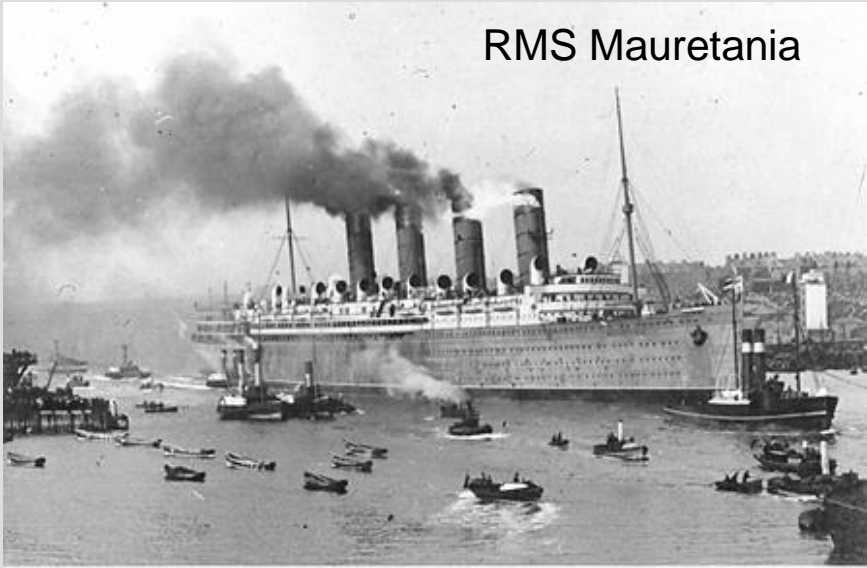
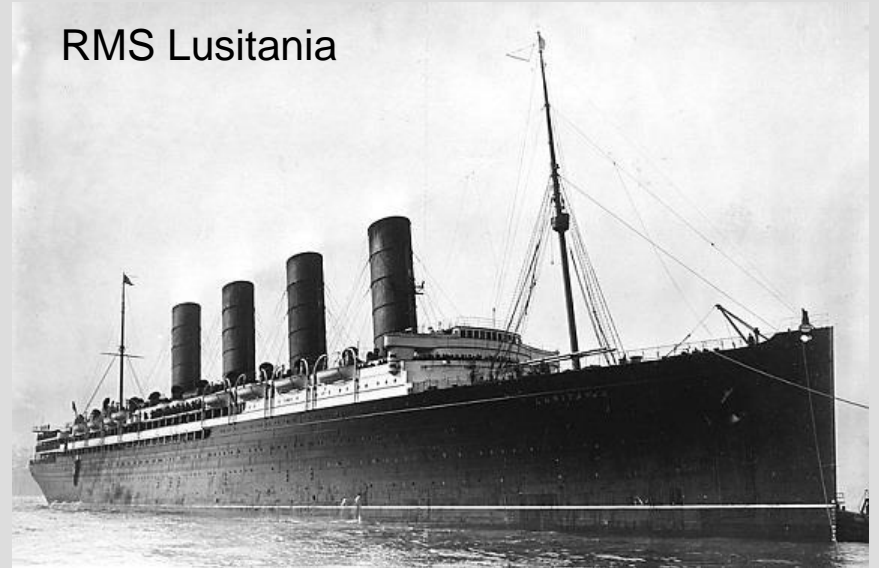


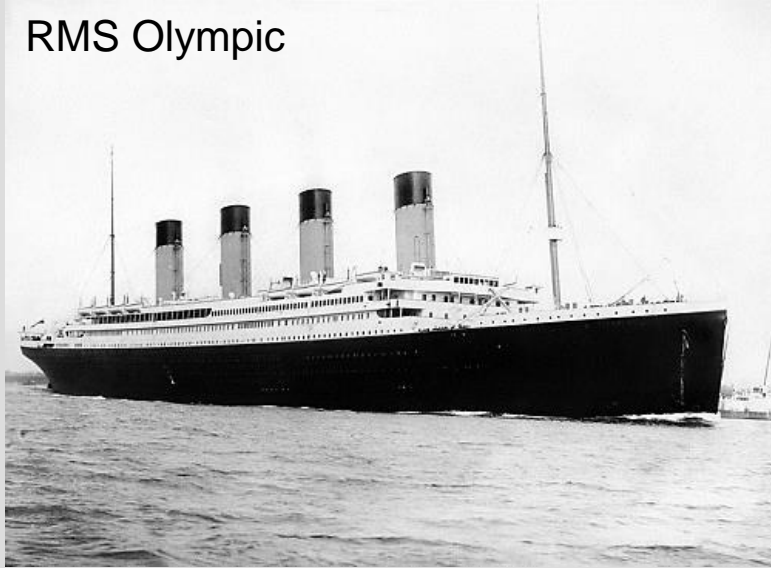
RMS Mauretania



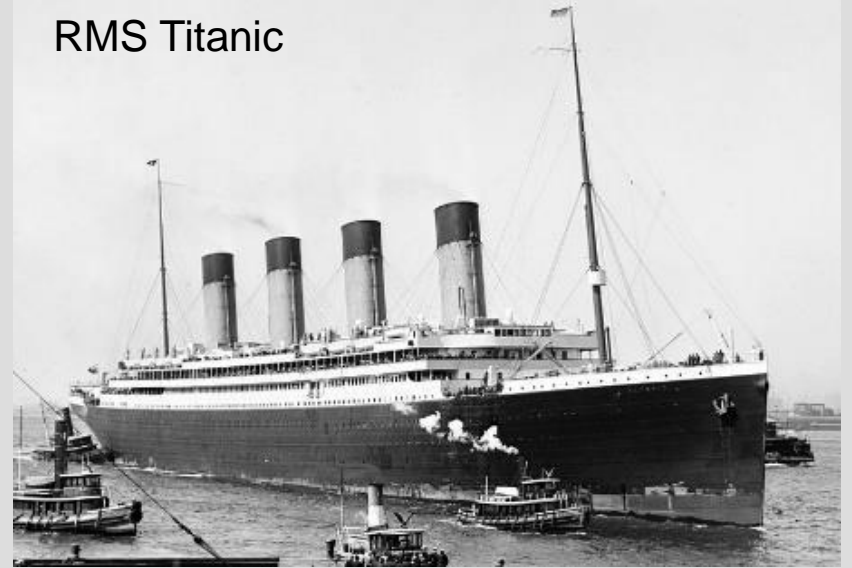
RMS Lusitania



RMS Olympic



RMS Titanic



The Engines of the First Giant Turbine Passenger Liners

Geoff Horseman

The Blue Riband

The Blue Riband was an unofficial prize awarded to the passenger liner in regular service which made the fastest Atlantic crossing based on average speed.

This competition began in 1838 although there wasn't an actual trophy until Harold Hales, a British politician and shipping owner donated one in 1935.

In 1902, Cunard decided to build two gigantic liners to win the prize.

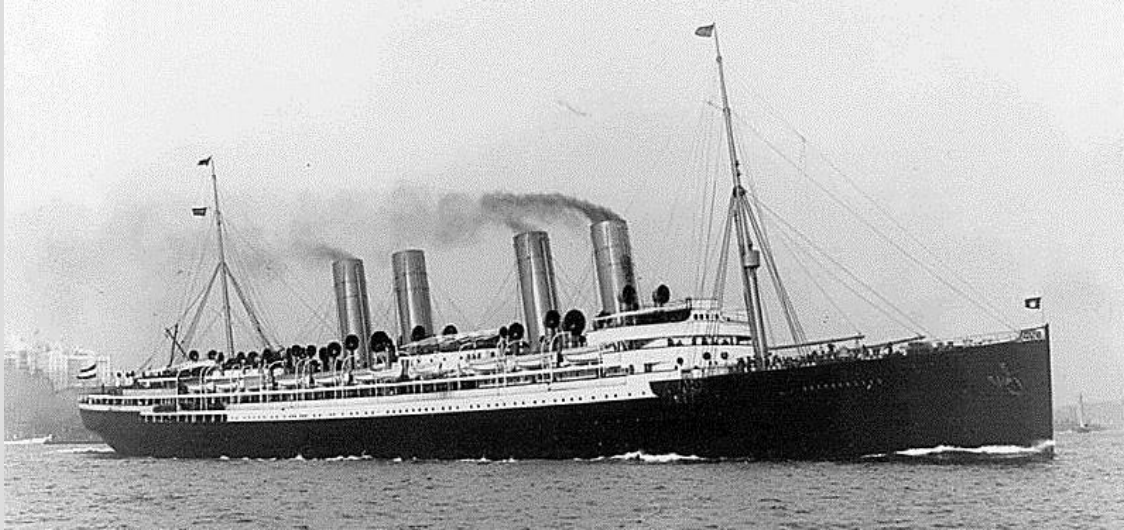
Charles Parsons proposed that the ship's engines should be turbines.



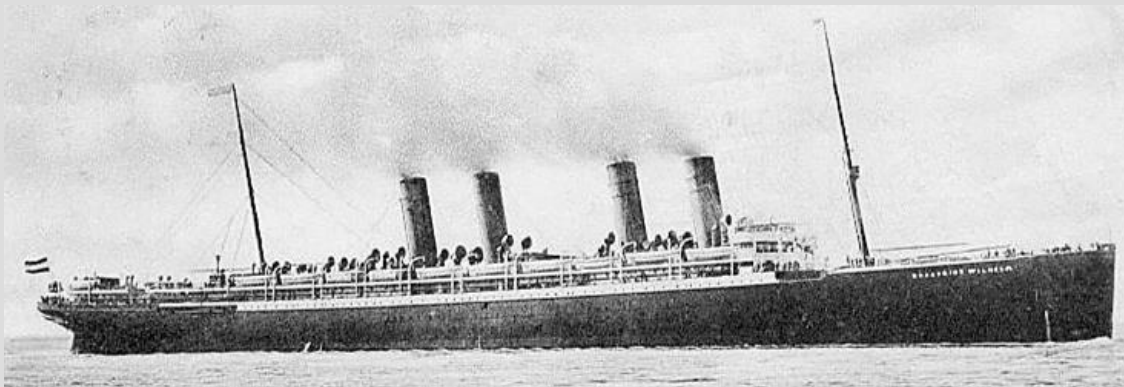
1935 Blue Riband trophy

The Blue Riband was held by German ships

They used reciprocating steam engines.

