Experiment 4

The DC Compound Generator

OBJECTIVE

To study the properties of compound DC generators under no-load and full-load conditions.

To learn how to connect both the compound and the differential compound generators.

To obtain the armature voltage vs armature current load curves for both generators.

DISCUSSION

Self-excited shunt generators have the disadvantage in that changes in their load current from no-load cause their output voltage to change also. Their poor voltage regulation is due to three factors:

1. The magnetic field strength drops as the armature voltage drops, which further reduces the magnetic field strength, which in turn reduces the armature voltage, etc.
2. The armature voltage drop (I2 x R losses) from no-load to full-load.
3. The running speed of the driving motor may change with load. (This is particularly true of internal combustion engines and induction motors).

The two field windings (shunt and series) on the compound generator are connected so that their magnetic fields aid each other. Thus, when the load current increases, the current through the shunt field winding decreases, reducing the strength of the magnetic field. But, if the same increase in load current is made to flow through the series field winding, it will increase the strength of the magnetic field.

With the proper number of turns in the series winding, the increase in magnetic strength will compensate for the decrease caused by the shunt winding. The combined magnetic field strength remains almost unchanged and little change in output voltage will take place as the load goes from no-load to full-load.

If the series field is connected so that the armature current flows in such a direction as to oppose the shunt field, we obtain a differential compound generator. This type of generator has poor regulation but is useful in applications such as welding and arc lights where maintaining a constant output current is more important than a constant output voltage. It is the purpose of this Experiment to show these major points.

EQUIPMENT REQUIRED

<To be updated>

PROCEDURE

**CAUTION!**

**High voltages are present in this Experiment! Do not make any connections with the power on! The power should be turned off after completing each individual measurement!**

1. Because of its constant running speed, the synchronous motor will be used to mechanically drive the DC generator. Using your Power Supply, AC Ammeter and Three-Phase Synchronous Motor/Generator, connect the circuit shown in Figure 4.1.

A close up of text on a white background

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Figure 4.1.

1. Terminals 1, 2, and 3 on the power supply provide fixed three-phase power for the three stator windings (Three-phase power will be covered in later Experiments). Terminals 8 and N on the power supply provide fixed DC power for the rotor winding. Set the rheostat control knob to its proper position for normal excitation.
2. :
   1. Using your DC Motor/Generator, DC Voltmeter/Ammeter and Resistive Load, connect the circuit shown in Figure 4.2.

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Figure 4.2.

* 1. Couple the synchronous motor and the DC generator with the timing belt.
  2. Turn the DC generator field rheostat control knob full cw for minimum resistance.
  3. Make sure the brushes are in their neutral position.
  4. Place the resistance switches for no-load (all switches open).

1. :
   1. Turn on the power supply. The synchronous motor should start running.
   2. Close the switch S.
   3. Note if voltage EA builds up. Yes/No
   4. If not, turn off the power supply and interchange any two of the stator connection leads on the synchronous motor.
   5. Measure the open circuit armature voltage.

EA = \_\_\_\_\_\_\_\_\_\_ Vdc

1. Vary the field rheostat and notice if the armature voltage EA changes. Explain. Yes/No

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Adjust the field rheostat for a no-load current (IA = 0 A) and output voltage EA of 120 Vdc.

**Do not touch the field rheostat control for the remainder of the Experiment!**

1. :
   1. Adjust the load resistance to obtain each of the values listed in Table 4.1.
   2. Measure and record EA and IA for each of the resistance values listed in the Table.

**Note:** Although the nominal output current rating of the generator is 1 A dc, it may be loaded up to 1.5 A dc (50% overload) without harm.

* 1. Turn off the power supply.
  2. Calculate and record the power for each of the resistance shown in Table 4.1.

Table 4.1.

|  |  |  |  |
| --- | --- | --- | --- |
| RL (ohms) | IA (amps) | EA (volts) | Power (watts) |
| ∞ |  |  |  |
| 600 |  |  |  |
| 300 |  |  |  |
| 200 |  |  |  |
| 150 |  |  |  |
| 120 |  |  |  |
| 100 |  |  |  |
| 80 |  |  |  |
| 75 |  |  |  |

1. :
   1. Change the connections to the series field only, so that the armature current flows through it in the opposite direction.
   2. Complete the drawing shown in Figure 4.3 showing your proposed circuit change.
   3. Have your instructor check your circuit and your drawing.

A picture containing clock

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Figure 4.3.

1. :
   1. Turn on the power supply.
   2. Adjust the field rheostat for an EA of 120 Vdc.
   3. Do not touch the rheostat after this.
2. :
   1. Adjust the load resistance to obtain each of the values listed in Table 4.2.
   2. Measure and record EA and IA for each of the resistance values listed in the Table.
   3. Turn off the power supply.
   4. Calculate and record the power for each of the resistances shown in Table 4.2.

Table 4.2

|  |  |  |  |
| --- | --- | --- | --- |
| RL (ohms) | IA (amps) | EA (volts) | Power (watts) |
| ∞ |  |  |  |
| 600 |  |  |  |
| 300 |  |  |  |
| 200 |  |  |  |
| 150 |  |  |  |
| 120 |  |  |  |
| 100 |  |  |  |
| 80 |  |  |  |
| 75 |  |  |  |

REVIEW QUESTIONS

1. State which procedure, (7 or 10) is concerned with:
   1. the differential compound generator.

Procedure \_\_\_\_\_\_\_\_\_\_

* 1. the compound generator.

Procedure \_\_\_\_\_\_\_\_\_\_

1. Plot the EA vs IA regulation curve on the graph of Figure 4.4. Use the data from Table 4.2.

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Figure 4.4.

1. Over what voltage range is the armature current nearly constant in the differential compound generator?

From \_\_\_\_\_\_\_\_\_\_ Vdc to \_\_\_\_\_\_\_\_\_\_ Vdc

1. Plot the EA vs IA regulation curve on the graph of Figure 4.5. Use the data from Table 4.1.

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Figure 4.5.

1. Calculate the regulation from no-load to full-load (1 Adc) for the compound generator.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Regulation = \_\_\_\_\_\_\_\_\_\_ %

1. Compare the regulation of the compound generator with the regulation of the self-excited generator and the separately-excited generator.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Explain briefly why the voltage does not drop with increasing load for the compound generator.

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