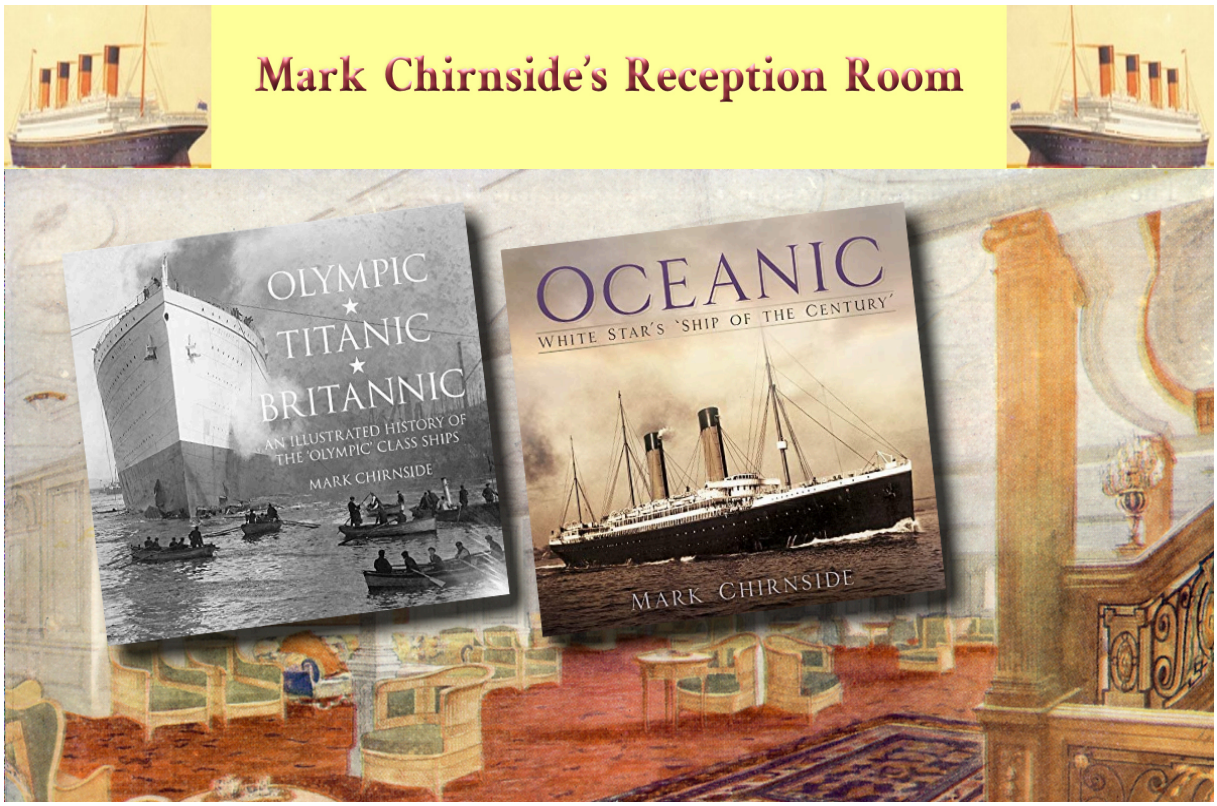
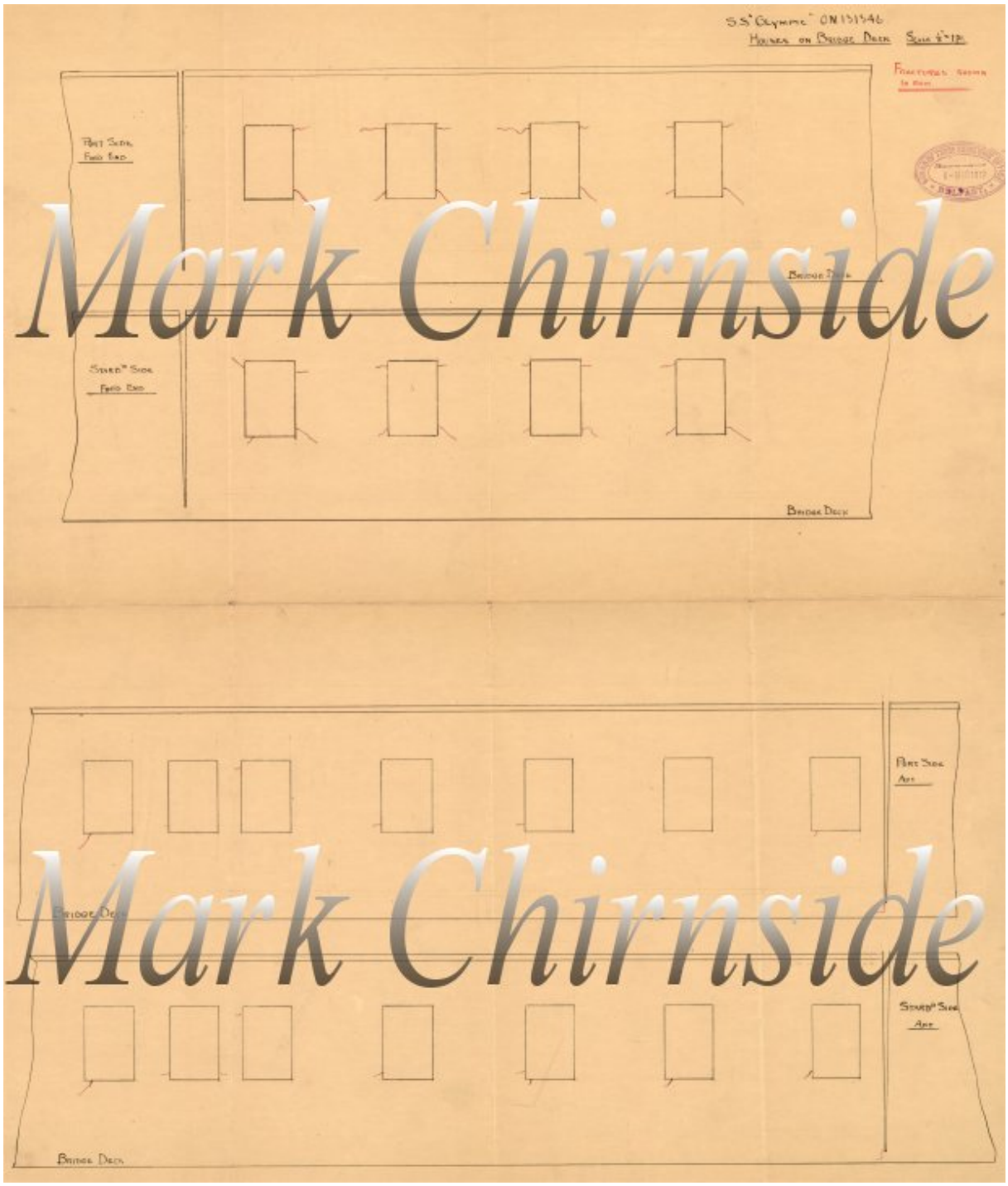


