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UNIT 8 | SECTION A | LESSON 2 | PRESENTATION

ELECTRICAL SYSTEMS

LEARNING OBJECTIVES

At the end of this lesson, you will be able to:

- **Describe the components of aircraft electrical systems and their purpose.**
- **Predict the results of an electrical system failure.**
- **Determine the best procedure to resolve in-flight electrical problem scenarios.**

WARM-UP

Make a list of the things you use every day that depend on electricity.

Then look at the cockpit picture and think back to what you've learned in previous lessons to identify items in an aircraft that you think are likely powered by electricity.

How would not having the everyday items you listed affect you?

How might a pilot be affected by losing power in flight?

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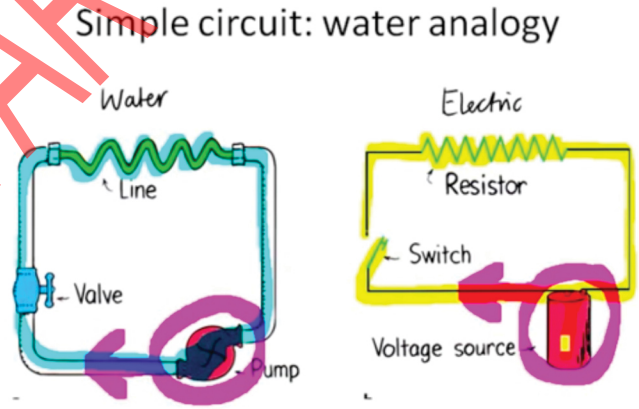
VIDEO

WATER ANALOGY

- **Think of electricity as water flowing through pipes.**
  - Water pipes = electrical wires
  - Water pump = battery/power source
  - Constricted pipe = load (something that creates resistance, usually the device that does the work, such as a lightbulb or motor)



VIDEO

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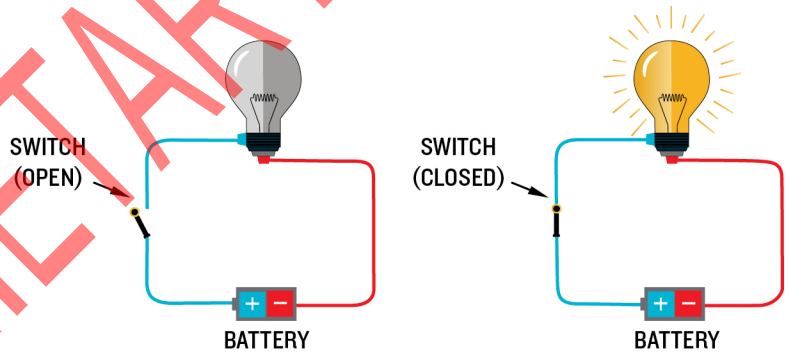
VOLTAGE AND CURRENT

- **Voltage is the pressure in the system.**
  - Measured in volts
- **Current is the amount of electricity flowing through the system.**
  - Measured in amps
- **Electrical devices need a combination of pressure (volts) to push electricity through the system and enough electrons or current (amps) to power the device.**

A BASIC ELECTRIC CIRCUIT

- **A circuit is the pathway the electricity follows.**
  - As the name implies, in its simplest form, it's like a circle with current flowing from the power source, around the circle, and back to the power source.
  - For the circuit to work, the pathway has to be unbroken.



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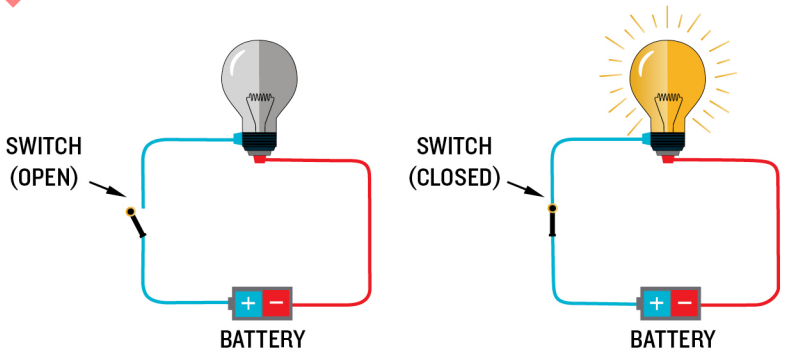
BUILD A CIRCUIT

