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INLET

The air entrance is designed to:

- conduct incoming air to the compressor with a minimum energy loss resulting from drag or ram pressure loss;

the flow of air into the compressor should be:

- free of turbulence to achieve maximum operating efficiency.

Proper inlet design contributes materially to aircraft performance by:

- increasing the ratio of compressor discharge pressure to duct inlet pressure.

This is also referred to as the :

- compressor pressure ratio

This ratio is the:

- outlet pressure divided by the inlet pressure.

The amount of air passing through the engine is dependent upon three factors:

1, The compressor speed (rpm).
2, The forward speed of the aircraft.
3, The density of the ambient (surrounding) air.

Turbine inlet type is dictated by the:

- type of gas turbine engine.

high bypass turbofan engine inlet is completely different from a:

- Turboprop or turboshaft inlet.

Large gas turbine powered aircraft almost always have a turbofan engine
The inlet on this type of engine is :

- bolted to the front (A flange) of the engine

modern turbofan engines the huge fan is the first part of the aircraft the incoming air comes into contact with:

- icing protection

This prevents

- chucks of ice from forming on the leading edge of the inlet, breaking loose, and damaging the fan
- Warm air is bled from the engine's compressor and is ducted through the inlet to prevent ice from forming

Turboprops and turboshafts can use an inlet screen to:

- help filter out ice or debris from entering the engine

On military aircraft, the divided entrance permits the use of :

- very short ducts with a resultant small pressure drop through skin friction

Military aircraft can fly at speeds above Mach 1, but :

- the airflow through the engine must always stay below Mach 1

Because Supersonic air flow in the engine would:

- destroy the engine

By using convergent and divergent shaped ducts:

- the air flow is controlled and dropped to subsonic speeds before entering the engine

Supersonic inlets are used to slow the incoming engine air to less than Mach 1 before it enters the engine.

TURBINE ENGINE INLET SYSTEMS (Ho dose it make air straight)

+ First sentence in the Book Define the inlet

Many engines use inlet guide vanes (IGV)

- to help straighten the airflow and direct it into the first stages of the compressor.

uniform and steady airflow is necessary to:

- avoid compressor stall (airflow tends to stop or reverse direction of flow)
- and excessive internal engine temperatures in the turbine section

Normally, the air inlet duct is considered:

- an airframe part and not a part of the engine

the duct is very important to the engine's overall performance and the engine's ability to produce an optimum amount of thrust.

The air entrance passage is correspondingly

- larger

Furthermore, it is more critical in determining

- engine and aircraft performance, especially at high airspeeds

Inefficiencies of the inlet duct result in:

- successively magnified losses through other components of the engine

The inlet varies according to the:

- type of turbine engine

Small Turboprop and turboshaft engines have a:
- lower airflow than large turbofan engines which require a completely different type of inlet

Many Turboprop, auxiliary power units, and turboshaft engines use:
- screens that cover the inlet to prevent foreign object damage (FOD).

FOD:
- forgein object depress

As aircraft speed increases, thrust tends to From the Book
- decrease

as the aircraft speed reaches a certain point:
- ram recovery compensates for the losses caused by the increases in speed.

The inlet must be able to:
- recover as much of the total pressure of the free airstream as possible.

As air molecules are trapped and begin to be compressed in the inlet:
- much of the pressure loss is recovered.

This added pressure at the inlet of the engine increases the
- pressure and airflow to the engine.
- This is known as "ram recovery" or "total pressure recovery."

My statement about the decreased thrust and ram recovery

Understanding Ram Recovery in Aircraft Engines: A Simple Breakdown

1. Thrust and Speed: As an aircraft moves faster, the engine's thrust may slightly decrease.
2. Ram Recovery: At high speeds, the air gets compressed as it enters the engine inlet, helping to recover some of the pressure lost.
3. Pressure Boost: The faster the plane moves, the more air is trapped and compressed, which increases the pressure of air entering the engine.
4. Inlet Efficiency: The inlet is designed to capture as much of the air pressure as possible, helping the engine operate efficiently at high speeds.

In short, ram recovery is the process where compressed air entering the engine improves its performance at high speeds.

inlet duct must uniformly deliver air to the compressor inlet with as little :

- turbulence and pressure variation as possible

The engine inlet duct must also hold the drag effect on the aircraft to a

- minimum

DIVIDED ENTRANCE DUCT

wing root inlet or a scoop at each side of the fuselage.

VARIABLE GEOMETRY DUCT

The main function of an inlet duct is to:

- furnish the proper amount of air to the engine inlet

In a typical military aircraft using a turbojet or low bypass turbofan engine:

- the maximum airflow requirements are such that the Mach number of the airflow directly ahead of the face of the engine is less than Mach 1.

