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THE LOSS OF THE TITANIC - AN ENGINEER'S VIEWPOINT

By Lieutenant Commander Geoffrey Carr MSc CEng MIMechE Royal Navy (Retired)

The following article is a condensed version of the presentation, sponsored by the Society, that was given to technicians and officers at HMS SULTAN on the 100th anniversary of the TITANIC tragedy.

Introduction

In 1912 there occurred a shipping disaster of such proportions that we are still talking and speculating about it one hundred years later. Over 1400 people lost their lives in a ship that was at the peak of modern technology at that time. On the face of it, it was a gross failure in engineering design and nautical practice. This article is about that ship: the TITANIC ('Figure 1' on Front Page). It aims to explain the circumstances that led to her creation, her collision, and her eventual loss, with particular emphasis on engineering and the role that engineers played in her short life.

The Titanic—Some of the Myths

Most people now have a fair idea about the TITANIC:

- the biggest of her time,
- fast,
- unsinkable,
- not enough lifeboats,
- a design disaster and
- the worst passenger ship sinking ever.

In fact, only "1½" of those statements is really true. Eliminating the last of those early, she certainly was not the worst passenger ship sinking ever: that was the German passenger ship WILHELM GUSTLOFF, which was sunk by a Soviet submarine in the Baltic in 1945 with the loss of approximately 9,400 lives - about a quarter of the strength of the Royal Navy today.

Concept and Design

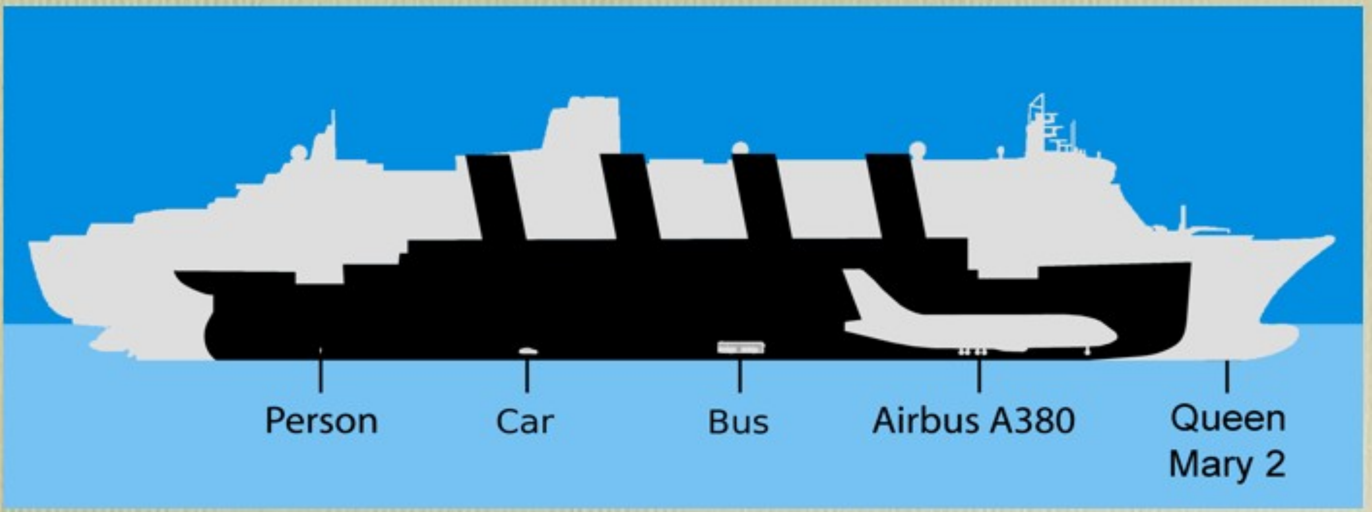
The ship was envisaged at the end of the 19th century, when sail was giving way to steam, wood was giving way to iron and then steel, and trans-Atlantic crossings were becoming commonplace. It was also a time of encouraged mass emigration to the United States and the era of emigrant ships, built specially to transport a large number of people comfortably and cheaply across the Atlantic. And that is what TITANIC was: primarily she was an emigrant ship.

Various companies ran these Atlantic steamers, but TITANIC was owned by the Ocean Steam Navigation Company, otherwise known as the White Star Line, which was ultimately part of an American company; but the ship was registered in Liverpool and sailed under the British flag with a British Crew. Working with Lord PIRRIE of the shipbuilders Harland and Wolff in Belfast, Bruce ISMAY, the Managing Director of the White Star Line, conceived the idea of three ships for the North Atlantic run that would be bigger, more luxurious, and better appointed than ever before. The ships took the form of OLYMPIC, TITANIC and BRITANNIC in that order and were known overall as the OLYMPIC Class.

TITANIC herself was 269m (882' 6") long with a beam of 28m (92' 6") and a gross tonnage of 46,328 tons. Even by today's standards she was big. ('Figure 2')

Warships are measured by *Displacement* Tonnage - the actual weight one would get if one could lift the ship out of the water and put her on a set of scales. In the commercial shipping industry, however, the interest is in a ship's *carrying* capacity: her commercial

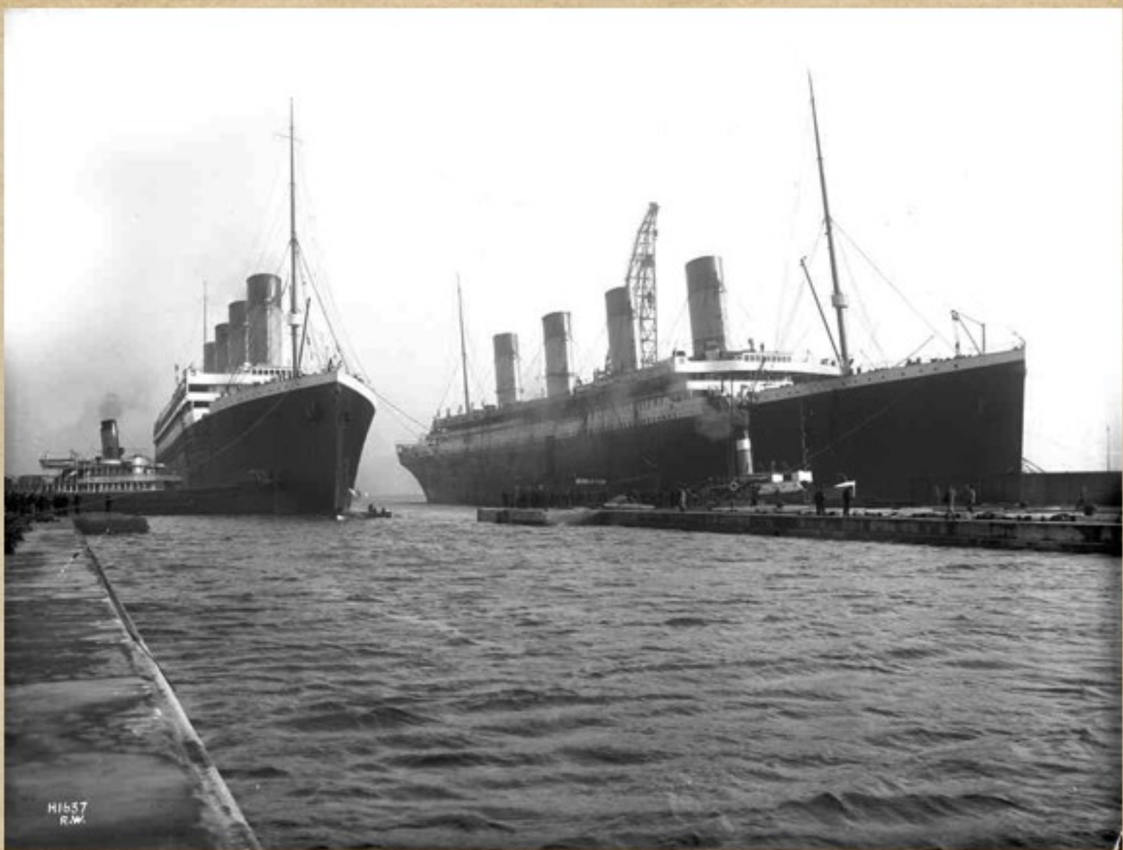
Figure 2



TITANIC VERSUS MODERN TRANSPORT

worth. Hence, passenger ships are measured by *Gross* tonnage, which is a measure of the *enclosed volume* of the ship. This is a technical point, but it does have some significance when considering the half-truth about the ship: TITANIC was only technically and marginally

Figure 3



OLYMPIC AND TITANIC WERE SISTER SHIPS

the largest ship of her kind; her sister ship OLYMPIC was a year ahead of her and was virtually identical ('Figure 3').

