

No: 9/91

Ref: EW/C91/3/1

Category: 2c

Aircraft Type and Registration: Air Command 532 Elite, G-BPFW

No & Type of Engines: 1 Rotax 532 piston engine

Year of Manufacture: 1989

Date & Time (UTC): 2 March 1991 at 1400 hrs

Location: Melbourne airfield, near Pocklington, North Humberside

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - None

Injuries: Crew - Fatal Passengers - N/A

Nature of Damage: Aircraft destroyed

Commander's Licence: Private Pilot's Licence (Aeroplanes)

Commander's Age: 39 years

Commander's Flying Experience: 222 hours (of which 2 were on type)

Information Source: AAIB Field Investigation

The pilot, who held a Class 1 medical certificate, was the owner of a Cessna 172. In late 1990, he contacted a qualified gyrocopter instructor who agreed to provide him with the necessary training at Melbourne airfield with a view to his obtaining a gyrocopter licence. Having successfully completed a course of gyroglider training, the pilot began powered training on a single-seat Montgomerie gyrocopter on 26 January 1991. This lesson and a subsequent lesson on 2 February 1991, followed the established pattern of ground manoeuvres followed by short ground hops along the runway. On 20 February 1991, the pilot bought the accident gyrocopter secondhand and took it to Melbourne. The gyrocopter was inspected and test flown by an instructor who was satisfied that it was airworthy. The pilot subsequently flew a two hour session of short hops along the runway. The instructor was satisfied with his performance but the pilot had experienced two Pilot Induced Oscillations (PIO) from which he had recovered successfully. During this series of hops, a ground witness heard a grating noise coming from the gyrocopter. The instructor again examined the gyrocopter but he could find nothing untoward and pronounced it fit for flight.

On day of the accident, the pilot went to Melbourne for a further period of instruction. The runway in use was 24/06 and the instructor estimated that there was a 5 kt crosswind from the south. An aftercast gave the surface wind as 140° at 12 to 17 kts. The pilot was briefed on crosswind handling

techniques and authorised for a session of flights along the length of the runway. This exercise continued for about 30 minutes during which time the instructor was satisfied with the pilot's performance. A video recording of some of these flights showed that the pilot was having no significant problems with aircraft handling in the prevailing conditions. On the last take off, in a westerly direction, the aircraft was seen to accelerate normally and climb to a height of about 30 feet before levelling off. After several seconds of stable flight, during which the engine was heard to be operating normally, the aircraft was seen to roll suddenly to the left and impact the runway whilst inverted and in a steep nose-down attitude. There was no fire, but the pilot sustained fatal injuries at impact. A post mortem examination did not reveal any medical condition that could have caused or contributed to the accident.

Examination of wreckage

In the direction of flight, the first mark found on the runway surface was a rotor strike with a three foot section of upper surface blade skin lying close by. The orientation of the mark indicated that the gyrocopter had been inverted at the time of the strike. The wreckage had come to rest approximately 60 yards further on, the groundslide being parallel to the runway heading. Examination of the ground marks showed that the rotor supporting mast had snapped off level with the top of the pilot's seat when the rotor blades struck the ground. This had allowed the pilot's helmet to contact the runway immediately afterwards.

The wreckage was recovered to the AAIB at Farnborough, where a detailed examination revealed no evidence of structural failure of either the airframe or rotor. There had been no pre-impact disconnection of the flying controls. Examination of the rotor head showed that the rotor retaining bolt had been loose. The gyrocopter was equipped with a pre-rotator, the purpose of which was to spin up the rotor prior to take-off by means of a flexible drive shaft driven by the engine and engaged by operating a caliper on the control column. When the drive shaft rotated, a Bendix drive pinion was thrown into engagement with a ring gear attached to the rotor head. Figure 1 shows the head with the drive pinion in the disengaged position. The engaged position is illustrated at Figure 2, where it can be seen that there are a number of witness marks on the drive unit bell housing which have been caused by the lower corners of the ring gear teeth. It was found that the rotor head, which includes the ring gear, could move relative to the torque tube on which the drive unit was mounted. The degree of movement was such that with the drive pinion in the disengaged position, the ring gear was capable of partially meshing with the pinion; this caused the latter to be driven up into full gear engagement, where, with the head tilted to the rearwards limit of its free play, the ring gear teeth could contact the bell housing. The owner had exacerbated the problem by machining away 0.060 inch from the

attachment casting in order to increase the amount of drive spindle engagement within its upper bearing. This had positioned the drive unit closer to the ring gear.

