CH.11.

Applications of Electricity and Magnetism In Medicine

Electrical Shock: When an electrode is connected to each hand &60 Hz currets of different levels are passed through the body , various reactions are produced

1.About 50% of adult men feel a 60 Hz current about 1.0 m A.

2.Women feel lower levels, about 0.67 m A.

The perception levels rise as the frequency increases above 100 Hz.

1.As a 60 Hz current is increased above the perception level , it causes a tingling sensation in the hands or body.

2.At currents of 10 to 20 m A ,a sustoined muscular contraction takes place in the hands &many subjects do not have the a bility to control their mascle a ctions.

3.As the current is increased still further, pain &in some cases fainting occur

4.Near the 100 m A level, the portion of the 60 Hz current passing through the heart is sufficient to cause ventricular fibrillation **(rapid irregular& ineffectual , contraction of the ventricles).**

The heart is especially vulnerable to fibrillation during one portion of its cycle . this portion is beginning repolarization of the ventricle**(the upswing of the T – Wave)** T = time

Note:

The current level that will induce fibrillation decreases at the duration of the shock increases.

The damage depends upon :

1.the individual the dampness of the skin.

2.The contact of the skin with the conductor.

Marco shock : when the electrical contact is made on the surface of the body and the level of current that cause damage and fibrillation is in mA.

Micro shock : it is the shock which occurs when the current is applied inside the body . it does not move to pass through the high resistance of the skin .

*ventricular fibrillation can be induced with very much smaller than the current level of macro shock.

It has been estimated 30 μA through human heart would cause ventricular fibrillation .

Electrical hazard

*to protect patients from microshock , modern power cores have three wires ; two that supply the **AC** power and one that serves as a ground.

***leakage current :** in all electronical equipment , there is some current flow from the **AC** power parts to the metal case of the instrument or appliance . this leakage current usually flowes to ground through the ground wire in the power cord.

The main source of the leakage current is the capacitance between the AC power wires &ground or between the power transformer & its case.

Wayes to reduce shock hazards in hospitals

1.By using DC current to operate the equipment because human body is less sensitivity to this current .

Ie $Xc = 1/2\pi fc$ & $f = 0$ in D.c ($Xc = \infty$)

So there is no leakage current ie I (LEAKGE)= $v/\chi c = v/\infty = 0$

2.By operated electrical equipment of frequency much higher than 60 Hz, where the sensitive of the heart to ventricular fibrillation is much less.

3.By using rechargeable battry powered instrument in diagnostic therapeutic and monitoring situation.

4.By using AC current with connecting safe ground wire with high frequency

Types of electricity :

(I) - high – frequency electricity (HFE) in medicine used in :

A. heat therapy :the heating effects of (HFE) is done by using :

1.shot wave diathermy. (diathermy)

2.long wave diathermy.

3.microwave diathermy.

B. Electro surgery : uses of (HFE) to :

1.control hemorrhage during suring surgery .

2. Electro surgery = cut through tissues.

3.Electro cauterizing = coagulate small or moderate – size blood vassels that are too small to tie. Fig-11-8

(II) - **Low frequency electricity (LFE) & magnetism in medicine it is used to:**

A .measure the blood flow by electromagnetic methods.

When an electrical conductor is moved ⊥ perpendicular to a magnetic field _ a voltage is induced .

Blood act as a conducting fluid . if it passed with a mean velocity v through magnetic field B .

A voltage V is induced between the electrodes such that

V= Bdv d= diameter of blood vessel.

The volume flow of blood (Q) = mean velocity x the area of the vessel Fig-11-9

$$Q = (V/Bd) * \pi d^2 / 4 \; (cm^3/s)$$

(3 – 8)

B. Measure the skin resistance by LFE to monitor psychological change :

*perspiration depends on sweat gland activity that concentrated in the palm of the hand and sole of the foot.

*change perspiration (sweat gland activity) are related to skin resistance .a decrease in skin resistance indicates increased sweat gland activity, while an increased in skin resistance indicates reduced sweat gland activity.

