Collective protection

- Some indicators provide sound signal in the presence of voltage. Unipolar pointers indicate the presence or absence of voltage between conductive parts and ground (Fig. 4.15).

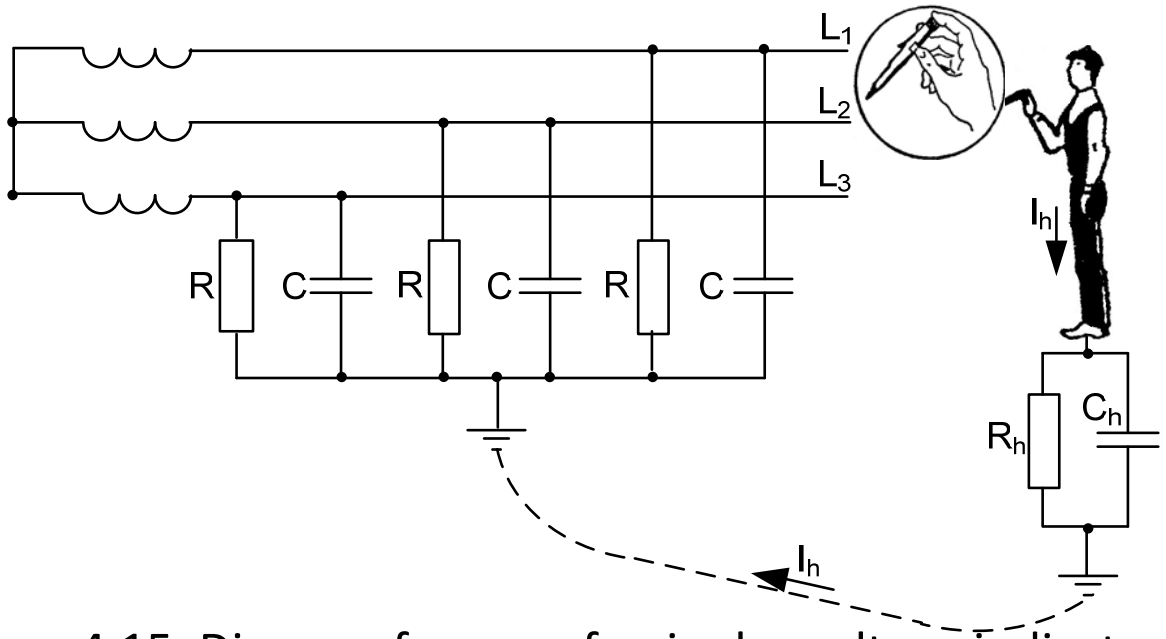


Figure 4.15. Diagram for use of unipolar voltage indicator

Collective protection

- Using pliers in electric systems with voltage over 1000V, the operator must have dielectric gloves with protective glasses and to step on dielectric rug or path. The measurement is performed in the presence of a second technician (Fig. 4.12). In this case, the operatort of the apparatus has to work with both hands (Fig. 4.13). Electrical pliers have an insulating part not less than 0,38m and handle not less than 0,13m.

