

A QUIET SEA

RMS TITANIC

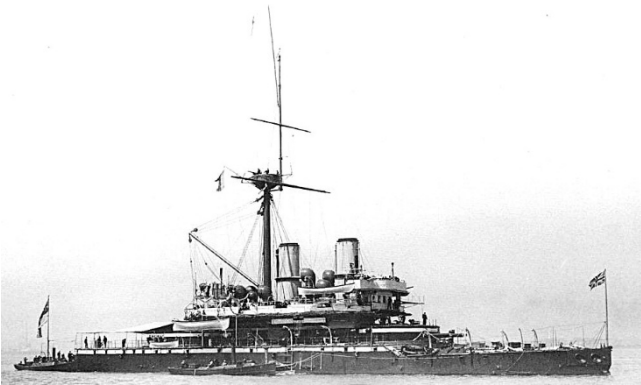


ENGINEERS

TITANIC: ENGINEERS

INTRODUCTION

Although steam power was gaining in reliability and favor as the primary mover of ships in the mid-19th century, ship owners continued to include sailing rigs as backup in the event of mechanical failure. Shippers and merchants longed for regular schedules, which steam provided. However, after the steam-assisted SS Savannah crossed the Atlantic in 1819, it took more than 60 years for steam power to be completely trusted. The Royal Navy took the lead in 1871 with the battleship HMS Devastation, considered to be the first vessel of any kind to dispense entirely with sails. She was designed for service in home waters and based on the island of Malta for long-term duty in the Mediterranean. Twelve years later, Cunard's twin liners Umbria and Etruria were the company's last ships fitted with sails. Although the sails appeared redundant, both liners put them to good use when their propeller shafts failed. In the right conditions, sails also could be set to steady the ship and reduce rolling in a beam sea. Nevertheless, steamships gradually developed into great machines, run by crew with the expertise to man them. Titanic's engineers were part of this great tradition.



HMS Devastation 1871

Credit: Wikipedia



RMS Etruria, under partial sail and power 1886

Credit: Wikipedia

ASCENT OF THE MARINE ENGINEER

Designing, building and installing machinery in a ship is an engineering marvel. Equally impressive are the skills needed to keep that machinery running reliably under all conditions. On every transatlantic crossing, the challenge for the marine engineer was to keep the ship to the schedule and make up lost time from foul weather.



French liner La Touraine in heavy seas 1894

Credit: Wikimedia Commons (Antonio Jacobsen 1850-1921)

Every bit of machinery on board was the engineer's responsibility, from engines, boilers, dynamos, refrigeration equipment, propeller shafts and bearings, winches and the ship's windlass and steering gear to elevators and lighting. When a ship was in the middle of the ocean, far from any repair facility, engineers were on their own. They had to be resourceful and ingenious and cultivate a stout set of nerves. They had to make sure that the feed water in the boilers was salt-free and that the furnaces didn't devour too much coal, lest the ship wind up powerless. Smoldering coal in the bunkers could raise temperatures enough to spontaneously ignite. Engineers had to tackle failures to equipment and the main propulsion engine to get the ship safely to port. When the ship was pitching heavily in big seas, the engineer had to focus on the throttle, where timing was everything. Minding the sounds of the engine and the feel of the ship, he would slow the propeller when it broke the surface spinning in air and spray to prevent the engine from racing wildly and tearing itself to pieces. When the stern plunged down again, the propeller would spin in foam until it was fully submerged, biting into the sea. Feeling the shaft slow, he would carefully increase the revolutions to keep the ship ploughing ahead—exhausting work with little margin for error. The machinery was tended by the skilled hands of the engineers, oilers, and greasers, who had to be constantly vigilant, aware of the sights, sounds and temperatures of their equipment.

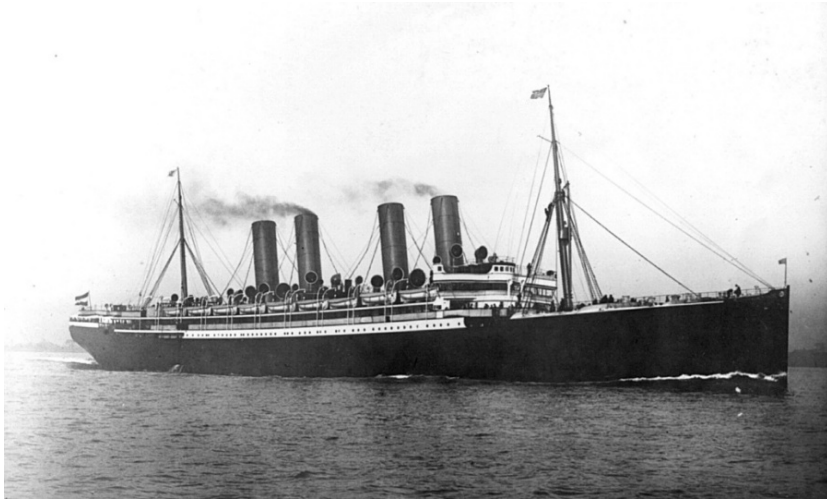


Engineers at the engine telegraph and controls on the starting platform
Credit: GG Archives

Marine engineers began as something of a poor relation to engineers with jobs on shore. There was no specific apprenticeship system for marine engineers; they did their training in various land-based mechanical trades. They were viewed with suspicion and treated with contempt by the windjammer “stick and string” sailors who resented the encroaching technology and scoffed at the new breed of engineering “mariner.” Companies kept the two groups apart to avoid any conflicts. After all, their interests were in providing service and earning dividends.

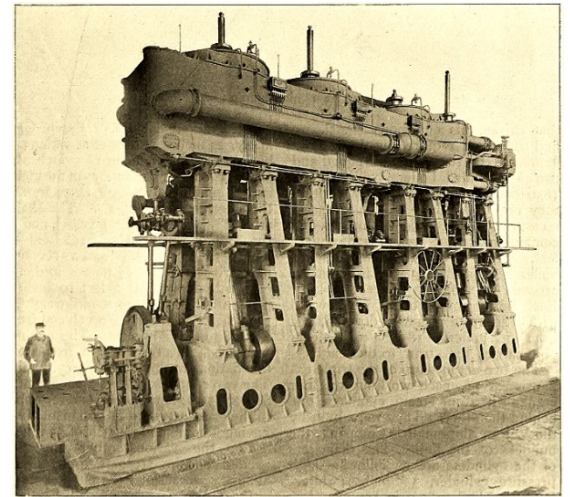
Early marine engineers had a steep learning curve in a tough environment. The vagaries of early steam engine design often put their abilities to the test. In times of collision and disaster, the engineer's job was to patch the hull, keep steam in the boilers and the ship afloat with steam-powered pumps. If a major engine part, like the crankshaft or connecting rod, failed they had to fix the problem with hand drills, files, bolts, rods and hammers while the ship coped under sail alone or, if becalmed, rolled endlessly in the sea. As if taking care of the machinery wasn't enough, the engineers had to maintain order among unruly firemen and trimmers, who often showed up

for duty drunk. (Given their hard lot in the boiler rooms, some latitude was given to those who snuck bottles of alcohol on board.) The engineer's work wasn't over once in port, because the duty firemen had to maintain steam to keep the lights and heat on and the winches and deck gear working to discharge and load cargo. Needless to say, finding good people was difficult. Ship owners often sought the engine builder's advice to find the best people.



