CONDENSER DEFECTS

by

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FIG. 1

During 1947-48 a series of exasperating defects, sometimes not without lighter moments, occurred in the main condensers of H.M.S. *Cossack* (Captain D.8, Far Eastern Fleet). The ship had been built in the lean years towards the end of the war, which no doubt accounted for the indifferent workmanship to which the main defect was eventually found to be due.

Slight condenseritis had been experienced soon after the ship had been accepted, but this was followed by several months of trouble-free running. The starboard condenser, however, developed a nasty trick of shedding its main inlet gratings soon after undocking. The first indication of this was provided in an amusing way before leaving a shallow water berth at Tokyo, when on opening the starboard strainer box, in addition to the normal small live fish, a 40 lb barracuda was found, in two portions (Fig. 1). The small fry were rapidly cooked and devoured by the Chinese stewards, but the barracuda had gone a considerable way towards joining its ancestors, and required very early disposal. On another occasion, on attempting to shut the starboard main inlet valve for a routine condenser examination, debris from Hong Kong harbour had collected under the valve disc, preventing it shutting. By screwing up on the small screw at the bottom of the valve box, and running the circulator at full speed with the main outlet valve wide open, an 8 inch length of 2 in × 2 in timber was forced clear and later retrieved from the strainer box.

Intermittent condenseritis, apparently in both condensers, then started. Endless Canterbury tests were carried out, with completely negative results. All other possible sources of contamination were of course explored, including opening up and testing one air ejector. (This was undertaken at an open anchorage in Korea. Due to the bad machinery arrangement in the vicinity of the Allen's ejectors fitted, only one very small E.R.A. could work on it at a time, and what should have been a simple job took four days.)

The limitations and disadvantages of the Canterbury test soon became very evident. A quick and effective method of packing the turbine glands was evolved (Appendix I) which eliminated the necessity for keeping steam while testing, or alternatively of laboriously fitting the water test plates and glands as supplied by the manufacturers : these fittings appear to serve no useful purpose whatever.) The *Cossack* method proved invaluable and simple. But the main disadvantage of the Canterbury test remains, in that unless the ship is on a dead steady keel, each slight roll will produce streams of false air bubbles from the top tubes as they cover up.

One ship of the flotilla who had to carry out a check Canterbury test, experienced this difficulty, but with an added snag. The gland steam pipes passing in front of the condenser top inspection doors completely masked the line of sight of the " viewer " from practically all the top tubes. Removing the gland steam pipes would have meant that the glands had to be packed with the " official " water test plates, etc., referred to above, the Engineer Officer not then being aware of the *Cossack* method. With nice disregard for his own safety (and certainly not with the prior approval of the Flotilla Engineer Officer !) he donned a Salvus, and sat in the condenser inlet box while it was flooded up to the top of the tubes. Unfortunately his enterprise was not rewarded with positive results, as false bubbles were emitted by his clothing and the Salvus. For those who prefer the orthodox method of steam packing condenser glands and who have so far escaped the necessity for a Canterbury test, the suggestion is ventured that a check should be made that the gland steam pipes (in particular) have not been fitted in such a way as to obstruct a free view through inspection doors of the top condenser tubes. Should they do so, the *Cossack* method may commend itself.

The condenseritis in *Cossack* still persisted. It seemed possible that leakage was taking place at the stay nuts. Each stay nut was therefore removed in turn, its face machined true, and additional small nicks cut round the periphery of the " flange " (Fig. 2). This allowed each nut to be taken up hard and still admit the locking pin. Jointing paste was used.

This expedient cured the trouble, but only until a successful full power trial had been run, when contamination started again. By this time, serious inroads had been made into the Station's supply of silver nitrate. Most of the engine room department knew their way in and out of the condensers blindfold, or could recognise individual crabs which vanished with a dark chuckle down towards the grottoes of the main circulators. The Canterbury test seemed to

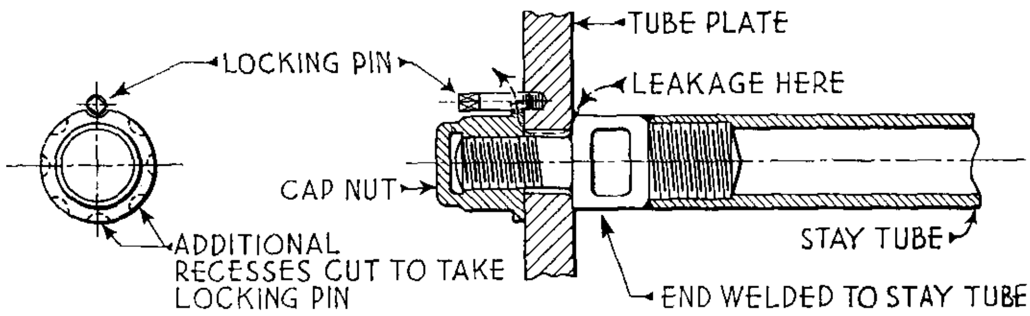


FIG. 2

give no indication at all (Appendix 2). Moreover the weather was too humid to allow the tube plates to be dried off for a satisfactory water pressure test.

