

Airplane Flight Controls

AROW

Required Equipment

Airplane Antennas

Transponders

Airplane Weight and Balance

Engine and Systems

Fixed-Pitch & Constant Speed-Variable Pitch Propellers

[Starting Fuel Injected Engines 1](#)

[Starting Fuel Injected Engines 2](#)

[American Bonanza Society - Hot Start](#)

[How to tell if your Aircraft is airworthy 91.213 91.205 explained](#)

[FlightInsight - How a Constant Speed Propeller Works](#)

[FlightInsight - Is Your Plane Airworthy?](#)

[Pilot Institute - Weight and Balance Explained](#)

[How airplane engine turbocharging systems work](#)

[Turboprop Torque, ITT, NP, and %NG Explained](#)

[BIG Differences Flying a Turboprop vs. Piston Aircraft](#)

[This Turboprop Is WAY Easier Than a Piston](#)

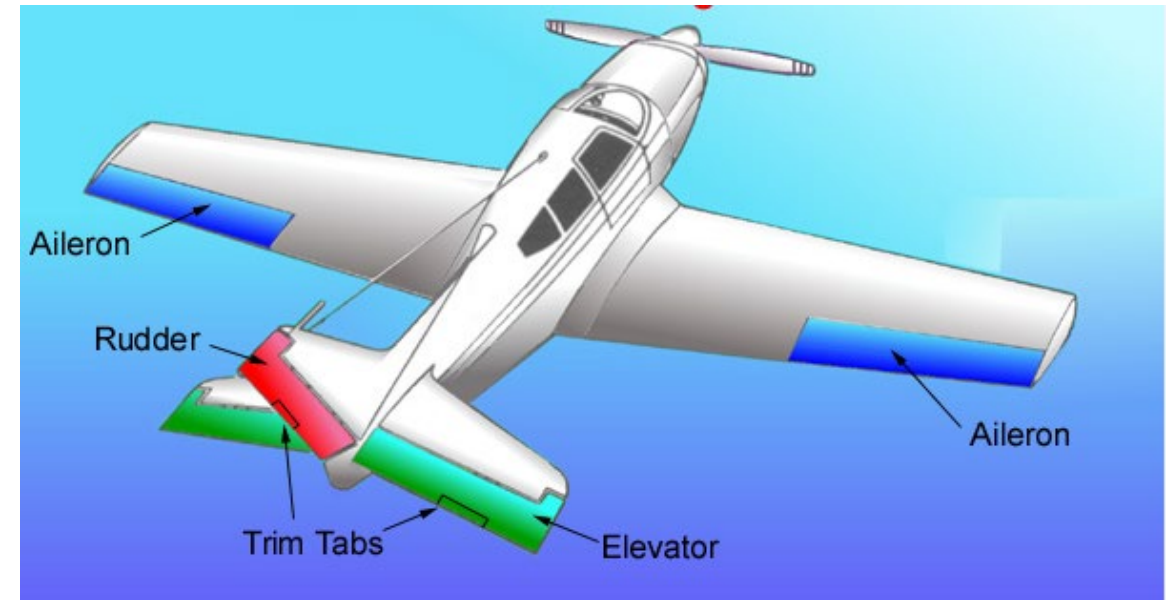
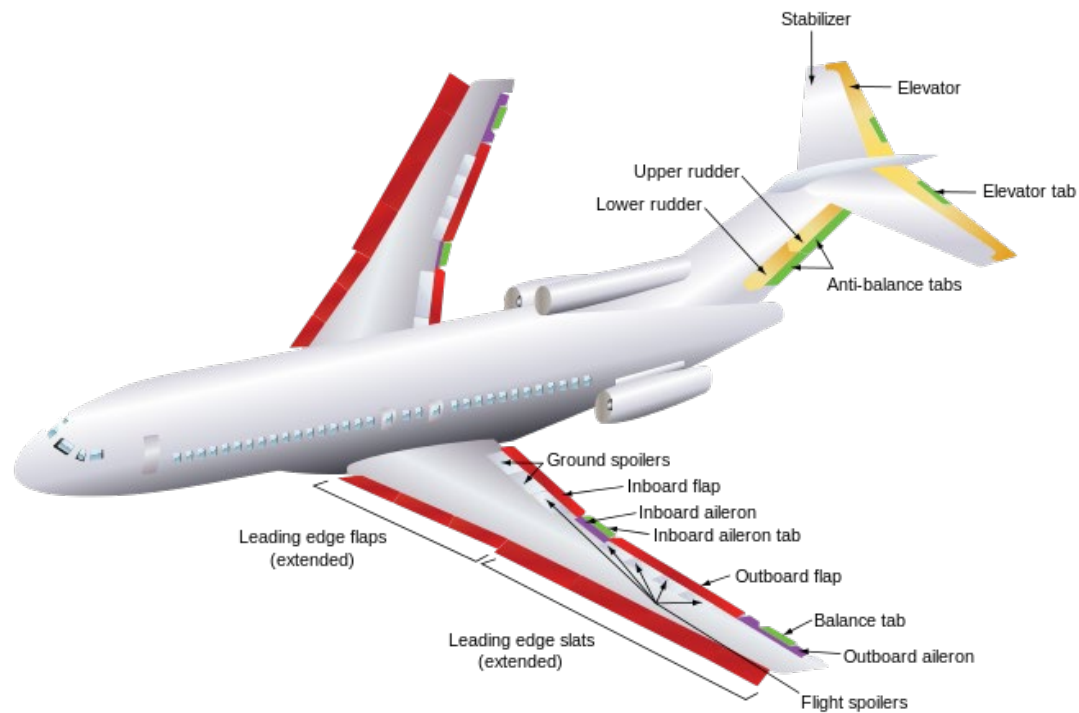
Airplane Flight Controls



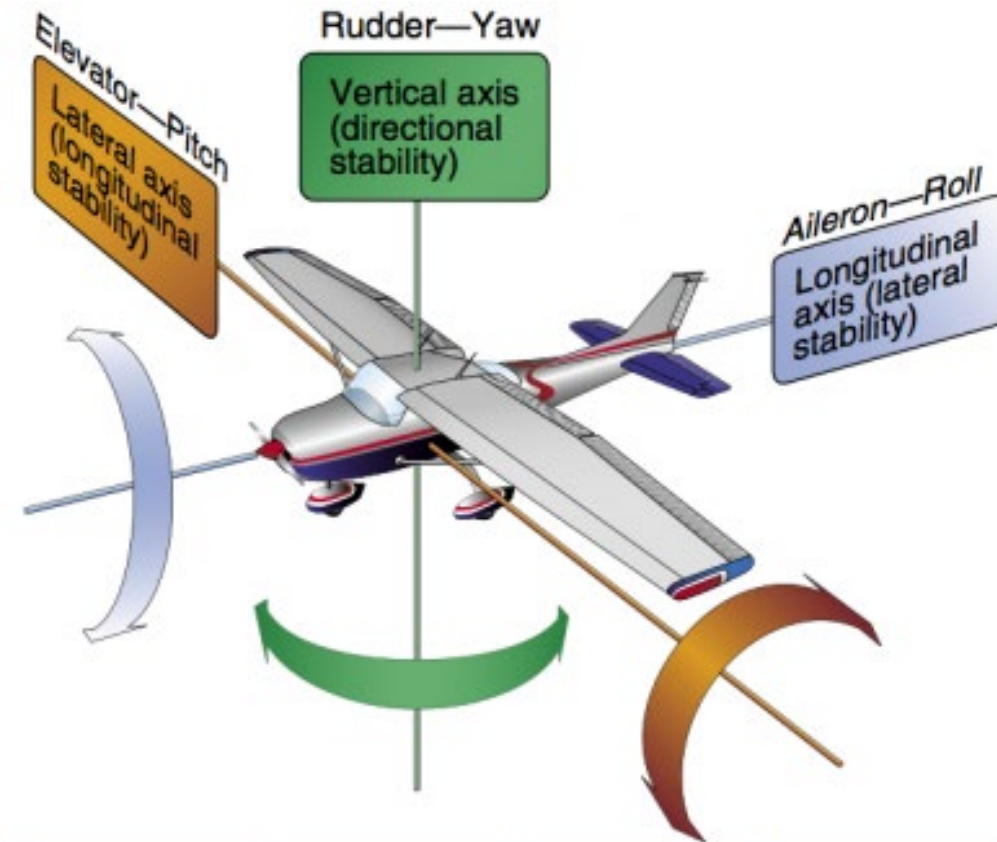
Lesson Objective

To develop understanding of how we can make the plane go in the direction we planned on

First Some Diagrams



And Another



Primary Control Surface	Airplane Movement	Axes of Rotation	Type of Stability
Aileron	Roll	Longitudinal	Lateral
Elevator/Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional

On the Ground

Throttle for speed

Taxi at 'wake speed'

Yoke/stick => Nothing except to counter act the wind

Left rudder pedal => Plane's nose moves left

Right rudder pedal => Plane's nose moves right

In the Air

Move the yoke/stick to the right => Plane rolls right/clockwise

Move the yoke/stick to the left => Plane rolls left/counterclockwise

Move the yoke/stick forward => Plane itches down

Move the yoke/stick toward you => Plane itches up

Left rudder pedal => Plane's nose moves left

Right rudder pedal => Plane's nose moves right

Pitch for Airspeed

Plane itches down => Goes faster

Plane itches up => Goes slower

Think about driving on level road then up or down a hill

...without changing the gas pedal

In the plane you 'control the hill'

If the airspeed is 90 knots and we desire 75 knots what do you do?

If the airspeed is 60 knots and we desire 75 knots what do you do?

The Recipe for Turns

When flying, you must **combine** the ailerons and rudder pedals to have a coordinated turn.

Roll right + right yaw => Plane banks to the right

Roll left + left yaw => Plane banks to the left

Effectiveness

Control surface effectiveness increases with speed; therefore, large deflections at low speeds and small deflections at high speeds may be required to provide the desired reaction.

In propeller-driven aircraft, any slipstream flowing over the rudder increases its effectiveness.

Slip

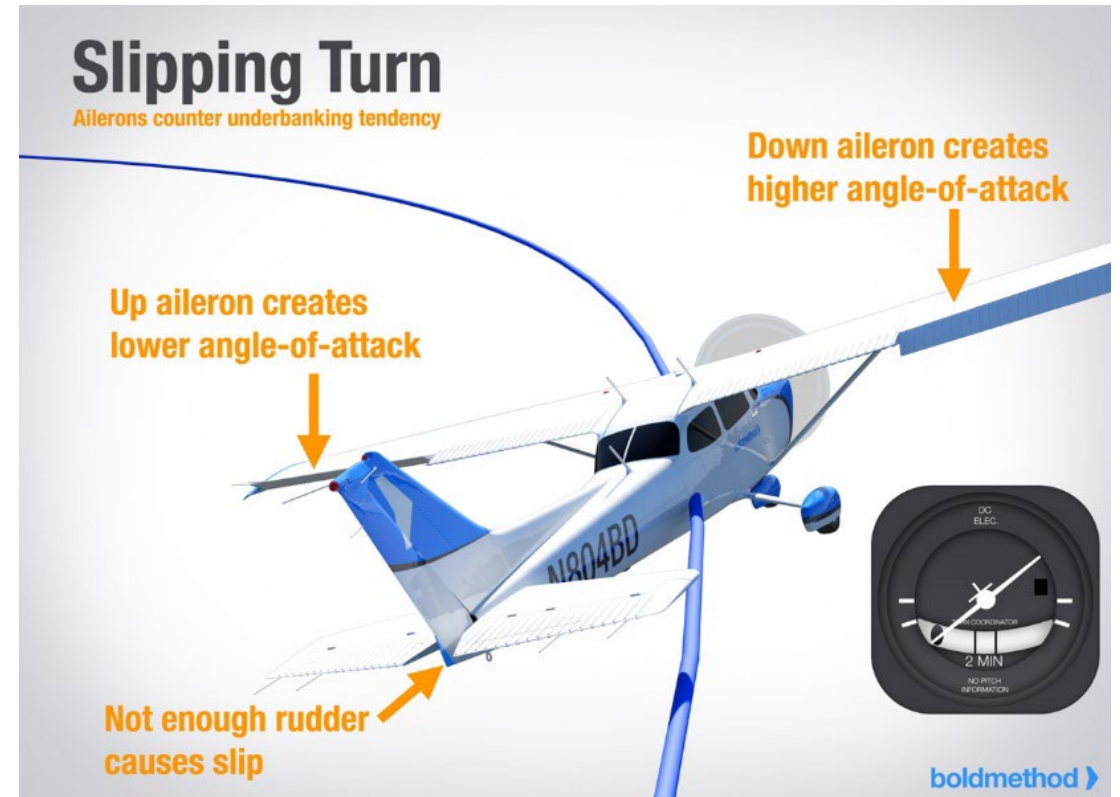
A slip does not have enough rudder, or more likely rudder opposite to the direction of the bank.

A slip is a turn that is stopped by use of the rudder.

Not enough rudder

Centrifugal force < Horizontal lift

Imagine the ball is where the tail is



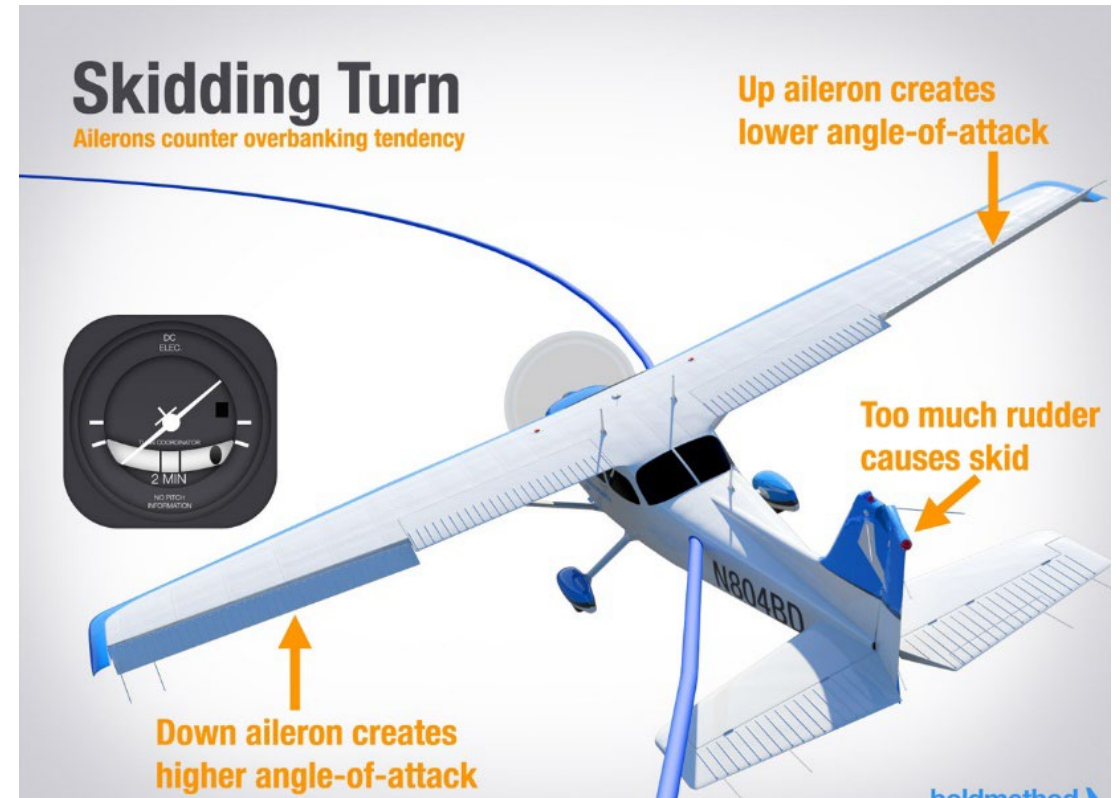
Skid

A skid has too much rudder used in the direction of bank.

Too much rudder

Centrifugal force > Horizontal lift

Imagine the ball is where the tail is



Flaps

Increase lift to assist in flying slower

Increase drag to help reduce airspeed

Increase decent angle without increasing the airspeed

Flaps change:

Chord line

Angle of attack

Camber/Mean camber

Lift and Drag

Flaps Down - Camber

Camber Line



Trim Systems

Although an aircraft can be operated throughout a wide range of attitudes, airspeeds, and power settings, it can be designed to fly hands-off within only a very limited combination of these variables.

Trim systems are used to relieve the pilot of the need to maintain constant pressure on the flight controls, and usually consist of flight deck controls and small hinged devices attached to the trailing edge of one or more of the primary flight control surfaces.

Use of Trim

Although an aircraft can be operated throughout a wide range of attitudes, airspeeds, and power settings, it can be designed to fly hands-off within only a very limited combination of these variables.

Trim systems are used to relieve the pilot of the need to maintain constant pressure on the flight controls, and usually consist of flight deck controls and small hinged devices attached to the trailing edge of one or more of the primary flight control surfaces.



Use of Trim

The normal trim procedure is to continue trimming until the aircraft is balanced and the nose-heavy condition is no longer apparent.

Pilots normally establish the desired power, pitch attitude, and configuration first, and then trim the aircraft to relieve control pressures that may exist for that flight condition.



Use of Trim

As power, pitch attitude, or configuration changes, retrimming is necessary to relieve the control pressures for the new flight condition.

Pitch Power Trim (Rudder)

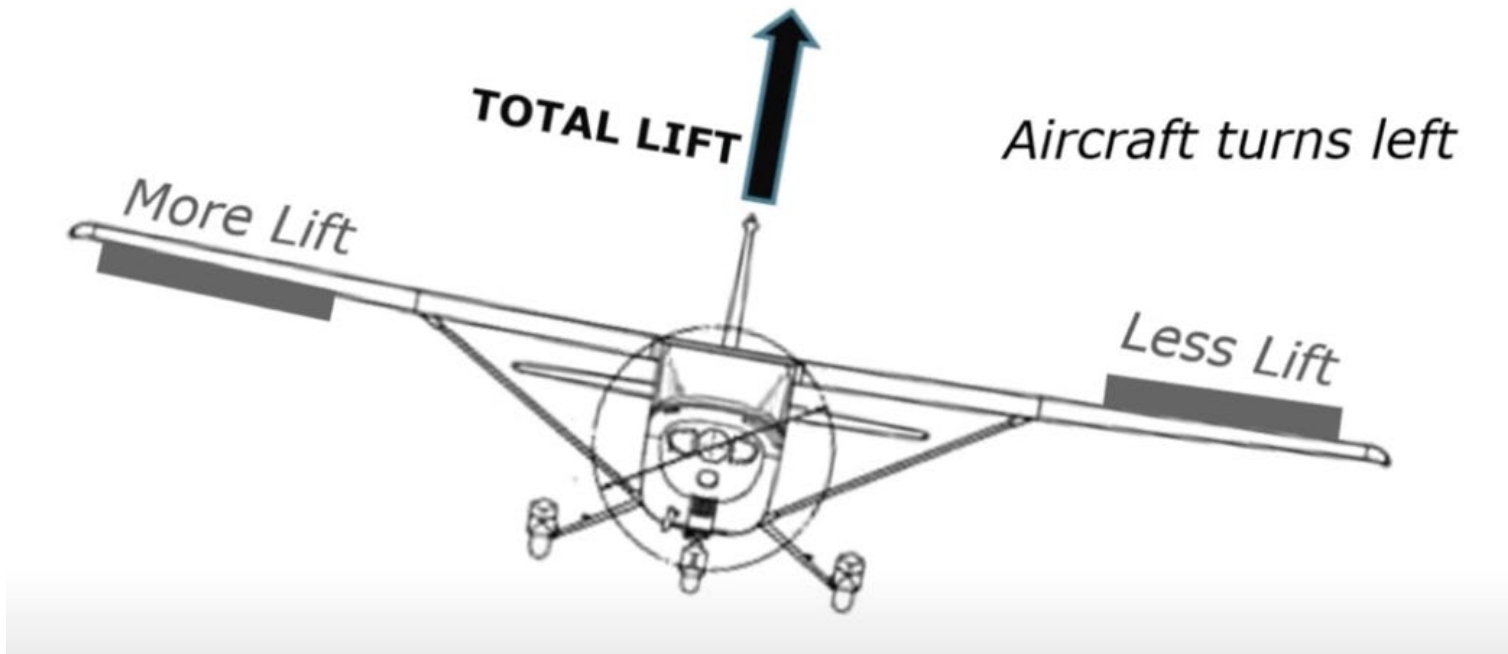




Now the Deep Dive



Adverse Yaw Summary



Adverse yaw during a turn entry is caused by:

- decreased induced drag on the lowered wing
- increased induced drag on the raised wing

See separate lesson for more details

Rudder

Use the rudder to counteract adverse yaw, applying rudder input in the same direction as the turn to align the aircraft's nose with its flight path and maintain a coordinated turn; essentially, the rudder is the primary control used to combat the yawing effect created by aileron deflection during a turn.

Types of Flaps

Fixed Slots

Direct airflow up

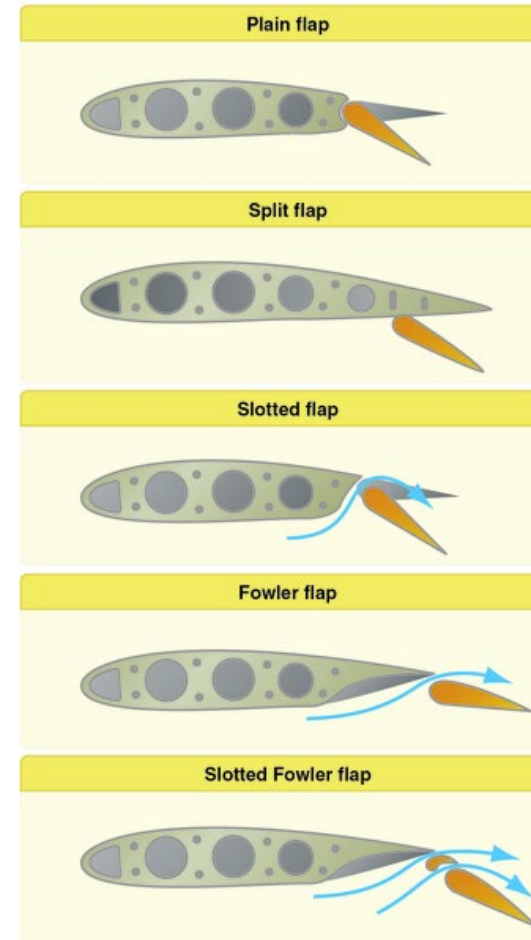
Delay airflow separation at high AOA

Leading edge flaps/cuffs

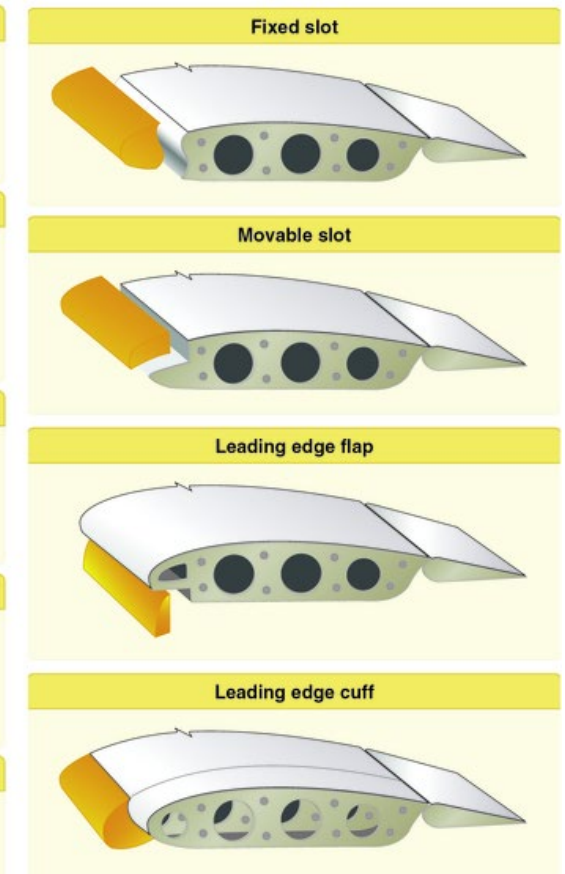
Maximize lift & camber

Lowers stall speeds

Five Common Flap Types



Four Common Leading Edges



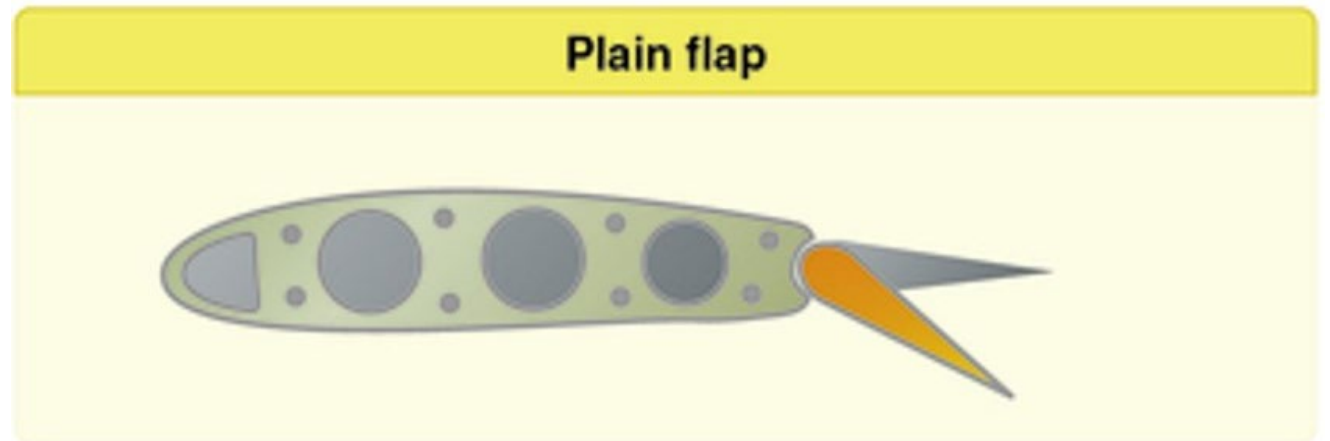
Plain Flap

The plain flap is the simplest of the four types.

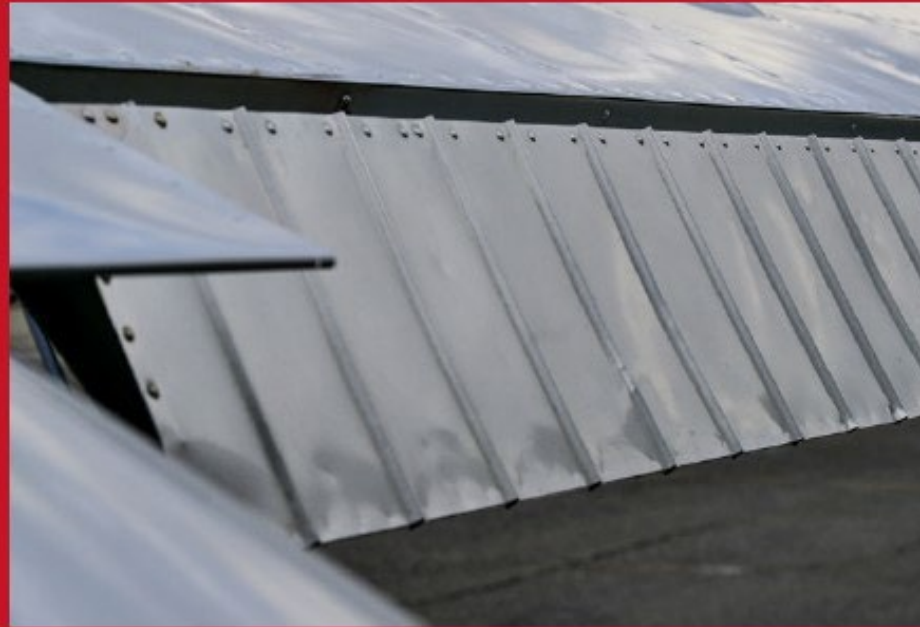
It increases the airfoil camber, resulting in a significant increase in the coefficient of lift (CL) at a given AOA.

At the same time, it greatly increases drag and moves the center of pressure (CP) aft on the airfoil, resulting in a nose-down pitching moment.

More lift, more drag.



Plain Flap



Plain flaps
A simple, hinged surface

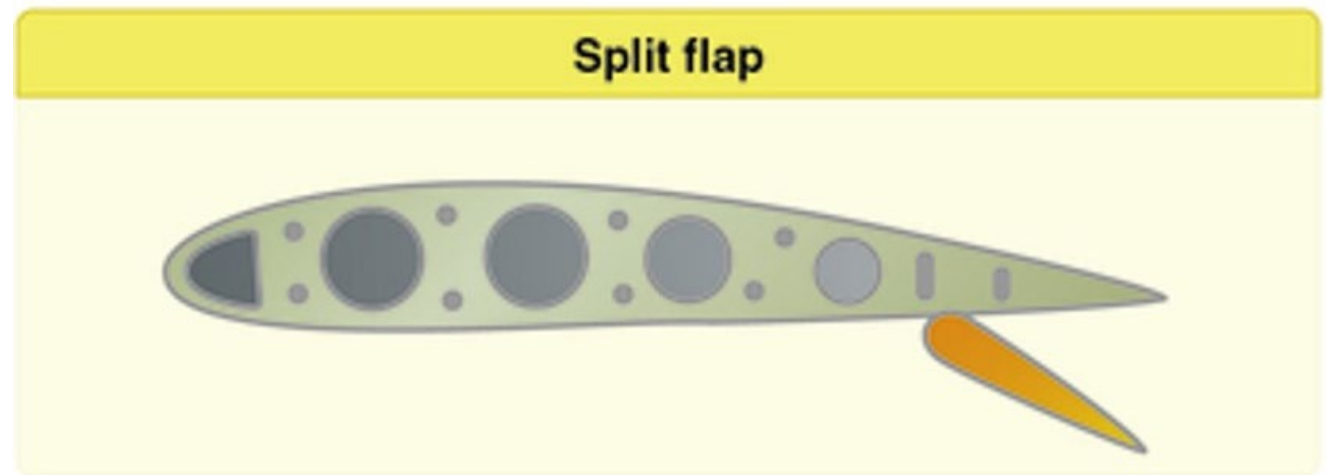
Split Flap

The split flap is deflected from the lower surface of the airfoil and produces a slightly greater increase in lift than the plain flap.

More drag is created because of the turbulent air pattern produced behind the airfoil.

When fully extended, both plain and split flaps produce **high drag with little additional lift**.

The split flap produces the least change in the pitching moments of a wing when it is lowered.



Split Flap



Split flaps

Folds out below the wing; creates more drag than lift

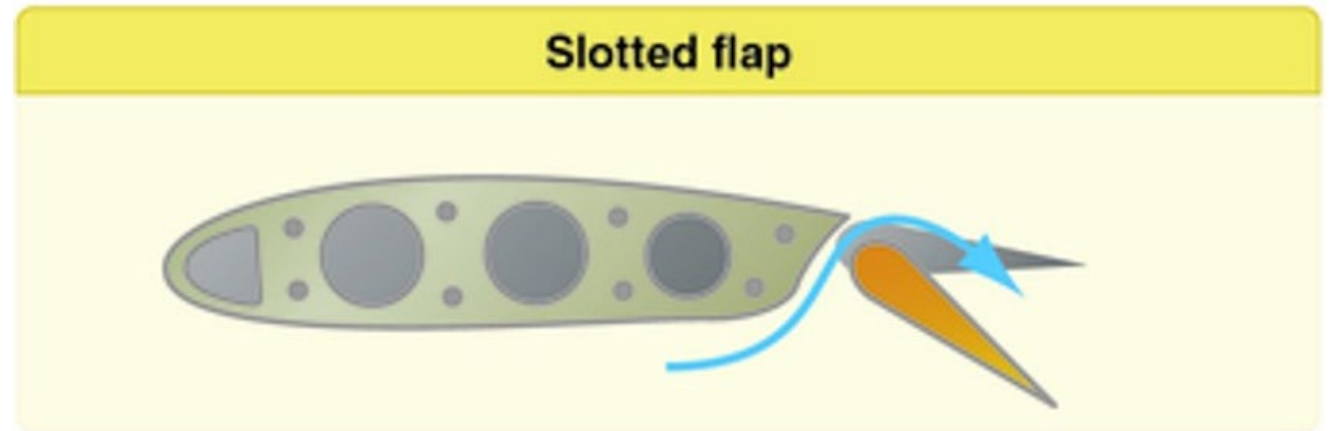
Slotted Flap

Variations of this design are used for small aircraft, as well as for large ones.

Slotted flaps increase the lift coefficient significantly more than plain or split flaps.

On small aircraft, the hinge is located below the lower surface of the flap, and when the flap is lowered, a duct forms between the flap well in the wing and the leading edge of the flap.

When the slotted flap is lowered, high energy air from the lower surface is ducted to the flap's upper surface.



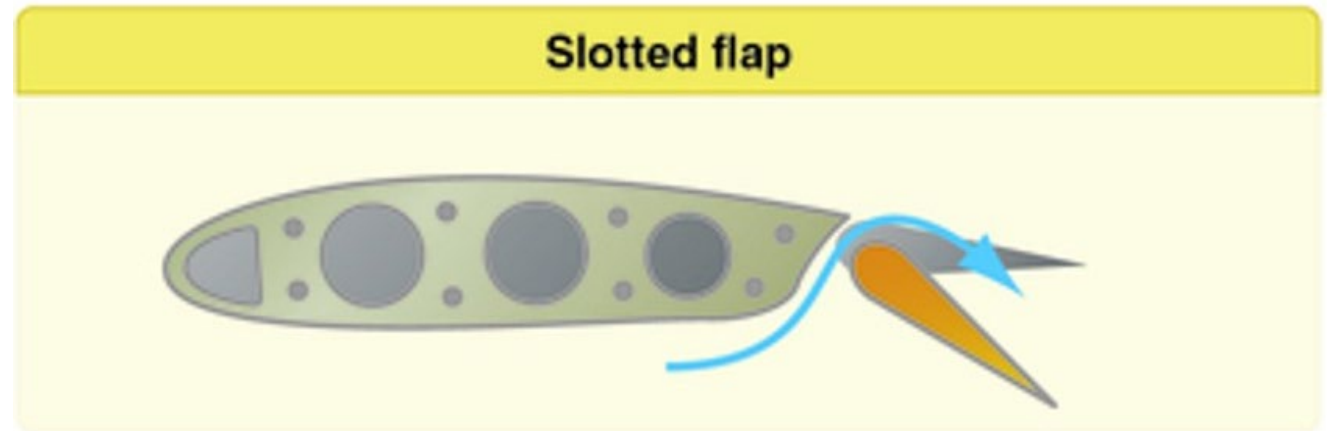
Slotted Flap

Thus, the slotted flap produces much greater increases in maximum coefficient of lift (CL_{MAX}) than the plain or split flap.

While there are many types of slotted flaps, large aircraft often have double- and even triple-slotted flaps.

These allow the maximum increase in drag without the airflow over the flaps separating and destroying the lift they produce.

Cessna 172, 182 use these.



Slotted Flap



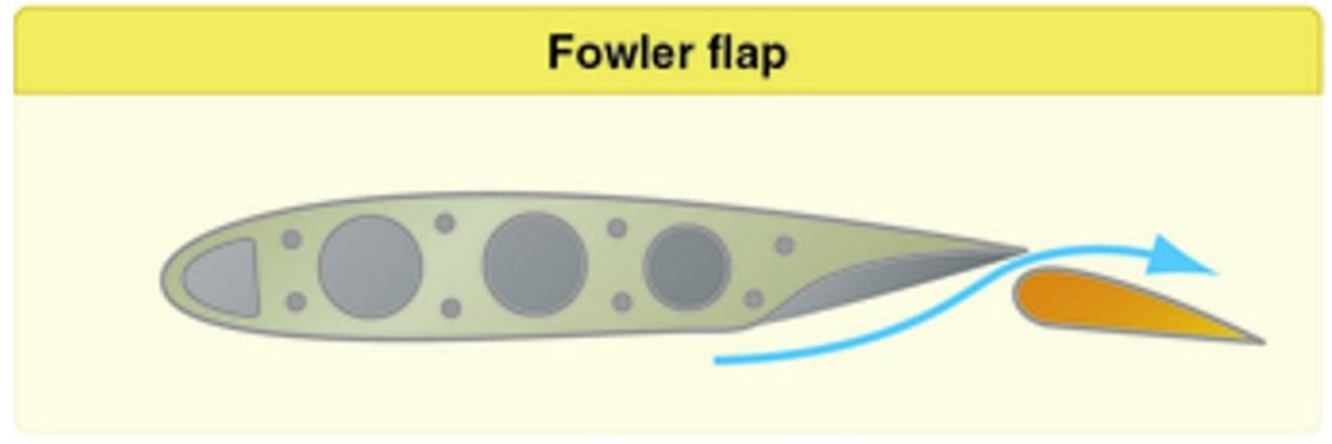
Fowler Flap

Fowler flaps are a type of slotted flap.

This flap design not only changes the camber of the wing, it also **increases the wing area**.

Instead of rotating down on a hinge, it slides backwards on tracks.

In the first portion of its extension, it **increases the drag very little, but increases the lift a great deal** as it increases both the area and camber.

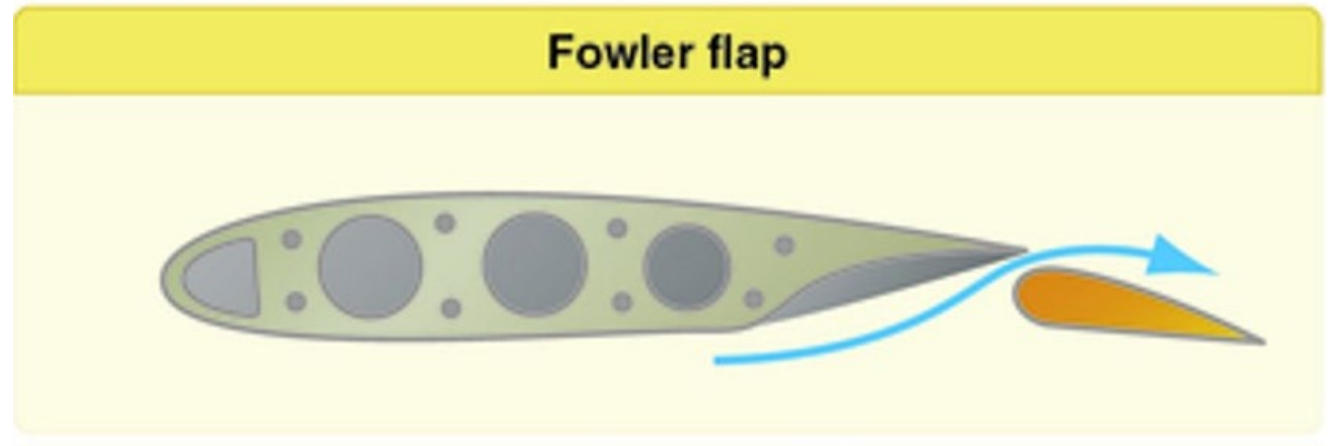


Fowler Flap

As the extension continues, the flap deflects downward.

During the last portion of its travel, the flap increases the drag with little additional increase in lift.

The Fowler flap also creates the greatest change in pitching moment.



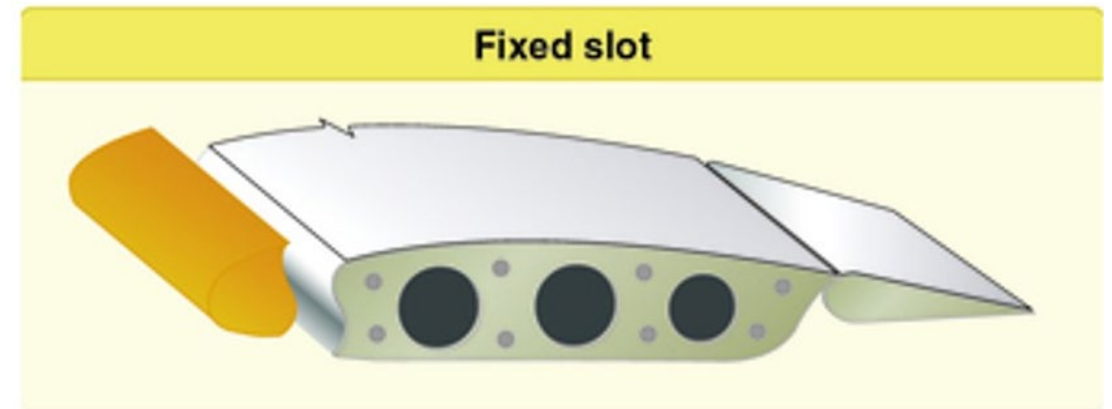
Fowler Flap



Fixed Slot

Fixed slots direct airflow to the upper wing surface and delay airflow separation at higher angles of attack.

The slot does not increase the wing camber but allows a higher maximum CL because the stall is delayed until the wing reaches a greater AOA.



Moveable Slot

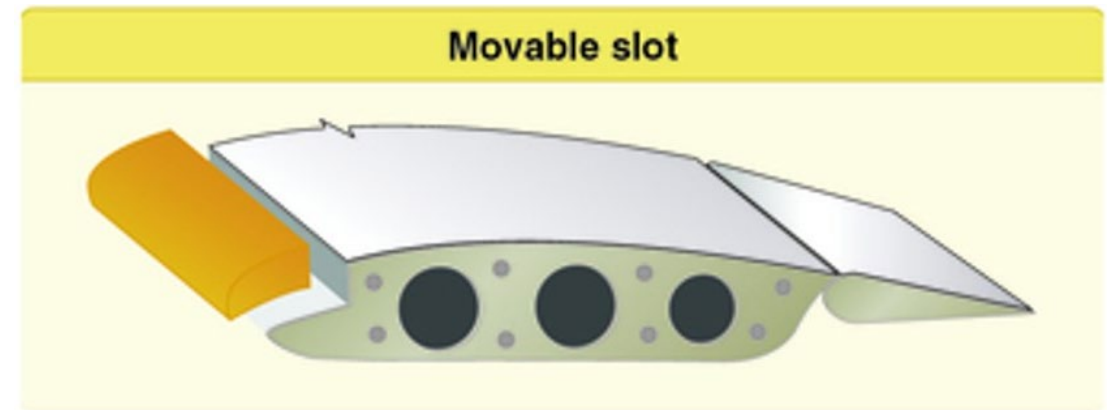
Movable slots consist of leading edge segments that move on tracks.

At low angles of attack, each slot is held flush against the wing's leading edge by the high pressure that forms at the wing's leading edge.

As the AOA increases, the high-pressure area moves aft below the lower surface of the wing, allowing the slots to move forward.

Some slots, however, are pilot operated and can be deployed at any AOA.

Opening a slot allows the air below the wing to flow over the wing's upper surface, delaying airflow separation.



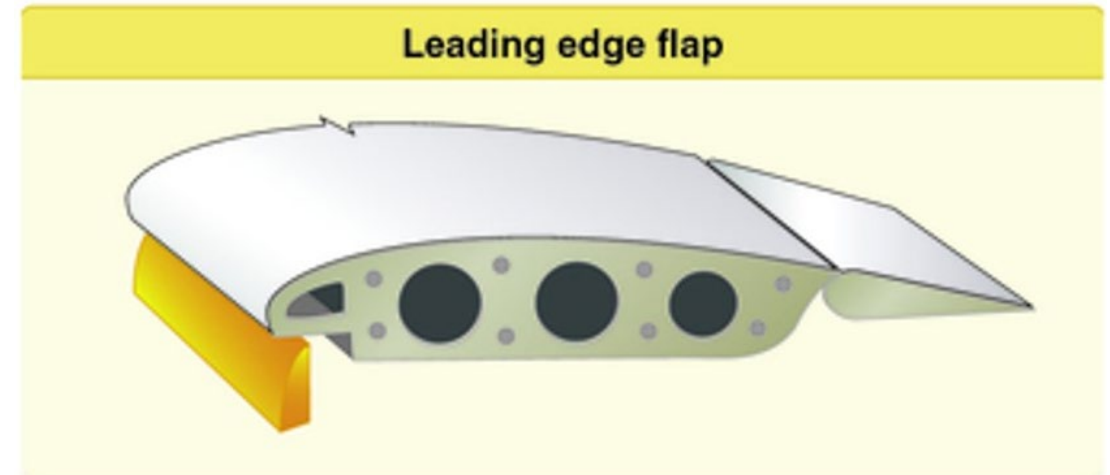
Leading Edge Flap

Leading edge flaps, like trailing edge flaps, are used to increase both CL_{MAX} and the camber of the wings.

