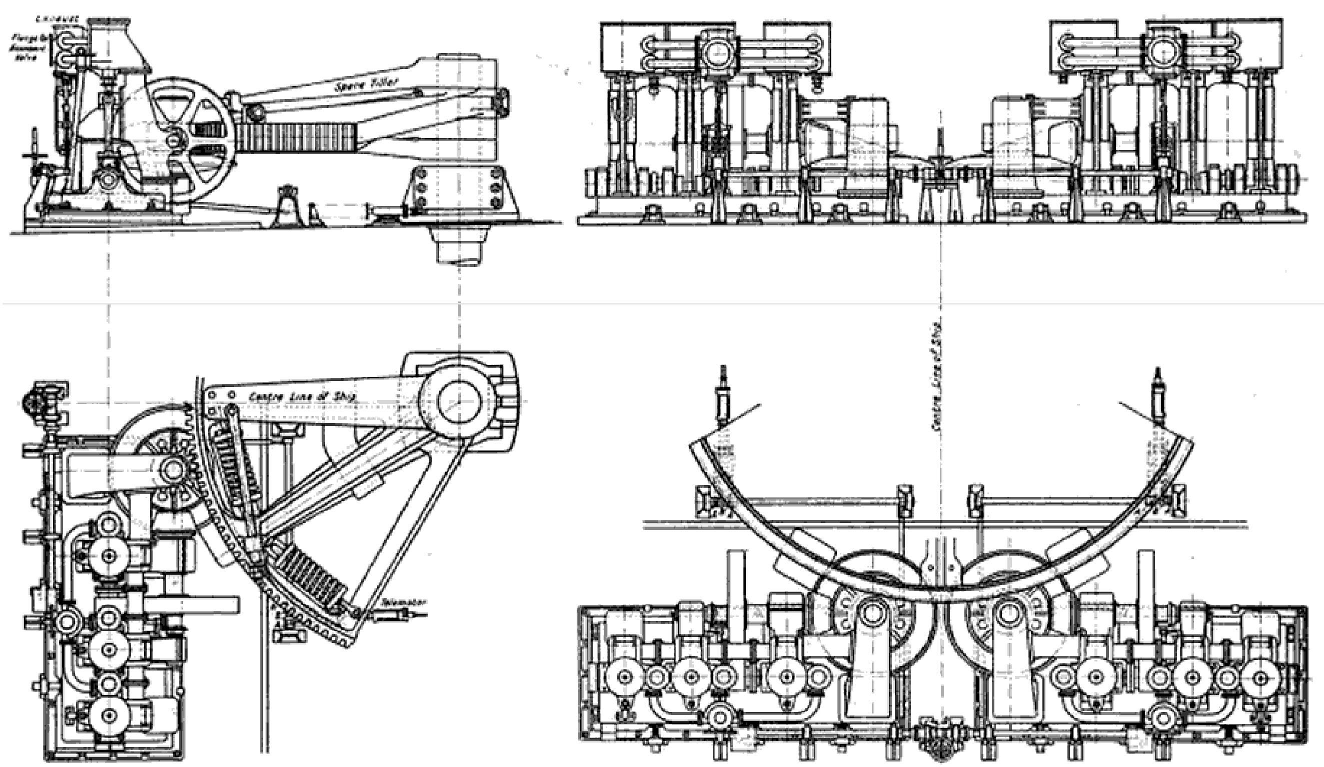
# Titanic's Steering Engines

**By Brad Payne**




Titanic's steering engines and gears[i] were situated on C deck, under the poop deck. The steering engine room started at aft frame 138 and ended at the end of the ship. Access to the steering engine room was by a door on C deck aft of the third class general room or by a stairway leading down from the poop deck, located on the starboard side at aft frame 144, underneath the docking bridge. Light and air was admitted to this room via two sky lights, one port and one starboard on the poop deck between aft frames 140 and 143, being 6ft 2in in length and 12ft 9in in width, and sitting 16ft 6in off center of their outboard coamings.

