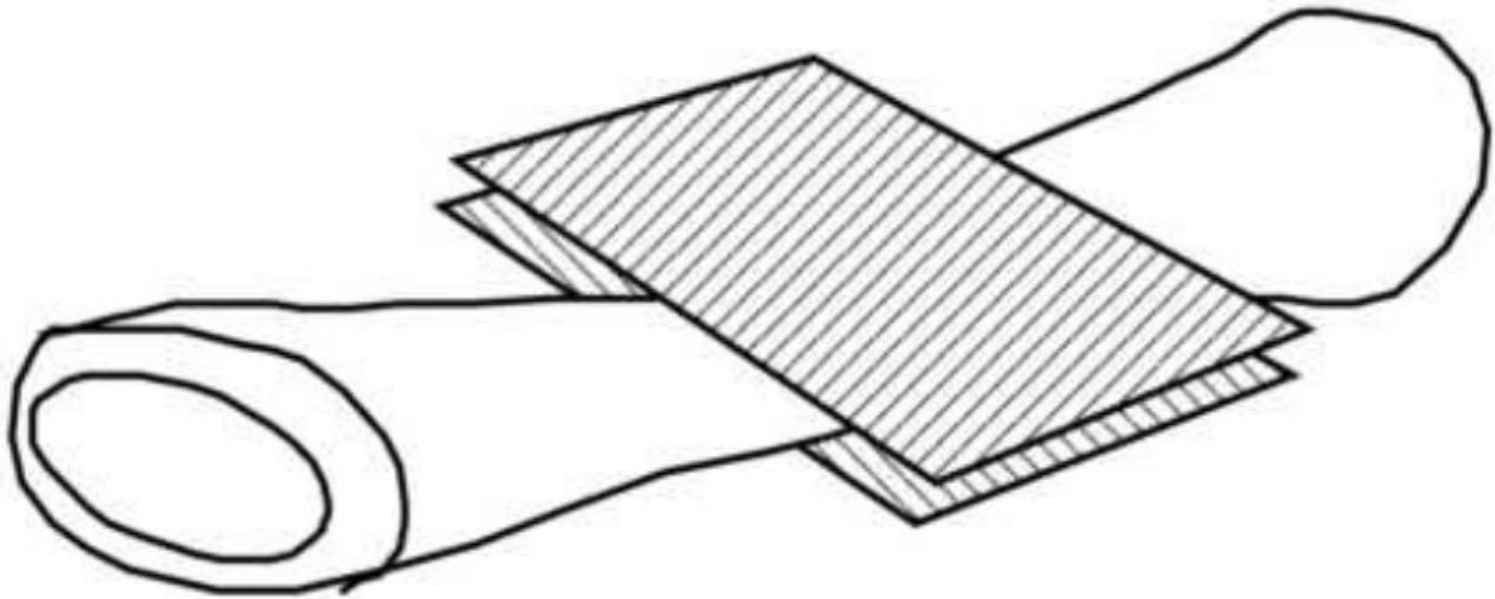
- Grounded
- Referred to ground
- Isolated
- No isolation system is ideal



# [ Example Application ]



# [ Bipolar Vessel Sealing ]



# [ ESU Hazards ]

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- 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>