Initial examination suggested that the teeth marks on the bell housing had been present before the accident. Further evidence of a loose head bolt was provided by circular fretting marks on the soft alloy washer located immediately beneath the head bolt. (See the diagram at Figure 3). This could only have occurred due to relative rotation between the bolt and the washer. Supporting evidence was provided by the cadmium plating on the bolt shank and on the associated AN 960-816 washer having been worn away. The washer was found to have a Vickers Hardness value of 112. This low figure suggested the possibility of the washer material undergoing plastic flow as a result of flight loads, with a consequent loss of assembly torque. The dust cover, which had a hexagonal cut-out matching the shape of the bolt head, was shown in the aircraft build manual as being threaded on the bolt shank in the same way as a washer. It was designed to be pushed over the bolt head after assembly. Damage to the edges of the cut-out indicated that it may have become trapped under the bolt head and this could have occurred as a result of being threaded onto the bolt shank during assembly. An inspector associated with the Popular Flying Association stated that another gyrocopter had been submitted to him for inspection with the head so assembled. The dust cover had extruded itself out from beneath the bolt head during transportation, leading to loss of assembly torque on the head bolt.

The loose bolt had allowed the rotor head to move about 3° from the position set by the flying controls, which are attached, by means of a cross tube, to the torque tube shown in Figure 3. It was not possible to assess the exact amount of free play that existed before the accident due to the additional distortion of the soft alloy washer that had occurred at impact.

It was concluded that periodic pre-rotator engagement caused by the free play in the rotor head may have caused the grating noises reported by witnesses. However, neither the manufacturers nor experienced autogyro operators were able to provide a definitive statement as to the likely effect this defect would have on the behaviour of the aircraft, and thus whether it contributed to the accident.

Following this accident, which resulted in the sixth fatality involving an Air Command gyrocopter in less than two years, the CAA provisionally suspended Permits to Fly in respect of all UK registered Air Commands on 6 March 1991. At the request of the CAA, the AAIB undertook to review previous Air Command accidents with a view to identifying any common cause. The results of this review will shortly be passed to the CAA.