OLYMPIC only had a slightly smaller gross tonnage because part of her promenade deck was not glassed in like it was on the TITANIC. That gave her a slightly smaller enclosed volume and, hence, smaller Gross Tonnage. The significant point is that OLYMPIC had already completed voyages across the Atlantic when TITANIC sailed on her maiden voyage. If TITANIC had not sunk on her maiden voyage she would not have been regarded, historically, as particularly remarkable - though that it should be made clear that *both* ships *were* the biggest and most magnificent of their kind in terms of size, luxury and innovation.

Machinery

The machinery of these ships matched their size, and the machinery spaces took up a significant proportion of TITANIC's length, as was common in fast steam ships ('Figure 4').

Figure 4

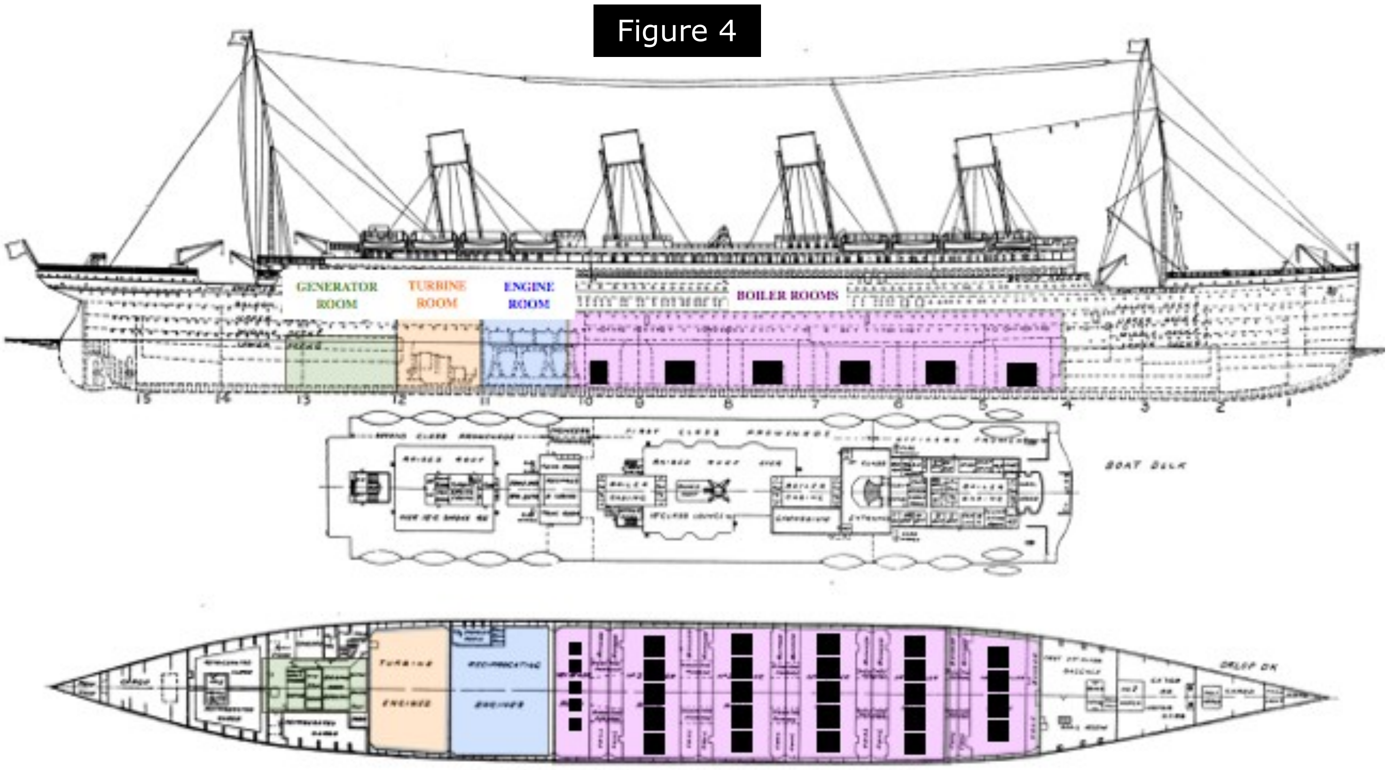


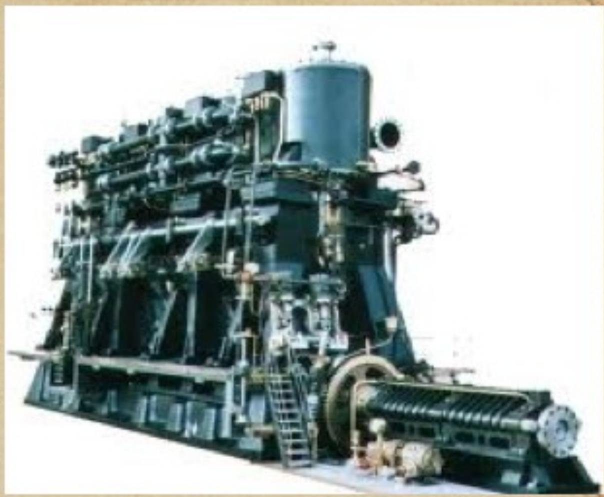
FIG. 1.—TITANIC, OUTBOARD PROFILE, BOAT DECK AND ORLOP DECK PLANS

There were six boiler rooms (shown in purple) with 29 coal-fired boilers in all - mostly arranged five-abreast in each. Aft of that was the engine room (in blue), then the turbine room (in yellow), and finally the main generator room (in green). The boilers were coal-fired and of the fire-tube type. Twenty four were double-ended, with six furnaces each, hand-stoked by two stokers. The remainder were single-ended and intended for use when the ship was steaming auxiliary. They burned 650 tons of coal a day at cruising speed, generating saturated steam at 14.8 bar (215 lbf/in^2).

The ship had three propeller shafts: two wing shafts, each with a three-bladed propeller, and one centre-line shaft with a four-bladed propeller, in a configuration that was quite unique and innovative at the time, and which generated quite a bit of interest among engineers.

Each wing shaft was driven by a triple expansion, 4-cylinder, double-acting reciprocating engine ('Figure 5'). These behemoths stood 10m (30 feet) high and the crank stroke, alone, was 2m (6ft 3"). The largest cylinder - the LP cylinder - had a diameter of 2.5m (8ft 1"). Each of these units developed 11.2 MW (15,000 shp) at 75 rpm - less than half of the power of a WR21 gas turbine used today in the latest RN warships; but they were reliable, economical, quiet and state-of-the-art in their day. There was no need for a gearbox, because that type of engine develops enormous torque from rest. The centre-line shaft was

Figure 5



TITANIC MAIN RECIPROCATING ENGINES

Figure 6

TITANIC CENTRE-LINE SHAFT TURBINE CASING

The enormous size was dictated by the fact that it operated with exhaust steam at very low pressure and, hence, high volume of steam. Pressure at entry was 0.6 bar absolute (9 lbf/in²) and the shaft ran at 165 rpm - over twice the speed of the wing shafts. Again, there was no gearbox on that shaft.

