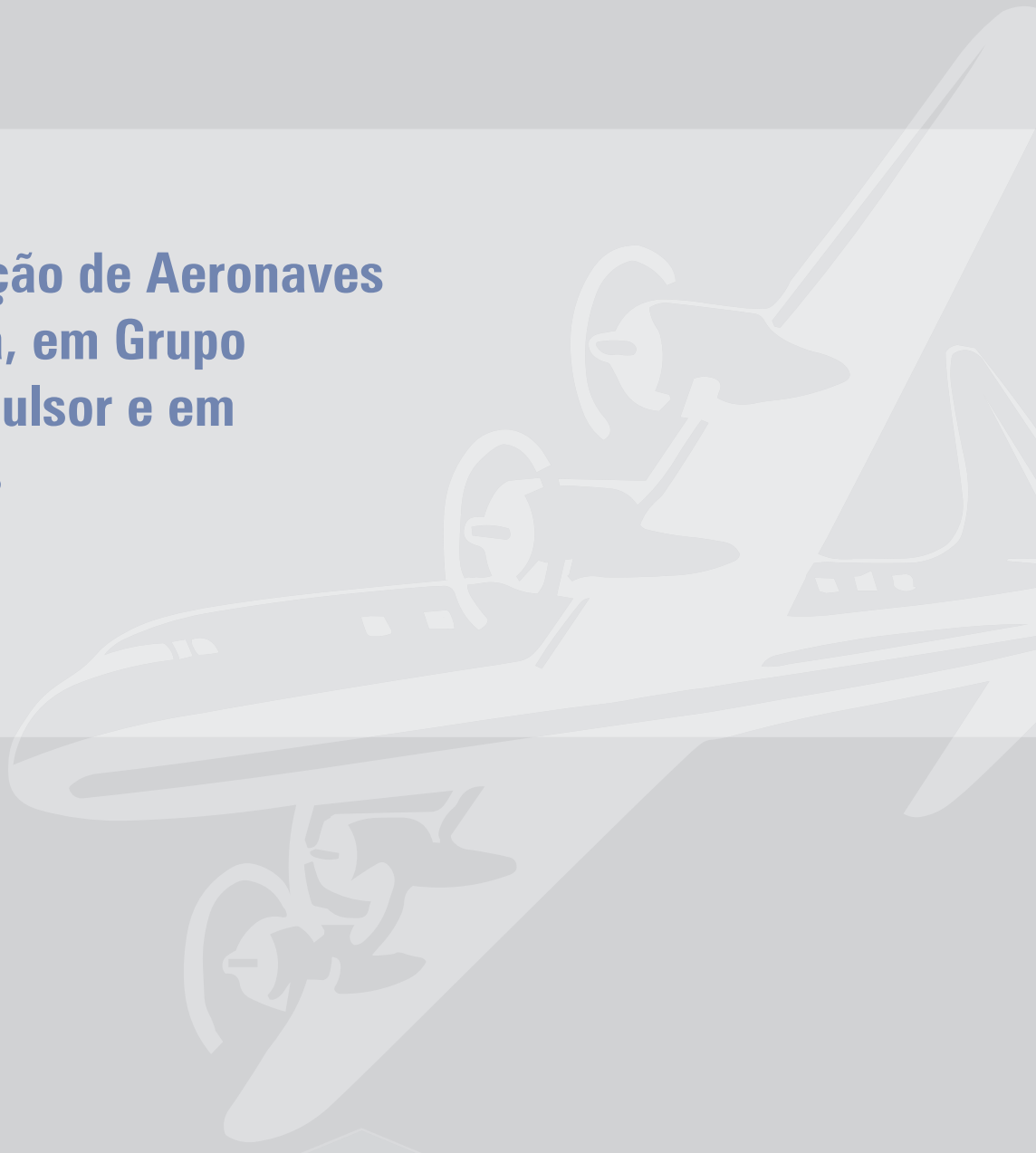
Manutenção de Aeronaves em Célula, em Grupo Motopropulsor e em Aviônicos

Básico



SEST SENAT
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Serviço Nacional de Aprendizagem do Transporte

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Manutenção de Aeronaves em Célula, em Grupo Motopropulssor e em Aviônicos

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1. Fatores humanos 2. Física 3. Inglês técnico 4. Redação técnica - Formulários e registros de manutenção 5. Matemática 6. Ferramentas manuais e de medição 7. Doutrinamento básico - O mecânico de manutenção aeronáutica e sua formação profissional 8. Primeiros socorros 9. Química 10. Regulamentação da aviação civil 11. Tráfico de drogas e dependência química

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Apresentação

O SEST SENAT atua nas formações inicial, continuada e técnica de trabalhadores do transporte, de suas famílias e da comunidade, por meio de 149 unidades operacionais, distribuídas em todo o país. O programa educacional do SEST SENAT visa ao aperfeiçoamento e à atualização que permitem ao profissional lidar com as constantes mudanças e inovações do mundo do trabalho.

Os cursos são acompanhados de materiais didáticos, elaborados em formatos pedagógicos arrojados e inovadores, com metodologias criativas e linguagem adequada a cada público. Assim, possibilitam o desenvolvimento de competências profissionais que viabilizam a inserção no mercado de trabalho.

Para contribuir com as novas demandas que têm surgido no modo aéreo, o SEST SENAT se empenhou em desenvolver um conjunto de livros técnicos, atualizados e inovadores, tanto no que diz respeito ao setor quanto ao mercado educacional, a fim de oferecer um material de referência aos alunos do Curso Técnico de Mecânico de Manutenção de Aeronaves, ofertado em várias unidades do SEST SENAT.

Esses livros técnicos compreendem desde o que é exigido pela legislação vigente até temas atualizados. Ressalta-se que isso atende à demanda das empresas por profissionais altamente qualificados e adequados às novas tecnologias presentes no transporte aéreo no Brasil e no mundo.

As ilustrações e imagens são também um diferencial dos livros. Além da qualidade técnica, mostram diversas opções de aeronaves, peças, motores e situações para que o aluno do Curso Técnico de Mecânico de Manutenção de Aeronaves possa sentir-se apoiado em seus estudos teóricos e práticos.

Esperamos, dessa forma, que esses livros sejam instrumento motivador para uma aprendizagem de qualidade e que possam continuar sendo para você uma fonte de consulta no futuro, quando se tornar mecânico de manutenção de aeronaves.

NICOLE GOULART

Diretora Executiva Nacional do SEST SENAT

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Inglês técnico

O exercício da profissão de técnico em manutenção aeronáutica requer o estreito cumprimento de normas técnicas inerentes aos equipamentos e às aeronaves. Para tanto, a principal ferramenta com que o técnico deve contar são os manuais técnicos, os quais, em muitos casos, estão em Língua Inglesa. Ademais, tendo em vista o caráter técnico desses manuais, é imprescindível o entendimento dos termos que orientarão o trabalho dos profissionais da área de manutenção aeronáutica.

Nesse cenário, é importante que o profissional desenvolva o hábito da leitura de textos técnicos para que, progressivamente, aumente seu vocabulário, o que lhe permitirá a leitura e compreensão dos diversos manuais utilizados durante a manutenção e operação de aeronaves e equipamentos.

Esta unidade tem por objetivo apresentar os termos técnicos mais comuns utilizados no universo da manutenção aeronáutica, abordando vários sistemas presentes em uma aeronave. Logicamente, o estudo deste material não esgota o assunto, haja vista a vastidão de termos técnicos empregados.

O conteúdo da presente unidade está dividido em seis capítulos que abordam alguns pontos gramaticais básicos da Língua Inglesa. Apresenta, também, os principais termos técnicos da área de aviação, contextualizados por sistemas comuns em aeronaves e organizados da seguinte forma: *Aircraft Definitions and Structure, Power Plant, Hydraulic and Lubrication Systems, Electrical System and Avionics, Pressurization and Fuel System* e *Tools and Safety Equipments.*

Capítulo 1
Aircraft – definitions and structure

Aeronave (*aircraft*, do inglês) é qualquer máquina capaz de sustentar voo, ou seja, um nome genérico que abrange todo aparelho de navegação aérea. Dentre eles temos: avião, helicóptero, balão, etc. A estrutura de um avião é dividida em cinco partes: fuselagem, empenagem, asas, trem de pouso e sistema de propulsão (também conhecido como grupo motopropulsor). Cada modelo apresenta suas particularidades em relação a esses itens, o que diferencia uma da outra.

Pelo fato de a aeronave ser muito complexa, a área da manutenção foi dividida em três grupos: grupo motopropulsor, células e aviônicos. Assim, o técnico se especializa em uma área específica e tem um conhecimento básico nas outras partes.

Aircraft: avião, qualquer máquina capaz de sustentar voo. Dentro deste grupo, pode-se ter balões, dirigíveis, helicópteros, aviões e planadores. Assim, tomar cuidado para não confundir *aircraft* com *airplane* (avião).

Power plant: pode ser traduzido como grupo motopropulsor ou sistema motopropulsor. É composto basicamente pelo motor e pela hélice ou somente o motor (quando não utiliza hélice).

1.1 Parts of an airplane and their functions

What is an airplane?

> Definition: Any of various vehicles capable of flight, held up by the force of air flowing around their wings, and driven by jet engines or propellers.

An aircraft has five structural components:

- fuselage;
- wings;
- empennage (tail structures);
- power plant (propulsion system);
- landing gear.

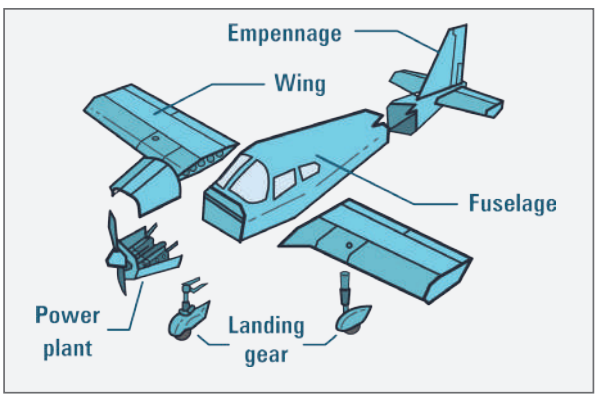


Figura 1 - Partes da aeronave

1.1.1 Fuselage

Is the central part of an airplane. It is designed to carry the pilots, passengers and cargo. At the front of the fuselage, there is an area called cockpit, where the pilots control the airplane. Fuselage is the main structure or body of the fixed-wing aircraft. It provides space for cargo, controls, accessories, passengers, and other equipment. In single-engine aircraft, the fuselage

houses the power plant. In multiengine aircraft, the engines may be either in the fuselage, attached to the fuselage, or suspended from the wing structure.

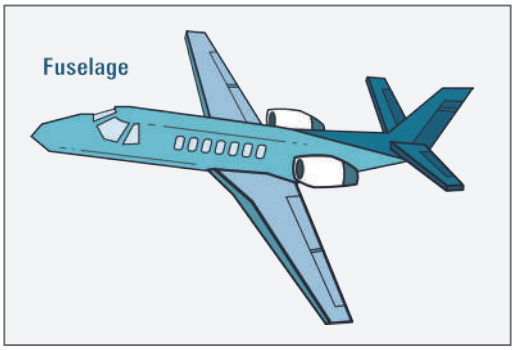


Figura 2 - Fuselagem

There are two general types of fuselage construction: truss and monocoque.

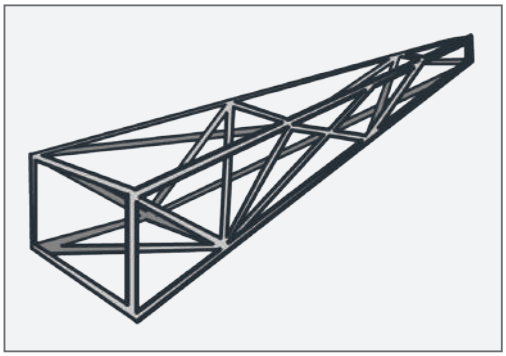


Figura 3.A - Fuselagem truss

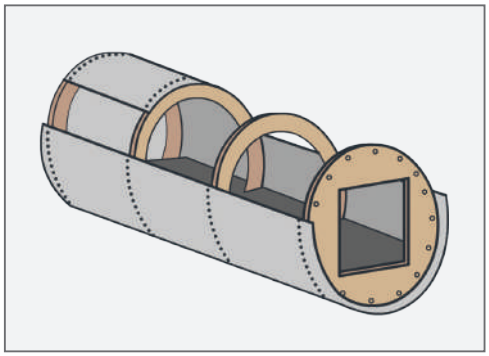


Figura 3.B - Fuselagem monocoque

There is also a type called semimonocoque.

The fuselage or body of the airplane holds all the pieces together. The pilots sit in the cockpit at the front of the fuselage. Passengers and cargo are carried in the rear of the fuselage. Some aircraft carry fuel in the fuselage; others carry the fuel in the wings.

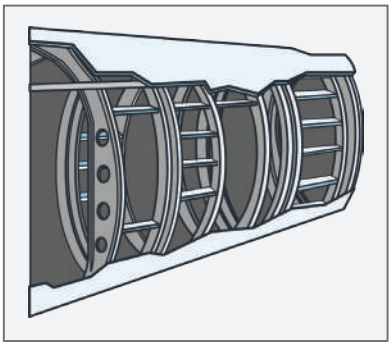


Figura 3.C - Fuselagem semimonocoque

Houses: neste contexto, a palavra Houses é utilizada como verbo alojar. Neste caso, a fuselagem do avião aloja o grupo motopropulsor. Em inglês, é comum uma palavra que normalmente é aplicada como substantivo ser utilizada como verbo.

Monocoque: são estruturas com revestimento trabalhante. Seu formato aerodinâmico é determinado pelas cavernas. As cargas aerodinâmicas são suportadas por essas cavernas e também pelo revestimento.

Semimonocoque: são estruturas nas quais os esforços são suportados pelas cavernas e/ou anteparos, revestimento e longarinas.

O combustível, em algumas aeronaves, também é transportado dentro das asas. Esse tipo de asa recebe o nome de *wet wing* (asa molhada). Observe a Figura 4.

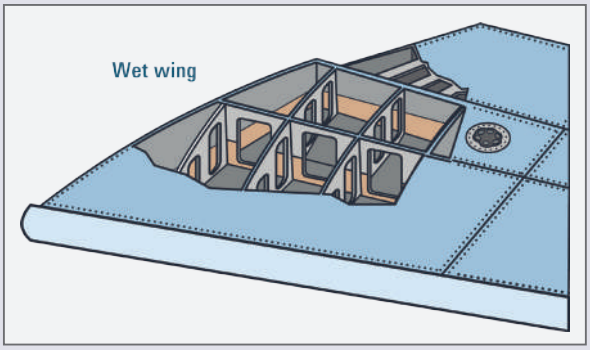


Figura 4 - Asa molhada

1.1.2 Power plant

Is composed by engine and propeller. Each airplane has a different power plant configuration.

Engine - the function of the engine is to provide the power to turn the propeller and generate electrical power for some flight instruments.

Propeller translates the rotating force of the engine into a forward-acting force called thrust that helps move the airplane through the air.

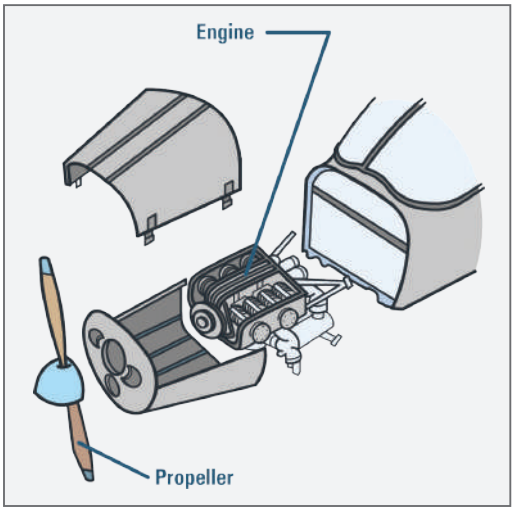


Figura 5 - Grupo Motopropulsor

1.1.3 Landing gear

Is the principle support of the airplane when parked, taxiing, taking off, or when landing. The most common type of landing gear consists of wheels, but airplanes can also be equipped with floats for water operations, or skis for landing on snow.

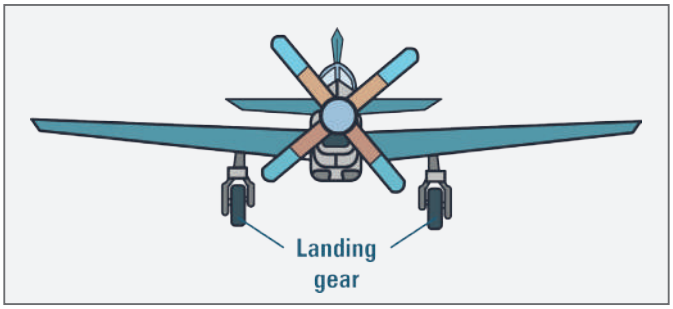


Figura 6 - Trem de pouso

Landing gear employing a rear-mounted wheel is called conventional landing gear. Airplanes with conventional landing gear are sometimes referred to as tail wheel airplanes.

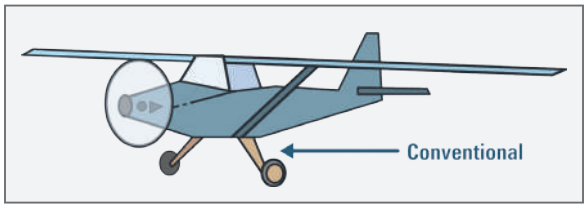


Figura 7 - Trem de pouso convencional

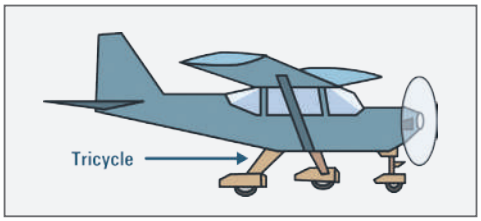


Figura 8 - Trem de pouso triciclo

a) When the third wheel is located on the nose, it is called a nosewheel, and the design is referred to as a tricycle gear.

b) Few aircraft are designed with tandem landing gear. This landing gear has the main gear and tail gear aligned on the longitudinal axis of the aircraft.

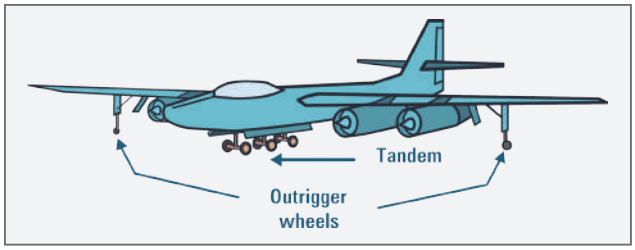


Figura 9 - Trem de pouso tandem

1.2 Grammar point – verb to be

Os textos apresentados ao longo do curso são ricos em termos técnicos usados no cotidiano do técnico em manutenção aeronáutica. Os manuais informam o que deve ser feito e a execução incorreta de um procedimento pode acarretar um alto custo para a empresa, podendo gerar um acidente com consequências muito sérias.

A seguir, há algumas regras gramaticais importantes para a tradução dos textos em Língua Inglesa.

O verbo *to be* significa ser ou estar em português. Ele é muito utilizado e a correta tradução depende do contexto em que está inserido. Veja alguns exemplos:

John is a pilot. (John é um piloto.)

The airplane is inside the hangar. (A aeronave está dentro do hangar.)

No primeiro exemplo, John is a pilot (John é um piloto), o verbo to be (is) é utilizado como o verbo ser. Já, no segundo exemplo, The airplane is inside the hangar (A aeronave está dentro do hangar), o verbo to be (is) é utilizado como o verbo estar. Vamos aprender a conjugar esse verbo.

Tabela 1 - Verbo *to be*: (conjugações e formas contraídas)

Verbo to be = ser/estar		
	Tradução	**Forma contraída**
I am	Eu sou/estou	I'm
You are	Você é/está – Tu és/estás	You're
He is	Ele é/está	He's
She is	Ela é/está	She's
It is	Ele(a) é/está (objetos e animais)	It's
We are	Nós somos/estamos	We're
You are	Vocês são/estão – Vós sois/ estais	You're
They are	Eles(as) são/estão	They're

O verbo *to be* será bastante utilizado nesta unidade e, na maioria das vezes, a frase aparecerá com palavras que equivalem aos pronomes da tabela acima (I, you, he, she, it, we, you, they).

Veja os exemplos a seguir:

a) The inspector is young. (O inspetor é jovem.) The inspector - he ou she.

b) The mechanics are tired. (Os mecânicos estão cansados.) The mechanics - they.

c) The airplane is new. (A aeronave é nova.) The airplane (objeto) - it.

d) The propellers are broken. (As hélices estão quebradas.) The propellers (objeto) - they.

O verbo *to be* pode ser utilizado nas formas negativa e interrogativa (ver tabelas).

Tabela 2 - Verbo *to be*

Negative form		Interrogative form
Forma extensa	Forma contraída	
I am not	-- X --	Am I?
You are not	You aren't	Are you?
He is not	He isn't	Is he?
She is not	She isn't	Is she?
It is not	It isn't	Is it?
We are not	We aren't	Are we?
You are not	You aren't	Are you?
They are not	They aren't	Are they?

Examples:

The weight of the airplane isn't light. (O peso da aeronave não é leve.)

The pilots aren't in the cockpit. (Os pilotos não estão na cabine do avião.)

Are the crew ready? (A tripulação está pronta?)

Is the vertical stabilizer working? (O estabilizador vertical está funcionando?)

Diferente do português, utiliza-se o verbo *to be* para responder a idade em inglês. A tradução será sempre de acordo com o contexto em que estiver inserida.

How old are you? (Quantos anos você tem?)

I am 26 years old. (Tenho 26 anos.)

Tabela 3 - Vocabulário

Inglês	Português	Inglês	Português
Aircraft	Aeronave	*Landing gear*	Trem de pouso
Axis	Eixo	*Power plant*	Grupo motopropulsor
Cargo	Carga	*Ski*	Esqui para pouso em neve
Cockpit	Cabine dos pilotos	*Tail*	Cauda
Empennage	Empenagem	*Thrust*	Empuxo, tração
Flight instruments	Instrumentos de voo	*To land*	Pousar
Float	Flutuador	*To take off*	Decolar
Fuel	Combustível	*Wheel*	Roda
Fuselage	Fuselagem	*Wing*	Asa
House (verbo)	Alojar		

1.3 Flight, wings and empennage

a) Lift, weight, drag, thrust, wings are responsible to provide lift. They support the weight of the airplane and can also carry fuel. There are many types of wings in different aircraft.

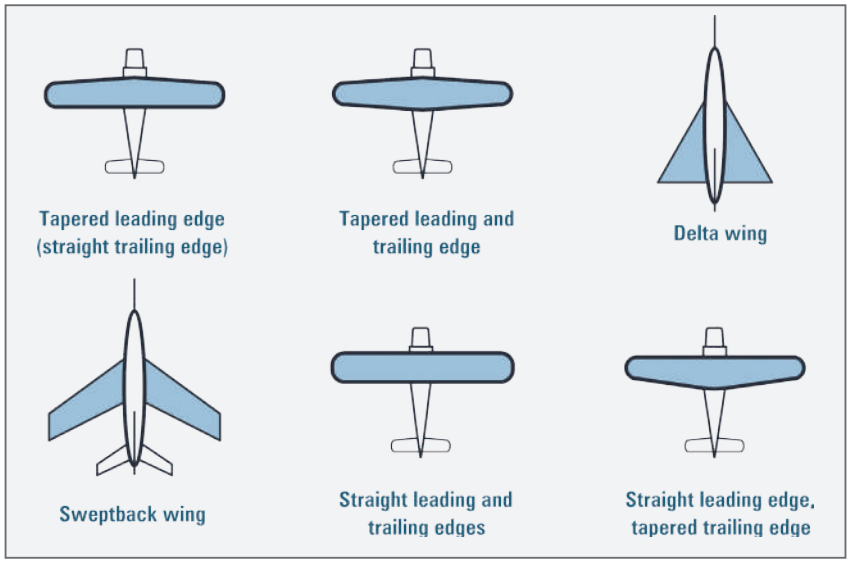


Figura 10 - Tipos de asas

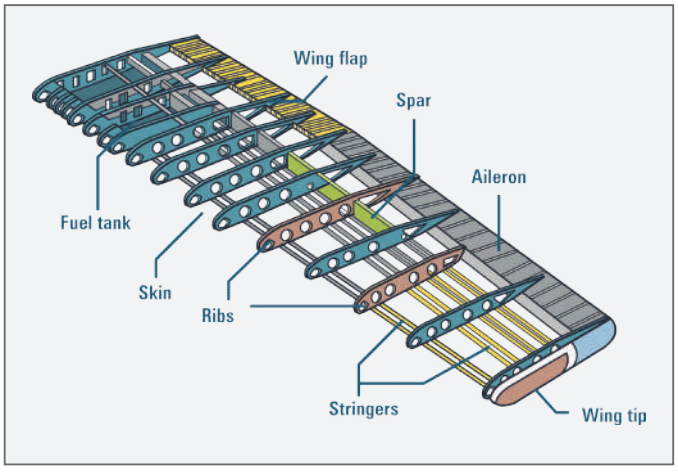


Figura 11 - Componentes de uma asa

Let's know more about Wings!

- Structural elements of an aircraft wing - fixed--wing aircraft wings have structural elements that provide strength, flexibility, and a streamlined shape that generates lift when the aircraft moves at relative wind.
- Spars: correspond to the longerons of the fuselage. They run parallel to the lateral axis of the aircraft, from the fuselage toward the tip of the wing. Spars are the main members of the wing.
- Ribs: are the structural crosspieces that combine with spars and stringers to make up the framework of the wing.
- Stringers: are also used in the semimonocoque fuselage. These longitudinal members are typically more numerous and lighter in weight than the longerons. Stringers and longerons together prevent tension and compression from bending the fuselage.
- Skin: is attached to the wing structure and carries part of the loads imposed during flight.
- Hinge: is a movable mechanism that attaches flaps to wings.

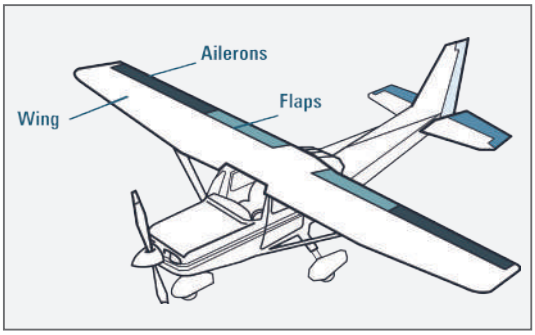


Figura 12 - Sistema de controle de voo

Aircraft flight control systems consist of primary and secondary systems. The ailerons, elevator and rudder constitute the primary control system and are required to control an aircraft safely during flight. Wing flaps, leading edge devices, spoilers, and trim systems constitute the secondary control system and improve the performance characteristics of the airplane or relieve the pilot of excessive control forces.

Spoiler: também chamados de *Speedbrakes*, são superfícies móveis posicionadas sobre as asas de aviões que, ao se abrirem, descolam o escoamento do vento relativo criando um estol controlado nas asas, reduzindo a sustentação naquela região da asa.

Trim tabs: compensadores são superfícies de controle de voo auxiliares ligadas a bordo de fuga das superfícies de controle de voo primárias. Os compensadores reduzem a força necessária para mover uma superfície de controle primária.

- Flaps are movable sections located on the airplane's wings. There is one flap in each wing and they move in the same direction at the same time, resulting in the creation of drag and lift. Flaps are responsible to make the airplane to fly more slowly when preparing to land.
- Ailerons are movable sections located on the edge of the airplane's wings. There is one aileron in each wing and they move in opposite directions (when one goes up, the other goes down). They are responsible for making turns by controlling movement around the longitudinal axis.

b) Empennage is the tail assembly or the rear part of an airplane. It includes the horizontal and vertical stabilizers, elevators and rudder.

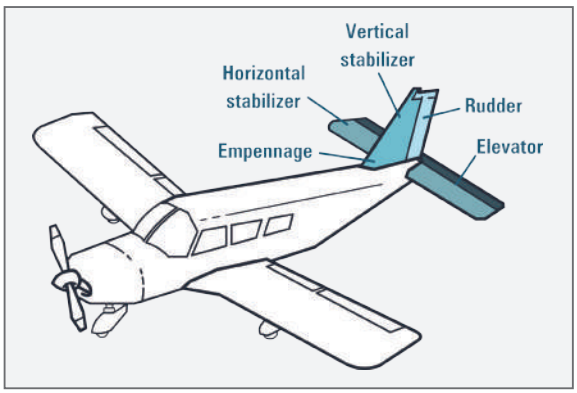


Figura 13 - Empenagem

- Horizontal stabilizer prevents an up-and-down motion of the nose, which is called pitch.
- Vertical stabilizer keeps the nose of the plane from swinging from side to side, which is called yaw.
- Rudder is the movable and vertical section of the tail. It is responsible to control the lateral movement around the vertical axis. When the rudder moves in one direction, the aircraft nose moves to the same direction.
- Elevator is the movable, horizontal section of the tail. It is responsible to climb or descend the airplane. When the elevator moves in one direction, the aircraft nose moves in the same direction (up or down).

Pitch: arfagem. Movimento da aeronave em torno do seu eixo lateral ou horizontal, fazendo com que o nariz da aeronave se mova para cima ou para baixo.

Yaw: guinada é o movimento da aeronave em torno do seu eixo vertical, fazendo com que o nariz da aeronave se mova de um lado para o outro.

c) Flight

Whenever an airplane changes its flight attitude or position in flight, it rotates about one or more of three axes, which are imaginary lines that pass through the airplane's center of gravity. At the point where all three axes intersect, each is at a 90° angle to the other two.

The axis, which extends lengthwise through the fuselage from the nose to the tail, is the longitudinal axis.

The axis, which extends crosswise from wing tip to wing tip, is the lateral axis.

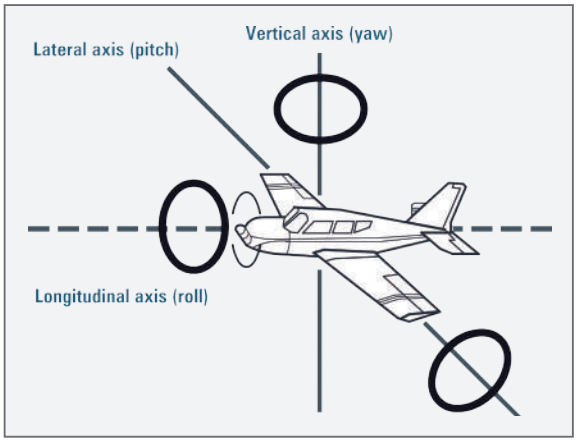


Figura 14 - Eixos da aeronave

The axis, which passes vertically through the center of gravity, is the vertical axis.

The motion about the airplane's longitudinal axis is called roll. The motion about its lateral axis is referred to as pitch. Finally, an airplane moves about its vertical axis in a motion, which is termed yaw – that is, a horizontal (left and right) movement of the airplane's nose.

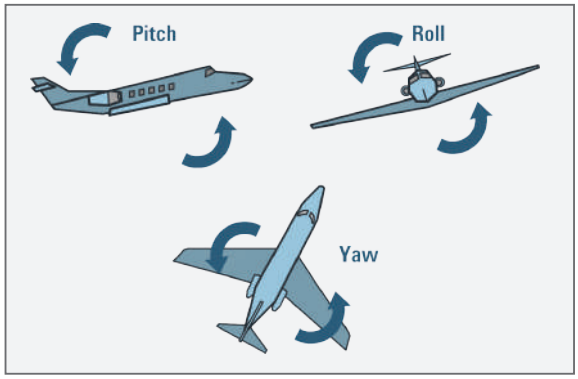


Figura 15 - Movimentos da aeronave

The three motions of the airplane (roll, pitch, and yaw) are controlled by three control surfaces. Roll is controlled by the ailerons; pitch is controlled by the elevators; yaw is controlled by the rudder.

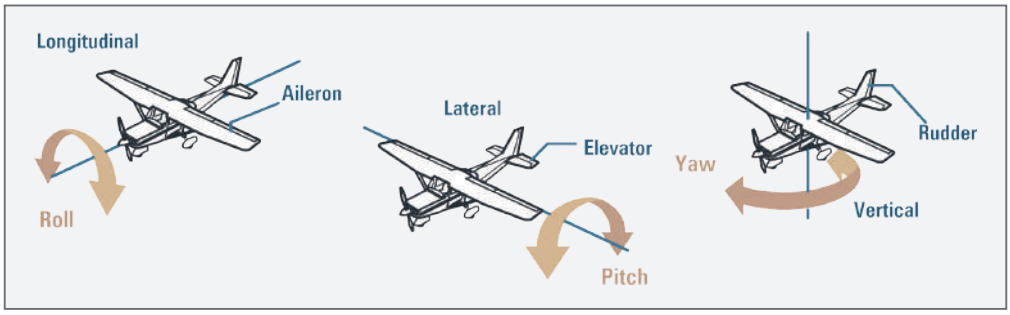


Figura 16 - Movimentos e eixos da aeronave

Motions of an airplane

Technical text

One aircraft filled with passengers, cargo, and fuel can weigh more than 400,000 kilos. How do you get an aircraft with that amount of weight into the air? And how do you keep it there? Simple! An aircraft is help up by air.

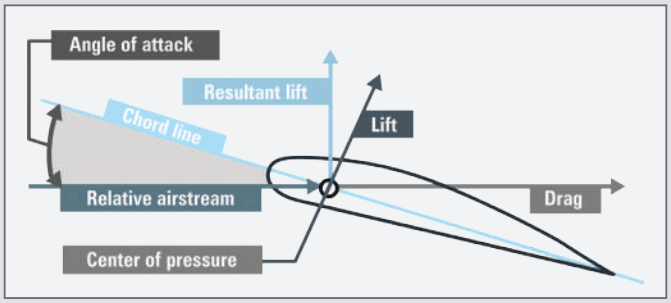


Figura 17 - Ângulo de ataque

When an aircraft runs on the runway, during the takeoff, the faster it goes, the more air comes under the wings. This causes a "low pressure system" above the wing, the faster the air travels, the lower the pressure is. Finally, the pressure difference is so great that it pulls the jet up into the air.

Fonte - *EUA, 2012a.*

• Takeoff angle

As the aircraft hurtles down the runway, finally attaining a speed of 300 kilometers per hour, the pilot pulls back on the yoke, lifting the nose wheels off the runway and, finally, the whole aircraft takes off. With the help of flaps on the wings and tail, the pilot can adjust how the air flows around the aircraft.

To control and maneuver the aircraft, smaller wings are located at the tail of the plane. The tail usually has a fixed horizontal piece, called the horizontal stabilizer, and a fixed vertical piece, called the vertical stabilizer. The stabilizers keep the aircraft flying straightly, providing stability. The vertical stabilizer keeps the nose of the plane from swinging from side to side, which is called yaw. The horizontal stabilizer prevents an up-and-down motion of the nose, which is called pitch.

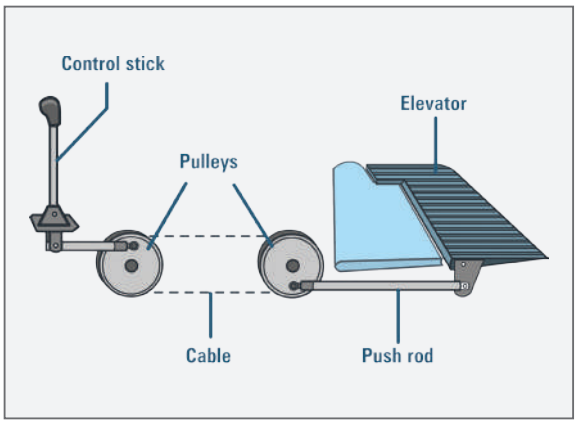


Figura 18 - Sistema mecânico de controle das superfícies de comando

These surfaces are controlled by a system that can be mechanical, hidromechanical (hydraulic system) or fly-by-wire (FBW). The mechanical control system of an aircraft can include cables, push-pull tubes, and torque tubes. The cable system is the most widely used.

The fly-by-wire (FBW) control system employs electrical signals that transmit the pilot's actions from the flight deck through a computer to the various flight control actuators.

Fly-by-wire: sistema de comando de voo que utiliza a transmissão de dados às superfícies de controle por meio de cabos ou fios protegidos. Dessa forma, todo comando feito pelo piloto no manche é processado e avaliado pelo computador, para então ser transmitido, total ou parcialmente, às superfícies de comando de voo.

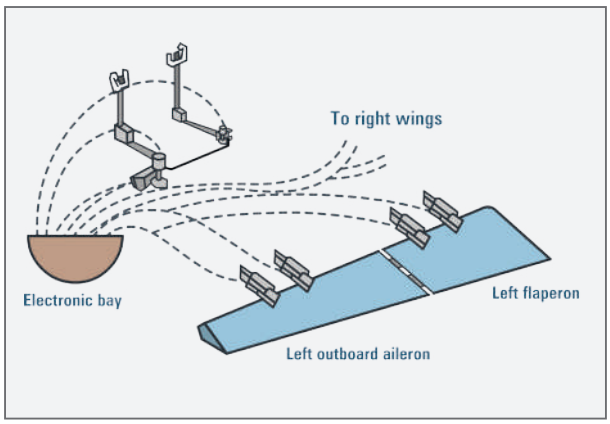


Figura 19 - Controle de voo por fios

A figura a seguir apresenta as principais partes da aeronave, juntamente com as superfícies de comando (palavras escritas em negrito na figura). Além disso, são apresentadas as respectivas funções de cada parte indicada na figura (palavras escritas entre parênteses).

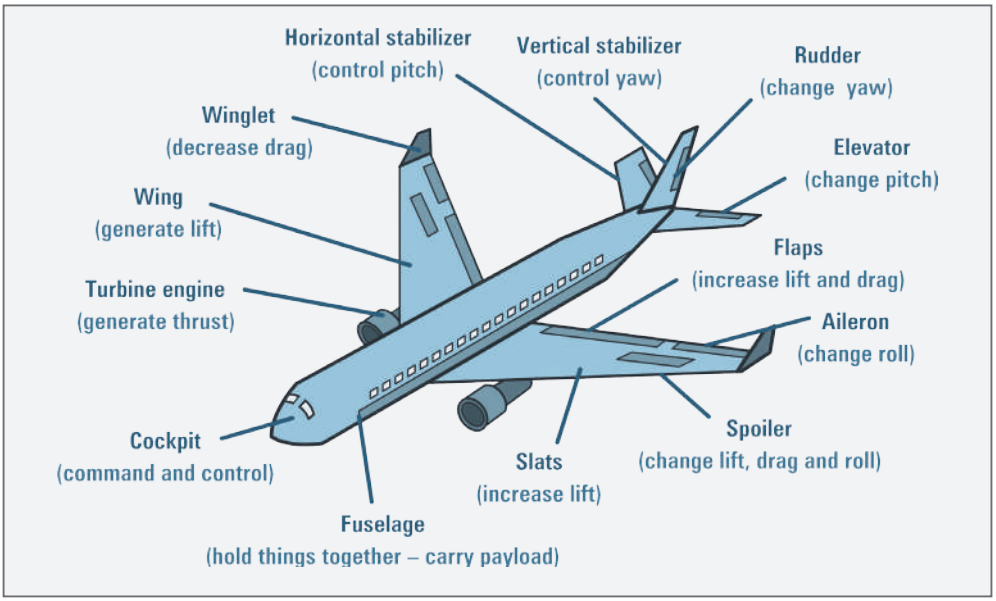


Figura 20 - Superfícies de comando da aeronave

Tabela 4 - Vocabulário

Inglês	Português	Inglês	Português
Aileron	Aileron	*Rudder*	Leme de direção
Drag	Arrasto	*Runway*	Pista
Edge	Bordo, aresta	*Slat*	Aleta (aerofólio auxiliar)
Elevator	Profundor	*Spar*	Longarina transversal
Empennage	Empenagem	*Spoiler*	Espoiler
Flap	Flape	*Straight*	Reto
Flaperon	Flap + aileron	*Streamline*	Aerodinâmico
Flight deck	Cabine de pilotagem	*Stringer*	Reforcador longitudinal
Float	Flutuador	*Tail*	Cauda
Fly-by-wire	Sistema de controle de voo eletrônico	*Takeoff*	Decolagem
Hinge	Dobradiça	*Taxi* (verbo)	Taxiar
Horizontal stabilizer	Estabilizador horizontal	*Thrust*	Empuxo, tração
House (verbo)	Alojar	*Trailing edge*	Bordo de fuga
Land (verbo)	Pousar	*Trim*	Compensador
Landing gear	Trem de pouso	*Truss*	Armação, treliça
Leading edge	Bordo de ataque	*Vertical stabilizer*	Estabilizador vertical
Lift	Sustentação	*Weight*	Peso
Longeron	Longarina	*Wheel*	Roda
Outrigger wheel	Roda alar do trem de pouso	*Wing tip*	Ponta da asa
Pitch	Arfagem	*Yaw*	Guinada
Rib	Nervura	*Yoke*	Manche

Flaperon: superfície de comando que funciona como *flap* e *aileron*.

Outrigger wheels: são pequenas rodas instaladas próximas às pontas das asas das aeronaves que possuem trem de pouso em tandem.

1.4 Grammar point – nouns

Noun (substantivo) é a palavra usada para denominar coisas – *engine* (motor), pessoas (John, Mary), sentimentos - *faith* (fé) e lugares - *airport* (aeroporto). Pode estar acompanhada por um adjetivo - *jet engine* (motor a jato), numeral - *two wings* (duas asas) ou pronome - *my gloves* (minhas luvas).

Devido a sua grande aplicação no idioma, é necessário conhecer as regras que formam o plural.
Plural dos substantivos:

a) Regra geral - o plural dos substantivos ocorre da mesma maneira que em português, acrescentando-se S à palavra.

- Aileron - ailerons.
- Force - forces.
- Spoiler - spoilers.

b) Substantivos terminados em CH, S, SS, SH, X, Z e O acrescenta-se ES no final.

- Airbus - airbuses.
- Approach - approaches.
- Compass - compasses.
- Crash - crashes.
- Box - boxes.
- Cargo - cargoes.
- Quiz - quizzes.

Exceções - radio (rádio), commando (commandos), kilo (kilos),

c) Substantivos que terminam em vogal + y - acrescenta-se somente –s no final.

- key - keys.
- day - days.

d) Substantivos que terminam em consoante + y - retira-se o y e acrescentam-se -ies.

- accessory - accessories.
- facility - facilities.
- sky - skies.

e) Plurais irregulares que não seguem a regra geral.

- man - men (homens).
- woman - women (mulheres).
- child - children (crianças).

- person - people (pessoas).
- foot - feet (pés).
- life - lives (vidas).
- knife - knives (facas).

f) Substantivos incontáveis que só existem na forma singular e, por mais que o sentido seja plural, o verbo fica sempre no singular.

- equipment - equipamento(s).
- homework - tema(s) de casa.
- information - informação(ões).
- luggage/baggage - bagagem(ns).
- weather - tempo meteorológico.

O substantivo *aircraft* apresenta a mesma forma tanto no singular quanto no plural.

Apenas as principais regras gramaticais do plural dos substantivos foram apresentadas como base para tradução e compreensão de textos técnicos. É importante o aprofundamento do estudo para melhorar a base de entendimento do idioma.

1.5 Forces acting on the airplane

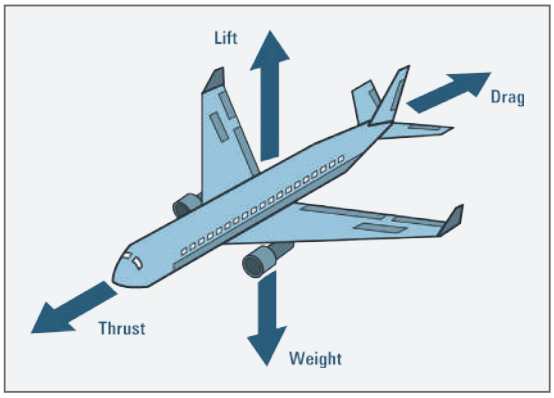


Figura 21 - Forças aerodinâmicas

The ability of the pilot is essential to plan and coordinate the use of the power and flight controls for changing the forces of thrust, drag, lift, and weight. He has to control the balance among these forces. Let's know a little bit more about them.

a) Thrust is the forward force produced by the power plant/propeller. It opposes or overcomes the force of drag.

b) Drag is a rearward, retarding force, and is caused by disruption of airflow by the wing, fuselage, and other protruding objects. Drag opposes thrust.

c) Weight is the combined load of the airplane itself, the crew, the fuel, and the cargo or baggage. Weight pulls the airplane downward because of the force of gravity. It opposes lift, and acts vertically downward through the airplane's center of gravity.

d) Lift opposes the downward force of weight and it is produced by the dynamic effect of the air acting on the wing, and acts perpendicular to the flight path through the wing's center of lift.

