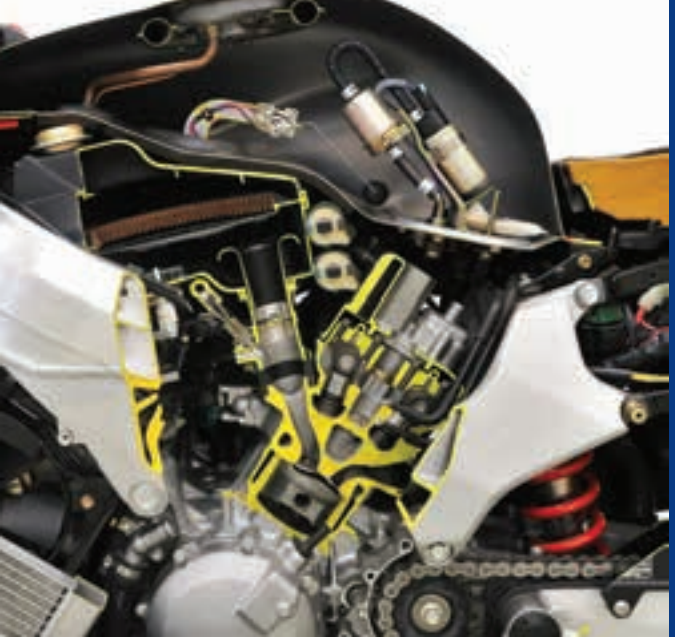


Chapter 12

Electrical Accessory Systems

Learning Outcomes

After studying this chapter, you will be able to:

- ✓ Describe the major components of electrical accessory systems on powersports vehicles.
- ✓ Explain the fundamentals of troubleshooting procedures for the various electrical accessory systems.
- ✓ Describe analog and digital instrument panel displays.
- ✓ Identify the important electrical warning and indicator devices on powersports vehicles.
- ✓ Understand the importance of switches in electrical circuits.
- ✓ List the communication and entertainment systems equipped on some powersports vehicles.
- ✓ Explain the operation of a motorcycle cruise control system.
- ✓ Identify power winches on ATVs and UTVs.
- ✓ Outline the basic components and operation of electric starter systems.

Technical Terms

analog display
anti-lock brake light
brake light
charging gauge
coolant temperature gauge
digital display
dimmer switch
electrical accessory system
electric starting motor
FI light
fuel level gauge
halogen bulb
horn circuit
oil level indicator
oil pressure warning light
power winch
sealed beam tungsten bulb
side stand indicator light
speedometer
starter clutch
switch
tachometer
taillight
turn signal flasher
turn signal light

Powersports vehicles need other systems besides the powertrain, frame, brake, and suspension systems. Some of these additional systems are critical for operation. Some are needed for safety, and a few are not essential but add to the value and convenient use of the powersports vehicle. This chapter discusses some of the accessory systems used on powersports vehicles.

A good understanding of Chapter 9, *Basic Electrical and Electronic Theory*, is essential for successful comprehension and troubleshooting of the electrical accessory systems covered in this chapter.

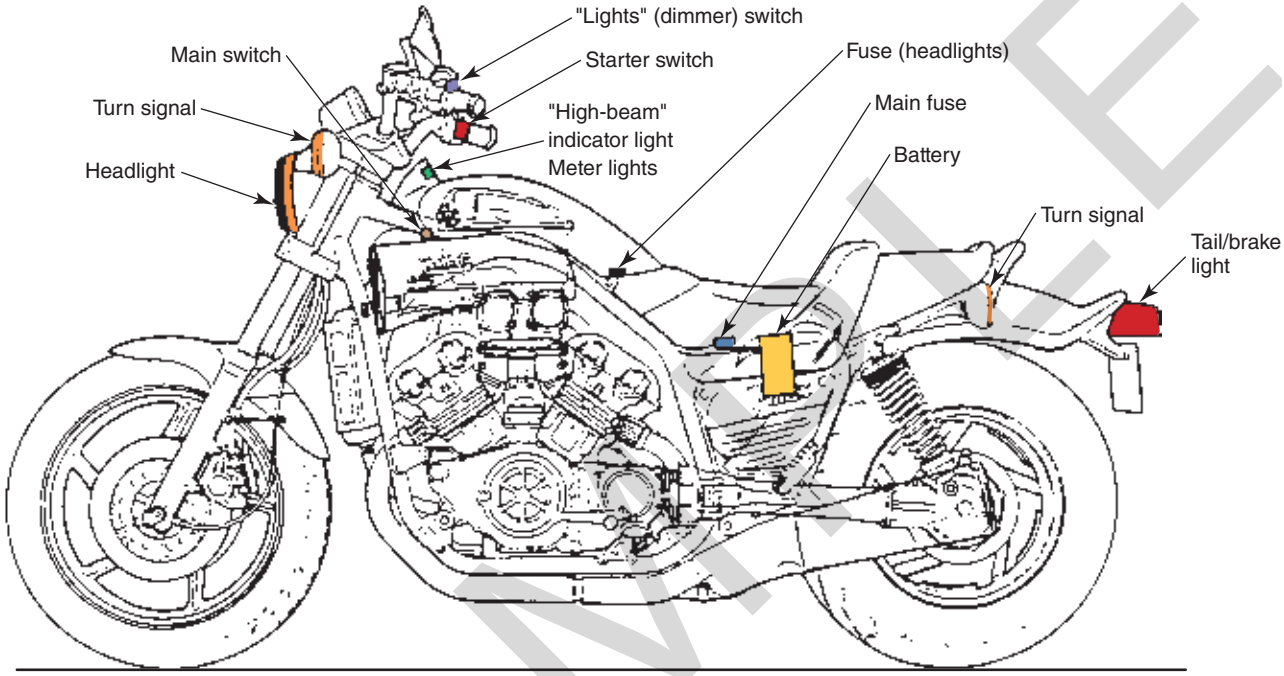
Electrical Accessory Systems

Electrical accessory systems are groupings of electrical and electronic circuits that are part of the electrical system. They include lighting circuits, instrument panels, warning and indicator circuits, switch circuits, communication systems, cruise control, security systems, electric starters, and power winches. Street motorcycles and noncompetition, off-road motorcycles, ATVs, and UTVs commonly have electrical accessory systems. Until recent years, competition

motorcycles, such as motocross bikes, had few, if any, electrical accessory systems. Many of these bikes are now equipped with electric start systems.

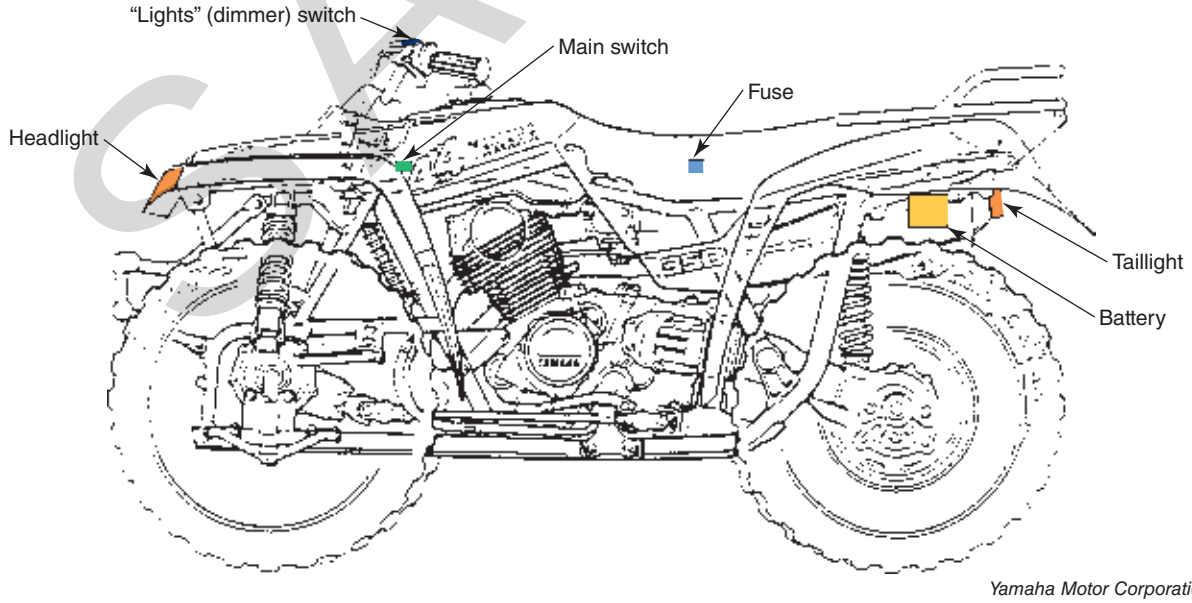
Lighting Systems

A street motorcycle's lighting system usually includes the headlight, taillight, brake light, directional turn signals, warning lights, and instrument illumination, **Figure 12-1**. Off-road and competition motorcycles, ATVs, and UTVs have a limited number of lights. **Figure 12-2** shows the location of lights on a typical ATV.



Yamaha Motor Corporation U.S.A.