SS Kaiser Wilhelm der Grosse 1897

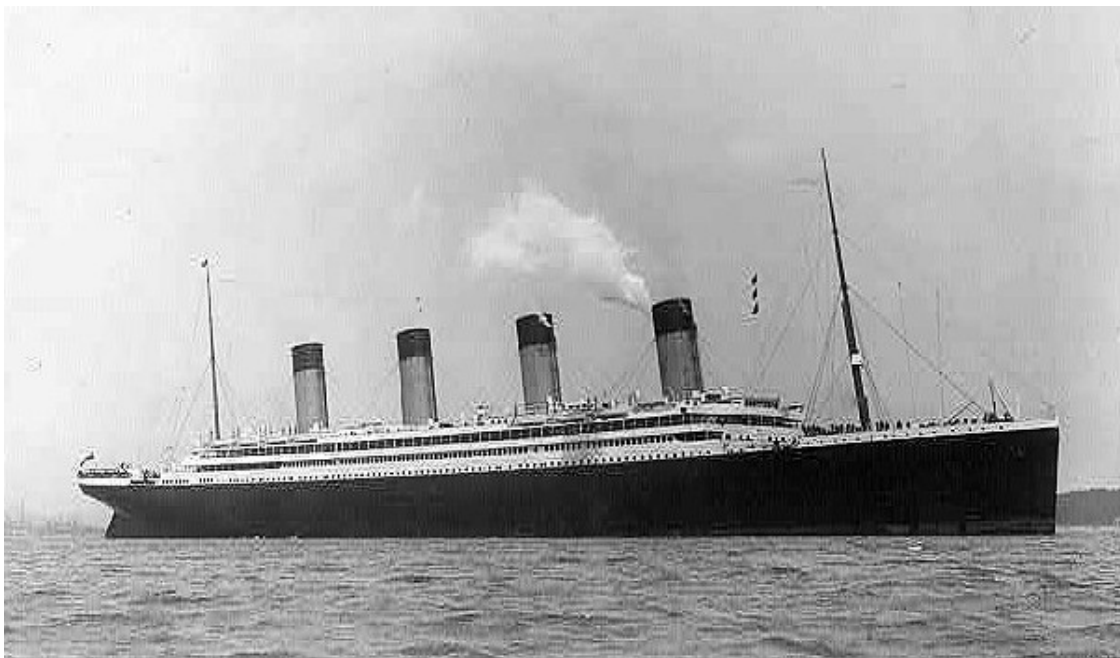
Credit: Wikipedia



And one of her engines

Credit: Wikimedia Commons

With bigger ships came the challenge of ever larger and more powerful engines, and it took great care to get the machinery ready for a voyage. With steam up in the boilers, the chief engineer would gently pre-heat the main engine with hot steam, taking care that water condensing in the cold engine was constantly drained. With the engines properly warmed and scanning the steam gauges to check that all was as it should be, he would stand at the ready to smartly respond to orders from the bridge. Alert at their stations would be the assistant engineers (at the reverse gears), the oilers and greasers (ready to lubricate the engine's joints), the water tenders and firemen. With the raucous clanging of the telegraph, the engine obeys the chief engineer's silent turn of the steam valve and the voyage begins.



RMS Olympic on her maiden voyage 1911

Credit: Get Archive LLC

ADVENT OF LIGHT

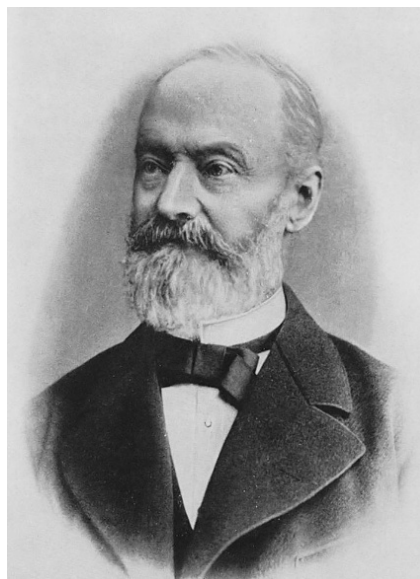
One of the earliest devices to illuminate a ship's interior was the glass prism. Laid flush into the deck, it would diffuse light rays laterally below. Of various shapes and sizes, their simplicity and lack of fire risk rendered them safer than lanterns. In coal-carrying ships, they could detect the start of a fire by concentrating the light of the flame, making it visible on deck. But because they depended on the available ambient light, the amount of illumination they could provide was limited.



Set of deck prisms
Credit: Wikipedia

Oil-fired lanterns were portable and could light up hard-to-reach spaces in the hold and bilges. Oil lamps were also used for masthead and navigation lights. However, oil lamps needed care and maintenance to keep the smoke down, and wicks had to be trimmed to produce a uniform flame. Moreover, they posed a significant fire risk, and a supply of oil (fish, seal, whale, and later, kerosene) had to be carried on board to refill the lanterns.

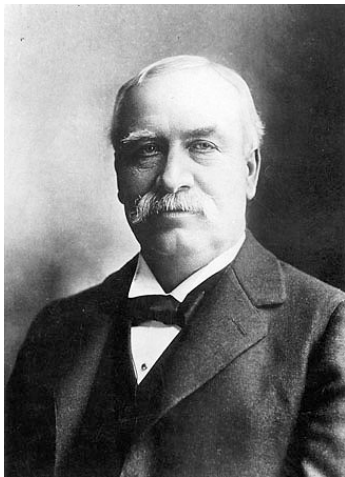
Gas lighting provided advantages over oil as fuel. Lighthouses and early lightships were fitted with illuminating gas compressed and held in tanks. In the late 1870s, the Pintsch Patent Lighting company, founded by tinsmith Julius Pintsch (1815-1884), produced a naphtha-derived gas that permitted lighted navigation beacons and lightships to remain unattended and stay lit for months. The system also provided buoys and beacons to illuminate the Suez Canal. Acetylene gas, burning with a brighter flame, replaced Pintsch gas by the early 20th century.



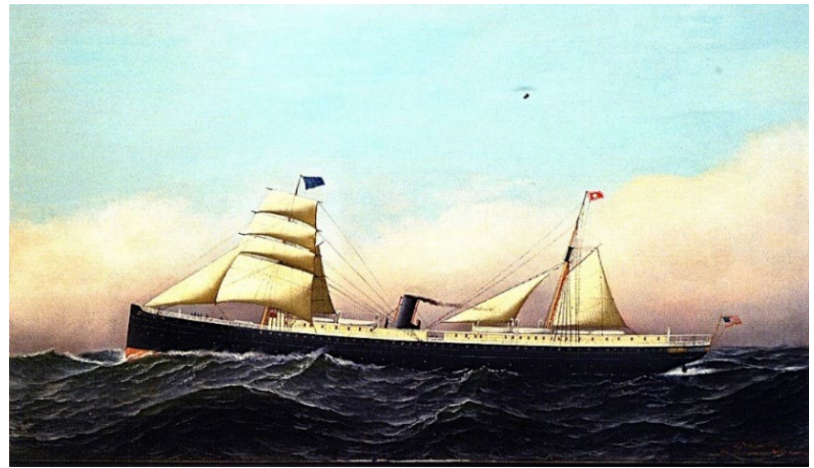
Julius Pintsch (1815-1884)
Credit: Wikipedia

The use of pressurized explosive gas on a transatlantic liner crossing the tempestuous Atlantic was something else. What might be good on a small lightship or buoy wouldn't work on a large vessel rolling and plunging into the sea. Liners fitted with pressurized gas systems experienced dangerous risks. The working of the ship and the corrosive environment led to fractured pipes, putting passengers and crew at risk from toxic gas. Electricity was the answer but, oddly, the traveling public was more fearful of electrocution than death by gas.

The innovative SS Columbia was the first passenger ship to use electric light bulbs and incorporated the first commercial marine use of the new technology. Columbia was ordered by Henry Villard, Oregon Railroad and Navigation Company magnate. Villard attended Thomas Edison's Menlo Park public lighting exhibit on New Year's Eve 1879 and was instantly taken by the incandescent bulb. He suggested that Edison install electricity in his new ship, but the inventor didn't think the technology was up to the task. When John Roach, the shipbuilder constructing the vessel, refused to install an electrical system because he feared there was a risk of fire, Villard returned to convince Edison to undertake the project. Columbia was launched on the Delaware River and sailed to New York to have her lighting system installed in May 1880, the first commercial system of its kind.



Henry Villard (1835-1900)
Credit: Wikipedia



SS Columbia 1880
Credit: Wikipedia

Columbia was designed for the San Francisco to Portland Oregon service. Once completed, she departed Chester, Pennsylvania on her maiden voyage around Cape Horn to San Francisco. Electricity was supplied by four reciprocating engine-driven dynamos.

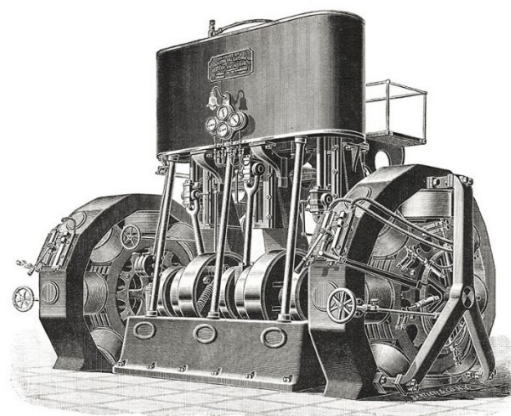
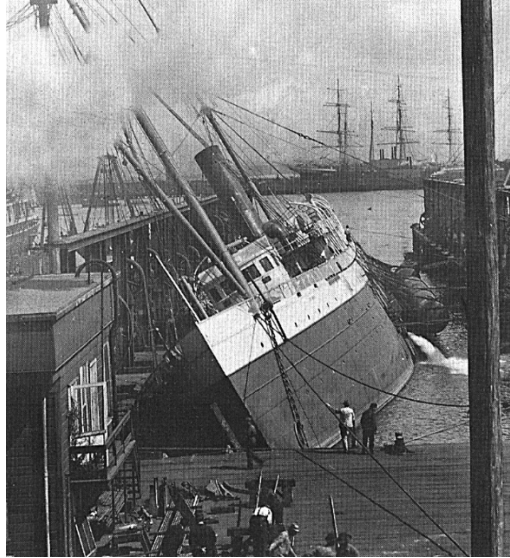


Fig. 343—Edison Central Station Dynamo and Engine.

