14

Horns, Wiper, and Washer System Operation

LEARNING OBJECTIVES

Upon completion and review of this chapter, you should be able to:

- Explain the operation of an automotive horn.
- Identify the different types of wiper systems and explain their operation.
- Identify the different types of windshield washer systems and explain their operation.

KEY TERMS

Automobile Horn
Depressed Park Position
Horn Relay
Horn Switch
Washer Pumps
Wiper Switch

INTRODUCTION

This chapter introduces you to the operation of an automotive horn and washer/wiper circuits. It will further show how various original equipment manufacturers apply technology to their horn and washer/wiper systems. Chapter 14 of the *Shop Manual* shows you how to diagnose horn and wiper/washer system concerns.

HORN CIRCUITS

An **automobile horn** is a safety device operated by the driver to alert pedestrians and other motorists. Some states require two horn systems, with different sound levels for city and country use.

Circuit Diagram

Some early automobiles used a simple series horn circuit, as shown in Figure 14-1A. Battery current is supplied to the horn circuit through the fuse panel, or from a terminal on the starter relay or solenoid. The normally open horn switch is installed between the power source and the grounded horn. When the driver pushes the horn button, the horn switch closes and current flows through the circuit to sound the horn. If the car has more than one horn (Figure 14-1B), each horn will form a parallel path to ground.

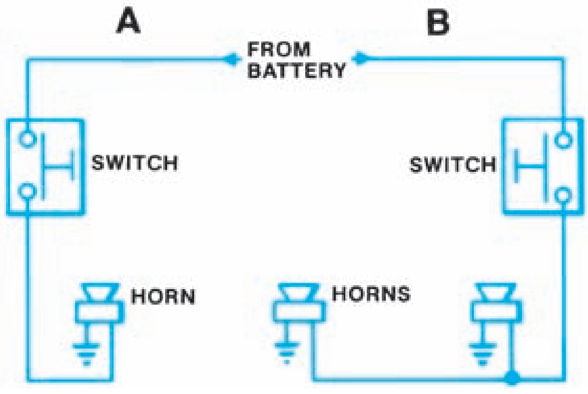

Figure 14-1. A simple circuit with a single horn in series with the switch (A), or two horns in parallel with each other and in series with the switch (B).

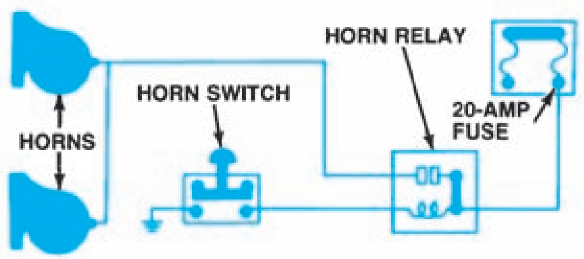

Figure 14-2. Many horn systems are controlled by a relay. (DaimlerChrysler Corporation)

Most horn circuits include a **horn relay** (Figure 14-2). The normally open relay contacts are between the power source and the grounded horn. The horn switch is between the relay coil and ground. When the horn switch is closed, a small amount of current flows through the relay coil. This closes the relay coil and allows a greater amount of current to flow through the horns.

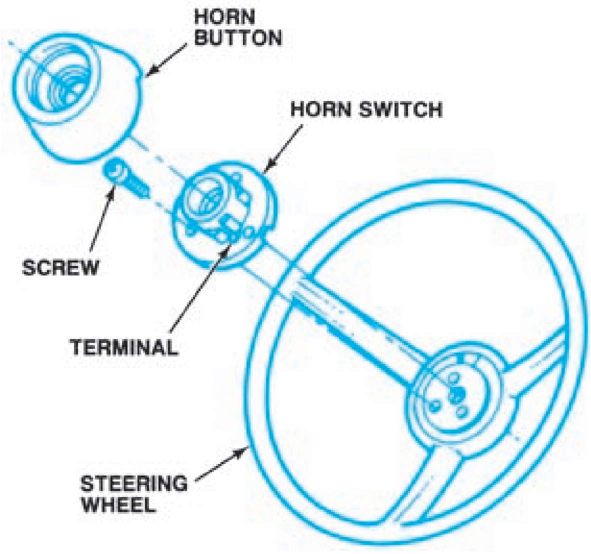

Figure 14-3. The horn switch is mounted in the steering column. (DaimlerChrysler Corporation)

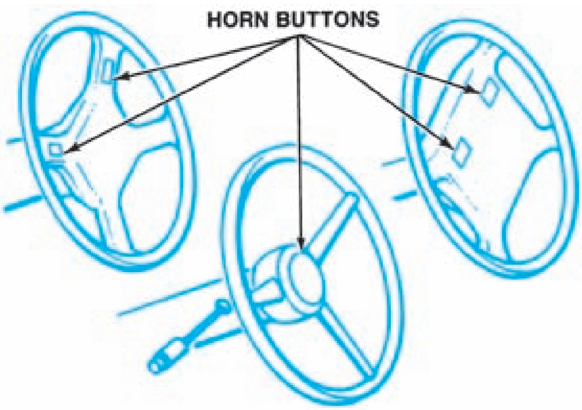

Figure 14-4. Horn buttons can be placed at various locations around the steering wheel.

