Aircraft Systems

Objective

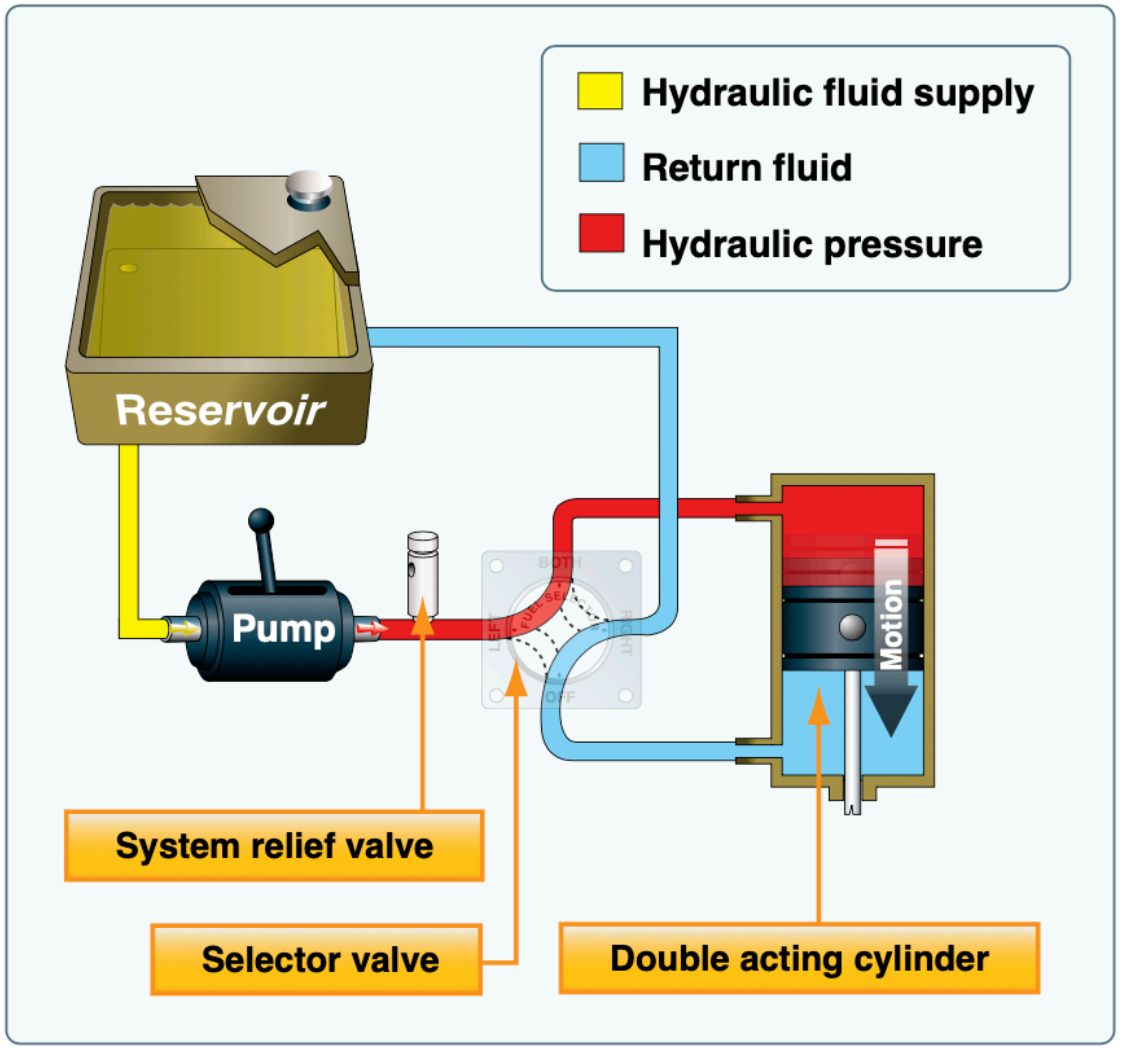
To understand the basics electrical, environmental, and deicing systems of a trainer aircraft.

Motivation

It is important to have an intuitive understanding of how the electrical system of airplane works to troubleshoot issues, and to understand common failure modes of the flight instruments.

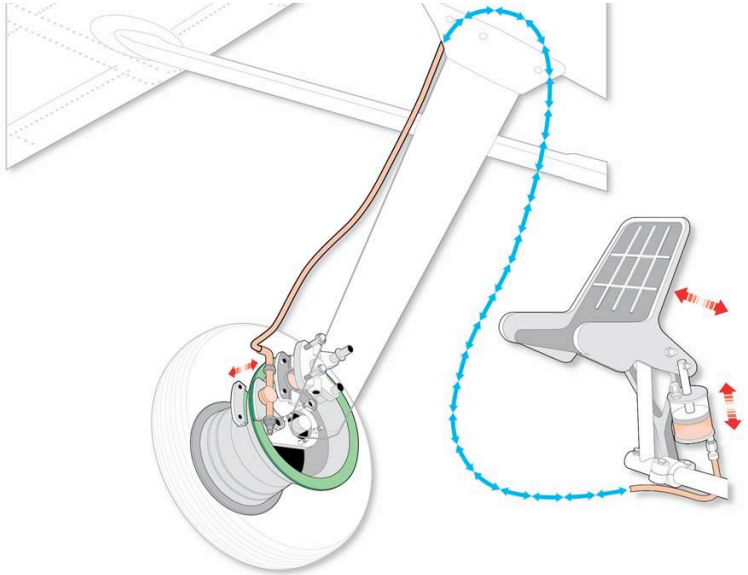
Overview

- Hydraulic brakes
- Brake system
- Landing gear
- Electrical system
- Circuit vs Water
- Light Aircraft Electrical Systems
- Alternators
- Environmental Systems
- Deice and Anti-ice system
- Deicing Systems



