OVERHEATING OF MAIN PROPULSION TURBINE ROTOR JOURNAL

A CASE STUDY

BY

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ABSTRACT

Overheating of an HP turbine rotor journal in way of the oil baffle was reported by a vessel requesting lifting of the HP turbine rotor for a thorough examination. This lifting would have caused a delay of two or three months in the completion of the refit. Though an easy and straightforward solution to the problem, it would nonetheless have been time-consuming, laborious and extremely expensive. This was however overcome by a very novel method, conceived by the author, thereby saving valuable time and heavy cost.

Problem

Particulars of the Stal-Laval main HP turbine of the vessel are given in FIG. 1 and TABLE I.

The main HP turbine forward bearing and oil baffle were opened up by the ship's staff as a routine examination during the six months long scheduled refit of the vessel. The rotor shaft in way of the oil baffle was found to be discoloured, showing bluish colour marks. The bottom half of the oil baffle also showed excessive rubbing marks, thereby indicating some metallurgical structural changes of the rotor shaft. Metallurgists were called upon to examine and report but were unable to do so as they opined that unless the complete rotor were made available to them on the shop floor, it was not possible for them to make any start in the investigation, let alone arrive at any definite conclusion. This obviously meant that the HP turbine casing had to be lifted to enable access to the rotor shaft for a thorough examination.

Analysis of the Problem

The request of the metallurgists and the ship's staff for lifting of the main HP turbine was not acceded to due to the following facts:

(*a*) The ship had very successfully carried out full power trials, thereby indicating and confirming the healthy condition of the main turbine.

TABLE I—*Particulars of main HP turbine*

Make	Stal Laval
Shaft horse power	15 000
Maximum Speed	5893 rev/min
Diameter of H.P. Rotor	min 570 mm, max 825 mm
Length of H.P. Rotor	1835 mm (approx) (journal to journal)
Weight of H.P. Rotor	0.8 ton
No. of Stages	8
Material of rotor journal bearings	Babbit
Turbine lubricating oil	OM 100
Material of oil baffle	gunmetal
Material of H.P. Rotor	3% Cr. Mo alloy steel

