

CPL Theory Aircraft Systems (CSYA)

CSYA 7 – Electrical System



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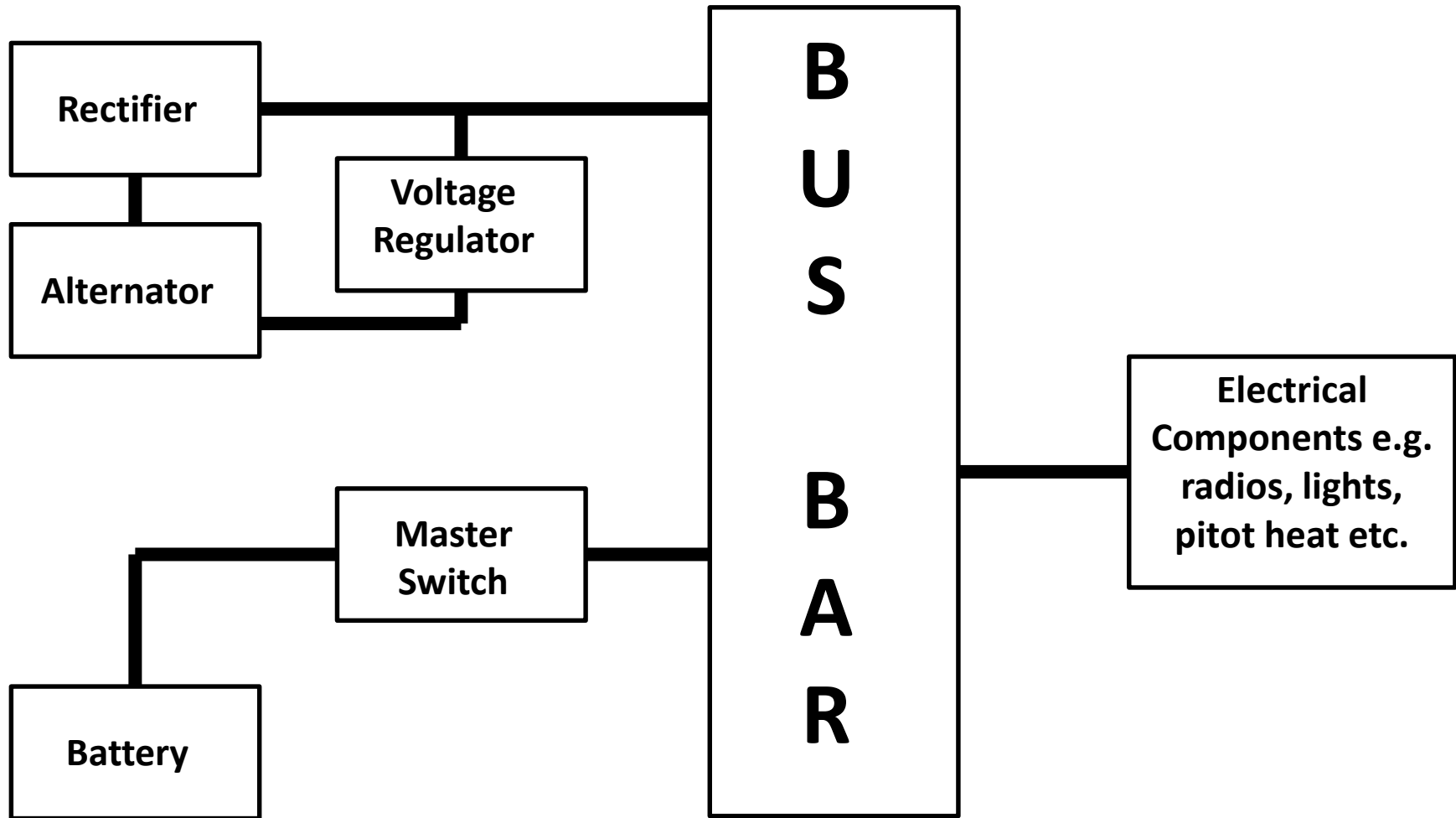
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3. Disclaimer