The forces must be balanced to the airplane move in a straight line at airspeed. The next figure shows the equality.

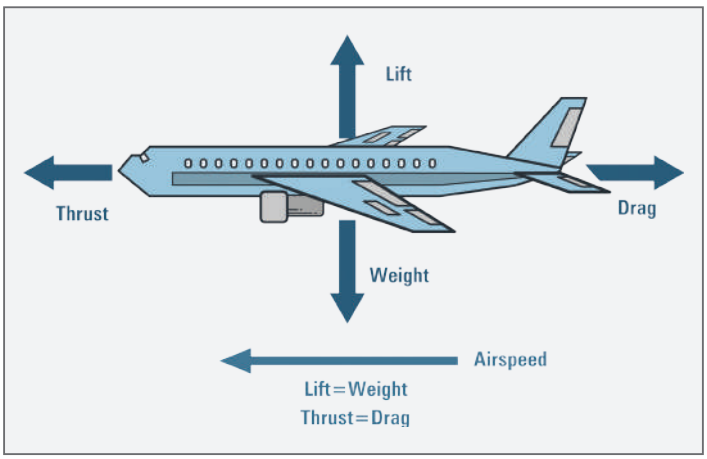


Figura 22 - Forças balanceadas

Let's see what happens when the forces are unbalanced (not balanced).

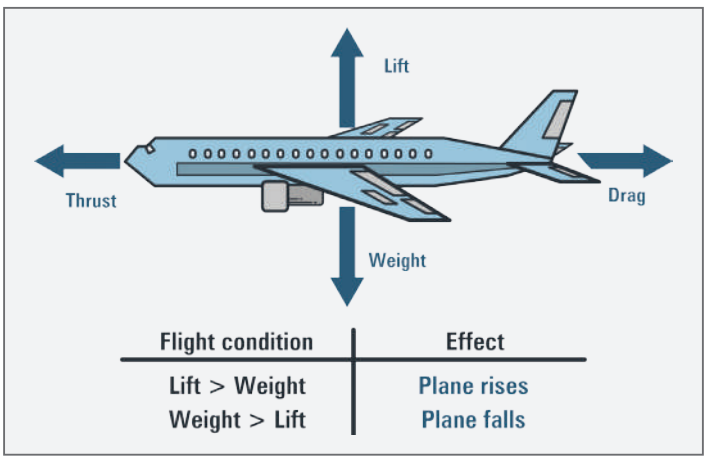


Figura 23 - Forças desbalanceadas

O vocabulário técnico disponibilizado no final do texto serve de apoio para a tradução do texto a seguir.

Forces and movements

An airplane in flight, four forces are ever present: lift, weight, thrust, and drag. Lift and drag are considered aerodynamic forces because they exist due to the movement of the aircraft through the air. The weight pulls down on the plane opposing the lift created by air flowing over the wing. Thrust is generated created by the propeller or engine and opposes drag caused by air resistance to the frontal area of the airplane.

At the rear of the wings and stabilizers are small moving sections that are attached to the fixed sections by hinges. Changing the rear portion of a wing will change the amount of force that the wing produces. The ability to change forces gives us a means of controlling and maneuvering the airplane.

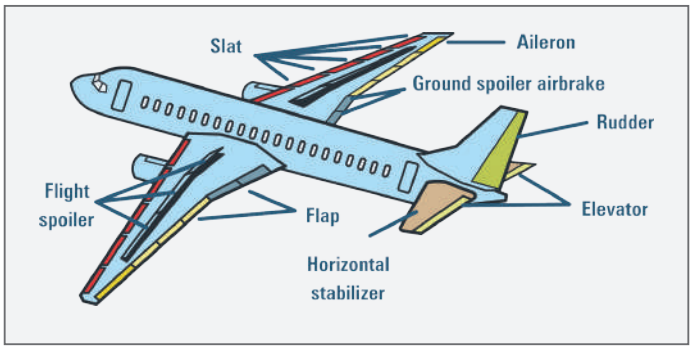


Figura 24 - Comandos de voo da aeronave

The hinged part of the vertical stabilizer is called rudder and it is used to deflect the tail to the left and right. The hinged part of the horizontal stabilizer is called elevator and it is used to deflect the tail up and down. The outboard hinged part of the wing is called aileron and it is used to roll the wings from side to side.

Spoilers are small plates that are used to disrupt the flow over the wing and to change the amount of force by decreasing the lift when the spoiler is deployed. The wings have additional hinged, rear sections near the body that are called flaps. Flaps are deployed downward on takeoff and landing to increase the amount of force produced by the wing. On some aircraft, the front part of the wing will also deflect. Slats are used at takeoffs and landings to produce additional force. The spoilers are also used to slow the plane down during landing and to counteract the flaps when the aircraft is on the ground.

Tabela 5 - Vocabulário

Inglês	Português	Inglês	Português
Airflow	Fluxo de ar	*Maneuvering*	Manobra
Counteract (to)	Contrariar, neutralizar	*Plate*	Chapa, placa
Crew	Tripulação	*Rearward*	Para trás
Flight path	Trajetória de voo	*Roll (to)*	Rolar (a aeronave)
Ground	Solo	*Slat*	Aleta (aerofólio auxiliar)
Load	Carga		

1.6 Good practices in maintenance

Este item irá abordar a segurança. Além dela, serão abordados os assuntos ordens técnicas, segurança na área operacional e detritos de objeto estranho ou, em inglês, *foreign object debris* (FOD). Todos eles fazem parte da rotina de um técnico em manutenção aeronáutica.

Resumidamente, ordens técnicas são manuais de procedimentos para manutenção e operação de aeronaves e equipamentos. Elas são importantes para as atividades de manutenção.

FOD: de *Foreign Object Debris*. É qualquer objeto, vivo ou não, localizado em local inadequado, podendo potencialmente causar danos a aeronaves e pessoas.

Technical order: são publicações técnicas que fornecem todas as informações sobre a operação e a manutenção de sistemas e equipamentos utilizados em uma aeronave.

Technical Orders

Technical Orders, commonly called 'TO', are a written reference for all aspects of aircraft maintenance, providing information ranging from schematics and wiring diagrams to how to change aircraft parts. They lay out every aspect of aircraft maintenance for specific aircraft, providing a blueprint in maintaining a particular aircraft.

It's MANDATORY the use of technical orders in an aircraft maintenance to ensure that the procedures will be performed as determined by the manufacturer of the aircraft or equipment.

Ground Safety

Keeping hangars, shop, and the flight line orderly and clean is essential to safety and efficient maintenance. It is very important that maintenance personnel don't let any debris or object on the floor, because they can get sucked into a jet engine and causes serious damages. This is what we call FOD – Foreign Object Debris or Foreign Object Damage.

But what is a FOD?

Foreign Object Debris (FOD) is a substance, debris or article alien to the vehicle or system which would potentially cause damage.

Foreign Object Damage is any damage attributed to a foreign object that can be expressed in physical or economic terms that may or may not degrade the product's required safety and/or performance characteristics. Typically, FOD is an aviation term used to describe debris on or around an aircraft or damage done to an aircraft.

FOD includes loose hardware, tools, parts, pavement fragments, catering supplies, building materials, rocks, sand, pieces of luggage, pens, coins, badges, hats, soda cans, paper clips, rags, trash, paperwork and even wildlife. Anything that can find its way into an aircraft engine or flight control mechanisms is a recipe for foreign object damage.

And this damage can result in anything from minor repairs to catastrophic events. FOD can be found anywhere in the aviation environment – from the manufacturing plant to airport terminal gates, cargo aprons, taxiways and runways.

The National Aerospace FOD Prevention, Inc. estimates the cost of FOD to the global aerospace industry at $4 billion annually. These dollars are spent largely repairing aircraft engine damage caused by the ingestion of foreign objects from runways. Perhaps most importantly, FOD is preventable.

Um simples objeto esquecido no hangar ou pedaços de peças ou ferramentas podem resultar em enormes danos e até em morte. A seguir, serão listados os tipos mais comuns de FOD.

Tipos mais comuns de FOD

Entre todos os objetos listados no texto, nenhum tem maior ou menor importância. Ressalta-se que um objeto, por menor que seja, é um FOD e deve ser descartado no local correto. A seguir será abordado um grupo de itens chamados de prendedores (*fasteners*), que podem representar exemplares de FOD, caso não sejam corretamente utilizados.

Screws (parafusos) - a type of threaded connector used to fix things together by rotating it.

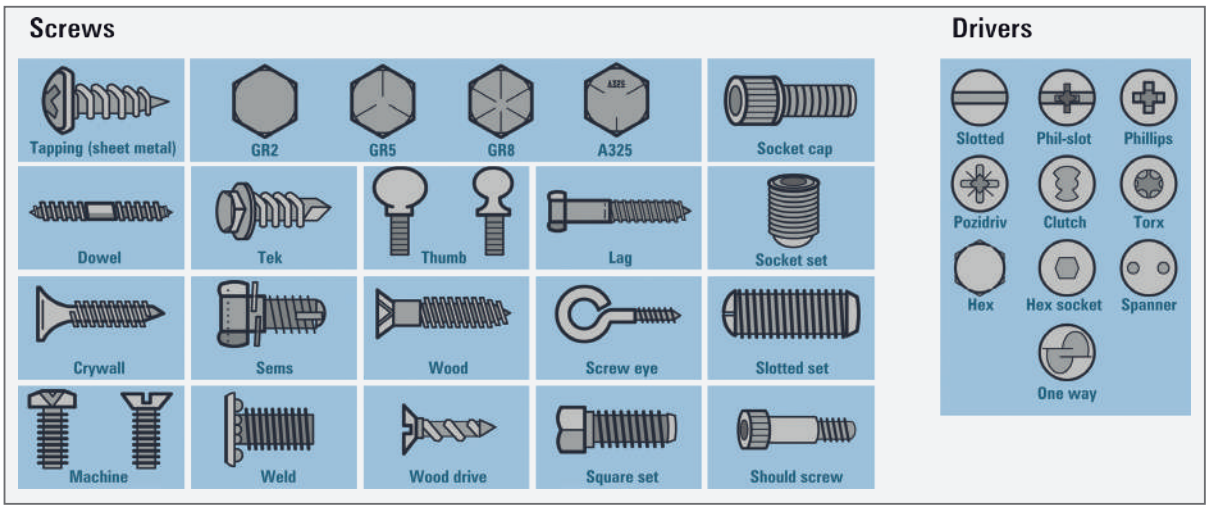


Figura 25 - Parafusos

Bolts (parafusos com cabeça e porca) - a metal rod with a head, which screws into a nut.

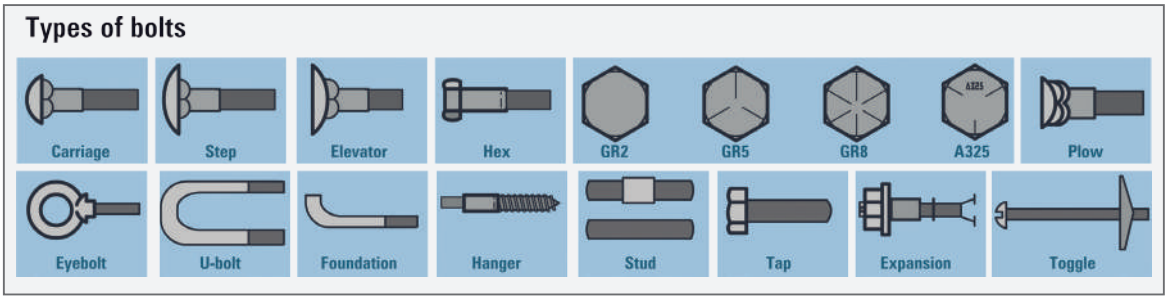


Figura 26 - Parafusos com cabeça e porca

Nuts (porcas de parafusos) - a metal ring which screws on a bolt to hold it tight.

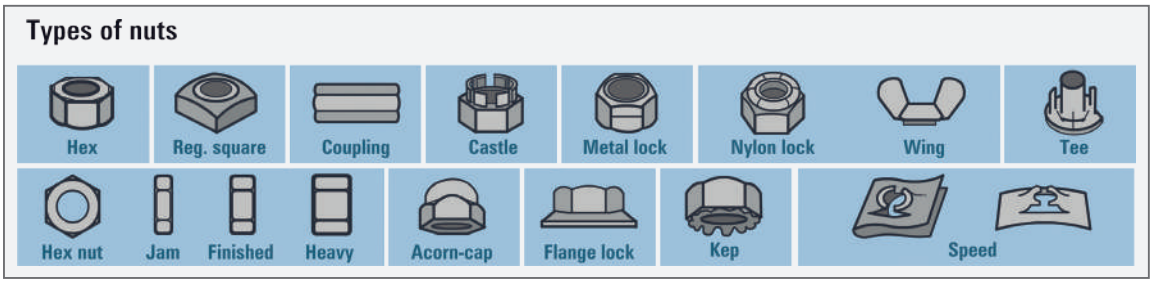


Figura 27 - Porcas de parafusos

Washers (arruelas) - a flat thin ring or a perforated plate used in joints or assemblies to ensure tightness, prevent leakage, or relieve friction.

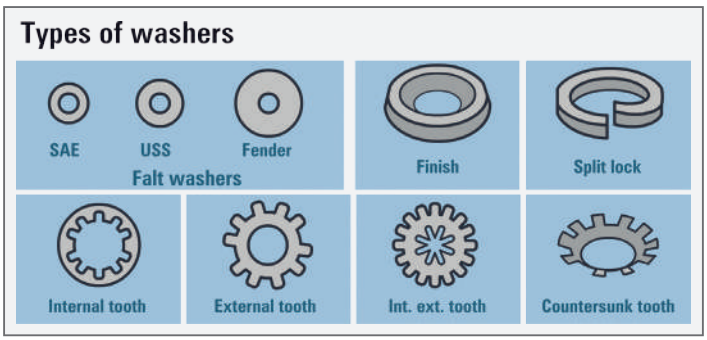


Figura 28 - Arruelas

Cotter pin - a metal pin used to fasten two parts of a mechanism together.

Rivet - is a type of metal bolt or pin with a head on one end, inserted through one of the aligned holes in the parts to be joined and then compressed on the plain end to form a second head.

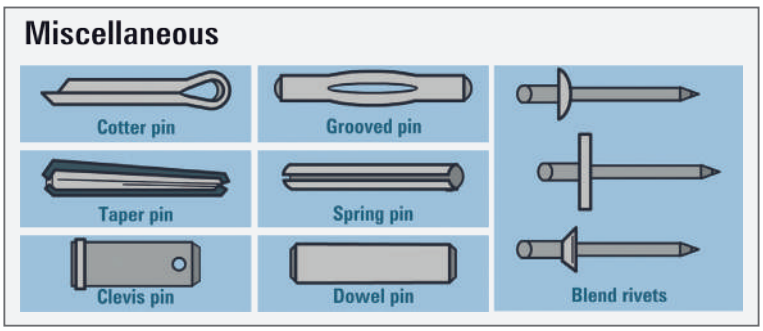


Figura 29 - Diversos

Be careful! Small parts such as fasteners, wires, fittings, safety wires, pins and gaskets are easily forgotten and difficult to be found. It is very important the work area remains clean, organized and all debris can be placed in appropriate containers.

In July 2000, during takeoff, one aircraft of a french company (Flight 4590) ran over a piece of metal on the runway. The piece of metal caused a tire to fail. Pieces of the tire ruptured the fuel tank, ignited the fuel and ultimately resulted in a loss of aircraft control that ended with it crashing into a nearby hotel. The result was the death of 113 people, the destruction of the hotel and the loss of a 46 million dollar aircraft. It was a FOD incident.

Tabela 6 - Vocabulário

Inglês	Português	Inglês	Português
Blueprint	Diagrama, desenho técnico	*Lag*	Atraso, retardo
Cap nut	Porca de capa	*Leakage*	Vazamento
Carriage bolt	Parafuso de carruagem	*Rivet*	Rebite
Clutch	Embreagem	*Rod*	Haste
Cotter pin	Contrapino	*Safety wire*	Arame de freno
Coupling nut	Porca de acoplamento	*Set*	Jogo, conjunto

Fuel tanks: tanques de combustível dos aviões devem ser concebidos, localizados e instalados para reter o combustível quando sujeito a cargas de inércia resultantes de fatores de carga estática e em possíveis ocasiões em que o avião pousa com o trem de pouso recolhido. Eles também devem reter o combustível no caso de perda de um motor.

Inglês	Português	Inglês	Português
Damage	Dano, avaria	*Slotted screw*	Parafuso de fenda cruzada
Debris	Detritos	*Spanner*	Chave
Dowel screw	Cavilha rosqueada	*Spline*	Estriado
Eyebolt	Pino com olhal	*Tapping screw*	Parafuso autoatarraxante
Fasten (verbo)	Apertar	*Taxiway*	Pista para o avião taxiar
Fastener	Prendedor	*Tool*	Ferramenta
Fitting	Conexão	*Wire*	Arame
Gasket	Gaxeta, junta	*Wiring diagram*	Diagrama de fiação elétrica
Jam nut	Contraporca		

1.7 Grammar point – compound words

Palavras compostas (*compound words*) são muito comuns e possuem uma importância muito grande nos textos técnicos para a identificação de peças e onde elas são utilizadas. Portanto, é imprescindível saber a utilização dos termos gramaticais na ordem correta. Este assunto é motivo de grande confusão por parte dos estudantes, pois, dependendo da ordem em que os termos são colocados, muda todo o significado da expressão. Alguns exemplos como door lever, fuel tanks e ground service operations são comuns nos textos que estudaremos ao longo do curso.

O princípo básico em uma palavra composta é: uma palavra é considerada chave, enquanto as outras são qualificadoras.

Tabela 7 - Palavra-chave

Qualificadora	Palavra-chave	Significado
Door (porta)	Lever (alavanca)	Lever of the door (alavanca da porta)
Fuel (combustível)	Tank (tanque)	Tank for fuel (tanque de combustível)
Discharge (descarregar)	Valve (válvula)	Valve for discharging (válvula de descarga)
Eyebolt	Pino com olhal	Tapping screw

Quando uma palavra composta está em um texto, a palavra-chave é a última na sequência. As palavras antecedentes qualificam a palavra-chave com informações específicas.

- *Ground service operations* - nesse caso, *operations* é a palavra-chave e *ground service* são as qualificadoras.

O sentido da expressão depende da ordem das palavras. Veja os exemplos abaixo:

- Brake disc - a disc on the brake.
- Disc brake - a type of brake.

Ao observar as duas frases anteriores, nota-se que o significado da expressão foi alterado quando a ordem das palavras foi invertida. No primeiro exemplo, *brake disc* significa disco de freio, enquanto, no segundo exemplo, *disc brake* significa freio a disco. O mesmo ocorre com *flight level* e *level flight*.

- Flight level - aircraft altitude (altitude de voo da aeronave).
- Level flight - horizontal flight (voo horizontal).

Para encerrar, segue uma curiosidade a respeito do inventor do voo mais pesado que o ar.

The first flight of our glorious Santos Dumont was on October 23, 1906, flying the airplane 14-Bis. This date is known as the Day of Aviation. He invented, besides 14-Bis, the wristwatch, the hangar and the seaplane prototype. He did not patent their inventions.

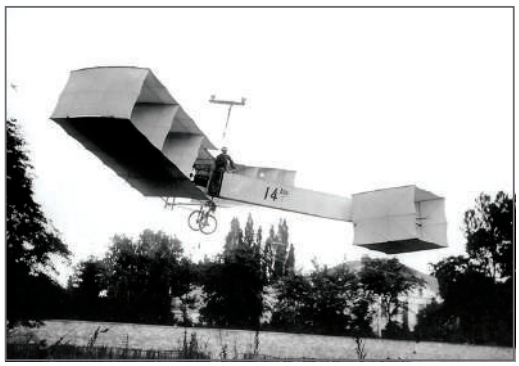


Figura 30 - 14 Bis
Fonte: Agência Força Aérea.

Resumindo

Foram descritas, neste capítulo, as partes principais de uma aeronave, bem como suas funções, modelos e diferenças. Além disso, foram vistas as forças que nela agem e as condições para que o avião estabeleça um voo seguro.

Ao se estudar as práticas de manutenção, foi explicada a importância de uma ordem técnica e os cuidados a serem tomados em uma área operacional, principalmente na limpeza e na organização do ambiente para prevenção de danos causados por objetos estranhos (FOD), que custa às empresas aéreas milhões de dólares todos os anos. Na parte gramatical, foi ensinado o verbo *to be* e os substantivos simples e compostos, servindo de apoio para as futuras traduções dos manuais técnicos.

Capítulo 2
Power plant

Neste capítulo, será abordado o conjunto motopropulsor, que é o conjunto formado por motores, hélices e partes que complementam esses dois grupos. Serão mostrados os principais tipos de motores utilizados em aeronaves e seus componentes básicos e um pouco sobre as hélices.

Conceitos gramaticais serão apresentados durante o capítulo, servindo de base para tradução dos textos e manuais técnicos do assunto mencionado.

2.1 Power plant

Power plant is the complete installation of an aircraft engine, propeller, and all accessories needed for its proper function. It is responsible for providing thrust to the aircraft. This thrust, or propulsive force, is provided by a suitable type of aircraft heat engine. All heat engines have in common the ability to convert heat energy into mechanical energy by the flow of air through the engine.

Aircraft engines come in many different types, such as gas turbine and reciprocating piston engine.

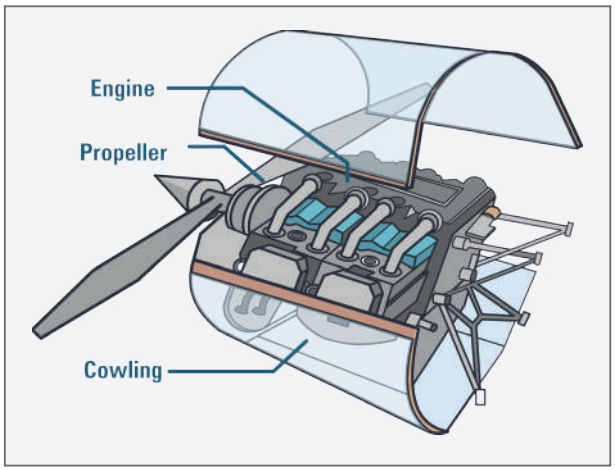


Figura 31 - Grupo motopropulsor

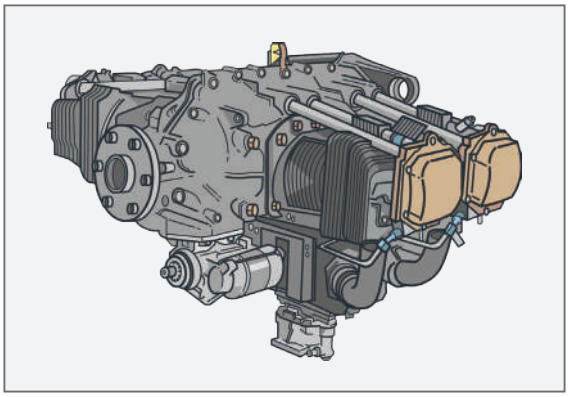


Figura 32 - Motor a pistão

Gas turbine: turbinas a gás são motores térmicos de combustão interna. Elas utilizam a expansão dos gases provenientes da queima de combustível para girar uma ou mais turbinas que geram empuxo.

Reciprocating piston engine: motores alternativos também são motores térmicos de combustão interna. Eles convertem a expansão dos gases de combustão em movimento linear dos pistões dentro de cilindros.

2.1.1 Reciprocating piston engines

They power the conventional vehicles like automobiles, tractors, motorcycles, boats, trains, airplanes, and other devices used by us. All reciprocating engines are basically the same. Most of them use liquid fuel, requiring an ignition system, a cooling system, and a lubrication system.

2.1.2 Parts of reciprocating piston engines and their functions

A reciprocating engine has seven major parts:

- crankcase;
- cylinder;
- piston;
- connecting rod;
- valve;
- valve operating mechanism (cam);
- crankshaft.

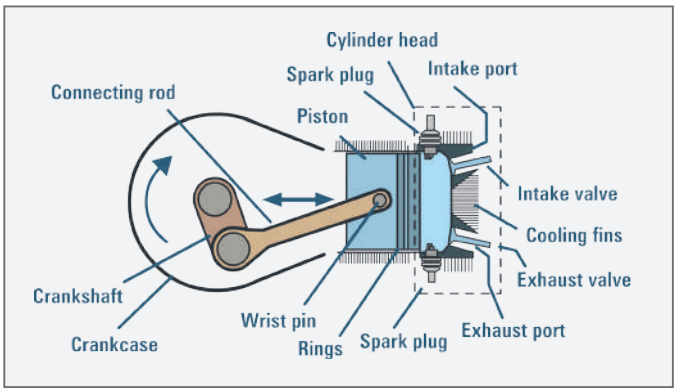


Figura 33 - Componentes internos do motor a pistão

a) Crankcase is the foundation of an engine. It contains bearings and bearing supports in which the crankshaft revolves.

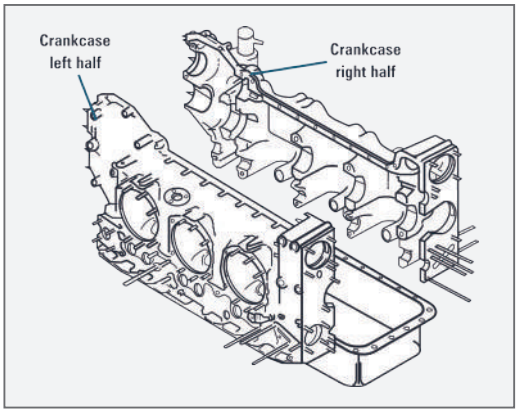


Figura 34 - Cárter do motor

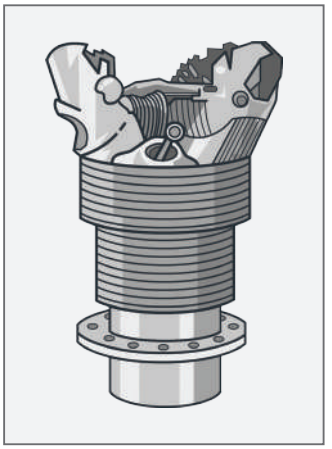


Figura 35 - Cilindro

Movements of the piston: etapas de um ciclo de motor a combustão interna, ciclo Otto: admissão (*induction stroke*), compressão (*compression stroke*), explosão (*power stroke/ expansion stroke*) e escapamento (*exhaust stroke*).

b) Cylinder is the portion of the engine in which the power is developed. It provides a combustion chamber where the burning and expansion of gases take place, and it houses the piston and the connecting rod.

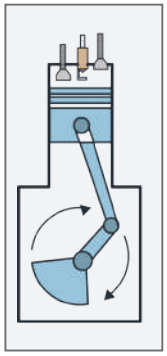


Figura 36.A - Admissão

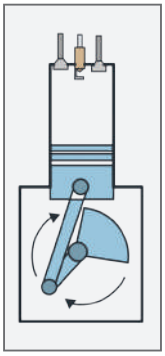


Figura 36.B - Compressão

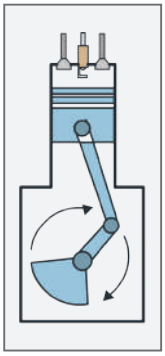


Figura 36.C - Explosão

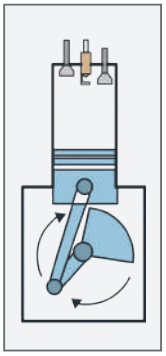


Figura 36.D - Escapamento

c) Piston is a cylindrical part that moves back and forth within a steel cylinder. The piston acts as a moving wall within the combustion chamber. As the piston moves down in the cylinder, it draws in the fuel/air mixture. As it moves upward, it compresses the charge, occurs the ignition and the expanding gases force the piston downward. The figure beside shows the movements of the piston (four strokes) and five events of a cycle.

d) Connecting rod is the link that transmits forces between the piston and the crankshaft. Connecting rods must be strong enough to remain rigid under load and yet be light enough to reduce the inertia forces that are produced when the rod and piston stop, change direction, and start again at the end of each stroke.

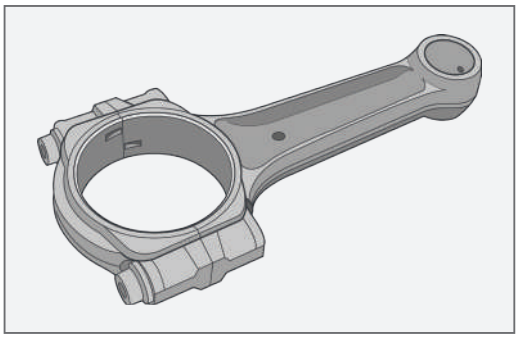


Figura 37 - Biela

e) Valve - the fuel/air mixture enters the cylinders through the intake valve ports, and burned gases are expelled through the exhaust valve ports. The head of each valve opens and closes these cylinder ports.

f) Valve Operating Mechanism (Cam) - for a reciprocating engine operate properly, each valve must open at the proper time, stay open for the required length of time, and close at the proper time.

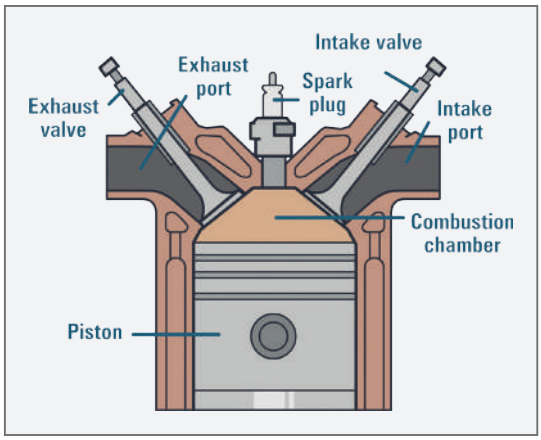


Figura 38 - Figura em corte do cilindro do motor a pistão

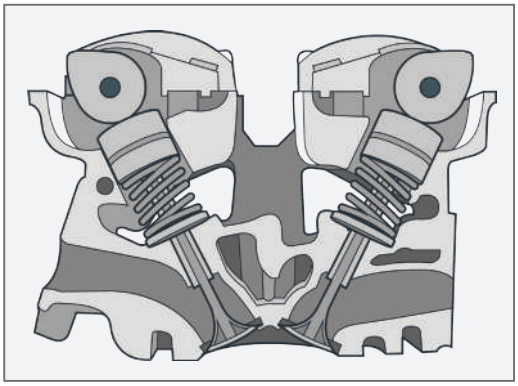


Figura 39 - Figura em corte de um came e válvulas

g) Crankshaft is the backbone of the reciprocating engine. It is subjected to most of the forces developed by the engine. Its main purpose is to transform the reciprocating motion of the piston and connecting rod into rotary motion for rotation of the propeller.

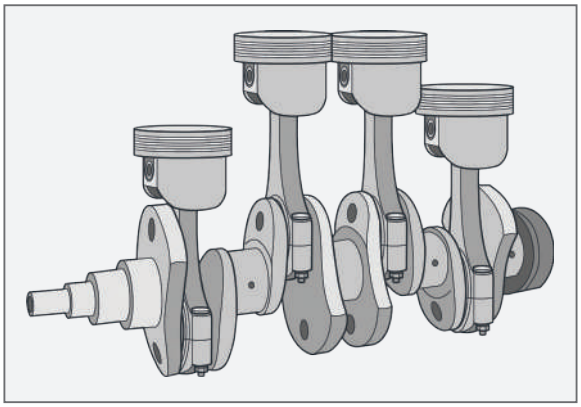


Figura 40 - Conjunto do eixo de manivelas

A figura a seguir mostra o motor alternativo completo empregado em aeronaves e suas diversas partes. Além dos sete principais itens, existem outros acessórios que compõem o equipamento.

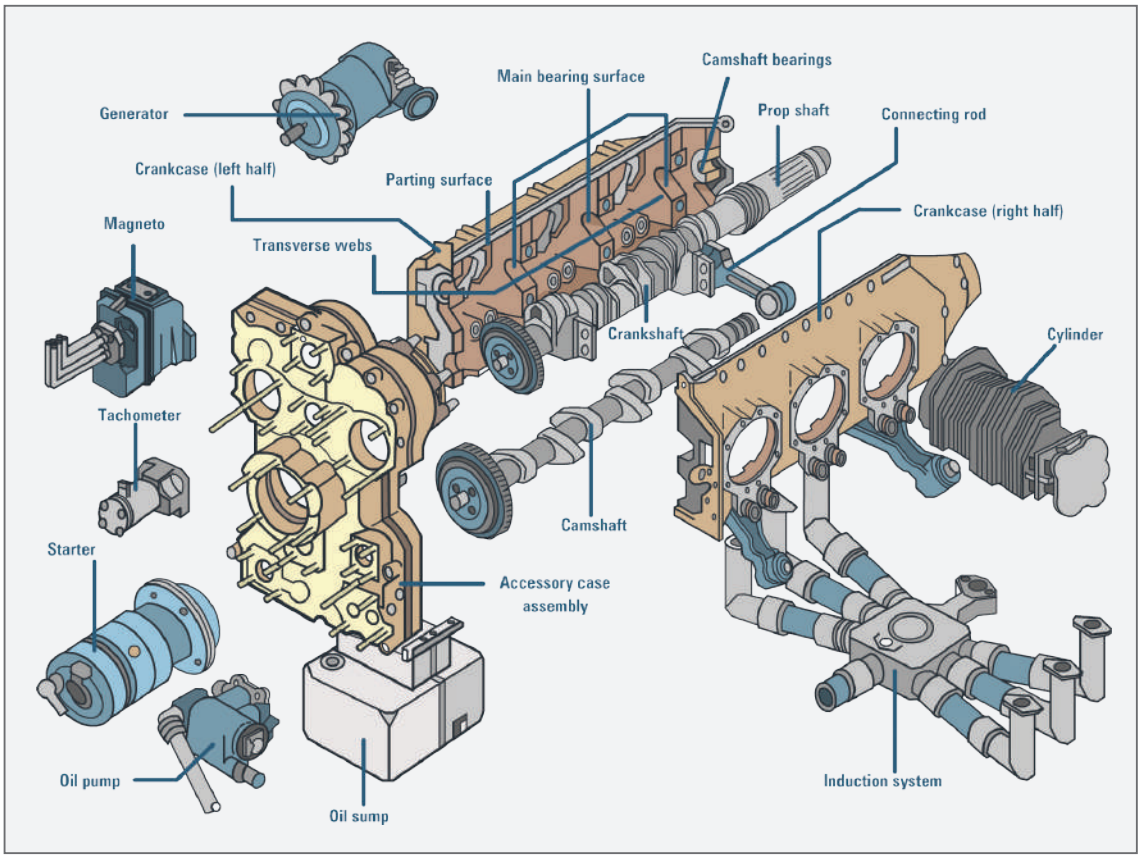


Figura 41 - Vista explodida de um motor a pistão

2.1.3 Let's know more about reciprocating engines!

a) Accessory section - on some engines, it is cast in one piece and provided with means for mounting the accessories, such as magnetos, carburetors, fuel, oil, vacuum pumps, starter, generator and tachometer drive.

b) Magneto is a special type of engine-driven alternate current (AC) generator that uses a permanent magnet as a source of energy.

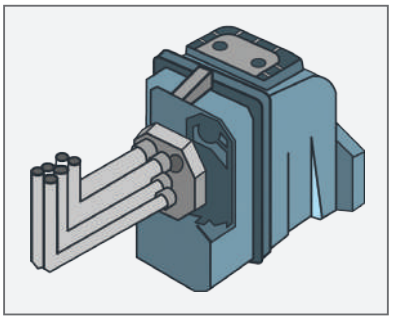


Figura 42 - Magneto

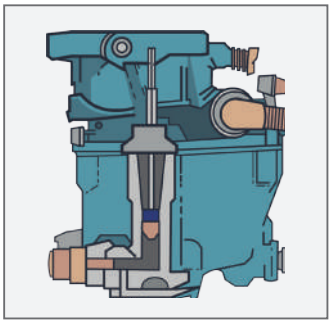


Figura 43 - Carburador

c) Carburetor meters the correct amount of fuel. The fuel/air mixture passes through the intake pipes and intake valves into the cylinders. The quantity or weight of the fuel/air charge depends upon the degree of throttle opening.

d) Oil pump is designed to supply oil under pressure to the parts of the engine that require lubrication, then circulate the oil through coolers as needed, and return the oil to the oil tank.

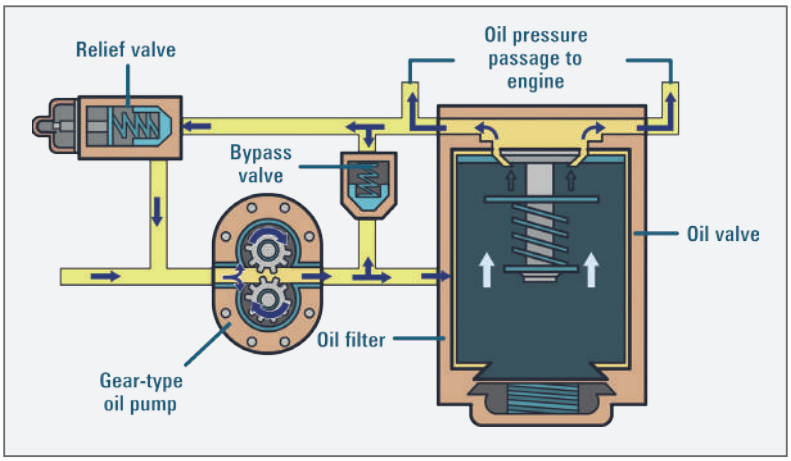


Figura 44 - Bomba de óleo tipo engrenagem e válvulas

e) Cylinder head - the purpose of the cylinder head is to provide a place for combustion of the fuel/air mixture and to give the cylinder more heat conductivity for adequate cooling.

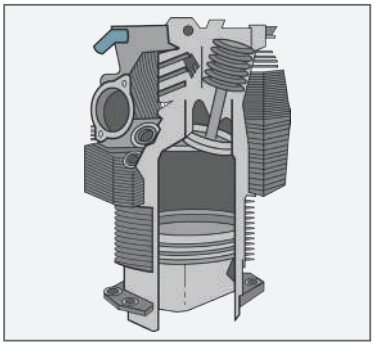


Figura 45 - Cabeça do cilindro

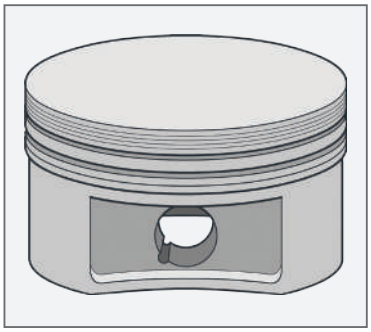


Figura 46 - Pistão com anéis de segmento

f) Piston ring prevents leakage of gas pressure from the combustion chamber and reduces to a minimum the seepage of oil into the combustion chamber.

g) Spark Plugs - the function of the spark plug in an ignition system is to conduct a short impulse of high-voltage current through the wall of the combustion chamber.

h) Starter is used for rotating an internal-combustion engine so as to initiate the engine's operation under its own power.

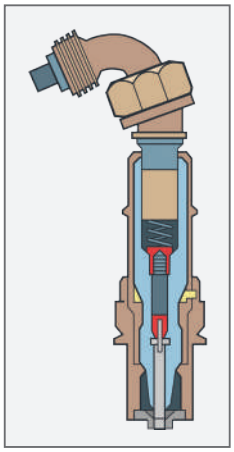


Figura 47 - Figura em corte de uma vela de ignição

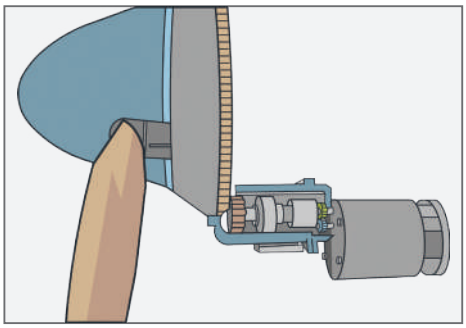


Figura 48 - Arranque

i) Generator is turned directly by the engine through the accessory gear box and produces power any time the engine is turning.

j) Tachometer is an instrument that measures the rotational speed of an object.

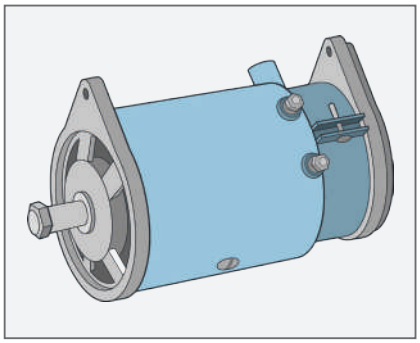


Figura 49 - Gerador

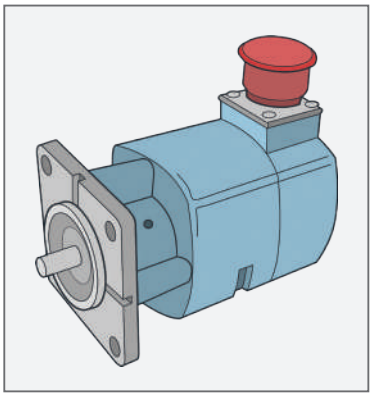


Figura 50 - Tacômetro

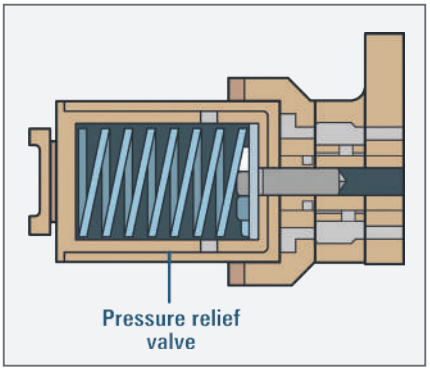


Figura 51 - Figura em corte de uma válvula de alívio de pressão

k) Oil Filter - as oil passes through the fine-mesh screen, dirt, sediment, and other foreign matter are removed and settle to the bottom of the housing.

l) Oil Pressure Relief Valve - an oil pressure regulating (relief) valve limits oil pressure to the value specified by the engine manufacturer.

m) Bearings - any surface which supports, or is supported by, another surface. The parts must be held in position within very close tolerances to provide efficient and quiet operation, and yet allow freedom of motion.

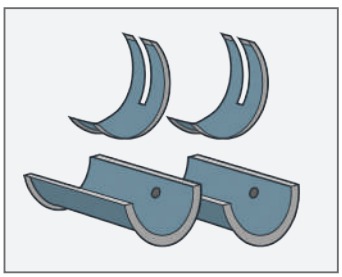


Figura 52.A - Mancal liso

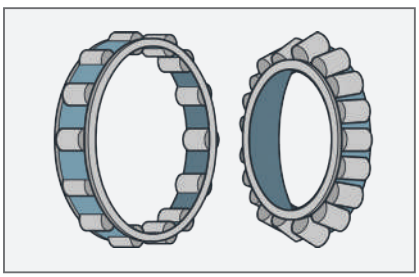


Figura 52.B - Rolamento de roletes

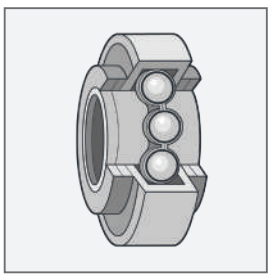


Figura 52.C - Rolamento de esfera

2.1.4 Gas turbine engines

To move an airplane through the air, we have to use some kind of propulsion system to generate thrust. The most widely used form of propulsion system for modern aircraft is the gas turbine engine. Turbine engines come in a variety of forms.

