LIFTING AN H.P. TURBINE BY SHIP'S STAFF

by

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The following is an account of lifting a high pressure turbine by the ship's staff of H.M.S. "Devonshire" during the Spring Cruise 1948 to the West Indies. As this operation is not often carried out by a ship's staff, the details should be of interest to most readers of this Journal.

History

The impulse stages and 75% of the reaction stages of the starboard inner high pressure turbine had been rebladed in 1943 which was the last time the turbine had been opened. There was no record of any trouble with this turbine subsequent to this reblading and it had steamed satisfactorily.

H.M.S. *Devonshire* sailed from Devonport on 16th January and, after visiting Barbados, Trinidad, Grenada, Dominica and Antigua, reached Montego Bay, Jamaica, on 26th February. The same day she was ordered to Kingston, and leaving Montego Bay at 2230 arrived at Kingston the following morning, having steamed the whole way at 20 knots.

On arrival at Kingston *Devonshire* replenished with fuel, and embarked troops with their transport, ammunition, and equipment. She left at 0600 on Saturday 28th February for Belize, British Honduras, steaming at 25 knots. This was necessary to make a rendezvous at the entrance of the channel.

First Indication of Trouble

No officer or rating had previously steamed the ship at 25 knots but it was noticeable that the general vibration was greater at this speed than had been experienced at any other speed, although it was not sufficient to give rise to any alarm.

During the course of the day, trouble was experienced with various items of machinery, noticeably part of the closed feed system and some of the forced lubrication pumps. Later in the day a serious defect developed in the port outer main gearing which necessitated stopping the ship to lock the shaft. While easing down to lock the shaft, a noise was heard in the starboard inner H.P. turbine. It is worth stressing that this engine is in the Aft Engine Room and the damaged gearing in the Forward Engine Room so that the two defects could have no connection. The noise was variously described as a "rumbling noise," a "metallic clang," and as a "tinkling noise." The starboard inner shaft was stopped immediately.

After the port outer shaft had been locked the ship proceeded on two shafts and speed was slowly increased to 110 revolutions. At this speed the starboard inner shaft had not started to trail so a small amount of steam was admitted to start it at slow speed. With the ear pressed against the cleading of the H.P. turbine a faint but distinct thumping noise could be heard. There was no unusual symptom from the L.P. turbine.

In the circumstances it was decided to lock this shaft as well and accordingly the ship proceeded to Belize at 12 knots on two shafts arriving there at 0900 1st March.

Preliminary Examination

A preliminary examination of the damaged gearing on passage had shown that it was beyond the capacity of ship's staff to repair it and it was decided to prepare to lift the starboard inner H.P. turbine so as to have three shafts for the passage home and to establish that there was no defect in that turbine which was likely to recur or happen in one of the other turbines.

From the time of getting under way at Kingston to the moment of the incident, there had been no reason to suspect this turbine. At all times receiver pressures and stage pressures were normal, lubrication was normal and continuous, and there was no sign of any water having come over. The steam strainer was clear and intact.

Organization

Work was continuous throughout the day and night. The staff worked in two watches, 24 hours about, as for auxiliary watchkeepers. Each watch consisted of 1 Chief E.R.A. (a senior E.R.A. in one watch), 4 E.R.As. or Mechanicians (including 2 under training), 1 P.O. Stoker Mechanic and 8 Stoker Mechanics or Stokers. It is considered that this produced a better answer than straight watches. An engineer officer was in charge of each watch.

The Engineer Officer and Senior Engineer were present when any operation other than routine work was going on but it was found of great assistance to have a fresh mind available and, for this reason, they avoided embarrassing the engineer officers in charge of the watches and succeeded in getting an adequate amount of sleep even if not always at the right time of night. It was remarkable how many of the more important operations seemed to take place in the middle of the night.

SEQUENCE OF WORK

Some preliminary work was done at Belize, mainly consisting of minor stripping of oil pipes, cleading and lagging, valve handwheels, etc., and about a quarter of the bolts in the horizontal joint. Many of these bolts were very hard to remove and the special spanner provided required regular attention from the engine-smith. Watchkeeping began at noon on Saturday 6th March, the day the ship arrived back at Kingston and ceased at noon on Monday 15th March after a basin trial had been carried out.

Preparation of Lifting Gear

Lifting gear was largely prepared for use on passage and labels made for all gear to be removed from the engine. All readily portable gear was taken up to the Workshop where it was out of the way. The value of labelling parts, however obvious their identity, and of stowing everything portable right away from the main work was borne out time and time again and greatly simplified the operation. Whenever E.R.As. or stoker ratings were not required in the Engine Room they were employed in preparing the gear for replacement, even in the early stages. All this saved much time and avoided having men standing about doing nothing with the feeling that they were being kept watchkeeping unnecessarily.

Removal of the Eduction Pipe

The eduction pipe was removed p.m. Saturday and placed on top of the main gearing. Reaction valves and spindles were removed and wooden blanks placed. Nozzle valves were removed and lifting gear placed in position. By Sunday afternoon the strainer box was ready for lifting. It was realized

that this would prove the most difficult part of the operation and it did not disappoint us. Slinging was difficult and headroom very little. This state of affairs was aggravated by the fact that many of the pipes for the new set of evaporators, fitted in the course of the conversion to a cadet training cruiser, fouled the sling. It was found necessary to cut the top bolts of the reaction valve flange by hacksaw in order to free the box. It would appear to have been the intention to lift the strainer box simultaneously with the first and third reaction valve boxes. This was decided against owing to the lack of headroom and space for landing the gear on the plates. As it was, the strainer box blocked the passage and was a nuisance.