Only the wing engines could go astern, and this was achieved by stopping the engines and altering the linkage of the steam valves so that the shafts rotated in the opposite direction. When running astern, steam was shut off from the centre-line turbine, and that propeller was allowed to free-wheel.

The boilers and three engines combined developed 34 MW (46,000 shp), giving TITANIC a top speed of 22 knots - not exceptionally fast by the standards of the day.

Of the four funnels, only the forward three were used; the after funnel was a dummy used to enhance ventilation in the Engine Room. TITANIC's rudder was operated by a steam engine, controlled by hydraulics with auxiliary back-up: perfectly normal today of course, but very forward-thinking in 1912.

TITANIC had full electrical power, based on 100V DC, supplied by 4 steam reciprocating generators with 2 steam-driven emergency generator sets, to yield a total electrical capacity of just over 1.6 MW. Electricity was used mainly for cooking, lighting, ventilation, heating and the passenger lifts. There was a 55-line telephone system, which was quite progressive for 1912. She also had radio, which had become quite common on the North Atlantic run by 1912. The 5 kW set had a range of about 350 miles and used wireless telegraphy - Morse code, not voice - communications. Radio voice communications had not been invented.

Two Myths

TITANIC was never intended as a competitor in a race across the Atlantic among passenger ships: the so-called Blue Riband. The emphasis was on *large, luxurious and better appointed*. She was built for comfort, not speed. This helps to dispel any myths that her Master was trying to complete the passage in record time. He was not, for TITANIC did not have the speed; several other transatlantic liners, such as those owned by Cunard, were turbine driven and could go much faster, but they were noisier, less comfortable and used much more fuel as a result.

Moreover, the White Star Line never claimed that TITANIC was unsinkable: they said in their technical literature that she was, '...as far as possible to do so, designed to be unsinkable...'. A technical magazine paraphrased this into, '..practically unsinkable'. Neither of these statements featured heavily in the advanced publicity beyond the technical press - they only came to the foreground and the spotlight after the sinking.

Complement

TITANIC could carry 2,566 passengers in three classes of accommodation, supported by a crew of 945.

Classification	Max Capacity	Carried on Voyage
Third Class Passengers	1022	706
Second Class Passengers	510	285
First Class Passengers	1034	325
Total Passengers	**2566**	**1316**
Crew	945	885
Total Accommodation	**3511**	**2201**

She was carrying only about half her full capacity of passengers on her maiden voyage, which was just as well. Nevertheless, she had 2,201 souls on-board including the crew on that fateful voyage.

As can be imagined, the vast and sophisticated machinery took a lot of looking after and needed a large and highly-qualified engine room complement. Of the 885 crew, 325 - or 37% - were members of the Engineering Department; it was the second largest department on-board.

RMS Titanic Engineering Complement	Number
Chief Engineer	1
Engineers	24
Electricians	6
Boilermakers	2
Plumbers	1
Greasers	34
Leading Stokers	13
Stokers	161
Trimmers	73
Clerk, Stewards, Storekeepers	10
TOTAL	**325**

At the top of the list were the Engineer Officers, what would be called in the Navy today the senior technicians: highly skilled, trained to be innovative and capable of effecting repairs far from shore support. There were 31 of them. Next were the Greasers who assisted the engineers with general maintenance and watchkeeping; the rough equivalent today would be junior technicians in the Navy. There were 34 of them. Finally were the Stokers - or Firemen - and Trimmers: the so-called Black Gang. There were 247 of them. Thankfully, there is no real equivalent today.

The Engineering Department also had its own stewards and messboys: the Engineer Officers messed separately from the Deck Officers, a practice that continued in the Merchant Navy until well into the mid 20th Century (it was generally considered that oil and water did not mix). There were separate Engine Room Artificer (ERA) messes in the Royal Navy too, until the early 1970s.

It was a hard life below, particularly in the boiler rooms where, despite the modern electrical ventilation, ambient temperatures could reach 50℃ on occasions. There was no question of covering up bare arms or chests in machinery spaces, as would be done today; the men would wear just a vest and trousers, possible with a neck-cloth.

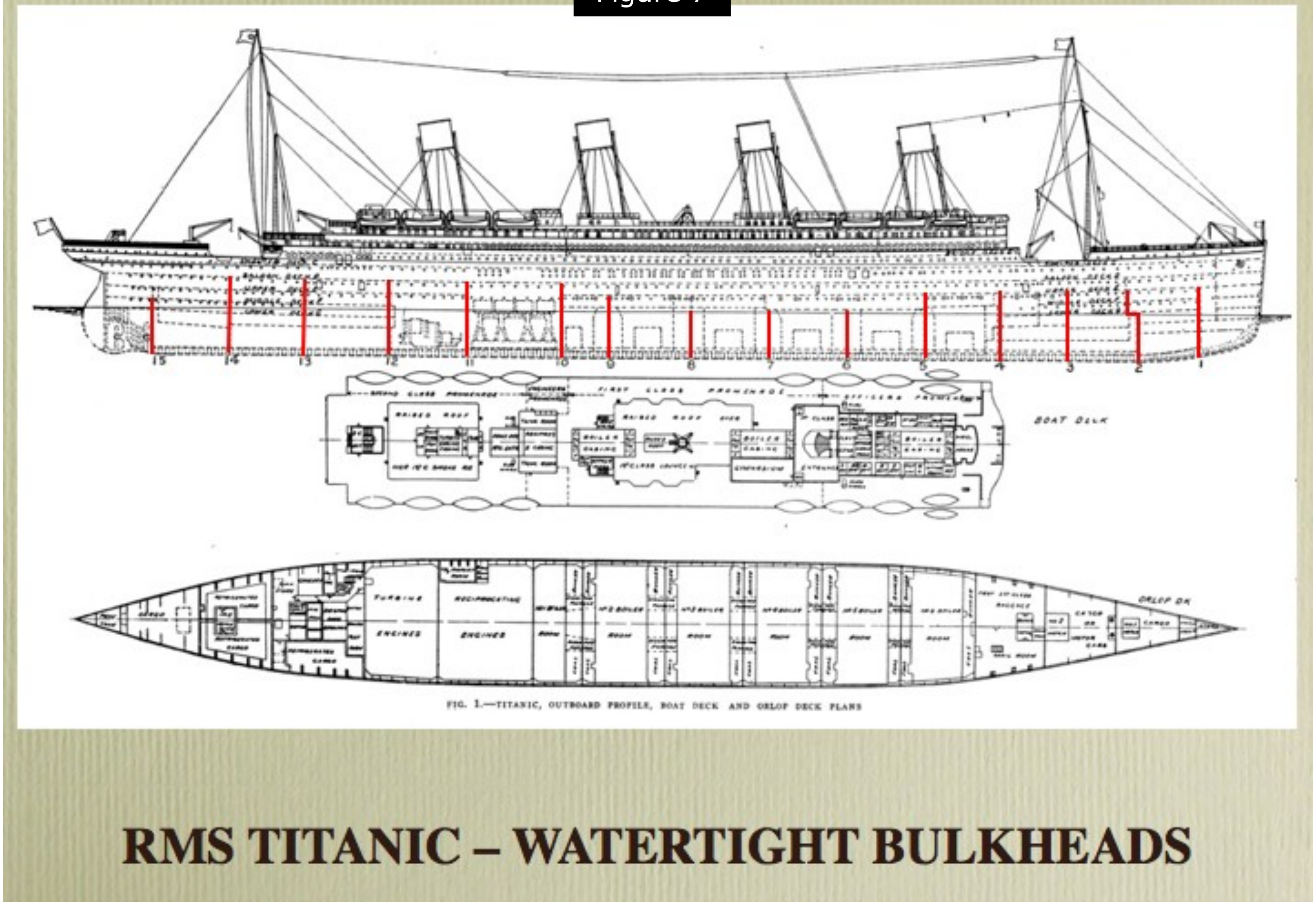
A stoker's life was hard: each lump of coal was about the size of a house brick and shovels-full had to be thrown into the furnace at shoulder height. 174 stokers were needed to do the job, supported by 73 trimmers to level off the coal in the bunkers as it was used. Like the engineers, they worked in three watches - 4 hours on, 8 hours off - and they were a tough bunch, almost a law unto themselves: there had been instances, in other ships at that period, of difficulty in controlling them, and even mutiny. Certainly it was difficult to get them to participate in whole-ship evolutions, such as lifeboat drill, because they claimed it was not part of their duties.

