Mains synchronization and control characteristic Of the Synchronous Generator

Object: The object of this experiment is to synchronize the synchronous generator with the aid of the synchronizing dark method so that it operates parallel to the three – phase mains. Calculate the active power which the generator feeds to the mains. Determine the control characteristic IL = f (Ie) for (cos φ = 1).

Theory: If a synchronous generator operates parallel on a mains, it must be synchronized first. The following conditions must be satisfied between the generator and the mains:

- Same voltage.
- Same frequency.
- Same phase sequence.
- Same phase position.

If these conditions are not completely satisfied, a very high compensation current flows which can destroy the generator. Various methods are used to check these conditions. A simple method for this is the synchronizing dark method shown in Figure (45). In this a filament lamp is circuited between mains and the synchronous machine in every phase. At equal amplitude and phase sequence, but low frequency difference, a beat is produced in the light intensity of the lamp which gets lower or slower the more the frequencies approach. The generator operates synchronously with the mains when the lamps go out. The switch via which the generator is connected to the mains must then be closed. Table (15) gives an exact description of the synchronization conditions for the synchronizing dark method.

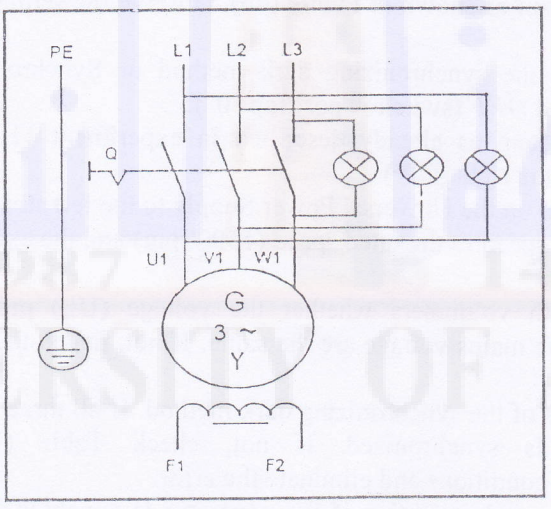

Figure (45)
Synchronization with synchronizing dark method

Table (15)

Description of the synchronization conditions with synchronizing dark method

Condition	Check	Condition satisfied	Condition not satisfied	Remedy
same voltage	Measure the mains voltage and the voltage on the machine.	Mains voltage and voltage on the machine are the same.	Mains voltage and voltage on the machine are not the same.	Change the excitation until voltages match.
same frequency	synchronizing dark method	All lamps are dark.	All lamps light together and rhythmically.	Match the speed of the machine by „fine" increase or reduction.
same phase sequence	synchronizing dark method	All lamps go on and off regularly (frequencies not the same) or all lamps are dark.	revolving light	Exchange any two phases on the machine.
same phase position	synchronizing dark method	All lamps are dark.	All lamps light.	Reduce the speed briefly, then increase the speed again.

Necessary equipments:

1. Synchronous Machine (Type 2711).
2. Brake Unit (Type 2719).
3. Control Unit (Type 2730).
4. Universal Power Supply (Type 2740).
5. Synchronization with lamps (Type 2289).
6. Power factor meter (10 A).
7. 2 Ammeters, range (0 – 5 A).
8. 2 Voltmeters, range (0 – 1000) V.

Procedure:

1. Connect the circuit as shown in Figure (46). Observe the setting of the torque attenuator.
2. Make sure that the synchronizing dark method or Synchronization (Type 2289) is switched *OFF* (switch in position "0").
3. Start up the system as already described in experiment 11. The machine should rotate to the right (CW).
4. Set the excitation on the Universal Power Supply to the left stop (0 V).
5. Set the machine speed to the rated speed (1500 rpm) and the excitation field to (0.95 A).
6. Check with both voltmeters whether the voltage (UL) produced by the generator and the mains voltage are the same. If not, match the voltages with the excitation.
7. Watch the lamps of the synchronizing dark method. If all three lamps are dark the generator is synchronized. If not, check Table (15) with the synchronization conditions and eliminate the error.
8. Switch *ON* the synchronization if the generator is synchronized (switch on position "1").
9. Measure the voltage (UL), the current (IL) and the power factor ($\cos \varphi$). Record the values:

UL = ... V
IL = ... A
cos φ = ...

