AAIB Bulletin No: 9/95 **Ref: EW/C95/5/4** **Category: 1.3**

INCIDENT

Aircraft Type and Registration:	Beech B95A Travelair, G-ATRC
No & Type of Engines:	2 Lycoming IO-360-B1A piston engines
Year of Manufacture:	1962
Date & Time (UTC):	7 May 1995 at 0950 hrs
Location:	6 nm south of Brookmans Park, Hertfordshire
Type of Flight:	Test flight
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Failure of rudder tab actuating rod
Commander's Licence:	Private Pilot's Licence with Night Rating
Commander's Age:	39 years
Commander's Flying Experience:	660 hours (of which 147 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

The aircraft was being test flown after undergoing an Annual Inspection. A previous attempt had to be aborted after the engines had been started, when the oil was dumped overboard from both engines due to incorrect fitment of the oil filters. Approximately 10 minutes after taking off from Biggin Hill on this flight the pilot felt a slight vibration through the rudder pedals. After applying right rudder, it apparently jammed, causing the aircraft to sideslip. The vibration then became very severe, such that the pilot found it almost impossible to read the instruments. In addition, rudder pedal movement became so violent that the pilot had difficulty in keeping his feet on them. The aircraft continued to sideslip, whilst losing height, and adopted a 20° bank to the left. The pilot noted that the elevators had become difficult to move. The stall warning horn sounded at an airspeed of approximately 120 kt as the power was reduced. A "MAYDAY" message was transmitted to Stansted Radar and the pilot, by using differential power settings, was able to level the aircraft at approximately 700 feet agl. North Weald Airfield was nearby, and a successful emergency landing was made there some 10 minutes after the onset of the problem.

During discussions after the event, it was apparent that the pilot considered himself lucky to have regained a measure of control. However, he may have compounded his problems by inadvertently applying too much corrective aileron, hence the bank angle to the left, as opposed to the right bank that would be the expected result of a rudder jammed to the right. In addition, it was subsequently found that at some stage during the Annual Inspection the ailerons had been mis-rigged to the extent that the control wheel had to be displaced 20° to the left to maintain level flight.

Subsequent examination of the aircraft revealed that the rudder tab actuating rod had failed at its attachment to the rudder trim jack, which is mounted in the rear of the fin. Once the failure had occurred, the tab would have been free to flutter, and to 'servo' the rudder giving rise to the violent pedal movement. A diagram of the relevant part of the rudder trim system is attached, together with a detail of the actual failure. The rudder trim system consists of pulleys and cables, with the input to the trim jack being via a rotating rod. The jack converts the rotational motion into a linear output, and the output rod is connected directly to the rudder tab. The fork end of the output rod had failed at its attachment to the jack. The problem appeared to be due to the bolt that attached the fork end to the jack fitting having been significantly overtightened. This prevented the joint from swivelling as the rudder moved left and right.

A metallurgical examination of the failed fork end did not reveal any evidence of pre-existing cracks, although the threads were somewhat rusty despite the assembly being liberally greased. The fracture surface was indicative of bending overload in one direction, although the expected failure mode would be one of reverse bending, low cycle fatigue.

The broken fork end that remained attached to the jack could not be rotated. Moreover it was noted that with a small amount of right trim applied (thereby extending the jack), the fork end could be made to foul on a flange within the rudder leading edge in such a way that the rudder was inhibited from returning to neutral from a large right deflection. This may have accounted for the rudder jam as reported by the pilot.

Removal of the fork end from the jack revealed no evidence of corrosion on the inner faces that might have contributed to an inability of the bolted joint to rotate. Furthermore, the split pin was still in position, thereby eliminating any possibility of the joint tightening in service. It was therefore concluded that the bolt was simply overtight, although this part of the flying controls had reportedly not been disconnected during the Annual Inspection.

The rudder control system had remained intact, and smooth stop-to-stop operation was noted when the aircraft weight was taken off the nosewheel. The elevator controls were also satisfactory in operation, and it is thought that the elevator control problems reported by the pilot stemmed from the excessive sideslip angles that were encountered.