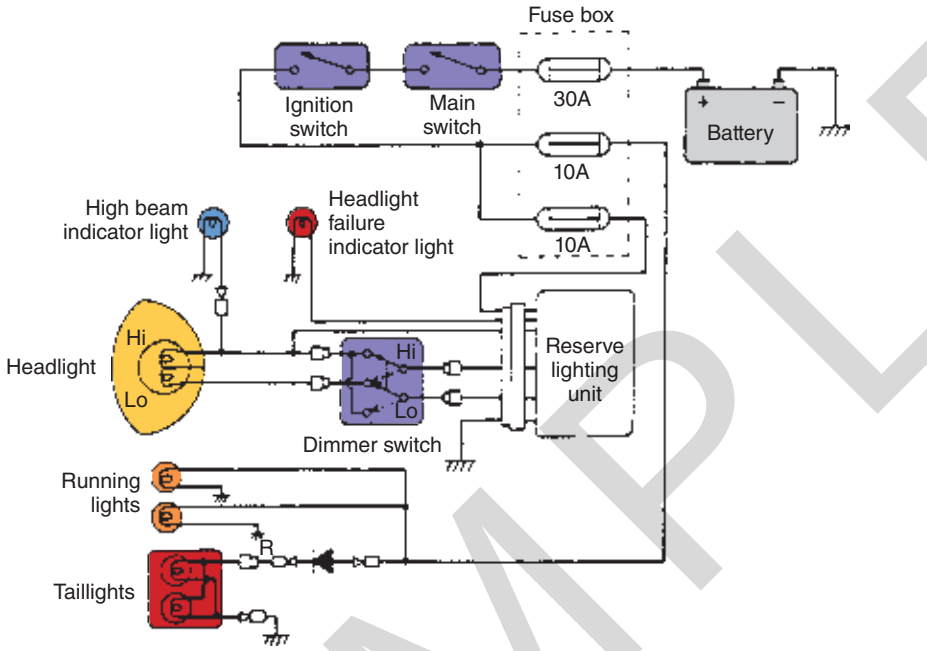
Figure 12-1. The major components of a motorcycle lighting system.



Yamaha Motor Corporation U.S.A.

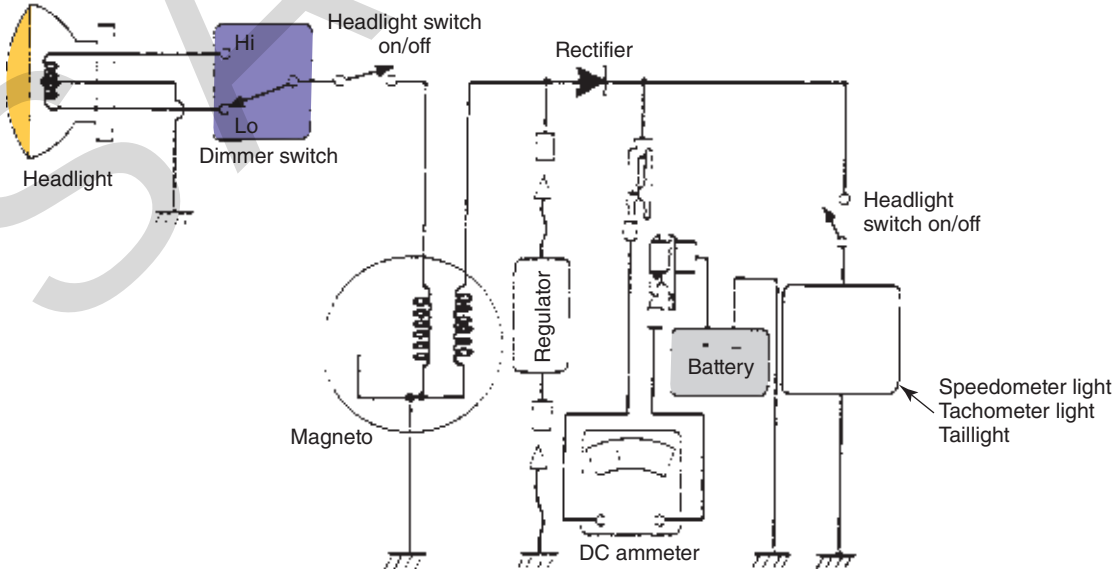
Figure 12-2. Typical ATV lighting system components.

There are two ways to power the lighting systems on motorcycles: the battery powers direct current (dc) lighting and the alternator or magneto powers alternating current (ac) lighting. On most dc lighting systems, the headlight comes on when the key is turned to the *on* position without starting the engine, **Figure 12-3**. Because of the steady dc current, the light remains the same brightness during operation. On most ac lighting systems, the headlight does not come on until the engine starts, **Figure 12-4**. The brightness of the light varies because of the change in voltage output from the alternator or magneto.



Kawasaki Motors Corporation U.S.A.

Figure 12-3. A wiring diagram of a dc headlight circuit.



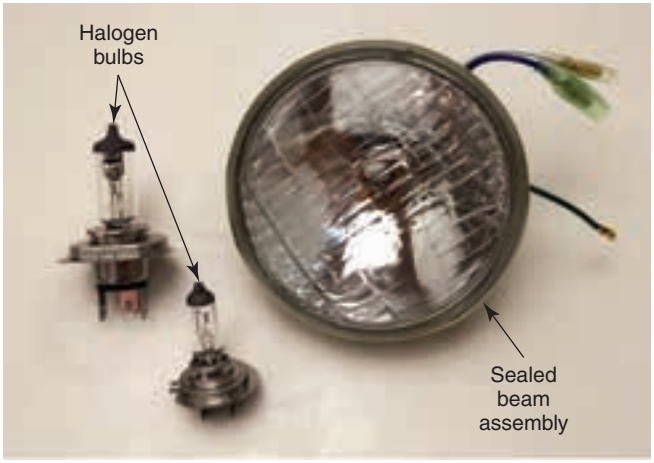
Kawasaki Motors Corporation U.S.A.

Figure 12-4. A wiring diagram showing the headlight circuit in an ac lighting and charging system.

Headlights

Powersports vehicles may have a single headlight or a pair of headlights, which may be stacked or placed side by side. Some ATVs are fitted with three or more headlights.

There are two types of headlight bulbs that are commonly used: sealed beam tungsten bulbs and halogen bulbs. For many years, the ***sealed beam tungsten bulb*** was the most common. This headlight has two filaments: one for a high beam and one for a low beam. The bulb is built into a case with a reflective backing and a lens cut with a refractoring surface. In recent years, ***halogen bulbs*** have become popular since they provide substantially more light than the traditional sealed beam bulb, extending the rider's range of vision and making the motorcycle more visible to other motorists at night. A halogen light contains a small quartz-glass bulb. Inside the bulb is a filament surrounded by halogen gas. The gas-filled bulb fits within a larger metal reflector and lens element. A glass balloon sealed to the metal reflector allows the halogen bulb to be removed without danger of water or dirt damaging the optics within the light. The replaceable bulbs are removed by unplugging the electrical connector, twisting the retaining rings about 1/8 turn counterclockwise, and removing the bulb from its socket. The new bulb is installed by reversing this procedure. Sealed beam halogen light assemblies may be used. See **Figure 12-5**.



Goodheart-Willcox Publisher

Figure 12-5. Some headlights have replaceable halogen bulbs. Other headlights have a sealed beam assembly.

Caution

When handling the halogen bulb, never touch the glass portion with your bare hands. Always use a clean cloth. Oil contamination from hands or dirty rags will reduce bulb life or even cause the bulb to explode.

Halogen headlight bulbs become very hot while the headlight is on, and remain hot for a while after they are turned off. Be sure to turn the ignition switch off and let the bulb cool before replacing it.

High-intensity discharge (HID), also referred to as xenon, headlights and light-emitting diode (LED) headlights are available as headlight upgrades. See **Figure 12-6**. They are now finding their way onto production motorcycles. Additional lighting, such as running lights and light bars, may be added as well.

Goodheart-Willcox Publisher

Figure 12-6. An LED headlight equipped on a motorcycle.

Headlight Aim

In most cases, the headlight beam is adjustable both horizontally and vertically. The headlight beam must be correctly adjusted for maximum visibility and safety. In most areas, it is illegal to ride with an improperly adjusted headlight. Check local regulations for specifications, which may differ from those given here.

When making a headlight adjustment, make sure the tire pressure is correct and the fuel tank is approximately half full. Park the motorcycle on a level surface with the headlight approximately 25′ (7.62 m) from a vertical wall, **Figure 12-7**. When checking the headlight, the motorcycle must be off of its side or center stand and a rider, preferably wearing normal riding gear, should be seated. Measure the

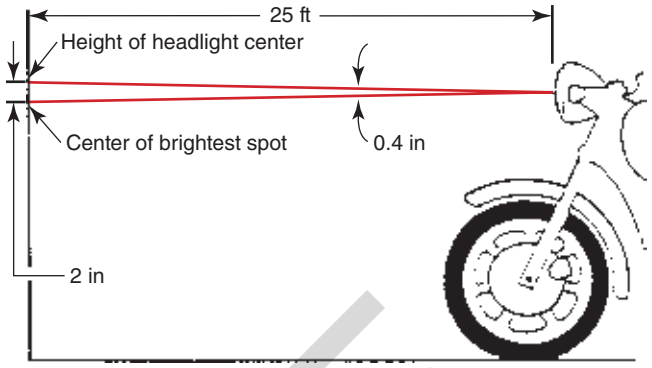
distance from the center of the headlight to the ground and mark this distance on the wall. Adjust the headlight as follows:

- **Vertical adjustment.** With the headlight on high beam, the brightest point of light should be 2″ (50.8 mm) below the mark for the headlight center at a distance of 25′ (7.62 m). To make a vertical adjustment, loosen the headlight mounting bolts, matching the punch mark (if available) on the case and the bracket by moving the headlight up or down, **Figure 12-8**. Some motorcycle headlights have an adjusting screw on the bottom. In this case, turn the screw to make the vertical adjustment.
- **Horizontal adjustment.** Turn the headlight on high beam. The beam should be pointing straight ahead. For headlights with an adjusting screw on the side of the headlight rim, turn this screw to make the horizontal adjustment.

On some models, the headlight is completely encased. The adjustment can be made either with the light beam adjustment knob on the back of the light case or with a remote cable and knob. Refer to the service manual for the proper adjustment method.

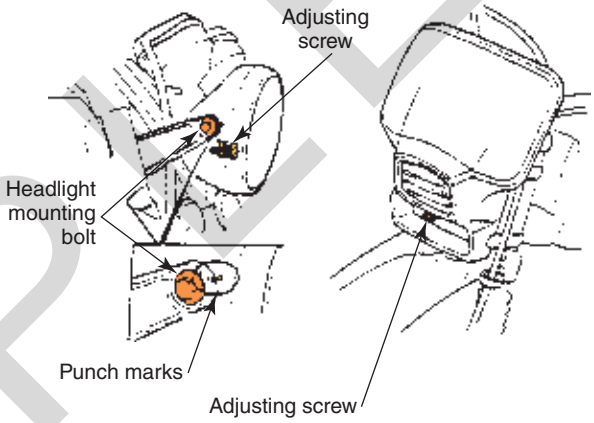
Most headlights have both a high beam and a low beam. Switching from high beam to low beam is controlled by a dimmer switch. The ***dimmer switch*** is a simple two-position switch that controls the headlight output. Most motorcycles have a high beam indicator on the dash panel.

