EXPERIMENT NO. 18

SHUNT MOTOR CHARACTERISTICS

PURPOSE:

To discover the characteristic change in speed of a DC Shunt Motor as it is loaded.

To discover the characteristic change in torque output of a DC Shunt Motor as it is loaded.

PERFORMANCE OBJECTIVES:

Upon successful completion of this experiment, the student will be able to:

1. Run load tests on DC shunt motors.

2. Analyze the behavior of DC shunt motors under load.

BRIEFING:

DC Shunt Motors are widely used because of their constant speed characteristics. It's not that their speed doesn't ever change. The change in speed between no load and full load is less or a shunt motor than for other types. The torque output of shunt motors is directly proportional to the load applied. For many applications this is satisfactory. But as we will see in Experiment 19, series motors can more easily handle overloads.

The torque output is proportional to armature current and field flux. Since the field is in parallel with the armature and applied voltage is constant, the field flux is constant between no-load and full load. This makes torque directly proportional to armature current. Armature current, however, does change with the load on the motor.

With a shunt motor running at no load, the only torque required is to overcome windage and friction losses in the motor and the apparatus connected to it. A good deal of CEMF is generated because of the strong field flux and the speed of the motor (which is slightly above rated speed). This CEMF limits armature current to a very low value just enough to provide the torque to overcome the losses.

Then as the motor is loaded, part of the torque that had been driving the shaft is used to drive the load. The motor begins to slow down. As it does, less CEMF is generated. This increases the armature current enough to handle the extra torque required to handle the load. The speed, torque and armature current balance out pretty fast, producing only a small change in speed.

As load is reduced, the torque no longer needed by the load makes the motor speed up. This generates more CEMF limiting armature current, and thus torque, to the amount needed by the reduced load.

MACHINES REQUIRED:

DM-100A DC Machine operating as a motor
DYN-100-DM Dynamometer

POWER REQUIRED:

0-125 volt Variable DC, 5 amps
0-150 volt Variable DC, 1 amp

METERS REQUIRED:

0-150 volt DC voltmeter
0-150 volt DC voltmeter
0-5.0 amp DC ammeter
0-2.5 amp DC ammeter

ADDITIONAL MATERIAL REQUIRED:

MGB-100 Bedplate
RL-100A Resistance Load Bank
HT-100J Tacho-generator and indicator

PROGRAM PLAN:

Step 1. Place the two machines on the bedplate with the motor on the left and the dynamometer on the right.

Step 2. Couple the two machines tightly, using the rubber coupling. Be sure the coupling fits snugly inside both flanges. Be sure the rotor locking device has been removed from the dynamometer.

Step 3. Clamp the machines tightly to the bedplate. Place the coupling guard over the coupling and the shaft guard over the motor and dynamometer shafts.

Step 4. Connect the motor as shown in Figure 18-1. Note that this is a shunt motor connection. Turn the motor's field rheostat fully counterclockwise to its minimum resistance position.

Step 5. Turn the knob of the 0-125 volt supply fully counterclockwise to its zero output position. Power should remain off.

