SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE401 SYNCHRONOUS AND INDUCTION MACHINES

II YEAR /IV SEMESTER

UNIT – I SYNCHRONOUS GENERATOR

Parallel operation of Synchronous Generators

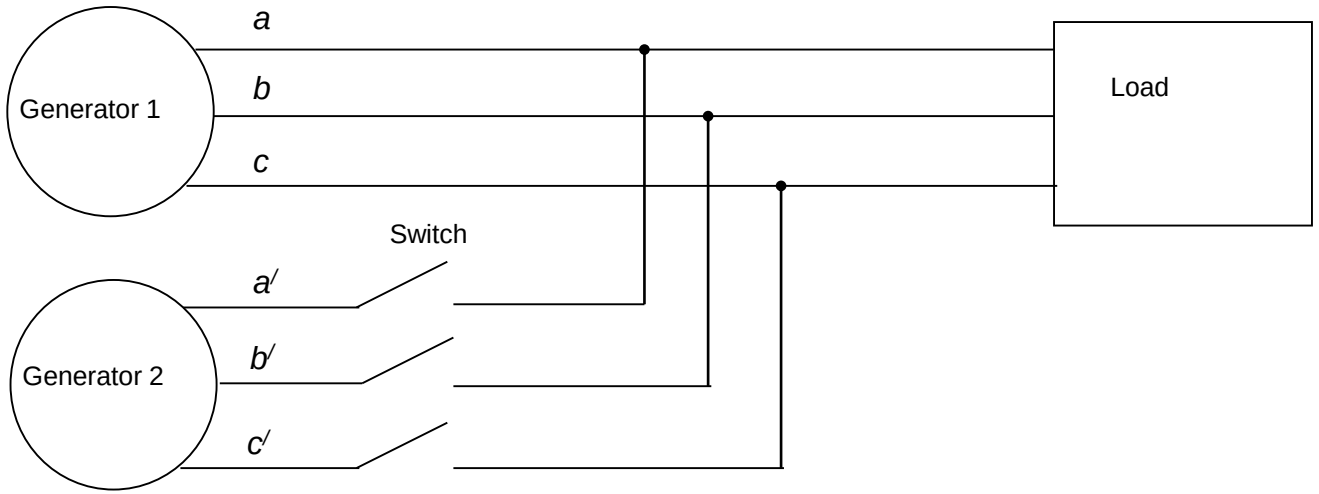
There are several major advantages to operate generators in parallel:

- Several generators can supply a bigger load than one machine by itself.
- Having many generators increases the reliability of the power system.
- It allows one or more generators to be removed for shutdown or preventive maintenance.

Synchronization

Before connecting a generator in parallel with another generator, it must be synchronized. A generator is said to be synchronized when it meets all the following conditions:

- The *rms line voltages* of the two generators must be equal.
- The two generators must have the same *phase sequence*.
- The *phase angles* of the two *a* phases must be equal.
- The *oncoming generator frequency* is equal to the running system frequency.



Synchronizing And Parallel Operation Of Alternators

- Necessary conditions for synchronization :

The terminal voltage, frequency and phase sequence of the incoming machine should be same as those of the bus bars.