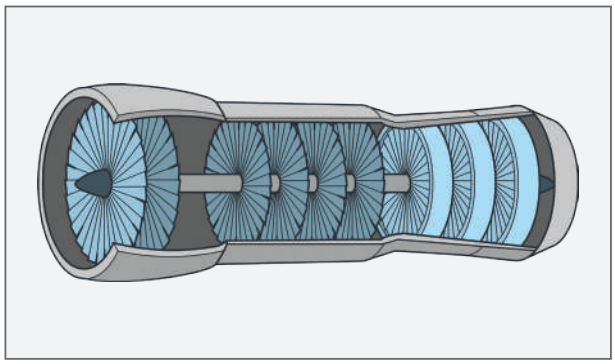


Figura 53.A - Motor turbofan

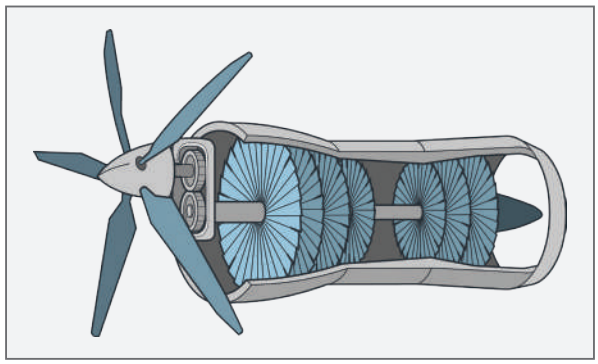


Figura 53.B - Motor turboélice

Parts of a gas turbine engine and their functions

All of these engines have:

a) combustion section

b) compressor

c) turbine

d) inlet and a nozzle

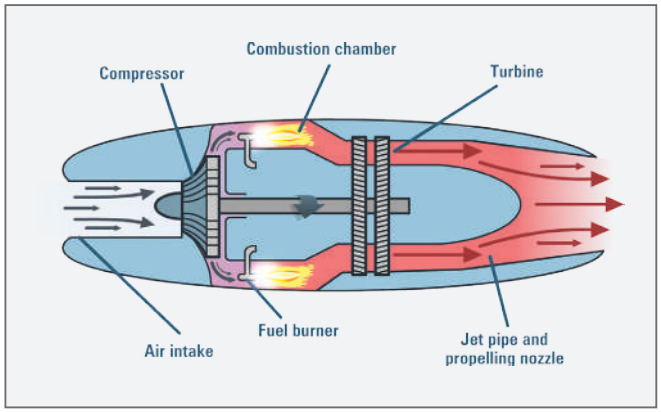


Figura 54 - Motor a jato

The compressor, burner, and turbine are called the core of the engine, since all gas turbines have these components. The core is also referred to as the gas generator. The output of the core is hot exhaust gas. The gas is passed through a nozzle to produce thrust for the turbojet, while it is used to drive the turbine of the turbofan and turboprop engines.

The compressor and turbine are linked by the central shaft and rotate together. This group of parts is called the turbomachinery.

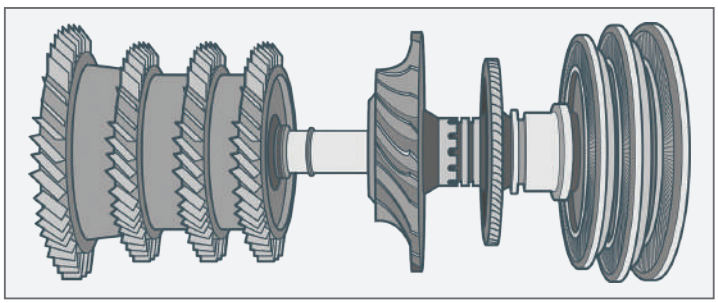


Figura 55 - Núcleo do motor a jato

2.1.5 Let's know more about gas turbine or jet engines!

Most modern passenger and military aircraft are powered by gas turbine engines, which are also called jet engines. There are several different types of gas turbine engines, but all turbine engines have some parts in common. All turbine engines have an inlet to bring free stream air into the engine.

The compressor increases the pressure of the incoming air before it enters the combustor. There are two main types of compressors: axial and centrifugal. In the axial compressor, the flow through the compressor travels parallel to the axis of rotation. In the centrifugal compressor, the flow through this compressor is turned perpendicular to the axis of rotation. Centrifugal compressors are still used on small turbojets and turbo shaft engines. Modern large turbojet and turbofan engines usually use axial compressors.

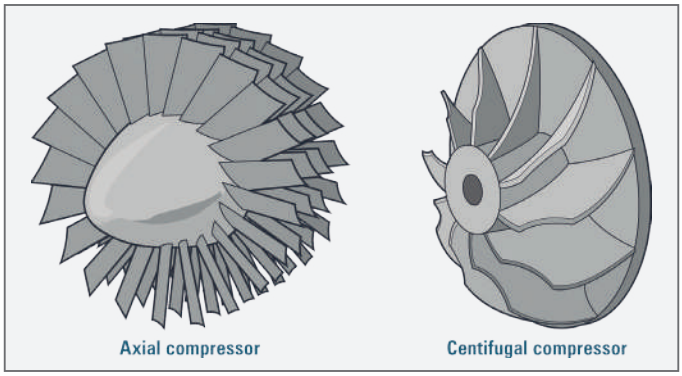


Figura 56.A - Compressores axial e centrífugo

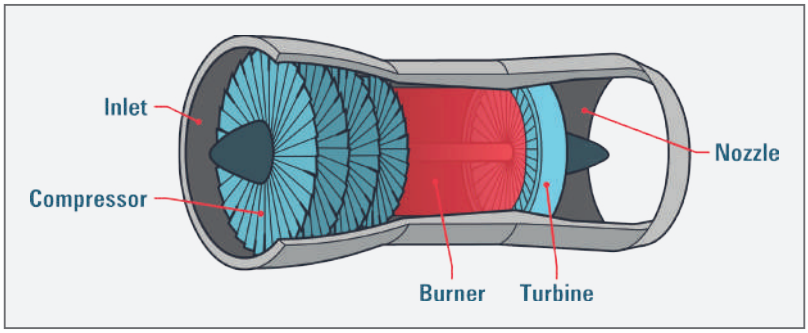


Figura 56.B - Elementos de um motor a jato

A turbine typically has a series of compressor wheels mounted on a single shaft, and each wheel or fan is referred to as a stage. Each stage increases the compression of the airflow – what is referred to as a multistage compressor. In contrast, the term multispool engine refers to turbine engines where there is more than one shaft running though the core, each shaft having it own

independent set of compressors and turbines that turn at different speeds. The term spool denotes the compressor, the turbine, and the shaft that connects the two.

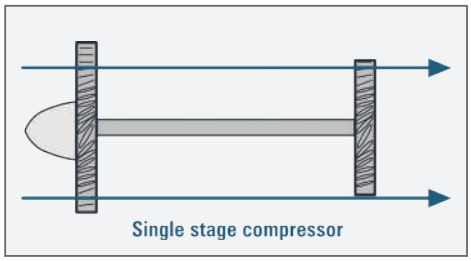


Figura 57 - Compressor de estágio único de compressão

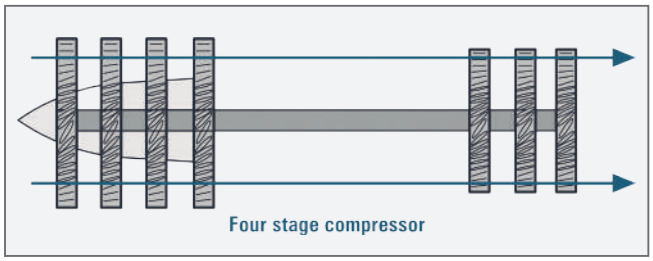


Figura 58 - Compressor de quatro estágios de compressão

Turbine transforms a portion of the kinetic (velocity) energy of the exhaust gases into mechanical energy to drive the gas generator compressor and accessories

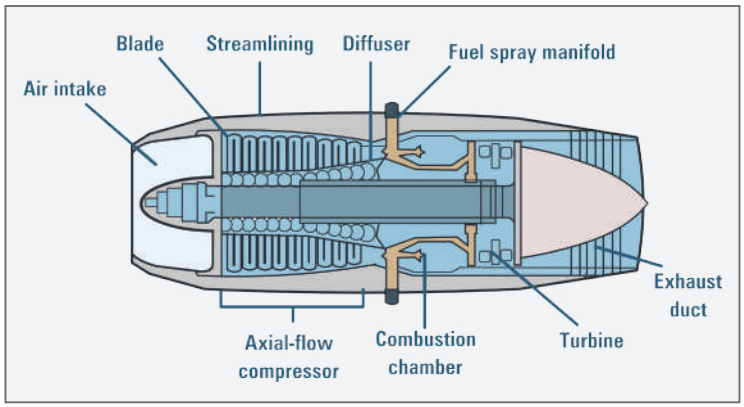


Figura 59 - Figura em corte de um motor a jato

Cold section is the portion of a gas turbine engine ahead of the combustion section. The cold section includes the inlet, compressor, and diffuser.

Diffuser is a component in the gas turbine engine that decreases the velocity of air flowing through it and increases its pressure.

Combustion chamber or combustor - the section of a gas turbine engine in which fuel is injected. This fuel mixes with air from the compressor and burns. The intense heat from the combustion expands the air flowing through the combustor and directs it through the turbine. Combustors are also called burners.

Blade is the portion of a gas turbine engine that operates at a high temperature. The hot section includes the combustion, turbine, and exhaust sections.

Exhaust section of the jet engine is designed to give additional acceleration to the gases and thereby increase thrust. The exhaust section also serves to straighten the flow of the gases as they come from the turbine. Basically, the exhaust section is a cone mounted in the exhaust duct. This duct is also referred to as the tailpipe. The shape of the tailpipe varies, depending on the design operating temperatures and the speed-performance range of the engine.

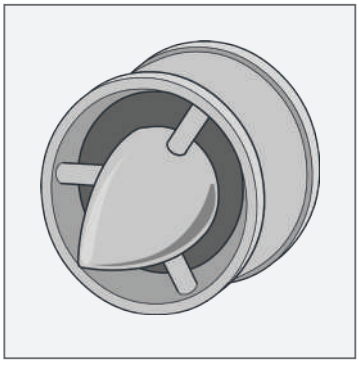


Figura 60 - Seção de escapamento de motor a jato

Blade stations: estações das pás são linhas de referências imaginárias, transversais à pá e medidas a partir do centro do cubo da hélice. Nessas estações, são realizadas as medições de alinhamento, ângulo, largura e espessura das pás.

Impeller is a type of compressor that uses a vaned plate like impeller. Air is taken into the center, or eye, of the impeller and slung outward by centrifugal force into a diffuser where its velocity is decreased and its pressure increased.

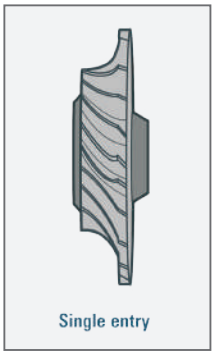


Figura 61.A - Compressor centrífugo de entrada simples

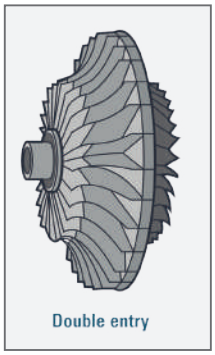


Figura 61.B - Compressor centrífugo de entrada dupla

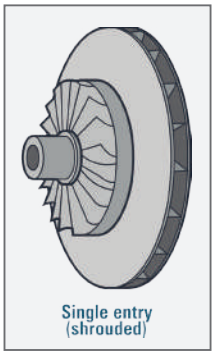


Figura 61.C - Compressor centrífugo de entrada simples carenado

Core engine is the gas generator portion of a turboshaft, turboprop, or turbofan engine. The core engine consists of the portion of the compressor used to supply air for the engine operation, diffuser, combustors, and turbine(s) used to drive the compressor. The core engine provides the high-velocity gas to drive the fan and/or any free turbines that provide power for propellers, rotors, pumps, or generators.

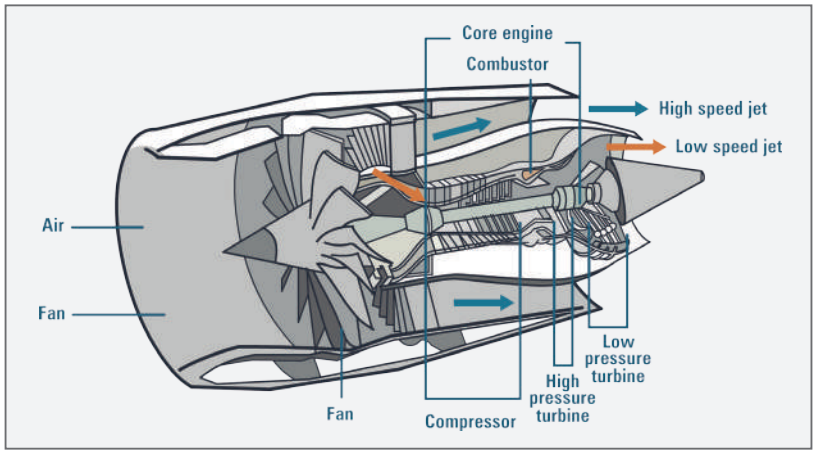


Figura 62 - Figura em corte do núcleo do motor a jato

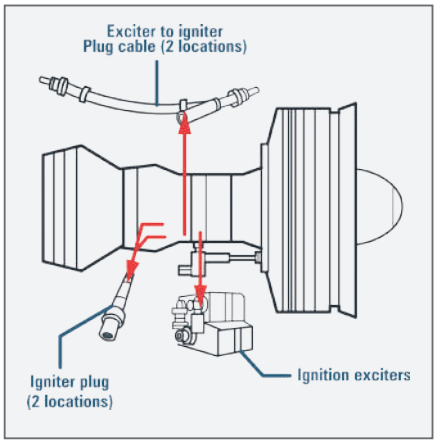


Figura 63 - Ignitor

Igniter is the component in a turbine-engine ignition system that provides a high-energy spark for igniting the fuel-air mixture in the combustion chamber for starting.

Fuel nozzle is responsible to inject the proper amount of fuel into the combustion chamber.

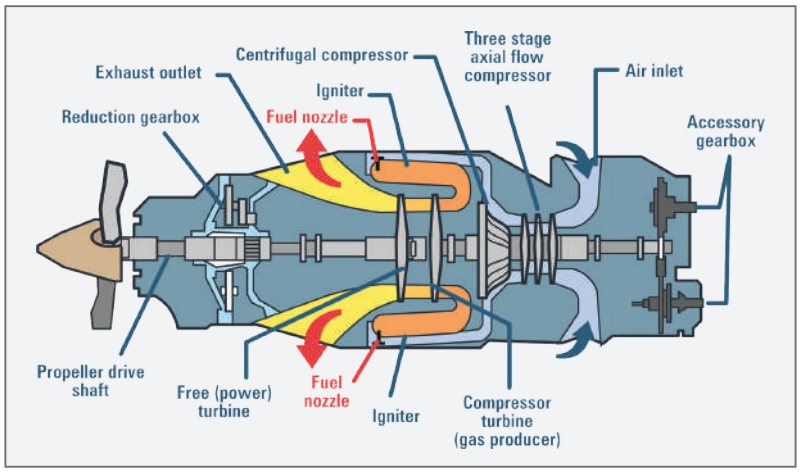


Figura 64 - Bicos injetores de combustível e componentes internos de um motor a jato

Fuel Control Unit (FCU) controls power output by varying fuel flow to the burner.

Afterburner is a component in the exhaust system of a turbojet or turbofan engine used to increase the thrust for takeoff and for special flight conditions. Fuel is sprayed into the hot, oxygen-rich exhaust in the afterburner, where it is ignited and burned to produce additional thrust.

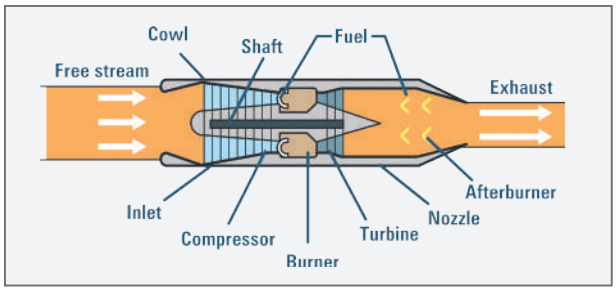


Figura 65 - Ilustração de um pós-combustor

Full authority digital engine - or electronics - control (FADEC) uses electronic sensors for its inputs and controls fuel flow with electronic outputs.

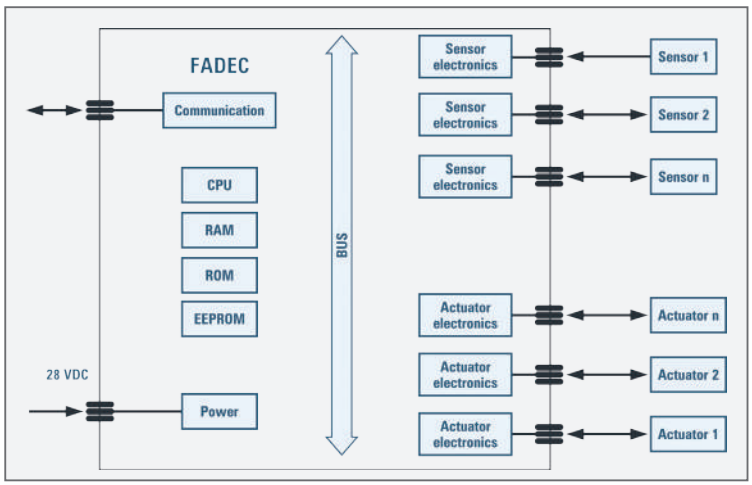


Figura 66 - Fadec

Full authority digital engine control (FADEC): equipamento eletrônico digital responsável pelo controle de combustível dos motores das aeronaves. Ele atua durante todas as operações do motor, exercendo a plena autoridade pelo controle de fluxo de combustível, a partir dos comandos recebidos da cabine de pilotos.

Cowling - the removable cover that encloses an aircraft engine.

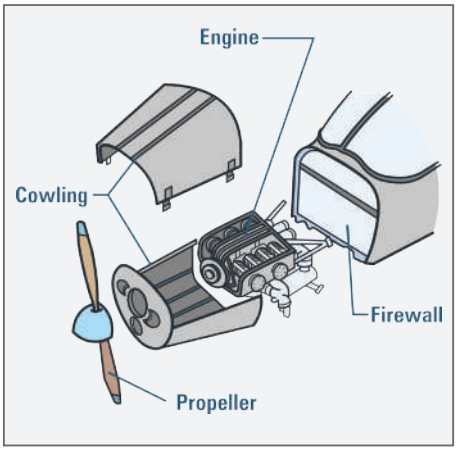


Figura 67 - Hélice, motor, parede de fogo e carenagem do motor

Tabela 8 - Vocabulário

Inglês	Português	Inglês	Português
Afterburner	Pós-combustor	*Nozzle*	Bocal, bico
Backbone	Espinha dorçal	*Pipe*	Tubo, bico
Bearing	Mancal, rolamento	*Piston*	Pistão
Blade	Lâmina, pá da hélice	*Plug*	Plugue, bujão, tomada
Cam	Came	*Port*	Abertura, passagem
Carburetor	Carburador	*Pump*	Bomba
Chamber	Câmara	*Reciprocating*	Alternativo, a pistão
Connecting rod	Biela	*Relief valve*	Válvula de alívio
Cooler	Radiador, resfriador	*Seepage*	Infiltração
Core	Núcleo	*Shaft*	Eixo
Cover	Cobertura, tampa	*Stream*	Corrente, fluxo
Crankcase	Cárter do motor	*Stroke*	Tempo, curso
Crankshaft	Eixo de manivela	*Spark plug*	Vela de ignição
Cylinder	Cilindro	*Spool*	Rotor (turbina a gás)
Diffuser	Difusor	*Starter*	Arranque
Duct	Duto	*Tachometer*	Tacômetro
Fan	Ventilador, reator	*Tailpipe*	Tubo de escape
Gear box	Caixa de redução	*Throttle*	Manete
Generator	Gerador	*Throttle valve*	Válvula tipo borboleta
Impeller	Compressor centrífugo	*Turbofan*	Turbofan, turbo reator com ventilador
Lubrication	Lubrificação	*Turboprop*	Turboélice
Magnet	Imã	*Turboshaft*	Turbo eixo
Magneto	Magneto		

2.2 Grammar point – articles and sentence structure

Para realizar uma tradução correta e concisa, é necessário o domínio do contexto no qual a leitura é realizada. Neste caso, ter conhecimento do assunto relacionado sobre uma parte específica da aeronave. Entretanto, só o vocabulário técnico não permitirá a compreensão em sua totalidade, sendo necessário o conhecimento básico de alguns pontos gramaticais. O conteúdo a seguir é um resumo das principais regras gramaticais de uma das classes de palavras mais utilizadas: o artigo.

2.2.1 Artigo

Artigo é a classe de palavras que indica, ao mesmo tempo, o gênero e o número dos substantivos. Além disso, ele indica se o nome a que se refere é definido ou indefinido.

a) Definite article - the

O artigo definido *the* pode significar O, A, OS, AS, em português. Sua correta tradução depende da frase em que está inserido.

Exemplos:

- The cylinder - O cilindro.
- The pistons - Os pistões.
- The propeller - A hélice.
- The valves - As válvulas.

Em inglês, o uso do artigo definido ocorre, em algumas situações, de forma diferente à que usamos em português, fato que gera dúvidas e confunde o leitor. Segue alguns casos em que o artigo não deve ser utilizado, conforme a gramática da Língua Inglesa.

I. Antes de nomes de países, estados e cidades

- Brazil is a beautiful country. (Brasil é um lindo país.)
- Minas Gerais is bigger than Pernambuco. (Minas Gerais é maior que Pernambuco.)
- Rio de Janeiro is a wonderful city. (Rio de Janeiro é uma cidade maravilhosa.)

II. Antes de nomes próprios e pronomes possessivos

- John replaced the crankshaft of the reciprocating engine.

  (John trocou o eixo de manivela (eixo virabrequim) do motor à combustão.)

- My cousin Frank connected the generator to the turbine.

  (Meu primo Frank conectou o gerador à turbina.)

b) The indefinite articles (a/an)

Os artigos indefinidos *a* e *an* significam UM ou UMA em português. A correta tradução depende do contexto em que está inserido. São utilizados da seguinte forma:

I. A (um, uma) é utilizado antes de palavras que iniciam com som de consoante.

- A cylinder (um cilindro).
- A turbine (uma turbina).

II. AN (um, uma) é utilizado antes de palavras que iniciam com som de vogal.

- An accelerator (um acelerador).
- An installation (uma instalação).

2.2.2. Estrutura básica das orações

Conhecer a estrutura básica das orações facilita a compreensão e a tradução dos textos técnicos. Segundo o autor Philip Shawcross, a frase está basicamente dividida em sujeito, verbo, objeto, meios e propósitos. Não é necessário que toda oração tenha esses cinco elementos, conforme será visto nos exemplos a seguir.

Tabela 9 - Estrutura básica das orações

Sujeito	Verbo	Objeto	Meio	Propósito
Powerplant	is	responsible	through the engine and propeller	to provide thrust to the aircraft

Outros exemplos que ajudam a compreender melhor esse conceito.

The mechanics fix the airplane.

Sujeito - The mechanics.

Verbo - fix.

Objeto - the airplane.

The fuel/air mixture enters the cylinders through the intake valve ports.

Sujeito - The fuel/air mixture.

Verbo - enters.

Objeto - the cylinders.

Meio - through the intake valve ports.

Starter is used for rotating an internal-combustion engine.

Sujeito - Starter.

Verbo - is used.

Propósito - for rotating an internal-combustion engine.

2.3 Propeller

Aircraft propellers or airscrews convert rotary motion from piston engines or turboprops to provide propulsive or traction force. There are several types of propellers. It can have two, three, four, five, six or more blades and can be installed in front or behind the wing. The propeller is usually attached to the crankshaft of a piston engine, either directly or through a reduction gear box. They may be fixed or variable pitch.

Propeller: hélice é a unidade que deve absorver a potência de saída do motor e gerar o empuxo para a aeronave.

2.3.1 Parts of a propeller

Blade is the component of a propeller that converts the rotation of the propeller shaft into thrust. The blade of a propeller corresponds to the wing of an airplane.

Hub - the high-strength component inside a propeller that attaches the blades to the engine propeller shaft.

Propeller reduction gearing provides reduction gears to limit the propeller rotation speed to a value at which efficient operation is obtained.

Counterweight is a variable-pitch propeller that has counterweights around the blade shanks and the blades angled back from the hub to increase the effects of aerodynamic and centrifugal twisting forces.

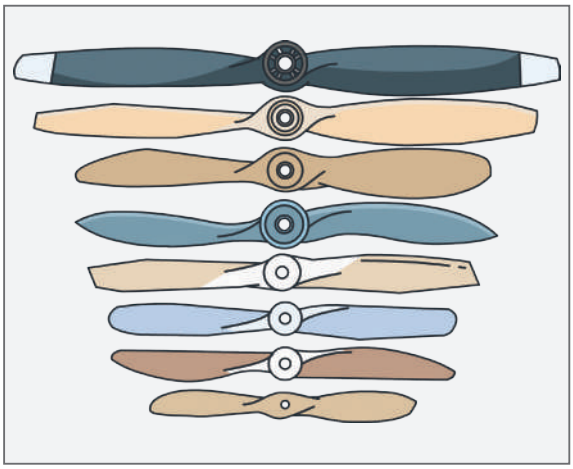


Figura 68 - hélices de passo fixo (pás)

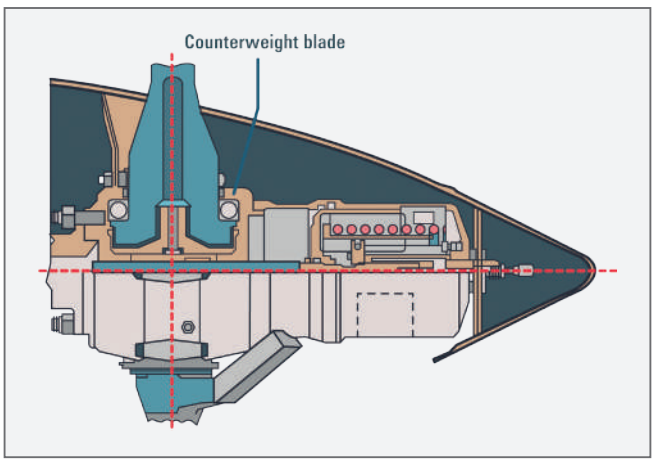


Figura 69 - Contrapeso da hélice

2.3.2 Let's know more about propellers!

Pusher propeller is a propeller installed on an aircraft engine so that it faces the rear of the aircraft. Thrust from the propeller pushes rather than pulls the aircraft.

Tractor propeller is a propeller mounted on the upstream end of a drive shaft in front of the supporting structure.

Track is the path followed by a blade segment of a propeller in one rotation.

Effective pitch is the actual distance a propeller advances in one revolution through the air.

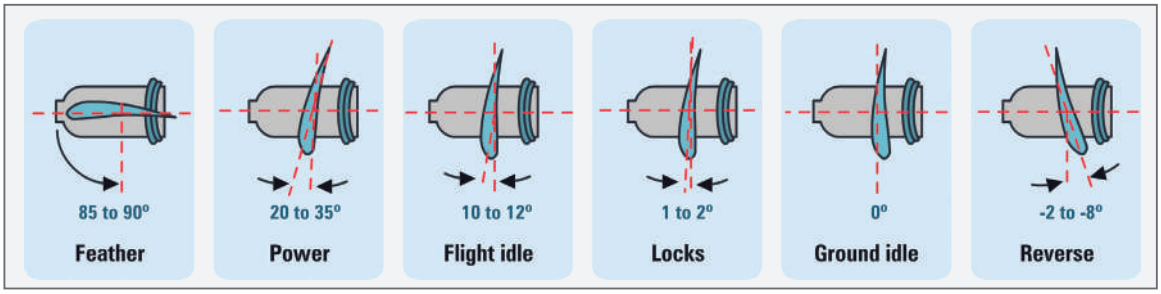


Figura 70 - Passos típicos de uma hélice

The Picture above shows typical propeller blade positions from feather position through the reverse position. Normal sequence of blade travel is feather, high pitch, low pitch, locks/ground idle, reverse pitch, and then back following the same path. Fixed turboprop engines are shut down on the locks to prevent load on the engine during restart.

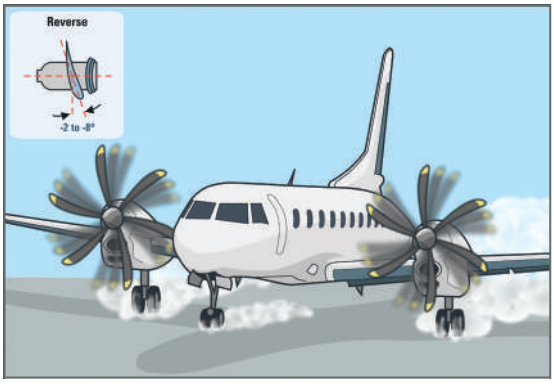


Figura 71 - Hélice em passo reverso

Governor is a control used to automatically change the pitch of a constant speed propeller to maintain a constant engine rpm as air loads vary in flight.

Reverse pitch is a controllable propeller in which the blade angles can be changed to a negative value during operation. It is used during landing.

Feathering Pitch - in a controllable-pitch propeller, blades can be moved into a high pitch angle of approximately 90º. Feathering the propeller of an inoperative engine prevents it from wind-milling and greatly decreases drag.

Spinner is a streamlined fairing fitted over a propeller hub that reduces the aerodynamic drag.

Blade station is a reference position on a propeller blade that is a specified number of inches from the center of the propeller hub. Blade shank is the rounded portion of a propeller blade between the root and the airfoil section. Blade butt is the end of a propeller blade that fits into the hub. Blade tip is the opposite end from the root of a propeller blade.

Figura 72 - Hélice em passo bandeira

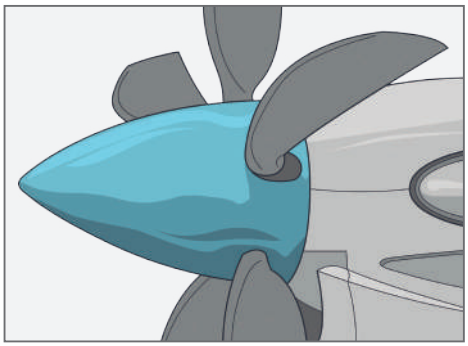


Figura 73 - Carenagem do cubo da hélice

Overspeed condition is a speed condition in which the engine is turning at an rpm higher than that for which the propeller governor is set.

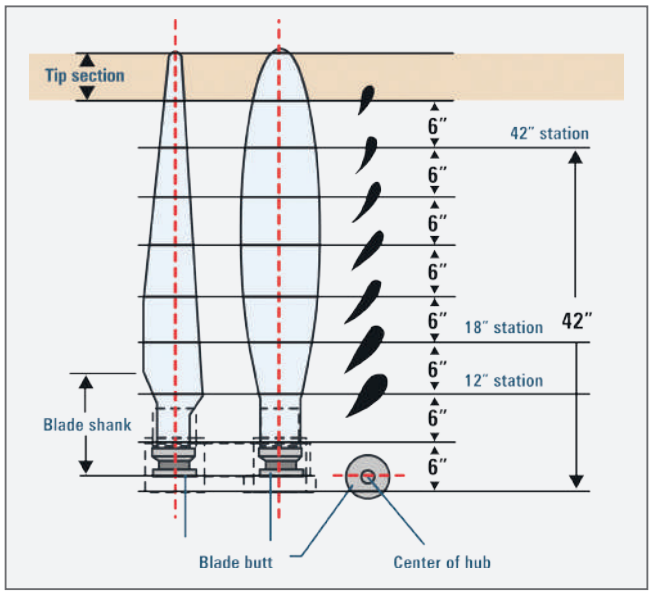


Figura 74 - Estações de uma pá de hélice

Constant-speed feathering propeller is the feathering propeller, utilizes a single oil supply from a governing device to hydraulically actuate a change in blade angle.

Axis of rotation is the center line about which a propeller rotates.

Blade tracking is the process of determining the positions of the tips of the propeller blades relative to each other (blades rotating in the same plane of rotation).

Propeller unbalance is a source of vibration in an aircraft, may be either static or dynamic.

Propeller unbalance: para corrigir o desbalanceamento da hélice, são realizados o balanceamento estático das pás e o balanceamento dinâmico da hélice.

Hydromatic propeller is the pitch changing mechanism of hydromatic propeller. It is a mechanical-hydraulic system in which hydraulic forces acting upon a piston are transformed into mechanical forces acting upon the blades.

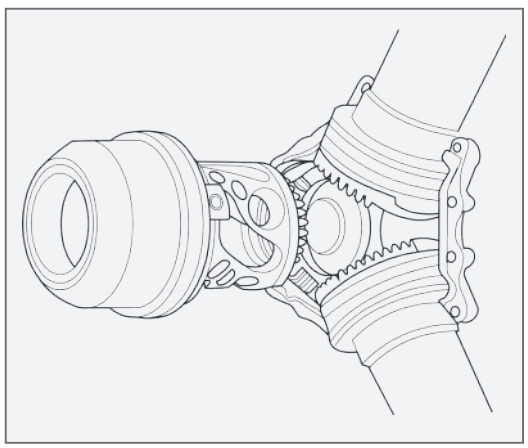


Figura 75 - Hélice hidramática em corte

Tabela 10 - Vocabulário

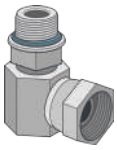
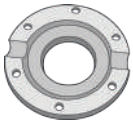
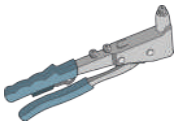
Inglês	Português	Inglês	Português
Airfoil	Aerofólio	*Revolution*	Rotação
Butt	Topo	*Shank*	Espiga, flanco
Counterweights	Contrapesos	*Spinner*	Carenagem do cubo da hélice
Fairing	Carenagem	*Streamlined*	Fuselado
Feathering	Embandeiramento	*Strength*	Resistência
Governor	Governador	*Track*	Trajetória, centragem
Hub	Cubo	*Tracking*	Rastreio
Hydromatic	Hidramática	*Traction*	Tração
Idle	Marcha lenta	*Tractor*	Trator (de tração)
Path	Trajetória	*Twisting*	Torção
Pusher	Impulsor	*Unbalance*	Desequilíbrio
Reduction gear box	Caixa de redução	*Upstream*	Parte traseira
		Wind-miling	Hélice livre, molinagem

Tabela 11 - Vocabulário de materiais

Inglês	Português	Inglês	Português
Alloy	Liga	*Iron*	Ferro
Aluminum	Alumínio	*Magnesium*	Magnésio
Asbestos	Amianto	*Nickel*	Níquel
Bronze	Bronze	*Plastic*	Plástico
Carbon	Carbono	*Rubber*	Borracha
Chromium	Cromo	*Silver*	Prata
Composite material	Material composto	*Stainless steel*	Aço inoxidável
Copper	Cobre	*Steel*	Aço
Cork	Cortiça	*Titanium*	Titânio
Fiber	Fibra	*Wood*	Madeira
Gold	Ouro	*Zinc*	Zinco

Algumas peças são identificadas pela semelhança dessas com objetos, partes do corpo humano ou objetos conhecidos, conforme a tabela a seguir.

Tabela 12 - Nomenclatura de termos por semelhança

Figura	Item	Semelhança		Tradução
	Nose gear	Nose	Nariz	Nariz do avião
	Jaw pliers	Jaw	Mandíbula	Alicate
	Control arm	Arm	Braço	Braço de controle
	Elbow hose adapter	Elbow	Cotovelo	Cotovelo de mangueira
	Claw hammer	Claw	Garra	Martelo com garra
	Toe brake pedal	Toe	Dedo (pé)	Pedal de freio
	Washer head screw	Head	Cabeça	Cabeça do parafuso
	Eye bolt	Eye	Olho	Parafuso com olhal
	Body valve	Body	Corpo	Corpo da válvula
	Hand plier rivet tool	Hand	Mão	Alicate manual de rebite
	Finger filters	Finger	Dedo (mão)	Filtros em forma de dedos
	Landing gear legs	Leg	Perna	Pernas do trem de pouso

2.4 Grammar point – verb tenses

Ao utilizar documentos técnicos, é imprescindível compreender exatamente a mensagem do texto. Conhecer as formas verbais e as suas particularidades é essencial na compreensão da mensagem do texto e facilita a atividade de contextualização das orientações constantes em textos técnicos, além da atividade que se deve realizar nos ambientes de manutenção aeronáutica.

Dessa forma, serão estudados os tempos verbais comumente utilizados em documentos técnicos (os mais usuais nesse tipo de linguagem).

Tempos verbais

a) Infinitivo

O infinitivo é a forma nominal que indica a ação propriamente dita, sem situá-la no tempo, aproximando-se da função substantiva. É utilizado para expressar um objetivo ou um propósito.Ele serve de base para os outros tempos verbais.

Em português, os verbos no infinitivo terminam em AR, ER e IR. Já, em inglês, é formado por TO + forma base do verbo.

- Heat engines have the ability to convert heat energy into mechanical energy.
- The oil pump is designed to supply oil under pressure to the parts of the engine.

b) Presente simples

É o tempo verbal utilizado para descrever generalidades, processos e sistemas.

- Tachometer measures the rotational speed of an object.

(Tacômetro mede a velocidade rotacional de um objeto.)

- Turbine engines come in a variety of forms.

(Motores a turbina apresentam-se em uma variedade de formatos.)

O presente simples é o tempo verbal mais utilizado em documentações técnicas. Ele possui a particularidade de se acrescentar S ao verbo quando conjugado na terceira pessoa do singular (HE, SHE e IT). Nas demais pessoas, o verbo permanece inalterado.

Tachometer measures the rotational speed of an object. (singular)

Tachometers measure the rotational speed of an object. (plural)

Os verbos *to be* (ser, estar) e *to have* (ter) se destacam por serem amplamente utilizados.

Powerplant is responsible for providing thrust to the aircraft.

All reciprocating engines have the same major parts.

Os adjetivos em inglês são INVARIÁVEIS. Isto significa que eles não variam em gênero e número, tendo a mesma forma tanto para o singular quanto para o plural.

Exemplos:

The propeller is new. (singular)

The propellers are new. (plural)

c) Imperativo

No caso dos manuais técnicos, o imperativo é utilizado para mostrar quais instruções devem ser seguidas ou realizadas, apresentando-se na mesma forma que o infinitivo sem o TO.

Turn on the equipment.

Follow the checklist.

O imperativo é utilizado quando se deseja dar uma ordem, conselho, advertência e, no caso de manuais técnicos, quais instruções devem ser seguidas ou realizadas. Tem a mesma forma que o infinitivo sem o TO.

Select the right position.

Fasten the seat belt.

O imperativo negativo é formado precedendo a oração com Do not ou Don't.

Do not seat on the wings.

De acordo com o livro *english for aircraft*, de Philip Shawcross, os verbos listados na tabela a seguir são os mais utilizados na linguagem técnica.

Tabela 13 - Verbos mais utilizados

Verbo (ação)	Significado	Tradução
Adjust	Regulate	Ajustar
Check	Verify	Checar, verificar
Control	Command	Controlar, comandar
Decrease	Reduce	Reduzir
Ensure	Make sure	Garantir, checar
Increase	Raise	Aumentar
Monitor	Follow	Monitorar, olhar parâmetros
Observe	Look, watch, respect	Observar, respeitar
Perform	Do, execute	Fazer, executar
Press	Push	Apertar, empurrar
Record	Register, note, memorize	Gravar, registrar
Remove	Take away	Remover
Set	Select, place	Colocar, selecionar

Apenas com o intuito de familiarização com textos técnicos, será apresentada a seguir uma lista de procedimentos, conhecida como *check list*. Nesse tipo de texto, são utilizados os verbos preponderantemente na forma nominal do infinitivo. A seguir, será apresentado um exemplo de *check list* para os procedimentos a serem efetivados antes da partida de um motor de uma aeronave.

Before starting an aircraft engine

- Position the aircraft to head into the prevailing; wind to ensure adequate airflow over the engine, for cooling purposes.
- Make sure that no property damage or personal injury will occur from the propeller blast or jet exhaust.
- If external electrical power is used for starting, ensure that it can be removed safely and it is sufficient for the total starting sequence.
- During any and all starting procedures, a "fireguard" equipped with a suitable fire extinguisher shall be stationed in an appropriate place. A fireguard is someone familiar with aircraft starting procedures. The fire extinguisher should be a CO_2 extinguisher of at least pound capacity. The appropriate place is adjacent to the outboard side of the engine, in view of the pilot, and also where he or she can observe the engine/aircraft for indication of starting problems.
- If the aircraft is turbine engine powered, the area in front of the jet inlet must be kept clear of personnel, property, and/or debris (FOD).
- These "before starting" procedures apply to all aircraft powerplants.
- Follow manufacturer's checklists for start procedures and shutdown procedures.

Em documentos como "*troubleshooting*" (pesquisa de panes), os verbos são empregados, principalmente, no imperativo.

Failure of engine to start

- Lack of fuel.
- Ignition switch off.
- Under-priming or over-priming.
- Incorrect throttle setting.
- Cold oil.
- Defective battery (battery ignition systems).
- Dirty or defective spark plugs.
- Water in magneto.
- Wet ignition harness.
- Wrong grade of fuel.
- Spark advance retarded too far.

Check list: lista de verificação que fornece a sequência correta de um determinado procedimento. Ao usar o *check list*, o técnico diminui drasticamente o risco de esquecer alguma etapa de uma sequência de procedimentos de manutenção.

Fire extinguishers: trata-se dos extintores de incêndio para as classes A, B, C e D. Os extintores são itens obrigatórios nos ambientes de manutenção e operação de aeronaves.

- Vapor in fuel system.
- Water in carburetor.
- Defective ignition wiring.
- Booster magneto defective.
- Incorrect valve and/or ignition timing.
- Defective magneto.
- Broken impulse coupling.
- Magneto breaker points defective.
- Incorrect valve clearance.
- Defective priming system.
- Internal trouble in carburetor.
- Intake manifold air leaks.
- Broken, shredded or defective camshaft.
- Internal engine failure.
- Spark plug wires crossed.
- Miscellaneous (turn engine over slowly by hand with the master & magneto switch off and note any unusual condition, particularly low compression.

d) Gerúndio

O gerúndio é a forma nominal do verbo utilizada para indicar uma ação contínua que está, esteve ou estará em andamento, ou seja, um processo verbal não finalizado.

Em Português, os verbos no gerúndio terminam em -NDO. Já, em inglês, é formado por: forma base do verbo + ING. O verbo terminado em -ING nem sempre funcionará como o verbo na frase. Em determinadas situações, ele poderá exercer a função de substantivo, inclusive desempenhar a posição sintática de sujeito de uma oração.

Smoking is forbidden.

Testing the equipment is only allowed after some procedures.

No primeiro exemplo, *Smoking is forbidden*, o verbo funciona como sujeito da oração. Já, no segundo exemplo, *Testing the equipment is only allowed after some procedures*, toda a oração destacada funciona como sujeito da oração.

O verbo no gerúndio também pode qualificar um substantivo, indicando sua função, como neste exemplo: *icing equipment*.

e) Particípio passado

O particípio passado é utilizado para indicar uma ação realizada, um estado ou uma condição.

Starter is used for rotating an internal-combustion engine.

The compressor is located inside the engine.

The compressor and turbine are linked by the central shaft.

Como a maioria dos verbos utilizados em textos técnicos é regular, eles são formados da seguinte maneira:

Forma base do verbo + ED

- Fix - Fixed
- Clean - Cleaned
- Drill - Drilled

Apesar de a maioria dos verbos utilizados em manuais técnicos serem regulares, existem alguns irregulares que devem ser estudados com atenção, pois estão presentes nesse tipo de texto. A peculiaridade desses verbos é que eles não seguem uma regra para diferenciar o infinitivo do particípio passado, sendo necessária a memorização de cada grupo de verbos e suas variações. A seguir, serão apresentados alguns exemplos de verbos irregulares.

Tabela 14 - Verbos irregulares

Infinitivo	Particípio
Be	Been
Do	Done
Fly	Flown
Go	Gone
Have	Had
Read	Read
Send	Sent
Set	Set

f) Futuro

Para escrever frases no futuro em Língua Inglesa, pode-se utilizar as palavras shall e will. Enquanto este último pode ser usado para uma ação no futuro, o primeiro (shall) é utilizado para indicar necessidade, ordem ou procedimento que deve ser realizado. O futuro é formado da seguinte maneira:

WILL/SHALL + forma base do verbo

Compressor shall increase the pressure of the incoming air before it enters the combustor.

The mechanics will fix the airplane tomorrow.

2.5 Good practices in maintenance

Ground safety

Safety around airplanes

Flight line is a place of dangerous activity. Technicians who perform maintenance on the flight line must constantly be aware of what is going on around them. It is also important to be aware of propellers. Do not assume the pilot of a taxiing aircraft can see you. Technicians must stay where the pilot can see them while on the ramp area.