Many modern street motorcycles and scooters are equipped with a pass button, **Figure 12-9**. This button works only when the headlight is on low beam. When the pass button is pressed or held, it turns on the high beam. The headlight returns to low beam when the button is released. Riders may flash the high beam to alert vehicles in front of the motorcycle.



American Suzuki Motor Corporation

Figure 12-7. Proper method of testing headlight aim.



Honda Motor Co., Ltd.

Figure 12-8. Adjusting a motorcycle headlight assembly.

Goodheart-Willcox Publisher

Figure 12-9. The pass button turns on the high beam when pressed and returns to low beam when released.

Taillights

Most state laws require that ***taillights*** on street vehicles be dc powered so they remain on to warn trailing traffic, even if the engine stalls. Ac taillights may be used on off-road motorcycles when no battery is used.

As shown in **Figure 12-10**, the taillight lens assembly also provides license plate illumination, as required by law for street motorcycles and scooters. To make the unit as watertight as possible, a gasket is used between the lens and the base.

On street motorcycles and scooters, the taillight is also used as a parking light. The taillight is activated when the main switch is placed in the park position. While in the park position, the taillight will remain lit after the engine is turned off and the key is removed.

Current powersports vehicles are being fitted with LED taillights to provide brighter lighting with lower power consumption. LED taillights are also more durable than incandescent bulbs since they do not use filaments. See **Figure 12-11**.

Goodheart-Willcox Publisher

Figure 12-10. Typical taillight, brake light, and license lamp assembly.

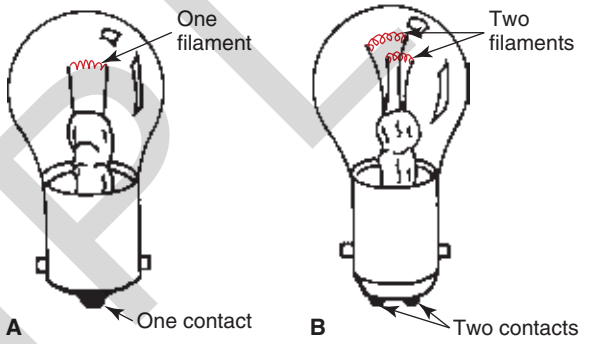
Goodheart-Willcox Publisher

Figure 12-11. LED taillights are brighter and more durable than incandescent bulbs.

Brake Lights

Another feature built into the taillight is the ***brake light***, which comes on before the actual brakes are applied when the brake lever or pedal is pressed. The brake light warns trailing traffic that the vehicle will be slowing or stopping. Due to legal requirements, red lenses or bulbs are used on brake lights.

Brake light and taillight bulbs may be single-filament or double-filament bulbs, **Figure 12-12**. When the brake light and taillight are a combined unit, a double-filament bulb is used. One filament lights the taillight, while the other lights the brake light. The brake light filament has less resistance, so the brake light appears brighter than the taillight. Some motorcycles use two bulbs to increase the taillight and brake light brightness, **Figure 12-13**.



Goodheart-Willcox Publisher

Figure 12-12. Bulbs used for auxiliary illumination. A—Single-filament bulb. B—Double-filament bulb.

Goodheart-Willcox Publisher

Figure 12-13. Taillight and brake light brightness is often increased by using two bulbs in a single light housing.

Turn Signal Lights

The ***turn signal light*** circuit normally includes four turn signals, one or two indicator bulbs, a turn signal flasher, switches, and wiring. The turn signal circuit is a dc circuit powered by the battery and controlled by the ignition switch and turn signal switch.

The turn signal indicator bulbs are controlled by a relay, referred to as the ***turn signal flasher***, **Figure 12-14**. A bimetallic strip, made of two strips of dissimilar metals, in the flasher causes the circuit to open and close. As current flows through the bimetallic strip, the strip heats and expands, opening the circuit, **Figure 12-15**. The strip contracts as it cools, closing the circuit again. This permits the flasher to perform its function while the switch selects the pair of bulbs (right or left) to flash.

Some street motorcycles may incorporate a turn signal canceling device. The self-canceling control feature is activated when the motorcycle turns and cancels the turn signal lights. Street motorcycles may also use two-way or four-way hazard lights using the turn signal function. This is accomplished through the use of a multifunction switch. The two- or four-way hazard system activates either the front or all four turn signals.

Double-filament bulbs may be used for the front turn signals. One filament is used for the turn signal, and the other is used for running lights.

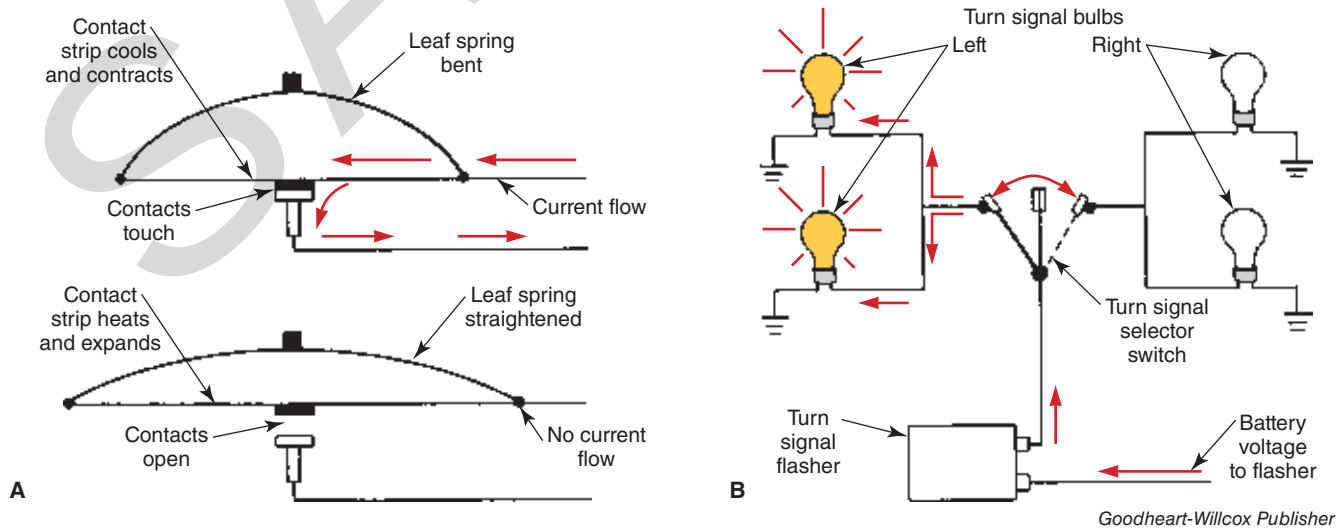
Goodheart-Willcox Publisher

Figure 12-14. Turn signal flashers use a thin bimetallic strip to open and close the power circuit to the indicator bulbs. The strip is enclosed in a small metal or plastic housing.

Lighting System Problems

Lighting system problems can be easy to troubleshoot, such as a burned-out bulb; moderately difficult to troubleshoot, such as a broken wire hidden in the harness; or very difficult to troubleshoot, such as a wiring failure that intermittently opens and closes the circuit.

Troubleshooting lighting system problems requires basic electrical understanding and the use of a multimeter, test light, and wiring schematics, **Figure 12-16**. To troubleshoot



Goodheart-Willcox Publisher

Figure 12-15. Flasher and turn signal operation. A—Flasher unit operation. B—Turn signal circuit operation depends on the position of the selector switch.

Goodheart-Willcox Publisher

Figure 12-16. A multimeter can be used to check for voltage at the headlight or other plug connections.

Goodheart-Willcox Publisher

Figure 12-17. Check the bulb socket for corrosion and wear at the terminals.

lighting system problems, you must check for voltage and voltage drops in the circuit, continuity of switches, and wiring. You also need to verify that the circuit has a good ground.

The logical place to start troubleshooting is at the bulb. If the bulb is good, check for power and ground to the socket and body. If the tests do not show any problems, visually check the wiring. Look for any place where wires could get pinched or damaged. Loose or corroded connections resulting in voltage drops can cause dim lights, difficult starting, battery drain, and damage to the alternator and regulator. Moisture can enter a bulb socket and cause corrosion of the electrical contacts and the bulb. Corrosive conditions can be repaired by using sandpaper or an abrasive pad on the affected areas. For severe cases, replace the socket and bulb. After any repair, always attempt to waterproof the assembly to prevent future problems. Cracked or broken assemblies can be easily replaced.

A common electrical lighting problem is flickering lights. This is usually caused by a loose electrical connection or a circuit breaker opening and closing because of a short. If only one light flickers, the problem is in that section of the circuit. Check the bulb socket for corrosion. Also, make sure the bulb is the correct voltage and wattage and that the terminals are not worn, **Figure 12-17**. This could upset the electrical connection. If needed, replace the bulb socket and bulb. If more than one light flickers, the problem will be in a section of the circuit common to those lights. Check to see which lights flicker with the switch in one position. For example, if the lights flicker only when the headlights are on high beam, check the components and wiring in the high-beam section of the circuit.

Before unplugging the wiring harness, make sure you understand the schematic and have decided the troubleshooting sequence you will follow.

Brake Light Problems

Check the brake light switch operation and adjustment by applying the brakes. Visually inspect for damage and make sure the reflector plate within the light is clean. When replacing a bulb, inspect the bulb socket. If the socket is rusted or corroded, the socket or light assembly base should be replaced. Also, inspect the lens and gasket for damage while the lens is removed and replace any damaged parts.

