Medical Equipment I - 2009
Part II: Misc. Devices and Medical Equipment Safety

Professor Yasser M. Kadah

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DC Shock Defibrillator

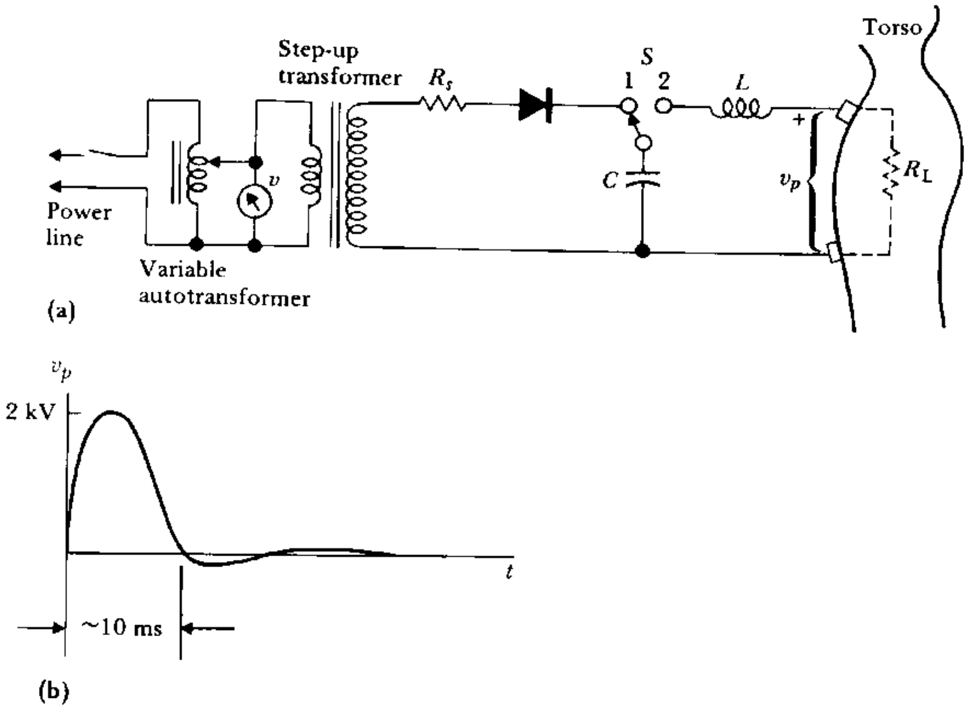


Figure 13.9 (a) Basic circuit diagram for a capacitive-discharge type of cardiac defibrillator. (b) A typical waveform of the discharge pulse. The actual waveshape is strongly dependent on the values of L, C, and the torso resistance R_L.

Cardioverter

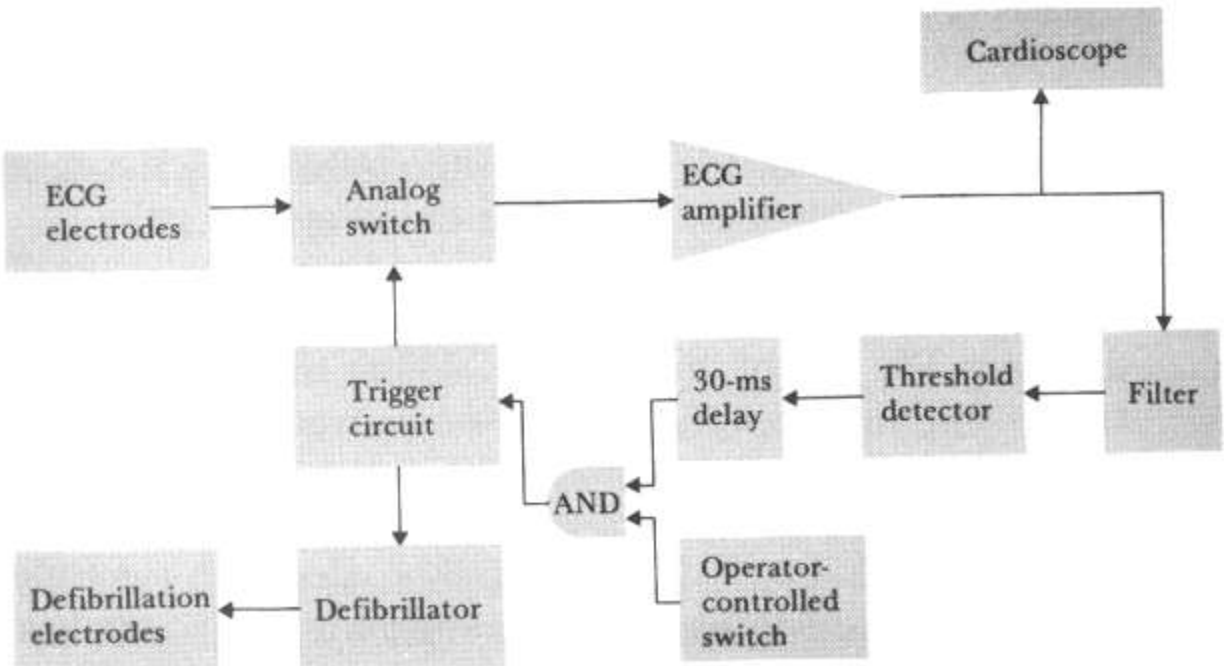


Figure 13.11 A cardioverter The defibrillation pulse in this case must be synchronized with the R wave of the ECG so that it is applied to a patient shortly after the occurrence of the R wave.