This type of leading edge device is frequently used in conjunction with trailing edge flaps and can reduce the nose-down pitching movement produced by the trailing edge flaps.

As is true with trailing edge flaps, a small increment of leading edge flaps increases lift to a much greater extent than drag.

As flaps are extended, drag increases at a greater rate than lift.



Leading Edge Cuff

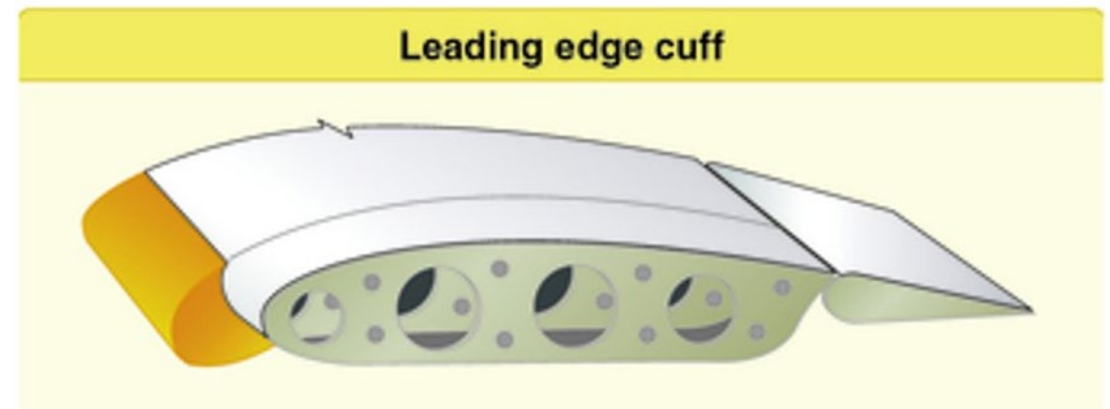
Leading edge cuffs, like leading edge flaps and trailing edge flaps are used to increase both CL_{MAX} and the camber of the wings.

Unlike leading edge flaps and trailing edge flaps, leading edge cuffs are fixed aerodynamic devices.

In most cases, leading edge cuffs extend the leading edge down and forward.

This causes the airflow to attach better to the upper surface of the wing at higher angles of attack, thus lowering an aircraft's stall speed.

The fixed nature of leading edge cuffs extracts a penalty in maximum cruise airspeed, but recent advances in design and technology have reduced this penalty.



Spoilers

High drag devices called spoilers are deployed from the wings to **spoil the smooth airflow, reducing lift and increasing drag.**

On gliders, spoilers are most often used to control rate of descent for accurate landings.

On other aircraft, spoilers are often used for roll control, an advantage of which is the elimination of adverse yaw.



Spoilers

To turn right, for example, the spoiler on the right wing is raised, destroying some of the lift and creating more drag on the right.

The right wing drops, and the aircraft banks and yaws to the right.

Deploying spoilers on both wings at the same time allows the aircraft to descend without gaining speed.

Spoilers are also deployed to help reduce ground roll after landing. By destroying lift, they transfer weight to the wheels, improving braking effectiveness.



Differential Ailerons

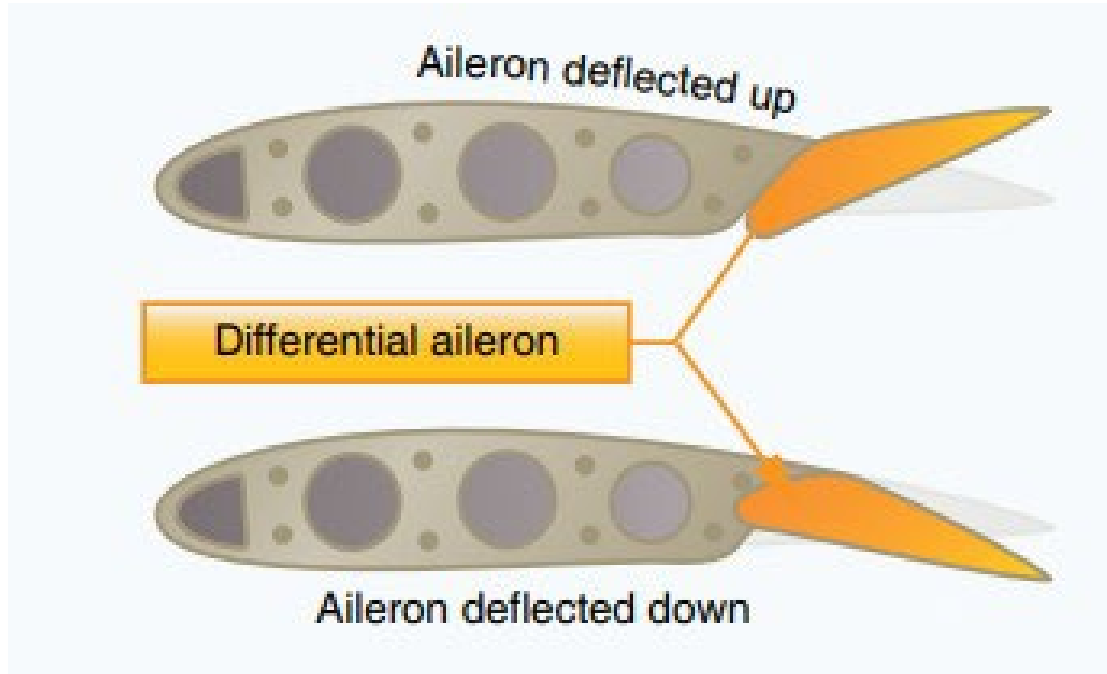
With differential ailerons, one aileron is raised a greater distance than the other aileron is lowered for a given movement of the control yoke or stick.

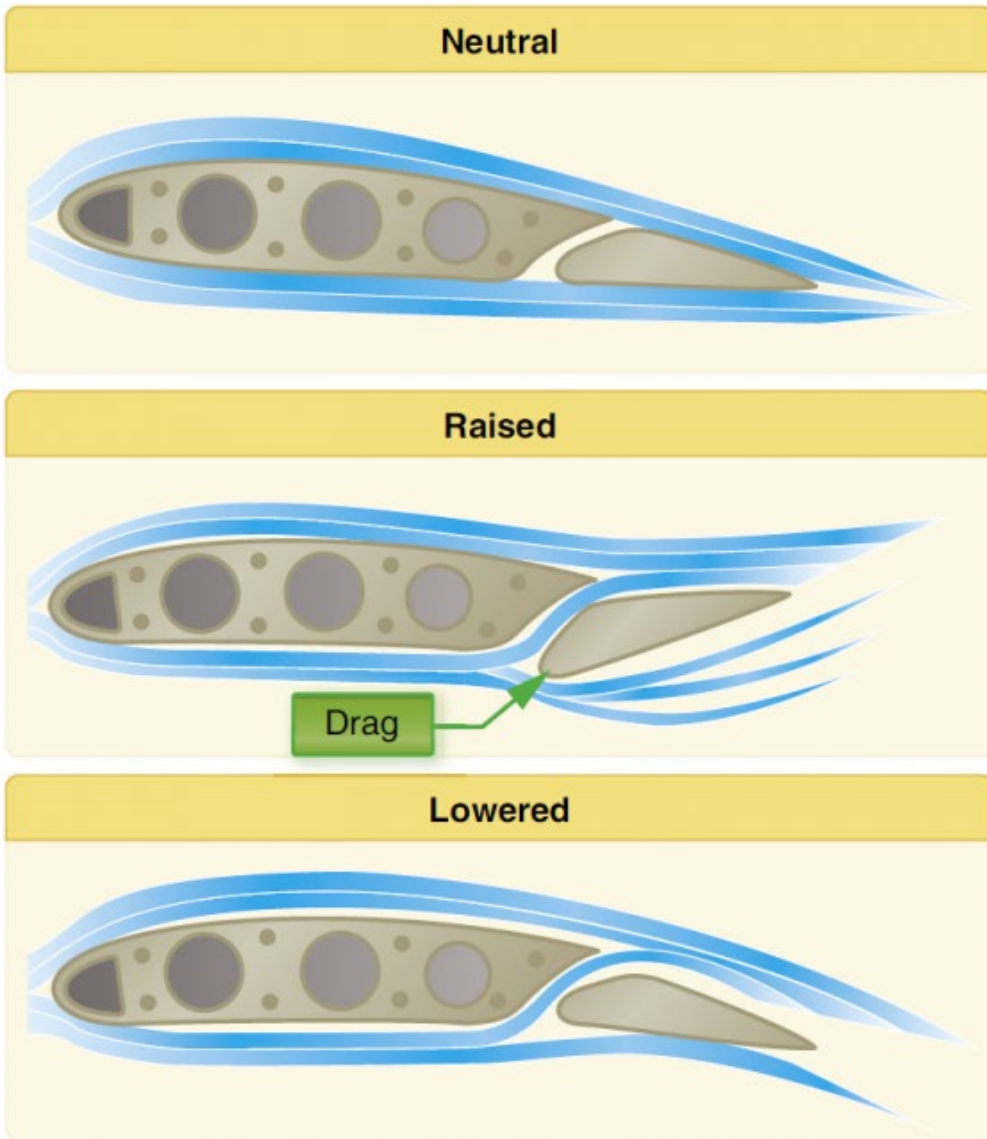
This produces an increase in drag on the descending wing.

The greater drag results from deflecting the up aileron on the descending wing to a greater angle than the down aileron on the rising wing.

While adverse yaw is reduced, it is not eliminated completely.

Cessna 150, 152, 172, 182 use these.





Frise-Type Ailerons

With a frise-type aileron, when pressure is applied to the control yoke or stick, the aileron that is being raised pivots on an offset hinge.

This projects the leading edge of the aileron into the airflow and creates drag.

It helps equalize the drag created by the lowered aileron on the opposite wing and reduces adverse yaw.

Elevators and affect CG

Elevator movement causes a pitching moment about the center of gravity (CG).

The strength of the pitching moment is determined by the distance between the CG and the horizontal tail surface, as well as by the aerodynamic effectiveness of the horizontal tail surface.

Trim Tabs

The most common installation on small aircraft is a single trim tab attached to the trailing edge of the elevator.

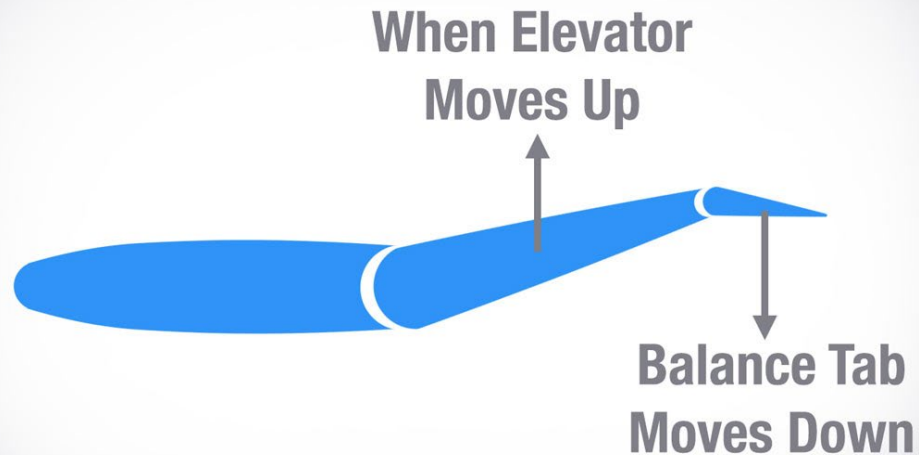
Placing the trim control in the full nose-down position moves the trim tab to its full up position.

With the trim tab up and into the airstream, the airflow over the horizontal tail surface tends to force the trailing edge of the elevator down.

This causes the tail of the aircraft to move up and the nose to move down.



Balance Tab



[boldmethod](#) >

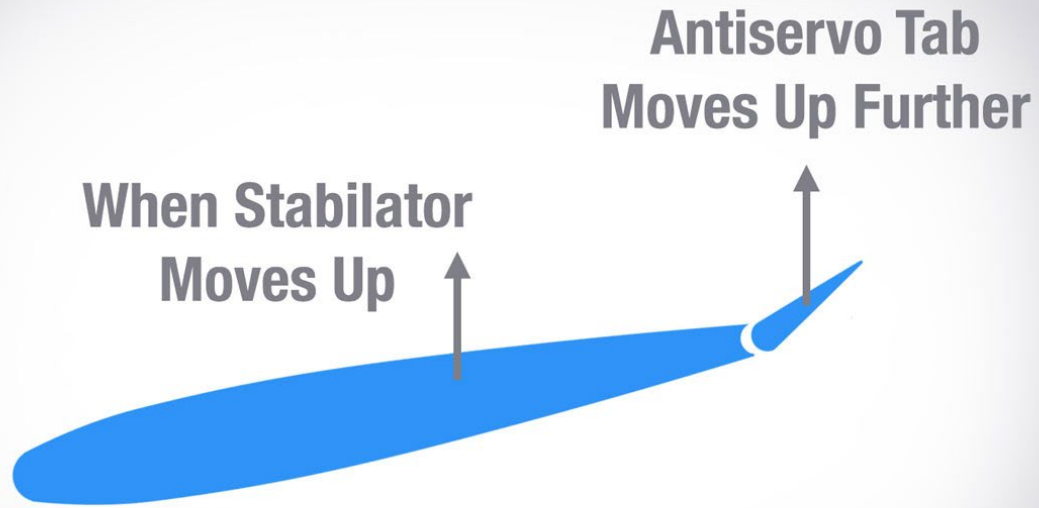
Balance Tab

Some aircraft have very heavy control loads, especially at high speeds. That's where balance tabs come in handy. Balance tabs look like trim tabs, but they have one major difference: balance tabs are attached to the control surface linkage, so when the control surface is moved in one direction, the balance tab moves in the opposite direction.

By moving the balance tab in the opposite direction, the control load on your yoke is significantly reduced, making your airplane easier to fly.

Antiservo Tab

Antiservo Tab



boldmethod ▶

Antiservo tabs are similar to balance tabs, but they move in the opposite direction. For example, when your elevator or stabilator moves up, the antiservo tab moves in the same direction.

In small aircraft, it increases the control feel, and helps prevent you from over-controlling your aircraft's pitch. One of the most popular examples of the antiservo tab is on the Piper Cherokee. Without it, the plane would be much easier to pitch up and down, but it would also be easy to over-control, and possibly overstress the airframe.

Ground Adjustable Tabs



Many small aircraft have a nonmovable metal trim tab on the rudder.

This tab is bent in one direction or the other while on the ground to apply a trim force to the rudder.

The correct displacement is determined by trial and error.

Usually, small adjustments are necessary until the aircraft no longer skids left or right during normal cruising flight.



Any questions I can answer or
follow up later on?

AROW/ARROW



Cleared For
the Option!

Lesson Objective

To develop a deeper understanding of the term AROW and making sure the plane is legal to fly.

First the List

- Airworthiness Certificate
- Registration Certificate
- Radio Station License (international flights only)
- Operating Handbook + associated placards + airspeed markings
- Weight and Balance

The logo for SPAROW, featuring the word "SPAROW" in a white, bold, sans-serif font. The text is positioned on the left side of the image, which has a dark blue background with a large, lighter blue circular graphic element behind it.

SPAROW

+ Supplements/STCs

+ Placards

91.7

§ 91.7 Civil aircraft airworthiness.

(a) No person may operate a civil aircraft unless it is in an airworthy condition.

(b) The pilot in command of a civil aircraft is responsible for determining whether that aircraft is in condition for safe flight. The pilot in command shall discontinue the flight when unairworthy mechanical, electrical, or structural conditions occur.

91.9

§ 91.9 Civil aircraft flight manual, marking, and placard requirements.

(a) Except as provided in paragraph (d) of this section, no person may operate a civil aircraft without complying with the operating limitations specified in the approved Airplane or Rotorcraft Flight Manual, markings, and placards, or as otherwise prescribed by the certifying authority of the country of registry.

(b) No person may operate a U.S.-registered civil aircraft -

(1) For which an Airplane or Rotorcraft Flight Manual is required by § 21.5 of this chapter unless there is available in the aircraft a current, approved Airplane or Rotorcraft Flight Manual or the manual provided for in § 121.141(b); and

91.9

(2) For which an Airplane or Rotorcraft Flight Manual is not required by § 21.5 of this chapter, unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof.

(c) No person may operate a U.S.-registered civil aircraft unless that aircraft is identified in accordance with part 45 of this chapter.

91.203

§ 91.203 Civil aircraft: Certifications required.

(a) Except as provided in § 91.715, no person may operate a civil aircraft unless it has within it the following:

(1) An appropriate and current airworthiness certificate. Each U.S. airworthiness certificate used to comply with this subparagraph (except a special flight permit, a copy of the applicable operations specifications issued under § 21.197(c) of this chapter, appropriate sections of the air carrier manual required by parts 121 and 135 of this chapter containing that portion of the operations specifications issued under § 21.197(c), or an authorization under § 91.611) must have on it the registration number assigned to the aircraft under part 47 of this chapter. However, the airworthiness certificate need not have on it an assigned special identification number before 10 days after that number is first affixed to the aircraft. A revised airworthiness certificate having on it an assigned special identification number, that has been affixed to an aircraft, may only be obtained upon application to the responsible Flight Standards office.

91.203

(2) An effective U.S. registration certificate issued to its owner or, for operation within the United States, the second copy of the Aircraft registration Application as provided for in § 47.31(c), a Certificate of Aircraft registration as provided in part 48, or a registration certification issued under the laws of a foreign country.

(b) No person may operate a civil aircraft unless the airworthiness certificate required by paragraph (a) of this section or a special flight authorization issued under § 91.715 is displayed at the cabin or cockpit entrance so that it is legible to passengers or crew.

AFM, POH

POH = Pilot's Operating Handbook

AFM = Airplane Flight Manual

The POH is for a type of aircraft, while the AFM is for one specific airframe. The AFM is generally a copy of that type's POH. However, it'll have the specific serial number listed and contain the weight and balance, equipment list, and operating limitations for that specific airframe.

The AFM comes with the plane...leave it in the plane...do not lose it

The AFM in my plane is older than me...I never touch it

A POH for say a Cessna 172S you can buy online...you can beat it up all you want

AFM



**Pilot's Operating Handbook
And FAA Approved
Airplane Flight Manual
SKYHAWK
SP**



 Member of GAMA

Model 172S
NAV III Avionics - GFC 700 AFCS
Serials
172S10468, 172S10507, 172S10640
and 172S10656 and On

SERIAL NUMBER 172S12971
REGISTRATION NUMBER N971TH

This publication includes the material required to be furnished to the pilot by 14 CFR 23.

APPROVED BY

FAA APPROVED UNDER 14 CFR PART 21 SUBPART J
Cessna Aircraft Co.
Delegation of Authority DCA-2000-04

RLS

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REVISION 4 - 11 JUNE 2021

172SPHUS-04

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POH

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Cessna Aircraft Information Manual - 172 Skyhawk Overview:

Cessna Aircraft Information Manuals include the same data and limitations contained in the original aircraft Pilot's Operating Handbook, however they are not specific to your serial numbered aircraft. These aircraft manuals are NOT FAA-approved replacements for your aircraft's POH. FAA-approved replacement POH's are specific to your aircraft serial number and can only be obtained directly from the manufacturer.

Most manuals are in stock however some of the less popular ones may have to be special ordered. We will notify you via email if there will be any delay. If you cannot find your Cessna aircraft in the list, please call us toll-free at 1-877-314-7575.

If you are looking for a different model of aircraft, visit the [Aircraft Manuals / Pilot Operating Handbooks](#) area.

POH

The POH describes the specific airplane and its operation

SECTIONS INCLUDE:

General – Description of the Airplane

Limitations – Description of operating limits

Emergency Procedures – What to do in each emergency situation

Normal Procedures - Checklists

Performance – Graphs and tables relating to airplane capabilities

Weight and Balance – Equipment list and airplane's empty weight

Airplane and Systems Description – Description of the airplane's systems

Handling, Preventative and Corrective Maintenance – Explanation of what and when and how

Supplements – Description of optional equipment or upgrades

23.2620

§ 23.2620 Airplane flight manual.

The applicant must provide an Airplane Flight Manual that must be delivered with each airplane.

(a) The Airplane Flight Manual must contain the following information -

- (1) Airplane operating limitations;
- (2) Airplane operating procedures;
- (3) Performance information;
- (4) Loading information; and
- (5) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) The following sections of the Airplane Flight Manual must be approved by the FAA in a manner specified by the administrator -

- (1) For low-speed, level 1 and 2 airplanes, those portions of the Airplane Flight Manual containing the information specified in paragraph (a)(1) of this section; and
- (2) For high-speed level 1 and 2 airplanes and all level 3 and 4 airplanes, those portions of the Airplane Flight Manual containing the information specified in paragraphs (a)(1) thru (a)(4) of this section.

KINDS OF OPERATIONS EQUIPMENT LIST

System, Instrument, Equipment and/or Function	KIND OF OPERATION				COMMENTS
	V F R D A Y	V F R N I G H T	I F R D A Y	I F R N I G H T	
PLACARDS AND MARKINGS					
1 - 172S Nav III - GFC 700 AFCS POH/AFM	1	1	1	1	Accessible to pilot in flight.
2 - Garmin G1000 Cockpit Reference Guide	1	1	1	1	Accessible to pilot in flight.
AIR CONDITIONING					
1 - Forward Avionics Fan	1	1	1	1	

2.25 GARMIN G1000 AVIONICS SYSTEM LIMITATIONS

(a) Cockpit Reference & Pilot's Guide

The Garmin **G1000 Cockpit** Reference Guide P/N 190-02131-02 (latest appropriate revision) must be immediately available to the flight crew.

Garmin also provides a detailed G1000 Pilot's Guide P/N 190-02130-02 (latest appropriate revision). This reference material is not required to be on board the aircraft but does contain a more in depth description of all the functions and capabilities of the G1000 avionics system.

Ramp Check Instructions

17. AIRCRAFT DOCUMENTS. Following are considerations when examining aircraft documents, including registration and airworthiness certificates and approved flight manuals. Discrepancies found concerning the airworthiness or registration certificates shall be brought to the attention of the operator, documented, and given to the airworthiness unit for action.

A. N-Numbers. The N-number on the registration certificate must match the N-number on the airworthiness certificate.

B. Registration Certificate. If the registered owner has changed you may see a temporary registration (Pink Slip) which is good for 120 days. If the ownership has changed without a Pink Slip or the N- numbers do not match, the registration is not valid.

C. Radio Station License. An aircraft FCC radio license is required although the FAA does not regulate the requirement. The license may be for that particular N-number or a fleet license. The expiration date of the license is in the upper right hand corner. Any discrepancy concerning the radio license should be brought to the attention of the operator only.

Ramp Check Instructions

D. Flight Manual. An Aircraft Flight Manual is required to be on board the aircraft (FAR § 91.9 {91.31}) along with the appropriate markings and placards.

E. Weight and Balance Information. Weight and balance documents, including a list of equipment, must be on board the aircraft. Some multiengine operators have Minimum Equipment Lists (MEL's) with a letter of authorization issued by a district office. These constitute a supplemental type certificate for the aircraft and must be on board. The inspector should compare inoperative equipment to the MEL to assure compliance. (Refer to Related Task #58, Approve a Minimum Equipment List.)

Ramp Check Instructions

F. Airworthiness Certificate. The certificate most often seen by an inspector is a standard airworthiness certificate, which is issued for normal, utility, acrobatic, and transport category aircraft. A restricted, limited, or experimental certificate must be accompanied by a list of limitations and conditions (FAR § 21.183 -191) necessary for safe operation. A Special Flight Permit (Ferry Permit) is issued to aircraft that may not be airworthy but are capable of safe flight under certain conditions which are listed and issued with the permit (FAR §§ 21.197 , 91.203 {91.27}, and 91.213 {91.30}). Review the list of limitations and conditions to assure a valid airworthiness certificate. The N-number on the certificate must match the N-number on the fuselage to be valid.

Airworthiness Certificate and Registration Certificate

Airworthiness Certificate

The standard airworthiness certificate is issued when the airplane is manufactured or when the N number changes. In addition to the standard Airworthiness Certificate, there are Experimental, Restricted, or Special Flight Certificates that may apply to your aircraft.

Registration Certificate

Registrations must be renewed every three years. The FAA has a page that explains the process. You can also check the status of an aircraft's registration and who it is registered to on the FAA website.

30FTDUC

30FTDUC “30 Foot Duck”

30 – Thirty Days After Death

F – Foreign Registry

(change to another country for aircraft registration)

T – Transfer of Ownership

(If you sell your airplane)

D – Destroyed

U – United States citizenship revoked

C – Cancelled

Airworthy Definition

8130.2H Chapter 2. General Policies and Procedures

Section 1. General Information

200. Definition of the Term “Airworthy” for U.S. Type-Certificated Aircraft. The FAA must find that an aircraft is airworthy before issuing an airworthiness certificate. Two conditions must be met for an aircraft to be considered “airworthy.” Title 49 of the United States Code (49 U.S.C.) 44704 and Title 14 of the Code of Federal Regulations (14 CFR) part 21, Certification Procedures for Products and Parts, state the conditions necessary for issuance of an airworthiness certificate:

a. The aircraft must conform to its type design. For the purpose of airworthiness, conformity to the type design is considered attained when the aircraft configuration and the engine, propeller, and articles installed are consistent with the drawings, specifications, and other data that are part of the type certificate (TC). This includes any supplemental type certificate (STC) and repairs and alterations incorporated into the aircraft.

Airworthy Definition

b. The aircraft must be in a condition for safe operation. This refers to the condition of the aircraft relative to wear and deterioration, for example, skin corrosion, window delamination/crazing, fluid leaks, and tire wear.

Note 1: If either of these conditions are not met, the aircraft is not considered airworthy.

Note 2: Aircraft presented for the issuance of a certificate under § 21.191 do not need to conform to their type design, but must be in a condition for safe operation.

Radio Station License

A radio station and operators license is required if you make international flights or communicate with foreign stations. They might not be enforced but this is still the rule.

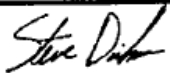
You must obtain an FCC Aircraft Radio Station License if you make international flights or communicate with foreign stations. If you are not required to obtain a license – you do not need to file this form [Form 605] with the FCC. The license has a term of 10 years.

At least one person on each aircraft flying or communicating internationally must have a Restricted Radiotelephone Operator Permit. This requirement is in addition to the requirement to have an aircraft radio station license for the aircraft. No Restricted Radiotelephone Operator Permit is required to operate VHF radio equipment on board an aircraft when that aircraft is flown domestically. You may obtain a Restricted Permit using FCC Form 605. No test is required to obtain this permit. The permit when issued will be valid for your lifetime. The fee for a Restricted Permit is in addition to any fee paid for an aircraft license.

N3889J
A

UNITED STATES OF AMERICA DEPARTMENT OF TRANSPORTATION—FEDERAL AVIATION ADMINISTRATION			
STANDARD AIRWORTHINESS CERTIFICATE			
1. NATIONALITY AND REGISTRATION MARKS	2. MANUFACTURER AND MODEL	3. AIRCRAFT SERIAL NUMBER	4. CATEGORY
N 3889J	CESSNA 150G	15065189	UTILITY
5. AUTHORITY AND BASIS FOR ISSUANCE This airworthiness certificate is issued pursuant to the Federal Aviation Act of 1958 and certifies that, as of the date of issuance, the aircraft to which issued has been inspected and found to conform to the type certificate therefor, to be in condition for safe operation, and has been shown to meet the requirements of the applicable comprehensive and detailed airworthiness code as provided by Annex 8 to the Convention on International Civil Aviation, except as noted herein. Exceptions: NONE			
6. TERMS AND CONDITIONS Unless sooner surrendered, suspended, revoked, or a termination date is otherwise established by the Administrator, this airworthiness certificate is effective as long as the maintenance, preventative maintenance, and alterations are performed in accordance with Parts 21, 43, and 91 of the Federal Aviation Regulations, as appropriate, and the aircraft is registered in the United States.			
DATE OF ISSUANCE REPLACEMENT 10-06-66	FAA REPRESENTATIVE William R. Neely		SIGNATURE NUMBER SO 66
Any alteration, reproduction, or misuse of this certificate may be punishable by a fine not exceeding \$1,000, or imprisonment not exceeding 3 years, or both. THIS CERTIFICATE MUST BE DISPLAYED IN THE AIRCRAFT IN ACCORDANCE WITH APPLICABLE FEDERAL AVIATION REGULATIONS.			
FAA Form 8100-2 (8-82)			
GPO 674-155			

REGISTRATION NOT TRANSFERABLE

UNITED STATES OF AMERICA DEPARTMENT OF TRANSPORTATION - FEDERAL AVIATION ADMINISTRATION CERTIFICATE OF AIRCRAFT REGISTRATION		This certificate must be in the air- craft when operated.
NATIONALITY AND REGISTRATION MARKS N 3889J		AIRCRAFT SERIAL NO. 15065189
MANUFACTURER AND MANUFACTURER'S DESIGNATION OF AIRCRAFT CESSNA 150C		
ICAO Aircraft Address Code: 51076236		
I S S U E D T O	VEDUCCIO GARY ROBERT 54 CEDAR RIDGE AIRPORT RD GRIFFIN GA 30223-6803	This certificate is issued for registration purposes only and is not a certificate of title. The Federal Aviation Administration does not determine rights of ownership as between private persons.
	Individual	
It is certified that the above described aircraft has been entered on the register of the Federal Aviation Administration, United States of America, in accordance with the Convention on International Civil Aviation dated December 7, 1944, and with Title 49, United States Code, and regulations issued thereunder.		
DATE OF ISSUE EXPIRATION DATE	December 20, 2021 December 31, 2024	 ADMINISTRATOR
		 U.S. Department of Transportation Federal Aviation Administration

N3889J
O

CESSNA



CESSNA

MORE PEOPLE BUY AND
FLY CESSNA AIRPLANES
THAN ANY OTHER MAKE

1967

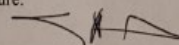
WORLD'S LARGEST PRO-
DUCER OF GENERAL
AVIATION AIRCRAFT
SINCE 1956

MODEL
150

OWNER'S
MANUAL

N3889J
W

Aircraft Weight & Balance, Equipment List Revision

Tail Number: N3889J		Date: September 9, 2020																																									
Prepared by: Scott Gerken 135 Westminister Village Blvd Sharpsburg, GA 30277		Reason: Radio Upgrade																																									
		Type Certificate Data Number: <i>SAI 9</i>																																									
Aircraft Make: Cessna	Model: 150G	Serial No: 15065189	Airframe Total Time: 5796.61																																								
Registered Owner: Fox Victor Aviation LLC		Address: 919 N Market St, STE 425 Wilmington, DE 19801																																									
Maximum Weight: 1600 lbs		CG Range: 32.9 to 37.5 at 1600 Lbs 31.5 to 37.5 at 1280 or less																																									
As Received; Date of Previous W&B: July 10, 2019	Useful Load: 514	Empty Wt: 1086.0	EWCG: 36.09																																								
Moment: 39197.8																																											
Notes:																																											
<table border="1"> <thead> <tr> <th>Item</th> <th>Weight</th> <th>Arm</th> <th>Moment</th> </tr> </thead> <tbody> <tr> <td>Removed:</td> <td></td> <td></td> <td></td> </tr> <tr> <td>KX 170B transceiver S/N 33792</td> <td>-7.6</td> <td>10.5</td> <td>-79.8</td> </tr> <tr> <td>KI 208 indicator S/N 24673</td> <td>-1.0</td> <td>16.5</td> <td>-16.5</td> </tr> <tr> <td>Val Com 760 transceiver 11732</td> <td>-3.2</td> <td>10.5</td> <td>-33.6</td> </tr> <tr> <td>Flight Com Hlx intercom 20168</td> <td>-0.5</td> <td>19.5</td> <td>-9.75</td> </tr> <tr> <td>Installed:</td> <td></td> <td></td> <td></td> </tr> <tr> <td>PAR200A audio panel/com controller P/N 050-228-0200 S/N E01516</td> <td>1.5</td> <td>16.5</td> <td>24.75</td> </tr> <tr> <td>TY91L P/N 01192-00-09 S/N 03989</td> <td>0.8</td> <td>1.0</td> <td>.80</td> </tr> <tr> <td>Weight / Moment change</td> <td>-10.0 lb</td> <td></td> <td>-114.10</td> </tr> </tbody> </table>				Item	Weight	Arm	Moment	Removed:				KX 170B transceiver S/N 33792	-7.6	10.5	-79.8	KI 208 indicator S/N 24673	-1.0	16.5	-16.5	Val Com 760 transceiver 11732	-3.2	10.5	-33.6	Flight Com Hlx intercom 20168	-0.5	19.5	-9.75	Installed:				PAR200A audio panel/com controller P/N 050-228-0200 S/N E01516	1.5	16.5	24.75	TY91L P/N 01192-00-09 S/N 03989	0.8	1.0	.80	Weight / Moment change	-10.0 lb		-114.10
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X As Calculated	Moment: 39083.7	New Empty Weight CG: 36.32	New Useful Load:																																								
☐ As Weighed	Weight: 1076.0		524 Lbs.																																								
Signature: 																																											
License No: <i>3211721 AP/FA</i>																																											

N3889J Online Registration

<https://flightaware.com/resources/registration/N3889J>

<https://registry.faa.gov/AircraftInquiry/Search/NNumberResult?nNumberTxt=3889J>

The Other A

Airworthiness Directives (ADs) An "airworthiness directive (AD)" can be either "one-time" - requiring a single inspection or modification to be performed on an aircraft - or "recurring" - meaning it needs to be checked or serviced at specific intervals on an ongoing basis, like every so many hours of flight or calendar years; essentially, a one-time AD is a single action, while a recurring AD is a repetitive action at set intervals.

One-time AD:

Requires a single inspection or modification to be completed within a specified timeframe.

Once completed, the AD is considered compliant and no further action is needed for that specific issue.

Recurring AD:

Requires periodic inspections or maintenance actions to be performed at specified intervals (like every 100 hours of flight or annually).

Continued compliance necessitates performing the required checks at the specified intervals.

The Other A

Airworthiness Directives

Airworthiness Directives (ADs) are legally enforceable regulations issued by the FAA in accordance with 14 CFR part 39 to correct an unsafe condition in a product. Part 39 defines a product as an aircraft, engine, propeller, or appliance.

You do not need all the paperwork in the plane but you better be in compliance if you get checked. Keep all the paperwork with your maintenance logs.

Required Equipment

See separate lesson on Required Equipment

Part 91 Maintenance and Checks

§ 91.405 Maintenance required.

Each owner or operator of an aircraft—

- (a) Shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in part 43 of this chapter;
- (b) Shall ensure that maintenance personnel make appropriate entries in the aircraft maintenance records indicating the aircraft has been approved for return to service;
- (c) Shall have any inoperative instrument or item of equipment, permitted to be inoperative by § 91.213(d)(2) of this part, repaired, replaced, removed, or inspected at the next required inspection; and
- (d) When listed discrepancies include inoperative instruments or equipment, shall ensure that a placard has been installed as required by § 43.11 of this chapter.

Part 91 Maintenance and Checks

§ 91.409 Inspections.

Annual inspections

100 Hour inspections if used for hire or instruction

§ 91.411 Altimeter system and altitude reporting equipment tests and inspections.

Static Pressure System and Altimeter tests required for IFR flight

Required every 24 calendar months

§ 91.413 ATC transponder tests and inspections.

Transponder tests and inspections required

Required every 24 calendar months

Part 65

Subpart D

Who can work on the plane?

An A&P

An owner working with an A&P monitoring

Who can sign off an annual?

A&P with IA (Inspection authorized)

For other details see

§ 65 Subpart D—Mechanics

§ 65.71 Eligibility requirements: General.

Part 91 Maintenance and Checks

§ 91.207 Emergency locator transmitters.

Inspection requirements

Every 12 calendar months

The batteries must be replaced (or recharged)

When the transmitter has been in use more than 1 cumulative hour

When 50% of their useful life has expired

Special Flight Permits

§ 21.197 Special flight permits.

(a) A special flight permit may be issued for an aircraft that may not currently meet applicable airworthiness requirements but is capable of safe flight, for the following purposes:

- (1) Flying the aircraft to a base where repairs, alterations, or maintenance are to be performed, or to a point of storage.
- (2) Delivering or exporting the aircraft.
- (3) Production flight testing new production aircraft.
- (4) Evacuating aircraft from areas of impending danger.
- (5) Conducting customer demonstration flights in new production aircraft that have satisfactorily completed production flight tests.

Special Flight Permits

(b) A special flight permit may also be issued to authorize the operation of an aircraft at a weight in excess of its maximum certificated takeoff weight for flight beyond the normal range over water, or over land areas where adequate landing facilities or appropriate fuel is not available. The excess weight that may be authorized under this paragraph is limited to the additional fuel, fuel-carrying facilities, and navigation equipment necessary for the flight.

(c) Upon application, as prescribed in §§ 91.1017 or 119.51 of this chapter, a special flight permit with a continuing authorization may be issued for aircraft that may not meet applicable airworthiness requirements, but are capable of safe flight for the purpose of flying aircraft to a base where maintenance or alterations are to be performed. The permit issued under this paragraph is an authorization, including conditions and limitations for flight, which is set forth in the certificate holder's operations specifications. The permit issued under this paragraph may be issued to—

- (1) Certificate holders authorized to conduct operations under part 119 of this chapter, that have an approved program for continuing flight authorization; or
- (2) Management specification holders authorized to conduct operations under part 91, subpart K of this chapter for those aircraft they operate and maintain under a continuous airworthiness maintenance program prescribed by § 91.1411 of this chapter.

Special Flight Permits

§ 21.199 Issue of special flight permits.

(a) Except as provided in § 21.197(c), an applicant for a special flight permit must submit a statement in a form and manner prescribed by the FAA, indicating—

- (1) The purpose of the flight.
 - (2) The proposed itinerary.
 - (3) The crew required to operate the aircraft and its equipment, e.g., pilot, co-pilot, navigator, etc.
 - (4) The ways, if any, in which the aircraft does not comply with the applicable airworthiness requirements.
 - (5) Any restriction the applicant considers necessary for safe operation of the aircraft.
 - (6) Any other information considered necessary by the FAA for the purpose of prescribing operating limitations.
- (b) The FAA may make, or require the applicant to make appropriate inspections or tests necessary for safety.

Special Flight Permits

See <https://www.faa.gov/media/29886>

For More Detailed Info

PHAK FAA-H-8083-25B

FAA Order 8130.2H

FAA Airworthiness Certification Page

https://www.faa.gov/aircraft/air_cert/airworthiness_certification/aw_overview

FAA Aircraft Registration Page

https://www.faa.gov/licenses_certificates/aircraft_certification/aircraft_registry/reregistration

FAA Airworthiness Directives Page

https://www.faa.gov/regulations_policies/airworthiness_directives/

CHAPTER 56 CONDUCT A FAR PART 91 RAMP INSPECTION

https://fsims.faa.gov/WDocs/8700.1%20GA%20Ops%20Insp%20Handbk/Volume%202/2_056_00.htm



Any questions I can answer or
follow up later on?

Required
Equipment



Lesson Objective

To develop understanding of what better be working

RULES

91.205

For the full rules see

91.205 Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements.

1

2

3



Required Equipment

VFR Day

A TOMATO FLAMES:

A – airspeed indicator

T – tachometer (for each engine)

O – oil pressure gauge (for each engine using a pressure system)

M – manifold pressure gauge (for each altitude engine)

A – altimeter

T – temperature gauge (for each liquid cooled engine)

O – oil temperature gauge (for each air cooled engine)

F – fuel gauge

L – landing gear position indicator

A – anti collision lights*

(for aircraft certified after March 11th 1996)

M – magnetic compass

E – ELT

S – safety belts

Required Equipment

VFR Night

A TOMATO FLAMES plus FLAPS:

F – fuses (one complete spare set)

L – landing light (only if you are flying for hire)

A – anti collision lights*

P – position lights

S – source of electricity (alternator, generator)

Lights

The strobe and beacon are both anti-collision lights.

The red and green wingtip lights are position lights (required at night, but not during the day).

§ 91.209 Aircraft lights.

(b) Operate an aircraft that is equipped with an anticollision light system, unless it has lighted anticollision lights.

However, the anticollision lights need not be lighted when the pilot-in-command determines that, because of operating conditions, it would be in the interest of safety to turn the lights off.

91.213

91.213 Inoperative instruments and equipment.

(a) Except as provided in paragraph (d) of this section, no person may take off an aircraft with inoperative instruments or equipment installed unless the following conditions are met:

- (1) An approved **Minimum Equipment List** exists for that aircraft.
- (2) The aircraft has within it a letter of authorization, issued by the responsible Flight Standards office, authorizing operation of the aircraft under the Minimum Equipment List. The letter of authorization may be obtained by written request of the airworthiness certificate holder. The Minimum Equipment List and the letter of authorization constitute a supplemental type certificate for the aircraft.
- (3) The approved Minimum Equipment List must -
 - (i) Be prepared in accordance with the limitations specified in paragraph (b) of this section; and
 - (ii) Provide for the operation of the aircraft with the instruments and equipment in an inoperable condition.
- (4) The aircraft records available to the pilot must include an entry describing the inoperable instruments and equipment.
- (5) The aircraft is operated under all applicable conditions and limitations contained in the Minimum Equipment List and the letter authorizing the use of the list.

91.213

(b) The following instruments and equipment may not be included in a Minimum Equipment List:

- (1) Instruments and equipment that are either specifically or otherwise required by the airworthiness requirements under which the aircraft is type certificated and which are essential for safe operations under all operating conditions.
- (2) Instruments and equipment required by an airworthiness directive to be in operable condition unless the airworthiness directive provides otherwise.
- (3) Instruments and equipment required for specific operations by this part.

(c) A person authorized to use an approved Minimum Equipment List issued for a specific aircraft under subpart K of this part, part 121, 125, or 135 of this chapter must use that Minimum Equipment List to comply with the requirements in this section.

(d) Except for operations conducted in accordance with paragraph (a) or (c) of this section, a person may takeoff an aircraft in operations conducted under this part with inoperative instruments and equipment without an approved Minimum Equipment List provided -

(1) The flight operation is conducted in a -

- (i) Rotorcraft, non-turbine-powered airplane, glider, lighter-than-air aircraft, powered parachute, or weight-shift-control aircraft, for which a master minimum equipment list has not been developed; or
- (ii) Small rotorcraft, nonturbine-powered small airplane, glider, or lighter-than-air aircraft for which a Master Minimum Equipment List has been developed; and

91.213

(2) The inoperative instruments and equipment are not -

(i) Part of the VFR-day type certification instruments and equipment prescribed in the applicable airworthiness regulations under which the aircraft was type certificated;

(ii) Indicated as required on the aircraft's equipment list, or on the **Kinds of Operations Equipment List** for the kind of flight operation being conducted;

(iii) Required by § 91.205 or any other rule of this part for the specific kind of flight operation being conducted; or

(iv) Required to be operational by an airworthiness directive; and

(3) The inoperative instruments and equipment are -

(i) Removed from the aircraft, the cockpit control placarded, and the maintenance recorded in accordance with § 43.9 of this chapter; or

(ii) Deactivated and placarded "Inoperative." If deactivation of the inoperative instrument or equipment involves maintenance, it must be accomplished and recorded in accordance with part 43 of this chapter; and

91.213

4) A determination is made by a pilot, who is certificated and appropriately rated under part 61 of this chapter, or by a person, who is certificated and appropriately rated to perform maintenance on the aircraft, that the inoperative instrument or equipment does not constitute a hazard to the aircraft.

An aircraft with inoperative instruments or equipment as provided in paragraph (d) of this section is considered to be in a properly altered condition acceptable to the Administrator.

(e) Notwithstanding any other provision of this section, an aircraft with inoperable instruments or equipment may be operated under a special flight permit issued in accordance with §§ 21.197 and 21.199 of this chapter.

91.213

MEL = An FAA approved listing of instruments / equipment that may be inoperable and remain airworthy

WITHOUT an MEL Follow the flow provided in AC 91-67

Is it required by the aircraft's equipment list or the kinds of equipment list?

Is it required by the VFR type certificate requirements prescribed in the airworthiness certification requirements?

Is it required by an AD?

Is it required by FAR § 91.205, § 91.207, etc.?