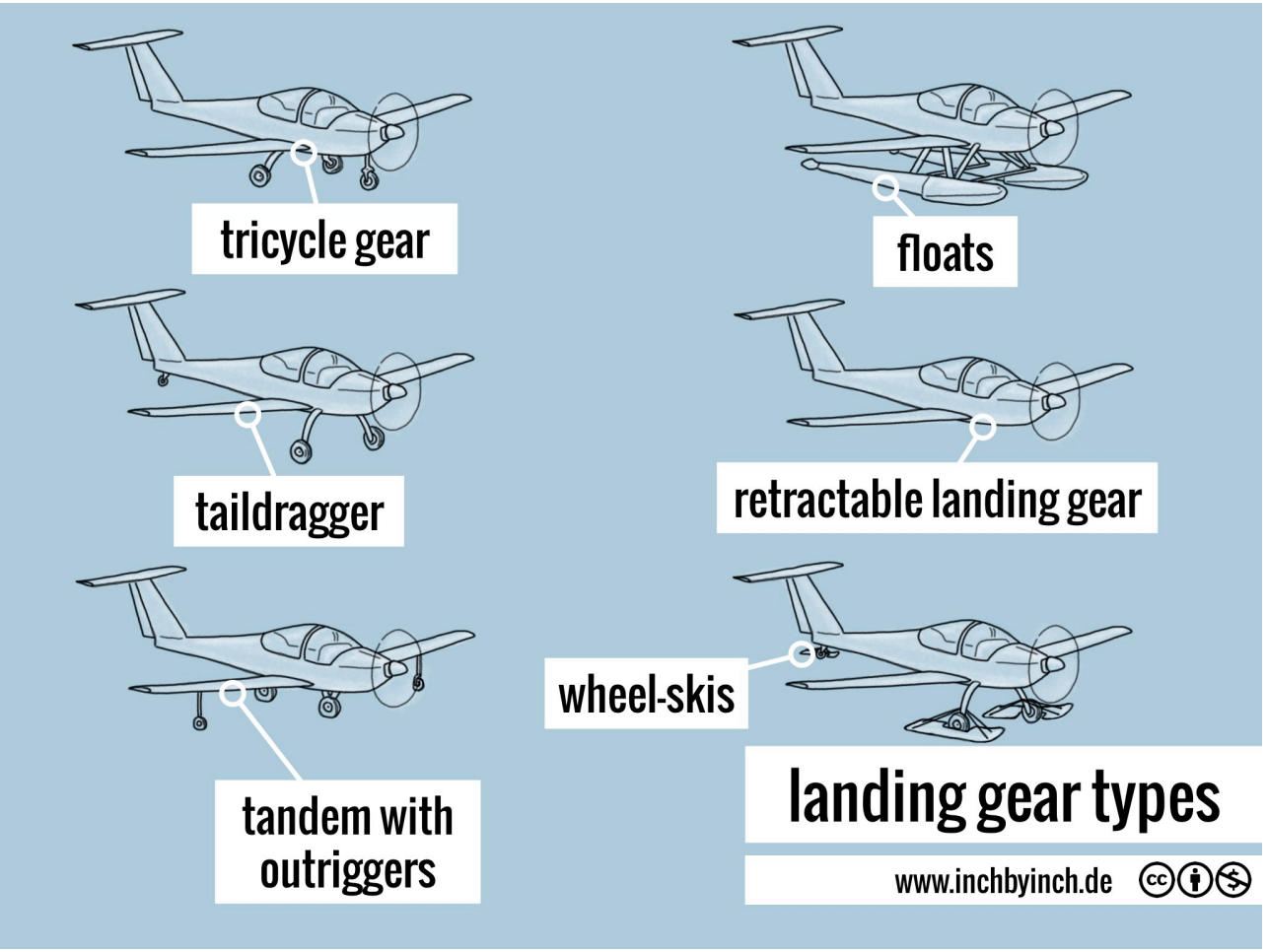
Hydraulic systems

- Incompressible fluid is forced through a hydraulic line to a piston
- Piston moves whatever needs to be moved



Hydraulic Brakes

- Hydraulic lines connect brake pedals to brake calipers
- Toe pedals applies pressure to the fluid, which in turn closes the brake caliper



Landing Gear

- Tricycle landing gear common on trainers
- Nosewheels can be steerable or free-castering
- Retractable landing gear
  - Electronic or hydraulically actuated

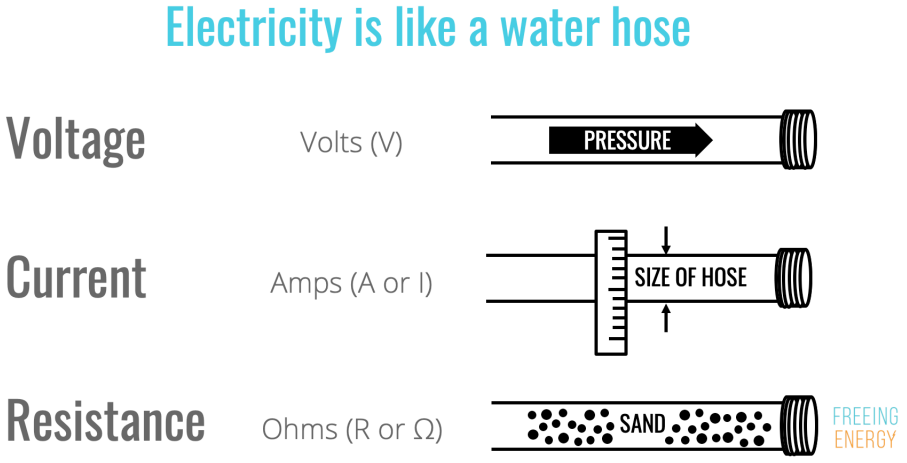
Tricycle Landing Gear

- Supports stability on landing since CG is forward of main landing gear
- Less susceptible to ground-looping
- Good visibility on the ground