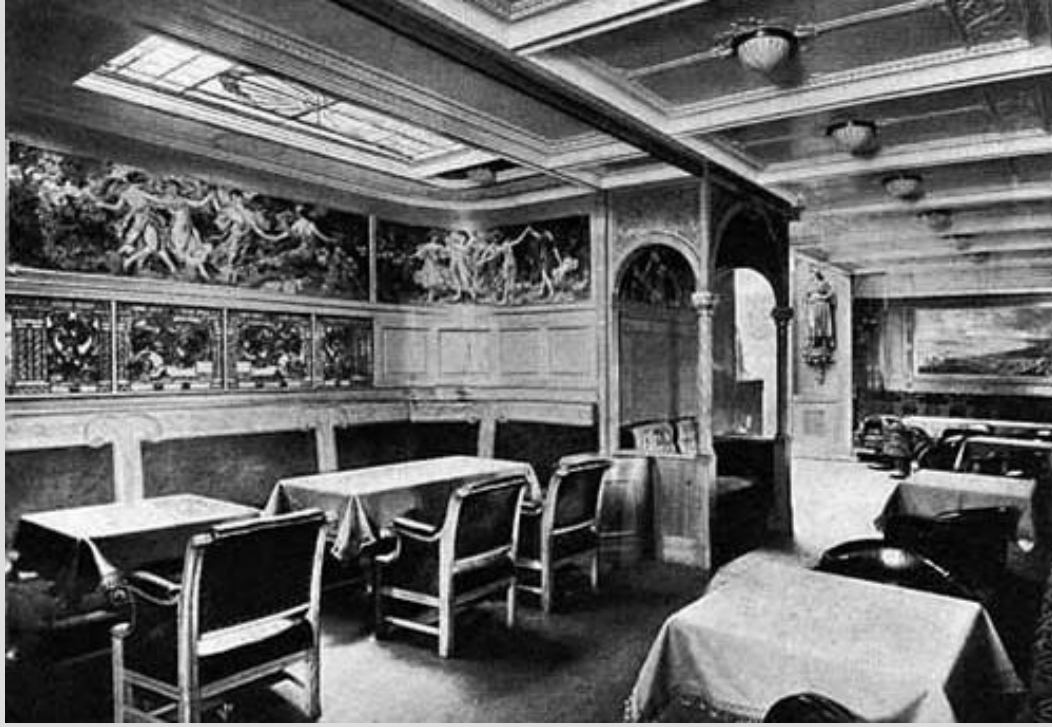


SS Deutschland
Blue riband 1901 23.06 knots
37,000 shp
16,800 tons



SS Kronprinz Wilhelm (1901)
Blue riband 1902 23.09 knots
33,000 shp
15,200 tons

The German ships were opulent in style as well as fast



First class accommodation
on SS Deutschland

Cunard wanted power!

The power required to propel a ship is approximately proportional to speed **cubed**.

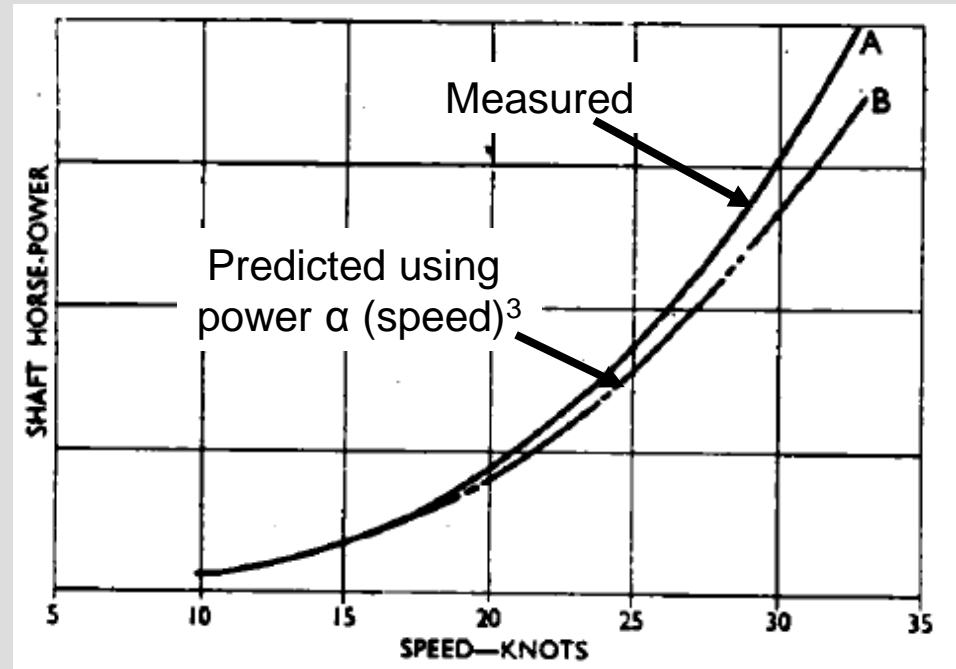
The German ships achieved 23 knots.

Cunard wanted 26 knots.

Raising speed from 23 to 26 knots needed $(26 / 23)^3 = 1.44$ times more power.

The SS Deutschland produced 33,000 shp.

Cunard needed at least $1.44 \times 33,000 = 48,000$ shp.



Actual speed-power curves for the Cunard liners

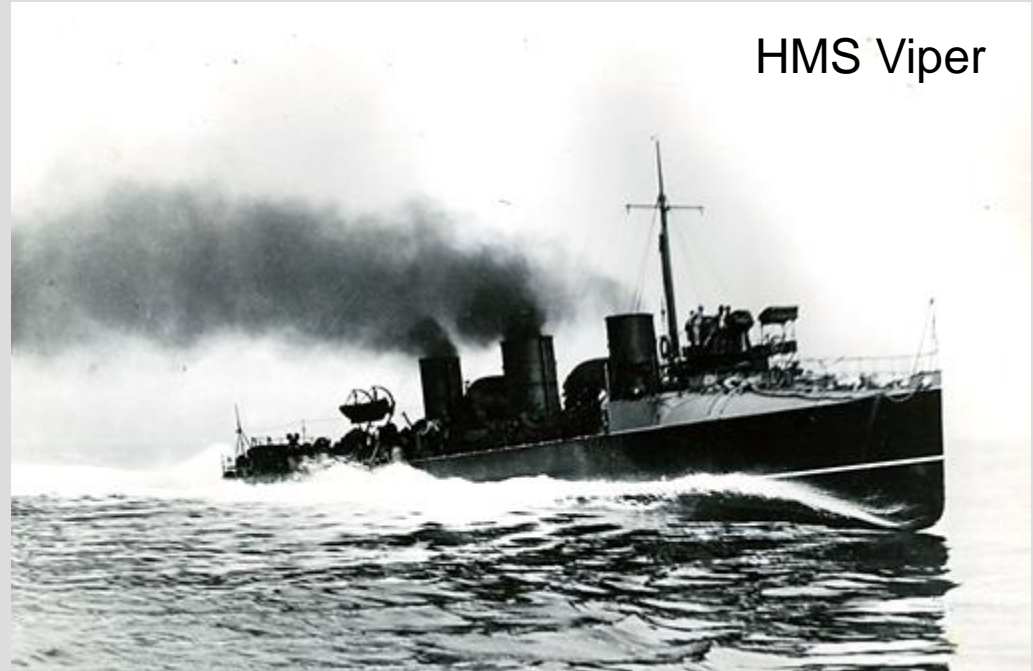
Cunard specified 68,000 shp each for Mauretania and Lusitania

But the only proven turbine ships were the destroyers HMS Viper and Cobra of 1899 (12,000 shp each) and the Clyde steamer TS King Edward of 1901 (with 2,000 shp)! But no reciprocating engines produced this power output either.

