MECHANICS OF FLUIDS

COURSE CODE: AO307

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Success is when your "signature" changes to "autograp' by- Dr. A P J Abdul Kalam





AIRCRAFT FUEL

- Reciprocating engine fuels
- Turbine engine fuels
 - Jet A– Which is Kerosene
 - Jet B- A blend of kerosene & gasoline
 - Jet A-1 used for operation at extremely low Temperature

Water contaminaion

- *Water contamination in fuel can be in two form
 - Dissolve in the fuel
 - Entrained or suspended
- *Water in fuel can cause icing in the aircraft fuel system usesally in
 - Boost Pump Screens
 - Low pressure filters

Fuel system

- *The purpose of an aircraft fuel system is to store and deliver the proper amount of clean fuel at the correct pressure to the engine
- *Fuel system should provide positive & reliable fuel flow through all phases of flight including
 - Change in altitudes
 - Violent maneuvers
 - Sudden acceletration & deceleration

Fuel system (conti)

- *Fuel system should also continous monitor system opration such as
 - ☐ Fuel pressure
 - ☐ Fuel flow
 - warning singnal
 - ■Tank quantity

Type of fuel system

- Fuel system can be classified in two broad categories
 - ☐ Gravity feed csystem
 - ☐ Pressure feed system

Fuel system component

- Pump
- Tanks
- Lines valves
- Fuel flow meters
- □Filters & stainer
- Quantity indicator
- Warning components
- □Fuel drains
- heaters

Fuel pumps

- *Fuel pumps are used to move fuel through the system than gravity feed is insufficiet.
- *There are three main funtions of fuel pumps they are to move fuel.
 - ☐ The tank to the engine
 - One tank to another
 - ☐ The engine back to the tank

Engine fuel system require main pumps and in some system emergincy pumps

*There requiremant depends on the type of engine installed on the aircraft

Reciprocating engine fuel pump requirement

- Reciprocating engines which are not gravity fed require
 - ■At least one main pump for each engine
 - ☐ There pumps must be engine driven
 - ■The pump capacity must capable of providing enough fuel flow for all aperation

Tubine-engine fuelpump requirment

- Turbine engine requirement
 - ✓ At least one main pump for each engine
 - Main pump power supply must be indepndent of all other main pump power supplies
 - Each positive aisplacement main pump must be able to be bypassed

fuel pump classification

- *One way to classify fuel pumps is according to the pumps funtion.
- There classification are
 - ■Boost pump
 - ■Scavenge pump
 - ■Cross-feed pump
- *Another way to classify fuel pump is by then methods of operation
- Those pump are.
 - Vane-type
 - ✓ Variable- volume
 - Centrifugal
 - Ejector

Fuel Tanks

- *Fuel system on different aircraft may use several types of fuel tanks
- The Three basic types of fuel tanks used on aircraft are.

Integal fuel tanks

- Intergral fuel tanks are commonly located in the aircraft wing or fuselage
- There tanks are ones that are built into structure of the aircraft &generally can't be removed
- Integral fuel tanks are formed by the actual structure of the aircraft
- This type ao tanks is used in some light hightperformance aircraft

Rigid removable fuel tanks

- Rigid removable fuel tanks are often made of aluminium component that are welded together
- There tanks are in installed in compartment specifically made for the tanks
- The tank may be held in place with padded straps
- This types of tank is often found on more expensive light aircraft

Bladder type fuel tanks

- Bladder type fuel tank are bassically a reinforced rebberized bag
- There tank are installed in compartment which support thw weight of the fuel
- These tank id held in palce with bottom & slides og the tank
- This type of tank is usually found on light aircraft

<u>Fuel line</u>

- *Fuel lines on aircraft are either made of rigid metal tubing or flexible hose
- Most of the fuel line are the regid type which are usually made of aluminium alloy
- *The flexible hose fuel lines are either made of synthetic rubber or tefton
- *The diameter of tubing used is decided by the engine fuel requirement

<u>Valves</u>

- *Fuel selector valves sre used in aircraft aff system to
 - □Shot off fuel flow
 - □Cross -feed
 - Transfer- fuel
- Selector valves may be operated manually or electrically depending on the installation

Flighters and strainers

*Fuel is usually strained at the point in the system

Quantity indicators

- *Mechanical
 - □Inverted float gauge

Fuel subsystem

Some aircraft fuel system allow for fuel

REQUIREMENTS OF FUEL SYSTEM

- All powered aircraft require fuel on board to operate the engine(s).
- Each system must provide an uninterrupted flow of contaminant free fuel regardless of the aircraft's attitude.
- Since fuel load can be a significant portion of the aircraft's weight, a laft cently strong airframe must be designed.
- Varying fuel loads and shifts in weight during maneuvers must not negatively affect control of the aircraft in flight.