The Fleet Engineer Officer then came to the rescue by recommending the Frobisher test (Appendix 3). This consisted of filling the inside of the condenser to the tops of the tubes, and slowly blowing the sea-water side down by air pressure. The Senior Engineer and the Chief E.R.A., who were both of thin stature, had insinuated themselves inside the condenser and lay on the tops of the middle lane tubes with only their heads above water. (Note : Any clothing may give off false bubbles). With the aid of underwater torches they searched the tube nests, but in vain. This test would seem to have much to commend it, since the test load on the tube plates is in the same direction as it is when under steam. There is grave danger, however, of rupturing the main sea-water system (including condenser doors) unless very careful regulation of the air pressure is carried out : for this reason it is considered the prior approval of the administrative authority should be obtained.

In the course of carrying out this test it was noticed that there were heavy rust streaks on the inner sides of the tube plates from below such stay tubes as were visible. It was quite evident that sea-water leakage had taken place into the condenser around the stay tube stub-ends despite the work done on the stay nuts described above. The decision was therefore given that both condensers were to be re-stayed. This, of course, entailed the removal of all tubes (7,900 total in the two condensers), the tube plates and all auxiliary machinery in front of the condensers. The heavily-loaded Hong Kong Dockyard estimated three months for the job, and in fact achieved it in exactly that time, during the hottest part of the summer.

The cause of the leakage was found to be some very rough machining of the faces of the stub ends butting on the inner sides of the tube plates (Fig. 2). New stub ends were screwed and welded into the stays. Some difficulty was experienced in making the assembled stays the correct length, as the tube plates now free of constraint, were found to have an appreciable curvature. Each stay assembly had therefore to be fitted individually for length. The air ejector baffles bolted to the tube plates were found to be $\frac{1}{16}$ in short of the tube plates inner faces, and were corrected by washers to avoid distortion of the tube plates.

Opportunity was taken to remake the port condenser horizontal joint, which had been causing loss of vacuum. The whole condenser was lowered, and the joint remade with permanite smeared with graphitic grease.

Some anxiety was felt by the Engineer Officer during the re-tubing and repacking stages. The Chinese chargeman assured him, however, that " he had *often* done the job before ! " Only 48 of the 7,900 tubes failed to return on board. (It was no doubt a coincidence that the flagship's padre came out with some nice new cupro-nickel altar rails about this time !) Forty-eight aluminium brass tubes had to be substituted in lieu.

A successful Canterbury test was applied, and eventually, with the burning of many joss sticks, the chargeman was to see the fruits of his labours on a full power trial, when not a sign of contamination occurred.

For two months all was well. Then suddenly both main salinometers glowed like lighthouses. Alarm and despondency was quickly allayed when it was found that some ninety tubes this time actually *did* show up on a Canterbury test. Inspection of the back tube plates showed that some of these tubes had worked aft to the extent that $\frac{3}{4}$ in was projecting out of the back tube plate. The worst tubes were repacked ; others were just tapped forward and the ferrules taken up. (One hard night's work by ship's staff, while still keeping auxiliary steam.) Subsequent regular inspection of the tube ends enabled any further tendency to tube movement to be checked.

Repacking 7,900 tubes to exactly the correct tension on the ferrule is presumably a job which would tax the perseverance of not only a Chinese in the height of a Hong Kong summer !

The main lessons learnt during this somewhat trying period were :—

(*a*) The value of reliable and sensitive salinometers and the importance of quarter-hourly check nitrate tests on extractor pump discharges.