Taildragger or Conventional Landing Gear

- More propeller clearance
- Less visibility when taxiing
- Since C.G. is behind the main gear it they are susceptible to ground-looping
    - If airplane were to swerve, pilot may not have enough rudder authority to prevent tail from swinging around

Electrical System



Electrical system

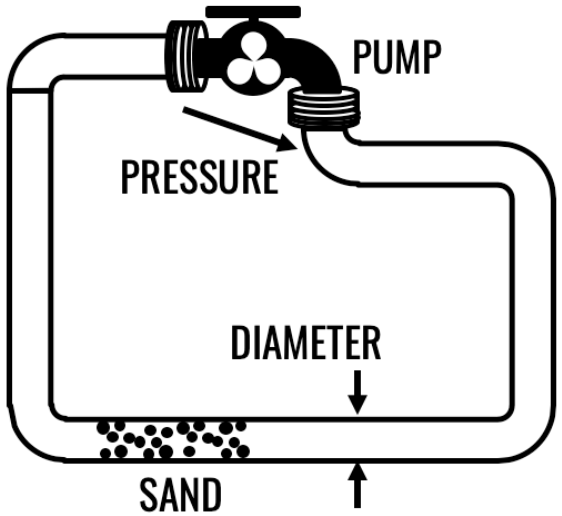
- Basic circuit:
  - Voltage (pressure)
  - Current (volume)
  - Resistance/load (anything impeding the flow of water)

Circuit vs Water

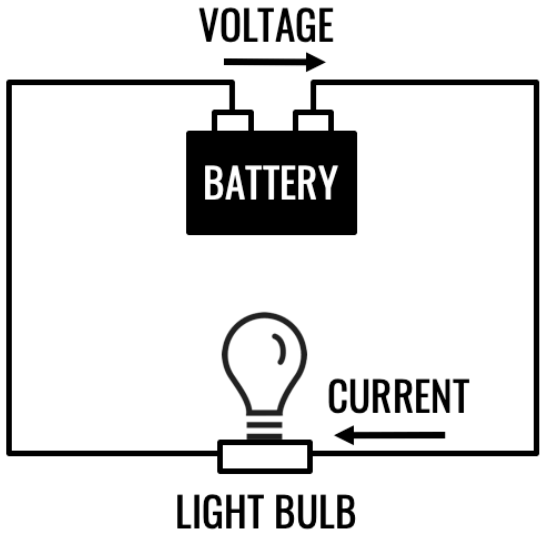
Voltage = Current x Resistance

(V = I x R)

