Understanding the relation between Sound Barrier, Sonic Boom and vapor cones

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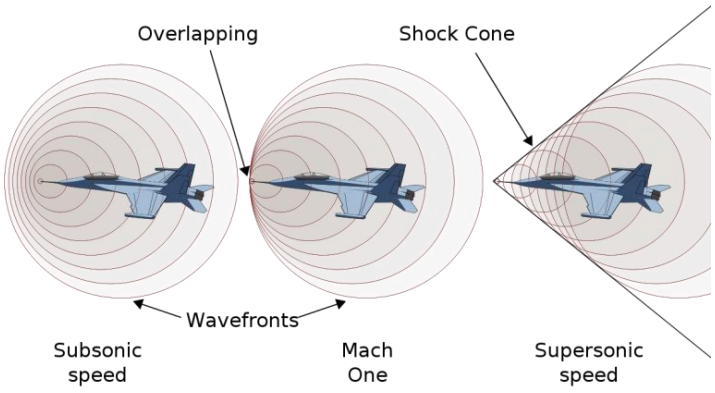
Objective:

Understanding the meaning of sound barrier and what is meant by breaking it and what is sonic boom is, and the phases of changing the speed of aircraft while flying and what results due these changes and how vapor cones are created.

Introduction:

The sound barrier can be defined as a hypothetical barrier. When an object moves faster than the speed of sound, the object is said to have broken the sound barrier. To break the sound barrier an object must travel faster than the speed of sound which is approximately 340m/s or 760 mph. Often supersonic speeds are referred to in terms of a Mach number. The Mach number is the speed of the object divided by the speed of sound. Thus Mach 3 means three times the speed of sound. The speed of sound in the air always differs depending on the density and type of medium it is passing through. For example, the speed of sound in water is almost four times that of its speed in the air approx. 1,500 m/s.

phases of changing the speed of aircraft:



Phase (1) Subsonic speed:

Aircraft which fly slower than the speed of sound create air pressure disturbances that move at the speed of sound, at a distance from the plane. The airflow has enough time to spread out and disperse the pressure disturbance. In these conditions, the sound of the air Aircraft will reach an observer before the craft does.

Phase (2) Mach one speed:

When the aircraft reaches the speed equaling that of sound, the pressure disturbances are combined in front of the aircraft. The aircraft gets very close to the waves of pressure it is creating due to its high-powered forward thrust. This causes a sudden and significant increase in drag, as the airflow has very little time to adjust, and gets compressed into a wall or barrier.

Phase (3) Supersonic speed:

When the Aircraft travel so fast in the sonic speed breaking the sound barrier and the observer is lower that object ex: at the ground. The waves compression due to the sonic speed creating a cone due to the overlapping of the waves. At the surface of the cone the compressions are very close to each other they combine to produce a percussion wave which a person at the ground perceives a sharp booming sound. Wherever the percussion wave hits the ground a supersonic boom can be heard.

Due to shock waves of supersonic flow speed, where the waves are compressed at the head of the aircraft causing the stretching of the waves in the tail which causes a reduction in air pressure, the temperature drops below the saturation temperature creating the condensation of atmospheric water where a cloud forms which is known as vapor cones that one sees around an aircraft approaching transonic velocity.

Conclusion:

The vapor cones are created by a shockwave that is generated by the aircraft as it picks up speed. The shock waves are the physical effects of the aircraft travelling so fast through air. As the aircraft picks up speed, and approaches the speed of sound – around 767mph (1,234km/h) at sea level – shockwaves form around the aircraft. Across these shockwaves there is 'discontinuity' in the local air pressure and temperature. This causes the air to lose its capacity to hold water and condensation starts to form, creating the vapor cone.

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