***The variation from the basal skin resistance due to psychological changes or external stimuli is called "GSR" (galvanic skin response) .**

*The **"GSR"** can be easily measure where there is a concentration of sweat gland , such as the palm of the hand or the sole of the foot.

* **"GSR"** depends on the activity of sweat gland , only **&** not upon the amount of visible perspiration

* an active electrode is placed on the palm of the hand **&** a second neutral electrode is placed on the wrist or the back of the hand.

Usually a constant direct current (~ $10\mu A/cm^2$) is passed through the electrodes. The resulting voltage indicate the **" GSR"** , since the voltage is proportional to resistance . Fig. 11-10

*The problem with using a **"DC"** is that polarizing voltage is developed between the electrodes & the skin . That is indistinguishable .

To reduce this problem , we use a :

1.silver _ silver chloride electrode

2.with an electrode jelly between the electrodes & the skin.

Absorption of microwave beam depend on :

1.The a mount of water in the tissue.

The energy is deposited more effectively in tissue with high water content , microwave energy is a bsorbed better in musle tissue which have less water.

2.The frequency of microwaves :

The energy is absorbed is very high at frequency 20 GHZ (GHZ=10^9 Hz) . its poorly absorbed at lower frequency nearly 100MHz & at very high frequency >1000GHz.

*2450MHz for kitchen uses but best frequency for medical treatment uses is 900 MHz.

