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POWERPLANTS GROUP CHAIRMAN's FACTUAL REPORT OF INVESTIGATION NTSB ACCIDENT MIA82IA051 March 18, 1982

(16 PAGES)

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AS-40

Disc 185

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Technology
Washington, D.C. 20594

March 18, 1982

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

A. Accident

Location	:	Miami, Florida
Airline	:	Pan American Airways
Aircraft	:	Boeing, B-727-200 Tri-jet, N4734
Date	:	February 17, 1982
Time	:	3:30 p.m. e.s.t.
NTSB No.	:	MIA-82-IA-051

B. Powerplants Group — Paul Baker, NTSB - Chairman

C. SUMMARY

About 3:30 p.m., e.s.t. on February 17, 1982, Pan American Airlines flight No. 975, Miami to Orlando service, was aborted during takeoff from Miami International Airport. The abort was initiated when the flight crew heard a loud explosion followed by severe vibration and a fire warning light. The explosion occurred as power was being increased to the desired takeoff power setting of 1.96 RPTO-EPR 1/ when the EPR indicator was reading 1.94. The Miami Tower advised the crew of flight 975 that there was fire and smoke coming from the area of the No. 2, (center) engine. After the explosion, the aircraft was diverted to an adjacent intersecting taxiway where the aircraft was stopped, and the 47 passengers and crew evacuated through the emergency exits and slide chutes. Two passengers sustained minor injuries during the evacuation process. The airport fire department extinguished the fire in the tail of the aircraft when the onboard fire extinguishing system was ineffective.

A cursory examination of the aircraft tail section after the incident indicated that the probable cause of the explosion was a failed, front compressor, front hub, (1st stage compressor fan disc) on the No. 2 engine. During liberation, a section of the disc cut into and severed the fuel supply line to the No. 2 engine causing the subsequent aircraft fire. See attachments 1 through 4.

The failed parts were recovered from the runway and adjacent areas and were forwarded to the engine manufacturer for failure analysis.

D. DETAILS OF THE INVESTIGATION

1. Pan American flight 975 is operated with Boeing B-727 type airplanes. On February 17, 1982 a B-727-200 airplane, Registration No. N-4734 was assigned to this flight. The B-727 airplane is powered by 3 Pratt & Whitney model JT8D turbo fan engines located on the aft section of the fuselage.

1/ Reduced Power Take-off - Engine Pressure Ratio

(1)

QUALITY CONTROL CHECK

2. Powerplants:
Manufacturer: Pratt & Whitney Aircraft Group, East Hartford, CT.
Model: JT8D-7B
Serial No. and Position: P-654892 No. 2, Center fuselage location.
Total Engine Time/Cycles: 30,943 Hrs. 28,637 cycles.
The JT8D-7B is an axial flow, fully ducted, front turbo-fan engine. The JT8D- 7B engine is rated at 14,000 lbs. thrust at takeoff power.

It employs a four-stage turbine to drive a "dual-spool", thirteen-stage compressor. consisting of 6 low-pressure and 7 high-pressure stages. The term "dual-spool" identifies the compressor design which separates the compressor into two independent rotating assemblies. The six-stage, low-pressure compressor (N1) is driven by the second, third and fourth stage turbines. The seven stage high-pressure compressor, (N2) is driven by the first stage turbine. The two-stage fan is equipped with a full length annular discharge duct. This permits the fan air (secondary air flow) to be discharged with the exhaust gases (primary gas flow) through a common exhaust nozzle. The major rotating assemblies are supported by seven main bearings.

The dry weight of the engine is 3,156 lbs.

Low-Pressure Compressor (N1)

Purpose:

Fan stages accelerate secondary (outer) flow
N1 compresses the air that passes through primary (inner) air stream to the high-pressure compressor

Stages:

2-stage fan
4-stage low-pressure compressor

Support:

No. 1 and No. 2 bearings

Rotor Assembly:

6 disks (2 fan - 4 low-pressure compressor)
2 hubs
4 interstage spacers/airseals
28 tiebolts, 16 fan/12 low-pressure compressor
Blade retention scheme
- 1st stage fan - dovetail slots/positioning ring
- 2nd stage fan - pin-joint attachment/rivet
- 3rd stage - dovetail slots/retaining plate
- 4th through 6th - dovetail slots/tablocks

Driven by 2nd, 3rd and 4th stage turbines

(2)

QUALITY CONTROL CHECK

3. Engineering Investigation:

a. Failed Part Statistics:

Removed from Engine: JT8D-7B, Ser. No. P654892
Part Name: Hub, Front compressor, front.
Part Number: 749701C
Part Time: 12,534 Hrs. / 9,360 cylces
Engine Application: JT8D-1 through - 7 engine models
Part Serial No.: 5A5786
Part Heat Cone: WENS 2028
The front compressor, front hub was forged by Wyman Gordon from PW A 1215 (6Al-4V) titanium base alloy material. The part was machined by Pratt & Whitney, at its North Haven, CT, plant.

b. Preliminary Metallurgical Examination

A preliminary metallurgical examinat on was completed on the failed hub by the Pratt & Whitney Materials Engineering and Research Laboratory, East Hartford, CT. on February 19, through 22, 1982 As a result of this examination the following data were developed relative to the failure of the hub:

(1) The hub fractured radially through the bore and rim in two locations, releasing two sections comprising approximately 120° and 240° of the hub circumference, respectively. See attachment No. 5a to 5c.