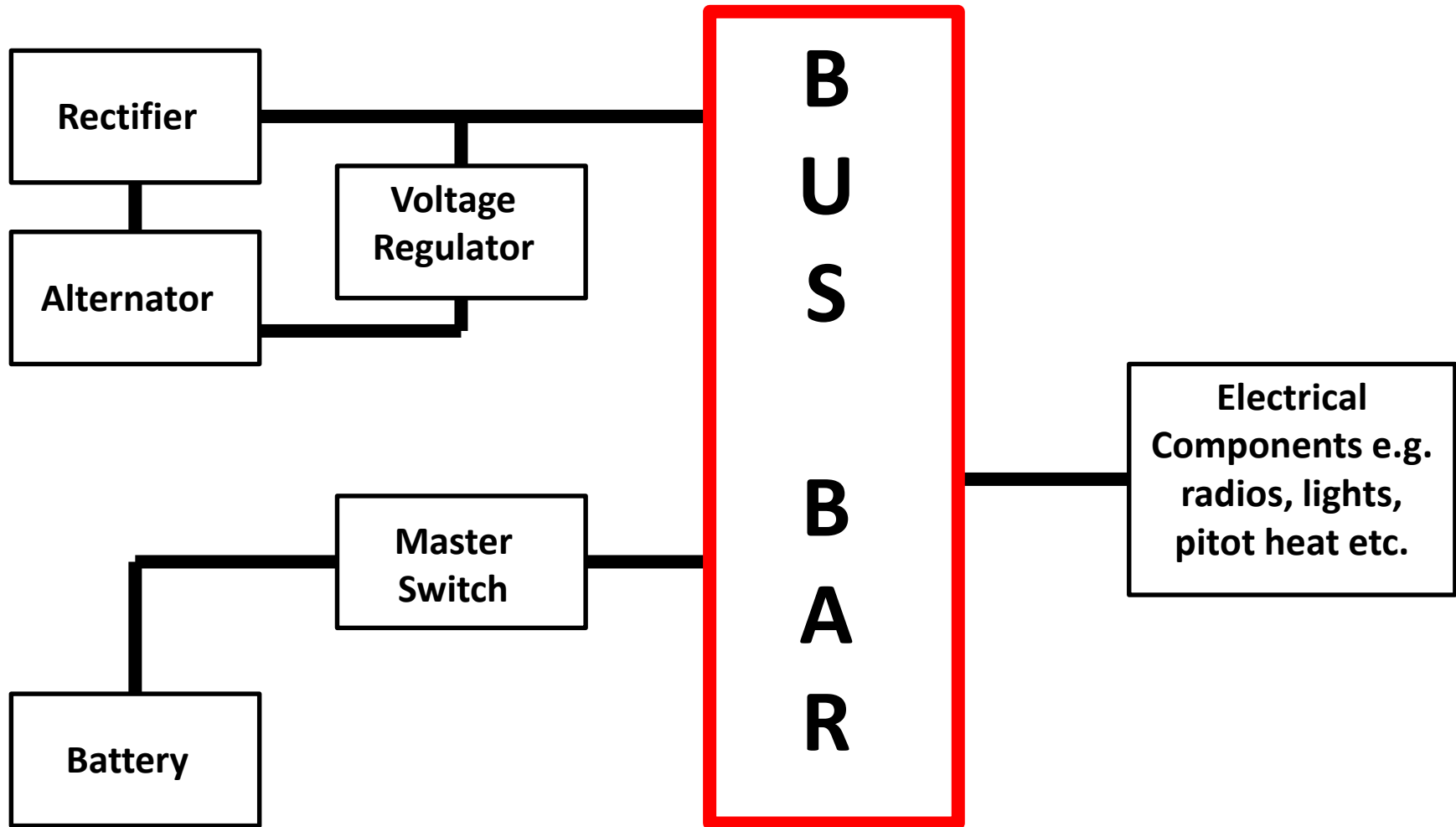
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ELECTRICAL SYSTEM COMPONENTS

Electrical System Components



Electrical System Components



Bus Bar

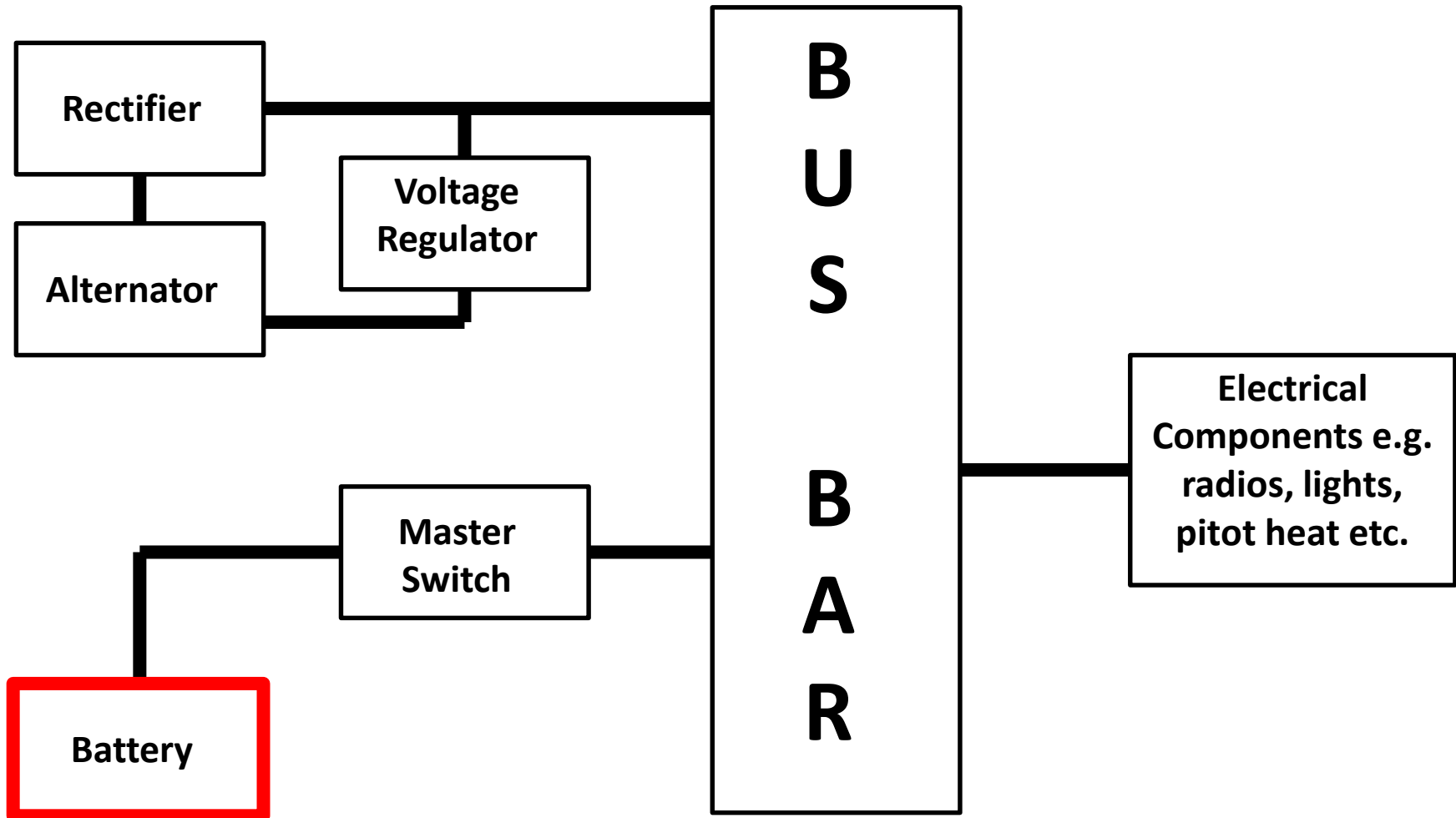
- The main distribution centre in the electrical system
- It is supplied with electrical power from either the alternator or battery and distributes this to the various electrical systems e.g. lights, electric flaps, electric instruments etc
- The C172 has the following Bus Bars:

1. 2 x Primary Bus Bars

2. A Cross feed Bus Bar & An Essential Bus Bar

3. 2 x Avionics Bus Bars

Electrical System Components



Battery

➤ The battery provides Direct Current (DC) for:

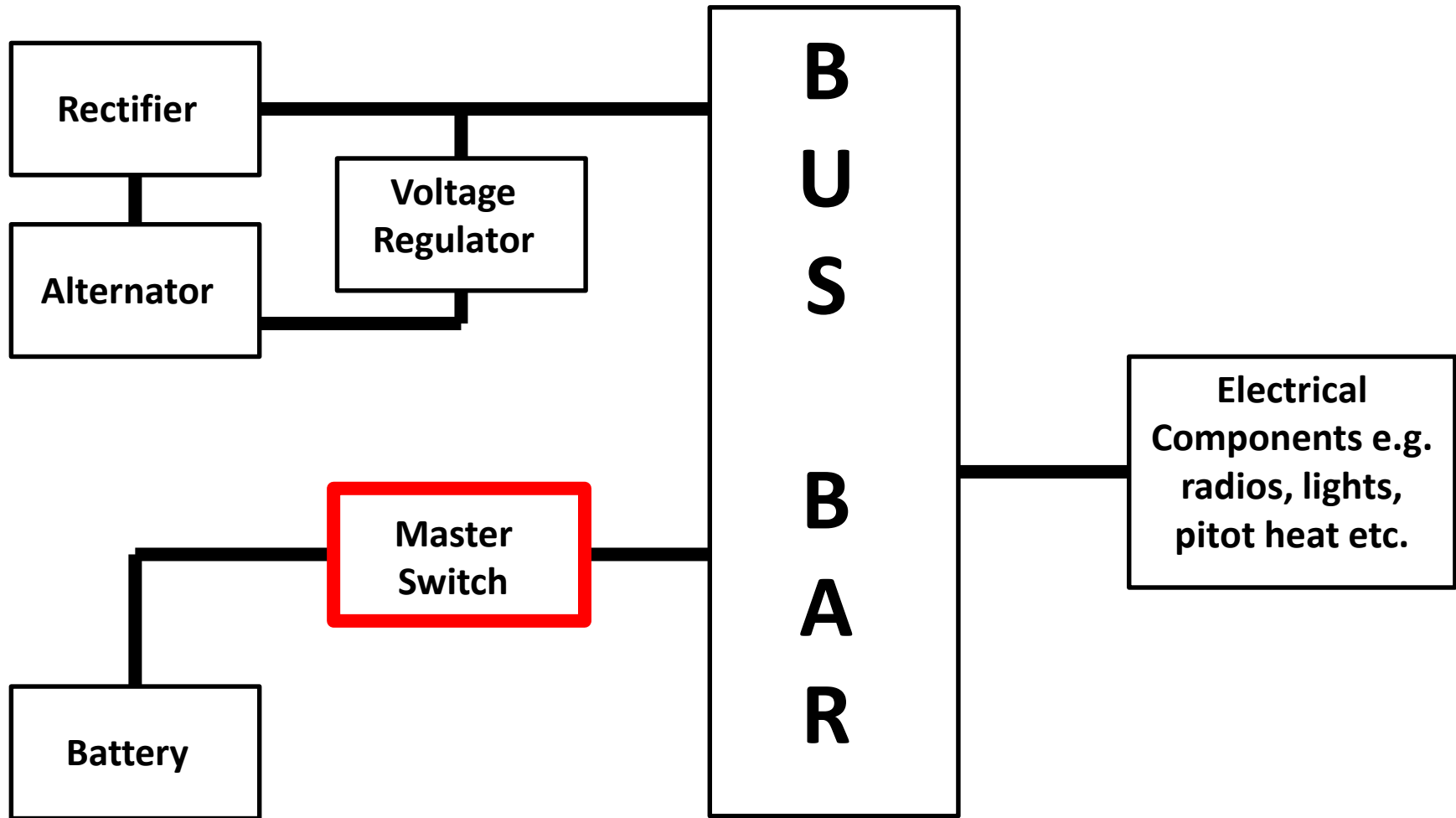
1. The starter motor and excitation of the alternator magnetic fields

2. Back up/emergency electrical power should the alternator fail

- It is not self-charging and will eventually run flat if uncharged by the alternator
- Aircraft batteries are usually lead-acid batteries
- When the battery is charging, a chemical reaction causes the release of hydrogen gas which is explosive when mixed with air in high concentrations
- For this reason, the battery compartment is kept well ventilated to ensure there is not a build up of hydrogen gas around airframe components