OLYMPIC'S EXPANSION JOINTS

NOTE: This article was first published in the *Titanic* Historical Society's *Titanic Commutator* 2007: Volume 31 Number 178: Pages 84-86.

There seem to be some popular misconceptions regarding the expansion joints of the 'Olympic' class ships prior to, and after, the recent (June 2007) airing of the History Channel's programme *Titanic's Achilles Heel*. The following article is not a direct response to the programme. Its purpose is merely to point out that Harland & Wolff were aware that *Olympic*'s expansion joints could have been increased in number and their design refined and improved early in 1912, before *Titanic* sank. As practical experience was gained with *Olympic*, so improvements were incorporated into each succeeding vessel - part of the shipbuilders' philosophy of continuous improvement. Such was the nature of progressive shipbuilding. Given that it can be demonstrated that Harland & Wolff had reason to improve *Britannic*'s expansion joints prior to *Titanic*'s loss, it is hard to accept that they were changed as part of some sort of 'conspiracy', and it is important that this evidence is made available.



Above: Although simplistic, as they do not show the intricate details of the bridge deck's thin side plating or expansion joints, these diagrams give a good idea of the pattern of fractures that were localised at the corners of windows close to each of the expansion joints - particularly towards the forward end of Olympic*'s B-deck. (Courtesy National Archives, Author's Collection.)*

Olympic's Expansion Joints

Olympic's expansion joints served her well throughout her twenty-four years' service, and performed as well as similar expansion joints did on other large liners of the period, such as *Aquitania* and *Berengaria*, yet there is always room for improvement and Harland & Wolff worked to improve *Britannic*.

It is to their credit that Harland & Wolff were engaged in a policy of continuous improvement, making changes to *Olympic* based on her performance in service, improving *Titanic* and assessing the design of the third sister ship.

Olympic and *Titanic* were constructed with two expansion joints. These allowed the superstructure to flex on top of the structural hull. The heavy sheer strake plating between C and B-deck formed the top of the structural hull proper, even if C-deck was white painted as the superstructure was. On B-deck, Scott Andrews explains that: '*Everything* above the level of the deck plates was superstructure, and was built of light plating; none of it was intended to take any degree of severe stress.'