- **Build a simple model of an aircraft electrical system.**
- **Start by building a basic circuit that includes**
  - A battery to provide voltage and current
  - A light bulb to provide load (do work)
  - A switch to control the flow of electricity
- **Later, you will add additional elements following the instructions on Student Activity 1.**
- **For now, simply complete steps 1 and 2.**



ALTERNATORS AND GENERATORS

WHAT WOULD HAPPEN IF AIRCRAFT ELECTRICAL SYSTEMS DEPENDED ONLY ON BATTERIES FOR POWER?

- **Aircraft use an alternator to create electricity.**
  - Powers aircraft equipment
  - Recharges the battery
- **If the alternator fails, the electrical system will drain the battery.**
- **The alternator generates electricity by spinning an electromagnet inside a wire coil.**

ALTERNATOR CONTROL UNIT

- **Some aircraft components are sensitive to power spikes and could be damaged by rapid changes in power availability**
  - Avionics
  - Radios
- **Alternator control unit protects delicate components**
  - Electronically monitors electrical system needs
  - Varies power output to maintain safe operating level
  - Works by varying spin rate of electromagnet

AMMETERS AND LOAD METERS

- **Two types**
  - Charge/Discharge ammeter shows only the state of the battery: charging, neutral, discharging
  - Load Meter shows the total load placed on the alternator by the electrical system (see image)
- **Allows the pilot to monitor electrical system status**
- **Return to Student Activity 1 and complete step 3**

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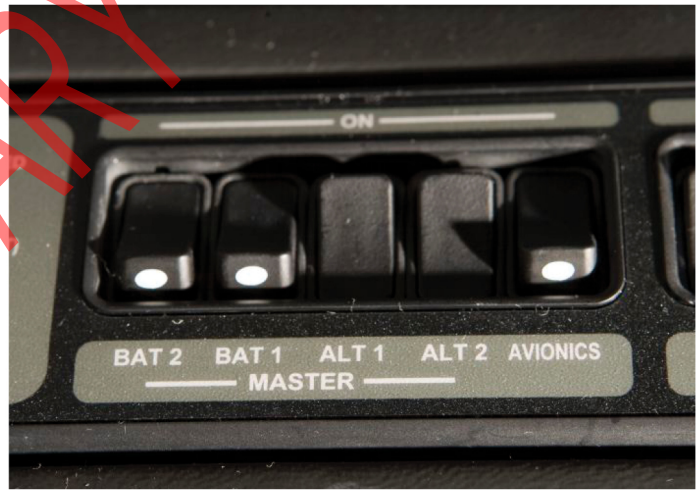
BUS BARS AND MASTER SWITCHES

- **Bus Bar**
  - Simplifies wiring
  - Distributes power
- **Primary Bus**
  - Activated with Master Switch(es)
  - Controls all electrical equipment except avionics
- **Avionics Bus**
  - Activated with Avionics Master Switch
  - Isolates sensitive avionics from power spikes
- **Create a second bus for your electrical circuit by following the instructions in Student Activity 1, step 4**



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VIDEO

CIRCUIT BREAKERS AND FUSES

- **Designed to break the circuit in the event of an overload or malfunction**
  - Like an open switch, stops electricity from flowing
  - Helps prevent damage to electric components
  - Helps prevent fire
- **Circuit breakers can be reset but fuses must be replaced if they are tripped**
- **Organized in cockpit according to which bus they are on**

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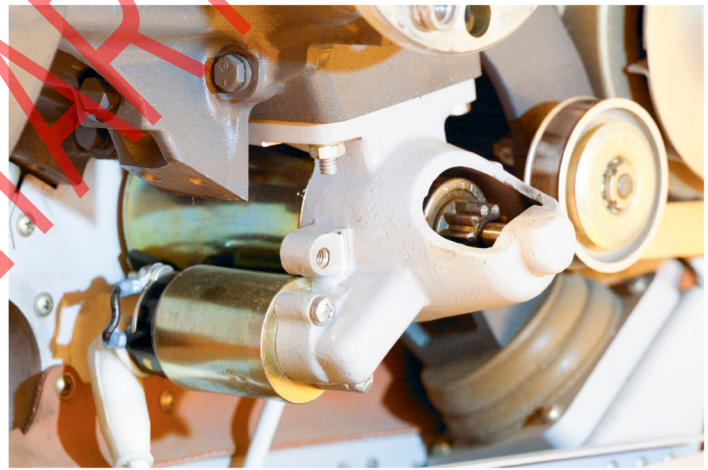
STARTERS