If no, the inoperative equipment must be removed or deactivated and placarded as inoperative

§ 91.405 - Inoperative equipment must be repaired, replaced, removed at the next required inspection

Ultimately, the PIC decides whether the equipment creates a hazard for the anticipated flight

KOEL

The Kinds of Operations Equipment List (KOEL) is a list of equipment installed in an aircraft that specifies for which kinds of operations a specific piece of equipment is required.

The KOEL is used as part of the process of determining if an aircraft with inoperative equipment is airworthy.

The KOEL is typically published by the aircraft manufacturer as part of the Limitations section of the Airplane Flight Manual (AFM) or Pilot's Operating Handbook (POH).

SECTION 2 OPERATING LIMITATIONS

CESSNA
MODEL 182T NAV III
GFC 700 AFCS

KINDS OF OPERATIONS EQUIPMENT LIST

System, Instrument, Equipment and/or Function	KIND OF OPERATION				COMMENTS
	V F R D A Y	V F R N I G H T	I F R D A Y	I F R N I G H T	
PLACARDS AND MARKINGS					
182T Nav III - GFC 700 AFCS POH/AFM	1	1	1	1	Accessible to pilot in flight.
Garmin G1000 Cockpit Reference Guide	1	1	1	1	Accessible to pilot in flight.
AIR CONDITIONING					
1 - Forward Avionics Fan	1	1	1	1	
2 - PFD Fan	0	0	0	0	
3 - MFD Fan	0	0	0	0	
4 - Aft Avionics Fan	1	1	1	1	
COMMUNICATIONS					
1 - VHF COM	0	0	1	1	
ELECTRICAL POWER					
1 - 24V Main Battery	1	1	1	1	
2 - 28V Alternator	1	1	1	1	
3 - 24V Standby Battery	0	*	*	*	* Refer to Note 1.
4 - Main Ammeter	1	1	1	1	
5 - Standby Ammeter	0	*	*	*	* Refer to Note 1.

91.509

§ 91.509 Survival equipment for overwater operations.

(a) No person may take off an airplane for a flight over water more than 50 nautical miles from the nearest shore unless that airplane is equipped with a life preserver or an approved flotation means for each occupant of the airplane.

(b) Except as provided in paragraph (c) of this section, no person may take off an airplane for flight over water more than 30 minutes flying time or 100 nautical miles from the nearest shore, whichever is less, unless it has on board the following survival equipment:

- (1) A life preserver, equipped with an approved survivor locator light, for each occupant of the airplane.
- (2) Enough life rafts (each equipped with an approved survival locator light) of a rated capacity and buoyancy to accommodate the occupants of the airplane.
- (3) At least one pyrotechnic signaling device for each life raft.
- (4) One self-buoyant, water-resistant, portable emergency radio signaling device that is capable of transmission on the appropriate emergency frequency or frequencies and not dependent upon the airplane power supply.
- (5) A lifeline stored in accordance with § 25.1411(g) of this chapter.

91.509

(c) A fractional ownership program manager under subpart K of this part may apply for a deviation from paragraphs (b)(2) through (5) of this section for a particular over water operation or the Administrator may amend the management specifications to require the carriage of all or any specific items of the equipment listed in paragraphs (b)(2) through (5) of this section.

(d) The required life rafts, life preservers, and signaling devices must be installed in conspicuously marked locations and easily accessible in the event of a ditching without appreciable time for preparatory procedures.

(e) A survival kit, appropriately equipped for the route to be flown, must be attached to each required life raft.

(f) As used in this section, the term shore means that area of the land adjacent to the water that is above the high water mark and excludes land areas that are intermittently under water.

For More
Detailed Info

See PHAK FAA-H-8083-25B 10

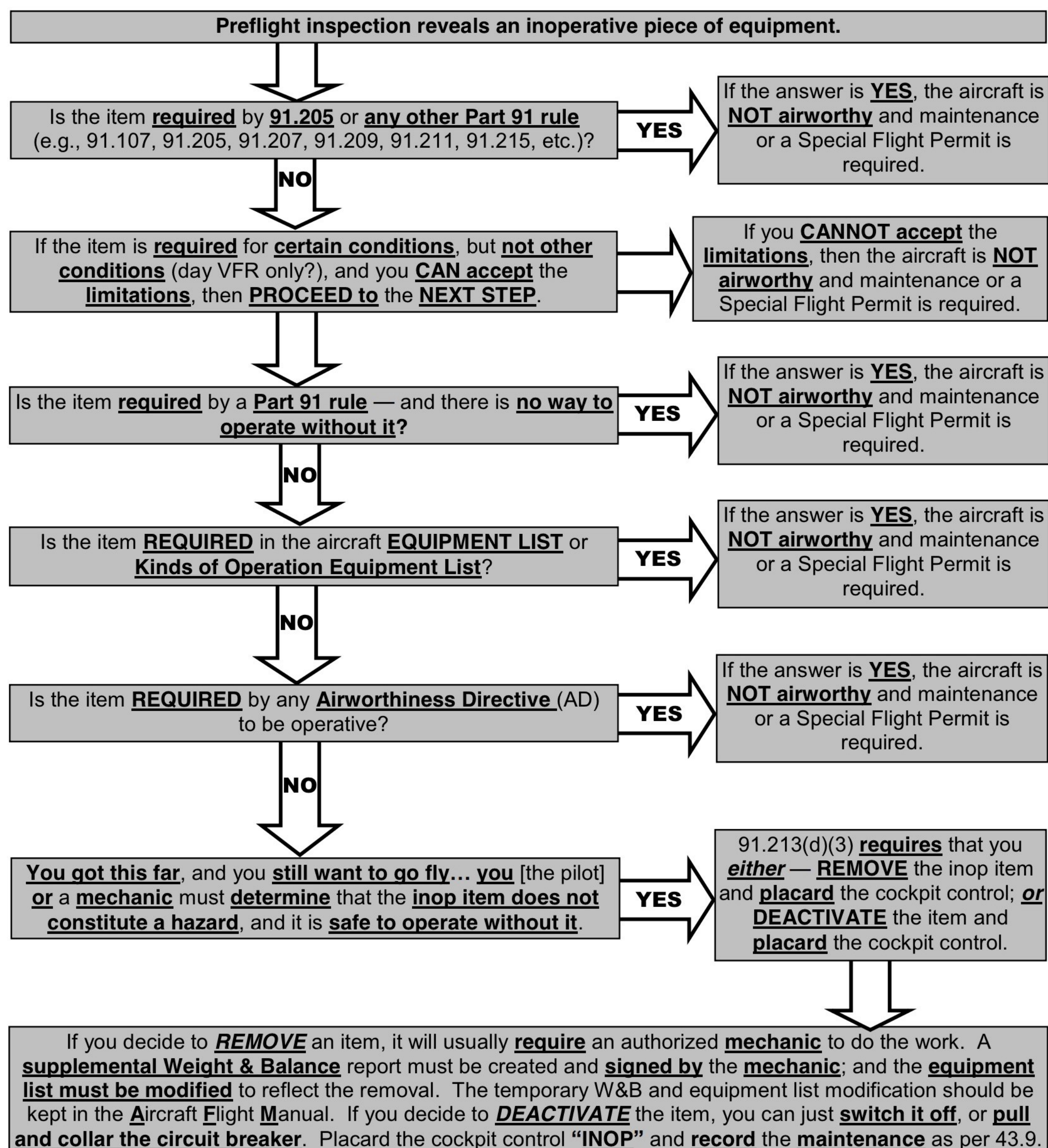


Any questions I can answer or
follow up later on?

Operating **WITHOUT** a Minimum Equipment List: (AC 91-67)

MEL RESTRICTIONS — Operators of **SMALL** rotorcraft, **NONTURBINE POWERED** small single and multiengine airplanes [**12,500 pounds or less**], and other aircraft for which a MMEL has been developed, **may elect** to **operate WITH** a **MEL** — **OR** — under the provisions of **FAR § 91.213(d)** [**WITHOUT** a **MEL**]. However, the **latter option does not apply if** the aircraft **has an MEL approved under FAR Parts 121, 125, 129, or 135**. For example, an owner has leased an aircraft to an air carrier operator, and the air carrier operator has applied for and received an approved MEL for FAR Part 135 operations. **Compliance with** such a **MEL** is **mandatory, even during FAR Part 91 operations**. If the operator wants to operate under FAR § 91.213(d), the operator would have to surrender the MEL authorization.

DECISION PROCESS WHEN OPERATING **WITHOUT** a MEL:



Airplane Antennas

VHF between wings

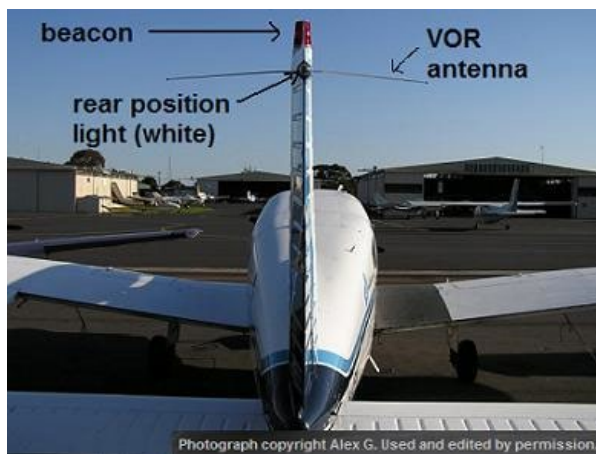
VOR on tail

ELT between wings and tail

GPS flat one between wings

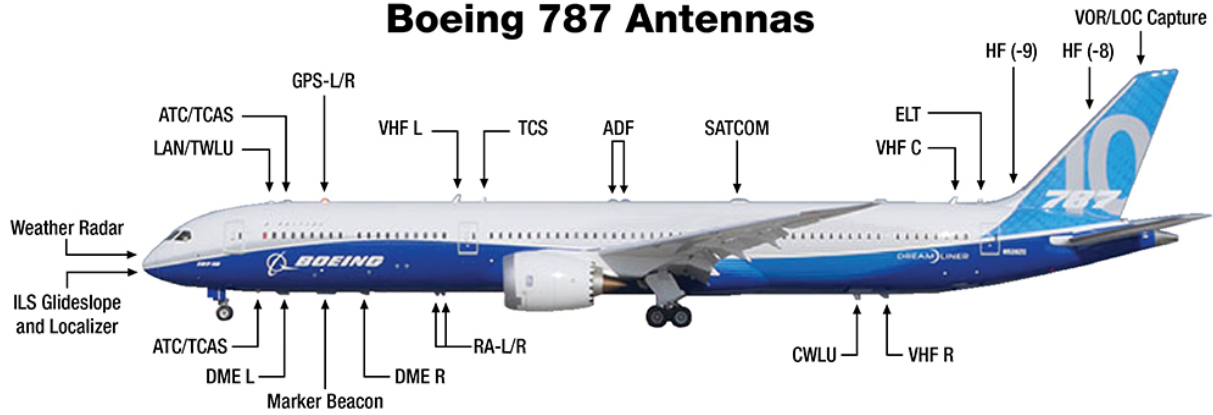
Transponder on bottom

ADF long wire connecting wings to tail



Airplane Antennas

Boeing 787 Antennas



- **LAN/TWLU** Terminal wireless local area network (LAN) unit
- **ATC/TCAS** Air traffic control/traffic collision and avoidance system
- **DME** Distance measuring equipment
- **RA** Radio altimeter

- **GPS** Global positioning system
- **TCS** Terminal cellular system
- **ADF** Automatic direction finder
- **CWLU** Crew wireless LAN unit

- **ELT** Emergency locator transmitter
- **HF** High-frequency radio
- **VOR** VHF omni-directional ranging

Source: Boeing

Transponders



Lesson Objective

To develop understanding of transponders more in depth
Atlanta Approach: “N123AB squawk 4321...radar contact...”

Modes and Codes

Mode A

Civil Mode A is identical to military Mode 3.

Mode A responds to an ATC interrogation signal with the transponder code set by the pilot.

Mode C

Refers to aircraft equipped with an altitude encoder and altimeter.

With Mode C, ATC will actually see the flight level altitude on their radar screen if the transponder is operating in the Mode C or "ALT" (altitude) Mode.

Mode S

Mode S is a possible platform for a variety of other applications, such as Traffic Information Service (TIS), Graphic Weather Service, and Automatic Dependent Surveillance-Broadcast (ADS-B).

Under ADS-B, each aircraft periodically broadcasts its identification, position, and altitude.

Overall, Mode S provides improved surveillance quality, discrete aircraft addressing function, and digital capability.

Squawk Codes

1200 = Visual Flight Rules (VFR)

1202 = Gliders

7500 = Hijack

7600 = Communications failure

7700 = Emergency

7777 = military intercept code

75 My passenger wants to drive

76 The radio needs a fix

77 We're all going to heaven

Transponder Equipment Suffixes

For filing VFR/IFR plans

/U = Transponder with Mode C DME

/P = Transponder with Mode C AREA NAVIGATION (RNAV)

/E = Flight Management System (FMS) with DME/DME and IRU position updating

/F = FMS with DME/DME position updating

/G = Global Navigation Satellite System (GNSS), including GPS or Wide Area Augmentation System (WAAS), with en route and terminal capability.

/R = Required Navigational Performance (RNP). The aircraft meets the RNP type prescribed for the route segment(s), route(s) and/or area concerned.

Mode C Required

Operations within Class A, Class B, and Class C airspace.

Operations within 30 nautical miles of the primary airport within Class B airspace from the surface to 10,000 feet MSL.

Operations above the ceiling and within the lateral boundaries of Class B and C airspace.

Operations above 10,000 feet MSL in the contiguous 48 states, excluding the airspace at and below 2,500 feet AGL.

Into or out of the United States, or into, within, or across an ADIZ designated unless operating a transponder with Mode C. (FL to Bahamas)

Flying into a Mode C Veil without a Transponder

For flying into a Mode C veil without an operable transponder, the pilot needs to telephone the appropriate radar facility for the Class B airspace and ask for permission to make the flight. Upon agreeing to conditions (including direction of flight and altitude), the pilot will be given a code number that he will mention to the controller upon initial radio contact. This is the same procedure that a pilot with an inoperative transponder/encoder would use to fly in or out of the Mode C-veil airports for avionics repair.

Testing

According to 14 CFR 91.413, a transponder may not be used for the above purposes unless, within the preceding 24 calendar months, the ATC transponder has been tested and inspected and found to comply with appendix F of FAR Part 43.

ATC Transponder Phraseology

Squawk = Enter designated code given.

Ident = Engage the "IDENT" feature on the transponder.

Squawk and Ident = Operate transponder on designated code in Mode A and engage the "IDENT" feature.

Squawk Standby = Switch transponder to "STANDBY" or "SBY" position.

Squawk Altitude = Active Mode C with automatic altitude reporting. Typically this is the "ALT" option.

Stop Altitude Squawk = Turn off altitude reporting switch and continue transmitting Mode C framing pulses. If your equipment does not have this capability, turn off Mode C.

Stop Squawk = Switch off transponder.

Squawk Mayday = Operate transponder in the emergency position (7700).

Squawk VFR = Operate transponder on code 1200.



Any questions I can answer or
follow up later on?

Airplane Weight and Balance



Lesson Objective

To develop understanding of loading and operating the aircraft to ensure its weight is within the allowable max limit and the center of gravity (CG) is within the allowable range.

Car vs Plane



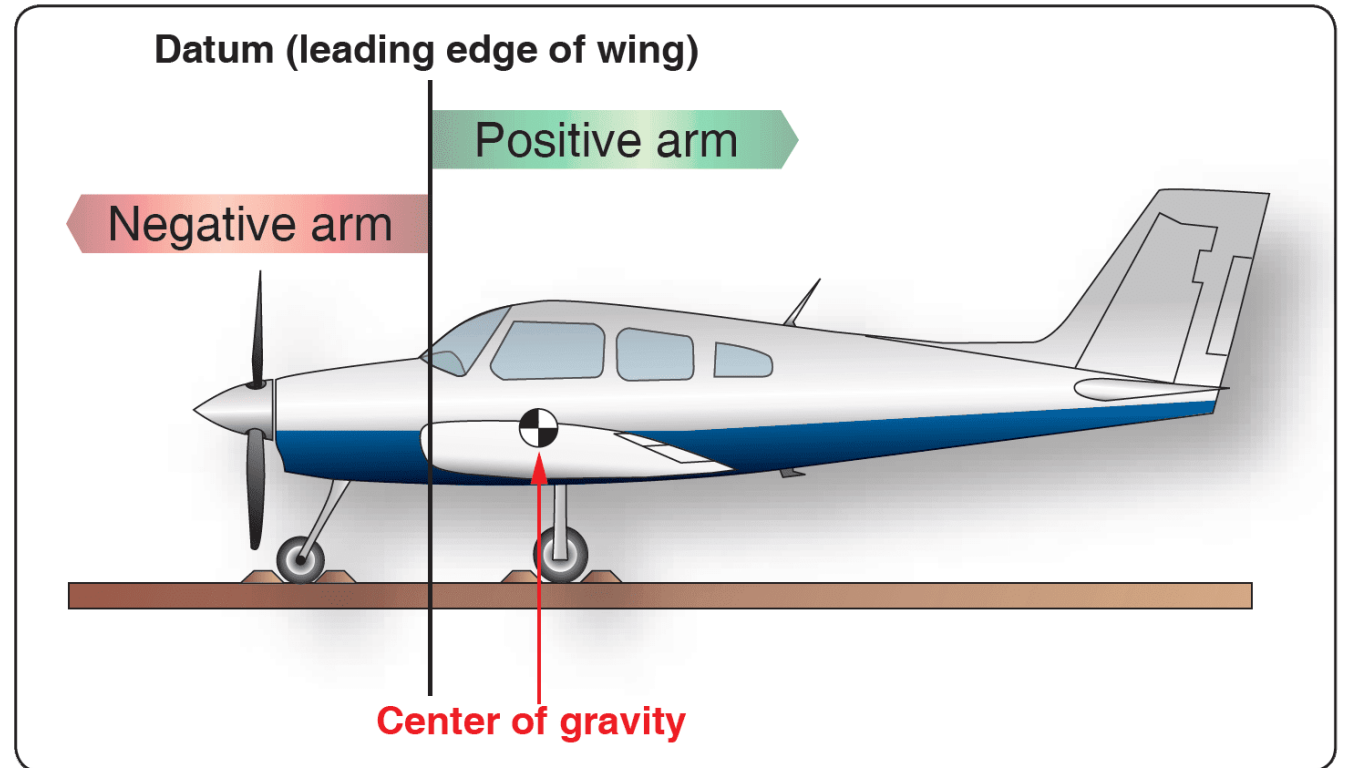
General Concepts



Arm

The arm is usually measured and expressed in inches and refers to the horizontal distance between the CG of an item or object and the datum, a point from where all measurements are taken.

Datum & Arms +/-



The datum is an imaginary vertical plane from which all horizontal distances are measured for balance purposes.

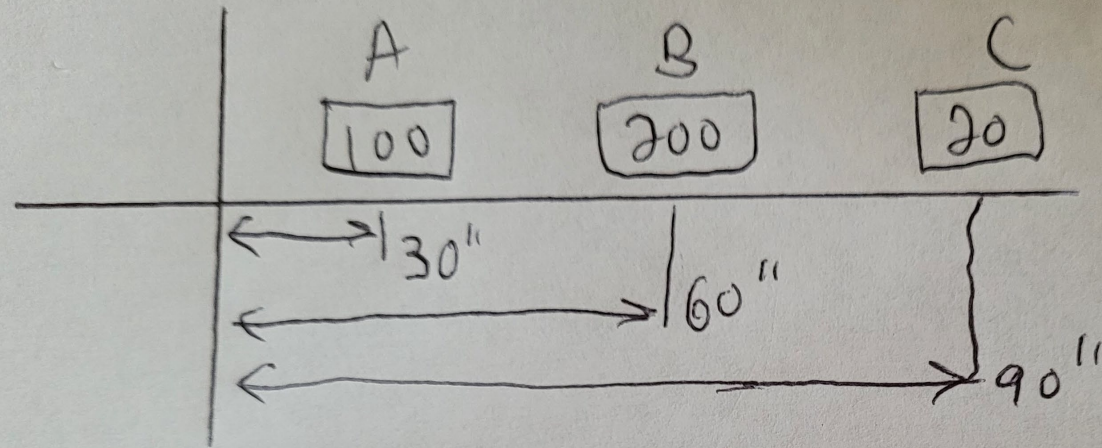
The position of the reference datum varies by aircraft design and manufacturer.

Moment

A moment is a force that tries to cause rotation and is the product of the arm, in inches, and the weight, in pounds.

Moments are generally expressed in pound-inches (lb-in) and may be either positive or negative.

Moment = weight x arm



datum A $100 \text{ lbs} \times 30'' = 3000 \text{ lbs inches}$

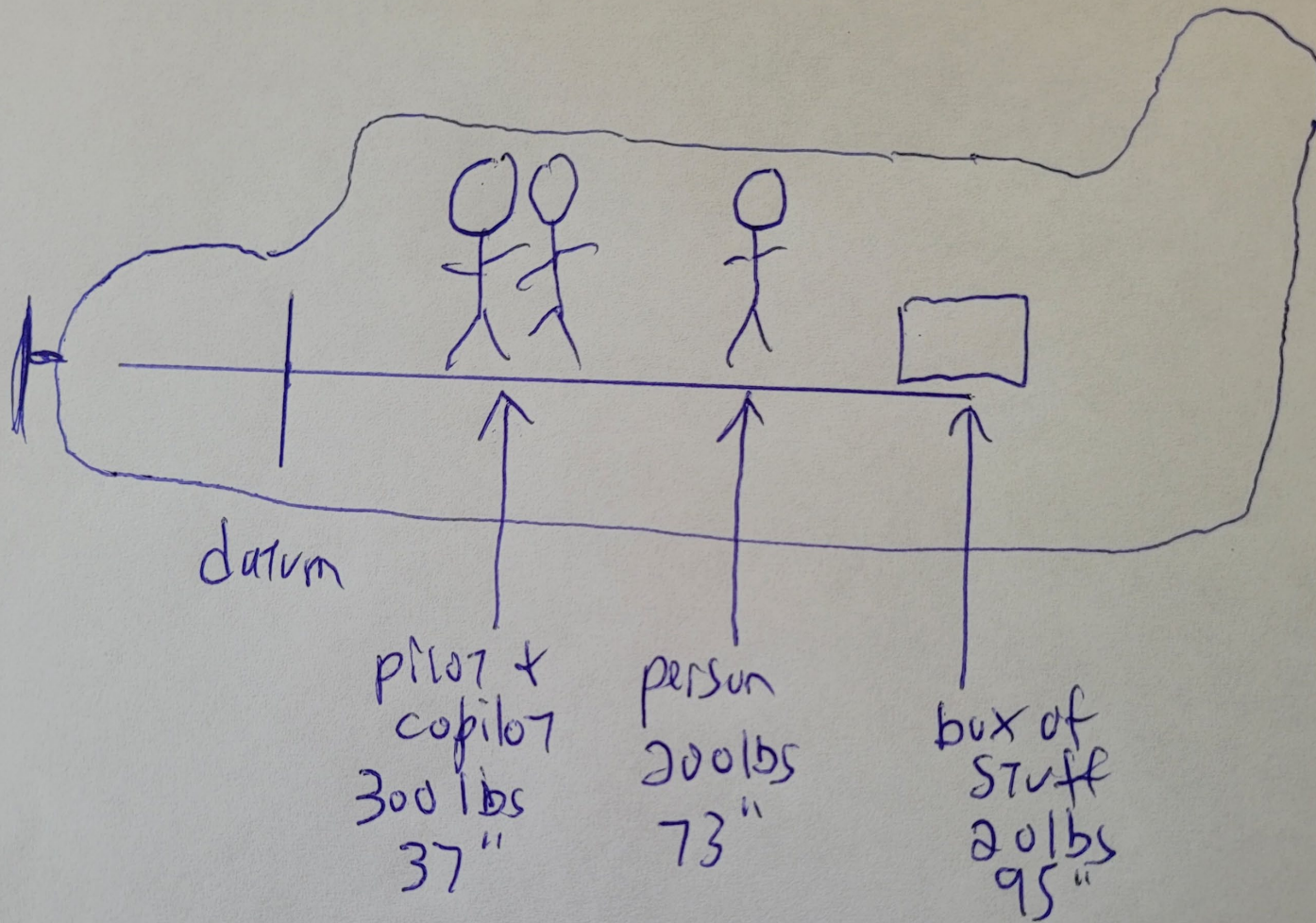
B $200 \text{ lbs} \times 60'' = 12000 \text{ lbs inches}$

C $20 \text{ lbs} \times 90'' = 1800 \text{ lbs inches}$

Total weight
320 lbs

16800 lbs
Total Moment

Moment



$$\begin{aligned} 300 \text{ lbs} \times 37" &= 11100 \text{ lbs"} \\ 200 \text{ lbs} \times 73" &= 14600 \text{ lbs"} \\ 20 \text{ lbs} \times 95" &= 1900 \text{ lbs"} \end{aligned}$$

Moment

Center of Gravity

Center of gravity (CG), or the point at which all of the weight of the aircraft is considered to be concentrated, must be maintained within the allowable range for the operational weight of the aircraft.

CG is where everything forward of it balances with everything behind it.

$CG = \text{Total moment(s)} / \text{Total weight}$

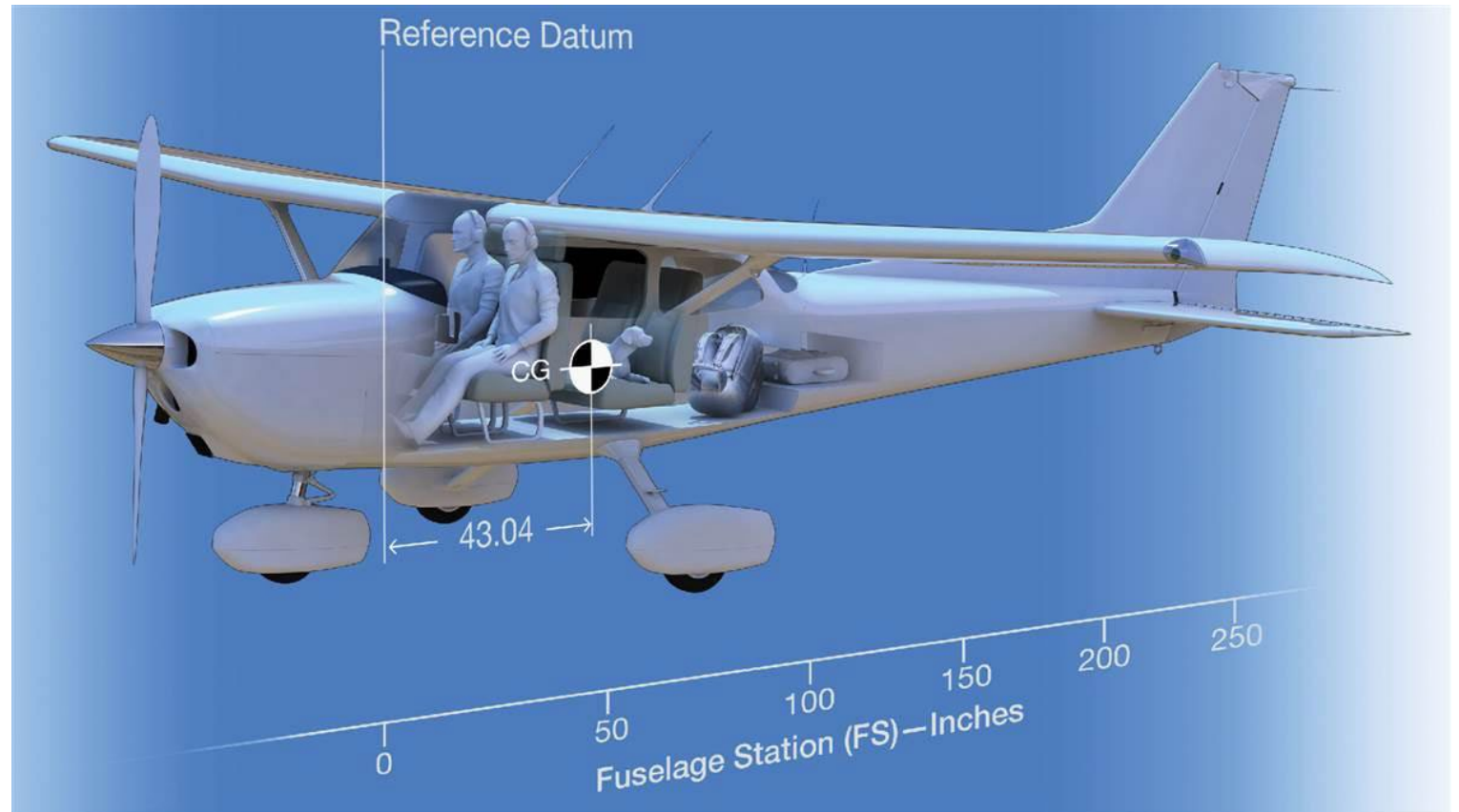
$\text{New CG} = ((\text{Total moments}) + \text{or} - (\text{change in moments})) / \text{New total weight}$

Center of Gravity

How can I picture CG with front loaded weight?

Walk around your yard with a sledgehammer

Center of Gravity



More Terms

Standard Empty Weight

The weight of an empty airplane including unusable fuel, full operating fluids (hydraulic fluids) and full engine oil.

Basic Empty Weight

Standard Empty Weight plus optional equipment. This is the starting point of weight and balance calculations.

Useful Load

Useful load is total usable fuel, people (pilots and passengers), cargo, and drainable fuel.

Equation: Maximum Ramp Weight - Basic Empty Weight = Useful Load

More Terms

Maximum Ramp Weight (Taxi Weight)

This is the maximum allowable weight mass for ground operations.

MRW assures acceptable ground maneuverability and includes fuel for taxi, run-up and start.

Maximum Takeoff Weight (MTOW)

Maximum allowable mass for the initiation of a takeoff roll.

Depending on how big your airplane is, you may have a variety of MTOWs limited by: structural limitations, runway distance, climb performance, or landing weight limits.

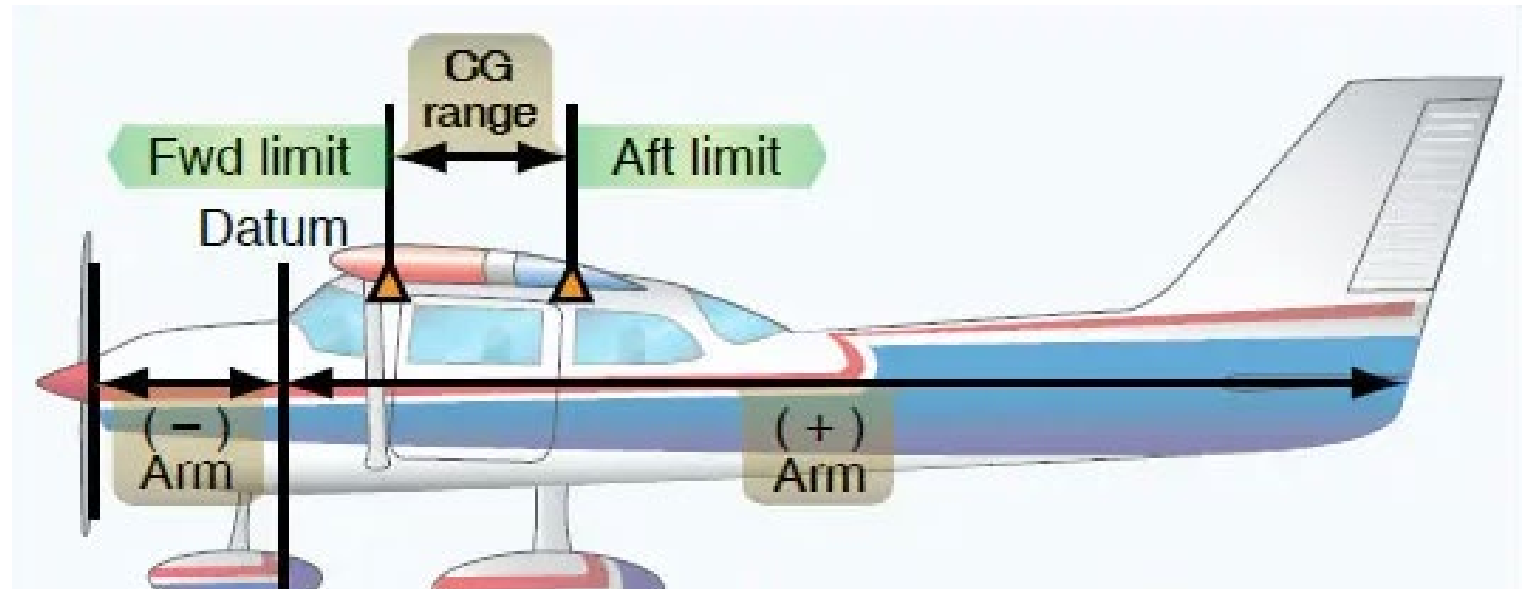
More Terms

Payload

Payload is the weight of passengers, cargo, and baggage.

Weight of passengers and stuff makes money...pilot weight does not.

Center of Gravity Limits



Forward Center of Gravity

The horizontal stabilizer has a long moment arm, the airplane will be very stable longitudinally, and resist any pitching moment.

The forward position of the CG is limited to ensure that the elevator has sufficient turning moment to overcome the nose-heaviness and excessive longitudinal stability, ensuring that you are able to rotate the airplane for takeoff and flare it for landing at relatively low airspeeds.

If you push down on the tail of most Cessna planes on the ground...then let go...they will naturally have the nose wheel come back down.

Think about how you carry a sledgehammer around the yard as an extreme example.

Forward Center of Gravity

Pro

More stable

Cons

Higher stall speed – will stall sooner

Slower cruise speed

Longer takeoff roll

Higher approach speed needed

Problems with flare

Aft Center of Gravity

The airplane will be tail-heavy and less stable longitudinally, because of the shorter moment arm from the CG to the CP.

There will be less distance from the CG to the tail so there will be less tail force.

Remember the tail is responsible for 2 of the 3 controls – pitch and yaw.

With a CG that is too far aft, the airplane will be difficult to control and tend to stall and/or spin more easily.

Should a spin occur, this could be impossible to recover.

Aft Center of Gravity

Pros

Lower stall speed – will take longer to stall

Higher cruise speed

Cons

Less stable

Recovery from a stall in any aircraft becomes progressively more difficult

Moving Weight

(Weight to be shifted / Total Weight)

=

(Change in CG / Distance)

Weight Loss

- During the flight fuel will be burned
- Flying jumpers

Line of Thrust

If an increase in power tends to make the nose of an airplane rise, this is a result of the line of thrust being below the CG.

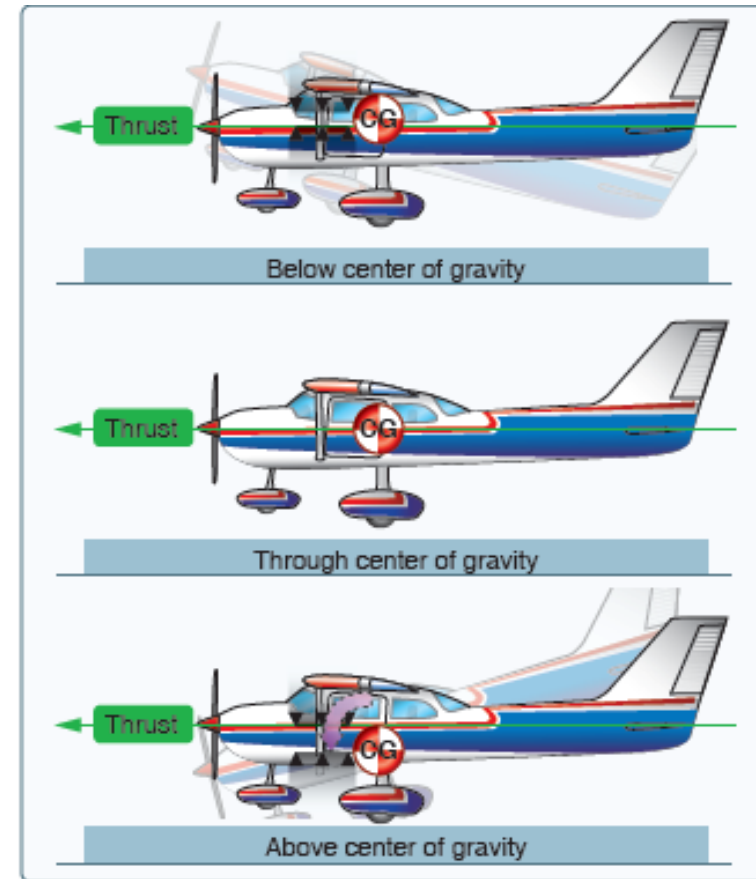


Figure 5-26. Thrust line affects longitudinal stability.

Center of Pressure

The average of the pressure variation for any given AOA is referred to as the center of pressure (CP).

Aerodynamic force acts through this CP.

At high angles of attack, the CP moves forward, while at low angles of attack the CP moves aft.

Center of Pressure

The designers determine how far the center of pressure (CP) will travel.

It is important to understand that an aircraft's weight is concentrated at the CG and the aerodynamic forces of lift occur at the CP.

When the CG is forward of the CP, there is a natural tendency for the aircraft to want to pitch nose down.

If the CP is forward of the CG, a nose up pitching moment is created.

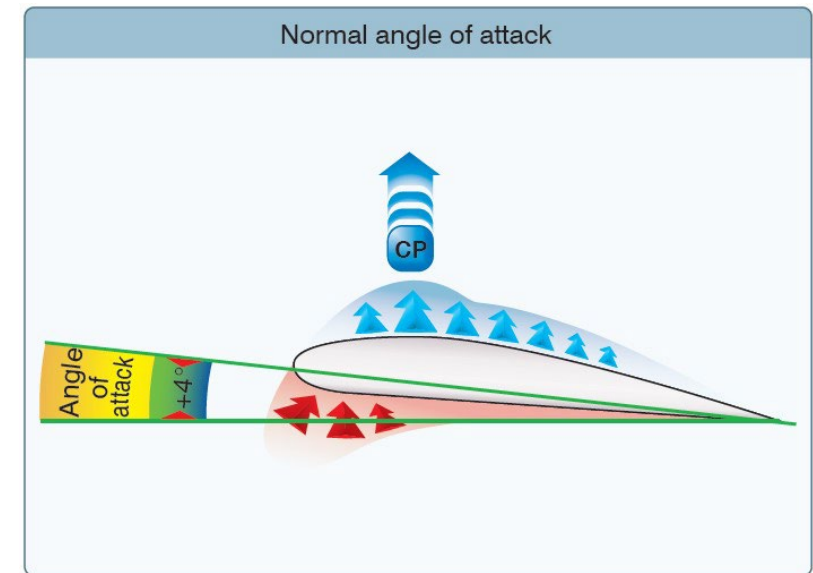
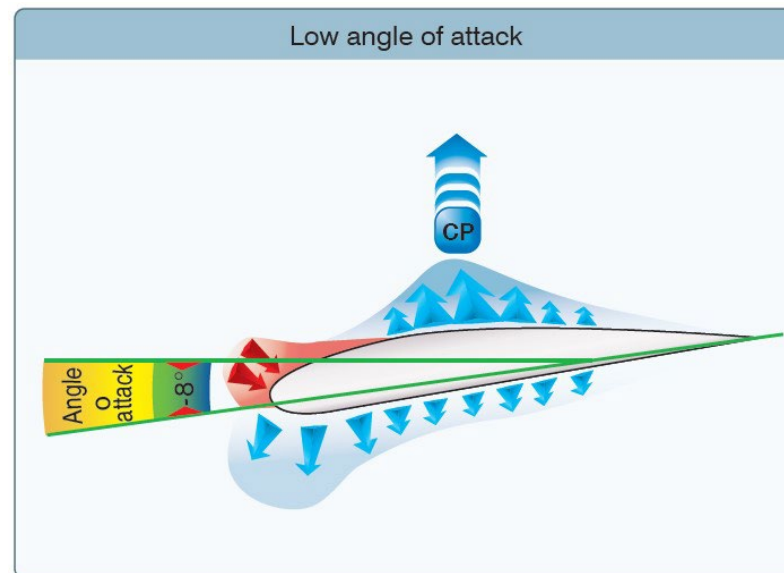
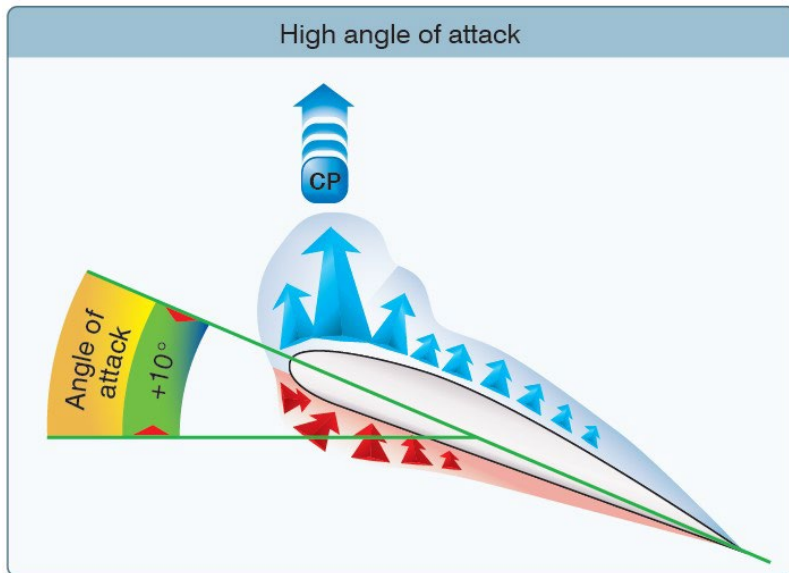
Therefore, designers fix the aft limit of the CG forward of the CP for the corresponding flight speed in order to retain flight equilibrium.

Center of Pressure

When the angle of attack (AOA) of a symmetrical airfoil is increased, the CP will remain unaffected.



