The Excitation System

The excitation system provides the necessary field current to the rotor winding of the synchronous machine. The amount of excitation system depends on the power factor, speed of the machine and the load current. An excitation may be a centralized excitation system or individual excitation system. The main requirements of an excitation system are reliability, simplicity, stability and high transient response.

The excitation system can be broadly classified into following types:

1. ***The DC Excitation System***
2. ***The AC Excitation System***
3. ***The Static Excitation System***

17.1 The DC Excitation System:

The DC excitation system consist of dc generators for supplying field current to the synchronous machine.
The system has two exciters; the main exciter & the pilot exciter.

- ***The main exciter is a separately excited dc generator and provides the field current to the alternator.***
- ***The pilot exciter is generally a compound wound self excited dc generator and supplies the field current to the main exciter.***

The main & pilot exciter can be either driven by the main shaft or separately driven by a motor. A sudden opening of

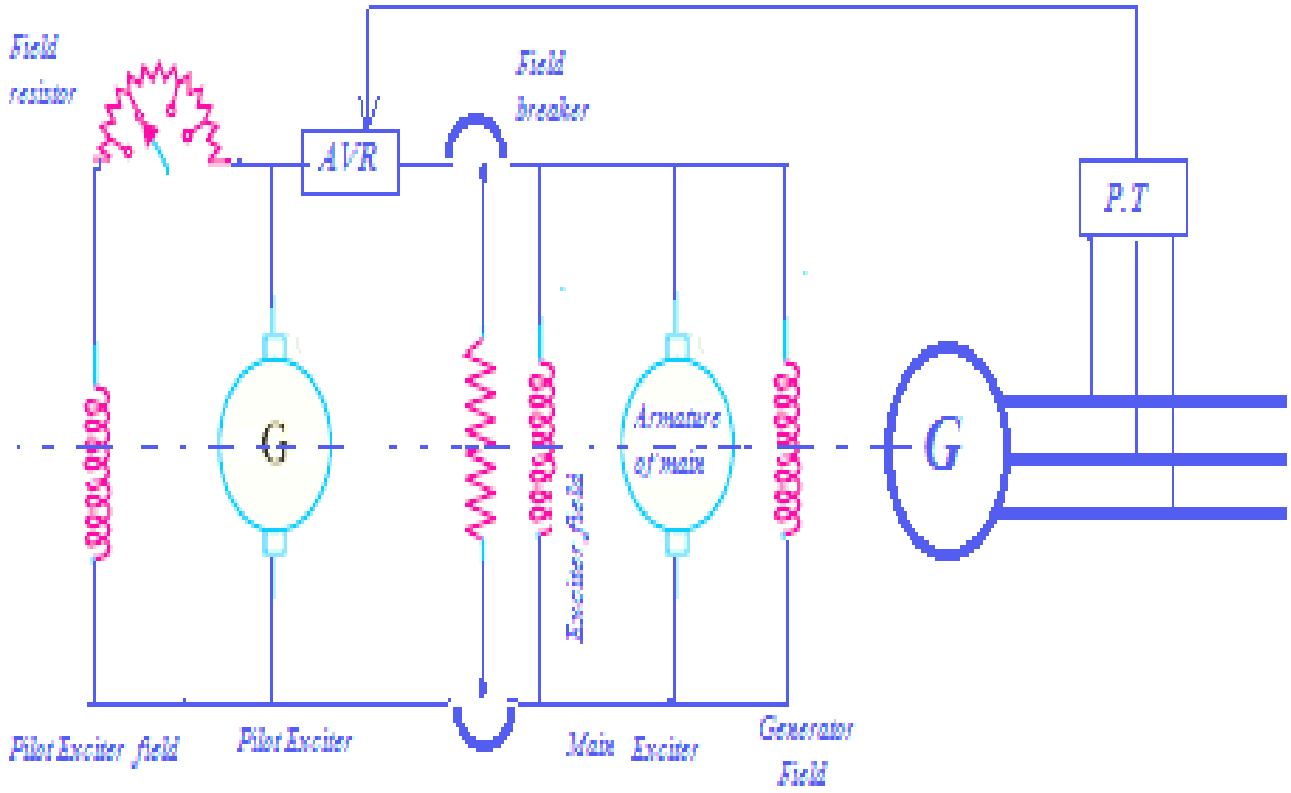
the excitation system may causes a high voltage to be induced in the inductive field winding due to a sudden release of energy stored in it. As the field breaker opens, it connects of field discharge resistance across the field winding and the energy is dissipated in this resistor.

