No: 2/86 **Ref: EW/C933/03**

Aircraft type and registration:	BAC 1-11 500 G-AXMG (twin jet public transport aircraft)
Year of Manufacture:	1969
Date and time (GMT):	19 September 1985 at 2350 hrs
Location:	Stansted Airport, Essex
Type of flight:	Positioning
Persons on board:	Crew — 3 Passengers — None
Injuries:	Crew — None Passengers — N/A
Nature of damage:	Nose landing gear components damaged, forward fuselage under-surface abraded, two small dents in fuselage side.
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Total Flying Experience:	6300 hours (of which 2020 were on type)
Information Source:	AIB Field Investigation.

The aircraft departed Stansted for Gatwick on its first flight subsequent to a B2 Maintenance Check. On selection of landing gear up after take-off the red gear-unsafe light remained on, indicating that the landing gear was not fully retracted. In addition an abnormal vibration from the nose landing gear area was noted.

The landing gear lever was lowered and the annunciator lights then indicated that both main landing gears had locked down, but that the nose landing gear had not. This was confirmed by the nose landing gear mechanical indicator. Stansted Air Traffic Control informed the crew, after a fly-past with landing lights on, that the nose landing gear appeared to be down. The landing gear free-fall lever was then operated. As there was no change in indications the lever was returned to its normal position in order to retract the main landing gear doors and prevent possible damage to them by runway contact should the nose landing gear collapse on landing. Checklists cautioned against returning the lever to normal in flight, but did not cater for the situation where free-fall lever operation did not achieve full gear extension. It was noted that the Checklist caution was at odds with a placard adjacent to the free-fall lever warning only that the "lever must not be reset until normal gear lever is selected down" and thus implying that an in-flight reset was acceptable.

After a normal approach to Stansted the aircraft touched down at 110 KIAS. The nosewheel was held off longer than usual, until approximately 100 KIAS, at which point lift dump and reverse thrust were selected. Wheel braking was not used at any point in the ground roll. At around 80 KIAS the nose landing gear collapsed. The aircraft was kept straight on the runway and halted without problem, and engines, APU, and battery were shut down and the aircraft evacuated without difficulty. There were no injuries.

Nose landing gear locking on the BAC 1-11 is performed by a lock jack (Fig 1), which is held

extended by internal springs, and in turn holds the toggle links and hence the drag links aligned when the nose landing gear is fully down. To retract the nose landing gear, hydraulic pressurization of the lock jack overcomes the spring force and causes the jack to retract. This breaks the toggle links and hence the drag links, after which the lock jack is de-pressurized, and leg retraction continues under the influence of the retraction jack. The linkage geometry is such that the lock jack reaches maximum retraction at around 10° leg angle from full down, before extending again as the leg continues up. Nose landing gear snubbing is provided by a one-way restrictor valve in the lock jack hydraulic fluid connector which allows rapid jack retraction but limits the rate of extension. During jack extension the fluid flow carries the ball of the valve against the valve seat and the flow path is limited to a slot in the seat.

Examination of the aircraft revealed that the seat was missing. Tests on a similar actuator showed that this could effectively convert the restrictor valve to a very effective non-return valve by virtue of the ball seating against the adaptor port during jack extension and completely blocking the outlet flow, thus preventing further jack extension. In such a situation nose landing gear retraction could proceed only to the point of maximum lock jack retraction. As subsequent leg movement either up or down would require the lock jack to extend, the leg would be effectively locked at the 10° position, and it would not be possible to remove this lock by means of the free-fall lever. With the leg in this position nosewheeel tyres would not contact the spin brakes, and continued wheel rotation could account for the abnormal vibration felt.

The lock jack hydraulic cylinder was found split as a result of gross overpressure, which was consistent with nosewheel ground loads having been reacted by the hydraulically locked jack. Jack de-pressurization as a result of the split then allowed the nose leg to retract on the ground.

The B3 Maintenance Check carried out immediately prior to the accident flight included a lock jack check, as required by CAA Mandatory Alert Service Bulletin (ASB) 32-A-PM 5191. The check was introduced following cases of the BAC 1-11 nose landing gear failing to lock down because of excessive lock jack spring deterioration. It involved partial pressurization of the disconnected jack "using a suitable hand-operated test rig connected to the lock jack banjo connector", followed by de-pressurization. The ASB did not provide an illustration to identify this banjo connector, but referred to Chapter 32-31-11 of the Maintenance Manual. This identified the "banjo connection" as shown on Fig 2, and it was to this component that the test rig pipe was attached for the test. In this situation the valve seat was unrestrained, and checks after the accident showed that it was quite possible for a light force to lodge the valve seat in the flared end of the rig pipe (Fig 2). It is understood that the intention of the Alert Service Bulletin was in fact for the rig to be connected to the "adaptor" in place of the flexible hose.

The Alert Service Bulletin did not schedule a landing gear retraction test after the lock jack had been tested.