The operation of lifting the top half of the turbine casing began at 1900 on Sunday 7th and this was up and on its columns by 2200. The damage to the turbine was now visible and showed the last three rows of blades in the 3rd stage of the rotor and last two rows in the casing 3rd stage had stripped.

Removal of Damaged Blading

The rotor lifting gear was now put in place and the rotor lifted by Monday afternoon. Damage in the bottom half of the casing corresponded to that in the top half. The rotor was therefore lowered and the damaged blading in the rotor and the top half of the casing was cut out by hand. The rotor was then again lifted and the damaged blading in the bottom half removed.

While this work was in progress much work was done to prepare for closing up. Nuts and bolts were run down, flanges cleaned, and joints prepared. For the purpose of turning the rotor one of the straps supplied as part of the rotor lifting gear was fitted on the shaft and a " handy billy " attached to one lug. This proved simple and effective.

On completion of the removal of the damaged blading by p.m. Tuesday 9th March, the bottom half casing was thoroughly cleaned and searched. As a final method of removing any dirt and foreign matter it was then washed through with distilled water. The condensate and drain pump was used for this purpose taking suction from the drain tanks and discharging through a hose. During this operation, it was seen that the water was not running away as freely from the 3rd stage drain as from the others and it was found that there were two blades lodged in the drain pocket. These were removed with difficulty and found to be similar to those fitted in the impulse wheel.

Closing up

The rotor was now lowered into place, checked with a clock gauge, and tip clearances taken. The top half casing was then lowered while the remaining preparatory work for the final closing up was carried out. This occupied another 24 hours and, by the afternoon of Thursday 11th, the stator and rotor were finally lowered. Manganesite was used as a jointing compound. The joint was completed by midnight.

It had been found that when the top half casing was lifted some of the studs of the reaction valve cover had to be removed so as to clear an overhead beam. Some of these sheared on removal ; one of them extended right through the box so as to form a stay bolt. These now had to be drilled out and new ones made and fitted. This was the first snag and took 25 hours.

The remainder of the watch were employed during this period in preparing the strainer box and eduction bend flanges and in replacing the remainder of the horizontal joint bolts. The full-power valve cover and spindle were also replaced.

The strainer box was then hoisted into place. Prior to this the top holes in the reaction valve boxes had been tapped and the corresponding holes in the strainer box enlarged to a clearance size. The studs were placed in the holes in the strainer box before lifting as the clearance between the flanges of the box and the box itself was insufficient to allow the insertion of the studs once the box was in position. This was the second major snag. The operation of hoisting the strainer box was finally completed by 0600.

It had been intended to use 1/64 in. permanite for the joints but the clearances between the joints were so small that this was impracticable and red lead and copal varnish was used instead. Some difficulty was experienced in screwing the studs in place but the joints were all completed by 1000 Saturday 13th March.

During the forenoon the eduction bend was replaced.

Thereafter the staff were employed in replacing all miscellaneous fittings and making oil-pipe joints etc. The original lagging was softened with water and applied in a plastic form. All cleading was replaced by midnight on Sunday and lubricating oil was circulated for two hours during the forenoon watch. The tank was then emptied, cleaned, and a fresh supply of oil run down.

Steam was raised in A3 boiler at 0700 and, after warming through, the engine was turned under steam at 1015 every two minutes for twenty minutes. At 1045 the engine was turned at 40 revolutions for half an hour. At the end of this time the trial was considered satisfactory and the engine room shut down. The turbine subsequently steamed 4000 miles home at 15 knots.

The major snags encountered have been mentioned in the previous narrative of the operation. There were, however, other small but annoying snags.

Temperature

The temperature of the engine room was 110 deg. F. and when a portable fan was tried it made such a mess in blowing dirt and lagging about and into the open turbine that it had to be stopped.

Slinging

Slinging constituted the most difficult snag and the final arrangements for slinging the strainer box would have been worthy of caricature even though they did the job. It would appear that the ideal arrangement would be an overhead rail for the strainer box and eduction bend and more substantial eyebolts for the strainer box.

Remaking of Joints

It proved most difficult to lower the strainer box over one set of studs, making that joint and two vertical joints at the same time, and getting them hardened down before the joints dried. In fact the first attempt failed and the joints had to be cleaned off and done again.

Conclusion

While no one likes these things happening, it cannot be denied that it gave one some satisfaction to do some engineering.

The operation—aptly called by the Medical Officer " Turbinectomy "—was of great value from an instructional point of view for the Engineer Officer and other engineer officers, E.R.As., stoker mechanic ratings, cadets, and a number of executive officers who having seen a turbine opened up professed that for the first time in their lives they understood what it looked like and how it worked.

When they saw the small clearances, they appreciated the necessity of careful warming through and treatment when standing by.

The value of marking all fittings before removal and of preparing them immediately for replacement has been mentioned but cannot be emphasized too strongly.