In some cases the dc excitation system is equipped with amplidyne control. The amplidyne is a high response cross field generator, energized from automatic voltage regulator (AVR). The voltage rating of the main exciter, for both hydro generator and turbo alternator, is around 400V. The exciter capacity 0.5% of alternator capacity.

The main drawback of dc excitation systems are;

1- large time constant (about 3sec) and

2- commutation difficulties.



17.2 A.C. Excitation System:

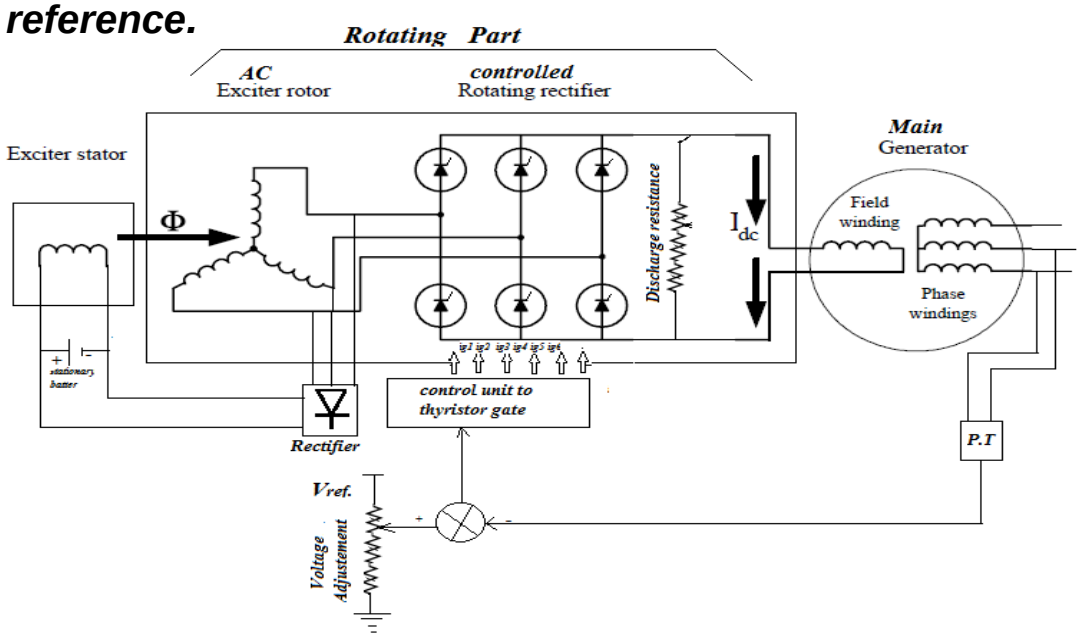
An excitation system consists of an ac generator and thyristor rectifier bridge directly connected to the alternator shaft. This approach eliminates the commutator, the main alternator field collector and the other connections. The main exciter can either be self excited or separately excited. There are two types of AC excitations;

17.2.1 The Rotating Thyristor Excitation System:

It consists of ac exciter having a rotating armature and stationary field winding. The output of the exciter is rectified by a full wave thyristor bridge rectifier circuit and fed to the field winding of the main alternator. The field winding of the exciter is also fed from the exciter output through another rectifier circuit. The station battery used for shorten voltage build up in the exciter.

The main alternator field rectifier generally consists of four parallel thyristors each having a fuse in its circuit so that if the thyristor fails, the fuse opens thereby allowing the system to continuous operation.

