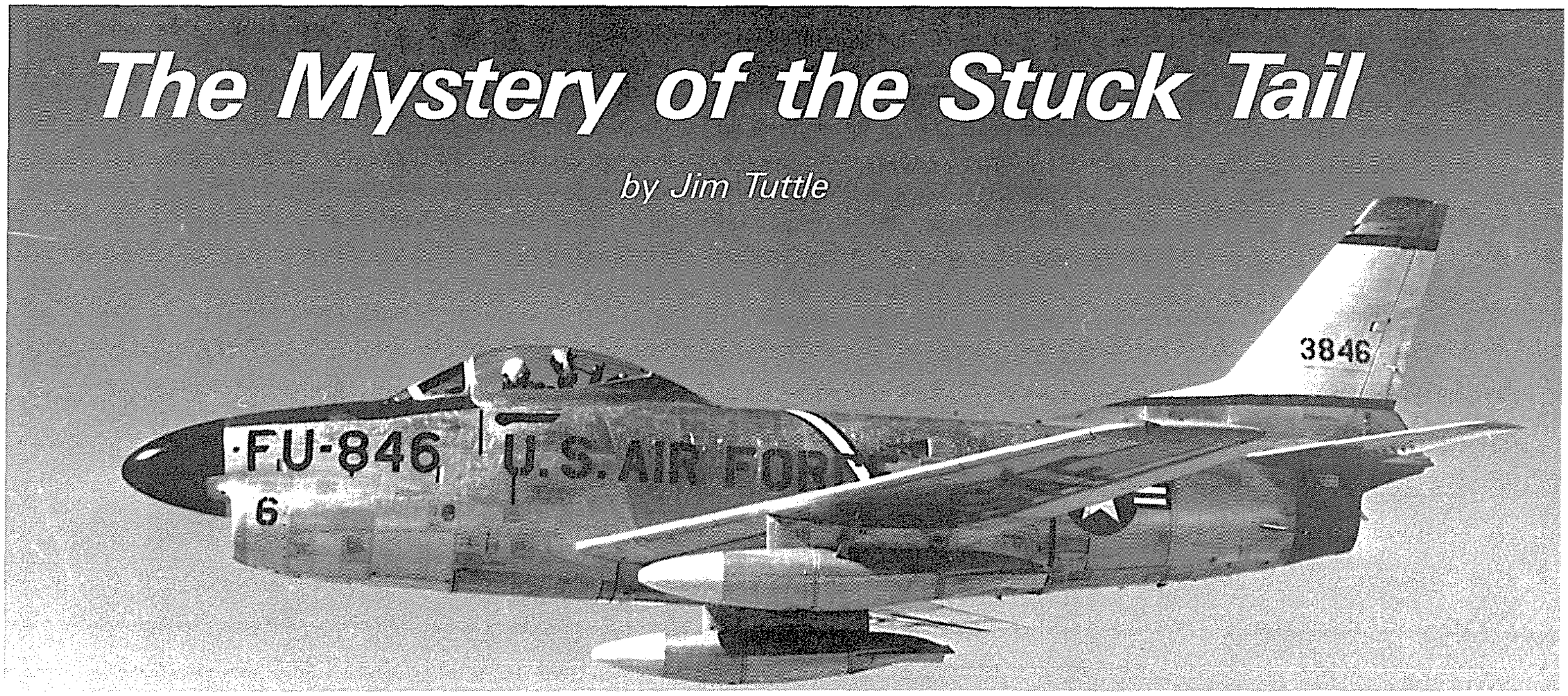
The Mystery of the Stuck Tail

by Jim Tuttle



The F-86D was the interceptor version of the F-86 *Sabre* series. In this photo of a late model "D" it is carrying two 120-gallon drop tanks. The bulge just above the jet engine exhaust held the drag chute and directly above that is the rudder that gave North American's engineering department such a difficult time. The rudder section, just above and to the right of the "6" on the tail number is the rudder balance weight, extending inside the vertical stabilizer.

In the late 1940s, there was a battle raging within the United States Air Force as to whether our interceptor aircraft should have one- or two-man flight crews. The question revolved around whether a pilot could operate the fire-control radar while flying intercept missions under instrument flight rule conditions. The Air Force was unable to resolve the issue, so both types of ships were built. The two-man version was the Northrop, twin-engined F-89 *Scorpion.* North American Aviation built the single-seater, single-engine F-86D *Sabre.* The F-86D shared the same wing, vertical stabilizer, landing gear and rudder as its sister F-86A, F-86E and F-86F *Sabres.* The F-86D had a new fuselage, an afterburning J47 engine, a Lear autopilot, a new horizontal stabilizer, a Hughes fire-control radar replacing the gunsight radar and 24 *Mighty Mouse* rockets, replacing the six .50-caliber machine guns. The F-86D successfully passed its testing and was becoming fully deployed in the field, in the mid-1950s, when a mysterious ailment appeared.

