Jet Aircraft Propulsion

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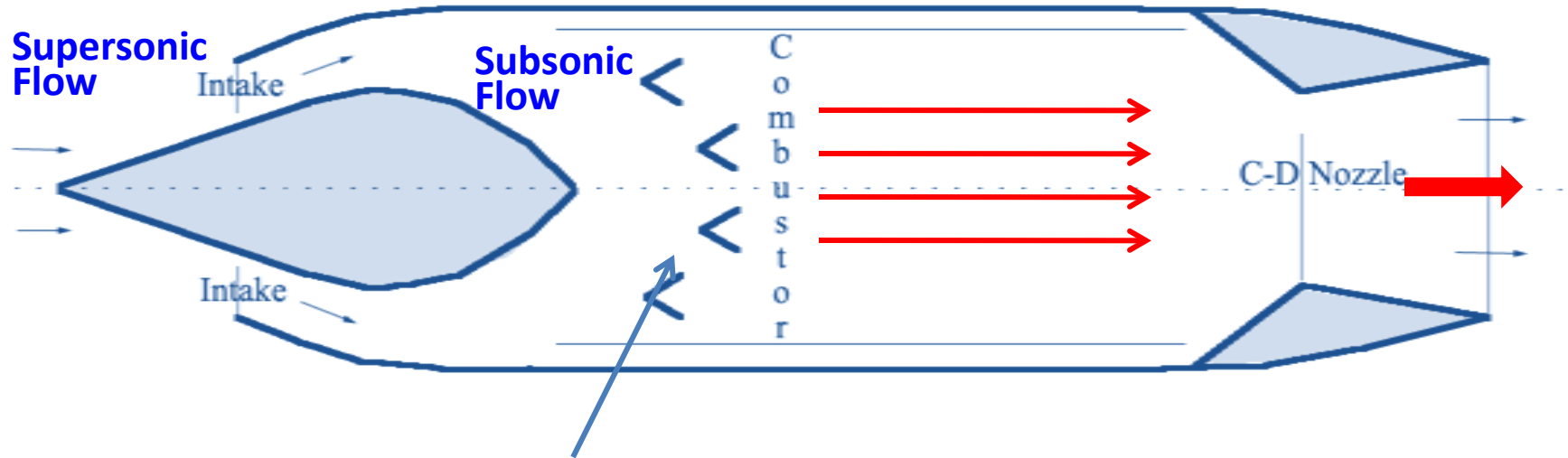IIT Bombay