The system is equipped with automatic voltage regulator, the generator voltage signal is averaged and compared with voltage reference.

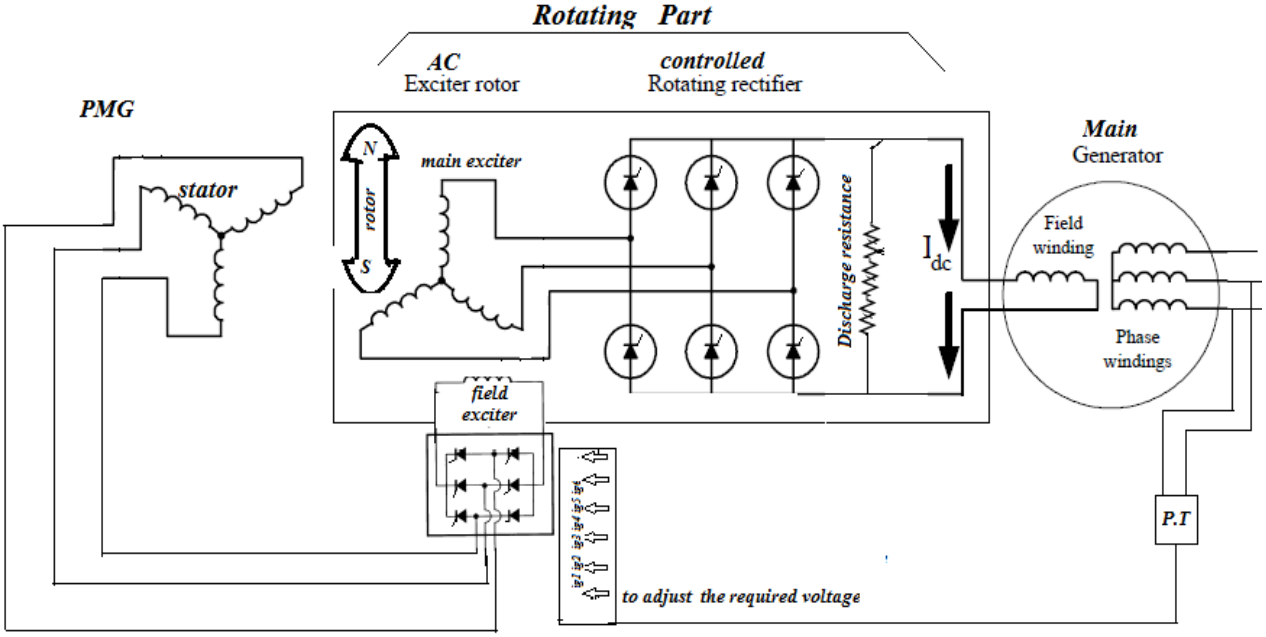


17.2.2 Brushless Excitation System:

The excitation system consists of an alternator rectifier main exciter and a permanent magnetic generator (PMG) pilot exciter. Both the main and pilot exciter are driven directly from the main shaft. The main exciter has a stationary field and a rotating armature which is directly connected, the bridge controlled rectifier to main alternator field. Thus the commutator, collectors and brushes are eliminated.

The main exciter field is fed from a shaft driven permanent magnet generator having rotating permanent magnet attached to the shaft a stationary three phase armature. The ac output of PMG is rectified by a three controlled rectifier thyristor bridge. The base excitation is controlled by an input setting to the thyristor gating circuits. This control signal is derived from PMG via a regulated dc supply with regulator logic circuit.

