Investigation Report: Failure of Combustion Chamber in a Turbojet Engine

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Background

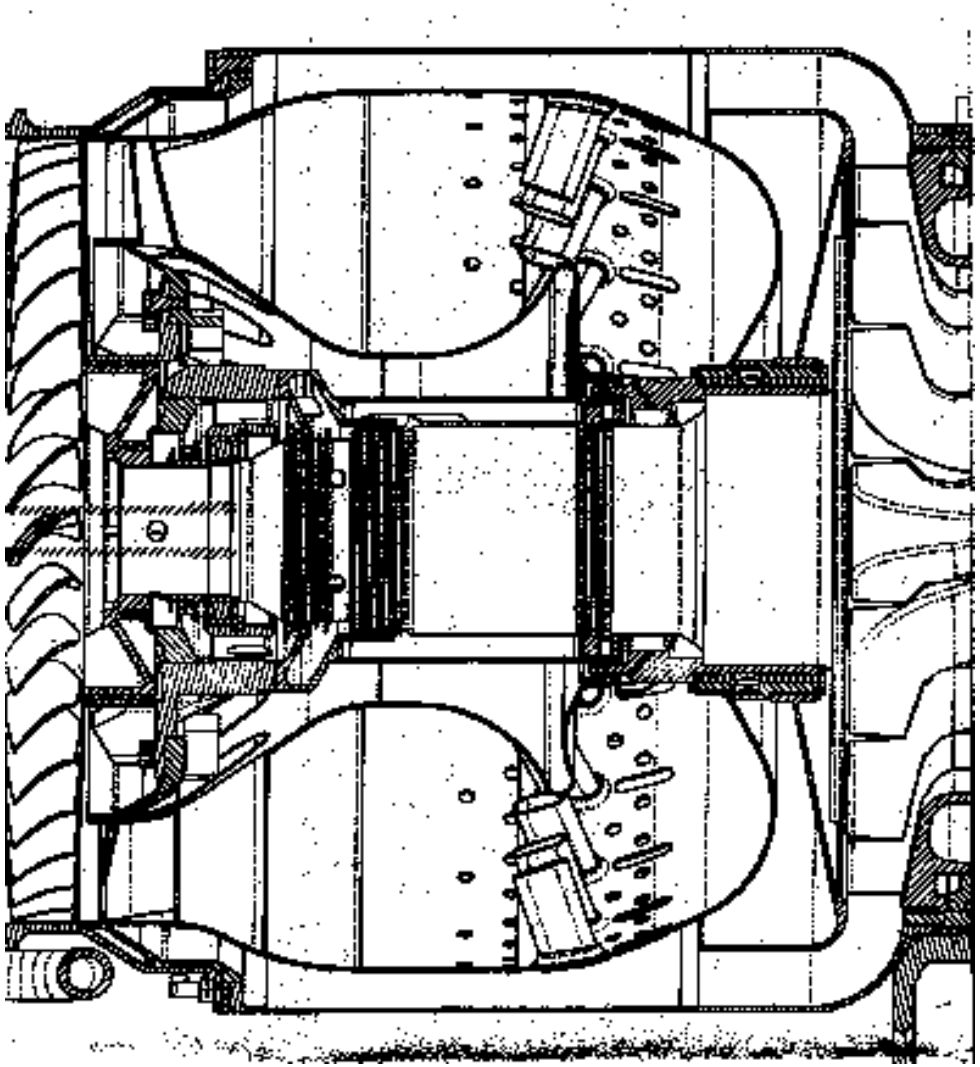
- **The combustion chamber of the turbojet Sorek is a slinger annular type.**
- **The annular configuration is ideal for compact - minimal diameter engines designs since the maximum use is made of the space available within a specified diameter.**
- **This design also assures minimal pressure losses.**
- **The fuel is injected centrifugally and the air is introduced through twisted radial vanes resulting in vortex motion - this assures excellent spread of the fuel in the combustor and flame stability throughout the flight envelope.**

Background (Cont.)

