DATA SUMMARY

LOCATION

Date and time	**Wednesday, 25 July 2007; 14:45 local time**[1]
Site	**Lillo (Toledo)**

AIRCRAFT

Registration	**EC-FTJ**
Type and model	**SOCATA TOBAGO TB-10**
Operator	

Engines

Type and model	**LYCOMING O-360-A1AD**
Number	**1**

CREW

Pilot in command

Age	**42 years old**
Licence	**Commercial airplane pilot**
Total flight hours	**Approximately 5,000 h**
Flight hours on the type	**246 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**2**
Passengers			
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**None**

FLIGHT DATA

Operation	**General aviation – Flight training – Dual**
Phase of flight	**En route**

REPORT

Date of approval	**30 September 2008**

[1] All times in this report are local, unless otherwise indicated.

1. FACTUAL INFORMATION

1.1. History of the flight

Aircraft EC-FTJ took off from the Ocaña Aerodrome (Toledo) on a planned Ocaña-Requena-Casas de los Pinos-Ocaña route as part of the practical training for obtaining a private pilot license. Onboard were one instructor and one student.

As stated by the crew, some 3 hours into the incident-free flight, on the return leg to Ocaña and with the aircraft at an altitude of 3,500 ft, the engine experienced a loss of power on several occasions, resulting in a loss of altitude. The instructor assumed control of the aircraft and decided to divert to Lillo, where the nearest aerodrome was, but due to the loss of power and altitude he was forced to make an off-field landing, with the engine coming to a complete stop once the aircraft was on the ground. The landing took place approximately 2 NM north of the Lillo Aerodrome and 14 NM southeast of the Ocaña Aerodrome.

The landing was done with full flaps and the aircraft suffered slight damage to the fuselage. The instructor and the student were not harmed during the landing and were able to exit the aircraft under their own power.

After conducting several field checks that ruled out problems in the fuel supply, induction system, spark plugs, and cylinder intake and exhaust, a fracture was found in the distributor block of the D4LN-3000 dual magneto installed in the engine.

1.2. Aircraft information

1.2.1. *General information*

The Socata TB-10 aircraft, S/N 1573, was built in 1993 and registered the same year in Spain. It had belonged to the same owner since its manufacture and had been used for instructional activities, first at Salamanca airport and then at the Ocaña aerodrome. It was outfitted with a Lycoming O-360-A1AD engine, S/N L33583-36A.

At the time of the incident, the aircraft had 6,530 flight hours and the engine 2528. The last flight had taken place the day before. The last checks of the aircraft had been the 100-hour (20-07-2007 with 6,525 aircraft hours) and the 500-hour (02-07-2007 with 6,500 aircraft hours) inspections. The engine had last been overhauled on 03-10-2005 with 6,000 aircraft hours.

1.2.2. *Information on the magneto*

The dual magneto on aircraft EC-FTJ, from Teledyne Continental Motors, model D4LN-3000 P/N 10-682555-11 S/N J079232G, was manufactured in October of 1992. It had been installed with 6,074 h on the aircraft on 21-03-2006, with 0 hours since the last overhaul.

The magneto had previously been installed on another TB-10 aircraft and overhauled in 2005 following a propeller ground strike. As a result of this overhaul, the distributor block was replaced, with P/N 10-682054 being installed. After this overhaul, the magneto was not in operation until its installation on aircraft EC-FTJ. At the time of the incident, the distributor block was that installed during the last overhaul and the operating hours of the magneto since the last overhaul totalled 456.

1.3. Tests and research

1.3.1. *Magneto removal and inspection*

The initial inspection following the incident revealed that the distributor block, P/N 10-682054, had broken in two down its centre, where the magneto shaft is housed. This fracture had left exposed the metallic bearing liner that sits between the roller bearing and the plastic material from which the block is made. During the disassembly of the magneto it was noted that both the bearing liner and the roller bearing had bound to the shaft and were spinning with it.

The bearing (30 in Figures 1, 2 and 3) showed obvious signs of intense overheating and friction with deformation and loss of material in the rollers, most of which had come loose from their housing. Two diametrically opposed friction marks were found on the contact face between the bearing and its liner in the distributor.

