GAS TURBINE ENGINE

Introduction

- The flow of air into the compressor should be free of turbulence to achieve maximum operating efficiency.
- 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

Inlets also depends upon which type of engine is used. A high-bypass turbofan engine inlet is completely different from a turboprop or turboshaft inlet.

Introduction

- If inlet guide vanes are used to straighten the air flow, then they also have anti-icing air flowing through them.
- Turboprops and turboshafts can use an inlet screen to help filter out ice or debris from entering the engine . A deflector vane and a heated inlet lip are used to prevent ice or large chunks from entering the engine.
- Military aircraft can fly at speeds above Mach 1, but the airflow through the engine must always stay below Mach 1. 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.

- The primary function of inlet duct is to convert the kinetic energy of the rapidly moving airstream into ram pressure rise inside the duct.
- Inlet ducts are rated in to ways;

1)duct pressure efficiency ratio-the ability of the duct to convert the kinetic or dynamic pressure energy at the inlet of the duct into static pressure energy at the inlet of the compressor without a loss in total pressure.

2)Ram recovery point-that speed at which the compressor inlet total pressure is equal to the outside ambient air pressure.

INLET DUCTS

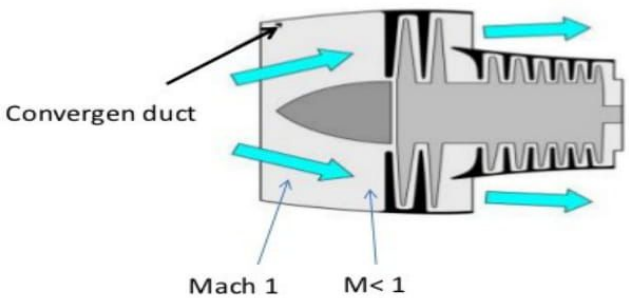
Inlet duct are divided into two categories.

1. Subsonic inlet

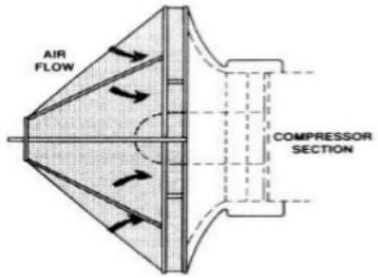
SUBSONIC TYPE INLET

Aircraft speed can up to Mach 1.2

CONVERGEN TYPE INLET

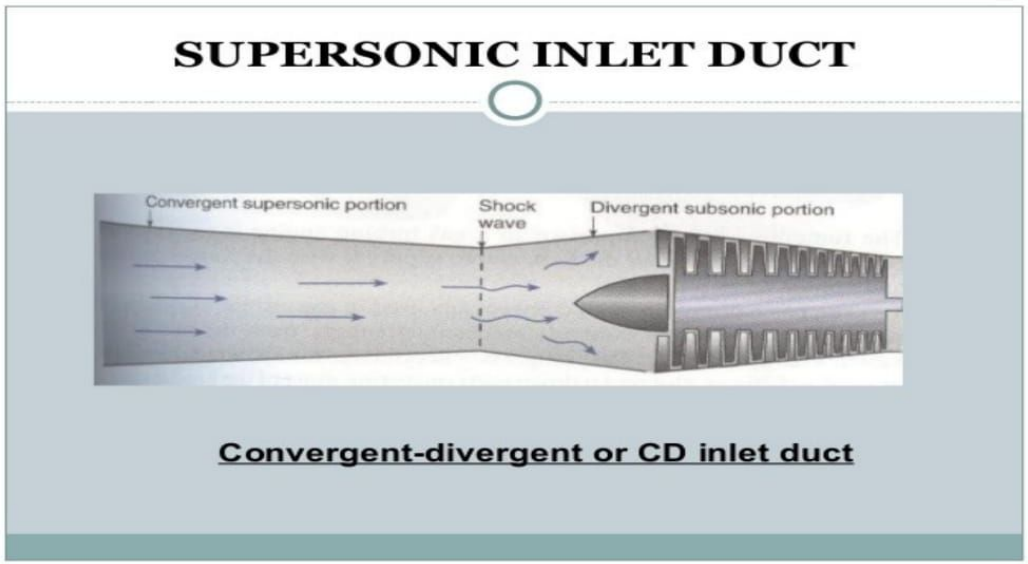


BELLMOUTH INLET (HELICOPTER)