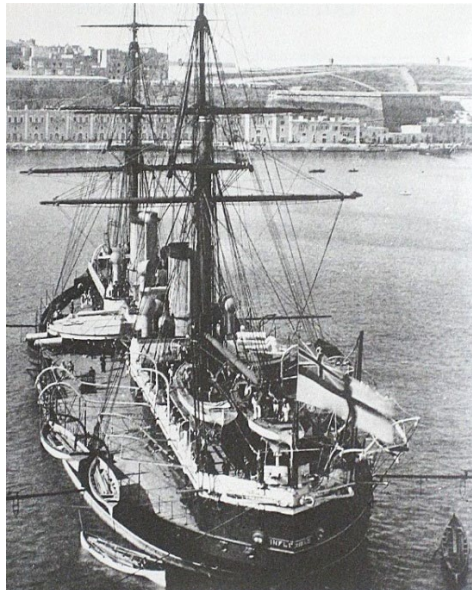
Edison dynamo (power station generator)
Credit: Wikimedia Commons

Throughout her maiden passage, the electrical system fulfilled all expectations; not a bulb failed for over 400 hours. The chief engineer expressed his admiration in a letter to Edison. Columbia had shown that electric lights in a ship were practical. For many years, this pioneering vessel performed sterling service between Portland and San Francisco, but she also had her share of bad luck. Surviving several collisions and serious hull damage in dry dock during the San Francisco earthquake, she was finally lost after colliding in fog with the steam schooner San Pedro. San Pedro's cargo of redwood lumber kept her afloat, but Columbia sank in 8 minutes with a loss of 81 of the 251 on board.



SS Columbia, San Francisco earthquake 1906
Credit: Wikipedia

The Royal Navy's groundbreaking battleship *Inflexible*, launched in 1876, was the first British man o' war fitted with a limited electrical system. The warship had an 800-volt direct current system and Swan bulbs invented by Joseph Swan. His bulbs were provided with a filament that would glow when excited by electricity. The ship also used arc lamps that caused an electric arc to jump between two electrodes, resulting in a bright, continuous spark producing light. Initially, the engine and boiler rooms benefited from the electric lights; other areas were partially illuminated. But the use of two different types of lamps complicated the system, and *Inflexible* suffered the first fatal electrocution of a crew member.



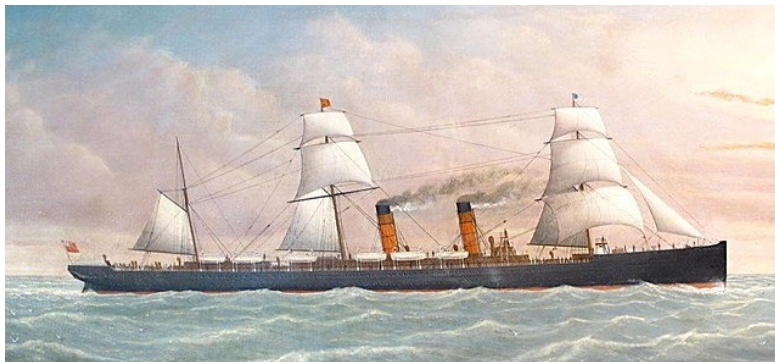
HMS Inflexible about 1881
Credit: Wikipedia

RMS SERVIA

The North Atlantic ferry service perfected the use of electric lights on ships. The Cunard ship RMS Servia, named after the Republic of Serbia, was built in Clydebank by J&G Thomson in 1881. Servia incorporated a number of new concepts. Notably, she was the first large transatlantic liner built of steel and fitted with 12 bulkheads, providing good subdivision. The bulkheads were fitted with remotely operated watertight doors and, for the first time, a ship was built with a double bottom. The double hull allowed water ballast to be carried to adjust the vessel's trim and displacement as fuel was consumed and provided some protection from grounding damage.

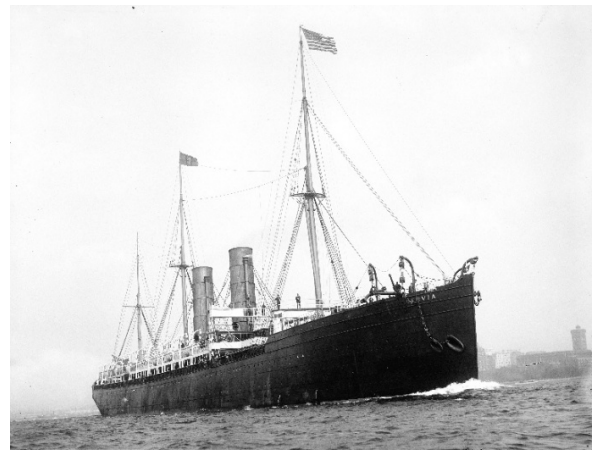
Servia was designed to be fast, hold little cargo and devote a majority of her internal hull space to more than 1200 passengers, with another 300 as crew. With a 10,000-horsepower engine, Servia was not the fastest ship, but she provided consistently good passages and could cross the Atlantic in less than 7 days. Just in case, she was built with a sailing rig. In one stroke, Cunard had established the transatlantic express liner devoted to the passenger trade.

Impressed by the smaller SS Columbia, Cunard had contracted Edison (now working with the Swan Electric Light Company) to install Servia's electrical system, the first in an Atlantic liner. A dynamo provided direct current power for the arc lamps, and an inverter converted the direct current to alternating current for the incandescent bulbs. Like in Columbia, Servia's lights were limited to the ship's engine and public rooms. As with Inflexible, there was a mix of Swan and arc lamps, but there were only two arc lamps out of about 120 carried. To work at night in port, deck areas in way of the cargo hatches were also illuminated. Servia carried on until 1893, when she was put on a secondary run, then converted to take troops to the Boer War in South Africa. She was scrapped in 1902 at the relatively young age of 21, an indication of the rapid progress of the transatlantic ferry.



RMS Servia 1881

Credit: Wikipedia (artist Joseph Whitman)



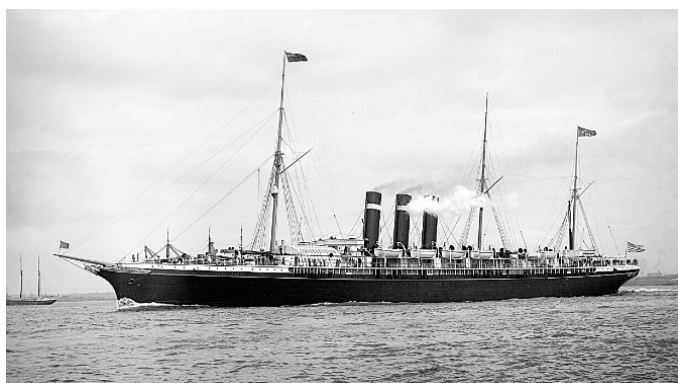
Servia with sailing rig removed

Credit: Library of Congress

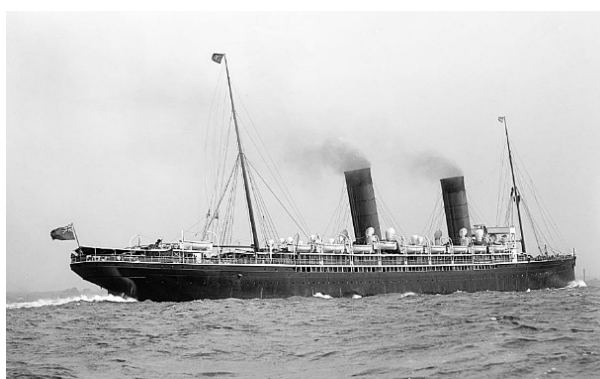
GREATER SHIPS

City of Paris, Lucania, Kronprinzessin Cecilie and Mauretania made history in the Atlantic ferry service. Each was larger and offered more amenities and comforts than its predecessor. Some, like Mauretania and her ill-fated sister Lusitania, introduced the first large-scale use of the steam turbine, making them the fastest liners afloat. Mauretania held the Blue Riband, the trophy for the fastest crossing, for 22 years. All were lit by electricity. But until Titanic, no one fully appreciated