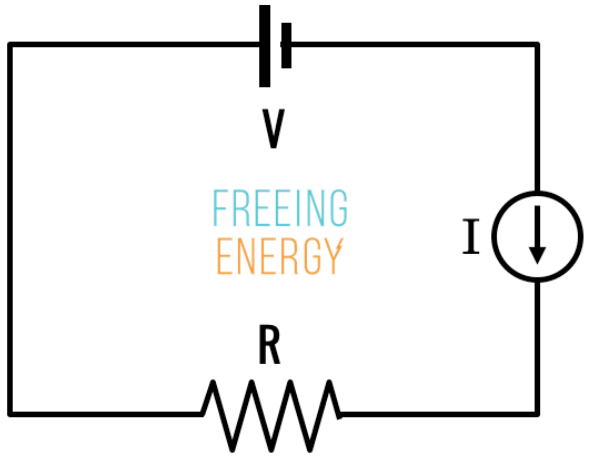
Water

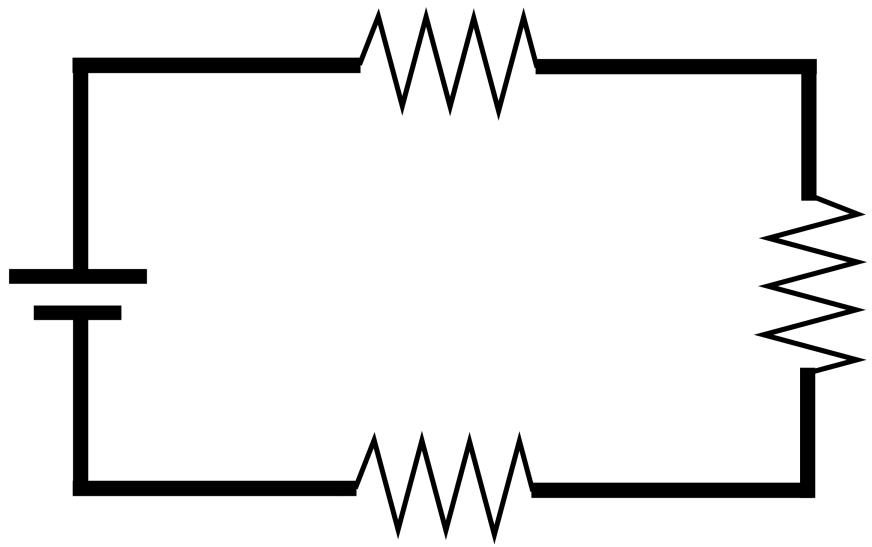


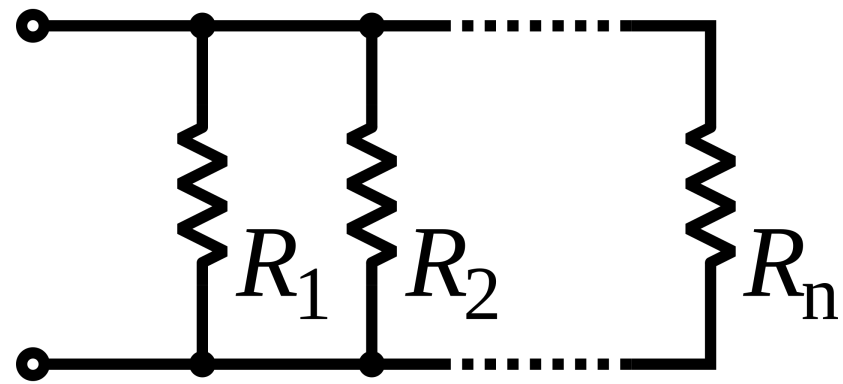
Electricity

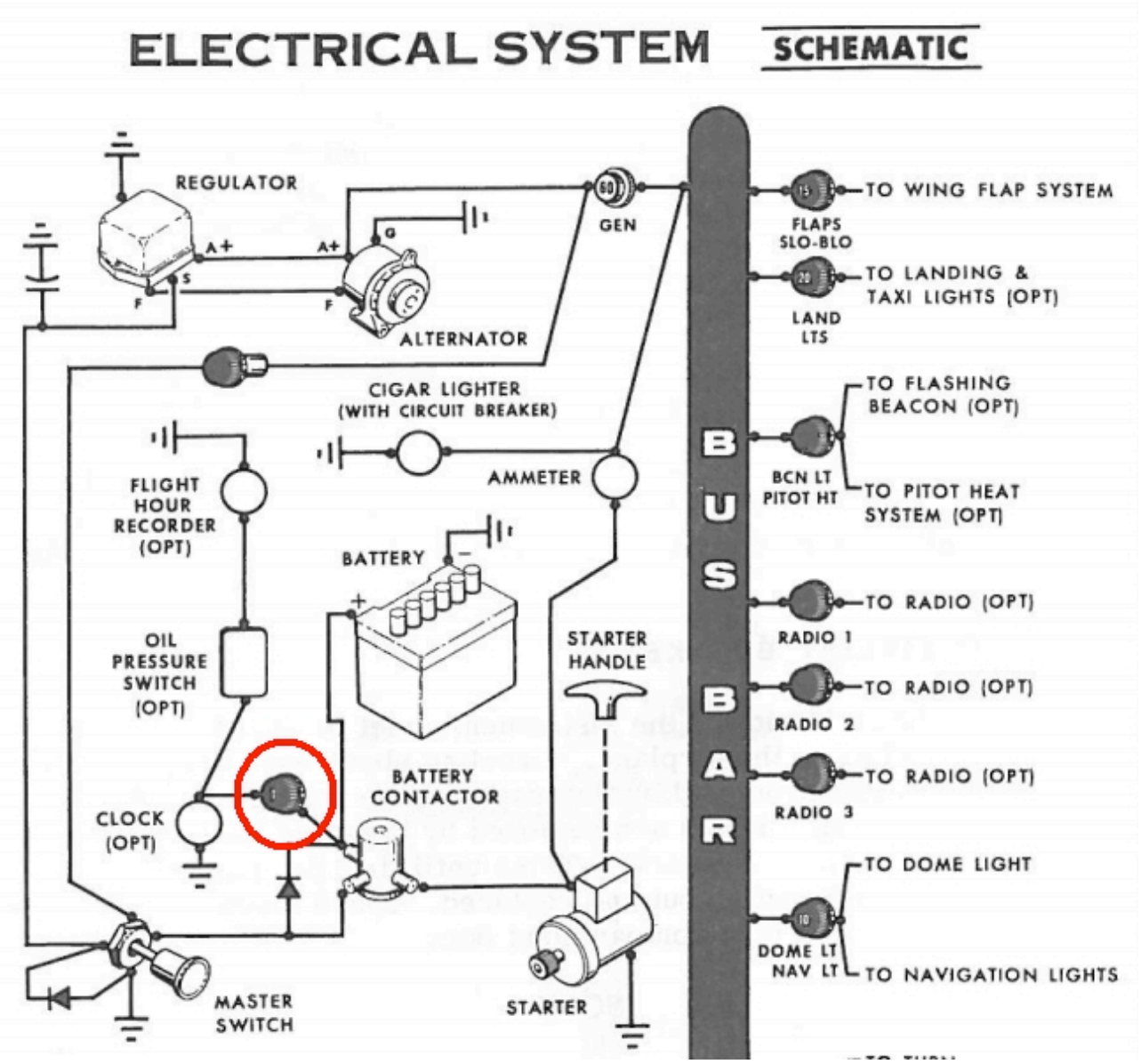


Circuit Diagram



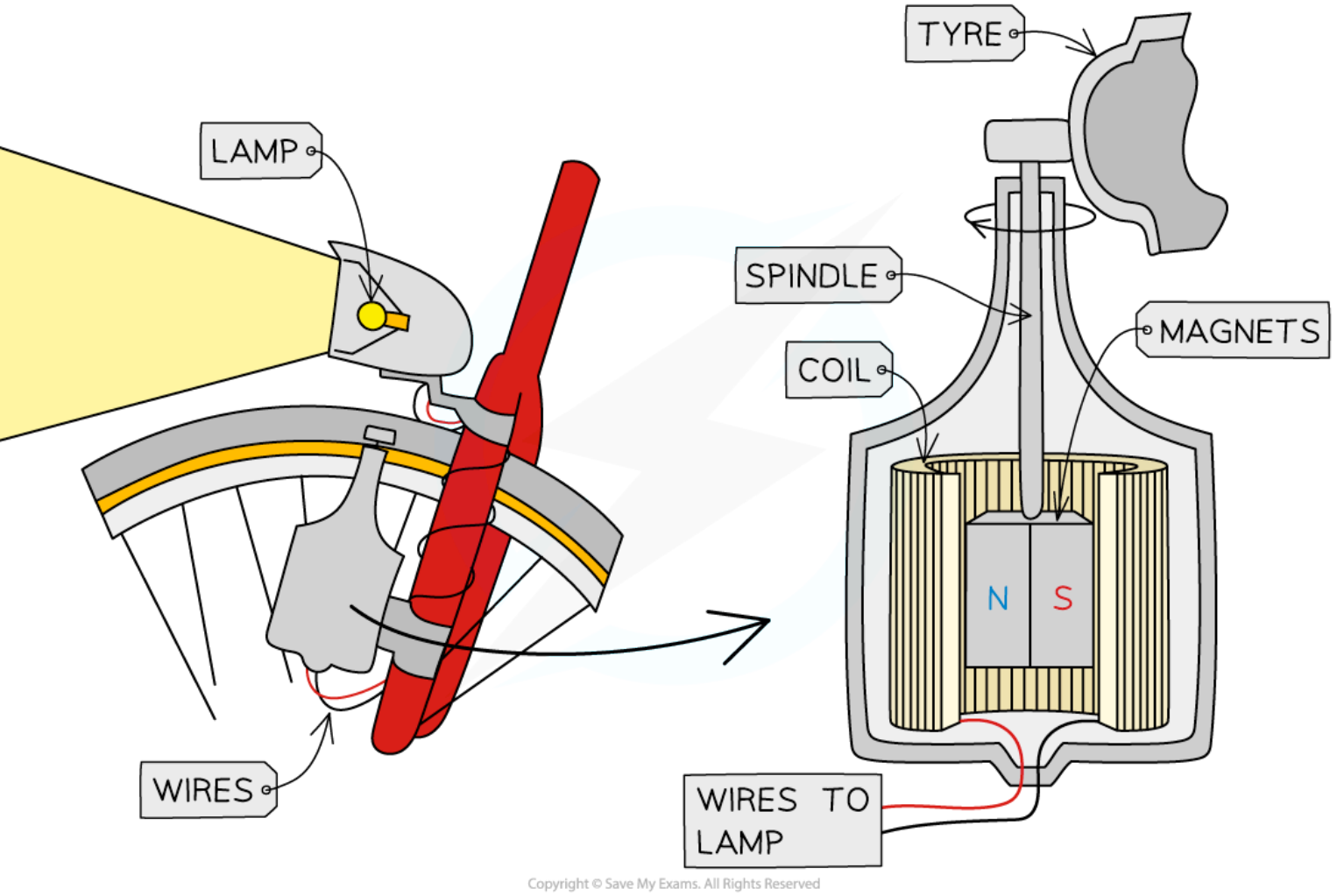



R_1
R_2
R_n