The aircraft manufacturer was asked to provide information on any previous occurrences involving their twin-engined range of aircraft. Two similar failures occurred in 1967 to Beech Baron aircraft, with both cases resulting in uneventful landings. The failed fork ends had the same Part Number (45-135038) as those used on the Beech 95 series. Late in 1967, a revised rod end was introduced (Part Number 96-526012) which had a larger cross sectional area in the threaded portion. This was approved for use on the Model 95 series (serial number TD-698 onwards), the Model 55 series (TC-1034 and TE-389 and after) and the Model 56 series (TG-1 onwards). The existing 45-135038 rod end remained in service on aircraft with prior serial numbers. Subsequent to these changes, there have been two reported occurrences of rod end failures on Model 95 aircraft. These occurred in 1976 and 1980, and both were on early build aircraft fitted with the original fork end. In both cases the reports indicate rudder vibration followed by uneventful landings.

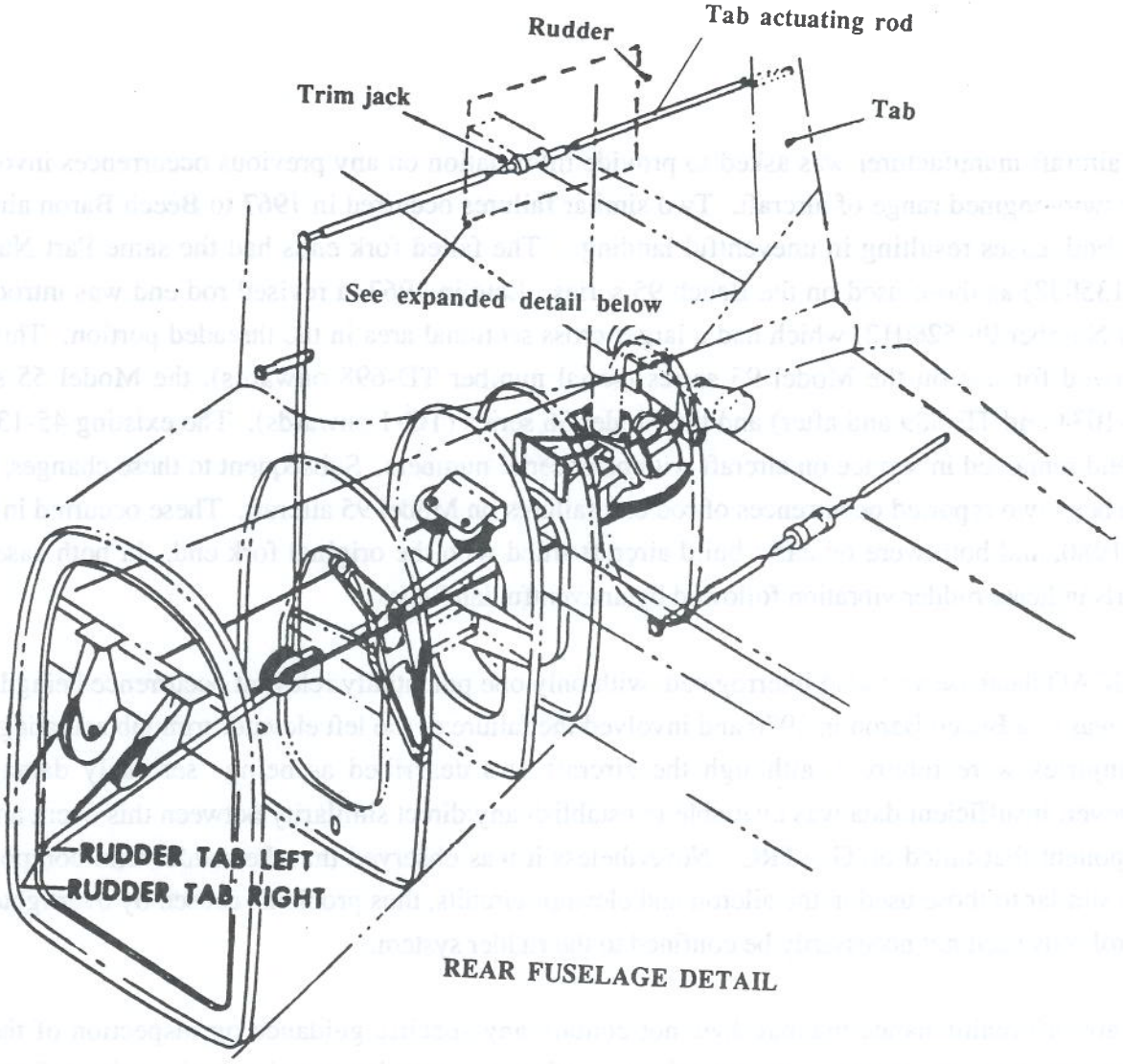
The ICAO database was also interrogated, with only one potentially relevant occurrence being listed. This was to a Beech Baron in 1970 and involved the failure of the left elevator trim tab actuating arm. No injuries were reported, although the aircraft was described as being "seriously damaged". However, insufficient data was available to establish any direct similarity between this event and the component that failed on G-ATRC. Nevertheless it was observed that the rudder trim components were similar to those used in the aileron and elevator circuits, thus problems caused by overtightening control rods need not necessarily be confined to the rudder system.