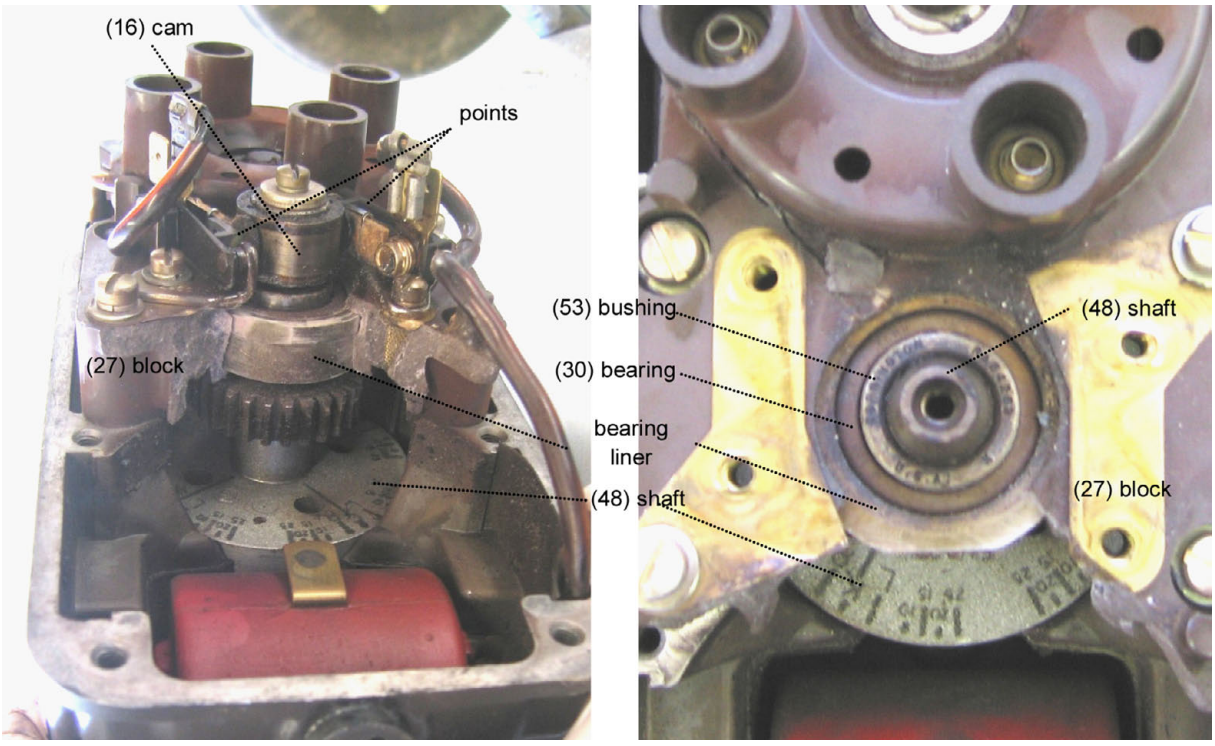

Figure 1. Damage to distributor block

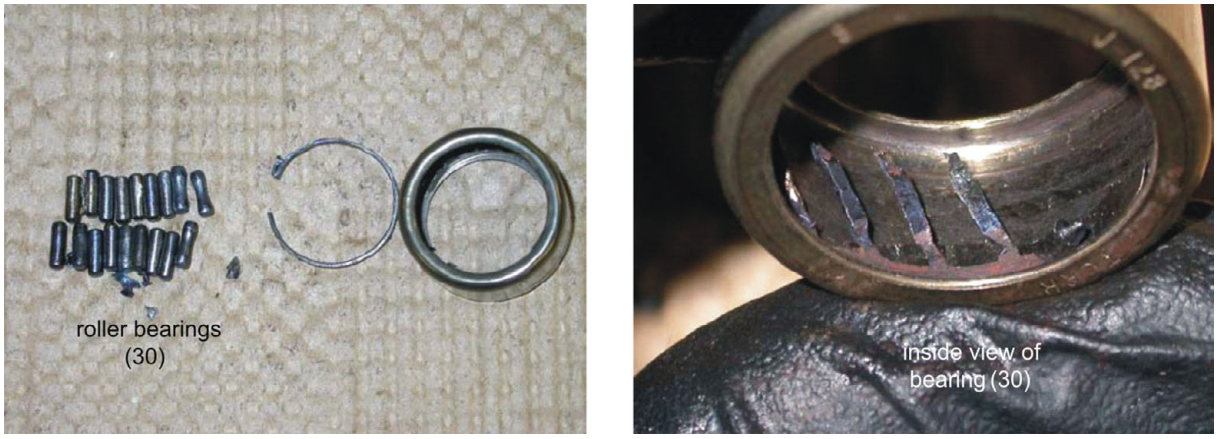

Figure 2. Damage to bearing (53)

The bushing (53 in Figures 1 and 3), which rotates inside the bearing, had severe friction marks consistent with the damage in the roller bearings.

The plastic material in the distributors block was fretted due to friction in the central area where the shaft is housed. The magneto shaft was spinning off-centre at the distributor end and the entire area showed signs of overheating. One of the platinum points did not open and the other opened incorrectly.

1.3.2. *Background and further actions*

According to information provided by the engine manufacturer (TCM), there was no record of failures similar to that which occurred on aircraft EC-FTJ.

The maintenance centre for aircraft EC-FTJ inspected the condition of the magnetos whose blocks had been supplied by the manufacturer in the same lot as that installed on aircraft EC-FTJ. No signs or indications of any problems similar to that described herein were noted.

TCM has informed that after the investigation of this accident they will continue to evaluate the processes and procedures for the manufacturing and installation of the magneto components. Up to present they have not identified any anomalies.

1.4. Additional information

1.4.1. *Description of magneto*

The DL4N-3000 is an engine-driven single-shaft dual magneto (rotating magnet, 48 in Figures 1 and 3) to which two distributors are attached on a single block (distributor block, 27 in Figures 1 and 3). The shaft spins on two bearings, one with rollers (roller

bearing, 30 in Figures 1, 2 and 3) located in the distributor block, and one with balls (ball bearing, 50 in Figure 3) situated on the engine end of the shaft.

The centre of the distributor block has a circular perforation covered by the metallic bearing liner, inside which the roller bearing is installed. There is a bushing that contacts the inner face of this bearing (roller bearing bushing, 53 in Figures 1 and 3) and which rotates along with the magneto shaft.

At one end of the shaft there is a single cam (16 in Figures 1 and 3) whose purpose is to open the platinum points through which the high voltage current is generated and distributed to the spark plugs along the corresponding wires.

