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Department of Biomedical Engineering

Vision Tit 2 Vision Title 3

Course Name: 19BMT204 Biomedical Instrumentation

II Year : IV Semester

Unit V – Patient Safety

Topic : Basic Approaches to Shock Protection and Isolation Power system

Safety Codes & Standards

- Limits on leakage current are instituted and regulated by the safety codes instituted in part by the National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Association for the Advancement of Medical Instrumentation (AAMI), and Emergency Care

Electric Appliance	Chassis Leakage, μA	Patient-lead Leakage, μA
Appliances not intended to contact patients	100	NA
Appliances not intended to contact patients and single fault	500	NA
Appliances with *nonisolated* patient leads	100	10
Appliances with *nonisolated* leads and single fault	300	100
Appliances with *isolated* patient leads	100	10
Appliances with *isolated* leads and single fault	300	50

Basic Approaches to Shock Protection

- There are two major ways to protect patients from shocks:
  - Completely isolate and insulate patient from all sources of electric current
  - Keep all conductive surfaces within reach of the patient at the same voltage

- Neither can be fully achieved ➔ some combination of these two
  - Grounding system
  - Isolated power-distribution system
  - Ground-fault circuit interrupters (GFCI)

Grounding Systems

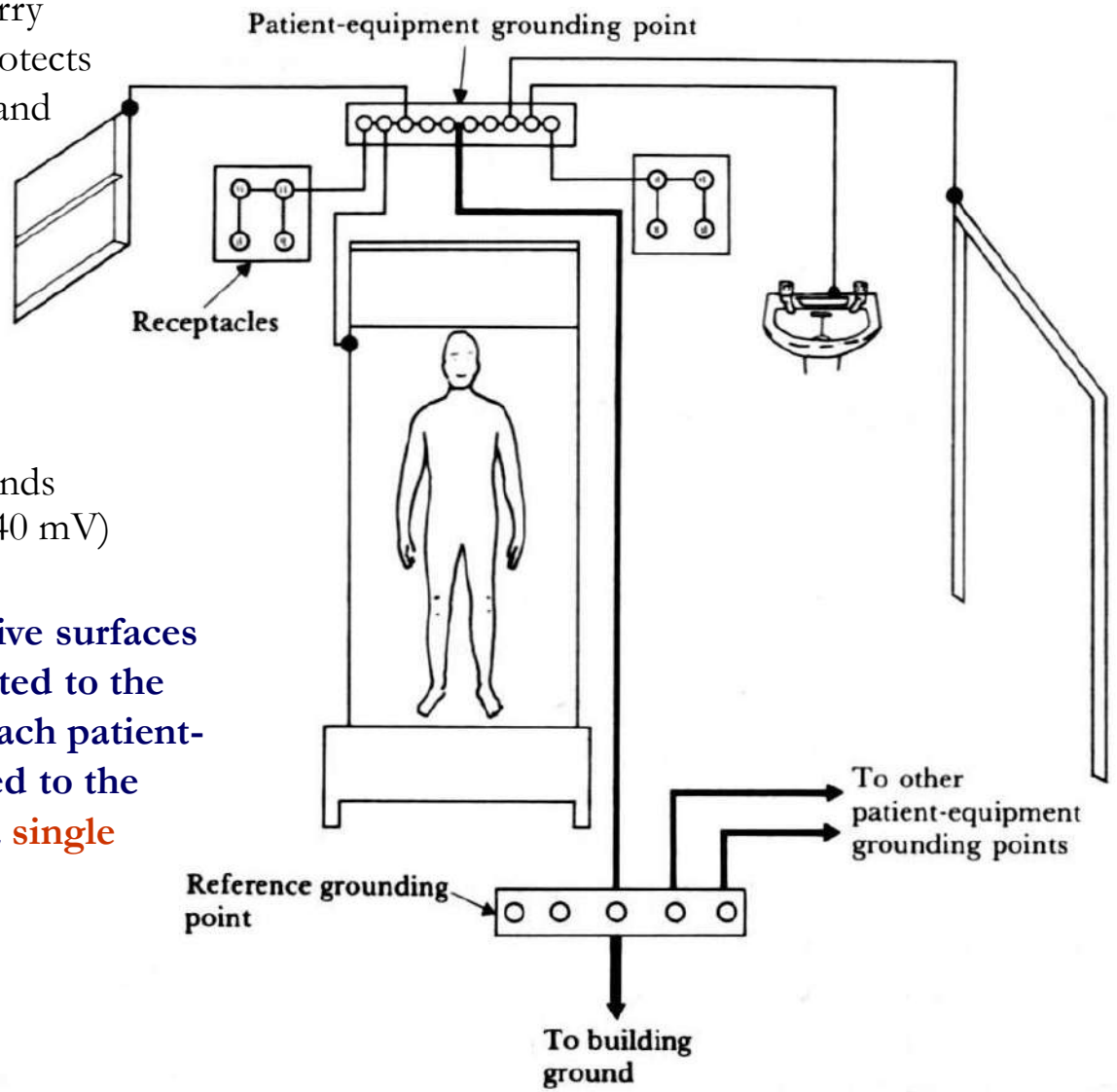
Low resistance (0.15 Ω) ground that can carry currents up to the circuit-breaker ratings protects patients by keeping all conductive surfaces and receptacle grounds at the same potential.