Supersonic inlet

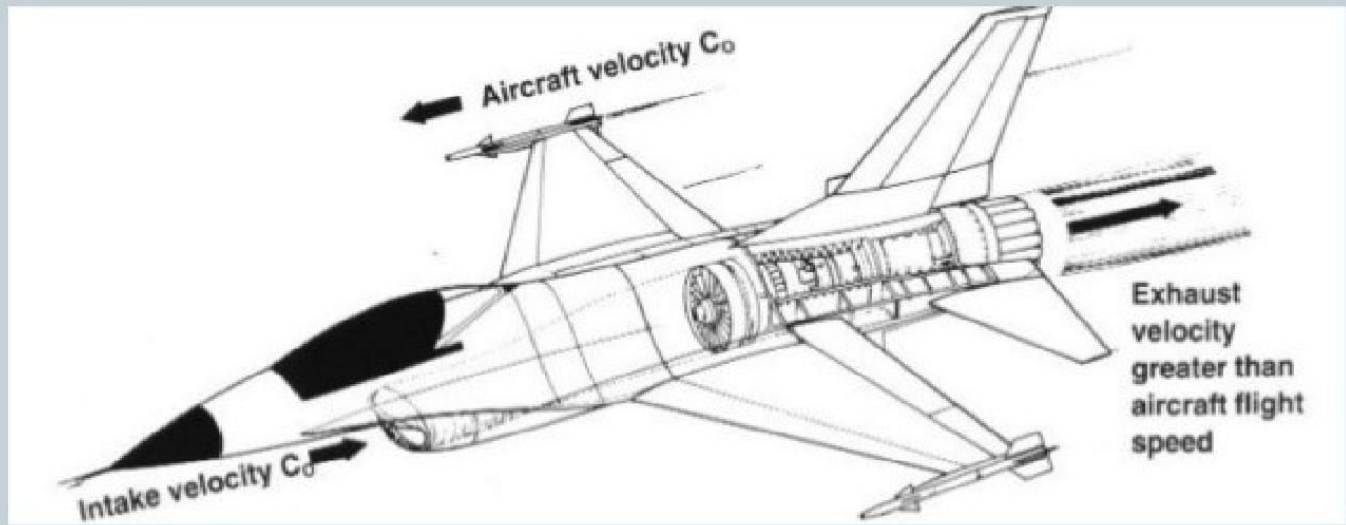
- In supersonic flight, the flow is decelerated by shock waves that can produce a total pressure loss much greater than, and in addition to, the boundar



DIVIDED-ENTRANCE DUCT

- The requirements of high-speed, single or twin engine military aircraft, in which the pilot sits low in the fuselage and close to the nose, render it difficult to employ the older type single-entrance duct, which is not used on modern aircraft.
- This divided duct can be either a wing-root inlet or a scoop at each side of the fuselage.

SINGLE ENTRANCE DUCT



Single entrance duct

AIR INLET DUCTS
SINGLE ENTRANCE DUCT

- Duct inlet is located directly ahead of the engine and aircraft in such a position that it scoops undisturbed air.
- It is either straight configuration or with relatively genital curvatures.
- Due to long shape there is a chance of pressure lost but that is offset by smooth airflow characteristic.
- In multi engine installation a short straight duct results minimum pressure drop.