Horn Switches, Relays, and Fuses

The **horn switch** is normally installed in the steering wheel or steering column (Figure 14-3). Contact points can be placed so that the switch will be closed by pressure at different points on the steering wheel (Figure 14-4). Some cars have a button in the center of the wheel; others have a number of buttons around the rim of the wheel, or a large separate horn ring. Many imported cars and some domestic cars have the horn button on the end of a multifunction lever or stalk on the steering column. All of these designs operate in the same way: Pressure on the switch causes contacts to close. When the pressure is released, spring tension opens the contacts.

Horn relays can be mounted on the fuse panel (Figure 14-5). They also can be attached to the bulkhead connector or mounted near the horns in the engine compartment. The relay is not serviceable, and must be replaced if defective. The horn circuit often shares a 15- to 20-ampere fuse with several other circuits. It may also be protected by a fusible link.

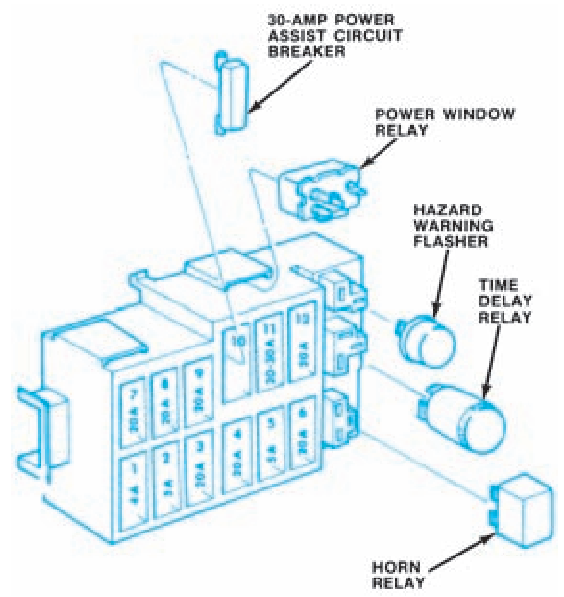

Figure 14-5. The horn relay can be mounted on the fuse panel. (DaimlerChrysler Corporation)

Horns

Except for Chrysler's air horn, which uses air pressure from the compressor, automobile horns use *electromagnetism* to vibrate a diaphragm and produce sound waves. A typical horn contains normally closed contact points in series with a coil. One of the contact points is mounted on a movable armature to which the horn diaphragm is connected.

The horn coil is in series with the horn switch or horn relay contacts. When the horn switch or horn relay contacts close, current flows through the horn coil to ground. The electromagnetic field created by the coil attracts the armature, also moving the diaphragm. The armature movement opens the contact points, which open the coil circuit. With no magnetic field to hold them, the armature and diaphragm move back to their normal positions. The points are again closed, allowing current to flow through the coil. This making and breaking of the electromagnetic circuit causes the horn diaphragm to vibrate.

Since this cycle occurs very rapidly, the resulting rapid movements of the diaphragm create sound waves. The speed or frequency of the cycling determines the pitch of the sound created. This can be adjusted by changing the spring tension on the horn armature to increase or decrease the electromagnetic pull on the diaphragm.

The History from the Bell to the Electric Horn

Many types of signal alarms have been used on cars as follows:

- Mechanical bell
- Bulb horn
- Compression whistle
- Exhaust horn
- Hand-operated horn (Klaxon)
- Electric horn

The mechanical bell was used on very early cars; the driver operated the bell with a foot pedal. The bulb horn, similar to that on a child's bicycle, proved to be inconvenient and unreliable. The compression whistle was most often used in cars with no battery or limited battery capacity; a profiled cylinder provided the whistle's power. Exhaust horns used gases from the engine exhaust; they, too, were foot-operated. The hand-operated Klaxon horn amplified a grating sound caused by a metal tooth riding over a metal gear. This did not work well, because the horn had to be near the driver rather than at the front of the car. Over the years, the electric horn has been the most popular type of signal alarm.

WINDSHIELD WIPERS AND WASHERS

Federal law requires that all cars built in, or imported into, the United States since 1968 have both a two-windshield wiper system and a windshield washer system. Wiper systems on older vehicles may be operated by engine vacuum or by the power steering hydraulic system.

Modern wiper systems are operated by *electric motors.* The washer system can be manually operated, or it can have an electric pump. Many vehicles also have a single-speed wiper and washer for the rear window. This is a completely separate system, but it operates in the same way as the windshield wiper and washer system.