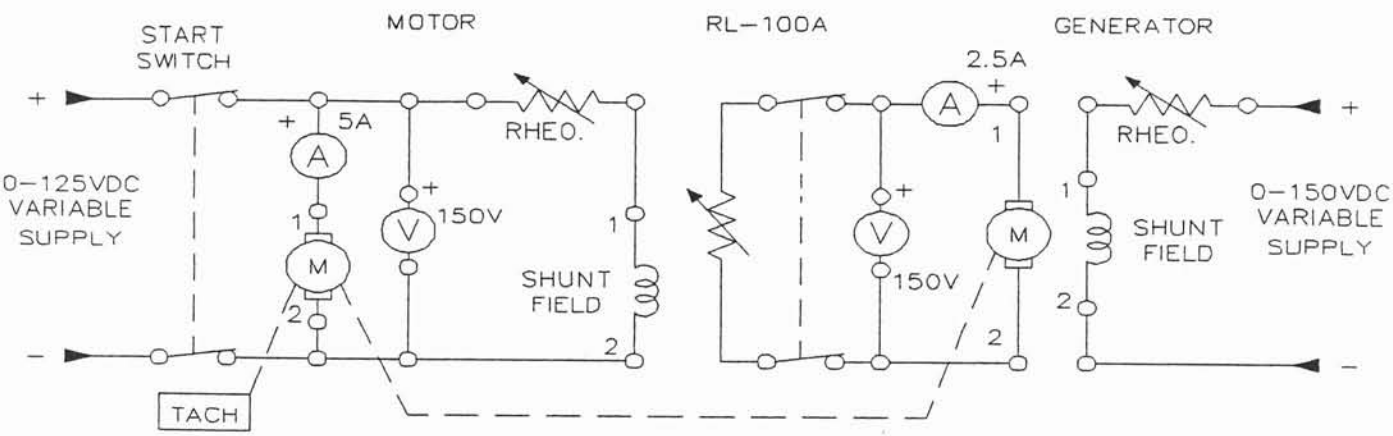

Figure 18-1

Step 6. Connect the dynamometer as shown in Figure 18-1. Note that this is a separately excited generator connection. Turn the dynamometer's field rheostat knob fully counterclockwise to its minimum resistance position

Step 7. Have someone check your connections to be sure they are correct. Then turn ON only the main AC and the 0-150 supply circuit breakers.

Step 8. Temporarily connect a voltmeter across the 0-150 volt supply and adjust the knob until there is 115 volts across the dynamometer's shunt field. Then connect the voltmeter across the RL-100A Resistance Load Bank. Be sure all toggle switches are in the downward (OFF) position. Turn the dynamometer's field rheostat fully clockwise to its maximum resistance position.

Step 9. Turn ON the 0-125 volt supply and the motor's circuit breaker switches. Start the motor by slowly increasing the output of the 0-125 volt supply to 125 volts.

Step 10. Place the Tacho-Generator against the motor shaft and turn the knob of the field rheostat clockwise until the indicator reads 1950 rpm.

Step 11. Use the dynamometer's field rheostat to adjust its output voltage to 115 volts.

Step 12. Recheck the output of the 0-125 volt supply to be sure that there is still 125 volts applied to the motor armature. If not adjust the supply. Then repeat step 11.

Step 13. In Table 18-1 of TEST RESULTS, record the motor speed, armature voltage, armature current, torque, and generated voltage.

Step 14. Switch ON resistance legs 1, 2, and 3 on the load bank.

Step 15. Repeat Steps 11, 12, and 13.

Step 16. Switch ON resistance legs 4, 5, and 6, on the load bank.

Step 17. Repeat Steps 11, 12, and 13.

Step 18. Switch ON resistance legs 7, 8, and 9 on the load bank.

Step 19. Repeat Steps 11, 12, and 13.

Step 20. Turn OFF all circuit breaker switches. Disconnect all leads.

TEST RESULTS:

	NO LOAD	STEP 14	STEP 16	FULL LOAD
SPEED				
ARMATURE VOLTAGE				
ARMATURE CURRENT				
TORQUE (N-m)				
GENERATED VOLTAGE				

TABLE 18-1

DE-BRIEFING:

1. On the graph provided, used the data you have recorded in Table 18-1 to plot a curve showing how the speed of a DC shunt motor changes as the armature current increases with increasing load. Label the curve SPEED.

2. On the same graph, use the data from Table 18-1 to plot a curve showing how the output torque of a DC shunt motor changes as the armature current increases with increasing load. Label the curve TORQUE.

3. The percent change in speed from no load to full load is called "speed regulation". It is computed by dividing the change in speed by the full load speed.

$$\% \text{ Speed Regulation} = \frac{\text{Speed (NL)} - \text{Speed (FL)}}{\text{Speed (FL)}} \times 100$$

   Compute the speed regulation for the DC shunt motor.

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4. As load was applied to the dynamometer, did the motor's armature current increase in direct proportion to the motor's output torque? Explain why this was or was not expected.

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5. As load was applied to the dynamometer, did the motor's armature current increase in inverse proportion to the motor's speed? Explain why this was or was not expected.