Lecture 37

Ramjets and Pulsejets
in
Aircraft Propulsion

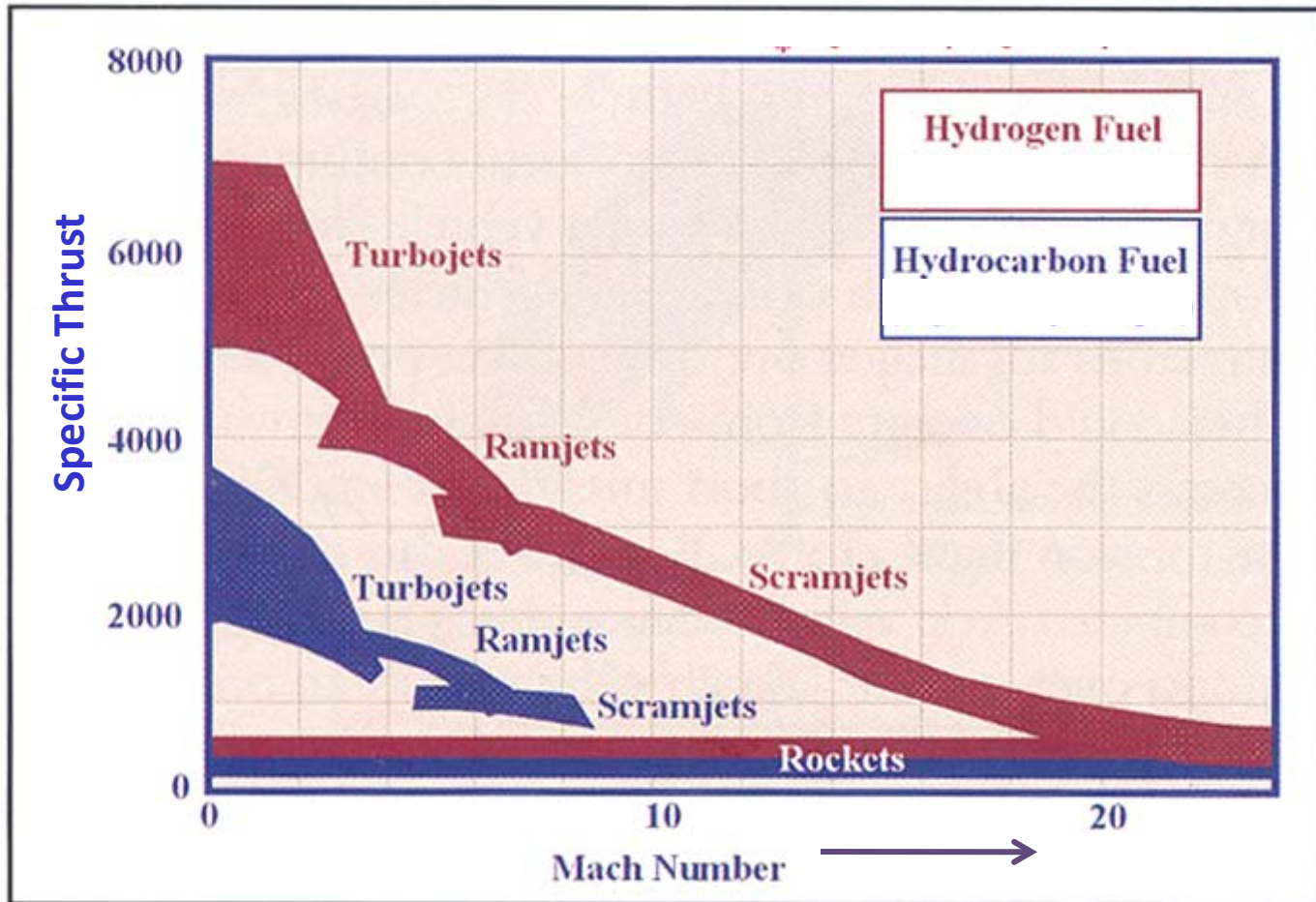**Prof. Bhaskar Roy, Prof. A M Pradeep, Department of Aerospace, IIT Bombay**

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Ramjet

• The ramjet operates on the same cycle as a turbojet.