Center of Pressure



Calculations

ITEM	WEIGHT	ARM	MOMENT
Empty weight	1668.1	40.8	68059.4
Fuel (gals. x 6)	300	47.9	14370
Left front seat	160	37	5920
Right front seat	140	37	5180
Rear seat	20	73	1460
Baggage Area 1	10	95	950
Baggage Area 2			
TOTAL	2300	41.71	95939.4

Center of Gravity (c.g.) =

In limits: Yes No

moment/1000

95.94
pound-inches

page 6-15 POH
July 8/98

6-16 May 30/00

In Normal limits

Calculations

ITEM	Weight	Arm	Moment
Basic Empty Weight	1718	41.08	70575.44
Pilot 1	140	37	5180
Pilot 2	160	37	5920
Basic Condition	2018	CG: 40.47	81675.44
Passenger 1		73	0
Passenger 2		73	0
Baggage Area 1	20	95	1900
Baggage Area 2		123	0
Zero Fuel Condition	2038	CG: 41.01	83575.44
Fuel Load	50 x 6 = 300	47.9	14370
Ramp Condition	2338	CG: 41.89	97945.44
Fuel Burned On Ground(-)	x 6 = 0	47.9	-0
TakeOff Condition	2338	CG: 41.89	97945.44
Fuel Burned During Flight(-)	x 6 = 0	47.9	-0
Landing Condition	2338	CG: 41.89	97945.44

Maneuvering Speed (V_A) :

V_A @ Max Gross Weight

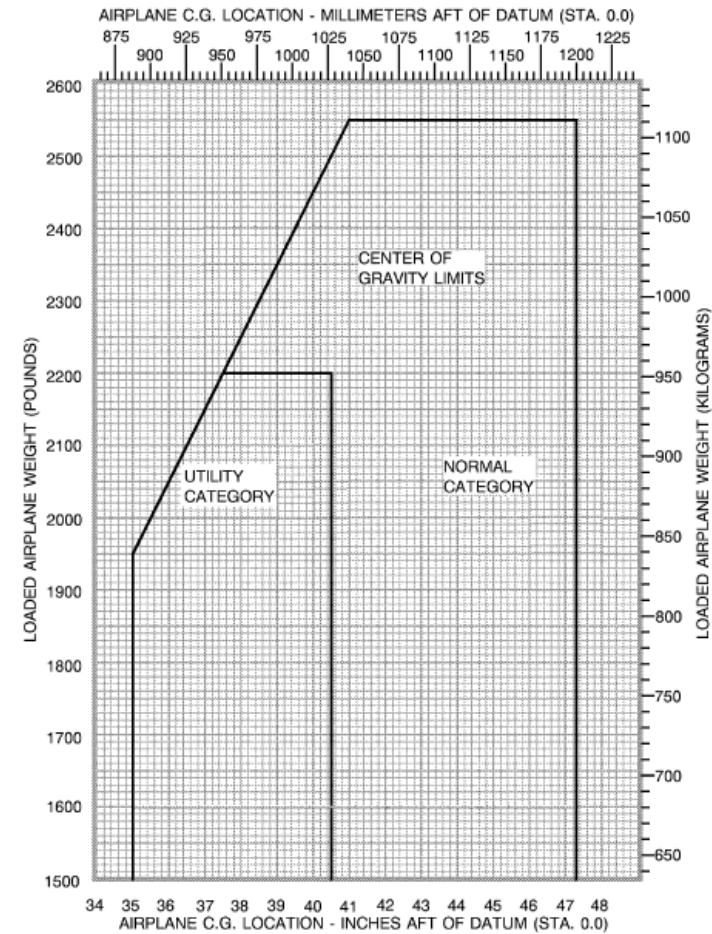
97

Aircraft Weight :

Max Gross Weight :

2550

Check the Chart



0585C1008

Figure 6-8. Center of Gravity Limits

Another Way

A	B	C	D	E
	Weight	Arm	Moment/1000	
Empty Plane	1933		62	
Gas (75 gal)	440		21	minus taxi
Gary	140	37	5.18	
Front Passenger(s)	200	37	7.4	
Back Passenger(s)	250	74	18.5	
Stuff in back	20	97	1.94	
	2983		116.02	

Chart for C182RG

6-12

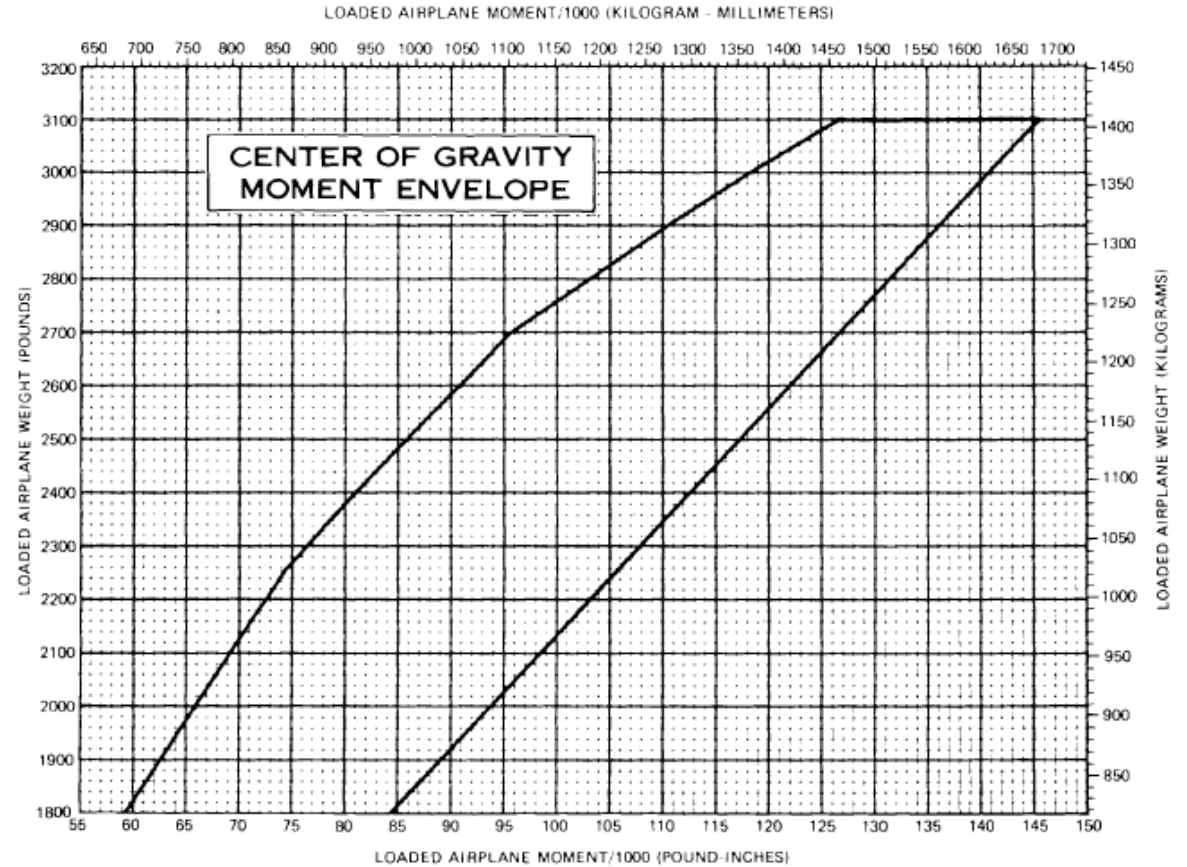


Figure 6-7. Center of Gravity Moment Envelope

Note

All of the numbers for calculations are from that exact tail number...not the model/type

Issues from Overloading

- Required takeoff speed is increased
- Takeoff roll is increased
- Landing roll is increased
- Rate and angle of climbed are reduced
- Service ceiling is reduced
- Cruising speed is reduced
- Cruising range is reduced
- Maneuverability is reduced

Misc to discuss

- 4 Seats in a Cessna 172...so me the wife and our friends?
- Cessna 172/182 vs Bonanza with 4 seats
- CAP fill to tabs rule
- CAP standard is 182 now
- That PDK flight...



Just fill er up

Ever Seen American Made? <https://youtu.be/2XmLLBZnvDg&t=75s>



Effect of Weight on Flight Performance

The takeoff/climb and landing performance of an aircraft are determined on the basis of its maximum allowable takeoff and landing weights.

A heavier gross weight results in a longer takeoff run and shallower climb, and a faster touchdown speed and longer landing roll.

Even a minor overload may make it impossible for the aircraft to clear an obstacle that normally would not be a problem during takeoff under more favorable conditions.

Effect of Weight on Stability and Controllability

Overloading also affects stability.

An aircraft that is stable and controllable when loaded normally may have very different flight characteristics when overloaded.

Although the distribution of weight has the most direct effect on this, an increase in the aircraft's gross weight may be expected to have an adverse effect on stability, regardless of location of the CG.

The stability of many certificated aircraft is completely unsatisfactory if the gross weight is exceeded.

An Exercise in W&B

Bob weighs 200 pounds he has the pilot certificate

His wife Sally weighs 120 pounds...she likes sitting in the back seat

Plane is a C172 with 1717 empty weight with an arm of 41.63

53 Gallons usable at arm 48

They want to bring 300 pounds of camping stuff



Now the Deep Dive



Effect of Load Distribution

The effect of the position of the CG on the load imposed on an aircraft's wing in flight is significant to climb and cruising performance. An aircraft with forward loading is “heavier” and consequently, slower than the same aircraft with the CG further aft.

PHAK Figure 5-63 illustrates why this is true. With forward loading, “nose-up” trim is required in most aircraft to maintain level cruising flight. Nose-up trim involves setting the tail surfaces to produce a greater down load on the aft portion of the fuselage, which adds to the wing loading and the total lift required from the wing if altitude is to be maintained. This requires a higher AOA of the wing, which results in more drag and, in turn, produces a higher stalling speed.

Effect of Load Distribution

With aft loading and “nose-down” trim, the tail surfaces exert less down load, relieving the wing of that much wing loading and lift required to maintain altitude. The required AOA of the wing is less, so the drag is less, allowing for a faster cruise speed. Theoretically, a neutral load on the tail surfaces in cruising flight would produce the most efficient overall performance and fastest cruising speed, but it would also result in instability. Modern aircraft are designed to require a down load on the tail for stability and controllability. A zero indication on the trim tab control is not necessarily the same as “neutral trim” because of the force exerted by downwash from the wings and the fuselage on the tail surfaces.

Wing Loading

Wing Loading = MTOW / Wing Area

Piper Warrior => 14.3 lb/sq ft

Beechcraft Baron => 26 lb/sq ft

F-16 => 141.1 lb/sq ft

F-15 => 112 lb/sq ft

Airbus A360 => 140 lb/sq ft

Wing Loading

Wing loading is a useful measure of the stalling speed of an aircraft.

Wings generate lift owing to the motion of air around the wing.

Larger wings move more air, so an aircraft with a large wing area relative to its mass (i.e., low wing loading) will have a lower stalling speed.

Therefore, an aircraft with lower wing loading will be able to take off and land at a lower speed (or be able to take off with a greater load).

It will also be able to turn at a greater rate.

For More Detailed Info

See PHAK 5-43 to 5-44

See PHAK FAA-H-8083-25B 10

See Weight and Balance FAA-H-8083-1

See AC 120-27

LEARN TO FLY

CENTER

OF GRAVITY



WEIGHT AND BALANCE EXPLAINED





Any questions I can answer or
follow up later on?

Engine and Systems



Lesson Objective

To develop understanding of the components in the engine

Specs

Four horizontally opposed cylinders

Air cooled

Normally/Naturally aspirated

Direct drive

Specs

Continental or Lycoming O-360 / IO-360

360 cubic inches

O-360 carbureted series

IO-360 fuel-injected series

TO-360 turbocharged series

LTO-360 turbocharged left-hand rotation series

Normally /Naturally Aspirated

A naturally aspirated engine, also known as a normally aspirated engine, and abbreviated to N/A or NA, is an internal combustion engine in which air intake depends solely on atmospheric pressure and does not have forced induction through a turbocharger or a supercharger.

As a general rule, a naturally aspirated combustion engine will lose 3% of its power for every 1,000 ft of elevation gain.

If you have 100 horsepower at sea level by the time you get to 5,000 feet of elevation your engine is making 85 horsepower.

At 10,000 feet of elevation your engine will make 70 horsepower.

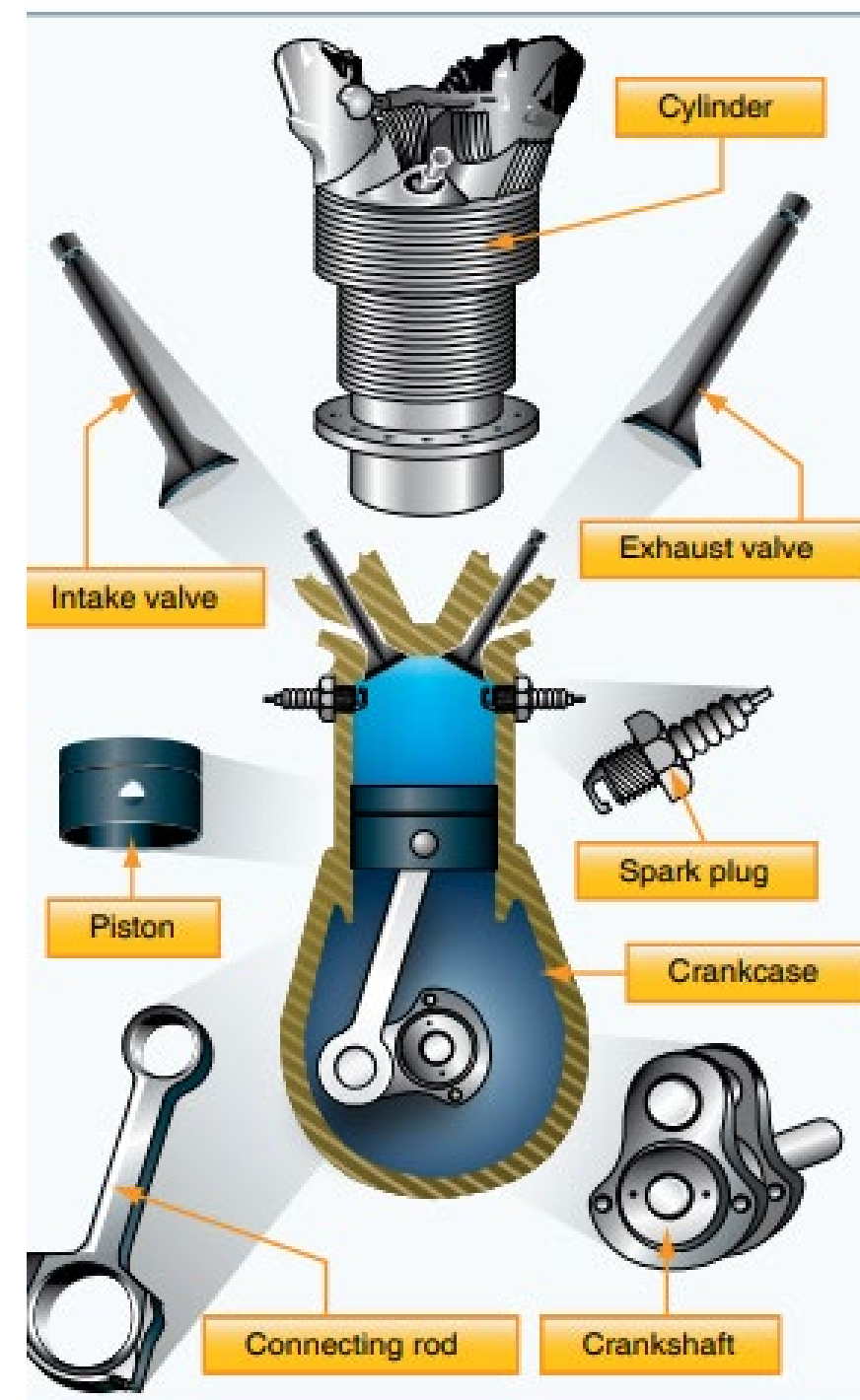
Cylinders

Each cylinder has one piston and two spark plugs.

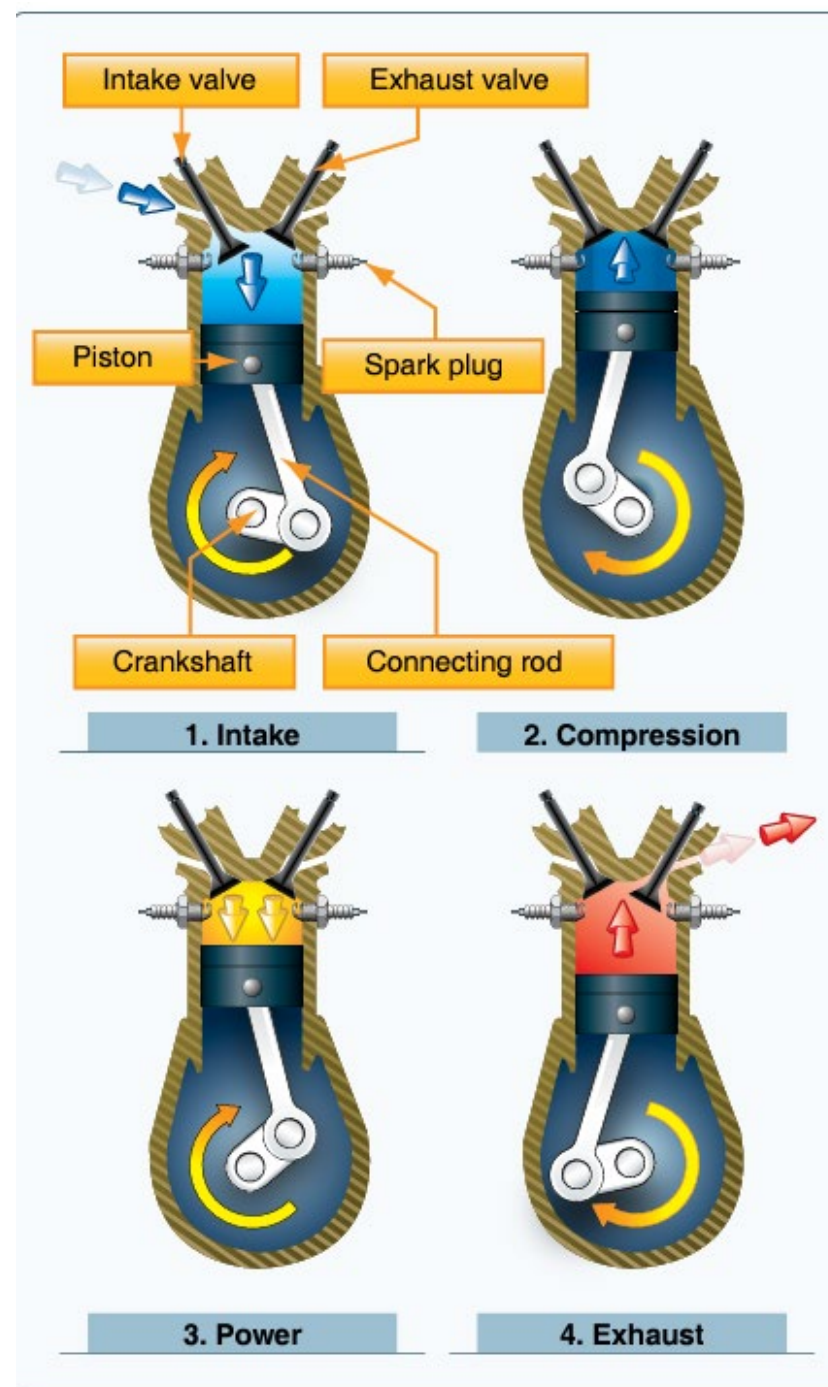
They each have an intake valve and an exhaust valve.

The intake valve is what feeds the cylinder with air and fuel when it opens.

The exhaust valve is connected to the aircraft exhaust, and it is where the burnt gasses exit the cylinder. This process happens for every other revolution.

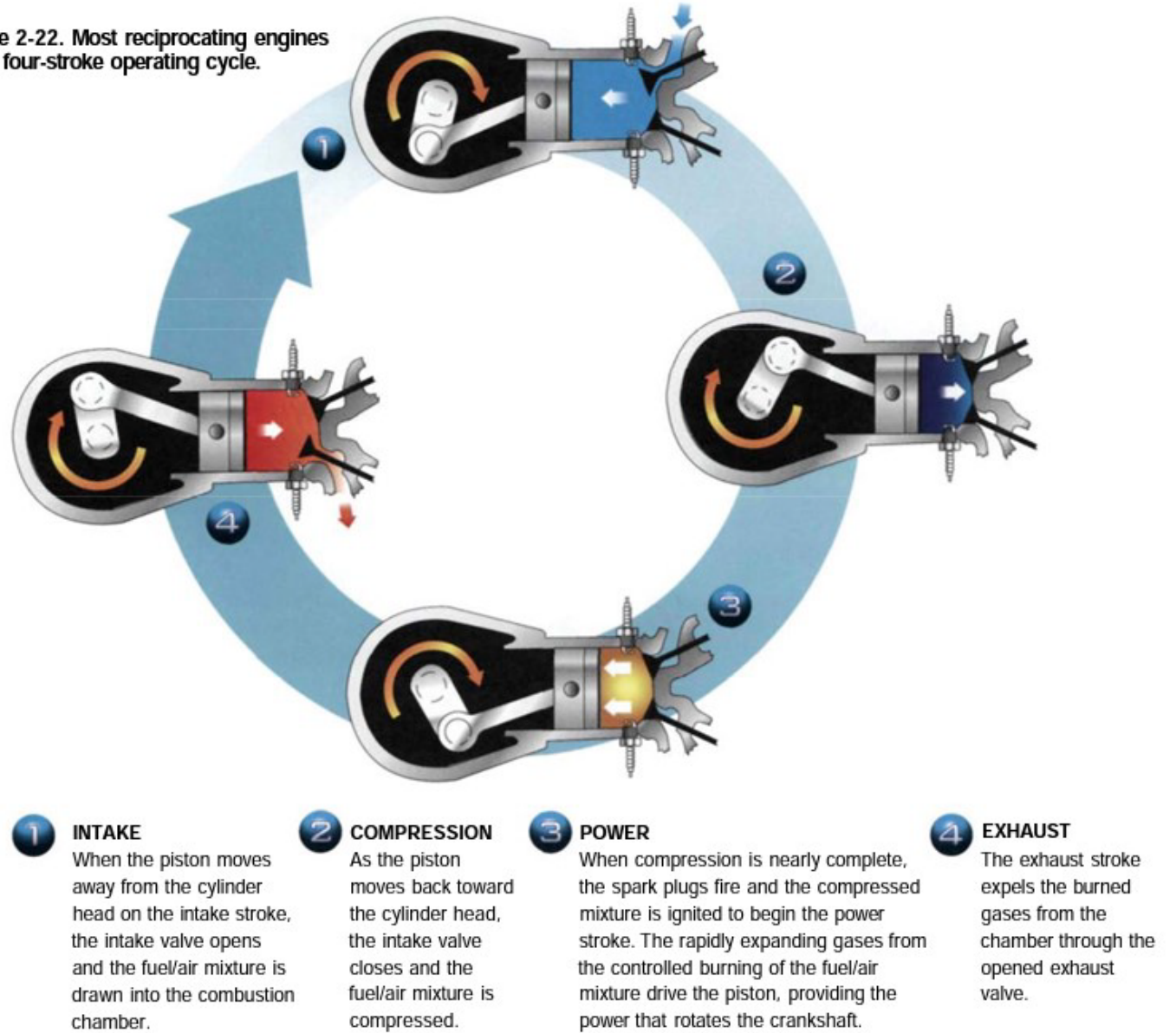


Cylinders



Cylinders

Figure 2-22. Most reciprocating engines use a four-stroke operating cycle.



Spark Plugs and Magnetos

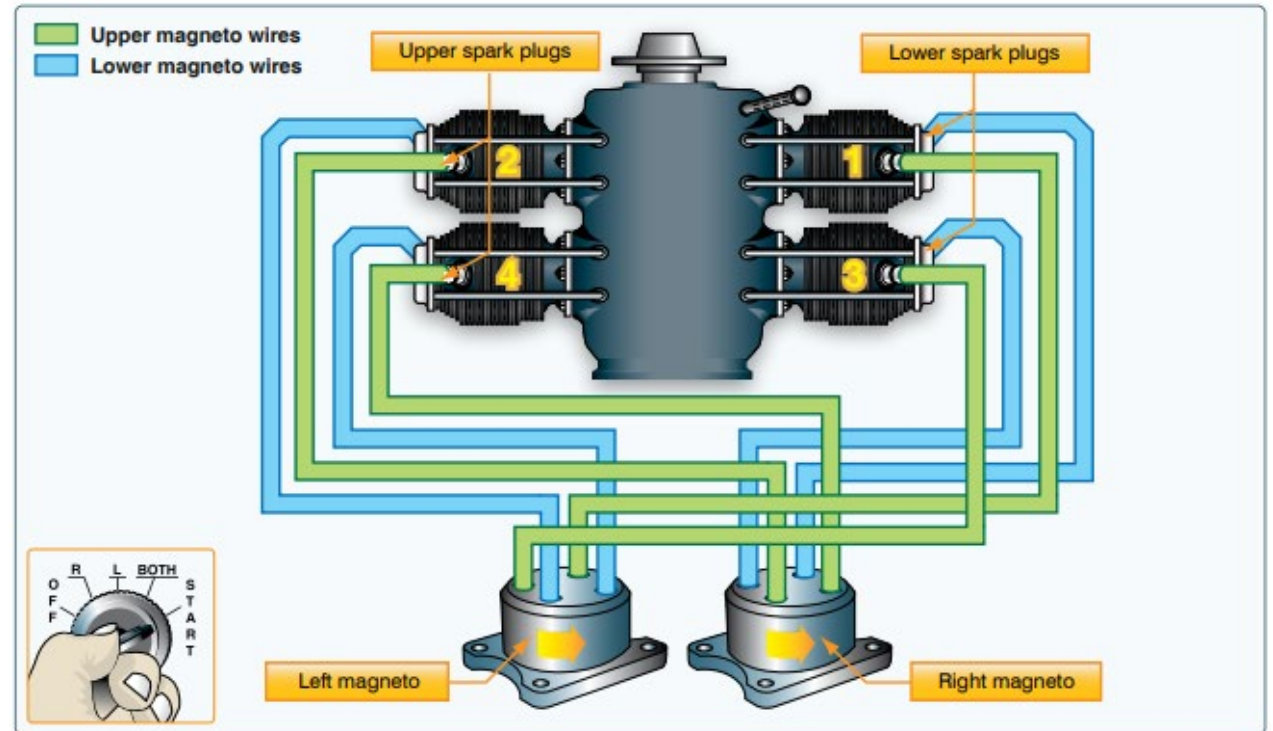
Each cylinder has two sparkplugs for redundancy and better performance.

There are a total of 8 sparkplugs.

Magnetos supply the power needed to cause a spark in the spark plugs.

We have two magnetos per engine.

Each magneto feeds one spark plug per engine so that in the event of a magneto failure, the remaining magneto can continue to provide the spark needed to keep the engine running.

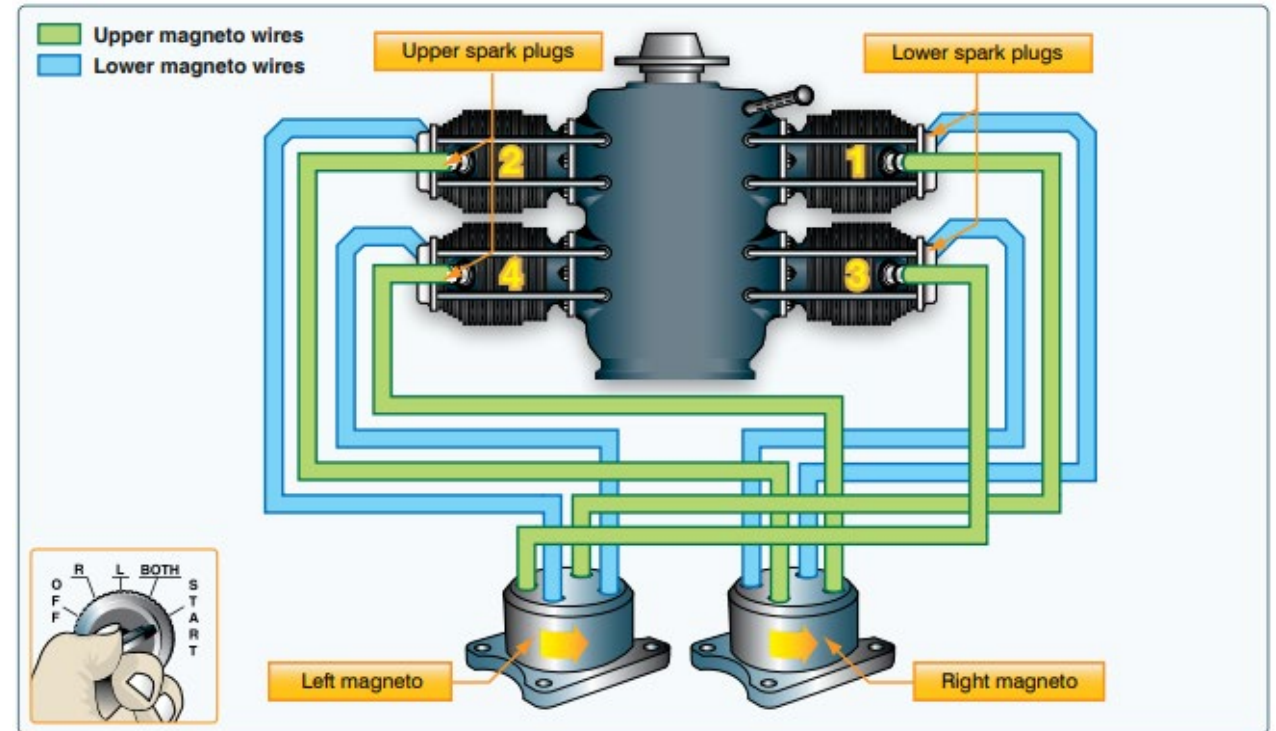


Spark Plugs and Magnetos

The magneto is engine-driven, meaning once the engine starts, it will continue to run until it quits.

A total loss of electrical power has no effect on the magnetos or the operation of the engine.

They use a permanent magnet to generate the electrical field needed.



Magneto Testing

Magneto Key Positions

Both: Both magnetos are active, providing power to the engine.

L: The left magneto is grounded (turned off), and the engine runs on the right magneto.

R: The right magneto is grounded, and the engine runs on the left magneto.

Grounding a Magneto

When a magneto is grounded, it's essentially turned off. This is typically achieved by connecting a grounding wire to a specific point on the magneto.

Why Ground a Magneto?

Troubleshooting: To determine if a specific magneto is functioning correctly.

Emergency Procedure: In case of a magneto failure, grounding the faulty one can allow the engine to continue running on the remaining magneto.

Preflight Check: As part of a preflight inspection, grounding each magneto individually can help verify their functionality.

<https://youtu.be/ZQ9Kmh.nz0ZY>



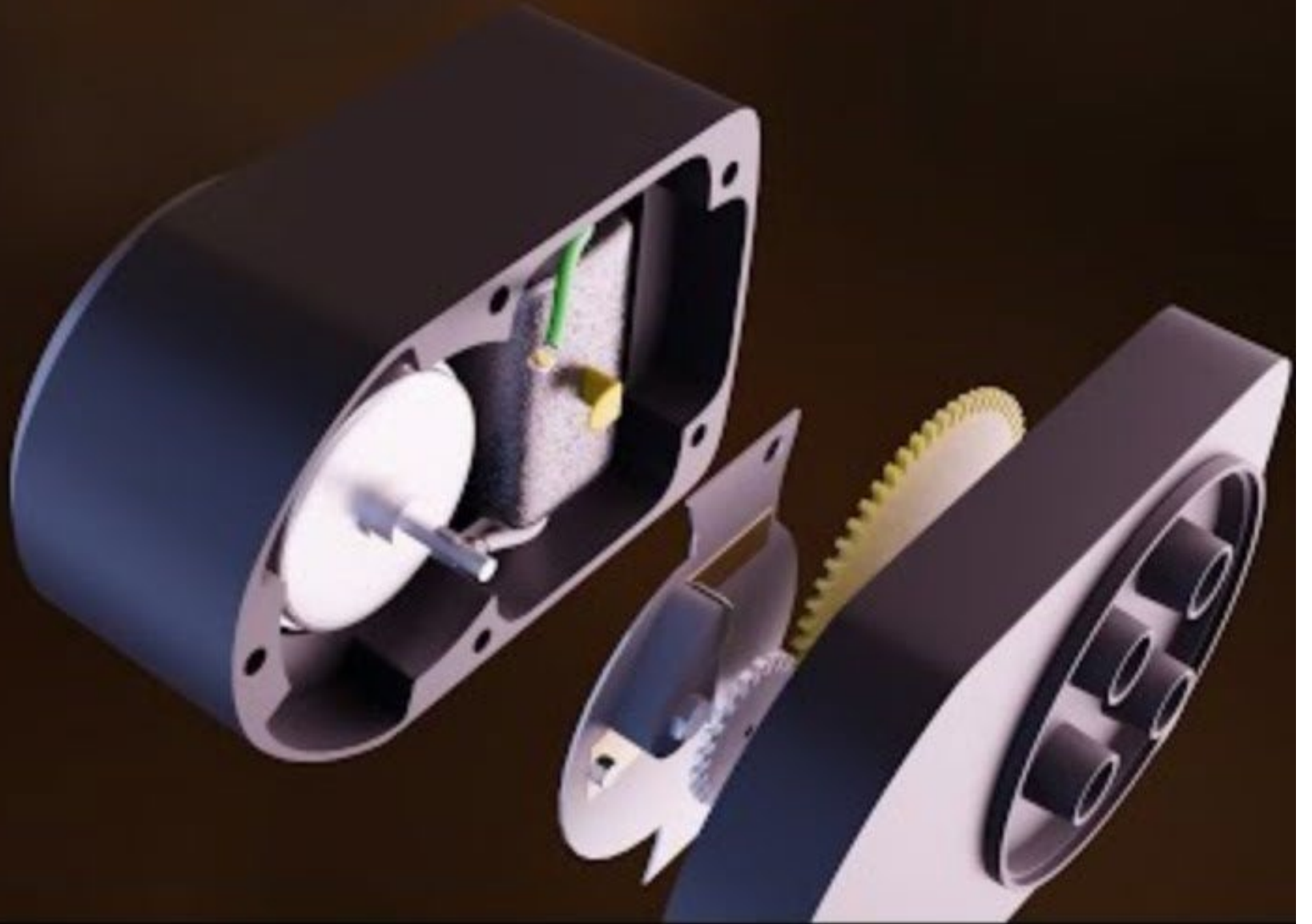
<https://youtu.be/vSAvx4aquHM>



https://youtu.be/dqt_pQSHuEA



Impulse Coupling



<https://youtu.be/9JnI8oN4h8I>





Detonation

Detonation, as the name suggests, is an explosion of the fuel-air mixture inside the cylinder. It occurs after the compression stroke near or after top dead center. During detonation, the fuel/air charge (or pockets within the charge) explodes rather than burning smoothly.

Detonation occurs when the engine is operated under conditions which cause the fuel mixture to burn instantaneously. Using low grade fuel can cause it.

Detonation occurs when the unburned charge in the cylinders explodes instead of burning normally.

If a pilot suspects that the engine is detonating during the climb out after a takeoff, the initial corrective action is to lower the nose slightly.

Lubrication

Four cycle engines are lubricated by forcing oil directly to the components requiring lubrication.

Without oil, the engine won't take you very far, that is why it is so important to always check the engine oil and never fly below the manufacture's recommendation. Here is what the oil does for us:

Lubricates engine parts which also prevents corrosion

Cools the engine by reducing friction

Removes heat from the cylinder and disperses the heat evenly provides a seal between the cylinder walls and the pistons and cleans contaminants that are later removed in oil changes

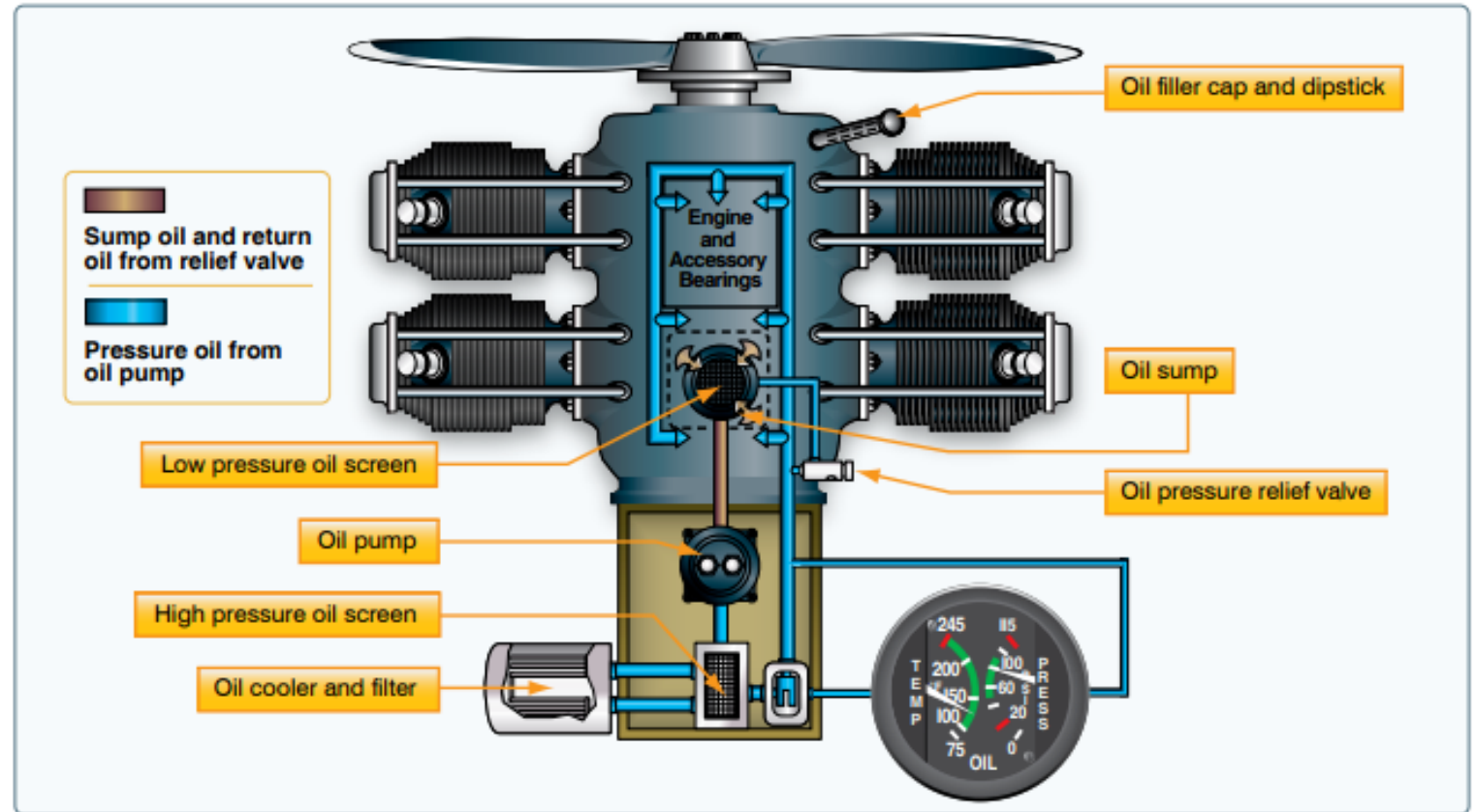
Lubrication

A common problem pilots face is faulty gauges.

We know that it is impossible for the engine to remain cool with no oil pressure, we can assume that the gauge has failed and can plan a diversion to the nearest suitable airport to troubleshoot the problem.

Now if we were to look at the engine gauges and the oil pressure is 0 psi and the oil temperature is rising, then a plan to land at the nearest airport should be made because a catastrophic engine failure is likely about to happen.

Lubrication



Vacuum Pump

The Vacuum pump is also engine drive.

It sucks filtered air from the cabin to run through vacuum instruments.

If the engine is a low RPM then there might not be enough vacuum suction to provide the gyros the energy they need to work properly.

Since the vacuum pump is engine-driven, it has a shear coupling that may cause damage to the engine if it fails.

Vacuum pumps are being phased out with the introduction of affordable digital, glass cockpit instruments.



Alternator

The alternator is also engine driven via a belt.

The alternator can provide electrical current to the electrical system at different RPMs.

Operating at low RPM's may cause a low voltage warning, which may be eliminated if/when RPM's increase.

Failure of the belt or the alternator will result in the electrical system using only the battery as a source of energy.

However, on a VFR flight, this could just mean you won't be able to communicate with Air Traffic Control (ATC) or operate the flaps, and gear (depending on the aircraft).



<https://youtu.be/PxEbCoYhLTM>



Starter

Before we had starters, airplanes had to be started by hand, or also known as hand propping.

Very dangerous, and tiring work if not done properly.

Starters are only used for starting, you could possibly be flying with a failed starter and have no clue. Once the engine is turning you don't need them anymore.

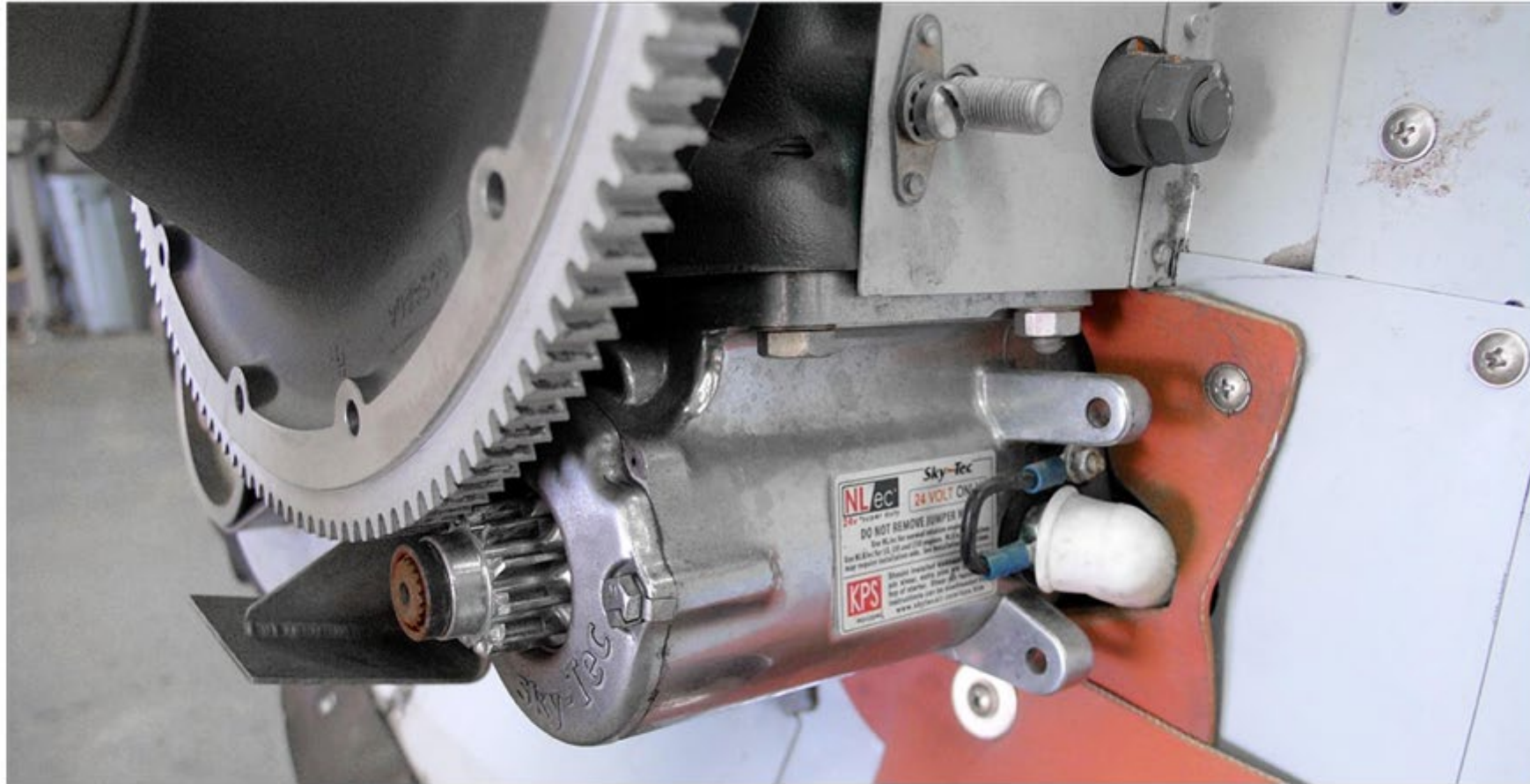
With that said it's important to take care of the starter during starts...do not keep cranking and perform the cooling periods.

Many require pilots to not crank for more than 10 seconds, and then to allow a 20 seconds cooldown.

You can repeat this up to 6 times, then after you must wait 30 minutes to allow the starter to cool down.



Starter Description/Operation (80-00-00)



The airplane has a direct drive 24 VDC starter at the front (propeller end) lower left side of the engine. The ignition key in the instrument panel operates the starter solenoid. When the solenoid energizes, its contacts close and an electrical current energizes the starter. A pinion gear in the starter engages the crankshaft ring gear. When the engine reaches a given speed, centrifugal action decouples the starter pinion from the crankshaft ring gear.

Carburetor

The carburetor mixes the fuel and air at the selected mixture ratio.

The throttle cable is connected to the carburetor and controls the butterfly valve.

The mixture is also connected to the carburetor and controls how much fuel is added to the air.

Most light trainers will also have an accelerator pump.

The accelerator pump can be visualized as a syringe that squirts gas into the venturi, this aids in starting and during rapid acceleration to provide the engine with enough gas so it can respond.