Structural Design and Flooding

It is not generally appreciated that TITANIC was very well designed and solidly built and was equipped to a very high standard of technology. With minor changes, her watertight integrity would meet most of *today's* SOLAS (Safety Of Life At Sea) Regulations that govern the safety standards of modern passenger ships.

She was equipped with 15 watertight bulkheads ('Figure 7'), some with hydraulic self-closing watertight doors. This was not a new innovation, but it was not mandatory at the time. There was a full-length double bottom that extended at least 1.6m (5ft 3") above the keel.

Figure 7



She could endure flooding in four of the forward compartments and still stay afloat; the regulations required staying afloat only with two compartments flooded – and still do.

For flooding, she had 5 bilge and ballast pumps, each of 250 tons/hour capacity; and 3 bilge pumps, each of 150 tons/hour capacity. There was also the option of emergency pumping, using the main condenser circulating pumps, of a further 2,000 tons/hour. The salvage pumps operated through two general suction mains that could be cross connected, or operated independently so that it was possible to pump from any flooded compartment.

Her hull was specially strengthened, with close framing in the bows and stern. Double plating 35mm (1.5") thick was used at the curve of her bottom and on her strength deck (C Deck), and 25mm (1") plating was used in the central 40% of her length. Hydraulic riveting was used extensively for consistency of strength and, in key areas, triple riveting was used. She was a very solid ship: her sister ship, OLYMPIC, had already survived a collision with HMS HAWKE in 1911 when the cruiser's armoured bow ram pierced her above and below the waterline, and OLYMPIC would later survive collisions with other vessels in a long and successful career. The structural design and watertight integrity were very sound.

Lifeboats

It is generally believed that the owners and builders of TITANIC were criminally and deliberately negligent in not providing enough lifeboats. It is, of course, quite true that she did not carry enough lifeboats; but that is a judgement made with the benefit of hindsight. There was a reason for it, though not an excuse. She had 14 lifeboats with a capacity of 65 people each; 2 cutters with a capacity of 40 people each; and 4 'collapsible' boats with a capacity of 47 people each: a total life-saving capacity of 1,178 - for 2,201 people on-board on that maiden voyage.

There were no power davits, no motor lifeboats, and there was no fixed design standard for the boats which, today, would probably be judged by SOLAS as capable of only carrying about 24 people each, as opposed to 65. But, odd though it may seem, the number of lifeboats carried reflected the practice in every other trans-Atlantic steamer at the time, and was based on sound – if now known to be flawed - reasoning. The number carried actually exceeded the Board of Trade regulations of 1894, which was based on tonnage and which allowed a trade-off between a ship's watertight integrity and the number of lifeboats carried. It was reasoned that the chances of survival were better if people stayed with a large ship with good watertight integrity - which would, of course, survive collision until help arrived summoned by radio. This reasoning was based on statistical evidence from actual incidents before 1912 and is still true and is still practised in principle today: always stay dry and with the ship for as long as possible.

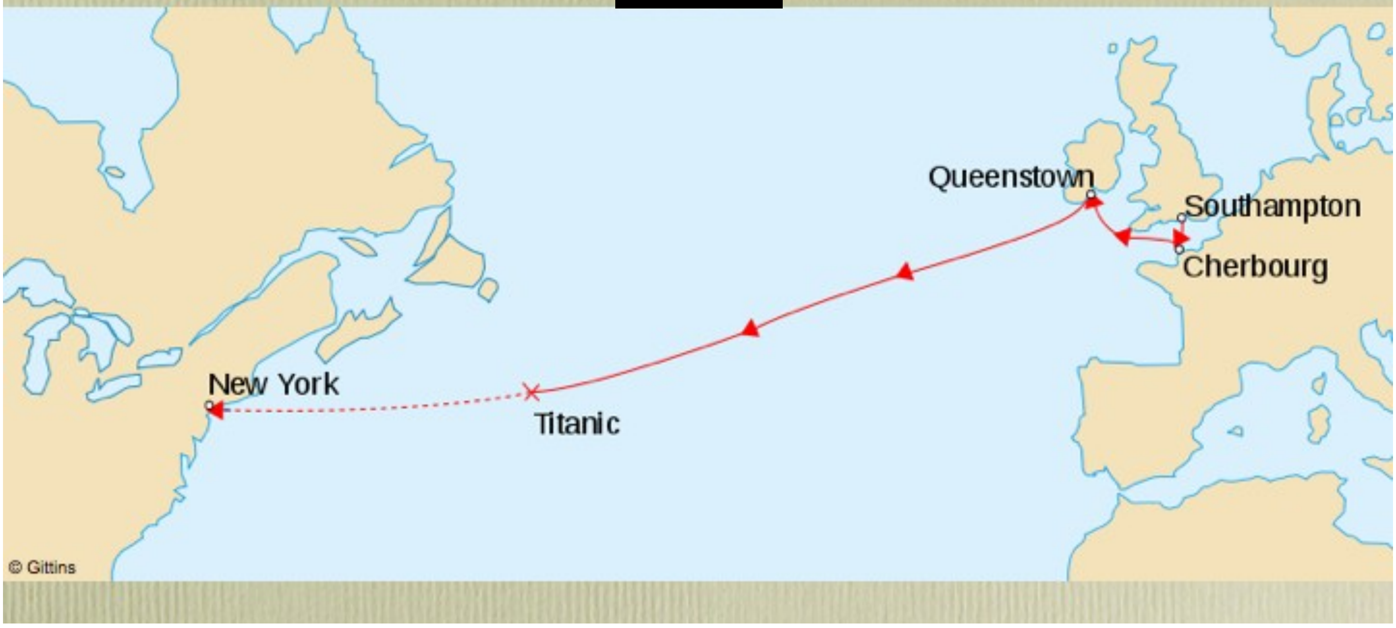
It is worth noting that the lifeboats on a modern cruise ship or cross-channel ferry may look very reassuring, and the sea often looks quite calm from high up. However, launching boats at sea is extremely hazardous and rarely achievable without accident unless one has special equipment and a well-trained crew. This is particularly so in the North Atlantic, where there is usually a very heavy swell that will smash boats against the ship's side or overturn them.

The Voyage and Impact

TITANIC sailed from Southampton on Wednesday 10 April 1912 and called at Cherbourg, then Queenstown (now Cobh) in southern Ireland, before setting course for New York on Thursday 11 April at 22 knots. Although there was no international monitoring system for icebergs like there is today, it has since been suggested that 1912 was probably the worst year for icebergs in the North Atlantic since the mid 19th century.

TITANIC's course was along established shipping lanes for liners, specifically chosen to avoid the known incidence of icebergs at that time of year, based on experience over the previous 60 years ('Figure 8').

Figure 8



Nevertheless, as icebergs were encountered in April 1912, ships did send out general radio messages as warnings to other vessels and TITANIC did receive them, though there is some evidence that not all were passed on to the bridge. As a result, TITANIC ended up sailing right into the middle of a reported ice field.

Shortly after departure on Wednesday, a small fire was discovered in a coal bunker on the starboard side, at the after end of No 6 (the foremost) boiler room. This was not entirely uncommon in coal-fired ships, but the fire was not put out until Saturday night and it did bring part of the watertight bulkhead between the boiler rooms up to a cherry-red heat. It was planned to replace the plates, as a precautionary measure, at the next opportunity.

