Electrical Engineering Tutorials

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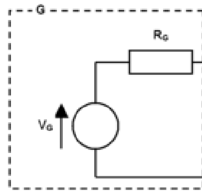
13 MARCH, 2007

Generator Equivalent circuit and Main parts



Equivalent circuit of Generator and load
G = generator
V_G= generator open-circuit voltage
R_G= generator internal resistance
V_L= generator on-load voltage
R_L= load resistance

The equivalent circuit of a generator and load is shown in the diagram to the right. To determine the generator's V_G and R_G parameters, follow this procedure:

- Before starting the generator, measure the resistance across its terminals using an ohmmeter. This is its DC internal resistance R_{GDC}.
- Start the generator. Before connecting the load RL, measure the voltage across the generator's terminals. This is the open-circuit voltage V_G.
- Connect the load as shown in the diagram, and measure the voltage across it with the generator running. This is the on-load voltage V_L.
- Measure the load resistance R_L, if you don't already know it.
- Calculate the generator's AC internal resistance R_{GAC} from the formula

$$R_{GAC} = R_L \left(\frac{V_G}{V_L} - 1 \right)$$

Note 1:The AC internal resistance of the generator when running is generally slightly higher than its DC resistance when idle. The above procedure allows you to measure both values. For rough calculations, you can omit the measurement of RGAC and assume that RGAC and RGDC are equal.
Note 2: If the generator is an AC type (distinctly not a dynamo), use an AC voltmeter for the voltage measurements.

Maximum power : The maximum power theorem applies to generators as it does to any source of electrical energy. This theorem states that the maximum power can be obtained from the generator by making the resistance of the load equal to that of the generator. However, under this condition the power transfer efficiency is only 50%, which means that half the power generated is wasted as heat and Lorentz force or back emf inside the generator. For this reason, practical generators are not usually designed to operate at maximum power output, but at a lower power output where efficiency is greater.

Terminology:
The parts of a dynamo or related equipment can be expressed in either mechanical terms or electrical terms. Although distinctly separate, these two sets of terminology are frequently used interchangeably or in combinations that include one mechanical term and one electrical term. This causes great confusion when working with compound machines such as a brushless alternator or when conversing with people who are used to working on a machine that is configured differently than the machines that the speaker is used to.

Mechanical

- Rotor: The rotating part of an alternator, generator, dynamo or motor.
- Stator: The stationary part of an alternator, generator, dynamo or motor.

Electrical

- Armature: The power-producing component of an alternator, generator, dynamo or motor. The armature can be on either the rotor or the stator.
- Field: The magnetic field component of an alternator, generator, dynamo or motor. The field can be on either the rotor or the stator and can be either an electromagnet or a permanent magnet.

Main Parts of Generator :

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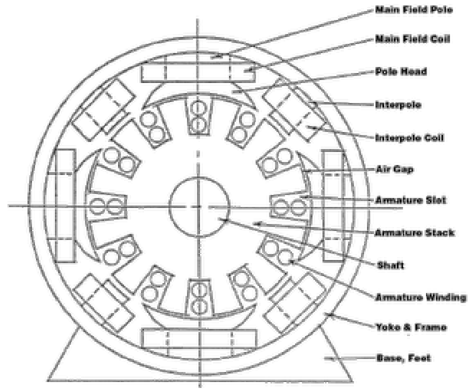
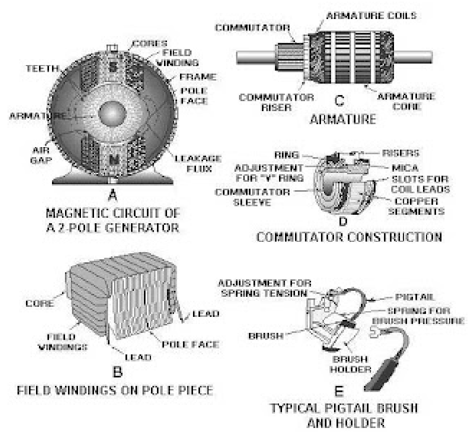


Actual generator consists of the following essential parts
1. Magnetic frame or Yoke **2**. Pole-cores and Pole-Shoes **3**.Field Poles **4**. Field Coils **5**. Armature Core **6**. Armature Windings or Conductors **7**.Commutator **8**. Brushes and Bearings



In the above figure,views A through E, shows the component parts of dc generators.