Pump Oxygenator

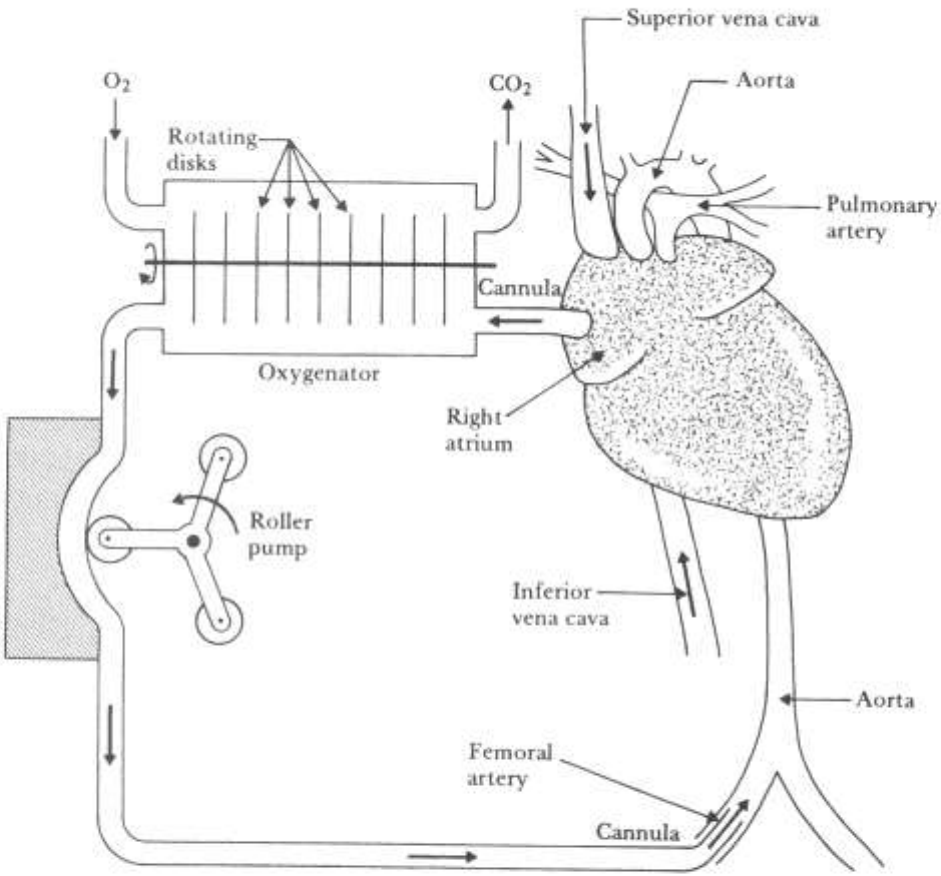


Figure 13.12 **Connection of a pump oxygenator to bypass the heart** A disk-type oxygenator is used with a roller pump. Venous blood is taken from a cannula in the right atrium, and oxygenated blood is returned through a cannula in the femoral artery.

Lithotripsy

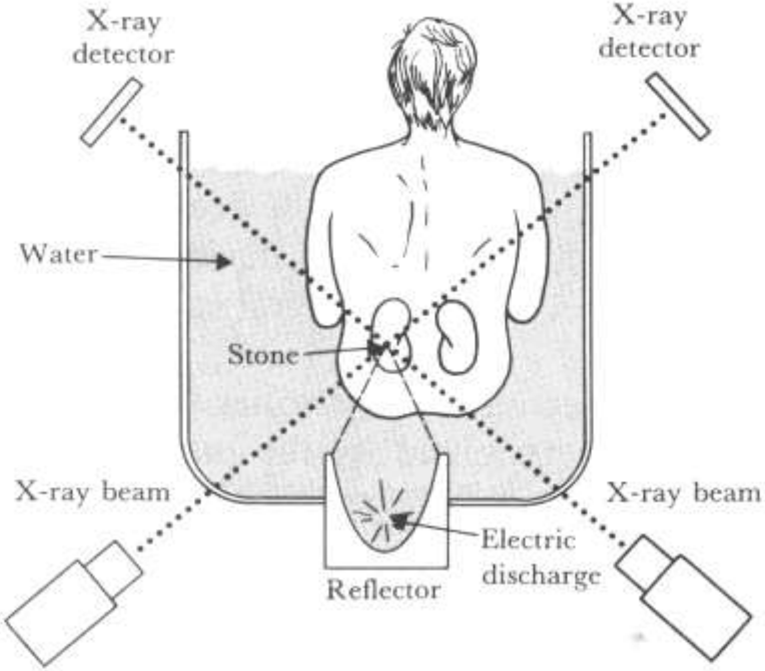


Figure 13.14 In extracorporeal shock-wave lithotripsy, a biplane x-ray apparatus is used to make sure the stone is at the focal point of spark-generated shock waves from the ellipsoidal reflector.