TS King Edward



HMS Viper



HMS Cobra



The principles of the turbine were simple

Each row of blades acted as a high speed windmill

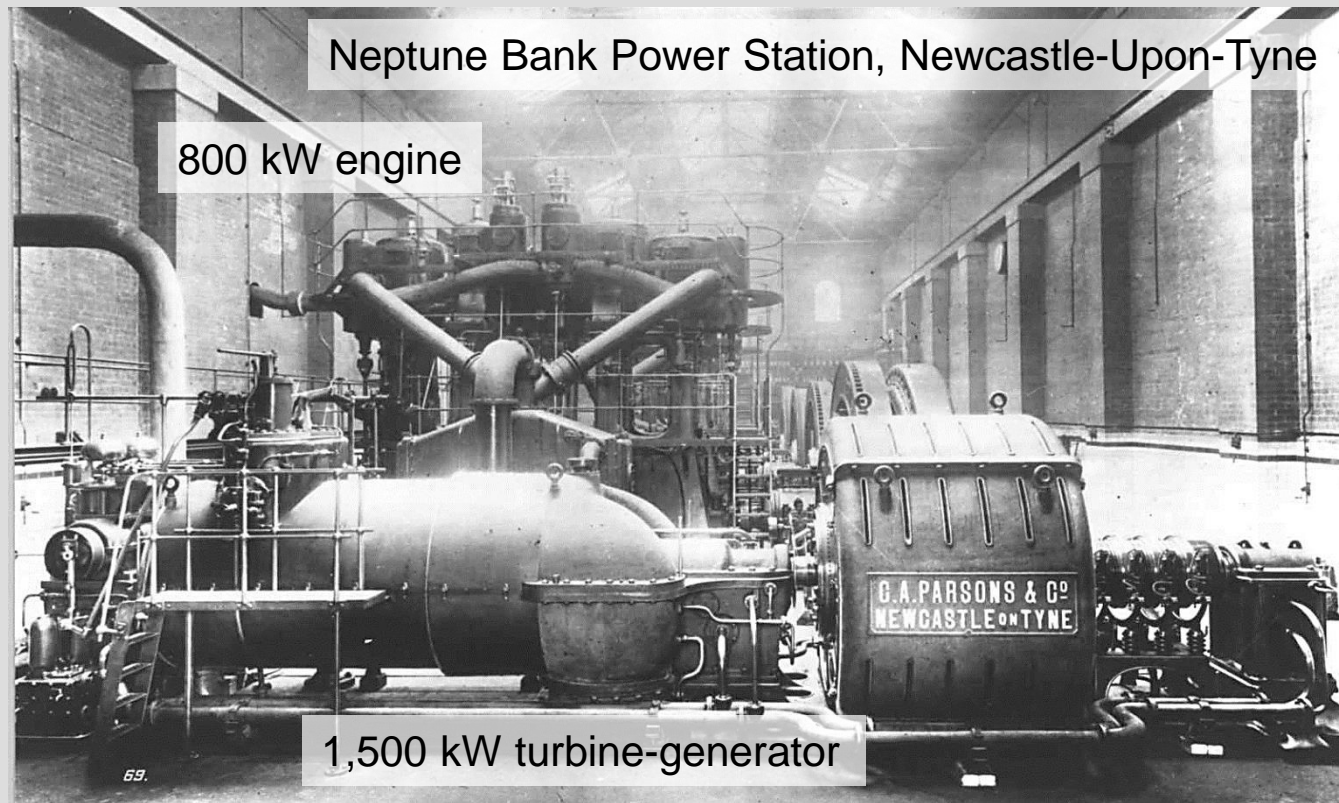


The high pressure turbine of TS King Edward



10p coin (24 mm)

Cunard carried out many tests before choosing their engines



Cunard formed a committee to review experience with turbines and piston engines.

At Neptune Bank, an 800 kW piston engine was compared with a 1,500 kW Parsons turbine. The turbine used 23% less steam at full load and maintained an advantage down to 75% load.

In March 1904, Cunard decided to use turbines for the Mauretania and Lusitania.

The first turbine driven super-liners

Mauretania (1906)

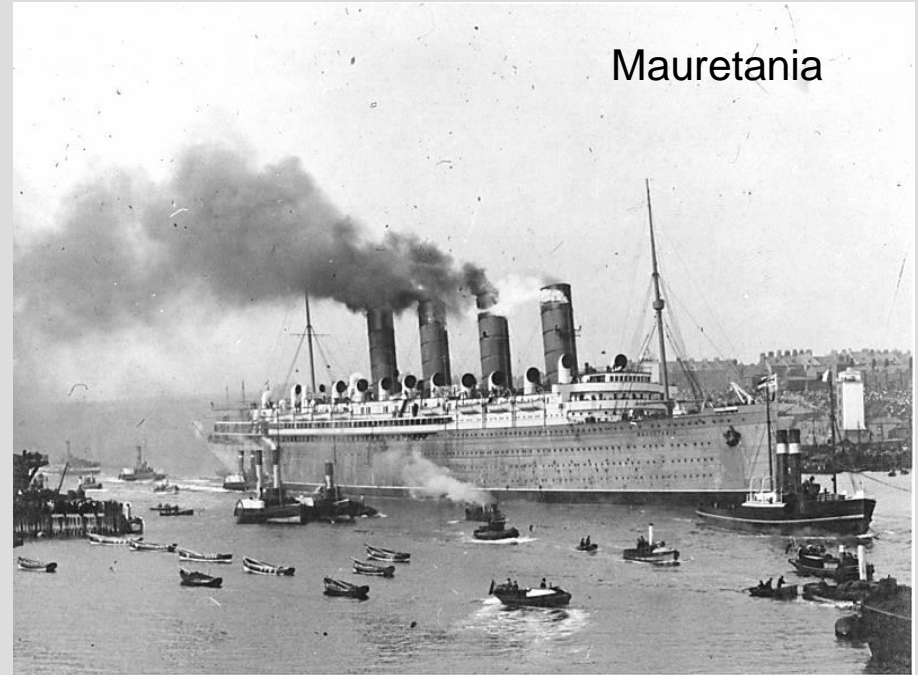
Blue riband 1909 – 1929 26.06 knots

Eastbound record held from 1907

2 Parsons direct-drive turbines

68,000 shp

31,938 tons



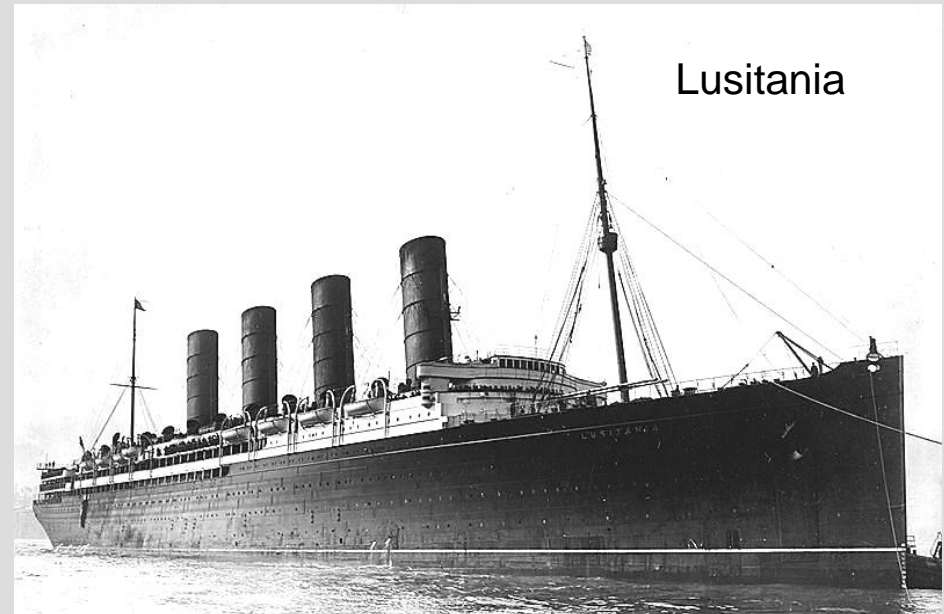
Lusitania (1906)

