Physical Therapy

Hubbard Hydrotherapy Tank, Carlos Andreson, Watercolour, 1943

Methods in Physical Therapy

Non-Electric heat therapy – (heating or cooling)

Elecrotherapy

Ultrasound therapy

Magneto-therapy

Phototherapy

Non-electric heat therapy

Conduction of heat

Radiation

EM radiation

US

Therapeutique application of electric current

Non-stimulating

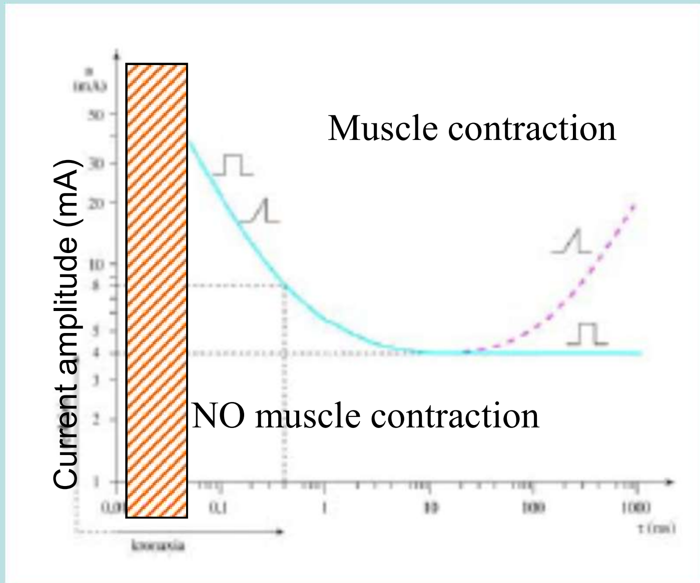
- Direct current– galvanotherapy, iontophoresis
- High frequency alternating current - diathermy

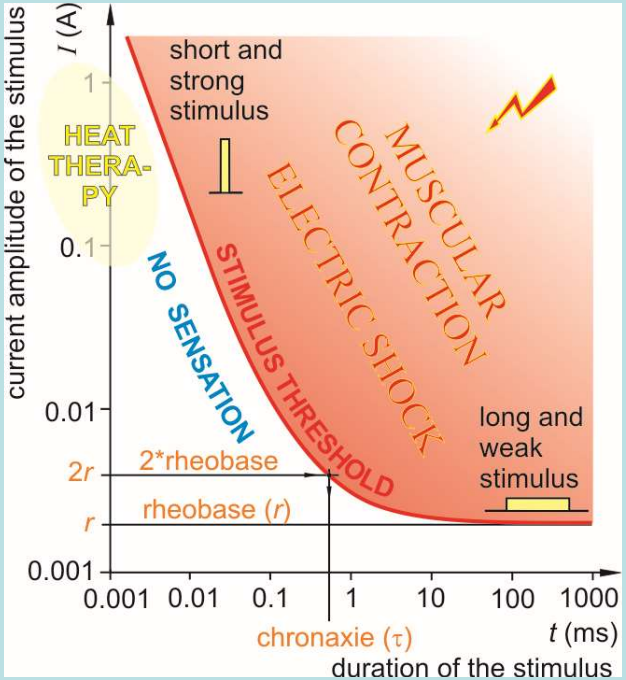
Stimulating

- individual current pulses
- series of pulses

Effects of electric current

Stimulus-characteristic curve





- **Rheobase**- *(*the lowest point on the curve) *by definition is the lowest voltage that* results in myocardial depolarization at infinitely long pulse duration

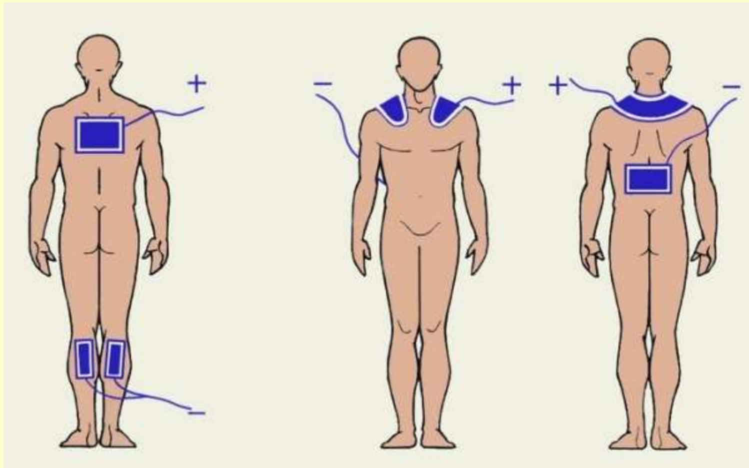
- **Chronaxie***(*pulse duration time) by definition, the chronaxie is the threshold pulse duration at twice the rheobase voltage

Direct current– galvanotherapy, iontophoresis

Galvanotherapy: constant direct current

Cranial or Caudal anode

Effects: pain relief
modulation of stimulus threshold of motoric neurons
modulation of vasodilatation



Direct current- galvanotherapy, iontophoresis

Hidro-Galvanic Treatment

sympathicus activity decreases
vasodilatation in deep tissues

Direct current– galvanotherapy, iontophoresis

Iontophoreses: ionic drugs can be delivered through the skin into the tissues situated between two electrodes

pain reliefs,

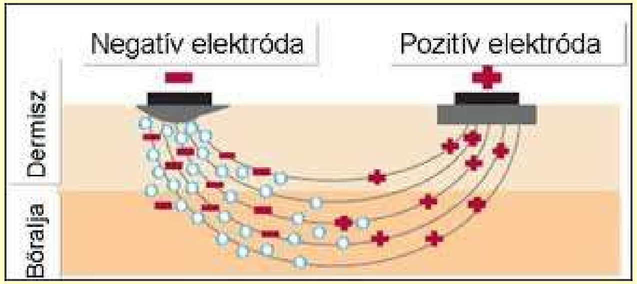
anty-inflammatory agents,

vasodilatators,

tissue softeners

Katophorezis – e.g. seroidos, lidocain

Anophorezis – e.g.. Non-strereoidal anty-inflammation drugs



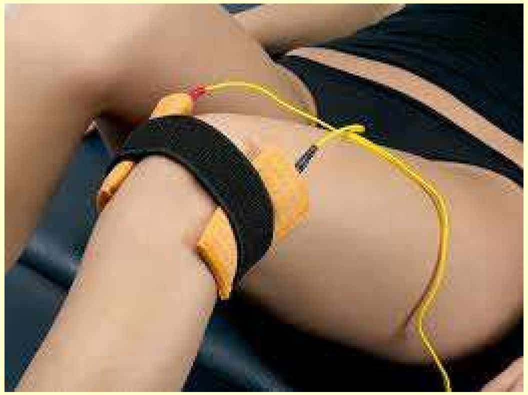
Direct current- galvanotherapy, iontophoresis