(2) Binocular examination of the fractures re ealed fatigue which progressed from origins in a circumferential groove at the rear end of the tie rod hole. Fatigue extended approximately 1.25 inches inboard toward the bore and 0.035 inches outboard toward the rim. Fracture termination w s due to rapid tensile overload. See attachment No. 6.

(3) The surface of the groove exhibited a very rough, smeared appearance and there were numerous axial cracks. See attachment No. 7.

(4) A dimensional inspection of the circumferential groove was accomplished using a shadowgraph. Examination of replicas made of the groove revealed that the groove had a maximum width of approximately 0.125 inch and a maximum depth of 0.025 inch. There were some narrow areas between the groove and the rear break edge of the tie rod hole that were apparently machined flush with tie rod hole surface on the other side of the groove.

(5) The groove was not concentric with the bore of the tie rod hole.

(6) Scanning electron microscope (SEM) examination of the fracture surface revealed striations typical of low cycle fatigue (LCF). A striation count analysis revealed 7,200 cycle (± 10%) of fatigue progression.

(3)

10-79 - Engine P-655019 was removed for FOD, 6/ 1st and 2nd stage rotors replaced. Hub Ser. 5A5786 had the following work accomplished.

- o Graphite Anti-gallant varnish stripped per SPOP-18.
- o Zyglo inspection.
- o Dimensionally inspected (critical dimensions).
- o Blade slots were shotpeened and graphite varnished. Hub Ser. 5A5786 was then installed in JT8D-7B engine Ser. No. P-654892, TPT - 7,725 hours and 6,578 cycles.

2-17-82 - Hub Ser. 5A5786 fractured in Engine Serial P-654892, TPT - 12,537 hours and TPC - 9,361 cycles.

The design of the front compressor, front hub for the JT8D-1 through 7 engine models has been essentially unchanged in the area of the hole configuration since it was first introduced in the JT8D engine in 1964. A total of 3,750 JT8D-1 through -7 engines delivered since 1964 have accumulated in excess of 140 million cycles and there have been no reported problems associated with the bolt hole condition or configuration. An estimated 12,700 front compressor, front hubs have been retired from service during the same period.

A total of 3,750 part No. 749701 front compressor, front hubs have been delivered as spare parts since the hub was introduced in 1974. In addition 1,863 front compressor, front hubs, of an improved design for JT8D-1 through -7 engines have also been delivered since being introduced in 1977. This translates to over 5,000 front compressor, front hubs being retired from service since 1974 with no reported problems.

d. Manufacturing Review

A comprehensive review of the manufacturing and inspection operations was conducted to determine the adequacy of these operations in the production of the front compressor, front hub, as applicable to the bolt and lightening hole area. In addition, the Quality Review records were surveyed for any activity relating to bolt hole operations and/or inspection discrepancies.

The tie rod and lightening holes are produced by drilling, boring, honing, and a barrel finishing process. Deburring and break edge operations are performed after each major step in the hole production. An etch anodizing process, fluorescent penetrant inspection, and visual and dimensional checks are completed at prescribed points in the fabrication process.

The survey of the Quality Review file of 3,261 front compressor, front hubs, manufactured since 1974 disclosed a total of 59 nonconformances submitted for a variation to engineering requirements in the area of hole inspection and production. Of the 59 nonconformances reviewed, 29 were submitted by the manufacturing department and 30 by the inspection department. These 59 nonconformances were cleared and/or disposed of as follows: 34 hubs were salvaged by the installation of a sleeve repair; 4 hubs were scrapped; and the balance of 21 hubs were either reworked or accepted "as is."

The failed hub was not one of the 59 nonconformances detailed above.

6/ Foreign Object Damage.

(4)

(7) A metallographic examination of a section through the fatigue origin (nonconforming circumferential groove) revealed a work hardened area at the surface of the tie rod hole which extended to a depth of about 0.25 inch below the hole surface. The hardness of the work affected area was as high as HRC-55. 2/ The hardness of the part material in areas away from the groove and, therefore, not affected by any machining operation, was found to be HRC-34 to HRC-36, and within part specifications. An increase of the material hardness is not uncommon during abusive machining operations.

(8) Fluorescent Penetration Inspection (ZL-22) (FPI) of the fractured hole exhibited indications in the groove indicative of smeared metal and axial cracking. The other 15 tie rod holes exhibited no evidence of cracking.

(9) The hub material conformed to the composition, hardness and microstructure requirements of the PWA 1215 specification. A dimensional inspection of the tie rod holes adjacent to the fractured hole indicated that they conformed to drawing diameter requirements.

c. Failed Part History

4-75 - Shipped by P&W to TWA as spare part.