Adjust the rear brake light switch so the brake light comes on just prior to the brake actually being engaged. If the light fails to come on, adjust the switch so the light comes on at the proper time. Turn the adjusting nut on the brake light switch, not the switch body and wiring. Be sure to hold the switch body firmly while turning the adjusting nut, **Figure 12-18**. After adjustment, check that the brake light comes on at the proper time.

Note

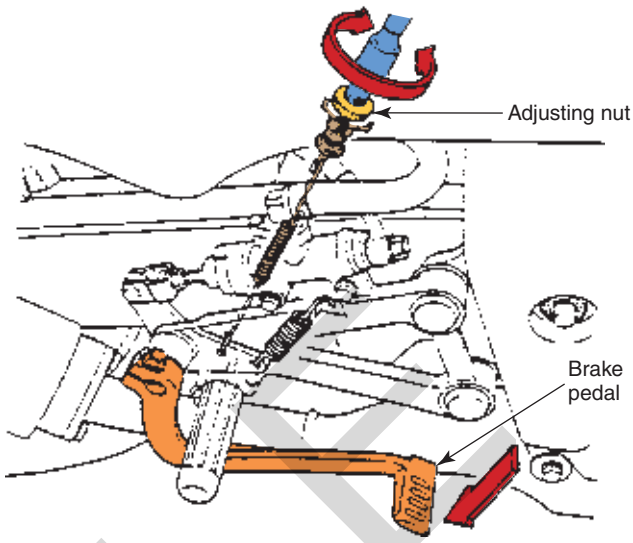
The brake light switch on the front brake lever of most motorcycles cannot be adjusted. If the front brake light switch actuation and brake engagement are off, replace the switch or other malfunctioning parts. Make brake light switch adjustments after height and brake pedal free play adjustments have been completed.

If the brake light does not come on, check for a burned-out bulb or a poor connection at the brake light switch connector. If the problem is not found, disconnect the brake light switch connector and check for continuity between the terminals while operating the brake lever or pedal, **Figure 12-19**.

- When the brake lever or pedal is depressed, there should be continuity between the terminals.
- When the brake lever or pedal is released, there should be no continuity between the terminals.

If there is no continuity when the brake light switch is closed, replace the switch. If the brake light switch is working, check for the following:

- Burned fuse.
- Ignition switch power continuity.
- Poor connection at the fuse connector.
- Broken wire between the fuse and brake light switch.
- Broken wire between the brake light switch and brake light.



Honda Motor Co., Ltd.

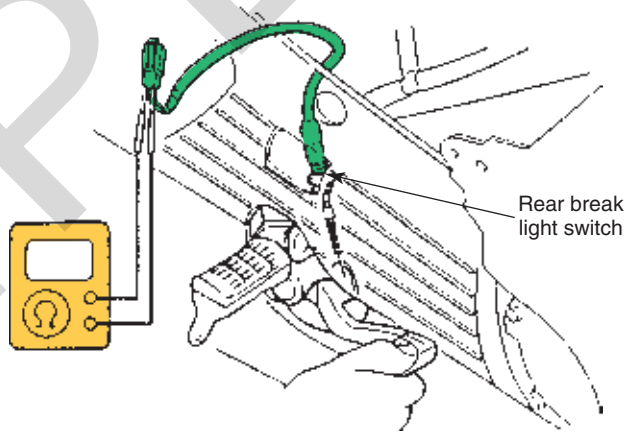
Figure 12-18. Setting the brake light switch adjusting nut.

Turn Signal Problems

If the turn signal does not blink, check the following:

- Battery charge.
- Fuse block for burned fuses.
- Burned-out bulb.
- Correct voltage and wattage bulb.
- Bulb connector.
- Ignition and turn signal switch operation.

If these are normal and the turn signal flasher has two terminals or prongs, disconnect the connector from the flasher and short the connector with a jumper wire, **Figure 12-20A**. Turn on the ignition switch and check the turn signal light by turning on the signal indicator. If the turn signal lights do not come on, there is a broken wire in the harness. If the lights do come on, the flasher is faulty or there is a poor connection at the connector.



Honda Motor Co., Ltd.

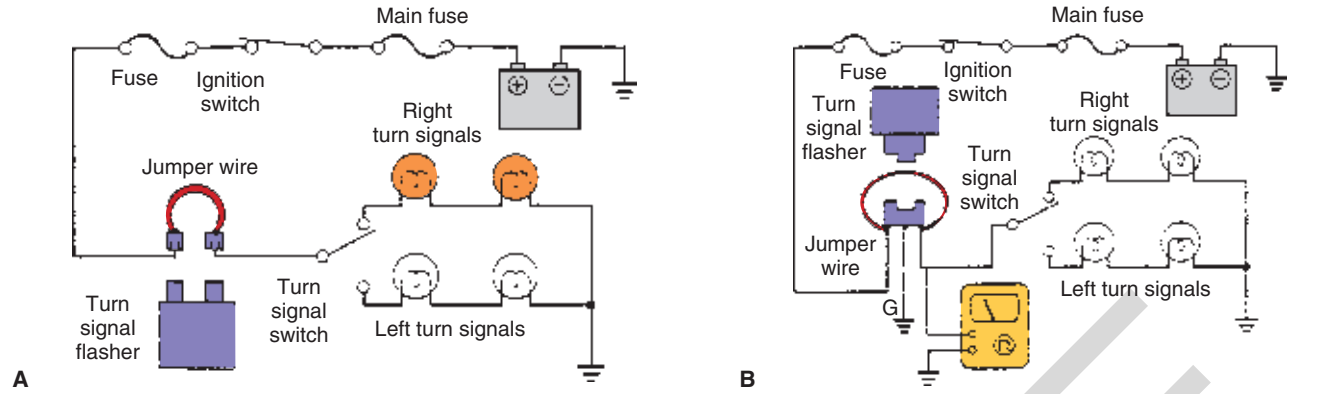
Figure 12-19. An ohmmeter can be used to check the rear brake light switch for continuity.

If the turn signal flasher has three terminals or prongs, short the terminals with a jumper wire as before. If the lights come on, check for continuity between the points shown in **Figure 12-20B**. If there is continuity, either the turn signal flasher is faulty or there is a poor connection at the connector. If the lights do not come on, there is a broken wire in the harness.

Occasionally, the flasher will flash too slowly or too quickly. If this occurs, check for a burned-out bulb. If all the bulbs are fine, replace the flasher.

Instrument Panel

Instrument panels contain a lot of useful information for the vehicle operator. There are various instrument panel designs and layouts. Some are very simple with only basic information displayed, while others are more sophisticated with more complex information available. The two types of instrument panel displays are analog and digital. In



Honda Motor Co., Ltd.

Figure 12-20. Testing a flasher. A—Testing a two-terminal flasher. B—Testing a three-terminal flasher.

Goodheart-Willcox Publisher

Figure 12-21. An analog speedometer and tachometer.

Goodheart-Willcox Publisher

Figure 12-22. A digital display shows exact data.

a traditional ***analog display***, **Figure 12-21**, an indicator moves in front of a fixed scale to give a variable readout. The indicator is often a needle, but it may be a liquid crystal or graphic display. This type may be electrical or mechanically driven. A ***digital display*** uses numbers instead of a needle or graphic symbol. A digital or electronic display is better for showing exact data, such as miles traveled or operating hours, **Figure 12-22**.

Analog displays show relative change better than digital displays. Analog displays are useful when the rider must see something quickly and the exact reading is not important. For example, an analog tachometer shows the rise and fall of engine speed better than a digital display. The rider does not need to know the exact engine rpm. The most important thing is how fast the engine is reaching the red line on the gauge. Many speedometer-odometer combinations are examples of both analog (speed) and digital (distance) gauges.

A digital signal has only two states: on and off. If a switch is turned on and off many times, the number of pulses can be counted. For example, a speed sensor can be turned on and off each time a wheel moves a certain distance. The number of pulses counted in a given period of time allows the computer to display the speed. The pulses can also be used by the computer to change the odometer reading.

Analog instrument panels are lighted directly or indirectly. With direct lighting, the bulb is inside the gauge. Indirect lighting is external and reflected to the appropriate area. Digital panels use LEDs, either as signal indicator lights or as lights grouped to show a set of numbers or letters.

Warning and Indicator Circuits

Motorcycles are equipped with any number of instrument gauges, lights, and warning indicators that provide the rider with valuable information concerning the operation of various vehicle systems. The following devices are a sample of what may be found on instrument panels, whether analog

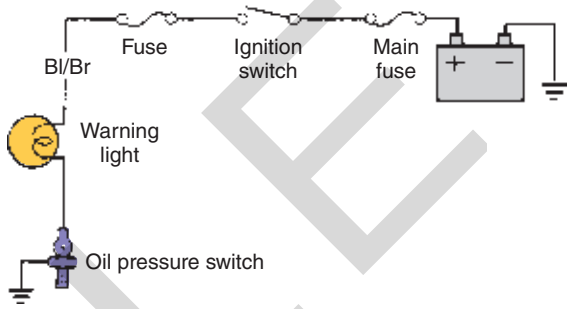
or digital. There are many others that may be included depending on the vehicle, its use, and the information needed by the operator.

Oil Pressure Warning Light

On four-stroke engines, the ***oil pressure warning light*** indicates low engine oil pressure, **Figure 12-23**. When oil pressure is below specifications, the oil pressure switch senses it and turns the warning light on. The light should be off while the engine is running. If the oil pressure warning light does not come on with the ignition switch turned on, disconnect the oil pressure switch wire and turn the ignition on. Check the battery voltage between the switch wire and ground. If there is voltage, the oil pressure switch is faulty. You can also connect the wire to a good ground and the indicator light will light up.

Should the light not come on, check for voltage between the warning light terminals. If there is no voltage, the ignition switch is faulty or the fuse has blown. If there is voltage, the bulb is blown or there is a broken wire between the warning light and the oil pressure switch. If the oil pressure light stays on while the engine is running, the problem is caused by low oil pressure or a faulty oil pressure switch. Check oil level.

Chapter 13, *Lubrication Systems*, provides additional service information.