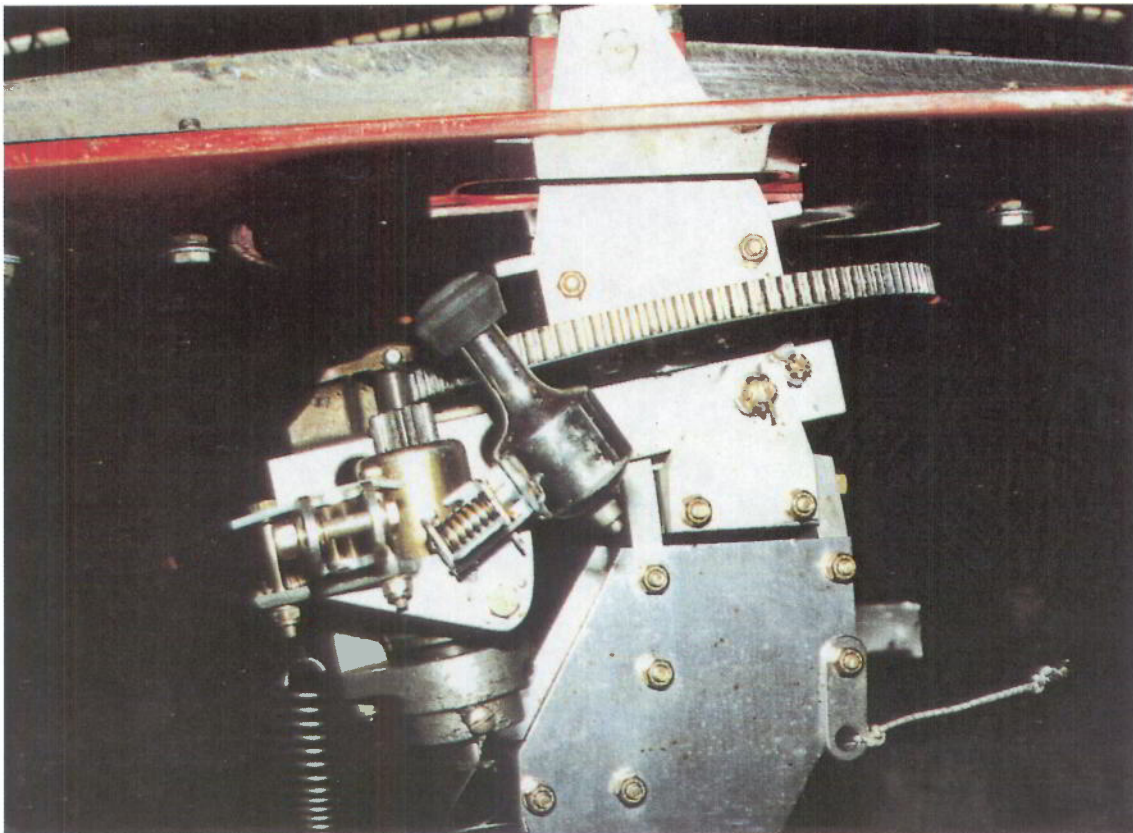


FIGURE 1 Rotor head showing prerotator ring gear with drive pinion disengaged