Blue riband 1907 – 1909 25.65 knots

2 Parsons direct-drive turbines

68,000 shp

31,550 tons

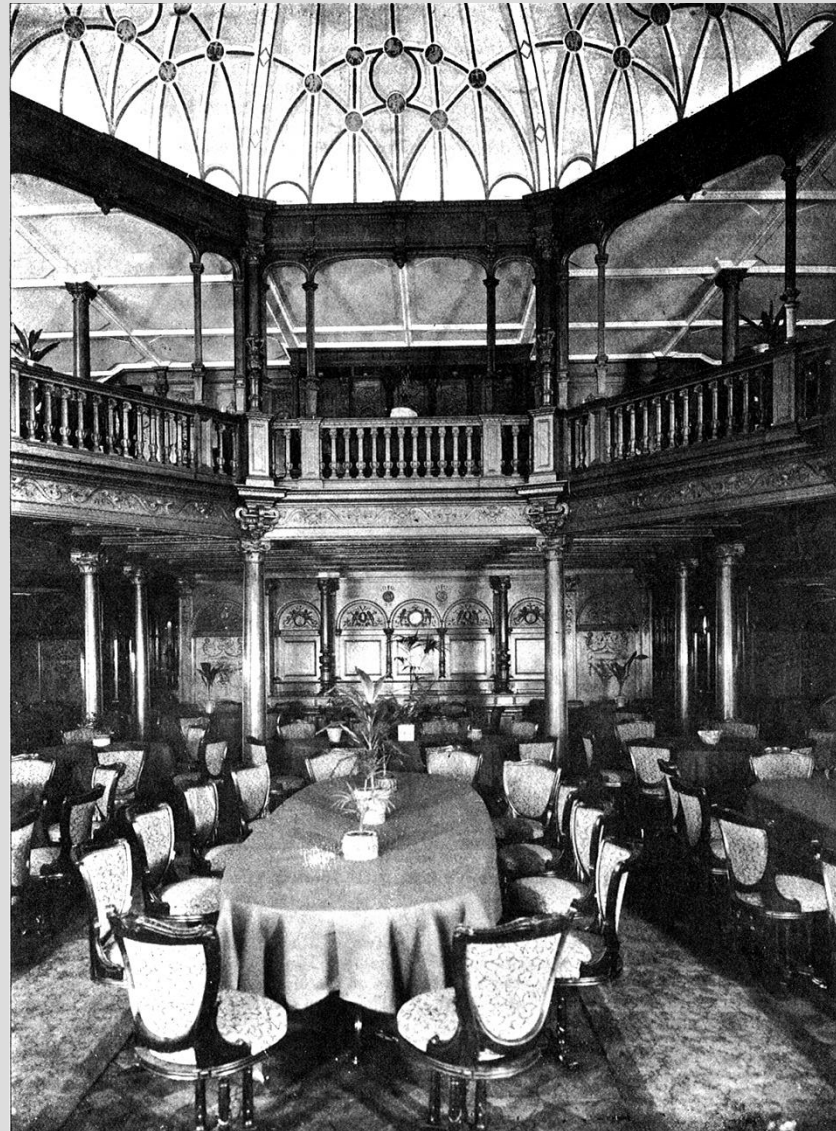


Mauretania

First class life was luxurious

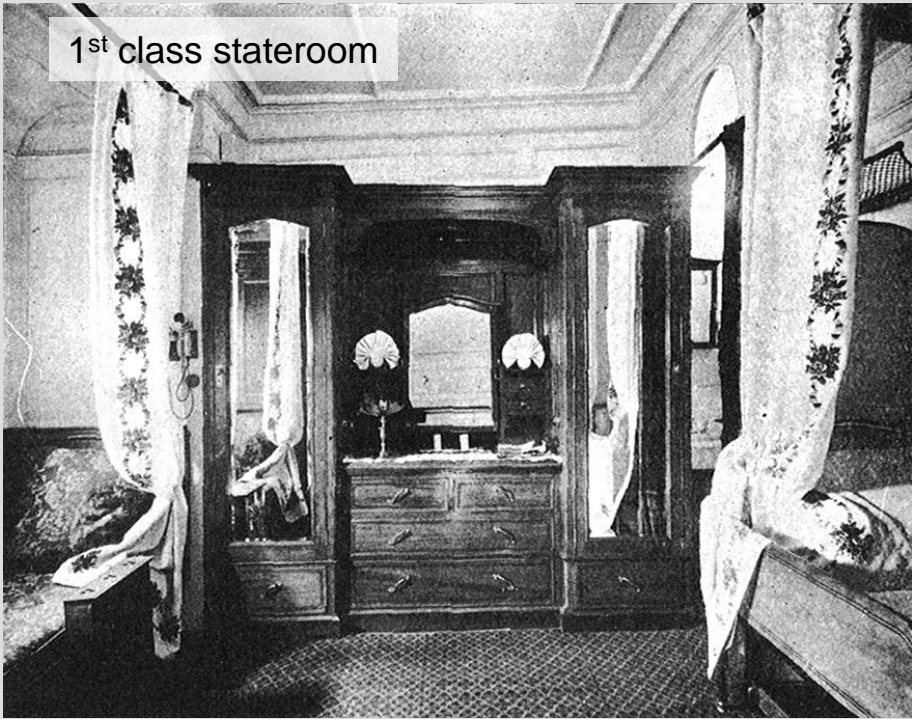


Music room

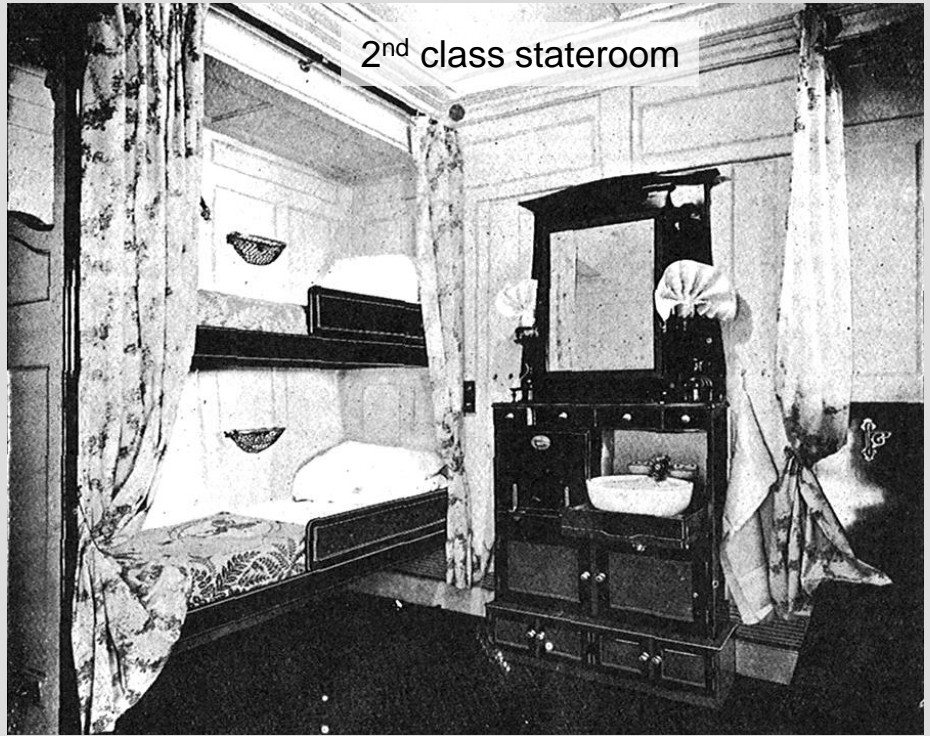


1st class dining