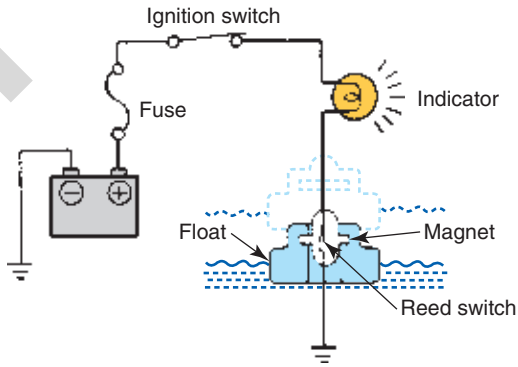


Honda Motor Co., Ltd.

Figure 12-23. Simplified oil pressure warning light system found on many motorcycles with four-stroke engines.

Oil Level Indicator

Some oil-injection, two-stroke engines are equipped with an ***oil level indicator***. The float in the oil tank moves up and down in relation to the volume of oil in the tank, **Figure 12-24**. When the oil level is low, the float goes down and the reed switch (oil level switch) is closed by the float's magnetic force. When the ignition switch is turned on, current flows through the reed switch and the oil level indicator comes on. Chapter 13, *Lubrication Systems*, provides additional service information.



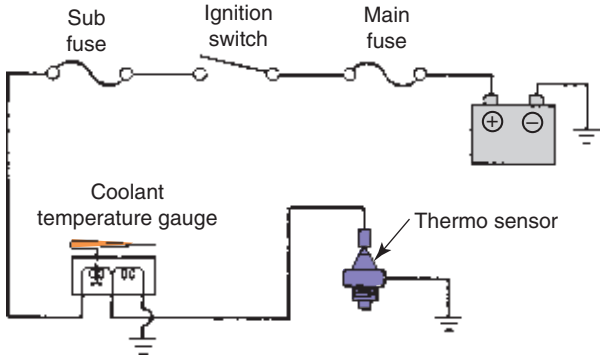
Honda Motor Co., Ltd.

Figure 12-24. Typical oil level indicator found in two-stroke engine circuits.

Coolant Temperature Gauge

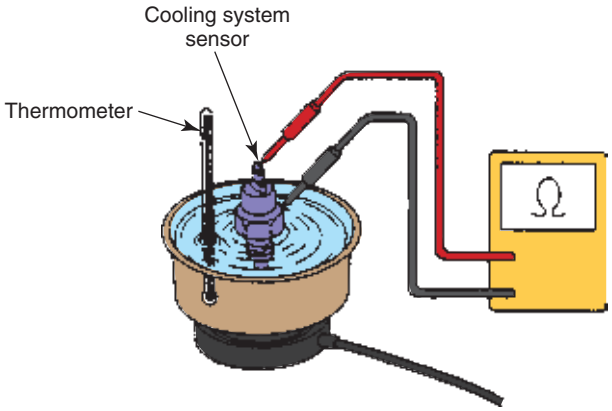
The ***coolant temperature gauge*** indicates the engine operating temperature. The gauge may show a needle with Fahrenheit and Celsius scales or a scale from *C* for cool to *H* for hot. The gauge may simply be a light that comes on when coolant temperature exceeds a certain level. On some digital instrument panels, this gauge shows a bar divided into segments. The number of illuminated segments varies according to the voltage across the gauge sender.

In liquid-cooled engines, the coolant temperature is monitored by sensors, such as a thermistor. The sensors determine current flow through the temperature gauge winding, **Figure 12-25**. With low coolant temperature, sender resistance is high and current flow is low. The gauge will indicate cooler temperatures. As coolant temperature increases, sensor resistance decreases and current flow increases. The gauge will indicate hotter temperatures.



Honda Motor Co., Ltd.

Figure 12-25. Typical coolant temperature gauge circuit.



Honda Motor Co., Ltd.

Figure 12-26. Method of testing a cooling system sensor. As the water heats, the sensor will lose resistance.

To test the coolant temperature circuit, first bypass the temperature sensor by completing the circuit to ground. This will check the entire circuit. Next, measure battery voltage at the ignition switch, fuse, temperature gauge, and temperature sensor. If voltage is found at all these points, do the following to check the sensor:

1. Disconnect the wire from the temperature sensor and remove it from the system.
2. Suspend the sensor in a pan of coolant (50–50 mixture) over an electric heating element, **Figure 12-26**.
3. Measure the resistance through the sensor as the coolant heats. More resistance should be indicated when the coolant is cold than when it is hot.

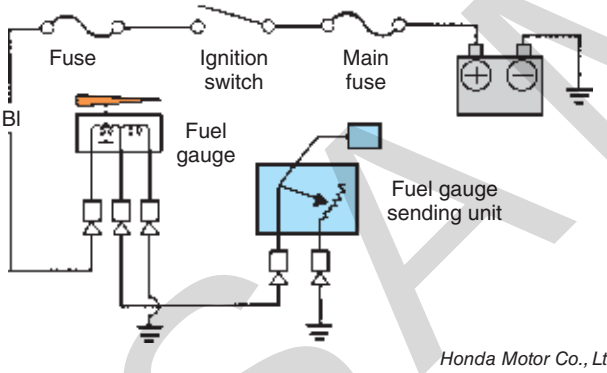
Additional service information is covered in Chapter 14, *Cooling Systems*.

Fuel Level Gauge

A ***fuel level gauge*** indicates the fuel level in the fuel tank. It is a magnetic indicating system that can be found on both analog and digital instrument panels.

The fuel gauge sending unit is combined with the fuel pump assembly and consists of a variable resistor controlled by the level of an attached float in the fuel tank, **Figure 12-27**. When the fuel level is low, resistance in the sender is low and gauge indicator movement from the empty position is minimal. When the fuel level is high, resistance in the sender is high and gauge indicator movement from the empty position is greater.

There are two types of fuel gauges: return and stop. The return-type fuel gauge has a needle that returns to empty when the ignition switch is turned off. The stop-type fuel gauge has a needle that stays in position when the ignition switch is turned off.



Honda Motor Co., Ltd.

Figure 12-27. Typical two-terminal fuel level gauge hookup.

Some motorcycles and scooters are equipped with a low fuel indicator rather than a gauge. In this system, a thermistor is built into the fuel tank, and the thermistor's self-heating turns on the low fuel indicator. When the thermistor is in the gasoline, heat radiation increases and the self-heating action is reduced. Because the resistance increases, the current does not flow and the low fuel indicator does not turn on. When the fuel level is low and the thermistor is out of the gasoline, heat radiation decreases and the self-heating action increases. Because the resistance is low, current flows and the low fuel indicator turns on.

Charging Gauge

The ***charging gauge*** and indicator light allow the rider to monitor the charging system. While a few motorcycles use an ammeter, some charging systems have a voltage gauge or an indicator light. On bikes with an ammeter gauge, the gauge is in series with the battery and alternator. When the alternator delivers current to the battery, the gauge displays a positive (+) indication. When the battery is not receiving enough current from the alternator or the battery receives no current, the gauge shows a negative (–) display.

Voltmeters show a scale from 10 to 18 volts with a needle indicating the approximate charge rate reaching the battery.

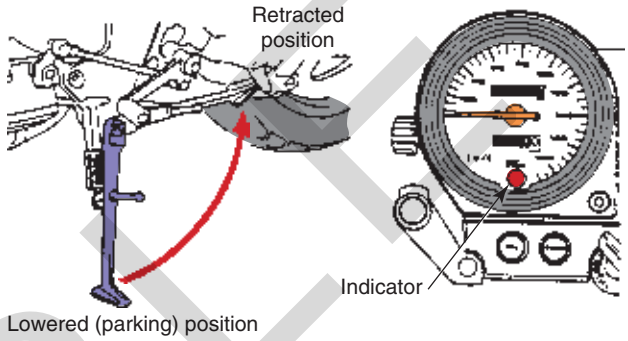
If a gauge is not used, a light may indicate the condition of the alternator and charging system. If there is a problem with the alternator or charging system, the light may come on while the engine is running. Additional service information was covered in Chapter 11, *Battery and Charging Systems*.

FI (Fuel Injection) Light

Electronic fuel injection control systems have a warning light, called an ***FI light***, that indicates the condition of the vehicle's electronic control systems. If there is a fault, the FI light comes on while the engine is running. The FI light is triggered when the engine control computer that monitors engine systems senses a fault. See Chapter 8, *Fuel Systems*, for more information.

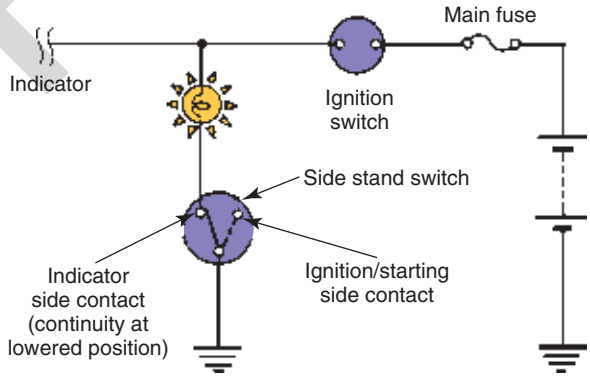
Side Stand Indicator Light

On motorcycles and scooters equipped with side stands, there is a ***side stand indicator light*** on the instrument panel, **Figure 12-28**. When the side stand is lowered (parking position), the side stand switch detects the side angle, the indicator side contact is turned on (closed), and the indicator light comes on, **Figure 12-29**. When the side stand is retracted, the indicator goes off. Most modern motorcycles will not crank or provide spark if the side stand light is on and the machine is in gear. Scooters will not crank unless the machine is placed on the center stand.



Honda Motor Co., Ltd.

Figure 12-28. Operation and location of the side stand indicator light.



Honda Motor Co., Ltd.

Figure 12-29. Side stand electrical circuit. The switch is closed when the side stand is lowered.