Electrical System Components

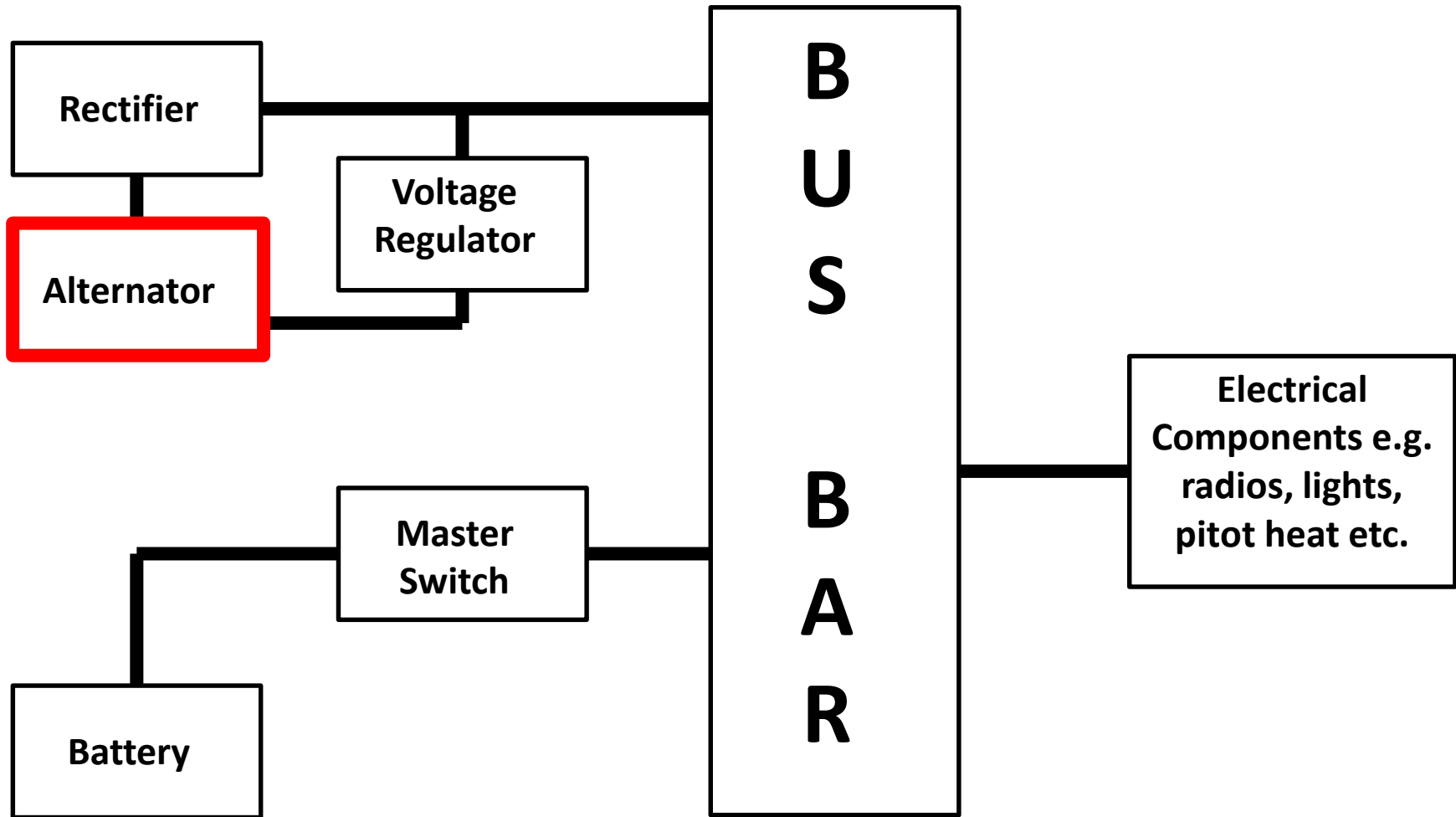


Master Switch

- Controls the aeroplane's electrical system
- Turning on the master switch connects:
 1. The battery to the bus bars, through which electrical power is supplied to various aircraft systems
 2. The alternator field to the bus bars, providing the alternator with battery power for field excitation



Electrical System Components



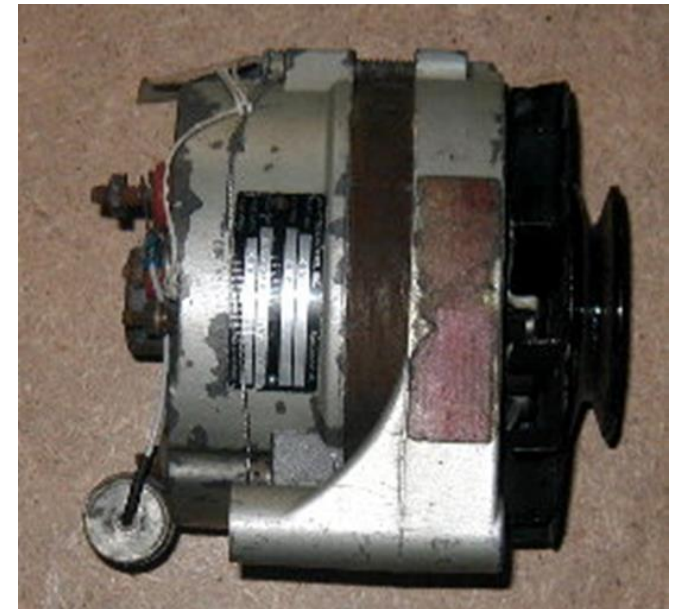
Alternator

- The alternator is an engine-driven (gears or belt) electrical generating device
- It generates Alternating Current for:

1. Electrical systems when the engine is running

2. Charging the battery

- So, the battery is required to start the alternator; then the alternator is required to keep the battery from running flat



Alternator vs. Generator

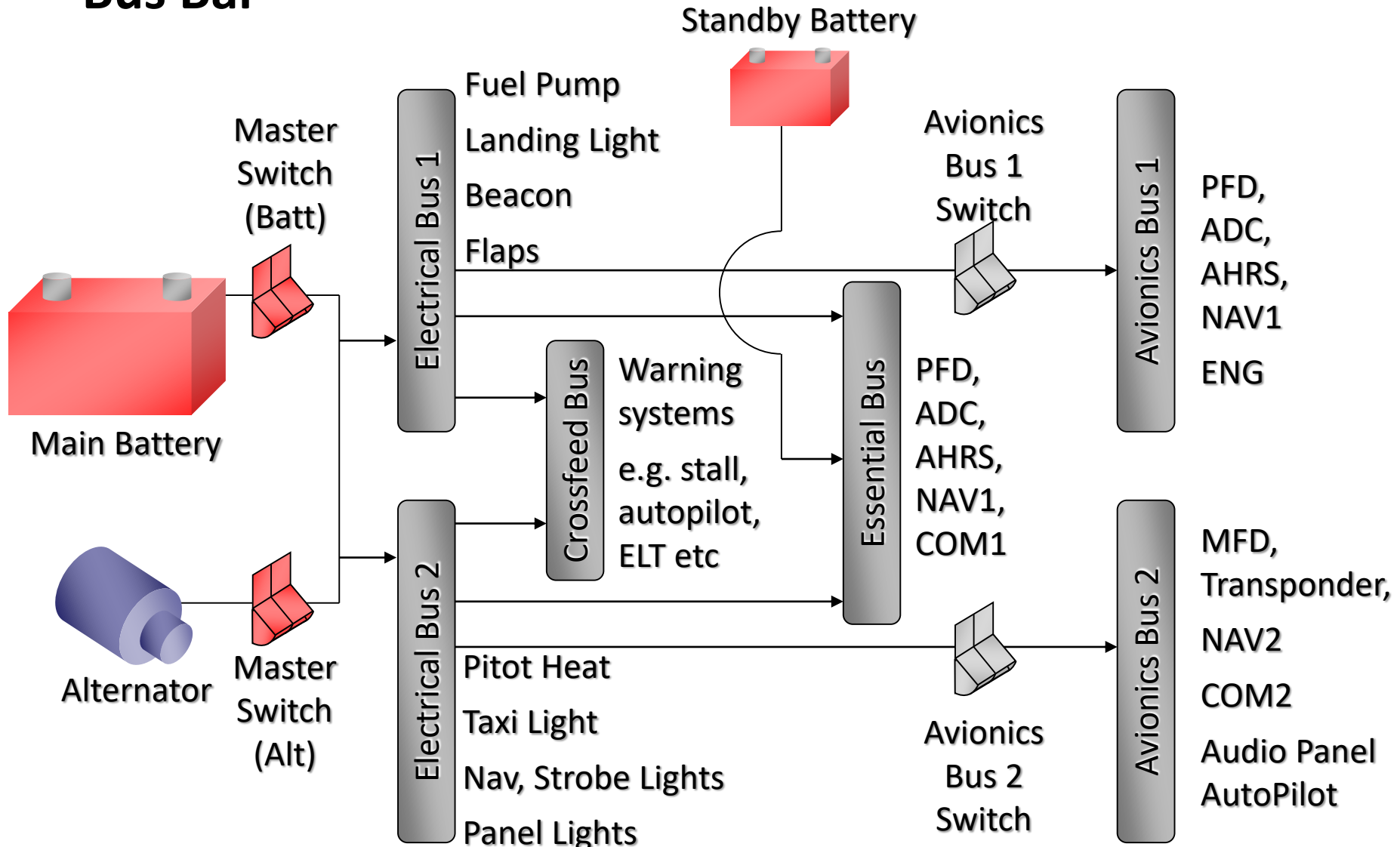
- Older aircraft may have a **generator** instead of an alternator - producing DC
- The disadvantage of a generator is that power output is directly affected by RPM - when the engine is at low RPM, the generator voltage is too low and the battery must assist in supplying power
- An alternator, on the other hand, uses an electromagnet instead of a permanent magnet like in a generator
- Some of the alternator output can be fed back to the electromagnet to energise it even at low RPM
- The disadvantage of this is that during start, the electromagnet must be supplied with electrical power from the battery