Ventilator

- Controller
- Assister
- Positive pressure
- Negative pressure
- Time cycled
- Volume cycled
- Pressure cycled

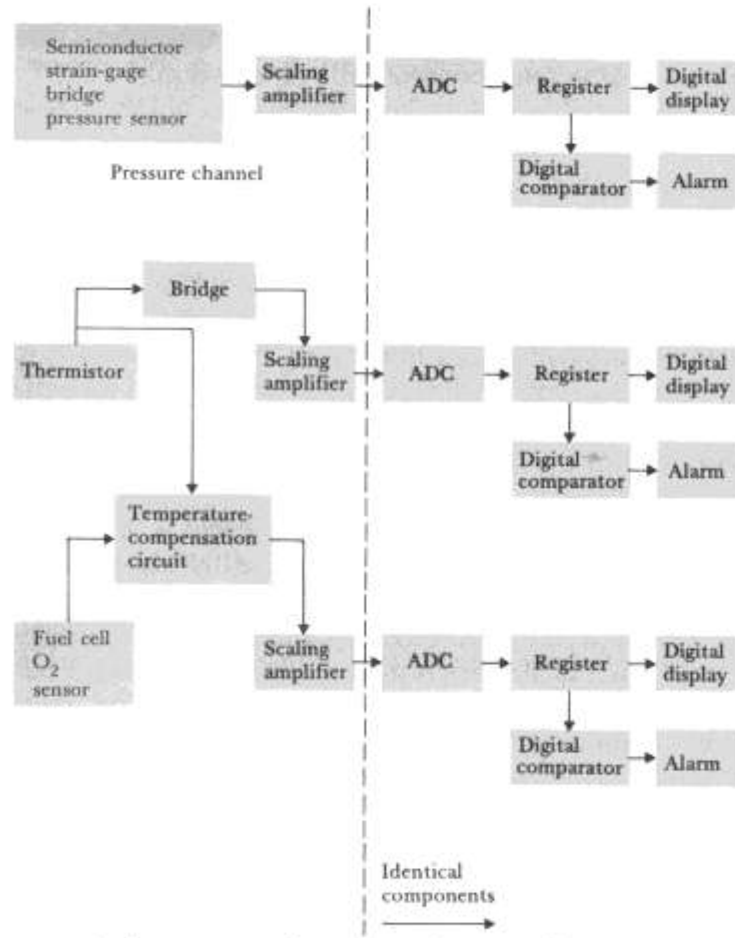


Figure 13.15 An instrumentation system for recording pressure, temperature, and percentage of O_2 in inspired air coming from a continuous-positive-airway-pressure apparatus.

Infant Incubator

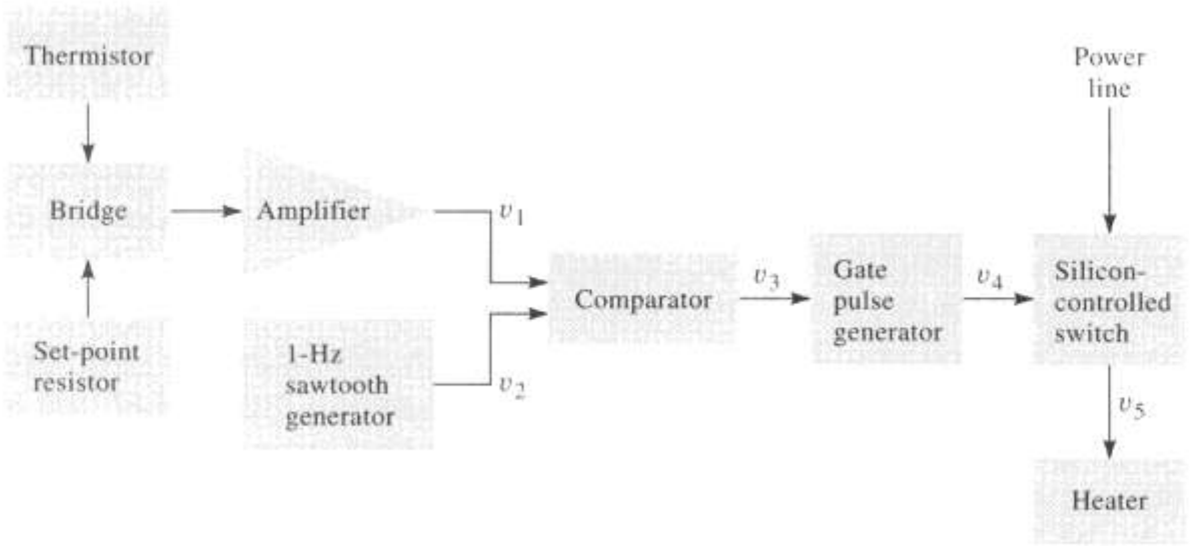


Figure 13.16 Block diagram of a proportional temperature controller used to maintain the temperature of air inside an infant incubator.

Drug Delivery Devices: Infusion Pumps

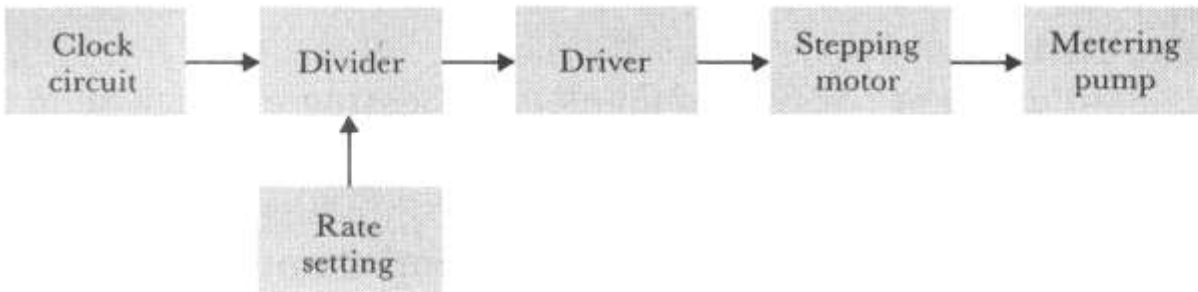


Figure 13.17 Block diagram of the electronic control system for a fluid or drug delivery pump