- The ability of the fuel system to provide fuel at a rate of flow and pressure sufficient for proper engine operation is vital in aircraft.
- Fuel system must deliver the final at the aircraft attitude that is most critical with respect to fuel feed and quantity of unusable fuel.
- Fuel system must be ree from various lack when using fuel at its critical temperature, with respect to varior formation, when operating the airplant in all critical operating and environmenta conditions.
- Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation.

Types of Aviation Fuel

- Each aircraft engine is designed to burn a certain fuel
- There are two basic types of fuel discussed in this section:
- reciprocating-engine fuel (also known as gasoline or AVEAS) and turbine-engine fuel (also known as jet fuel or

kerosene)

Reciprocating Engine Fuel—AVGAS

- Reciprocating engines burn gasoline, also known as AVGAS.
- It is specially formulated for use in aircraft engines
- AVGAS of any variety is primarily a
 hydrocarbon compound refined from crude
 oil by fractional distillation.
- AVGAS is very volatile and extremely flammable, with a low flash point.

CHARACTERSTICS OF AVGAS

- Volatility: term used to describe how readily a substance changes from liquid into a vapor.
- For reciprocating engines, highly volating fuel is desired.
- Liquid gasoline delivered to the engine adduction system carburetor must vaporize
 in the carburetor to burn in the engine of the
- Fuel with low volatility vapor to acceleration it can use the uneven fuel distribution to the cylinders and excessive dilution of the oil in the crankcase in engines equipped with oil dilution systems.
- However, fuel can also be the manufacture causing detention and vapor lock
- AVGAS is a blend of namerous hydrocarbon compounds, each with different boiling points and volatility. A straight chain of volatile compounds creates a fuel that vaporizes easily for starting, but also delivers power through the acceleration and power ranges of the engine.

- Vapor Lock
- Vapor lock is a condition in which AVGAS vaporizes in the fuel line or other components between the fuel tank and the carburetor.
- This typically occurs on warm days on aircraft with engine-driven fuel pumps that suck fuel from the tanks.
- Vapor lock can be caused by
 - -excessively hot fuel,
 - -low pressure, or
 - -excessive turbulence of the fuel traveling through the fuel system.
- In each case, liquid for paperizes prematurely and blocks the flow of liquid fuel to the carting cor.
- Various steps can be taken to prevent vapor lock. The use of boost pumps located in the fuel tank that force pressurized liquid fuel to the engine is most common.



- Octane ratings and performance numbers are given to fuels to describe their resistance to detonation.
- Fuels with high critical pressure and high octane or performance numbers have the greatest resistance.

Turbine Engine Fuel

- Aircraft with turbine engines use a type of fuel different from that of reciprocating aircraft engines.
- Commonly known as jet keel turbine engine fuel is designed for use in turbine engines and should never be mixed with aviation gasoline or introduced into the fuel system of a reciprocating aircraft engine fuel system.

Characteristics of turbine engine fuels

- The characteristics of turbine engine fuels are significantly different from those of AVGAS.
- Turbine engine fuels are hydroca tion compounds of higher viscosity with much lower volatility and higher bolling points than gasoline.
- In the distillation process from chude of, the kerosene cut from which
 jet fuel is made condend to higher to reture than the naphtha
 or gasoline cuts.
- The hydrocarbon replaces of turbine engine fuels are composed of more carbon than are in AVGAS.
- Turbine engine fuels sustain a continuous flame inside the engine.
 They have a higher sulphur content than gasoline.

Color coded labeling and markings used on fueling equipment.