It is important to emphasize that *Titanic*'s expansion joints did not cause the ship's hull to break apart. They did not penetrate the strength deck or sheer strake, as they were intended to relieve stresses in the superstructure. The superstructure plating near an expansion joint would not be under tension stress, which would only be acting on the strength deck below (the uppermost part of the hull girder). However, that tends to create a slight stress concentration point. If the hull girder gets stressed by tension to the point of failing then the initial failure has to begin somewhere. Areas in close proximity to the joints would therefore be more likely to experience failure as opposed to elsewhere along the sheer strake, regardless of whether the ship initially broke 'bottom up' or 'top down'.

Britannic's forward expansion joint was located in the same place as her sisters', yet in 2006 the History Channel expedition team discovered the base shape had been altered and widened to a 'pear' like shape. (Although – if the forward expansion joint's base was changed – it seems probable that the others were as well, this has not yet been confirmed by exploration of the wreck) An additional joint was installed toward the middle of the superstructure, the aft expansion joint was moved closer to the stern, and the newly-enclosed aft well deck required a fourth expansion joint there. In many ways *Britannic* was very different from her sisters, and it is not the purpose to argue precisely why her expansion joint arrangement was changed, but to point out that *Olympic*'s early performance may have convinced the shipbuilders to review and improve the arrangement of the expansion joints even before *Titanic*'s loss.

By early 1912, *Olympic* had been in service for half a year, and experienced two very heavy storms in December 1911 and January 1912. When she was dry-docked for a new propeller blade to be fitted, early in March 1912 some signs of 'undue stress' were observed. On the bridge deck, B, there were a number of fractures at the corners of rectangular windows near

the expansion joints, while 'one very short fracture only was found in the houses on the promenade deck [A].' Fortunately the fractures were 'confined entirely to what is shown here, neither the promenade deck or bridge deck plating nor the bulwark plating at the sides showing any signs.'

It is important to emphasize that these fractures were not of a serious structural nature, for the plating was light, yet they indicated that the expansion joints were not facilitating the 'working' of the bridge deck enough to prevent some localised stress fractures in severe weather conditions. The window corners allowed stress concentrations to form, facilitating fracture, and it was preferable to try and avoid these issues in future.

There was a very interesting surveyor's observation:

> It will be observed that these fractures have occurred at the portion of the [deck] houses between the expansion openings and near to the openings.

Technical researcher Scott Andrews offered some fascinating comments about the fracturing:

> I think the problems with the exterior screen plating occurred along this deck [B-deck] simply because of the *long lengths at which it continued unbroken by any sort of joint* [author's emphasis], coupled with the fact that the bottom edge of this screen was securely riveted to the top edge of the shell [plating of the sheer strake]. This last part is critical here because this meant that even though the side screen plates were not designed as part of the hull structure, all of the flexing and bending the hull experienced was being directly transmitted to this entire line of light plating. The deckhouse bulkheads inboard of these screens were in a better position to handle this movement, partly due to the greater internal bracing they had in places, and also because of the numerous changes in direction they made along their path lengths, which would tend to behave like the expansion loops and bends designed into long runs of steam piping.

Although *Lusitania* had two expansion joints, *Aquitania* was constructed with three, as did other large liners. It became unusual for a liner *Olympic*'s length to have only two.

Another interesting point is that two of the small fractures were located on the port and starboard sides beneath the aft expansion joint. This suggests that Harland & Wolff were already aware that the design could be improved by changing the shape of the base of the joint, thus reducing the likelihood of localised stress cracking.

It was *Olympic*'s aft expansion joint that was observed to have fractured at the light plating near the base. That would seem to indicate that it had opened more than anticipated. At the aft end of the deck, there was far less fracturing yet spread over a wider area, whereas at the forward end the fracturing was more extensive but around fewer windows. What seems

apparent is that the forward end of *Olympic*'s bridge deck 'worked' considerably more than the after end. *Britannic*'s forward expansion joint was located in the same place and this may have been an influence as regards its altered shape. Her additional expansion joints reduced the likelihood of one of the after joints opening more than was desirable.

It can be demonstrated that Harland & Wolff were continuously improving their designs; that prior to the disaster they were aware that *Olympic*'s two expansion joints had not been sufficient to prevent localised stress fractures as the bridge deck erections 'worked' at sea; and that a fracture in the light plating had been observed at the base of the aft expansion joint. *Titanic*'s construction was too far advanced for her expansion joints to be modified, yet *Britannic*'s was not. In the absence of more evidence, a strong circumstantial case can be made that the changes to *Britannic* were under consideration before the *Titanic* disaster. Harland & Wolff were certainly aware of the potential for improvement and continued to improve their previous best practise.

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