Circuit Diagram

A typical *two-speed wiper system* circuit diagram is shown in Figure 14-6. The motor fields are permanent magnets. The wiper switch controls both the wiper motor speeds and the washer pump. The park switch within the wiper motor ensures that

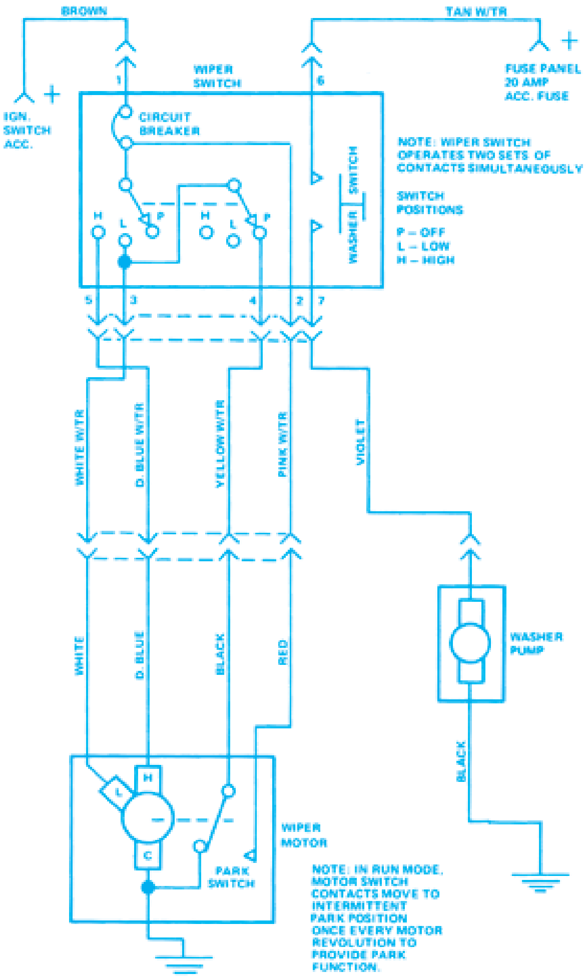

Figure 14-6. A simple two-speed wiper circuit.

when the wiper switch is turned off, the motor will continue to turn until the wiper arms have reached the bottom edge, or park position, of the windshield. The circuit shown has a circuit breaker built into the wiper switch. The circuit breaker also can be a separate unit, or it can be mounted on the wiper motor.

Figure 14-7 shows low-speed current flow through the simple circuit. Current flows through the wiper switch contacts, the low-speed brush L, and the common (shared) brush C to ground. During high-speed operation, the current flows through the high-speed brush H and the common brush to ground. When the wiper switch is turned to park, or off, the park switch comes into the circuit.

The *park switch* is a two-position, cam-operated switch within the wiper motor. It moves from one position to the other during each motor revolution. When the wiper arms are at their park

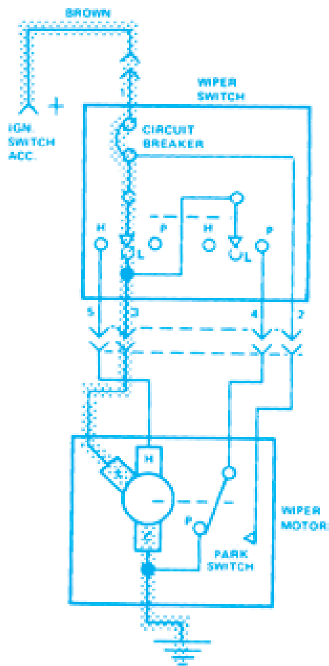

Figure 14-7. Low-speed current flow.

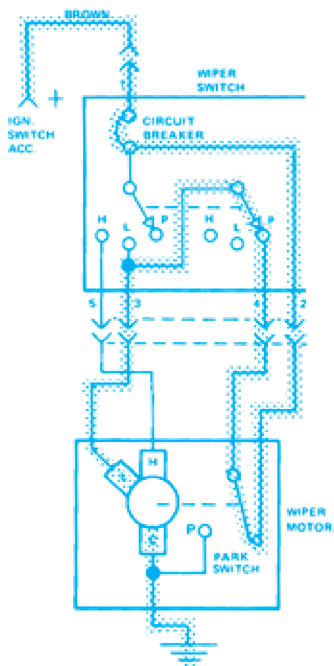

Figure 14-8. The park switch allows the motor to continue turning until the wiper arms reach their park position.

position, the park switch is at the P contact, as shown in Figure 14-8. No current flows through the park switch. At all other wiper arm positions, the park switch is held against spring tension at the other contact. If the wiper switch is turned