On the evening of Sunday 14 April, the air temperature was down to 0℃ (32°F). It was a clear night, with no moon or wind and, unusually, the sea was calm. Lookouts were posted in the crow's nest, as was normal, and both they and the Officers of the Watch were on the lookout for ice, implying that Captain SMITH was well aware of the hazard.

It is difficult to explain, or justify, why the ship was still steaming flat out at full speed in these circumstances other than to say that – astonishingly - it was fairly common practice at the time for liners: it was believed that any iceberg big enough to sink a large ship would be seen in time. Yet it was known that icebergs would be hard to see that particular night,

first, because they do not project much above the surface - typically, $^7/_8$ of an iceberg is submerged; second, because a calm sea meant there would be no breakers or phosphorescence to see as waves broke on the iceberg; finally, because, with no moon, there would be insufficient light to see an unlit obstruction well: the ambient light on that night was the equivalent of a single candle held 55m (180 feet) above the sea. The best hope the lookouts had of spotting an iceberg in such conditions was when it appeared on the horizon, about 16 km (10 miles) away as viewed from the crow's nest, as a silhouette outlined against the star-lit sky; once it got closer than that point, then it would be virtually invisible against the backdrop of the sea.

Some accounts condemn the fact that the lookouts did not have binoculars. Seamen disagree on this point. In fact, binoculars are fine at night for picking up lighted objects, but they do not work in total darkness - they even cut out some of the light that is available. So it would not have made any difference whether the lookouts had binoculars or not, and it was not normal practice to provide them anyway.

As it happens, the iceberg was not sighted by the lookout until it was about 460m (500 yards) away; TITANIC was right on top of it by then, and the Officer of the Watch had only just over 37 seconds to act before she hit.

Impact

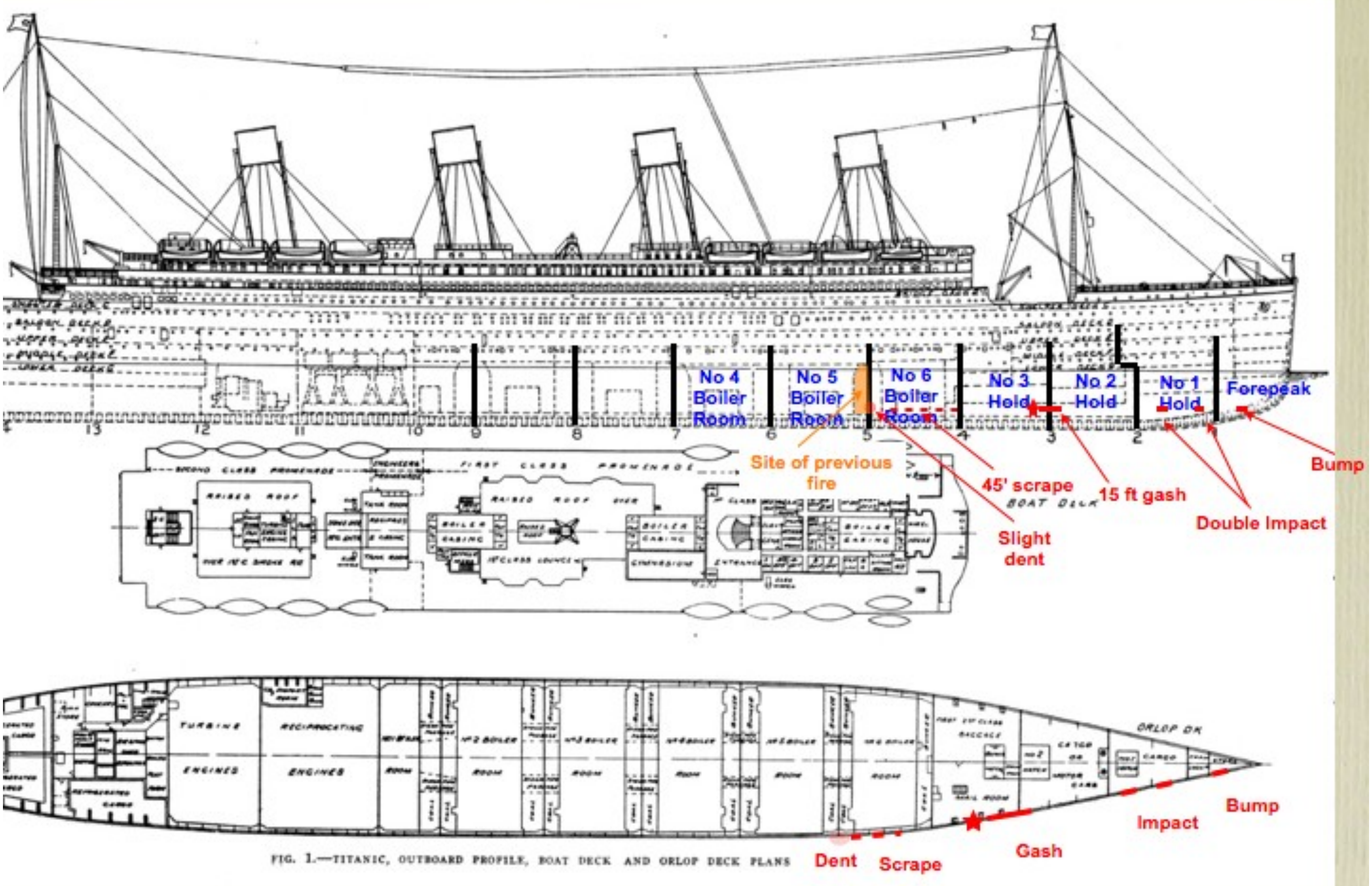
The Officer of the Watch ordered the wheel to be put hard over and rang 'Stop' on the engines (it is not clear if he then rang down 'Full Astern'). He also closed the watertight doors low down in the ship. The bow slowly swung to port...but one cannot stop or turn a 52,000 ton ship that quickly. Consider the situation down below. It was a merchant ship, on passage, in mid Atlantic towards the end of the First Watch. There was no bridge machinery control like there is today, nor was there a machinery control room. The throttles were big wheels at the control platform, which may not even have been manned. The watch below would have been doing rounds, checking readings, writing up logs, and generally monitoring the machinery.

Suddenly the telegraph clangs to 'Stop'. Imagine the initial consternation. Even if the duty engineer was in position it would take a good while to wind the throttles shut, let alone engage 'Astern' and wind them open again There was no hope of getting the power off in time - though that might have been a blessing as the ship needed all the momentum she could get to turn properly.

Of course, a ship does not turn like a car; initially she keeps on going in the same direction, and the stern slews out in opposite direction to the turn - a process known as Advance and Transfer. Computer simulations by Harland and Wolff have since indicated that, if she had hit head on, TITANIC would have suffered severe damage to her bow and taken casualties, but she would not have sunk. But, realistically, no Officer of the Watch is ever not going to avoid a collision, and he nearly got away with it. However, at 1140 pm on 14 April 1912, TITANIC struck.

The iceberg scraped down the starboard side, buckling the underwater hull and popping rivets 7m (24 ft) below the water line and 3m (10 ft) above the keel ('Figure 9'). There was not a 100m (300 foot) gash down the side as was first believed: the damage was sporadic and varied; but it did extend over a large length and was later calculated to be the equivalent size of a hole over 1 m^2 (12 $feet^2$) in area. Water immediately began to pour into the first six compartments and, from that moment, she was doomed.