The aircraft maintenance manual does not contain any specific guidance on inspection of the rod end-to-actuator bolt. However the manufacturer takes the view that such inspection criteria form part of the fundamental knowledge for licensed engineers, and relevant guidance is contained in such publications as the FAA's Airframe and Powerplant Mechanics Airframe Handbook.

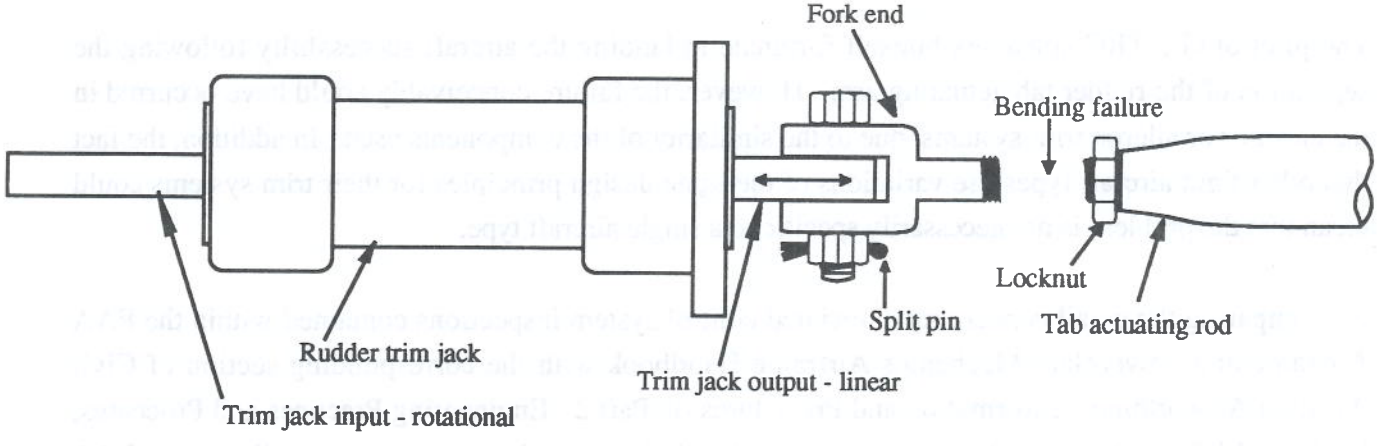
The pilot of G-ATRC considers himself fortunate in landing the aircraft successfully following the separation of the rudder tab actuating arm. However, the failure conceivably could have occurred in the elevator or aileron trim systems, due to the similarity of the components used. In addition, the fact that other light aircraft types use variations of the same design principles for their trim systems could mean that the problem is not necessarily specific to a single aircraft type.

On comparing the detail concerning associated control system inspections contained within the FAA Airframe and Powerplant Mechanics Airframe Handbook with the corresponding section of Civil Aviation Airworthiness Information and Procedures (ie Part 2 : Engineering Practices and Processes, Leaflet 2-13 Control Systems), it was considered that the latter guidance was not as explicit as the FAA handbook.

The CAA will be advised of the above and requested to include details of the incident in their GASIL publication.



REAR FUSELAGE DETAIL



DETAIL OF RUDDER TRIM ACTUATING ARM FAILURE