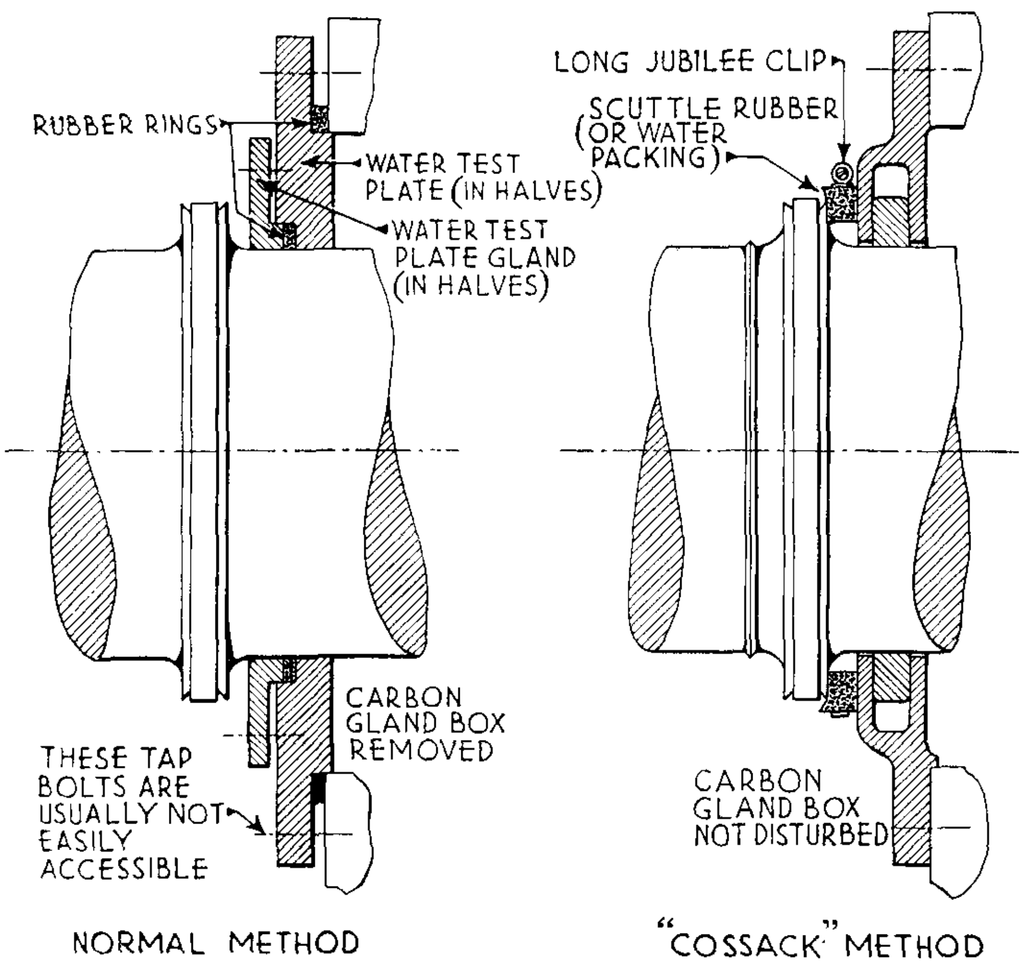
(*b*) The necessity for all watch-keeping E.R.A's to be familiar with both the detailed fittings, adaptors, etc., required for Canterbury tests, and with all the sea and other valves requiring to be closed for these tests. (A check-off list was found essential.) A ready supply of L.P. air should be ensured (particularly in destroyers, where the supply may have to be improvised from charged torpedoes), and underwater torches kept in good repair.

(*c*) The importance of checking that a clear line of sight can be obtained to the condenser top inspection doors.

(*d*) The possibility of leaky stay tubes should not be ruled out, even though a Canterbury test gives negative results.

APPENDIX 1

" Cossack " Method of Packing Turbine Glands for Testing Condensers



Insert suitable length of scuttle rubber or similar material between oil thrower and carbon gland box : tighten in place with a long Jubilee clip.

Advantages over using Water Test Plates and Glands normally provided

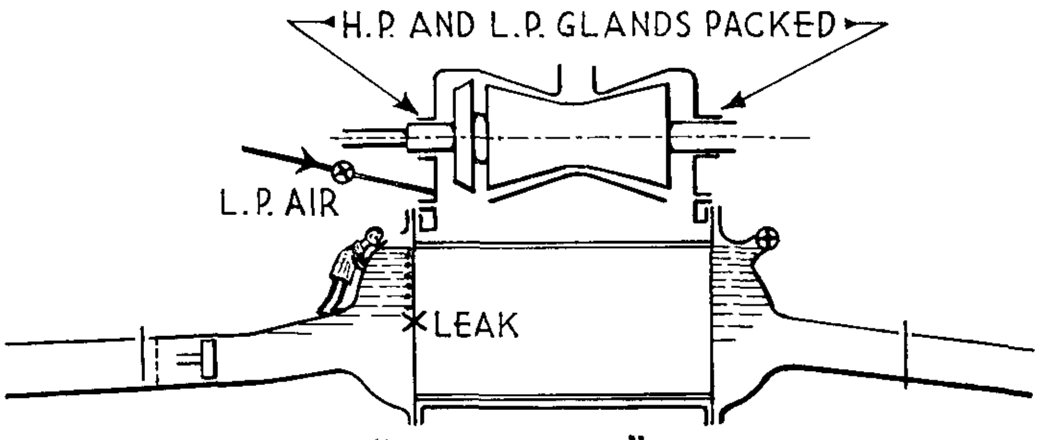
(*a*) Very simple to apply. All four glands of a H.P./L.P. set can be packed by one man in half an hour if materials are ready cut to length.

