

St. Regt. No 29393 F.E.
S. S. "CAIRNGLEN".

Rule Dimensions:- 400' x 55' x 37.25' to Upper Deck.
Class:- 100A1 "With Freeboard".
Owners:- Cairn Line of Steamships, Ltd.
Built by:- Messrs. Wm. Pickersgill & Sons, Ltd. in 1926.

This vessel is of the complete superstructure type with tonnage opening, and has three steel decks in the holds and two in the machinery space. She is strengthened for navigation in ice, and the frame spacing is 27 inches instead of $31\frac{1}{2}$ inches as required by the Rules, the framing only being reduced on account of the closer frame spacing.

Observations made of the behaviour of the ship's structure during the voyage Leith - Portland, Maine - Newcastle-on-Tyne.

OUTWARD PASSAGE.

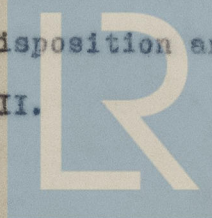
The ship left Leith on February 27th, in a partially loaded condition. The cargo consisted of coal and coke, and particulars of the loading at the time of departure are shown on Print I.

The mean draught was 19'-5", whereas the maximum winter draught of the ship is 25'-0 $\frac{1}{2}$ ".

The outward voyage was described by the Master of the ship as being fine for the time of the year.

The after hold, being the only one accessible, was carefully observed during the passage.

Four wires were arranged on each side of the ship in this hold for the purpose of measuring any transverse movement of the framing, and measurements were made at three equidistant points on each wire at frequent intervals of time during the passage. The disposition and arrangement of these wires were as shown on Print II.



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The recorded maximum daily movement of the framing, together with extracts from the ship's log regarding the weather, are as given on Print III.

It will be noticed that the maximum transverse movement measured was $\frac{3}{8}$ " at frame No. 25 on the port side, or a ratio of $\frac{\text{Movement}}{\text{Length of frame}}$ equal to $\frac{1}{630}$.

The movement of the frames took place as the after end of the ship was sinking in the water when rolling and pitching.

A diagonal wire was also arranged from a third deck beam knee to the tunnel top with a copper spring at the tunnel end of the wire for the purpose of measuring any racking movement, but no movement was visible.

Careful examination was made of the heads and heels of the pillars and the riveting of the top and bottom of the centre line bulkhead, with a view to ascertaining if there was any movement of the decks, but none was observed.

A number of rivets attaching the frames to the shell plating at the lower part of the frames above the ceiling were started and leaking, and, in addition to three cement boxes fitted previously on the port side of the after hold, five were fitted on the port side and two on the starboard side in way of leaking frame rivets during this passage, making in all ten cement boxes in the after hold. Frame rivets in the bilge below the ceiling on each side of the ship were also slack and leaking. Most of the rivets affected are stated to be those which were renewed at Leith in December 1927, and are situated towards the after part of the hold abaft frame No. 31, where the side of the ship is concave to the sea.

It would also appear to be likely that when the cement at the bilges is removed, other defective rivets will be found.

The third seam of shell plating above the bilge showed signs of leakage between frames Nos. 26 and 29, and 36 and 37 on

the starboard side, and between frames Nos. 26 and 32 on the port side.

The rivets attaching the frame to the bracket at the top of the tunnel recess on the port side were slack.

No other defects were observed in the after hold.

The bulwark rail bar is fractured on each side of the ship about amidships. During the heaviest weather encountered on this passage, and when the ship was on the crest of a wave, the fractures were observed to open 1/16 of an inch, and the adjacent butt of the bulwark plating was working.

The bulwark rails are said to have fractured during a previous voyage in the partially loaded condition when heavy weather was encountered.

The fore peak, shelter deck, hatch coamings, deckhouses, casings and tunnel were examined and found to be in order.

EXAMINATION AS THE CARGO WAS DISCHARGED AT PORTLAND, MAINE.

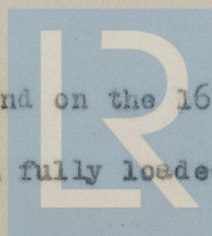
The ship arrived at Portland on Friday, 9th March, and during the time she was at this port the holds and tween decks Nos. 1, 2, 3 & 4, and the deep tank were examined. The permanent bunker was full of coal.

In No. 1 hold an old cement box is fitted at the after end on the starboard side. This is stated to be in way of a leaking bulkhead frame rivet. In the same hold three rivets in the lower stringer collision bulkhead bracket angle standing flange on the port side were found to be slack.

In No. 2 hold one butt of shell plating on each side in the first strake above the bilge, between frames Nos. 134 and 135, was showing signs of leakage, and cement boxes were fitted in way of same.

HOMeward PASSAGE.

The ship left Portland on the 16th March, and arrived at Newcastle on the 28th March fully loaded with grain and



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0108 3/7

general cargo, after a passage stated by the Master as being fine for the time of the year.

During the passage the behaviour of the structure in way of the engine and boiler spaces was carefully observed. Wires were fixed on each side of the ship for the purpose of measuring transverse movement of the framing and stringers, one vertical wire being arranged in the engine space, and in the boiler space on each side of the ship, and a horizontal wire along the face of the side stringer on the port side in the boiler room.