Collective protection

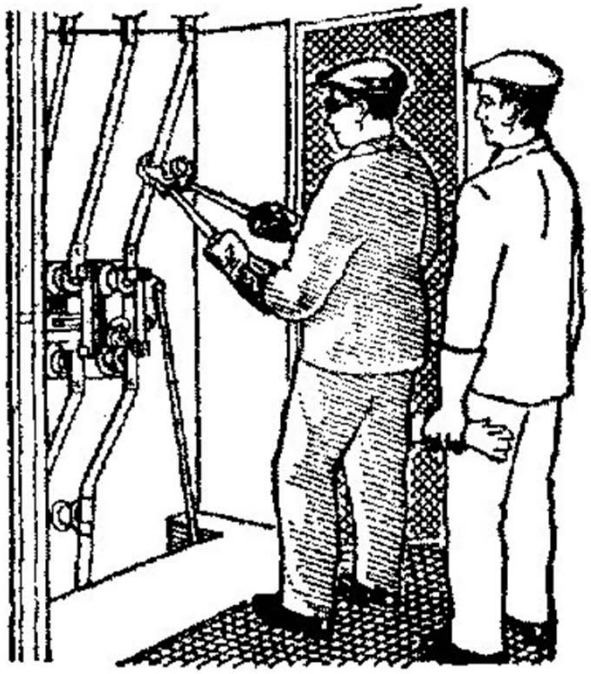
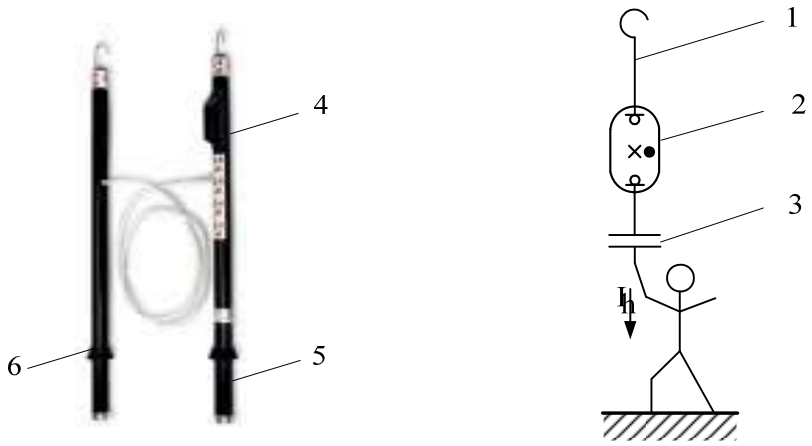


Figure 4.12. Measurement of electrical current of rails system with voltage over 1000V

Figure 4.13. Electrical pliers Ц4502 for AC circuits with voltage (1 ... 10) kV and frequency (50 ... 60) Hz

Collective protection

- In electrical installations for over 1000V are also used devices operating on the principle of flowing of capacitive current (Fig. 4.16). Despite the diversity all structures have 3 main parts
  - hook (1) neon lamp (2) capacitor (3), placed in a plastic case;
  - sealed unit having length depending on the voltage of the electrical installation;
  - handle (5) and the stop (6).



a) b)

Figure 4.16. Outside view of a) electric diagram b) high voltage indicator

Collective protection

- When the conductive part (a high voltage conductor) comes close to a hook (about 1cm), a current I_h (usually with voltage 1μA) flows through the human body. It is sufficient to ignite the neon lamp. These indicators should be used with dielectric gloves.
- For protection of technical staff from the effects of electromagnetic fields are used special shielding costumes. Such fields are formed by the conductors of overhead lines and distribution systems, with voltage Up $\geq$ 330kV.
- Shield costumes are used during repair, installation and other construction activities within the danger zone, i.e. distances less than 30m from the conductive parts being under voltage. The protective properties of the suit are made using the principle of so-called electrostatic shielding.

Collective protection

- Let a conductive body be entered to an electrostatic field (Fig. 4.17).

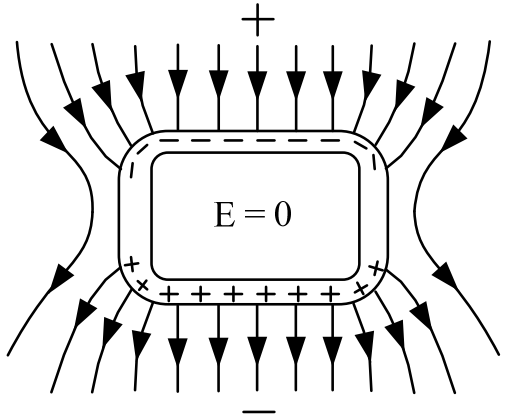


Figure 4.17. Electrostatic shield

- As a result of the phenomenon electrostatic induction starts separation of electric charges. The intensity of the electric field inside the body is zero, because the intensity of the external field is compensated by the field created by the charges located on the surface of the body. Therefore, in order to protect a conductive body by the application of an electric field is enough to placed it in a metal shell (shield).

Collective protection

- The screen can be solid or mesh. Shielding costume is made of fabric containing thin flexible copper wire, forming a net (Fig. 4.18). Protective garment can be made from fabric coated with conductive paint (metal).