Fuel Type and Grade	Color of Fuel	Equipment Control Color	Pipe Banding and Marking	Refueler Decal
AVGAS 82UL	Purple	82UL AVGAS	AVGAS 82UL	82UL AVGAS
AVGAS 100	Green	100 AVGAS	AVGAS 100	100 AVGAS
AVGAS 100LL	Blue	100LL AVGAS	AVGAS 100LL	100LL AVGAS
JET A	Colorless or straw	AT I	JET A	JET A
JET A-1	Colorless or straw	##	JET A-1	JET A-1
JET B	Colorless or straw	JET B	JET B	JET B



Small Single-Engine Aircraft Fuel Systems

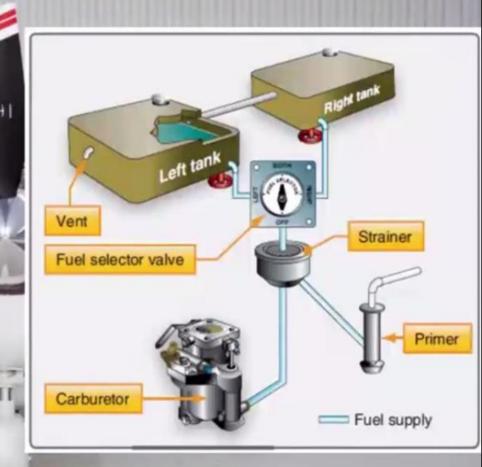
Small single-engine air raft fuel systems vary depending on factors, such as:

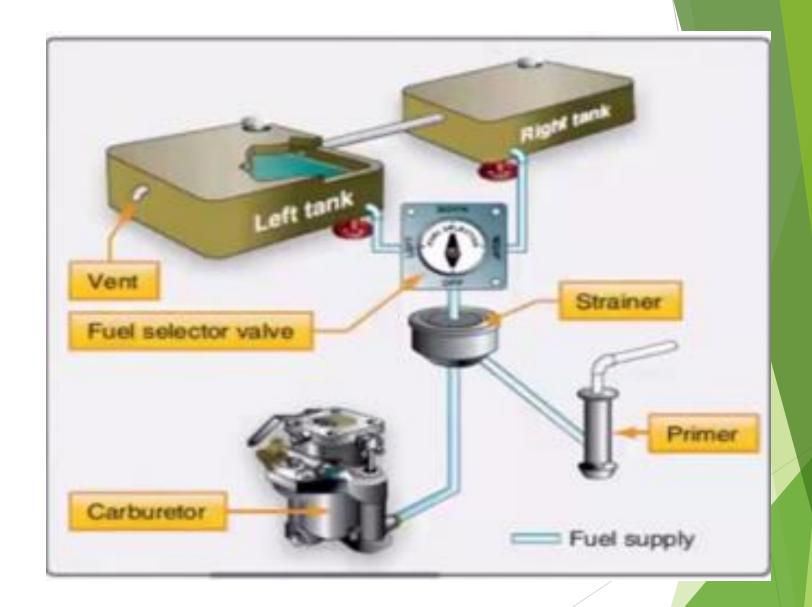
-tank location (high wing aircraft or low wing aircraft)

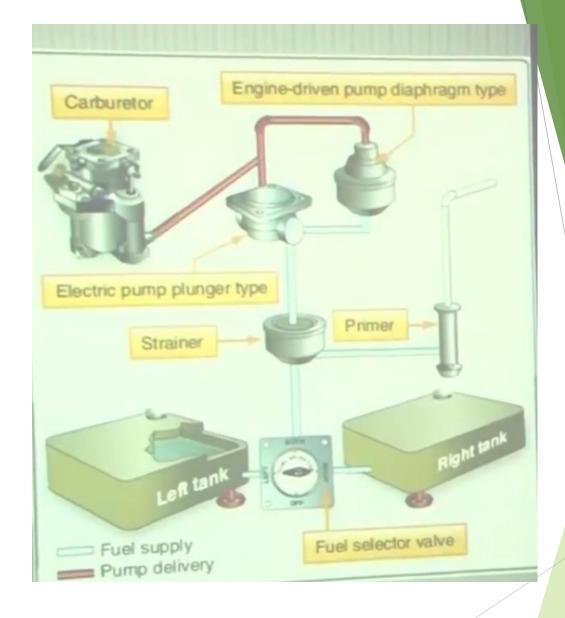
-method of metering fuel to the engine. (engine with a carburetor or with fuel injection)