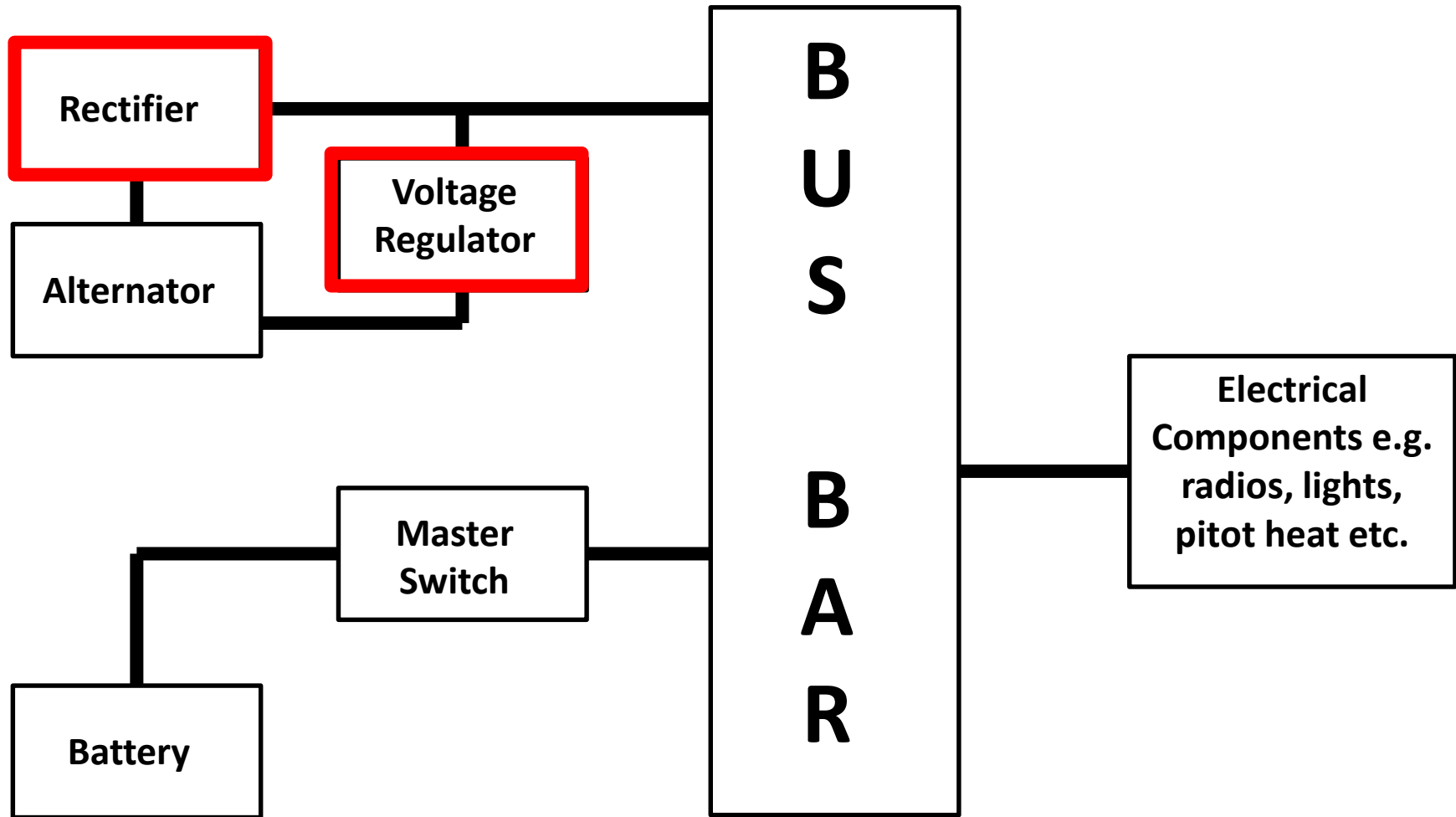
Alternator

- You should know what kind of electrical system your aeroplane has
- The Cessna 172 has a 28 volt DC electrical system containing:
 - 1. A belt-driven 60 ampere alternator**
 - 2. A 24 volt main battery (located in the engine cowl on the left firewall)**
 - 3. A standby battery (located between the firewall & the instrument panel)**
- Note that the system voltage (alternator voltage) is higher than the battery voltage
- This is so the alternator can overcome the battery's internal resistance and recharge it. If the two voltages were the same, current would not flow into the battery
- The standby battery is available to supply power to the Essential Bus Bar in the event of both an alternator and main battery power source failure

Bus Bar



Electrical System Components



Rectifier

- Most light aircraft (such as the C172) run on DC
- **Diodes**, known as **rectifiers**, are required to **convert the AC** produced by the alternator **into DC** for use in the electrical system
- An **inverter** would be used to convert DC into AC – rarely seen in aircraft

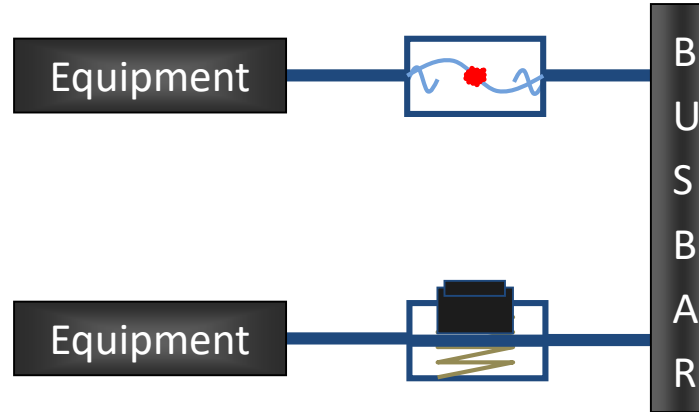
Voltage Regulator

- The voltage regulator measures output from the alternator and maintains a constant voltage in the system
- If this fails, **overvoltage** could occur which may lead to melting of circuits and even an electrical fire – in this case, turn off alternator and unnecessary loads
- Some aircraft are also fitted with an overvoltage relay in case the voltage regulator fails