6-26-75 - Installed new, zero time, by TWA in National Airlines engine P-655019.

?-76 - Engine P-655019 was removed for being EGT 3/ limited. No low pressure compressor work performed.

1-78 - Engine P-655019 was removed for compressor stall; discovered 12th and 8/13 stage damage; hub received visual inspection. No rework required. Reinstalled in P-655019, TPT 4/ - 4,100 hours and TPC/ 5/- 4,056 cycles.

9-78 - Engine P-655019 was removed for being EGT limited, high turbine vibration and slow acceleration. Hub removed. The blade slots were cleaned and the journal diameter measured. A visual inspection cleared the hub for reinstallation in P-655019, TPT - 5,719 hours and TPC - 5,317 cycles.

2/ HRC-55 = Hardness, Rockwell "C" scale with a relative hardness reading of 55.
3/ Exhaust Gas Temperature.
4/ Total Part Time.
5/ Total Part Cycles.

(5)

A sequential, step-by-step, listing of the machining and inspection operations pertinent to the production of the 32 tie rod and lightening holes in the front compressor, front hub, is provided as attachment No. 8. During the production of the front compressor, front hub, tie rod and lightening holes there are a total of 13 separate inspection operations involving six different individuals, several of which pertain to the exact area of the tie rod hole at which the nonconformance groove was found.

e. Authorized Part Life

The latest authorized part life for Part No. 749701, front compressor, front hub, is 16,000 hours and 13,500 cycles.

[redacted]

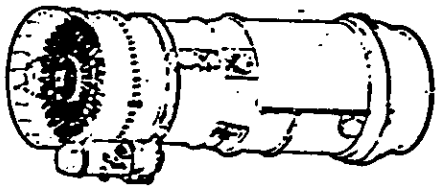
Paul Baker
Powerplant Specialist

(6)

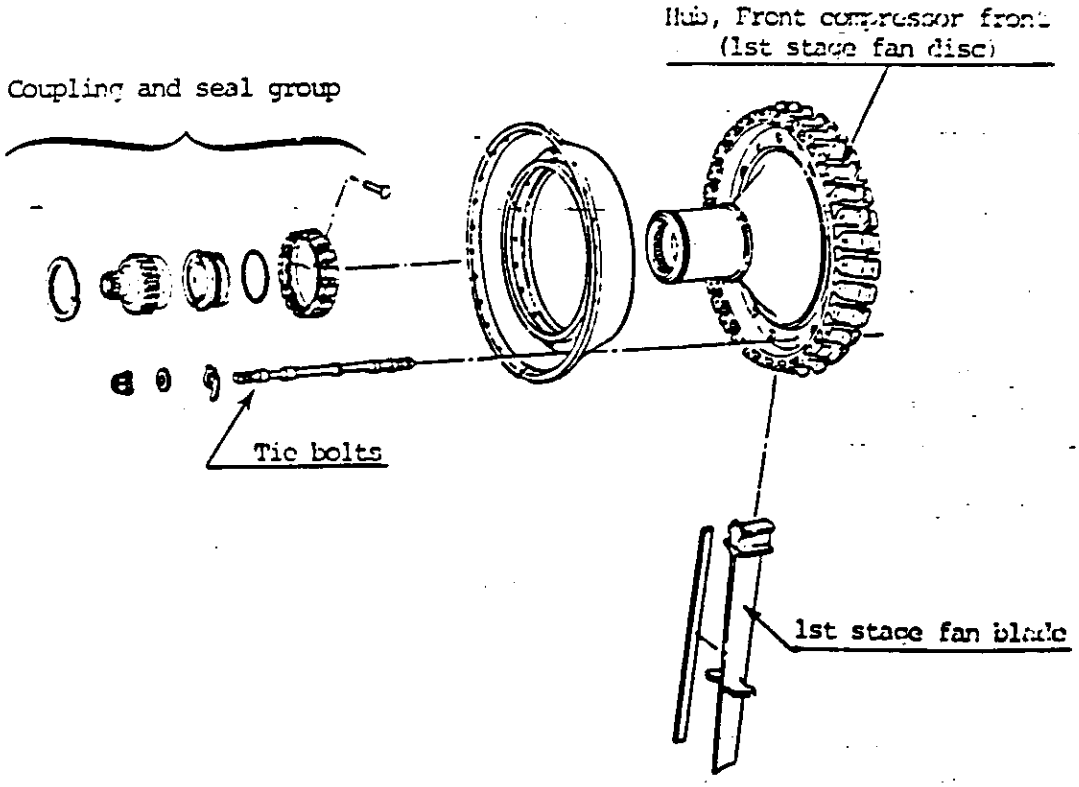
QUALITY CONTROL CHECK

ATTACHMENT No. 2

Front compressor, front hub build-up and miscellaneous parts.