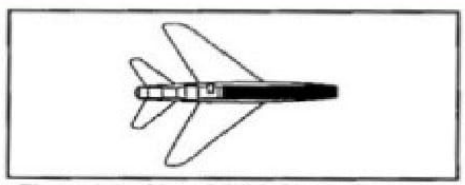


Figure 3-5. Aircraft With Single-Entrance Duct

Divided entrance duct

AIR INLET DUCTS

DIVIDED ENTRANCE DUCT

- It is used in high speed, single engine aircraft where pilot sits low in the fuselage and close to the nose.
- This divided duct can be either a wing root inlet or a scoop at each side of fuselage.
- Create huge amount of drag

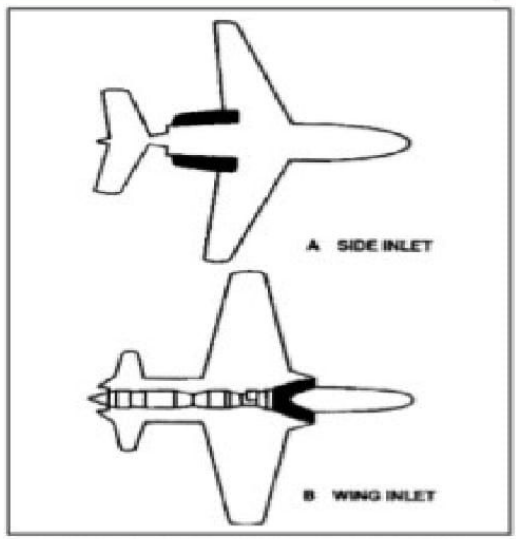
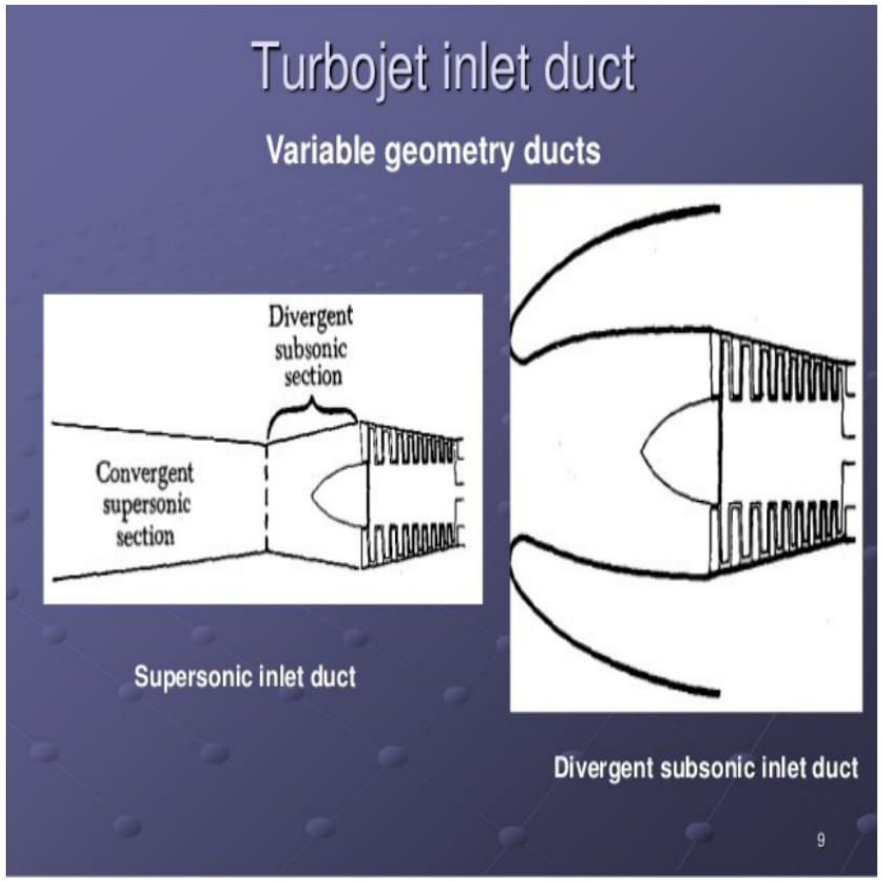


Figure 3-3. Types of Entrance Ducts

VARIABLE-GEOMETRY DUCT

- The main function of an inlet duct is to furnish the proper amount of air to the engine inlet.
- Airflow through the engine must be less than Mach 1 at all times.
- the velocity of the airflow as it enters the air-inlet duct must be reduced through the duct before the airflow is ready to enter the compressor.
- inlet ducts are designed to function as diffusers, decreasing the velocity and increasing the static pressure of the air passing through them.