<u>The advantages of brushless excitation system are eliminate of commutator, collectors, brushes, reducing the time constant and increasing response to less than 0.1sec, which is improve dynamic performance and power stabilizing signals.</u>

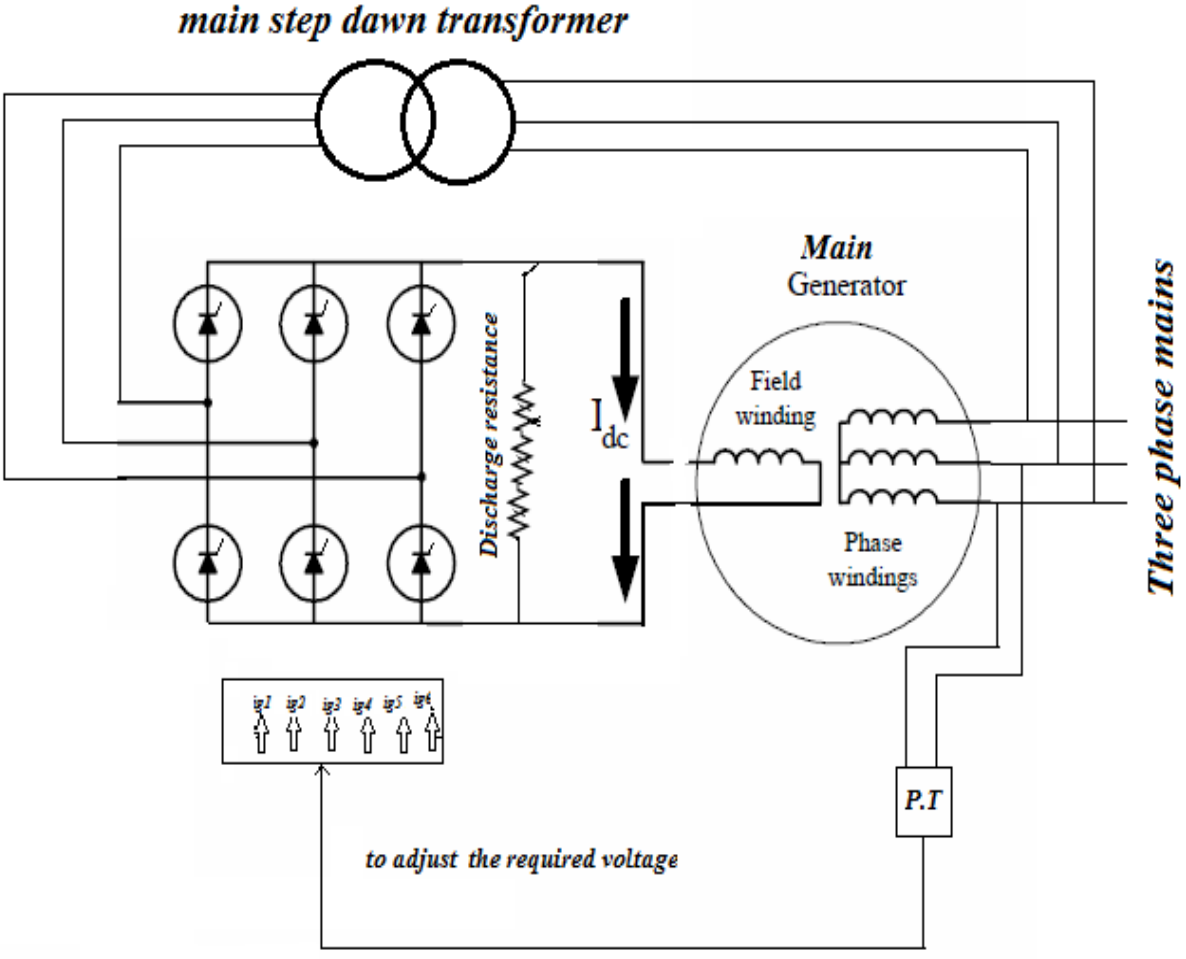


17.3 The Static Excitation System:

A static excitation system draws excitation power from the main alternator terminals through a step down transformer and a rectifier system using silicon controlled rectifier (SCR). The static excitation system have a very small response time about 20msec and provides excellent dynamic performance. The advantage of static excitation circuits are;

1. ***Elimination of exciter windage losses, commutator bearing and winding maintenance, all these factors result in reduced operating cost.***
2. ***The static excitation system responds with electronic speed.***

From the main synchronous machine itself through a transformer rectifier bank unit. For large synchronous machines, quite a dc often exciter is placed between the main machine and the transformer rectifier bank unit.