JT2D Reference location



7

QUALITY CONTROL CHECK

ATTACHMENT No. 6

Hub-Front Compressor, Front
P/N 749701, S/N 5A5786

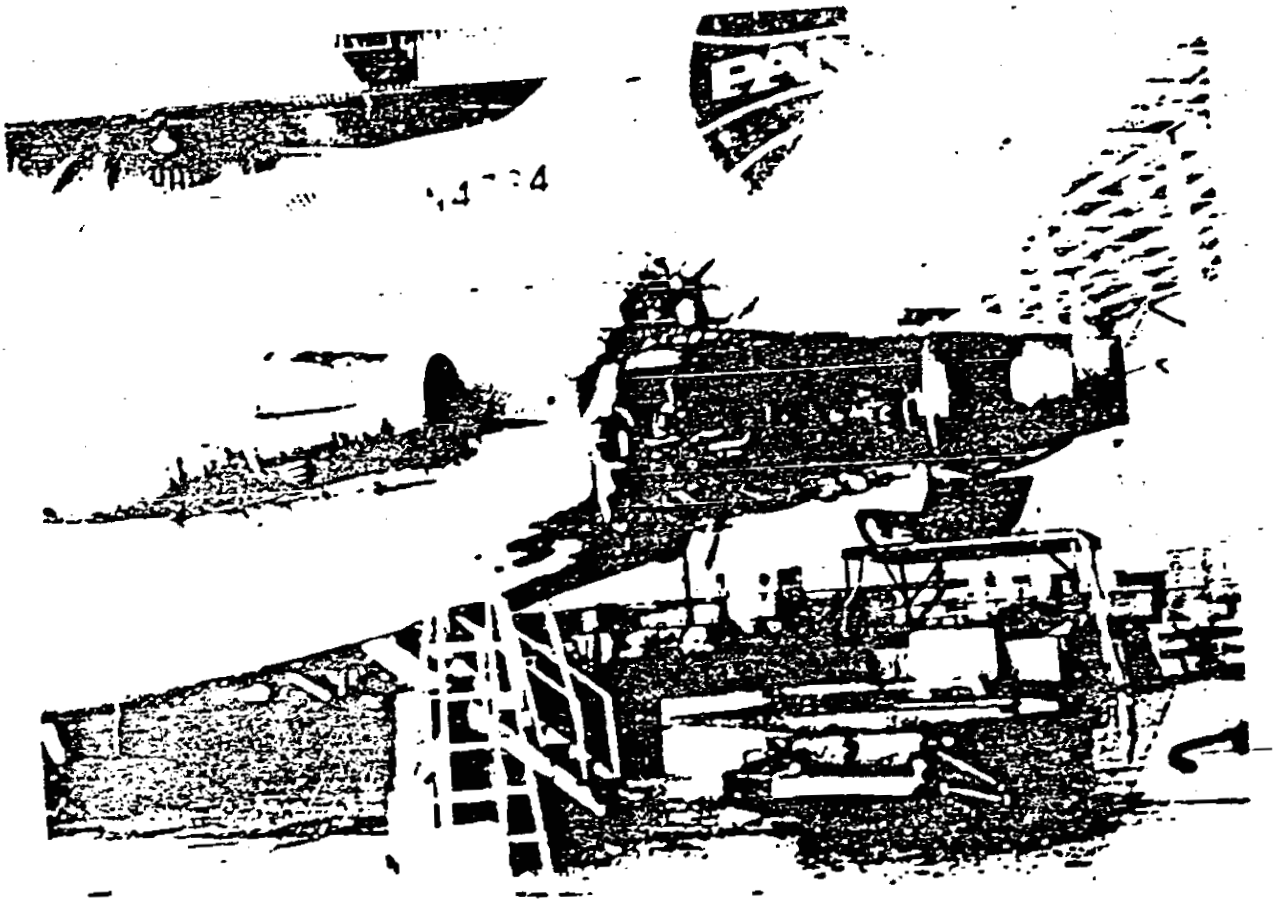
Below is a sequential listing of the Machining/Inspection events germane to the area of distress experienced on the subject hub.