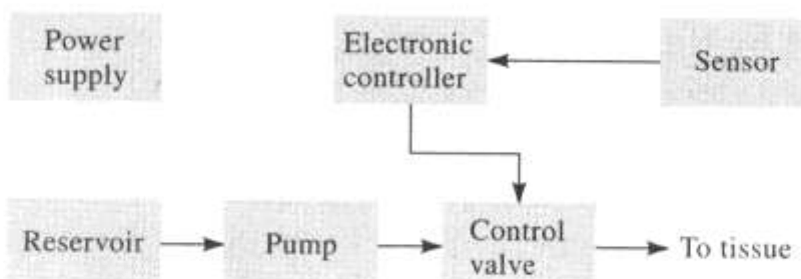


Figure 13.18 A block diagram of an implantable artificial pancreas showing the major components of the system.

Physiological Effects of Electricity

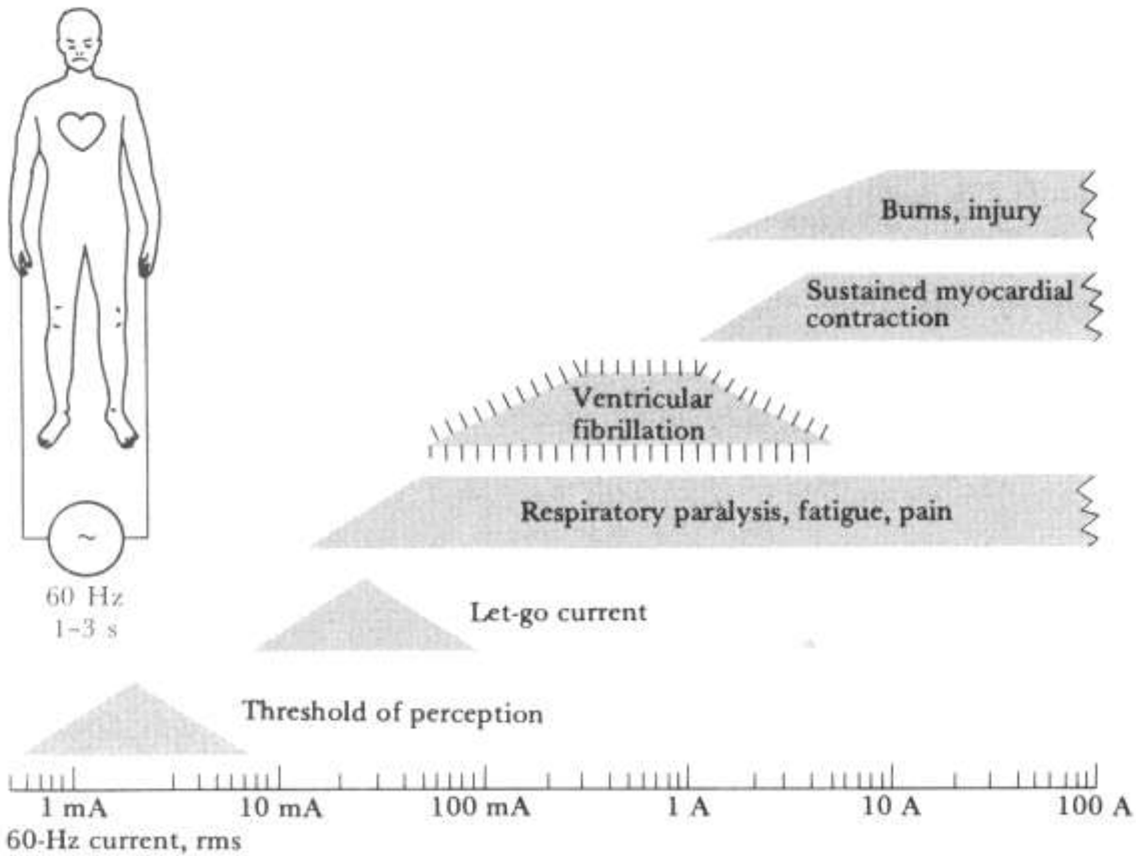


Figure 14.1 Physiological effects of electricity Threshold or estimated mean values are given for each effect in a 70-kg human for a 1- to 3-s exposure to 60-Hz current applied via copper wires grasped by the hands.