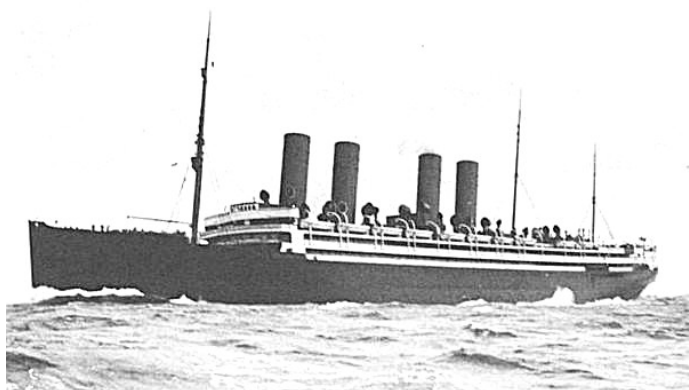
how crucial it was for electric lamps to stay on during the evacuation of a ship sinking in the middle of the night, in the middle of the ocean.



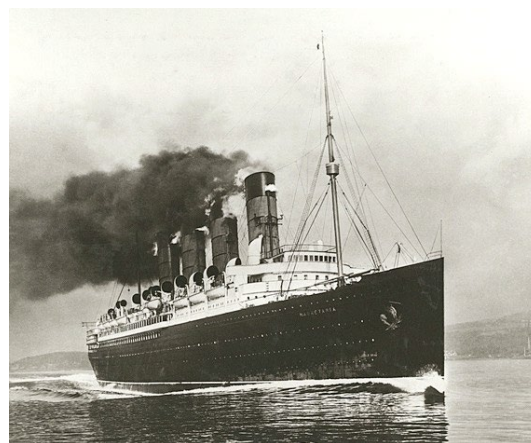
SS City of Paris 1888
Credit: Wikimedia Commons



RMS Lucania 1893
Credit: Wikimedia Commons



SS Kronprinzessin Cecilie 1906
Credit: Wikimedia Commons



RMS Mauretania 1907
Credit: Wikimedia Commons

While the ships got larger, the number of lifeboats did not. Bureaucratic paralysis, pressure from steamship companies and political lobbying meant there were few lifeboats on the big ships. Their size and subdivision were touted as insurance against collision, bolstered by the frequency of passing ships that would surely come to the rescue. Add the wonder of wireless communication, and the chances of something horrible happening were rationalized away. Thus, lifeboats and an organized evacuation plan were lacking when the largest ship in the world was evacuated on the cold night of April 14, 1912. It was the engineers who made a difference.

TITANIC

It took a lot of people to run Titanic's machinery; automation and remote monitoring were undreamed of in 1912. With an engine staff of 326, it was up to the engineers and lead firemen to organize the hundreds of men into a cohesive group. The complex hierarchy of the engineering staff began with the chief engineer and the 18 engineering officers. The chief engineer's right-hand man was the senior second engineer, followed by the second engineer. The second through sixth engineers each had a junior engineer to assist. These were followed by the senior assistant engineers, also with a junior assistant engineer to assist. In addition, the chief and senior second engineer had an extra assistant fourth engineer for refrigeration and an extra assistant fifth engineer for the turbine engine. For the deck machinery, there were the deck and assistant deck engineers. The extensive electrical system was looked after by the chief and second electricians and their assistants. This group, from the storekeepers, plumbers, greasers, firemen and

trimmers, who trundled coal and removed ashes from the boilers, had a demanding routine. Titanic's chief engineer was Joseph Bell.



Joseph Bell (1861-1912)
Credit: Wikipedia

JOSEPH BELL

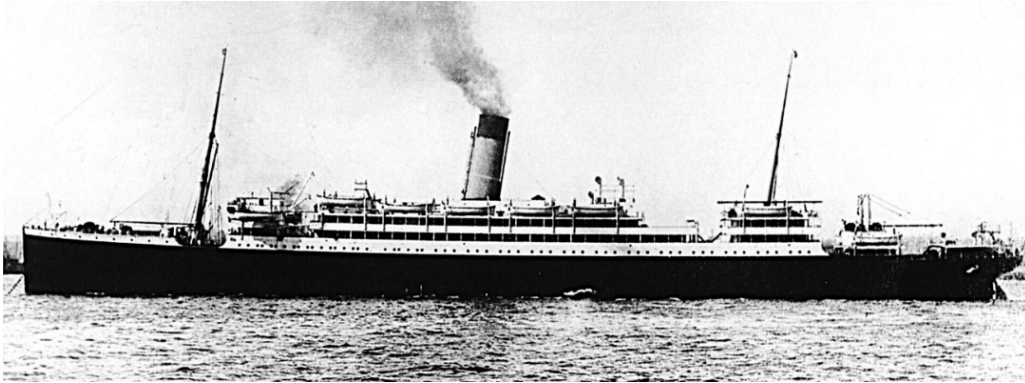
Joseph Bell was born in 1861 into a yeoman farming family. Yeoman farmers held their land and paid no rent to wealthy landlords. Their social standing bridged the gap between poor farm workers and aristocratic landowners. This gave them a degree of independence within British society that contributed to the agricultural economy and benefited standards of living in rural life.

Bell was raised in the small town of Farlam in Cumberland County. When his mother died, after the birth of her fourth child, his father moved the family to the town of Carlisle. After graduating from the local academy at age 15, Bell began an apprenticeship as an engine fitter with the locomotive builder Robert Stephenson & Company. Such apprenticeships generally took 7 years. During that time, he learned to read blueprints, use hand and power tools, fashion machine parts in lathes and milling machines, and check the parts for proper fit. Completing his apprenticeship, Bell joined Lamport & Holt of Liverpool, sailing between Liverpool and South America. (In 1883, Lamport & Holt initiated the carrying of frozen meat on ships, a great boon to the international cattle trade.)

Bell joined White Star Line in 1885, beginning more than a quarter century of service with the company. Engaged in round-the-world service ranging from New Zealand to South Africa and New York, Bell served in numerous White Star liners. At the age of 30, he became chief engineer in the Shaw, Saville, and Albion Company's Coptic, which was under charter to White Star. The Derbyshire Times wrote that the following year, Bell married Miss Maud Bates. The couple eventually had four children.

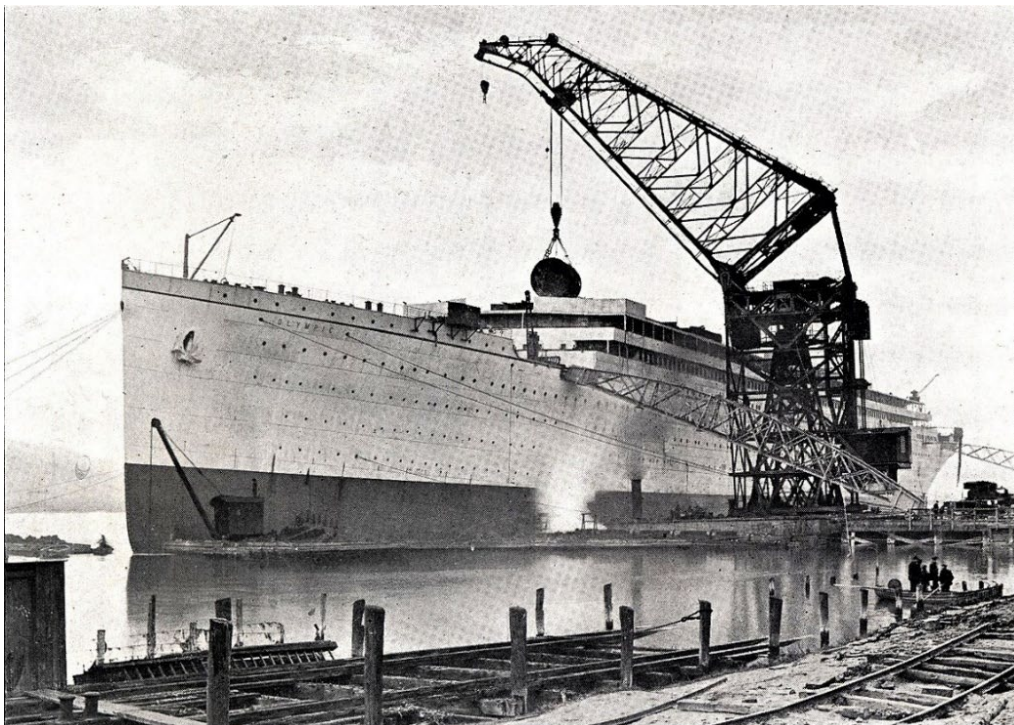
By 1907, White Star was assembling plans to build three Olympic class ships. Bell, a highly valued engineer and a member of the Institute of Marine Engineers and the Royal Naval Reserve, was

given the job of overseeing the machinery installations in the Laurentic and Megantic, built for the Canadian route. White Star was contemplating a new type of machinery for the Olympic class but decided to install two different types of machinery in these two smaller sister ships before committing to a larger installation for the superliners. Lower fuel consumption was the goal. Megantic had two conventional quadruple expansion steam engines turning twin screws, while Laurentic had combination machinery: two steam engines and a low-pressure turbine turning three screws.