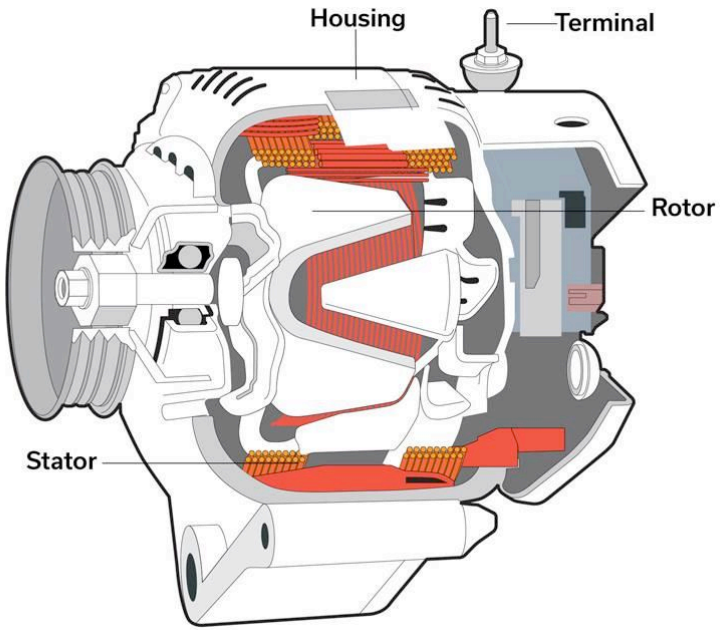
Light Aircraft Electrical Systems

- Direct current systems are common in most training airplanes
- Cessna usually have 28V electrical systems
- Batteries: Capacity measured in amp-hours (17 amp-hours means 17 amps for 1 hour, or visa-versa)



