



MINISTRY OF COMMUNICATION
Civil Aeronautics Administration
Brussels

TECHNICAL INVESTIGATION REPORT
ACCIDENT TO HELICOPTER BELL 47G2
REGISTERED OO-ART
OCCURRED ON 1TH MARCH 1972

CELLULE D'ENQUETES
D'ACCIDENTS
ET D'INCIDENT D'AVIATION

CEL VOOR ONDERZOEK VAN
LUCHTVAART
ONGEVALLLEN-EN INCIDENTEN

MINISTRY OF COMMUNICATIONS
CIVIL AERONAUTICS ADMINISTRATION
TECHNICAL DEPARTMENT

1130 HAREN, 14 February 1973.

ACCIDENT TO HELICOPTER BELL 47G2 - C4
REGISTERED OO - ART.
TECHNICAL INVESTIGATION REPORT

1. AIRCRAFT INFORMATION

- 1.1. Type of aircraft : Helicopter BELL 47G2 - C4.
- 1.2. Manufacturer : Bell Helicopter Corp
Fort Worth, Texas, U.S.A.
- 1.3. Serial nr. : 1137.
- 1.4. Year of production : 1956.
- 1.5. Registration marks : OO - ART.
- 1.6. Owner : HELISERVICE, N.V.
Helmweg 15 A
B - 8300 KNOCKE.
- 1.7. Certificate of registration : nr. 2183, issued 16 February 1972.
- 1.8. Certificate of airworthiness : a provisional permit to fly was issued on 17 February 1972, awaiting for issuance of the Certificate of Airworthiness. The permit was valid until 10 March 1972.
- 1.9. Engine : type : 1, Franklin 6VS 335A.
Serial nr. : 45144.
Year of construction : 1965.
Time since overhaul : new engine.
Total time : 8 h. 45 m.
- 1.10. Aircraft history :
The helicopter under German registration D - HECI was stopped on 14 June 1966, at 1150 flying hours, for complete obstruction of the oil filter, due to use of improper oil grade.
It sustained major overhaul and modification works at "Clever and Rietdorf GMBH, Saffig, Germany".
Among these works, following modifications were embodied :
- a new Franklin engine was fitted, replacing the former Lycoming VO 435 engine.

- Installation of the cabin modification kit "Carson C4".
- Installation of the Carson turbo-supercharger modification kit.

On 20 December 1971, after test flight, the main gearbox is completely disassembled and overhauled again owing to a heavy smell of burning oil. Severe corrosion was noted in the gearbox where some parts showed traces of overheating : lower end of rotor mast and its needle bearing, bottom of sun gear and the cooling fan drive and its bearing. Some bearings and shafts were damaged.

All mandatory modifications and inspections were complied with, before or during the major overhaul.

At the moment of the accident, the helicopter had flown :

- total time since new : 1 158 h. 45 min.
- time since overhaul : 8 h. 45 min.

The last maintenance work took place at 1 156 h. 45 min. A 25 hours inspection was carried out and the engine oil was changed. (ESSO Aviation oil, grade E 80).

2. MAIN GEAR-BOX

2.1. DISASSEMBLY AND FINDINGS :

The case of the main gearbox shows visible signs of overheating (see photographs nr. 1, 2 and 3.)

The main gearbox and the rotor mast were completely disassembled in the following order, referring to figure 12, rev. 15.1.67, of the "Illustrated Parts Catalog" (figure in appendix) :

- removal of the rotor head ;
- removal of the main rotor mast ;

FINDINGS : The lower end of the rotor mast had been abnormally overheated, the inner race of the needle bearing is damaged and the lower stud is twisted off. (see photographs nr. 4, 5 and 6.)

- removal of top case (item 62) and upper ring (item 61.)

FINDINGS : All the teeth of the pinion gears of the upper spider (item 60.) are sheared. There are many metal chips and evidence of overheating. (see photograph 7.)

- removal of the upper spider (item 60.)
- removal of the center case (item 57) and of the free wheel (item 56- photograph nr. 8).

FINDINGS : All the pinion gears of the upper spider (item 60, were shaved, they are heavily distorted and their roller bearings are damaged (see photographs nr. 9, 10 and 11.)

- removal of the lower spider (item 54 photograph nr. 12).

FINDINGS : All the teeth of the upper crown of the sun gear (item 53) are severely damaged (see photograph nr. 13). The bearing cages of the opinion gears of the lower spider are broken and some rollers are missing (see photograph nr. 14.)

- removal of the sun gear (item 53.)

- removal of the lower case (item 9.)

- removal of the clutch (item 3.)