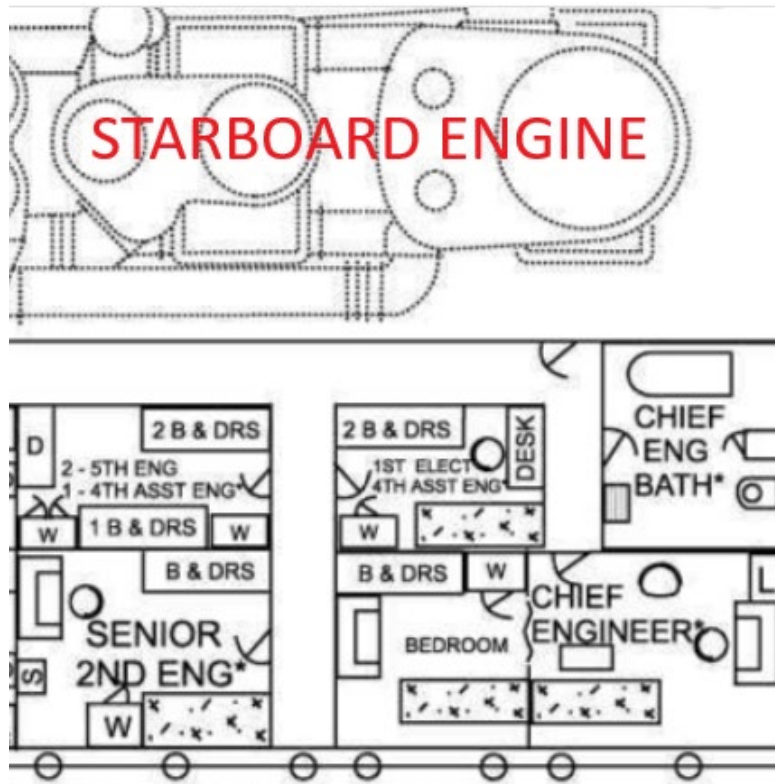
SS Laurentic (1908)

Both ships entered service in 1909, and Bell ran the ships on their maiden voyages to assess their performance. Laurentic proved the more economical, so the decision was made to power the big Olympic liners with combination machinery. White Star was making great strides amassing, for the only time in the history of ship construction, enough industrial muscle to build two of the three huge liners simultaneously. Bell and his family found a house in Belfast so he could continue his work fitting out Olympic. His son Frank, following in his father's footsteps, headed for an apprenticeship with Harland & Wolff, shipbuilders for White Star Line.



RMS Olympic receiving her machinery
Credit: Creative Commons

Bell made many operational suggestions regarding Olympic's machinery and was named chief engineer on her maiden voyage. Olympic performed well and easily made 22½ knots, or just under 26 mph. Upon her return to Belfast, Bell was relieved by another engineer so he could be closely involved with the construction of Titanic's machinery. Thus, it was natural to have Bell in Titanic's engine room for her maiden voyage. He signed the shipping articles and arrived aboard on April 2, 1912. He occupied a spacious cabin on F Deck, just above the waterline. The cabin was nearly equal to that of Captain Smith and the only other officer's cabin with a private bath. The following day, April 3, his son Frank arrived to tour the ship with his father.



Chief Engineer Bell's cabin on F Deck
Credit: Titanic Deck Plans

When Titanic began her maiden passage at noon on April 10, she had a smoldering coal fire in one of her bunkers. Coal may spontaneously combust through auto oxidation when stored in a confined space, so Bell was interested in the condition in the starboard aft corner of the coal bunker in boiler room #6. The fire was extinguished and the coal removed so Harland & Wolff's Managing Director Thomas Andrews, and his eight-man Guarantee Group (aboard to ensure systems were working properly) could inspect the hull structure in the bunker. The paint on the watertight bulkhead had blistered off, and there was minute distortion in the steel, but the strength of the bulkhead was not compromised. On April 11, Titanic stopped to pick up passengers in Queenstown, and Bell took the opportunity to post a letter to Frank:

"Dear Frank

I hope that you got to Belfast all right & started work on time. I got your wire from Liverpool. We have made a good run from Southampton everything working A1, we nearly had a collision with New York & Oceanic when leaving S'ton [Southampton] the wash of our propellers made the two vessels range about when we were passing them, this made their mooring ropes break & the New York set across the river until the tugs got hold of her again no damage was done but it

looked like trouble at the time. Keep well and be a good lad. Regards to Mrs. Johnston. Your loving father, J. Bell.” [Mrs. Johnston owned the boarding house where Frank was staying.]

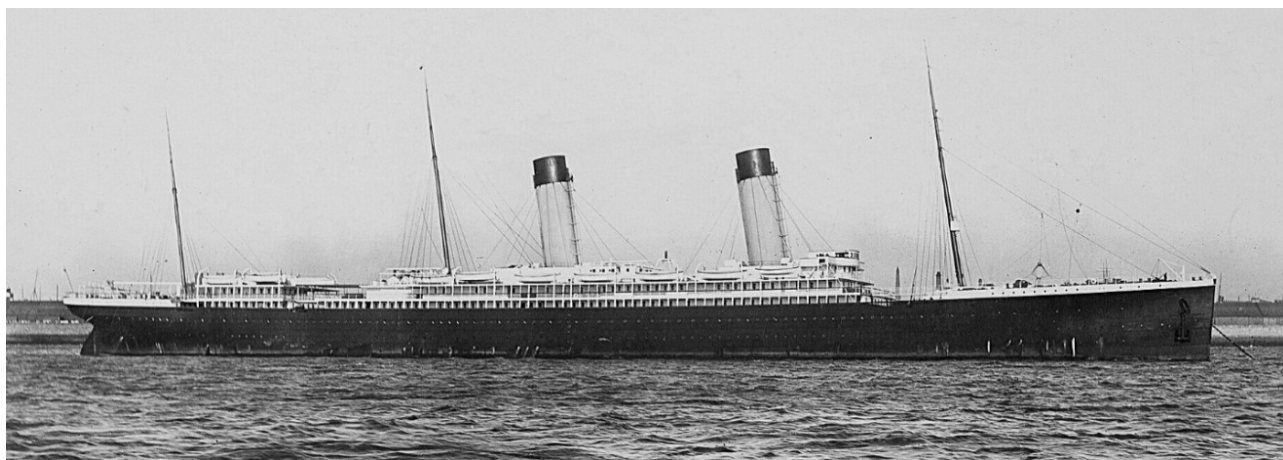
WILLIAM E. FARQUHARSON

An expert chief engineer needs a first-rate senior second engineer. Bell’s was W. E. Farquharson. Born in Liverpool in 1873, he came from a large family, having seven siblings. Along with several of his brothers, he served an apprenticeship learning tool making and fitting, a trade where structural steel members are cut to size and accurately fitted in place to be fastened with rivets.