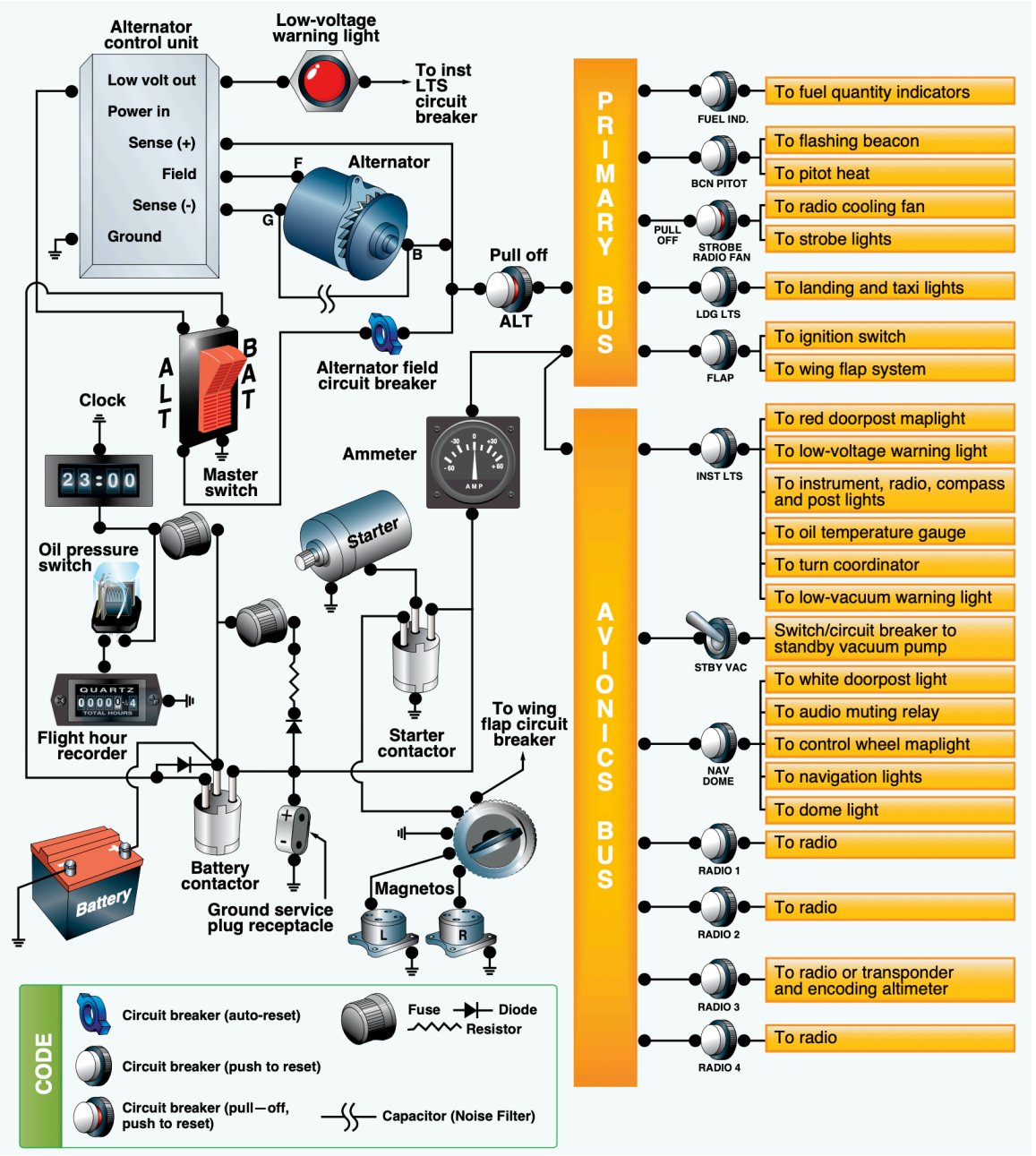
Generating Electricity: Generators

- DC current is induced by the spinning magnet
- Current is proportional to the speed of the spin