Yoke

Yoke is a outer frame. It serves two purposes.
(i) It provides mechanical support for the poles and acts as a protecting cover for the whole machine and
(ii) It carries the magnetic flux produced by the poles.
In small generators where cheapness rather than weight is the main consideration, yokes are made of cast iron. But for large machines usually cast steel or rolled steel is employed.The modern process of forming the yoke consists of rolling a steel slab round a cylndrical mandrel and then welding it at the bottom. The feet and the terminal box etc, are welded to the frame afterwards.Such yokes possess sufficient mechanical strength and have high permeability.

Pole Cores and Pole Shoes The field magnet consist of pole ores and pole shoes. The pole shoes have two purposes
(i) they spread out the flux in the air gap and also, being larger cross section,reduce the reluctance of the magnetic path
(ii) they support the exciting coils (field coils)

Field Poles

The pole cores can be made from solid steel castings or from laminations. At the air gap, the pole usually fans out into what is known as a pole head or pole shoe. This is done to reduce the reluctance of the air gap. Normally the field coils are formed and placed on the pole cores and then the whole assembly is mounted to the yoke.

Field Coils

The field coils are those windings, which are located on the poles and set up the magnetic fields in the machine. They also usually consist of copper wire are insulated from the poles. The field coils may be either shunt windings (in parallel with the armature winding) or series windings (in series with the armature winding) or a combination of both.

Armature Core or Stack The armature stack is made up thin magnetic steel laminations stamped from sheet steel with a blanking die. Slots are punched in the lamination with a slot die. Sometimes these two operations are done as one. The laminations are welded, riveted, bolted or bonded together.
It houses the armature conductors or coils and causes them to rotate and hence cut the magnetic flux of the field magnets.In addition to this its most important function is to provide a path of low reluctance to the flux through the armature from a N-pole to a S-pole.It is cylindrical or drum shaped and is built up of usually circular sheet stee discs or laminations approximtely 5mm thick.It is keyed to the shaft.

Armature Windings

Power Failures,Protection from outages and Restora...
Electric Power Systems and its components
Thermal power plant,Advantages and Disadvantages
Power Station or Power Plant and classification
Combination of Two Port Networks
Two Port Networks - Z , Y , h , g , ABCD Parameter...
Vector Diagrams - RLC Series and Parallel circuit
Parallel and Series Resonance
Electrical Resonance and Resonant frequency
Capacior Transient Response
Inductor Transient Response
Faraday's Law and Lenz's Law
Transient Response and Time constant
Admittance and Susceptance
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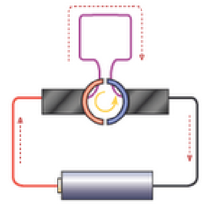
The armature windings are usually former-wound. These are first wound in the form of a flat rectangular coils and are then pulled into their proper shape in a coil puller.Various conductors of the coil are insulated rom each other.The conductors are placed in the armature slots which are lined with tough insulating material.This slot insulation is folded over above the armature conductors placed in the slot and is secured in place by special hard wood or fibre wedges.

CommutatorA commutator is an electrical switch that periodically reverses the current in an electric motor or electrical generator.It converts the alternating current induced in the armature conductors into unidirectional current in the external load circuit.

It typically consists of a set of copper contacts, fixed around the circumference of the rotating part of the machine (the rotor), and a set of spring-loaded carbon brushes fixed to the stationary part of the machine (the stator) that complete the electrical circuit from the rotor's windings to the outside of the machine. Friction between the copper contacts and the brushes eventually causes wear to both surfaces. The carbon brushes, being made of a softer material, wear faster and are designed to be replaced easily without dismantling the machine. The copper contacts are usually inaccessible and, on small motors, are not designed to be repaired. On large motors the commutator may be re-surfaced with abrasives. Each segment of the commutator is insulated from the adjacent segments; a large motor may contain hundreds of segments.



Conventional continuous current flows from the battery. The commutator itself is the red and blue curved segments. The brushes are dark gray and contacting the commutator contacts, and the rotor winding is violet. As the motor rotates, the commutator contacts will turn through 180° and the current flowing in the winding will reverse. However the fixed magnetic field that the rotor is in has also switched polarity relative to the rotor winding, and so rotation continues in the same direction.

Brushes and Bearings

The brushes whose function is to collect currnet from commutator,are usually made of carbon or graphite and are in the shape of a rectangular block. These brushes are housed in brush-holders usually of the box type variety.

Because of their reliability, ball-bearings are frequently employed,though for heavy duties,roller bearings are preferable.The ball and rollers are generally packed in hard oil for quieter operation and for reduced bearing wear,sleeve bearings are used which are lubricated by ring oilers fed from oil reservoir in the bearing bracket.

To know more about Generator basics, operating principle and construction Click here

Posted by Admin at 11:15 AM

Labels: Generator

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