No: 3/85 **Ref: EW/C890**

Aircraft type and registration:	Piper PA-24-250 Comanche G-ARXG (light single engined fixed wing aircraft)
Year of Manufacture:	1962
Date and time (GMT):	24 October 1984 at 1145 hrs
Location:	2 miles North West of Daventry
Type of flight:	Private
Persons on board:	Crew — 2 Passengers — None
Injuries:	Crew — None Passengers — None
Nature of damage:	Minor
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	40 years
Commander's total flying experience:	653 hours (none on type)
Information Source:	AIB Field Investigation

History of the flight

The aircraft was on a positioning flight from Manchester to Leavesden with two pilots as the sole occupants. During the start up at Manchester using the aircraft's battery, the engine was sluggish to turn over and proved difficult to start. As a consequence the ammeter showed a high charge rate after the engine had finally started. However, the charge rate indicated had returned to normal by the time of take-off some 15 minutes later. Apart from this, the departure from Manchester was uneventful.

The aircraft reported over Congleton at 2000 feet and the cruise checks showed that everything was normal. The intention was to route via Lichfield and Daventry, and approaching Lichfield the pilot decided to carry out a cruise climb to Flight Level (FL) 35. When the aircraft was passing through 2500 feet the direction indicator, which was an air driven instrument, spun through approximately 180° and took up a reciprocal heading. The pilot stopped the climb to steady the aircraft and allow the magnetic compass to settle.

At the time the aircraft was in cloud and there was some light turbulence. Shortly afterwards the direction indicator returned to a reasonable heading but the pilot now became concerned about the reliability of not only the heading information, but also the indications being supplied by the ADF and VOR navaids.

As the ADF needle rotated slowly to indicate passage over the Lichfield NDB it struck on the 120° relative bearing position. Confirmation that the aircraft had arrived over the beacon was obtained from the DME. The VOR also seemed at this time to be giving inconsistent information and a heading of 220° appeared to be necessary to maintain a 170° radial. A decision was taken to descend to 2000 feet in order to try and maintain VMC, and Castle Donington ATC was informed. Shortly afterwards ATC asked the aircraft for its heading and when told 200°, advised that the magnetic track to Daventry was 150°. About four minutes later ATC again requested heading information but received no reply from the aircraft, and no further radio contact could be made. This loss of radio communications occurred approximately 40 minutes after the aircraft had taken off.

By now it was apparent to the crew that a complete electrical power failure had occurred. The pilot decided to climb in order to try and get clear of cloud and eventually levelled the aircraft at 7500 feet, where it was in the clear between cloud layers. The crew carried out a check of all the equipment in the cabin but were unable to identify the cause of the failure. The pilot therefore decided to fly a triangular pattern with two minutes legs in the hope that some ground radar station might be alerted to their predicament. This pattern was completed three times while an assessment was made of the fuel state and of the options regarding the weather and the terrain. It was decided to fly on a north easterly heading to an area where the ground was more level. However, the weather seemed to be intensifying in that direction and after about ten minutes the course was reversed. The pilot became increasingly concerned about the fuel state because, although there was plenty of fuel on board, its disposition between the tanks could no longer be determined as the fuel gauges had ceased to give any readings. The aircraft was turned on to a southerly heading and, as the cloud to the west appeared to be breaking, a descent was made to 2000 feet. Eventually a break in the cloud cover was found through which the ground was visible, and a descent was made in the clear area to below the cloud base, which was about 600 feet. The crew identified their position as being in the vicinity of Daventry and

because the tops of the hills were covered in cloud the pilot decided to discontinue the flight and carry out a precautionary landing. A large arable field of recently sown winter corn was selected and overflown for inspection. During the descent the pilot had requested the lowering of the landing gear by the emergency system but guessed from the lack of change in noise and pitch trim that it was still retracted. When the aircraft was committed to land, the shut down drills were carried out and a successful touch-down was made on the fuselage under surfaces. The aircraft skidded for a short distance before coming to rest in a relatively undamaged condition. The crew were uninjured and disembarked rapidly.

Examination of the wreckage

The aircraft was examined in the field and it was found that the generator circuit breaker had tripped and the battery was fully discharged. The undercarriage was found to be partially extended from the undercarriage bays. The emergency lowering disconnect lever, which disconnects the undercarriage actuator to allow the legs to free fall, was in the normal (stowed) position.

The direction indicator was bench tested and found to operate satisfactorily, with no tendency to drift. The engine starter motor was found to be a 24 volt unit although the aircraft had a 12 volt electrical system. Detailed examination of the electrical supply system components has shown that the regulator cut-out tended to stick slightly and that the voltage setting level was slightly low, but the indications are that the unit would have been serviceable in a normal aircraft environment with some vibration present. The ammeter calibration was found to be accurate. The ammeter was of the automotive type with scale divisions at ± full scale deflection, zero (mid) and ± half full scale deflection. The needle was broad and positioned some distance away from the instrument inner face, giving rise to considerable parallax unless read with an eye position normal to the instrument face.

It was not possible to accurately estimate the current drain on the DC bus bar during the earlier part of the flight prior to the electrical failure, but the electrical services selected would have been drawing between 15 and 20 amps and the battery charging current would add to this. An additional peak load from the DC system would have occurred during undercarriage retraction, during which the current being supplied to the undercarriage actuator could be expected to exceed 25 amps by a significant margin. This would result in a total current passing through the generator circuit breaker at this stage approaching, or exceeding 50 amps. Tests carried out on the generator circuit breaker, which is a nominal 50 amp circuit breaker located in the output line between the generator terminal and the generator bus bar, showed that the unit tripped at lower current levels than would normally be expected. (The unit went open circuit after 25 seconds at the rated 50 amp current, instead of the more typical 30 seconds at twice rated current). Laboratory examination of the battery showed that its post-accident state was fully discharged, that its capacity had been reduced to approximately 50% of the nominal value as a result of normal age deterioration, and that the discharge time from a fully charged condition, supplying a constant current at 20 amps, was 45 minutes.

On two occasions previously the aircraft had lost all electrical power as a result of a generator circuit breaker tripping. On each of these occasions, the first indication of a problem was the loss of radio contact coincident with a total loss of electrical power. On both occasions the aircraft was being flown in VMC conditions and a successful recovery was made.

G-ARXG was not fitted with any form of generator low voltage or failure warning light. The location of the ammeter was on the far side of the right hand instrument panel, making the instrument difficult to read accurately from the left hand seat, and tending to bias the apparent reading in the 'positive' charge direction. The only other visual indication that the charging system was not operating was the visual appearance of the circuit breaker itself. However, the main circuit breakers are located on a horizontal panel, mounted underneath the main instrument panel above the pilot's legs, where they are completely hidden from all normal eye positions. These breakers are identified by labels on the lower edge of the instrument panel, but the spacing of the labels did not match the spacing of the circuit breakers from one end. A subsidiary set of circuit breakers, covering the avionics equipment, was prominently mounted on the front face of the pilot's instrument panel at the lower left corner. G-ARXG was not uncommon in having no clear warning system to alert the crew to the failure of the charging system. This shortcoming has contributed to previous accidents and was highlighted in AIB Bulletin No 15/81.