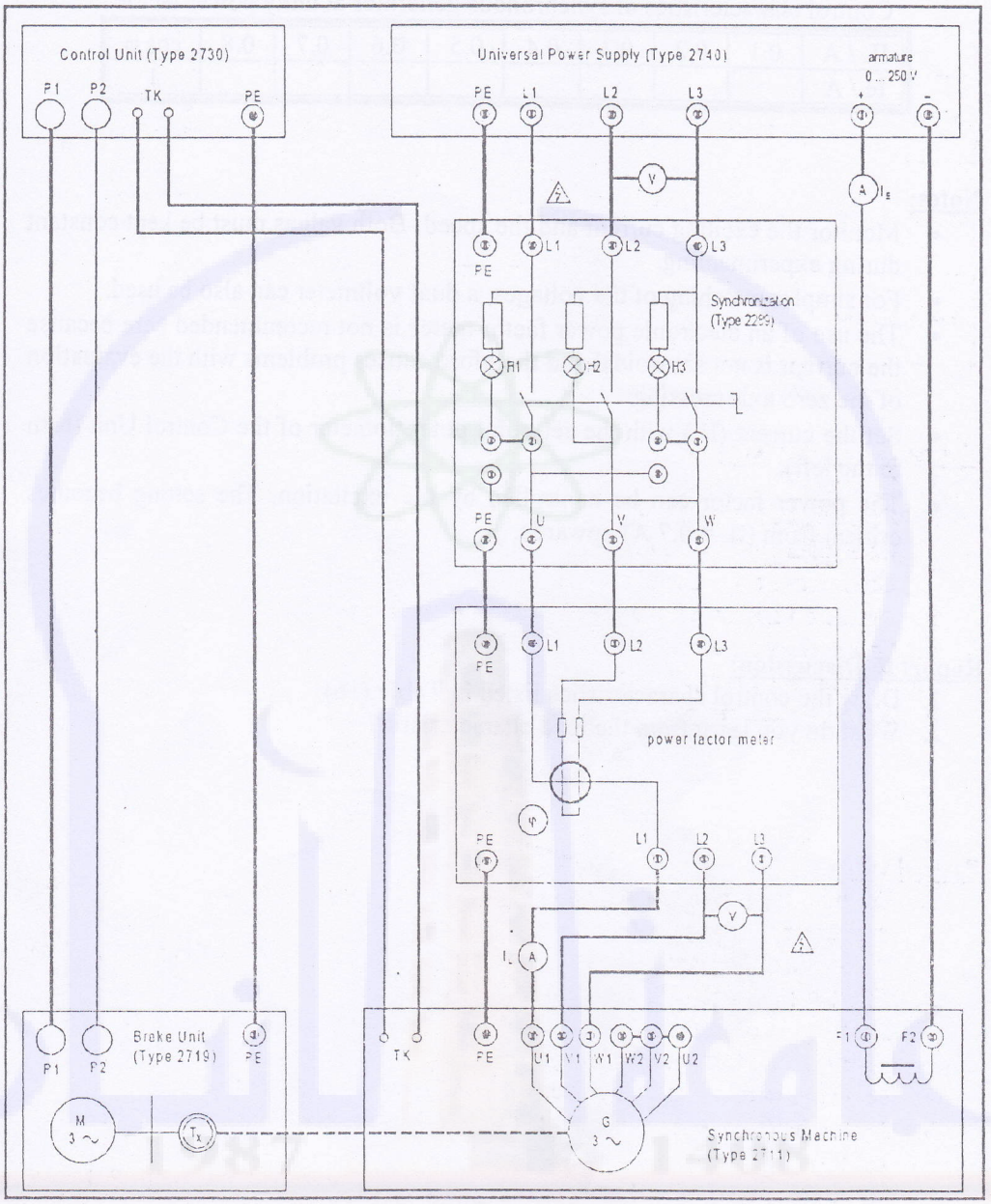

Figure (46)
Connection circuit diagram for synchronizing the synchronous generator
With the Synchronizing Dark Method

10. Set the values for IL and (cos φ) specified in Table (16) one after the other to record the control characteristic. Measure the respective exciting current (Ie).
11. Switch (*OFF*) the system.
12. Calculate the active power which the generator feeds to the mains;
    Pin = ...KW

Table (16)

Control characteristics of synchronous generator at unity power factor

IL / A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	cos φ
Ie / A									1

Notes:

- Monitor the exciting current and the speed. Both values must be kept constant during experimenting.
- For simpler matching of the voltages, a dual voltmeter can also be used.
- The use of an electronic power factor meter is not recommended here because the current is not sinusoidal and therefore causes problems with the evaluation of the zero axis crossing.
- Set the current (IL) with the set point potentiometer of the Control Unit (turn to the left).
- The power factor can be controlled by the excitation. The setting becomes critical from (IL = 0.7 A) upwards.

Report & Discussion:

1. Draw the control characteristics listed in Table (16).
2. What do you learn from the load characteristic?