Carburetor

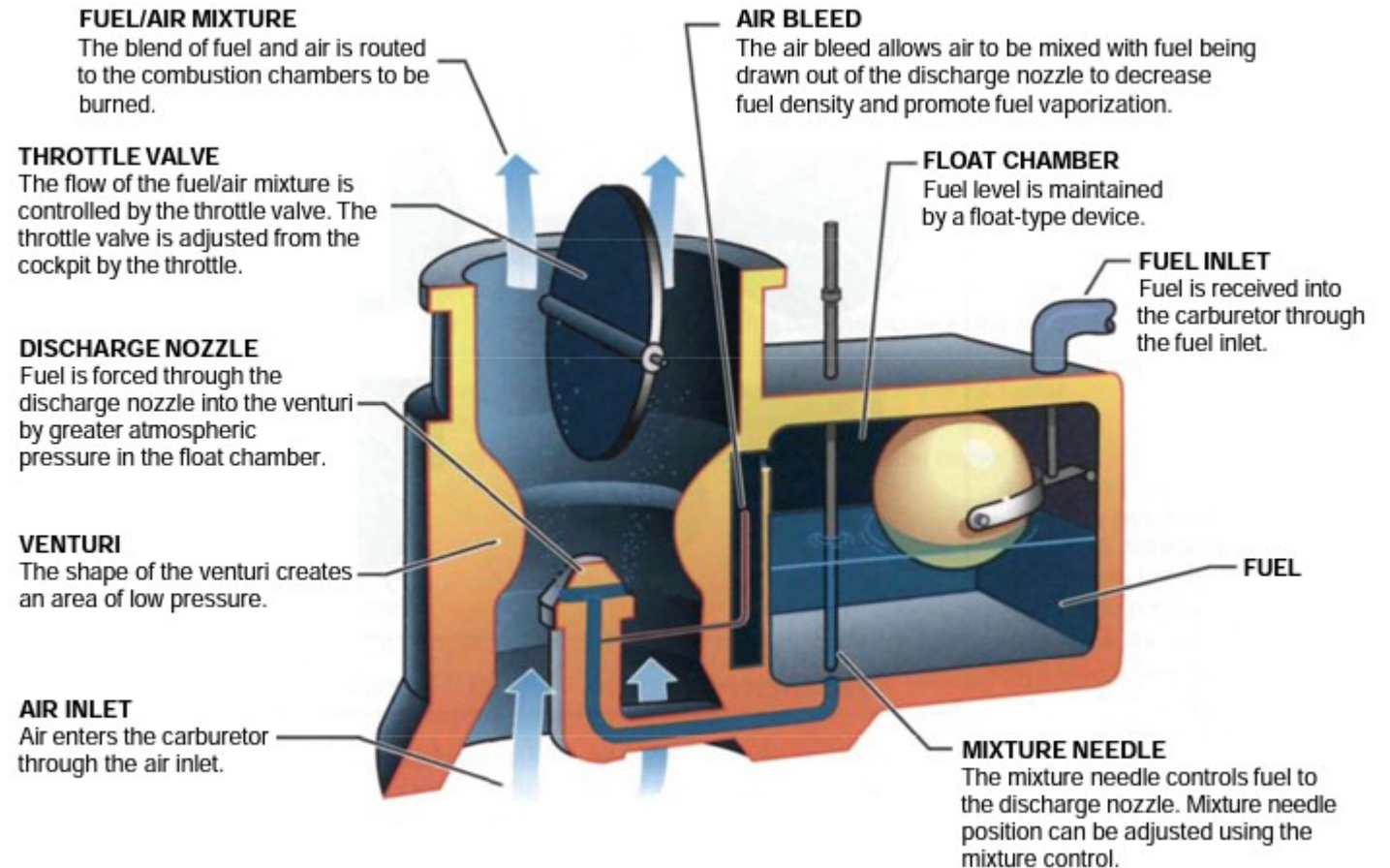


Figure 2-25. In a float-type carburetor, fuel is drawn from the float chamber past a mixture needle and into the venturi where it mixes with the incoming air.

Carburetor Heat

They are more susceptible to icing than fuel-injected engines and also require the use of carb heat during certain temperatures and high humidity.

Carburetor heat uses hot air taken from the engine exhaust system. Avoid use of either system for extended periods on the ground because the air is unfiltered from dust.

The use of carburetor heat causes a decrease in engine power, sometimes up to 15 percent, because the heated air is less dense than the outside air that had been entering the engine. This enriches the mixture.



Carburetor Ice

ICE

If conditions warrant, ice will generally form in the vicinity of the throttle valve

VENTURI

The reduced air pressure at the venturi throat creates a temperature decrease.

FUEL/AIR MIXTURE

The vaporization of the fuel contributes to a temperature decrease in the carburetor.

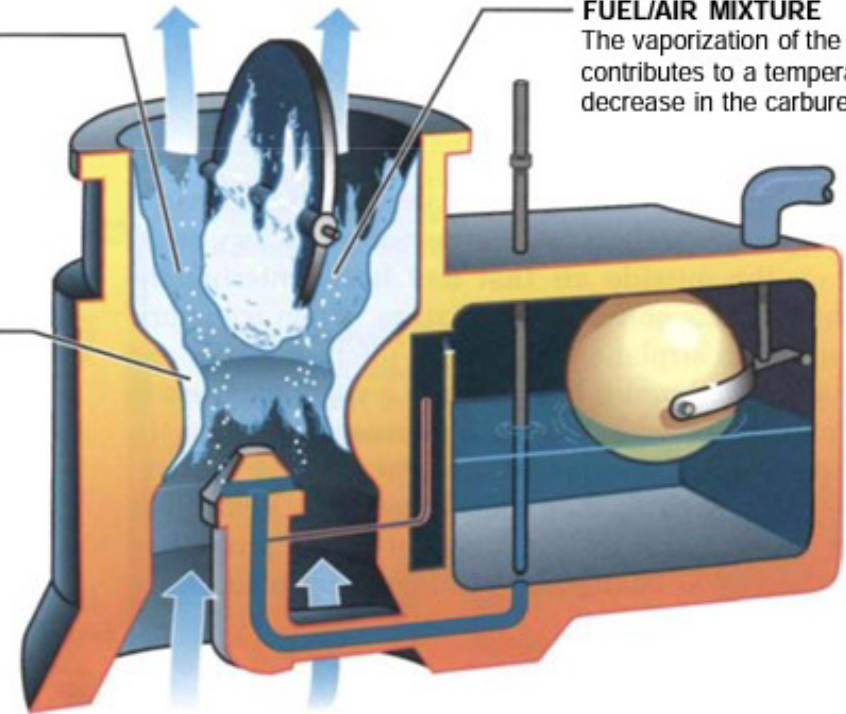


Figure 2-26. Carburetor ice reduces the size of the air passage to the engine. This restricts the flow of the fuel/air mixture and reduces power. If enough ice builds up, the engine can cease to operate.

INTAKE AIR

Carburetor ice is most likely to occur when intake air temperature is below 21 °C (70°F) and the relative humidity is above 80%.

Lubrication

For airplanes with a fixed-pitch propeller, the first indication of carburetor ice is loss of RPM.

You can verify the presence of carburetor ice by applying carburetor heat and watching the tachometer.

If there is carburetor ice, the RPM will momentarily decrease because the warm air enriches the mixture. Then, as the ice melts, the airflow into the cylinders increases and the RPM gradually increases.

If there is no carburetor ice, pulling on the carburetor heat will cause the RPM to decrease, but there will be no increase in RPM until carburetor heat is removed.



Mixture Control

Fuel/air ratio is the ratio between the weight of the fuel and the weight of air entering the cylinders.

Proper mixture control and better economy in the operation of fuel injected engines can be achieved best by use of an exhaust gas temp (EGT) indicator.

Spark plug fouling results from operating with an excessively rich mixture.

Throttle

The throttle is an air valve, opened all the way for full power and closed almost completely at idle. In a carbureted engine, as the throttle is opened further and further, more and more fuel is automatically drawn through the carburetor. The fuel and air combine in the carburetor throat and are sucked into the cylinder via intake tubes.

In a fuel-injected engine, the pilot still controls the volume of air entering the engine by moving the throttle, but the fuel is delivered separately into each cylinder, mixing with the air inside the cylinders. Fuel-injected engines are more efficient and develop more power than the same-size carbureted engine because of more precise fuel delivery.





Primer

A manual fuel primer injects vaporized fuel directly into one or more of the engine's cylinders or the induction manifold to aid in starting.

Why not do throttle back and forth? Fire hazzard

Fuel Injection

The following are advantages of using fuel injection:

- Reduction in evaporative icing
- Better fuel flow
- Faster throttle response
- Precise control of mixture
- Better fuel distribution
- Easier cold weather starts

The following are disadvantages of using fuel injection:

- Difficulty in starting a hot engine
- Vapor locks during ground operations on hot days
- Problems associated with restarting an engine that quits because of fuel starvation

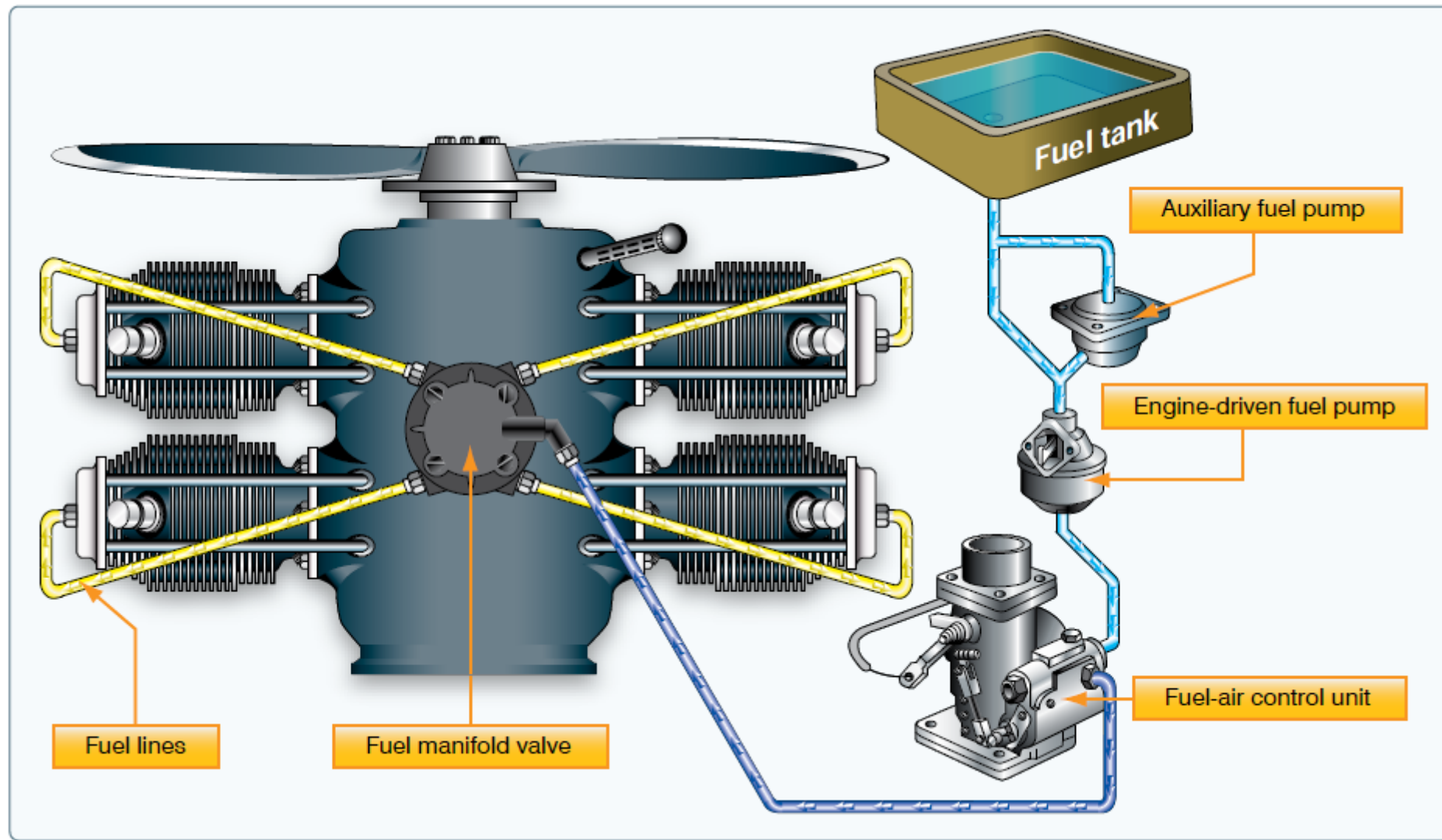
Fuel Injection

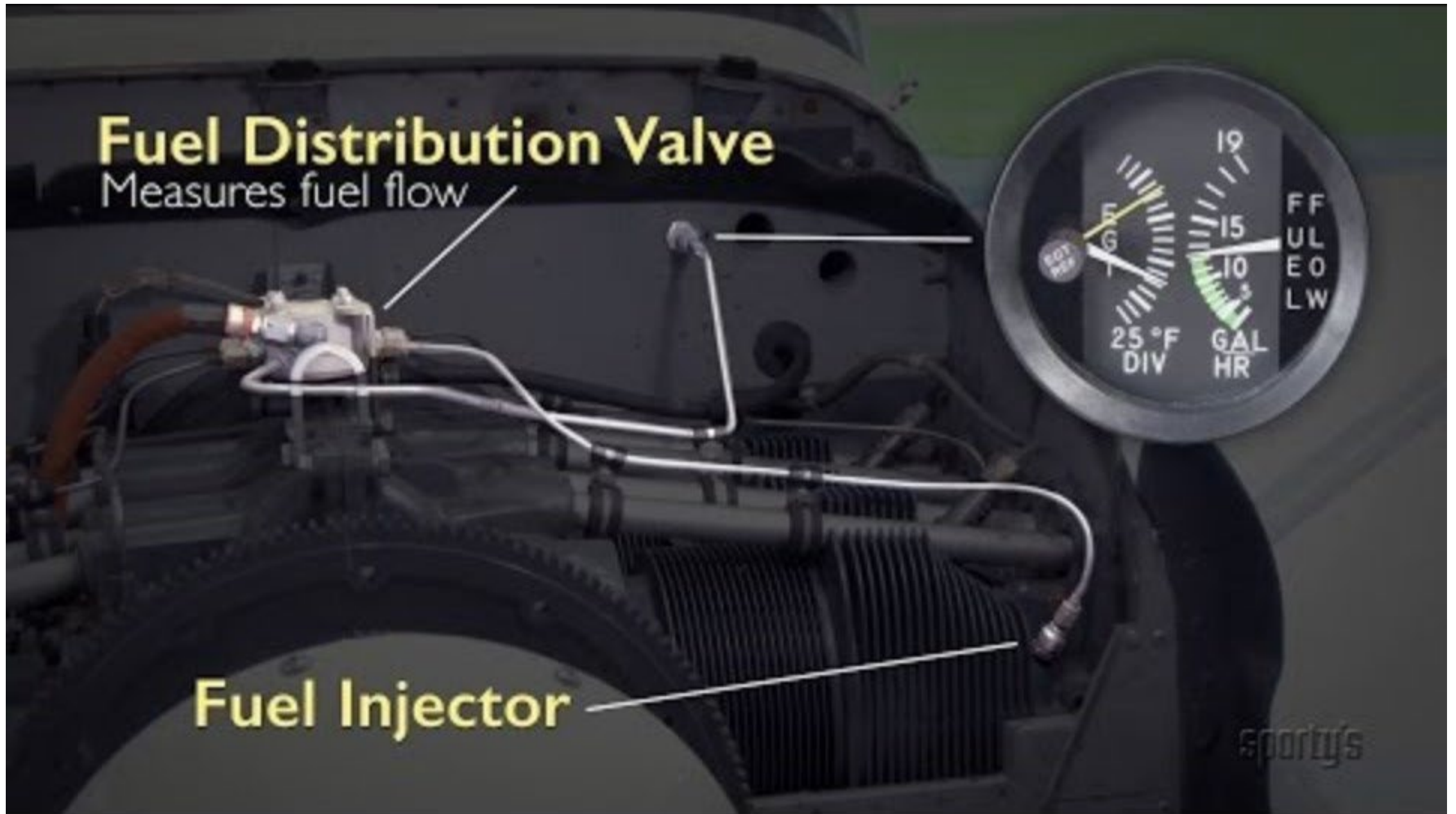
Fuel injection systems can have faster throttle response than other systems.

The throttle and fuel servo or metering valve in the system regulate how much fuel enters the engine.

As the pilot adjusts the throttle, the airflow through the throttle body changes, which in turn changes the air pressure in the venturi.

This can make the system more sensitive to changes in airflow, allowing it to react quickly to sudden throttle changes.





SAFETY TIP:

HOT STARTS



Leaning <https://youtu.be/BbR9D1Uwf2U>



Electrical System

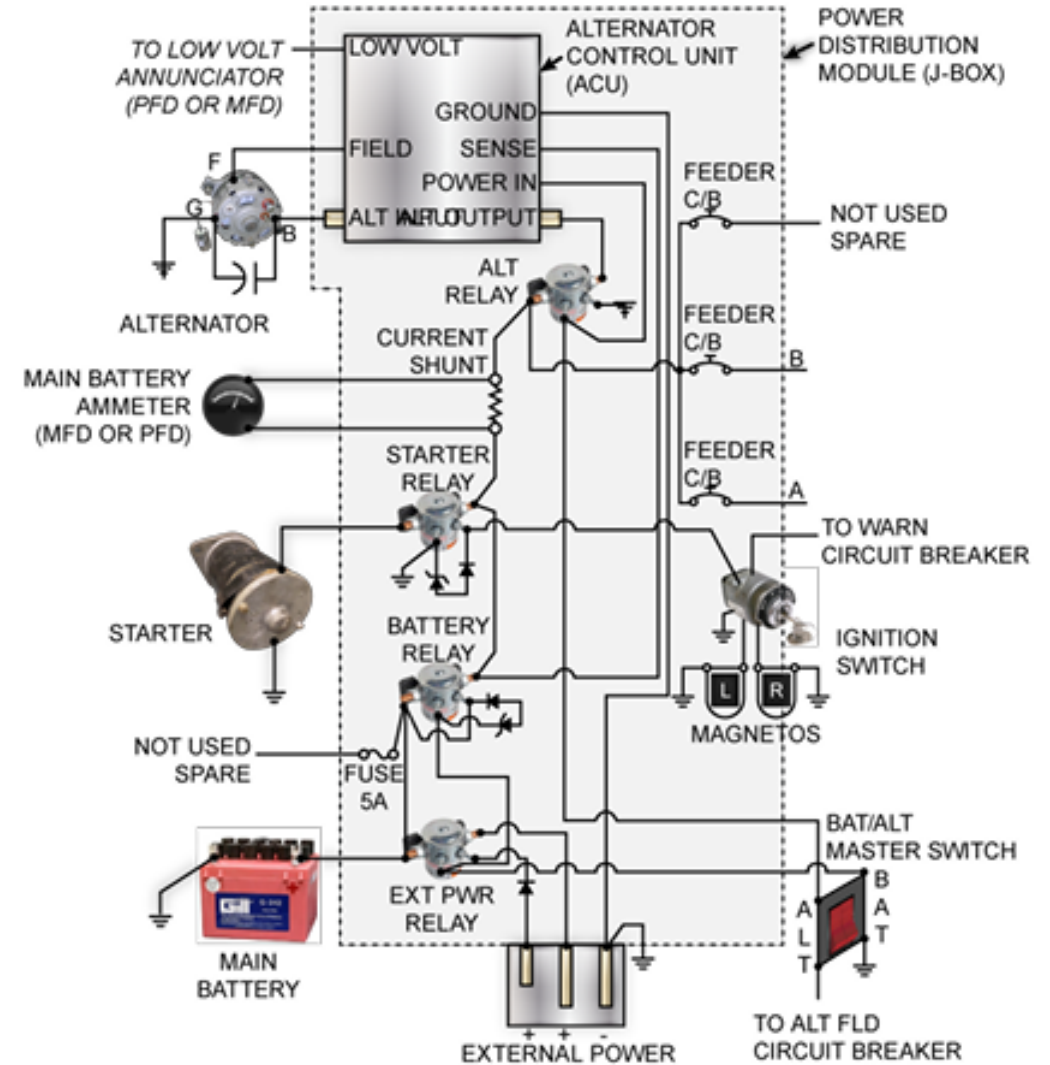
Newer planes:

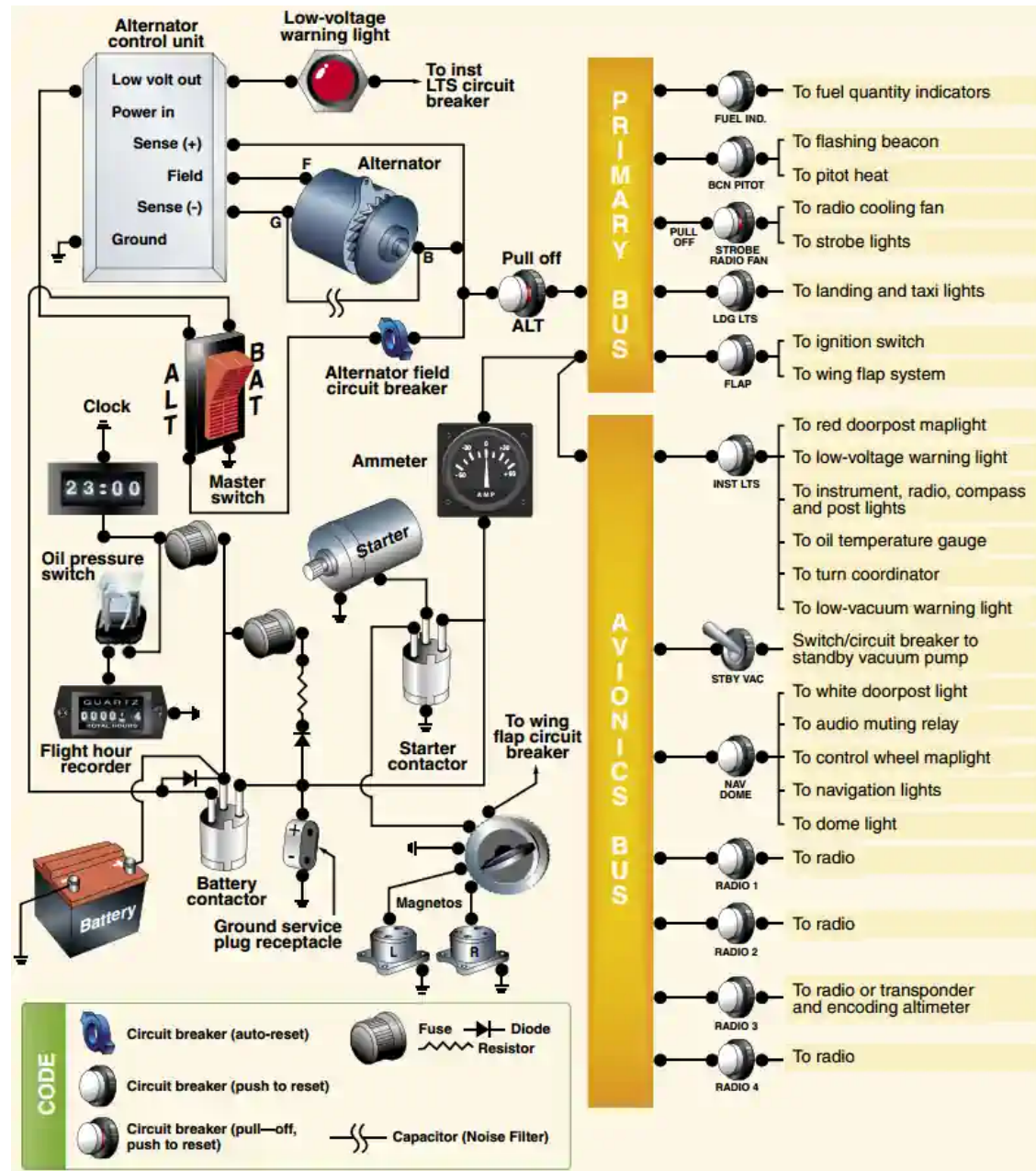
28 volt DC system using a 24 volt battery

28 so battery can charge

Older planes:

14 volt DC system using a 12 volt battery





ELECTRICAL SYSTEM (Continued)

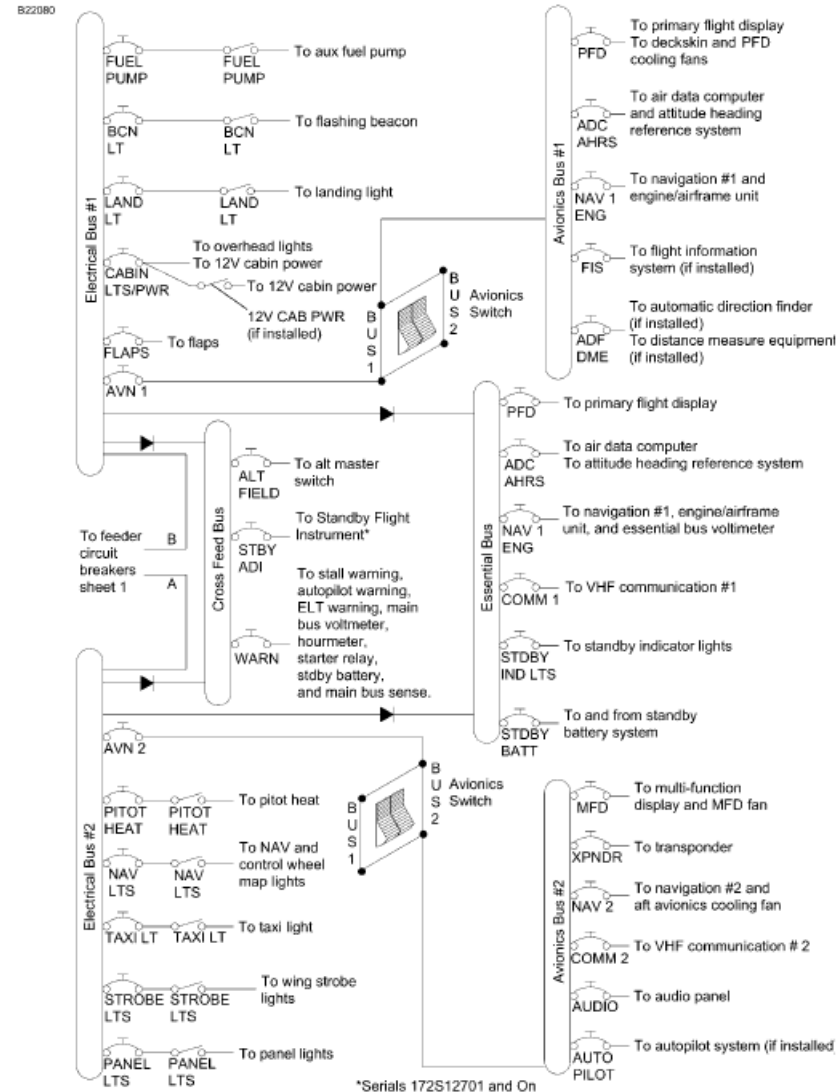
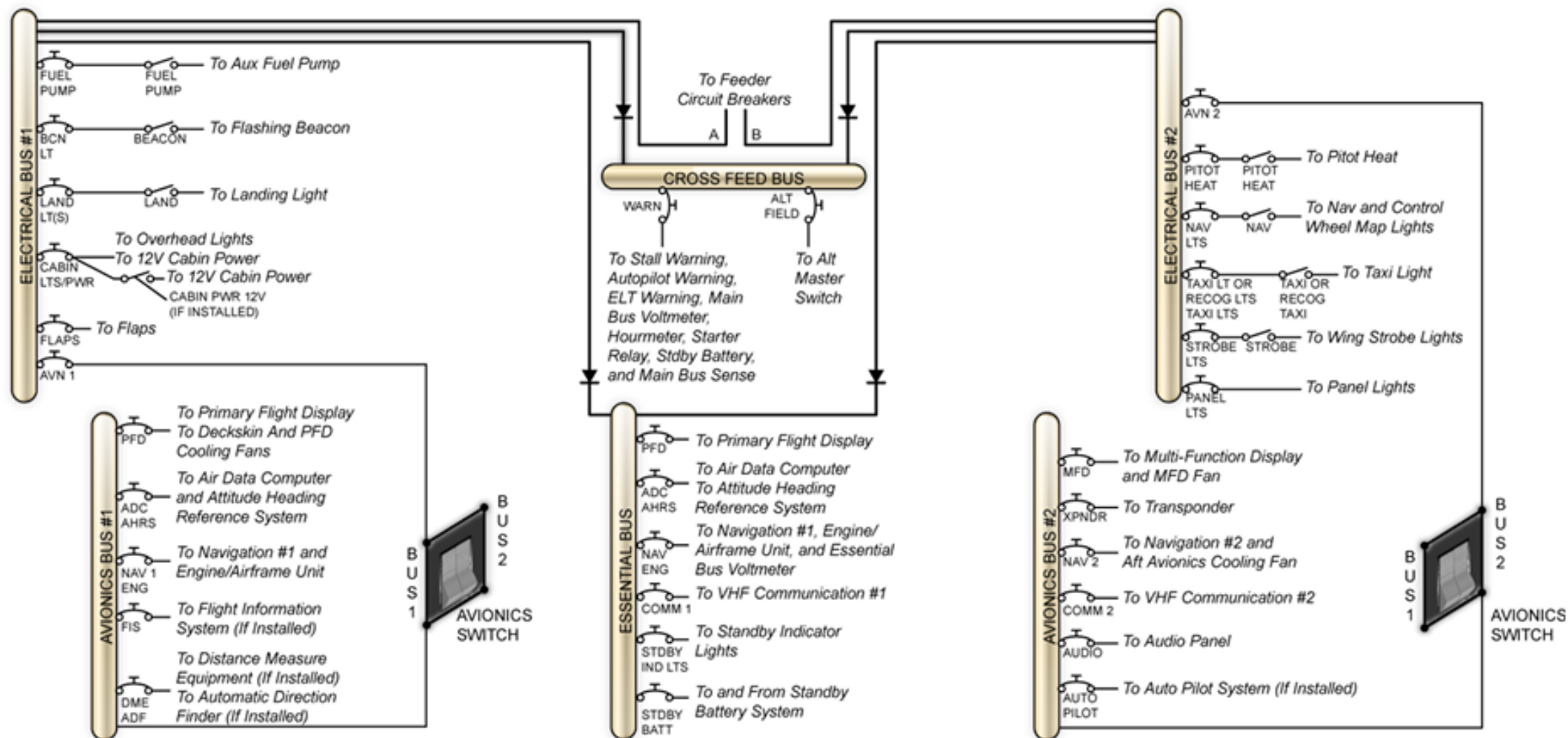
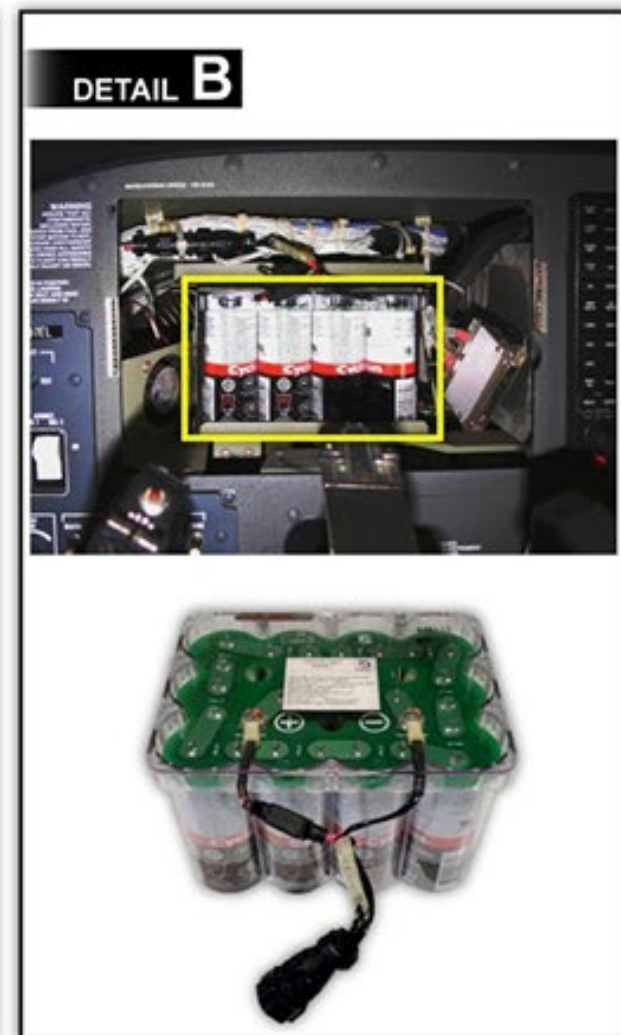
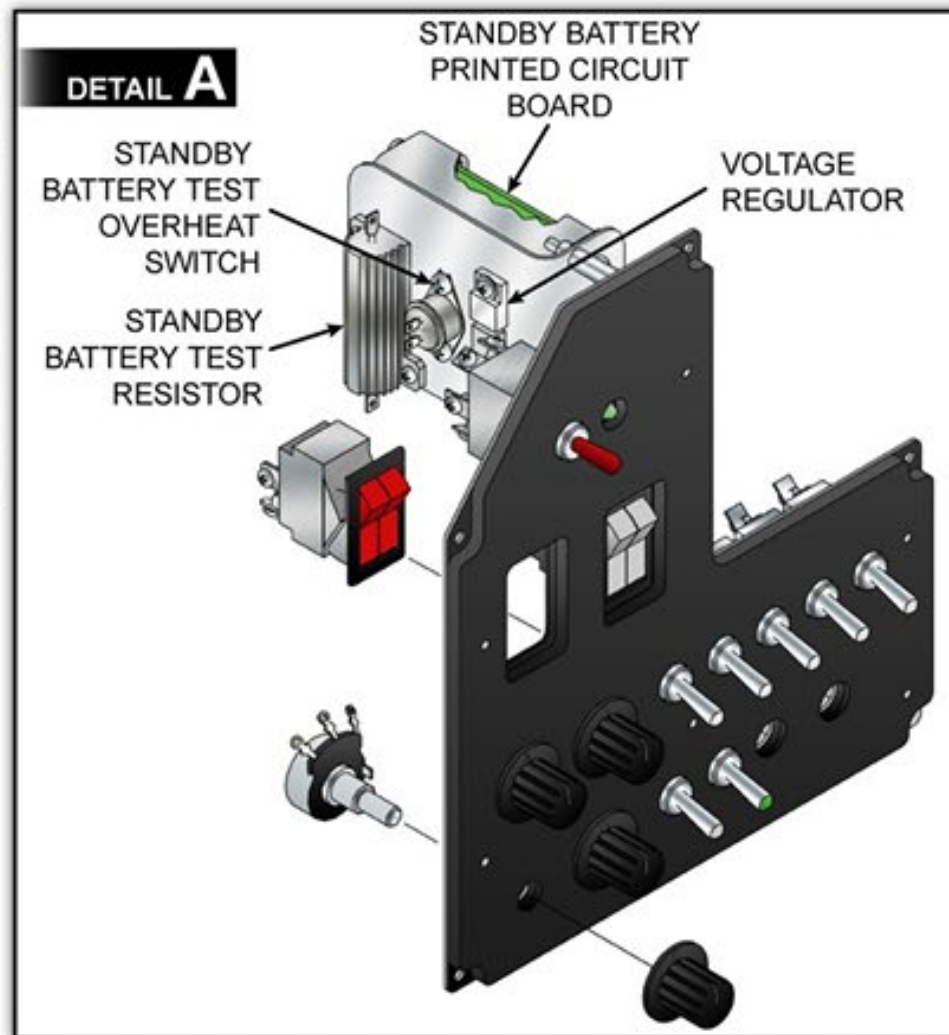
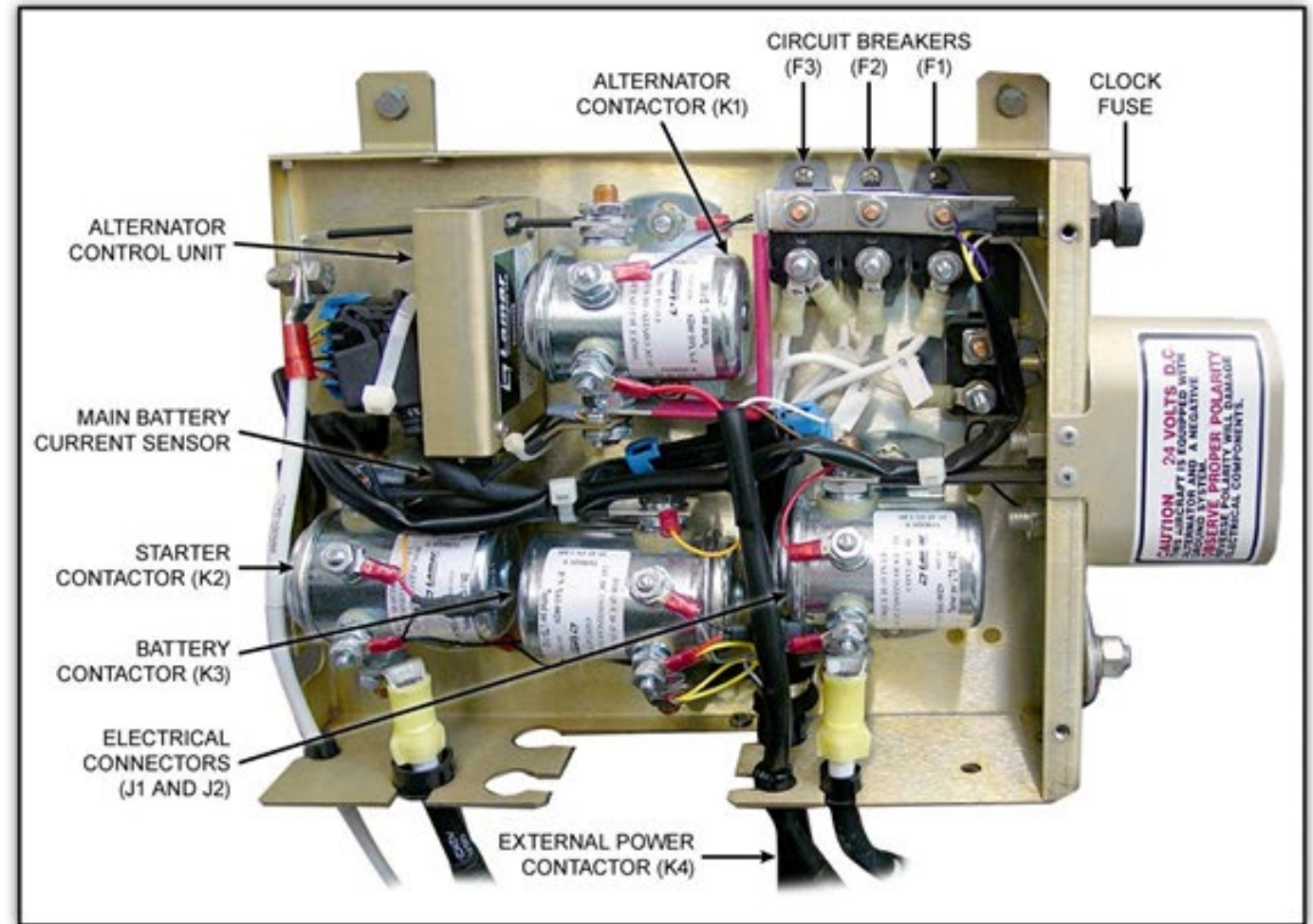


Figure 7-7* (Sheet 2)





Power Junction Box (24-60-00)



182/206 - DIFFERENCES ELECTRICAL POWER- GENERAL (24-00-00) ELECTRICAL PANEL

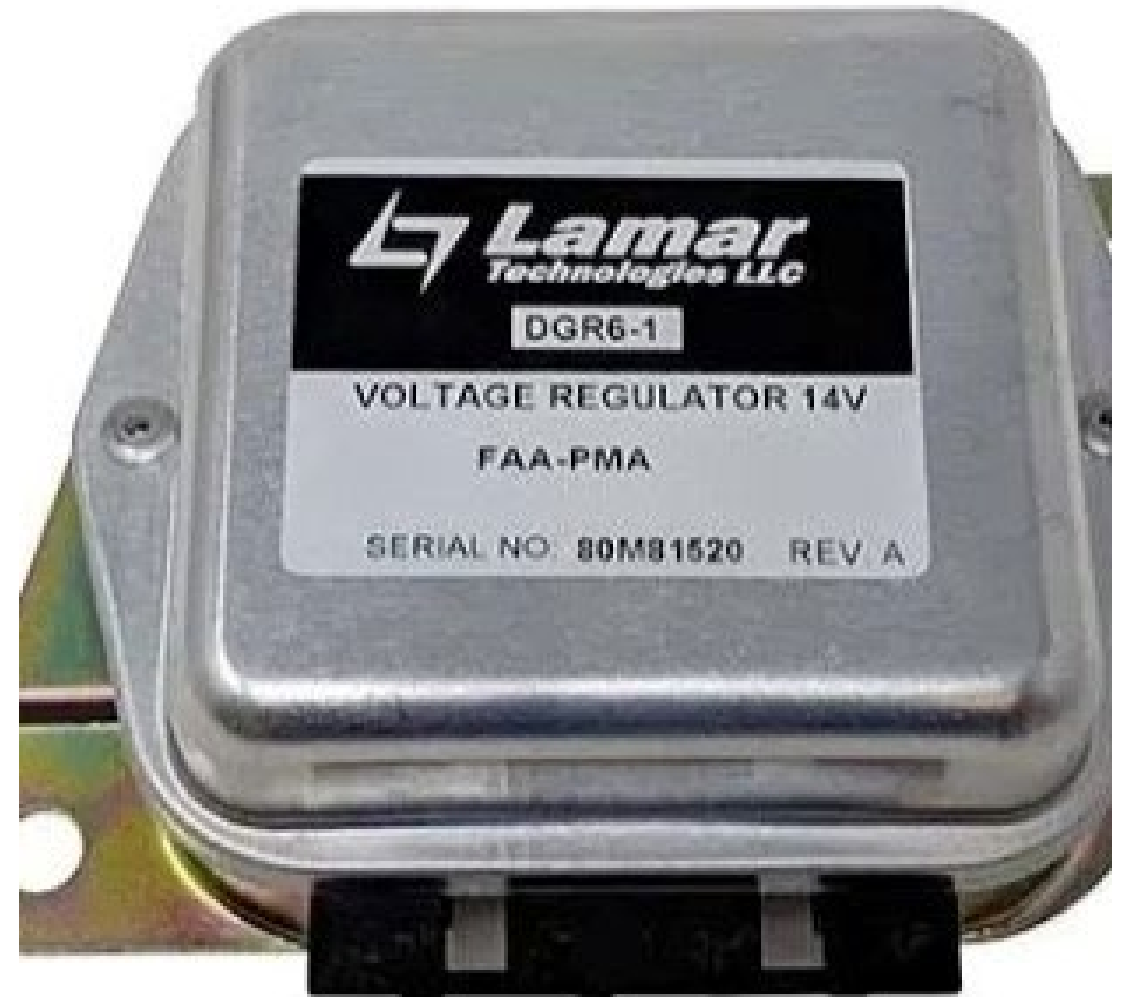


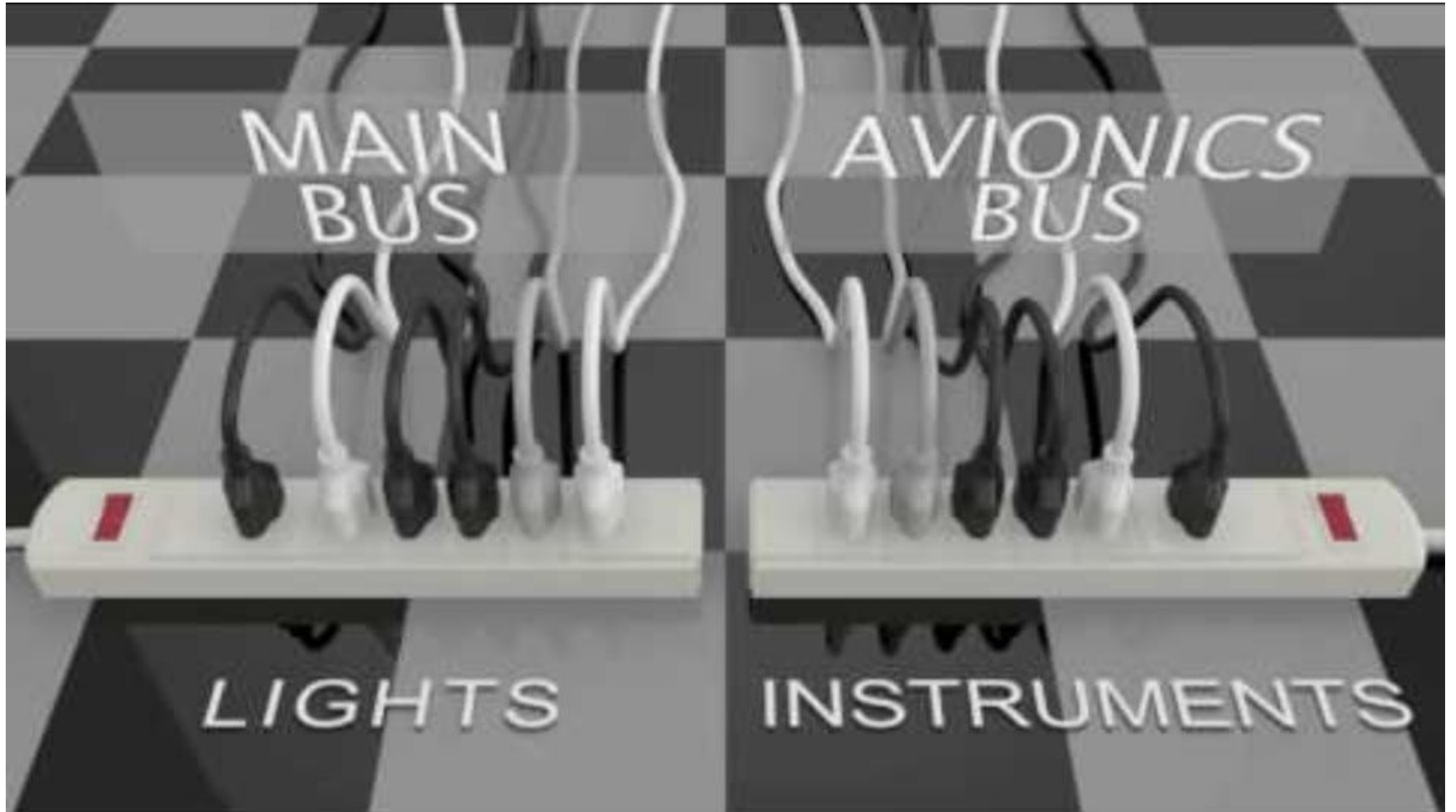
Voltage Regulator

An aircraft voltage regulator (also called a voltage controller) protects the aircraft's electrical system by maintaining a constant voltage output from the generator or alternator.