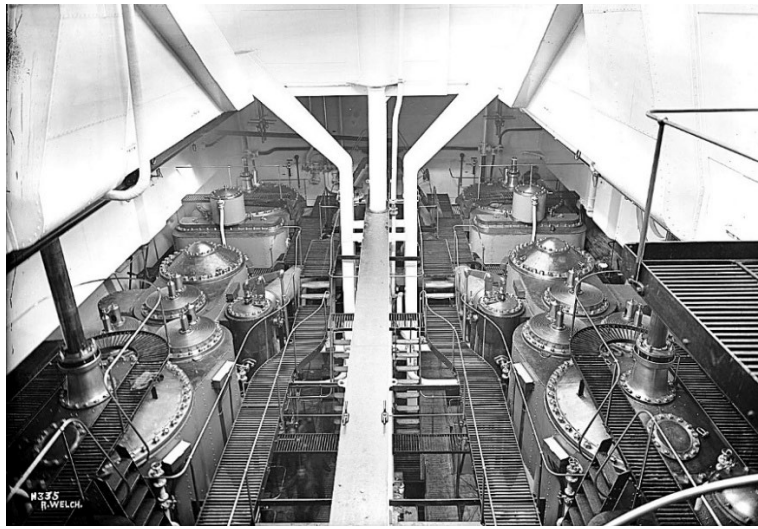


W. E. Farquharson (1873-1912)
Credit: Find a Grave

After his apprenticeship, Farquharson worked for the Anglo-American Tool Company, which built high quality tools for fabricating sheet metal components. About 1895, Farquharson began his seagoing career with shipowners Jonhson & Co. Ltd. He was hired by White Star in 1900. He began aboard Teutonic as junior second engineer, was transferred to Suevic for 3 years, then served aboard Teutonic’s sistership, Majestic. He then returned to Teutonic and served for a number of years as senior second engineer aboard RMS Oceanic.



RMS Oceanic
Credit: Wikipedia



RMS Oceanic main engines
Credit: Wikipedia

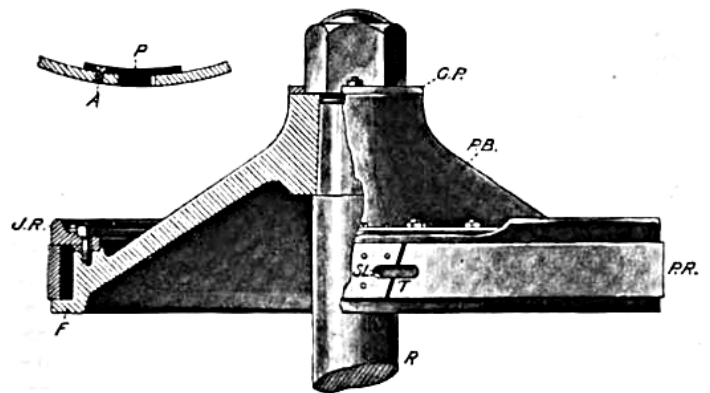
In 1907, Farquharson, his wife and three children moved to Southampton. He had an excellent reputation with White Star and attended to Titanic during her fitting out, working with Joseph Bell overseeing the final stages of the machinery installation. He officially signed on Titanic on April 6, 1912. As second in charge of engineering, he had a cabin adjacent to that of Chief Bell.

RUNNING IN THE ENGINES

Being a new ship on her maiden voyage, the engines had to undergo a careful break-in period. This would allow all the parts to properly wear and fit themselves under correct lubrication, and for properly cleaning away small metal chips that might collect. It was very important that the main journals, crankshaft bearings and piston rings were properly seated.



Olympic class ship crankshaft in lathe (background)
Note offset crank throws
Credit: Museum of Northern Ireland

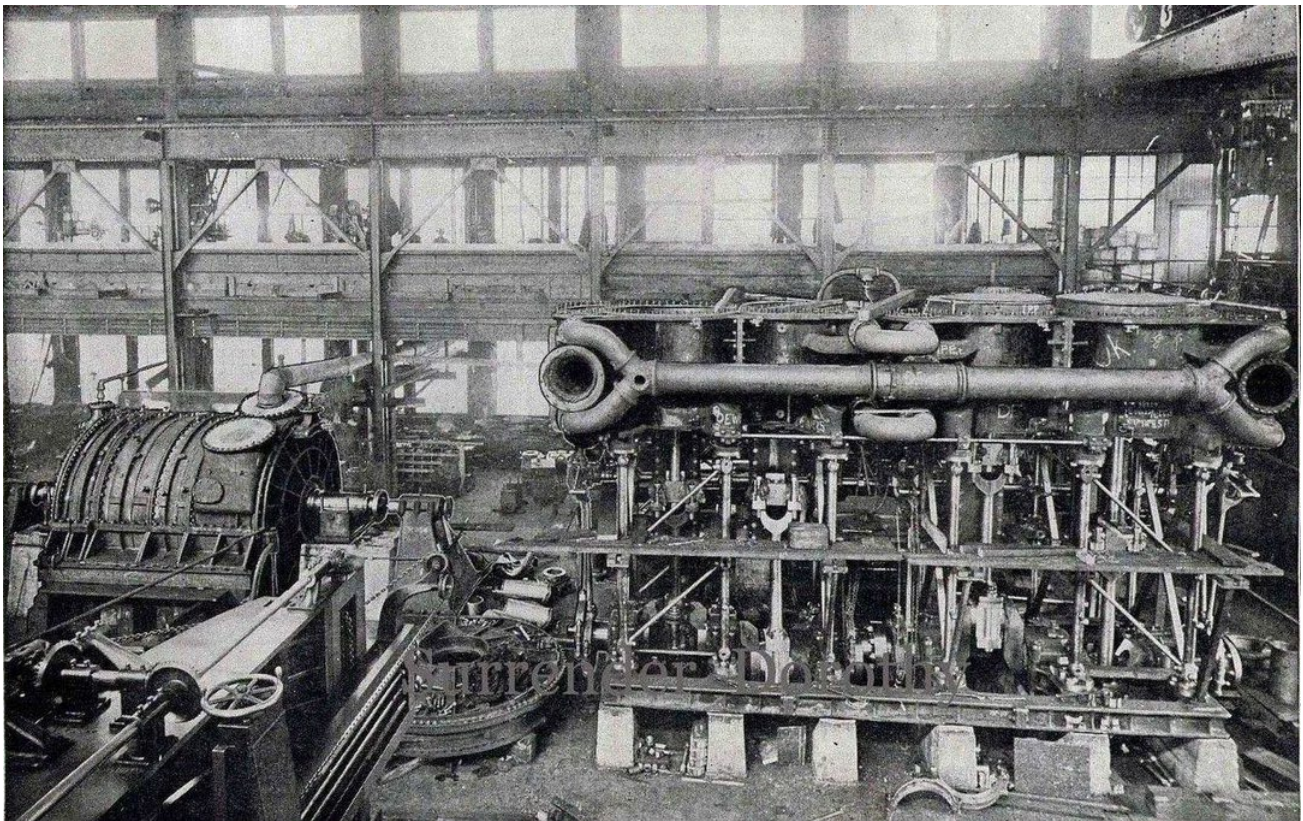


Piston, piston rod (R) and piston ring (PR)
Credit : Wikipedia

Piston rings surround the piston and create a good seal between the piston and the cylinder walls, preventing the steam from slipping past, thus not wasting steam pressure. Steam pushed the piston, swung the crankshaft, revolved the propeller shaft and turned the propeller. The whirling crank throws and journals would be carefully felt by hand for overheating. The valves that admit

steam into the cylinders would also have to be carefully run in and their temperatures checked. They also had to be properly synchronized so that the steam would enter the cylinder at exactly the time when the piston was in the proper position. Steam engines were double-acting; that is, the steam would alternately push on the top or bottom of the piston, ensuring maximum use of the great expansive power of steam.

With triple expansion reciprocating engines, the steam was expanded in three stages: high, intermediate and low pressure distributed through four cylinders. In Titanic's engines, the valves would admit the steam at 215 pounds per square inch (psi) into the high-pressure (HP) cylinder, the smallest piston of the engine using the highest pressure first. The valves would then direct the steam into the intermediate pressure (IP) cylinder, which had a somewhat larger cylinder volume and accepted the steam at a medium pressure. Next, the steam was routed into the two large low pressure (LP) cylinders. By this time, the steam had expanded with such great volume that two large pistons and cylinders were required to convert its energy to work. Two LP pistons were needed, because one piston, having the correct volume to accept the steam, would be gigantic and clumsy. The LP pistons, one at each end, divided the volume needed, balanced the engine and gave enough piston area to use the steam pressure down to 9 psi. Still capable of work, the steam was directed into the LP turbine that used the pressure down to 1 psi.



