ACCIDENTS INVESTIGATION BRANCH
Department of Trade and Industry

Bensen B8M Gyrocopter G-AWBO

Report on the accident half a mile east of Mount Karrin, Isle of Man on 15 September 1969

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Department of Trade and Industry
Accidents Investigation Branch
Shell Mex House
Strand
London WC2

22 December 1971

The Rt. Honourable John Davies MBE MP
Secretary of State for Trade and Industry

Sir,

I have the honour to submit the report by Mr G M Kelly, an Inspector of Accidents, on the circumstances of the accident to Bensen B8M Gyrocopter G–AWBO which occurred half a mile east of Mount Karrin, Isle of Man on 15 September 1969.

I have the honour to be
Sir,
Your obedient Servant,

V A M Hunt
Chief Inspector of Accidents

Accidents Investigation Branch
Civil Accident Report No EW/C325

Aircraft:	Bensen B8M Gyrocopter* G–AWBO
Engine:	Volkswagen 1600 cc (modified)
Owner and Operator:	Mr N D Hamilton-Meikle
Crew:	Mr N D Hamilton-Meikle – Killed
Passengers:	None
Place of Accident:	Half a mile east of Mount Karrin, Isle of Man
Date and Time:	15 September 1969 at about 18.30 hrs
	All times in this report are GMT

*Gyrocopter is the Bensen Aircraft Corporation registered trade name (in the USA) for a powered gyroplane of their own design.

Summary

Half an hour after take-off when the aircraft was flying in good weather between 1,000 and 1,500 feet above mean sea level it went out of control following a rapid and uncontrollable rearward tilt of the rotor disc. The rotor blades came into contact with the fin and the tail of the aircraft and one rotor blade became detached. The wreckage fell to the ground and the pilot was killed.

The report considers a number of modifications to the original design incorporated by the builder but finds no indication that any of them was a factor in the accident. The evidence was insufficient to establish a cause.

1. Investigation

1.1 History of the flight

The pilot brought the aircraft by trailer to Ronaldsway Airport, assembled the rotor to the airframe, and took off at 18.00 hrs for a local VFR flight, climbing away to the north. The aircraft was next seen approaching Jurby aerodrome at a height of about 1,200 feet when the pilot throttled back the engine and the aircraft descended and flew over the aerodrome. Power was then increased and the aircraft climbed away to the south where at a distance of 3 miles the ground rises to 1,000 feet amsl.

A little while later the aircraft was heard and seen making alterations in heading whilst flying near the village of Ballaugh about 3½ miles south of Jurby. The sound of the engine was quite normal. The witnesses, who were approximately ¾ of a mile from the site of the accident, then saw the aircraft tumble forward, and pieces fall away from it before it went out of sight.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	1	-	-

1.3 Damage to aircraft

Destroyed.

1.4 Other damage

None.

1.5 Crew information

Mr Hamilton-Meikle was 57 years of age. He held a current student pilot's licence endorsed 'holder to wear spectacles which correct for near and distant vision and shall have available a second pair whilst exercising the privileges of the licence'.

Since there was no qualified gyroplane instructor on the Isle of Man under whose supervision he could fly as a student pilot, the Department of Trade and Industry granted special exemption from Article 20 of the Air Navigation Order so that a 'fixed wing' flying instructor could supervise him.

Mr Hamilton-Meikle had been a fixed wing flying instructor in the Royal Air Force and had left the service in 1945 with 1,003 flying hours. He returned to flying in 1967 and built a Bensen Gyroglider on which he completed approximately 30 hours flying before he converted it to a powered Gyrocopter. At the time of the accident he had accumulated 65 hours powered flying on the Gyrocopter, 6 hours 20 minutes of which had been in the four weeks prior to the accident.

This powered experience included 157 take-offs and landings and flights of up to 1½ hours duration and to altitudes of up to 5,300 feet.

1.6 **Aircraft information** (See Appendix A)

Mr Hamilton-Meikle built the 'gimbal head' Bensen B8M Gyroglider in 1967 with materials mainly purchased in the United Kingdom and made up in accordance with approved drawings, some of which were supplied by the Bensen Aircraft Corporation, North Carolina, USA and others by Campbell Aircraft Ltd, Lambourn, Berkshire. Campbell Aircraft Ltd also supplied a number of approved precision built parts manufactured under licence.