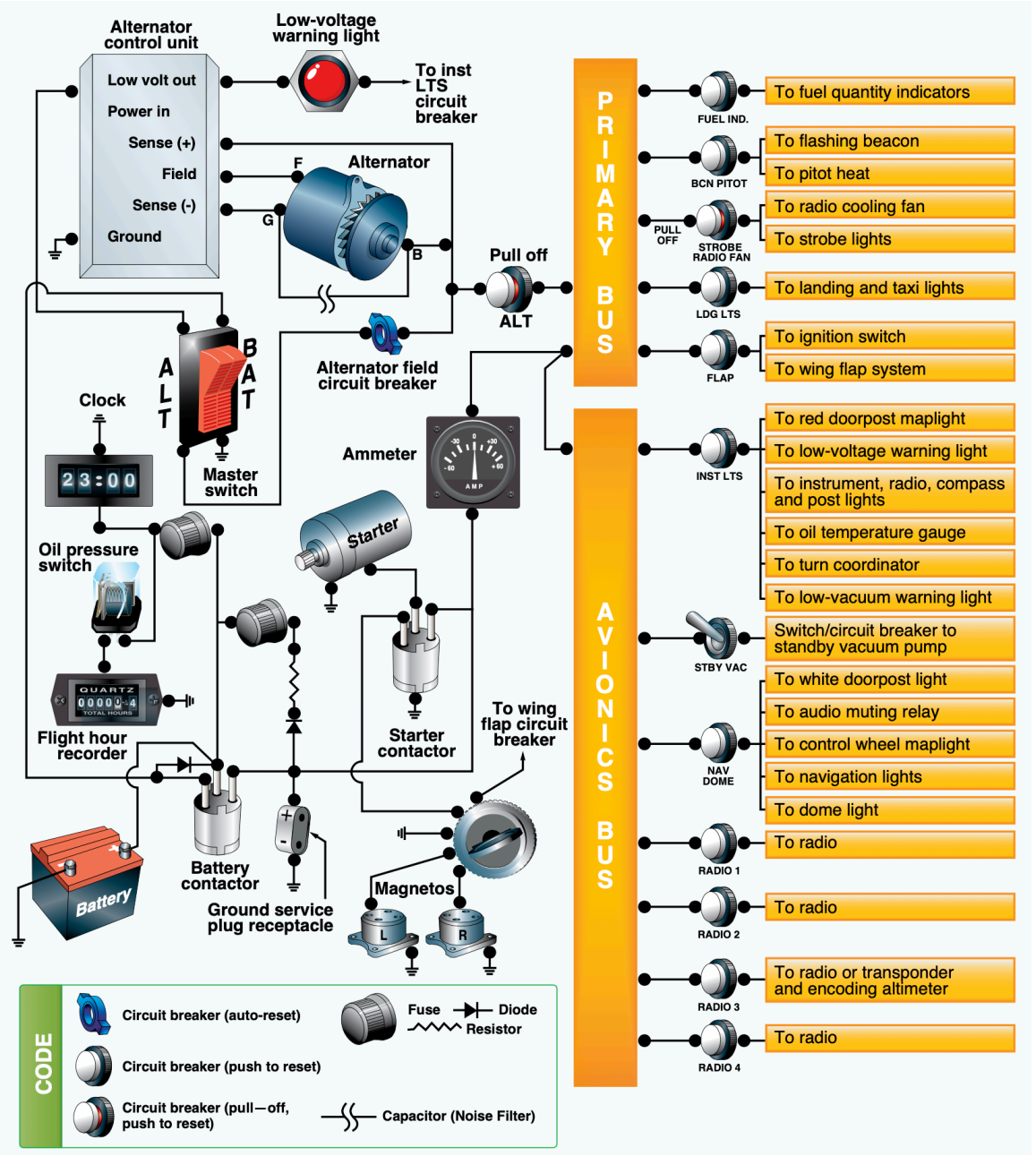
Generating Electricity: Alternators

- Instead of spinning a magnet, we spin an electromagnet
- This produces AC current, which we convert to DC using a rectifier
- Gives more consistent current output at low RPMs than a generator
- Voltage must be higher than the battery to charge it
    - At 24V battery with a 28V alternator is common



Electrical Components

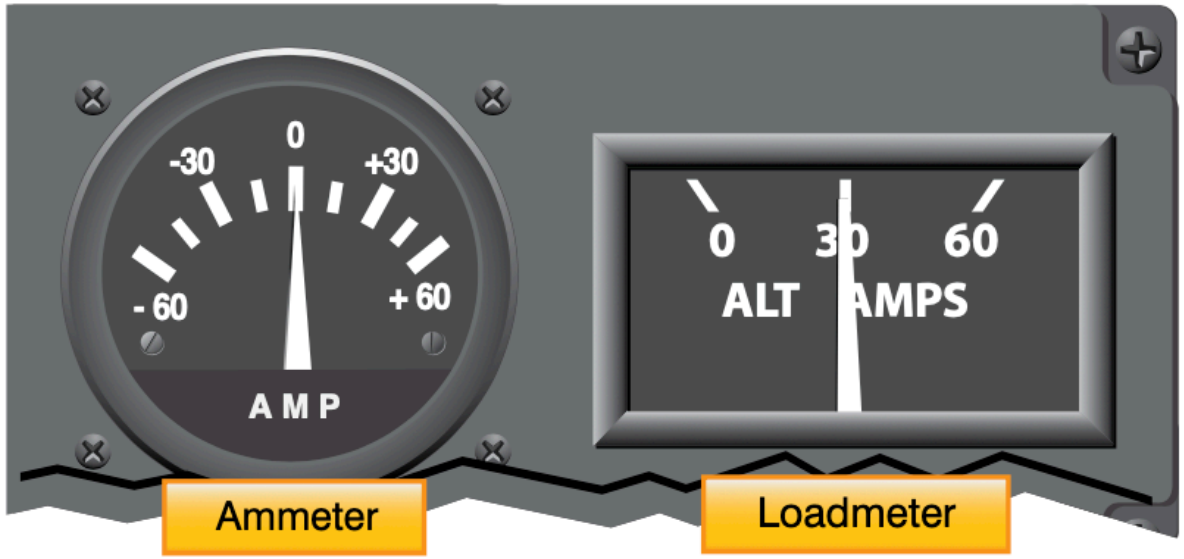
- Contactors/Relays/Solenoid
  - Essentially a "remote switch"
  - Avoids all the current to have to pass through the physical switch
- Master switch
  - Left half for alternator master
  - Right half for battery master



Electrical Components: Circuit Breakers

- Bus bars: efficient way of connecting may components to power
- Overcurrent protection for individual circuits
    - Circuit breakers: Push/pull devices which can be reset
    - Fuses: Need to be replaces
- If a circuit breaker pops, it could be a sign of a short circuit or overcurrent
    - Try resetting it once
    - If it pops again, leave it popped

Electrical Instrumentation



- Ammeter: Is the alternator is producing sufficient power for the current load?
  - A discharge on the ammeter indicates a draw from the battery
- Load meter: Shows a percentage of the load placed on the alternator/generator
- Low voltage warning light

Electrical Problems

- Alternator failure
  - Discharge on the ammeter, meaning we're drawing from the battery
  - Eventually a LOW VOLTS illumination
- Stuck starter
  - Starter solenoid remains engaged after engine start
  - Draws enormous load from the battery, alternator begins charging at a fast rate
  - Ammeter will show high positive charge
- "Load shedding" - Turning off unnecessary equipment to conserve battery