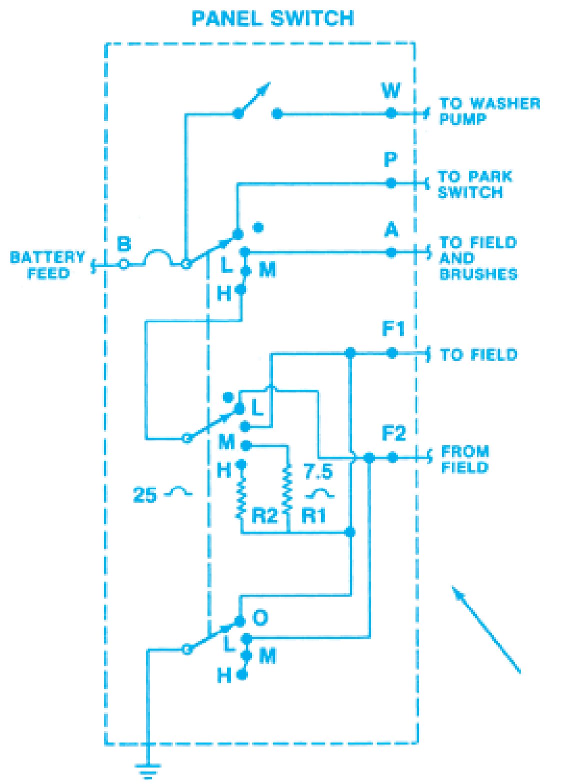

Figure 14-9. This three-speed wiper system controls motor speed by routing field current flow through various resistors. (DaimlerChrysler Corporation)

Figure 14-10. Many late-model cars have a depressed-park wiper position.

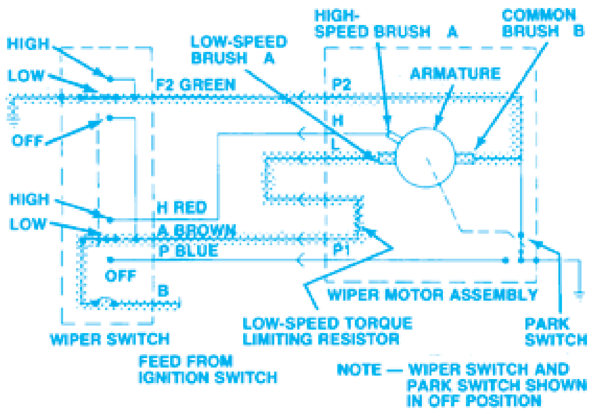

Figure 14-11. Low-speed current flow in a depressed-park system. (DaimlerChrysler Corporation)

off while the wiper arms are not at their park position current will flow through the park switch to the low-speed brush. The motor will continue to turn until the wiper arms reach their park position. At that point, the park switch moves to the P contact and all current stops.

When extra features are added to the wiper system, the circuits become more complex. For example, many manufacturers offer three-speed wiper systems. These systems use electromagnetic motor fields. The switch contacts route field current through resistors of various values (Figure 14-9) to vary the wiper motor speed. Some GM two-speed wiper circuits also use this type of motor.

Many late-model vehicles have wiper arms that retreat below hood level when the switch is turned off (Figure 14-10). This is called a **depressed park position** and is controlled by the park switch. When the wiper switch is turned off, the park switch allows the motor to continue turning until the wiper arms reach the bottom edge of the windshield. The park switch then *reverses* current flow through the wiper motor, which makes a partial revolution in the opposite direction. The wiper linkage pulls the wiper arms down below the level of the hood during this motor reversal. The motor reversal also opens the park switch to stop all wiper motor current flow.

A depressed-park wiper system is shown in Figure 14-11. During normal operation, current flows through either brush A or common brush B to ground. When the wiper switch is turned off (Figure 14-12), current flows through the park switch, into brush B, and through low-speed brush A to ground. This reverses the motor's rotation until the wiper arms reach the depressed park position, the park switch moves to the grounded position, and all current stops.

Many wiper systems have a low-speed intermittent or *delay mode*. This allows the wiper arms to sweep the windshield completely at intervals of three to 30 seconds. Most intermittent, or delay, wiper systems route current through a solid-state module containing a variable resistor

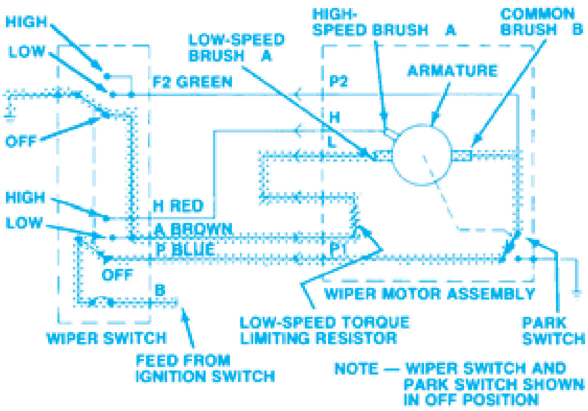

Figure 14-12. The park switch reverses current flow through the motor so that the wiper arms are pulled down into the depressed-park position. (DaimlerChrysler Corporation)