• As per the name all the compression in the cycle is made to occur in the intake diffuser, producing a significant rise in static pressure.

• Fuel is burnt in this high pressure air and the mixture is then expanded to ambient static pressure through a nozzle system.
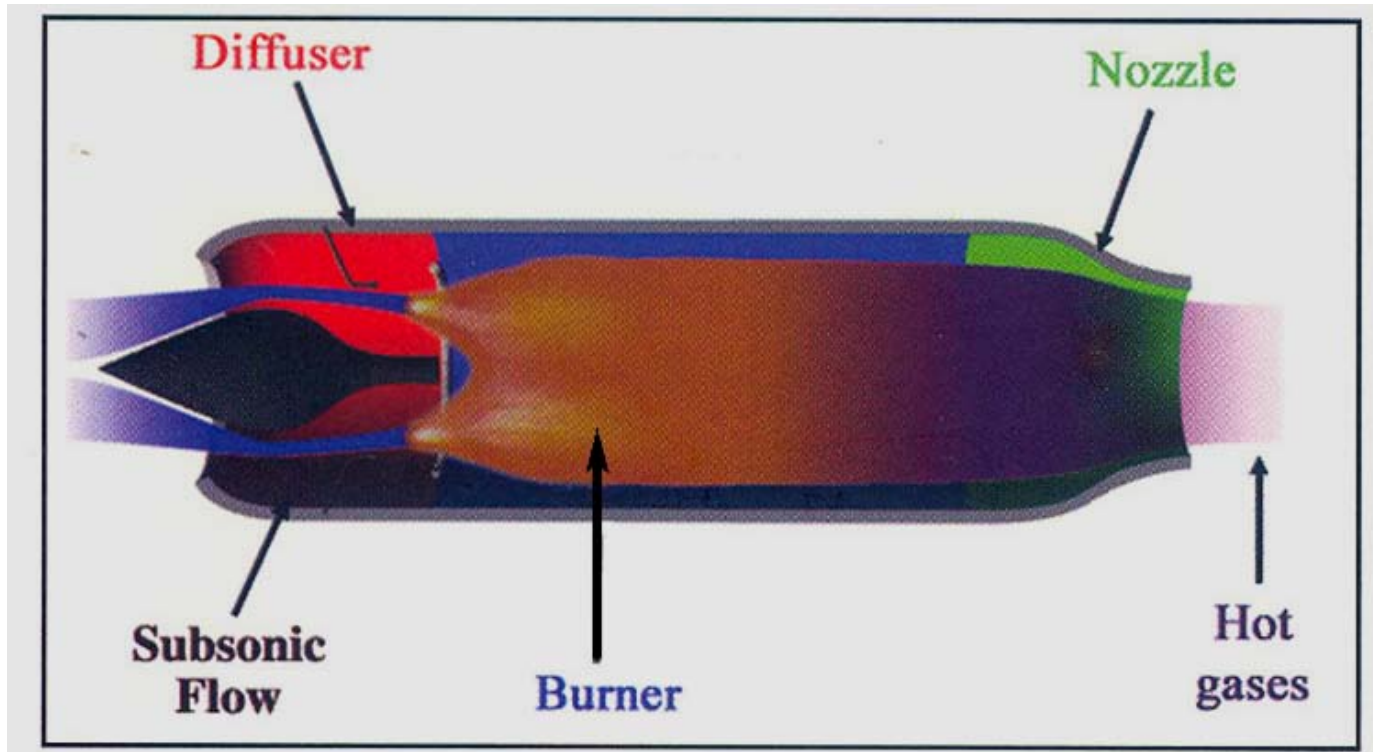
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Ramjet