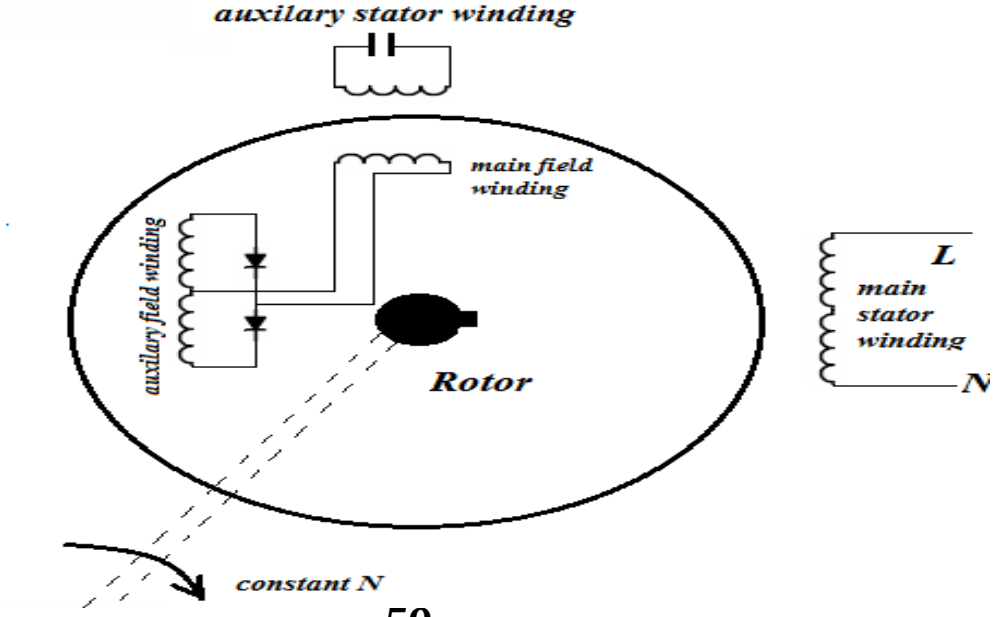
17.4 Excitation in single phase S.G:

The Stator has two windings, the main winding which delivers power to the external load, another auxiliary stator winding. The auxiliary windings are connected across the capacitor.

When the alternator rotor is driven by its prime mover, the residual flux present in the machine causes a small emf to get induced, to start in both main and auxiliary winding. The emf in auxiliary winding charges current through capacitor. This current set up additional flux in the air gap that induces emf in the auxiliary field winding. This is rectified to dc by two diodes fitted in the rotor itself and dc voltage causes the main field winding to get its exciting current.

Fluxes set up by main field winding increases the air gap fluxes caused voltage induced in both stator windings.

Auxiliary armature and main armature winding delivers load current, an additional flux is set up by current carrying main winding giving rise to an extra emf getting induced in auxiliary winding by transformer action. Tis causes the charging in auxiliary winding to increase, the air gap flux to increase and the emf induced in main stator winding to increase and compensates for the voltage drops due to armature resistance synchronous reactance. Thus the voltage across load terminal remains fairly constant.



17.5 The Automatic Voltage Regulators(AVR):

Every alternators in modern power plants is equipped with an automatic voltage regulator, whose functions are:

1- ***Control of system voltage between prescribed limit.***
2- ***Increase of excitation under system fault conditions, to prevent losses of synchronism.***
3- ***Prevention of dangerous over voltage on the occurrence of sudden loss of load on the system.***
4- ***Proper division of reactive power between the unit operating in parallel.***

Qualities of AVR:

1- ***High gain***
2- ***Good open circuit response***
3- ***Good steady stability***
4- ***High speed of response***