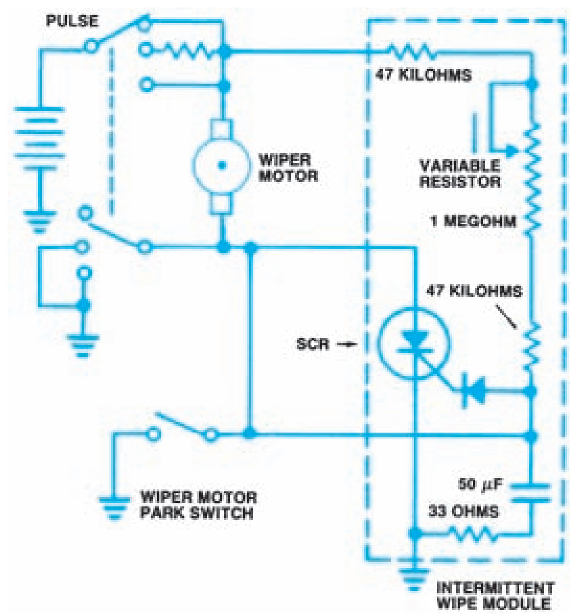

Figure 14-13. An SCR in the solid-state intermittent wiper module or control unit triggers the wiper motor for intermittent wiper arm sweeps. (DaimlerChrysler Corporation)

and a capacitor (Figure 14-13). Once the current passing through the variable resistor has fully charged the capacitor, it triggers a silicon-controlled rectifier (SCR) that allows current flow to the wiper motor. The park switch within the motor shunts the SCR circuit to ground. Current to the motor continues, however, until the wiper arms reach their park position and the park switch is opened. The driver through the variable resistor controls the capacitor rate of

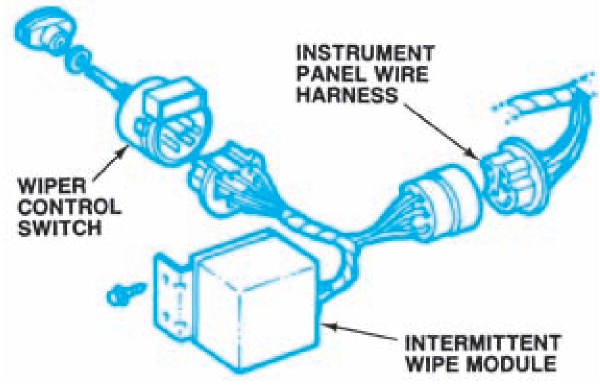

Figure 14-14. The intermittent wipe governor or module is installed between the wiper switch and the wiper motor.

charge, and therefore the interval between the wiper arm sweeps.

SCR Intermittent Wipers

On some imported cars, the intermittent or delay mode is sensitive to vehicle speed and varies from approximately 15 seconds (at low road speed) up to the wipers' normal low speed (at moderate road speed) as vehicle speed changes. The intermittent mode can be cancelled by pressing a cancel switch, and wiper speed can be set manually with the wiper switch. Intermittent wiper control circuitry on many cars is contained in a separate module that is installed between the wiper switch and the wiper motor, as shown in Figure 14-14.

Switches

The **wiper switch** is between the power source and the grounded wiper motor. The wiper switch does not receive current unless the ignition switch is turned to the Accessory or the Run position. The wiper switch may be mounted on the instrument panel, or it can be mounted in the steering column and controlled by a multifunction lever or stalk (Figure 14-15).

If the system has an electric washer pump, the pump is generally controlled by contacts within the wiper switch. The washer is usually operated by a spring-loaded pushbutton that is part of the wiper switch (Figure 14-16). Moving the switch to its wash position or pressing the pushbutton will operate the washer pump as long as the switch is held in position or is pressed.

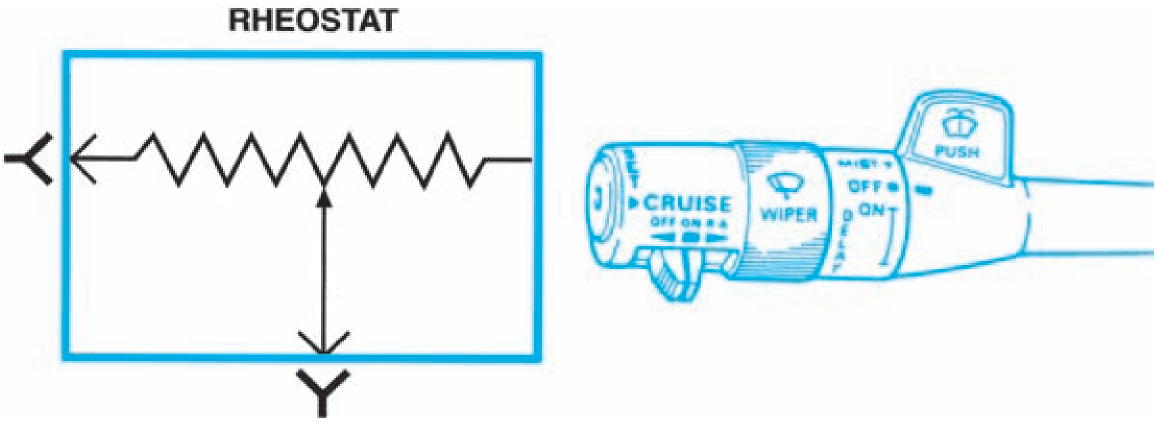

Figure 14-15. The washer switch is usually a spring-loaded pushbutton mounted on the instrument panel or on a multifunction lever. (GM Service and Parts Operations)