(*b*) It does not entail the removal of the carbon gland boxes, the tap bolts securing the lower halves of which may require special spanners.

(*c*) If the turbines are hot, the method can be equally effective using asbestos water packing instead of rubber.

(*d*) Water test plates and glands, which occupy appreciable weight and space, can be eliminated.

APPENDIX 2



"CANTERBURY" TEST

Advantages

(*a*) Turbine need not be cool.

(*b*) Exact position of leaky tube can be found.

(*c*) Test is comparatively simple.

Disadvantages

(*a*) Test is rendered most difficult if ship is rolling *even very slightly* due to entrapped air in upper tubes giving false bubbles.

(*b*) The large amount of gland steam required for packing turbine glands—

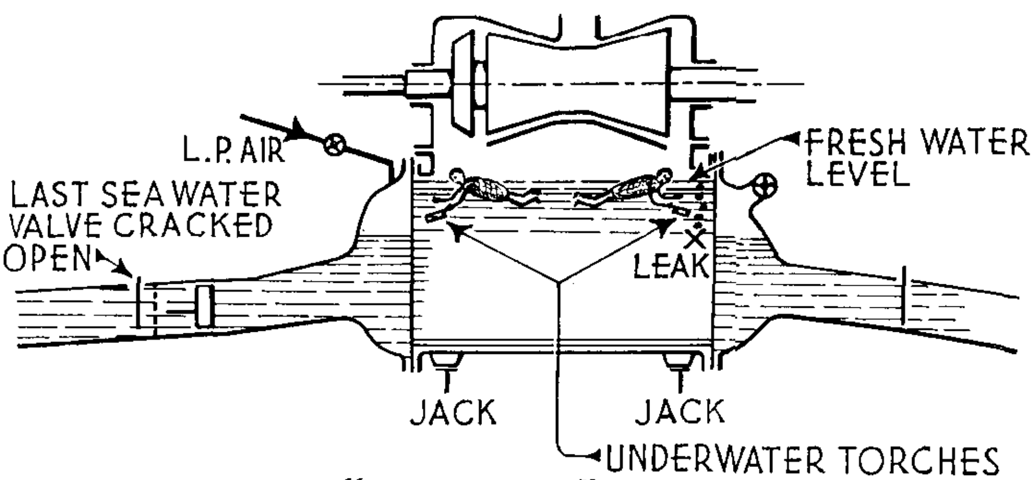
(i) Hardens any soapy mixture applied to upper tubes to facilitate sighting ;

(ii) Rapidly heats turbine bearings.
(See *Cossack* method of packing glands.)

(*c*) All sea valves must be reasonably tight.

(*d*) Pressure is applied in the wrong sense compared with a condenser under vacuum conditions.

APPENDIX 3



"FROBISHER" TEST

Method

Open L.P. turbine manhole doors. Cool off turbine.

Jack up condenser. Fill condenser with fresh water to top of tubes.

Close all but one of the sea valves.

Two observers enter L.P. turbine, lying in centre lane of condenser, with heads above water, playing underwater torches on top tubes.

Apply L.P. air to one condenser vent, with others shut. Great caution must be exercised not to approach test pressure of sea water side (usually 10 lb for mild steel doors).

Sea water is slowly blown out. Bubbles will appear inside condenser when faulty tube row is uncovered. Pressure can be regulated by last sea-water valve and air valve.

Advantages

Pressure is applied in the same sense as when the condenser is under vacuum, which may reveal leaks not apparent under Canterbury test, *i.e.*, stay tube leakage.

Rolling of ship does not interfere with test.

Disadvantages

Turbine must be cool enough to enter.

Fresh water must be warm enough for observers' comfort.

A degree of claustrophobia is experienced by the observers.

Great danger of bursting the sea water side if extreme care is not exercised.

Approximate position only of leaky tube or stay can be found.