5.2 KELVIN'S LAW

Kelvin's Law states that the most economical area of conductor is that for which the variable part of annual charge is equal to the cost of energy losses per year.

5.2.1 Graphical illustration of Kelvin's law.

Kelvin's law can also be illustrated graphically by plotting annual cost against X-sectional area '*a*'of the conductor as shown in Fig. 7.28.

In the diagram, the straight line

(1) shows the relation between the annual charge (*i.e.*, *P*1 + *P*2*a*) and the area of X-section *a* of the conductor.

Similarly, the rectangular hyperbola

(2) gives the relation between annual cost of energy wasted and X-sectional area *a*. By adding the ordinates of curves (1) and (2), the curve (3) is obtained.

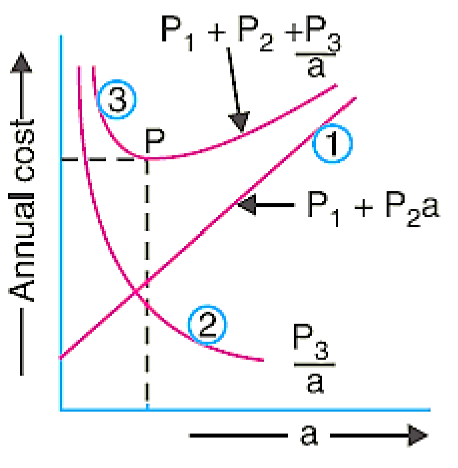

Figure 5.2.1 Graphical Representation of Kelvin's Law

[Source: "Principles of Power System" by V.K.Mehta Page: 128]

This latter curve shows the relation between total annual cost (*P*1 + *P*2*a* + *P*3_*a*) of transmission line and area of X-section *a*. The lowest point on the curve (*i.e.*, point *P*) represents the most economical area of X-section.

Limitations of Kelvin's law.

(*i*) It is not easy to estimate the energy loss in the line without actual load curves, which are not available at the time of estimation.

(*ii*) The assumption that annual cost on account of interest and depreciation on the capital outlay is in the form $P1 + P2a$ is strictly speaking not true. For instance, in cables neither the cost of cable dielectric and sheath nor the cost of laying vary in this manner.

(*iii*) This law does not take into account several physical factors like safe current density, mechanical strength, corona loss etc.

(*iv*) The conductor size determined by this law may not always be practicable one because it may be too small for the safe carrying of necessary current.

(*v*) Interest and depreciation on the capital outlay cannot be determined accurately.