Protects patients from

- Macroshocks
- Microshocks
- Ground faults elsewhere (!)

The difference between the receptacle grounds and other surface should be no more then 40 mV)

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.

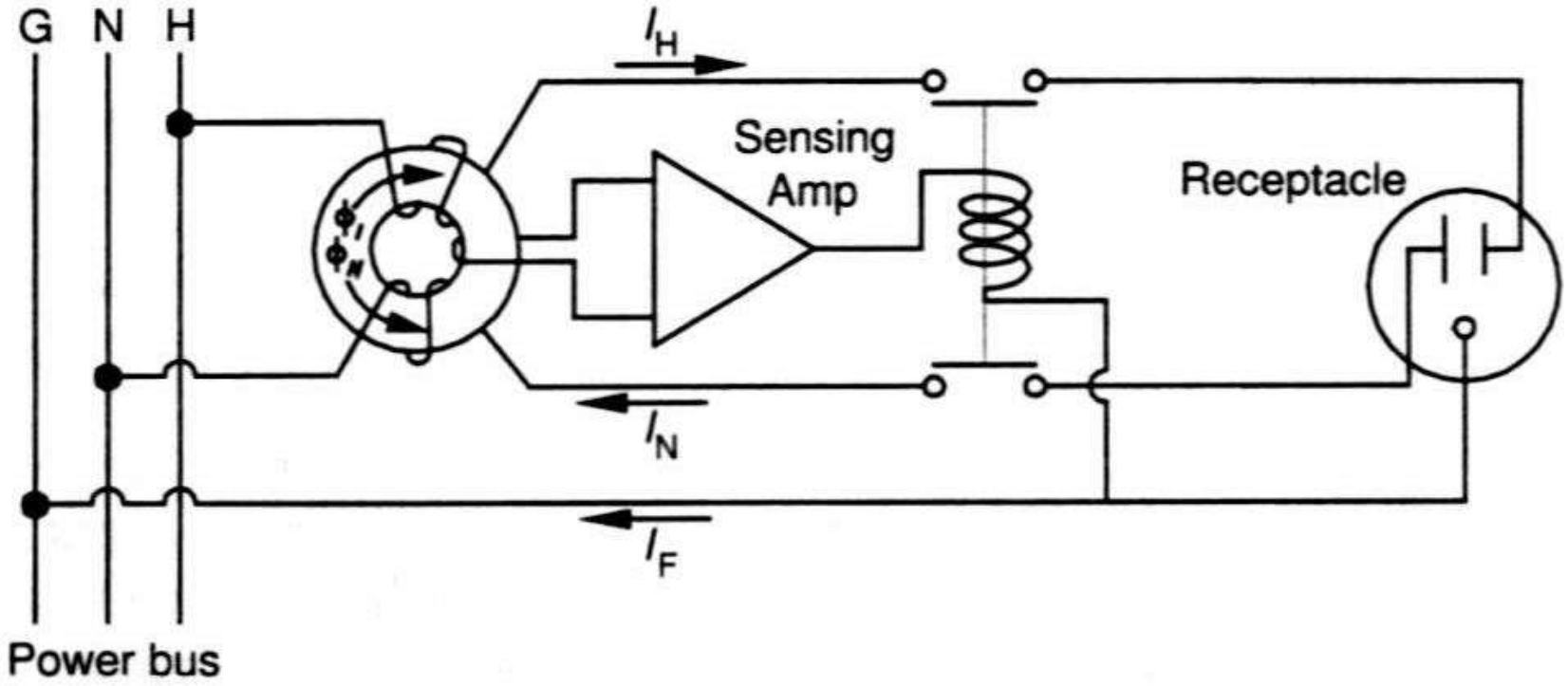


Isolated Power Systems

- A good equipotential grounding system cannot eliminate large current that may result from major ground-faults (which are rather rare).
- Isolated power systems can protect against such major (single) ground faults
  - Provide considerable protection against macroshocks, particularly around wet conditions
  - However, they are expensive !
  - Used only at locations where flammable anesthetics are used. Additional minor protection against microshocks does not justify the high cost of these systems to be used everywhere in the clinical environment

Ground – Fault Circuit Interrupters (GFCI)