Figure 9



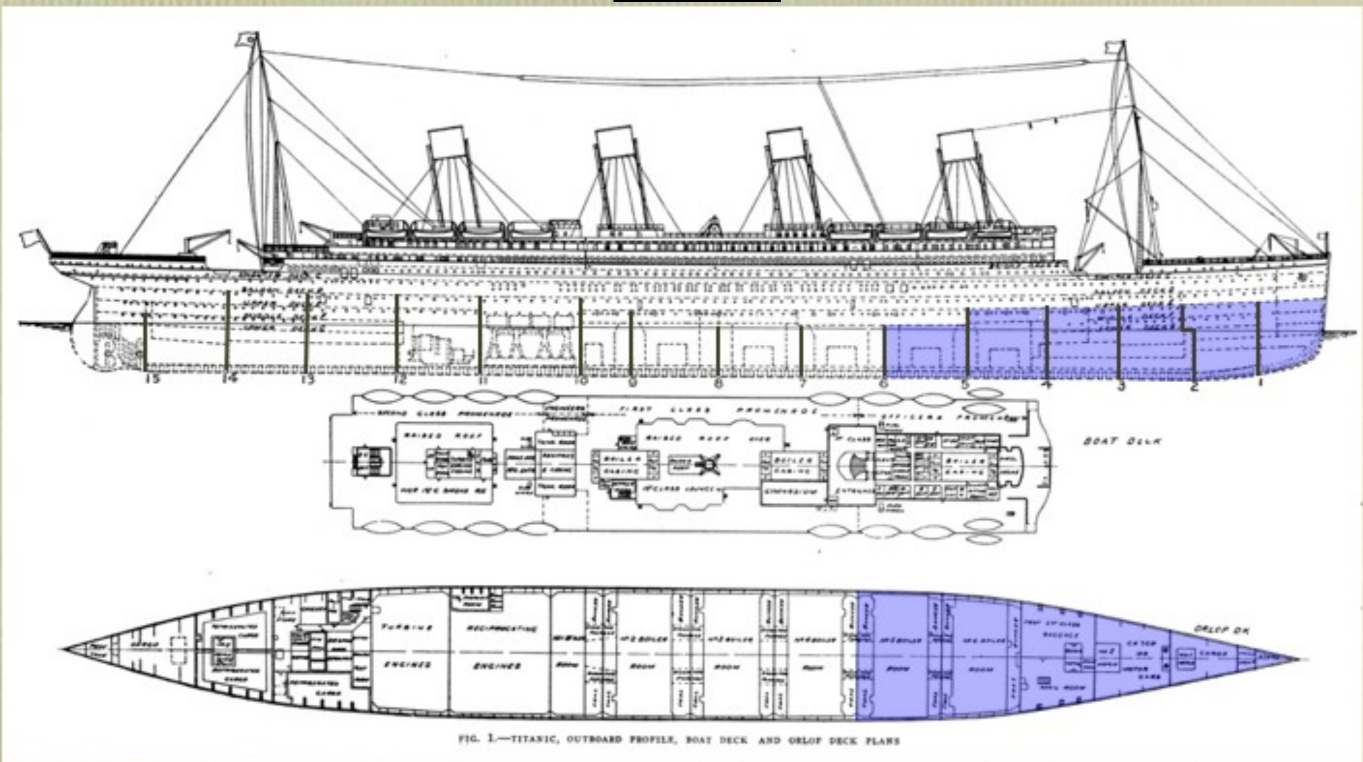
DAMAGE IN 10 SECONDS

It will be recalled that TITANIC had 15 watertight bulkheads that extended right up to various deck-levels. Beyond that, the decks were not watertight. In a warship, decks and bulkheads are watertight at all levels because one expects warships to be able to survive a lot of punishment. However, that sort of watertightness is difficult to achieve in practical terms in a passenger ship, where people expect to be able to move around as in every-day life, without stepping over storm sills or opening heavy hatches. In TITANIC, because the watertight bulkheads only reached as far as certain deck levels, water poured over the top of the for’d bulkheads into the next compartment, then the next one, as the ship sank lower and lower into the water. This was not a design flaw, however; it was an accepted part of the design. With three of her forward compartments flooded, the water would not have flooded over the top of the bulkheads; even with four compartments flooded, and the water pouring over the top of some bulkheads, she would have stayed afloat. But she could not cope with five or more compartments open to the sea (‘Figure 10’ - next page).

It will be recalled that hydraulic triple riveting was used in the critical areas of the hull to give consistency and strength. Of course, in modern, welded, ships the plates are butted up to each other and welded. In riveted ships, the plates had to be overlapped slightly at the ends, holes were punched or drilled through, and the rivets were hammered home by hand when red hot to hold the two plates together as the rivets cooled, forming a watertight joint. Three million wrought iron rivets were used in TITANIC. It was a very labour-intensive task: there were men inside and outside the hull for this operation, along with others to heat the rivets and to pass the hot rivets to the riveter. Hydraulic riveting eliminated the hand operation and gave a more consistent standard. If one had a serious bump in a riveted ship then, very occasionally, the rivets would stretch or pop and the seam would ‘spring’, i.e. open slightly, letting in some water. The shipbuilders used the best material available at the time, but what they did not know was that the steel and iron used in TITANIC - and every

RMS TITANIC – EXTENT OF FLOODING

Figure 10



other steel ship of that time - was susceptible to a phenomenon known as the *Ductile-Brittle Transition Temperature*: that is the temperature below which steel completely alters its toughness and will crack and shatter like glass under impact. The temperature of the sea on that night was well below the Transition Temperature for the steel and iron used in TITANIC. The designers and builders did not know any of that - it was an aspect of engineering that was not fully understood until the 1950s.

There had been a fire against the watertight bulkhead between Numbers 5 and 6 Boiler Rooms, that had been extinguished earlier, but which had heated the bulkhead - in parts - to a cherry-red heat and which had distorted the plating. It is debatable whether this, and the cracking, were significant factors in the sinking, but they certainly did not help.

Overall, flooding was slow at first and the severe damage was confined to just Number 3 hold, just under the foremast. However, it was steady and, within the first few minutes of assessing the damage, Thomas ANDREWS of Harland and Wolff, who was on-board, told Captain SMITH that the ship was going to sink and that they had about 2 hours. It says something for his ability in the days before computers or calculators that his calculation was correct. ANDREWS was not the naval architect who designed the ship, he was Managing Director of the Design Department and, sadly, he went down with the ship.

Abandon Ship

Once it was known that the ship was doomed, Captain SMITH ordered that a distress signal be sent out by radio. This was picked up by various ships but not, unfortunately, by the nearest ship that could readily have saved everyone, the SS CALIFORNIAN ('Figure 11'). The CALIFORNIAN was stopped in the ice field, within sight of TITANIC, but her radio was not manned because her operator had gone to bed: it was not normal practice, at that time, to man the radio 24 hours a day and, in any case, one man could not have done it.

Distress rockets were sent up by TITANIC at regular intervals, and these were seen by the CALIFORNIAN, but it was thought that the rockets were either company signals to another ship or, perhaps, some form of firework display to entertain the passengers. CALIFORNIAN

