Ward Leonard Motor-Generator Set

Objective
To control the speed of a DC motor using a Ward Leonard motor-generator set.

Apparatus
1. 3 x FHP 12V DC motors with separate field connections
2. 4 mm leads
3. 56 Ω rheostat connected as a potentiometer
4. Reversing switch
5. Rubber tube to connect pair of motors
6. Unilab PSU

Method
1. Couple two of the motors using the rubber tube.
2. Set the PSU to 15V
3. Set the switch to its central position (OFF).
4. Set the rheostat to minimum.
5. Connect the components as shown in the schematic, bear in mind that high currents flow in the armature connections, so arrange these leads to minimise voltage drop.
6. Switch ON.
7. Move the reversing switch to one direction.
8. Increase the speed by slowly moving the rheostat to the maximum position.
9. Decrease the speed to zero by moving the rheostat to the minimum position.
10. Move the reversing switch to the opposite direction.
11. Increase and decrease the speed as before.
The Ward Leonard system was used to provide a variable speed drive that was capable of very fine speed adjustment and easily reversed. The speed of a DC motor can be controlled by reducing the current through the field winding – which weakens the field and thus increases the speed of the motor. The alternative is to reduce the voltage to the armature windings which reduces the speed – this can be done by adding resistance in series with the armature. Both these methods are used but only give a limited control of the speed and make it more dependent on the mechanical load.

What is required is a method of adjusting the armature voltage smoothly from zero to maximum in both directions without wasting enormous amounts of power.

Any convenient prime mover can be used. There needs to be a constant DC supply available – this can come from a small extra generator driven by the prime mover. In this demonstration the prime mover is a DC motor – so a single DC supply can be used to power everything.

The prime mover drives the main generator. The field current can be adjusted by some system of resistors and switches – this frequently incorporates a change-over switch so that both the magnitude and direction of the current can be controlled by a single lever. In this demonstration a standard rheostat and reversing switch are used. Changing the field current changes the output voltage of the generator; reversing the field current reverses the output voltage of the generator. All this control circuitry is operating at relatively low power – even the reversing switch does not have to break the full field current as that has been reduced to zero before the direction is changed.

The output of the generator drives a DC motor. The field winding of the motor is connected directly to the constant DC supply – alternatively there may be additional resistance that can be added to weaken the field and thus increase the speed further when required.

The Ward Leonard system was rendered obsolete by the introduction of electronic systems capable of handling the power levels involved.

**Notes**

The supply measures about 13V at zero speed, falling to 11V at full speed. The output of the generator is about 9V at full speed.

**Safety**

Check that the PSU has a current PAT label. Keep hair and clothing out of moving parts.