Variability of Threshold and Let-Go Current

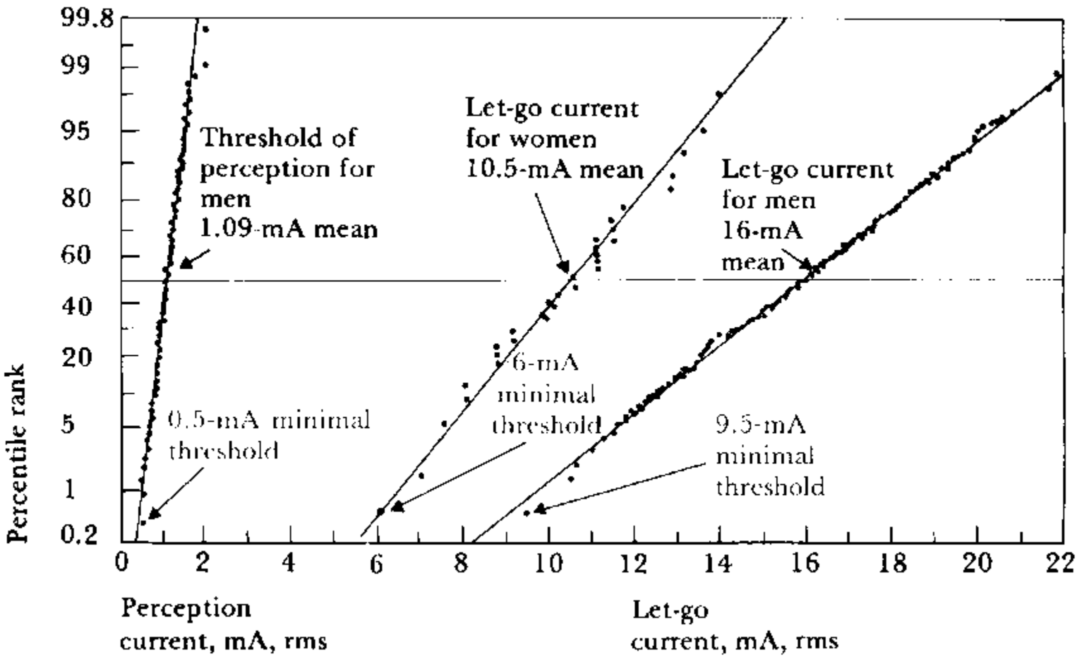


Figure 14.2 Distributions of perception thresholds and let-go currents These data depend on surface area of contact (moistened hand grasping AWG No. 8 copper wire). (Replotted from C. F. Dalziel, "Electric Shock," *Advances in Biomedical Engineering,* edited by J. H. U. Brown and J. F. Dickson III, 1973, 3, 223–248.)

Frequency Effect

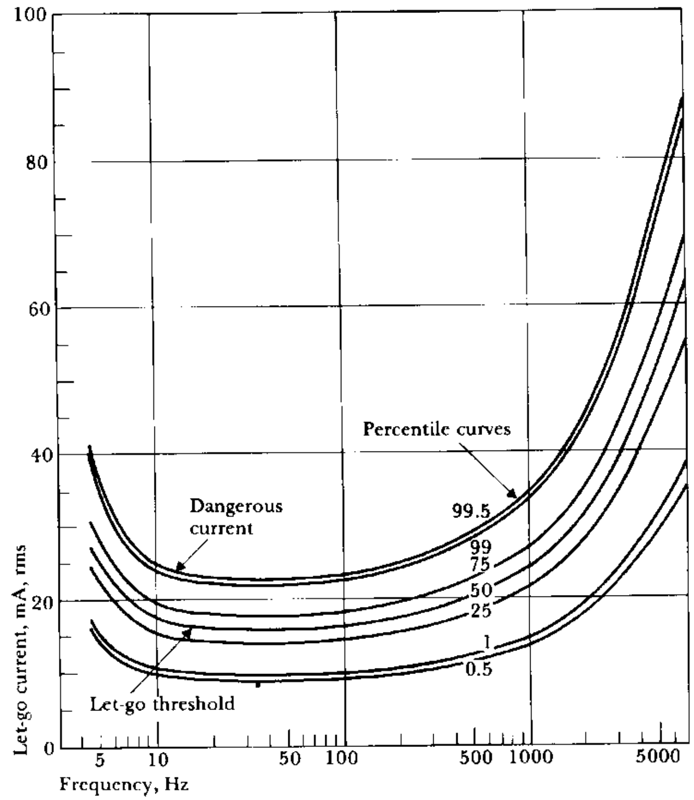


Figure 14.3 Let-go current versus frequency Percentile values indicate variability of let-go current among individuals. Let-go currents for women are about two-thirds the values for men. (Reproduced, with permission, from C. F. Dalziel, "Electric Shock," *Advances in Biomedical Engineering,* edited by J. H. U. Brown and J. F. Dickson III, 1973, 3, 223–248.)

Shock Duration Effect

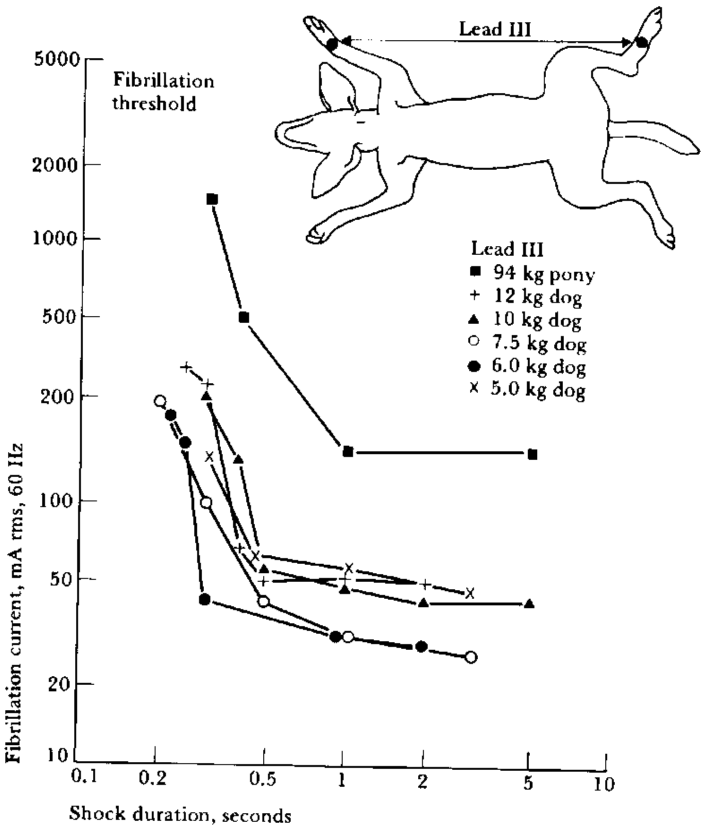


Figure 14.4 Fibrillation current versus shock duration. Thresholds for ventricular fibrillation in animals for 60-Hz ac current. Duration of current (0.2 to 5 s) and weight of animal body were varied. (From L. A. Geddes, *IEEE Trans. Biomed. Eng.*, 1973, 20, 465–468. Copyright 1973 by the Institute of Electrical and Electronics Engineers. Reproduced with permission.)