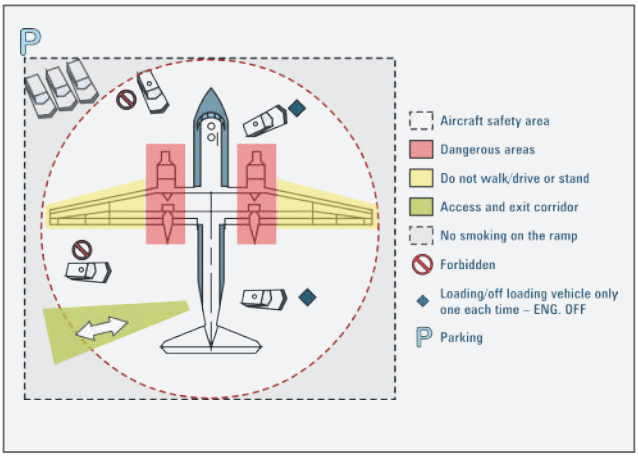


Figura 76. A - Áreas de segurança ao redor da aeronave

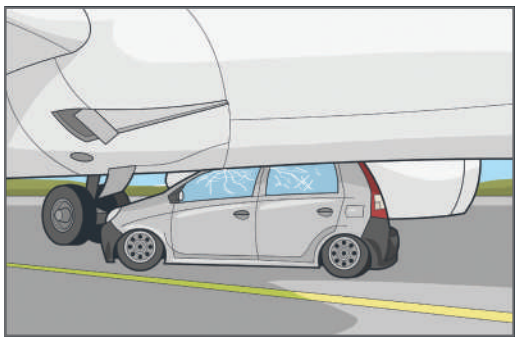


Figura 76.B - Incidente de solo

Turbine engine intakes and exhaust can also be very hazardous areas. There should be no smoking or open flames anywhere near an aircraft in operation. Be aware of aircraft fluids that can be detrimental to skin. When operating support equipment around aircraft, be sure to allow space between it and the aircraft and secure it so it cannot roll into the aircraft. All items in the area of operating aircraft must be stowed properly.

Flight line: linha de operação de aeronaves onde ocorrem as partidas e chegadas das pistas de pouso e decolagem.

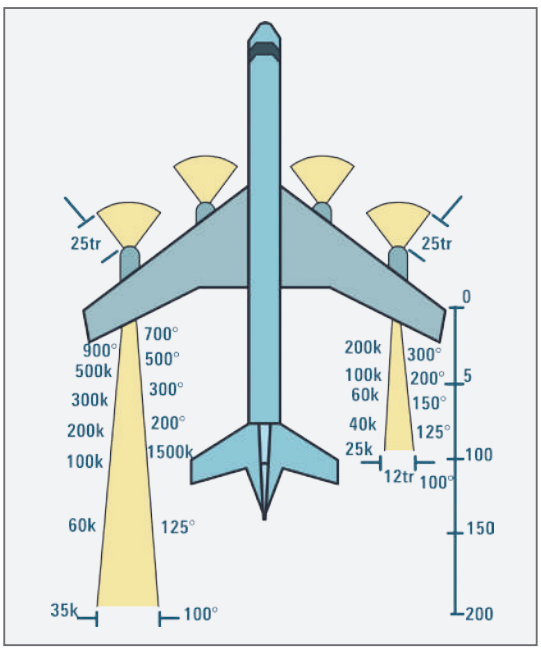


Figura 77 - Áreas de risco na admissão e escapamento dos motores a jato

Figura 78 - Alerta para elevado ruído

Hearing *Protection*

Technicians who perform maintenance on the flight line must constantly be aware of what is going on around them. The noise on a flight line comes from many places. Aircraft are only one source of noise. There are auxiliary power units (APUs), fuel trucks, baggage handling equipment, and so forth. Each has its own frequency of sound. Combined all together, the ramp or flight line can cause hearing loss. There are many types of hearing protection available. Hearing protection can be external or internal. The external protection is the earmuff/headphone type. The internal type fit into the auditory canal. Both types will reduce the sound level reaching the eardrum and reduce the chances of hearing loss.

Auxiliary power unit (APU) is a gas turbine engines used primarily during aircraft ground operation to provide electricity, compressed air, and/or shaft power for main engine start, air conditioning, electric power and other aircraft systems. APUs can also provide backup electric power during in-flight operation.

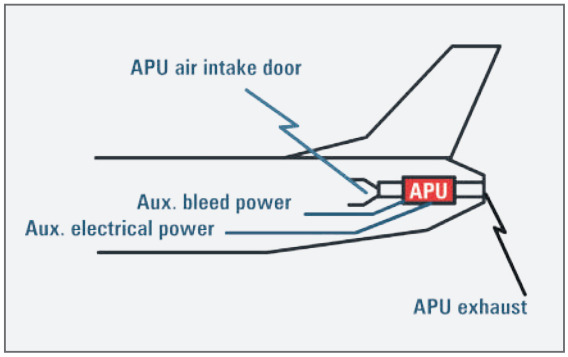


Figura 79.A - Ilustração de um gerador elétrico auxiliar de uma aeronave

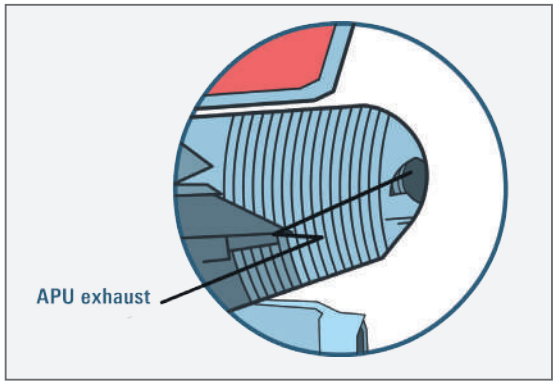


Figura 79.B - Escapamento do gerador elétrico auxiliar

Tabela 15 - Vocabulário

Inglês	Português	Inglês	Português
Backup	Reserva	*Priming*	Injeção
Booster	Reforçador, gerador	*Ramp*	Pátio de manobras
Clearance	Folga, abertura	*Switch*	Interruptor
Eardrum	Tímpano	*Technician*	Técnico
Earmuff	Protetor auricular	*Throttle*	Manete
Flight line	Linha de voo	*Timing*	Calagem
Harness	Chicote (fiação)	*Troubleshooting*	Pesquisa de panes
Hazard	Risco	*Wiring*	Fiação, cablagem
Hearing loss	Perda de audição		

2.6 Grammar point – adverbs and prepositions indicating place

Advérbios e preposições indicando lugar.

Advérbios e preposições indicando lugar aparecem frequentemente em textos técnicos. É preciso saber identificar os advérbios de lugar e as preposições para compreender o contexto técnico.

Seguem as listas de advérbios e de preposições mais comuns.

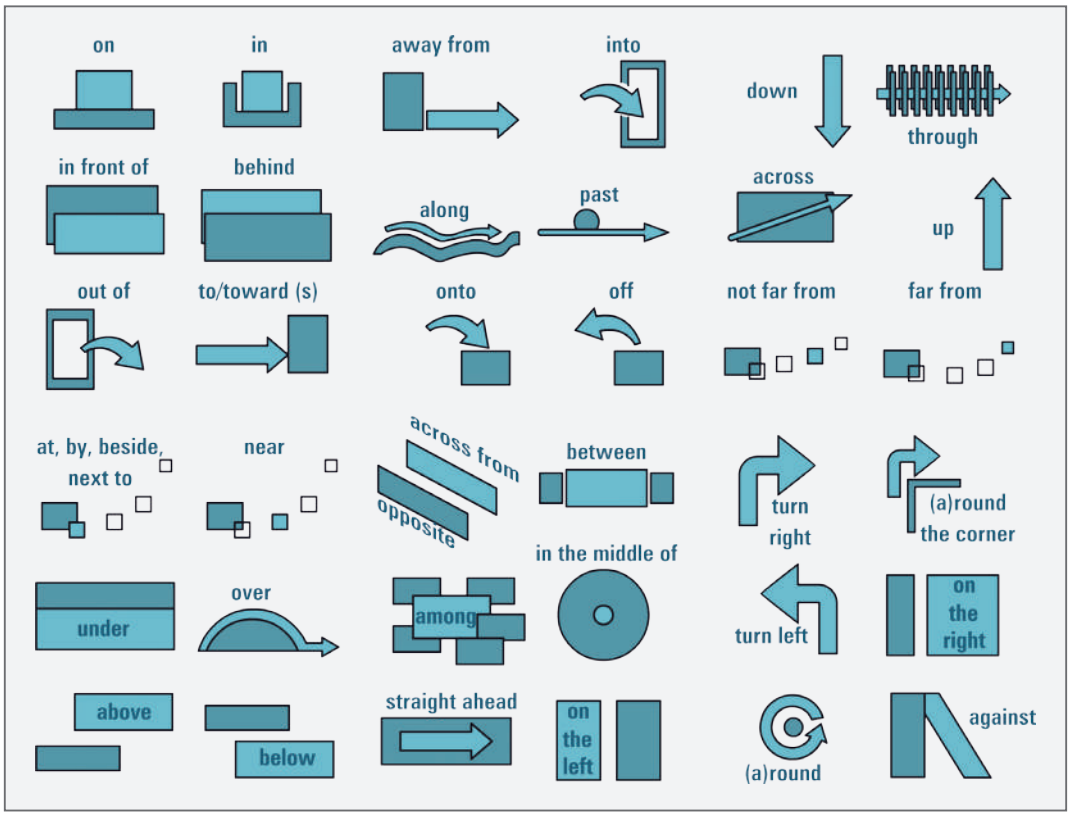


Figura 80 - Advérbios e preposições

- Near - perto.
- Away from - distante de.
- Across from - em frente de; transversalmente.
- In the middle of - no meio de.
- Straight ahead - direto em frente.
- Right - direita.

• Left - esquerda.

• Far from - longe de.

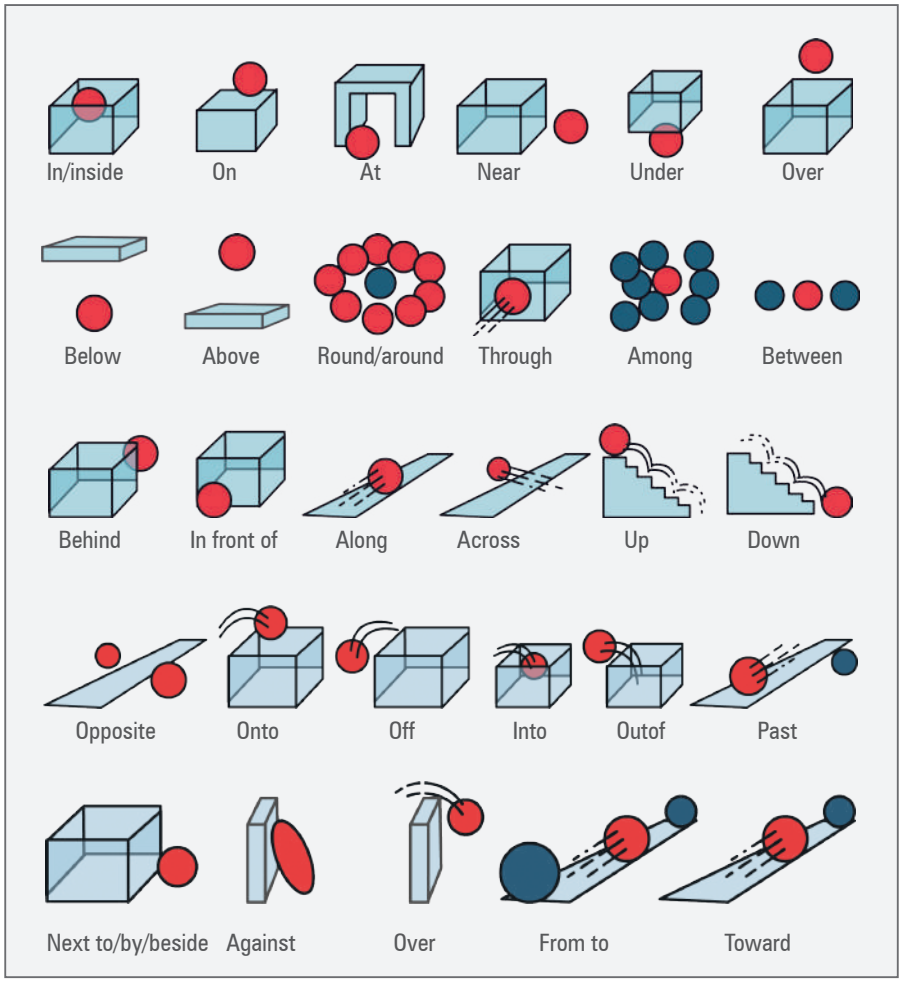


Figura 81 - Advérbios

• In/inside - dentro.

• On - sob; em contato com.

• At - em local específico.

• Near - perto.

• Under - abaixo; em contato com.

• Over - em cima; sem estar em contato.

• Below - debaixo; sem estar em contato.

• Above - em cima; sem estar em contato.

• Round/around - por todo lado; em volta de; em torno.

• Through - através; quando algo entra por um lado e sai pelo outro.

- Among - entre; mais de duas pessoas, objetos.
- Between - entre; duas pessoas, objetos.
- Behind - atrás.
- In front of - em frente a.
- Along - ao longo; quando algo se move em uma direção constante.
- Across - de um lado para outro.
- Up - para cima.
- Down - para baixo.
- Opposite - oposto.
- Onto - deslocar-se para um local; sobre a superfície de alguma coisa.
- Off - para fora.
- Into - para dentro.
- Out of - fora de; para fora de.
- Past - passado; em referência a outro ponto.
- Next to/by/beside - próximo.
- Against - contra; em contato físico com.
- Over - por cima da superfície; topo de alguma coisa.
- From to - *from* indica um ponto de partida; *to* indica um ponto de chegada.
- Toward - em direção de algo.

O sufixo *ward* ou *wards* indica movimento em direção específica (*backwards, downwards, eastward, forwards, homewards, upwards*).

- Towards - em direção a; para.
- Forwards - para a frente.
- Backwards - para trás.
- Downwards - para baixo.
- Upwards - para cima.
- Eastward - a leste.
- Homewards - para casa.

Resumindo

Neste capítulo, foi visto que o grupo motopropulsor (*powerplant*) é formado pelo motor, hélice e outras partes complementares. A diversidade e complexidade deste assunto fizeram com que a Agência Nacional de Aviação Civil (ANAC) criasse uma especialidade chamada Grupo Motopropulsor para formação de técnicos nesta área. Todas as três especialidades estudam os conceitos básicos gerais da aeronave, tendo cada uma o aprofundamento direcionado para cada área de atuação.

Além do conteúdo técnico, práticas adequadas de manutenção foram mostradas com o intuito de aumentar a segurança na área operacional. Todo conceito gramatical estudado serve de apoio à correta compreensão e tradução dos textos e manuais técnicos.

Capítulo 3
Hydraulic and lubrication systems

Neste capítulo, serão estudados os termos técnicos peculiares aos sistemas hidráulicos de aeronaves, do trem de pouso e do sistema de lubrificação de motores convencionais de aeronaves. Todos eles são essenciais ao funcionamento das aeronaves. Os primeiros estão presentes em diversos equipamentos, principalmente naqueles relacionados com comandos de voo, abertura de portas e rampas, acionamento de trem de pouso e outros que precisam do sistema hidráulico para reduzir os esforços para o acionamento de superfícies ou dispositivos.

Valves: válvulas são utilizadas para diversas funções dentro dos sistemas de uma aeronave. No sistema hidráulico, elas controlam a pressão, a direção e o volume do fluido.

Power-driven pumps: são bombas mecânicas, ou seja, são acionadas por dispositivos mecânicos a partir do movimento transmitido do motor da aeronave.

Electrically-driven pumps: são bombas acionadas por motores elétricos que não dependem do acionamento do motor para funcionar, desde que haja energia elétrica suficiente em seu circuito.

3.1 Hydraulic system and landing gear

Um sistema hidráulico nada mais é do que um conjunto de partes que acionam outros componentes por meio de pressão transmitida por um fluido. Esse conceito está baseado na Lei de Pascal, cujo teorema explica que, quando se aplica uma força a um líquido, a pressão causada se distribui de forma integral e igualmente em todas as direções e sentidos.

Serão apresentados, a seguir, textos técnicos explorando o vocabulário básico encontrado nos manuais técnicos que tratam de sistemas hidráulicos de aeronaves.

3.1.1 Definition and components

Hydraulic system is where liquid under pressure is used to transmit this energy. It provides a means for the operation of aircraft components like landing gear, flaps, flight control surfaces and brakes. Hydraulic system complexity varies from small aircraft that require fluid only for manual operation of the wheel brakes to large transport aircraft where the systems are large and complex. A basic system consists of a pump, reservoir, directional valve or selector valve, check valve, pressure relief valve, actuator, and filter.

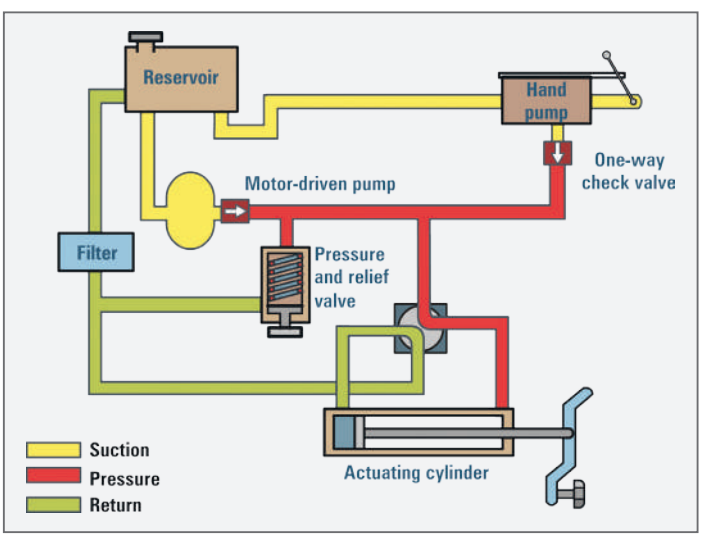


Figura 82 - Sistema hidráulico básico

a) Hydraulic pump is responsible to convert the engine power or electrical power to hydraulic power. This power is distributed throughout the airplane by tubes and may be reconverted to mechanical power by an actuating cylinder. All aircraft hydraulic systems have one or more power-driven pumps or electrically-driven pumps and may have a hand pump as an additional unit when the engine-driven pump is inoperative.

Hand pump is used in some older aircraft for the operation of hydraulic subsystems and in a few newer aircraft systems as a backup unit. Hand pumps are generally installed for testing purposes, as well as for using in emergencies.

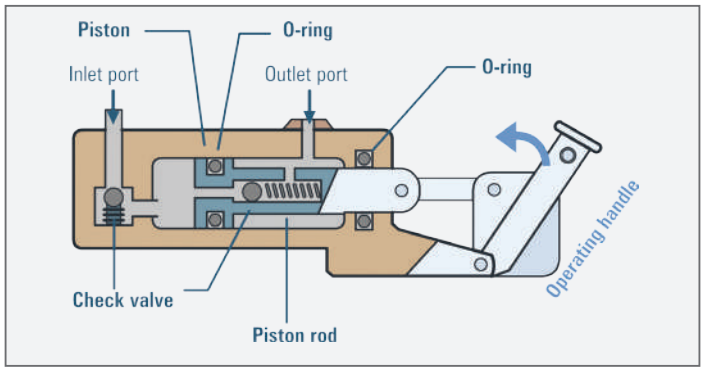


Figura 83 - Bomba manual

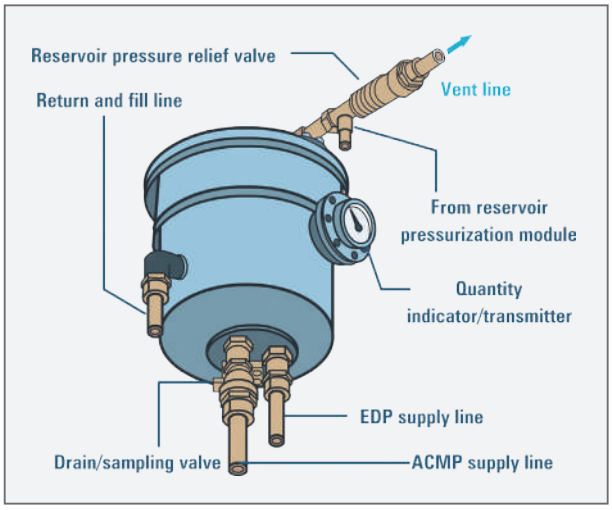


Figura 84 - Reservatório de óleo

Reservoir is a tank in which an adequate supply of fluid for the system is stored. Fluid flows from the reservoir to the pump, where it is forced through the system and eventually returned to the reservoir. They are either pressurized or non-pressurized. The drain valve is used to drain the fluids out of the reservoir for maintenance operation.

Selector valve or directional valve is used to control the direction of movement of a hydraulic actuating cylinder or similar device. It provides for the simultaneous flow of hydraulic fluid both into and out of the unit. There are two main types of selector valves: open-center and closed-center. Selector valves may be poppet-type, spool-type, piston-type, rotary-type, or plug-type.

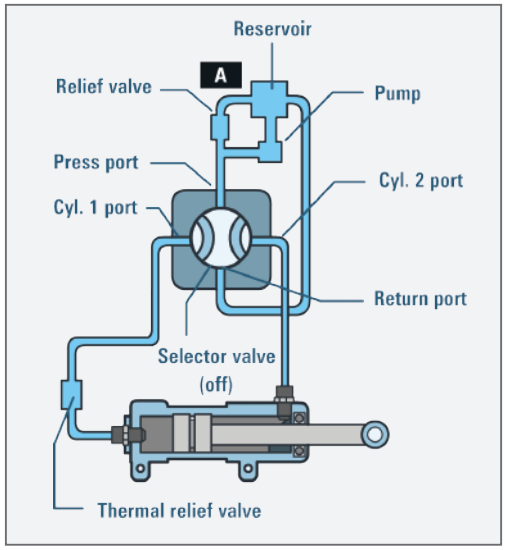


Figura 85 - Ilustração esquemática da válvula seletora ou direcional

Check valve allows fluid to flow unimpeded in one direction, but prevents or restricts fluid flow in the opposite direction.

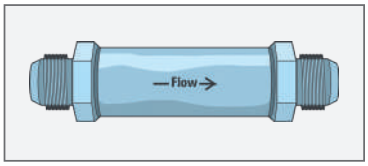


Figura 86 - Válvula de retenção

Pressure relief valve is used to limit the amount of pressure being exerted on a confined liquid. This is necessary to prevent failure of components or rupture of hydraulic lines under excessive pressures. The pressure relief valve is, in effect, a system safety valve.

Actuator converts the fluid pressure into mechanical force, or action, to perform work. It is used to impart powered linear motion to some movable object or mechanism.

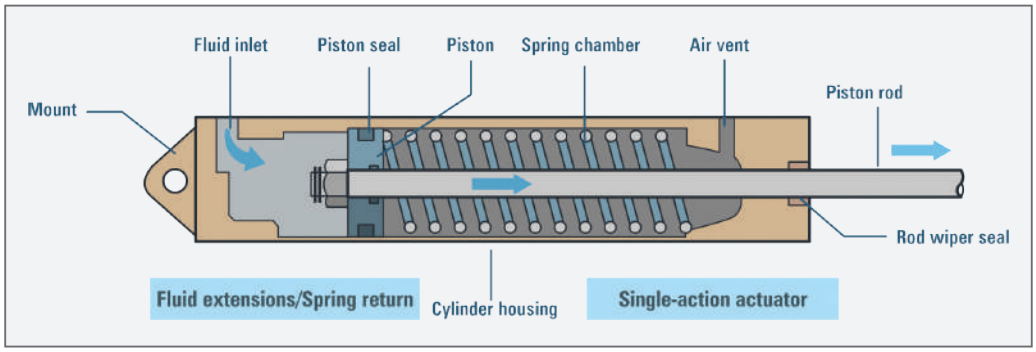


Figura 87 - Atuador

Filter is a screening or straining device used to clean the hydraulic fluid, preventing foreign particles and contaminating substances from remaining in the system. Filter modules are often equipped with a bypass relief valve to open if the filter clogs, permitting continued hydraulic flow and operation of aircraft systems.

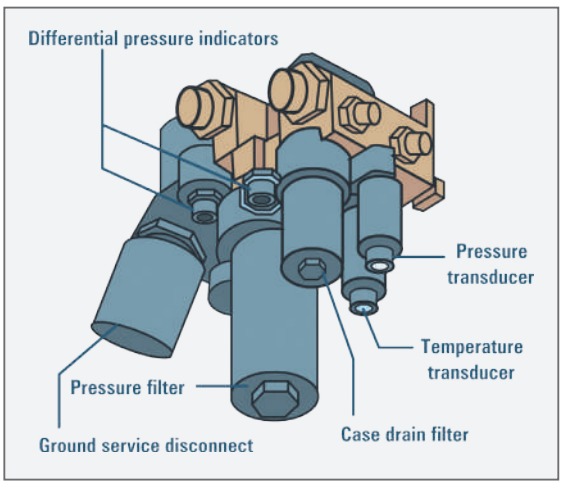


Figura 88 - Filtro hidráulico

Figura 89 - Indicador de pressão

Pressure gauge is any instrument for measuring fluid pressure.

Gauge: instrumento de medição.

A próxima figura mostra um diagrama esquemático de um sistema hidráulico simples. Cada elemento tem a sua função específica no sistema.

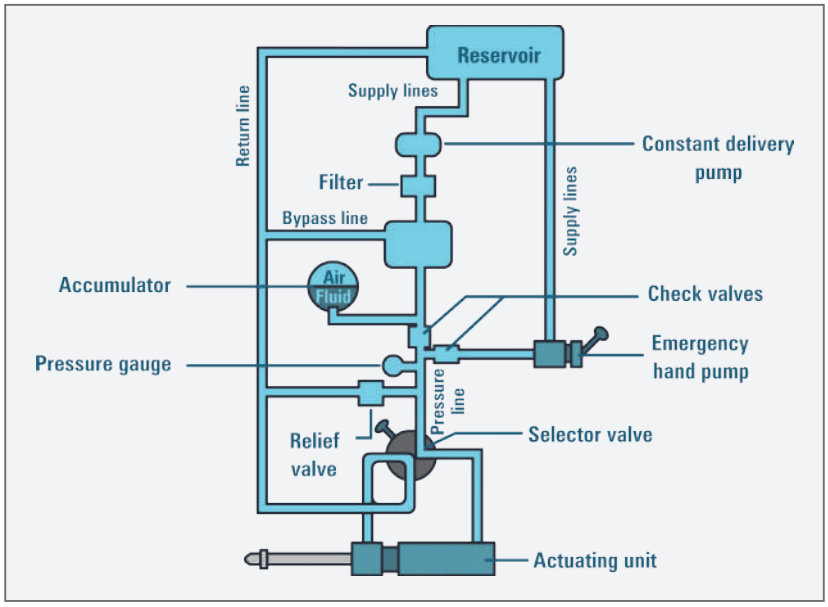


Figura 90 - Diagrama esquemático de um sistema de lubrificação

3.1.2 Let's know more about hydraulic system components!

a) Accumulator is a steel sphere divided into two chambers by a synthetic rubber diaphragm. The upper chamber contains fluid at system pressure, while the lower chamber is charged with nitrogen or air. There are two general types of accumulators used in aircraft hydraulic systems: spherical and cylindrical.

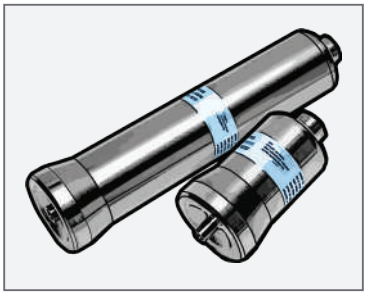


Figura 91 - Acumulador de pressão hidráulica

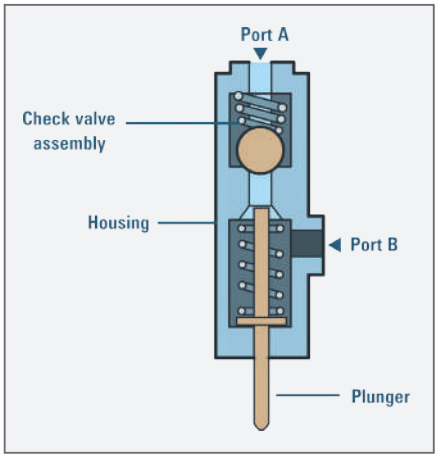


Figura 92 - Válvula sequencial

b) Sequence valves are used in a hydraulic system that requires a certain action to be completed before another action begins. An example of the use of a sequence valve is in an aircraft landing gear actuating system.

Quick disconnect valves are installed in hydraulic lines to prevent loss of fluid when units are removed.

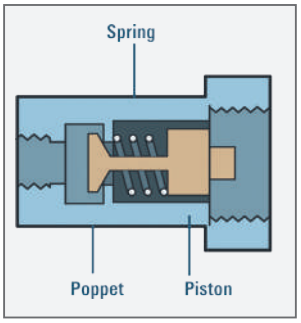


Figura 93 - Figura em corte de uma válvula hidráulica de desengate rápido

Pressure regulators manage the output of the pump to maintain the system operating pressure within a predetermined range. They can also permit the pump to turn without resistance (termed unloading the pump) when the pressure in the system is within normal operating range. Pressure

reducing valves are used in hydraulic systems where it is necessary to lower the normal system operating pressure by a specified amount.

Shuttle valve is an automatic selector valve mounted on critical components such as landing gear actuation cylinders and brake cylinders. For normal operation, system fluid flows into the actuator through the shuttle valve, but if normal system pressure is lost, emergency system pressure forces the shuttle over and emergency fluid flows into the actuator.

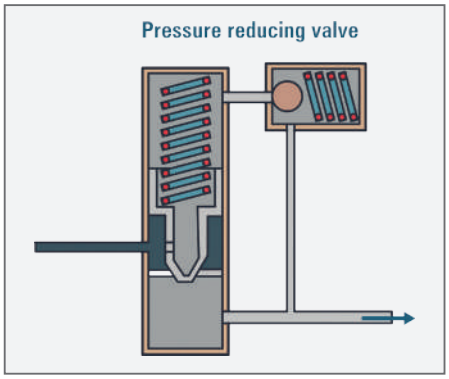


Figura 94 - Válvula de redução de pressão hidráulica

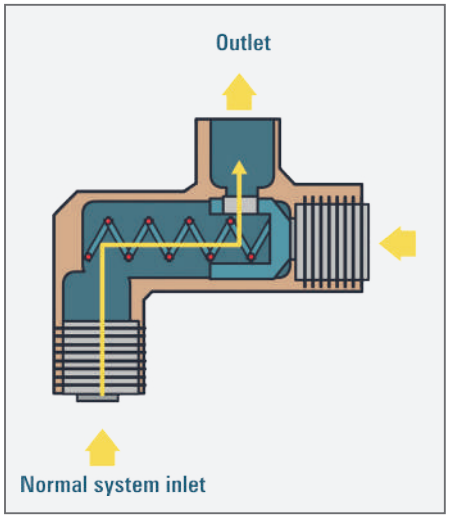


Figura 95.A - Válvula lançadeira em posição normal

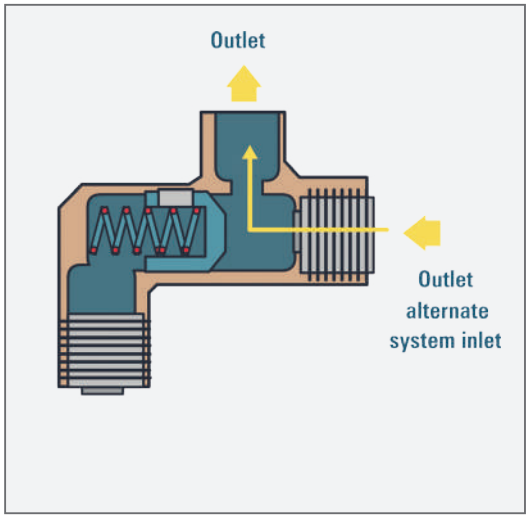


Figura 95.B - Válvula lançadeira em posição de emergência

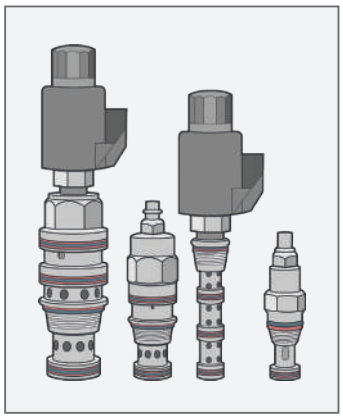


Figura 96- Fusível hidráulico

Hydraulic fuse is a type of flow control valve that allows a normal flow of fluid in the system but, if the flow rate is excessive, or if too much fluid flows for normal operation, the fuse will shut off all further flow.

Heat exchangers - transport-type aircraft use heat exchangers in their hydraulic power supply system to cool the hydraulic fluid from the hydraulic pumps.

Hydraulic power pack is a small, self-contained hydraulic system that consists of a reservoir, pump, selector valves, and relief valves. The power pack is removable from the aircraft as a unit to facilitate maintenance and service.

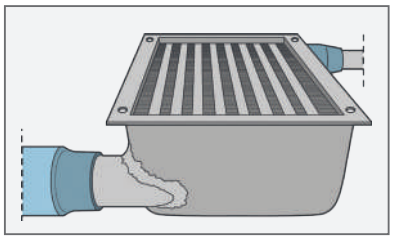


Figura 97 - Trocador de calor

Seals are used to prevent the passage of fluid to another point. They are gathered in three main classes: packings, gaskets, and wipers.

a) Packing is a hydraulic seal used internally on a sliding or moving assembly.

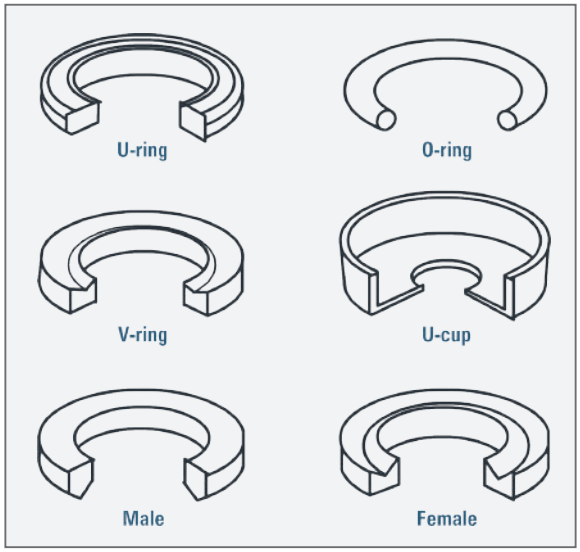


Figura 98 - Juntas de vedação

b) Gasket - a seal between two parts where there is no relative motion.

c) Wipers are used to clean and lubricate the exposed portions of piston shafts. They prevent dirt from entering the system and help protect the piston shaft against scoring. Wipers may be either metallic or felt. They are sometimes used together, a felt wiper installed behind a metallic wiper.

Fitting is an attachment device that is used to connect components to the hydraulic system. They have different sizes and types.

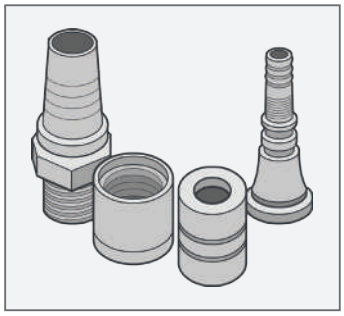


Figura 99.A - Conexões para tubo hidráulico

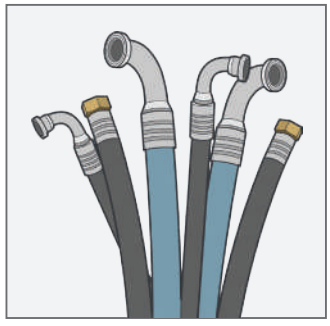


Figura 99.B - Conexões de mangueira hidráulica

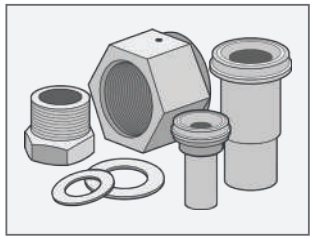


Figura 99.C - Conexões hidráulicas

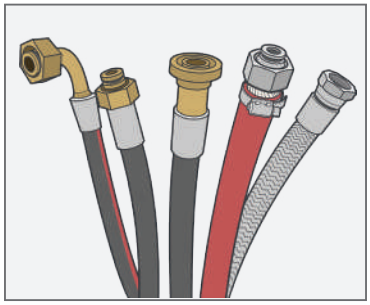


Figura 100 - Mangueiras hidráulicas

Hydraulic hose provides a basic means for transporting fluid from one component to another and, at the same time, it supplies an inherent versatility to designers. The flexibility of hose enables components to be positioned in the most efficient or convenient places.

Hydraulic tubes are usually made from stainless steel, aluminum or titanium. One disadvantage of aluminum tubing is that it is easier to damage when compared to steel and titanium ones. Steel is cheaper and more resistant than titanium.

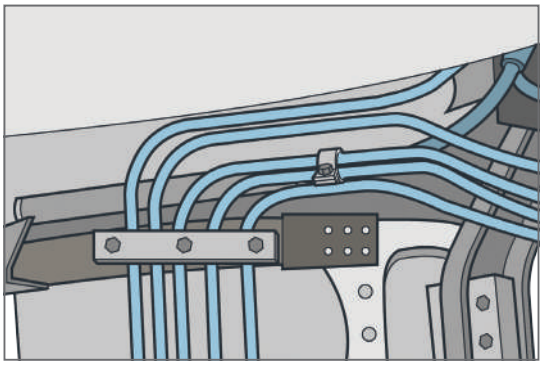


Figura 101 - Tubos hidráulicos

Tabela 16 - Vocabulário

Inglês	Português	Inglês	Português
Accumulator	Acumulador	*Power-driven pump*	Bomba acionada pelo motor
Brake	Freio	*Rate*	Regime, taxa
Bypass	Desvio	*Reservoir*	Reservatório
Drain	Dreno	*Screening*	Peneira, de tela
Failure	Falha	*Seal*	Vedação
Felt	Feltro	*Shut off (verbo)*	Interromper
Fluid	Fluido	*Shuttle valve*	Válvula lançadeira
Fuse	Fusível	*Sphere*	Esfera
Hand pump	Bomba manual	*Spool-type*	Tipo êmbolo
Hose	Mangueira	*Spring*	Mola
Mount	Berço	*Straining*	Drenagem, filtragem
Packing	Bucha, gaxeta	*Vent*	Ventilação, suspiro
Poppet	Gatilho	*Wiper*	Raspador

3.1.3 Landing gear

Landing gear - aircraft landing gear supports the entire weight of an aircraft during landing and ground operations. They are attached to primary structural members of the aircraft. The type of gear depends on the aircraft design and its intended use.

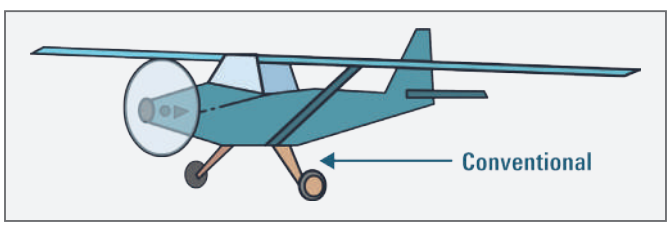


Figura 102 - Trem de pouso convencional

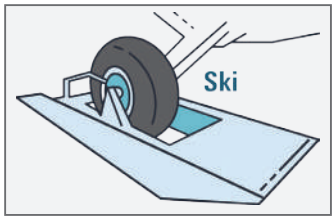


Figura 103 - Trem de pouso com esqui

Most landing gears have wheels to facilitate operation to and from hard surfaces, such as airport runways. Other gear feature skids for this purpose, such as those found on helicopters, balloon gondolas, and in the tail area of some tail dragger aircraft. Aircraft that operate to and from frozen lakes and snowy areas may be equipped with landing gear that have skis.

Aircraft that operate to and from the surface of water have pontoon-type landing gear. Regardless of the type of landing gear utilized, shock absorbing equipment, brakes, retraction mechanisms, controls, warning devices, cowling, fairings, and structural members necessary to attach the gear to the aircraft are considered parts of the landing gear system.

Three basic arrangements of landing gear are used: tail wheel-type landing gear (conventional), tandem landing gear, and tricycle-type landing gear.

a) Tail wheel - type landing gear is also known as conventional gear because many early aircraft use this type of arrangement.

Arrangement: arranjo ou configuração de um sistema ou componente.

Center of gravity: o centro de gravidade de um avião é o ponto onde os pesos das partes da aeronave e da carga se concentram.

The main gear are located forward of the center of gravity, causing the tail to require support from a third wheel assembly. A few early aircraft designs use a skid rather than a tail wheel.

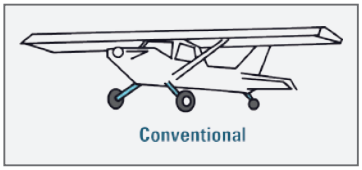


Figura 104 - Trem de pouso convencional

b) Tandem landing gear - few aircraft are designed with tandem landing gear. As the name implies, this type of landing gear has the main gear and tail gear aligned on the longitudinal axis of the aircraft.

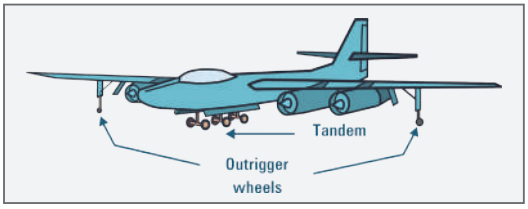


Figura 105 - Trem de pouso em tandem

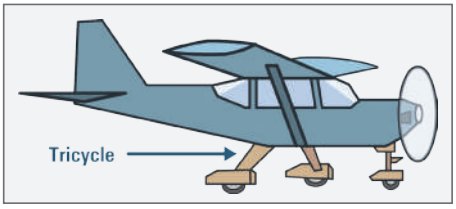


Figura 106 - Trem de pouso triciclo

c) Tricycle - type landing gear - the most commonly used landing gear arrangement is the tricycle-type landing gear. It is comprised of main gear and nose gear.

The landing gear can be fixed or retractable. Fixed landing gears are used in many small, single engine aircraft. The retractable ones are used to eliminate the parasite drag as the speed of the aircraft increases.

In addition to supporting the aircraft for taxi, the forces of impact on an aircraft during landing must be controlled by the landing gear. This is done in two ways:

a) The shock energy is altered and transferred throughout the airframe at a different rate and time than the single strong pulse of impact.

The leaf - type spring gear utilizes flexible spring steel, aluminum, or composite struts that

receive the impact of landing and return it to the airframe to dissipate at a rate that is not harmful. The gear flexes initially and forces are transferred as it returns to its original position.

b) The shock is absorbed by converting the energy into heat energy. True shock absorption occurs when the shock energy of landing impact is converted into heat energy, as in a shock strut landing gear. This is the most common method of landing shock dissipation in aviation. It is used on aircraft of all sizes. A typical pneumatic/hydraulic shock strut uses compressed air or nitrogen combined with hydraulic fluid to absorb and dissipate shock loads.

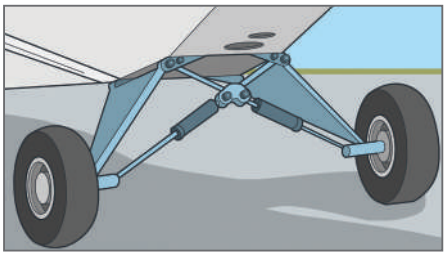


Figura 107 - Trem de pouso com feixes de mola

As tricycle-type landing gear is the most commonly used landing gear arrangement, let's know its configuration. It consists of a nose landing gear, a left and right main landing gear. Each landing gear includes a shock strut with two wheel and tire assemblies. The nose and main landing gear can be retracted only during ground operations.

The nose landing gear is steerable. It is retracted forward and up into the lower forward fuselage and is enclosed by two doors.

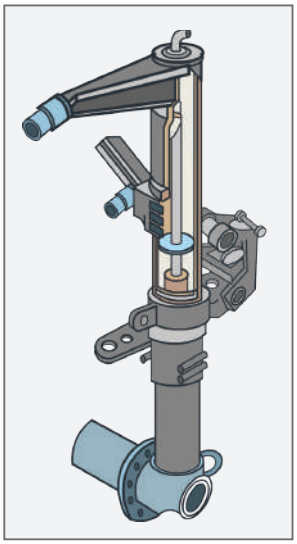


Figura 108 - Figura em corte do amortecedor do trem de pouso

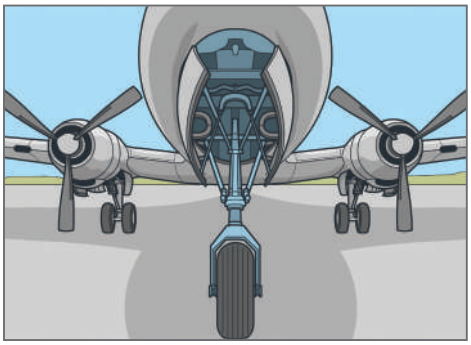


Figura 109 - Trem de pouso de nariz de um DC-6B

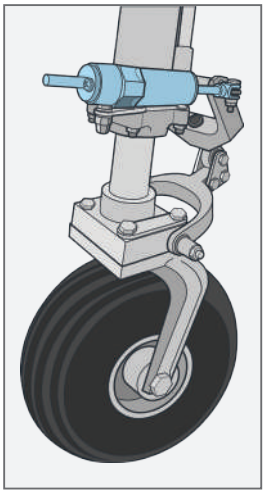


Figura 110 - Amortecedor de oscilações laterais (roda do nariz)

An abnormal vibration of the nose wheel of an airplane is called shimmy. It is often violent and is usually caused by looseness of the nose wheel support mechanism or an unbalanced wheel.