Fuses, Circuit Breakers & Overload Switches

- These provide protection to electrical equipment from any **current overload**
- If there is any electrical overload, then:
 - 1. A fuse will melt**
 - 2. A circuit breaker will pop**
 - 3. An overload switch will turn off**
- The circuit will be broken, saving any electrical equipment in that circuit from damage such as overheating, smoking or even fire
- Circuit breakers and overload switches can be re-set, but it is recommended that you wait at least 90 seconds to allow the element to cool
- Should the circuit breaker pop again, you can be fairly sure there is an electrical problem and should not re-set it again

Fuses, Circuit Breakers & Overload Switches



VOLTMETERS

Voltmeter

➤ The voltmeter indicates:

1. The positive charge of the alternator

2. The state of the electrical system if you have an alternator failure

- Normally, the voltmeter should indicate slightly below the system voltage i.e. 27.5 volts on a 28 volt system
- If the alternator fails, the voltage will drop, indicating that the battery is being drained
- As the voltage drops to the rated voltage of the battery, this indicates that the battery is almost drained
- In the C172, when the voltage reaches less than 24.5V, a LOW VOLTS annunciation will appear on the G1000

AMMETERS & LOADMETERS

Ammeters & Loadmeters

➤ There are 2 types of ammeters you need to be aware of:

1. Left-Zero Ammeter (also known as a Loadmeter)
2. A Centre-Zero Ammeter (the C172 has this type)



Left-Reading Ammeter



Centre-Zero Ammeter

Ammeters & Loadmeters

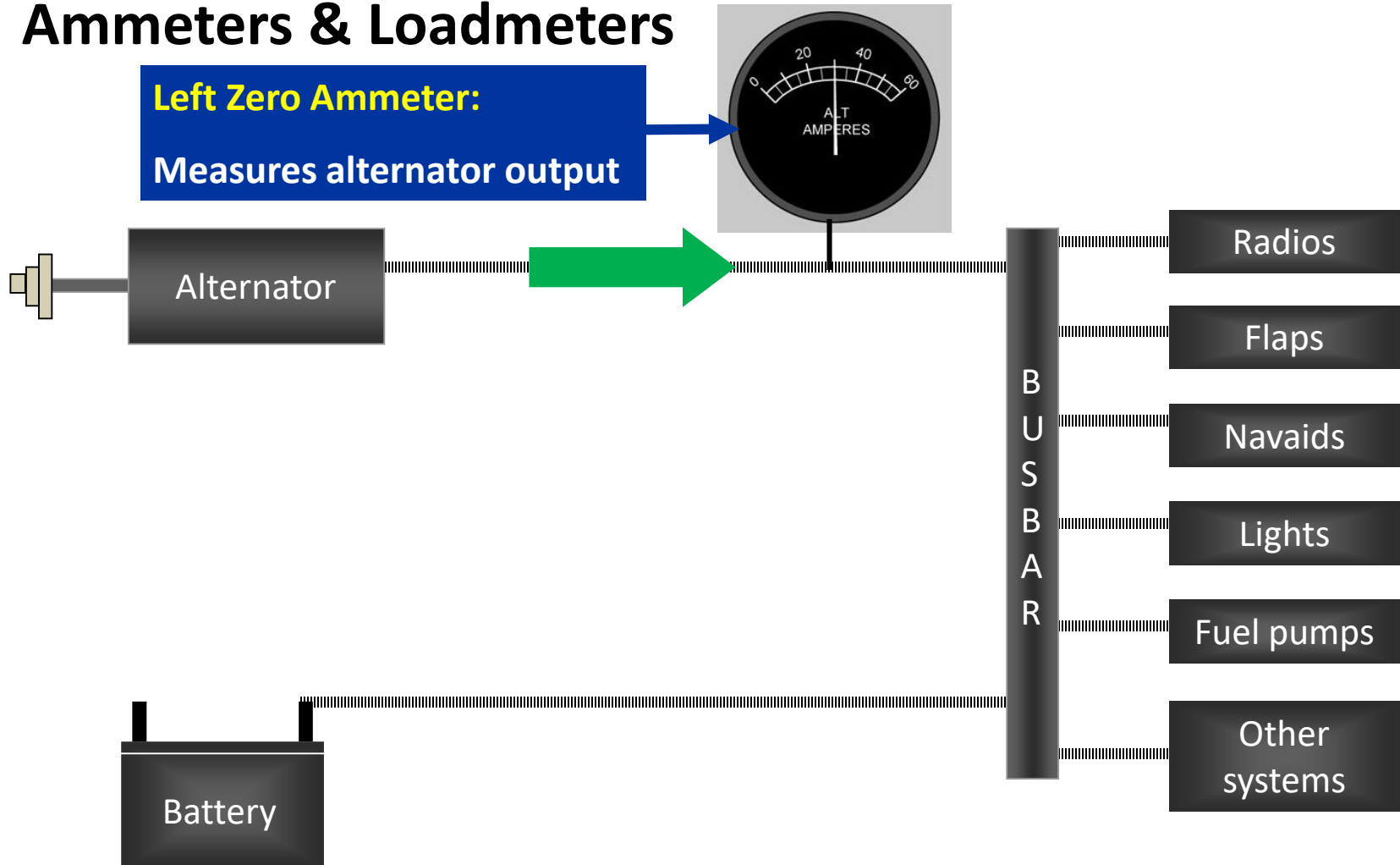
- A left-zero ammeter measures the electrical load on the alternator – **alternator output**
- The more electrical components that are turned on, the higher the amperes indicated by the needle



Ammeters & Loadmeters

Left Zero Ammeter:

Measures alternator output



Ammeters & Loadmeters

Alternator is off:

- Left-reading ammeter shows zero

Start-up:

- Initially a high indication as the battery is recharging, eventually settling to just above zero if all other electrical circuits are switched off

As more circuits are switched on:

- Left-reading ammeter reading will increase

Alternator failure:

- Left-reading ammeter shows zero

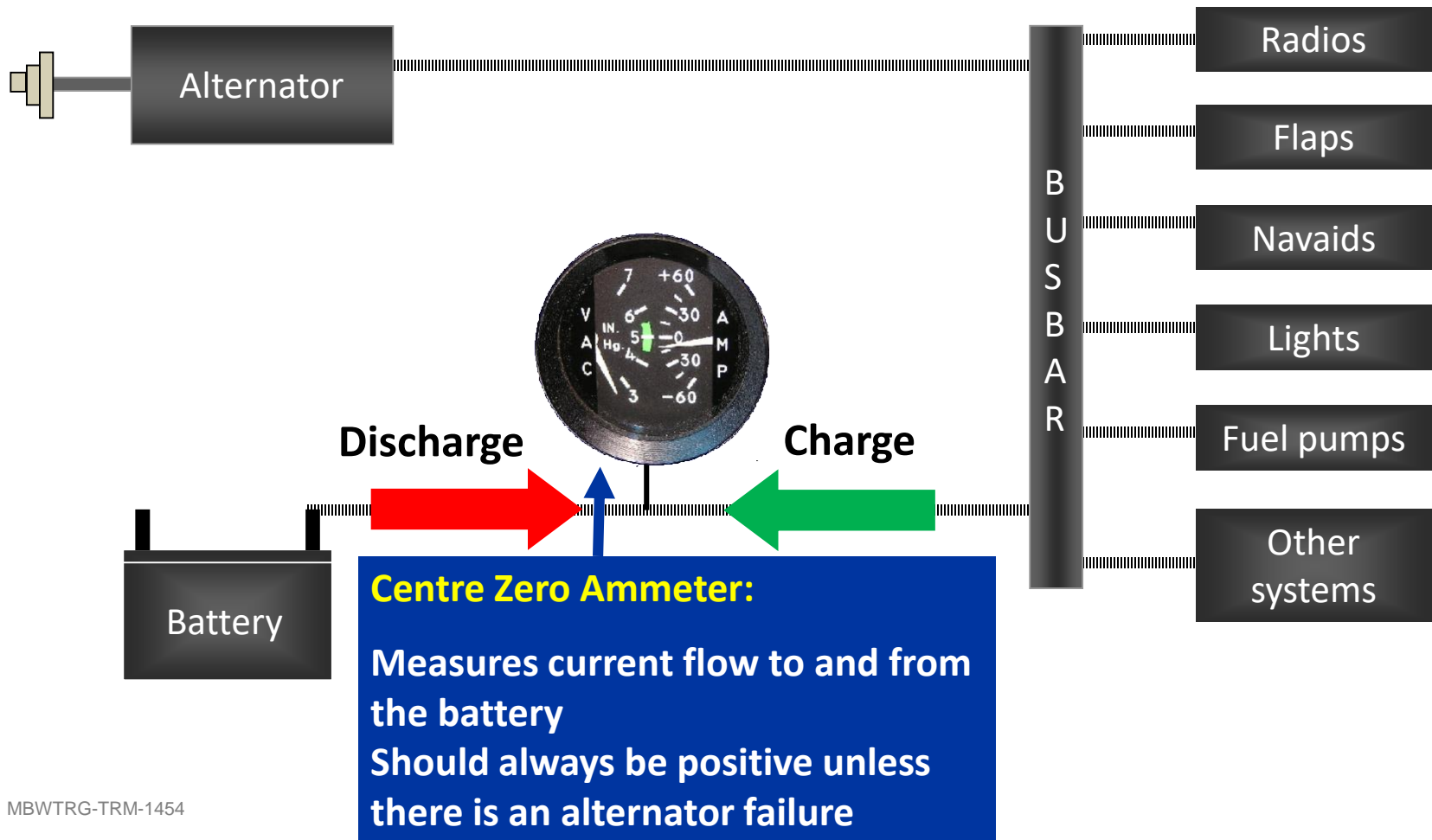


Ammeters & Loadmeters

- A centre-zero ammeter measures the flow of current to or from the battery
- Current into the battery is a **“charge”** and the needle is deflected **up or to the right**
- Current out of the battery is a **“discharge”** and the needle is deflected **down or left**
- **No current flow** is shown by the needle being in the **centre ‘zero’ position**



Ammeters & Loadmeters



Ammeters & Loadmeters

Battery on with Alternator Off:

- Centre-zero ammeter shows discharge

Alternator failure in flight:

- Centre-zero ammeter shows discharge

Alternator on and functioning correctly:

- Centre-zero ammeter shows charge



Alternator on but incapable of supplying sufficient power:

- Battery will have to contribute also so Centre-zero ammeter shows discharge

Too much current:

- Centre-zero shows an unusually high charge (this will mean a faulty battery that is charging at an excessive rate)
- This means the battery could overheat and become damaged

ABNORMALITIES IN THE ELECTRICAL SYSTEM

Electrical System Abnormalities

- Should the alternator be disconnected (by a fuse, circuit breaker etc) or indeed fail by itself, the battery will act as an emergency source of electrical power
- However, this will only be for a limited time as the battery will eventually run flat. The recommended action is to:

- 1. Switch off all unnecessary electrical loads
(this will prolong battery life)**

- 2. Land at the nearest suitable aerodrome whilst
electrical power is still available (prepare for a
no-radio arrival)**