The regulator system senses the voltage and adjusts the field current to always maintain proper output voltage.

In a nutshell...keeps voltage in proper range.





How does centre-zero ammeter work?



Lighting System Review



Tachometer

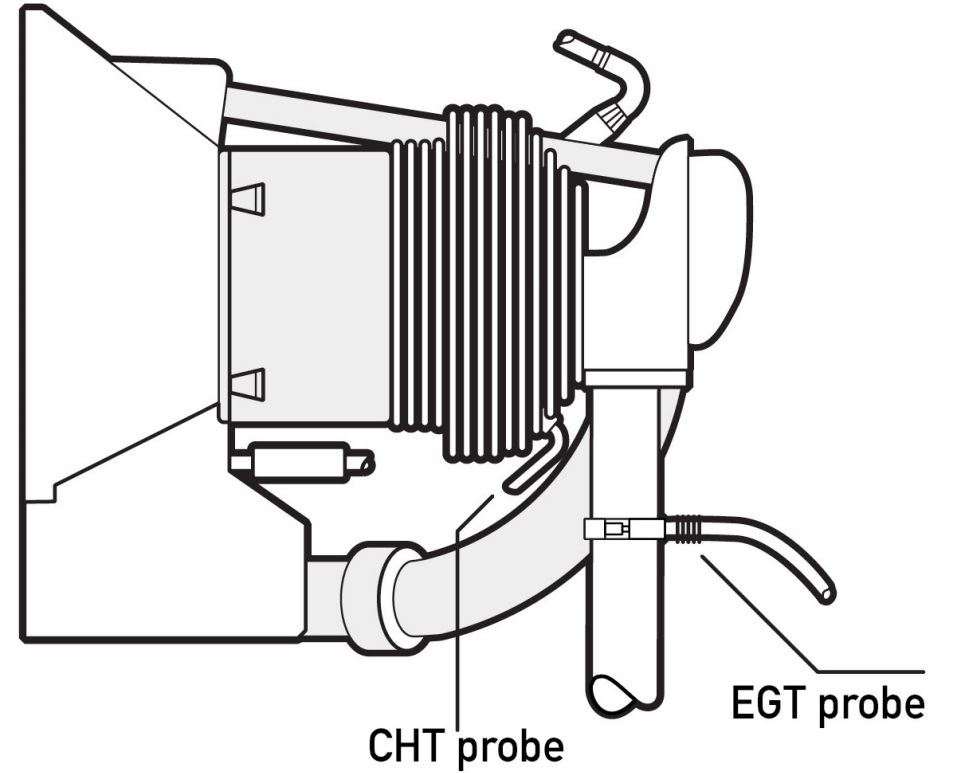
The tachometer, or tach, is an instrument that indicates the speed of the crankshaft of a reciprocating engine. It can be a direct- or remote-indicating instrument, the dial of which is calibrated to indicate revolutions per minutes (rpm). On reciprocating engines, the tach is used to monitor engine power and to ensure the engine is operated within certified limits.

Too much to say here how it works

See 10-30 in the Aviation Maintenance Technician Handbook - Airframe Volume 2 FAA-H-8083-31A



Engine Monitor



CHT vs EGT

From SavvyAviation.com

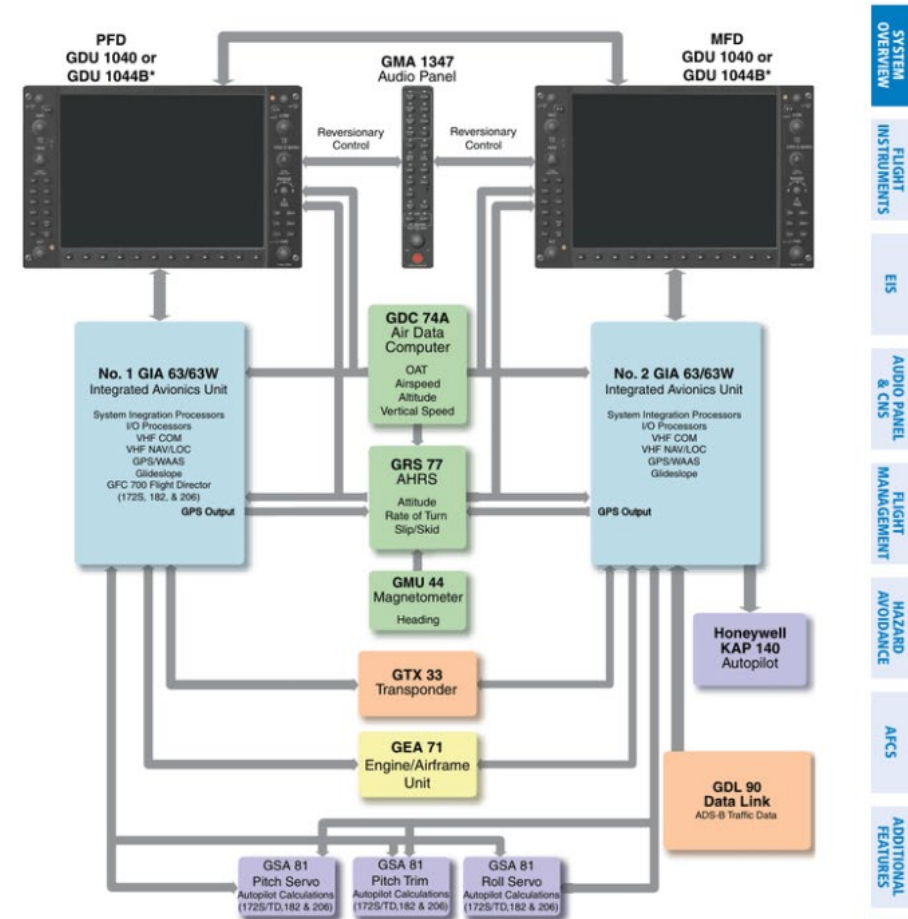
CHT (Cylinder Head Temp) measures heat energy wasted during the power stroke, when the cylinder is under maximum stress from high internal pressures and temperatures.

EGT (Exhaust Gas Temp) measures heat energy wasted during the exhaust stroke, when the cylinder is under relatively low stress.

High CHTs generally indicate that the engine is under excessive stress for its own good. That's why it's so important to manage the powerplant in a fashion that limits CHTs to a tolerable value. For Bonanzas and Barons, a reasonable rule-of-thumb is that optimum engine longevity is achieved by limiting CHTs to 380°F. CHTs above 400°F should be considered abusive, and grounds for “doing something right now” to bring them down.

By contrast, high EGTs do not indicate that the engine is under excessive stress. They simply indicate that a lot of energy from the fuel is being wasted out the exhaust pipe rather than being extracted in the form of mechanical energy sent to the propeller. High EGTs do not represent a threat to engine longevity. The engine is simply not capable of producing EGTs that are high enough to harm anything.

G1000 Units



* The GDU 1040 is available in systems not using the GFC 700 Automatic Flight Control System. The GDU 1044B is available in systems using the Garmin GFC 700 Automatic Flight Control System.

Figure 1-1 Basic G1000 System

No Vacuum Indicator

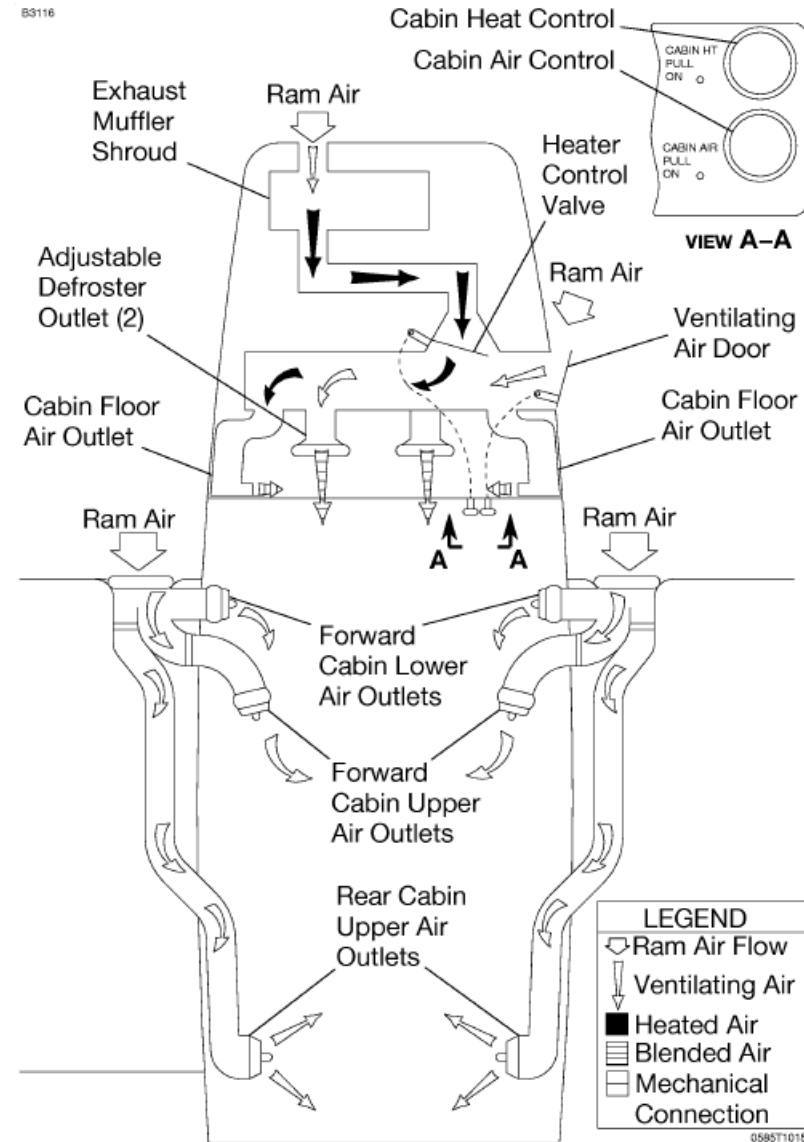
In the new Cessna 172S models there is no vacuum pumps...one less thing to break. In the manual I found this...

ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS) AND MAGNETOMETER (GRS)

The AHRS provides airplane attitude and flight characteristics information to the G1000 displays and to the integrated avionics units, which is located in the tailcone. The AHRS unit contains accelerometers, tilt sensors and rate sensors that replace spinning mass gyros used in other airplanes. The magnetometer is located inside the left wing panel and interfaces with the AHRS to provide heading information.

CABIN HEATING, VENTILATION AND DEFROSTING SYSTEM

B3116



0505T1015

Figure 7-8

GFC 700 SYSTEM SCHEMATIC

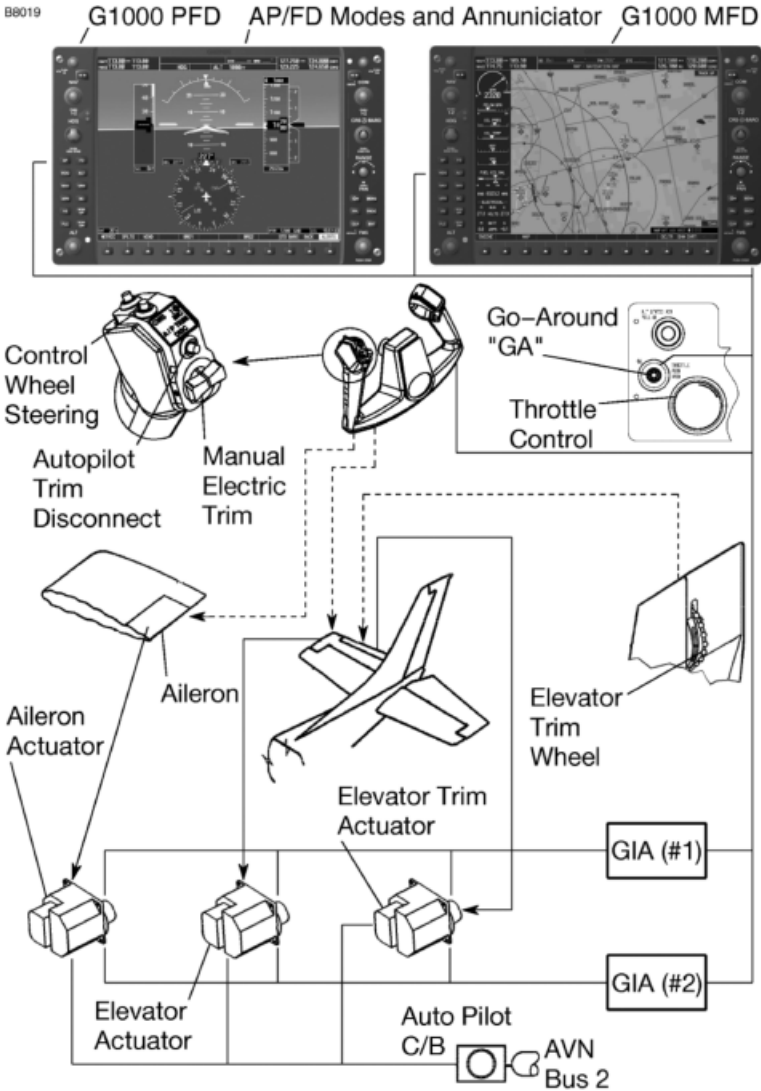


Figure 7-10

What can I fix?

When Can You Fix Your Own Airplane?

As a pilot certificated under 14 CFR Part 61 (private pilot, sport pilot, or higher certificate), you can perform specified preventive maintenance on any aircraft that you own or operate. This does not apply to airplanes that you don't own or operate.

Additionally, according to 14 CFR Part 43 you can only conduct this maintenance when the aircraft is NOT used under 14 CFR Part 121, 127, 129, or 135. Authorized preventive maintenance cannot involve complex assembly operations. But what exactly does this mean?

What Can You Fix?

According to 14 CFR 43 Appendix A, Part C (that's a mouthful), "preventive maintenance is limited to the following work, provided it does not involve complex assembly operations." There are currently 31 items listed that you're allowed to work on yourself.

What can I fix?

Here's a short-list of the most common examples of preventive maintenance (refer to the full regulation for a comprehensive list):

- Remove, install, and repair landing gear tires.
- Service landing gear wheel bearings (for example, cleaning and greasing).
- Service landing gear shock struts (for example, adding oil, air, or both).
- Replace defective safety wire or cotter keys.
- Lubricate items not requiring disassembly other than removal of nonstructural items (for example, cover plates, cowling, and fairings).
- Replenish hydraulic fluid in the hydraulic reservoir.
- Replace safety belts.
- Replace bulbs, reflectors, and lenses of position and landing lights.
- Replace or clean spark plugs and set spark plug gap clearance.
- Replace any hose connection, except hydraulic connections.
- Replace and service batteries.
- Make simple fabric patches not requiring rib stitching or the removal of structural parts or control surfaces.
- Replace any cowling not requiring removal of the propeller or disconnection of flight controls.

<https://youtu.be/gldXLMVP6VU>

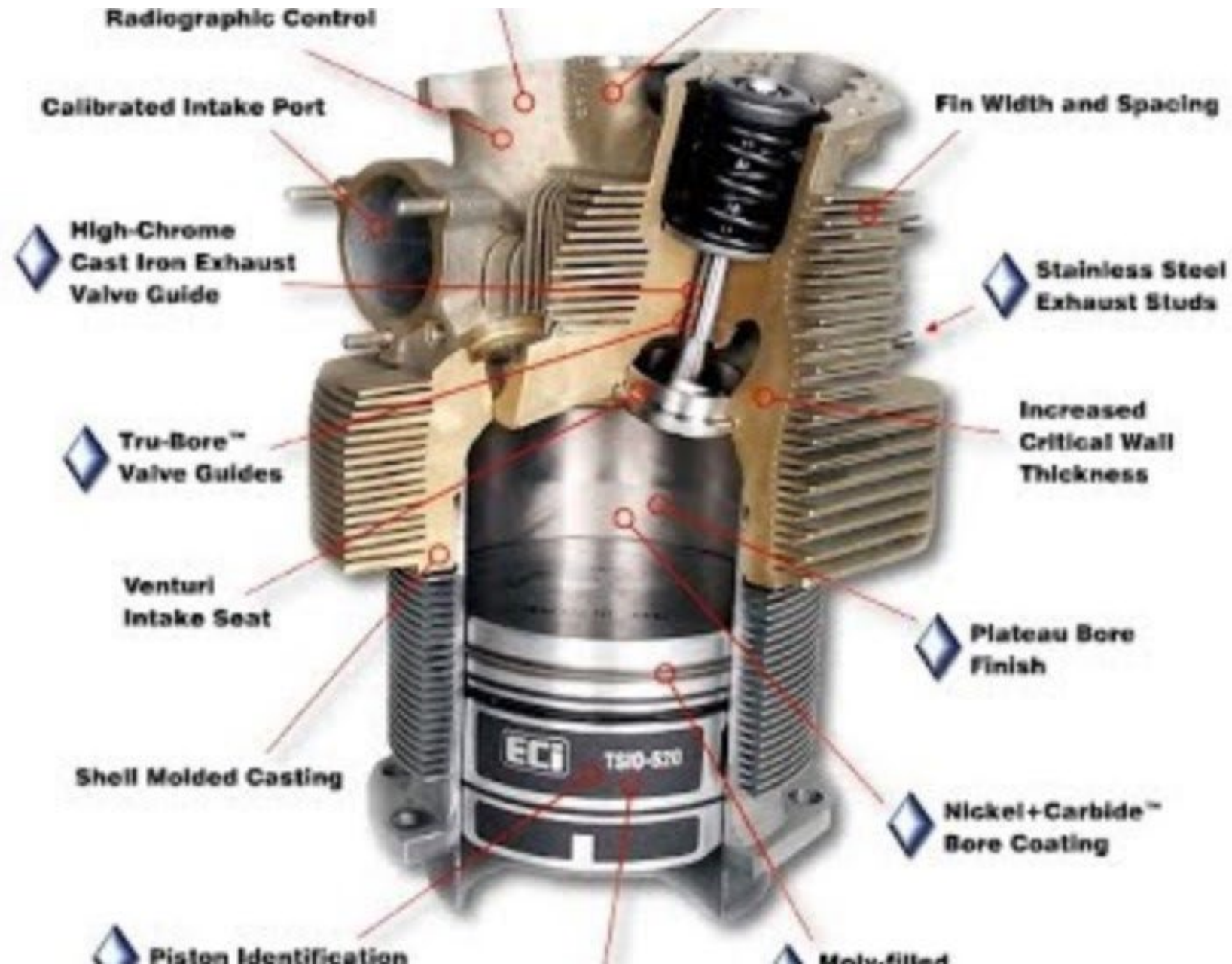


<https://youtu.be/oknUNd5-nWg>



<https://youtu.be/RuFKRDm-MDg>





Under the Hood of your Cessna



https://youtu.be/st7xh_09m1Y



<https://youtu.be/aG6cIKBP5UA>



<https://youtu.be/hOGJ5fNPvZo>



Exploring Crankshafts and Camshafts



Exploring The Case



Exploring The Cylinder



Exploring The Propeller





Any questions I can answer or
follow up later on?

Understanding Magnetos

- Magnetos are independent electrical generators that provide the spark to ignite the fuel-air mixture in an aircraft's engine.
- They're crucial for engine reliability, as they function independently of the aircraft's electrical system.
- A typical aircraft piston engine has two magnetos for redundancy.

In order to understand what you should be looking for while performing the magneto check during the engine runup it's important to understand what the mag switch actually does. The Off position of the magneto switch is different from that of other electrical switches you use. When you switch off the radio, you are removing the electricity from the radio. The Off position of the mag switch does not actually remove electricity from the magneto because the magneto is what makes the electricity. Remember, any time the magnet in a magneto spins, we get electricity. Think about it - if you move the propeller by hand, the magneto is working.

Turning the mag switch Off actually causes a short circuit (called grounding) in the magneto coil that prevents it from working. The wire that does the grounding is called a P-lead.

Although the mag switch in your plane only shows one, there are really three Off positions. "Off" means that both mags are grounded and should not be able to power their ignition systems. Remember, grounding only occurs if the P-lead is connected properly. A broken P-lead could cause an engine start if the prop is moved ever so slightly. The other two Off positions on the mag switch are those labeled "L" and "R". When you switch to the left mag (L) you are actually grounding the right mag. If you think about it, the only way to test the left magneto is to switch off the right magneto.

Common Magneto Check Issues

RPM Drop

- During a magneto check, a pilot switches from "both" magnetos to each individual magneto.
- A drop in RPM is expected, but an excessive drop indicates a potential problem.

Causes can include:

- Fouled spark plugs.
- Faulty ignition wires.
- Improper magneto timing.
- A failing magneto.

No RPM Drop

- This could indicate a broken "P-lead," which is the wire that grounds the magneto when switched off.
- A broken P-lead means the magneto is always "hot," posing a safety hazard.

Rough Running Engine

- If the engine runs rough on one magneto, it suggests a problem with that magneto or its associated components.

Timing Issues

- Incorrect magneto timing can significantly affect engine performance and efficiency.

P-Lead Issues

- Problems with the P-lead wiring can cause many issues, and are a common source of magneto related problems.

Spark Plug Issues

- Because the magnetos are the systems that fire the spark plugs, problems with the spark plugs will be evident during a magneto check.

Troubleshooting

Pilots perform magneto checks during pre-flight run-ups to identify potential issues.

Mechanics use various tools and techniques to diagnose and repair magneto problems, including:

- Inspecting spark plugs and ignition wires.
- Checking magneto timing.
- Testing magneto output.
- Checking the P-lead wiring.

Mag Test Issues:

If there is a big rpm drop...

Run high rpm...lean to peak

Run for about 30-45 seconds

Key Considerations

- Regular maintenance and inspections are essential for ensuring magneto reliability.
- Any abnormal magneto check results should be investigated by a qualified mechanic.
- Always consult the aircraft's Pilot Operating Handbook (POH) for specific procedures and allowable tolerances.



Cessna Single Engine High Wing Maintenance Electrical Systems



CESSNA SINGLE ENGINE HIGH WING MAINTENANCE**FOR TRAINING PURPOSES ONLY****Revision Record**

Rev Year	Rev Number	Rev Date	Revision Details	Reference	Revised by
2016	00	5/13/2016	Original Issue	172S Maintenance Manual, Rev 21, 01OCT15	
2016	01	8/11/2016	Model 182/206 Differences added	182 & 206 Maintenance Manual Rev 19, 01OCT15	Zimmerman
2017	02	1/19/2017	Graphic corrections to power system distribution diagram and electrical panel; text corrections from SME.	172S Maintenance Manual, Rev 21, 01OCT15 182 & 206 Maintenance Manual Rev 19, 01OCT15	Springer

Export Classification C, ECCN EAR99

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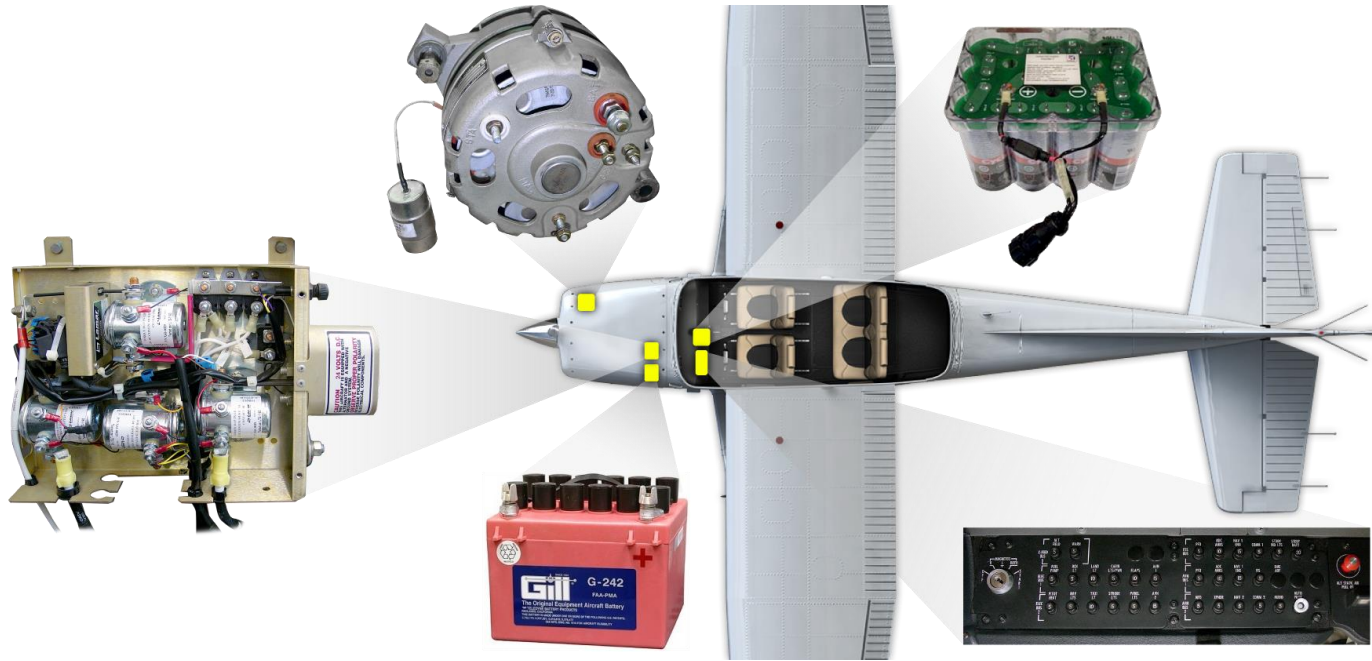
ATA24 - Electrical Power



LESSON OBJECTIVES

- Explain safety precautions related to the electrical power system
- Explain maintenance practices important to the electrical power system Explain normal system operations
- Explain system indications
- Explain special tooling and test equipment used with Cessna High Wing Series Aircraft
- Explain procedures for replacement of unique components

System Overview

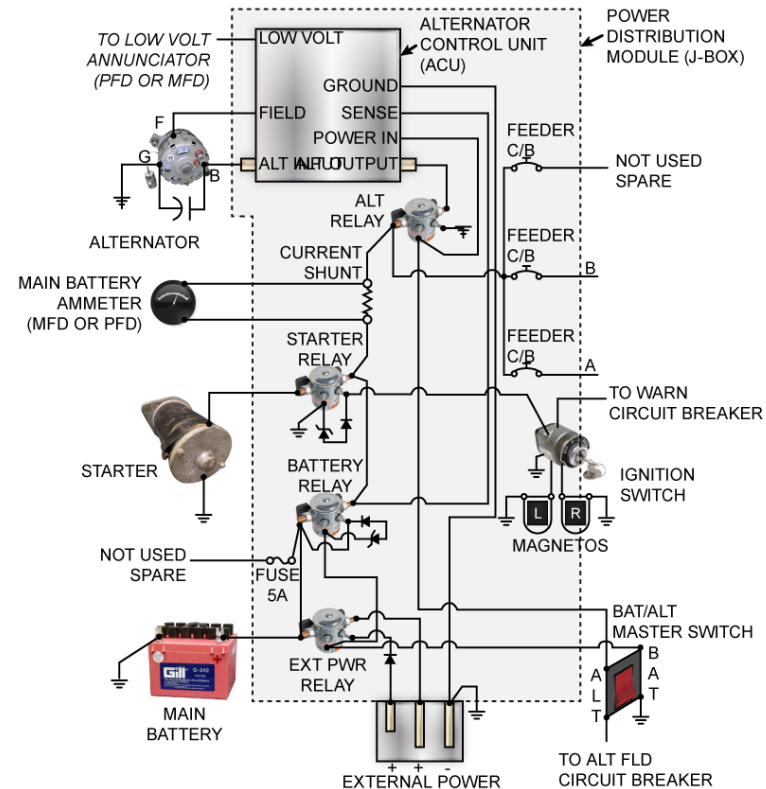


A 28-volt direct current (DC) electrical system powers the aircraft. A belt-driven 60-ampere alternator powers the system. A 24-volt main storage battery is inside the engine cowling on the left firewall. The MASTER switch on the pilot's switch panel controls the alternator and main battery.

Two primary buses supply power to most electrical circuits. An essential bus and a crossfeed bus connects the two primary buses to support essential equipment.

The system has a secondary, or standby, battery located between the firewall and the instrument panel. The STBY BATT switch controls power to or from the standby battery. The standby battery is available to supply power to the essential bus if both the alternator and main battery power sources have failed.

ELECTRICAL POWER SYSTEM OPERATION AND CONTROL (24-00-00)



The MASTER ALT BAT switch controls the operation of the main battery and alternator system. The switch is an interlocking split rocker and is on the left side of the switch panel. The right half of the rocker controls the main battery and the left half controls the alternator. It is possible in this configuration for the main battery to be online without the alternator. However, operation of the alternator without the main battery is not possible. The BAT MASTER switch, when operated, connects the main battery contactor coil to ground so that the contacts close and supply power to the system from the main battery only. The ALT MASTER switch, when ON, applies positive voltage to the ACU and to the alternator contactor coil at the same time, which then applies field voltage to the alternator field and supplies power to the electrical system from the alternator.

ELECTRICAL POWER SYSTEM OPERATION AND CONTROL (24-00-00)

A sensor in the power junction box controls the main battery ammeter. In flight, without the use of external power, the meter shows the quantity of current that flows to or from the battery. With a low battery and the engine at cruise speed, the ammeter shows a large positive output and a charge of the main battery. When the main battery is fully charged, the ammeter shows a minimum charge rate.

The AVIONICS switch is a two-pole rocker-type switch that controls electrical power to AVIONICS BUS 1 and BUS 2. Placing either side of the rocker switch in the ON position supplies power to the corresponding avionics bus.



AVIONICS POWER

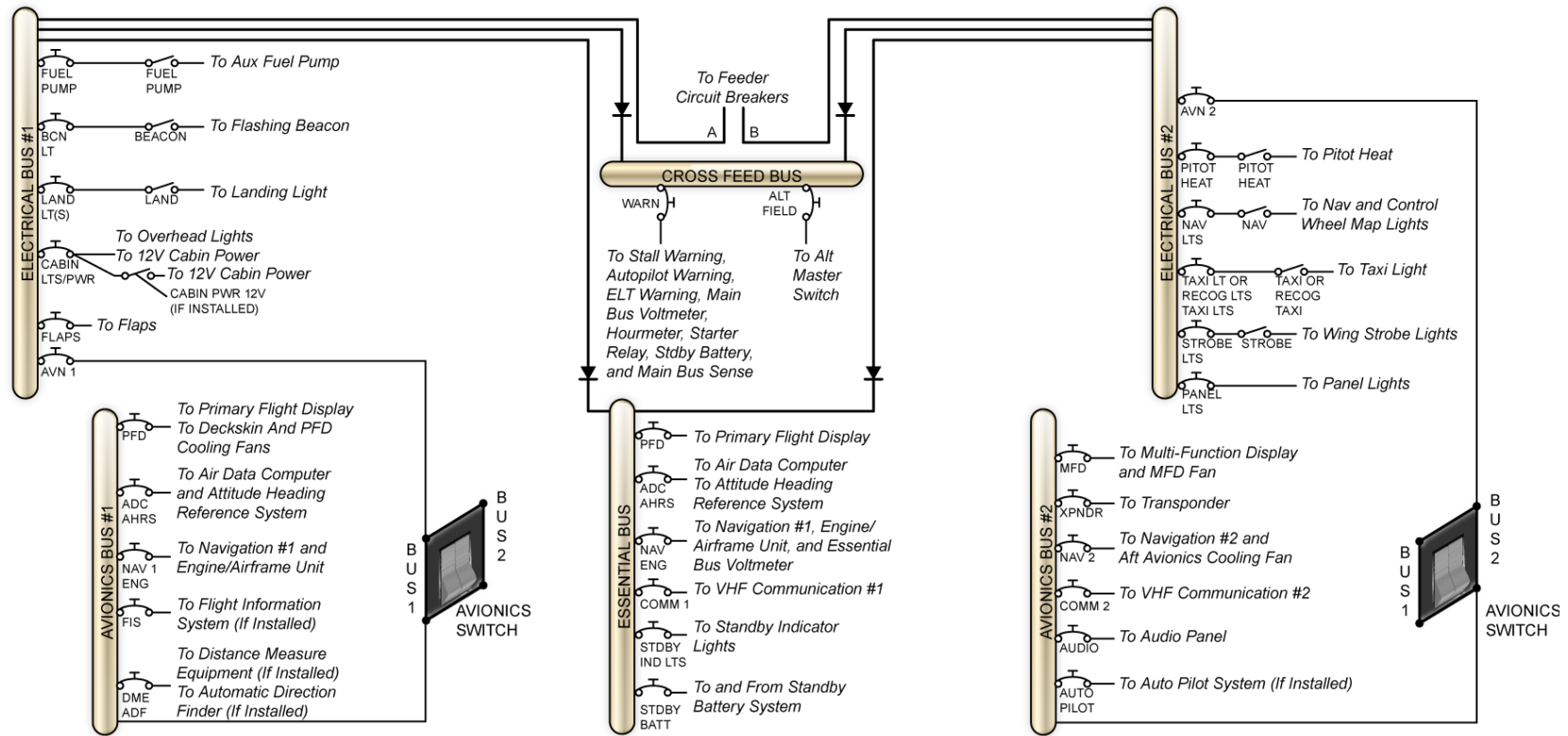
Both bus 1 and bus 2 avionics switches should be turned off to prevent any harmful transient voltage from damaging the avionics equipment prior to turning the MASTER switch on or off, starting the engine or applying an external power source.



AVIONICS MASTER SWITCHES

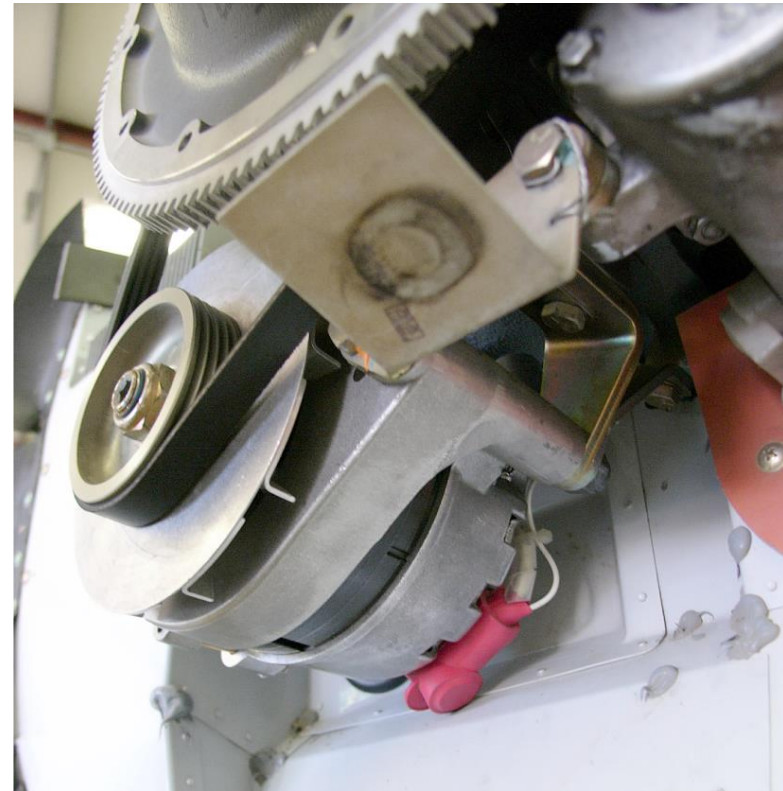
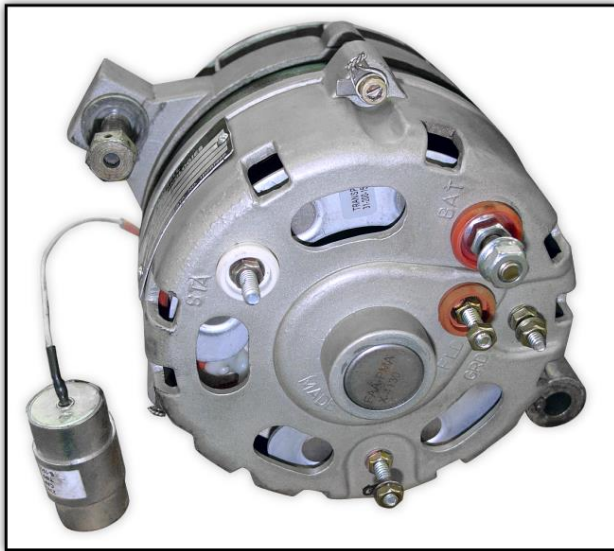
The Avionics and Master switches are high replacement items. Replacement is mandatory at 500 hrs. for the Avionics switch. There is no time requirement for the Master switch.

Electrical Power System Distribution (24-00-00)

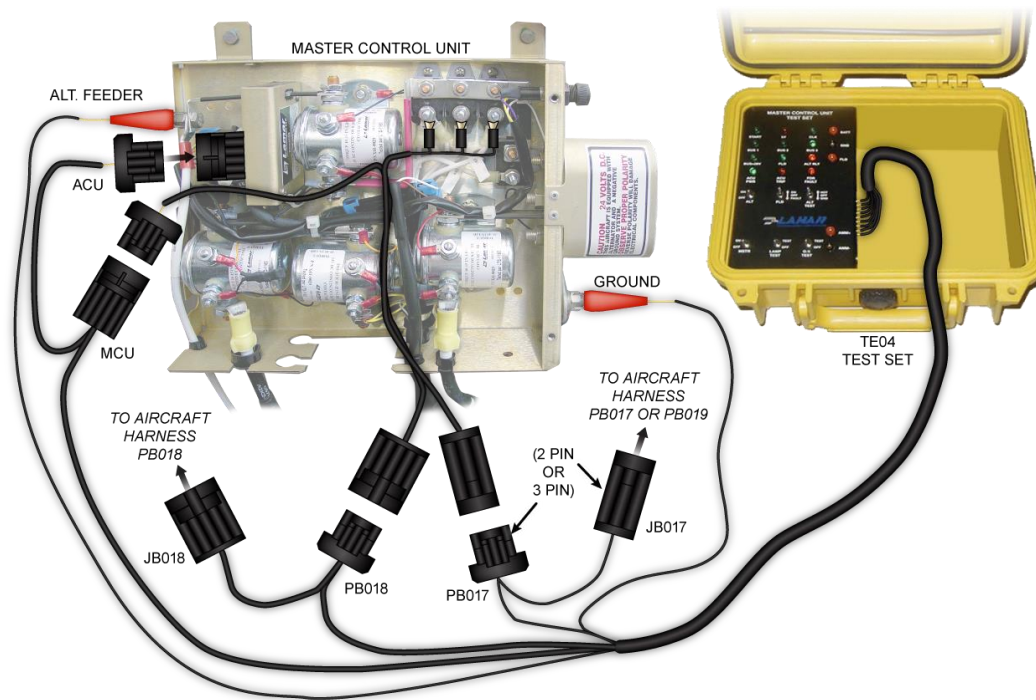


Electrical power to the two primary electrical busses passes through two 30A fuses, two 30A circuit breakers, or two 40A circuit breakers in the junction box. These electrical busses supply power to two avionics busses through 15A circuit breakers. An avionics master switch controls the two avionics busses.

Alternator (24-20-00)



A 60 amp alternator is on the forward side of the engine, below and to the right of the crankshaft.



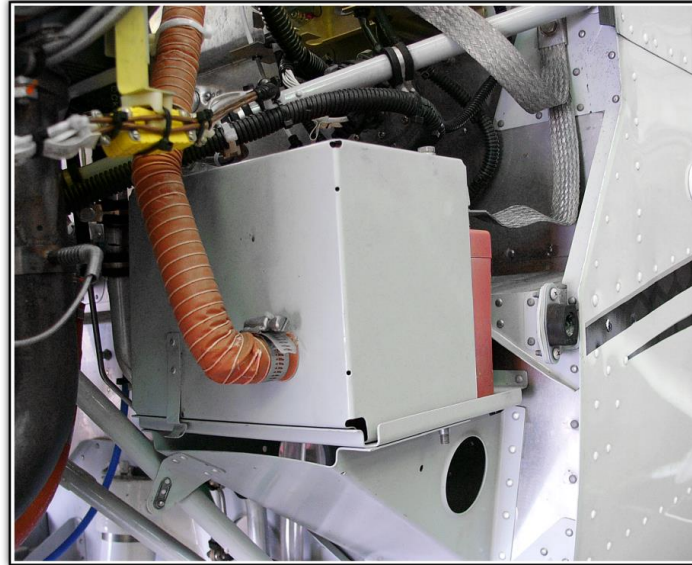
Refer to the Lamar TE04 MCU Test Set and the LI-0021 instructions for additional testing procedures for the alternator system. Refer to Electrical Power - General, Tools, Equipment, and Materials for listing.

ALTERNATOR TROUBLESHOOTING (24-20-00)

Troubleshooting charts in the Cessna Model 172 AMM include:

- Alternator Field Circuit Breaker Trips When Battery and Alternator Switches Are Turned On
- Alternator Field Circuit Breaker Trips When Battery and Alternator Switches Are Turned On. (Does Not Trip When Engine Is Not Running)
- Alternator Makes Abnormal Whining Noise, Noise Changes Pitch When Rpm Changes And Goes Away When Alternator Is Turned Off
- Low Voltage Light Does Not Go Out When Alternator and Battery Switches Are Turned On
- After Engine Start With All Electrical Equipment Turned Off, Charge Rate Does Not Taper Off In 1-3 Minutes
- Alternator Will Not Keep Battery Charged

Battery (24-30-00)



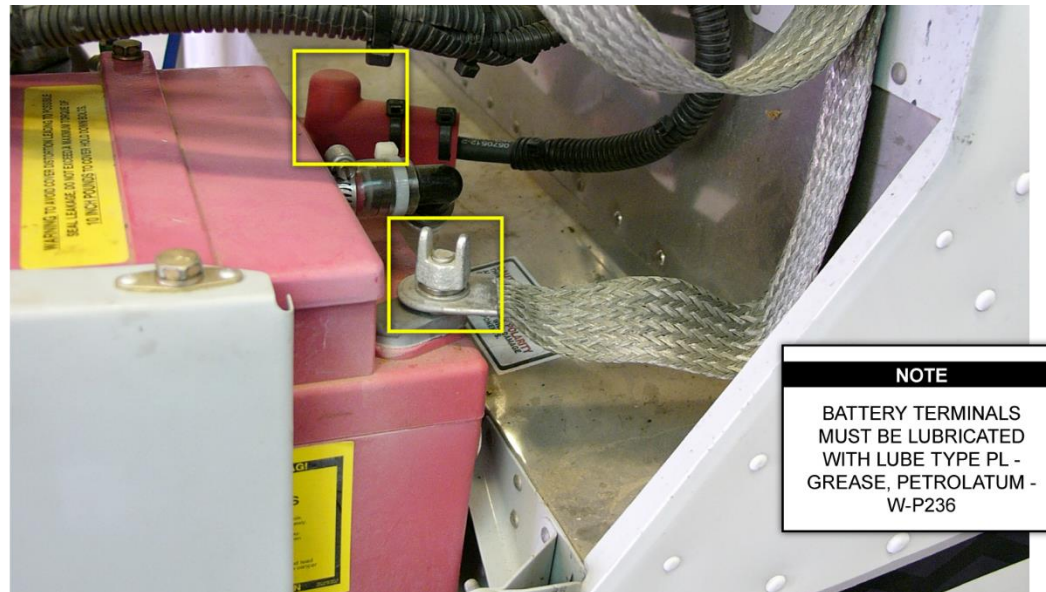
The standard aircraft main battery is a 24-Volt, 8.0 Amp-hour flooded lead-acid type battery. An optional 10.0 Amp-hour flooded type as well as a 13.6 Amp-hour sealed type have been approved. The aircraft main battery is on the front-left side of the firewall below the electrical power junction box.