Point of Contact Effect

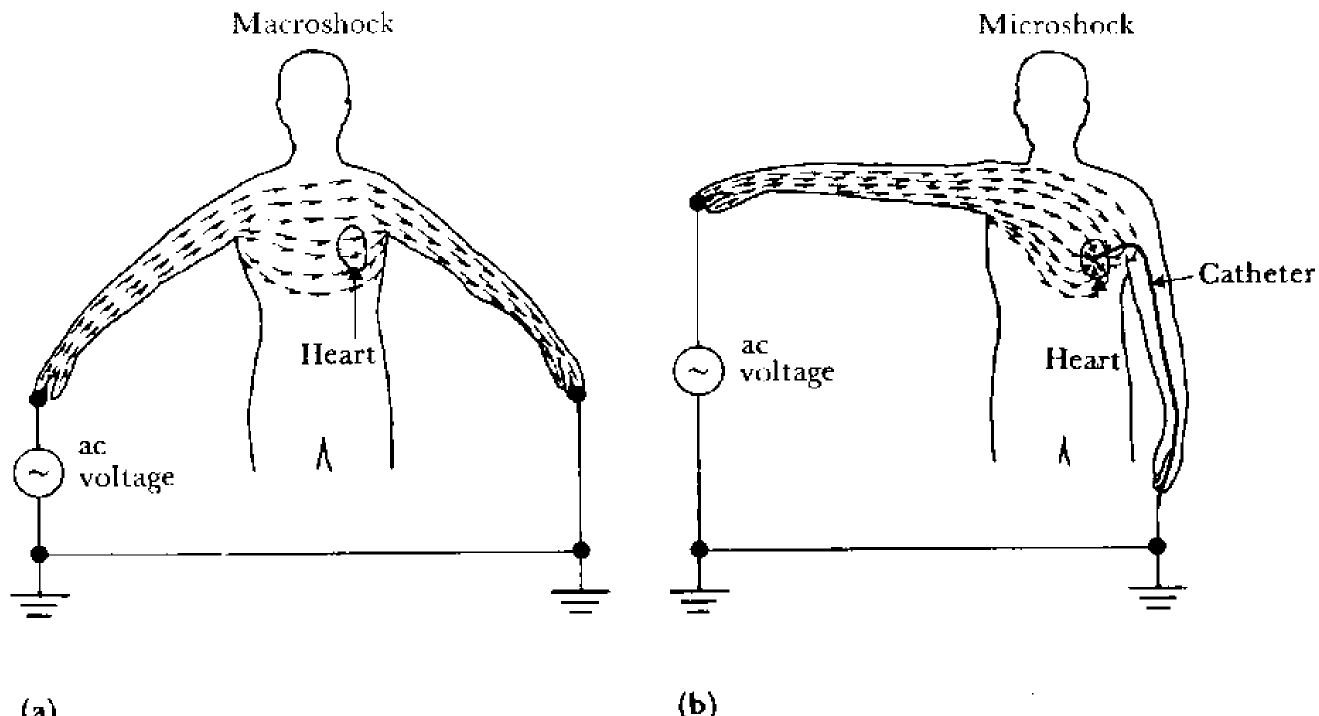
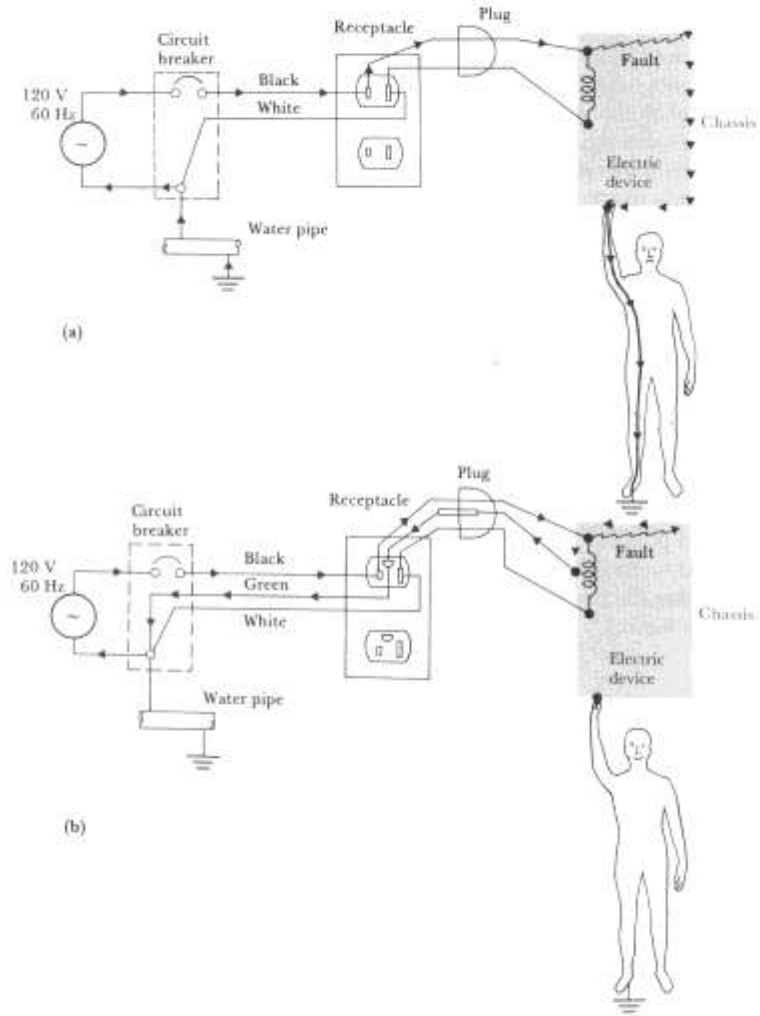