Airflow through the engine must be:

- less than Mach 1 at all times.

To accomplish this, inlet ducts are designed to function as :

- diffusers,
- decreasing the velocity and increasing the static pressure of the air passing through them.

As with mi l itary supersonic aircraft, a diffuser progressively decreases in area in the downstream direction. Therefore, a supersonic inlet duct follows this general configuration until the velocity of the incoming air is reduced to Mach 1. The aft section of the duct then increases in area, since this part must act as a subsonic diffuser.

In practice, inlet ducts for supersonic aircraft follows this general design only as much as practical, depending upon the design features of the aircraft. For very high speed aircraft, the inside area of configuration of the duct is changed by a mechanical device as the speed of the aircraft increases or decreases. duct of this type is usually known as a variable geometry inlet duct

Military aircraft use the three methods described above to diffuse the inlet air and slow the inlet airflow at supersonic flight speeds:

1, vary the area, or geometry
2, bypass arrangement
3, shock wave in the airstream.

1, vary the area, or geometry:

- the inlet duct either by using a movable restriction, such as a ramp or wedge, inside the duct

2, variable airflow bypass arrangement,

- which extracts part of the inlet airflow from the duct ahead of the engine.

meaning (my statement)

- Airflow Extraction: Some of the air entering the inlet duct is extracted or “bypassed” before it gets to the engine’s main combustion chamber. This happens ahead of the engine to control how much air actually enters the engine.

- Why It’s Useful: By controlling how much air enters the engine, the bypass system helps avoid overloading the engine with too much air at high speeds and improves efficiency, engine cooling, and even noise reduction.

3, shock wave in the airstream.

The shock wave results in:

- diffusion of the airflow, which, in turn, decreases the velocity of the airflow

In at least one aircraft installation, both the

- shock method and the variable geometry method of causing diffusion are used in combination

The same device that changes the area of the duct also sets up a:

- shock wave that further reduces the speed of the incoming air within the duct

The amount of change in duct area and the magnitude of the shock are;

- varied automatically with the airspeed of the aircraft

TURBOPROP AND TURBOSHAFT COMPRESSOR INLETS

The air inlet on a Turboprop is more of a problem than some other gas turbine engines because:

- the propeller drive shaft, the hub, and the spinner must be considered in addition to other inlet design factors

The ducted arrangement is generally considered:

- the best inlet design of the Turboprop engine as far as airflow and aerodynamic characteristics are concerned

The inlet for many types of Turboprops are:

- anti-iced by using electrical elements in the lip opening of the intake

Deflector doors are sometimes used to:

- deflect ice or dirt away from the intake.

The air then passes through a screen and into the:

- engine on some models

A conical spinner:

- which does not allow ice to build up on the surface, is sometimes used with Turboprop and turbofan engines

In either event, the arrangement of the spinner and the inlet duct plays an :

- important function in the operation and performance of the engine.

TURBOFAN ENGINE INLET SECTIONS

In dual compressor (dual spool) engines:
- the fan is integral with the relatively slow turning,
- low pressure compressor, which allows the fan blades to rotate at low tip speed for best fan efficiency.

My statement:
In high bypass turbofan engines, the fan is located at the front of the compressor and is connected to the low-pressure compressor. This fan runs at a slower speed to improve efficiency and allows for a simple air inlet design, reducing air losses.

The fan permits the use of a conventional air inlet duct, resulting in low inlet duct loss.

The fan has several benefits:

- It deflects ingested debris away from the engine core, reducing the risk of damage.
- Bleed air (warm air) is used to prevent ice buildup on the inlet and fan hub for safe operation.
- Inside the inlet, rub strips are installed to handle fan blade contact during flight adjustments.
- Sound-reducing materials help lower noise generated by the fan.

The fan on high bypass engines consists of:
- one stage of rotating blades and stationary vanes that can range in diameter from less than 84 inches to more than 112 inches.

The fan blades are either:
- hollow titanium
- composite materials

The air accelerated by the outer part of the fan blades forms a:
- secondary airstream, which is ducted overboard without passing through the main engine

This secondary air (fan flow) produces:
- 80 percent of the thrust in high bypass engines.

The air that passes through the inner part of the fan blades becomes the:
- primary airstream (core flow) through the engine itself

The air from the fan exhaust, which is ducted overboard, may be:
1, To the outside air through short ducts (dual exhaust nozzles) directly behind the fan

2, . Ducted fan, which uses closed ducts all the way to the rear of the engine, where it is exhausted to the outside air through a mixed exhaust nozzle. This type engine is called a ducted fan and the core airflow and fan airflow mix in a common exhaust nozzle.