1st class stateroom



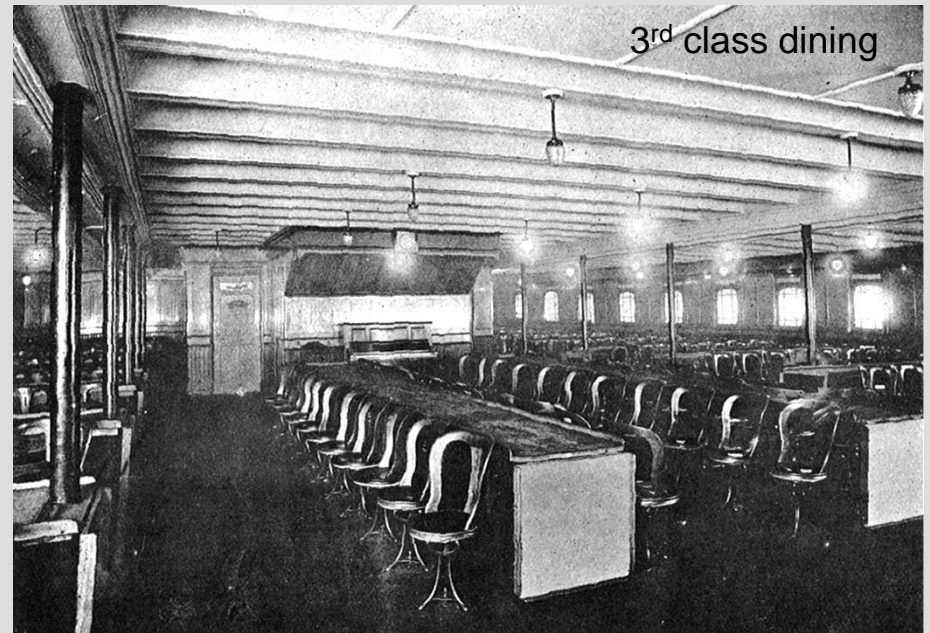
2nd class stateroom



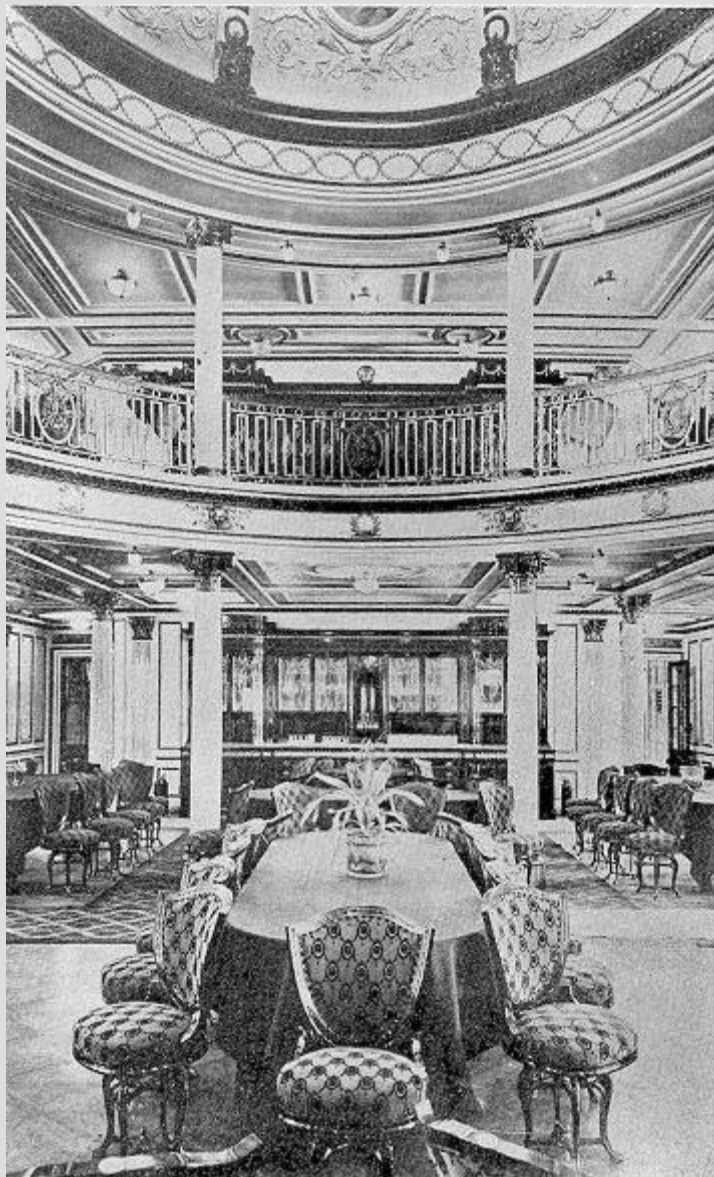
2nd class dining



3rd class dining



Lusitania



1st class dining saloon



1st class lounge

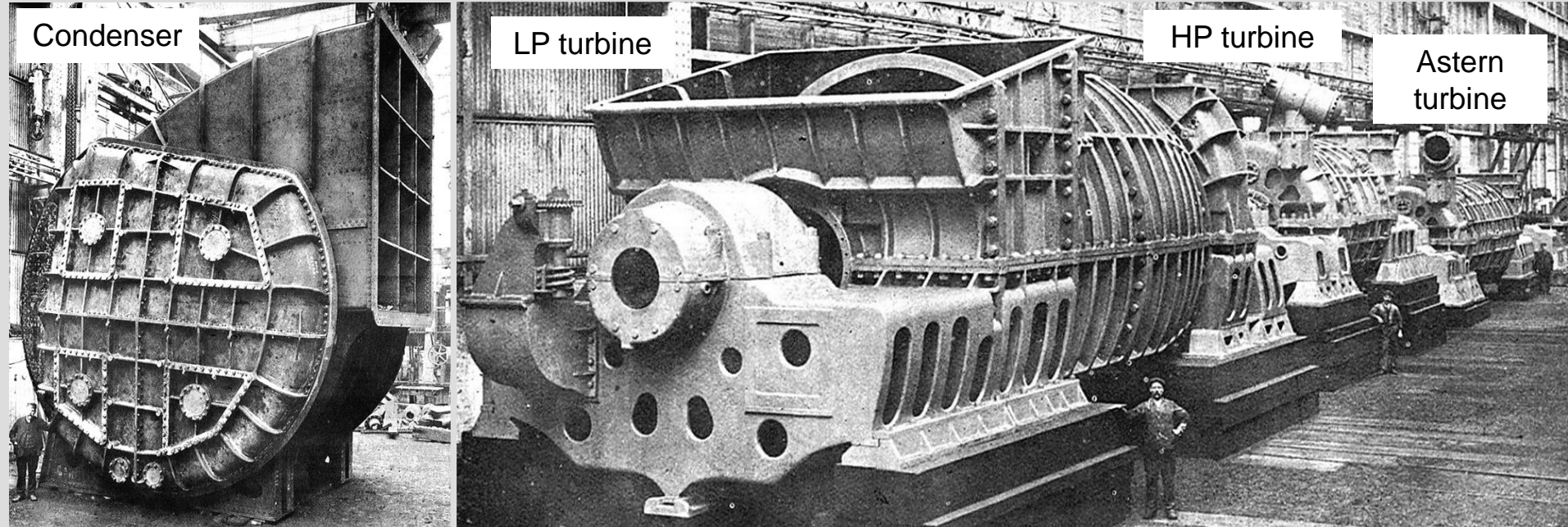
Mauretania: direct drive turbines

Condenser