Iontophoreses :

Advantage: smaller quantity of drug, local treatment,

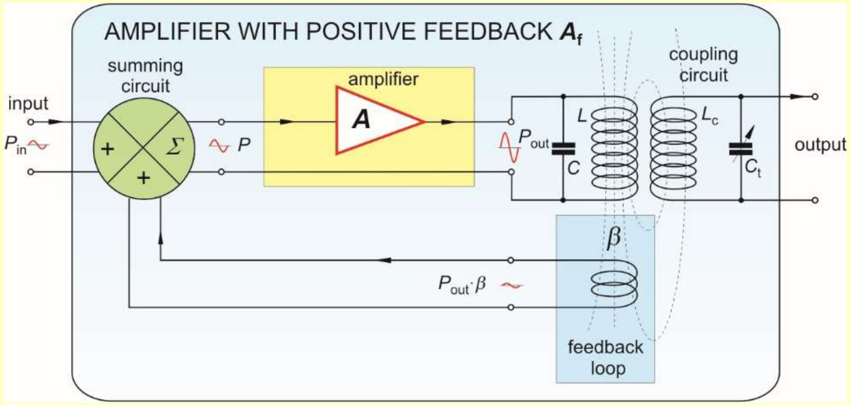
delivery of non-absorbing drugs

Disadvantage: doses are uncertain



High frequency heat therapy - Diathermy

Signal source: **sine-wave oscillator,**
feed-back amplifier with LC circuit

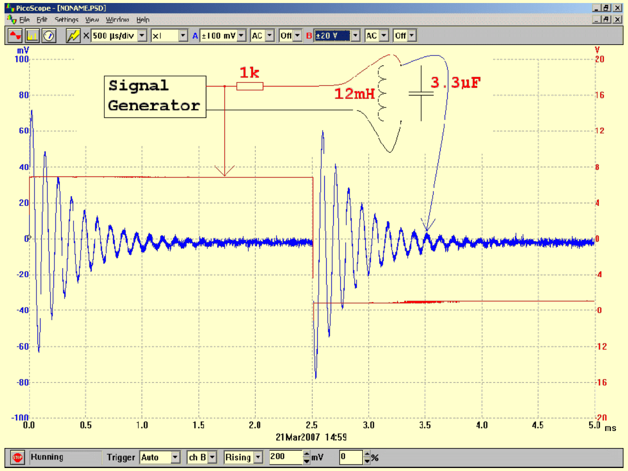


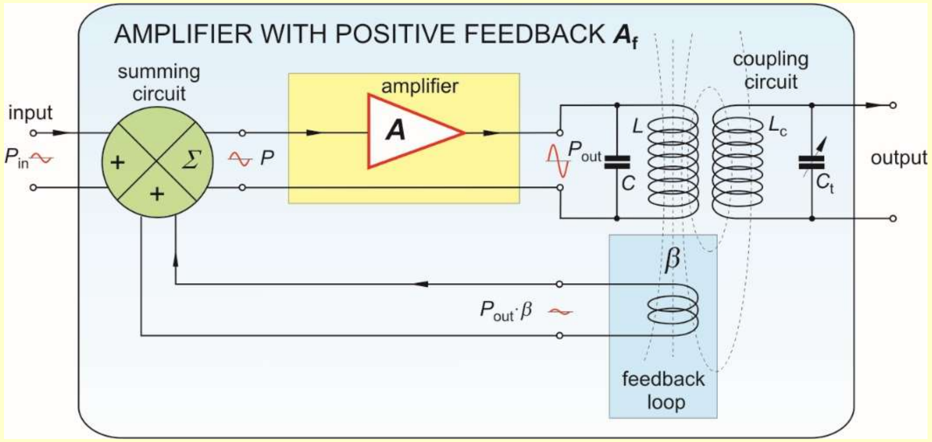
$$f = \frac{1}{2\pi\sqrt{LC}}$$

Effect depends on:

Structure of coupling circuit
Applied frequency
Structure of tissues to be treated

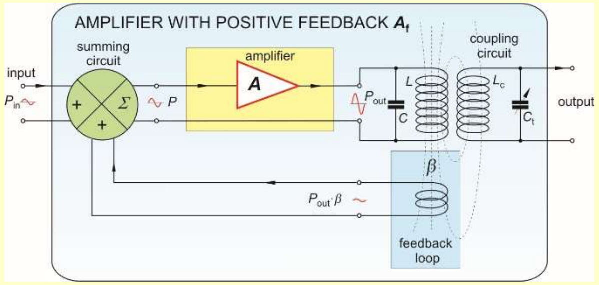
Electric signal source: **sine wave oscillator**