There were two sets of high-pressure three-crank (3 cylinder) vertical steam engines[ii] placed athwartships, with one engine being suffice to run the gears, and the other engine being for standby. Due to the size of Titanic's rudder it was necessary to have mechanical assistance in steering the ship. The engines had inverted directing-acting cylinders, each being 17in in diameter with an 18in stroke. The cylinders were supported at the front by three wrought steel columns and at the back by three cast iron columns- two of the latter also forming supports to the intermediate shaft. Piston steam valves were adopted working directly from the crank shaft by means of eccentrics. The engines took steam pressure at 100lbs per sq. in. The steering engine was the only auxiliary exhausting into the main condenser to accord with White Star practice.

The intermediate shaft, carried on the back columns of the engines, housed the spur wheel, driven by a pinion provided to the crank shaft of each engine, and the bevel gear. The intermediate shaft was connected to a vertical shaft by bevel gearing, which geared into the quadrant of the steering gears via a magnesium bronze pinion situated above the bevel gears. Both the pinion and quadrant had machine cut involute teeth.

The publication 'Cassier's Magazine' would describe the workings in brief:

> On the shaft is a worm, geared to a manganese bronze wheel working in a horizontal plane on a vertical shaft, on which also there is a spur pinion working on the manganese bronze teeth of the quadrant fitted...to the rudder head.

The gearing of the engines were of the double helical, or herringbone, type provided by Messrs. Andre Citroen and Co. The machine cut steel helical gears consisted of two sets of spur wheel and two sets of bevel wheels, with a total weight of 7½ tons. The teeth on all being specially designed through experience to limit wear in both directions.

The gears could not be made to standard pitches, as their noiseless running was accomplished by the absence of backlash achieved by the calculation of the exact pitch according to given diameters and a fixed number of teeth. To accomplish this, special cutters were made for each set of gearing.

The dimensions and a picture of the gears are below:

**<u>Spur Wheels</u>**

| | |
|---|---|
| Pitch Circle Diameters: | 14¼in & 19¾in |
| Number of Teeth: | 18 & 87 |
| Pitch (appx.): | 2½in |
| Width of Face: | 9½in |
| Spur Wheel Weight: | 1 ton 6 cwt |
| Spur Pinion Weight: | 5 cwt |

**Bevel Wheels**

Pitch Circle Diameters: 5ft 10½in & 2ft 0½in
Number of Teeth: 19 & 55
Pitch (appx.): 4¼in
Width of Face: 11in
Bevel Wheel Weight: 1 ton 16 cwt
Bevel Pinion Weight: 9 cwt

Teeth on both sides of bevel wheel's faces were shrouded to the pitch line, the total width over the shrouds being 14½ in.

The operation of the engines is explained in the publication 'Scientific American':

> The control is by means of a Brown's telemotor from the bridge actuating the steam valves. There is also fitted a Brown's Economic valve – or “get-out-of-the-way valve,” if we may be allowed to coin a word- to prevent leakage of steam while the engine is standing, due to absence of lap on the piston valves. This valve consists of a conical-seated valve in the steam admission port, with a coned projection extending into the engine valve chest, and when closed shuts steam completely off the engine. When the engine valve is moved by the telemotor it acts in the coned projection and pushes the valve back off its seat and admits steam, a strong spring returning the valve to its seat when the engine valve has resumes its current position. We understand that the engines are capable of putting the helm from hard-a-port to hard-a-starboard in twenty seconds.

The publication 'The Shipbuilder' would also state:

> The telemotor cylinders were placed near the steering engines, and are connected by levers and shafting to the steam control valve on the engines. The control valve of each engine is fitted with an economic valve of the Brown's type, which shuts off the steam automatically when the engine is at rest, and so prevents leakage of steam into the cylinders. The precise position of the rudder at any moment is shown by means of an electric helm indicator placed on the navigation bridge....supplied by Messrs. Evershed and Vignoles,

Ltd., of London.