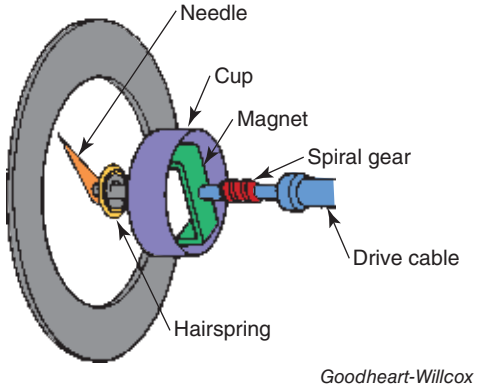
Anti-Lock Brake Light

The ***anti-lock brake light*** indicates a fault in the anti-lock brake system (ABS). If the ABS ECM detects a problem, it grounds the indicator circuit and the anti-lock brake light illuminates. If the light is on while the vehicle is underway, normal brake action will be available, but the ABS feature will not be available. See Chapter 17, *Brakes*, for more information.

Speedometers and Odometers

Speedometers and odometers on powersports vehicles may be operated mechanically or electrically. Mechanical meters have drive cables attached to the front wheel or to the transmission. On speedometer gauges, the cable turns a magnet inside a metal cup, **Figure 12-30**. The cup is attached to a speedometer needle and held at zero by a hairspring, or fine wire spring. As the cable rotates with increasing speed, magnetic forces act on the cup and force it to rotate. The speedometer needle then moves up the speed scale. On odometer-only meters, the cable turns mechanical gears, clicking each position while displaying the total. Some are also equipped with resettable trip meters.

In the electric (electronic) speedometer, the cable driven by the front wheel or transmission spins a small speed sensor. Others may have a wheel sensor similar to a mini alternator that sends an electrical signal to the meter.



Goodheart-Willcox Publisher

Figure 12-30. Components of an analog speedometer.

The sensor's voltage output increases as wheel speed increases. This voltage output is converted to a digital readout on the instrument panel. The higher the sensor voltage output, the higher the digital reading.

Tachometer

While a speedometer shows vehicle speed, a ***tachometer*** shows engine speed measured in rpm. Using a balanced coil gauge or sensor, a tachometer converts electrical impulses received from the engine to an rpm reading. The faster the engine rotates, the greater the number of impulses from the engine, and consequently, the greater the indicated rpm. Other types use a cable driven off the crankshaft or camshaft either directly or indirectly. The tachometer is placed next to the speedometer on most control panels.

Hour Meters

Some ATVs and UTVs are equipped with hour meters to track engine usage in time. This is useful when service intervals need to be tracked for a machine that does not travel a long distance. Hour meters are installed on modern four-stroke motocross motorcycles and other off-road motorcycles for the same purpose. They are connected to the secondary lead of the ignition to track ignition pulses and convert the information into hours of use.

Goodheart-Willcox Publisher

Figure 12-31. This twist-grip switch assembly includes a kill switch, starter switch, and cruise control switches.

Switches

In most of the electrical accessories covered so far, ***switches*** are used to turn the accessories on and off or to select other options, **Figure 12-31**. Switches can be tested for continuity with an ohmmeter or a test light at the switch connector plug by operating positions and comparing results with the switch operation.

There are many switches in the electrical system of a motorcycle. Many of the switches, including the main switch, clutch switch, engine stop switch, brake switch, dimmer switch, fan motor switch, turn signal switch, neutral switch, and passing switch, have been described in this or other chapters. In the following section, you will learn about a circuit that contains a very important switch, the horn circuit.

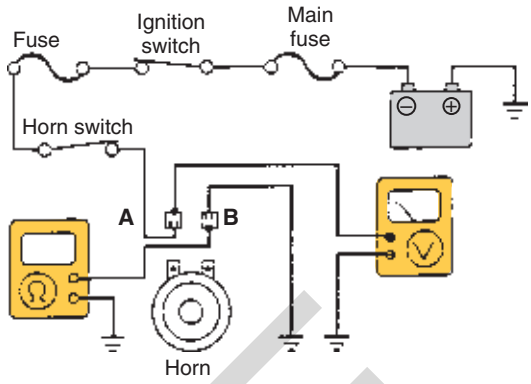
Horn Circuit

The ***horn circuit*** consists of a horn switch, fuse, wires, ignition switch, and horn. When the ignition switch is turned on, power is supplied to the horn. When the horn switch is pushed, the circuit is completed to ground and the horn honks. Most horns have an adjustment screw to clear the tone.

If the horn does not sound, check the fuse, the ignition switch, and the horn switch. If the voltage is normal, disconnect the wire from the horn. Turn the ignition switch on and press the horn switch. If the vehicle does not use a battery, start the engine and press the horn switch. Check for voltage between point *A* and ground, **Figure 12-32**. If there is voltage, check for continuity between point *B* and ground. The horn is faulty if

continuity is established between these two points. If there is no voltage at point *A*, the wire from the horn switch and horn is open.

Many riders seek to upgrade original equipment horns with louder, more powerful horns. Horn upgrades include more audible electric horns and louder air-assisted units.



Honda Motor Co., Ltd.

Figure 12-32. Troubleshooting a horn circuit, while simple, requires the use of a schematic.

Communication and Entertainment Systems

Modern cruisers, touring motorcycles, and even some ATVs and UTVs are available with communication and entertainment systems. These systems include features such as AM/FM radios, satellite radios, CD players, CB radios, and intercoms. See **Figure 12-33**. Many communication and entertainment systems are Bluetooth® compatible and can connect to cellular phones and MP3 players.

Internal examination of electrical entertainment equipment should be left to an authorized communication service center. However, a motorcycle technician should be able to analyze radio reception conditions and isolate the area or the component causing the problem. All radio reception conditions can be isolated to one of five areas: the antenna system, unit chassis (receiver), speakers, noise suppression device, or sound system.

AM/FM radio operation requires only the power from the fuse panel to be available at the radio. The radio intercepts broadcast signals with its antenna and produces a corresponding input to the system speaker. In addition, some radios have built-in memory circuits to ensure the radio returns to the selected station when the radio or ignition switch is turned off and back on again. Some of these memory circuits require full-time power input from the battery. The current draw is very small and requires no more power than a digital clock (no more than 0.2 mA). However, if battery power is removed, the memory circuit has to be reset.

The service manual and owner's guide for the vehicle equipped with this sophisticated gear will contain detailed information concerning its operation. If the system is not working, check the fuse. If the fuses are working properly, refer to the service manual. Remember, the receiver should only be serviced by a qualified technician or specialty service shop. If you determine the unit is the problem, remove the unit and send it to a qualified service center.

Goodheart-Willcox Publisher

Figure 12-33. This communication and entertainment system includes AM/FM radio, CB radio, satellite radio, and intercom.

Cruise Control

Another accessory system found on some cruiser and touring motorcycles is a cruise control or speed control system. With this electronic system, the rider can maintain a constant speed (usually above 30 mph or 48 km/h) without having to apply continual pressure on the twist grip. Selected cruise speeds are easily maintained and speed can be easily changed. Several override systems allow the vehicle to be accelerated, slowed, or stopped.

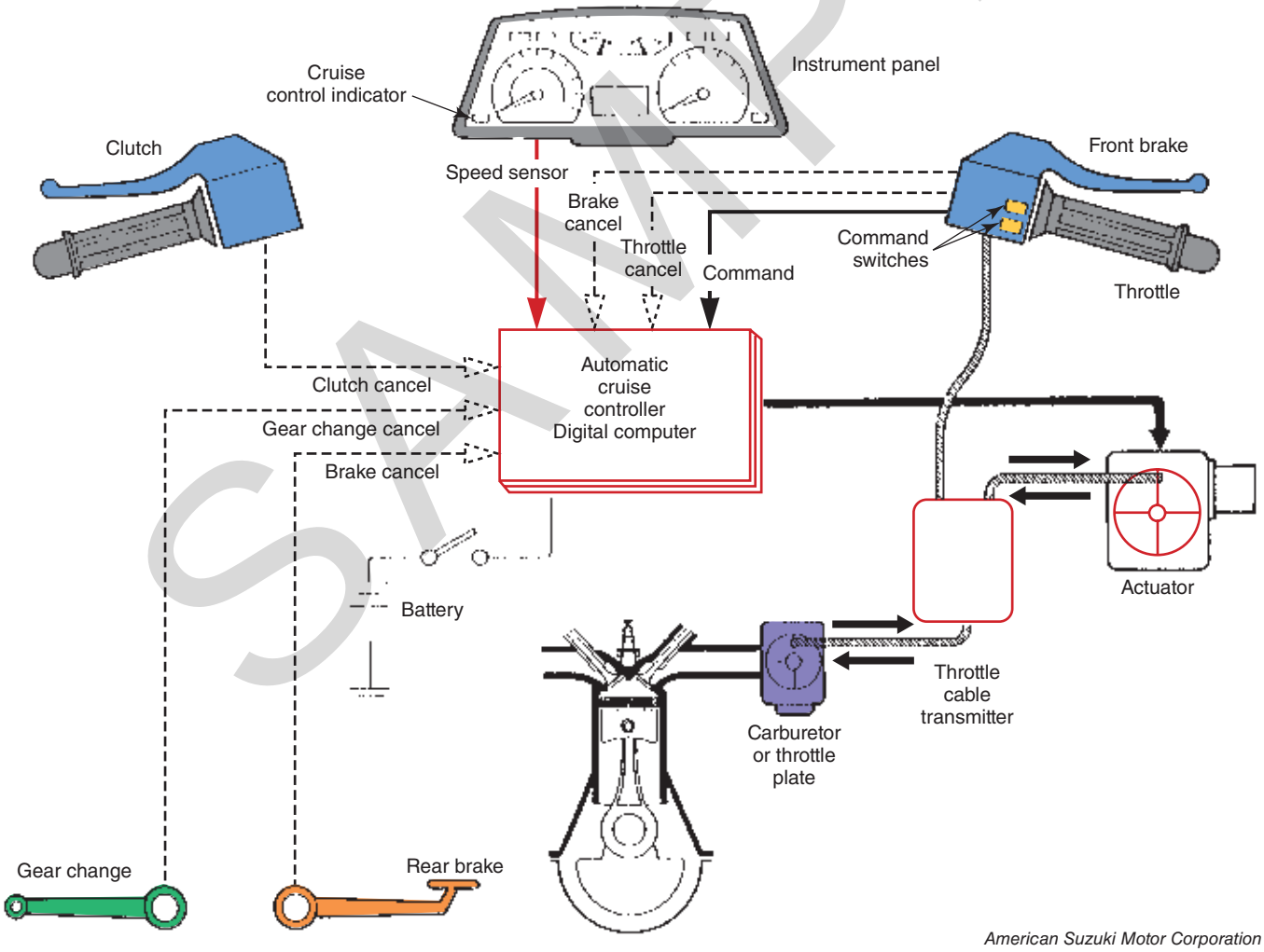
Improvements in technology resulted in each cruise control system being considerably different. Be sure to check the specific service manual before attempting any service.