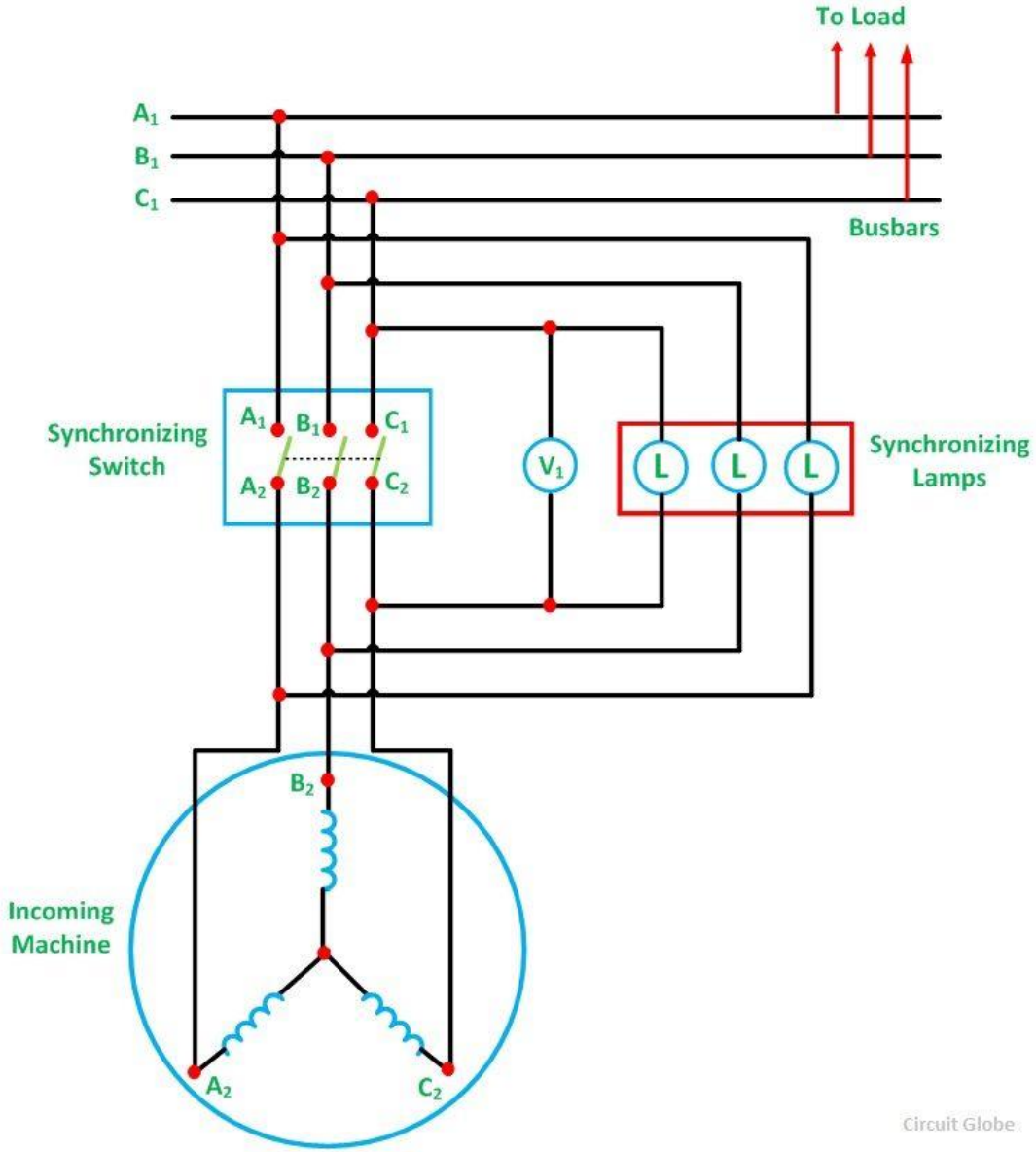
- Synchronization can be carried out using either

i) Dark lamp method

ii) Bright lamp method

iii) Synchroscope method.