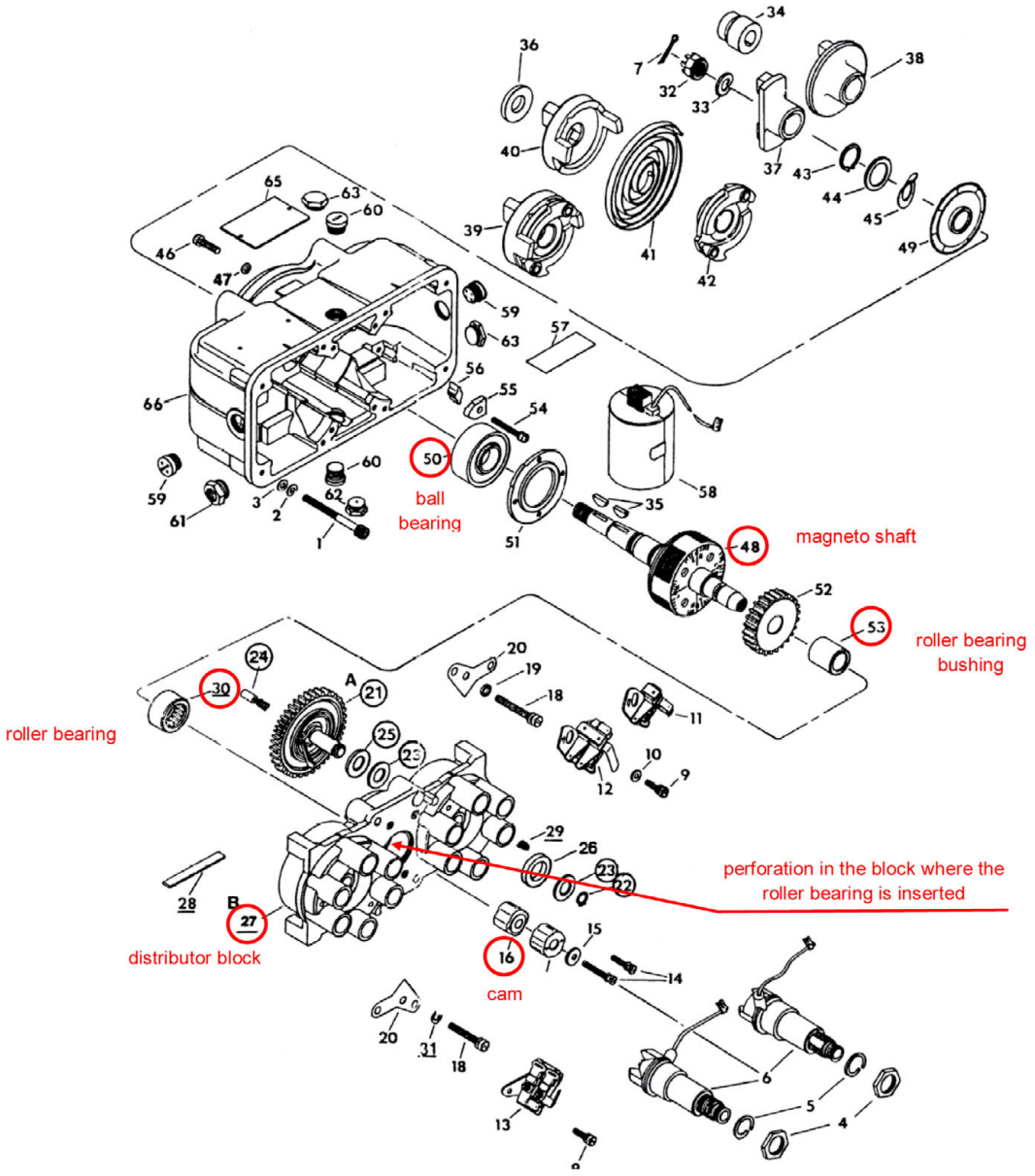

Figure 3. Location of magneto shaft and bearings

The distributor block is supplied by the manufacturer as a single assembly in which the roller bearing on which the magneto shaft spins is preinstalled and pre-lubricated.

1.4.2. *Magneto maintenance intervals*

The periodic maintenance of the aircraft and engine includes tasks affecting the magneto as an ignition system component. These tasks affect the spark plugs, the harness between the spark plugs and the magnetos, the platinum points and other applicable tasks depending on the hours of operation of the magnetos.

The maintenance intervals and procedures for the magneto are specified by the manufacturer in service bulletin SB643B, and in "Service Support Manual D-2000 & D-3000 Series High Tension Ignition Systems", and are as follows:

- Every 100 h or every year of operation, check the engine magneto timing, the magneto switches in the cockpit, the spark plugs and the spark plug harness.
- Every 500 h of magneto operation check the impulse coupling and disassemble the magneto for an internal inspection. This inspection is used to measure the diameter of the roller bearing and look for signs of clearance and overheating. It warns not to lubricate the bearing under any conditions.
- Overhaul when the engine is overhauled. In addition the magneto must be replaced or overhauled every 5 years following its manufacture date or since its last overhaul or 4 years since the magneto was placed in service (whichever occurs first), regardless of the accumulated operating hours.

2. ANALYSIS

The loss of power described by the crew of aircraft EC-FTJ resulted from the uncoordinated supply and eventual interruption of power from the magneto to the spark plugs which affected the combustion in the cylinders.