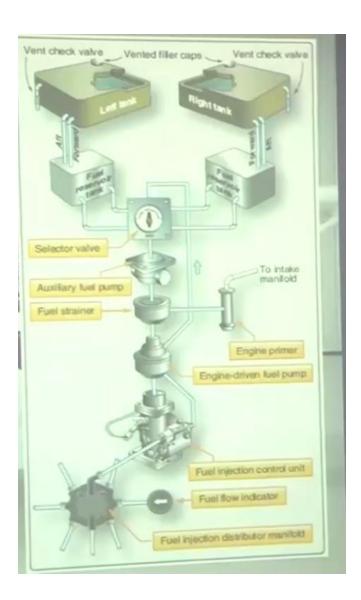
Gravity Feed Systems

- High-wing aircraft with a fuel tank in each wing are common.
- With the tanks above the engine, gravity is used to deliver the fuel
- The space above the liquid fuel vented to maintain atmospheric pressure on the fuel as the tank empties.
- The two tanks are also verted to each other to ensure equal pressure when both tanks feed the engine.
- A single screened outlet on each tank feeds lines that connect to either a fuel shutoff valve or multiposition selector valve.







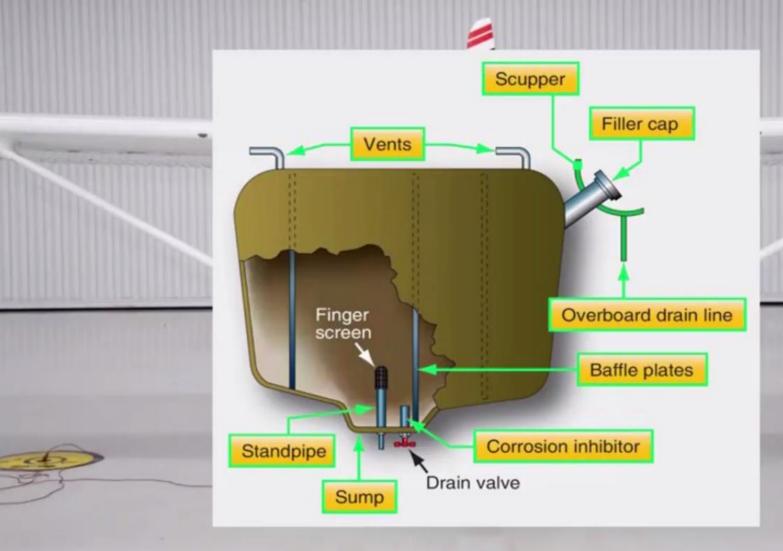


Fuel Tanks

There are three basic types of aircraft the tanks:

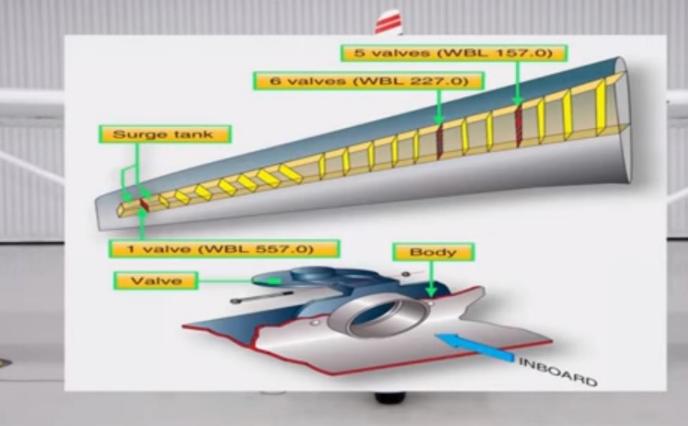
- rigid removable tanks,
- bladder tanks, and
- integral fuel tanks.
- They are typically made to be conted entired through a vent cap or a vent line.
- Aircraft fuel tanks have the call a sump that is designed as a place for contaminant of a water to settle. The sump is equipped with a drain valve used to remove the impurities during prefilent walk-around inspection.
- Most aircraft fuel tanks contain some sort of baffling to subdue the fuel from shifting rapidly during flight.
- The wings are the most popular location forfuel tanks.

Rigid Removable Tanks





Integral Fuel Tanks



Fuel System Servicing

- Maintaining aircraft fuel systems in acceptable condition to deliver clean fuel to the engine(s) is a major safety factor in aziation.
- Personnel handling fuel or maintaining fuel systems should be properly trained and use best practices to ensure that the fuel, or fuel system, are not the cause of an incident or accident.

- Onboard aircraft fuel systems must be maintained and serviced according to manufacurer's specifications.
- Samples from all drains should be taken and inspected on a regular basis.
- Filters should be changed at the specified intervals.
- The fuel load should be visually inspected and tested from time to time or when there is a potential contamination issue.
- Particles discovered in filters should be identified and investigated if needed.
- Inspection of the fuel system during periodic inspections should be treated with highest concern.