Telegrams and telephone calls started coming into the engineering department, followed by unsatisfactory reports, describing the following flight problem: ''Rudder travel would suddenly become limited to about three degrees (either side of center) or extremely high rudder breakout forces would be encountered at about the same point. By pushing very hard on the rudder pedals, the limiting or breakout force would suddenly disappear and the rudder system would operate quite normally again.'' Ground crews were unable to duplicate the problem and repair or service on the ships did not seem to have any effect. The F-86A, F-86E and F-86F had been in the field several years without encountering this problem. The nonpowered rudder system on the ''D'' was identical to its sister ships except for the autopilot servo motor. This motor put autopilot commands into the rudder via an iron-particle, electromagnetic clutch.

As this ''jamming'' could not be associated with any given airspeed, altitude or flight condition, aerodynamic problems were discounted. The problem didn't seem to have anything to do with any given Air Force base, climate or servicing, so these also were discounted. Also the problem could not be tied to aircraft hours, as low and high time airplanes seemed susceptible to the ''jamming.'' The problem never recurred on a given flight, although aircraft that once experienced the problem seemed more prone in the future. No aircraft were ever reported to experience the problem while in autopilot, and then to clinch the quandary some aircraft never encountered the ''jam'' or breakout problem at all.

The rudder servo-motor/clutch assembly was located at the base of the rudder, directly above the jet-engine tailpipe. An extensive test program was instituted at North American to see if the heat and/or vibration in this area was causing the iron particles in the clutch to pack into a solid, adding the servo-motor friction to the normal friction and aerodynamic loads on the rudder system. We shook and heated the ''h--l'' out of the part only to prove that Lear built good servo-motor/clutch assemblies. If the clutch could not be made to fail, then it was assumed that somehow the autopilot was being engaged without pilot input. Another set of tests was performed to see if flight loads were deflecting the ship wiring causing an intermittent short to engage the autopilot. Many hours were spent on this approach which only proved the problem did not lie there. As the random rudder-limiting problems were continuing to occur in the field, engineering had to admit to the Air Force that we were stumped. About this time a ''gutsy'' Air Force pilot pulled the fat out of the fire by providing an aircraft on the ground that was rudder-limited.

This pilot was airborne in an F-86D when he suddenly encountered a rudder-limited travel situation. Instead of attempting to break loose the "jam," he brought the ship back to the base without touching his rudder pedals. He made a straight-in approach and landing. As the nosewheel steering on the F-86 was via the rudder pedals, he was smart enough to shut the engine down at the end of the runway without attempting to taxi in. The ground crew disconnected the nosewheel steering and towed the ship back to a hangar. The ship was placed under guard until a "crack" engineering team from North American could arrive.

When the team arrived, the ship was gingerly handled to verify the rudder-limiting situation still existed. The pilot and ground crew had done a perfect job in that the condition still existed, and it was up to us to determine what was wrong. Access doors were gently removed and visual inspections were made looking for defective pulleys, mechanical obstructions, frayed cables, but all without success. The autopilot servo-motor/clutch assembly was carefully removed, and as you have probably guessed the rudder was still limited. Next the rudder cables were disconnected at the yoke of the rudder—and the problem still existed. Come on now—this just can't be! All that is left is the rudder and a couple of bearings. Nope—you're wrong this time as it wasn't the bearings. The culprit was discovered. We were looking for some exotic failure or problem, and the solution was so simple we never thought of it.

All F-86 aircraft had balance weights on their nonpowered rudder which extended inside the vertical stabilizer as shown in the photo. This balance weight consisted of a hollow aluminum casting, with a hole on top and bottom. During final assembly, the rudder was laid on its side and lead was poured into the hollow casting until a balance condition was achieved. To minimize aerodynamic drag, the clearances between the vertical stabilizer and the rudder balance weight was very small.

In the case of the F-86D, the additional vibration from the afterburning engine caused the lead to extrude out the bottom hole of the balance weight at a very slow rate. This continued until the lead column which was formed was captured inside the vertical stabilizer as shown in the figure. As lead is relatively soft, the pilots could shear off this column by heavy pressure on the rudder pedals. This immediately cured the rudder limiting, and as the sheared-off column fell clear of the aircraft, all evidence of the problem disappeared.

The reason for the random type failures was that it depended upon: 1) how much clearance existed between the balance weight and vertical stabilizer on a given ship; 2) how much lead was contained in the balance weight; 3) how often and how long the afterburner was used; and finally 4) the air temperature at the time the afterburner was used. The reason the problem was never seen while the autopilot was engaged was that the autopilot inputs were mild and never exceeded the three-degree limited-rudder travel.

The fix was simple, close over the lower balance weight hole with an aluminum plate. Thus, one concerned, dedicated pilot took the precise action necessary to allow an engineering department to solve a mystery that had thus far eluded them.

ABOUT THE AUTHOR

Jim Tuttle is a retired Senior Design Engineer from Rockwell International, North American Aircraft Division. He spent 33 years in the design of cockpits and most recently was responsible for the controls and displays on the B-1 bomber.

He is an avid aircraft historian, with his major interest in the field of United States military aircraft. He has an extensive collection of stories and thousands of photographs of these aircraft, especially in the area of cockpits.