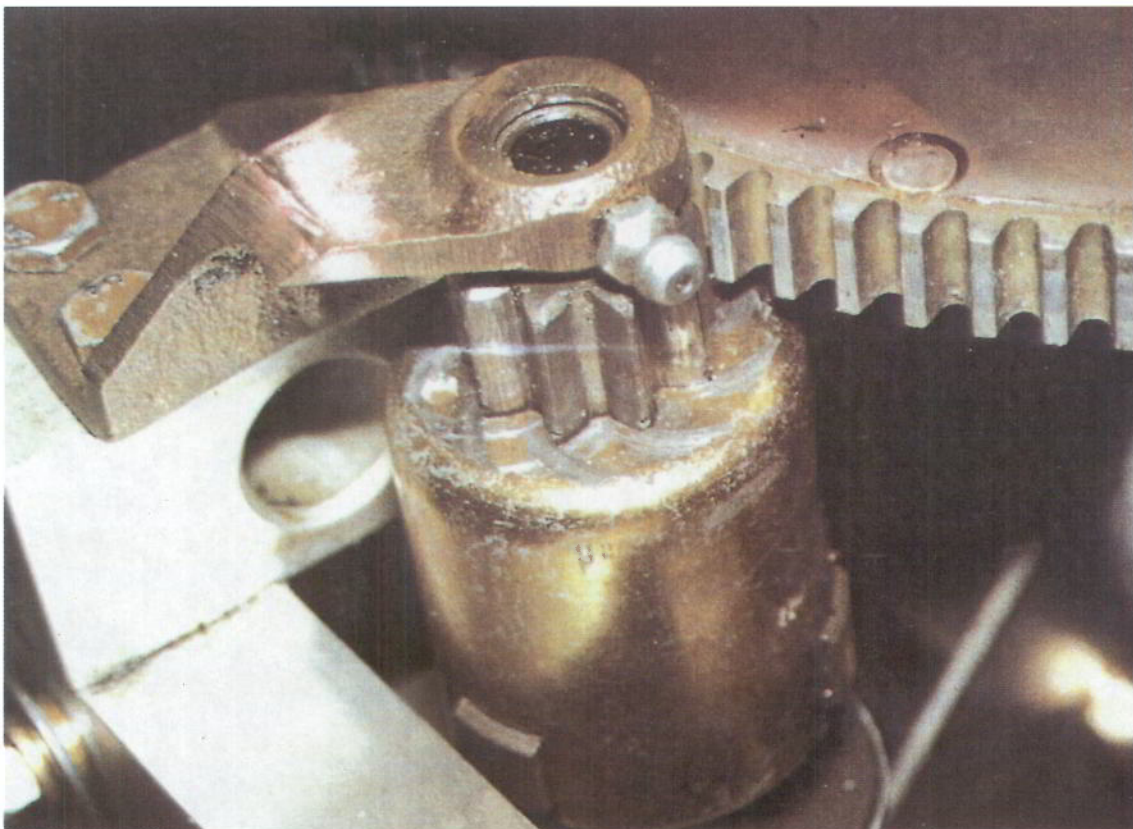


FIGURE 2 Drive pinion in engaged position; note gear teeth marks on bell housing