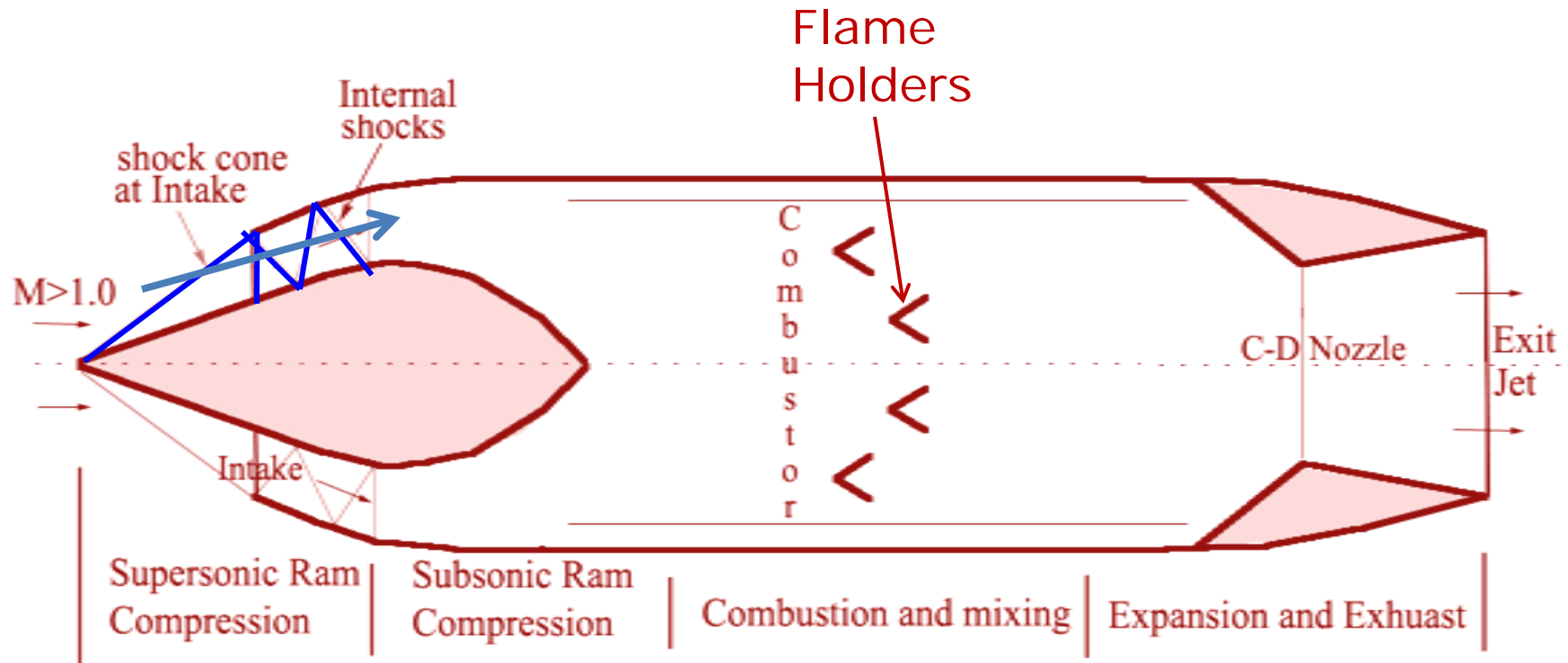Supersonic Flow   Intake   Subsonic Flow   < Combustor   C-D Nozzle   Intake

