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WORKING MODEL OF THRUST REVERSER: MECHANICAL BLOCKAGE

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Abstract

Thrust reversers play a critical role in aircraft deceleration by redirecting engine thrust to oppose forward motion. However, mechanical blockages in the thrust reverser system can lead to significant safety hazards, including loss of braking efficiency and asymmetric thrust conditions. This project investigates the causes, effects, and mitigation strategies for mechanical blockages in thrust reversers, focusing on both cascade and bucket-type reverser designs. Through failure analysis, simulation, and experimental testing, the study identifies key failure modes such as actuator malfunctions, foreign object__debris (FOD) interference, and structural deformations.

1. OBJECTIVE

Modern aircraft brakes are very efficient but on wet, icy, or snow-covered runways this efficiency may be reduced by the loss of adhesion between the aircraft tire and the runway thus creating a need for an additional method of bringing the aircraft to rest within the required distance **[1].**

The primary objective of aircraft reverse thrust is to assist in decelerating the aircraft during landing, thereby reducing the runway length required for safe landing and minimizing the risk of runway excursion. Reverse thrust is achieved by redirecting the exhaust gases of the engines in the opposite direction, creating a force that opposes the forward motion of the aircraft.

A simple and effective way to reduce the aircraft landing run on both dry and slippery runways is to

reverse the direction of the exhaust gas stream, thus using engine power as a deceleration force. Thrust reversal has been used to reduce airspeed in flight but it is not commonly used on modern aircraft **[1].**

A simple but effective method of slowing aircraft quickly after landing is to reverse the direction of engine thrust by reversing the exhaust gas stream. Devices in use today allow the pilot to control the degree of reverse thrust. In addition, the modem thrust reverser can be used for emergency descents and to slow the aircraft and vary the rate of sink during approaches while still keeping the rpm high to minimize the time needed to accelerate the engine in the event of a "go-around." High-idle rpm will also provide sufficient compressor bleed air for the proper performance of air-driven accessories. The use of the thrust reverser is also being evaluated as a method of improving air combat manoeuvrings **[2].**

2. INTRODUCTION

On high by-pass ratio (fan) engines, reverse thrust action is achieved by reversing the fan (cold stream) airflow. It is not necessary to reverse the exhaust gas flow (hot stream) as the majority of the engine thrust is derived from the fan.[1]

Thrust reversal, also called reverse thrust, is the temporary diversion of an aircraft engine's exhaust so that the thrust produced is directed forward this act against the forward travel of the aircraft, providing deceleration. Thrust reversers are used by many jet aircraft to help slow down just after touchdown, reducing wear on the brakes and enabling shorter landing distances. Reverse thrust is typically applied immediately after touchdown, often along with spoilers, to improve deceleration early in the landing roll when residual aerodynamic lift and high-speed limit the effectiveness of the metal friction brakes located on the gear. When thrust is reversed, passengers will hear a sudden increase in engine noise, particularly seated just forward of the engines [1]

The bucket target system is hydraulically actuated and uses bucket-type doors to reverse the hot gas stream. The thrust reverser doors are actuated by means of a conventional pushrod system. A single hydraulic-powered actuator is connected to a drive idler, actuating the doors through a pair of pushrods (one for each door).

3. METHODOLOGY

Deployment Command:

- The pilot activates the thrust reverser system via cockpit controls.
- A signal is sent to the thrust reverser actuation system.

Actuator Engagement:

- Hydraulic or pneumatic actuators move the clamshell or bucket doors into the exhaust flow.

Exhaust Flow Redirection:

- The mechanical blockage prevents normal rearward exhaust exit.
- The blocked exhaust is forced through ducts that direct it forward, creating reverse thrust.

Deceleration Assistance:

- The aircraft experiences additional braking force, reducing landing rollout distance.
- Pilots modulate reverse thrust as needed for safety and efficiency.

Stowing and Locking:

- Once reverse thrust is no longer needed, the system is deactivated.
- The actuators retract the doors back to their stowed position.
- Mechanical locks ensure the doors remain closed in normal flight.

4. IMPLEMENTATION PLAN

Bucket-type thrust reversal system: -

Bucket type thrust reversal system: -

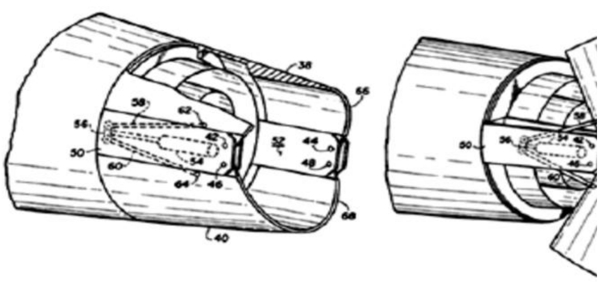

Fig 2 bucket target system.

Source:- https://images.app.goo.gl/eRMjxkyfURMMJG839

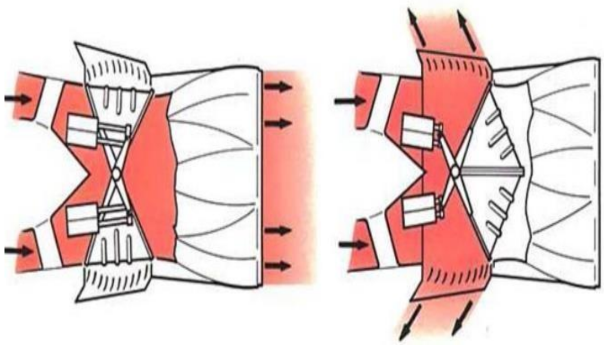

Fig 3 clamshell door system

Source: - https://images.app.goo.gl/hrNU4WTBW8nttQ2t5

5. EXPECTED RESULTS: -

Expected Results of Thrust Reverser Operation [2].

1. Be mechanically strong and constructed of high-temperature metals to take the full force of the high-velocity jet and, at the same time, tum this jet stream through a large angle.
2. Not affect the basic operation of the engine, whether the reverser is in operation or not.
3. Provide approximately 50 percent of the full forward thrust.
4. Operate with a high standard of fail-safe characteristics.
5. Drag should not be increased by increasing the engine and nacelle frontal area.
6. Cause few increased maintenance problems.
7. Do not add an excessive weight penalty.
8. It does not cause the reingestion of the gas stream into the compressor nor cause the gas stream to impinge upon the airframe. That is, the discharge pattern must be correctly established by the placement and shape of the target or vane cascade.
9. Allow the pilot complete control of the amount of reverse thrust.
10. Not affect the aerodynamic characteristics of the airplane adversely.

6. APPLICATION: -

Advantages of Thrust Reverser Mechanism 719 As far as use of Thrust Reverser Mechanism is concerned, it has several benefits related to safety and other factors.

1. Comparative landing runs with and without thrust reversal and it is seen that by using thrust reversers, landing is reduced up to an extent and this effect is more in slippery and icy runways. **[1]**
2. The airlines accept that thrust reversers are necessary for safe operations. In general, the airlines feel that thrust reversers provide an added margin of safety for transport aircraft operations **[2].**

7. CONCLUSION: -

The effective operation of thrust reversers yields multiple benefits, ranging from increased safety and control to enhanced performance and reduced wear on braking systems. By enabling quicker deceleration, preventing runway overruns, and ensuring smooth transitions during taxiing, thrust reversers are an indispensable component of modern aircraft landing systems. Their design and functionality not only improve operational efficiency but also contribute significantly to the overall safety and reliability of flight operations.

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