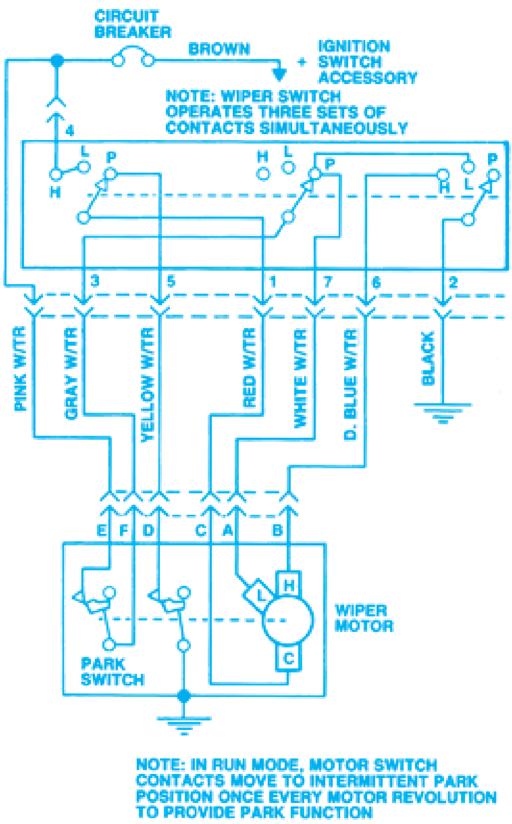

Figure 14-16. In this system, the high-speed brush is set directly opposite the common brush. The common brush is insulated, and the two speed-control brushes are grounded through the wiper switch.

Motors

Most two-speed wiper motors use permanent ceramic magnets as pole pieces. Three brushes ride on the motor's commutator. One brush is a common, or shared, brush and conducts current whenever the wiper motor is operating. The other brushes are placed at different positions relative to the motor armature. Current through one brush produces a different motor speed than current through the other brush. The wiper switch contacts route current to one of these two brushes, depending upon which wiper motor speed the driver selects.

In many wiper motors, the *high-speed brush* is placed directly opposite the common brush (Figure 14-16). The *low-speed brush* is offset to one side. This placement of the low-speed brush affects the interaction of the magnetic fields within the motor and makes the motor turn slowly. The placement of the high-speed brush causes the motor to turn rapidly. Chrysler and some GM two-speed motors vary from this pattern (Figures 14-13 and 14-17). The low-speed brush is directly opposite the common brush and the high-speed brush is offset. A resistor wired in series with the low-speed brush reduces the motor's torque at low speed. This extra resistance in the low-speed circuit results in a lower motor speed even with the reversed brush position.

The common brush can be grounded and the two speed-control brushes can be insulated, as shown in Figure 14-17. Other motors have the speed-control brushes grounded through the wiper switch contacts and the common brush insulated, as shown in Figure 14-17.

Some two-speed and all three-speed wiper motors have two electromagnetic field windings (Figure 14-18). One field coil is in series with a motor brush and is called the series field. The other field coil is a separate circuit branch directly to ground and is called the shunt field. The two coils are wound in opposite directions, so that their magnetic fields oppose each other.

The wiper switch controls current through these two field coils. At low speed, about the same amount of current flows through both coils. Their opposing magnetic fields result in a weak total field, so the motor turns slowly. At medium speed (three-speed motor), current to one coil must flow through a resistor. This makes the coil's magnetic field weaker and results in a stronger total field within the motor. The motor revolves faster. At high speed, current to the coil must flow through a greater value resistor. The total magnetic field of the motor is again increased, and the motor speed increases. The resistors can act on either the shunt coil or the series coil to reduce current flow and thereby increase the motor's total field strength and speed. In Figure 14-18, the resistors act on the shunt field. Many wiper motors can be serviced to some extent, as shown in the *Shop Manual*, Chapter 14.

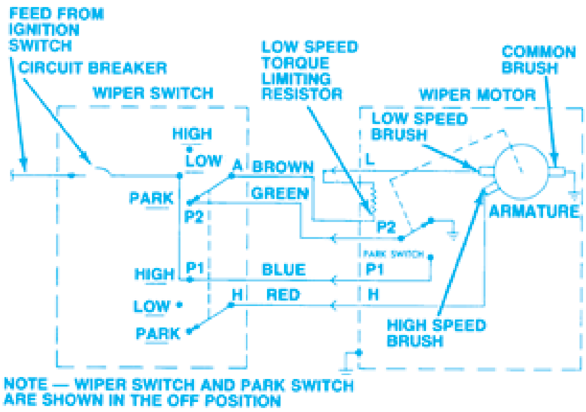

Figure 14-17. This motor has an extra resistor in the low-speed circuit, and so the low-speed brush is placed directly across from the common brush. The common brush is grounded, and the two speed-control brushes are insulated.