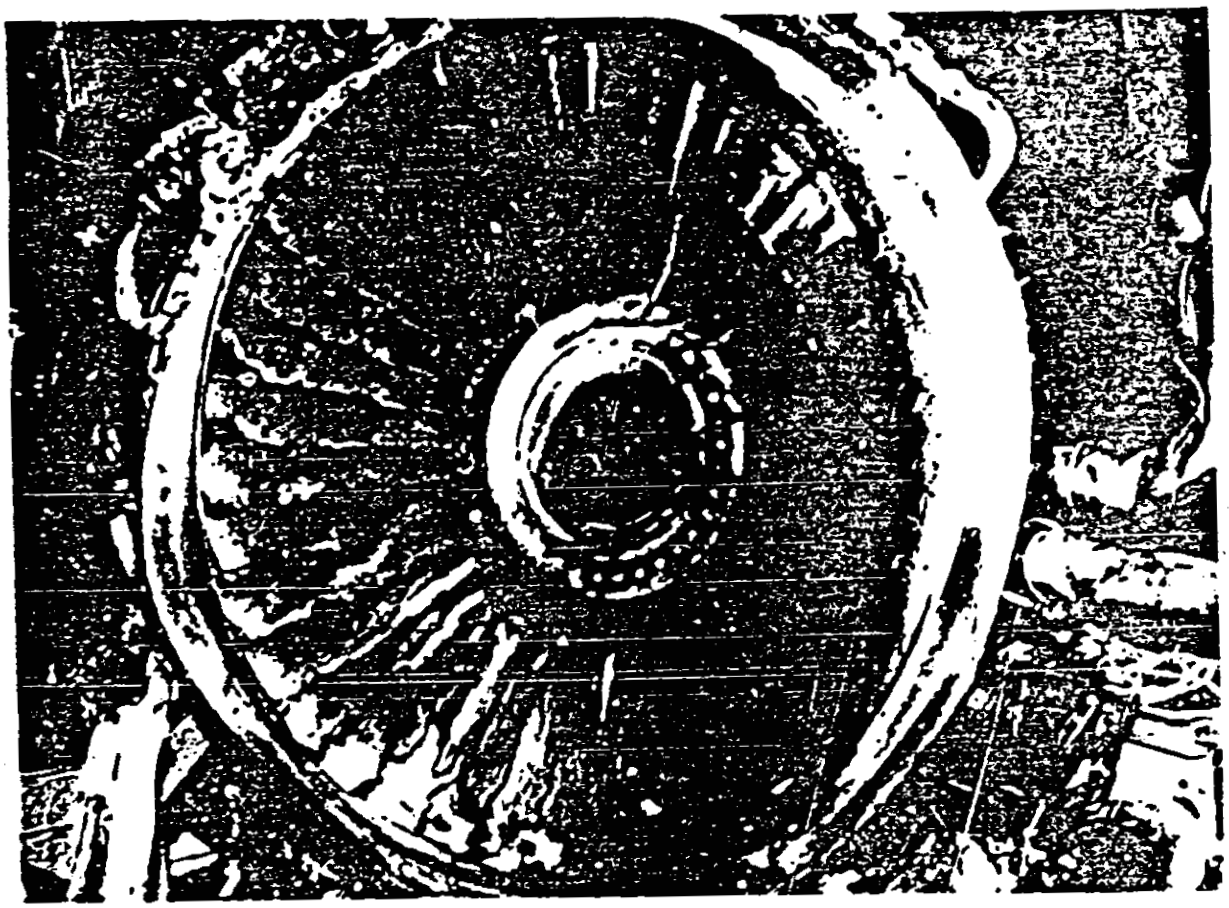
Sequence	Operation #	IMS #	Operation/Inspection
1*	280	--	Drill 32 holes, (16) .384-.389, (16) .400-.405. ream one random hole to .406-.407.
2*	290	--	Remove burrs and break edges .003-.010 at both ends of 32 holes
3	370	--	Rough bore and finish bore 32 holes, (16) .4165-.4175, (16) .435-.436
4	380	--	At 64 edges of 32 holes, de burr, abrasive cone polish and butterfly
5*	390	--	Hone 16 holes, .438-.439 - .001 T.P.
6*	400	--	Hone 16 holes, .4195-.4025 - .003 T.P.
7	490	25	Etch Anodize Inspection
8	580	32	Fluorescent Penetrant Inspection
9	610	36	General Visual Inspection
10	610	51-52	Barrel finish - inspect front end of 32 holes per VIS-72
		106	.437-.440, (16) holes dimensional inspectic with air gage
		107	.4185-.4215, (16) holes dimensional inspection with air gage
		161	Barrel finish - inspect rear end of 32 holes per VIS-72
		162	Inspection PWA 99 finish ID of 32 holes
		163	Inspection PWA 99 finish rear end of 32 holes
		164-165	.490 & .472 maximum diameter rear end
		113-114	.490 & .472 maximum diameter front end
		228, 267, 269	Visual inspection of hub, both sides, including holes to VIS-91 and DCS-104. IMS statemer - "Mount disk on rotary easel, if applicable, mar starting point, rotate 360° both sides, mark stopping point if interrupted. Hold white paper behind holes and slots."