My statement:
Fan exhaust air in high bypass turbofan engines can be discharged in two ways:

1. Dual Exhaust Nozzles: The fan air is directed outside through short ducts right behind the fan.
2. Ducted Fan: The fan air is guided through long ducts all the way to the back of the engine. There, it mixes with the core engine air and is released through a common exhaust nozzle.

In short, the first method sends fan air out right after the fan, while the second keeps the fan air enclosed until it mixes with the core engine air before exiting.

BELLMOUTH COMPRESSOR INLETS

bellmouth inlet is usually installed on an:
- engine undergoing testing in a test cell

It is generally equipped with probes that with the use of instruments, can measure :
1, intake temperature
2, pressure (total and static).

During testing, it is important that the outside static air is allowed to flow into the engine with as little resistance as possible. The bellmouth is attached to the movable part of the test stand and moves with the engine. The thrust stand is made up of two components, one nonmoving and one moving. This is so the moving component can push against a load cell and measure thrust during the testing of the engine. The bellmouth is designed with the single objective of obtaining very high aerodynamic efficiency. Essentially, the inlet is a bell shaped funnel having carefully rounded shoulders which offer practically no air resistance. Duct loss is so slight that it is considered zero. The engine can, therefore, be operated without the complications resulting from losses common to an installed aircraft inlet duct. Engine performance data, such as rated thrust and thrust specific fuel consumption, are obtained while using a bellmouth inlet. Usually, the inlets are fitted with protective screening. In this case, the efficiency lost as the air passes through the screen must be taken into account when very accurate engine data are necessary

COMPRESSOR INLET SCREENS

The use of a screen in an engine inlet has several advantages and disadvantages:

Advantages:

1. Protection Against Foreign Object Damage (FOD): Inlet screens prevent debris like birds, stones, or other objects from entering the engine, which is crucial for engines with fragile or sensitive components, such as aluminum compressor blades.
2. Increased Engine Lifespan: By filtering out harmful debris, the screen can prolong the life of the engine's internal components, reducing wear and tear.
3. Improved Safety: Preventing large objects from entering the engine can help avoid sudden catastrophic failures or engine stalls, ensuring safer operation.

Disadvantages:

1. Pressure Loss: Screens create an obstruction in the airflow, which can cause a significant drop in pressure across the inlet duct, reducing engine efficiency and performance.
2. Icing Susceptibility: In colder environments, the screen is prone to ice formation, which can block airflow and lead to engine shutdown or failure.
3. Fatigue and Failure Risks: Over time, the screen can suffer from metal fatigue due to constant vibration and airflow, potentially causing it to fail. A failed screen could then become debris itself, causing more damage than if no screen were present.

1. Maintenance Requirements: Screens can require regular inspection and maintenance to ensure they are functioning correctly and are free from debris or ice buildup.

In large turbofan engines having steel or titanium compressor (fan) blades, which:

- do not damage easily, the disadvantages of compressor screens outweigh the advantages, so they are not generally used

ICE PROTECTION

On many turbine aircraft, the engine cowling, fan, spinner, compressor inlet case, guide vanes, and nose dome are equipped with :

- internal passages that permit hot air to circulate for anti-icing purposes

On some Turboprops the warm oil reservoir located within the propeller gearbox, provides :

- some anti-ice capability
- only a minimum of additional hot air flow is needed to keep the inlet area free of ice.

When an anti-icing system is required to provide protection of the engine inlet

- hot bleed air is extracted from the compressor or diffuser from the point in the engine that provides the correct pressure and temperature to keep the engine ice free during both ground and flight operations

Ice can form in the inlet up to

- 5°C in dry air
- up to 7°C in moist air, such as fog or rain.

ANTI-ICING WITH ELECTRONIC ENGINE CONTROL AND FADEC:

Electronic Engine Control (EEC) as part of a

- FADEC system (Full Authority Digital Engine Control),

the anti-icing system will be linked to the

- EEC.

Controlling the flow of anti-icing air, in an infinitely variable manner based on multiple inputs:

- increases the efficiency of the engine

ELECTROTHERMAL ANTI-ICING SYSTEMS

Some smal ler Turboprop and turboshaft engines use

- electric heat strip systems, which are classed as electrothermal anti-icing systems

They are constructed of

- electrical resistance wire embedded in layers of reinforced neoprene materials
- located primarily at the lip of the nacelle inlet.