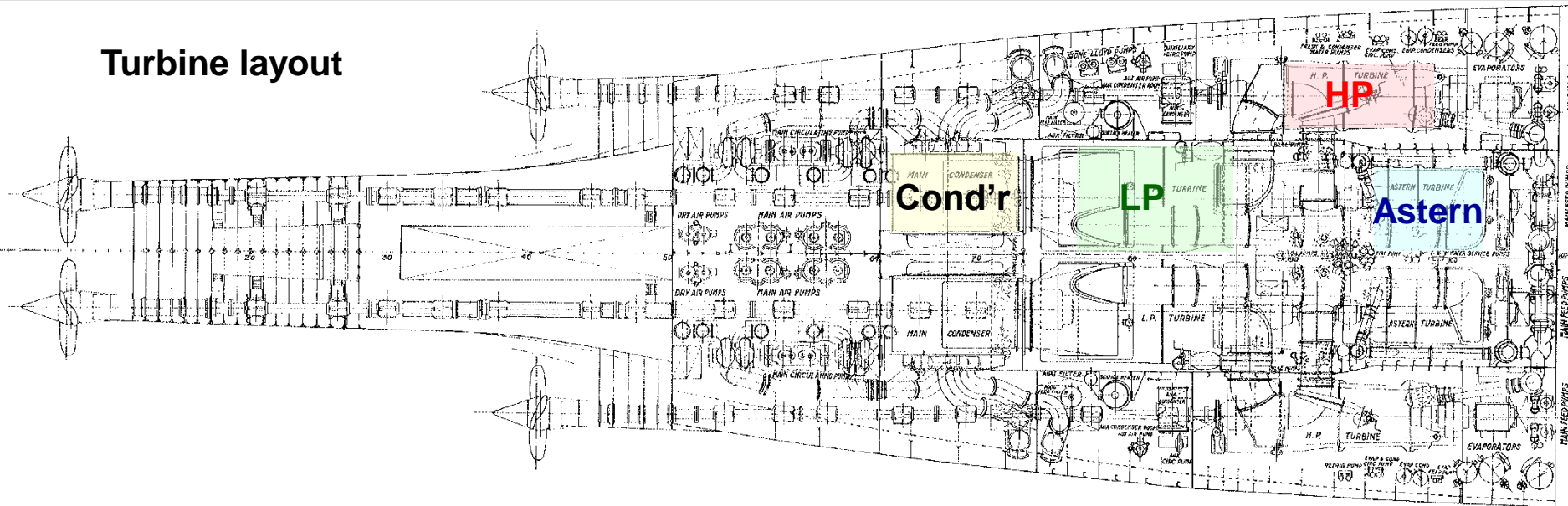
LP turbine

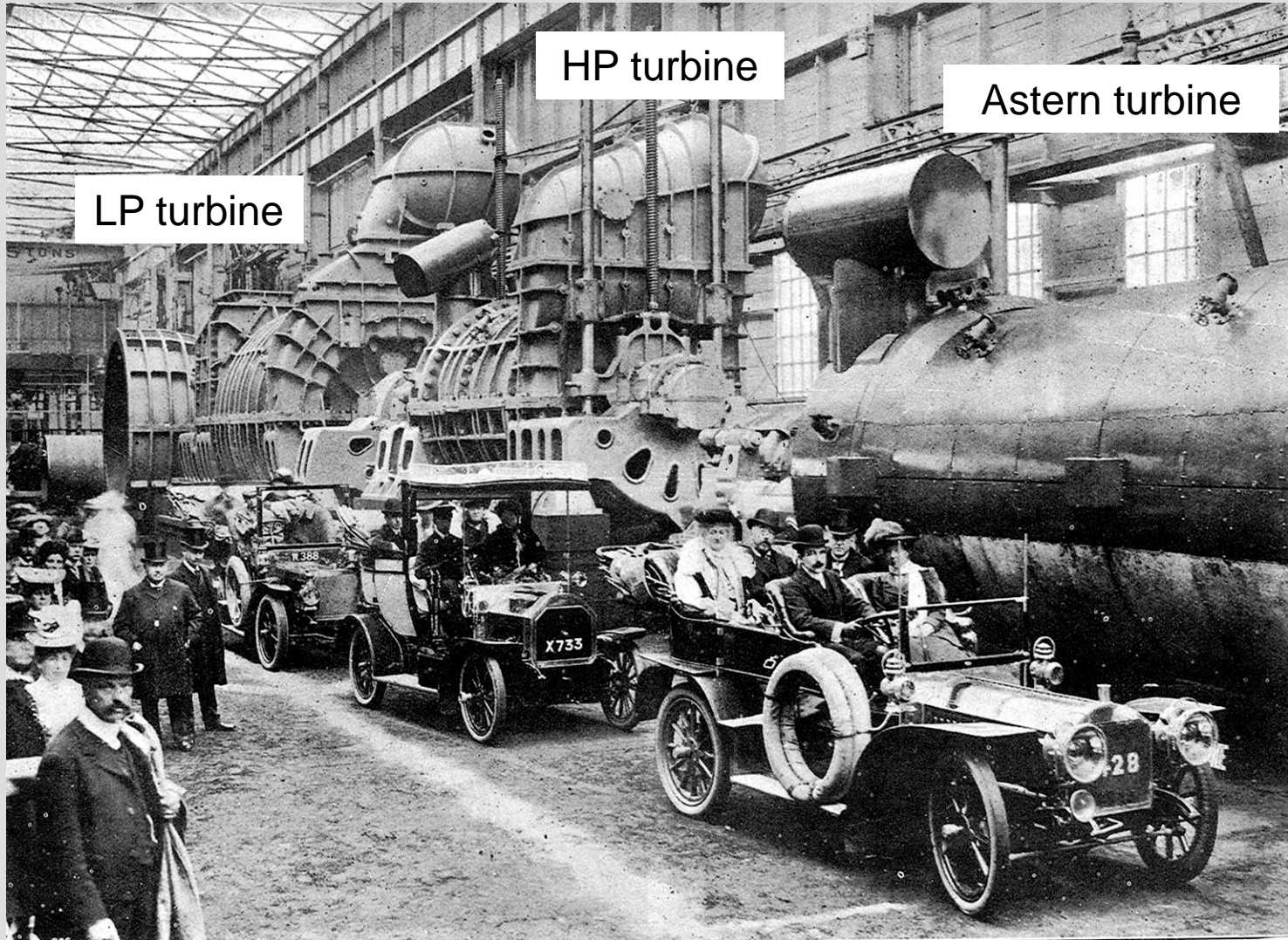
HP turbine

Astern turbine

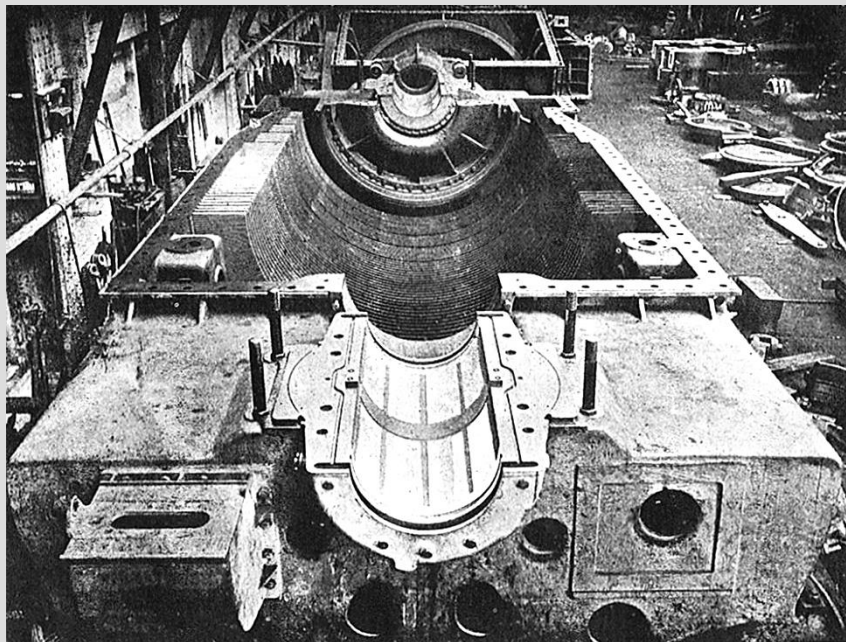


Turbine layout

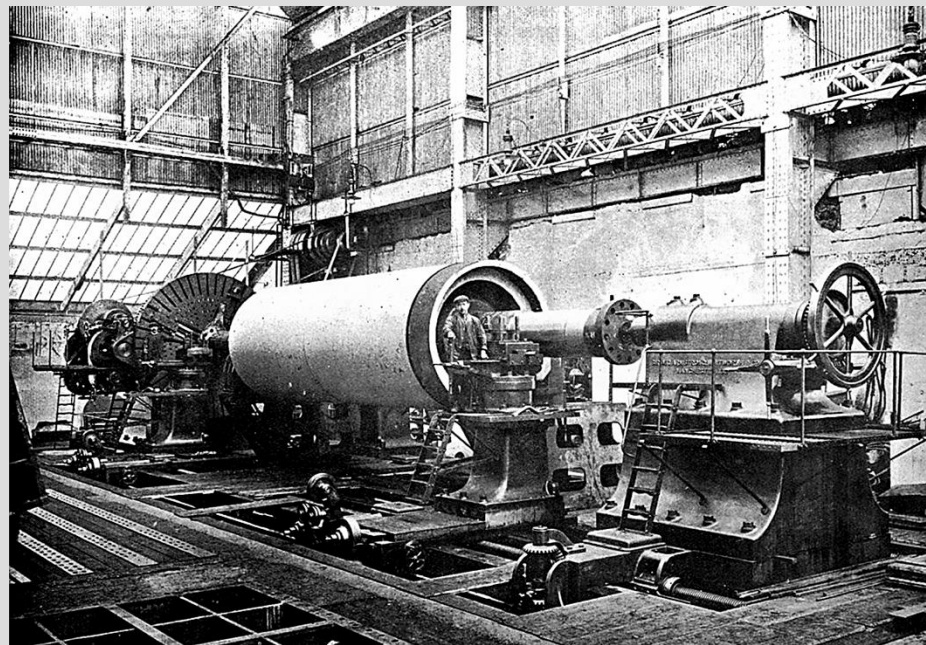




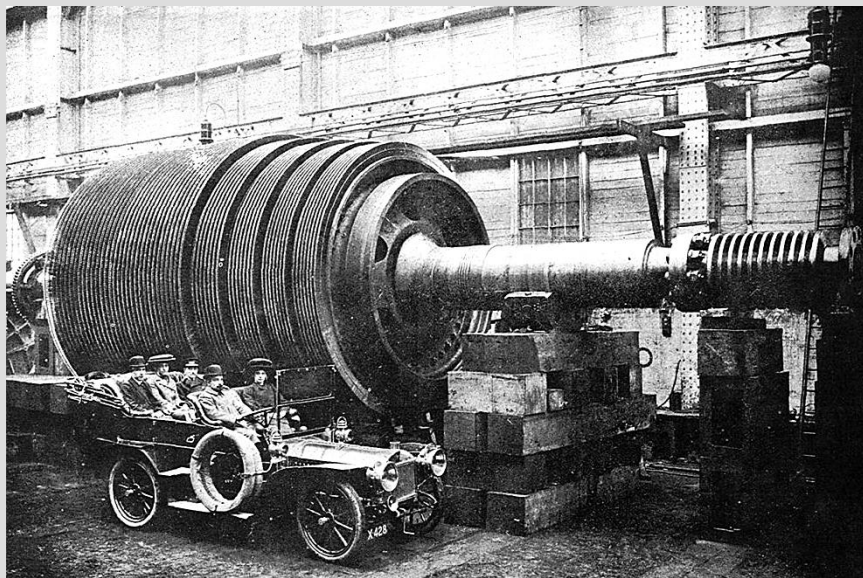
20th September 1906