- **The chamber raw material is NIMONIC 75 (Ni – base alloy with melting temperature around 1360 ºC). Fuel ignition is performed by using pyrotechnic igniter or by High Energy ignition.**
- **After operation of 5 and 41 minutes, structural damages consisting of cracks, deformations and pores appeared in the inner wall of the combustion chamber in front of the pyrotechnic igniter aperture (see sketch).**

The Combustion Chamber & the Microstructural Damage Images

Sketches of the Combustion Chamber & the Damage Location



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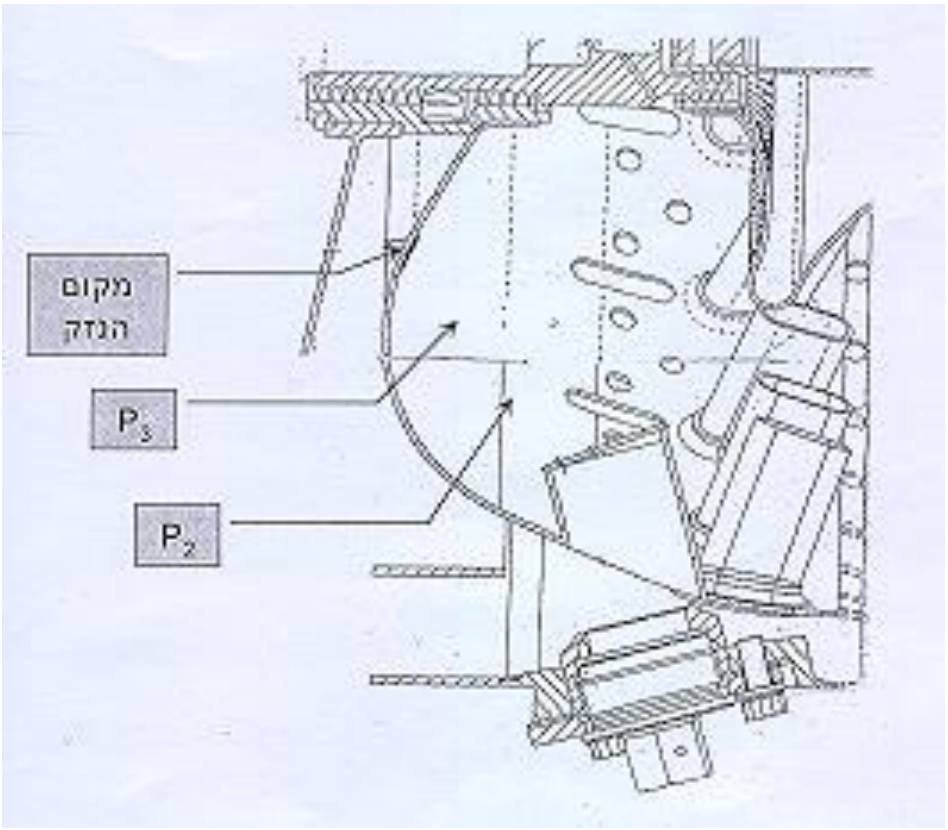
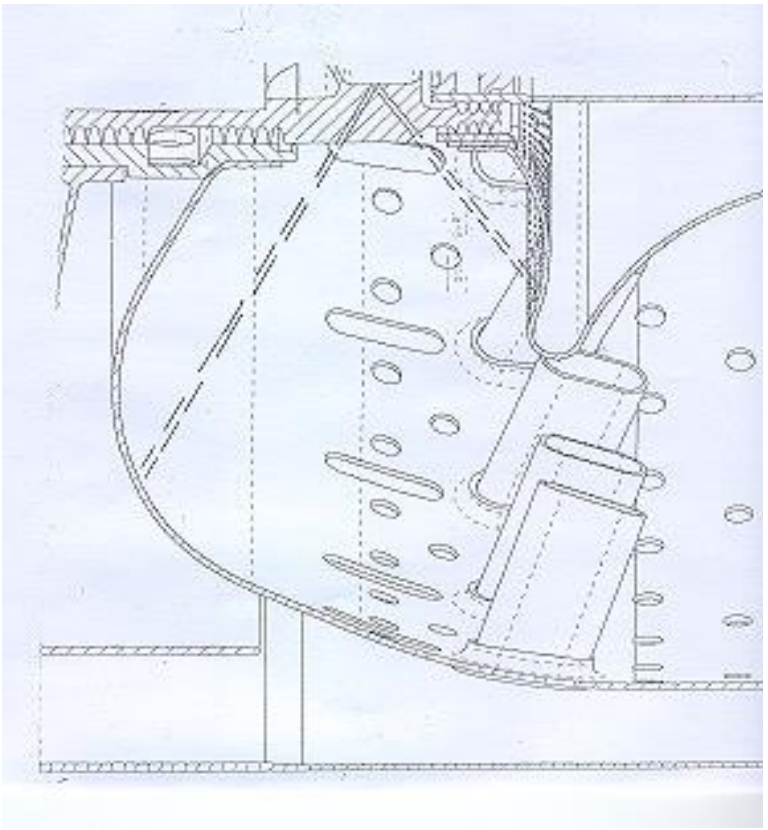