$$f = \frac{1}{2\pi\sqrt{LC}}$$

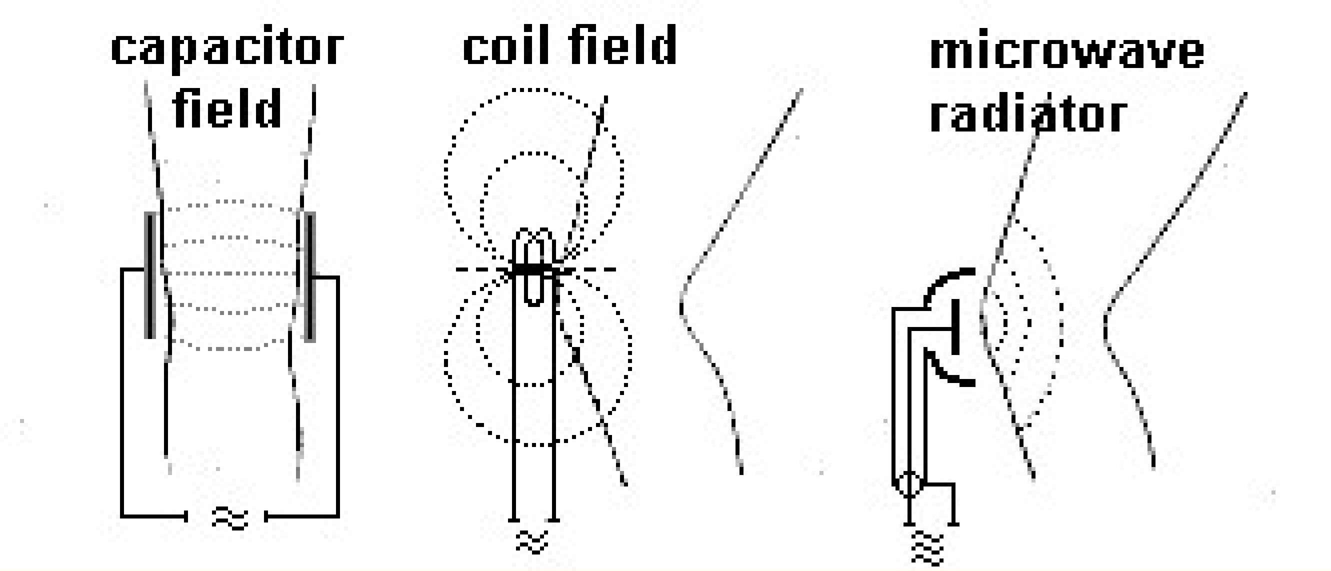
Coupling circuits



Optimal coupling - resonance

$$f = \frac{1}{2\pi\sqrt{LC}}$$

LC=L'C'



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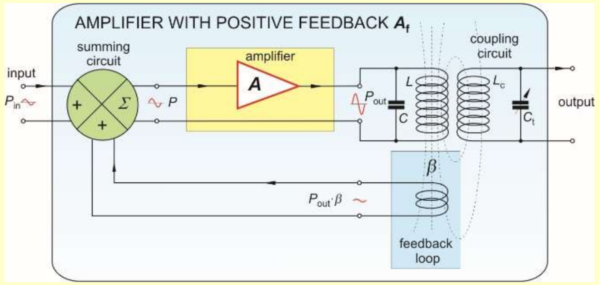

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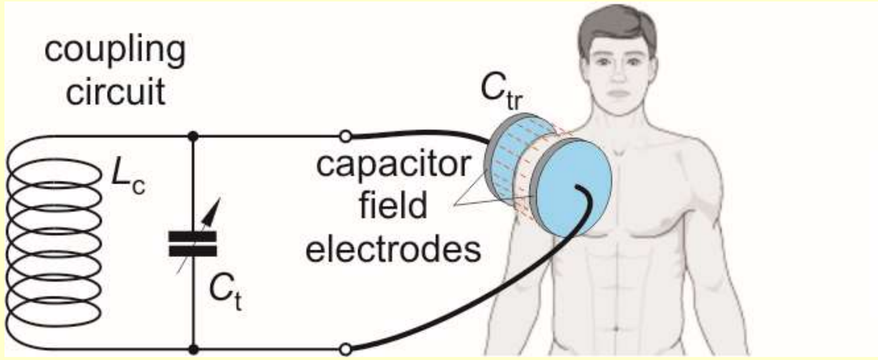
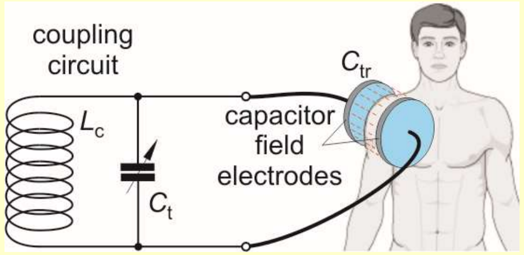
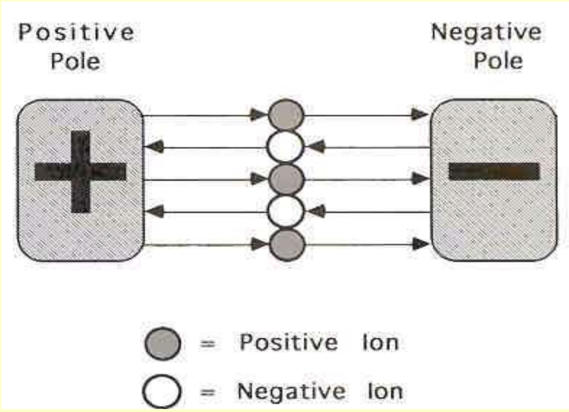


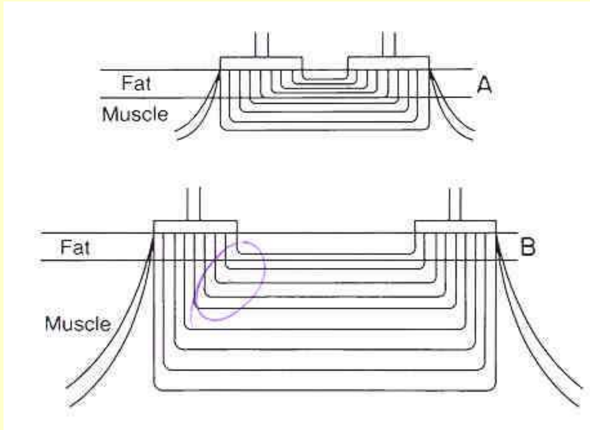
Capacitor field treatment

$$Q = \frac{U^2}{R} \cdot t = \frac{U^2}{\rho \frac{l}{A}} \cdot t = \sigma \frac{U^2}{l^2} \cdot l \cdot A \cdot t = \sigma \cdot E^2 \cdot V \cdot t$$

Capacitive electrodes Capacitor field







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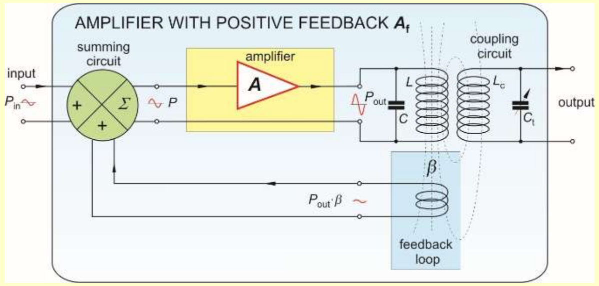
Coupling circuits