The typical cruise control system, shown in **Figure 12-34**, is designed to maintain any speed between 30–80 mph (48–128 km/h) in overdrive (fifth gear). The cruising speed can be set and then adjusted to a faster or slower speed by the control switch. Once a speed has been set, the resume function can return the vehicle to the set speed.

The cruise control system contains a control module, actuator, and speed sensor. When cruise control is activated, the speed sensor sends a signal indicating vehicle speed to the control module. The control module memorizes the set speed and controls the actuator to operate the throttle accelerator cable to keep vehicle speed at or near the set speed.

The actuator contains an electromagnetic clutch, a pulley drive motor, and a cable pulley. The cable pulley is ordinarily free from the pulley drive motor. It is engaged with the motor by the electromagnetic clutch when the cruise control is set. At the same time, the motor moves the pulley and operates the throttle cable. When the cruise control is canceled, the pulley is disengaged from the motor and returned to the original position with its spring.

The throttle cable assembly has the junction box in the middle so the throttle pulley can be controlled by the actuator beside the throttle grip.



American Suzuki Motor Corporation

Figure 12-34. Components for a typical cruise control system.

The cruise control can be canceled when the rider performs one of the following operations:

- Turning off the ignition switch.
- Turning off the engine stop switch.
- Turning off the main switch.
- Pulling the front brake lever.
- Depressing the rear brake pedal.
- Turning on the starter lockout switch.
- Pulling the clutch lever.
- Turning off the overdrive (fifth gear) switch.
- Changing gears from fifth gear.
- Turning off any of the cancel switches (throttle, front brake, or rear brake).
- Closing the throttle grip completely.

The cruise control will be canceled automatically under the following conditions:

- Blown cruise control circuit fuse.
- Losing more than 5 mph (8 km/h) from the set speed.
- Running below 27 mph (43 km/h).
- Running above 89 mph (142 km/h).
- No signal from the speed sensor.

Goodheart-Willcox Publisher

Figure 12-35. Winches on ATVs and UTVs are helpful if the vehicle gets stuck or needs to be loaded onto a trailer.

Power Winches

Another electrical accessory is the ***power winch***. See **Figure 12-35**. Power winches may be fitted to the front or rear of ATVs and UTVs. Some are factory installed or added on after the initial sale. They may be operated on-board by a switch or remotely by the operator for a distance. Winches usually contain 50 feet or more of cable and are capable of getting a vehicle unstuck or over an object. They may also be used to load the machine onto a trailer. Troubleshooting winch failures is similar to troubleshooting other electrical accessories. First determine whether the winch is at fault by running power directly to the winch, bypassing the switch that operates the winch. Continue by testing the power output, switches, and wiring. Winches use a relay to ease battery drain at initial startup similar to an electric starter motor.

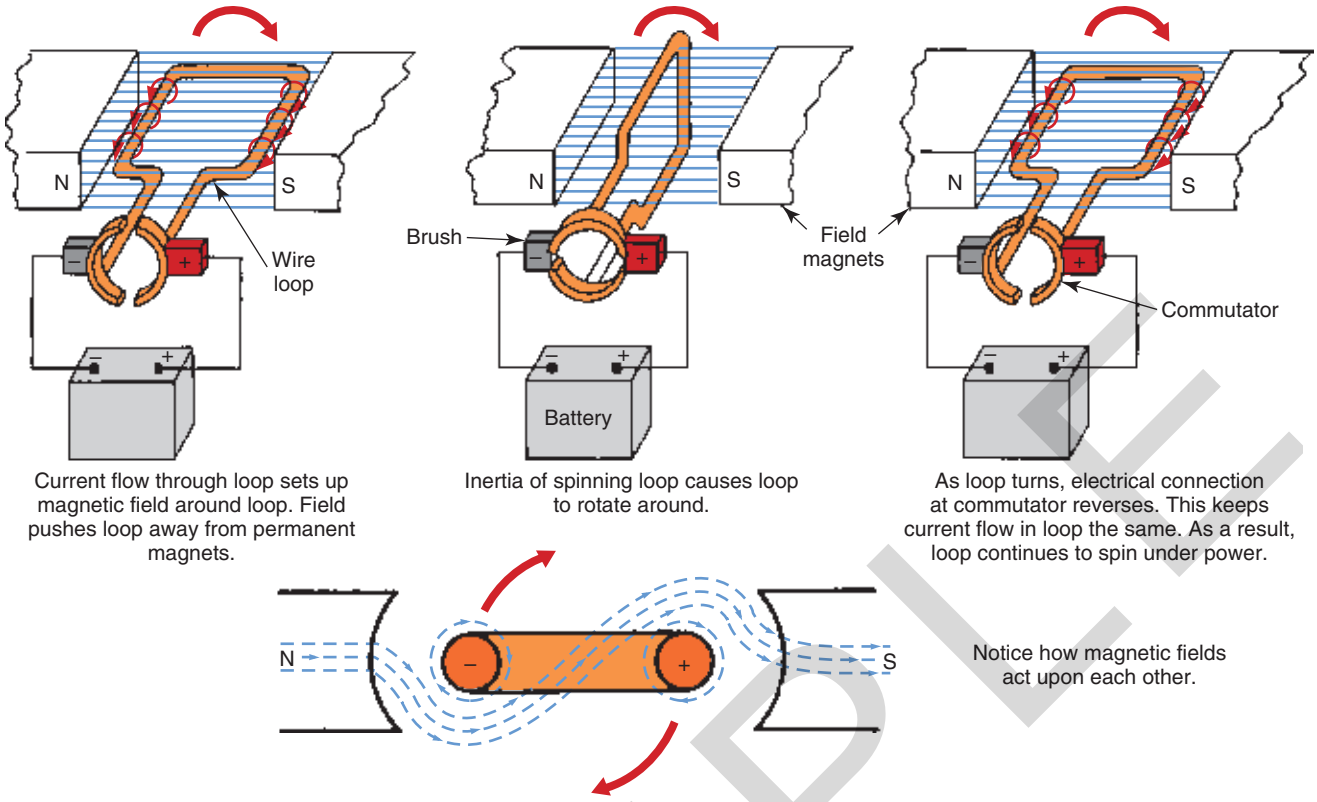
Goodheart-Willcox Publisher

Figure 12-36. An electric starter.

Electric Starter Systems

Probably the most convenient electrical accessory being used today on powersports vehicles is the electric starter, **Figure 12-36**. ***Electric starting motors*** use direct current from the battery for starting. They are similar in construction to a dc generator. A dc motor uses electrical energy to magnetically force its armature to turn, which creates mechanical energy. See **Figure 12-37** for an illustration of dc motor operation.

Electric starting motors will draw 70 amps or more when activated, so a relay is necessary to handle this current draw, **Figure 12-38**. When the starter switch is closed, battery voltage appears at the relay switch, or solenoid. If the ground line's neutral, clutch,



Goodheart-Willcox Publisher

Figure 12-37. In many ways a dc motor is similar to a dc generator. Instead of spinning the wire loop to induce current, the motor is connected to a source of electricity. This makes the loop spin inside a stationary magnetic field.

Goodheart-Willcox Publisher

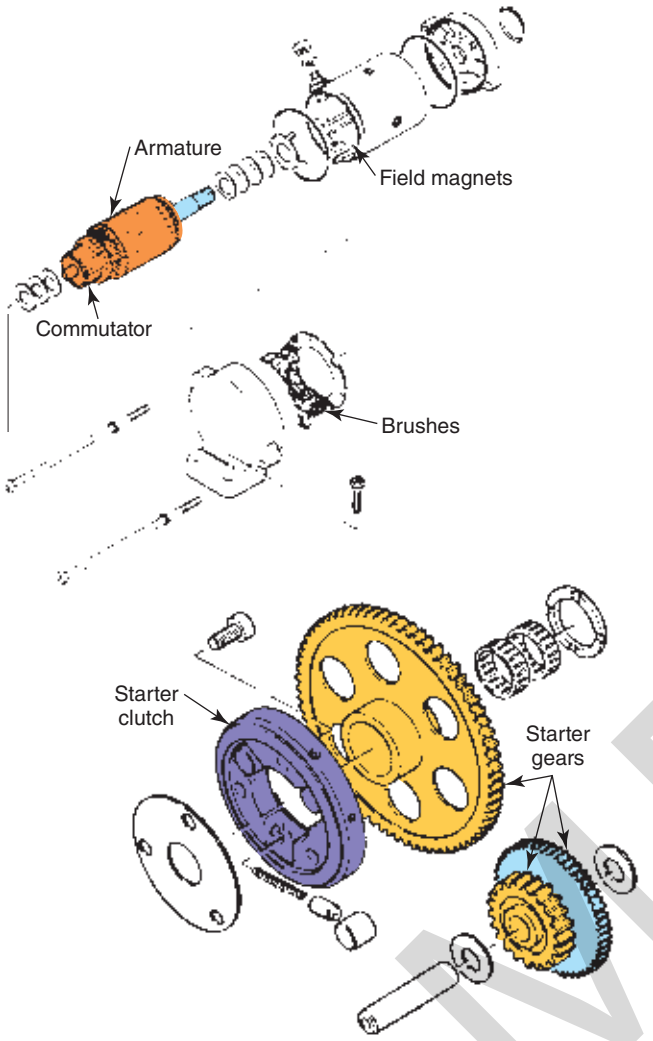
Figure 12-38. A relay is necessary to handle the current draw of electric starter motors.

or safety switch is closed, current flows through the relay and the starter motor operates. To check switch continuity, connect a battery test light across the switch leads. When the switch is closed, the test light should glow. When the switch is open, the test light should not glow. An ohmmeter can also be used to check switch operation.