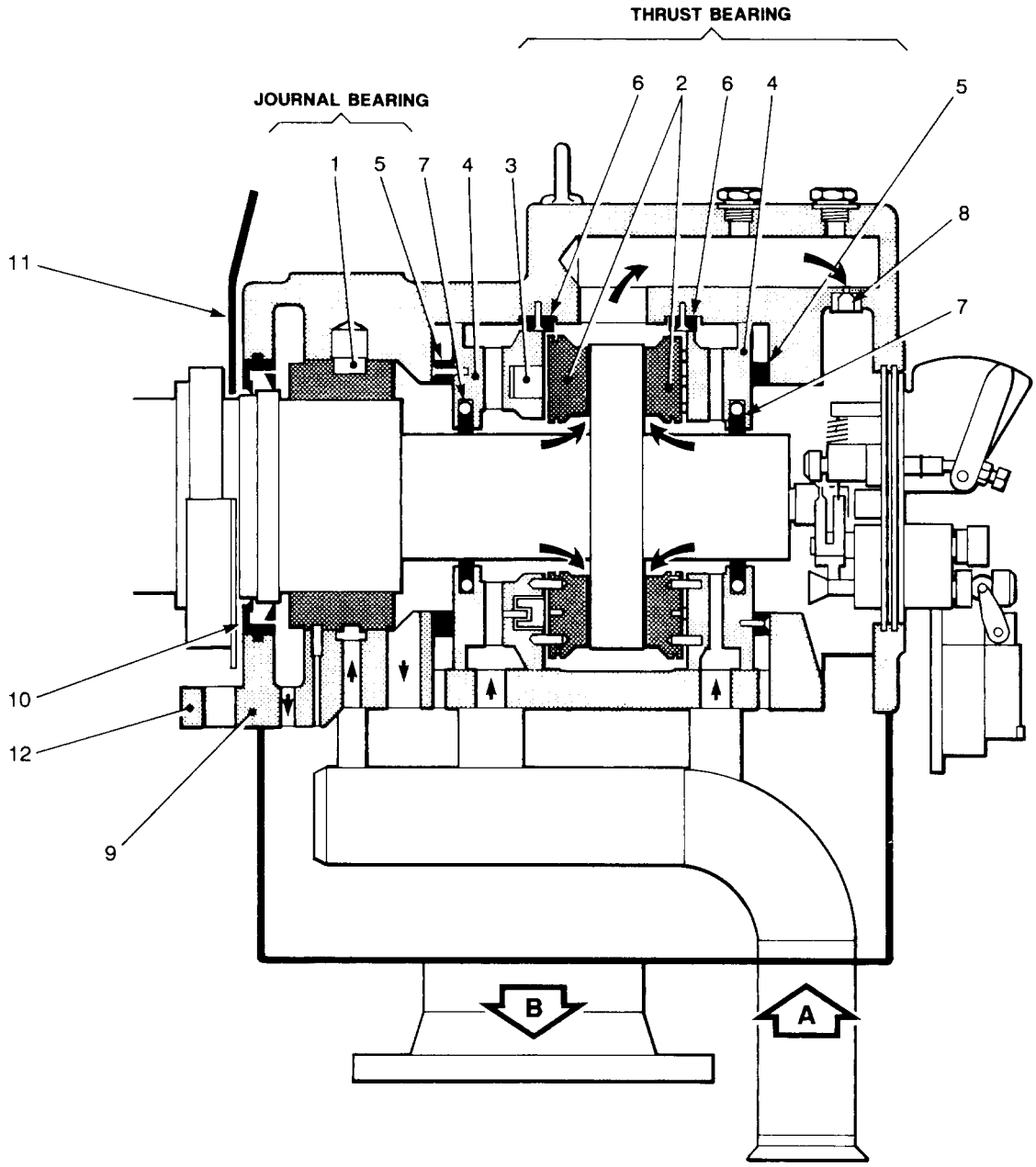

FIG. 1—MAIN HP TURBINE FORWARD BEARING PEDESTAL

1. Dowel (prevents rotation)
2. Thrust pads
3. Levelling links
4. Thrust pad holder
5. Distance ring
6. Key (prevents rotation)
7. Sealing ring
8. Orifice
9. Housing
10. Oil seal
11. Steam deflection shield
12. Connection to HP turbine casing
13. Overspeed and axial displacement trip

A. Oil inlet
B. Oil outlet

(*b*) No undue vibration or high bearing temperature or any sound had been reported during the entire operating period of five years ever since commissioning.

(*c*) Both forward and aft bearings of the main HP turbine were found to be in good condition and the wear down to be within limits.

(*d*) The rotor journal in way of the aft bearing and oil baffle was also examined and found to be free of any discoloration or overheating marks.

(*e*) The discoloration observed in way of the forward bearing and oil baffle of the HP turbine appeared to be strictly localized.

Solution to the Problem

The main turbine had done over 25 000 main steaming hours since commissioning of the vessel and had been in service for over five years. One approach was to leave the defect as it was and put back the vessel into operation, observing due precautions by the ship's staff. But this approach would have meant that the ship's engineering staff would be operating under a cloud of uncertainty, and moreover the personnel on watch would have to be extremely alert day in and day out which would be very demanding, particularly, from the point of view of morale and also from the professional point of view. It is with this in mind that a search was made to solve the problem without lifting the main HP turbine. The problem was finally resolved as described below.