- Recall that a starter is a small but powerful electric motor that turns the engine to enable it to begin firing
- Uses battery power
- Master switch must be on and ignition turned to “start” position
- Add a motor to your circuit by following the instructions in step 5 of Student Activity 1



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CONTACTOR

- A remote switch that allows high power current to flow from the battery to electrical devices that require a lot of power
- Uses low current power flowing from the pilot-activated switch to close a high-power circuit to devices such as the starter motor

PUTTING IT ALL TOGETHER

- **Watch this video to review what you've learned about electrical systems.**

VIDEO

- **Then, demonstrate your knowledge by completing Student Activity 2.**

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ELECTRICAL SYSTEM FAILURES

- **Alternator failure indications**
  - Ammeter or load meter discharge
  - Low voltage light
- **Voltage regulator failure indications**
  - Excessive ammeter charge
  - Warning light

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RESPONDING TO A FAILURE

- After noticing a high or low charge on the ammeter or load meter, the pilot should
    1. Turn off the avionics master switch to protect the electronics
    2. Turn off the main master switch, then turn it back on again to reset the alternator

Ammeter showing a discharge
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NEXT STEPS

- If a low charge/discharge reading continues, the battery is carrying the full load of the electrical system.
- Expect the battery to fail in less than 30 minutes.
- Turn off all non-essential equipment to preserve power for critical uses, such as communication and navigation.
- Plan to extend landing gear manually.
- Plan to make a no-flaps landing.
- If an overcharge reading continues, turn off the master switch to protect equipment.
- In either case, land as soon as practical.

FALSE READINGS

- False low-voltage readings can occur at low engine power settings (e.g., during taxi)
- Caused because the alternator is not turning fast enough to meet the demands of the electrical system
- Increasing RPM will correct this situation

IS IT AN EMERGENCY?

- Losing electrical power is serious, but not necessarily an emergency.
- In daytime, visual flight conditions (day VFR), it should be possible to land without issue.
- At night or in instrument conditions (IFR), the situation is more serious.
- A pilot should never be afraid to seek assistance from air traffic control or declare an emergency.

ELECTRICAL FIRE

- The smell of burning insulation is often the first sign of an electrical fire.
- Smoke may be apparent before you see flames.
- An in-flight fire is always an emergency.
- If you experience an electrical fire, follow the below steps.
    1. Turn off the master switches.
    2. Extinguish the fire, if possible.
    3. Land as soon as possible.

PRIVATE PILOT KNOWLEDGE TEST QUESTION

An electrical system failure (battery and alternator) occurs during flight. In this situation you would

A. Experience avionics equipment failure.

B. Probably experience failure of the engine ignition systems, fuel gauges, aircraft lighting system, and avionics equipment.

C. Probably experience engine failure due to the loss of the engine-driven fuel pump and also experience failure of the radio equipment, lights, and all instruments that require alternating current.

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PRIVATE PILOT KNOWLEDGE TEST QUESTION

A positive indication on an ammeter

A. Indicates the aircraft's battery will soon lose its charge.

B. Shows the rate of charge on the battery.

C. Means more current is being drawn from the battery than is being replaced.

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PRIVATE PILOT KNOWLEDGE TEST QUESTION

To keep a battery charged, the alternator voltage output should be

A. Less than the battery voltage.

B. Equal to the battery voltage.

C. Higher than the battery voltage.

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PRIVATE PILOT KNOWLEDGE TEST QUESTION

Which of the following is a true statement concerning electrical systems?

A. The master switch creates current that is supplied to the electrical system.

B. The airspeed indicator is driven by the electrical system.

C. Lights and radios use the electrical system for power.

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YOU DECIDE

Use Student Activity 3 to assess some real-world electrical failure scenarios. Troubleshoot the problem, explain the cause of the failure, and determine the best course of action based on what you've learned in this lesson.

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