Shimmy dampers are small hydraulic shock absorbers installed between the nose wheel fork and the nose wheel cylinder attached to the aircraft structure to solve this problem.

The main landing gear is located in the lower left and right wing area adjacent to the midfuselage. They are also retracted forward and up into the left and right lower wing area, and each is enclosed with a single door.

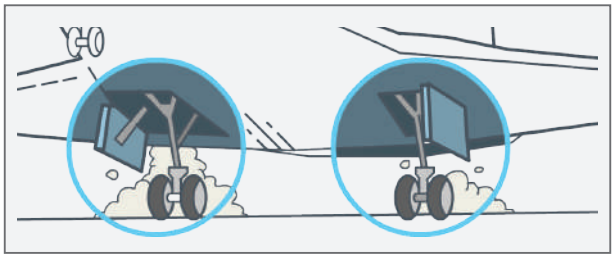


Figura 111 - Trem de pouso principal

There is a system of lights used to indicate the condition of the landing gear. It is called Landing Gear Warning System.

A red light illuminates when any of the gears are in an unsafe condition. A green light shows when all of the gears are down and locked, and no light is lit when the gears are all up and locked. An aural warning system is installed that sounds a horn if any of the landing gears are not down and locked when the throttles are retarded for landing.

Figura 112 - Luzes de alerta de posição do trem de pouso

3.1.4 Aircraft wheels

Aircraft wheels are important components of a landing gear system. They support the entire weight of the aircraft during taxi, takeoff, and landing. The typical aircraft wheel is lightweight, strong, and made from aluminum alloy. Some magnesium alloy wheels also exist. Nearly all modern aircraft wheels are of this two piece construction.

The wheel is divided in two halves: inboard wheel half and outboard wheel half and they are not identical.

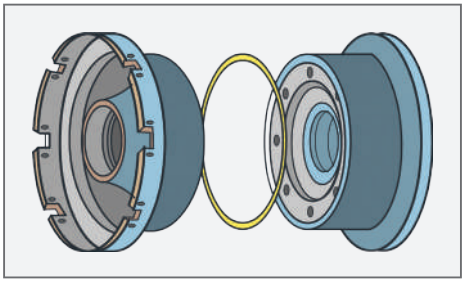


Figura 113 - Duas metades do cubo de roda

3.1.5 Aircraft brakes

All aircraft are equipped with brakes. Their proper functioning is relied upon for safe operation of the aircraft on the ground.

The brakes slow the aircraft and stop it in a reasonable amount of time. They hold the aircraft stationary during engine run-up and, in many cases, steer the aircraft during taxi. On most aircraft, each of the main wheels is equipped with a brake unit. In the typical brake system, mechanical and/or hydraulic linkages to the rudder pedals allow the pilot to control the brakes.

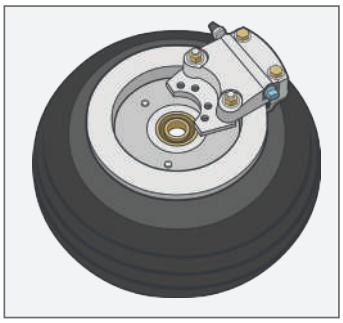


Figura 114 - Cubo de roda com disco de freio simples

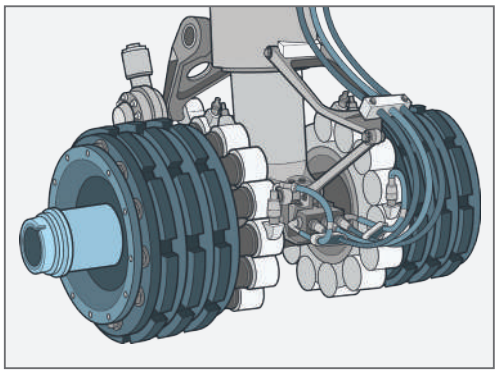


Figura 115 - Sistema de freios com múltiplos discos

Modern aircraft typically use disc brakes. The disc rotates with the turning wheel assembly while a stationary caliper resists the rotation by causing friction against the disc when the brakes are applied. The size, weight, and landing speed of the aircraft influence the design and complexity of the disc brake system. Single, dual, and multiple disc brakes are common types of brakes.

Single disc brakes are used on small and light aircraft. Dual disc brakes are used on aircraft where a single disc on each wheel does not supply sufficient braking friction. Two discs are keyed to the wheel instead of one. Multiple disc brakes are used on large and heavy aircraft.

3.1.6 Aircraft tires

Aircraft tires may be tube-type or tubeless. They support the weight of the aircraft while it is on the ground and provide the necessary traction for braking and stopping. The tires also help absorb the shock of landing and cushion the roughness of takeoff, roll-out, and taxi operations.

Tabela 17 - Vocabulário

Inglês	Português	Inglês	Português
Airframe	Célula de avião	*Pontoon*	Flutuador de hidroavião
Aural	Auditivo	*Puck*	Orifício
Caliper	Pastilha	*Retractable*	Escamoteável
Casting	Fundido, fundição	*Roll-out*	Rolagem
Cowling	Capota	*Roughness*	Aspereza, rugosidade
Cushion	Coxim	*Run-up*	Operação
Damper	Amortecedor	*Shimmy*	Oscilações laterais
Dragger	Bequilha	*Shock*	Choque
Fork	Garfo	*Skid*	Patim de aterragem
Grip	Comprimento útil	*Steerable*	Comandável, orientável
Harmful	Prejudicial	*Strut*	Montante
Horn	Buzina, alarme	*Tread*	Banda de rodagem
Inboard	Interno	*Tubeless*	Sem câmara
Keyed	Ajustado	*Undercarriage*	Trem de pouso
Linkage	Ligação	*Warning*	Alerta
Midfuselage	Fuselagem central (média)		

3.2 Grammar point – word endings

Conhecer as diversas terminações das palavras é essencial para a tradução e a compreensão do vocabulário técnico. Os sufixos e os prefixos usados em Língua Inglesa, muitas vezes, possuem significados iguais ou semelhantes aos utilizados em português. Eles podem informar a função, o componente ou o agente relacionado à palavra em que são empregados.

As terminações S e ES, no final da palavra, podem indicar plural, terceira pessoa do singular ou posse:

• brake (freio)	brakes (freios)	singular/plural
• switch (chave)	switches (chaves)	singular/plural
• provide (prover)	provides (prover)	3ª pessoa singular
• press (pressionar)	presses (pressionar)	3ª pessoa singular
• mechanic's tools (ferramentas do mecânico)		Pronome possessivo
• pilots' instructions (instruções dos pilotos)		Pronome possessivo

Uma mesma palavra pode ser um verbo em uma frase e substantivo em outra.

- Aircraft landing gear supports the entire weight of an aircraft during landing and ground operations. (verbo)
- The landing gear is a support for the aircraft. (substantivo)

A terminação -ING pode indicar uma ação (quando funciona como verbo da oração) ou função (quando é um substantivo).

a) Testing - the action (to test).

b) Actuating - the function (actuation).

No primeiro exemplo, a palavra *testing* é um verbo e indica a ação de testar. Já no segundo exemplo, a palavra *actuating* é um substantivo e indica a função de acionar, fazer acionamento. Nestes casos, mesmo os vocábulos apresentando a mesma terminação -ING, eles assumirão funções sintáticas diferentes no texto, gerando dúvida e confusão na tradução.

Também é comum ver a terminação -ING em palavras compostas, indicando a função ou a condição de outra palavra. No exemplo a seguir, a palavra *actuating* indica a função da palavra seguinte, *cylinder*. Logo, *actuating cylinder* significa cilindro de acionamento, que tem a função de acionar.

The actuating cylinder is broken. (function)

A terminação -ED é utilizada para indicar que uma ação foi realizada ou o estado de algo. Ela representa o particípio dos verbos regulares que, na maioria dos casos, funcionam como adjetivos e vêm antecedidos pelo verbo "to be". A seguir, são apresentados alguns exemplos.

a) Electrical motor pumps are installed for use in emergencies.

b) The operation of landing gear is accomplished with hydraulic power systems.

Já a terminação ER/-OR é utilizada para indicar um componente que faz uma ação ou função.

a) Controller - a component which controls.

b) Connector - a component which connects.

No primeiro exemplo, *controller* tem sua origem na palavra *control* (controlar). Assim, *controller* (controlador) é o componente que faz a ação do verbo control (controlar). Da mesma forma, temos a palavra connector, como o componente que faz a função de conectar.

3.3 Lubrication system

O objetivo primário de um lubrificante é reduzir a fricção entre partes móveis. Dessa forma, como o motor de uma aeronave possui diversas partes móveis, o sistema de lubrificação deve ser eficiente para suprir toda a necessidade do motor e dos acessórios.

Lubrication system - the primary purpose of a lubricant is to reduce friction between moving parts. In theory, fluid lubrication is based on the actual separation of the surfaces so that no metal-to-metal contact occurs. Oil is generally pumped throughout the engine to all areas that require lubrication. Engines are subjected to several types of friction. Friction may be defined as the rubbing of one object or surface against another. One surface sliding over another surface causes sliding friction.

In addition to reducing friction, the oil film acts as a cushion between metal parts. This cushioning effect is particularly important for such parts as reciprocating engine crankshafts and connecting rods, which are subject to shock loading. The engine's oil is the life blood of the engine and it is very important for the engine to perform its function and to extend the length between overhauls.

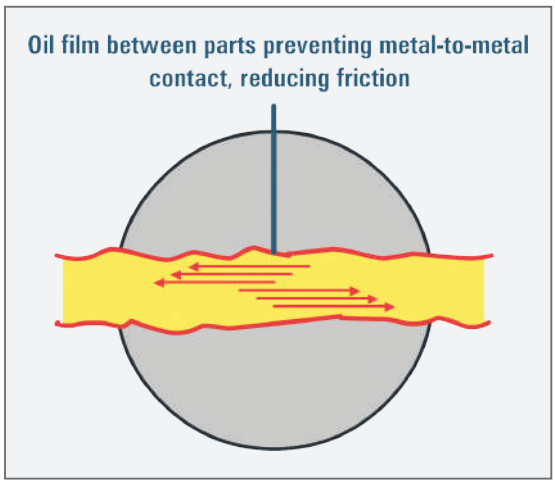


Figura 116 - Ilustração da ação do lubrificante entre duas superfícies metálicas

Aircraft reciprocating engine pressure lubrication systems can be divided into two basic classifications: wet sump and dry sump. The main difference is that the wet sump system stores oil in a reservoir inside the engine. After the oil is circulated through the engine, it is returned to this crankcase based reservoir. A dry sump engine pumps the oil from the engine's crankcase to an external tank that stores the oil. The dry sump system uses a scavenge pump, some external tubing, and an external tank to store the oil.

Parts of a lubrication system

a) Sump (aircraft engine component) is a low point in an aircraft engine in which lubricating oil collects and is stored or transferred to an external oil tank. A removable sump attached to the bottom of the crankcase of a reciprocating engine is often called an oil pan.

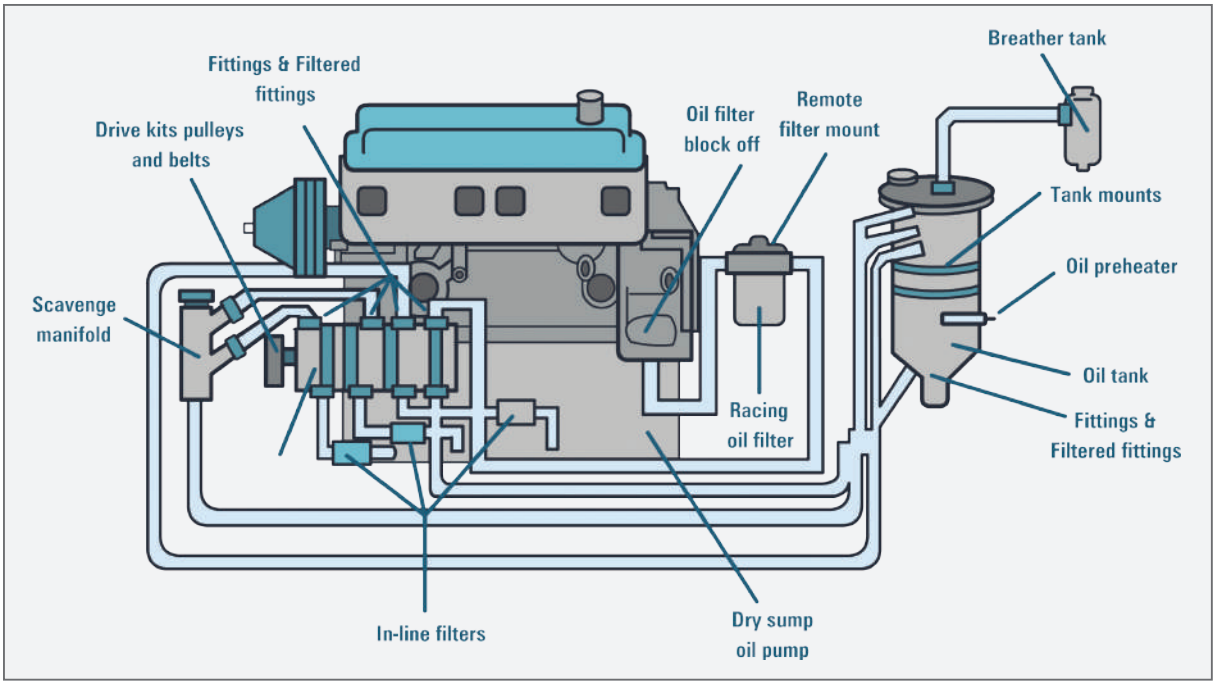


Figura 117 - Ilustração do sistema de lubrificação do motor tipo cárter seco

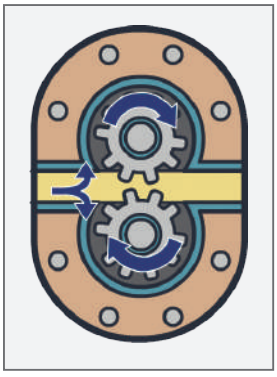


Figura 118 - Bomba de pressão de óleo tipo engrenagem

b) Oil Pressure Pump - oil entering the engine is pressurized, filtered, and regulated by units within the engine. As oil enters the engine, it is pressurized by a gear-type pump.

c) Oil tanks are generally associated with a dry sump lubrication system, while a wet sump system uses the crankcase of the engine to store the oil. Oil tanks are usually constructed of aluminum alloy.

Oil filter used on an aircraft engine is usually one of four types: screen, cuno, canister, or spin-on. As oil passes through the fine-mesh screen, dirt, sediment, and other foreign matter are removed and settle to the bottom of the housing.

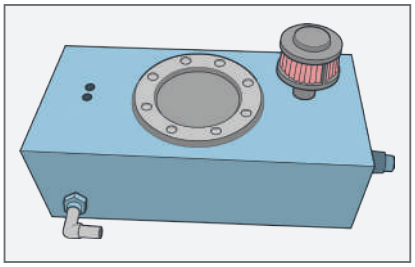


Figura 119 - Tanque de óleo lubrificante

Gear-type pump: são bombas mecânicas, ou seja, são acionadas por dispositivos mecânicos a partir do movimento transmitido do motor da aeronave.

d) Oil pressure regulating valve limits oil pressure to a predetermined value, depending on the installation. This valve is sometimes referred to as a relief valve but its real function is to regulate the oil pressure at a present pressure level.

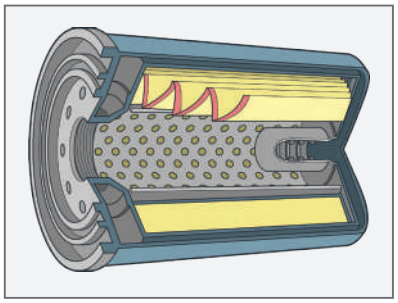


Figura 120 - Figura em corte do filtro de óleo

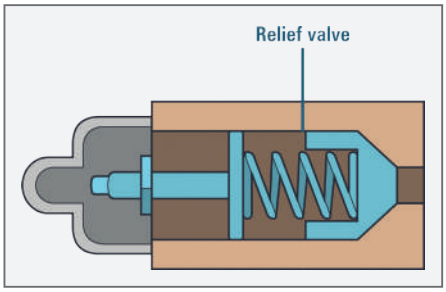


Figura 121 - Ilustração da válvula de alívio em corte

e) Oil cooler allows oil to flow through the spaces between the tubes while the cooling air passes through the tubes. The cooler, either cylindrical or elliptical shaped, consists of a core enclosed in a double-walled shell.

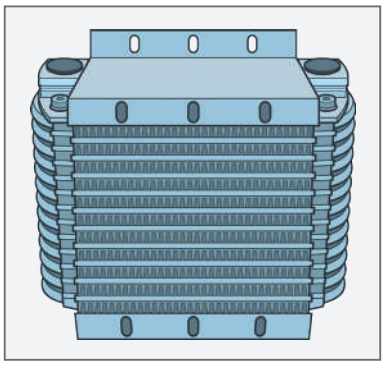


Figura 122 - Radiador de óleo

f) Scavenger oil pump has several stages that pull oil from the bearing compartments and gear boxes and sends the oil to the tank. At the tank, the oil enters the de-aerator, which separates the air from the scavenge oil. The oil returns to the tank and the air is vented through a check valve overboard.

g) Oil pressure gauge indicates the pressure that oil enters the engine from the pump. This gauge warns of possible engine failure caused by an exhausted oil supply, failure of the

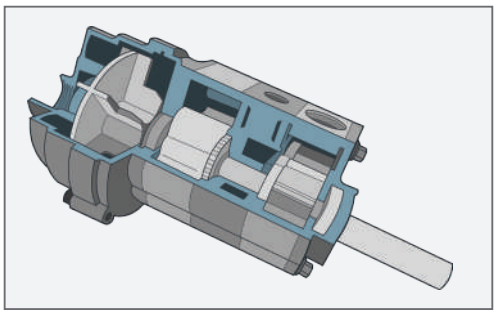


Figura 123 - Bomba de recuperação em corte

oil pump, burned-out bearings, ruptured oil lines, or other causes that may be indicated by a loss of oil pressure.

Tabela 18 - Vocabulário

Inglês	Português	Inglês	Português
Belt	Correia	*Rubbing*	Roçamento
Breather	Suspiro, respiradouro	*Scavenge*	Recuperação
Burn-out	Superaquecimento	*Screen*	Tela
Canister	Sede do cartucho	*Scupper*	Orifício
Cuno	Filtro de óleo do tipo borda	*Shell*	Revestimento
De-aerator	Desaerador (para tirar ar do óleo)	*Spin-on*	Enroscável
Housing	Sede, alojamento	*Sump*	Cárter
Lubricant	Lubrificante	*Vented*	Descarregado
Oil Pan	Cárter	*Walled*	Cercado
Overhaul	Revisão		

3.4 Grammar point – numeral

Numeral é a palavra que atribui números (quantidade) aos seres, ou os coloca em determinada ordem. Serão estudados os números cardinais e ordinais.

Cardinal numbers:

1 - one	6 - six	11 - eleven	16 - sixteen
2 - two	7 - seven	12 - twelve	17 - seventeen
3 - three	8 - eight	13 - thirteen	18 - eighteen
4 - four	9 - nine	14 - fourteen	19 - nineteen
5 - five	10 - ten	15 - fifteen	20 - twenty

Quando os números a serem escritos são superiores a vinte (*twenty*), coloca-se um hífen separando a dezena da unidade. (Ex.: 27 - *twenty-seven*).

21 - twenty-one	27 - twenty-seven	50 - fifty
22 - twenty-two	28 - twenty-eight	60 - sixty
23 - twenty-three	29 - twenty-nine	70 - seventy
24 - twenty-four	30 - thirty	80 - eighty
25 - twenty-five	31 - thirty-one	90 - ninety
26 - twenty-six	40 - forty	100 - one hundred

A utilização do ponto e da vírgula em inglês é exatamente oposta à do português.

Exemplos:

1,000 - one thousand	2.5 - two point five
1,000,000 - one million	7.8 - seven point eight
1,000,000,000 - one billion	18.9 - eighteen point nine

Os números ordinais são usados para exprimir ordem ou lugar de algo. A abreviação é feita de forma simples, bastando acrescentar as duas últimas letras de sua forma extensa ao número.

Exemplos:

primeiro - first - 1st	sexto - sixth - 6th
segundo - second - 2nd	sétimo - seventh - 7th
terceiro - third - 3rd	oitavo - eighth - 8th
quarto - fourth - 4th	nono - ninth - 9th
quinto - fifth - 5th	décimo - tenth - 10th

A abreviação torna-se simples porque, exceto os três primeiros números (*first* - 1st), (second - 2nd) e (*third* - 3rd), os demais terminam em -TH.

Os numerais também podem ser representados por prefixos que passam a ideia de quantidade.

Observe:

- unidirectional antena (antena unidirecional – uma só direção);
- one-engine airplane (aeronave com um motor);
- biplane (avião biplano);
- two-engine airplane (aeronave com dois motores);
- tridimensional graph (gráfico tridimensional).

Hydraulic ground power units: unidades hidráulicas de apoio utilizadas em atividades de manutenção. Elas fornecem óleo hidráulico pressurizado controlado para testes nos sistemas hidráulicos das aeronaves.

3.5 Good practices in maintenance

The hydraulic ground power unit provides pressure to the aircraft on the ground. It is used for testing purposes, avoiding to turn on the aircraft to test the pressurization system. This portable hydraulic test unit is usually electrically powered and uses a hydraulic system with a capacity of approximately 24 gallons per minute at pressures up to 3,000 psi.

Figura 124 - Unidade de pressão hidráulica de solo

During the maintenance procedures in aircraft hydraulic system is required much attention because of the risk of accidents with hydraulic oil leak under pressure, which can have serious consequences. So before pressurizing the system we must ensure that all fittings and system items are properly installed. It should be noted that the hydraulic ground power units should also be periodically reviewed in order to maintain in working safely.

Resumindo

Neste capítulo, foram vistos diversos termos peculiares aos textos técnicos sobre sistemas hidráulicos de aeronaves: trem de pouso, sistema de lubrificação de motores alternativos empregados em aeronaves e sistema de freios. Conheceram-se diversos componentes desses sistemas e suas funções. Da mesma forma, apresentaram-se algumas orientações de segurança que devem ser observadas durante a operação e a manutenção de sistemas hidráulicos e conceitos gramaticais da Língua Inglesa.

Capítulo 4
Electrical system and avionics

O sistema elétrico da aeronave tem como função gerar, distribuir e controlar a energia elétrica que será utilizada pelos equipamentos ali encontrados. Como as aeronaves estão utilizando cada vez mais recursos tecnológicos, o resultado é um maior número de dispositivos que necessitam desta energia fornecida pelo sistema elétrico, fazendo com que ele seja de vital importância para o funcionamento de todo o sistema.

Na aviação em geral, mas principalmente na aviação militar, os aviões estão sendo modernizados, ou seja, os equipamentos analógicos estão sendo substituídos por dispositivos eletrônicos controlados por computadores por meio de diversos sensores espalhados por toda a aeronave. Eles recebem o nome de aviônicos e o piloto consegue acessar informações como: temperatura do motor, nível de combustível, etc. por intermédio de *displays* LCD localizados na cabine de pilotagem. Por esses motivos, o sistema elétrico ajuda a garantir a segurança do voo e das pessoas a bordo do avião.

4.1 Electrical system, ignition system and flight instruments

Qualquer aeronave é composta por diversos sistemas que fazem os seus equipamentos funcionarem. Cada um possui uma finalidade específica e tem vital importância dentro de todo o conjunto em que está sendo utilizado. Neste capítulo, será visto os sistemas elétrico e de ignição e alguns instrumentos de voo da aeronave.

O sistema elétrico é o responsável por fornecer energia elétrica para o avião. Ele recebe atenção especial por parte dos técnicos de manutenção por interligar uma grande quantidade de equipamentos. Já o sistema de ignição tem uma finalidade mais específica. Ele é o responsável por produzir as centelhas (faíscas) nas velas para provocar a combustão nos cilindros do motor. Ele é separado completamente do sistema elétrico do avião e pode utilizar magnetos ou baterias para a ignição, dependendo do tipo da aeronave.

Em relação aos instrumentos de voo, cada avião apresenta uma configuração que será de acordo com a tecnologia nele aplicada. Os instrumentos têm como função suprir necessidades e limitações dos seres humanos, garantindo uma elevada segurança no voo. Existem os instrumentos que são básicos e todas as aeronaves possuem e outros que também auxiliam os pilotos, mas não são obrigatórios sua aquisição.

4.1.1 Electrical system

The satisfactory performance of any modern aircraft depends on a very great degree on the continuing reliability of electrical systems and subsystems. Modern aircraft have complex electrical systems that control almost every aspect of flight.

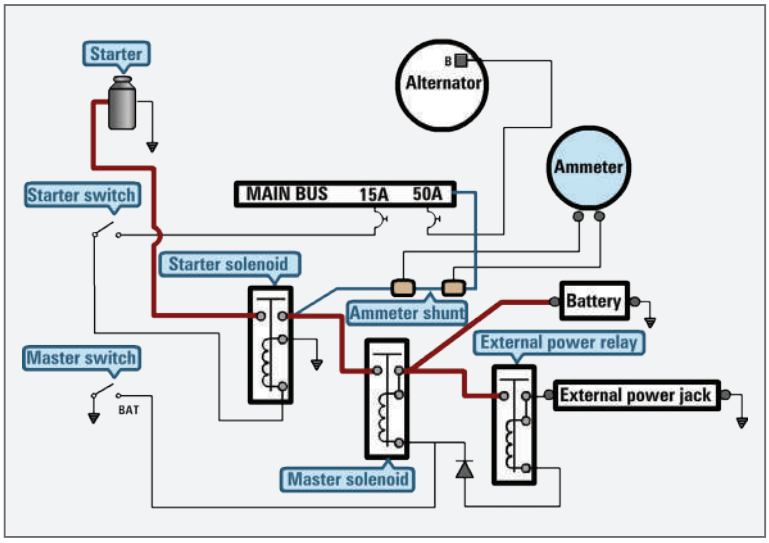


Figura 125 - Esquema de um circuito elétrico de bateria

In general, electrical systems can be divided into different categories according to the function of the system. Common systems include lighting, engine starting, and power generation. This system is powered by the engine-driven alternator or generator, but when the aircraft is on ground or emergency the battery is the responsible.

Aircraft batteries are usually identified by the material used for the plates. The two most common types of battery used are lead-acid and Ni-Cd batteries. Most small private aircraft use lead-acid batteries. Most commercial aircraft use nickel-cadmium (Ni-Cd) batteries.

The battery best suited for a particular application depends on the relative importance of several characteristics, such as weight, cost, volume, service or shelf life, discharge rate, maintenance, and charging rate. Lead-acid and Ni-Cd batteries are assembled with a number of cells that provide 12 or 24 volts.

Generators are responsible to power the aircraft while flying. They use a modified slip ring arrangement, known as a commutator, to change the AC into a DC voltage. The action of the commutator allows the generator to produce a DC output. DC generators transform mechanical energy into electrical energy.

As the name implies, they produce direct current and are typically found on light aircraft. In many cases, DC generators have been replaced with DC alternators. Both devices produce electrical energy to power the aircraft's electrical loads and charge the aircraft's battery. Typically, aircraft generators maintain a nominal output voltage of approximately 14 volts or 28 volts.

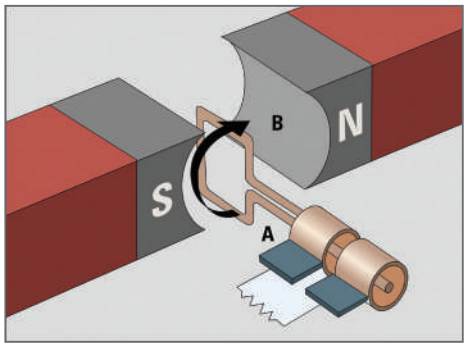


Figura 126 - Representação de um gerador básico de energia elétrica

There are three types of DC generator: series wound, parallel (shunt) wound, and series-parallel (or compound wound). The appropriate generator is determined by the connections to the armature and field circuits with respect to the external circuit.

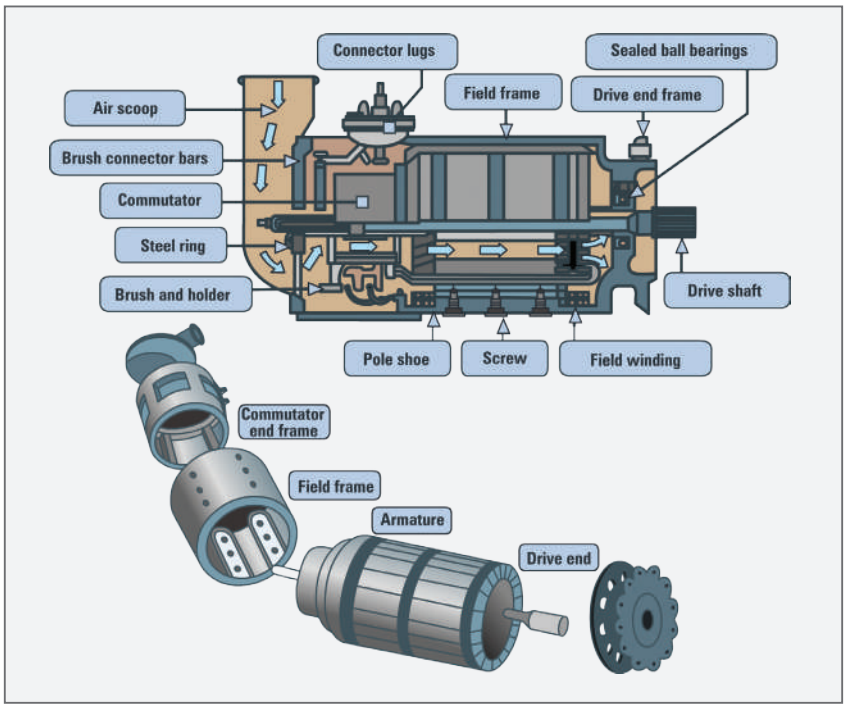


Figura 127 - Vista explodida de um gerador de corrente contínua

Twin engine aircraft use two alternators (or generators) and it is vital to ensure that both alternators share the electrical load equally. This process of equalizing alternator outputs is often called paralleling. In general, paralleling is a simple process when dealing with DC power systems found on light aircraft.

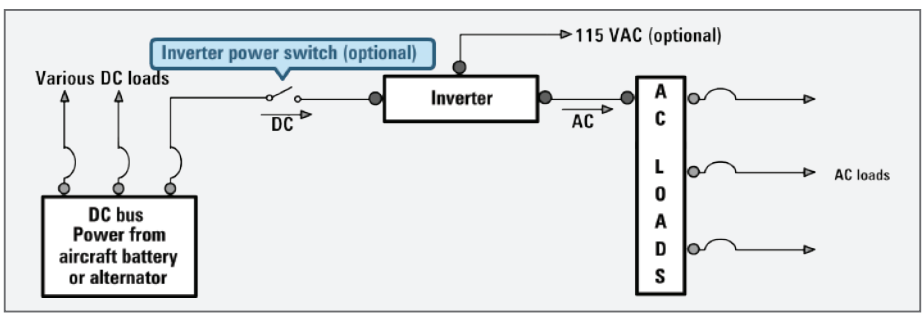


Figura 128 - Esquema de um circuito de distribuição de energia elétrica

Many aircraft employ an external power circuit that provides a means of connecting electrical power from a ground source to the aircraft. External power is often used for starting the engine or maintenance activities on the aircraft.

This type of system allows operation of various electrical systems without discharging the battery. The external power systems typically consists of an electrical plug located in a convenient area of the fuselage, an electrical solenoid used to connect external power to the bus, and the related wiring for the system.

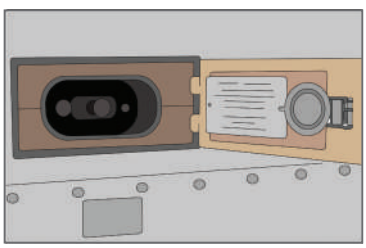


Figura 129 - Tomada de fonte externa de energia elétrica

Virtually all modern aircraft employ an electric motor to start the aircraft engine. Since starting the engine requires several horsepower, the starter motor can often draw 100 or more amperes. For this reason, all starter motors are controlled through a solenoid. The starter can be powered by either the aircraft battery or the external power supply.

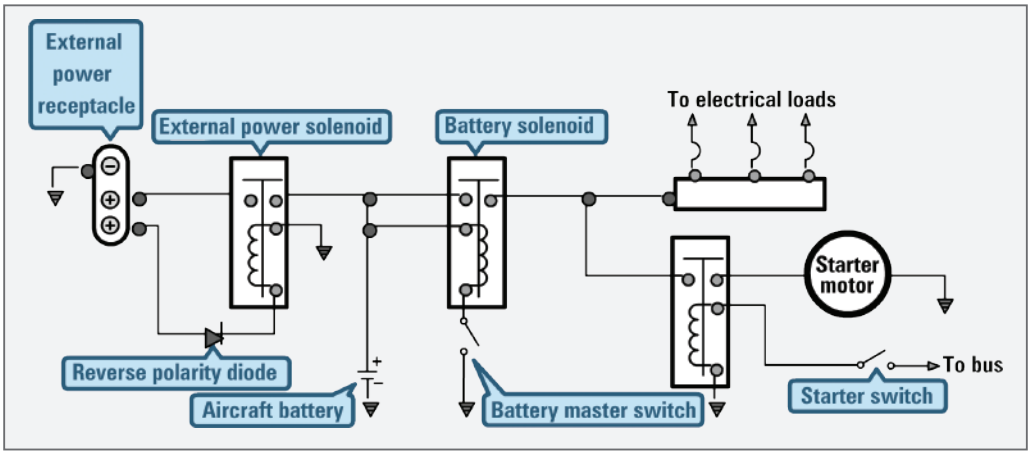


Figura 130 - Diagrama de uma fonte externa

Many aircraft contain a separate power distribution bus specifically for electronics equipment. This bus is often referred to as an avionics bus. Since modern avionics equipment employs sensitive electronic circuits, it is often advantageous to disconnect all avionics from electrical power to protect their circuits.

Bus: barramentos. Servem para comunicação ou alimentação entre os dispositivos da aeronave. O computador central recebe informação de diversos sensores por meio do barramento de dados do sistema.

Wiring: *wiring* representa toda a fiação da aeronave.

4.1.2 Let's know more about electrical system components!

a) Wiring - improperly or carelessly maintained wiring can be a source of both immediate and potential danger. A wire is described as a single, solid conductor, or as a stranded conductor covered with an insulating material. Because of in-flight vibration and flexing, conductor round wire should be stranded to minimize fatigue breakage.

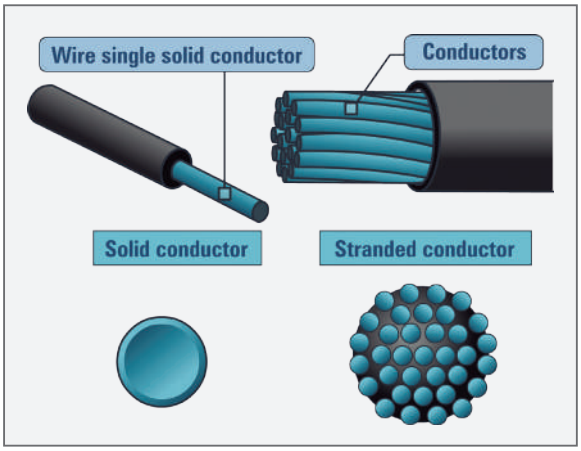


Figura 131 - Ilustrações de fios

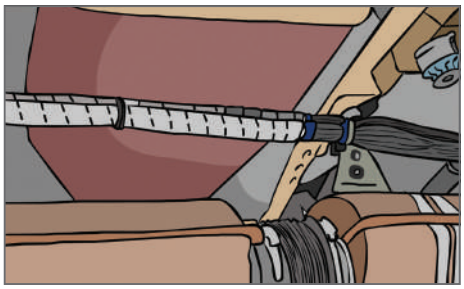


Figura 132 - Chicote isolado de fios

b) Wire shielding - with the increase in number of highly sensitive electronic devices found on modern aircraft, it has become very important to ensure proper shielding for many electric circuits. Shielding is the process of applying a metallic covering to wiring and equipment to eliminate electromagnetic interference (EMI).

c) Insulation is the protection of the wire. The type of conductor insulation material varies with the type of installation. It is based on environment, such as abrasion resistance, corrosion resistance, mechanical strength, heat distortion and others. The development of better and safer insulation materials is ongoing.

d) Grounding is the process of electrically connecting conductive objects to either a conductive structure or some other conductive return path for the purpose of safely completing either a normal or fault circuit.

e) Junction boxes are used for collecting, organizing, and distributing circuits to the appropriate harnesses that are attached to the equipment. Junction boxes are also used to conveniently house miscellaneous components, such as relays and diodes. Junction boxes that are used in high-temperature areas should be made of stainless steel.

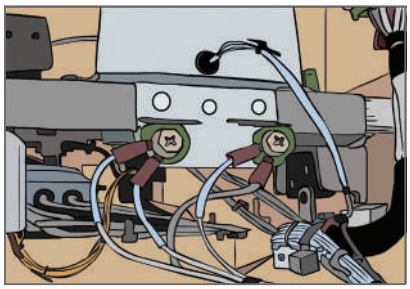


Figura 133 - Caixa de junção com chicotes conectados

f) Connectors (plugs and receptacles) facilitate maintenance when frequent disconnection is required. There is a multitude of types of connectors. The connector types that use crimped contacts are generally used on aircraft. Some of the more common types are the round cannon type, the rectangular, and the module blocks.

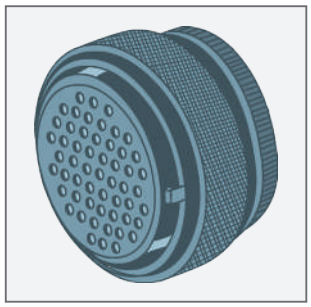


Figura 134 - Conector elétrico

g) Switches are devices that open and close circuits. They consist of one or more pair of contacts. The current in the circuit flows when the contacts are closed. There are many types of switches:

- Single-pole single-throw (SPST) opens and closes a single circuit pole indicates the number of separate circuits that can be activated, and throw indicates the number of current paths.
- Double-pole single-throw (DPST) turns two circuits on and off with one lever.

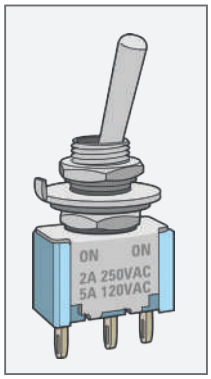


Figura 135 - Interruptor de duas posições

- Single-pole double-throw (SPDT) routes circuit current to either of two paths. The switch is On in both positions. For example, switch turns on red lamp in one position and turns on green lamp in the other position.
- Double-pole double-throw (DPDT) activates two separate circuits at the same time.
- Double-throw switches have either two or three positions.
- Two position switch pole always connected to one of the two throws.
- Three-position switches have a center Off position that disconnects the pole from both throws.

• Toggle and rocker switches control most of aircraft's electrical components. Aircraft that are outfitted with a glass cockpit often use push buttons to control electrical components.

Glass cockpit: designação de uma cabine de aeronave em que as informações dos instrumentos e equipamentos de voo são apresentadas de forma digital, tipicamente em telas de LCD.

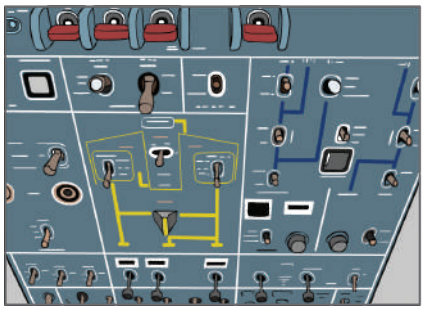


Figura 136.A - Interruptores tipo balancim

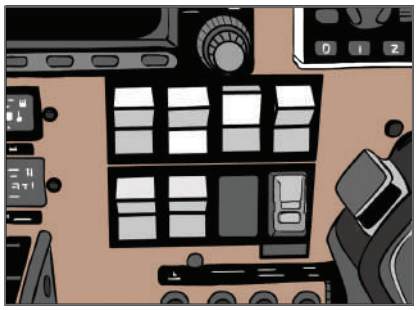


Figura 136.B - Interruptores tipo tecla

• Precision (micro) switches - micro switches require very little pressure to activate. These types of switches are spring loaded, once the pressure is removed, the contacts return to the normal position.

h) Solenoids are used as switching devices where a weight reduction can be achieved or electrical controls can be simplified. Solenoids have a movable core/armature that is usually made of steel or iron, and the coil is wrapped around the armature.

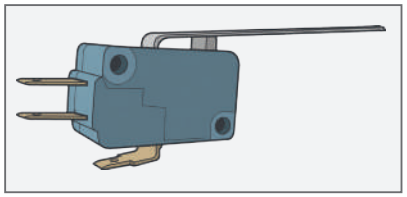


Figura 137 - Microcontactor

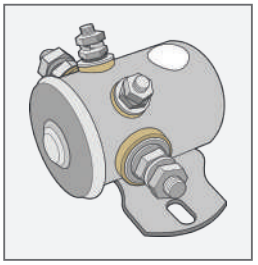


Figura 138 - Solenoide

i) Relays - current flowing through the coil of an electromechanical relay creates a magnetic field that attracts a lever and changes the switch contacts. The coil current can be on or off. So relays have two switch positions, and they are double throw switches.

j) Fuses and circuit breakers - conductors should be protected with circuit breakers or fuses located as close as possible to the electrical power source bus. The circuit breaker or fuse should open the circuit before the conductor emits smoke.

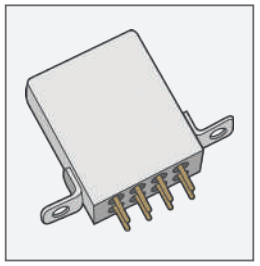


Figura 139 - Relé

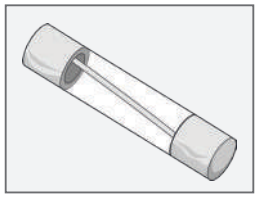


Figura 140 - Fusível

A fuse is placed in series with the voltage source and all current must flow through it. When the current exceeds the capacity of the fuse the metal strip heats up and breaks. As a result of this, the flow of current in the circuit stops.

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by an overload or short circuit. Its basic function is to detect a fault condition and immediately discontinue electrical flow. Unlike a fuse that operates once and then has to be replaced, a circuit breaker can be reset to resume normal operation.

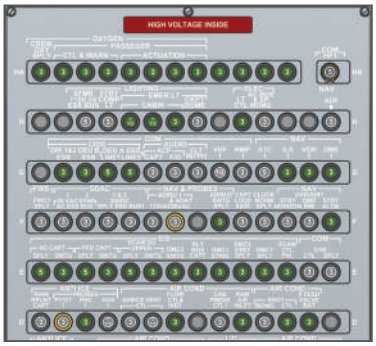


Figura 141 - Painel de disjuntores

4.1.3 Aircraft lighting systems

Aircraft lighting systems provide illumination for both exterior and interior use. Lights on the exterior provide illumination for such operations as landing at night, inspection of icing conditions, and safety from mid-air collision. Interior lighting provides illumination for instruments, cockpits, cabins, and other sections occupied by crewmembers and passengers.