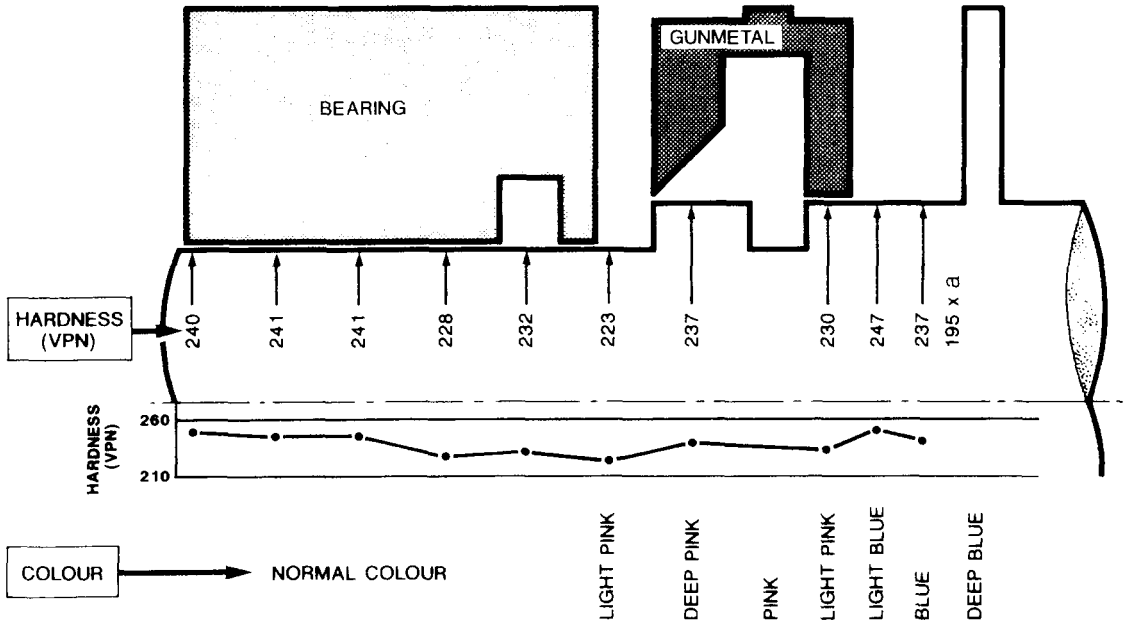

FIG. 2—DISTRIBUTION OF HARDNESS VALUES RECORDED ALONG THE ROTOR JOURNAL
VPN: Vickers Hardness Number

Advantage was taken of the fact that the hardness of a material has a certain relationship with the temperature. Accordingly, the rotor shaft in way of the oil baffle and the forward bearing were subjected to a hardness test by a portable hardness testing meter and the values of the hardness were noted at eleven points along the rotor shaft as shown in FIG. 2. The rotor shaft had a specified hardness ranging from 210 to 260 Vickers Pyramid Number along its length. A perusal of FIG. 2 will show that the observed hardness values, ranging from 223 to 247, were lying well within the specified hardness range of 210 to 260. The deep bluish mark observed in way of the oil baffle could be estimated to have a temperature around 250°C which was well below the maximum working temperature of operation, specified as 550°C for the turbine. Further, the hardness values substantiated this conclusion.

Conclusion

The vessel was cleared for operation without any reservations or limitations. The ship's staff was, however, directed to take the following precautionary measures:

(*a*) The following action to be taken on each occasion before turning the main engine for the first time under steam:

(i) Main turbine to be rotated by turning gear and the starting and running currents to be recorded.

(ii) Any unusual noise emanating from the main turbine to be watched for and, if detected, the turbine immediately stopped.

(*b*) Vibration meter readings of both HP and LP turbines to be carefully watched and recorded hourly.

(*c*) The expansion readings of the HP turbine rotor, both when cool and when under steam, to be recorded *vis-à-vis* the specified normal readings.

The above innovative solution, due to some original thinking backed up by thorough commonsense marine engineering knowledge, saved the considerable time (two to three months) and heavy cost of lifting the main turbine.