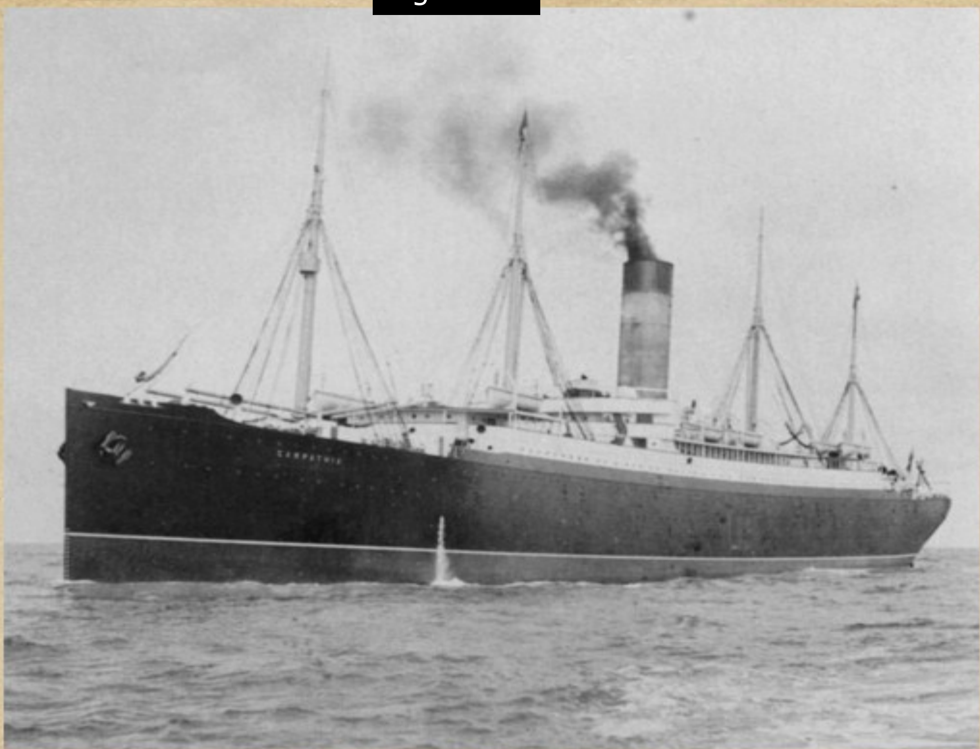
Figure 11

SS CALIFORNIAN WAS STOPPED WITHIN 12 MILES OF TITANIC

did try calling up TITANIC by lamp, but got no reply. Eventually, TITANIC’s lights disappeared and CALIFORNIAN assumed that she had sailed off. She had, of course, sunk.

The next nearest ship was the Cunard liner CARPATHIA (‘Figure 12’), 50 miles away. She immediately rang on full speed and headed for TITANIC’s position, but it would take 3½ hours to get there.

Figure 12



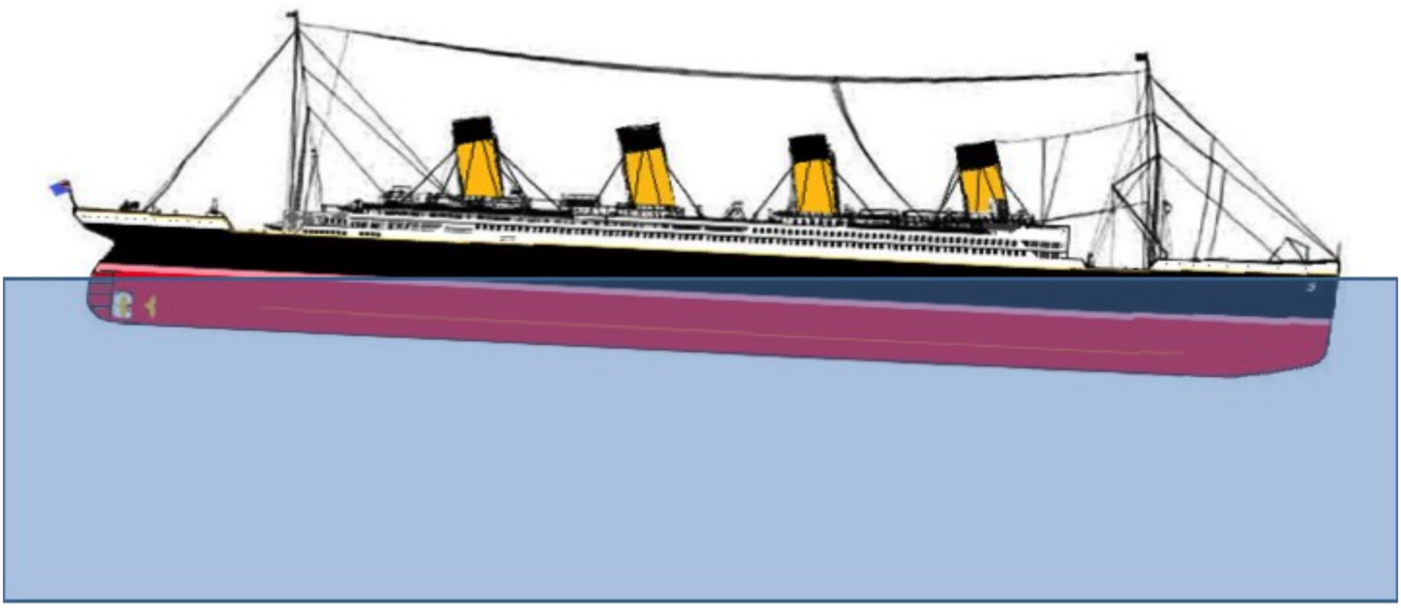
RMS CARPATHIA

When the order to abandon ship was given, the boats were cleared away and passengers were embarked 'women and children first'. TITANIC carried only 20 boats capable of carrying only half the people on-board. So over 1,000 people were doomed to die from the moment that abandonment became inevitable. But the situation proved to be worse: for the first hour, flooding was slow and this led to a false sense of security - the passengers did not want to get in the lifeboats ('Figure 13' below).

Not all the lifeboats were sent away full: the first boats were only partially filled - one boat had only 12 people in it. People did not really believe that the ship was sinking and did not want to leave the warmth or their belongings, particularly those in Third Class. They were also afraid of the height when climbing into the boats: 60 feet - rather like stepping out of a window of a six storey building onto a creaking wooden platform held by ropes. Some of the officers did not have the confidence in the boats' full capacity, both on the davits and in the water. Finally, many passengers, particularly those in the Third Class, had not yet found their way to the boat deck.

There was also inconsistency between the starboard side boats and the port side boats in terms of how full they were and who was in them. The policy of 'women and children first'', which was applied strictly on one side, split families and effectively condemned fathers to death.