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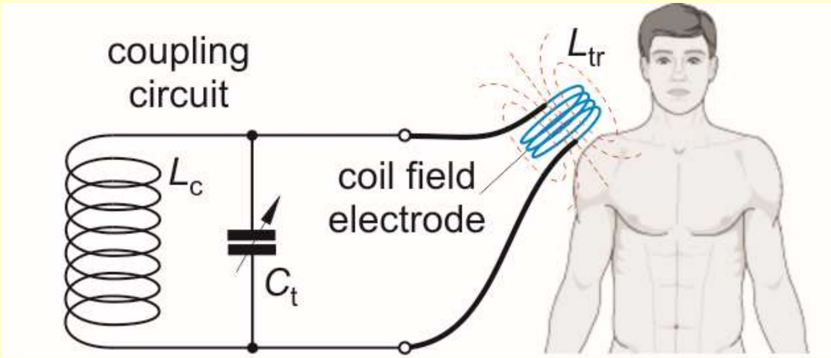


Coil field treatment
– induction field

Electric currents induced within conductors by a changing magnetic field

The greater the electrical conductivity the greater the currents that are developed

Induction field treatment

Patient is in the electromagnetic field or the electric circuit → produce strong magnetic field → induce electrical currents within the body (EDDY currents)

The greater the electrical conductivity the greater the currents that are developed

Utilizes either an insulated cable or an inductive coil applicator

Therapeutic effects

Increase blood flow

Assist in resolution of inflammation

Increase extensibility of deep collagen tissue

Decrease joint stiffness

Relieve deep muscle pain and spasm

Indications

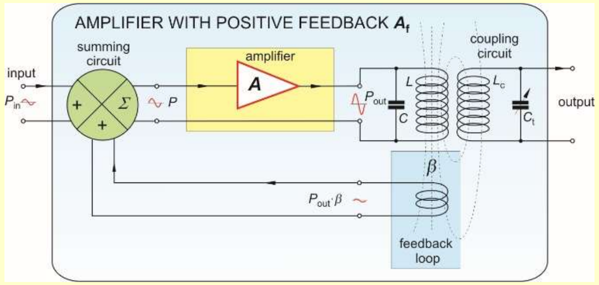
Soft tissue healing

Recent ankle injuries

Pain syndromes

Nerve regeneration

Coupling circuits



Optimal coupling - resonance

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Microwave hyperthermya

-joints disorders, rheumatism
-skin diseases (eczema, mollus, psoriasis)
-Selective local hyperthermy of tumor tissues– optimal: 42 – 43,5 °C tumor temperature (Healthy tissues have higher heat tolerance.) It can be combined with chemo- or radiotherapy Optimal power density: 200 mW/cm^2

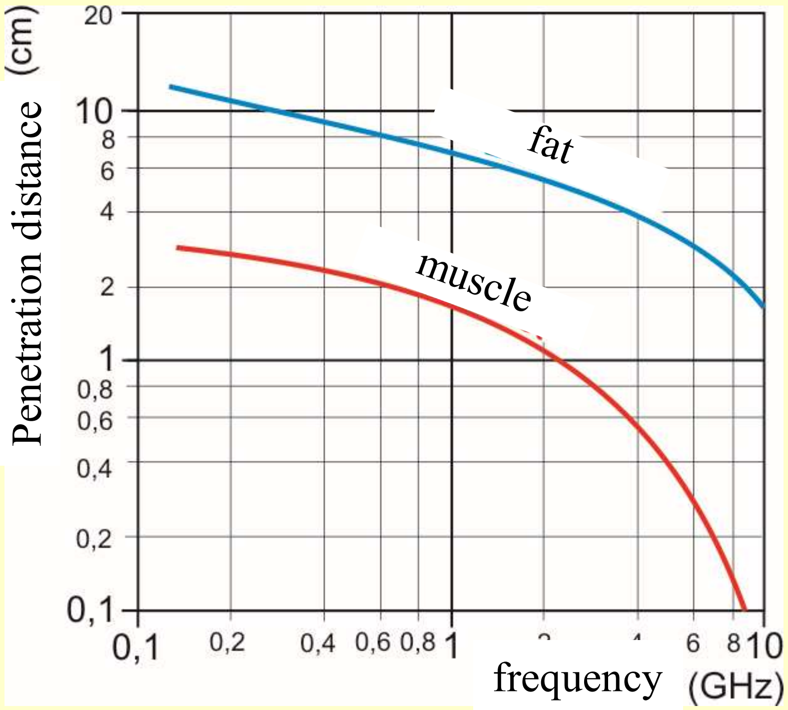
Microwave radiator – microwave treatment

Frequency and wavelength ranges:

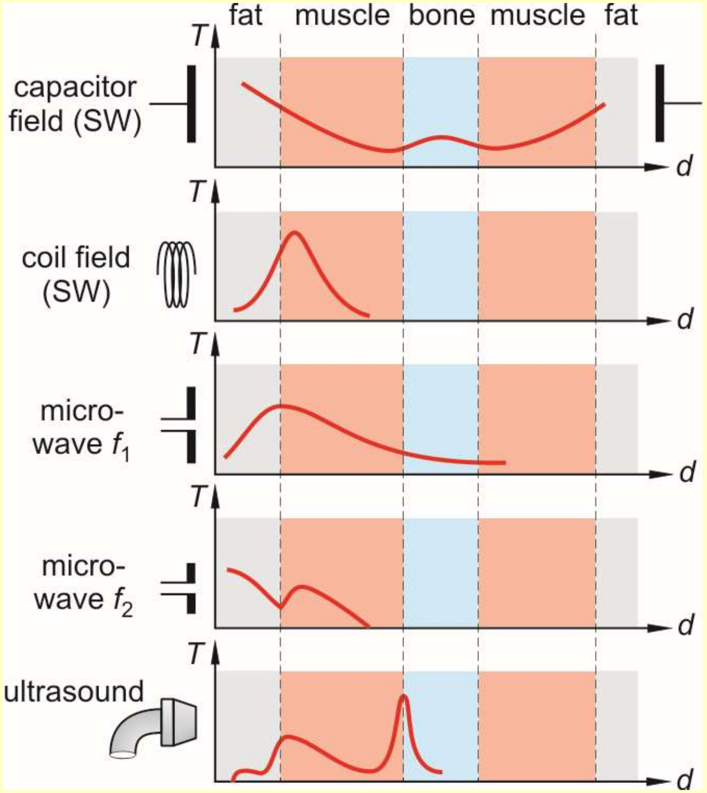
Short wave: $f \sim 30$ MHz $\rightarrow \lambda \sim 10$ m