A transverse diagonal wire was also arranged in the engine room extending from the second deck beam knee to the opposite bilge, with a copper spring at about the middle of its length for measuring any racking movement.

The disposition and arrangement of these wires and the points at which measurements were taken are shown on Print IV.

The recorded transverse movement of the framing and stringers and elongation of the racking wire spring, together with extracts from the ship's log regarding the weather are as shown on Print V.

The maximum measured movements of the framing and stringer are as follows:-

	Measured Movement.	Approx. Corrected Movement after allowing for movement of stringers.	Corrected movement. Length of frame or stringer.
	Inches.	Inches.	
Engine Room Framing) (Port side).)	$\frac{1}{8}$	--	$\frac{1}{1385}$
Engine Room Framing) Starboard side).)	$\frac{3}{16}$	$\frac{3}{16} - (\frac{1}{16} \times \frac{1}{2}) = \frac{5}{32}$	$\frac{1}{1110}$
Boiler Room Framing.	$\frac{1}{8}$	$\frac{1}{8} + (\frac{1}{32} \times \frac{1}{2}) = \frac{9}{64}$	$\frac{1}{1230}$
Engine Room Stringer) (Starboard Side.))	$\frac{1}{8}$	-----	$\frac{1}{2160}$
Boiler Room Stringer) (Port side).)	$\frac{1}{16}$	-----	$\frac{1}{3450}$

The movements took place as the vessel sank in the water when rolling and pitching. The time taken for each of the above movements (zero - maximum - zero) was about seven seconds.

Leaks were observed on four frame spaces in way of the side stringer on the starboard side of the engine room and appeared to come through slack rivets in the stringer shell chocks which are covered by cement.

The feed heater which is suspended from the engine room stringer was seen to oscillate slightly as the ship rolled and pitched. The seating of the evaporator, which is built on to the framing on the port side, was also observed to be moving $\frac{1}{8}$ " in a vertical direction.

The after peak was examined, and the tank found in order. The connection of the oxster plate to the sternpost on the port side was found to be leaking, as was also the plate shoe at the bottom of the transverse floor.

In No. 1 frame four shell rivets on the port side, and two on the starboard side, and in No. 2 frame six shell rivets on the port side and two on the starboard side were slack and leaking at about the level of the peak tank top.

The fractures in the bulkhead rail were open $\frac{1}{8}$ " and were working to the extent of about $1/32$ ".

The fore peak, shelter deck, deckhouses, casings and tunnel were examined and found to be in order.



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0108 5/7

CONCLUSIONS REGARDING OBSERVATIONS MADE DURING THE VOYAGE.

AFTER HOLD.

It is considered that the measurements of the movement of the framing confirm the opinion expressed by Dr. Montgomerie, Mr. Waldie Cairns, and self when a preliminary examination was made of the ship at Leith prior to sailing, that the defects in the after hold are due to excessive panting of the ship's side and a high shear stress on the frame rivets when rolling and pitching in heavy weather, with the hold not full of cargo, this panting and shear stress being accentuated by an insufficiency of stiffness in the framing.

When the measurements were being made the stern of the vessel, so far as could be ascertained, was not immersed at any time to a greater depth than the second deck, so that it would appear that when the vessel poops, as is stated to be frequently the case in very heavy weather with a head sea, the movement of the framing would probably be appreciably greater than recorded on this occasion.

The framing is composed of a bulb angle frame and reversed angle forming a girder 7" in depth.

This ship is propelled by steam turbines, the sea speed being $11\frac{1}{2}$ knots, and in heavy weather - which is stated by the Master to be the rule rather than the exception in the North Atlantic - when the vessel is partially loaded, the propeller does not race as it would if reciprocating engines were fitted, and therefore on this account it is not necessary to reduce the speed of the engines. It is thus probable that, as the speed of the ship in heavy weather in the partially loaded condition is greater than it would be if she were propelled by reciprocating engines, the strains in the structure will be correspondingly increased.

BULWARKS.

The fractures in the bulwark rail are not considered of importance.

NO. 1 HOLD.

The defects in No. 1 hold are of a minor character and are considered not to be due to weakness of the structure. Throughout the greater part of this hold the ship is specially strengthened for navigation in ice.

NO. 2 HOLD.

The defects in No. 2 hold could be caused either through panting of the ship's side, or through the ship touching a quay wall, which the Master stated happens sometimes at Leith.

If the loading of the ship will permit, observations will be made in this hold during the next voyage.

ENGINE AND BOILER SPACE.

The recorded movements of the engine and boiler room stringers are not considered to be excessive. The movement of the engine and boiler room framing, however, especially on the starboard side, is thought to be too great and may cause started rivets in the future.

The framing is formed of bulb angle frame and reversed angle as in the after hold; that in the boiler room being increased .06" in thickness. A web frame is also fitted about the middle of the machinery space.

The leaks in way of the side stringer in the engine room, if coming through started rivets in the shell attachment angles, appear to indicate excessive shear stress on these rivets.

AFTER PEAK.

The slight defects in the after peak are not considered to be due to any weakness of the structure.