Analysis

- **A sample from the defected region was sent to the metallurgic laboratory (Bet Shemesh Engines).**
- **Using X-Ray Fluorescence (XRF) technique, it was found that Aluminum oxide deposits were covering the sample, causing partial clogging of the air passages (0.75 mm holes). It was postulated that the clogging of the air passages led to the development of high localized temperatures loads that caused the damage.**
- **The existence of the Aluminum oxide deposit was attributed to the pyrotechnic igniter which utilizes Aluminum powder to locally increase temperatures in the combustion chamber.**
- **Later, it was found that cracks, pores and severe microstructural damage were formed in combustion chambers which were not exhibited pyrotechnic ignitions.**

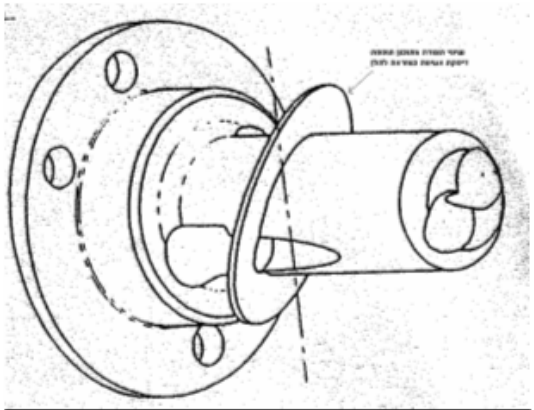
Current Status

- **Further examination of the failed combustion chambers revealed that in all of these chambers during operation only a single pyrotechnic igniter was installed while in the other side pressure and temperature gauges were installed.**

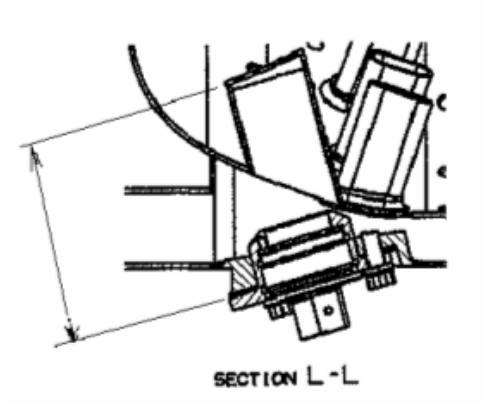
- **This installation, as we suspect, initiate a jet of air to enter through the opening between the gauges and the combustion chamber causing flame deflection to the combustion chamber walls due to unsymmetrical air flow.**

Current Status (Cont.)

- **An experiment to clarify this theory is plan: the air passage between the gauges and the combustion chamber will be blocked as described in the sketch below and the development of microstructural damages will be investigated in these conditions - updates and conclusions will be further reported.**



שינוי תצורה מתוכנן תוספת דיסקת אטימה בין המדיד לתא השריפה



שרטוט הרכבה מדיד לחץ בתצורה הנוכחית