Decimeter wave: $f \sim 0{,}5$ GHz $\rightarrow \lambda \sim 0{,}6$ m

Microwave: $f \sim 2{,}5$ GHz $\rightarrow \lambda \sim 12$ cm



Typical distribution of heat



frequency	σ_{fat} **(mS/cm)**	σ_{muscle} **(mS/cm)**
300 MHz	2,7	9,0 – 9,9
1000 MHz	3,6	13,0 – 14,5

Contraindications

- Pacemakers
- Metal implants
- Impaired sensation
- Pregnancy
- Hemorrhage
- Ischemic Tissue
- Testicles and eyes

- Malignant CA
- Active TB
- Fever
- Thrombosis
- X-ray exposure
- Uncooperative patient
- Areas of poor circulation

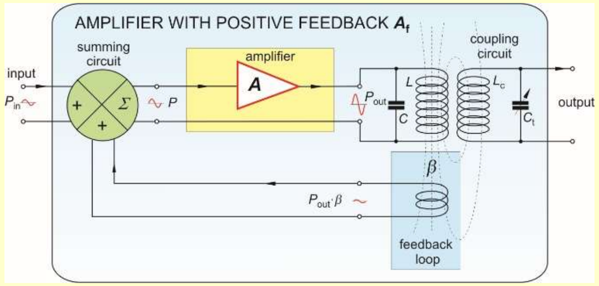
Potential risks of microwave and radiofrequency radiation

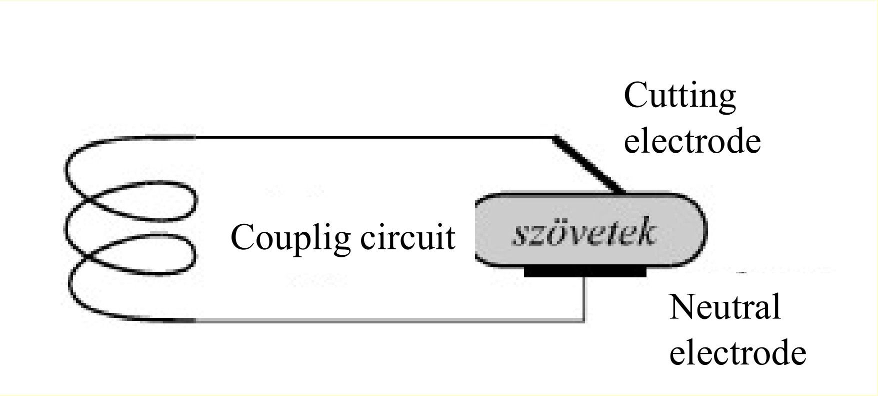
Mainly thermal effects.

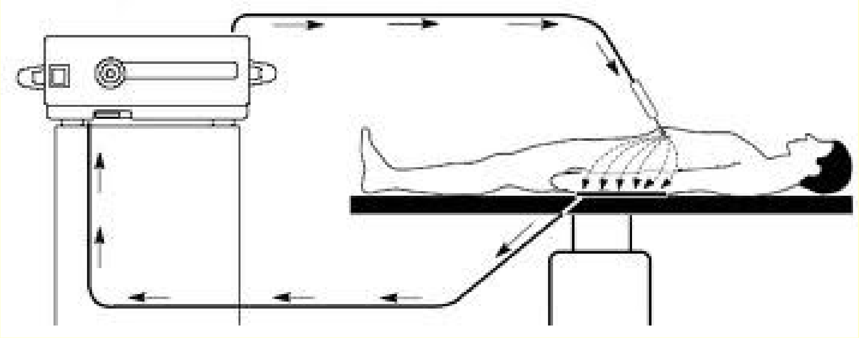
- Microwave sources
- Radars
- Cell phones
- Radio and TV transmitters
- Electric mains
- Trolley lines (wires)

Some studies showing carcinogenic effects of microwaves or low-frequency electromagnetic fields were not verified sufficiently, but it is prudent to reduce exposures.

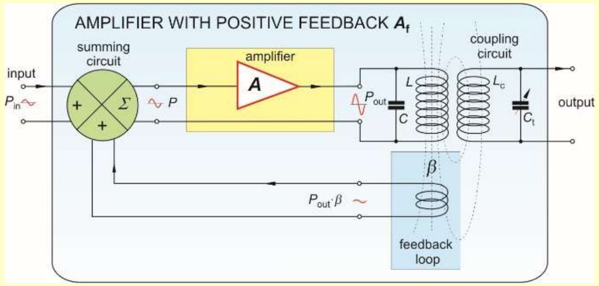
Microwave surgery - Electrosurgery

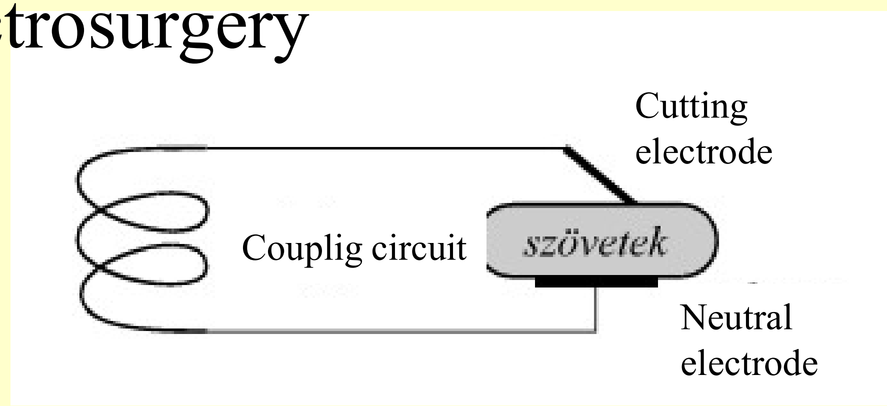






Microwave surgery - Electrosurgery





„Electrosurgery is currently used in over 80% of all surgical procedures, and is growing in popularity in dental surgery. **Electrosurgery also significantly reduces bleeding and provides the oral surgeon or dentist greater overall precision. ...”**