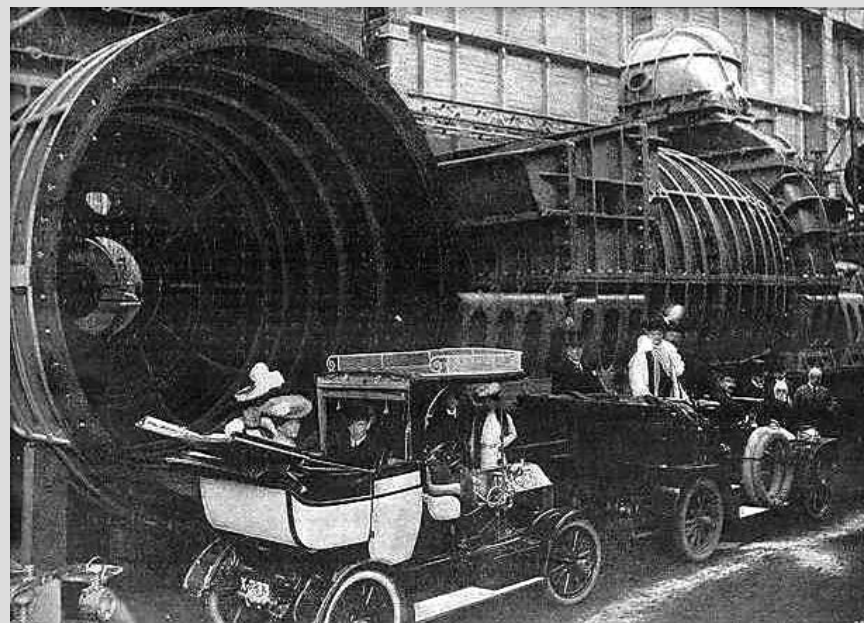
LP casing & bearing block

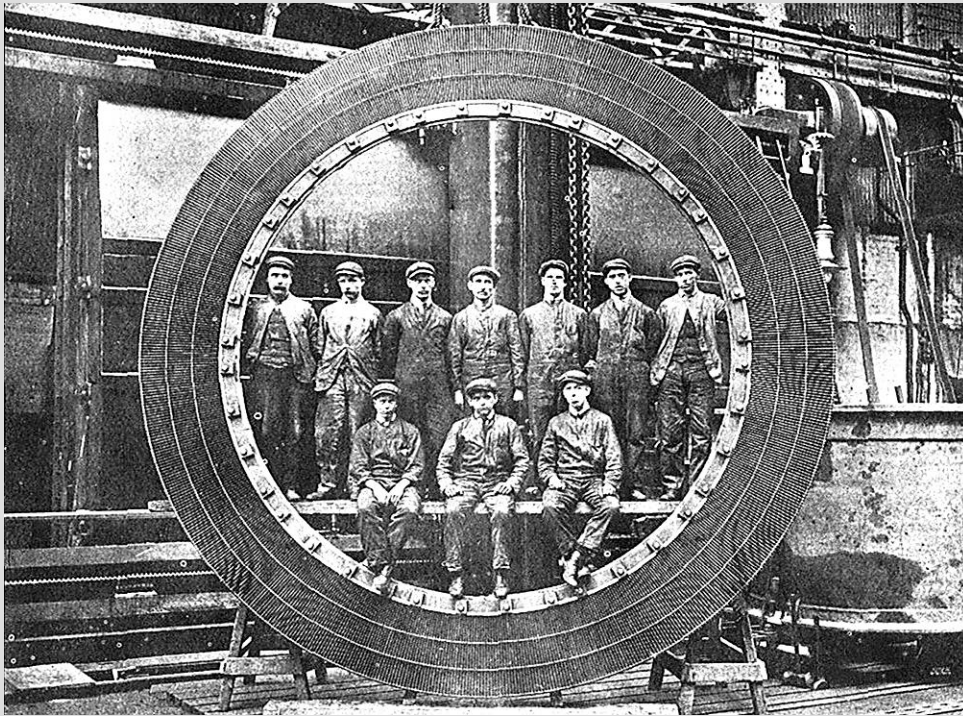


HP rotor

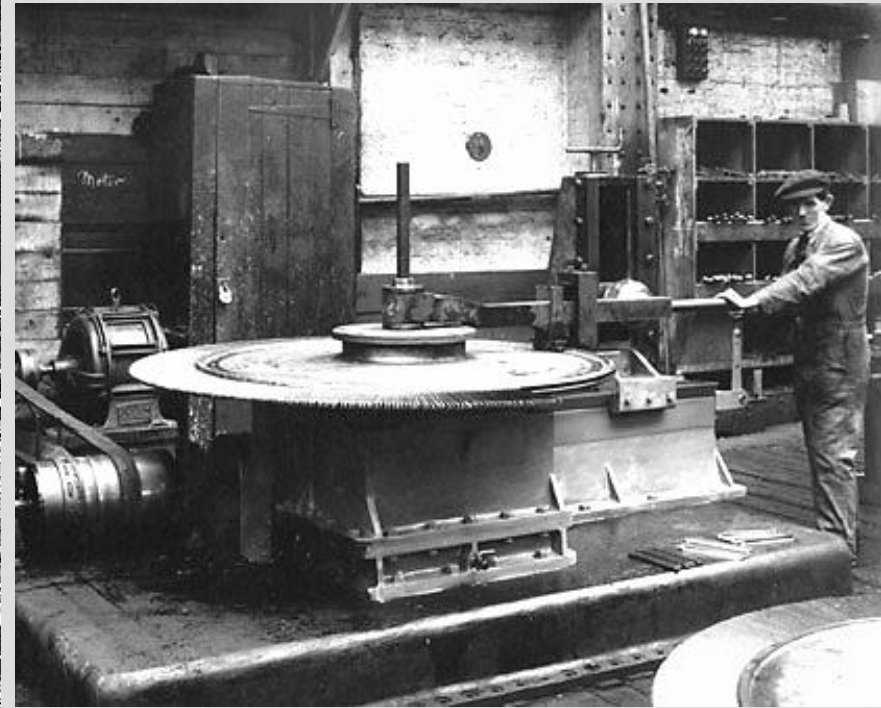


LP rotor

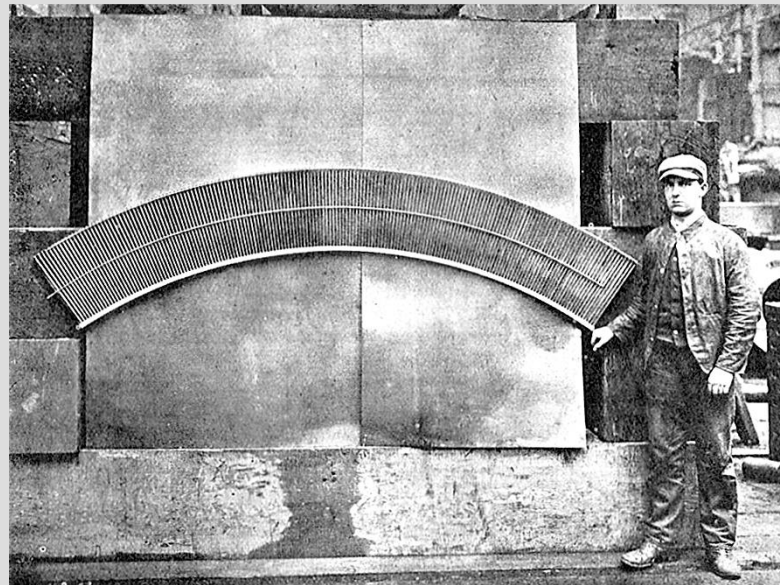




Assembled blade ring

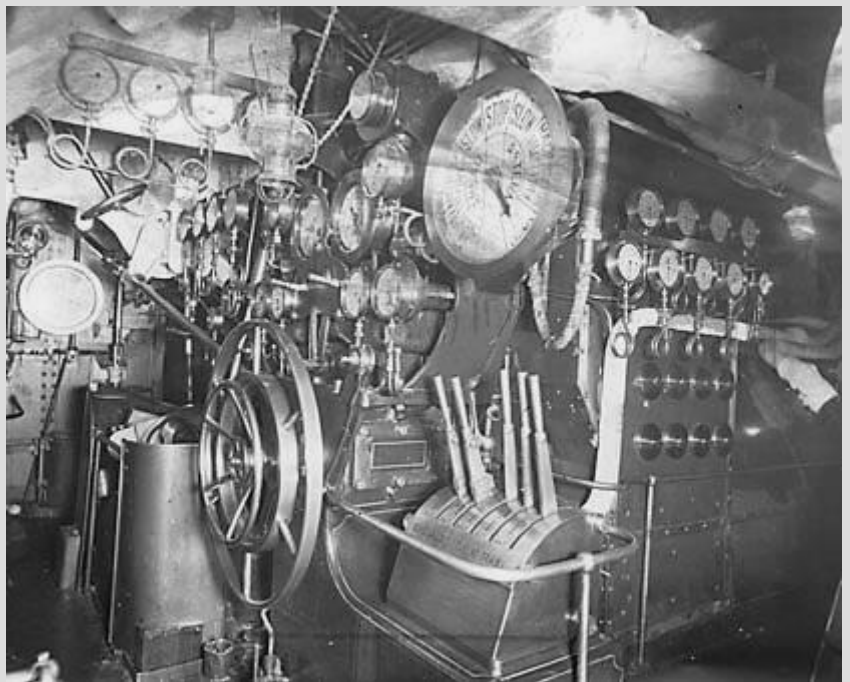
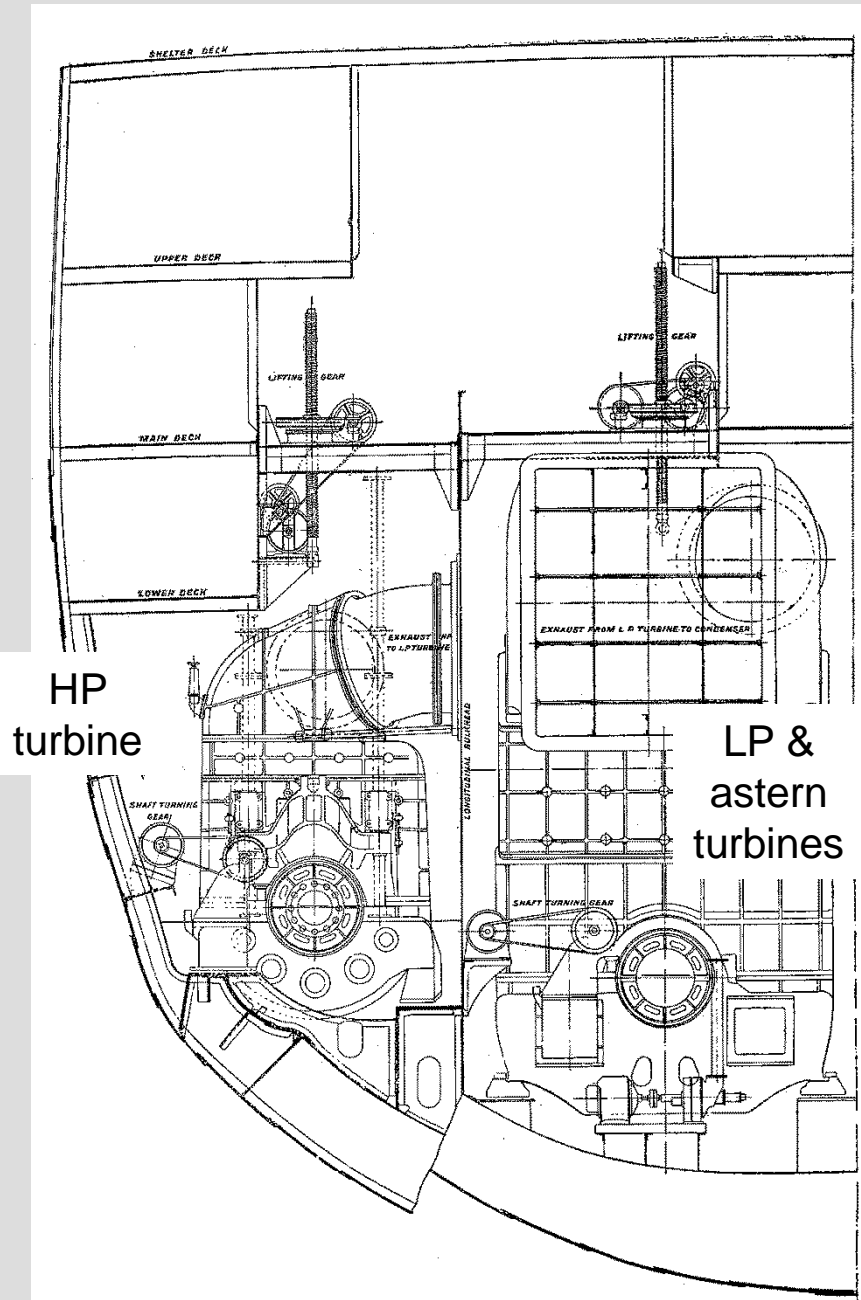


