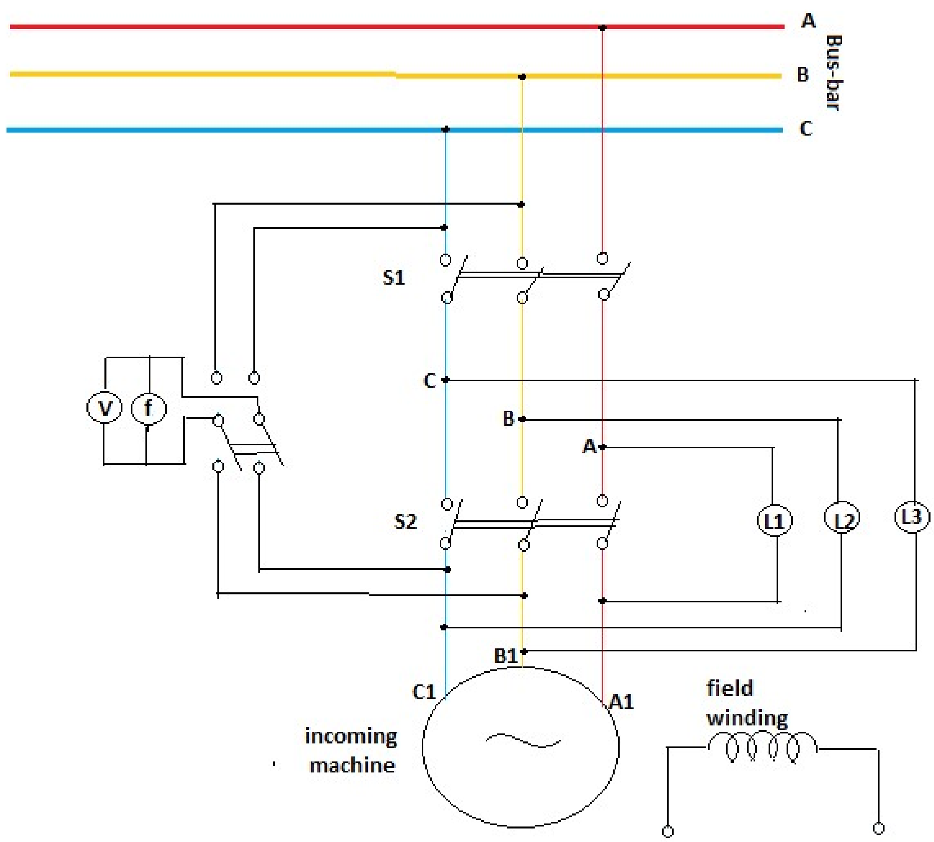
Synchronization is the process of switching connecting an alternator in parallel to another alternator or bus-bar, without any interruption in power flow. The conditions which must be fulfilled are given below:

- The terminal voltage of the incoming machine and the bus-bar must be equal.
- The frequency of the incoming machine and the bus-bsr must be nearly equal.
- The phase sequence of the incoming machine and the bus-bar must be same.

Departure from the above conditions cause appearance of current and power surges accompanied by undesirable electromechanical oscillation of the rotor.



The above figure illustrates the circuit for synchronizing an alternator with the bus bar. Switch S2 is the synchronizing switch. Three lamps L1, L2 and L3 are connected across switch S1. L1 is connected between phase A of the incoming machine and phase A of the bus-bar; L2 is connected between phase C of the incoming machine and phase B of the bus-bar and L3 is connected between phase B of the incoming machine and phase C of the bus-bar.

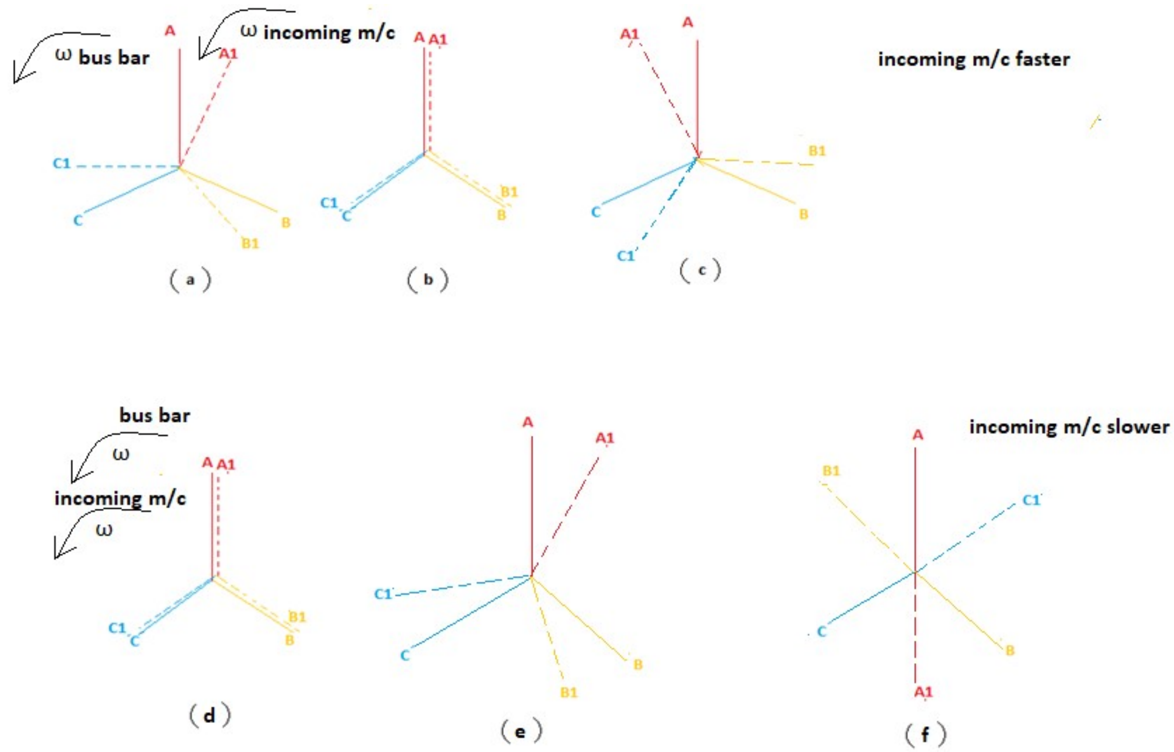
The incoming machine is brought up to its synchronous speed by the prime mover and the field is excited. The field current is adjusted to make the voltage and frequency approximately equal. (ensured by voltmeter “V” and frequency meter “f”.