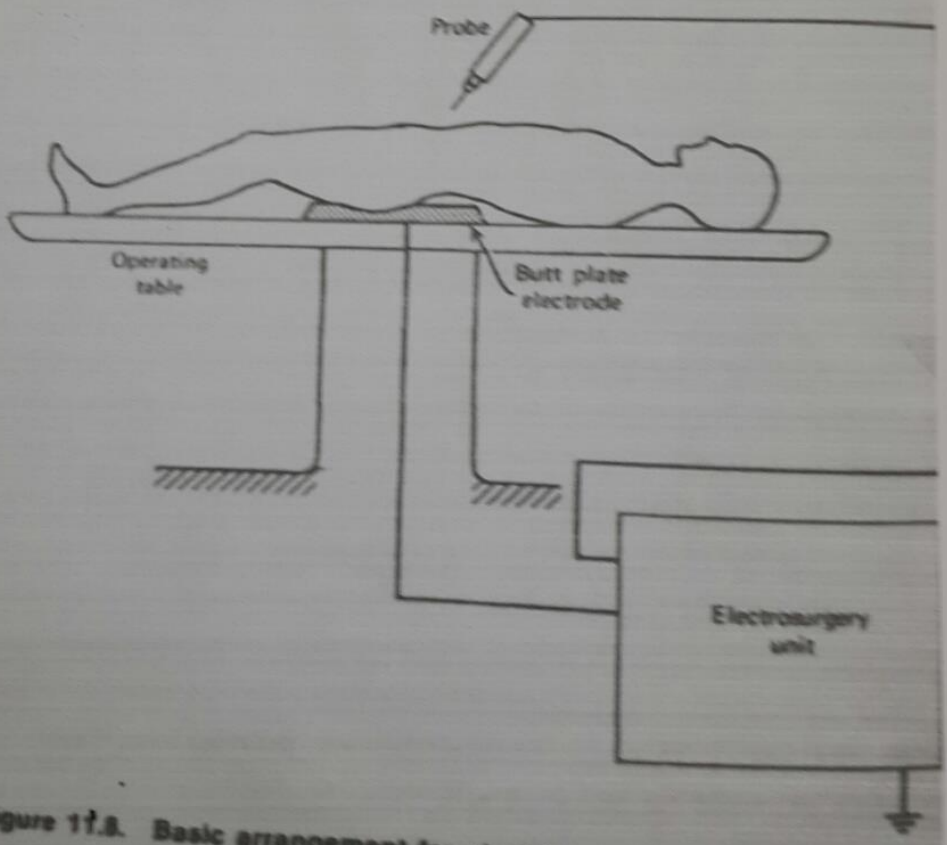

Figure 11.8. Basic arrangement for electrosurgery and electrocautery

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$$V = Bdv$$

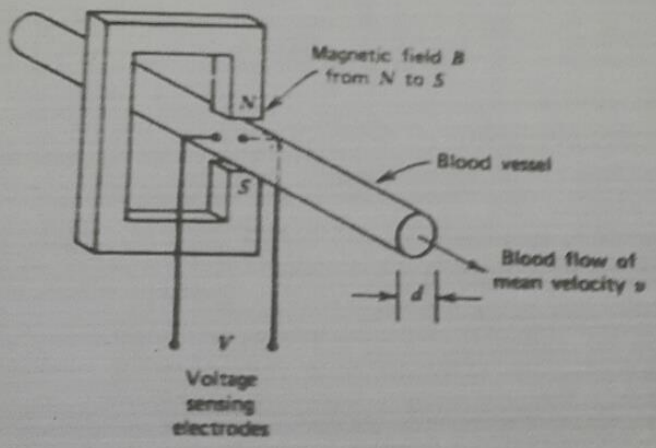

Figure 11.9. Schematic of a magnetic blood flow meter. When blood, a conducting fluid, passes through the magnetic field, positive and negative charges are separated, producing the voltage V.

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(7-8)

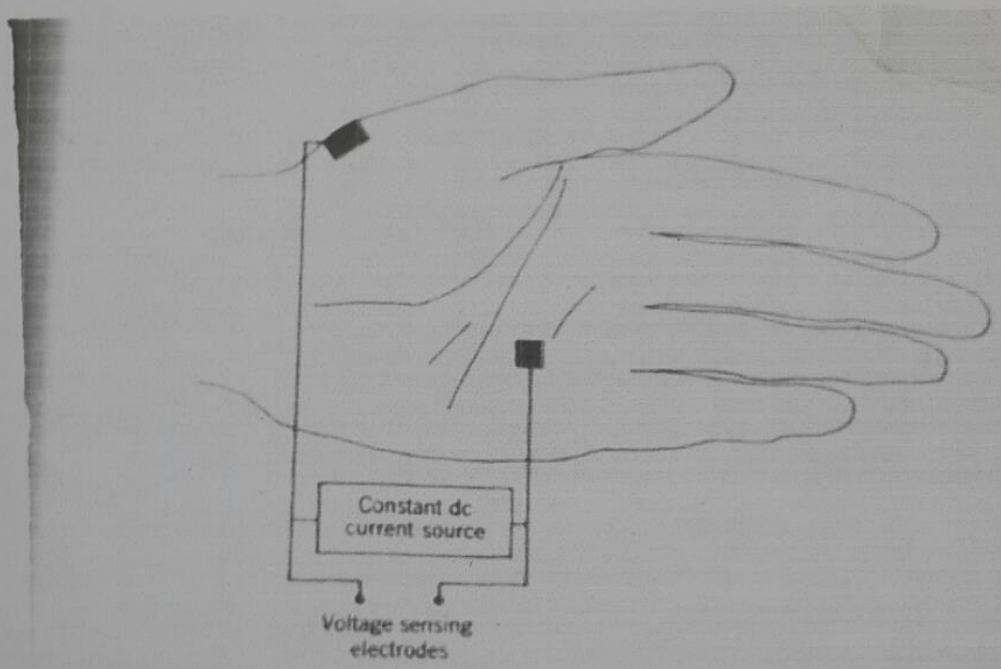

Figure 11.10. Method of measuring the galvanic skin response (GSR). The palm of the hand has a high sweat gland concentration, while the wrist region contains few sweat glands. The constant current source passes a current between the electrodes at these locations. The voltage produced depends upon the resistance (sweat gland activity) between the electrodes.