• The ramjet engine produces power by increasing the momentum of the working fluid by induction of energy by combustion of fuel, so that the momentum of the exhaust jet exceeds that of the incoming air, on a continuous basis.

• In contrast to the other air-breathing engines, the working cycle is accomplished without additional components of compression and expansion, and also without any need for enclosed combustion.

• Ramjet engine is mechanically the least complicated air-breathing jet engine for thrust production --- for flying vehicles.

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- This high pressure gas is expanded through a nozzle, converting a low subsonic flow in the combustion chamber -- to a supersonic jet.

- The mixture of air and burnt fuel is exhausted through a <u>convergent-divergent (C-D) nozzle</u>.

- Exit pressure (P_e) is same as or nearly same as the ambient pressure. Thus, the chocking pressure (P_c) at the throat is higher than the ambient pressure (P_a).

- However at low supersonic flights the exhaust may be sonic through a <u>convergent nozzle</u>.

- <u>At flight Mach 5 and above</u> the unit becomes a <u>Supersonic Combustion Ramjet</u> (SCRAMJET) in which the combustion is done in supersonic flow.

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German V-2 Bomber

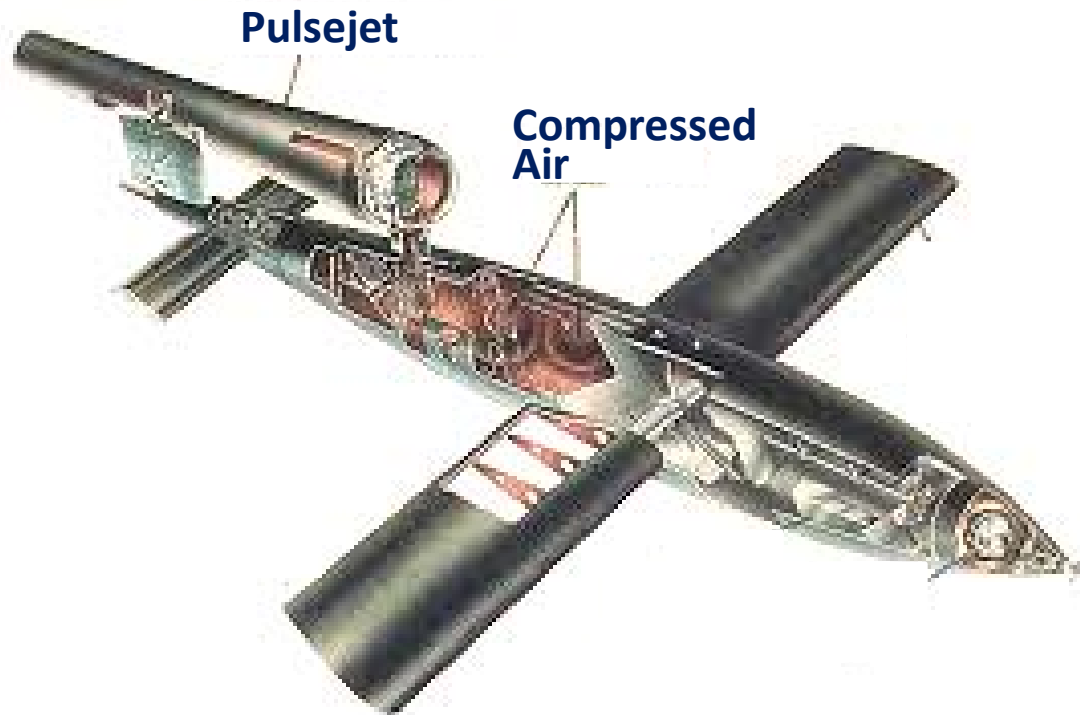Prof. Bhaskar Roy, Prof. A M Pradeep, Department of Aerospace, IIT Bombay
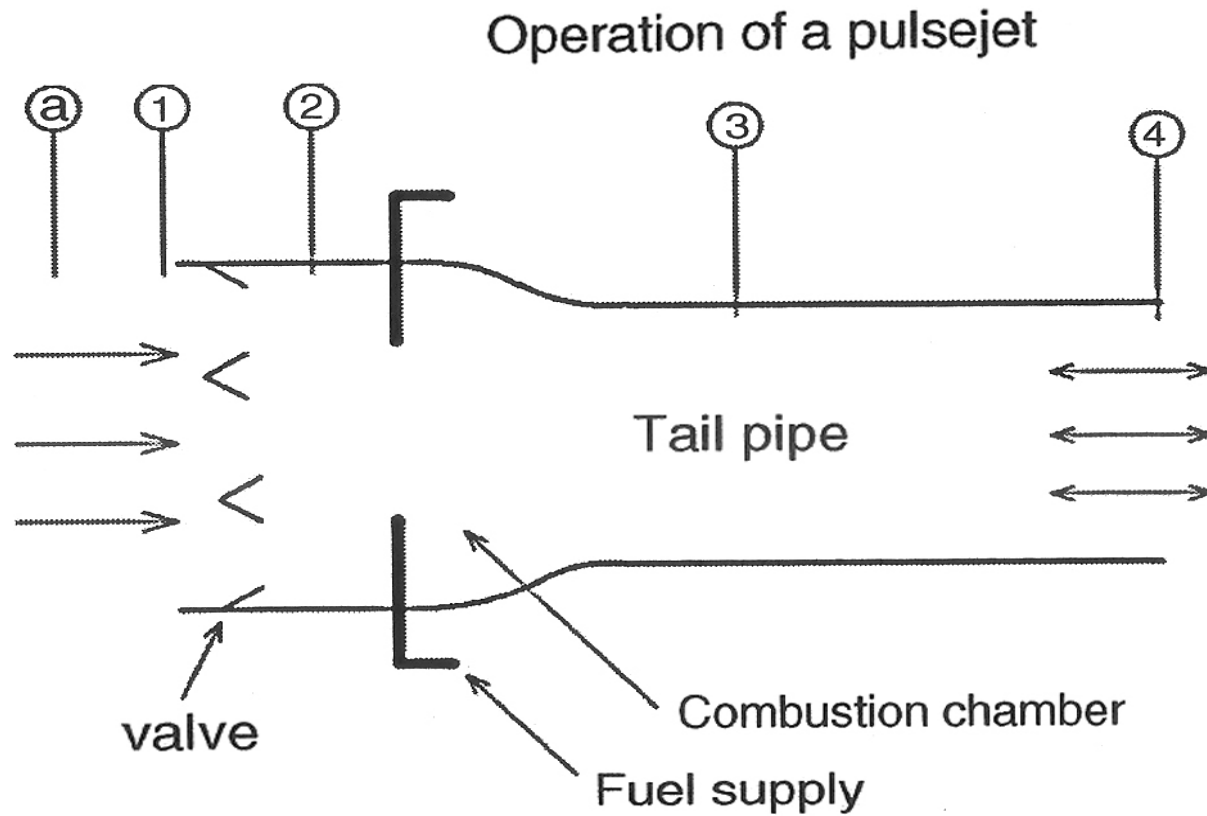
Ramjet Powered Supersonic Aircraft

Pulsejet

• Similar to ramjet in simplicity, but operating on different principle, is pulsejet, used in German V-1.

Pulsejet

Compressed Air

Operation of a pulsejet

• Air is drawn into the system through a <u>set of valves</u>, and fuel is sprayed into the incoming air.

• Combustion occurs and pressure is built up in the closed combustion region, closing the inlet valves and then accelerating the column of gas in the tailpipe outward.

• The escape of gases in exhaust permits the combustion gases to expand, and the inertia of the out moving column of gases leaving the system lowers the pressure in the combustion chamber, allowing a fresh charge to enter through the inlet valve and repeat the cycle.