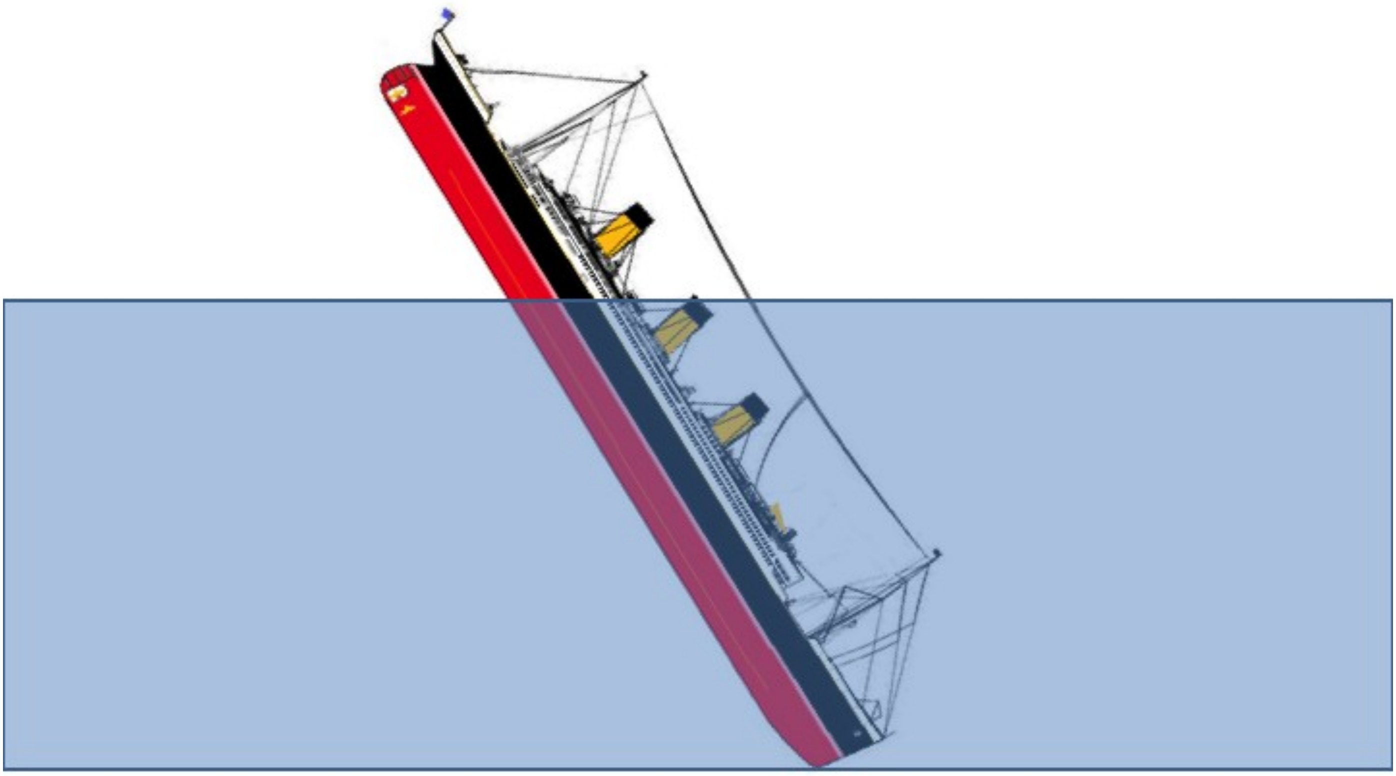
Much has been made of the fact that the proportion of First and Second Class passengers saved was greater than that of Third Class passengers and it is commonly believed that Third Class passengers were locked in by gates. However, neither the British nor the American Boards of Enquiry found this to be true and this finding is supported by a recent study. There *were* gates to separate the classes, it was required by law in emigrant ships to prevent the spread of disease, but these were only waist high and intended simply to mark the boundary between the different types of accommodation. There are three likely reasons for the disparity in social classes of the survivors: first, the order to abandon ship was announced individually and probably haphazardly by stewards – the ship was not fitted with a Main Broadcast or General Alarm system. Second, Third Class sleeping accommodation (in the bows and the stern) was significantly far from the boat deck and Third Class passengers would have been unfamiliar with the route to the boat deck. Finally, and perhaps most significantly, many Third Class passengers could not speak or understand English: nearly 60% of Third Class passengers were not native English speakers. This last suggestion seems to be borne out by the relatively high proportion of Third Class Irish passengers who – in fact - survived.



SINKING WAS SLOW AT FIRST

Ships sink either by capsizing or plunging by the head or the stern. TITANIC plunged by the head, with her stern sticking high out of the water before she went ('Figure 14' below).

The official enquiry concluded that she did *not* break in two, but the general view today, from examining the wreck, is that her hull did fracture near the fourth funnel under the enormous strain of sticking out of the water. The stern section lingered briefly because of its buoyancy, but then that went too. She finally sank at twenty past two on the morning of 15 April 1912.



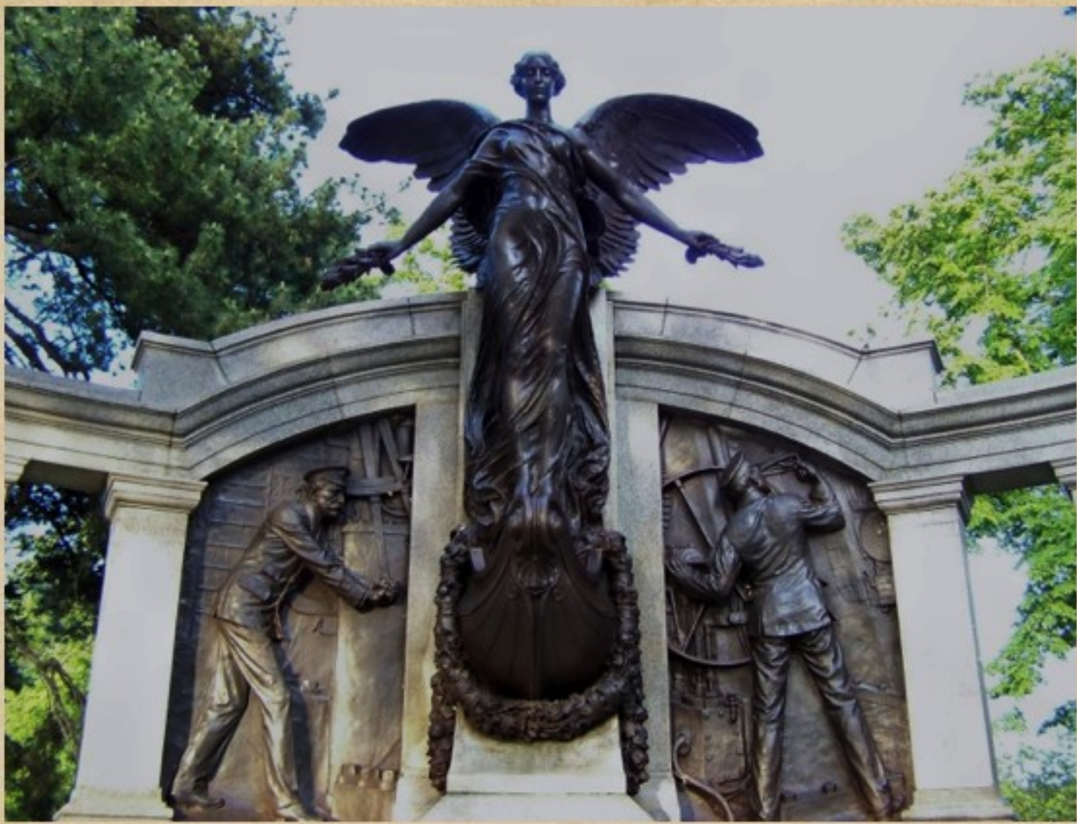
TITANIC AT 0220 - ABOUT TO PLUNGE

For the survivors in the water, there was virtually no hope. They died of exposure, as anyone would in sea temperatures of zero degrees Centigrade. Mercifully, after the initial agony of hitting the cold water, they would gradually have lost the use of their limbs and fallen asleep - a better end than drowning, which was the fate of those trapped in the hull. Only one boat returned to the survivor field to pick up people in the water; the rest held off because of fear of being swamped.

And so 1¾ hours later, at four o'clock, in the cold early light of a bleak Atlantic dawn, CARPATHIA found them: 712 survivors out of a complement of 2,201.

Some bodies were found, but not many initially. The current swept many of them away. In any case, bodies sink as they fill with water, but then float as gasses form from decomposition. Later, ships were sent out from Nova Scotia with coffins and embalming fluid for the grisly task of collecting bodies. There would not be enough.

And what of the engineers? They faired badly. Throughout the drama they were rigging suction hoses, pumping out, shoring bulkheads and generally buying time to get the lifeboats away. They kept the boilers steaming and the generators running, with the lights on, until the very last, even when TITANIC's hull was sticking out of the water at 60 degrees. The lights only went out when the hull broke in two and the electrical ring main fractured. At more or less the same time, the boilers and main engines broke loose from their mountings and crashed through the remaining watertight bulkheads.



MEMORIAL TO THE ENGINEER OFFICERS OF TITANIC IN SOUTHAMPTON

Every single one of TITANIC's engineer officers went down with her and there is a memorial to their sacrifice in Southampton ('Figure 15' above).

The inscription reads:

Greater love hath no man than this, that a man lay down his life for his friends.

To the memory of the engineer officers of the RMS TITANIC

who showed their high conception of duty

and their heroism by remaining at their posts.

It is a hard act to follow.

In Conclusion

TITANIC was only marginally the biggest ship of her time; she certainly wasn't the worst disaster at sea; nor was she badly designed or built. But she remains a topic of fascinating and morbid discussion and, no doubt, will continue to be so. Is it because she illustrates the result of too much faith in modern technology, of commercial indifference, of social injustice, or simply professional maritime complacency? Who can say? What is certain is that it was a disaster that should never, ever, have happened.

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