Troubleshooting

Troubleshooting charts in the Cessna Model 172 AMM include:

- Battery Will Not Supply Power To Bus or is Incapable Of Cranking Engine

Battery Inspections And Servicing (12-17-00) (12-21-00) (5-10-00)



Inspections

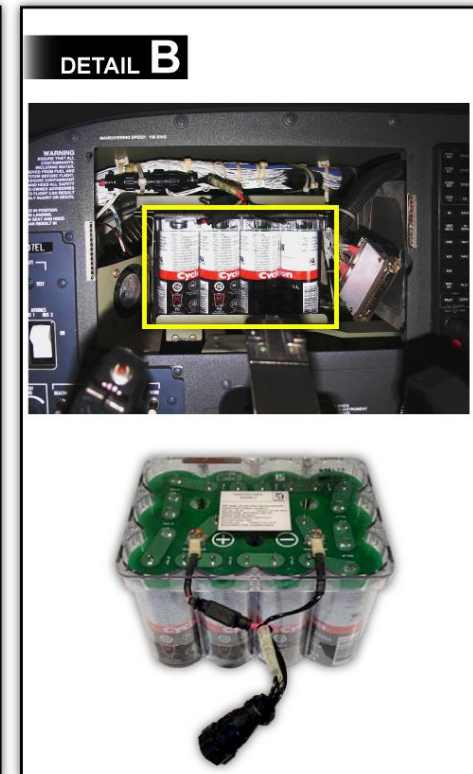
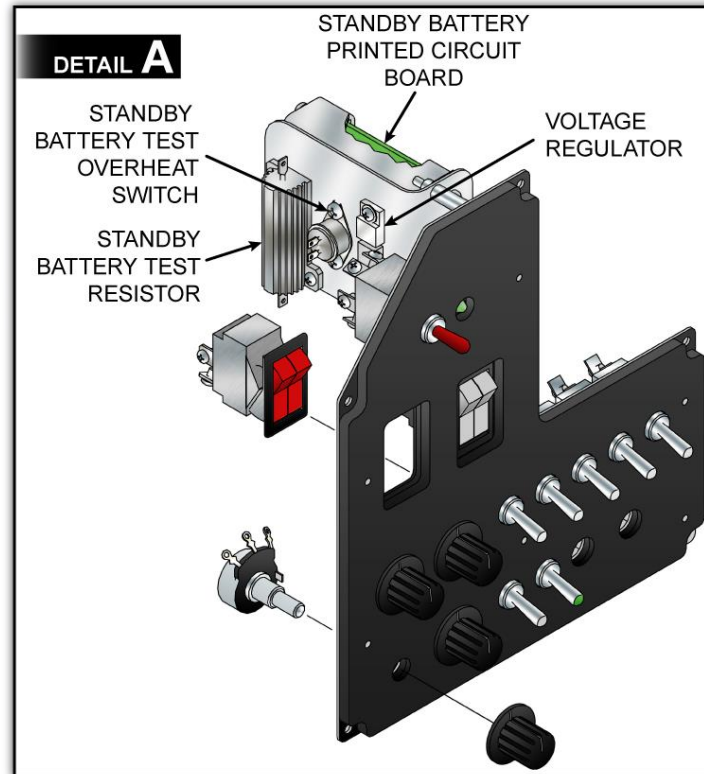
Main battery - Examine the general condition and security. (Every 100 hrs.)

Main battery box and cables – Clean and remove any corrosion. Examine the cables for routing, support, and security of connections. (Every 100 hrs.)

Servicing

Service the main aircraft battery every 100 hours. Servicing the flooded type aircraft main battery involves adding distilled water to maintain the electrolyte even with the horizontal baffle plate at the bottom of the filler holes, checking the battery cable connections, and neutralizing and cleaning off any spilled electrolyte or corrosion. Use bicarbonate of soda (baking soda) and water to neutralize electrolyte or corrosion. Follow with a thorough flushing with a wire brush, then coat with petroleum jelly before connecting. Inspect the battery box and clean if any corrosion is noted. Use distilled water, not acid or "rejuvenators" to maintain electrolyte level. 3.

Standby Battery (24-30-10)



The location of the standby battery is behind the Primary Flight Display (PFD). If there is no primary power source, the standby battery will give power to the essential bus for a limited amount of time depending on system load. The standby battery PC board controls and monitors the release of electrical power to and from the standby battery. The standby battery PC board is on the back of the switch panel.

STANDBY BATTERY (24-30-10)

Maintenance Practices



STANDBY BATTERY VOLTAGE

Do not let the battery voltage decrease below 20.0 volts or the standby battery can be damaged. Set the tester to stop discharge before the voltage drops to less than 20.0 volts. Voltage values less than 22.5 volts can decrease quickly, so monitor the voltage closely. If the voltage drops to less than 20.0 volts, charge the battery immediately and do the test again.



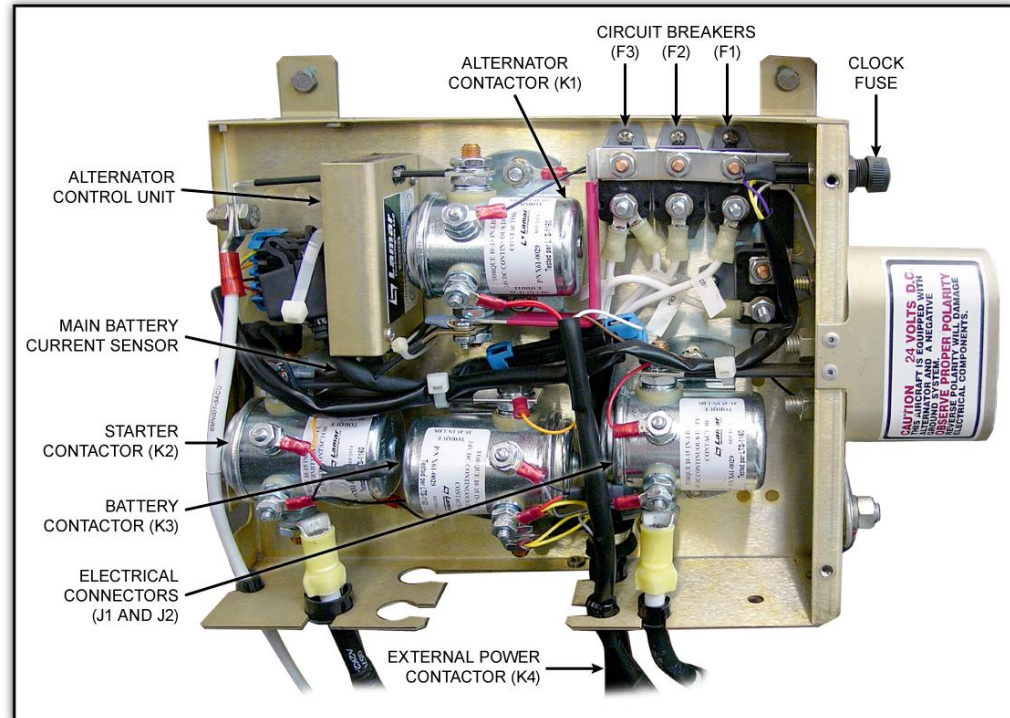
STANDBY BATTERY PCB

Make sure that you use a wrist strap when the standby battery PCB is removed. The standby battery PCB is sensitive to electrostatic discharge.

Maintenance Practices in the Cessna Model 172 AMM for the standby battery system include:

- Standby Battery Removal/Installation
- Standby Battery Storage
- Standby Battery Printed Circuit Board Removal/Installation
- Standby Battery Capacity Test
- Standby Battery Charging

Power Junction Box (24-60-00)



The power junction box, also referred to as a Master Control Unit (MCU), is on the forward, left side of the firewall. The power junction box has a battery relay, starter relay, alternator relay, current sensor, external power relay, alternator control unit, power distribution bus, and bus fuses (or circuit breakers as applicable). Electrical power flows to the two primary electrical busses through two 30A fuses, two 30A circuit breakers, or two 40A circuit breakers in the junction box.

POWER JUNCTION BOX (24-60-00)

External Power Receptacle

An external power receptacle is a part of the power distribution module. The receptacle allows the use of an external power source for cold weather starting or for lengthy maintenance work on electrical and avionics equipment. The receptacle is on the left side of the cowl near the firewall.

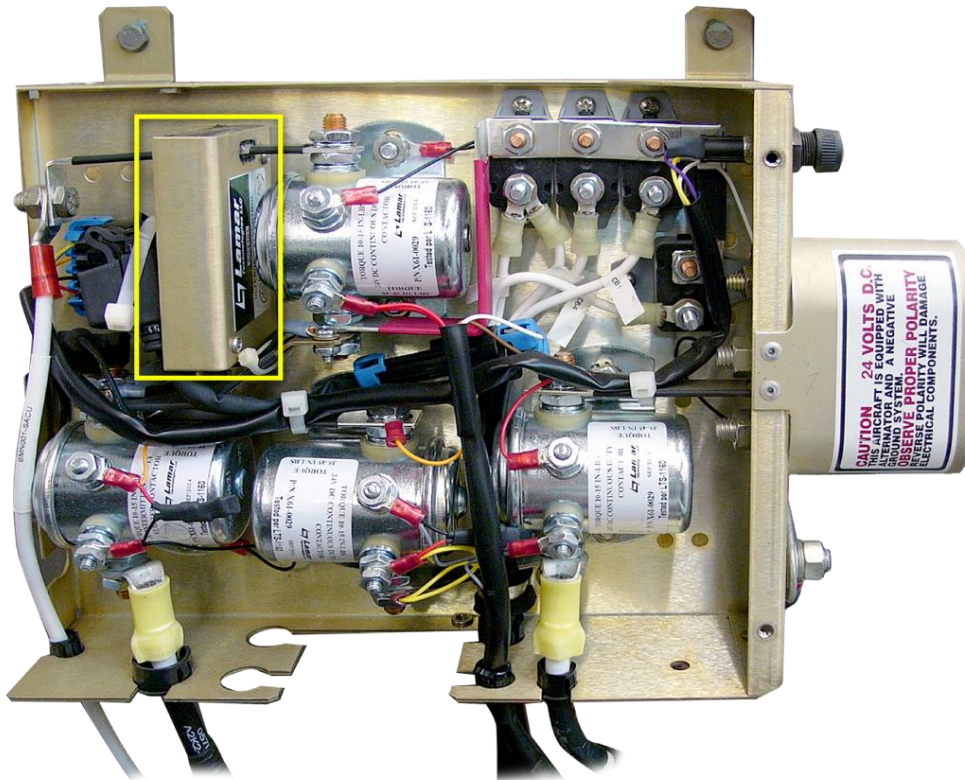


NOTE

EXTERNAL POWER FOR AVIONICS

Set the AVIONICS switches BUS 1 and BUS 2 to OFF if no avionics are required. If maintenance on the avionics equipment is required, a 28 VDC regulated and filtered external power source must be provided to prevent damage to the avionics equipment from transient voltages. Set AVIONICS switches BUS 1 and BUS 2 to OFF before starting the engine.

Alternator Control Unit (24-60-01)



The Alternator Control Unit (ACU) is inside the power junction box. The alternator system includes the ACU, Alternator Contactor, and alternator field circuit.

Alternator Control Unit (24-60-01)

The ACU functions are as follows:

Alternator Voltage Regulation - The ACU controls the alternator field circuit to supply a main bus voltage of approximately 28.5 volts.

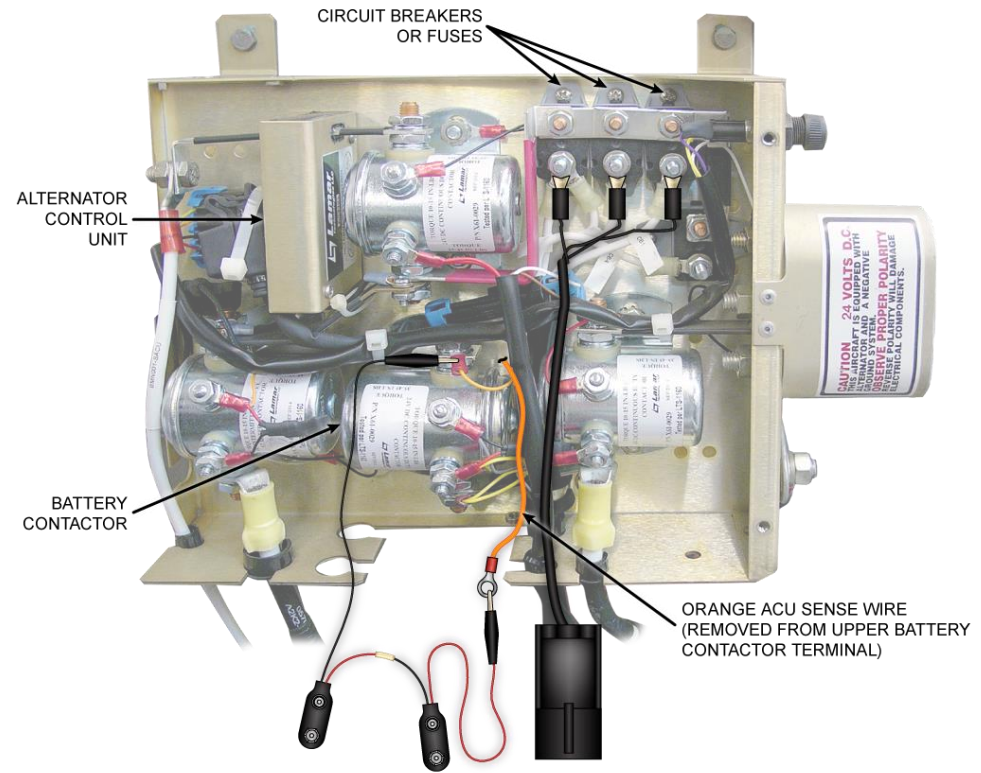
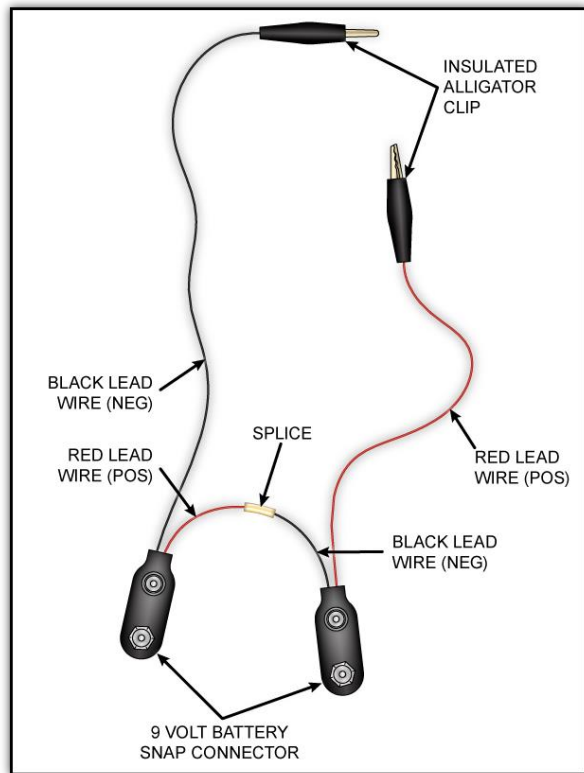
Low Voltage Annunciation - The ACU monitors the main bus voltage in the power junction box and supplies an output for low voltage (less than $24.5 +0.35$ or -0.35 volts) for the annunciation.

Over-voltage Protection - The ACU monitors the main bus voltage in the power junction box and disengages the aircraft ALT FIELD circuit breaker. This removes the power from the alternator system if there is an over-voltage condition greater than $31.75 +0.5$ or -0.5 volts.

Reverse Alternator Current Protection - The ACU monitors the alternator output current and disengages the aircraft ALT FIELD circuit breaker. This removes the power from the alternator system if there is a reverse alternator current. Excess Field

Current Protection - The ACU monitors the alternator field current and disengages the aircraft ALT FIELD circuit breaker. This removes the power from the alternator system if there is an excessive field current.

ALTERNATOR CONTROL UNIT MAINTENANCE PRACTICES (24-60-01)



ALTERNATOR CONTROL UNIT MAINTENANCE PRACTICES (24-60-01)

Over-voltage Protection Circuit Test

The ACU Over-voltage Protection Circuit must be tested in accordance with the time limits in Chapter 5 (*Cessna Model 172 AMM*), Inspection Time Limits. Use one of the two procedures that follow to do the test of the Over-voltage Protection Circuit. The recommended procedure uses the Lamar TE04 MCU Test Set. The external battery procedure can be used if a TE04 test set is not available.

Over-voltage Protection Circuit Test with External Batteries (*Reference Cessna Model 172 AMM for detailed procedures*)



NOTE

OVER-VOLTAGE PROTECTION CIRCUIT TEST

It is necessary to use two general non-rechargeable 9 volt batteries in new condition to apply a temporary over-voltage condition on the ACU Sense wire. A locally fabricated battery test harness is also necessary. The test harness uses two 9-volt snap connectors and two insulated alligator clips. (Refer to Figure) For ground safety reasons use only general household 9 volt batteries which have a relatively low ampere rating.

Circuit Breakers (24-61-00)



On airplanes with Garmin G1000, the circuit breaker panel is on the left lower instrument panel, below the pilot's control wheel. The circuit breaker panel has electrical circuit breakers and the MAGNETO switches.

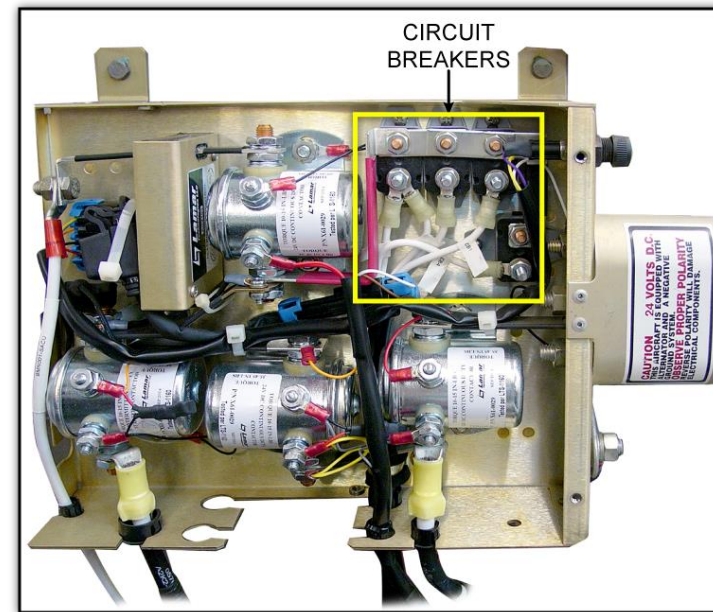
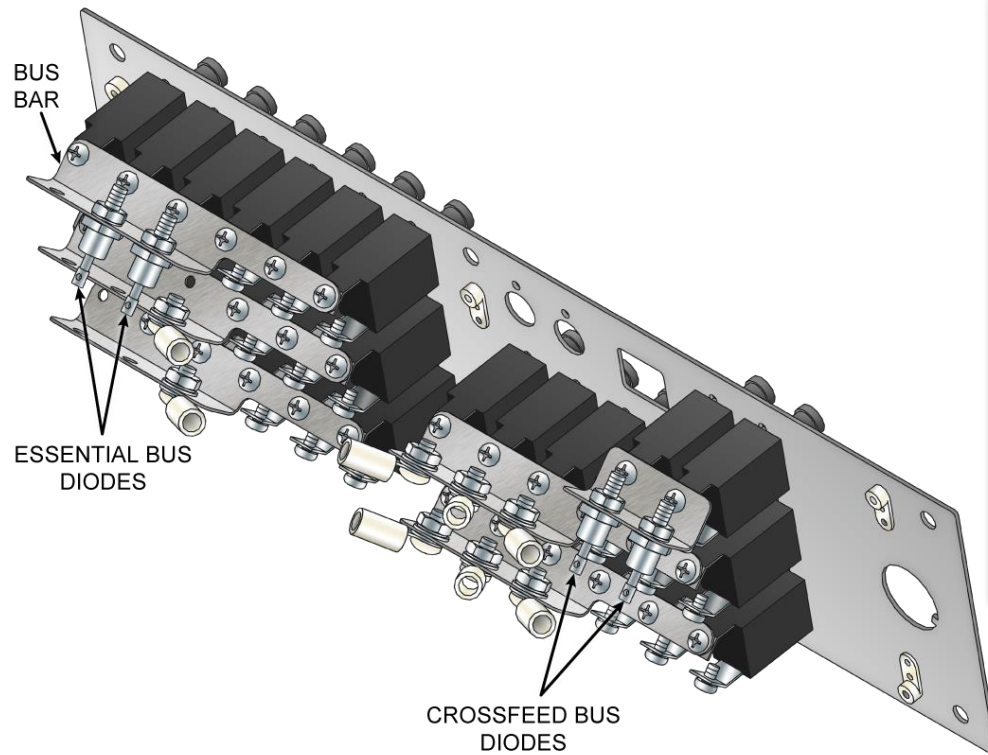
All circuit breakers on ESSENTIAL BUS, AVIONICS BUS 1 and AVIONICS BUS 2 can be opened, or disengaged from the electrical system, by pulling straight out on the outer ring for emergency electrical load management. Using a circuit breaker as a switch is discouraged since the practice will decrease the life of the circuit breaker.

Not all circuit breakers on ELECTRICAL BUS 1, ELECTRICAL BUS 2, and the CROSSFEED BUS can be opened or disengaged. The power distribution module uses three push-to-reset circuit breakers for the electrical bus feeders. The standby battery uses a fast blow automotive type fuse. The standby battery current shunt circuit uses two field replaceable fuses located on the standby battery controller printed circuit board.

Maintenance Practices

Circuit breaker maintenance practices are typical.

Essential and Crossfeed Bus Diodes (24-61-01)



Airplanes with Garmin G1000 have an essential bus and a crossfeed bus. The essential and crossfeed bus diodes are on the circuit breaker panel. The diodes allow power to the essential and crossfeed busses from the two primary buses and at the same time isolate the two primary busses.

Essential And Crossfeed Bus Diodes (24-61-01)

Maintenance Practices



CIRCUIT BREAKER MAINTENANCE

Do not remove bus wires from the circuit breakers with the MASTER BAT or the STDBY BATT switches in the ON position.

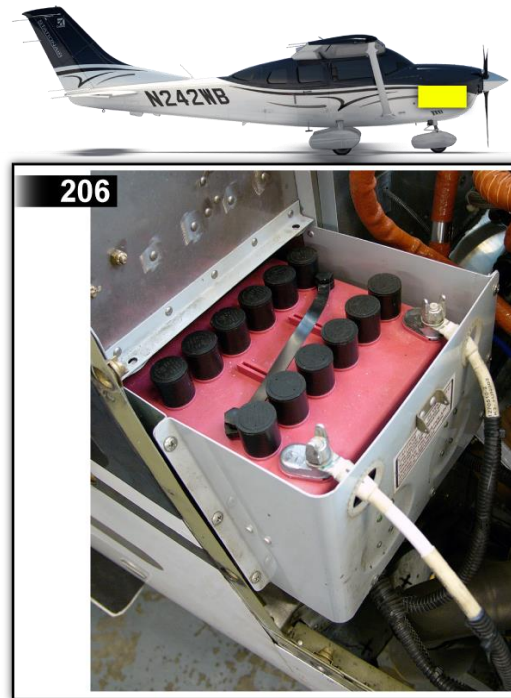


DIODE REPLACEMENT

When the diodes are replaced, inspections are required to make sure that all of the diodes operate correctly.

Model Differences

182/206 DIFFERENCES - ELECTRICAL POWER (24-00-00) BATTERY LOCATION

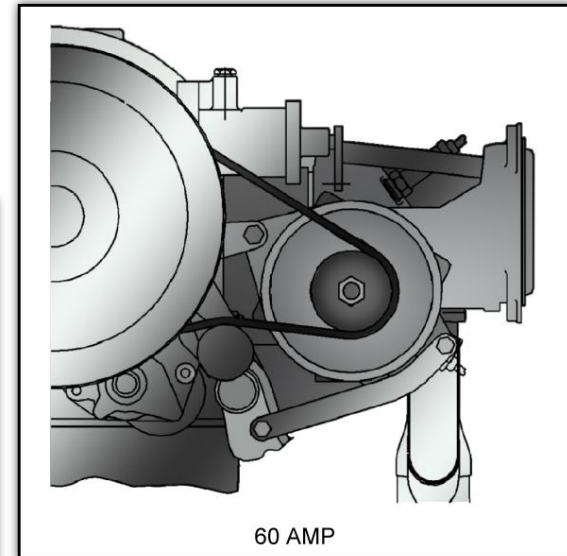
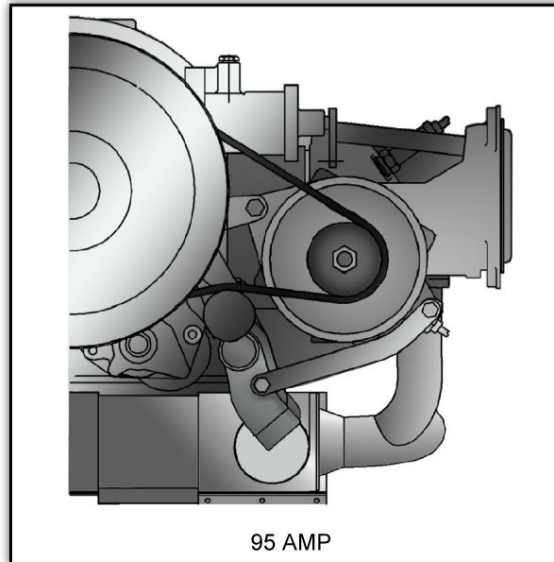


182 - The battery is a 24-Volt, 12.75 Amp-hour or an optional heavy-duty 15.5 Amp-hour flooded lead acid type. Either of these batteries can be installed. The battery is installed in the tailcone, aft of the baggage compartment on the left side.

206 - The battery is a 24-Volt, 12.75 Amp-hour, flooded lead-acid type. It is installed in the battery box on the front-right side of the firewall. In airplanes with the optional propeller heat, the battery is a heavy duty 24-Volt, 15.5 Amp-hour, lead-acid type.

182/206 - DIFFERENCES ELECTRICAL POWER- GENERAL (24-00-00) ELECTRICAL PANEL**Electrical Panel Difference**

- The 182 and 206 standby Battery Switch is different from the 172.

206 DIFFERENCES - ALTERNATOR MAINTENANCE PRACTICE (24-20-00)

The 206 Alternator Maintenance Practice consist of:

- Alternator Removal
- Alternator Installation

Refer to the Model 206 Maintenance Manual for full Procedures.

Either a 60-amp or a 95-amp alternator is installed on the forward left side of the engine

Alternator Removal/Installation

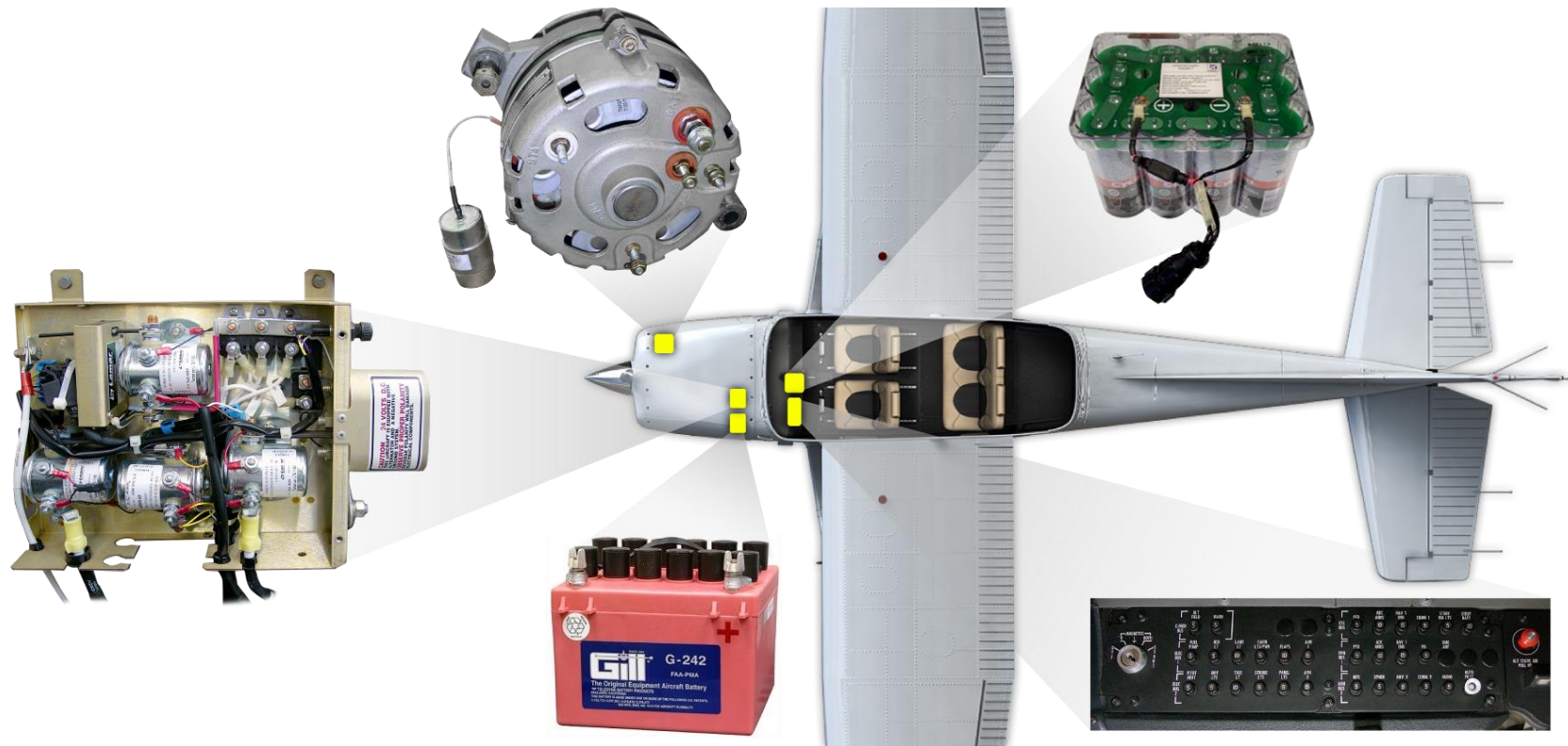
**ALTERNATOR REMOVAL/INSTALLATION 1**

- Make sure that you are careful when you remove and install the power and ground ring terminals.
- Do not bend or twist the terminals.
- If possible, always remove the terminals from the alternator before you remove the alternator.
- If possible, always install the terminals to the alternator after you install the alternator.
- If you must remove or install the alternator with the terminals installed, make sure that the terminals do not bend or twist.
- After the terminals are installed, make sure that the cables do not apply a load to the terminals that can cause them to bend or twist.

**ALTERNATOR REMOVAL/INSTALLATION 2**

On airplanes with a new alternator belt installed and on new airplanes, do a check of the belt tension again in the first 10 to 25 hours of operation.

ELECTRICAL POWER SYSTEM REVIEW



ATA33 - Lighting



LESSON OBJECTIVES

- Define the general layout and characteristics of the lighting system
- Identify special tooling and test equipment used with the lighting system
- Explain safety precautions related to the lighting system
- Explain maintenance practices important to the lighting system
- Explain normal system operations
- Explain procedures for replacement of unique components

Lighting Overview

Interior lighting includes:

- Combination of dimmable crew area flood lighting
- Internally lit switch and circuit breaker panels
- Avionics panel lighting
- Standby instrument lighting
- Pedestal lighting
- Pilot control wheel map lighting
- Passenger area flood lighting



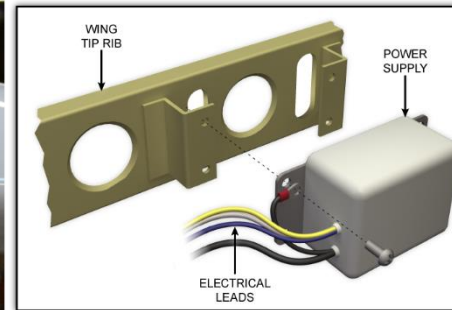
Exterior lighting includes:

- LED Navigation lights on the wing tips and the tip of the rudder
- LED Landing/recognition/taxi lights on left and right wing leading edges
- LED flashing beacon on top of the vertical stabilizer
- Strobe light on each wing tip

Two recessed courtesy lights in the lower surfaces of each wing supply lighting for each cabin door area.

NAVIGATION LIGHTS (33-40-00)

The airplane has fixed intensity navigation lights. Navigation lights are on the left wing tip, right wing tip and the top of the rudder. LED lenses for all three navigation lights are clear. The LEDs illuminate on the right wing tip green, the left wing tip is red, and the tailcone is white. Move the switch/circuit breaker to the NAV position to activate the navigation lights. This position supplies power to all three lights at the same time.

STROBE LIGHTS (33-40-00)

The airplane has pulsing strobe lights. The strobe and lens assembly are both clear. Activate the strobes by moving the switch/circuit breaker to the STROBES position. This position supplies power to the right and left power supply, providing pulsed energy to fire the strobes. The strobe power supply mounts to the wing tip rib.

**NOTE****POWER SUPPLY ACCESS**

It will be necessary to remove the wing tip to gain access to electrical connector and power supply.

VERTICAL FIN BEACON (33-41-00)

The vertical fin beacon is on top of the vertical fin cap assembly and provides a flashing red light to aid in airplane recognition. Move the LIGHTS BCN/OFF switch to the BCN position to start the flashing beacon. This position supplies power to the light. Internal circuitry makes the light flash on and off at approximately 50 cycles per minute.

LANDING/TAXI LIGHTS - LED (33-43-00)

The Landing/Taxi/Recognition light has 18 high intensity LEDs whose light emitting angles are determined by three lenses. Each lens diffuses the light for a string of 6 LEDs. The two outboard lenses have a high intensity narrow beam spread while the center lens (known as the spreader lens) has a lower intensity but broader horizontal beam spread.

The Landing/Taxi/Recognition light assembly has three functions:

- The outer elements illuminate with the Landing Light position.
- On the ground, the RECOG/TAXI Light position operates the center element.
- In flight, the RECOG/TAXI Light position briefly energizes the three elements in one light assembly, then the opposite light assembly flashes. This repeats as long as the switch is on.

The Recognition lights (center position) alternately flash in flight if there is an Intruder alert with the TIS (Traffic Information System) or TCAS I operating.



Lighting System Review



LIGHTING SYSTEM REVIEW

Interior lighting includes:

- Combination of dimmable crew area flood lighting
- Internally lit switch and circuit breaker panels
- Avionics panel lighting
- Standby instrument lighting
- Pedestal lighting
- Pilot control wheel map lighting
- Passenger area flood lighting

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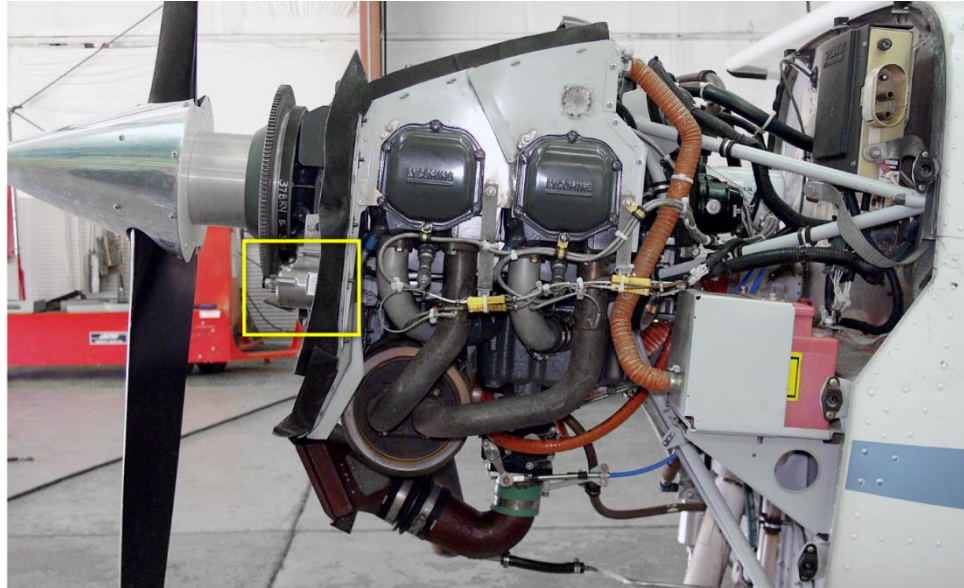
ATA80 - Starter



LESSON OBJECTIVES STARTER

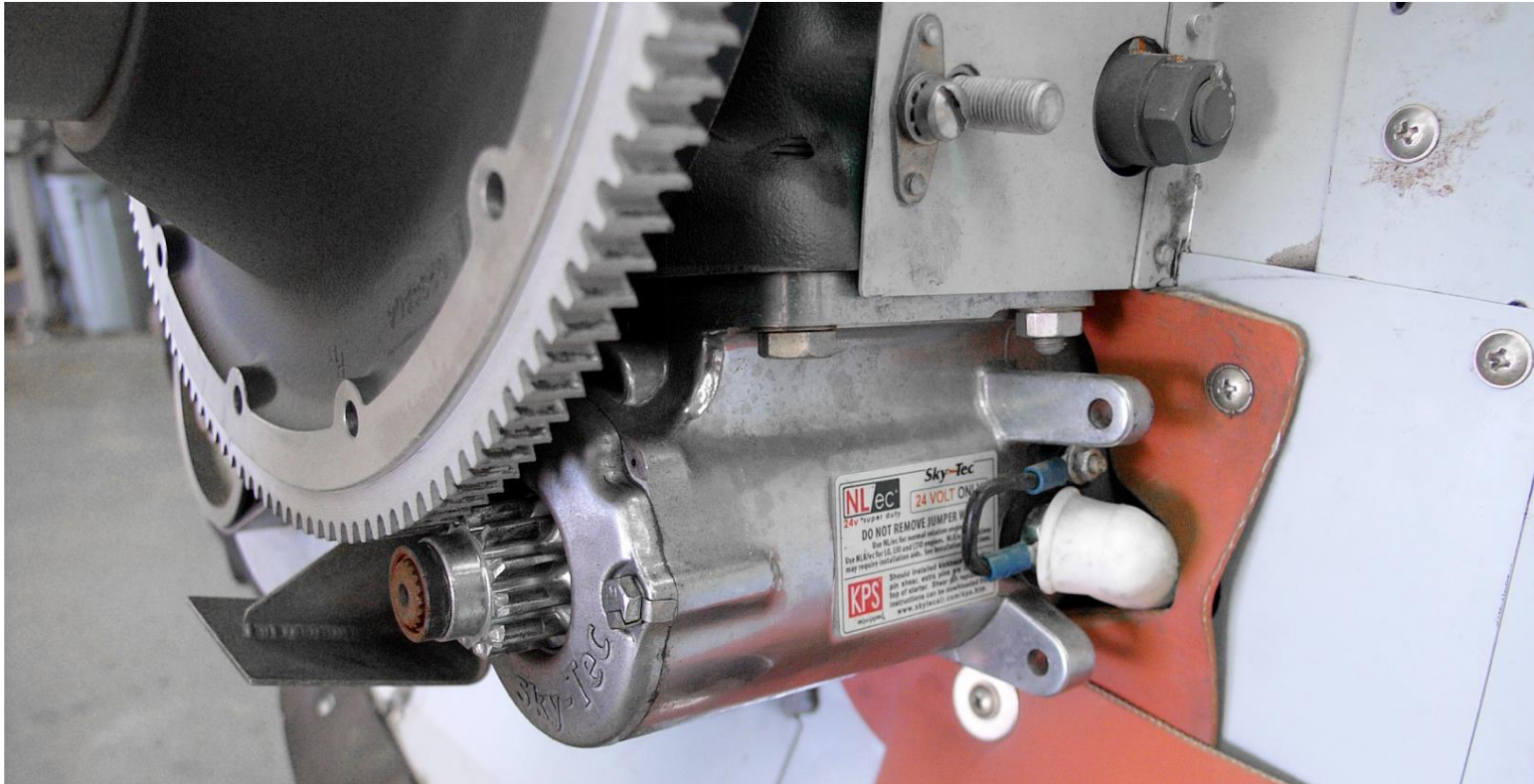
- Explain safety precautions related to the starter
- Explain maintenance practices important to the starter
- Explain normal system operations
- Explain procedures for replacement of unique components

SYSTEM OVERVIEW



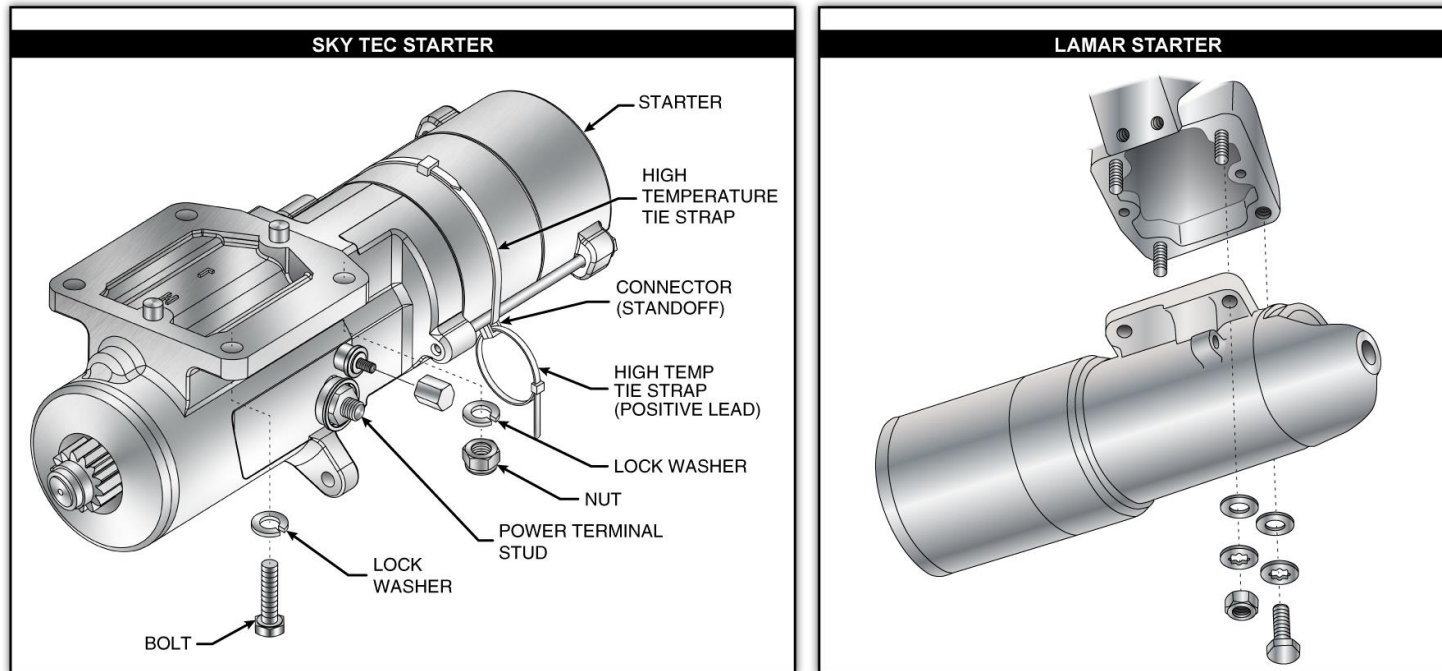
The airplane has a direct drive 24 VDC starter at the front (propeller end) lower left side of the engine.