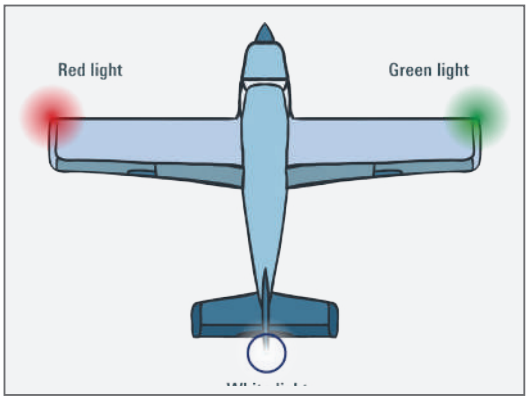


Figura 142 - Luzes externas do avião

- Exterior lights - position, anti-collision, landing, and taxi lights are common examples of aircraft exterior lights.
- Position lights - aircraft operating at night must be equipped with position lights. A set of position lights consist of one red, one green, and one white light.
- Anti-collision lights - an anti-collision light system may consist of one or more lights. They are rotating beam lights that are usually installed on top of the fuselage or tail in such a location that the light does not affect the vision of the crewmember or detract from the visibility of the position lights.

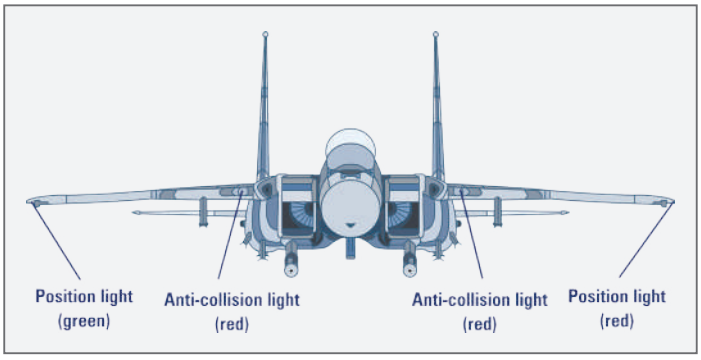


Figura 143 - Luzes externas da aeronave F-15 vistas de frente

- Landing and taxi lights - landing lights are installed in aircraft to illuminate runways during night landings.

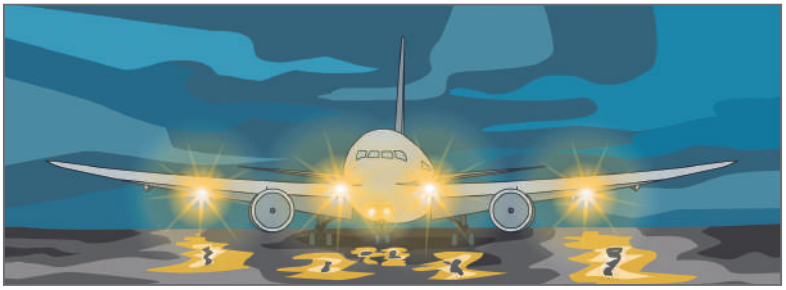


Figura 144 - Aeronave com luzes de taxi ligadas

Tabela 19 - Vocabulário

Inglês	Português	Inglês	Português
Armature	Induzido	*Inverter*	Conversor
Breakage	Rompimento, quebra	*Lighting*	Iluminação
Bus	Barramento, barra	*Mid-air collision*	Colisão em voo
Cannon	Canhão	*Performance*	Desempenho
Cell	Célula	*Plate*	Placa
Commutator	Coletor	*Pole*	Polo
Engine-driven alternator	Alternador acionado pelo motor	*Relay*	Relé
Fatigue	Fadiga	*Rocker switch*	Interruptor tipo tecla
Fuse	Fusível	*Slip ring*	Anel coletor
Glass cockpit	Painéis com informações integradas em displays de LCD	*Solenoid*	Solenoide
Grounding	Ponto de aterramento	*Toggle*	Chave de balancim
Insulating	Isolante		

4.1.4 Ignition system

All ignition systems must deliver a high-tension spark across the electrodes of each spark plug in each cylinder of the engine in the correct firing order. The potential output voltage of the system must be adequate to arc the gap in the spark plug electrodes under all operating conditions. The spark plug is threaded into the cylinder head with the electrodes exposed to the combustion area of the engine's cylinder.

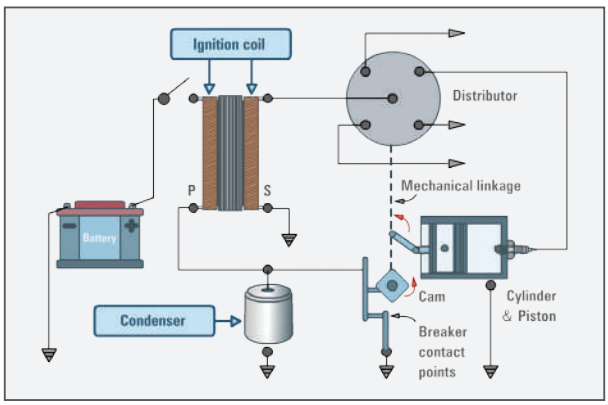


Figura 145 - Esquema de um circuito básico de ignição

Ignition systems can be divided into two classifications: magneto-ignition systems or electronic full authority digital engine control (FADEC) systems for reciprocating engines. Ignition systems can also be subclassified as either single or dual magneto-ignition systems.

The magneto, a special type of engine-driven alternate current (AC) generator, uses a permanent magnet as a source of energy. At first, the magneto generates electrical power by the engine rotating the permanent magnet and inducing a current to flow in the coil windings. This is the voltage used to arc across the spark plug gap.

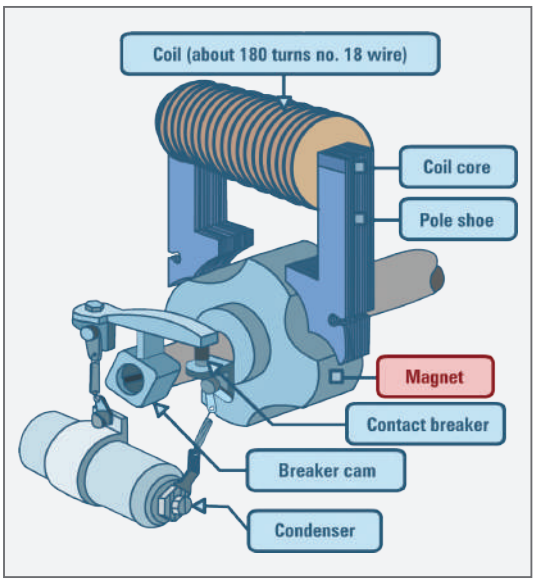


Figura 146 - Ilustração de um circuito de magneto de alta tensão

The magneto-ignition systems can be high-tension or low-tension. For purposes of discussion, the high-tension magneto system is divided into three distinct circuits: magnetic, primary electrical, and secondary electrical circuits.

The magnet is geared to the aircraft engine and rotates in the gap between two pole shoes to furnish the magnetic lines of force (flux) necessary to produce an electrical voltage.

The primary circuit carries low voltage. This circuit is controlled by the breaker points and the ignition switch. The secondary circuit consists of the secondary windings in the coil, the high tension lead between the distributor and the coil on external coil distributors, the distributor cap, the distributor rotor, the spark plug leads and the spark plugs.

Let's know more about ignition system components!

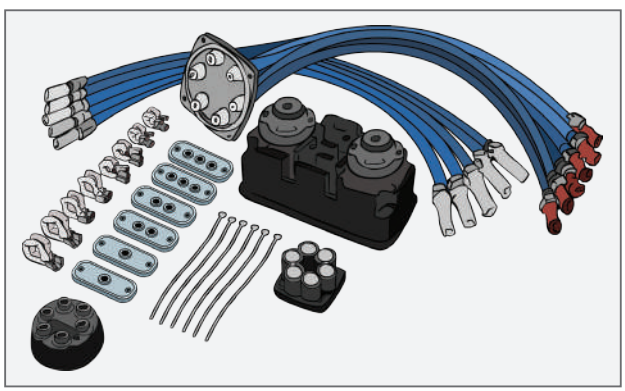


Figura 147 - Chicote de alta tensão para ignição

Ignition harness - the ignition lead directs the electrical energy from the magneto to the spark plug. The ignition harness contains an insulated wire for each cylinder that the magneto serves in the engine. One end of each wire is connected to the magneto distributor block and the other end is connected to the proper spark plug.

Ignition switches - all units in an aircraft ignition system are controlled by an ignition switch. The type of switch used varies with the number of engines on the aircraft and the type of magnetos used. All switches, however, turn the system off and on in much the same manner. The ignition switch is different in at least one respect from all other types of switches: when the ignition switch is in the off position, a circuit is completed through the switch to ground. In other electrical switches, the off position normally breaks or opens the circuit.

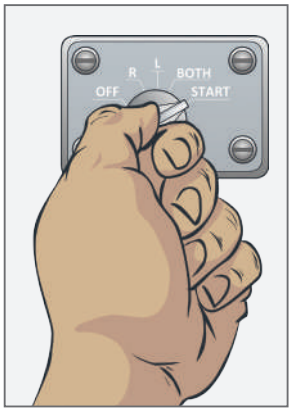


Figura 148 - Interruptor de partida do motor

Booster coil - the booster coil is separate from the magneto and can generate a series of sparks on its own. During the start cycle, these sparks are routed to the trailing finger on the distributor rotor and then to the appropriate cylinder ignition lead.

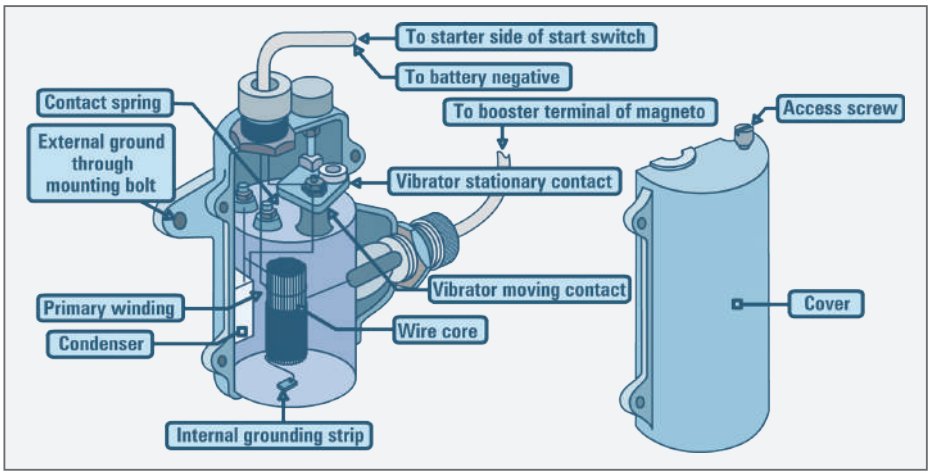


Figura 149 - Ilustração da bobina de arranque

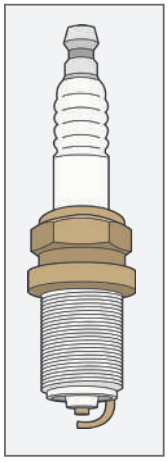


Figura 150 - Vela de ignição

Distributor is a high-voltage selector switch that is gear driven from the shaft of the rotating magnet in a magneto. The distributor rotor picks up the high voltage from the secondary winding of the coil and directs it to high-voltage terminals. From here, it is carried by high-tension ignition leads to the spark plugs.

Spark plug is responsible to conduct a short impulse of high-voltage current through the wall of the combustion chamber. Inside the combustion chamber, it provides an air gap across which the impulse can produce an electric spark to ignite the fuel/air charge. Spark plugs operate at extreme temperatures, electrical pressures, and very high cylinder pressures.

Tabela 20 - Vocabulário

Inglês	Português	Inglês	Português
Arc	Arco	*Insulated*	Isolado
Distributor	Distribuidor	*Magnet*	Imã
Electrode	Eletrodo	*Pole shoe*	Massa polar
Firing order	Ordem de ignição	*Winding*	Enrolamento
Gap	Folga		

4.1.5 Flight instruments and engine instruments

a) Flight instruments

They are crucial to conducting safe flight operations and it is important that the pilot have a basic understanding of their operation. Let's study some important instruments and their functions.

Pitot/Static systems - pitot pressure, or impact air pressure, is sensed through an open-

end tube pointed directly into the relative wind flowing around the aircraft. The pitot tube connects to pressure operated flight instruments such as the altimeter indicator (ASI).

Three basic pressure-operated instruments are found in most aircraft instrument panels. These are the sensitive altimeter, altimeter indicator (ASI), and vertical speed indicator (VSI). All three receive pressures sensed by the aircraft pitot-static system.

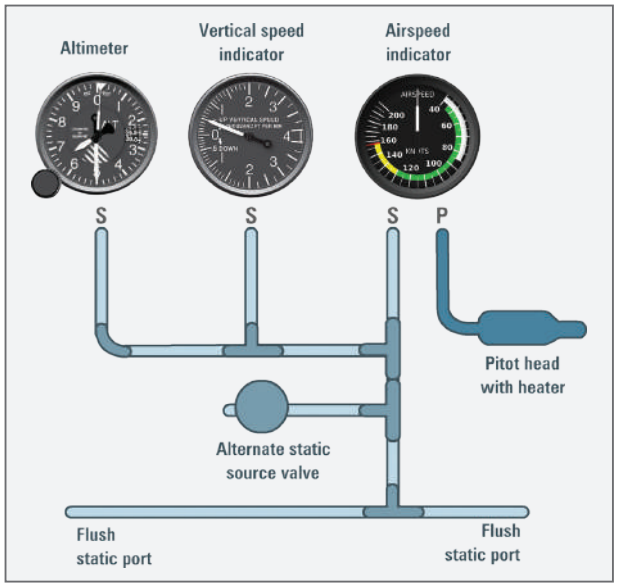


Figura 151 - Ilustração do sistema pitot estático

- Sensitive altimeter is an aneroid barometer that measures the absolute pressure of the ambient air and displays it in terms of feet or meters above a selected pressure level.
- Airspeed indicator (ASI) is a differential pressure gauge that measures the dynamic pressure of the air through which the aircraft is flying. Dynamic pressure is the difference in the ambient static air pressure and the total, or ram, pressure caused by the motion of the aircraft through the air.
- Vertical speed indicator (VSI) is a rate-of-pressure change instrument that gives an indication of any deviation from a constant pressure level.

Rigidity: rigidez é uma propriedade dos giroscópios que, enquanto seu rotor estiver girando a altas velocidades, tende a permanecer na mesma posição e no mesmo plano de rotação, exceto por uma pequena quantidade de precessão.

Precession: precessão é a força aplicada ao rotor do giroscópio com o objetivo de incliná-lo. A reação a essa força ocorre no ponto de 90 graus em relação ao plano rotacional.

Figura 152 - Bússola magnética

Magnetic compass is one of the oldest and simplest instruments for indicating direction. A magnet is a piece of material, usually a metal containing iron, which attracts and holds lines of magnetic flux.

Gyroscopic systems - flight without reference to a visible horizon can be safely accomplished by the use of gyroscopic instrument systems and the two characteristics of gyroscopes, which are rigidity and precession. These systems include attitude, heading, and rate instruments, along with their power sources. These instruments include a gyroscope that is a small wheel with its weight concentrated around its periphery.

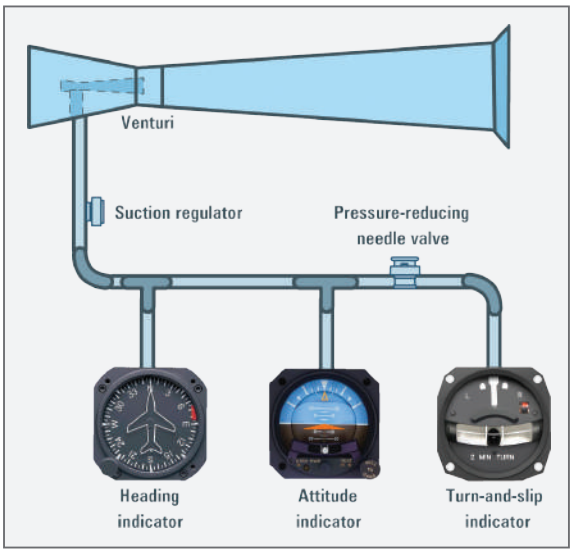


Figura 153 - Ilustração de um sistema de *pitot* estático

b) Engine instruments

Engine instruments can operate using different methods, some mechanically, some electrically, and some by sensing the direct pressure of air or liquid. Some of the basic instruments are:

- carburetor air temperature gauge;

- fuel pressure gauge;
- fuel flowmeter;
- manifold pressure gauge;
- oil temperature gauge;
- oil pressure gauge;
- tachometer;
- exhaust gas temperature gauge;
- cylinder head temperature gauge;
- torquemeter.

Generally, the instrument marking system consists of three colors: red, yellow, and green. A red line, or mark, indicates a point beyond which a dangerous operating condition exists. The yellow arc covers a given range of operation and is an indication of caution. The green arc shows a normal and safe range of operation.

Carburetor air temperature (CAT) gauge is regarded by many as an indication of induction system ice formation. Although it serves this purpose, it also provides many other important items of information.

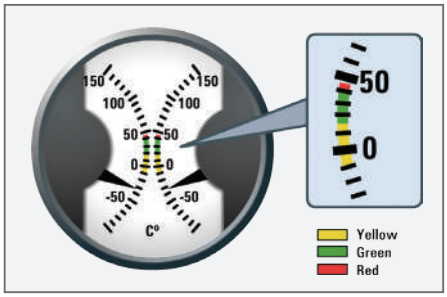


Figura 154 - Indicador analógico da temperatura do ar no carburador

Fuel pressure gauge is calibrated in pounds per square inch (psi) of pressure. It is used during the test run-in to measure engine fuel pressure at the carburetor inlet, the fuel feed valve discharge nozzle, and the main fuel supply line.

Oil pressure gauge - generally, there is only one oil pressure gauge for each aircraft engine. The oil pressure gauge indicates the pressure, in psi, that the oil of the lubricating system is being supplied to the moving parts of the engine. Excessive oscillation of the gauge pointer indicates that there is air in the lines leading to the gauge, or that some unit of the oil system is functioning improperly.

Figura 155 - Indicador analógico de pressão do combustível

Oil temperature gauge - the oil temperature gauge line in the aircraft is connected at the oil inlet to the engine. Three range markings are used on the oil temperature gauge. The green arc on the dial shows the minimum oil temperature permissible for ground operational checks or during flight. The green mark between 25 °F and below 245 °F shows the desired oil temperature for continuous engine operation. The red mark at 245 °F indicates the maximum permissible oil temperature.

Figura 156 - Indicador analógico de temperatura do óleo

Fuel flow meter measures the amount of fuel delivered to the engine. During engine testing procedures, the fuel flow to the engine can be measured by three different methods: a direct flow meter, a pressure-based flow meter, or a turbine sensor-based flow meter. From these

indications, the operator can determine whether an engine is operating at the correct fuel/air mixture for a given power setting. Fuel flow is measured normally in gallons per hour.

Manifold pressure gauge records the pressure as an absolute pressure reading. Absolute pressure takes into account the atmospheric pressure plus the pressure in the intake manifold. The red line indicates the maximum manifold pressure permissible during takeoff. The green arc starts at 35 ”Hg and continues to the 44 ”Hg. The red line on the gauge, at 49 ”Hg shows the manifold pressure recommended for takeoff. This pressure should not be exceeded.

Tachometer gauge shows the engine crankshaft rpm. The tachometer, often referred to as TACH, is calibrated in hundreds with graduations at every 100-rpm interval.

Cylinder head temperature gauge - cylinder head temperatures are indicated by a gauge connected to a thermocouple attached to the cylinder, that tests show to be the hottest on an engine in a particular installation. The scales are calibrated in increments of 10°, with numerals at the 0°, 100°, 200°, and 300° graduations. The space between any two graduation marks represents 10 °C.

Thermocouple: termopar é um sensor composto por uma liga de dois metais distintos, que se baseia na diferença de temperatura das suas extremidades para gerar uma força eletromotriz.

Figura 157 - Indicador analógico da pressão de admissão

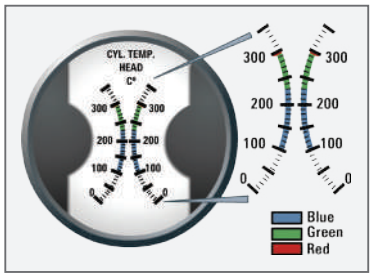


Figura 158 - Indicador analógico da temperatura na cabeça do cilindro

Figura 159 - Indicador analógico de torque

Torquemeter indicates the amount of torque being produced at the propeller shaft. A change in pressure from the valve that is connected to a transducer is then converted to an electrical signal and is transmitted to the flight deck. The torquemeter can readout in pounds-feet of torque, percent of horsepower, or horsepower.

Tabela 21 - Vocabulário

Inglês	Português	Inglês	Português
Airspeed	Velocidade relativa	*Gyroscopic*	Giroscópico
Altimeter	Altímetro	*Heading*	Proa
Aneroid	Aneroide	*Precession*	Precessão
Barometer	Barômetro	*Ram air*	Pressão de impacto do ar
Compass	Bússola	*Tachometer*	Tacômetro
Feedvalve	Válvula de alimentação	*Thermocouple*	Termopar
Flowmeter	Fluxômetro	*Torquemeter*	Torquímetro, indicador de torque
Gauge	Manômetro		

4.2 Grammar point – adjectives: comparisons

Adjetivo é a classe de palavras que serve para qualificar o substantivo. Eles podem ser usados na frase de três maneiras distintas: na sua forma comum, no comparativo e no superlativo, conforme os exemplos a seguir:

a) The aircraft 145 is big. (A aeronave 145 é grande.)

b) The aircraft 747 is bigger than the aircraft 145. (A aeronave 747 é maior que a aeronave 145.)

c) The aircraft AN-225 is the biggest airplane. (A aeronave AN-225 é a maior aeronave.)

No primeiro exemplo, o adjetivo *big* qualifica a aeronave 145. No segundo, o termo *bigger than* compara a aeronave 747 com a 145. No terceiro exemplo, o termo *the biggest* forma o superlativo. Seguem algumas regras gramaticais para formar o comparativo e o superlativo dos adjetivos.

4.2.1 Comparativo

a) Comparativos de igualdade são formados da seguinte maneira: as + adjetivo + as.

Ex: Relays are as important as fuses in an electric circuit.

b) Comparativos de inferioridade são formados com a seguinte estrutura: less + adjetivo + than.

Ex: Magnetic compass circuit is less complicated than gyroscope system circuit.

c) Comparativos de superioridade são formados acrescentando-se -er à maioria dos adjetivos curtos.

Ex: long - longer short - shorter fast - faster small - smaller

Observações:

• Quando o adjetivo termina em y, troca-se por i e acrescenta-se -er. Quando é formado por consoante - vogal - consoante, dobra-se a última letra e acrescenta-se o -er.

Ex: heavy - heavier , big - bigger

• Adjetivos longos e advérbios são precedidos de more (superioridade).

Ex: reliable - more reliable, slowly - more slowly

• Alguns adjetivos são considerados irregulares e, por isso, não seguem as regras citadas anteriormente.

Ex: good - better, bad - worse.

4.2.2 Superlativos

a) Acrescenta-se -est à maioria dos adjetivos curtos, sendo sempre antecedidos pelo artigo definido the. Adjetivos longos e advérbios são precedidos de the most (superioridade).

Ex.: long - the longest; fast - the fastest; reliable - the most reliable; slowly - the most slowly.

b) Os adjetivos irregulares não seguem as regras apresentadas.

Ex: good - the best, bad - the worst

4.3 Communication and navigation systems

With the mechanics of flight secured, early aviators began the tasks of improving operational safety and functionality of flight. These were developed in large part through the use of reliable communication and navigation systems. Today, with thousands of aircraft aloft at any one time, communication and navigation systems are essential to safe, successful flight. Let's see some important equipments used for navigation and communication.

Navigation system: sistema de navegação da aeronave. Utiliza equipamentos da aeronave trabalhando em conjunto com equipamentos de terra. Os dois devem estar em perfeito funcionamento para fornecer a informação correta para o voo.

Non-directional radio beacon (NDB) - the non-directional radio beacon (NDB) is a ground-based radio transmitter that transmits radio energy in all directions. The ADF, when used with an NDB, determines the bearing from the aircraft to the transmitting station. The ADF needle points to the NDB ground station to determine the relative bearing (RB) to the transmitting station.

Automatic direction finder (ADF) can be used to plot your position, tracking bound and outbound, and intercept a bearing. These procedures are used to execute holding patterns and non-precision instrument approaches. The airborne equipment includes two antennas, a receiver, and the indicator instrument.

Very high frequency omnidirectional range (VOR) is the primary navigational aid. The VOR ground station is oriented to magnetic north and transmits azimuth information to the aircraft, providing 360 courses TO or FROM the VOR station. When DME is installed with the VOR, it is referred to as a VOR/DME and provides both azimuth and distance information. The courses oriented FROM the station are called radials.

Figura 160 - Indicador do radiogoniômetro automático (ADF)

Figura 161 - Indicador do radiofarol omnidirecional VHF (VOR)

Distance measuring equipment (DME) - when used in conjunction with the VOR system, DME makes it possible for pilots to determine an accurate geographic position of the aircraft, including the bearing and distance TO or FROM the station. The aircraft DME transmits interrogating radio frequency (RF) pulses, which are received by the DME antenna at the ground facility.

Global positioning system (GPS) is a satellite-based radio navigation system, which broadcasts a signal that is used by receivers to determine precise position anywhere in the world. GPS

operation is based on the concept of ranging and triangulation from a group of satellites in space which act as precise reference points. Much of aviation communication and navigation is accomplished through the use of radio waves. Communication by radio was the first use of radio frequency transmissions in aviation. In aviation, a variety of radio waves are used for communication. The figure illustrates the radio spectrum that includes the range of common aviation radio frequencies and their applications.

- Very low frequency (VLF), low frequency (LF), and medium frequency (MF) - radio waves produced at these frequencies ranging from 3 kHz to 3 MHz are known as ground waves or surface waves.
- High frequency (HF) - radio waves travel in a straight line and do not curve to follow the earth's surface. These kinds of radio waves are known as sky waves.
- Above HF transmissions, radio waves are known as space waves. They are only capable of line-of-sight transmission and do not refract off of the ionosphere. Most aviation communication and navigational aids operate with space waves. This includes VHF (30-300MHz), UHF (300MHz-3GHz), and super high frequency (SHF) (3GHz-30GHz) radio waves.
- VHF communication radios are the primary communication radios used in aviation. VHF radios are used for communications between aircraft and air traffic control (ATC), as well as air-to-air communication between aircraft.

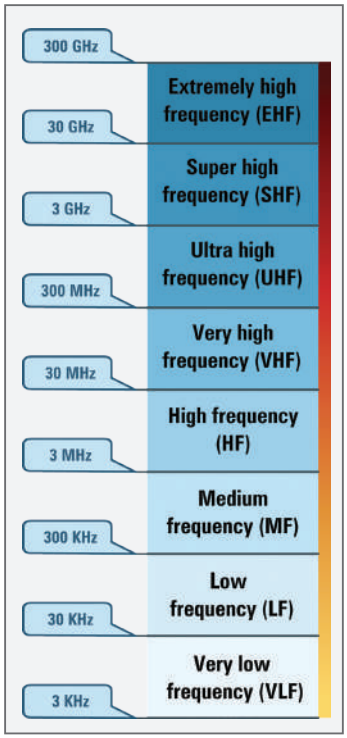


Figura 162 - Faixas de radiofrequência

Tabela 22 - Vocabulário

Inglês	Português	Inglês	Português
Beacon	Farol, baliza	*Omnidirectional*	Omnidirecional
Bearing	Rumo	*Outbound*	Afastamento
Broadcast	Radiodifusão	*Plot (verbo)*	Traçar
Holding pattern	Circuito de espera	*Receiver*	Receptor
Inbound	Aproximação	*Task*	Tarefa
Non-directional	Não direcional	*Wave*	Onda (som)

4.4 Avionic system and warning system

Pilots now have an unprecedented amount of information available at their fingertips. Electronic flight instruments use innovative techniques to determine aircraft attitude, speed, and altitude, presenting a wealth of information in one or more integrated presentations. A suite of cockpit information systems provides pilots with data about aircraft position, planned route, engine health and performance, as well as surrounding weather, traffic, and terrain.

The electronic flight instrument systems integrate many individual instruments into a single presentation called a primary flight display (PFD). A PFD presents information about primary flight instruments, navigation instruments, and the status of the flight in one integrated display. Some systems include powerplant information and other systems information in the same display.

In addition to a PFD directly in front of the pilot, a multi-function display (MFD) that provides the display of information added to primary flight information is used within the flight deck. Information such as a moving map, approach charts, terrain awareness warning system, and weather depiction can all be illustrated on the MFD.

Primary Flight Display **(PFD)**: é um *display* LCD que fornece diversas informações de voo como temperatura do motor, altitude, entre outras, simplificando o trabalho do piloto.

Figura 163 - Display de informações de voo

Figura 164 - Tela do display com informações do local do voo

The terrain awareness and warning system (TAWS) uses GPS positioning and a database of terrain and obstructions to provide true predictability of the upcoming terrain and obstacles. The warnings it provides pilots are both aural and visual, instructing the pilot to take specific action.

Another display is the head-up display (HUD). It is a display system that provides a projection of navigation and air data on a transparent screen between the pilot and the windshield. The concept of a HUD is to diminish the shift between looking at the instrument panel and outside.

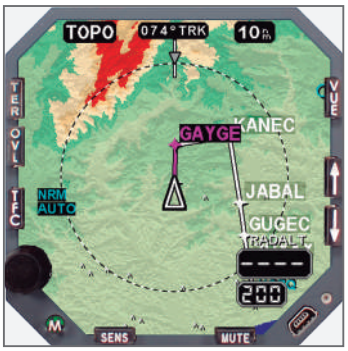


Figura 165 - Sistema de alerta e informações do terreno

Figura 166 - Display com visualização dos dados na altura dos olhos

Tabela 23 - Vocabulário

Inglês	Português	Inglês	Português
Aural	Auditivo, acústico	*Shift*	Variação, desvio
Awareness	Consciência	*Warning*	Alerta
Depiction	Representação	*Windshield*	Para-brisa

4.5 Grammar point – linking words

Conjunções são palavras que servem para ligar palavras ou orações, podendo expressar ideias de adição, condição, adversidade, consequência, entre outras. As conjunções mais utilizadas são:

• And (adição)

The two most common types of battery used are lead-acid and Ni-Cd batteries.

• If (condição)

If the switch is in the On position, the circuit is activated.

• But (adversidade)

This system is powered by the engine-driven alternator or generator but, when the aircraft is on ground or emergency, the battery is the responsible.

• So (consequência)

The coil current can be on or off, so relays have two switch positions.

• As (explicação)

DC generators produce direct current as the name implies.

• When (tempo)

Paralleling is a simple process when dealing with DC power systems found on light aircraft.

• In order to (propósito)

Connectors are used in order to facilitate maintenance when frequent disconnection is required.

A tabela a seguir apresenta outras conjunções com o mesmo valor semântico que as apresentadas anteriormente.

Tabela 24 - Conjunções

AND	IF	BUT	SO	AS	IN ORDER TO	WHEN
in addition	while	however	therefore	because	to	before
moreover	unless	despite	thus	due to	so that	as soon as
and also	provided	although		since		until

4.6 Good practices in maintenance

Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects usually caused by contact. It is important to take care when handling some equipments or components. If you touch them, it can create sparks and damage electronic devices. There are some ESD protection equipments used by the workers.

- ESD jacket - provide shielding from static charges on your clothing.

Figura 167 - Alerta para o risco de descarga eletrostática

Figura 168 - Jaleco com proteção de descarga eletrostática

- Grounders - worn on each shoe to connect a walking or standing person to ground. Also known as ESD heel.
- Wrist band - safely grounds a person working at a workstation.

Figura 169 - Calcanheira antiestática

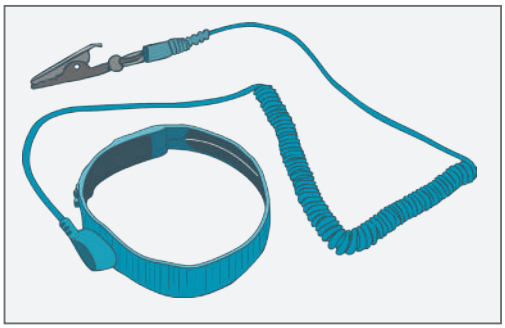


Figura 170 - Pulseira antiestática

Resumindo

Foram descritos, neste capítulo, diversos termos técnicos utilizados em manuais de sistemas elétricos de aeronaves e de ignição de motores alternativos utilizados em aeronaves. Identificaram-se também vários instrumentos de voo e suas funções, além de alguns itens de comunicação e aviônicos.

Capítulo 5
Pressurization and fuel system

O sistema de pressurização ganhou notoriedade com o avanço da aviação, quando surgiu a necessidade de voar em níveis mais altos para obter rendimentos melhores (economia de combustível), principalmente nos motores a jato. A pressão do ar diminui à medida que a altitude aumenta, tornando-se um problema para quem está na aeronave. Assim, o sistema de pressurização tem como função manter a pressão interna da aeronave a um nível que se possa respirar normalmente, independentemente da altitude que estiver voando.

Outro sistema utilizado pela aeronave é o de combustível, sendo ele quem armazena e distribui o combustível para o motor. Apesar de parecer simples esta função, ele deve fornecer a quantidade correta em todos os momentos do voo. Isso inclui as alterações na velocidade (acelerações e desacelerações), mudanças de altitudes e até mesmo em manobras bruscas. A eficiência desses sistemas garante um voo seguro e confortável para a tripulação e os passageiros.

5.1 Pressurization system

Pressurizing an aircraft cabin assists in making flight possible in the hostile environment of the upper atmosphere. The degree of pressurization and the operating altitude of any aircraft are limited by critical design factors. A cabin pressurization system must accomplish several functions if it is to ensure adequate passenger comfort and safety. A pressurization system must also be designed to prevent rapid changes of cabin pressure, which can be uncomfortable or injurious to passengers and crew. Additionally, a pressurization system should circulate air from inside the cabin to the outside at a rate that quickly eliminates odors and removes stale air.

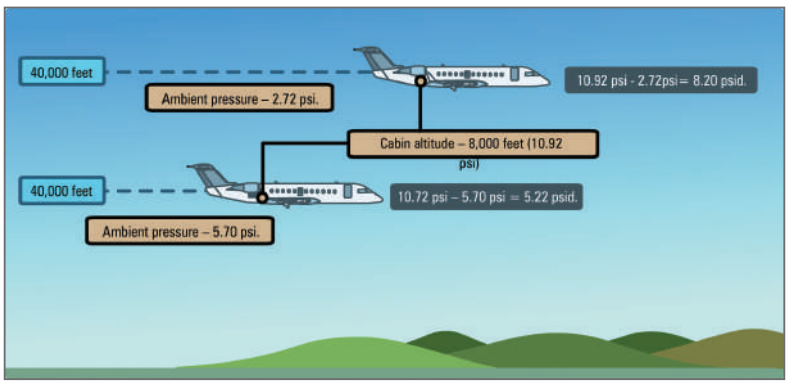


Figura 171 - Ilustração do sistema de pressurização de aeronaves

Aircraft cabin pressurization can be controlled via two different modes of operation. The first is the isobaric mode, which works to maintain cabin altitude at a single pressure despite the changing altitude of the aircraft. For example, the flight crew may select to maintain a cabin altitude of 8,000 feet (10.92 psi). In the isobaric mode, the cabin pressure is established at the

Hostile environment of the upper atmosphere: quanto maior a altitude do voo, menor é a pressão e a temperatura externas. Portanto, quanto maior a altitude, mais hostil é o ambiente. Por exemplo, no nível do mar, a pressão é de 14,69 psi e 15 ºC, ao subir à altitude de 30.000 pés, a pressão é de 4,37 psi e a temperatura, de 44,4 ºC negativos.

Isobaric mode: sistema de pressurização em que a pressão da cabine é mantida constante a despeito da mudança de altitude da aeronave.

8,000 foot level and remains at this level, even as the altitude of the aircraft fluctuates.

The second mode of pressurization control is the constant differential mode, which controls cabin pressure to maintain a constant pressure difference between the air pressure inside the cabin and the ambient air pressure, regardless of aircraft altitude changes. The device used to control the cabin air pressure is called cabin pressure controller.

Controlling cabin pressurization is accomplished through regulating the amount of air that flows out of the cabin. A cabin outflow valve opens, closes, or modulates to establish the amount of air pressure maintained in the cabin.

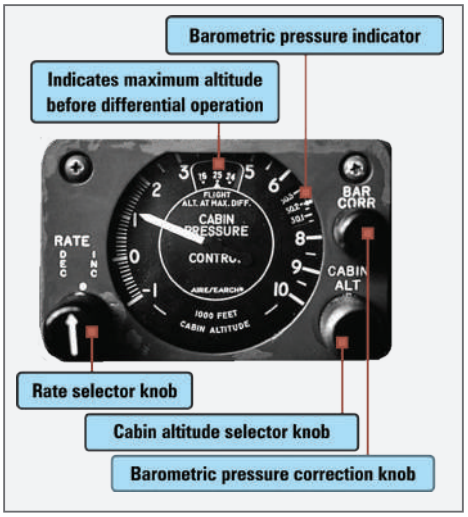


Figura 172 - Controle de pressão da cabine

Differential mode: sistema de pressurização que mantém uma diferença de pressão constante entre a pressão do ar no interior da cabine e a pressão do ar ambiente.

Alerts: Informações padronizadas que alertam os usuários sobre possíveis condições de perigo, bem como o grau que representa esse perigo. Podem ser de atenção, cuidado ou perigo, sendo utilizado em manuais de operação e manutenção de equipamentos, bem como nos ambientes de manutenção e linhas de voo.

Engine Indicating and Crew Alerting System(EICAS): sistema de monitoramento e alerta cujo objetivo é monitorar os sistemas da aeronave para o piloto. Ele monitora dados do motor e da célula do avião. Ele executa as mesmas funções do ECAM.

Electronic Centralized Aircraft Monitor (ECAM): conjunto de monitoramento e alerta automático dos sistemas e alerta automático da célula da aeronave e dados do motor. Quando um problema é detectado ou uma falha ocorre, o monitor primário, juntamente com uma sugestão auditiva e visual, alerta o piloto. O sistema também exibe a ação corretiva para o problema, bem como a ação sugerida em caso de fracasso na primeira sugestão. Ao realizar o sistema de monitoramento automaticamente, o piloto fica livre para fazer a pilotagem da aeronave.

5.1.1 Pressurization gauges

While all pressurization systems differ slightly, usually three cockpit indications, in concert with various warning lights and alerts, advise the crew of pressurization variables. They are the cabin altimeter, the cabin rate of climb or vertical speed indicator, and the cabin differential pressure indicator. These can be separate gauges or combined into one or two gauges.

Figura 173 - Indicador de pressão de cabine e pressão diferencial

On modern aircraft equipped with digital aircraft monitoring systems with LCD displays, such as engine indicating and crew alerting system (EICAS) or electronic centralized aircraft monitor (ECAM), the pressurization panel may contain no gauges.

5.1.2 Air conditioning systems

There are two types of air conditioning systems commonly used on aircraft. Air cycle air conditioning is used on most turbine-powered aircraft. It makes use of engine bleed air or APU pneumatic air during the conditioning process. Vapor cycle air conditioning systems are often used on reciprocating aircraft. This type system is similar to that found in homes and automobiles.

The temperature is monitored in the cabin, cockpit, conditioned air ducts, and distribution air ducts. These values are input into a temperature controller, or temperature control regulator, normally located in the electronics bay. A temperature selector in the cockpit can be adjusted to input the desired temperature.

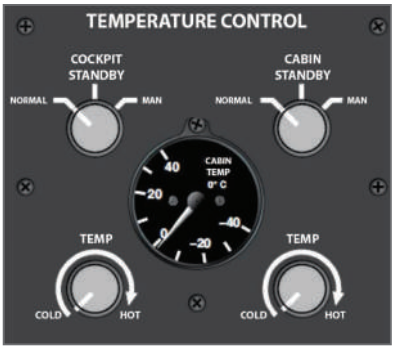


Figura 174 - Controle de temperatura ambiente da aeronave

5.1.3 Let's know more about pressurization system components!

Pack valve is the valve that regulates bleed air from the pneumatic manifold into the air cycle air conditioning system.

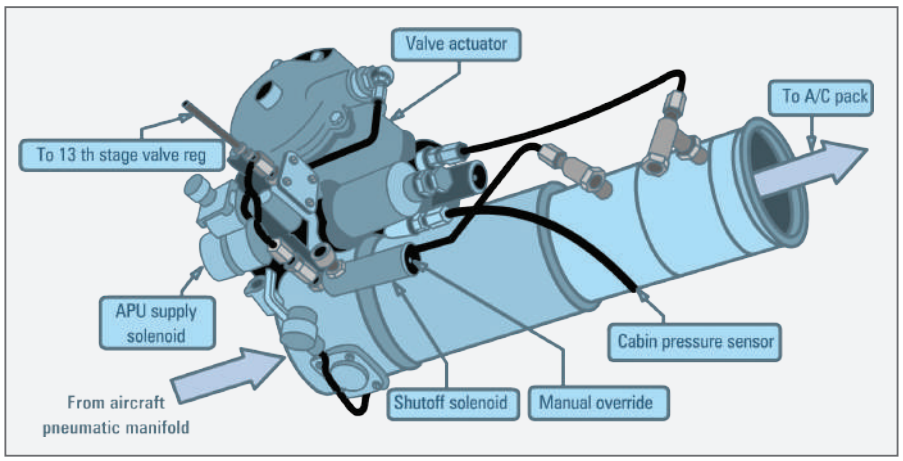


Figura 175 - Ilustração da captação do ar para o sistema de ar condicionado da aeronave

Primary heat exchanger - generally, the warm air dedicated to pass through the air cycle system first passes through a primary heat exchanger. It acts similarly to the radiator in an automobile.

Water separator - the cool air from the air cycle machine can no longer hold the quantity of water it could when it was warm. A water separator is used to remove the water from the saturated air before it is sent to the aircraft cabin.

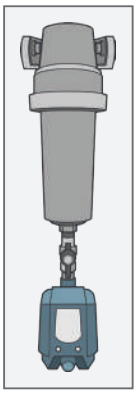


Figura 176 - Separador de água

Tabela 25 - Vocabulário

Inglês	Português	Inglês	Português
Cabin	Cabine	*Primary*	Primário
Isobaric	Isobárico	*Radiator*	Radiador
Pressurizing	Pressurização		

5.2 Grammar point – modal verbs

Os modais são verbos auxiliares que alteram o sentido do verbo principal da frase. Eles apresentam algumas características que os diferem dos outros verbos. São utilizados para expressar ideias como possibilidade, habilidade, probabilidade, necessidade, obrigação, proibição, permissão, etc. O mesmo modal pode ter significados diferentes dependendo do contexto em que está inserido e, muitas vezes, é utilizado de forma específica dentro do contexto técnico.

Quando um técnico faz a manutenção ou troca de algum equipamento da aeronave, ele deve seguir uma publicação técnica fornecida pelo fabricante do avião, que mostra exatamente os procedimentos que devem ser seguidos. A ordem dos procedimentos ou o procedimento em si não podem ser alterados, podendo resultar em dano ao equipamento. Os verbos modais são muito utilizados nestas ocasiões, passando a ideia de obrigatoriedade do que deve ser feito.

Como eles se enquadram em uma categoria especial de verbos, o próprio modal é utilizado para formar as frases negativas e interrogativas. Desta forma, não se utilizam os auxiliares do, does e did nas orações com modais, pois ele realiza esta função. A seguir, serão apresentadas algumas regras gramaticais para seu emprego.

a) Não é utilizado nas formas nominais: infinitivo, particípio e gerúndio.

b) Apresenta a mesma forma para todos os sujeitos (I, you, he, she, it, we, you, they).

You should rest. He should rest. They should rest.

c) São seguidos de verbos no infinitivo sem o To.

I can swim. You may go. He should study.

d) Seguem a mesma regra para a negação e interrogação do verbo To be.

He can work here. He cannot work here. Can he work here?

e) Não é permitido o uso de dois modais em uma mesma frase, neste caso, é necessário trocar um dos modais por seu equivalente.

We must go to the hospital. We will have to go to the hospital.

5.2.1 Possibility, probability

Os modais *can*, *may* e *could* são utilizados para expressar possibilidade, capacidade ou probabilidade, podendo ser técnica ou física.

- Aircraft cabin pressurization can be controlled via two different modes of operation.
- The electronic pressurization panel may contain no gauges.
- A temperature selector in the cockpit can be adjusted to input the desired temperature.
- Fuel valves can be manually operated.

5.2.2 Necessity

Os modais *must*, *have* e *shall* são utilizados para expressar necessidade. Nesses casos, *shall* não indica a ideia de futuro.

- A cabin pressurization system has to accomplish several functions.
- The total usable capacity of any tank(s) must be enough for at least 30 minutes of operation at maximum continuous power.