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. However, contamination of fuel with another fuel not intended for use on a particular aircraft is possibly the worst type of contamination.

Water

Water can be dissolved into fuel or entrained.

Entrained water can be detected by a cloudy appearance to the fuel. Cloub examination is required

Solid Particle Contaminants

Solid particles that do not dissolve in the fuel are common contaminates. Dirt, rust, dost, metal particles, and just about anything that can find its why into an open fuel tank.

Surfactants

Surfactants are liquid chemical contaminants that naturally occur in fuels. They can also be introduced during the refining or handling processes. These surface active agents usually appear as tan to dark brown much when they are present in large quantities.

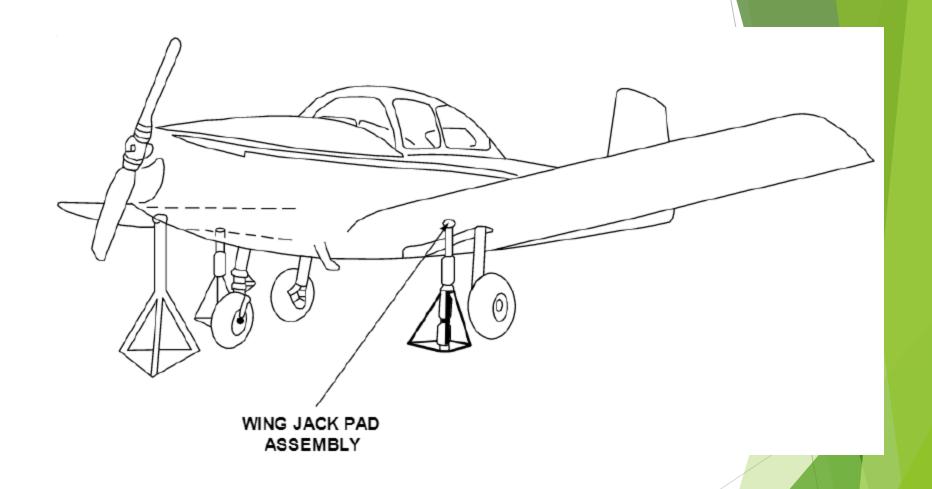
Microorganisms

The presence of microo paras ms in turbine engine fuels is a critical problem. The care 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. This microbial growth can multiply rapidly and can cause interference with the proper functioning of filter elements and fuel quantity indicators.

AIRCRAFT JACKING

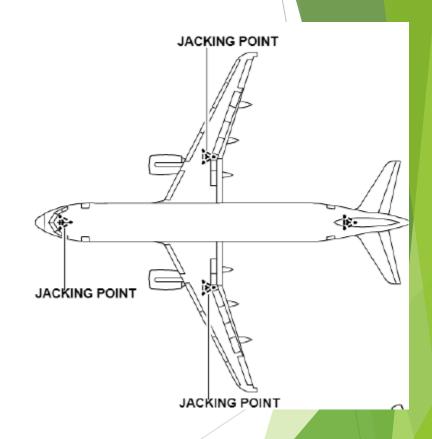
► INTROE

An aircraft may need to be jacked up for a variety of reasons. These include servicing, weighing, changing wheels and undercarriage retraction tests. During jacking operations great care is required to avoid damaging the aircraft. There have been many accidents and they usually occur when the jacking procedures have not been correctly carried out. Jacking should never be dangerous provided that you are always careful.

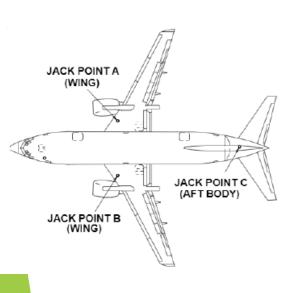


AIRCRAFT JACKING POINTS

- At least three places or points are provided on a all aircraft for jacking process
- Additional places on some aircraft are used to stabilize the aircraft while it is jacked it the main points
- The supports at the additional jack points are often called stabilizing jacks



AIRCRAFT JACKING POINTS



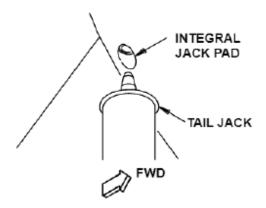
Main jacking points provided in the wings align with either the front or rear spar and those on the fuselage, with strengthened frames. These enable the whole aircraft to be lifted. In addition, jacking points are usually provided at the nose and main undercarriages to allow individual wheels to be changed.