Each engine was arranged on a sliding bed with adjusting screws so that each engine could be quickly put in or out of gear with the quadrant. The operation of setting up the backup engine is further described in the publication 'Scientific American':

> ...the other set being a stand-by, which can be quickly engaged by means of screw jacks embodied in the framing, which slide the base plate along for the distance necessary to engage the teeth of the pinion in the rudder quadrant, the bends in the steam pipe being sufficiently flexible to allow of this without the need for making any joints.

The steering gear design was of the Wilson-Pirrie type, constructed by Harland & Wolff. The deign was designated several names, such as Wilson-Pirrie spring engines, spring cushioned quadrant, elastic quadrant and Wheel and Pinion type. It was found that in the early days of steering engines, the engines were too rigid putting to much stress on the engines, gears, rudder and tiller causing costly damages or lose. The Wilson-Pirrie design was to help eliminate this problem. The first patent being placed in 1882, and a next one being placed in 1890.

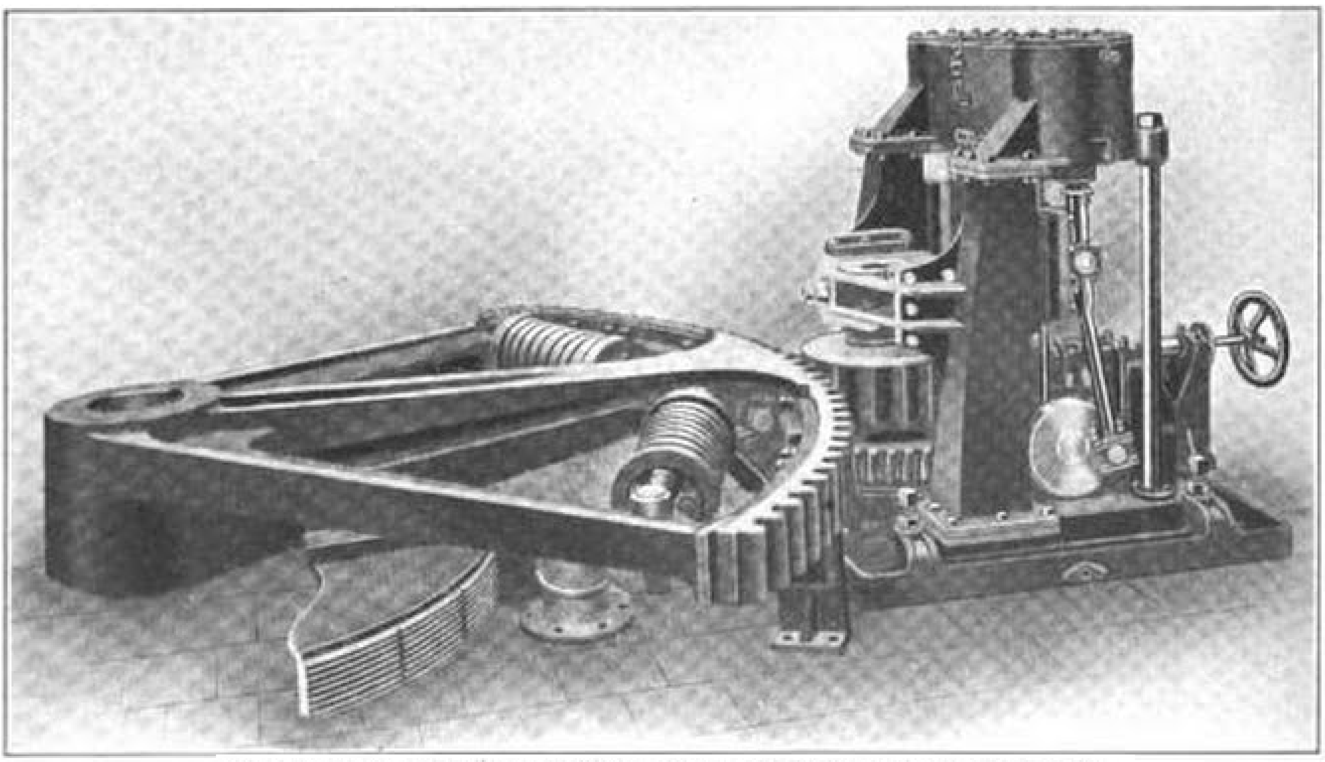


FIG. 3.—THE WILSON-PIRRIE GEAR, WITH SPRING-CUSHIONED QUADRANT.

The design of the steering gear consisted of a quadrant (which received its name due to it being a quarter of a circle), with a radius of 12ft 6in, that was loosely fitted, ie. not attached to the rudder head. The quadrant was turned via manganese bronze teeth, that were in interchangeable sections bolted to the casting, that lined with the teeth on the steering engine. Heavy steel springs connected the quadrant to the working tiller. The springs were fitted up under compression so that whether the rudder was put to port or starboard the springs were further compressed so that both were available for resisting the strain in the rudder. Neither spring was idle no matter which way the strain was coming from. The design of having the quadrant being loosely fitted and spring connected, allowed for any great stress or shocks not to be absorbed by the compete steering arrangement causing breakage. The tiller consisted of two forged tiller arms which were keyed to the rudder head. The two tiller arms sat in the center of each half of the quadrant, and were tied together by a wrought steel tie-bar. Access to the tiller from the poop deck was via two chequered steel plates 5ft 2½in wide and 15ft 8½in long starting at aft frame 144 and running aft.