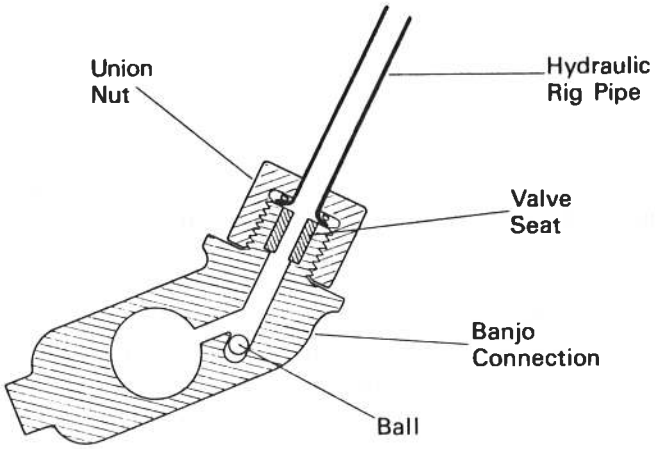

Fig 2 – Sectional View of the Banjo Connection as connected to the Hydraulic Rig

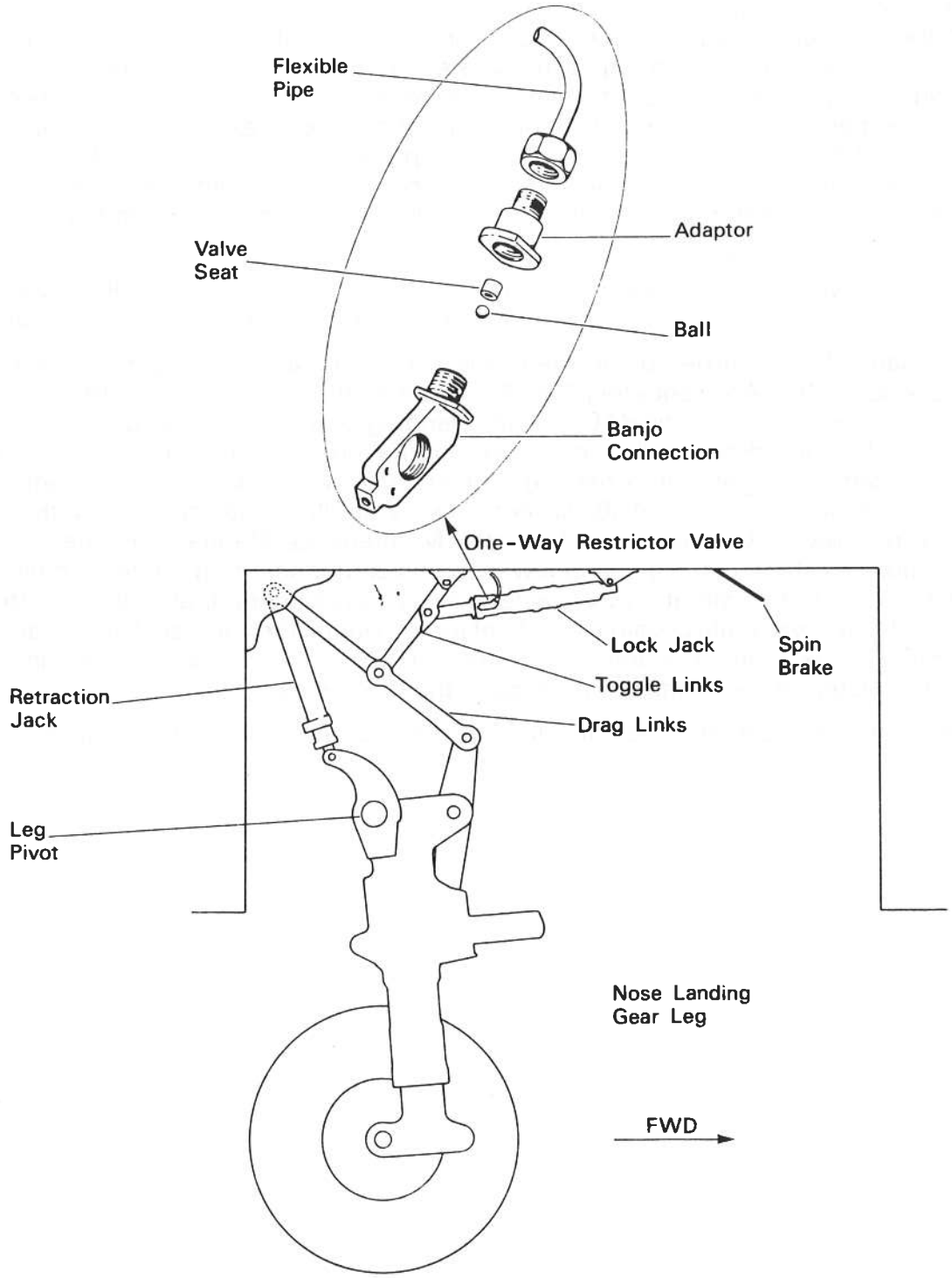

Fig 1 – Nose Landing Gear Schematic