FINDINGS : Filings and metal chips are at the bottom of the main gearbox (photograph nr. 15). There lie the end of the broken stud coming from the main rotor mast, with its nut, cotter pin, and washer (photograph nr. 6) and also the outer race of the needle bearing (item 52.) which came out of its housing in the sun gear (photographs nr. 16 and 17.)

Photograph nr. 17 shows the identification marks on the needle bearing

Photograph nr. 18 shows the metal scraps collected in the main gearbox

2.2. DISCUSSION :

The damage in the main gearbox is characteristic of a long running time with excessive heat.

The main rotor mast is colored blue at its lower end, due to overheating. The nut, the cotter pin and the washer retaining the inner race of the needle bearing are clear and did not overheat. (Photograph nr. 6.)

The cotter pin is sheared due to a clockwise motion of the nut and marks of seizing are visible on the mating faces of washer and nut.

The inner race of the needle bearing is seized on the main rotor mast (photograph nr. 19).

The outer race shows evidences of overheat and hammering in its housing in the sun gear. The needles are imprinted in the bearing outer race, show flat faces and are jammed (photograph nr. 16.)

3. LUBRICATION SYSTEM

The main gearbox is lubricated by nozzles spraying oil into it : one is located in the upper case (photograph nr. 3), another is located in the center case and a third one is plugged at the top of the engine crankshaft and sprays the oil in the bottom of the main gearbox (photograph nr. 15).

The temperature of the transmission is sensed by a resistance bulb located in the center case (item 26.)

The installation of a turbo-supercharger required a modification of the oil system : at the oil pump outlet, a "T" shaped connector distributes the oil to the main gearbox (upper line) and to the turbine (lower line) (photograph nr. 20.)

The oil used in the engine is ESSO AVIATION OIL-E-80.

One sample of new oil and one sample of oil coming from the engine were analysed. The tests show that the oil conforms to the appropriate specification and that the oil coming from the engine is still in good condition. The oil quality is not suspected to have had an influence in the accident.

Following checks were performed :

- oil level : satisfactory ;
- oil strainer : clean ;
- magnetic plug : filings (photograph nr. 21).
- oil lines to main gearbox, strainers and nozzles : clean ;
- oil nozzle on top of crankshaft : blocked (photograph nr. 15).

This nozzle was tested as follows: submitted to a pressure of 75 psi of E - 80 oil heated to 100° C, there was no oil flow through the nozzle. To clear the nozzle, a small piece of dirt looking like a thin plastic film 3 mm. long was extracted from it (photograph nr. 22).

4. TURBO-SUPER CHARGER :

There was abnormal friction in the turbo-super charger system. When disassembling the unit, it was found that the shaft rubbed against the case at the wheel end, instead of being guided in the bearing (photographs nr. 23 and 24). The lines supplying oil to the bearings and to the thrust bearing were fouled (photograph nr. 25 and 26.)

5. CONCLUSION

The damage to the main gearbox may have occurred as follows.

Due the obstruction of the oil nozzle at the bottom of the main gearbox, the needle bearing at the lower end of the main rotor mast is badly lubricated and cooled. The needles jam in the outer race and force the inner race to rotate on the shaft. The retainer washer rotates also and causes the nut to tighten, shearing the cotter pin and twisting off the stud. The needle bearing becomes overheated. The outer race becomes loose

in its housing and falls out of the sun gear. The main rotor mast is no longer guided at its bottom and the loading on the pinions and their bearings increases, leading to progressive deterioration by overheat and overload.

6. COMMENTS

6.1. After the flight test performed on 20 December 1971 at the completion of the major overhaul at "Clever and Rietdorf", the defect found at the lower end of the main rotor mast and the needle bearing is of the same nature than that which caused the accident, but the damage were more limited.

6.2. During the flight test performed on 17 February 1972 for the delivery of the belgian certificate of airworthiness, the transmission temperature rose up tot 120° C, with an engine oil temperature of 70° C.

During the flights performed between 20 February and 1 March 1972, the pilot reported transmission temperature rising up to 130° C, which is the upper limit mentioned in the aircraft's flight manual. The temperature indicator and the bulb were tested and found satisfactory.

7. PROBABLE CAUSE OF THE ACCIDENT

The accident was caused by mechanical damage in the main gearbox due to excessive overheating. The probable cause of heat building up is the obstruction of the oil nozzle located on the top of the engine crankshaft, which lubricates and cools the needle bearing at the bottom of the main rotor mast.

This defect was probably already existing when the helicopter came out of major overhaul at "Clever and Rietdorf", and no correction was brought to it.

Though the pilot reported high transmission temperature, no corrective action was taken because the temperature was within the limits specified in the flight manual. But continuous running at the upper limit was detrimental for the transmission.