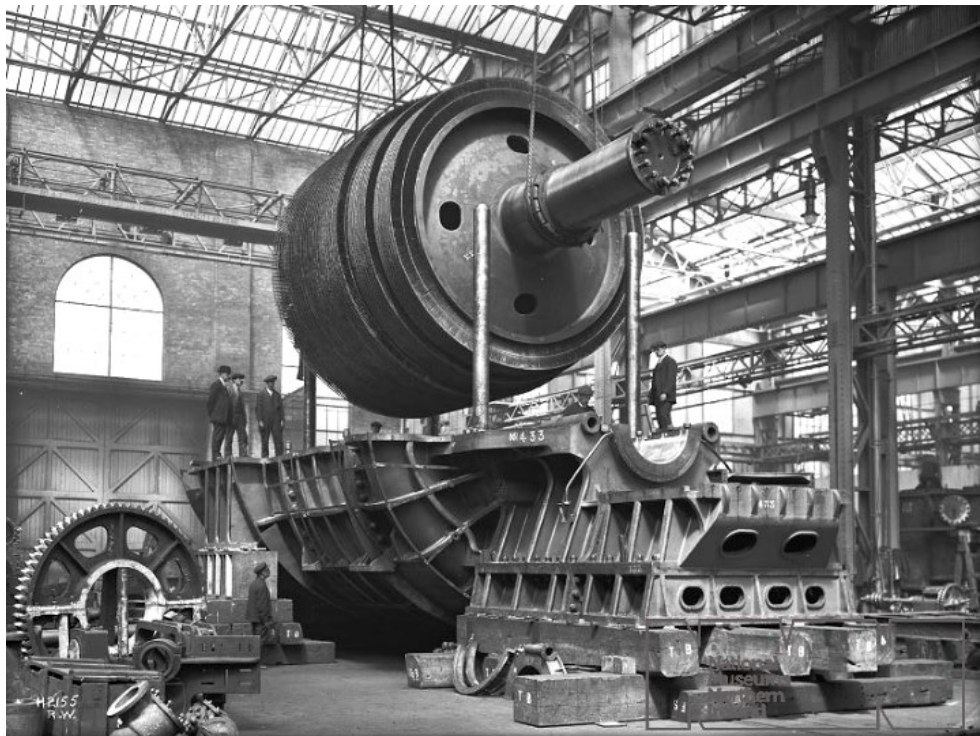
Olympic or Titanic reciprocating engines (R), turbine (L)
Credit: unknown

Once the steam turned the turbine, it exhausted into the condensers, where it was turned back into water. The water was then cleaned of oil and other pollutants with luffa sponges in "hotwell" tanks. It was pumped into the feed water tanks and checked for salts so as not to contaminate the boilers. (The condenser had tubes with cold circulating sea water to condense the steam. The condensed water was checked for salt in case there was a small leak in the tubes.) Once cleaned, the water was returned to the boilers to be heated and vaporized and do its work again. It was not a perfectly closed system, and some portion of water would be lost to evaporation and leaks.

To keep the steam pressure from getting too high, some was valved off on purpose. Extra water was carried and/or distilled from sea water, and this was used to maintain the supply of feed water. Pumps moved the water between the condensers and various tanks. The feed water went through pre-heaters so as not to enter the boilers cold. The auxiliary machinery, pumps, and dynamos took steam from the boilers and had their own condensing equipment and pumping systems.

WHAT COULD BE DONE?

Titanic was moving along at a good pace, although not at her top speed, as the five boilers in boiler room 1 were not yet online. If the weather was favorable, Chief Bell would run Titanic to her maximum for a few hours on Monday or Tuesday. Still, Titanic was clocking 22.5 knots with 24 of the 29 boilers lit; the reciprocating engines were turning 75 rpm, the turbine at 165 rpm. The flat calm sea gave an excellent opportunity to monitor the machinery's operation, to see that the main engines were synchronized, well balanced and turning smoothly with minimum vibration. April 14 was slipping away, and it was only a few minutes before the 8-12 watch would be relieved by the 12-4 watch, the start of April 15. Suddenly, frantic clangs from the telegraph indicated that things were not as they should be. Seconds passed while the astonished engineers, not knowing the threat, gathered themselves to respond to First Officer William McMaster Murdoch's order from the bridge to stop and reverse the engines. He simultaneously ordered the rudder shifted to turn Titanic to port. With the engines at full ahead, it was no simple task to stop and reverse the reciprocating engines. The turbine ran ahead only, and only when the ship was at sea. (In port, she was maneuvered with her two wing propellers.) To reverse the bulk of the reciprocating engines, they first had to be slowed from 75 rpms to at least 50 rpms and the 420-ton turbine slowed down from 165 rpms. Only then could the changeover valves be shifted to bypass the steam from the turbine into the condensers, leaving the center propeller to free wheel.



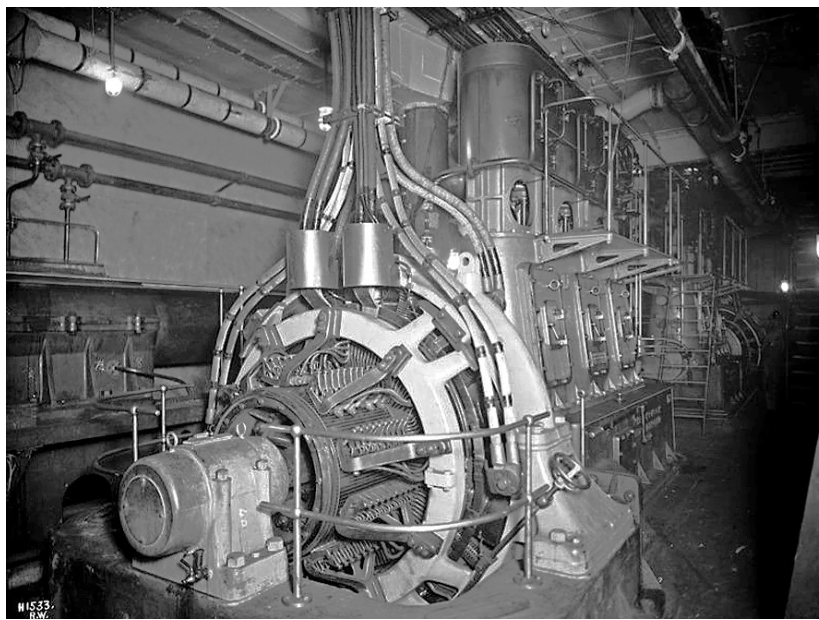
Olympic turbine engine
Credit: Museum of Northern Ireland

Titanic continued to plow ahead, starting her turn. Taken aback by this turn of events, the engineers rushed to handle the machinery in response to the orders. But Titanic was too close to the iceberg. To keep the ship from piling up on the ice, Murdoch shifted the rudder to swing the stern clear, a maneuver known as “porting ‘round.” He turned the switch that closed the ship’s watertight doors, the indicator lights above the doors flashing red as a warning. Then came the grinding vibration as Titanic’s starboard side jolted, slammed and thudded alongside the iceberg. The engine stop alarm sounded in the boiler rooms as the awestricken firemen began shutting the dampers as fast as they could to cut off the air supply and kill the fires in the furnaces. Boiler room #6 was open to the sea, and the ocean flooded in and swirled around their legs. Some firemen and an engineer leapt through the closing watertight door; others made their way up the escape ladders only to quickly return to draw and wet the fires. The men worked as fast as possible in the oily water and stifling steam-filled atmosphere. The water was waist deep and rapidly rising when a voice cried out, “That will do!” Captain Smith, other officers and Thomas Andrews, the ship’s designer, assessed the damage. Smith briefly rang for half ahead, then STOP, then optimistically left the telegraphs on STANDBY. With the ship stopped, the steam in the boilers was building and had nowhere to go; it was vented up and out the funnel steam pipes with a thunderous roar.

Quartermaster Alfred Olliver was dispatched from the bridge with a written message from Captain Smith for Chief Bell. Olliver found him in the engine room conferring with his engineers. Whatever the message said was lost that night, but Bell wrote on the note and told Olliver to tell the captain that he would get it done as soon as possible. Above all, Bell knew that it was imperative to confine the flooding and keep the lights on. In a chaotic situation, Bell had to assess his steam-making capability. Losing one boiler room and another not being lit wasn’t a great loss of steam production for what he needed: steam for the dynamos, pumps, heating, ventilating fans and the wireless. He still had 20 boilers left and could get by with fewer. With the reduced need for steam, he could cut out more boilers, as keeping them under pressure served no purpose. The safety valves were lifted to vent out the superfluous pressure. He also needed men to rig hoses for the pumps. Soon enough, half of the ship would be flooded. But he must have steam to continue pumping and keep the lights on.

Titanic had five ballast pumps and three bilge pumps, having a pumping capacity of 1,700 tons an hour. Titanic was initially taking 400 tons of water a minute, about 24,000 tons in the first hour (becoming less as the internal water pressure increased). Titanic’s two condenser circulating pumps could pump 12,000 tons an hour, a considerable amount that could have significantly slowed the rate of sinking. But being located aft in the turbine room and not configured to take a suction from the flooding boiler rooms forward, they were useless.