Suppose the frequencies of the bus bar and the incoming machine are f1 and f2. Then for equal voltages, the voltage across synchronizing switch S2 is

$$V_l = V_m \cos \omega t - V_m \cos \omega_1 t$$

$$V_L = 2V_m \left[\sin\left\{\frac{f_1 - f}{2}(2\pi f)\right\} \sin\left\{\frac{f_1 + f}{2}(2\pi f)\right\}\right]$$

The low frequency is called the beat frequency and the high frequency is called the carrier frequency.

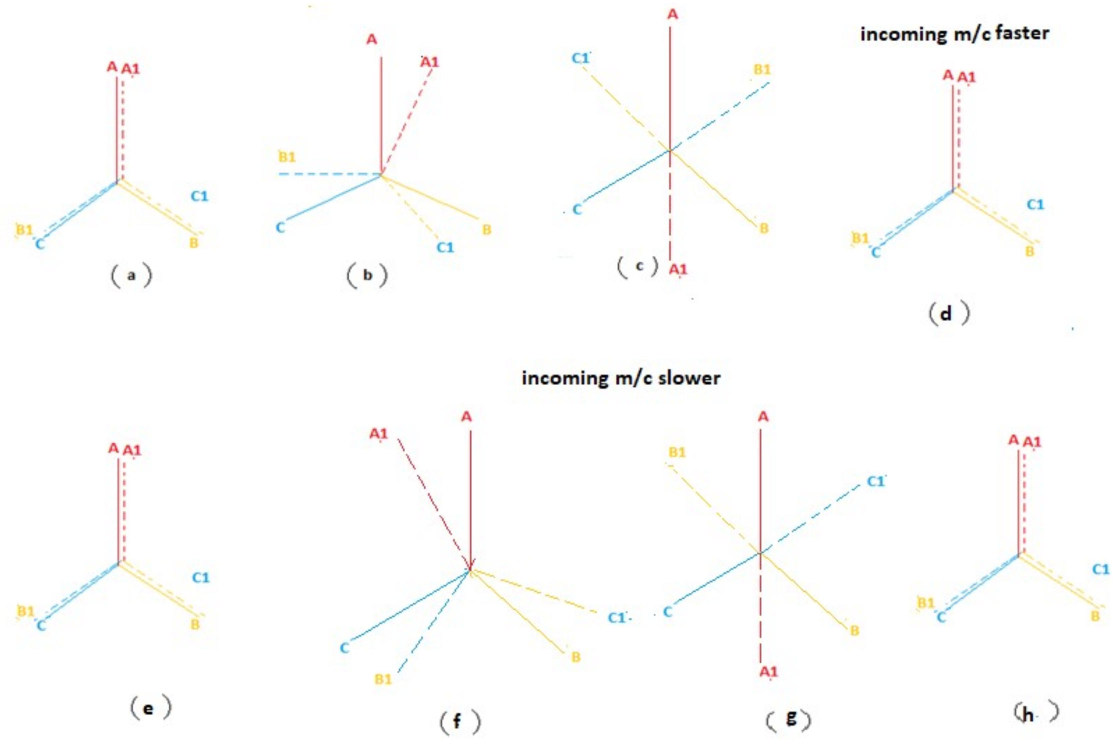


Phasor Diagram

If both the incoming machine and the bus-bar has the same phase sequence, the voltage across the lamp L1 becomes zero when the two phasors are superimposed. But voltage across L2 and L3 are equal to the line voltage. So, L1 will be dark and L2,L3 will be equally bright.(refer fig. (b) and fig. (d)). L1 will gradually starts glowing as the voltage across it ($V_{A\text{-}A1}$) starts increasing. Considering the incoming machine to be faster the phasor A1-B1-C1 will go ahead, so voltage across the lamp L2 ($V_{B\text{-}C1}$) starts decreasing and voltage across the lamp L3 ($V_{C\text{-}B1}$) starts increasing. So, L1 will start glowing gradually and L2 will gradually become dark. Next L3 will become dark.

If the incoming machine is slower the phasor A1-B1-C1 will fall back. L1 will gradually starts glowing as the voltage across it ($V_{A\text{-}A1}$) starts increasing. Voltage across the lamp L2 ($V_{B\text{-}C1}$) starts increasing and voltage across the lamp L3 ($V_{C\text{-}B1}$) starts decreasing. So, L1 will start glowing gradually and L3 will gradually become dark. Next L2 will become dark. As the speed difference is adjusted this sequential glowing will slow down.

If the bus bar and the incoming machine has opposite phase sequence then all the three lamps will glow and become dark together.



Phasor Diagram