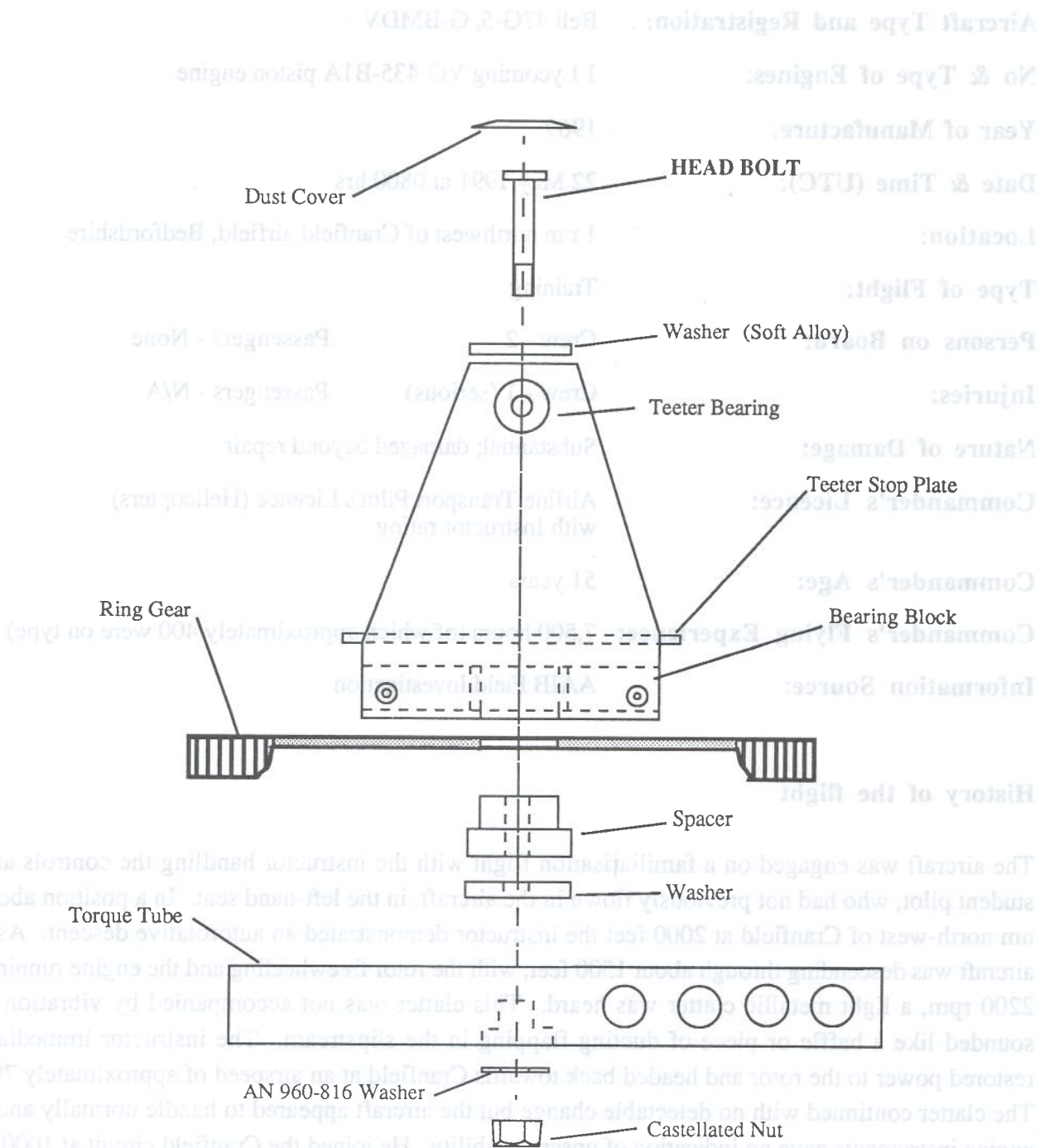


FIGURE 3 ROTOR HEAD SCHEMATIC

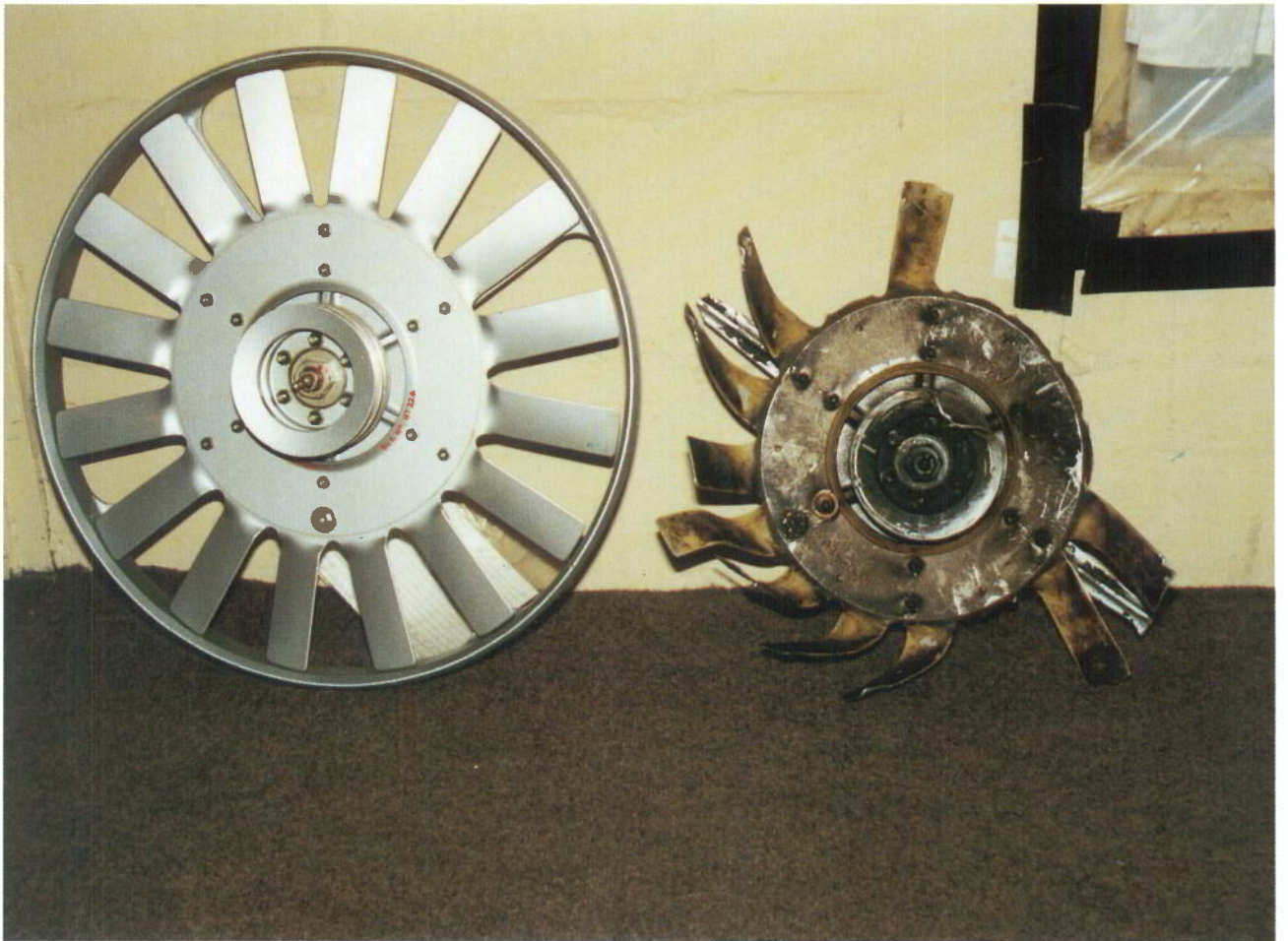


FIG 1 Fan assembly as removed from