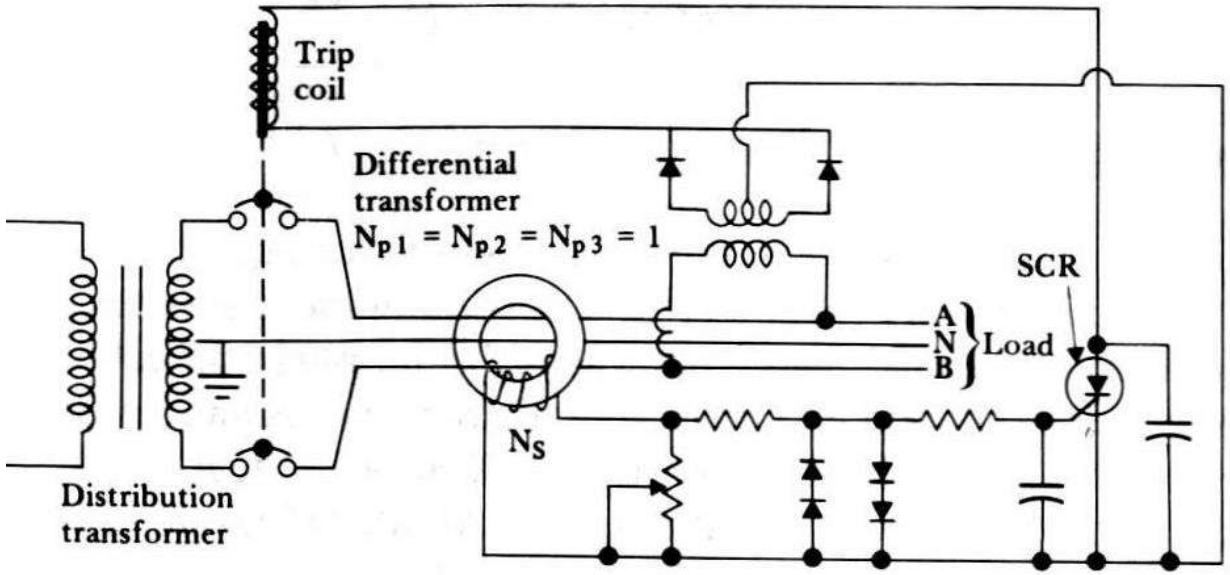
- Disconnects source of electric current when a ground fault greater than about 6 mA occurs!



When there is no fault, $I_{hot}=I_{neutral}$. The GFCI detects the difference between these two currents. If the difference is above a threshold, that means the rest of the current must be flowing through elsewhere, either the chassis or the patient !!!.

The device can be done through the monitoring the voltage induced by the two coils (hot and neutral) by the differential transformer!

GFCI



The National Electric Code (NEC - 1996) requires that all circuits serving bathrooms, garages, outdoor receptacles, swimming pools and construction sites be fitted with GFCI.

Note that GFCI protect against major ground faults only, not against microshocks.

Patient care areas are typically not fitted with GFCI, since the loss of power to life support equipment can also be equally deadly!