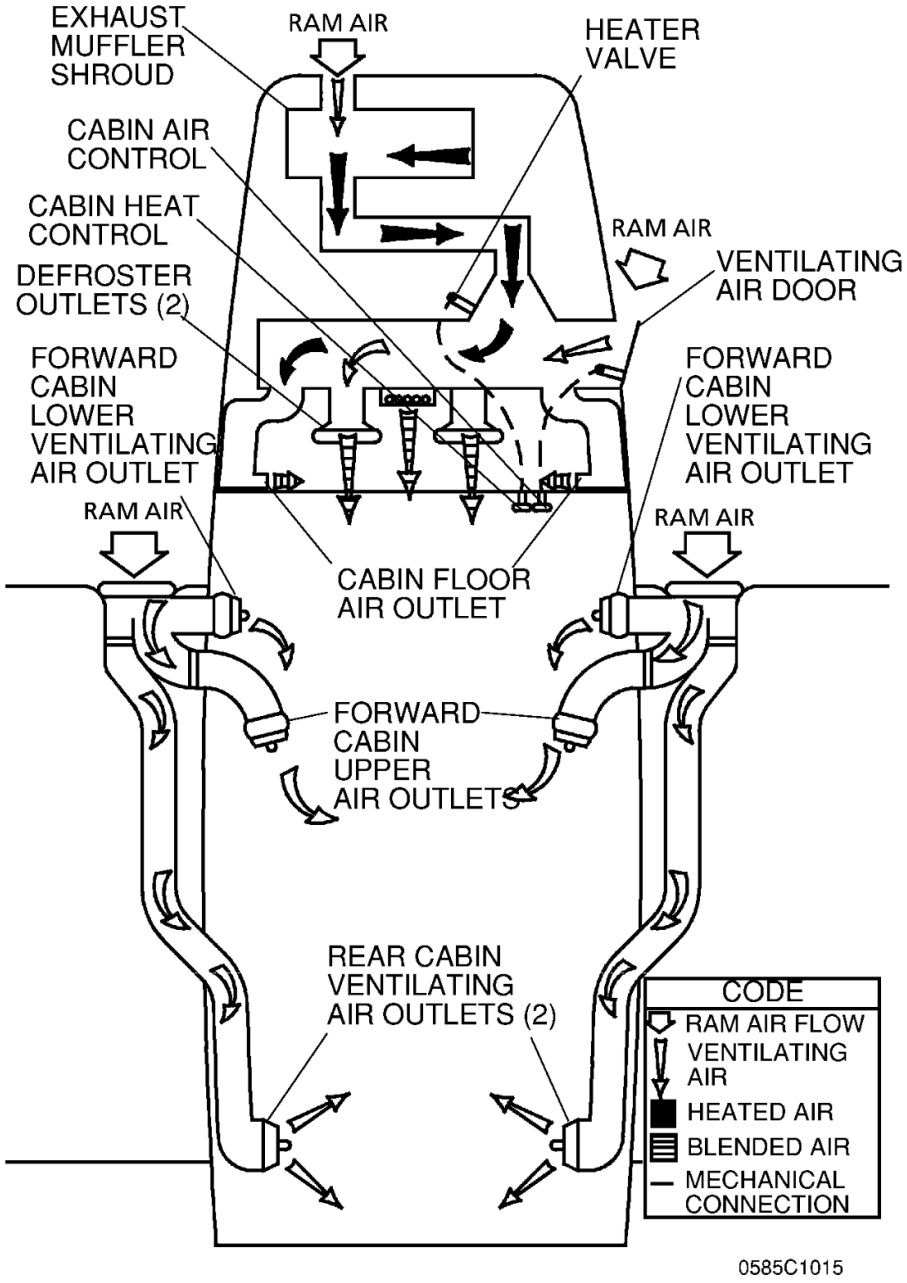
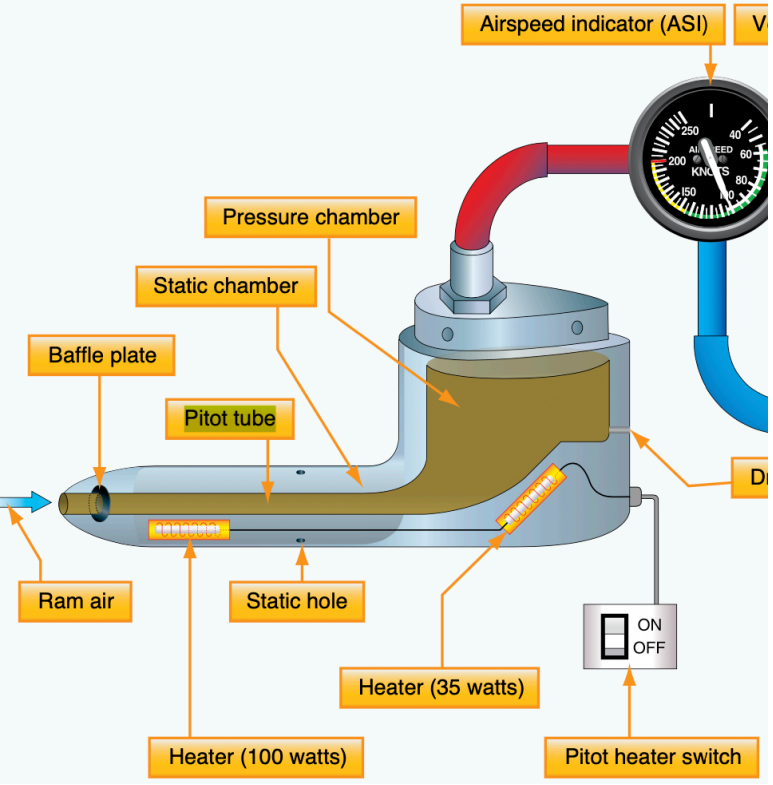


Figure 7-8. Cabin Heating, Ventilating and Defrosting System.

Environmental Systems

- Fresh air vents
- Heated air vents
  - Usually ducted over the hot exhaust manifold to heat the air
  - If the manifold has any leaks, this pumps exhaust directly into the cockpits
  - Potential source of CO in the cockpit



Deice and Anti-ice system

- Airplanes can be certified for flight into known icing (FIKI)
  - See 91.527
  - Most training aircraft are not FIKI certified
- Pitot heat (deice and anti-ice)
- Windscreen defrost can also be used

Deicing Systems: Wet Wings

- Some aircraft use a "weeping wing"
    - TKS fluid (a ethylene-glycol liquid) is force out of a porous membrane on the leading edge
    - Cirrus aircraft use this

Deicing Systems: Pneumatic Boots

- Boots are inflated with air break off accumulated ice
- Can only be used once some ice has formed on the wing
- Can be cycled as many times as needed
    - Unlike a wet wing system, which has a certain capacity

Summary

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- Brake system
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Knowledge Check

As you're flying you notice that the volt meter on your engine monitor is reading 25 volts, and the ammeter is showing a discharge.

What could this mean? What would you do?

Knowledge Check

True or false: All of the current for the primary and avionics bus are flowing through the master switch when you turn it on.

Knowledge Check

Flying home from a business meeting on the coast the circuit breaker for your second COM radio pops.

What should you do?