Dark Lamp Method



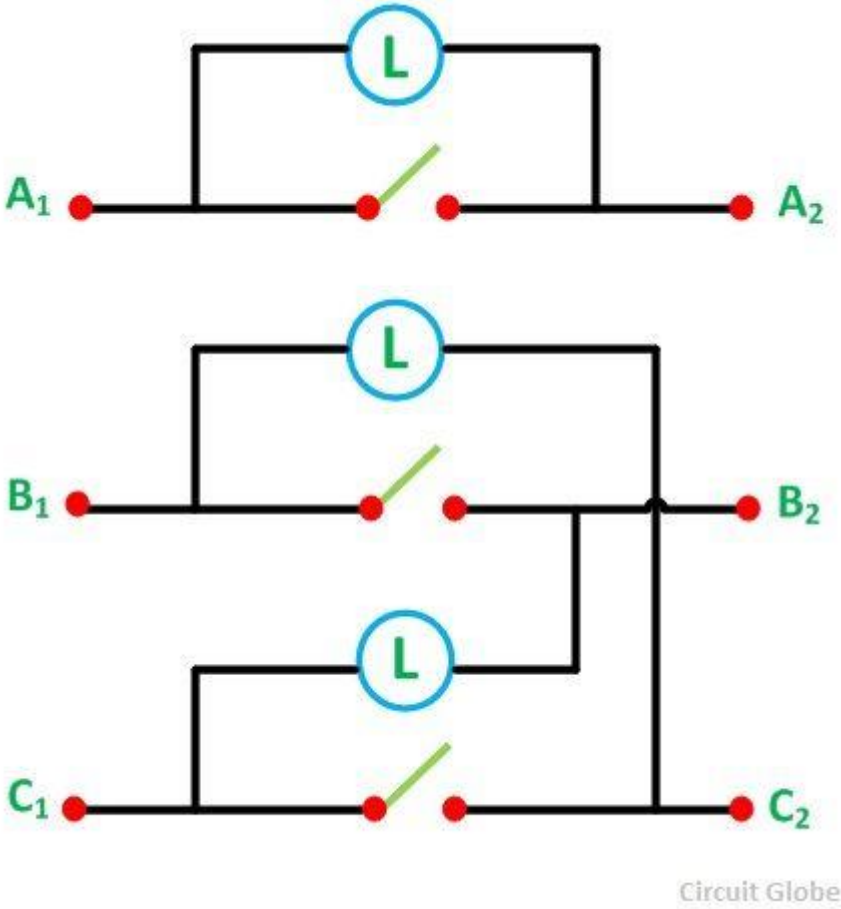
A set of three synchronising lamps can be used to check the conditions for paralleling or synchronisation of the incoming machine with the other machine. A dark lamp method along with a voltmeter used for synchronising is shown below. This method is used for low power machine.

Dark Lamp Method

The prime mover of the incoming machine is started and brought nearer to its rated speed. A field current of the incoming machine is adjusted in such a way so that it becomes equal to the bus voltage. **The flicker of the three lamps occurs at a rate which is equal to the difference in the frequencies of the incoming machine and the bus. All the lamps will glow and off at the same time if the phases are properly connected. If this condition does not satisfy, then the phase sequence is not connected correctly.**

Thus, in order to connect the machine in the correct phase sequence, two leads to the line of the incoming machine should be interchanged. The frequency of the incoming machine is adjusted until the lamp flicker at a slow rate. The flicker rate should be less than one dark period per second. After finally adjusting the incoming voltage, **the synchronising switch is closed in the middle of their dark period.**

Two Bright One Dark Lamp Method



In this method, one lamp is connected between corresponding phases while the two others are cross-connected between the other two phases

Here, A_1 is connected to A_2, B_1 to C_2 and C_1 to B_2. The prime mover of the incoming machine is started and brought up to its rated speed. The excitation of the incoming machine is adjusted in such a way that the incoming machine induces the voltage E_{A1}, E_{B2}, E_{C3}, which is equal to the Busbar voltages V_{A1}, V_{B1} and V_{C1}.