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QUICK QUIZ:

1. As additional load was placed on the motor, its field current:

    a. Increased.

    b. Decreased.

    c. Remains the same.

2. The torque output of a DC shunt motor is supplied by the field flux and:

    a. Armature current.

    b. Field current.

    c. Load current.

3. As the speed of a motor decreases, its CEMF:

    a. Increases, reducing armature current.

    b. Decreases, permitting additional armature current.

    c. Stays the same.

4. If a motor is producing more torque than is needed to drive the load connected to it, the extra torque:

    a. Speeds the motor up.

    b. Slows the motor down.

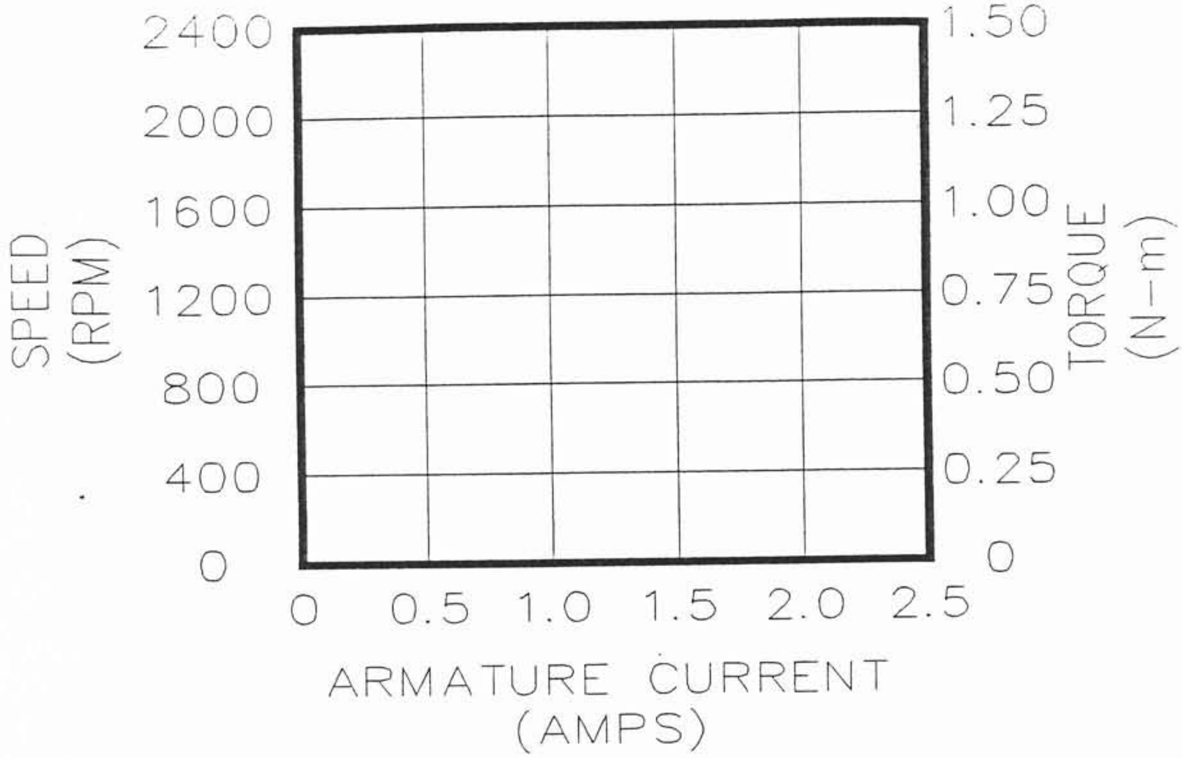
    c. Is converted to heat.

5. The speed of a DC shunt motor is:

    a. The same at no load and full load.

    b. Greater at no load than at full load.

    c. Less at no load than at full load.


2400
2000
1600
1200
800
400
0
SPEED (RPM)
1.50
1.25
1.00
0.75
0.50
0.25
0
TORQUE (N-m)
0 0.5 1.0 1.5 2.0 2.5
ARMATURE CURRENT (AMPS)