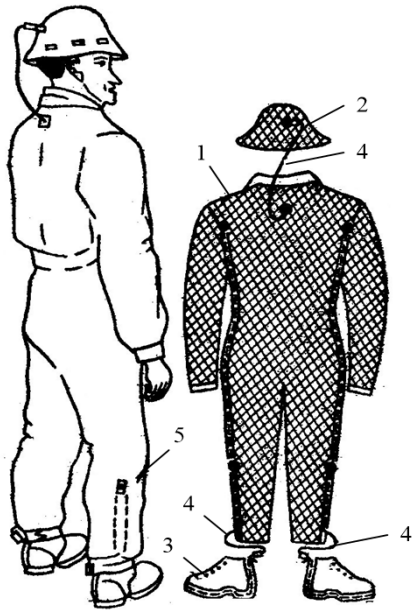


Figure 4.18. Shielding costume:
1- net; 2 – metalized plastic helmet; 3 – boots with conductive soles;
4 – conductive connection between the different parts; 5 – grounding split.

Collective protection

- Shielding costume is dressed on the top of underwear. If necessary, on the protective garment can be put a coat, warmer dress, etc. To measure the protective ability of the costume is used the equation:

$$I_h = I_e(1 - k_e)$$

Collective protection

- Portable earthing devices are used to protect the technical staff at work with switched-off conductive parts of electrical equipment.
- To avoid electric shock, the three phases of the switched-off section of the system is shorted to ground and to the transferring grounding (Fig. 4.19).

Figure 4.19. Portable grounding for switchgear up to 1000V

QUESTIONS?

Thank you!

Topic 12

Electromagnetic fields

Theory

- Electromagnetic field is considered as produced by electric and magnetic fields.
- At low frequencies (like f = 50Hz), it is accepted, that both fields are studied separately when estimating their effect on human body.
- The intensity of magnetic field in the working zones of electric devices and electricity lines for voltage up to 750 kV does not exceed (20 ... 25) $A.m^{-1}$. It is proved, that harmful effect of magnetic field over living tissue appears at values of the intensity over (150...200) $A.m^{-1}$.

Theory

- There are various sources of electromagnetic fields – devices and power lines, technological equipment for industrial and dielectric heating, radio and TV transmitters, radar systems, electro medical equipment, computer and communication systems etc.
- Any electromagnetic field is characterized by frequency f and wavelength λ.

$$f = \frac{c}{\lambda}$$

Theory

- The frequency range of some of the fields is:
  - Field with industrial frequency (50...30.10^3)Hz, λ=(10^4...10^6)m
  - Radiofrequency fields (60.10^3...300.10^6)Hz, λ=(10...5.10^3)m
  - Microwave fields (300.10^6...300.10^9)Hz, λ=(10^{-1}....10^{-3})m

- For estimation of the effect of electromagnetic fields over human body, the following magnitudes are used:
  - Current flowing through human to earth I_h,A
  - Intensity of electrical field E, A.m^{-1}
  - Intensity of magnetic field H, A.m^{-1}
  - Energy of electric field $\boldsymbol{W_E=E^2.t}$, V^2.m.$^{-2}$h
  - Energy of magnetic field $\boldsymbol{W_H=H^2.t}$, A^2.m.$^{-2}$.h
  - Density of energy flux S, in W.m^{-2}
  - Area of effect of the field around the source

Biological effect of electromagnetic field

- Biologic tissues consist of large number of cells, connected with intercellular tissue. The specific volume resistivity is ρ_v =(0.5...5)Ω.m. Its relative dielectric permittivity is $\varepsilon_r \approx 80$. The specific surface capacitance is (0.1...0.3)μF.cm^{-2}. Dielectric loses are characterized with $\delta \approx 0.1$
- The following parameters should be taken into account when estimating the electro physical processes in the biologic tissue under the effect of electrical field:
  - Electrical conductivity
  - Polarization
  - Dielectric losses

  This energy is transformed into heat, which increase in the temperature of the human body or feeling of local warming. Its very dangerous for the organs with weak thermo-regulation or limited blood flow – brain, stomach, etc.

Electromagnetic fields with low frequency

- They are present where current with f = (50...60)Hz is used – in outdoor switchgear and overhead power lines for high and ultrahigh voltages. In such cases two parameters of effect of the electromagnetic field are formed – continuously flowing of allowed electric current through the human and allowable period of stay of humans inside electric field.

QUESTIONS?

Thank you!