Each jacking point has a load limit, which if exceeded could result in structural damage to the aircraft. To avoid exceeding the load limit, it may be necessary to fit load cells between the jacks and the jacking pads (adapters).



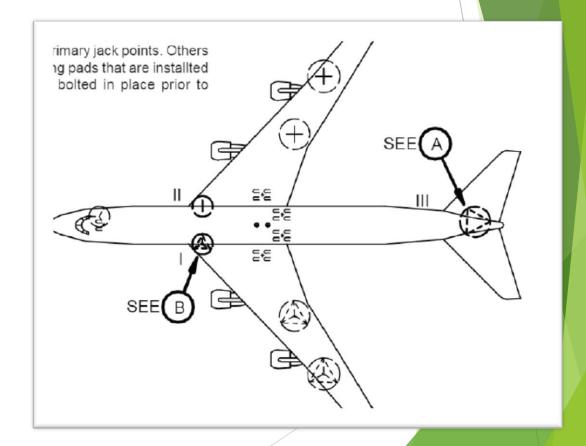
JACKING PADS

- They are two Kinds:
- Fixed or Integral
- Removable



AFT FUSELAGE INTEGRAL JACK PAD (III)





Safety Procedures

Extensive aircraft damage and serious personal injury have resulted from careless or improper jacking procedures. All jacks should have an inspection and test date placard showing when it is next due for overhaul, it must not be used after this date. As an added safety measure, jacks should be inspected before use to determine the specific lifting capacity, proper functioning of safety locks, condition of pins, and general serviceability. Before raising an aircraft on jacks, all workstands and other equipment should be removed from under and near the aircraft. No one should remain in the aircraft while it is being raised or lowered, unless Aircraft Maintenance Manual procedures require such practice for observing levelling instruments in the aircraft.

Jacking

- The aviation technician must be familiar with the jacking of aircraft in order to perform maintenance and inspection.
- ▶ Jacking procedure is vary with aircraft manufacturer maintenance manual must be referred for a particular aircraft.
- Extensive aircraft damage and serious personal injury have resulted from careless or improper jacking procedures.
- ► For safety measure, jacks should be inspected before use to determine the specific lifting capacity, proper functioning of safety locks, condition of pins, and general serviceability

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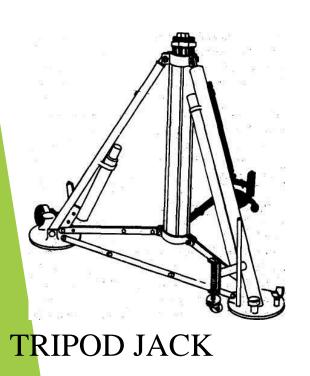
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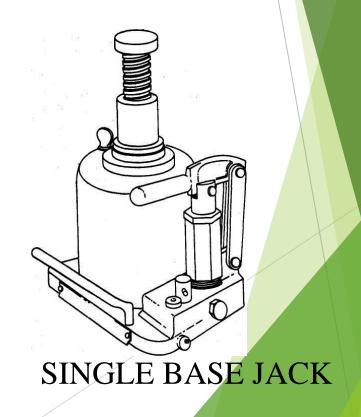
- The aircraft to be jacked must be located in a level position, well protected from the wind. A hangar should be used if possible
- Refer maintenance manual for jack points. These points are usually located in relation to the aircraft center of gravity so the aircraft will be well balanced on the jacks