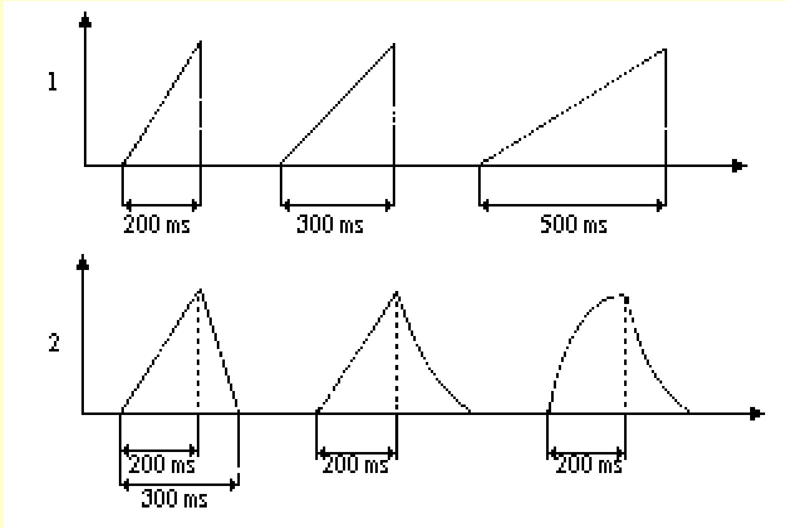
Advantages:

- High precision
- Immediate sterilization
- Reduced bleeding
- Analgesic effect

- Whitening

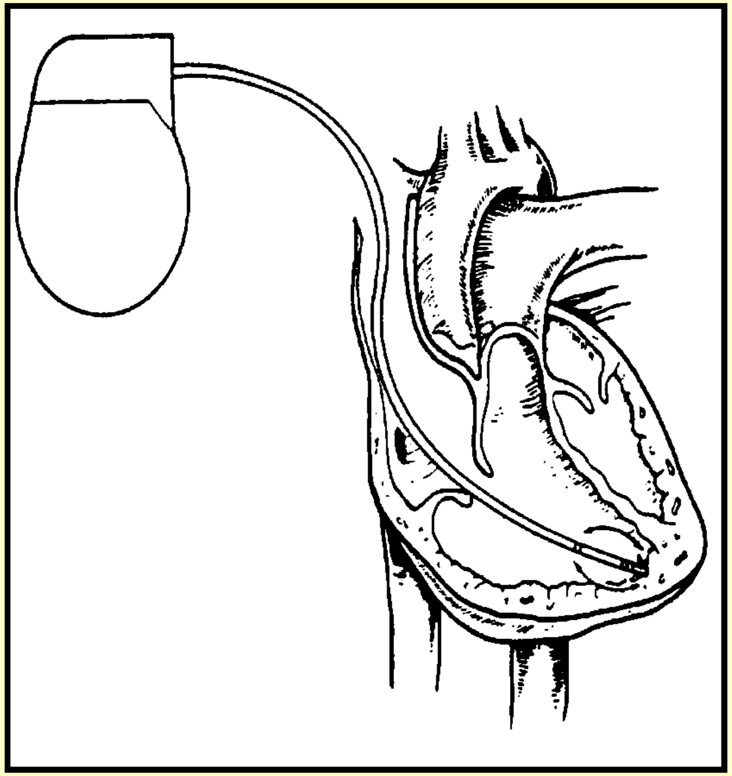
Electrostimulation

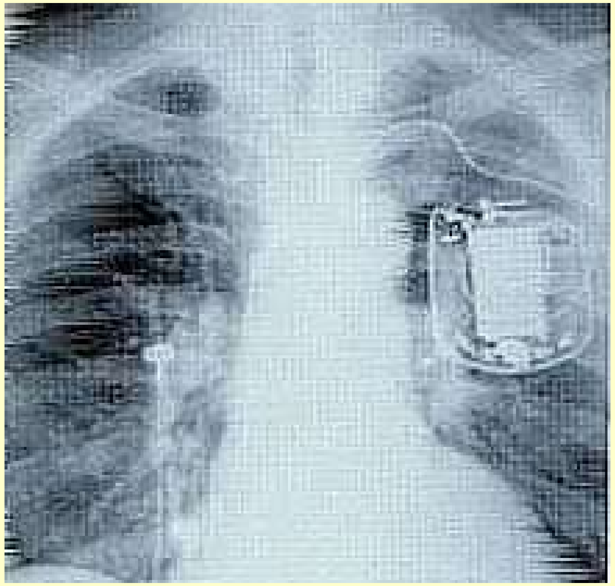
Creating muscle contraction through nerve or muscle stimulation

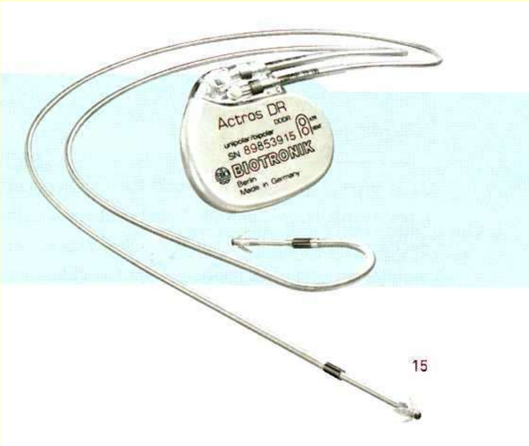


The stimulating effects depend on the amplitude, frequency, shape and modulation of pulses, and the kind of tissue!!!!!

Pacemaker – astable MV





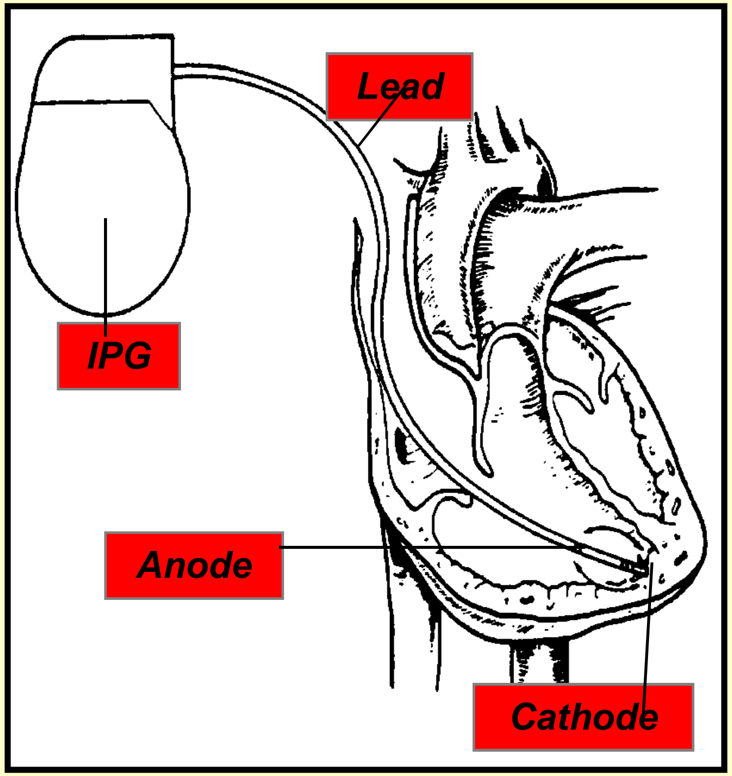


Pacemaker – astable MV

- Power source Longevity in single chamber pacemaker is 7 to 12 years,

  Generate 2.8 V in the beginning of life which becomes 2.1 to 2.4 V towards end of life
- Pulse generator
- Leads Deliver electrical impulses ,