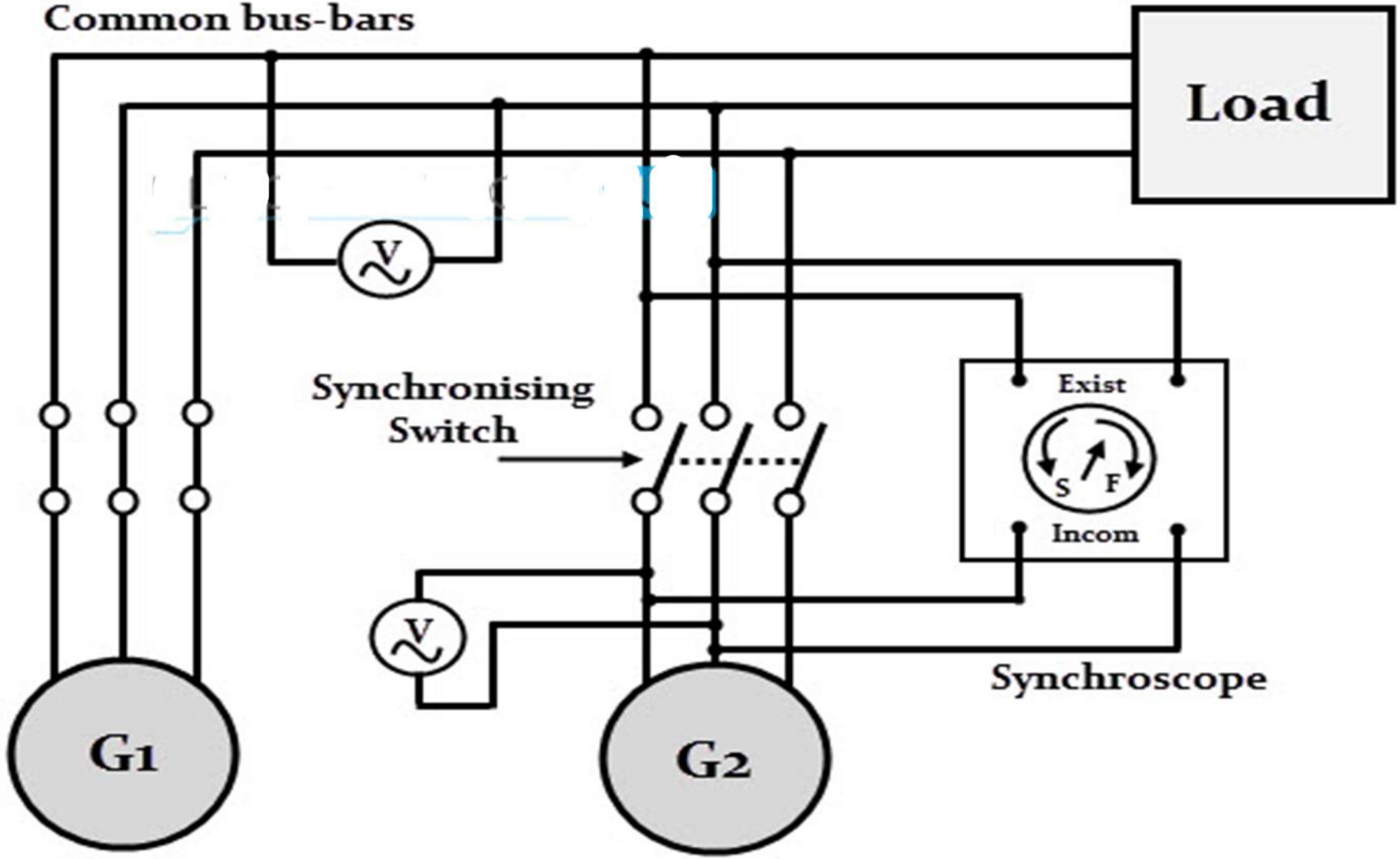
Two Bright One Dark Lamp Method

The correct moment to close the switch is obtained at the instant when the straight connected lamp is dark, and the connected cross lamps are equally bright. If the phase sequence is incorrect, no such instant will take place, and all the lamps will be dark simultaneously.

The direction of rotation of the incoming machine is changed by interchanging the two lines of the machine. Since the dark range of the lamp extends to a considerable voltage range, a voltmeter V_1 is connected across the straight lamp. The synchronising switch is closed when the voltmeter reading is zero.

Thus, the incoming machine is now floating on the Busbar and is ready to take up the load as a generator. If the prime mover is disconnected, it behaves as a motor. For paralleling small machines in power stations, three lamps along with the synchroscope are used. For synchronising very large machine in power stations, the whole procedure is performed automatically by the computer.

SYNCHROSCOPE



SYNCHROSCOPE

It is similar to the two bright and one dark lamp method and indicates whether the alternator frequency is higher or lower than the bus bar frequency. A synchroscope is used for better accuracy of synchronization and it consists of two pairs of terminals.

One pair of terminals marked as ‘existing’ has to be connected across the bus bar terminals or to the existing alternator and other pair of terminals marked as ‘incoming’ has to be connected across the terminals of incoming alternator.

The synchroscope has circular dial over which a pointer is hinged that is capable of rotating in clockwise and anticlockwise directions.

SYNCHROSCOPE

After the voltage condition is checked, the operator has to check the synchroscope. The rate at which the pointer rotates indicates the difference of frequency between the incoming alternator and the bus bar.

Also, the direction to which the pointer rotates (to either fast or slow) gives the information, whether the incoming alternator frequency is higher or lower than the bus bar frequency and hence the pointer moves either fast or slow.

REFERENCES

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THANK YOU