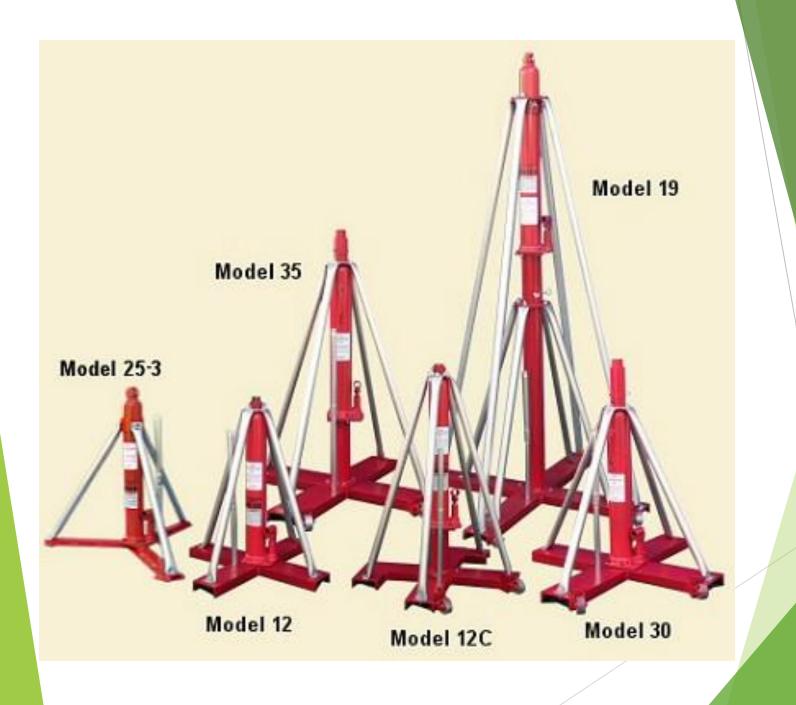
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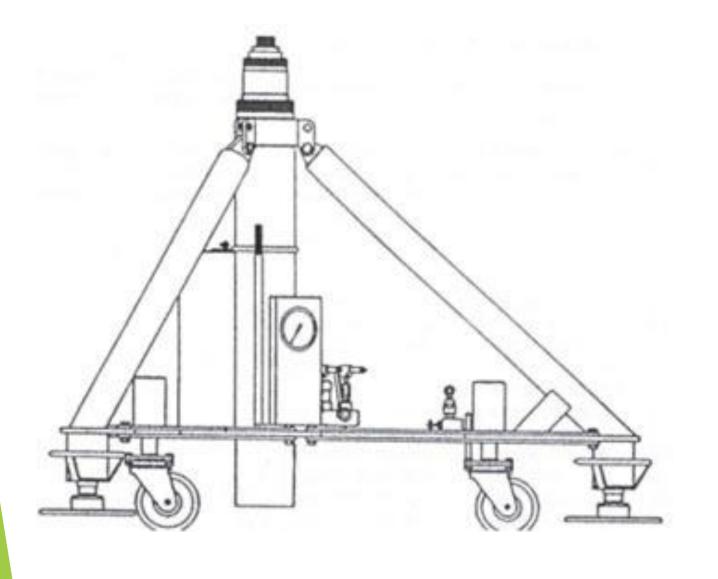
some aircraft it may be necessary to add weight to the nose or tail of the aircraft to achieve a safe balance. Sandbags are usually used for this purpose.