5.2.3 Condition

O *If* é utilizado para expressar a ideia de condição. As expressões *in the event of* e *in the case of* também são comumente usadas.

- The mechanic checks if there is a leakage in the tank.
- If the backlash is excessive, check the entire operating mechanism for worn joints, loose pins, and broken drive lugs.

5.2.4 Advice

Should é utilizado para expressar a ideia de conselho ou advertência.

- The technician should be aware that the terms "strainer" and "filter" are sometimes used interchangeably.

5.3 Fuel system

The engine fuel system must supply fuel to the engine's fuel metering device under all conditions of ground and air operation. It must function properly at constantly changing altitudes and in any climate. The basic parts of a fuel system include tanks, boost pumps, lines, selector valves, strainers, engine-driven pumps, and pressure gauges.

- Fuel tanks - each fuel tank must be able to withstand, without failure, vibration, inertia, fluid, and structural loads to which it may be subjected in operation. There are usually tanks in both wings and sometimes an auxiliary tank in the fuselage. The total usable capacity of any tank(s) must be enough for at least 30 minutes of operation at maximum continuous power.

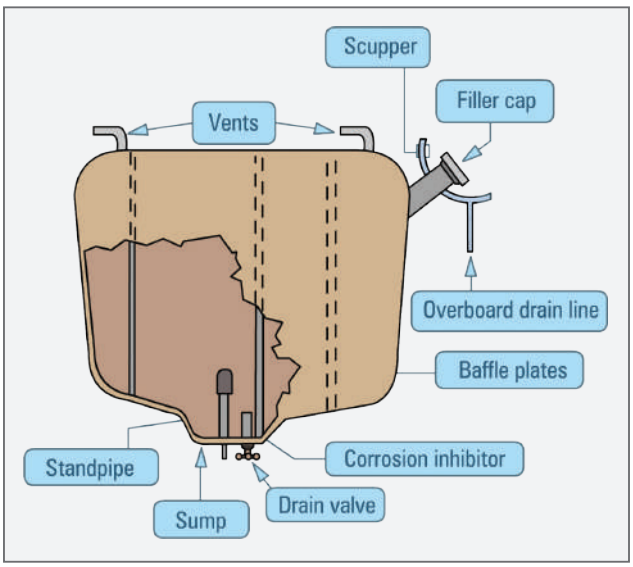


Figura 177 - Tanque de combustível

• Engine-driven pumps - all aircraft have at least one fuel pump to deliver clean fuel under pressure to the fuel metering device for each engine. Engine-driven pumps are the primary delivery device. On reciprocating engines, one main fuel pump must be engine-driven and there must be at least one for each engine. Turbine engines also require dedicated fuel pumps for each engine. Any pump required for operation is considered a main fuel pump.

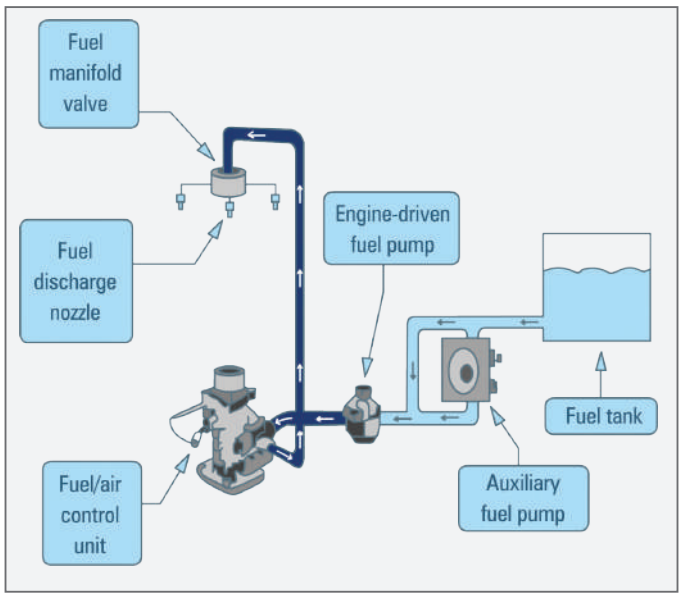


Figura 178 - Bomba acionada pelo motor

• Booster pumps are auxiliary pumps - sometimes known as booster pumps or boost pumps, auxiliary pumps are used to provide fuel under positive pressure to the engine-driven pump and during starting when the engine-driven pump is not yet up to speed for sufficient fuel delivery. On many large aircraft, boost pumps are used to move fuel from one tank to another.

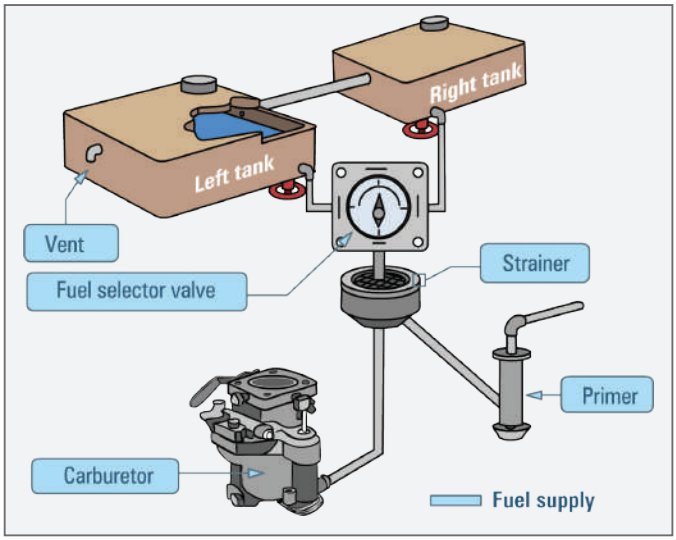


Figura 179 - Ilustração da válvula seletora

• Fuel valves - there are many fuel valves used in aircraft fuel systems. They are used to shut off fuel flow or to route the fuel to a desired location. Light aircraft fuel systems may include only one valve, the selector valve. Large aircraft fuel systems have numerous valves. Fuel valves can be manually operated, solenoid operated, or operated by electric motor.

• Selector valve - is set from the cockpit to select the tank from which fuel is to be delivered to the engine.

• Fuel pressure gauges - monitoring fuel pressure can give the pilot early warning of a fuel system related malfunction. Verification that the fuel system is delivering fuel to the fuel metering

device can be critical. In aircraft equipped with an auxiliary pump for starting and to backup the engine-driven pump, the fuel pressure gauge indicates the auxiliary pump pressure until the engine is started. When the auxiliary pump is switched off, the gauge indicates the pressure developed by the engine-driven pump.

- Lines - the components of an aircraft fuel system are joined together by fuel lines. They are made of metal tubing connected by flexible hoses. The metal tubing is usually made of aluminum alloy, and the flexible hose is made of synthetic rubber or polytetrafluoroethylene.
- Hoses - flexible hose assemblies are used when lines may be under pressure and subject to axial loads. Any hose that is used must be shown to be suitable for a particular application. Where high temperatures may exist during engine operation or after shutdown, fuel hoses must be capable of withstanding these temperatures.

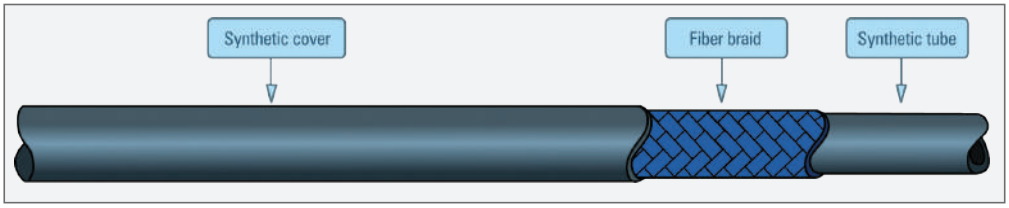


Figura 180 - Mangueira de combustível

- Fuel strainer or filter - two main types of fuel cleaning device are utilized on aircraft. Fuel strainers are usually constructed of relatively coarse wire mesh. They are designed to trap large pieces of debris and prevent their passage through the fuel system. Fuel strainers do not inhibit the flow of water. Fuel filters generally are usually fine mesh.

  In various applications, they can trap fine sediment that can be only thousands of an inch in diameter and also help trap water. The technician should be aware that the terms “strainer” and “filter” are sometimes used interchangeably.

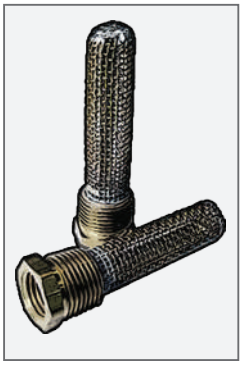


Figura 181 - Filtro de combustível tipo tela

- Fuel heaters and ice prevention - turbine powered aircraft operate at high altitude where the temperature is very low. As the fuel in the fuel tanks cools, water in the fuel condenses and freezes. It may form ice crystals in the tank. The formation of ice on the filter element blocks the flow of fuel through the filter. Fuel heaters are used to warm the fuel so that ice does not form.
- Fuel tank vents - to allow proper fuel flow, each fuel tank must be vented from the top part of the expansion space. The vents must be arranged to prevent the loss of fuel when the airplane is parked in any direction on a ramp having a one-percent slope.
- Fuel system drains - aircraft fuel systems must be fitted with at least one drain to allow safe drainage of the entire fuel system with the airplane in its normal ground attitude. The drain must discharge the fuel clear of all parts of the aircraft.

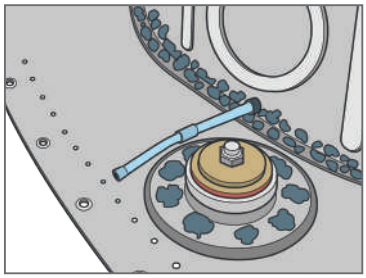


Figura 182 - Tubo de suspiro do tanque de combustível

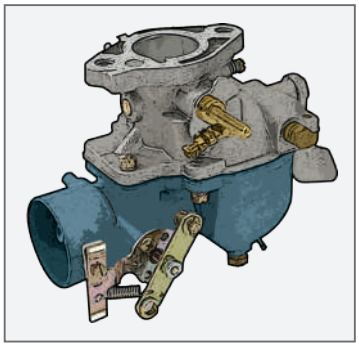


Figura 183 - Carburador

• Carburetor must measure the airflow through the induction system and use this measurement to regulate the amount of fuel discharged into the airstream.

• Fuel discharge nozzles - there is one nozzle for each cylinder located in the cylinder head. Each nozzle incorporates a calibrated jet. The jet size is determined by the available fuel inlet pressure and the maximum fuel flow required by the engine.

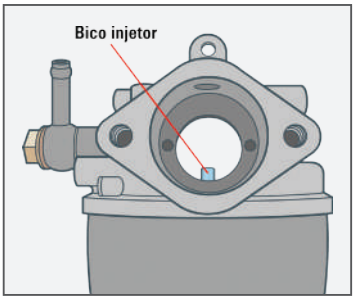


Figura 184 - Ilustração de um bico injetor de combustível do carburador

5.3.1 Aircraft cooling system

Excessive heat is always undesirable in both reciprocating and turbine aircraft engines. If means were not available for its control or elimination, major damage or complete engine failure would occur. Although the vast majority of reciprocating engines are air cooled, some diesel liquid-cooled engines are being made available for light aircraft.

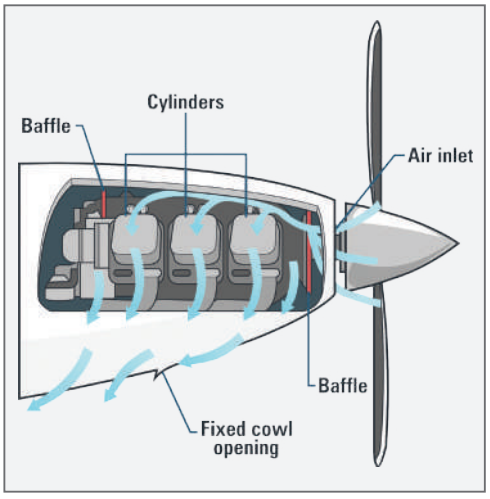


Figura 185 - Ilustração do sistema de refrigeração a ar do motor de aeronave

The most common means of controlling cooling is the use of cowl flaps. These flaps are opened and closed by electric motor-driven jackscrews, by hydraulic actuators, or manually in some light aircraft.

Cowling and baffles are designed to force air over the cylinder cooling fins. The baffles direct the air close around the cylinders and prevent it from forming hot pools of stagnant air while the main streams rush by unused.

5.3.2 Fuel system inspection and maintenance

The inspection of a fuel system installation consists basically of an examination of the system for conformity to design requirements together with functional tests to prove correct operation. Inspect the entire system for wear, damage, or leaks. Make sure that all units are securely attached and properly safetied. Here some procedures:

- The drain plugs or valves in the fuel system should be opened to check for the presence of sediment or water.
- The filter and sump should also be checked for sediment, water, or slime.
- The filters or screens, including those provided for flowmeters and auxiliary pumps, must be clean and free from corrosion.
- The controls should be checked for freedom of movement, security of locking, and freedom from damage due to chafing.
- The fuel vents should be checked for correct positioning and freedom from obstruction; otherwise, fuel flow or pressure fueling may be affected.
- If booster pumps are installed, the system should be checked for leaks by operating the pumps. During this check, the ammeter or load meter should be read and the readings of all the pumps, where applicable, should be approximately the same.

Após realizar os procedimentos de teste no sistema completo, veja a inspeção em partes específicas:

a) Fuel tanks - all applicable panels in the aircraft skin or structure should be removed and the tanks inspected for corrosion on the external surfaces, for security of attachment, and for correct adjustment of straps and slings. Check the fittings and connections for leaks or failures.

b) Lines and fittings - be sure that the lines are properly supported and that the nuts and clamps are securely tightened. Replace any hose that has collapsed at the bends or as a result of misaligned fittings or lines. Some hoses tend to flare at the ends beyond the clamps. This is not an unsatisfactory condition unless leakage is present.

c) Selector valves - rotate selector valves and check for free operation, excessive backlash, and accurate pointer indication. If the backlash is excessive, check the entire operating mechanism for worn joints, loose pins, and broken drive lugs. Replace any defective parts. Inspect cable control systems for worn or frayed cables, damaged pulleys, or worn pulley bearings.

d) Pumps - during an inspection of booster pumps, check for the following conditions:

- proper operation;
- leaks and condition of fuel and electrical connections;
- wear of motor brushes;
- be sure the drain lines are free of traps, bends, or restrictions;
- check the engine-driven pump for leaks and security of mounting;
- check the vent and drain lines for obstructions.

e) Main line strainers - drain water and sediment from the main line strainer at each preflight inspection. Remove and clean the screen at the periods specified in the airplane maintenance manual. Check for leaks and damaged gaskets.

5.3.3 Let's know more about fuel system components!

Tabela 26 - Combustíveis usados em aviação

Fuel type and grade	Color of fuel
AVGAS 82UL	Purple
AVGAS 100LL	Green
AVGAS 100	Blue
JET A	Colorless or straw
JET A-1	Colorless or straw
JET B	Colorless or straw

Each aircraft engine is designed to burn a certain fuel. Reciprocating engine fuel use gasoline (also known as AVGAS) and turbine engine fuel use kerosene (also known as Jet fuel). Mixing fuels is not permitted. AVGAS is generally either 80 (red) or 100LL (blue) octane. The "LL" stands for low lead although it contains four times the lead of 80 octane AVGAS.

Tabela 27 - Vocabulário

Inglês	Português	Inglês	Português
Ammeter	Amperímetro	*Leak*	Vazamento
Backlash	Folga, jogo	*Lug*	Alça, orelha
Baffle	Defletor	*Mesh*	Malha
Bend	Curva	*Misaligned*	Desalinhado
Braid	Trança	*Octane*	Octana
Brush	Escova	*Preflight*	Pré-voo
Chafing	Fricção, atrito	*Route (to)*	Dirigir, encaminhar
Collapsed	Avariado	*Safetied*	Frenado
Cowl flap	Flap de refrigeração	*Shutdown*	Parada
Drive	Acionamento, transmissão	*Slime*	Limo
Fin	Aleta	*Sling*	Alça, estropo
Flare (to)	Arredondar	*Slope*	Inclinação
Frayed	Desfiado, desgastado	*Strainer*	Filtro de tela
Heater	Aquecedor	*Strap*	Alça, cinta, braçadeira
Hot pool	Bolsa de ar quente	*Trap (to)*	Reter, prender
Induction system	Sistema de indução	*Wear*	Desgaste
Jackscrew	Macaco (equipamento)	*Withstand*	Resistir
Jet	Jato, esguicho		

***Preflight inspection*:** a inspeção de pré-voo de um avião é o processo para averiguar as condições de aeronavegabilidade da aeronave antes da decolagem. Há uma série de verificações constantes em *check list* que devem ser efetivadas pelo piloto ou pelo membro da tripulação com competência para tal.

5.4 Deicing system

Rain, snow, and ice are transportation's long time enemies. Under certain atmospheric conditions, ice can build rapidly on airfoils and air inlets. On days when there is visible moisture in the air, ice can form on aircraft leading edge surfaces at altitudes where freezing temperatures

start. Ice buildup increases drag and reduces lift. It causes destructive vibration and hampers true instrument readings. Control surfaces become unbalanced or frozen. Ice, snow, and slush have a direct impact on the safety of flight.

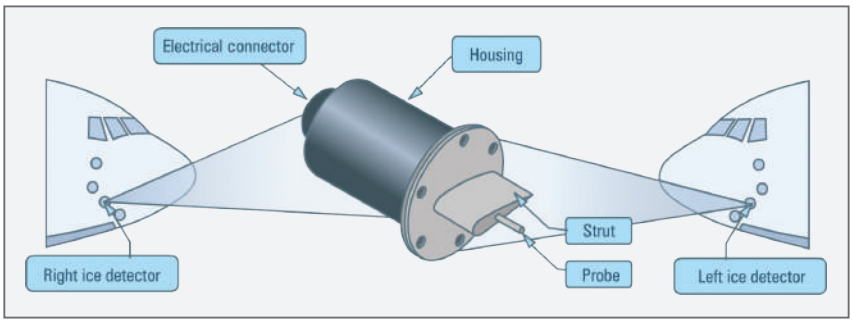


Figura 186 - Ilustração de detectores de gelo

In the figure above, an ice detector alerts the flight crew of icing conditions and, on some aircraft, automatically activates ice protection systems. One or more detectors are located on the forward fuselage.

5.4.1 Wing and horizontal and vertical stabilizer anti-icing systems

The wing leading edges, or leading edge slats, and horizontal and vertical stabilizer leading edges of many aircraft make and models have anti-icing systems installed to prevent the formation of ice on these components. The most common anti-icing systems used are thermal pneumatic, thermal electric, and chemical. The figure shows a thermal wing anti-icing (WAI) system.

Anti-icing systems: sistema que previne a formação de gelo em áreas críticas da aeronave sujeitas à formação de gelo.

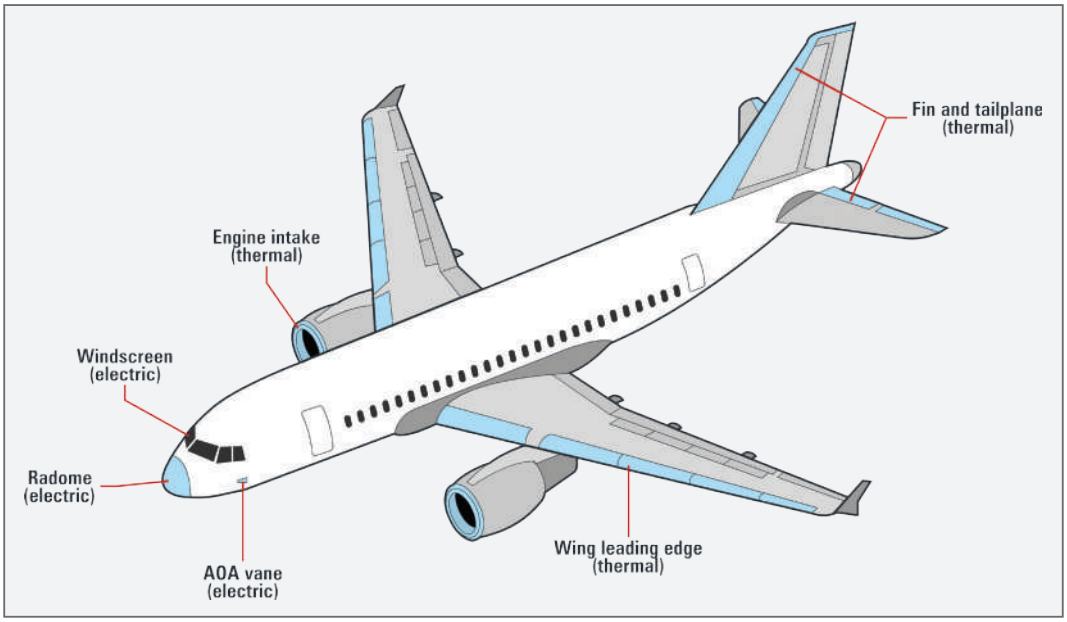


Figura 187 - Ilustração das áreas protegidas pelo sistema de proteção contra gelo

Chemical anti-icing is used in some aircraft to anti-ice the leading edges of the wing, stabilizers, windshields, and propellers. An antifreeze solution is pumped from a reservoir through a mesh screen embedded in the leading edges of the wings and stabilizers.

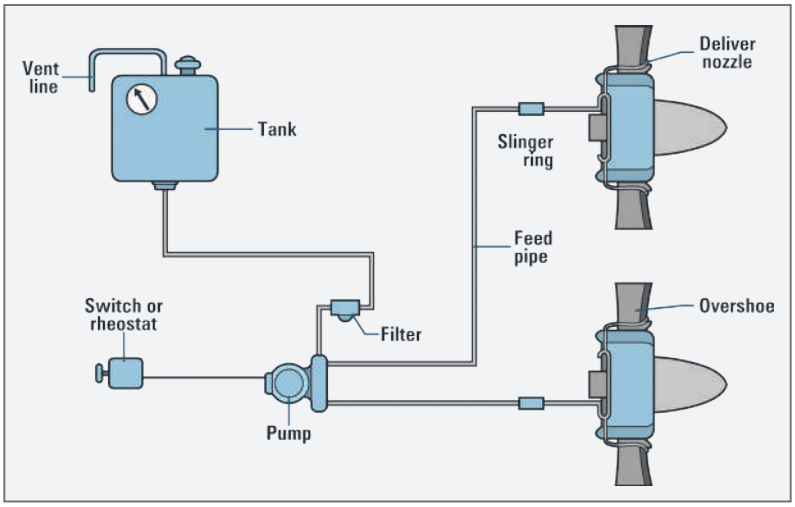


Figura 188 - Ilustração do sistema químico antigelo das hélices

The aircrew can monitor the WAI system on the onboard computer maintenance page. This system is composed by valves, ducts, pressure sensors and controlled by the ACIPS computer card.

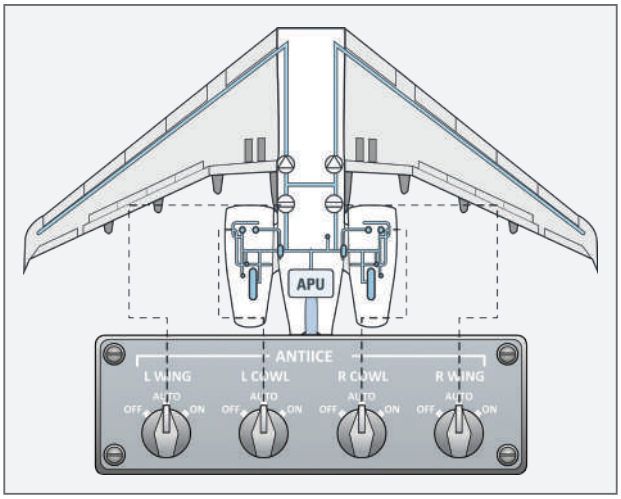


Figura 189 - Ilustração do sistema antigelo das asas de aeronave

A few modern aircraft are equipped with electric deice boots on wing sections or on the horizontal stabilizer. These boots contain electric heating elements which are bonded to the leading edges

similarly to pneumatic deice boots. When activated, the boots heat up and melt the ice off of leading edge surfaces. The elements are controlled by a sequence timer in a deice controller.

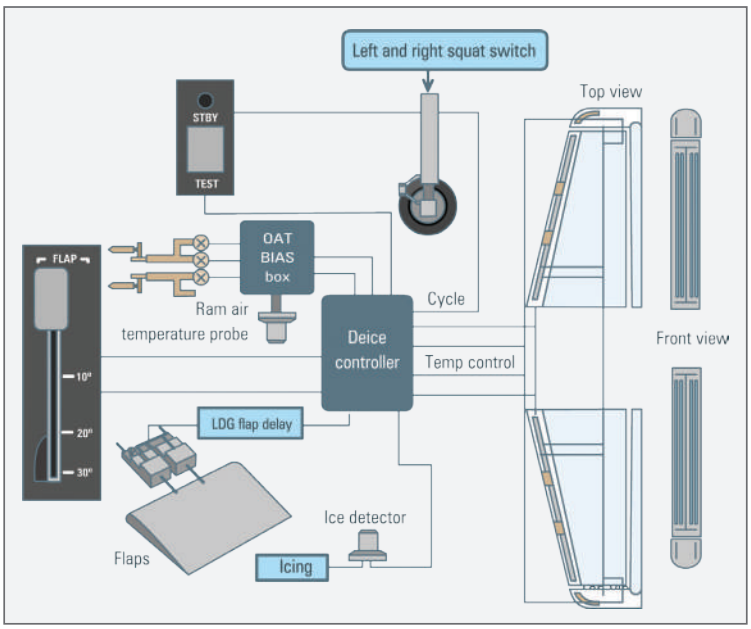


Figura 190 - Ilustração do sistema de degelo elétrico

5.4.2 Propeller deice system

The formation of ice on the propeller leading edges, cuffs (figure beside), and spinner reduces the efficiency of the powerplant system. Deice systems using electrical heating elements and systems using chemical deicing fluid are used.

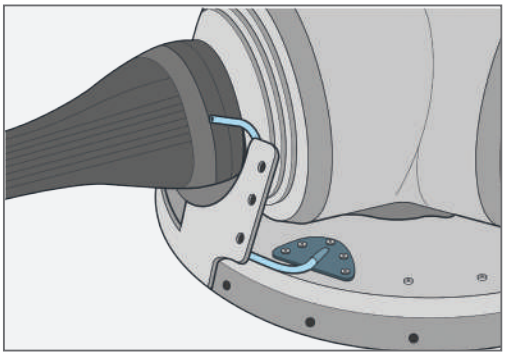


Figura 191 - Bota anti-gelo instalada em uma pá de hélice

- Electrothermal propeller device system - many propellers are deiced by an electrically heated boot on each blade. The centrifugal force of the spinning propeller and air blast breaks the ice particles loose from the heated blades.
- Chemical propeller deice - some aircraft models, especially single-engine GA aircraft, use a chemical deicing system for the propellers. Ice usually appears on the propeller before it forms on the wing.

Tabela 28 - Vocabulário

Inglês	Português	Inglês	Português
Aircrew	Tripulação	*Embedded*	Incrustado
Anti-icing	Antigelo	*Hamper (to)*	Dificultar, impedir
Bulkhead	Bandeja (do spinner)	*Melt (to)*	Derreter
Cuff	Dispositivo na pá da hélice que espalha o fluido degelador sobre a pá	*Slush*	Lama (neve e água)
Deice	Degelo	*Windshield*	Para-brisa
Brush	Escova	*Preflight*	Pré-voo

5.5 Grammar point – passive voice

A voz passiva é utilizada para dar ênfase à ação e não à pessoa que a realiza. Por esse motivo, ela tem destaque em documentos técnicos, em que o importante é orientar ou mostrar como um procedimento deve ser realizado. O verbo de uma frase na voz passiva apresenta a seguinte estrutura:

Verbo To be + verbo principal no particípio

Each aircraft engine is designed to burn a certain fuel.

As preposições *by*, *from* e *to* são muito utilizadas na voz passiva.

- The elements are controlled by a sequence timer in a deice controller.
- An antifreeze solution is pumped from a reservoir.
- Fuel valves are used to shut off fuel flow or to route the fuel to a desired location.

Uma das maiores dificuldades ao utilizar a voz passiva é distinguir o particípio dos verbos a serem utilizados. Os verbos em inglês são divididos em regulares e irregulares, sendo que os regulares apresentam uma regra simples para formar o particípio.

A regra geral é acrescentar -ed ao verbo. Em alguns casos, existem outras mudanças, como se verifica na tabela a seguir.

Tabela 29 - Verbos regulares

Base form	Participle
Move	Moved
Control	Controlled
Fix	Fixed
Land	Landed
Repair	Repaired
Use	Used

Contaminants: são impurezas que contaminam o combustível de aviação, as quais devem ser evitadas. Podem ser líquidas, sendo a água o exemplo mais comum; sólidas, como resíduos de materiais externos e de corrosão nos tanques integrais externos e de corrosão nos tanques integrais; além dos microorganismos que se multiplicam na interface do combustível com a água.

5.6 Good practices in maintenance

Checking for fuel system contaminants

Continuous vigilance is required when checking aircraft fuel systems for contaminants. Daily draining of strainers and sumps is combined with periodic filter changes and inspections to ensure fuel is contaminant free. Keeping a fuel system clean begins with an awareness of the common types of contamination. Water is the most common. Solid particles, surfactants, and microorganisms are also common.

The presence of microorganisms in turbine engine fuels is a critical problem. There are hundreds of varieties of these life forms that live in free water at the junction of the water and fuel in a fuel tank. They form a visible slime that is dark brown, grey, red, or black in color.

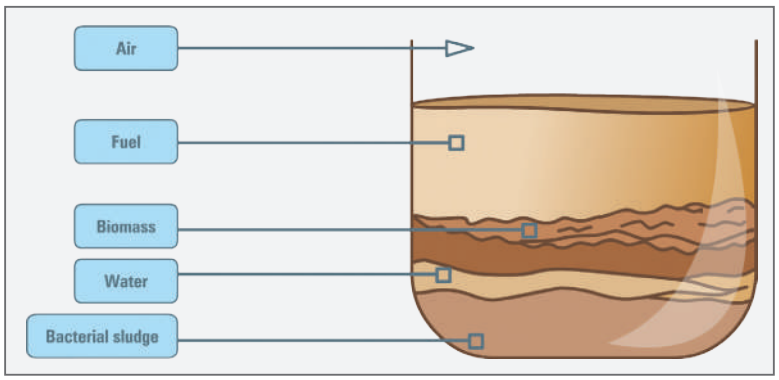


Figura 192 - Amostra de combustível com presença de micro-organismo

This microbial growth can multiply rapidly and can cause interference with the proper functioning of filter elements and fuel quantity indicators. Moreover, the slimy water/microbe layer in contact with the fuel tank surface provides a medium for electrolytic corrosion of the tank.

The presence and level of microorganisms in a fuel tank can also be measured with a field device. The test detects the metabolic activity of bacteria, yeast, and molds, including sulfate reducing bacteria, and other anaerobe microorganisms. This could be used to determine the amount of anti-microbial agent to be added to the fuel.

Tabela 30 - Vocabulário

Inglês	Português	Inglês	Português
Electrolytic	Eletrolítico	*Sludge*	Borra, sedimento oleoso
Growth	Crescimento expansão	*Surfactant*	Tensoativo (modifica a tensão superficial do líquido)
Slimy	Viscoso		

Resumindo

Foram apresentados termos e conceitos empregados em textos técnicos sobre sistemas de pressurização e ar-condicionado de aeronaves, sistemas de combustível utilizados em aeronaves equipadas com motores alternativos, sistemas de degelo e antigelo, bem como as principais fontes de contaminação de combustíveis de aeronaves.

Foram abordados também diversos itens que integram esses sistemas e algumas normas gramaticais da Língua Inglesa.

Capítulo 6
Tools and safety equipments

As ferramentas e equipamentos utilizados na manutenção e reparação de itens das aeronaves visam a facilitar a realização de tarefas que exigem força física, rapidez, precisão e adaptabilidade. Antes de utilizar qualquer ferramenta, é preciso ter o conhecimento da forma correta de sua utilização da mesma, evitando futuros danos ao material a ser reparado.

Esta recomendação deve ser seguida, pois na aviação existem ferramentas específicas para trabalhos que fogem ao senso comum. Além de ter o conhecimento do serviço a ser realizado, é necessário saber as normas de segurança e utilizar os equipamentos de proteção adequados para qualquer ocasião dentro da área de manutenção.

6.1 Power and hand tools

Hand tools: ferramentas manuais são largamente utilizadas nas atividades de manutenção aeronáutica. Dentre elas estão alicate, chave de fenda, martelo, punção, serra manual, entre tantas outras.

The satisfactory performance of an aircraft requires continuous maintenance of aircraft structural integrity. It is important that metal structural repairs be made according to the best available techniques because improper repair techniques can pose an immediate or potential danger. The reliability of an aircraft depends on the quality of the design, as well as the workmanship used in making the repairs. The tools below help the technician to perform this kind of maintenance.

a) Metal cutting tools - powered and non-powered metal cutting tools available to the aviation technician include various types of saws, grinders and others.

b) Circular-cutting saws cut with a toothed, steel disk that rotates at high speed. Handheld or table mounted and powered by compressed air, this power saw cuts metal or wood.

c) Reciprocating saw - the versatile reciprocating saw achieves cutting action through a push and pull (reciprocating) motion of the blade.

d) Cut-off wheel is a thin abrasive disc driven by a high-speed pneumatic die grinder and used to cut out damage on aircraft skin and stringers.

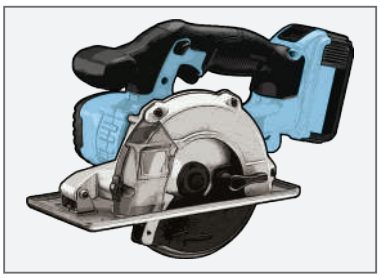


Figura 193 - Serra de corte circular

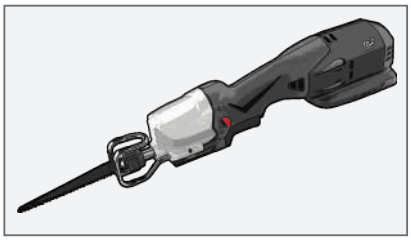


Figura 194 - Serra alternativa

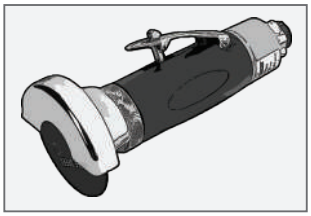


Figura 195 - Serra de corte

e) Grinders are used to sharpen knives, tools, and blades as well as grinding steel, metal objects, drill bits, and tools.

f) Grinding wheel is made of a bonded abrasive and provides an efficient way to cut, shape, and finish metals. Available in a wide variety of sizes and numerous shapes, grinding wheels are also used to sharpen knives, drill bits, and many other tools, or to clean and prepare surfaces for painting or plating.

g) Drills - drilling holes is a common operation in the airframe repair shop. While a small portable power drill is usually the most practical tool for common operations in airframe metalwork, a drill press is sometimes better for other situations.

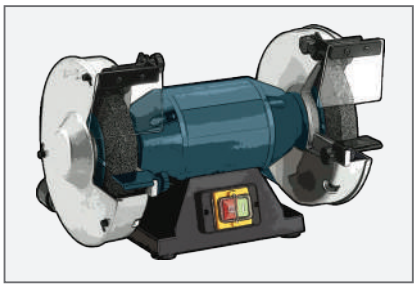


Figura 196 - Esmeril

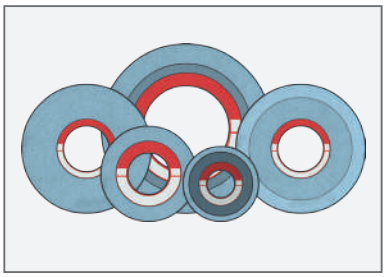


Figura 197 - Rebolo abrasivo

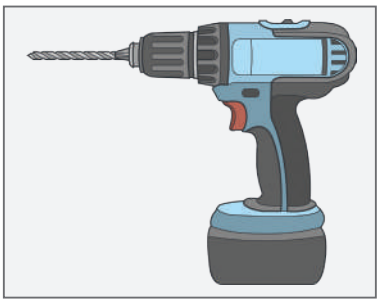


Figura 198 - Furadeira manual pneumática

h) Drill press is a precision machine used for drilling holes that require a high degree of accuracy. The upright drill press is the most common of the variety available.

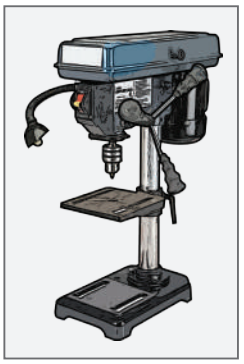


Figura 199 - Furadeira de bancada

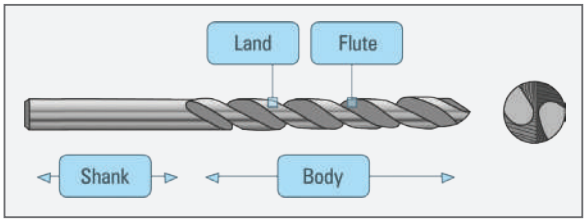


Figura 200 - Broca

When the access to a place where drilling is difficult or impossible with a straight drill motor, various types of drill extensions and adapters are used. Extension drill bits are widely used for drilling holes in locations that require reaching through small openings or past projections. The figure below illustrates the parts of the drill bit.

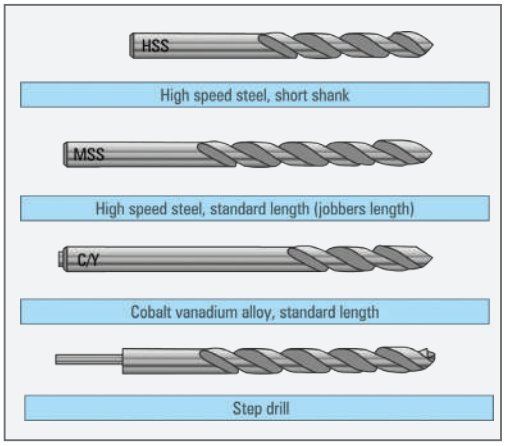


Figura 201 - Tipos de brocas

i) High speed steel (HSS) drill bits come in short shank or standard length, sometimes called jobbers length. HSS drill bits can withstand temperatures nearing the critical range of 1,400 °F without losing their hardness.

j) Hand snips - there are several kinds of hand snips, each of which serves a different purpose. Straight, curved, and aviation snips are in common use. Aviation snips are designed especially for cutting heat treated aluminum alloy and stainless steel. They are also adaptable for enlarging small holes. The blades have small teeth on the cutting edges and are shaped for cutting very small circles and irregular outlines.

k) Hacksaws - the common hacksaw has a blade, a frame, and a handle. The handle can be obtained in two styles: pistol grip and straight.

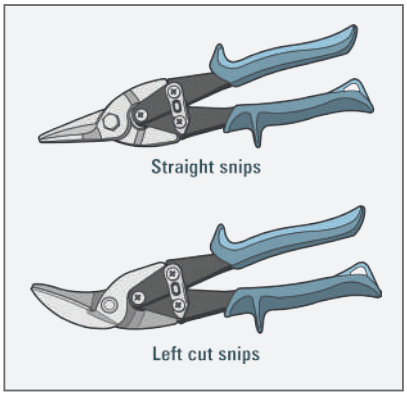


Figura 202 - Tesouras para cortar chapas metálicas

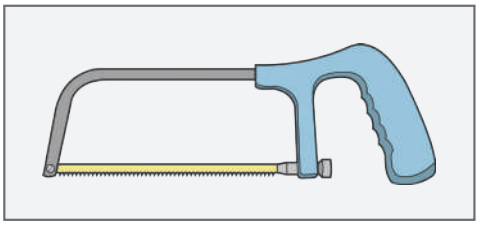


Figura 203 - Serra de arco

l) Scissors are used for cutting various thin materials, such as paper, cardboard, metal foil, thin plastic, cloth, rope, and wire.

m) Chisel is a hard steel cutting tool that can be used for cutting and chipping any metal softer than the chisel itself. It can be used in restricted areas and for such work as shearing rivets, or splitting seized or damaged nuts from bolts.

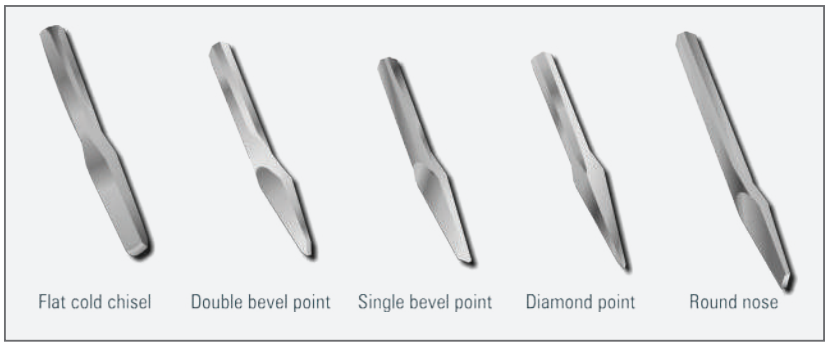


Figura 204 - Formão bedame

n) Files are manufactured in a variety of shapes and sizes. They are used to square ends, file rounded corners, remove burrs and slivers from metal, straighten uneven edges, file holes and slots, and smooth rough edges.

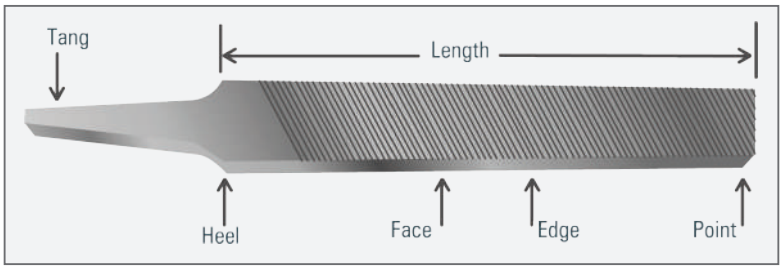


Figura 205 - Lima

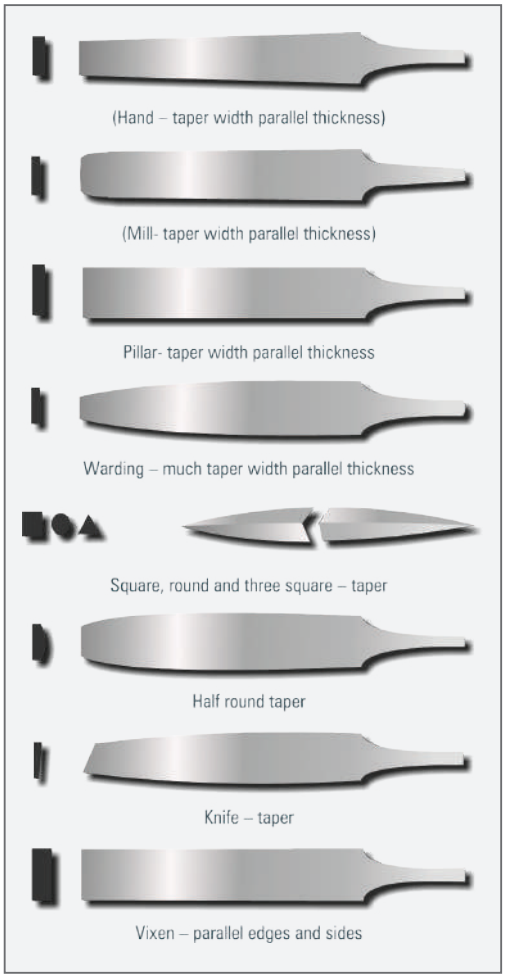


Figura 206 - Tipos de limas mais utilizadas

- hand files are parallel in width and tapered in thickness;
- mill files are usually tapered slightly in thickness and in width for about one-third of their length;
- square files may be tapered or blunt and are double cut;
- round or rattail files are circular in cross section and may be either tapered or blunt and single or double cut;
- triangular and three square files are triangular in cross section;
- half-round files cut on both the flat and round sides;
- warding file - rectangular in section and tapers to narrow point in width;
- knife file - knife blade section;
- vixen files - curved-tooth files are especially designed for rapid filing and smooth finish on soft metals and wood;

o) hand taps are used to cut threads on the inside of a hole. They are made of hard tempered steel and ground to an exact size. Hand taps are usually provided in sets of three taps for each diameter and thread series.