Figure 14.5 Effect of entry points on current distribution (a) *Macroshock,* externally applied current spreads throughout the body. (b) *Microshock,* all the current applied through an intracardiac catheter flows through the heart. (From F. J. Weibell, "Electrical Safety in the Hospital," *Annals of Biomedical Engineering,* 1974, 2, 126–148.)

Macrshock Hazard



gure 14.8 Macroshock due to a ground fault from hot line to equipment ses for (a) ungrounded cases and (b) grounded chassis.

Microshock

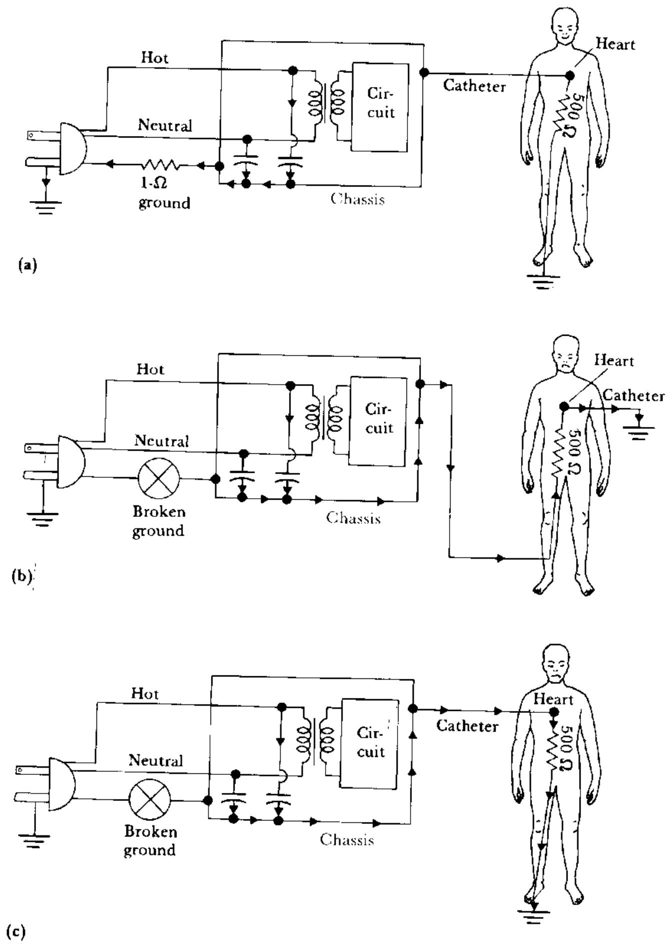


Figure 14.9 **Leakage-current pathways** Assume 100 μA of leakage current from the power line to the instrument chassis. (a) Intact ground, and 99.8 μA flows through the ground. (b) Broken ground, and 100 μA flows through the heart. (c) Broken ground, and 100 μA flows through the heart in the opposite direction.