JACKING INSTRUMENTS

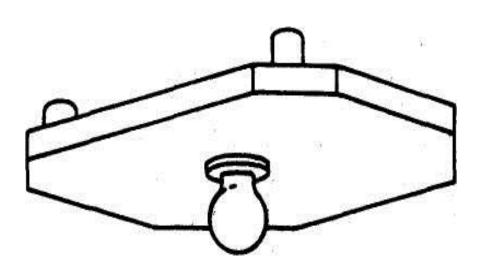








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Wing jack pad assembly



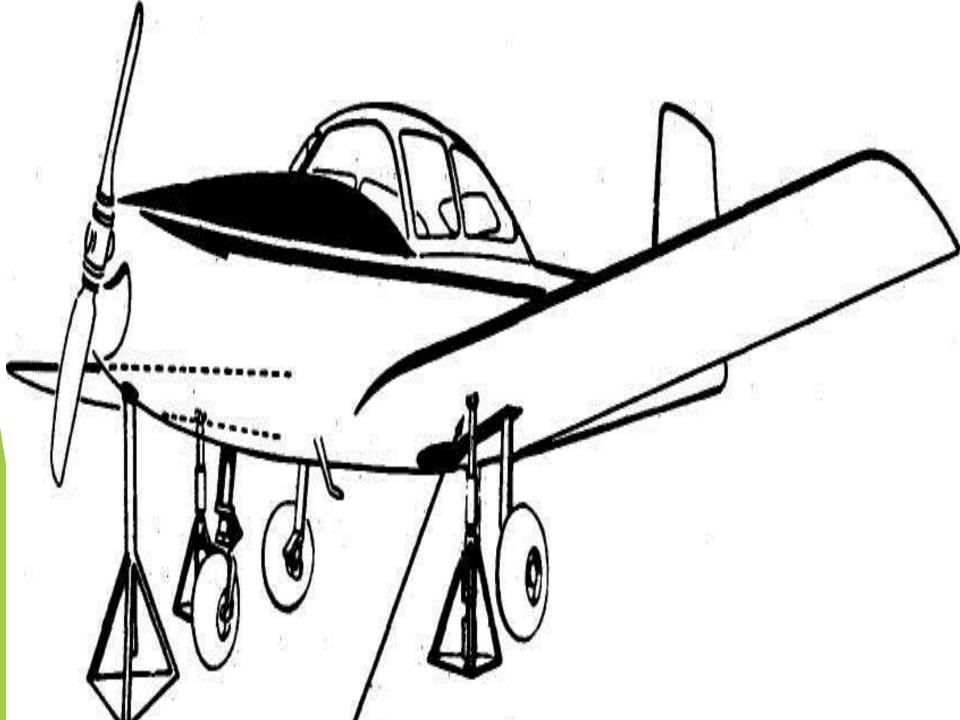
Forward jack fitting

Jacking Complete Aircraft

- Before jacking the aircraft, an overall survey of the complete situation should be made to determine if any hazards to the aircraft or personnel exist.
- Tripod jacks of the appropriate size for the aircraft being jacked should be placed under the aircraft jacking points and perfectly centered to prevent them from cocking when the aircraft is raised
- The legs of the jacks should be checked to see that they will not interfere with the operations to be performed after the aircraft is jacked, such as retracting the landing gear.

cont..

- At least three places or points are provided on aircraft for jacking purposes; a fourth place on some aircraft is used to stabilize the aircraft while it is being jacked at the other three points. The two main places are on the wings, with a smaller one on the fuselage near either the tail or the nose, depending on the landing gear design.
- Most aircraft have jack pads located at the jack points. Others have removable jack pads that are fixed in place prior to jacking. The correct jack pad should be used in all cases.



cont..

- ► There may be equipment or fuel which has to be removed from aircraft before jacking.
- Any critical panel removed from aircraft has to be reloaded before jacking.
- Extend the jacks until they contact the jack pads. A final check for alignment of the jacks should be made before the aircraft is raised, since most accidents during jacking are the result of misaligned jacks
 - When the aircraft is ready to be raised, a man should be stationed at each jack. The jacks should be operated simultaneously to keep the aircraft as level as possible and to avoid overloading any of the jacks.

Cont...

- ▶ Jacks should not be extended beyond the maximum limits.
- The area around the aircraft should be secured while the aircraft is on jacks. Climbing on the aircraft should be held to an absolute minimum, and no violent movements should be made by persons who are required to go aboard.
- Necessary supports should be placed under the fuselage or wings of the aircraft at the earliest possible time, particularly if the aircraft is to remain jacked for any length of time





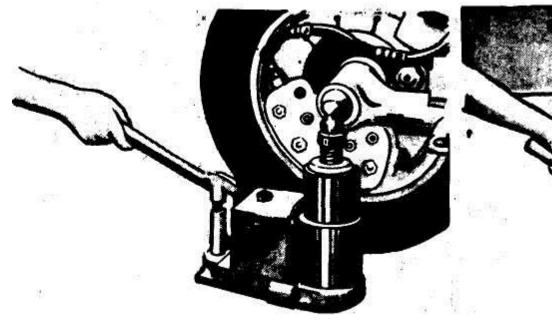
▶ Before releasing jack pressure and lowering the aircraft, make certain that all cribbing, work-stands, equipment, and persons are clear of the aircraft, that the landing gear is down and locked, and that all ground locking devices are properly installed.

Jacking One Wheel of an Aircraft

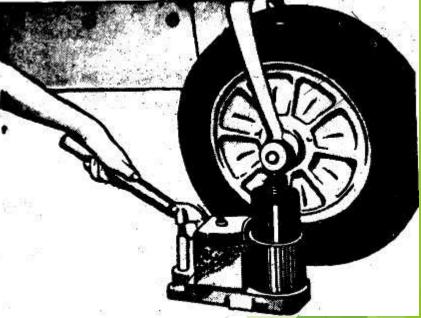
- When only one wheel has to be raised to change a tire or to grease wheel bearings, a low single-base jack is used.
- Before the wheel is raised, the remaining wheels must be chocked fore and aft to prevent movement of the aircraft.

Cont...

▶ If the aircraft is equipped with a tail wheel, it must be locked. The wheel should be raised only high enough to clear the concrete surface.







Nose landing gear jack pad