The dual magneto model D4L N-3000 P/N 10-682555-11 S/N J079232G used on the aircraft meant that the movement transmitted from the engine to the cam which opened the platinum points was common to both magnetos, with the platinum points being the first component in each magneto that is truly independent of the other. This means that any fracture or malfunction in the components shared by the magnetos will affect the operation of both, as was the case with aircraft EC-FTJ.

The damage found after the incident showed that the roller bearing and its liner in the distributor had overheated and fused together with the bushing. This resulted in having these two normally-fixed components rotate with the bushing, and therefore with the shaft, which are the rotating parts within the bearing. The rotational movement

produced by the magneto shaft must have been transmitted along the shaft-bushing-bearing-liner assembly, which led to a torsion movement in the distributor block, resulting in its fracture into two parts and the loss of the block's plastic material due to friction.

As the bearing fused to the shaft, the rotation of the latter must have slowed down until the eventual breakage of the block. It was during this process that the shaft was decentred. The torsion movement produced in the distributor block as it broke could have also shifted the block slightly, and therefore the relative position between the cam and the platinum points, thus preventing them from opening properly and probably contributing to the loss of power.

The problem, then, originated in the roller bearing on which the magneto shaft spins, the breakage of the distributor being a secondary effect.

The magneto maintenance records showed that all manufacturer-required maintenance actions had been carried out. The magneto had not reached the 500-hour operation mark since the last overhaul, during which distributor block P/N 10-682054 had been installed. Inspections prior to the 500-hour mark did not reveal any maintenance actions on the bearing. The roller bearing had been supplied by the manufacturer as part of the distributor block installed during the last overhaul, and had arrived from the factory already installed and lubricated in the block. The magneto maintenance requirements explicitly forbid lubricating the bearing, since it is not necessary. It seems unlikely, then, that a problem involving maintenance on the bearing was the cause of the incident.

The two diametrically-opposed friction marks found on the outer face of the bearing in contact with its liner in the block suggest an off-centre position with respect to the liner. This would lead to uneven contact between the bushing and the internal face of the bearing, since the rotational axis of the bushing would not have been parallel to that of the bearing. In this condition, the bushing, as it rotated about the magneto shaft, would have had greater contact with some rollers than with others, resulting in excessive friction and heating in the bearing, as evidenced by the damage noted following the incident.

This eccentricity between the bearing and its liner in the block seems likely to have originated during the installation of the bearing inside the block, since that is the only time in the life of the block when the bearing is handled. This places the problem in the bearing installation process inside the distributor block by the manufacturer. The data, however, suggest that this was an isolated case. The manufacturer is not aware of any similar previous occurrences. In addition, the manufacturer has been performing evaluations of the processes and procedures for the manufacturing and installation of the bearing and magneto components, without finding any anomalies so there is not sufficient cause to conclude that the reliability of the system is compromised. As a result, no safety recommendations have been issued.

3. CONCLUSIONS

3.1. Findings

- There was excessive heating of the roller bearing housed in the distributor block of the D4LN-3000 P/N 10-682555-11 S/N J079232G dual magneto, made by TCM.
- The bearing had been supplied by the manufacturer as part of distributor block P/N 10-682054. The roller bearing in the block had already been installed and lubricated at the factory.
- No maintenance actions were performed on the bearing since its installation in the magneto, as the conditions required for maintenance were not met.
- The breakage of the distributor block was secondary.
- Two diametrically-opposed friction marks were found on the outer face of the roller bearing where it contacts the bearing liner in the block.

3.2. Causes

The cause of the loss of power experienced by aircraft EC-FTJ was the malfunction of the D4LN-3000 P/N 10-682555-11 S/N J079232G dual magneto. The roller bearing fused to the bushing which rotates with the magneto shaft and dragged the bearing liner in the block. The shaft-bushing-bearing-liner assembly resulted in a torsion movement of the distributor block which caused it to break in two and led to the improper opening of the platinum points on the two magnetos.

The most likely cause of the roller bearing failure was an off-centre installation of the bearing inside its liner within the distributor block. This resulted in uneven contact between the bushing and the rollers in the bearing.