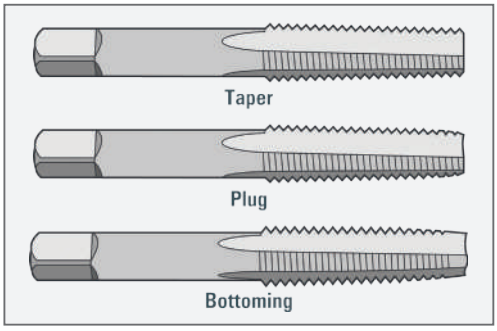


Figura 207 - Macho manual

p) Punches are used to locate centers for drilling circles, to start holes for drilling, to punch holes in sheet metal, to transfer location of holes in patterns, and to remove damaged rivets, pins or bolts. Solid or hollow punches are the two types generally used.

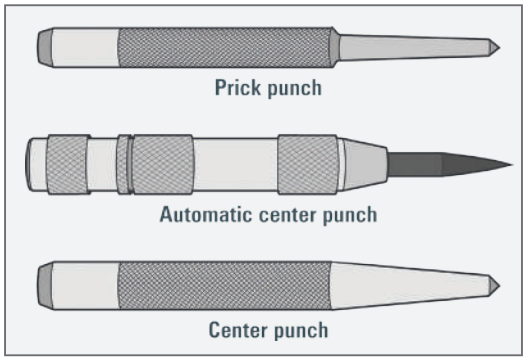


Figura 208 - Punções

- prick punch is primarily used during layout to place reference marks on metal because it produces a small indentation;
- center punch is used to make indentations in metal as an aid in drilling;
- drive punch is made with a flat face instead of a point because it is used to drive out damaged rivets, pins, and bolts that sometimes bind in holes;
- pin punch typically has a straight shank characterized by a hexagonal body;
- transfer punch - a transfer punch uses a template or existing holes in the structure to mark the locations of new holes.

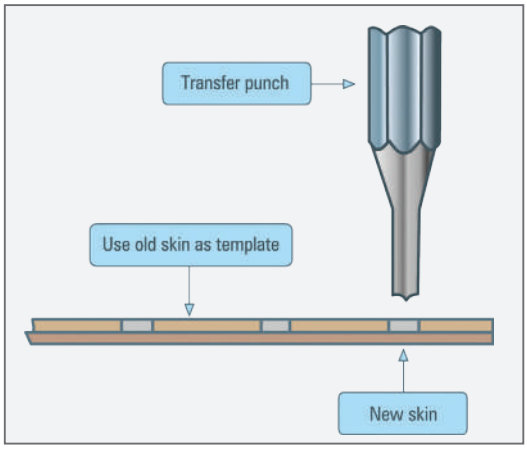


Figura 209 - Punção de transferência

Tabela 31 - Vocabulário

Inglês	Português	Inglês	Português
Bevel	Chanfrado, cônico	*Knife file*	Lima com lâmina de faca
Blunt file	Lima paralela	*Mill files*	Groza
Bottoming	Macho de acabamento	*Plating*	Banho, revestimento
Chipping	Raspagem, desbastar	*Plug tap*	Macho semicônico
Chisel	Formão, talhadeira	*Prick punche*	Punção de bico
Cut-off wheel	Disco de corte	*Punche*	Punção
Cutting edge	Aresta de corte, gume	*Rat tail file*	Lima redonda
Die-grinder	Esmerilhadeira	*Rough edge*	Rebarba
Drill press	Furadeira de bancada	*Saw*	Serra
File	Lima	*Scissors*	Tesoura
Flute	Canal, ranhura	*Shearing*	Cisalhamento, corte
Grinder	Esmeril	*Sliver*	Lasca
Grinding wheel	Rebolo de esmeril	*Smooth file*	Lima murça
Hacksaw	Serra de arco	*Snips*	Tesoura de cortar chapas
Hacksaw frame	Arco de serra	*Template*	Gabarito, modelo
Half-round file	Lima meia cana	*Three square files*	Lima triangular
Hand tap	Macho manual	*Upright drill press*	Furadeira de coluna, furadeira de bancada
Handheld	Portátil	*Vixen files*	Lima vixen
Hollow	Oco, núcleo oco	*Warding file*	Lima lanceteira
Jobbers length	Comprimento padrão de trabalho		

6.1.1 General purpose tools

a) Hammer - metal head hammers are usually sized according to the weight of the head without the handle. Occasionally it is necessary to use a soft-faced hammer, which has a striking surface made of wood, brass, lead, rawhide, hard rubber, or plastic. Mallet is a

hammer-like tool with a head made of hickory, rawhide, or rubber. It is handy for shaping thin metal parts without causing creases or dents with abrupt corners.

b) Screwdriver can be classified by its shape, type of blade, and blade length. It is made for loosening or tightening screws or screw head bolts. The two types of recessed head screws in common use are the Phillips and the Reed & Prince.

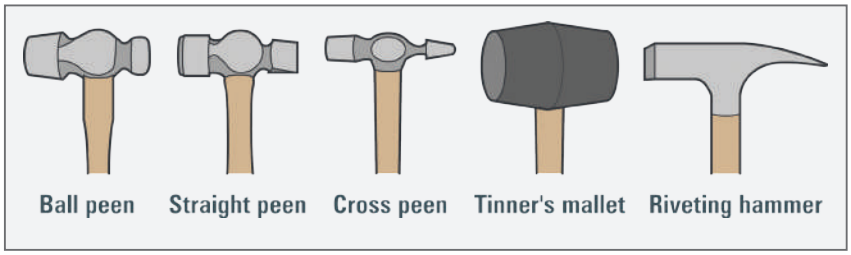


Figura 210 - Martelos e macete

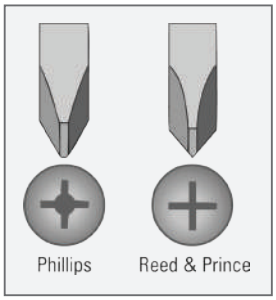


Figura 211 - Tipos de chave de fenda

If the screwdriver is the wrong size, it cuts and burrs the screw slot, making it worthless. A screwdriver with the wrong size blade may slip and damage adjacent parts of the structure.

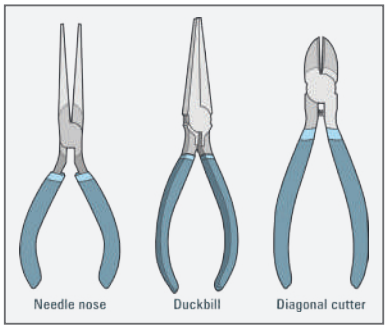


Figura 212 - Alicates

c) Pliers - there are many types of pliers and each one has a specific usage. In aircraft repair work, the most used are the diagonal, needle nose, and duckbill ones. The size of pliers indicates their overall length, usually ranging from 5 to 12 inches.

- diagonal pliers can be used to cut wire, rivets, small screws, and cotter pins, besides being practically indispensable in removing or installing safety wire;
- round nose pliers are used to crimp metal;
- duckbill pliers are used exclusively for twisting safety wire.
- needle nose pliers are used to hold objects and make adjustments in tight places.

d) Wrenches most often used in aircraft maintenance are classified as open-end, box-end, socket, adjustable, ratcheting and special wrenches.

One of the most widely used metals for making wrenches is chrome-vanadium steel. The wrenches are designed to fit a nut, bolt head, or other object, which makes it possible to exert a turning action.

A socket wrench is made of two parts: (1) the socket, which is placed over the top of a nut or bolt head, and (2) a handle, which is attached to the socket. Many

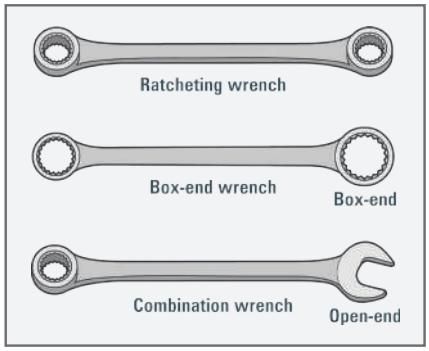


Figura 213 - Chaves

types of handles, extensions, and attachments are available to make it possible to use socket wrenches in almost any location or position.

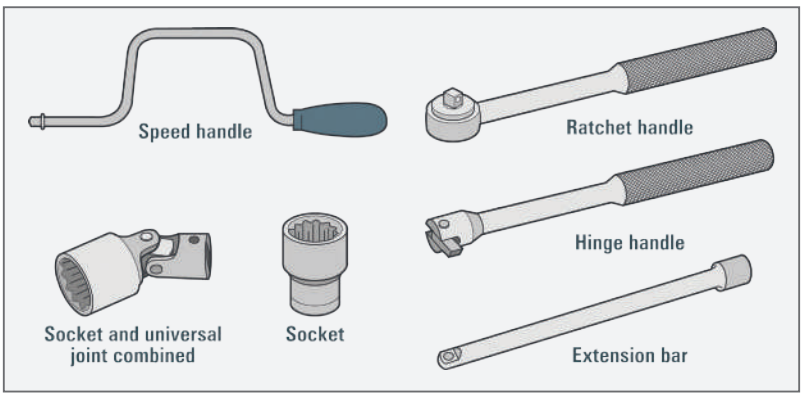


Figura 214 - Conjunto de chave soquete

The category of special wrenches includes the crowfoot, flare nut, spanner, torque, and allen wrenches. The crowfoot wrench is normally used when accessing nuts that must be removed from studs or bolt that cannot be accessed using other tools. The hook spanner is for a round nut with a series of notches cut in the outer edge.

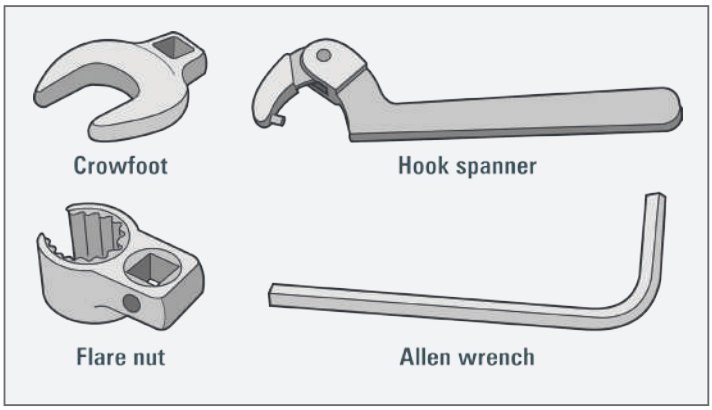


Figura 215 - Chaves especiais

6.1.2 Simple machines

Simple machine is any mechanical device that changes energy to help make tasks easier.

- Lever is considered the simplest machine. There are three basic parts in all levers: the fulcrum "F," a force or effort "E," and a resistance "R."

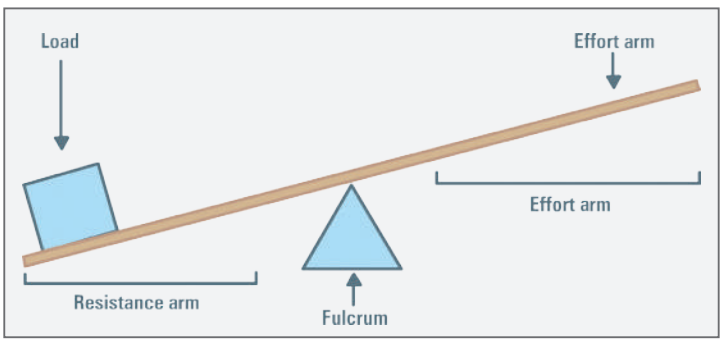


Figura 216 - Alavanca

- Pulleys are simple machines in the form of a wheel mounted on a fixed axis and supported by a frame. The wheel, or disk, is normally grooved to accommodate a rope.

• Wheel and axle - the axle is a rod that goes through the wheel. They help objects to move. The faster the axle is turned, the faster the wheel spins.

• Inclined plane is a simple machine that allows large objects to be raised against the force of gravity, with less work than needed to directly lift the object.

• Wedge is a simple machine made up of two inclined planes put together are used to push two objects apart, or cut an object into pieces. It can also hold objects in place. A wedge gets in between objects and splits it apart. An object like wood can be split apart with a wedge.

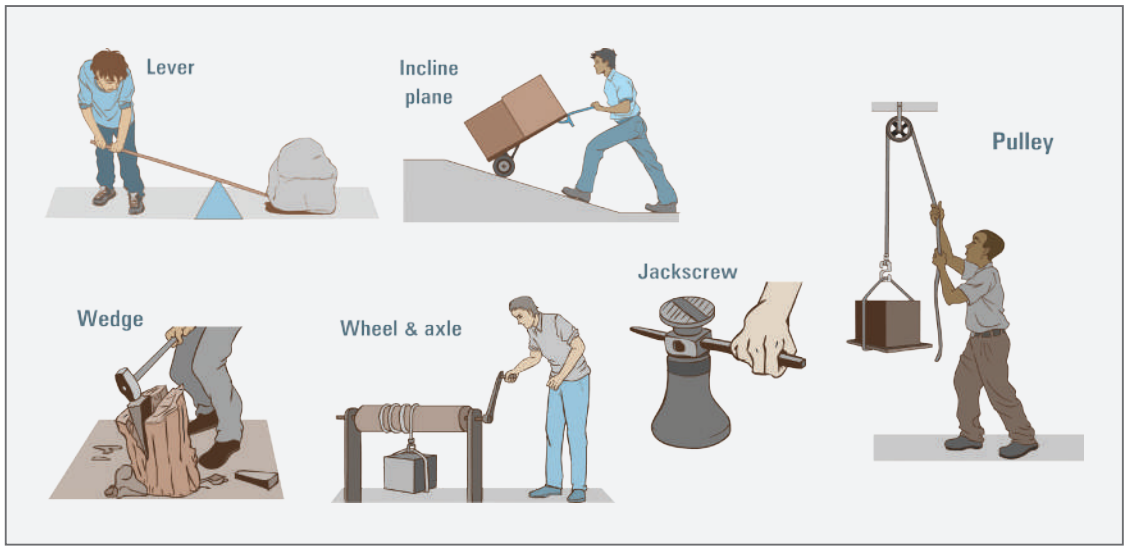


Figura 217 - Máquinas simples

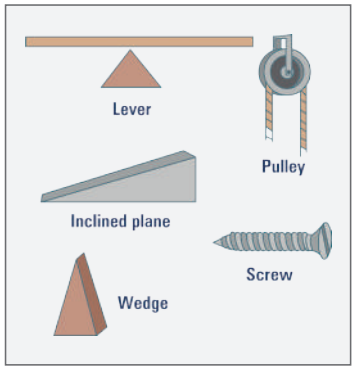


Figura 218 - Parafuso

• Screw is a simple machine made up of another simple machines. It is an inclined plane wrapped around a cylinder. It has two parts. The inclined plane is the thread that wraps around the screw. The cylinder is the long rod. Screws hold down objects and hold them together. They can be used to press or crush objects too.

6.1.3 Measuring instruments

Measuring tools are precision tools. They are carefully machined, accurately marked and, in many cases, are made up of very delicate parts. When using these tools, be careful not to drop, bend, or scratch them. It is very important to understand how to read, use, and care for these tools.

• Rules are made of steel and are either rigid or flexible. In aircraft work, the unit of measure most commonly used is the inch. The inch may be divided into smaller parts by means of either common or decimal fraction divisions.

• Scriber is designed to serve the aviation mechanic in the same way a pencil or pen serves a writer. In general, it is used to scribe or mark lines on metal surfaces. The scriber is made of tool steel, 4 to 12 inches long, and has two needle pointed ends. One end is bent at a

90° angle for reaching and marking through holes.

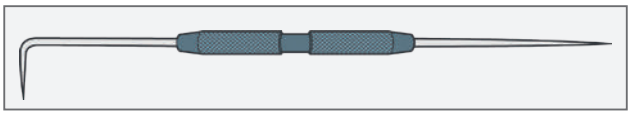


Figura 219 - Riscador

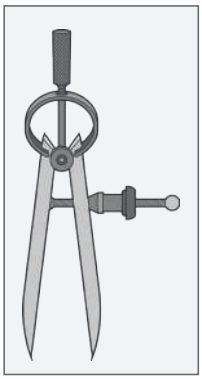


Figura 220 - Riscador de arcos

- Dividers have two legs joined at the top by a pivot. They are used to scribe circles and arcs and for transferring measurements from the rule to the work. Dividers have both legs tapered to needle points.
- Calipers are used for measuring diameters and distances or for comparing distances and sizes. The three common types of calipers are inside, outside, and hermaphrodite calipers, such as gear tool calipers.

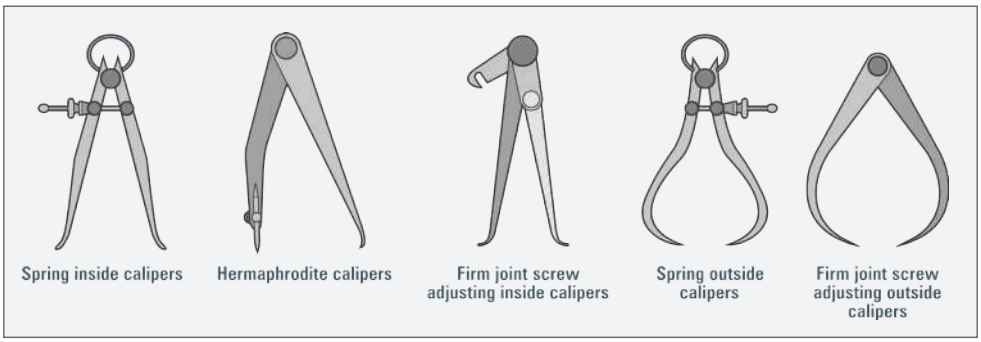


Figura 221 - Compasso de calibre

- Micrometers - the smallest measurement which can be made with the use of the steel rule is one sixty-fourth of an inch in common fractions, and one-hundredth of an inch in decimal fractions. To measure more closely than this (in thousandths and ten-thousandths of an inch), a micrometer is used.

  There are four types of micrometer calipers, each designed for a specific use: outside micrometer, inside micrometer, depth micrometer, and thread micrometer. They are available in a variety of sizes and some of them are equipped with electronic digital liquid crystal display (LCD).

- Feeler gauge is a type of measuring tool consisting of strips of precision-ground steel of accurately measured thickness. They are a bunch of fine thickened steel strips with marked thickness which are used to measure gap width or clearance between surface and bearings.

Feeler gauge: calibrador de folgas. Utilizado quando é necessário deixar uma determinada folga entre dois componentes. É composto por uma série de lâminas com espessuras precisas.

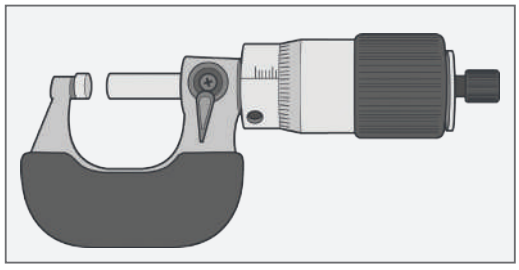


Figura 222 - Micrômetro

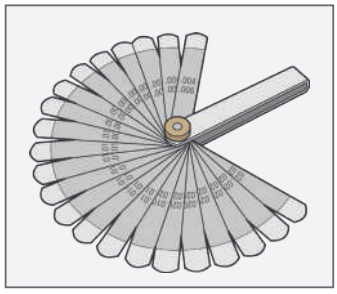


Figura 223 - Calibre apalpador ou calibrador de folga

- Steel tape is a flexible ruler. It consists of a ribbon of metal strip with linear-measurement markings.
- Screw-pitch gauges are used to determine the pitch or lead of a screw thread.
- Thickness gages are switchable from metric reading to inch reading. The figure beside is a digital thickness gage.

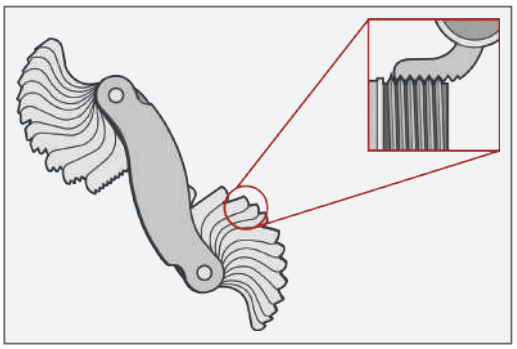


Figura 224 - Calibrador de roscas

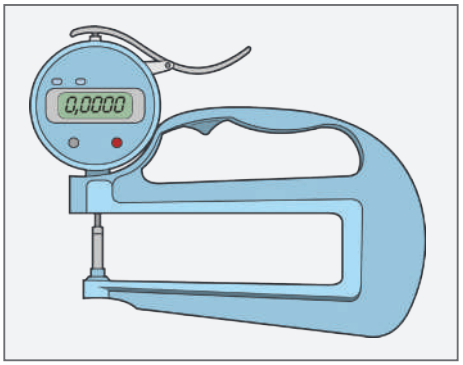


Figura 225 - Medidor de folga digital

- Multimeter is a general purpose instrument that measures voltage (voltmeter), current (Ammeter) and resistance (Ohmmeter). They can be analog or digital. Another electronic measuring equipment is the oscilloscope. It is used to display the waveform of a signal.

Electric ground power units: equipamentos móveis que fornecem energia elétrica em solo para a partida das aeronaves que não possuam unidade de potência (energia) auxiliar ou fonte de força auxiliar. Também é conhecida como APU, do termo *Auxiliary Power Unit* e pode ser usada por uma questão de economia de combustível.

Multimeter: multímetro é um instrumento de medição eletrônico que combina várias funções de medição em um único equipamento. Um multímetro típico é capaz de medir tensão, corrente e resistência de um circuito.

Oscilloscope: osciloscópio. Instrumento de medida eletrônico que cria um gráfico bidimensional visível de uma ou mais diferenças de potencial. O eixo horizontal do monitor normalmente representa o tempo, tornando o instrumento útil para mostrar sinais periódicos. Ele permite a visualização e análise, em geral, de sinais de tensão na forma de um gráfico em função do tempo. Pode ser do tipo digital ou analógico.

6.1.4 Ground support equipment

- Electric ground power units vary widely in size and type. However, they can be generally classified by towed, stationary, or self-propelled items of equipment. Some units are mainly for in-hangar use during maintenance. Others are designed for use on the flight line either at a stationary gate area or towed from aircraft to aircraft.

  The stationary type can be powered from the electrical service of the facility. The movable type ground power unit (GPU) generally has an onboard engine that turns a generator to produce power. Some smaller units use a series of batteries. The towed power units vary in size and range of available power.

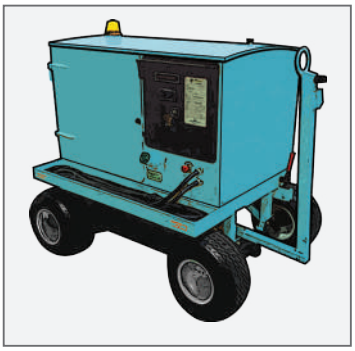


Figura 226 - Unidade de força terrestre

Figura 227 - Unidade de partida pneumática

- Ground support air units are used to provide low pressure (up to 50 psi high volume flow) air which can be used for starting the engines, and heating and cooling the aircraft on the ground (using the onboard aircraft systems). It generally consists of an APU built into the cart that provides bleed air from the APU's compressor for operating aircraft systems or starting engines.
- The MC-1A compressor is an engine-driven air compressor designed to furnish a source of high and low pressure for aircraft servicing.

- Hydraulic ground power units, sometimes called hydraulic mule, provide hydraulic pressure to operate the aircraft systems during maintenance.

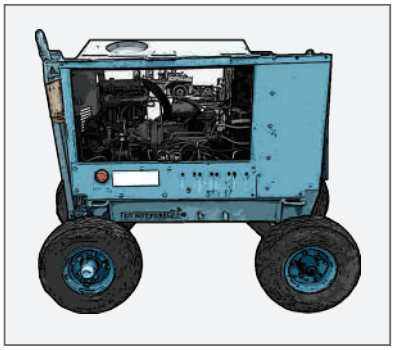


Figura 228 - Unidade móvel de ar comprimido

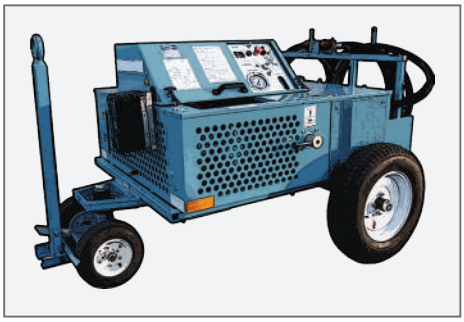


Figura 229 - Unidade de potência hidráulica (mula)

- Portable ground heater keeps cabins and cockpits efficiently heated during short or long durations, keeping personnel, electronics, cargo and customers comfortable. It can be brought to any location, providing portable emergency heat for stranded aircraft. Portable ground heater is also used for heating aircraft hangars and can be moved to a repair location to heat specific areas of a building.
- Aircraft maintenance stands provide ideal safety conditions for maintenance at high aircraft parts. They are essential for the maintenance services for large aircraft.

Aircraft maintenance stands: plataformas de manutenção utilizadas principalmente em aeronaves de grande porte que permitem o acesso seguro às partes altas das aeronaves. Existem diversos tipos de plataformas, conforme a finalidade e o tipo de aeronave apoiada.

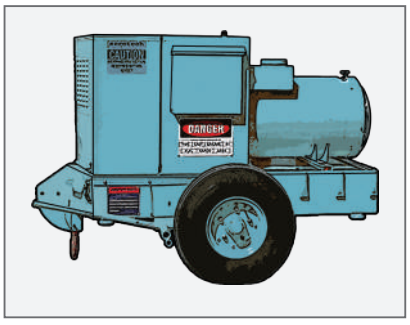


Figura 230 - Unidade móvel de aquecimento

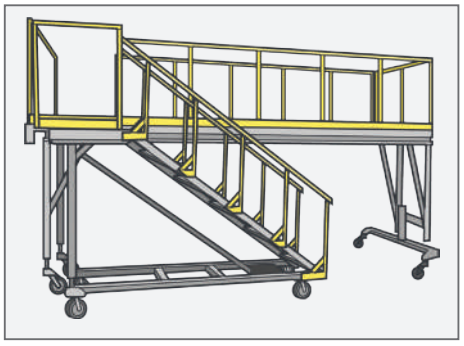


Figura 231 - Plataformas de manutenção de aeronaves

Tabela 32 - Vocabulário

Inglês	Português	Inglês	Português
Adjustable wrench	Chave ajustável	*Open-end wrench*	Chave de boca
Box-end wrench	Chave colar ou estrela	*Oscilloscope*	Osciloscópio
Crease	Vinco, ruga	*Pliers*	Alicate
Aicate universal	Raspagem, desbastar	*Plug tap*	Macho semicônico
Crowfoot	Chave de pé de galinha	*Pulley*	Roldana
Dent	Mossa	*Ratchet*	Catraca
Divider	Riscador de arcos	*Ratcheting wrench*	Chave estrela com catraca
Duckbill pliers	Alicate de bico chato	*Rawhide hammer*	Martelo de couro cru
Feeler gauge	Calibrador de folgas	*Recessed*	Parafuso de fenda phillips

Flare nut wrench	Chave estrela de boca aberta	*Ribbon*	Fita
Fulcrum	Apoio	*Round nose pliers*	Alicate de bico curvo
Ground power unit	Fonte externa de energia	*Rule*	Régua
Hammer	Martelo	*Safety wiring*	Frenagem
Hickory	Nogueira (madeira)	*Screwdriver*	Chave de fenda
Hinge handle	Cabo articulado	*Screw-pitch gauges*	Medidor de rosca
Hook spanner	Chave de gancho	*Scriber*	Riscador
Hydraulic mule	Mula hidráulica	*Speed handle*	Arco de velocidade
Mallet	Macete	*Steel tape*	Trena de aço
Micrometer	Micrômetro	*Striking*	Impacto
Multimeter	Multímetro	*Strip*	Tira, folha
Needle nose pliers	Alicate de bico fino	*Thickness gages*	Calibrador de folgas
Notches	Entalhes	*Thread*	Rosca
		Wedge	Cunha

6.2 Grammar point – units of measurements

As unidades de medida e de dimensão usadas em países como Estados Unidos e Inglaterra nem sempre seguem o mesmo padrão que o utilizado no Brasil. Como esses países são responsáveis pela produção de grande parte dos equipamentos de aviação, é necessário conhecer os padrões de medidas e dimensões utilizados por eles.

Serão mostradas a seguir as principais diferenças.

Tabela 33 - Unidades de medida

Brazil	USA e UK	Examples
Metres and centimetres (metros e centímetros)	Feet and inches (pés e polegadas)	The airplane is 4.80 metres long. The antenna is 6ft tall.
kilometres (quilômetros)	miles (milhas)	The distance to the airport is 40 kilometres. This jet flies 300 miles per hour.
kilograms and grams (quilogramas e gramas)	pounds and ounces (libras e onças)	The weight of the piece is 150 grams. Put 10 ounces of salt here.
litres (litros)	gallons (galões)	Add two litres of oil. I need ten gallons of gas/petrol for my car.

A escolha de qual tipo de medida deve ser utilizada está relacionada com a decisão do país em adotar o sistema métrico (metric) ou não métrico (non-metric) de medidas. No Reino Unido (UK)

e nos Estados Unidos (USA), predomina o uso do sistema não métrico. As tabelas a seguir fazem a correspondência entre esses dois padrões.

Tabela 34 - Relação entre sistema métrico e não métrico

Metric			Non-Metric
Lenght	10 milimetres (mm)	= 1 centimetre (cm)	= 0.394 inch
	100 centimetres	= 1 metre (m)	= 39.4 inches/ 1.094 yards
	1000 metres	= 1 kilometre (km)	= 0.6214 mile
Weight	1000 milligrams (mg)	= 1 gram (g)	= 15.43 grains
	1000 grams	= 1 kilogram (kg)	= 2.205 pounds
	1000 kilograms	= 1 tonne	= 19.688 hundredweight
Capacity	10 mililitres (ml)	= 1 centilitre	= 0.018 pint (0.021 US pint)
	100 centilitres (cl)	= 1 litre (l)	= 1.76 pints (2.1 US pints)
	10 litres	= 1 decalitre (dal)	= 2.2. gallons (2.63 US gallons)

Tabela 35 - Relação entre sistemas não métrico e métrico

Non-Metric			Metric
Lenght	1 inch (in)	-	= 25.4 milimetres
	12 inches	= 1 foot (ft)	= 30.40 centimetres
	3 feet (3ft)	= 1 yard (yd)	= 0.914 metres
	220 yards	= 1 furlong	= 201.17 metres
	8 furlongs	= 1 mile	= 1.609 kilometres
	1760 yards/5280 feet	= 1 mile	= 1.609 kilometres
Weight	437 grains	= 1 ounce (oz)	= 28.35 grams
	16 ounces	= 1 pound (lb)	= 0.454 kilogram
	14 pounds	= 1 stone(st)	= 6.356 kilograms
	8 stone	= 1 hundredweight (cwt)	= 50.8 kilograms
	20 hundredweight	= 1 ton	= 1016.04 kilograms
British capacity	20 fluidounces (fl oz)	= 1 pint (pt)	= 0.568 litre (56.8 cl)
	2 pints	= 1 quart (qt)	= 1.136 litres
	8 pints	= 1 gallon (gal.)	= 4.546 litres (4.55 litres)
American capacity	16 US fluidounces	= 1 USpint	= 0.473 litre
	2 US pints	= 1 US quart	= 0.946 litre
	4 US quarts	= 1 USgallon	= 3.785 litres

A escala de temperatura utilizada no Brasil é a de Celsius ou Centígrado (ºC). Já nos EUA, é utilizada a de Fahrenheit (ºF). Pode-se observar a diferença entre as escalas nos exemplos a seguir:

The temperature is 27 °C today.

In Chicago, it was 86 °F yesterday.

Para converter a escala de Fahrenheit para Celsius, utilizam-se as fórmulas a seguir:

$$86\ °F = ?\ °C$$

a) Subtrair 32 da temperatura em Fahrenheit. ⟶ (86 – 32 = 54)

b) Dividir o resultado por 1,8. ⟶ (54 / 1,8 = 30 °C)

$$86\ °F = 30\ °C$$

Para converter de Celsius para Fahrenheit, utilizam-se as fórmulas a seguir:

a) Multiplicar a temperatura em Celsius por 1,8. ⟶ (30 x 1,8 = 54)

b) Adicionar 32 ao resultado. ⟶ (54 + 32 = 86 °F)

$$30\ °C = 86\ °F$$

Water freezes at a temperature of zero degrees Celsius (0 °C) or thirty-two degrees Fahrenheit (32 °F).

The water boils at a temperature of one hundred degrees Celsius (100 °C) or two hundred and twelve degrees Fahrenheit (212 °F).

Materials and colors

Durante as atividades de manutenção aeronáutica, deve-se estar atento aos materiais trabalhados, que possuem características próprias e podem requerer procedimentos de execução diferentes. Portanto, o técnico deve conhecer muito bem o tipo de material com o qual está trabalhando. Da mesma forma, deve saber identificar as cores que normalmente são utilizadas em manuais técnicos de manutenção.

A seguir, serão mostradas tabelas que apresentam exemplos de materiais compostos utilizados em aeronaves e algumas cores básicas empregadas em textos técnicos.

Tabela 36 - Materiais de aviação

Inglês	Português	Inglês	Português
Aramid fiber	Fibra de aramida	*Graphite*	Grafite
Boron fiber	Fibra de boro	*Para-aramid synthetic fiber*	Fibra de aramida sintética
Carbon fiber	Fibra de carbono	*Phenolic Resin*	Resina Fenólica
Ceramic fiber	Fibra de cerâmica	*Polyester Resin*	Resina de poliéster
Cloth	Tecido	*Polyimides*	Poliimida
Epoxy	Epoxi	*Resin*	Resina
Fiberglass	Fibra de vidro	*Thermoplastic*	Termoplástico
Glass	Vidro	*Vinyl Ester Resin*	Resina ester vinílica

Tabela 37 - Cores

Inglês	Português	Inglês	Português
Amber	Âmbar	*Magenta*	Magenta
Black	Preto	*Orange*	Laranja
Blue	Azul	*Purple*	Roxo
Brown	Marrom	*Red*	Vermelho
Cyan	Ciano	*Violet*	Violeta
Gray	Cinza	*White*	Branco
Green	Verde	*Yellow*	Amarelo
Indigo	Anil		

6.3 Safety equipments and alerts

When working in aircraft areas or the aircraft maintenance, it is important to know all equipment and the signs that indicate hazard. There are specific alerts for each hazard situation.

6.3.1 Shop and flight line fire extinguishers

Performing maintenance on aircraft and their components requires the use of electrical tools which can produce sparks, along with heat-producing tools and equipment, flammable and explosive liquids, and gases. As a result, a high potential exists for fire to occur. Measures must be taken to prevent a fire from occurring and to also have a plan for extinguishing it.

Figura 232.A - Combustíveis Comuns

Figura 232.B - Líquido inflamável

Figura 232.C - Equipamentos elétricos

Figura 232.D - Metais

- Water extinguishers are the best type to use on Class “A” fires. Water has two effects on fire: it deprives fire of oxygen and cools the material being burned. Since most petroleum products float on water, water-type fire extinguishers are not recommended for Class “B” fires.
- Carbon dioxide CO_2 extinguishers are used for Class (**A**), (**B**), and (**C**) fires, extinguishing the fire by depriving it of oxygen. Additionally, like water-type extinguishers, CO_2 cools the burning material.

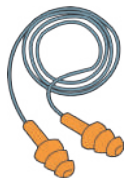
Never use CO_2 on Class (**D**) fires. As with water extinguishers, the cooling effect of CO_2 on the hot metal can cause explosive expansion of the metal.

- Dry powder extinguishers while effective on Class (B) and (C) fires, are the best for use on Class (D) fires. Dry powder is not recommended for aircraft use (except on metal fires as a fire extinguisher) because the leftover chemical residues and dust often make cleanup difficult, and can damage electronic or other delicate equipment.

6.3.2 Personal protective equipment

Commonly referred to as PPE, is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits.

Tabela 38 - Equipamentos de proteção individual

Protective boots		Respirator	
Earmuff		Earplug	
Work glove		Safety goggles	
Reflective clothe		Face shield	

6.3.3 Alerts

Alerts provide information on potential hazards, and proper procedures. They are used in situations from manuals, to descriptions of physical activities.

- Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- Notice is used to address practices not related to physical injury.
- Safety instructions signs indicate specific safety related instructions or procedures.

Figura 233 - Alertas

6.4 Grammar point – dimensions

Para trabalhar com aeronaves, faz-se necessário conhecer alguns termos técnicos referentes às dimensões do avião.

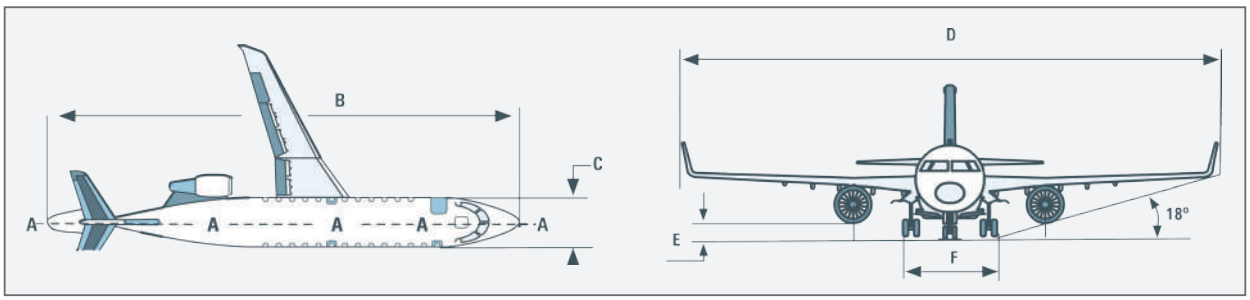


Figura 234 - Dimensões da aeronave

- Aircraft centerline is the central reference axis (A).
- Overall fuselage length is the total length of fuselage (B).
- Fuselage width is the distance from side to side (C).
- Wingspan is the distance from one wing tip to the other (D).
- Ground clearance is the distance from ground to lowest point on aircraft or engine (E).
- Wheel track is the distance between 2 main gears (F).
- Wing area is the surface of wing.

Basicamente, utiliza-se o seguinte vocabulário:

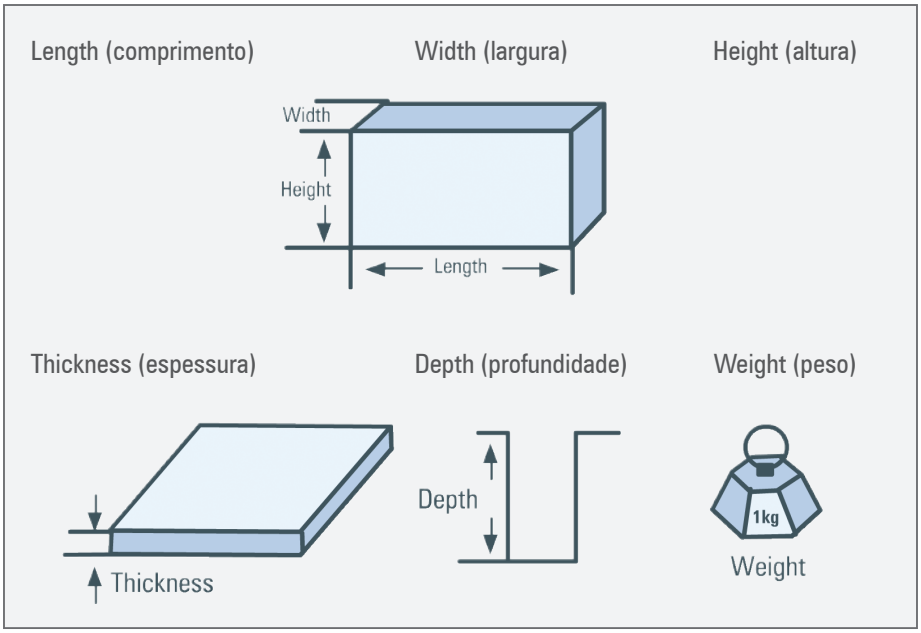


Figura 235 - Dimensões

Deve-se prestar atenção ao sistema de medida utilizado nos manuais dos equipamentos e de procedimentos usados na aviação. Dependendo do caso, será necessário fazer a conversão de um sistema de medida para outro.

6.5 Good practices in maintenance

A manutenção das aeronaves é realizada de forma periódica e de acordo com as indicações de falhas que os computadores da aeronave acusam. Outra forma é pelo relatório que o piloto preenche após cada voo. Além disso, a aeronave é inspecionada de acordo com o número de horas de voo realizadas. Mesmo que os itens não apresentem falhas ou defeitos, eles serão inspecionados se alcançarem o número de horas de voo estipulado pelo fabricante. Estas ações preventivas são vitais para a segurança do voo.

Nas inspeções não periódicas, são executados reparos extraordinários, como panes nos sistemas, colisões com objeto fixo, colisões com aves, etc.

Damage and defects inspection

Visual inspection is very important during maintenance services on aircraft and equipment for checking possible damages and defects.

- Corrosion - loss of metal from the surface by chemical or electrochemical action. The corrosion products generally are easily removed by mechanical means. Iron rust is an example of corrosion.
- Crack - a physical separation of two adjacent portions of metal, evidenced by a fine or thin line across the surface caused by excessive stress at that point.

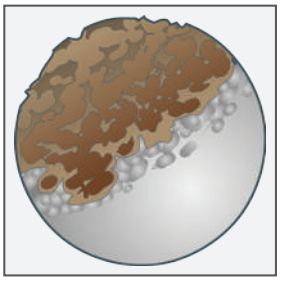


Figura 236 - Corrosão

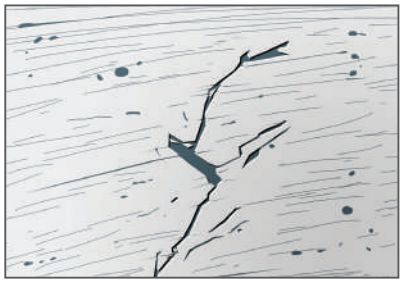


Figura 237 - Amostra de uma peça com rachadura

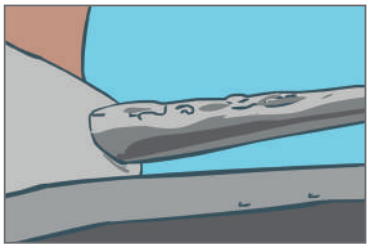


Figura 238 - Mossas no bordo de ataque do estabilizador horizontal

- Cut - loss of metal, usually to an appreciable depth over a relatively long and narrow area, by mechanical means, as would occur with the use of a saw blade, chisel, or sharp-edged stone striking a glancing blow.
- Dent - indentation in a metal surface produced by an object striking with force. The surface surrounding the indentation is usually slightly upset.

- Erosion - loss of metal from the surface by mechanical action of foreign objects, such as grit or fine sand. The eroded area is rough and may be lined in the direction in which the foreign material moved relative to the surface.
- Nick - local break or notch on an edge. Usually it involves the displacement of metal rather than loss.

Figura 239 - Fuselagem com mossas profundas

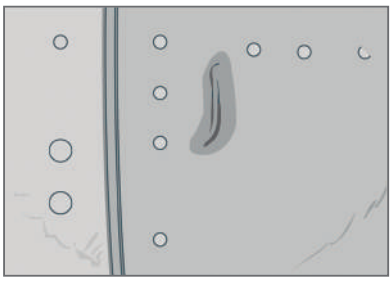


Figura 240 - Fuselagem com a pintura arranhada

- Pitting - sharp, localized breakdown (small, deep cavity) of metal surface, usually with defined edges.
- Scratch - slight tear or break in metal surface from light, momentary contact by foreign material.

Tabela 39 - Vocabulário

Inglês	Português	Inglês	Português
Chemical	Químico	*Hazard*	Risco
Crack	Fissura	*Left over*	Resto, remanescente
Dry powder	Pó químico	*Nick*	Mossa
Earplug	Plugue de ouvido	*Pitting*	Cavidade
Glancing blow	Golpe	*Rust*	Ferrugem
Glove	Luva	*Wheel track*	Bitola
Grit	Areia grossa, abrasivo	*Wingspan*	Envergadura da asa

Resumindo

Neste capítulo, conheceram-se algumas ferramentas manuais e elétricas de extrema importância na vida do mecânico de aeronaves. Analisou-se também o vocabulário técnico de diversos itens que integram os equipamentos de segurança e os tipos mais comuns de alertas, além de serem destacadas as diferenças entre as cores utilizadas no campo da aviação.

Para finalizar, foram vistas as unidades de medidas com as diferenças do sistema métrico e não métrico, utilizados em diversos países. Trabalharam-se as dimensões dos equipamentos, ampliando o vocabulário para compreender os textos técnicos que foram estudados ao longo desta unidade.

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