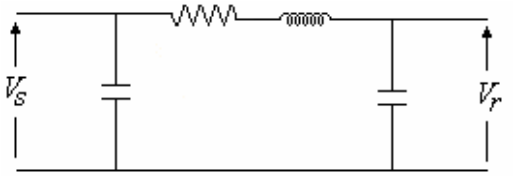
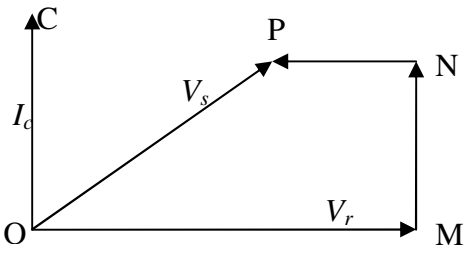
Ferranti Effect

A long transmission line draws a substantial quantity of charging current. If such a line is open circuited or very lightly loaded at the receiving end, the voltage at receiving end may become greater than voltage at sending end. This is known as ***Ferranti Effect*** and is due to the voltage drop across the line inductance (*due to charging current*) being in phase with the sending end voltages. Therefore both capacitance and inductance is responsible to produce this phenomenon.
The capacitance (*and charging current*) is negligible in short line but significant in medium line and appreciable in long line. Therefore this phenomenon occurs in medium and long lines.

Represent line by equivalent *π-model*.





Line capacitance is assumed to be concentrated at the receiving end.

OM = receiving end voltage V_r
OC = Current drawn by capacitance = I_c
MN = Resistance drop
NP = Inductive reactance drop

Therefore;
OP = Sending end voltage at no load and is less than receiving end voltage (V_r)

Since, resistance is small compared to reactance; resistance can be neglected in calculating Ferranti effect.

From π-model,

$$V_s = \left(1+\frac{YZ}{2}\right)V_r + ZI_r \qquad \{\text{refer eq. 5, in } \pi\text{-model ckt. derivation}\}$$

For open circuit line; $I_r = 0$

$$\therefore \quad V_s = \left(1+\frac{YZ}{2}\right)V_r$$

$$\text{or;} \qquad V_s - V_r = \left(1+\frac{YZ}{2}\right)V_r - V_r \quad = \quad V_r\left(1+\frac{YZ}{2}-1\right)$$

$$\text{or;} \qquad V_s - V_r = \left(\frac{YZ}{2}\right)V_r \quad = \quad \frac{(j\omega Cl)\,(r+j\omega L)l}{2}V_r$$

Neglecting resistance;

$$V_s - V_r = \frac{-V_r \omega^2 l^2 LC}{2}$$

The quantity $\frac{1}{\sqrt{LC}}$ is constant in all line and is equal to velocity of propagation of electromagnetic waves (= 3×10^5 km/sec)

$$\sqrt{LC} = \frac{1}{(3\times10^5)} \quad \Rightarrow \quad LC = \frac{1}{(3\times10^5)^2}$$

Substituting the value in above equation;

$$V_s - V_r = \frac{-V_r \omega^2 l^2}{2\,(3\times10^5)^2}$$

$$\therefore \quad V_s - V_r = \frac{-V_r \omega^2 l^2 \times 10^{-10}}{18}$$

$$\therefore \; V_s = V_r\left[1 - \frac{\omega^2 l^2 \times 10^{-10}}{18}\right]$$

Now, from above expression;

$$\left[1 - \frac{\omega^2 l^2 \times 10^{-10}}{18}\right] \; < 1$$

So,

$$V_s < V_r \qquad or; \qquad V_r > V_s$$

i.e. receiving end voltage is greater than sending end voltage and this effect is called ***Ferranti Effect***. It is valid for open circuit condition of long line.