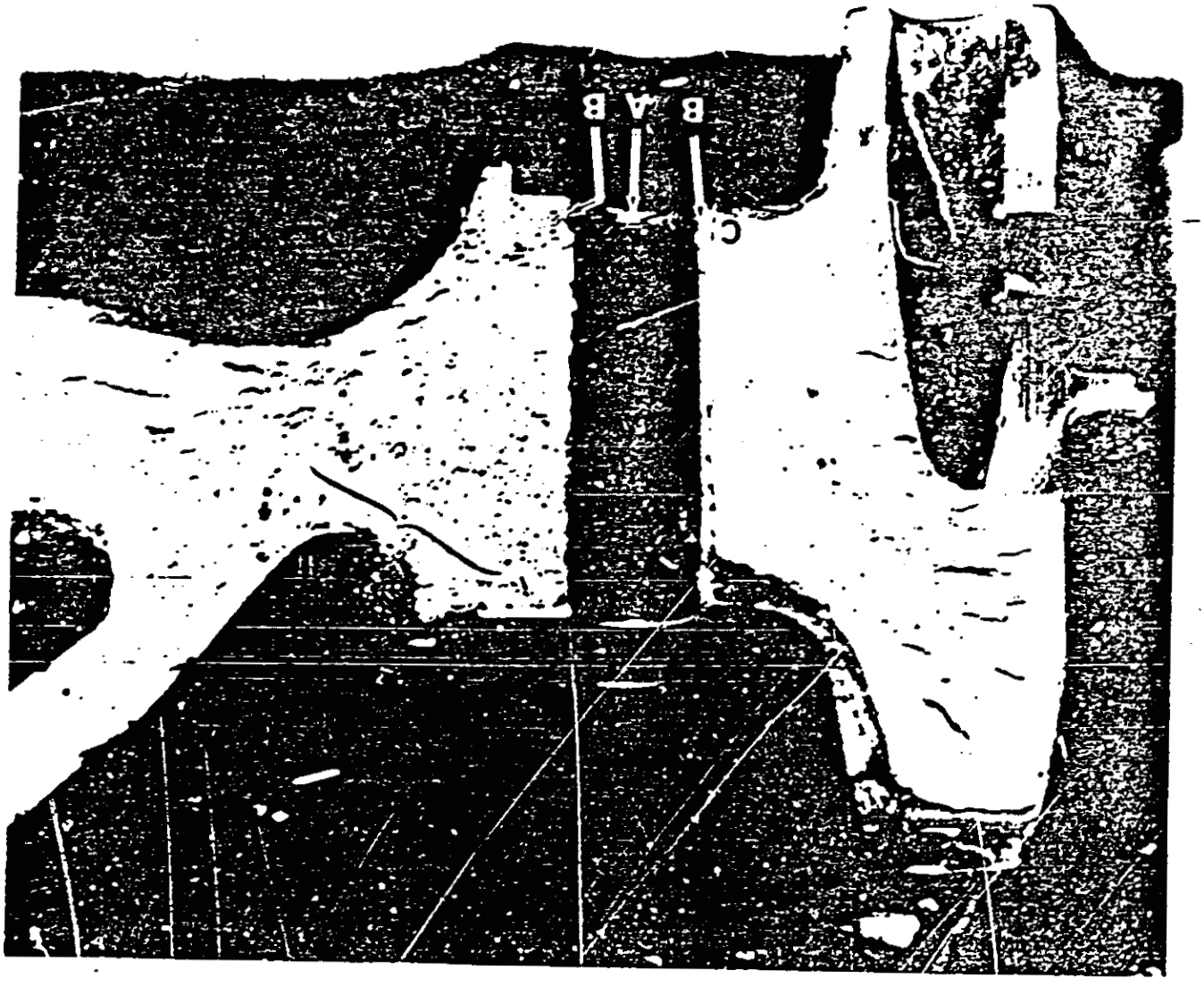
(8)