The Gyroglider was in general well constructed and the materials used were of good standard. The tail unit, however, differed in shape from the one shown in the Bensen scale drawings, although the surface area remained the same. The clearance between the tip of the fin and the rotor was less than was provided by the shape of the original fin.

The first flight was in 1967 with the glider towed behind a motor car. After initial short hops and kiting (tethered flight in strong winds), glider flying experience was built up to a total of 30 hours. The owner then purchased a 1,600 cc Volkswagen engine to which he made appropriate modifications, including dual ignition, and to which he fitted a Lockwood 50 inch diameter 26 inch pitch wooden propeller.

The Bensen drawings which had so far been used were for a Gyrocopter powered by a Bensen McCullough engine, which is both lighter and larger than the modified Volkswagen engine. The rotor head mounting plates specified on the drawing to restore the correct trim and balance on fitting a McCullough engine, moved the rotor centre 5 inches further aft and were 11 inches high to obtain safe ground clearance for the rotor at take-off. These were unsuitable for the Volkswagen installation and head plates of a different shape were specially made. It is not clear from the available records how the new shape was arrived at. The head plates that were eventually fitted were 5½ inches high. They shifted the rotor centre line 7¼ inches further aft than it had been when the aircraft was a glider. The final design appears to have been determined after a series of trials and a number of 'hang tests' in which the aircraft was suspended from its teeter bolt. They provided the correct trim and balance, and the proper 3^{o} nose-down inclination from the vertical of the rotor mast.

The aircraft, now a powered aircraft, was registered in January 1968 in Mr Hamilton-Meikle's name. In April 1968 it completed 3½ hours flying and was then surveyed for, and granted a permit to fly, valid from June 1968.

In July 1968 the aircraft was slightly damaged in a crosswind landing. The engine and mountings were examined and the gimbal head and torque tube were sent to Campbell Aircraft Ltd for checking, after which they were re-fitted. The records show that at this time the silver soldering on the cross piece of the control column was replaced by high tension electrical welding. In August 1968 the Lockwood propeller was cropped by two inches, and in January 1969 it was replaced by a 50 inch diameter 26 inch pitch Troyer propeller. The resulting increase in rev/min and thrust necessitated an adjustment of the gimbal head bias springs.

After some 40 hours flying, during which there were no recorded difficulties with the trim of the aircraft, the original wooden rotor blades were found to be defective, and were replaced. With the replacement blades the rotor turned much faster (no rotor tachometer was fitted) and the aircraft flew nose-heavy. This was corrected by removing the gimbal head bias springs from the front of the rotor mast and refitting them to the rear.

On 4 June 1969 the aircraft was surveyed by the Air Registration Board, and the permit to fly was subsequently renewed on 2 July 1969 for one year. A new set of the latest Bensen metal rotor blades with a lifting capacity of 600 lb had been delivered, but were not fitted to the aircraft when it was surveyed. When the aircraft was test-flown with the new blades on 5 July the pilot found them much smoother, but the aircraft flew 'terrifically nose-heavy'.

The gimbal head bias springs were adjusted to compensate for this by moving their anchorage 4 inches down the mast. On the next flight the pilot recorded that he must have unwittingly let his airspeed drop during the climb, for at 150 feet the aircraft fell 75 feet in what appeared to be a low speed porpoise.

By the time the pilot reported that the aircraft was in trim 'hands off' at 40-42 knots and 4,100 engine rev/min the bias spring anchorage had been moved a total of 11 inches, at which setting the springs themselves were stretched to 15 inches – ie almost twice their normal length. On the next flight, August 31, a further ½ inch extension of the bias springs was required.

The log book shows that a further ten flights were made without any adjustment being recorded or any additions made to the aircraft. The last recorded flight on 8 September 1969 brought the aircraft's total powered flying time to 62½ hours.

.7 Meteorological information

The weather at the time of the accident was fair with good visibility and a wind estimated to be E to NE at 10 to 15 knots. Any turbulence that might have been presented would have been weak, but there may have been subsidence as the accident site was on the leeward side of high ground.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The aircraft carried a radio but was not in radio contact with anyone at the time of the accident.