G-BMDV plus an intact unit

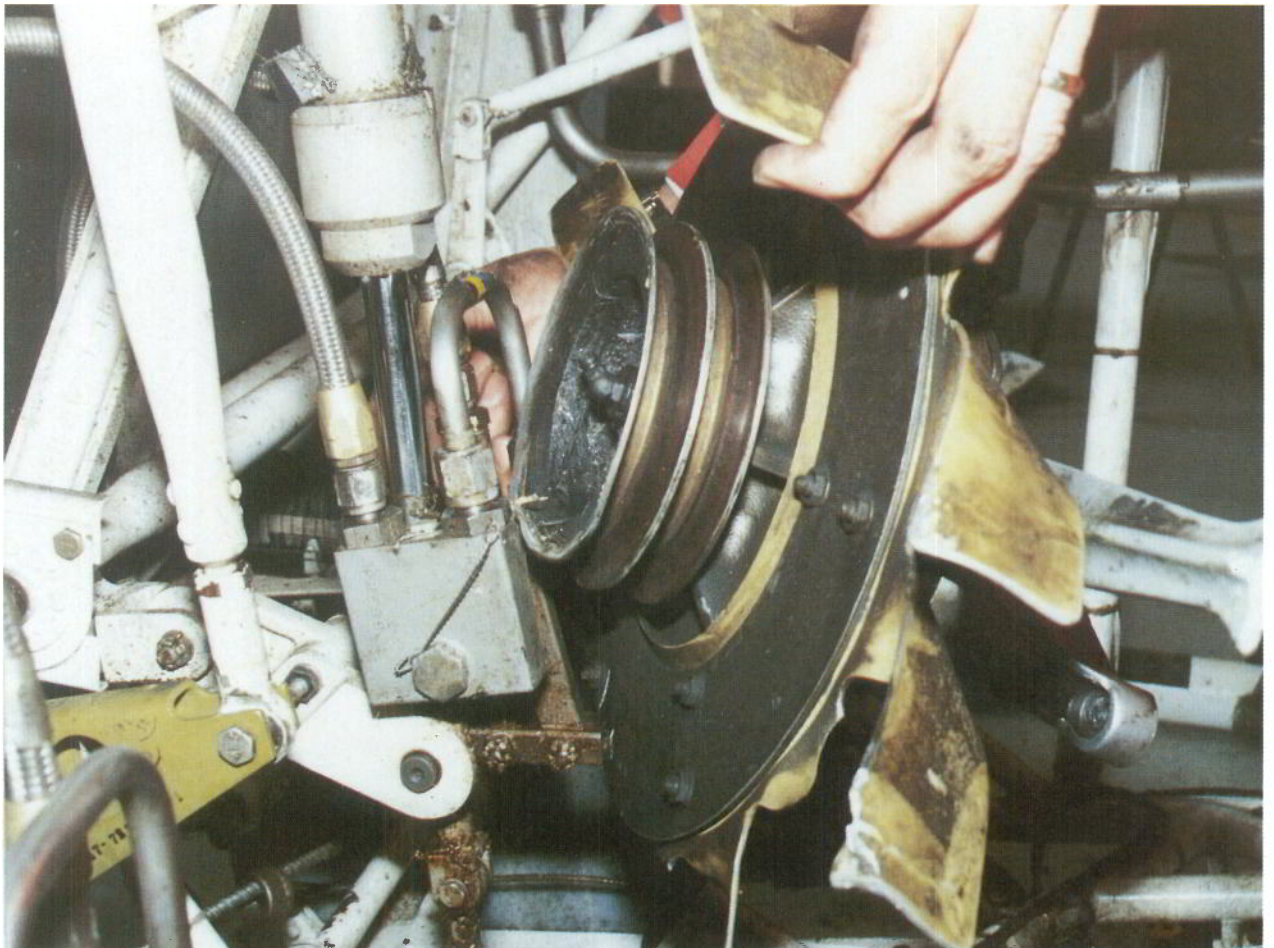


FIG 2 Estimated position at which fan assembly jammed servo