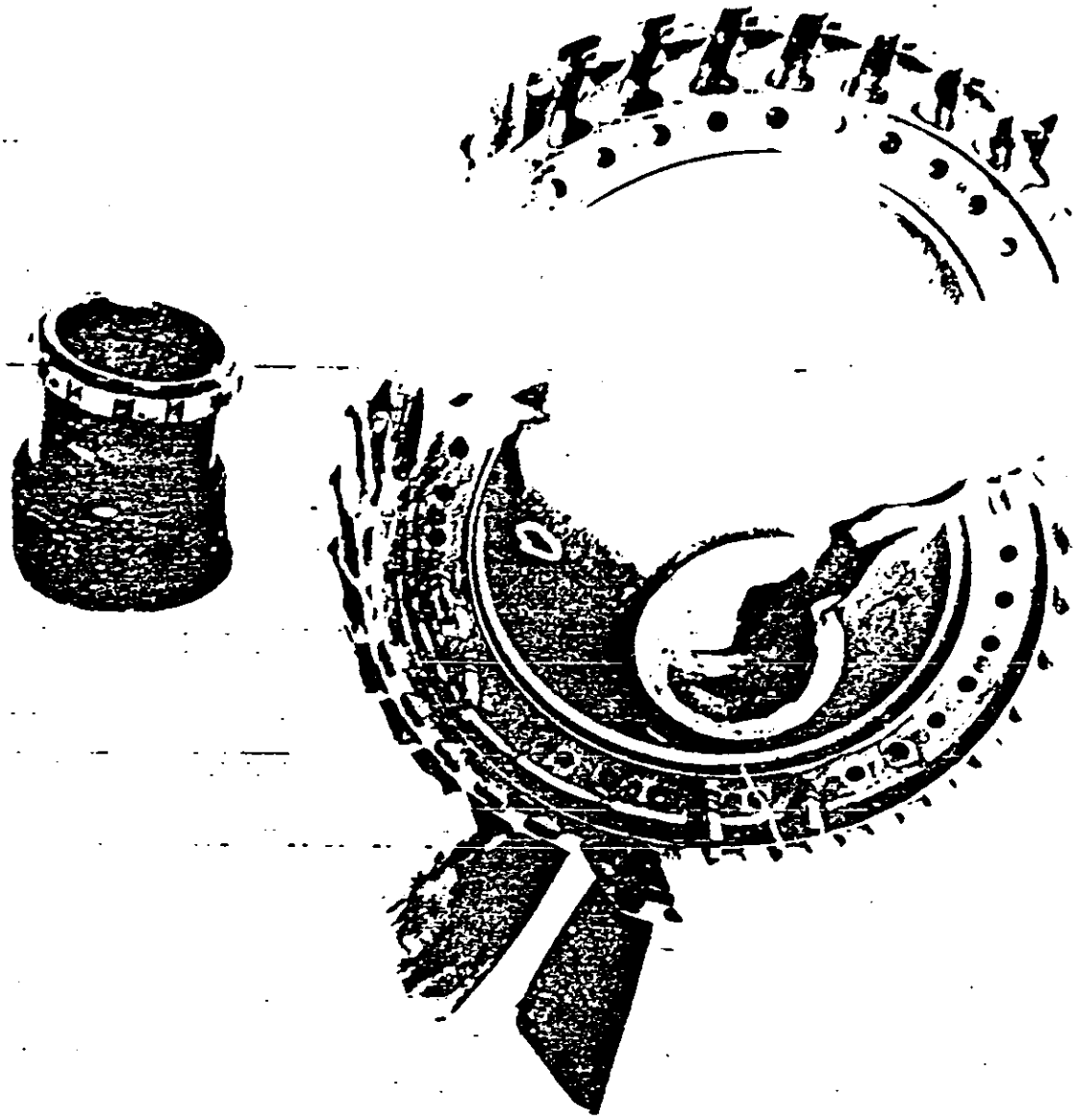
QUALITY CONTROL CHECK

*In process manufacturing inspection performed






B
A
B
C



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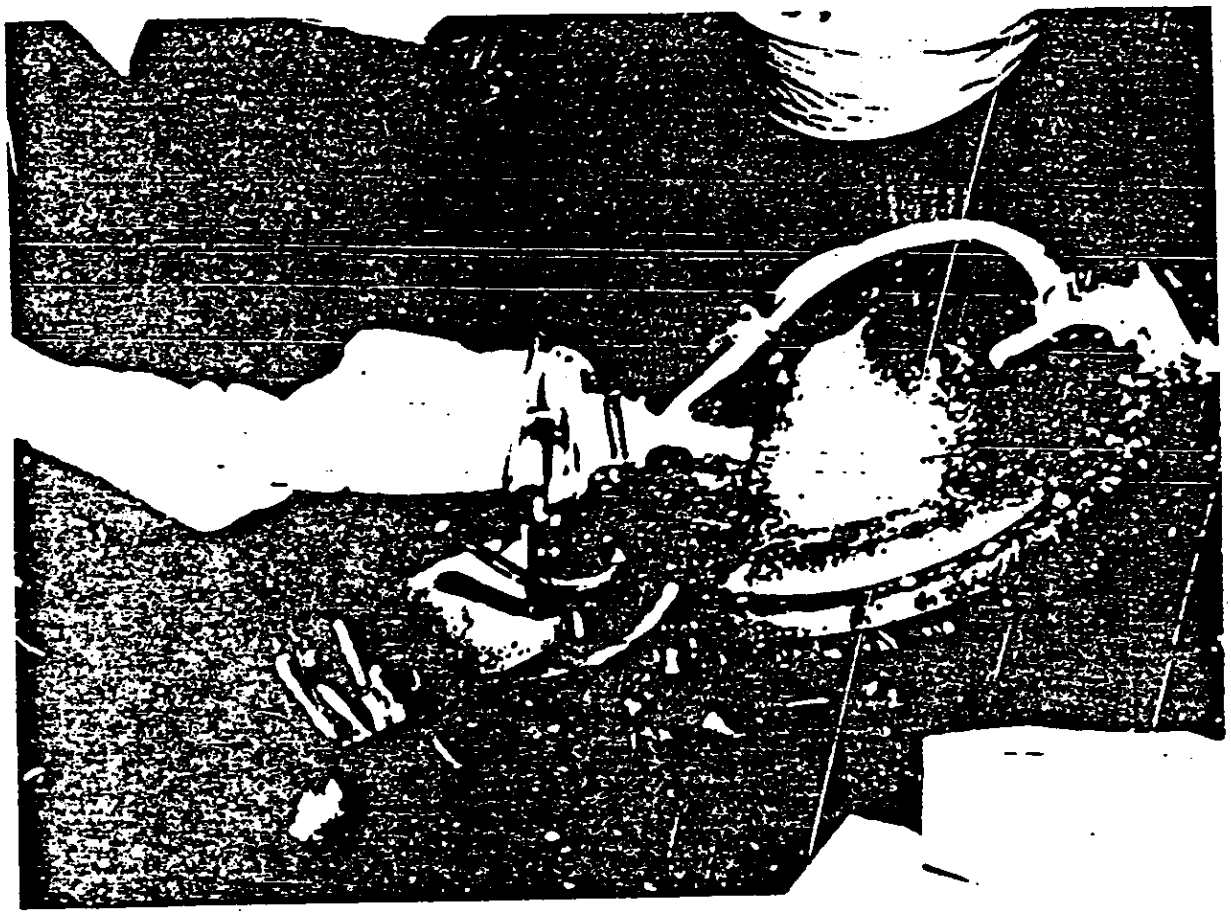