1.10 Aerodrome ground facilities

Not applicable.

1.11 Flight recorder

Not applicable.

1.12 Wreckage

The 350 yard wreckage trail lay on a heading of approximately 145° near the summit of a 1,000 feet high hill. It indicated that the aircraft had broken up in flight between 200 and 300 feet above the ground.

Several light fragments of the fin, rudder and propeller together with a top outer section panel of rotor blade No 5464 were found in the first 100 yards of the trail. Further pieces of the wooden propeller, the fin and rudder and several more panels of the same rotor blade were scattered over the next 100 yards, followed by a large section of rudder and almost the entire main spar extrusion of the rotor blade. In the final 150 yards of the trail, to the left of the main wreckage, were found the metal sheathed tips of the engine driven propeller.

One of the two 5 gallon fuel tanks had been thrown clear of the main wreckage and although both tanks were damaged and found empty, the interior of each smelt of fuel.

Examination of the main structure indicated that when it struck the ground it was the right way up, on a heading of 275° descending rapidly with little forward speed in a slightly nose down attitude and banked to the left. The impact had disrupted the engine support structure and broken the rotor mast in two places. Neither the engine driven propeller nor the remaining rotor blade were turning when they struck the ground. No evidence of bird strike or in-flight pilot injury was noted.

The engine was stripped and found to be in good mechanical condition and there was no evidence of pre-crash failure or malfunction.

The aircraft had been complete and all flying controls intact before control was lost and the structural failure occurred.

Reconstruction of the damaged propeller, rotor blades and tail unit, together with examination of the score marks and paint smears on the under side of the rotor blades indicated that both metal rotor blades had struck the rudder

three times, detaching it and the fin. At the same time the backward tilt of the rotor had brought the undersides of the blades into contact with the steel tips of the engine driven propeller. From the 40° angle of the first slash in the rudder and the increasing angle of the subsequent cuts it was evident that the retreating rotor blade and tail unit had come together with the rotor tilting relative to the rudder at some 30° per second, and that the rotor must have been in position and each blade intact and almost straight when it struck the tail unit.

Examination of the gimbal rotor head assembly showed that it had been subjected to a very considerable overloading. From the way that the torque tube had hammered its fore and aft stops and the manner in which the vertical bearing attachment bolt had pulled up and rearwards through the torque tube, it was evident that considerable force had induced a high rate of angular change between the rotor disc and the longitudinal axis of the aircraft. (Appendices B and C.)

No evidence was found to show that the horizontal teeter bolt had worked loose or that the rotor bearings were in any way defective. Deep indentations on the left and right gimbal head stop plates indicated that the rotor and/or fuselage had rolled violently and overridden the cyclic maximum travel stops.

Rotor blade No 5464 had fractured at a point 14½ inches outboard of its attachment point as a result of the blade having bent 80° upwards. The resultant compression loads sheared the rivets securing the top and lower panels to the spar, and a number of these panels had then detached in flight. All the rivets were sheared in the same direction.

Rotor blade No 5463, though grossly distorted was still attached to the mast. The direction in which it had bent indicated that it had been subjected to upward and backward and downward loading. The nature of the backward and downward loading suggested that it was the result of impact with the ground.

The degree and location of the upward bending on this blade was similar to that of the other rotor blade, but although both its top and bottom panels were loosened, none had become detached. General indications were that the excessive upward bending of both rotor blades had occurred after contact with the tail unit and propeller, and before the wreckage reached the ground.

Examination of the rotor blade attachments showed that all the nuts on the tension (horizontal) and outer drag (vertical) bolts were safe tied with what appeared to be their original light alloy split pins. The nuts on the inner vertical bolts were locked with safety pins in exact accordance with the manufacturers' instructions. Examination of the flying controls showed that the forward end of the control column was bent downwards and to the right and the two vertical cyclic/pitch control rods to the rotor head torque tube were bowed.

The brazing securing a bushed sleeve into the control mixing unit for pitch control had also failed on impact.

The blade incidence setting marks scribed on the underside of the attachment blocks during manufacture were misaligned by about 0.025 inches on the broken blade and 0.010 inches on the unbroken blade. When checked with an inclinometer these alignments indicated that the original (manufacturer's) incidence setting of about plus 3½° on each blade had been reduced by about 1°. Installation instructions of the Bensen blades state that operators may alter the manufacturer's original blade settings to obtain finer tracking.