Image


Turbojet inlet duct
Variable geometry ducts
Divergent subsonic section
Convergent supersonic section
Supersonic inlet duct
Divergent subsonic inlet duct
9

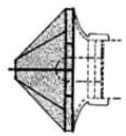
COMPRESSOR INLET SCREENS

- To prevent the engine from readily ingesting any items that can be drawn in the intake, a compressor inlet screen is sometimes placed across the engine air inlet at some location along the inlet duct.
- Screens, however, add appreciably to inlet duct pressure loss and are very susceptible to icing.
- A failed screen can sometimes cause more damage than no screen at all.
- inlet screens are made retractable and may be withdrawn from the airstream after takeoff or whenever icing conditions prevail.

Image

BELLMOUTH COMPRESSOR INLETS

- A bellmouth inlet is usually installed on an engine undergoing testing in a test cell.
- 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.
- The bellmouth is designed with the single objective of obtaining very high aerodynamic efficiency.



Bellmouth Compressor Inlet

COMPRESSORS

INTRODUCTION

- Compressor provide maximum of high pressure air that can be heated in the limited volume of the combustion chamber and then expanded through the turbine.
- Compressor efficiency will determined the power necessary to crate the pressure rise of a given airflow and will effect the temperature change that can take place in the combustion chamber.
- Now a days compressor having pressure ratios over 25:1 and more than 90 percent efficiency.

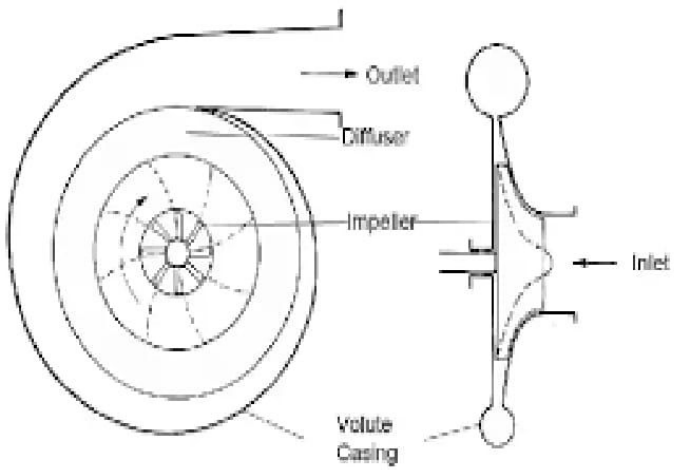
INTRODUCTION

- The primary purpose of the compressor is to increase the pressure of the mass of air entering the engine inlet and discharge it to the diffuser.
- The secondary purpose of the compressor section is to supply engine service bleed air to cool hot section parts to pressurize bearing seals and to supply heated air for inlet anti icing and fuel system heat for deicing.

Types of compressors

- 1.Centrifugal compressor
- 2.Axial flow compressor

CENTRIFUGAL COMPRESSOR



Centrifugal compressor schematic diagram

Centrifugal Compressors

- Receiving its air at the center of the impeller in an axial direction and accelerating the air outward by centrifugal reaction to its rotational speed after that this air is allowed to expand into a divergent duct (diffuser).
- Centrifugal flow compressor consists impeller rotor, a diffuser, and a manifold.
- Impeller is generally made from aluminum alloy or titanium alloy and can be single sided and double sided.