  Sense cardiac depolarisation
- Cathode (negative electrode)
- Anode (positive electrode)
- Body tissue



Most Pacemakers Perform Four Functions

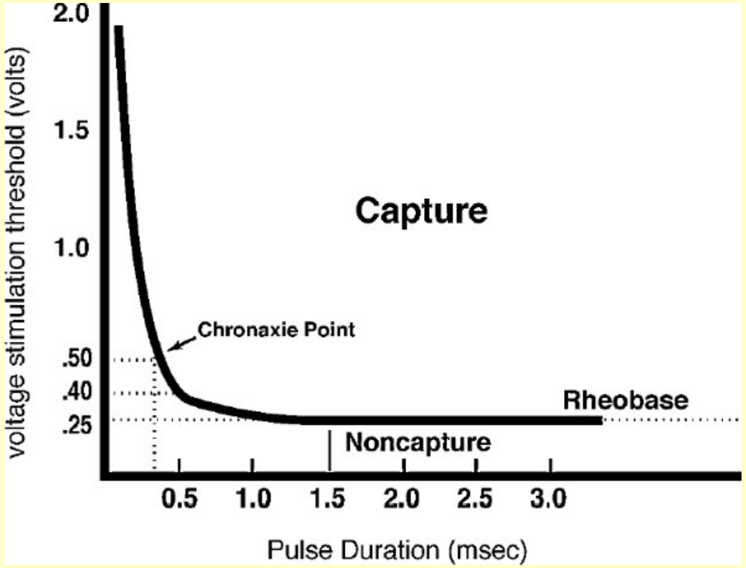
- Stimulate cardiac depolarization
- Sense intrinsic cardiac function
- Respond to increased metabolic demand by providing rate responsive pacing
- Provide diagnostic information stored by the pacemaker

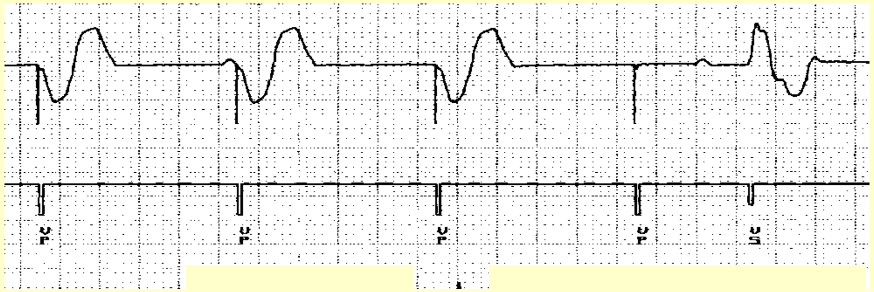
A Brief History of Pacemakers

- 1958 – Senning and Elmqvist
  - Asynchronous (VVI) pacemaker implanted by thoracotomy and functioned for 3 hours
  - Arne Larsson
    - First pacemaker patient
    - Used 23 pulse generators and 5 electrode systems
    - Died 2001 at age 86 of cancer
- 1960 – First atrial triggered pacemaker
- 1964 – First on demand pacemaker (DVI)
- 1977 – First atrial and ventricular demand pacing (DDD)
- 1981 – Rate responsive pacing by QT interval, respiration, and movement
- 1994 – Cardiac resynchronization pacing

Pacing thresholds

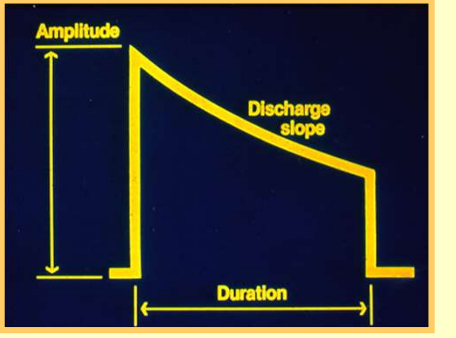
- Defined as the minimum amount of electrical energy required to consistently cause a cardiac depolarization
- "Consistently" refers to at least '5' consecutive beats
- Low thresholds require less battery energy





capture non-capture

Pacemaker

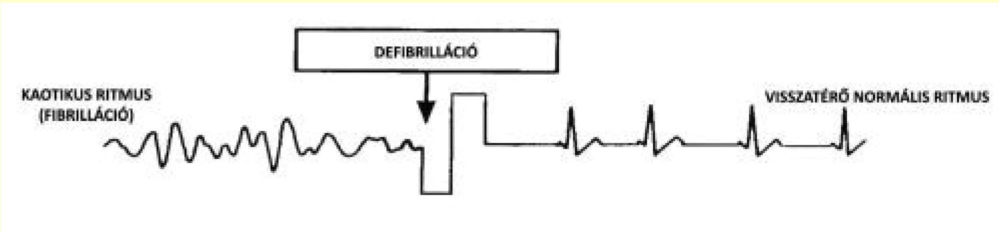


- E (μJ) = U (V) × I (mA) × t (ms).
- Q (μC) = I (mA) × t (ms).

Parameter	Optimal range	Comment
Voltage	1.5–2.5 V	Longevity is markedly reduced when the output is greater than 2.5 V. Voltages less than 1.5 V are not associated with significant increases in longevity.
Pulse duration	0.4–0.6 ms	Pulse durations of 0.4–0.6 ms correspond with the nadir of the threshold energy strength–duration curve (Fig. 1.7).
Safety margin	2:1 voltage 3:1 pulse duration	The strength–duration curve must be taken into account when determining the optimal type of safety margin programming.