The blade attachment bolts were all tensioned about 10 per cent below recommended minimum torque. However examination of the locating pins, bolts, bores, and mating friction surfaces showed no evidence of any continuous movement of the attachments during flight. This evidence, together with that of the almost identical pitch setting and torque tensioning of each blade, suggest that neither blade had altered from the position to which it had last been adjusted.

1.13 Fire

There was no fire.

1.14 Survival aspects

The accident was not survivable.

1.15 Tests and research

Not applicable.

2. Analysis and Conclusions

2.1 Analysis

Although the construction of the aircraft was of a high standard, there were some departures from the Bensen plans. These departures were deliberate, and appeared to have been carefully considered and checked within the limits of the holder's knowledge and experience with aircraft in general, which was considerable. Some of these differences from the drawings were not of great significance, but others may well have been.

The fitting of a different engine from the one specified in the drawing had called for some modification to make allowance for the differences. Notably, the mast/rotor head plates would have to be changed to get the centre line of the rotor disc in proper relationship with the new centre of gravity. The builder appeared (the records were not complete) to have made calculations and experiments until he had a set of head plates that had resulted in the aircraft hanging in the prescribed attitude when suspended by its teeter bolt.

The engine driven propeller was modified and then changed to give more thrust, and the resultant change of trim was satisfactorily compensated for by an adjustment of the gimbal head bias springs.

Subsequent flight tests and the first 40 hours flying indicated that there were no undue difficulties with the trim, and there is nothing to suggest that any departure so far made from the published data had rendered the aircraft any less safe than the prototype.

The next stage of development, fitting replacement rotor blades, first of wood and then of metal led to terrific nose-heaviness – although the blades were of approved design – and called for the transfer of the gimbal head bias springs to the rear of the mast, thus reversing their action, and to their being stretched to nearly twice their normal length. Undoubtedly this was done to correct an out of the trim condition and presumably had the desired effect. It was not clear, and the investigation did not show why the out of trim forces should be reversed and increased by fitting rotor blades of improved performance, and it was not possible to determine the precise significance of the loss, reported by the pilot of 75 feet during an after take-off climb on a test flight shortly after the metal replacement rotor blades had been fitted.

However, it must be remembered that the springs were intended to relieve uncomfortable loads on the control column and their absence or failure would be no more than a nuisance to the pilot; the stick forces would have been well within his ability to control. The amount of overloading to which the

gimbal head assembly had been subjected and the failure of the rotor blades on upward bending indicated a force and a rate of rearwards angular change of the rotor disc in relation to the aircraft body far in excess of anything the bias springs could have produced. No evidence has come to light of the origin of this force but its magnitude indicates that its nature was aerodynamic. There was no evidence that a pre-crash failure or a malfunction resulting from any of the constructional departures from the original plan had led to the accident.

This was the second fatal accident to a gyroplane in flight in the UK since March 1969 and while this investigation was in progress there were two more, all of which exhibited the same phenomenon of the rotor coming into contact with the tail. This was an effect, not a cause, but the similarity suggested that the accidents might have been related. However, no evidence came to light to indicate a possible cause or causes, common or otherwise.

2.2 Conclusions

(a) *Findings*

(i) The pilot was properly licensed.

(ii) There was no evidence of any incapacity of the pilot that could have caused the accident.

(iii) The aircraft had a current permit to fly.

(iv) There was a rapid uncontrollable rearward tilt of the rotor disc in relation to the fuselage the reason for which could not be determined.

(v) There was no evidence of failure or malfunction of the aircraft that could have led to the rearward tilt of the rotor, or that any of the modifications to the original design contributed to it.

(vi) The rearward tilt led to the rotor blades demolishing the aircraft's fin, rudder, and propeller and subsequently to the failure of the blades under excessive aerodynamic loads.

(b) *Cause*

The accident was the result of a rapid and uncontrollable rearward tilt of the rotor disc, in relation to the fuselage, the cause of which has not been established.

G M Kelly
Inspector of Accidents

Accidents Investigation Branch
Department of Trade and Industry
December 1971