Ideal Grounding System

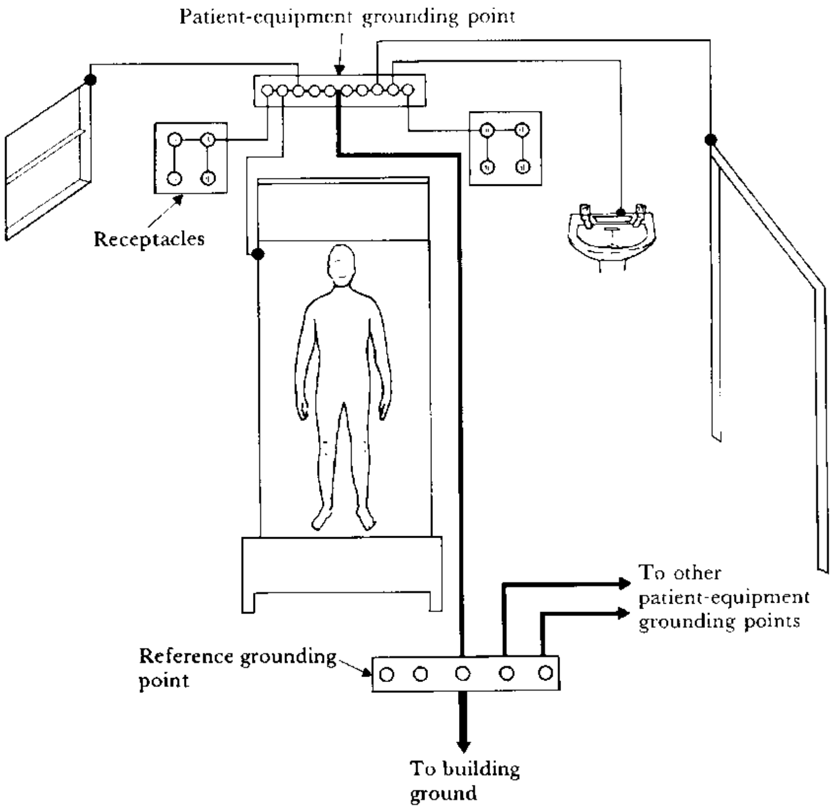
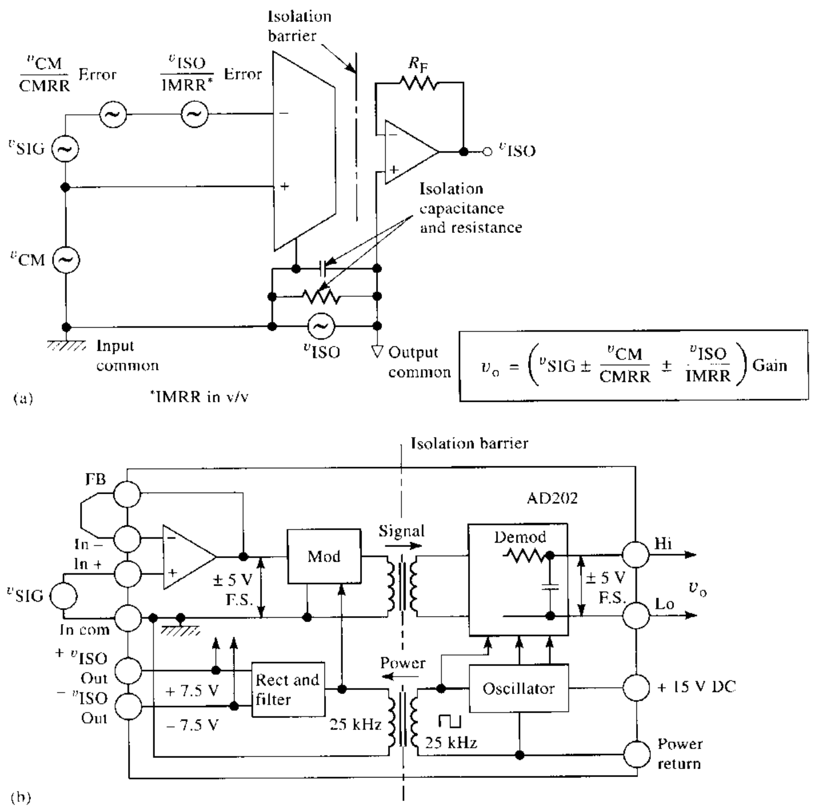


Figure 14.12 **Grounding system** All the receptacle grounds and conductive surfaces in the vicinity of the patient are connected to the patient-equipment grounding point. Each patient-equipment grounding point is connected to the reference grounding point that makes a single connection to the building ground.

Electrical Safety in Design

- Reliable grounding
- Reduction of leakage current
- Double insulated equipment
- Low voltage operation
- Electrical Isolation
    - Break ohmic continuity of electric signals between input and output

Example Isolation Circuits



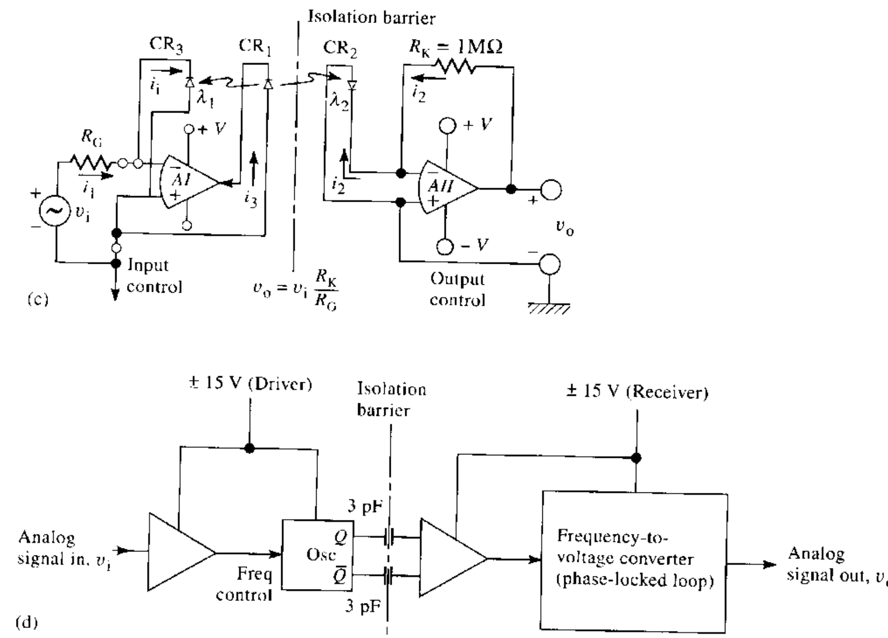


Figure 14.14 *(Continued)*

Figure 14.14 Electrical isolation of patient leads to biopotential amplifiers (a) General model for an isolation amplifier. (b) Transformer isolation amplifier (Courtesy of Analog Devices, Inc., AD202). (c) Simplified equivalent circuit for an optical isolator (Copyright © 1989 Burr-Brown Corporation. Reprinted in whole or in part, with the permission of Burr-Brown Corporation. Burr Brown ISO100). (d) Capacitively coupled isolation amplifier (Horowitz and Hill, Art of Electronics, Cambridge Univ. Press, Burr Brown ISO106).

Presentation Download

- Posted on class web site
- Reference: Webster Medical Instrum. textbook chapters 13 and 14.
- You are required to study only what was given in the lecture

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