There was also a spare tiller that sat above the quadrant in case the quadrant could not be operated by the other tiller arms. In case of damage to the quadrant itself, this spare tiller could be connected to two wrapping engines located in the wings of the steering engine room,

The gears were also operated from the docking bridge by mechanical means. The publication 'Cassier's Magazine' would write of how the gears would be worked from the poop on ships such as the *Norman*, of the Union Line, that was fitted with a Wilson-Pirrie steering arrangement:

> The engine is operated by shafting from the main bridge, or from the poop, on which it is placed, in a deck house. It can be readily thrown out of gear, whereupon the hand steering gear works direct on the rudder head. The turning of the wheels conveys, through gearing, rotary motion to a shaft with a right and left handed screw, on which are two nuts, working forward and aft, and connected by rods to the rudder head.

i Cassier's Magazine Vol. 12; May-October 1897 (pgs. 116-117)
Engineering October 21, 1910 (pgs. 434 & 445)
Marine Engineering Vol. 13; June 1908 (pg. 251)
The Mechanical Engineer Vol. 35; January 15, 1915 (pg. 51)
Scientific American: Supplement Vol. 71; June 17, 1911 (pg. 383)
The Shipbuilder' Midsummer, 1911 Olympic and Titanic Special ; Patrick Stephens, Cambridge 1983 reprint (pgs. 121-124)
Titanic The Ship Magnificent Vol. 1 Design & Construction'; Bruce Beveridge, Scott Andrews, Steve Hall, Daniel Kilstorner, Art Braunschweiger; History Press 2016 (pg. 528).
Titanic The Ship Magnificent Vol. 2 Interior Design & Fitting Out; Bruce Beveridge, Scott Andrews, Steve Hall, Daniel Kilstorner, Art Braunschweiger; History Press 2016 (pg. 298).
Thomas Andrews Notebook; Reproduced by Lagan Boat Company N.I. Ltd. (pg. 26)

ii Brian R Peterson at https://www.encyclopedia-titanica.org/community/threads/steering-gear.17386/ would state that the engines were about 10ft tall and wide with about a 20ft length. This author cannot confirm these measurements. (Post 2)