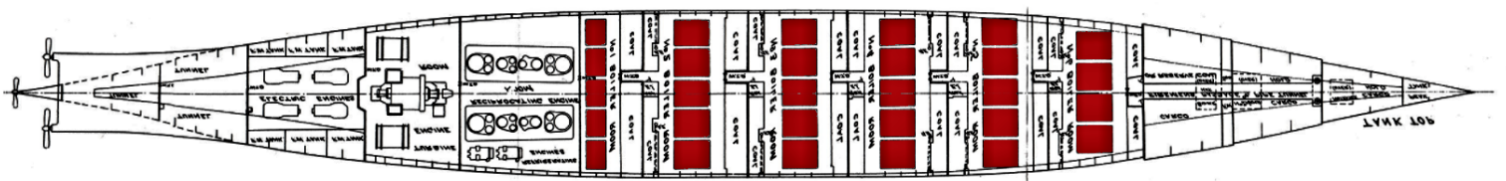
Titanic had 10,000 light bulbs. In addition, the ship was provided with numerous ventilating fans, heaters and other electrical equipment. To produce the required electrical power, she had four large dynamos located in their own space aft of the turbine room. Each dynamo was driven by three-cylinder steam engines; the four sets provided 1600 kW, or over 2,100 hp. An emergency electrical plant, located well above the waterline, was served by its own steam line from the boilers. It produced 80 hp and provided power for emergency lighting and the lifeboat hoisting winches. This is what Bell and his engineers had to work with.



Titanic dynamo
Credit: Wiki Fandom

IN EXTREMIS

Thus began the engineers' delaying action, fought by Bell, Farquharson and the others. The furnaces in boiler room #6 had to be immediately extinguished, lest the boilers be distorted and ruined by the cold seawater. Soon enough, the water rose, the sea putting out the last of the fires. Aft of boiler room #6 was boiler room #5. The space was damaged in the forward, starboard corner; the engineers set up the pumps and eventually got the water under control while the firemen drew the fires. Bell had a series of brief meetings with Andrews and Captain Smith in the engine room and the bridge. It became apparent that Titanic was gravely injured. On his way below from the bridge, Bruce Ismay, Director of White Star, met Bell and asked his opinion. Ismay recalled that, "...he thought the damage was serious, but that he hoped the pumps would be able to control the water."

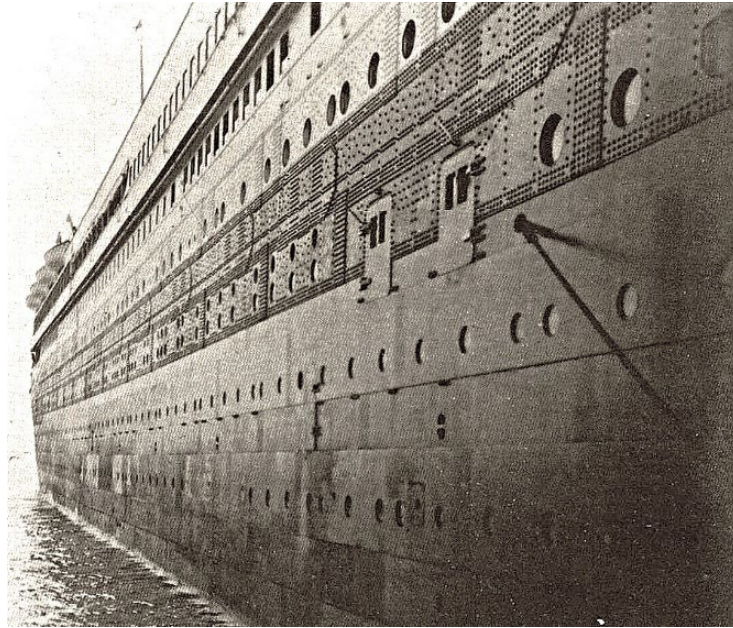


Titanic Boiler Rooms 1-6 (L-R), boilers in red
Source: Shipbuilder 1911

About an hour into the struggle, two junior engineers, Shepherd and Harvey, lost their lives in boiler room #5. With the stokehold filled with steam from drawing the fires, Shepherd fell in an open manhole, where pump valves were located, breaking his leg. Shortly after, he was moved to the pump room. When the bunker doors or the bunker bulkhead ruptured, water flooded the space at such great velocity that Shepherd was submerged on the spot. Harvey ordered the firemen out and went to save Shepard, but both men perished, becoming the first casualties of the night.

Faced with an ever-deteriorating event, it was vital that steam stay up and the lights stay on. Bell and his engineers directed the firemen while they handled the pumps. The grim truth was that

every minute of pumping earned 1 more minute of evacuation time. By 1:00 AM, flooding rapidly increased. Second Officer Lightoller, dubious that the lifeboats were safe with a full load of passengers, ordered men to open a gangway door on D-deck. The idea was to lower partially full boats and finish loading under the open door; passengers would climb down a rope ladder. Unfortunately, the open gangway door increased the rate of flooding.



Titanic starboard side gangway doors
Credit: Wikimedia Commons (Odell family)

Bell knew nothing of this, nor did Thomas Andrews, the ship's designer. Lightoller, who survived the sinking, later stated that he had made the decision to have the portside door opened. While he took this ill-advised action, Thomas Andrews and his group searched the ship and closed any portlight or opening they could find.

Bell directed the pumping effort from the reciprocating engine room, marshalling his firemen to keep up steam as they lost ground to the flooding. Approaching 1:30 AM, and with the certain knowledge that Titanic would founder, Bell began releasing his crew to save themselves. Half an hour before Titanic sank, several engineers made their way to the boat deck and waited for the end. Several crewmen who managed to escape testified that they last saw Bell attempting to call the bridge at about 2:00 AM. Steam pressure was still available and the lights were still on, but with the crew in retreat, steam production dwindled. As Titanic sank lower throughout the night, unneeded or submerged circuits were shut down to save electricity. Eventually, the failing supply of steam slowed the dynamos and the lights glowed red. Deep in her hull, the electricians kept the dynamos turning and coaxed the failing lights to stay on. With her stern lifting and the stress increasing, Titanic began to buckle, and the disintegrating hull ripped apart the steam pipes. The lights blinked out, then on, and finally flared out for good. One kerosene masthead lamp burned aloft against the brilliant sky, and she sank at 2:20 AM, taking the electricians and Joseph Bell with her.

EPILOGUE

Legend has it that Bell and his engineers died at their posts. It is not far from the truth. Assessing the collision damage and calculating how long Titanic would float, Thomas Andrews gave her from an hour to an hour and a half to live. Bell, Farquharson and their staff extended that by more

than an hour. That last hour gave time for at least 10 boats, nearly half of all launched, to get away, saving over 300 people.

On April 22, 1914, a ceremony was held to unveil the Titanic Engineers' Memorial Andrews Park in Southampton, 100,000 attended. Another memorial was erected in Liverpool.



Titanic Memorial Liverpool
Credit: Unknown

Neither Bell's nor Farquharson's bodies were recovered. Bell's wife Maud inherited his family farm. She never lived there, and Bell's relatives worked the farm until it was sold. His son Frank went to sea in 1919. Farquharson's wife Martha and their children received help from the Titanic Relief Fund. The Fund was set up by the Mayor of London to help dependents of lost crew and passengers. The public donated to the cause, and the funds were made available for long-term assistance. Martha never remarried and died in 1934.

Titanic's junior sixth engineer, 23-year-old William McReynolds, had been an apprentice at the Harland and Wolff engineering department and was hired by White Star on March 25. He left aboard Titanic on April 10, his first and last voyage.

Sources: Irish Independent; British and American Inquiries; Titanic Ships, Titanic Disasters by Garzke & Woodward; Encyclopedia Titanica; Wikipedia; Dr. Denis Griffiths; Titanic Facts; Friends of Titanic Memorial Park; Daily Mail; History HIT; Cumberland News; Cruise Arabia & Africa; Our Great American Heritage; Naval History and Naval Command; United States Lighthouse Society; Legislation, Gov.UK Merchant Shipping Act of 1894; Verbal Notes and Sketches for Marine Engineers, 1917; Birmingham Free Library Kilroy Stoking Indicator Patent; Tarn to Titanic, the Life of Joseph Bell; Titanic Photographs.Com; Ships Nostalgia; JosephBellEngineer.com; WikiTree; Titanic and Other Ships by Charles Lightoller; Canal World; Ask Anything; Martin's Marine Engineering Page; Charles Pelligrino; Titanic Pages; You Tube; Daily Mail