is the resultant of the receiver voltage and the resistance and reactance drop as shown in fig. 1.

If now we assume a power factor of 70 per cent., a very different condition of affairs will obtain, as shown in fig. 2. Fig. 2 shows graphically relative values and angular positions of the generator voltage Eg and the receiver voltage E for 70 per cent. load power factor, both lagging and leading. In this diagram, the horizontal line still represents the phase direction of the load current and the angle that

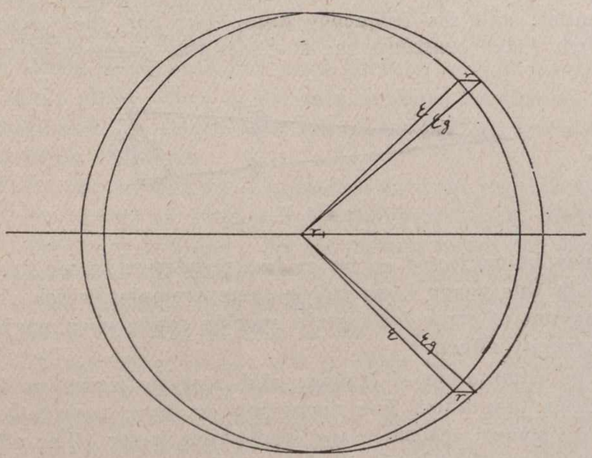
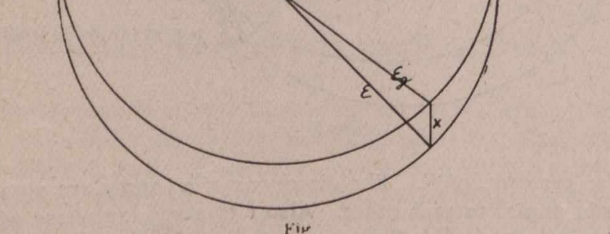


Fig. 3

E makes to the horizontal is the angle of lag or lead of the load current with respect to the load voltage. r and x, of course, remain horizontal and vertical respectively because they must be respectively in phase with and at right angles to the current which is assumed horizontal. It is evident, therefore, that the phase angle of the resultant voltage drop z of r and x with respect to the load voltage E depends upon the power factor of the load. It is therefore evident that so long as the load current is constant and also the load voltage is constant, the generator voltage Eg must follow a circle whose centre is displaced from the circle representing



Fig

E both in direction and distance by the resultant z. In fig. 2 the reactive volts x are still assumed to be 20 per cent. of E, and the resistance volts r 10 per cent.

A little study will show that the relation of these two circles is largely influenced by the ratio of x to r. Fig. 3 shows their relative locations when r is 10 per cent. of E and x is zero.

Fig. 4 shows their relative locations when x is 20 per cent. of E and r is zero.

It is evident from an inspection of figs. 2, 3 and 4 that if a transmission line contains resistance only the generator voltage is always necessarily higher than the receiver voltage; if inductance is present in the transmission line it is possible when the power factor of load is leading to obtain a condition where the generator voltage is lower than the receiver voltage or where, so to speak, the flow of energy is "uphill."

The generator voltage in figs. 2, 3 and 4 is drawn on the assumption that the current taken by the load is constant for all power factors. In actual practice, however, power factor variation of a load is secured by changing the field strength of synchronous motors so that power factor variation causes changes in the current in the transmission line although the true power transmitted remains unchanged. That is, when the true load in the receiver circuit is constant and the power factor changes, the current taken from the transmission line does not remain constant but varies inversely with the power factor.

Fig. 5 shows the shape of the curve taken by the genera-

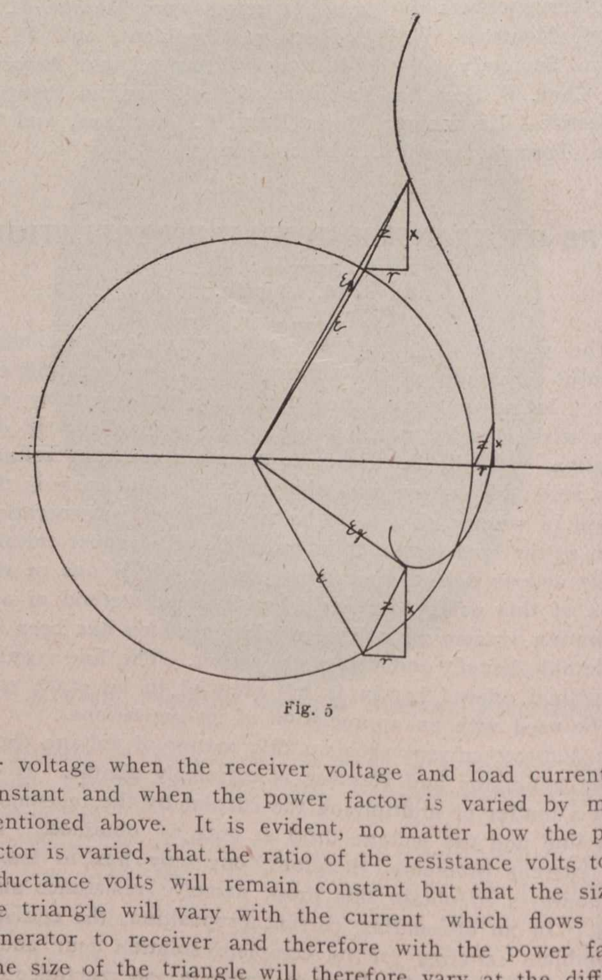


Fig. 5

tor voltage when the receiver voltage and load current are constant and when the power factor is varied by means mentioned above. It is evident, no matter how the power factor is varied, that the ratio of the resistance volts to the inductance volts will remain constant but that the size of the triangle will vary with the current which flows from generator to receiver and therefore with the power factor. The size of the triangle will therefore vary at the different power factors as is indicated by the drop triangles that have been shown in fig. 5.

Referring to all of the figures, it is evident that the transmission line regulation or the drop is equal to Eg—E. If O is the angle of lag of the receiver load and r and x are respectively the ohmic and reactive line drops, Eg is given by the following equation:

$$Eg = \sqrt{(E \cos O + r)^2 + (E \sin O + x)^2} \quad (1)$$

Where Eg = Generator Voltage
" E = Receiver Voltage
" r = Ohmic drop
" x = Inductive drop
" O = Angle of lag