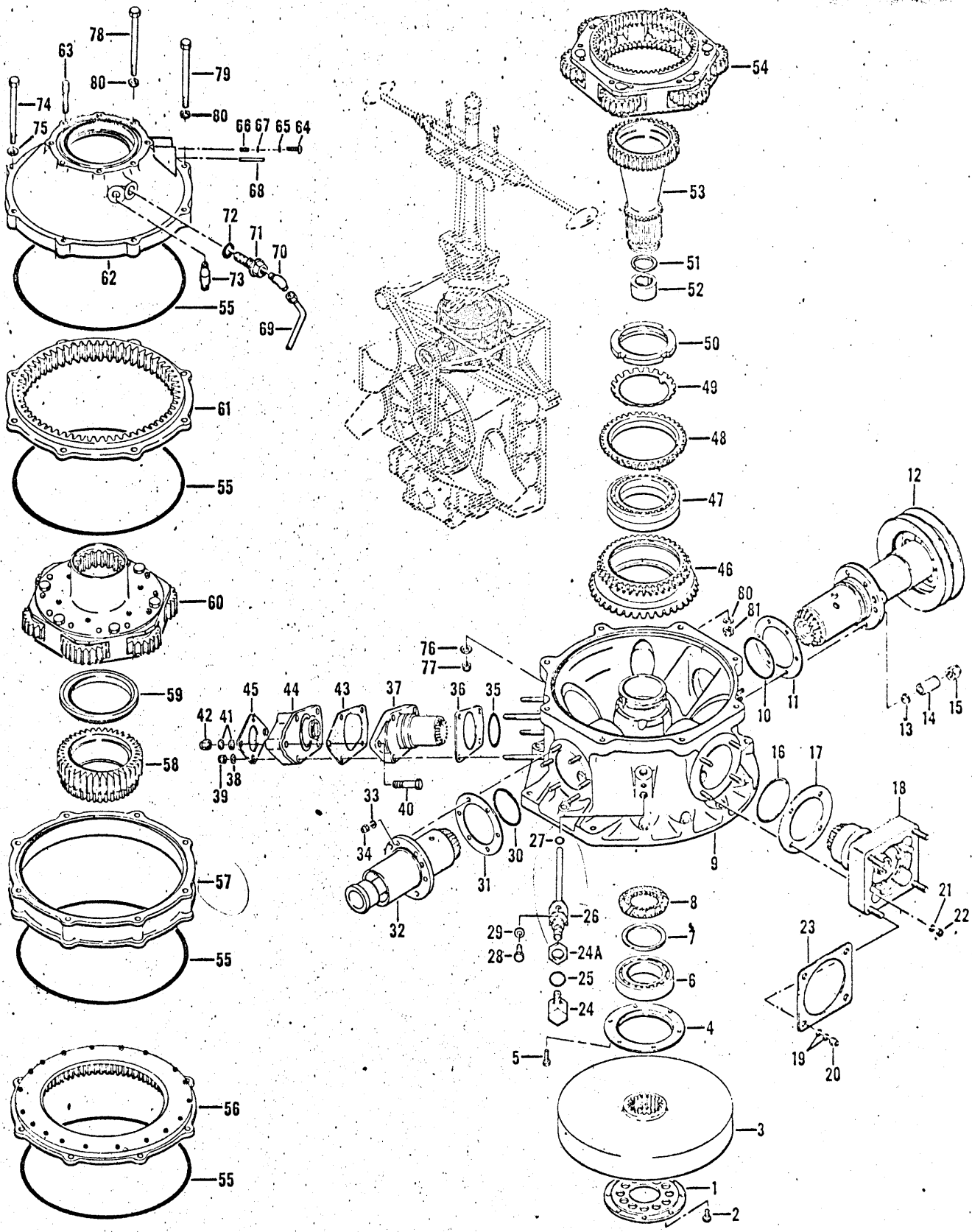
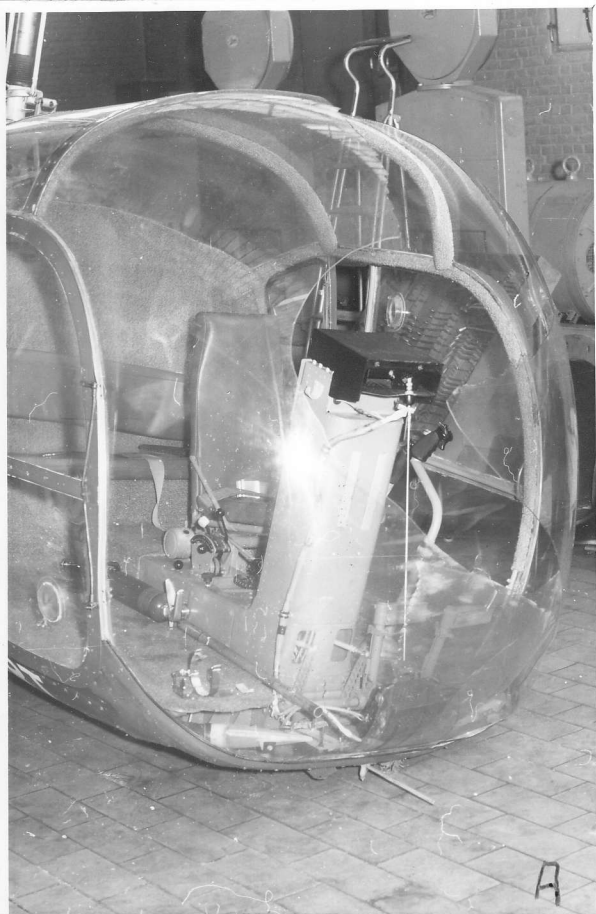
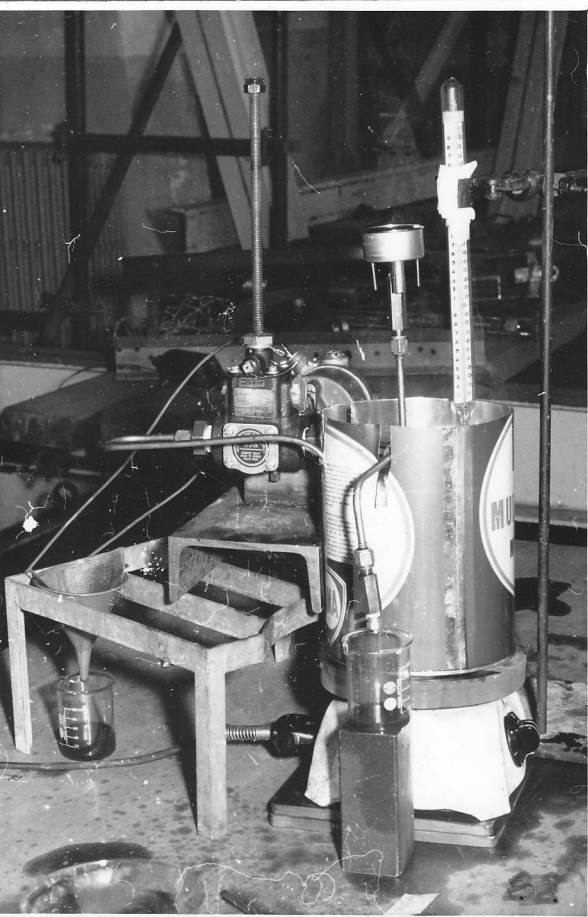
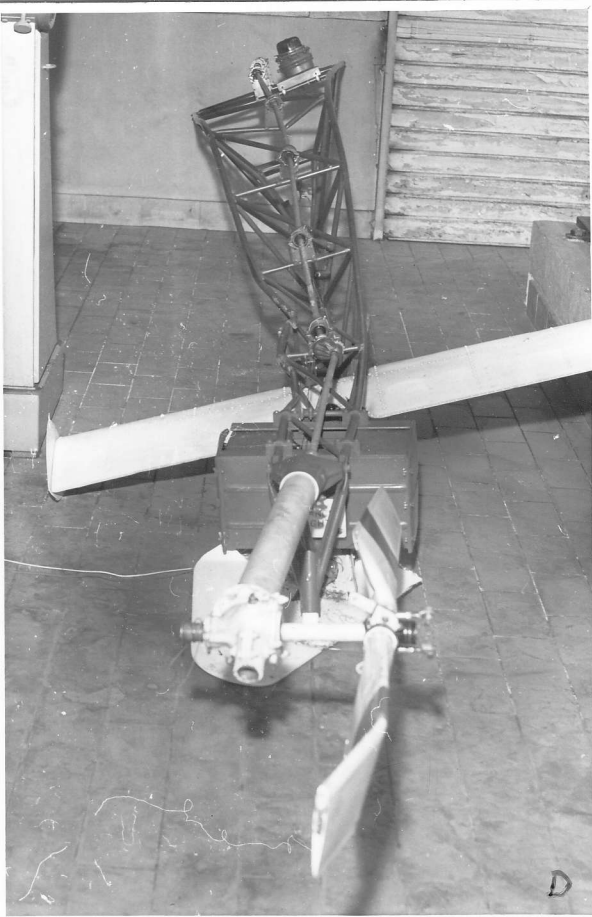


Figure 12. Main Rotor Transmission Assembly

Revised 15 January 1967







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