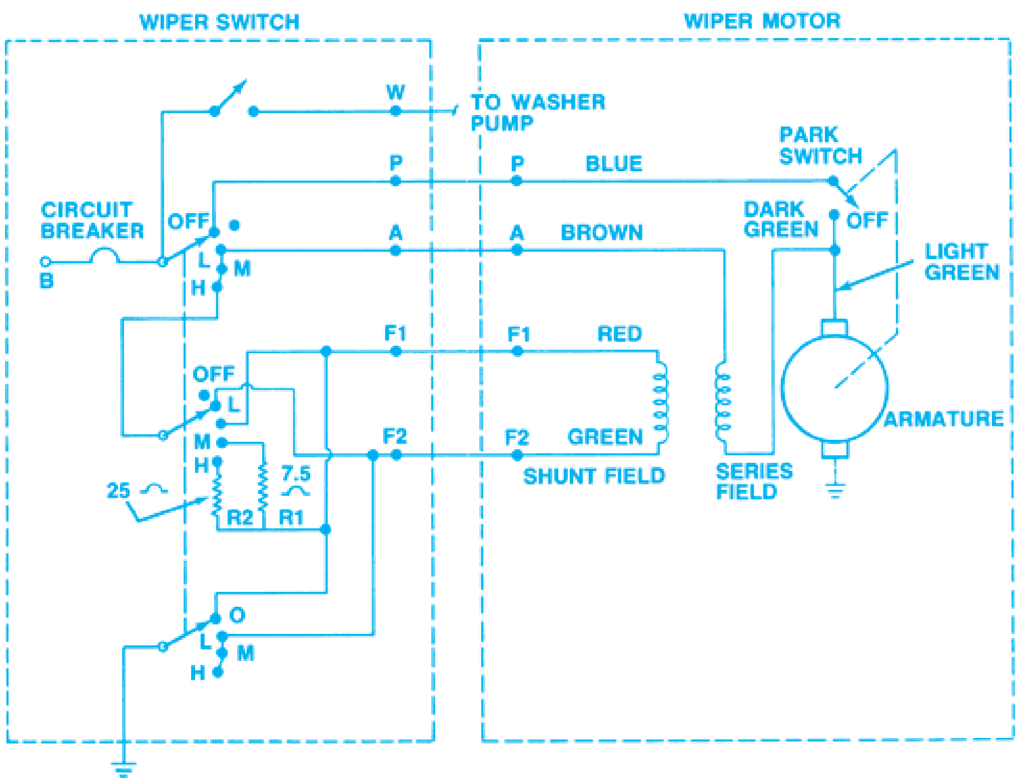

Figure 14-18. In this motor with two electromagnetic fields, the motor speed is controlled by the amount of current through one of the fields. (DaimlerChrysler Corporation)

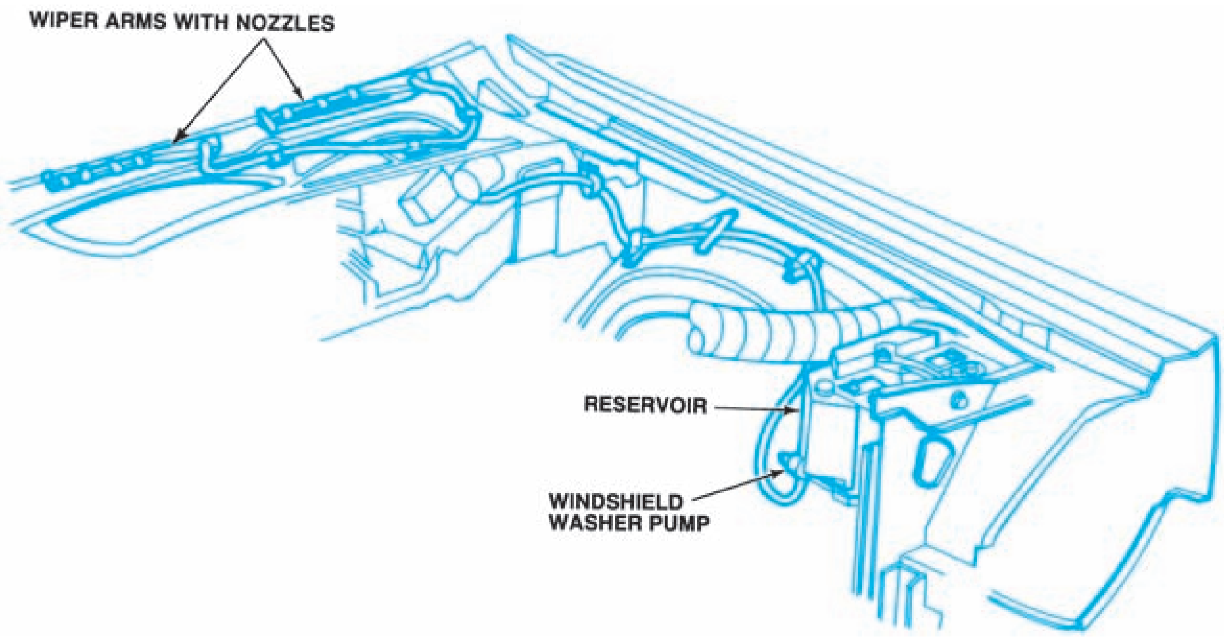

Figure 14-19. The washer pump is often mounted on the fluid reservoir. (DaimlerChrysler Corporation)