A gear or chain drive and a starter clutch are normally used to engage and disengage the starter motor. A starter bendix may be used in other cases. **Figure 12-39** illustrates a starter and starter drive mechanism. **Figure 12-40** shows the starting motor gears on an actual motorcycle. The ***starter clutch*** is a one-way clutch that allows the starter motor to spin the crankshaft. Once the crankshaft is spinning faster than the starter motor's speed, the starter is disengaged.

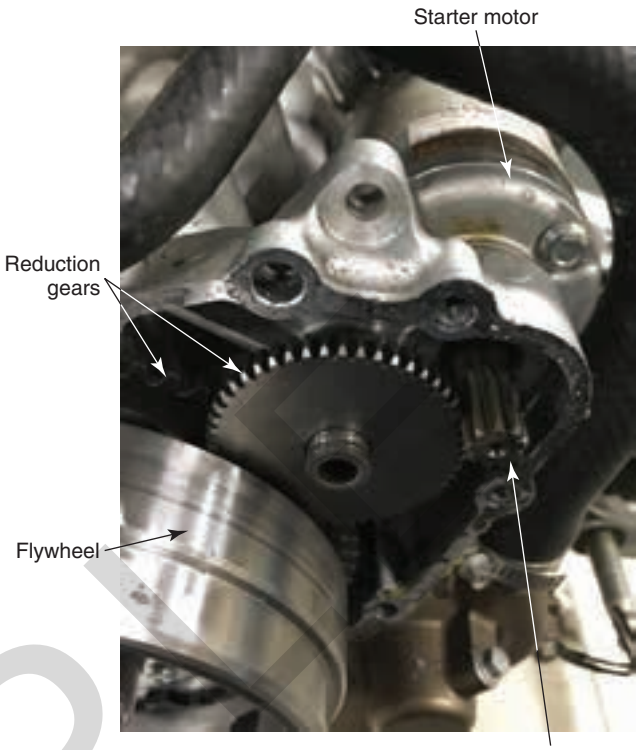
Security Systems

Some modern motorcycles are equipped with factory security systems. These systems incorporate many of the electrical accessories covered here, such as headlights and turn signals that flash when the machine is tampered with. Consult the service manual to troubleshoot problems with security systems.



American Suzuki Motor Corporation

Figure 12-39. Parts of a starter mechanism. Gears and a simple clutch are normally used to engage and disengage the starter.



Goodheart-Willcox Publisher

Figure 12-40. Starter gears provide gear reduction, which increases the starter motor's turning force. The starter clutch is hidden behind the flywheel.

Workplace Skills

Businesses and organizations use social media to provide information, reach customers, and find new followers. Individuals use social media to communicate with friends, post reviews, meet new people, and to find new places and things to see and do. Unfortunately, many people abuse social media and post negative and often false comments about others.

If you are responsible for your company's social media postings, use good judgment when you choose new postings or write replies to customers' queries or complaints. Do not ignore customers' requests to keep their email addresses private and use them only for receipts or appointment reminders. Remember that it is unethical to spam customers who have not requested to be on an organization's mailing list. Keep your messages honest and return messages from those who have taken time to respond to your communication. Always represent yourself and your organization in a professional and respectful manner.

Summary

- Electrical accessory systems are groupings of electrical and electronic circuits that are part of the electrical system. They include lighting circuits, warning and indicator circuits, switch circuits, communication systems, cruise control, security systems, electric starters, and power winches.
- A street motorcycle's lighting system usually includes a headlight, taillight, brake light, directional turn signals, warning lights, and instrument illumination.
- There are two ways to power the lighting systems on motorcycles: the battery powers dc lighting, and the alternator or magneto powers ac lighting.
- There are two types of headlight bulbs that are commonly equipped on powersports vehicles: sealed beam tungsten bulbs and halogen bulbs.
- The headlight beam is adjustable both horizontally and vertically and must be correctly adjusted for maximum visibility and safety.
- The taillight lens assembly also provides license plate illumination, and on some street motorcycles and scooters, the taillight can be used as a parking light. The brake light is built into the taillight assembly.
- The turn signal light circuit normally includes four turn signals, one or two indicator bulbs, a turn signal flasher, switches, and wiring.
- Troubleshooting lighting system problems requires basic electrical understanding and the use of a multimeter, test light, and wiring schematics.
- There are various instrument panel designs and layouts with two types of panel displays: analog and digital.
- On four-stroke engines, the oil pressure warning light indicates low engine oil pressure.
- Two-stroke engines may be equipped with an oil level indicator. The float in the oil tank moves up and down in accordance with the volume of oil in the tank.
- The coolant temperature gauge indicates the engine operating temperature.
- The fuel level gauge indicates the fuel level in the fuel tank.
- Charging gauges, which include voltmeters, ammeters, and indicator lights, allow the rider to monitor the charging system.
- Some electronic fuel injection control systems have an FI light that indicates the condition of the vehicle's electronic control systems.
- A side stand indicator light on the instrument panel indicates when the side stand is extended.
- The anti-lock brake light indicates a fault in the anti-lock brake system.
- Motorcycle speedometers and odometers may be operated mechanically or electrically.
- While the speedometer shows the vehicle speed, the tachometer indicates the engine speed measured in rpm.
- An hours meter equipped on some ATVs and UTVs tracks engine usage in time, which is useful when determining maintenance service intervals.
- In most electrical accessory systems, switches are used to turn the accessories on and off or to select other options. Switches can be tested for continuity with an ohmmeter or a test light at the switch connector plug.
- Many powersports vehicles are available with communication and entertainment systems, including systems with Bluetooth compatibility. The systems include features such as AM/FM radios, satellite radios, CD players, CB radios, and intercoms.
- When engaging a motorcycle's cruise control system, the rider can maintain a constant speed without having to apply continual pressure on the twist grip.
- Power winches can be equipped on the front or rear of ATVs and UTVs and are used to perform different tasks.
- Additional electrical accessory systems include electric starters and security systems. A gear or chain drive and a starter clutch are normally used to engage and disengage the electric starting motor, which is powered by direct current from the battery.

Review Questions

Answer the following questions using the information provided in this chapter.

1. The _____ provides power to a powersport vehicle's direct current (dc) lighting system.
   A. alternator coil
   B. ignition system
   C. electronic module
   D. battery
2. A(n) _____ headlight bulb has two filaments: one for a high beam and one for a low beam.
   A. tungsten
   B. halogen
   C. xenon
   D. LED
3. To adjust the headlight, the motorcycle should be _____ from the aiming wall.
   A. 3′ (.914 m)
   B. 25′ (7.62 m)
   C. 30′ (9.14 m)
   D. 250′ (76.20 m)
4. *True or False?* Most state laws require that the taillights on street vehicles be powered by an alternating current (ac) lighting system.
5. A double-filament bulb is used in what combined lighting unit?
   A. Brake light and turn signals.
   B. License plate and headlight.
   C. Taillight and brake light.
   D. Headlight and turn signals.
6. *True or False?* The brake light switch should be adjusted so that the brake light comes on at exactly the same time that the brake is engaged.
7. To troubleshoot a lighting system circuit, a technician refers to the circuit wiring schematic and uses a multimeter to check all of the following, *except*:
   A. continuity of the circuit switches.
   B. voltage and voltage drops in the circuit.
   C. operating temperature of the circuit's switch and fuse/relay.
   D. the condition of the circuit's electrical wiring and that the circuit has a good ground.
8. *True or False?* Digital instrument displays show relative change better than analog displays.
9. A return-type _____ gauge has a needle that returns to empty when the ignition switch is turned off.
   A. fuel level
   B. charging
   C. oil level
   D. coolant temperature
10. *True or False?* The anti-lock brake light comes on when the anti-lock braking system is being employed during vehicle operation.
11. Speedometers may be operated _____.
    A. mechanically or electrically
    B. pneumatically
    C. hydraulically
    D. thermally
12. Engine speed is displayed by the _____.
    A. speedometer
    B. odometer
    C. tachometer
    D. charging gauge
13. *True or False?* Most electrical accessory circuits use a switch to turn the accessories on and off.
14. All of the following areas are related to radio reception conditions, *except*:
    A. antenna system.
    B. speakers.
    C. microphone.
    D. noise suppression device.
15. *True or False?* In a motorcycle cruise control system, the electronic control module memorizes the set speed when the system is activated and controls the actuator to operate the throttle accelerator cable to keep vehicle speed at or near the set speed.
16. A motorcycle's cruise control system will automatically disengage when the rider _____.
    A. applies the brakes
    B. applies the clutch
    C. turns off the ignition switch
    D. All of the above.

17. All of the following statements about power winches equipped on ATVs and UTVs are true, *except*:
    A. power winches can be used to load the machine onto a trailer.
    B. troubleshooting power winch issues requires knowledge of diodes and rectifier circuits.
    C. power winches are capable of getting a powersports vehicle unstuck or over an object.
    D. power winches use a relay to ease battery drain at initial startup.

18. As an electric starting motor's armature spins during operation, the electrical connection at the _____ continually reverses to keep current flow in the armature moving in the same direction.
    A. stationary magnetic field
    B. regulator
    C. battery
    D. commutator

Suggested Activities

1. Following the procedures in the service manual, check the headlight alignment on a motorcycle and compare the results to the specifications for that vehicle. If the headlight alignment (high beam, low beam, or both) does not meet specifications, follow the procedures to realign the light.
2. Using the appropriate diagnostic equipment, inspect the electrical system of a motorcycle to determine its safety and reliability. If any faults are discovered, take corrective action.