Defibrillators

Defibrillators are used in emergency medicine to renew spontaneous heart activity (in case of chamber fibrillation).

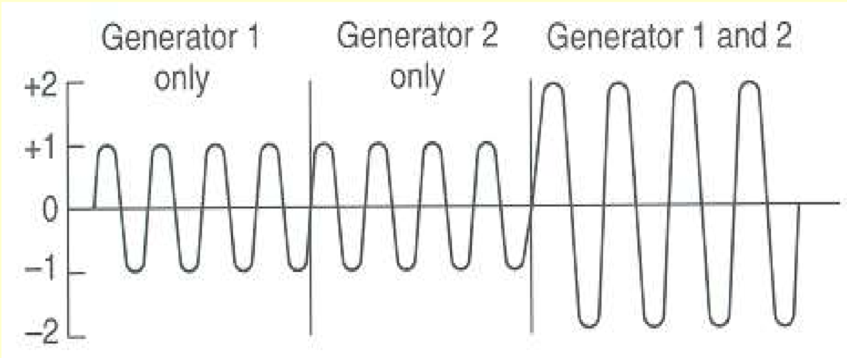


Therapeutic uses of electrically induced muscle contraction

- Muscle reeducation
- Muscle pump contractions
- Retardation of atrophy
- Muscle strengthening
- Increasing range of motion
- Reducing edema
- Stimulating denervated muscle

Interferential Currents

Make use of 2 separate generators
Produce sine waves at different frequencies

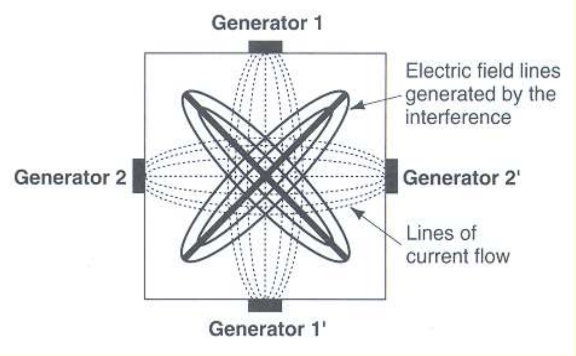


If produced in phase if or they originate at same time interference can be summative-amplitudes of the electric wave are combined and increase

Interferential Currents

When using an interference current set intensity according to peak .
Select the frequencies to create a beat frequency corresponding to choices of frequency when using other stimulators.

When electrodes are arranged in a square and interferential currents are passed through a homogeneous medium a predictable pattern of interference will occur.



US - THERAPY

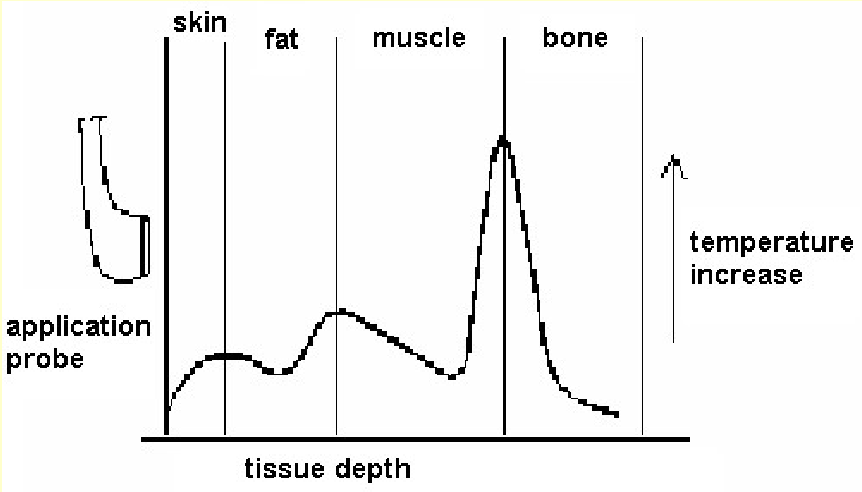
Ultrasound therapy

Typical parameters
f : 0,8 - 1 MHz (up to 3 MHz)
J : 0.5 - 1 W.cm-2
t: 5 - 15 min., in 5 - 10 repetitions.
US can be applied continuously or pulsed.

The main therapeutic mechanism is **high-frequency massage** of tissue. Additional effects are caused by tissue **heating** (causing hyperaemia) and some **physico-chemical effects**.

Main indications of US therapy: chronic joint, muscle and neural diseases. Limited success is reported in healing wounds after surgery, healing injuries and varicose ulcers.

Thermal action of ultrasound



In US therapy, thermal dissipation of acoustic energy takes place. Tissue heating depends on physical properties of tissue and its blood supply. The highest heating appears at the interfaces between tissues of very different acoustic impedances.

The thermal action of US cannot be considered without respect to other healing mechanisms (micromassage etc.)

Non-thermal hazards of electric currents

- The effects of alternating currents (mainly 50Hz) are more serious than the effects of direct currents. In currents above 10 kHz, the danger of non-thermal injury is small.
- The danger of injury depends on voltage, internal resistance of the source and body resistance. Sources with large internal resistance (e.g. TV screens) are not too dangerous because the short circuit current is very low.
- **Electric network (mains) and the sources with a small internal resistance represent main hazard. In high humidity, the skin resistance decreases, and the danger of injury becomes much higher.**

Injuries caused by electric currents

- The so called bipolar contact (when the circuit is formed only by source and human body) is very dangerous. Current goes through human body.
- In the unipolar contact, insulation from the Earth (shoes) plays an important role. Current can go to the Earth through human body.
- Brain, respiratory organs (mainly respiration centres and muscles) and heart are the most sensitive body parts.
- The safe value of current which can without endangering our health pass through the body, is about 10 mA in alternating currents below 1 kHz, in the direct currents about 25 mA.
- Critical value of alternating current at which it is still possible to release hold on a conductor is about 20 mA.

Injuries caused by electric currents

- Currents above 25 mA can cause respiratory failure, currents above 25 - 80 mA can cause a reversible cardiac arrest with death danger. Above 80mA, number of deadly injuries increases.
- The currents above 1A have fully irreversible consequences (death).
- To stimulate a muscle, the current must pass along the muscle fibres. In the heart, the fibres are oriented in many directions so that always only part of them is affected. This results in uncoordinated contractions of myocardium (extra-systoles), in higher values of currents (100-200 mA) ventricular fibrillation occurs.