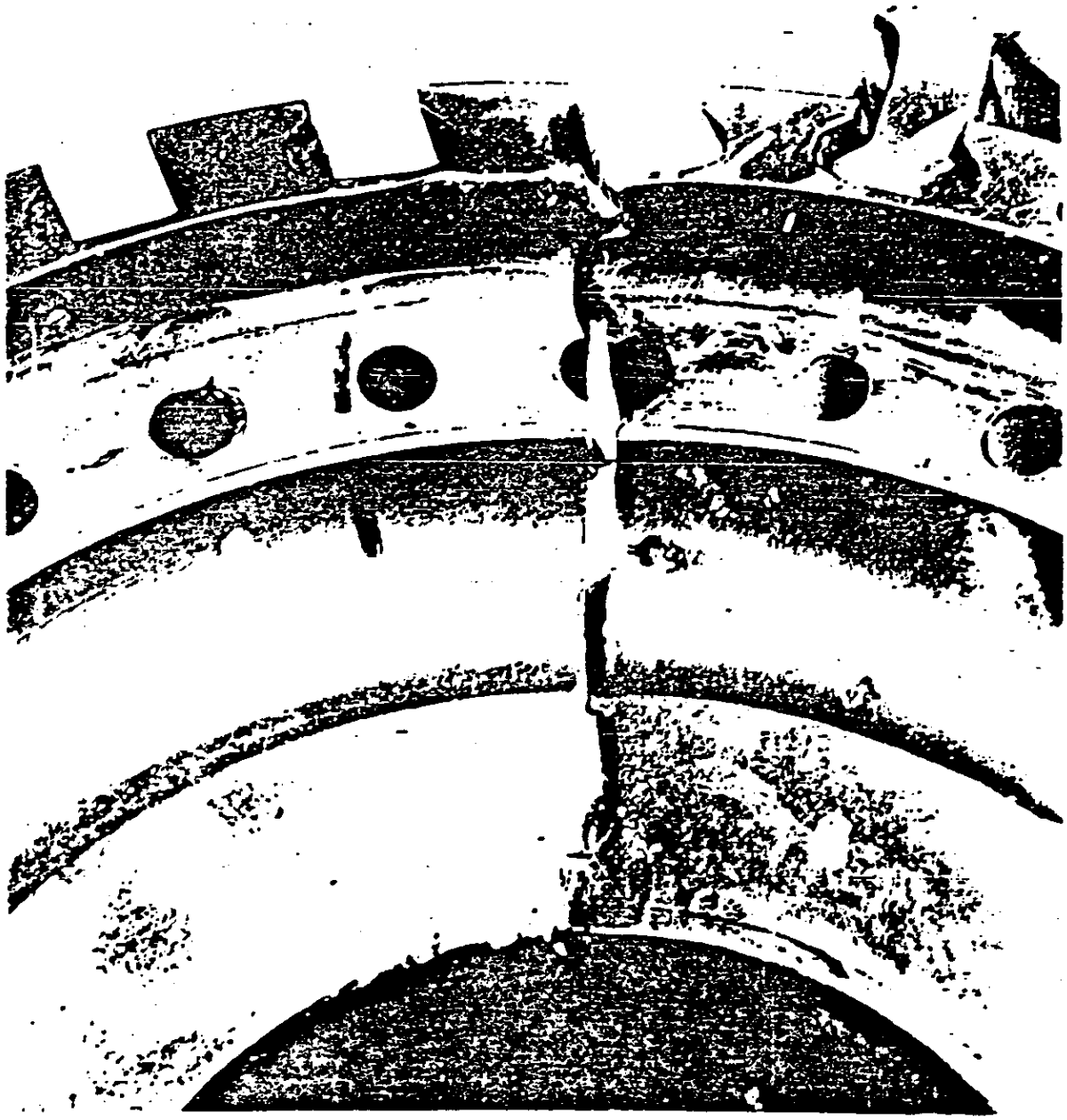

ATTACHMENT NO. 51

QUALITY CONTROL CHECK

(16)