Washer Pumps

Windshield **washer pumps** (Figure 14-19) draw a cleaning solution from a reservoir and force it through nozzles onto the windshield. The unit can be a positive-displacement pump or a centrifugal pump that forces a steady stream of fluid, or it can be a pulse-type pump that operates valves with a cam to force separate spurts of fluid.

The washer pump is generally mounted in or on the fluid reservoir (Figure 14-19). Some GM pulse pumps are mounted on the wiper motor (Figure 14-20). Washer pumps are not usually serviceable, so they are replaced if they fail.

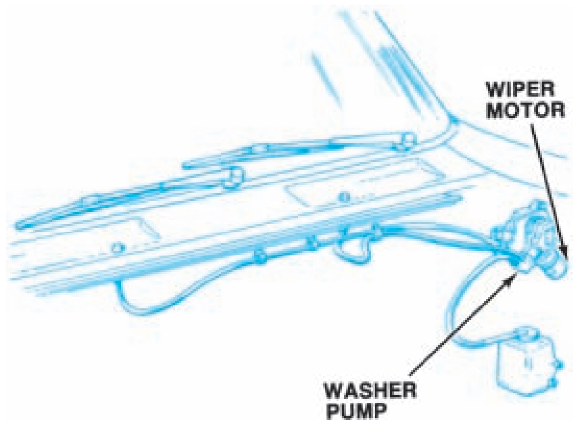

Figure 14-20. Some GM systems have a washer pump mounted on the wiper motor. (GM Service and Parts Operations)

SUMMARY

An automotive horn circuit can be a simple series circuit, or it can use a relay to control current through the horns. The horn switch is a normally open push-pull switch that is operated by the driver. Horns use electromagnetism to vibrate a diaphragm and to produce sound waves.

Windshield wiper and washer circuits have many variations. They can include a permanent magnet motor or one with electromagnetic fields. The park position can be at the bottom edge of the windshield or below the bottom edge. An intermittent wipe feature can be driver- or speed-controlled. Each of these variations requires slightly different circuitry. Washer pumps can be mounted at the cleaner reservoir or on the wiper motor. Pumps are not serviced, but are replaced.

Review Questions

1. Horn relays are sometimes included in the horn circuit to:
   a. Allow the use of two horns in the circuit
   b. Decrease the amount of current needed to activate the horn
   c. Increase the amount of current needed to activate the horn
   d. Allow the horn button to be placed on the end of a stalk on the steering column
2. Horn circuits are generally protected by a:
   a. Fuse
   b. Fusible link
   c. Either A or B
   d. Neither A nor B
3. The ________ within the wiper motor ensures that when the motor is turned off, the wiper arms will be brought to the bottom position.
   a. Wiper switch
   b. Park switch
   c. Recycle relay
   d. Park/neutral switch
4. Two-speed wiper motors generally use ________ to achieve the two speeds.
   a. Cams
   b. Reduction gears
   c. Speed-control brushes
   d. Gear reduction
5. All three-speed wiper motors have ________ fields.
   a. Electromagnetic
   b. Permanent magnet
   c. Two-series
   d. Two-shunt
6. Technician A says that when the driver pushes the horn button, electromagnetism moves an iron bar inside the horn, which opens and closes contacts in the horn circuit. Technician B says that many vehicle horn circuits include a relay. Who is right?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B
7. Which of the following do automotive horns use to operate?
   a. Electromagnetic induction
   b. Magnetic repulsion
   c. Magnetic resonance
   d. Electromagnetism
8. The wiper park switch is which of the following?
   a. Three-position cam-operated switch
   b. Four-position rotary switch
   c. Two-position toggle switch
   d. Two-position cam-operated switch
9. Technician A says the windshield washer pump draws a cleaning solution from a reservoir and forces it through nozzles onto the windshield. Technician B says the unit can be a positive-displacement pump or a centrifugal pump. Who is right?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B
10. Two technicians are discussing horn operation. Technician A says when the horn switch or horn relay contacts close, current flows through the horn coil to ground. The electromagnetic field created by the coil attracts the armature, also moving the diaphragm. Technician B says the armature movement closes the contact points, which opens the coil circuit. Who is right?
    a. A only
    b. B only
    c. Both A and B
    d. Neither A nor B