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• To start this process it is necessary to <u>initiate air flow</u> through the duct, often with the help of a high pressure air source.

• Once started and injected with fuel, the device is self-sustaining, requiring no further spark.

• The fuel flow is steady, and ignition is accomplished by the residual flame.

• The frequency of the pulses determines the thrust and depends upon the volume of the combustion region and the length of the tail pipe.

• The pulsejet, usable at subsonic speeds, in its present state of development is inferior to turbojet in over-all propulsive efficiency.
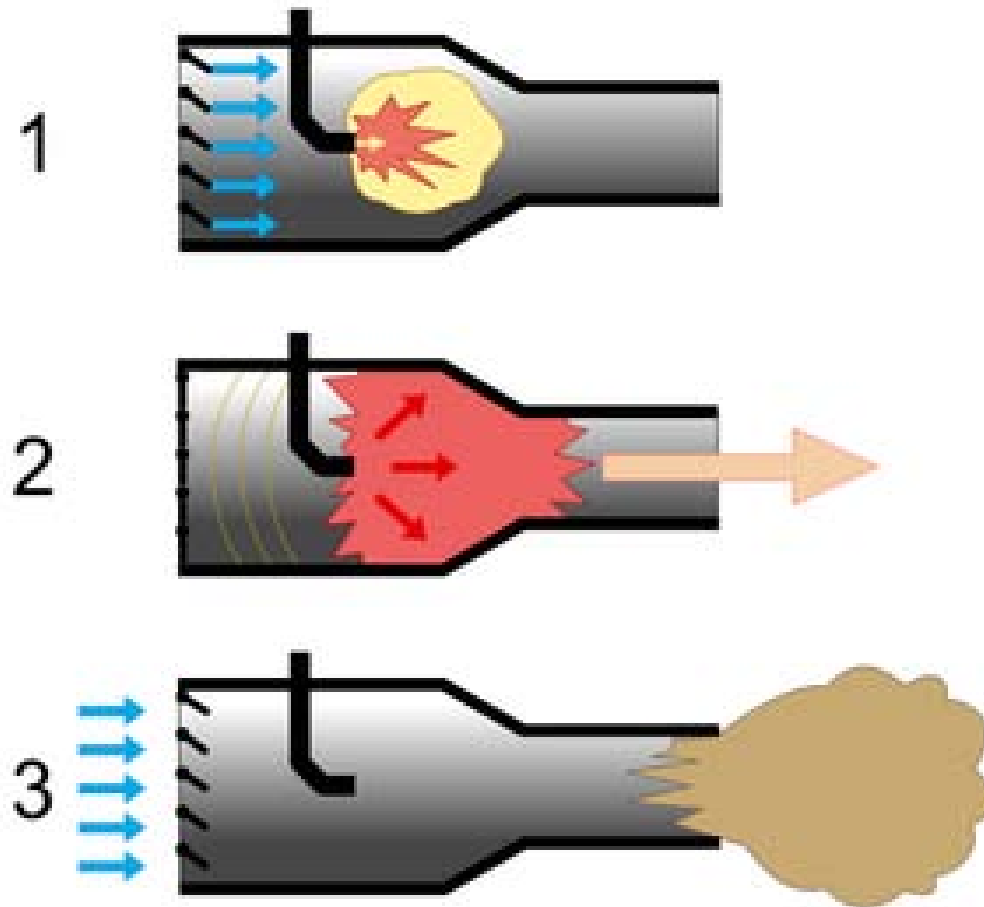
Pulsejets - operation

1) A spark plug initiates the combustion process inside the combustion chamber when the inlet valves are closed
2) Combustion occurs in an enclosed chamber and is approximately a constant volume process
3) Combustion is nearly an explosion in that enclosed volume and raises the pressure and temperature to high values

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Pulsejets - operation

4) The high pressure and temperature forces the gases to flow out of the tail pipe and nozzle

5) Evacuation of the combustion chamber results in pressure drop – that opens the spring loaded inlet valve and air comes in from the intake

6) The spring loaded inlet valves are normally closed and open only when the pressure difference across it is attained.

Pulsejet - operation

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German Heinkel Aircraft

Modern pulsejet powered aircraft

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Next :

Ramjets Continued

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