Starter Description/Operation (80-00-00)



The airplane has a direct drive 24 VDC starter at the front (propeller end) lower left side of the engine. The ignition key in the instrument panel operates the starter solenoid. When the solenoid energizes, its contacts close and an electrical current energizes the starter. A pinion gear in the starter engages the crankshaft ring gear. When the engine reaches a given speed, centrifugal action decouples the starter pinion from the crankshaft ring gear.

Starter Maintenance Practices (80-10-00)

**Maintenance Practices**

Maintenance Practices included in the Cessna AMM:

Starter Removal/Installation

Bendix Drive Assembly Cleaning and Lubrication

Starter Maintenance Practices



For More Information

REFERENCE

Reference Lycoming PC-306-12 for Parts Breakdown Cleaning and Lubrication



CAUTION

BENDIX DRIVE CLEANING

Use only a clean petroleum spirit to clean the Bendix Drive. Do not use any other type of solvent. Do not use grease, oil or graphite lubricants. Use only silicone spray lubricants which are recommended for correct operation.



NOTE

APPROVED STARTERS

See latest edition of Textron Lycoming Service Instruction No. 1154 for complete listing of FAA approved starters, generators, alternators, regulators and relays.

STARTER REMOVE AND INSTALL

Remove

Removal practices are typical

Install



Good Points

STARTER INSTALLATION

The three nuts must be threaded on to the studs at the same time to prevent binding. The starter has two alignment pins that are precision machined. Ensure proper alignment when installing, insure that the starter base is flush against the engine case.



Good Points

STARTER INSTALLATION

During the installation or removal of the starter electrical lead for any maintenance purposes, it is critical to hold the bottom nut on the electrical starter stud with a wrench to prevent this stud from rotating when torquing or removing the nut (on top of the stud) that attaches the power cable to the starter. Rotation of the starter stud identified in will cause internal damage to the starter. Starter installation has unique maintenance practices. (Ref. 80-10-00 Model 172s AMM)

STARTER REMOVE AND INSTALL

Install

- (1) With the one bolt and three nuts, attach the starter to the engine crankcase. Step torque the fasteners diagonally.
 - (a) On Sky-Tec starters, torque the bolt and nuts to 204 inch-pounds.
- (2) Attach the alternator attach bracket to the starter with the bolt and torque.
 - (a) On Sky-Tec starters, torque the bolt to 204 inch-pounds.
- (3) If necessary, reset the alternator belt tension.
- (4) Safety wire the bolt to the attach bracket.
- (5) Connect the positive lead to the starter. Make sure the protective boot fully covers the power terminal stud on the starter.
 - (a) On Sky-Tec starters, torque the nut on the power terminal stud to 50 inch-pounds, +5 or -5 inch-pounds.



NOTE

Sky-Tec Starters

Sky-Tec starters have a metric nut on the power terminal stud.

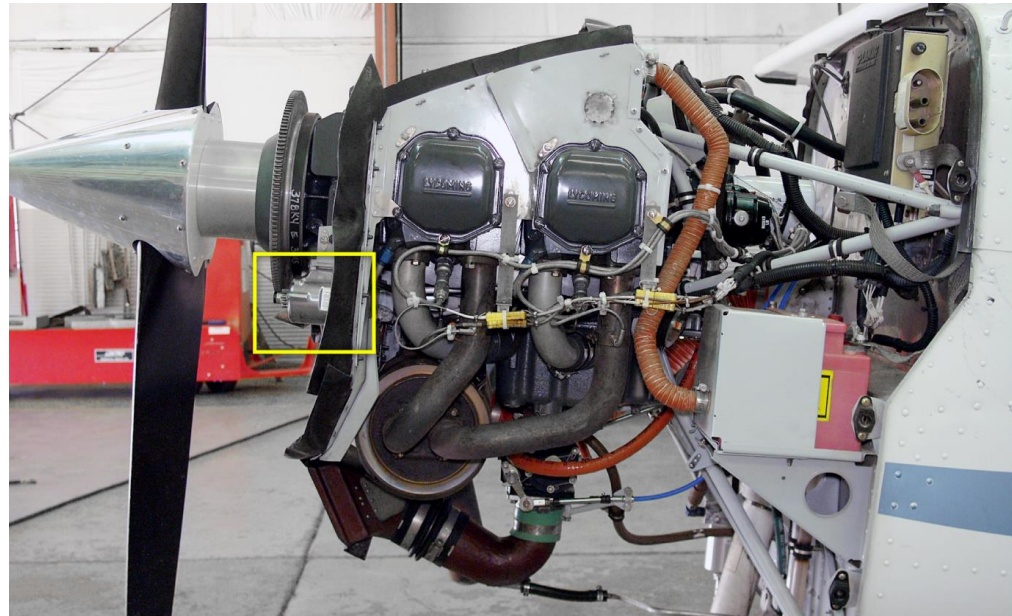
STARTER REMOVE AND INSTALL

Install

- (6) On Sky-Tec starters, use high-temperature tie straps and connector to attach the positive lead to the starter.
- (7) Attach the left front baffle to the engine assembly.
- (8) Attach the negative terminal to the battery.
- (9) Install the upper and lower engine cowling.

Starter Review

The airplane has a direct drive 24 VDC starter at the front (propeller end) lower left side of the engine.



Model Differences

206 DIFFERENCES - STARTER - MAINTENANCE PRACTICES (80-10-00)



- The 206 has a direct drive 24 VDC starter attached at the front (propeller end) lower left side of the engine.
- The ignition key operates the starter solenoid.
- Operation of the starter on the 206 is the same as on the 182.

206 DIFFERENCES - STARTER - MAINTENANCE PRACTICES (80-10-00)

Maintenance Practices:

Starter Removal/Installation

- To remove or install the starter follow the steps documented in the maintenance manual.

Bendix Starter Drive Assembly Cleaning/Lubrication

- Clean the Bendix starter drive assembly

	BENDIX STARTER DRIVE ASSEMBLY Use only a clean petroleum spirit. Do not use any other type of solvent.
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To properly lubricate the starter drive assembly follow detailed steps for Starter - Maintenance Practices in maintenance manual 80-10-00.

206 DIFFERENCES - STARTER - MAINTENANCE PRACTICES (80-10-00)**BENDIX STARTER DRIVE ASSEMBLY 2**

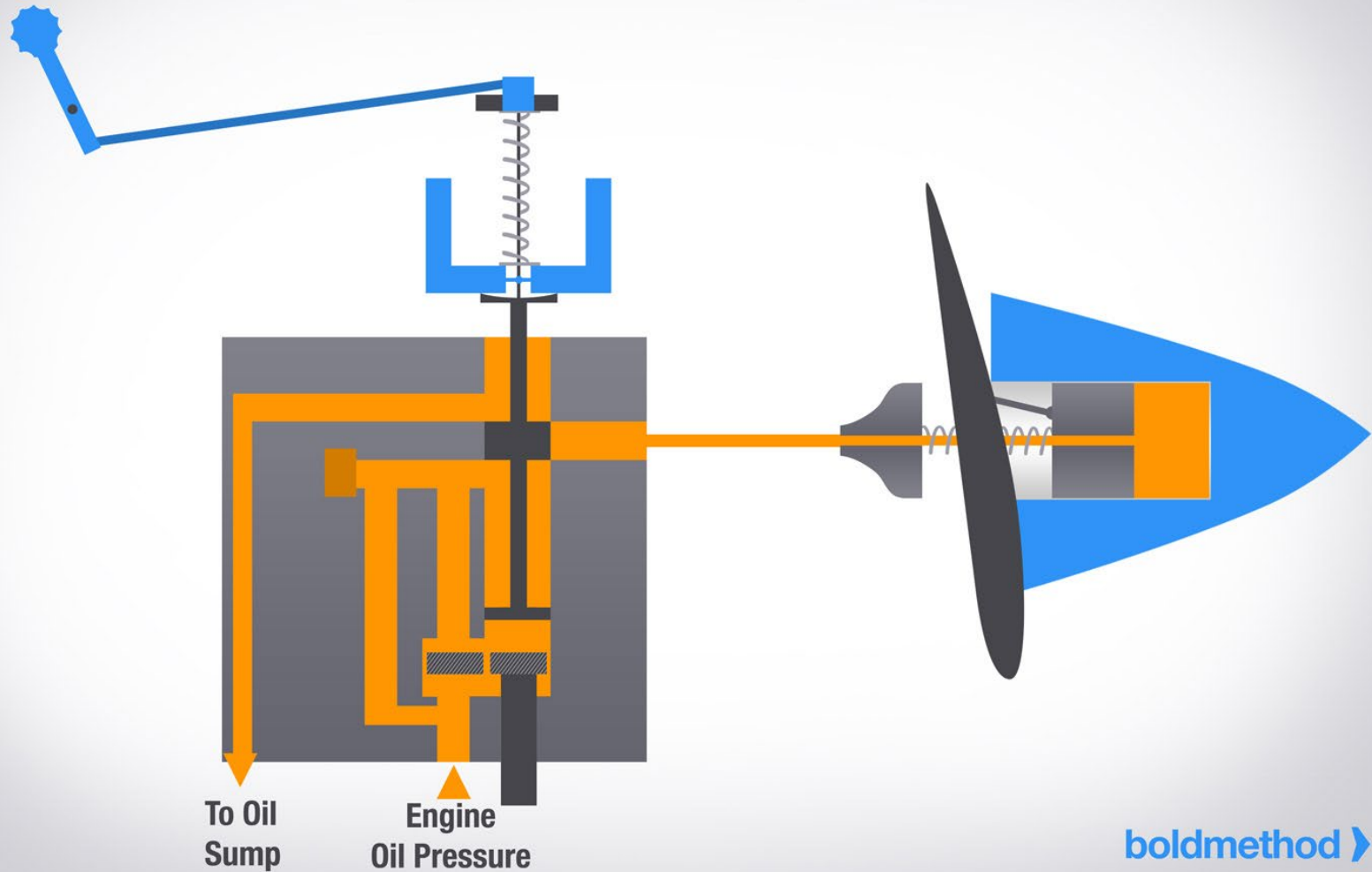
Do not use grease, oil or graphite lubricants. Use only silicone spray lubricants recommended for correct operation.

**LYCOMING SERVICE INSTRUCTION 1154L**

Lycoming service instruction 1154L gives the list of approved starters. However the Cessna 206 only has one approved starter because of the engine baffling.

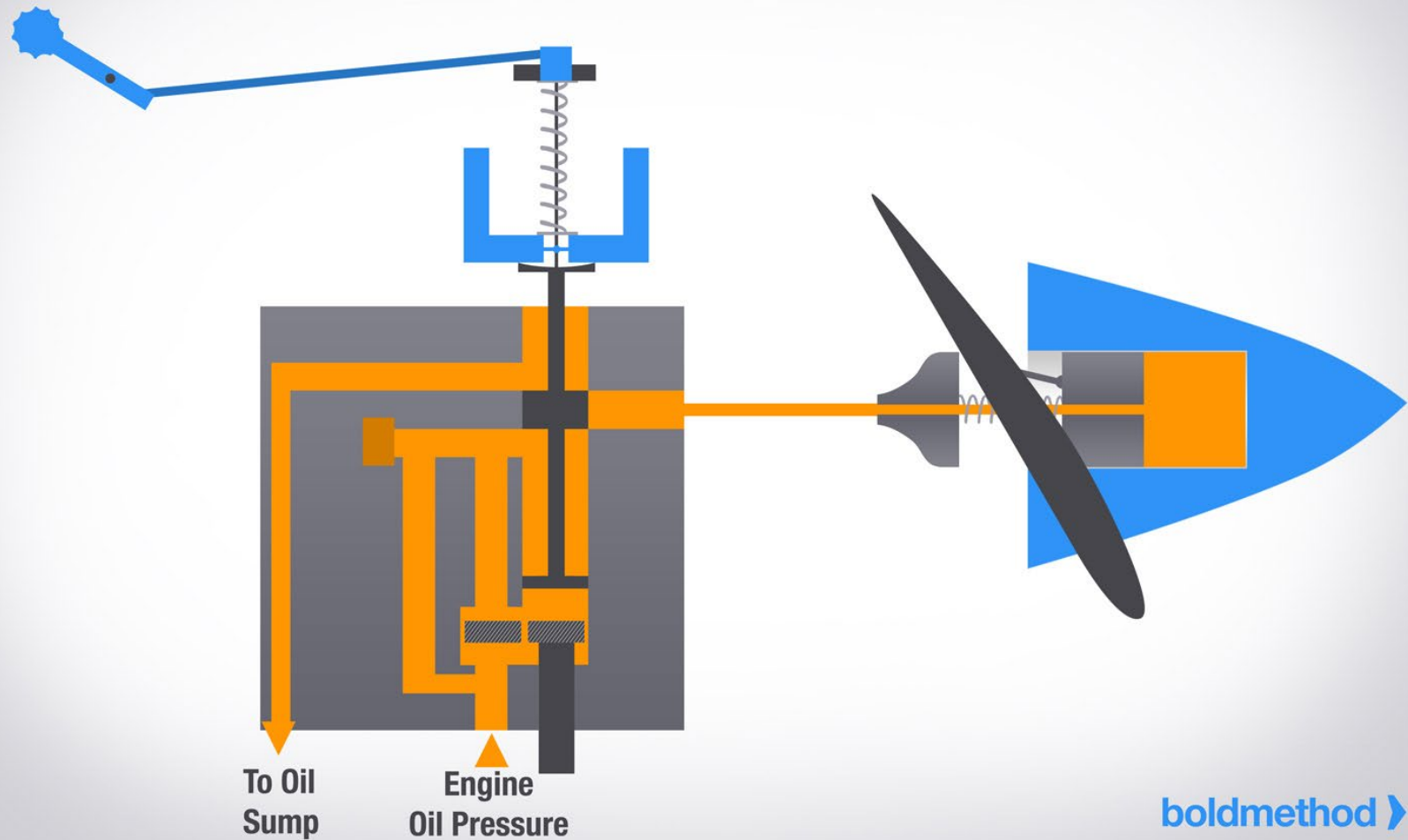
Constant Speed Prop - Takeoff Configuration

(Prop control forward, low pitch/high RPM propeller blade)



Constant Speed Prop - Cruise Configuration

(Prop control pulled back, high pitch/low RPM propeller blade)



FIXED PITCH & CONSTANT SPEED / VARIABLE PITCH PROPELLERS

REFERENCES: FAA-H-8083-3

OBJECTIVES The Student Will Understand The Elements Related to Constant Speed / Variable Pitch Propellers.

KEY POINTS

- Fixed-Pitch Propellers
- Constant Speed / Variable Pitch Propellers

ELEMENTS

1. Overview
2. Fixed Pitch Propeller Operation
3. Constant Speed/Variable Pitch Propeller Operation
4. Emergency Operations

SCHEDULE

1. Review Lesson Objectives
2. Review Lesson Material
3. Conclusion & Review

EQUIPMENT

1. White Board / Markers
2. References

CFI ACTIONS

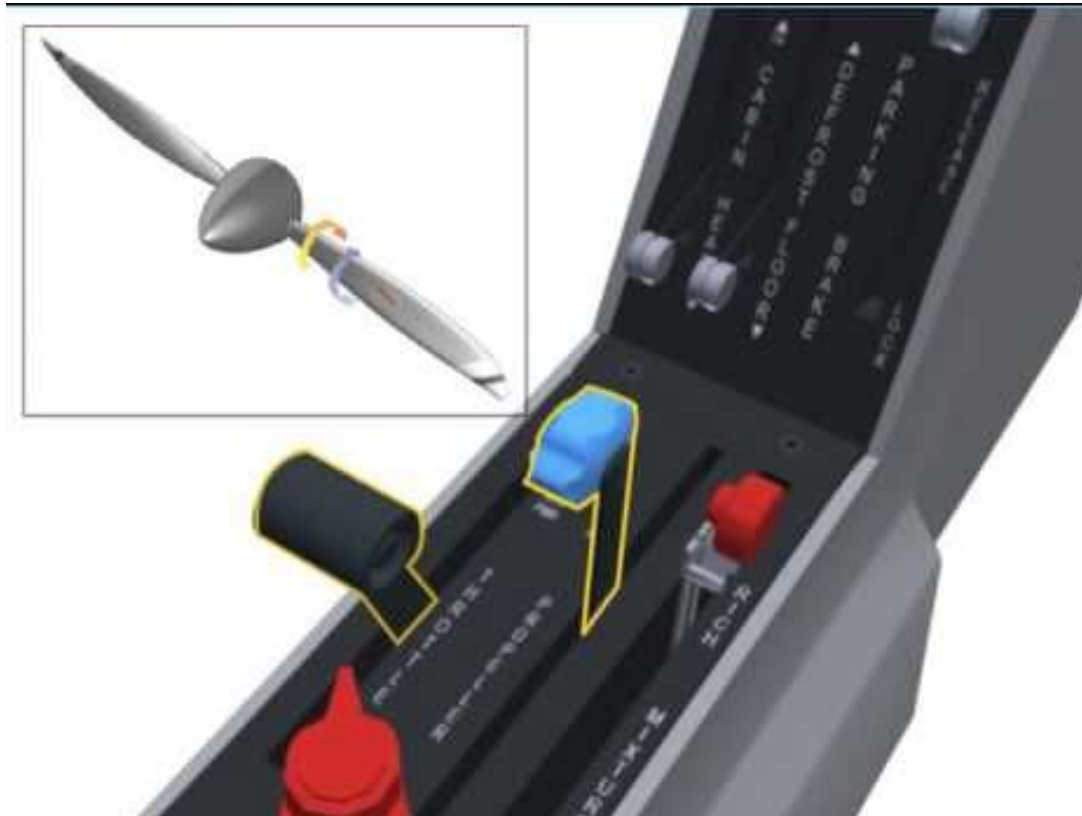
1. Review Lesson Objectives
2. Review Lesson Material
3. Ask / Answer Questions

STUDENT ACTIONS

1. Participate / Take Notes
2. Ask / Respond to Questions

COMPLETION STANDARDS The Student Can Explain the Operation and Use of Fixed-Pitch and Variable Pitch/Constant Speed Propellers

INSTRUCTOR NOTES: _____



INTRODUCTION

OVERVIEW

Review Objectives / Elements

WHAT

The propeller is a rotating airfoil held in place by a hub. It is just like a wing, facing forward which provides the necessary thrust to "propel" the aircraft through the air. It is subject to the same aerodynamic principles that apply to any airfoil.

WHY

Understanding how the propeller functions and the effects each control input has on the airplane, results in a more proficient pilot, with a better understanding of how to control the airplane.

HOW

OVERVIEW

- ➔ Normally Constructed of Fiberglass or Aluminum.
- ➔ The Powerplant Is Responsible for Providing the Power to Rotate the Propeller.

MULTIPLE POWERPLANT METHODS ARE USED

- ➔ Pull-type: (Piper Cherokee)
- ➔ Push-type: (Rutan Model 61 Long-EZ)
- ➔ Push-pull type: (Cessna Skymaster)

THE AMOUNT OF THRUST PRODUCED DEPENDS ON

- ➔ The shape of the airfoil
- ➔ The Angle of Attack (AoA) of the propeller blade
- ➔ The Revolutions Per Minute (RPM) of the engine

PROPELLER AERODYNAMICS

ROTATING PROPELLER

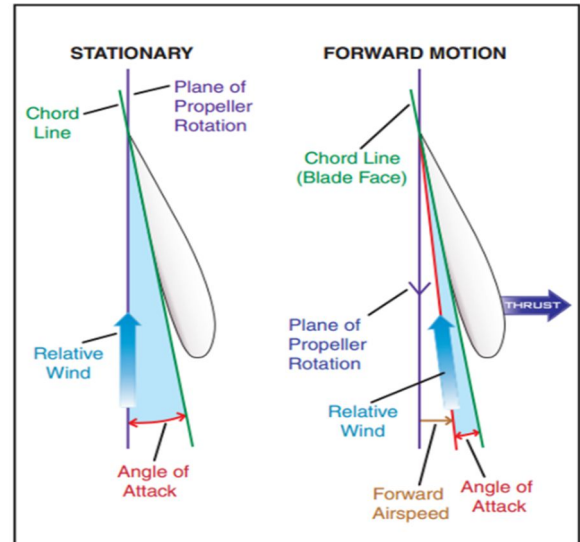
→ As the blade rotates, there are differences in the actual speed of the various portions of the blade

- ⇒ The tip of the blade travels faster than the part near the hub because it travels a greater distance than the hub in the same length of time
- ⇒ The propeller itself is aerodynamically twisted so blade angle changes from hub to tip

ANGLE OF INCIDENCE

→ Changing the angle of incidence (pitch) from the hub to the tip to correspond with the speed produces uniform lift throughout the length of the blade

- ⇒ The greatest angle of incidence (highest pitch), is at the hub while the smallest angle of incidence (smallest pitch) is at the tip
 - ⇒ A propeller blade designed with the same angle of incidence throughout its entire length would be inefficient because as airspeed increases in flight, the portion near the hub would have a negative angle of attack while the blade tip would be stalled



TYPES OF PROPELLERS

- Fixed Pitch
- Constant-Speed / Adjustable Pitch



FIXED-PITCH PROPELLER

- Designed with Fixed Blade Angles Which Are Set by The Manufacturer.
- Blade angle cannot be changed

ADVANTAGES:

- Low weight
- Simplicity
- Low costs

TWO TYPES OF FIXED-PITCH PROPELLERS:

CLIMB PROPELLER

- ⇒ Has a lower pitch, causing less drag
 - ▮ Less drag results in higher RPM and more horsepower capability, which increases performance during takeoffs and climbs, but decreases performance during cruising flight

CRUISE PROPELLER

- ⇒ Has a higher pitch, therefore more drag
 - ▮ More drag results in lower RPM and less horsepower capability, which decreases performance during takeoffs and climbs, but increases efficiency during cruising flight
 - ▮ Since a fixed-pitch propeller achieves the best efficiency only at a given combination of airspeed and RPM, the pitch setting is ideal for neither cruise nor climb and must compromise between the two
 - ▮ The propeller is usually mounted on a shaft, which may be an extension of the engine crankshaft
 - » In this case, the RPM of the propeller would be the same as the crankshaft RPM
 - ▮ On some engines, the propeller is mounted on a shaft geared to the engine crankshaft
 - » In this type, the RPM of the propeller is different than that of the engine

TACHOMETER

- In a fixed-pitch propeller, the **tachometer is the indicator of engine power**
- Calibrated in hundreds of RPMS, giving a direct indication of the engine and propeller RPM
 - ⇒ RPM is regulated by the throttle, which controls the fuel/air flow to the engine

➔ **At a given altitude, the higher the tachometer reading, the higher the power output of the engine**

⇒ As altitude changes, the position of the throttle must be changed to maintain the same RPM due to lower engine output, caused by a change in air density (higher/lower density altitude)

⇒ **As altitude is increased**, the throttle must be opened further to indicate the same RPM as at a lower altitude

⇒ **As altitude is decreased**, the throttle must be closed further to indicate the same RPM as at a higher altitude



➔ **The red line on the tachometer not only indicates maximum allowable r.p.m.; it also indicates the r.p.m. required to obtain the engine's rated horsepower**

⇒ The green arc on the tachometer indicates the normal operating range

⇒ When developing power in this range, the engine drives the propeller

⇒ Below the green arc, however, it is usually the wind milling propeller that powers the engine

⇒ Prolonged operation below the green arc can be detrimental to the engine

CONSTANT-SPEED PROPELLER

➔ **Controllable-Pitch Propeller Whose Pitch Is Automatically Varied in Flight by A Governor Maintaining Constant RPM Despite Varying Air Loads**

➔ **The most common type of adjustable-pitch propeller**

⇒ Also, referred to as a variable-pitch or controllable-pitch propeller

➔ **Uses oil and nitrogen pressure to control the pitch angle of the propeller, depending on the phase of flight**

ADVANTAGES

➔ **Converts a high percentage of brake horsepower (BHP) into thrust horsepower (THP) over a wide range of RPM and airspeed combinations**

➔ **More efficient than other propellers**

⇒ Allows selection of the most efficient engine RPM for the given conditions

➔ **An aircraft with a constant-speed propeller has two controls:**

THROTTLE LEVER

➔ **Controls power output and the propeller control regulates engine RPM (registered on the tachometer)**

⇒ Once a specific RPM is selected, a governor automatically adjusts the propeller blade angle as necessary to maintain the selected RPM

- ➡ For example, after setting the desired RPM during cruising flight, an increase in airspeed or decrease in propeller load will cause the propeller blade angle to increase as necessary to maintain the selected RPM



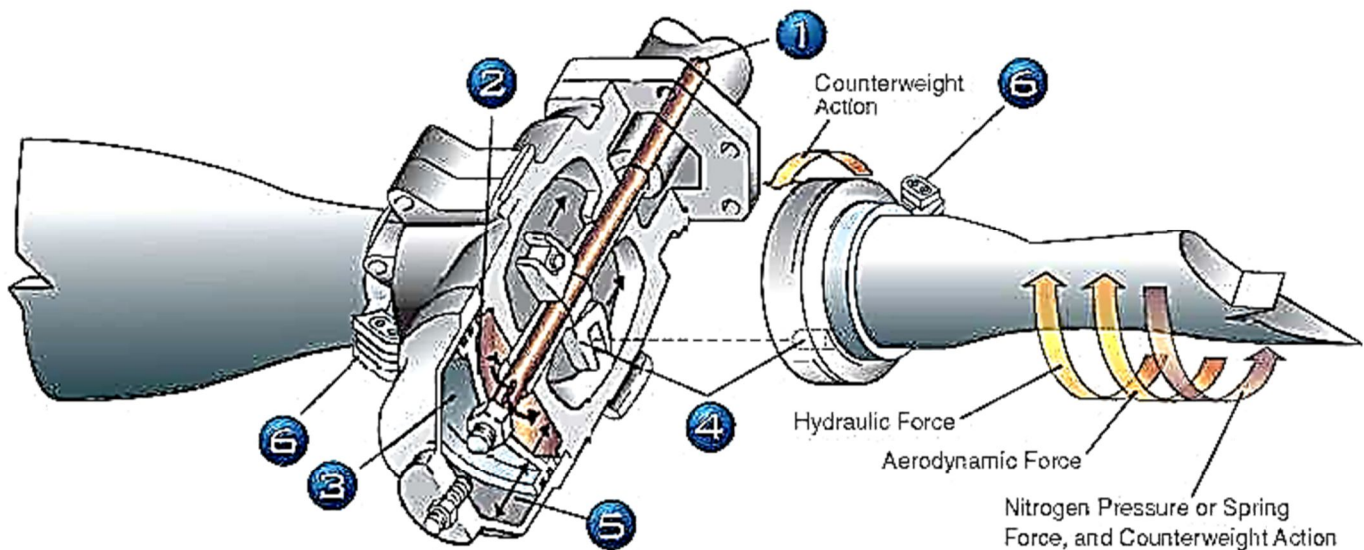
PROPELLER LEVER

➔ Propeller lever controls propeller pitch

- ⇒ This registers as pressure on the manifold gauge
 - ➡ The gauge measures the absolute pressure of the fuel/air mixture inside the intake manifold and is more correctly a measure of Manifold Absolute Pressure (MAP)
- ⇒ If the propeller blade angle is within the constant-speed range and not against either pitch stop, a constant engine RPM will be maintained
- ➔ **If the propeller blades contact a pitch stop, the engine RPM will increase or decrease as appropriate, with changes in airspeed and propeller load, as there is no more room to travel**
 - ⇒ *For example*, once a specific RPM has been selected, if aircraft speed decreases enough to rotate the propeller blades until they contact the low pitch stop, any further decrease in airspeed will cause engine RPM to decrease the same way as if a fixed-pitch propeller were installed

AOA CHANGES BASED ON

- ⇒ Blade Angle
- ⇒ Blade Speed
- ⇒ Velocity of Air



- 1 High-pressure oil enters the cylinder through the center of the propeller shaft and piston rod. The propeller control regulates the flow of high-pressure oil from a governor.
- 2 A hydraulic piston in the hub of the propeller is connected to each blade by a piston rod. This rod is attached to forks that slide over the pitch-change pin mounted in the root of each blade.
- 3 The oil pressure moves the piston toward the front of the cylinder, moving the piston rod and forks forward.
- 4 The forks push the pitch-change pin of each blade toward the front of the hub, causing the blades to twist toward the low-pitch position.
- 5 A nitrogen pressure charge or mechanical spring in the front of the hub opposes the oil pressure, and causes the propeller to move toward high-pitch.
- 6 Counterweights also cause the blades to move toward the high-pitch and feather positions. The counterweights counteract the aerodynamic twisting force that tries to move the blades toward a low-pitch angle.

OPERATION

PROPELLER LEVERS MOVES BACK (OR AIRCRAFT SLOWS)

- ➔ Flyweights move out (over speed)
- ➔ Speeder spring tension decreases
- ➔ Pilot valve moves upward
- ➔ Oil flows out of the propeller hub
- ➔ Propeller pitch increases

PROPELLER LEVERS MOVED FORWARD (OR AIRCRAFT ACCELERATES)

- ➔ Flyweights move in (under speed)
- ➔ Speeder spring tension increases
- ➔ Pilot valve moves downward
- ➔ Oil flows into the propeller hub
- ➔ Propeller pitch decreases

➔ **The Engine Is Started with The Propeller Control in The Low Pitch / High R.P.M. Position to Reduce the Load Or Drag of The Propeller and The Result Is Easier Starting and Warm-Up of The Engine**

- ⇒ During Warm-Up, The Propeller Blade Changing Mechanism Should Be Operated Slowly and Smoothly Through a Full Cycle to Determine Whether the System Is Operating Correctly, And to Circulate Fresh Warm Oil Through the Propeller Governor System
- ⇒ This is done by moving the propeller control the high pitch / low r.p.m. position, allowing the r.p.m. to stabilize, and then moving the propeller control back to the low pitch takeoff position
 - ▮ It should be remembered that the oil has been trapped in the propeller cylinder since the last time the engine was shut down
- ⇒ There is a certain amount of leakage from the propeller cylinder, and the oil tends to congeal, especially if the outside air temperature is low



Because of this, if the propeller isn't exercised before takeoff, there is a possibility that the engine may over-speed on takeoff

➔ **An airplane equipped with a constant-speed propeller has better takeoff performance than a similarly powered airplane equipped with a fixed-pitch propeller**

- ⇒ This is because with a constant-speed propeller, an airplane can develop its maximum rated horsepower (red line on the tachometer) while motionless
 - ▮ An airplane with a fixed-pitch propeller, on the other hand, must accelerate down the runway to increase airspeed and aerodynamically unload the propeller so that r.p.m. and horsepower can steadily build up to their maximum

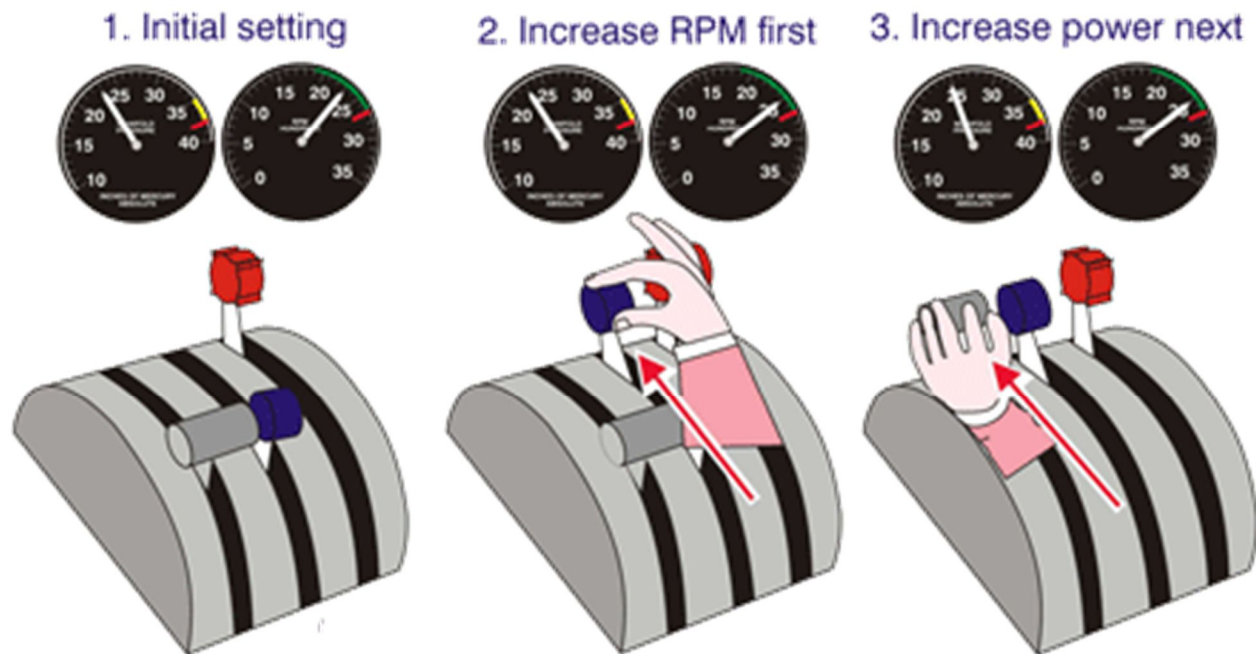
➔ **With a constant-speed propeller, the tachometer reading should come up to within 40 r.p.m. of the red line as soon as full power is applied, and should remain there for the entire takeoff**

➔ **Excessive manifold pressure raises the cylinder compression pressure, resulting in high stresses within the engine**

- ⇒ Excessive pressure also produces high engine temperatures
- ⇒ A combination of high manifold pressure and low r.p.m. can induce damaging detonation
- ⇒ To avoid these situations, the following sequence should be followed when making power changes
 - ▮ When increasing power, increase the r.p.m. first, and then the manifold pressure
 - ▮ When decreasing power, decrease the manifold pressure first, and then decrease the r.p.m.

HOW TO MAKE POWER CHANGES

INCREASING POWER IN AN AIRPLANE WITH A CONSTANT SPEED PROP



➔ **It is a common misconception that (in non-turbocharged engines) the manifold pressure in inches of mercury (inches Hg) should never exceed RPM for cruise power settings**

⇒ Whatever the combinations of RPM and manifold pressure listed in the POH/AFM charts-they have been flight tested and approved by the airframe and powerplant engineers for the respective airframe and engine manufacturer

➔ **With a constant-speed propeller, a power descent can be made without over-speeding the engine**

⇒ The system compensates for the increased airspeed of the descent by increasing the propeller blade angles

⇒ If the descent is too rapid, or is being made from a high altitude, the maximum blade angle limit of the blades is not sufficient to hold the RPM constant

 ➔ When this occurs, the r.p.m. is responsive to any change in throttle setting

➔ **Some pilots consider it advisable to set the propeller control for maximum r.p.m. during the approach to have full horsepower available in case of emergency**

⇒ If the governor is set for this higher r.p.m. early in the approach when the blades have not yet reached their minimum angle stops, the r.p.m. may increase to unsafe limits

- ⇒ However, if the propeller control is not readjusted for the takeoff r.p.m. until the approach is almost completed, the blades will be against, or very near their minimum angle stops and there will be little if any change in RPM.

IMPORTANT POINTS TO REMEMBER

- ➔ **In case of emergency, both throttle and propeller controls should be moved to takeoff positions**
- ➔ **All power changes should be made smoothly and slowly to avoid over-boosting and/or over-speeding**
- ➔ **A momentary propeller over-speed may occur when the throttle is advanced rapidly for takeoff**

⇒ This is usually not serious if the rated r.p.m. is not exceeded by 10% for more than 3 seconds

MANIFOLD PRESSURE GAUGE

- ➔ **On aircraft equipped with a constant-speed propeller, power output is controlled by the throttle and indicated by a manifold pressure gauge**

⇒ At a constant RPM and altitude, the amount of power produced is directly related to the fuel/air flow being delivered to the combustion chamber

▮ As the throttle setting is increased, more fuel and air flows to the engine and MAP increases

- ➔ **When the engine is not running, the manifold pressure gauge indicates ambient air pressure (i.e., 29.92 inches' mercury (29.92 "Hg))**

⇒ When the engine is started, the manifold pressure indication will decrease to a value less than ambient pressure (i.e., idle at 12 "Hg)

- ➔ **The face of the manifold pressure gauge contains a green arc to show the normal operating range, and a red radial line to indicate the upper limit of manifold pressure**

⇒ If manifold pressure is exceeded too frequently, this stress can weaken the cylinder components and eventually cause engine failure

- ➔ **Generally, manifold pressure (inches) should be less than the RPM**

⇒ A pilot can avoid conditions that over-stress the cylinders by being constantly aware of the RPM, especially when increasing the manifold pressure

- ➔ **When both manifold pressure and RPM need to be changed, avoid engine over-stress by making power adjustments in the proper order:**

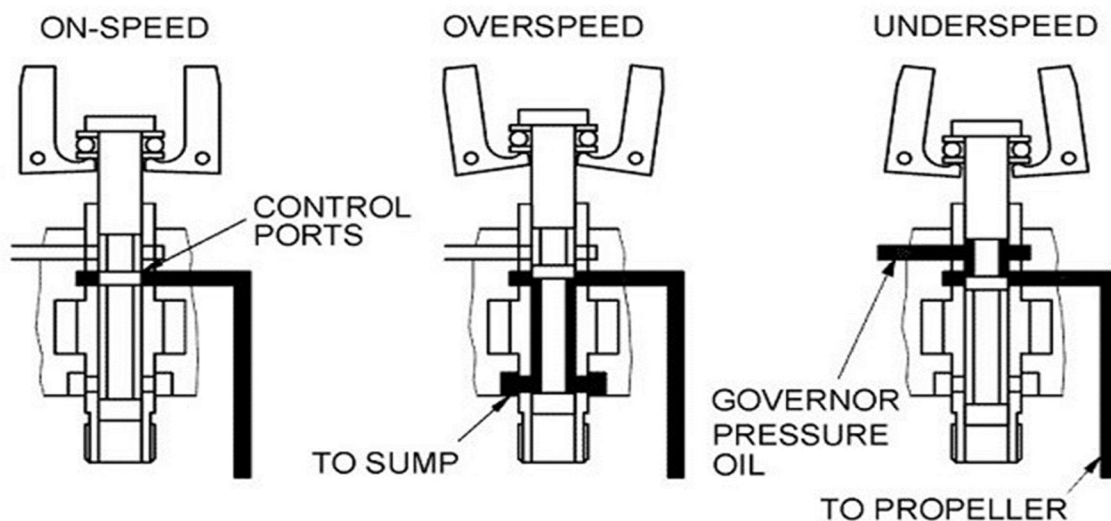
⇒ When power settings are being decreased, reduce manifold pressure before reducing RPM



- ▮ If RPM is reduced before manifold pressure, manifold pressure will automatically increase, possibly exceeding the manufacturer's tolerances
- ⇒ When power settings are being increased, reverse the order-increase RPM first, then manifold pressure
- ▮ The engine and/or airframe manufacturer's recommendations should be followed to prevent severe wear, fatigue, and damage to high-performance reciprocating engines
- ➔ **Engine failure or power loss is indicated on the manifold gauge as an increase in manifold pressure to a value corresponding to the ambient air pressure at the altitude where the failure occurred**
- ➔ **On takeoffs from low elevation airports, the manifold pressure in inches of mercury may exceed the r.p.m.**
 - ⇒ This is normal in most cases.
 - ⇒ The pilot should consult the AFM/POH for limitations

GOVERNOR

- ➔ **The governor is a mechanical device, which is used to sense the speed of a moving device and maintain its speed using mechanical feedback**
 - ⇒ Constantly works to balance optimum RPM vs. manifold pressure
- ➔ **The pilot controls the engine r.p.m. indirectly by means of a propeller control in the cockpit, which is connected to the governor**
 - ⇒ As conditions change, the governor moves a piston to maintain engine RPM
- ➔ **When a governor is employed, engine oil is used, and the oil pressure is usually boosted by a pump, which is integrated with the governor**
 - ⇒ Generally, the oil pressure used for pitch change comes directly from the engine lubricating system



COUNTERWEIGHTS

- ➔ Increases blade angle
- ➔ Overcome aerodynamic twisting force (low-pitch)

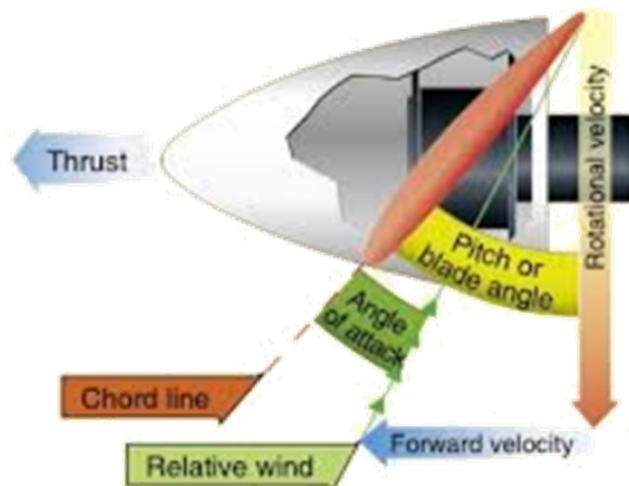
FUNCTION

- ⇒ When an engine is running at constant speed, the torque (power) exerted by the engine at the propeller shaft must equal the opposing load provided by the resistance of the air
 - ▮ RPM is controlled by regulating the torque absorbed by the propeller-in other words by increasing or decreasing the resistance offered by the air to the propeller
 - ▮ In the case of a fixed-pitch propeller, the torque absorbed by the propeller is a function of speed, or RPM
 - » If the power output of the engine is changed, the engine will accelerate or decelerate until an RPM is reached at which the power delivered is equal to the power absorbed
- ⇒ In the case of a constant-speed propeller, the power absorbed is independent of the RPM, for by varying the pitch of the blades, the air resistance and hence the torque or load, can be changed without reference to propeller speed
 - ▮ This is accomplished with a constant-speed propeller by means of a governor
 - ▮ The governor, in most cases, is geared to the engine crankshaft and is sensitive to changes in engine RPM

BLADE ANGLE CONTROL

- ➔ Higher Pressure Provides a Quicker Blade Angle Change

- ⇒ The RPM at which the propeller is to operate is adjusted in the governor head
 - ▮ The pilot changes this setting by changing the position of the governor rack through the cockpit propeller control
- ⇒ On some constant-speed propellers, changes in pitch are obtained using an inherent centrifugal twisting moment of the blades, that tends to flatten the blades toward low pitch, and oil pressure applied to a hydraulic piston connected to the propeller blades, which moves them toward high pitch



- ⇒ Another type of constant-speed propeller uses counterweights attached to the blade shanks in the hub

➔ **Governor oil pressure and the blade twisting moment move the blades toward the low pitch position, and centrifugal force acting on the counterweights moves them (and the blades) toward the high pitch position**

⇒ In the first case, above, governor oil pressure moves the blades toward high pitch, and in the second case, governor oil pressure and the blade twisting moment move the blades toward low pitch

⇒ A loss of governor oil pressure, therefore, will affect each differently

Aircraft Type	Design Speed (m.p.h.)	Blade Angle Range	Pitch	
			Low	High
Fixed Gear	160	11 $\frac{1}{2}$ °	10 $\frac{1}{2}$ °	22°
Retractable	180	15°	11°	26°
Turbo Retractable	225/240	20°	14°	34°
Turbine Retractable	250/300	30°	10°	40°
Transport Retractable	325	40°	10/15°	50/55°

FEATHERING

➔ **Chord line of each blade is rotated so that it nearly parallels the relative wind over the aircraft**

⇒ This is accomplished different ways for different aircraft, but the bottom line is pressure holding the propeller in its position is removed and mechanical spring pressure can feather the propeller

⚡ This decrease in the blade's frontal area exposed will cause parasite drag to decrease

⚡ The propeller rotation slows, then stops wind milling

PROPELLER SYSTEM FAILURES

➔ **Loss of oil pressure:**

⇒ Propeller will default to pitch setting; usually in multi-engine aircraft they may feather automatically

PROPELLER SYNCHRONIZING

➔ **Matches RPM of all engines together using a master and a slave**

⇒ Not all propellers are meant to rotate at the same phase angle. These systems are referred to as synchro-phasors

CONCLUSION & REVIEW

Review the Main Lesson Points

The airplane's propeller is an airfoil, just like the wings. It provides the necessary thrust to "propel" the aircraft through the air.

REVIEW

The student should be able to describe the airplane propeller's purpose, operation, control, and proper procedure for use.