Blade assembly

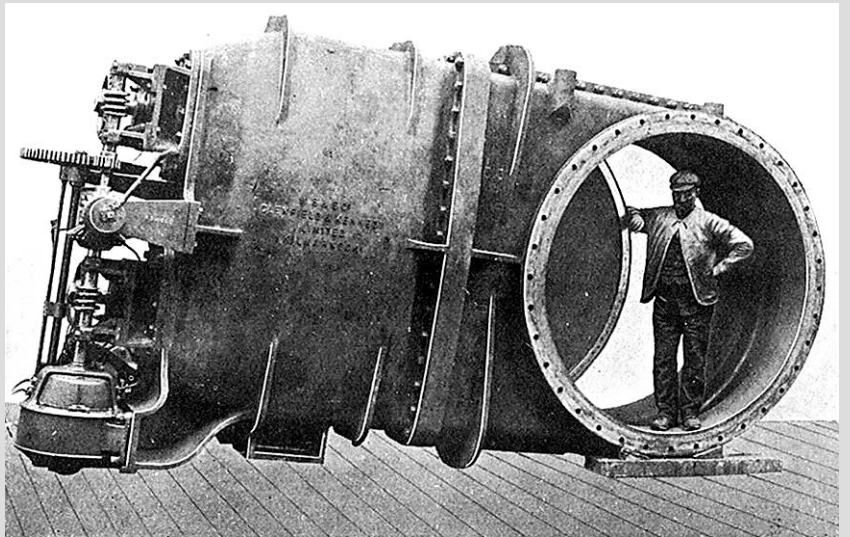


Blade
segment

The blades were
manufactured as
braced segments
for ease of handling

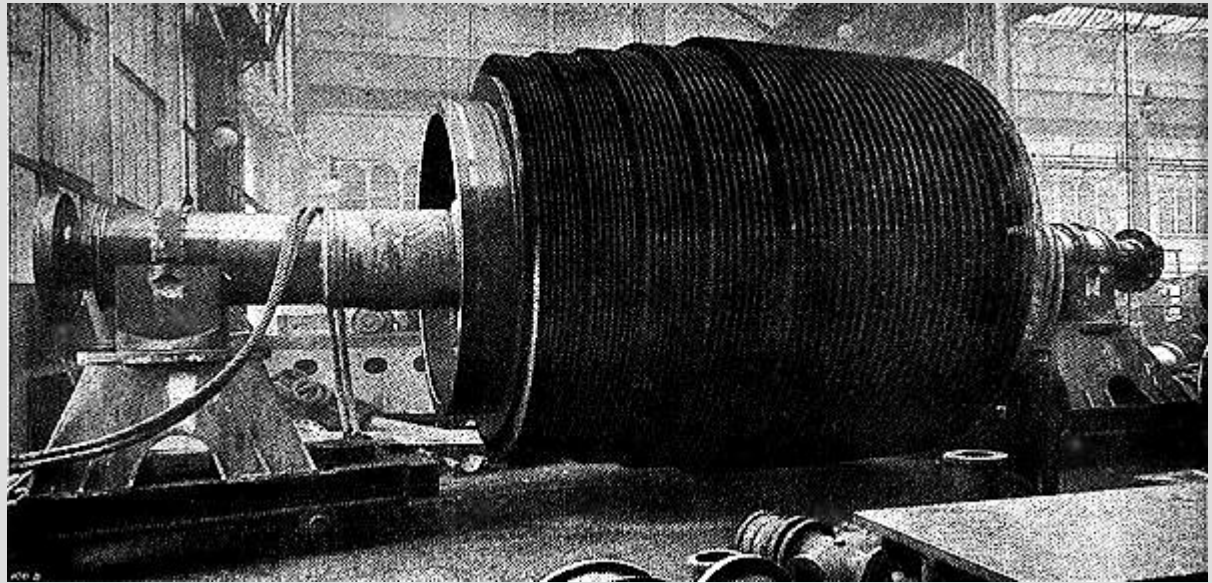


One of the engine control stations

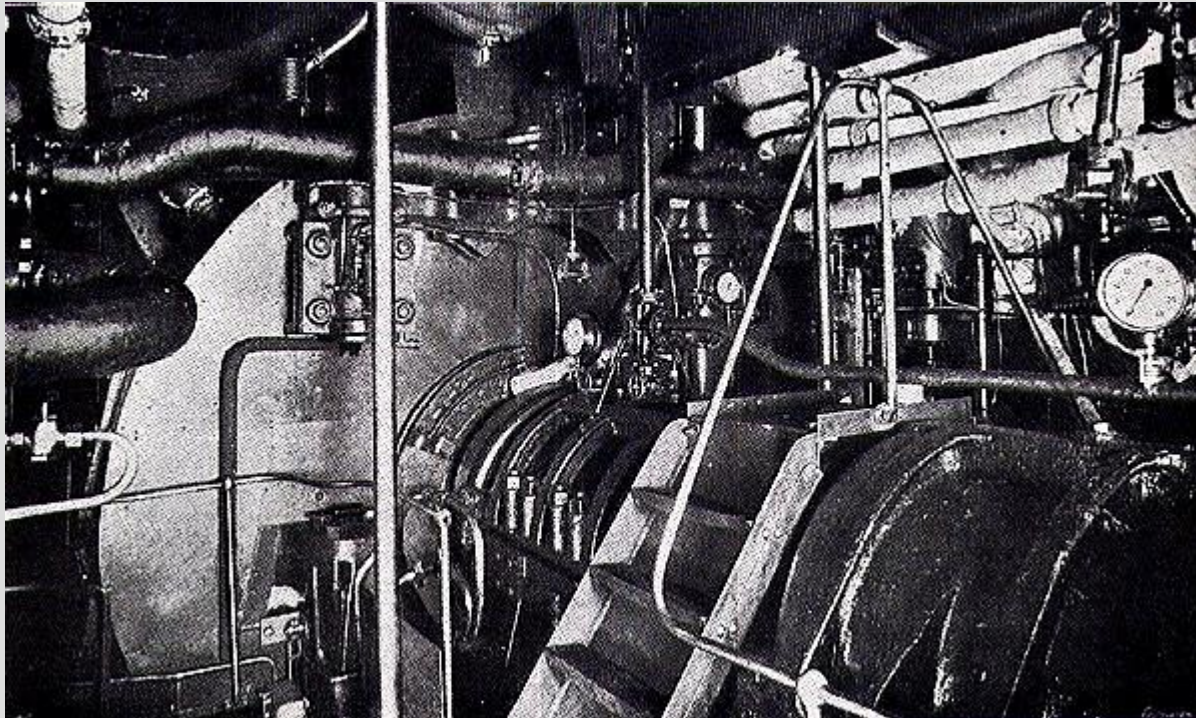


Isolating valve in HP-LP cross-over pipe

Lusitania's engines



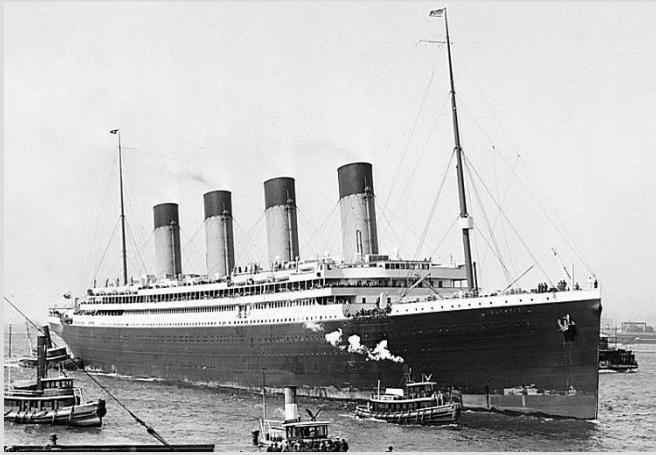
LP turbine rotor



LP turbine installed

White Star Line's grand trio

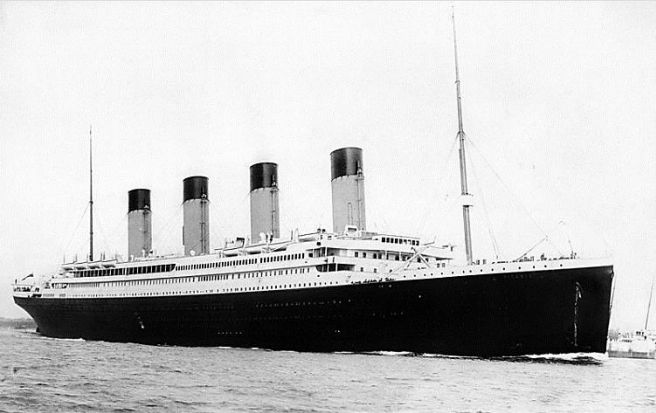
Large & luxurious but not intended to win the speed record



RMS Olympic (1910)

46,000 shp 21 knots

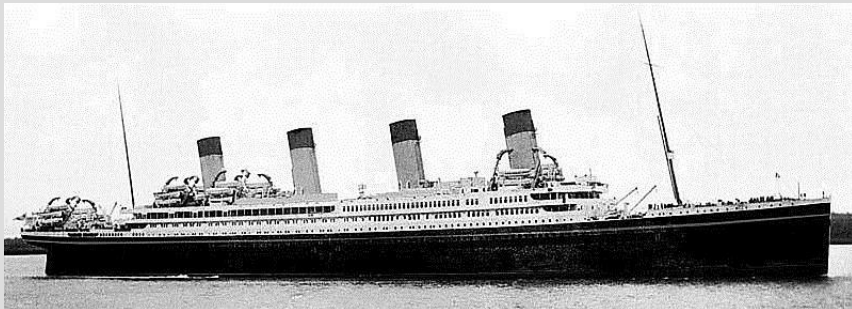
45,324 tons



RMS Titanic (launched 1911, sank 1912)

46,000 shp 21 knots

46,328 tons



HMHS Britannic (1914)

48,000 shp 21 knots

48,158 tons

Olympic



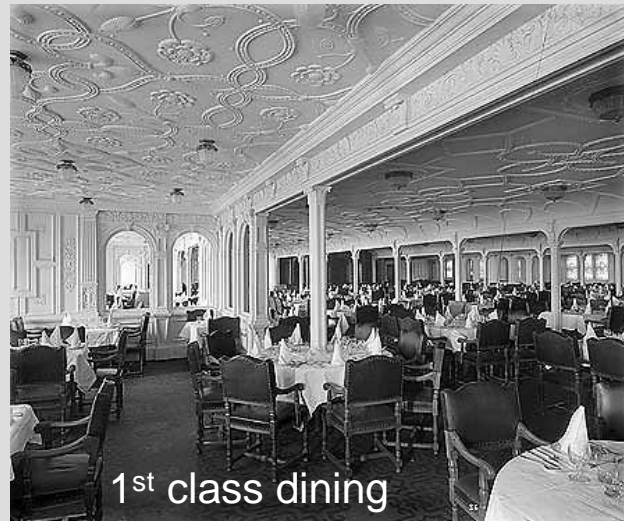
Grand staircase



1st class lounge



Verandah cafe

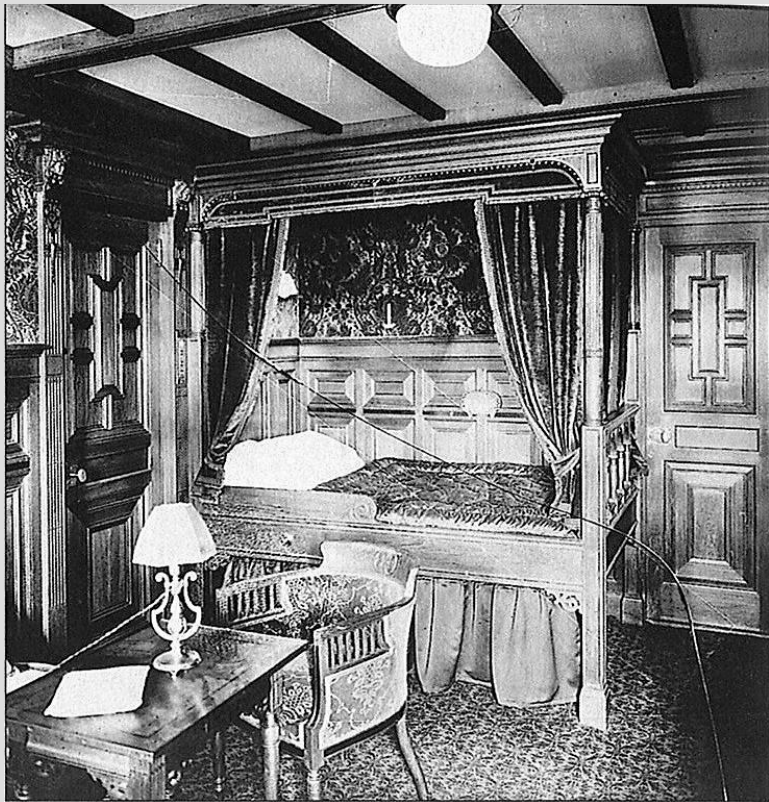


1st class dining

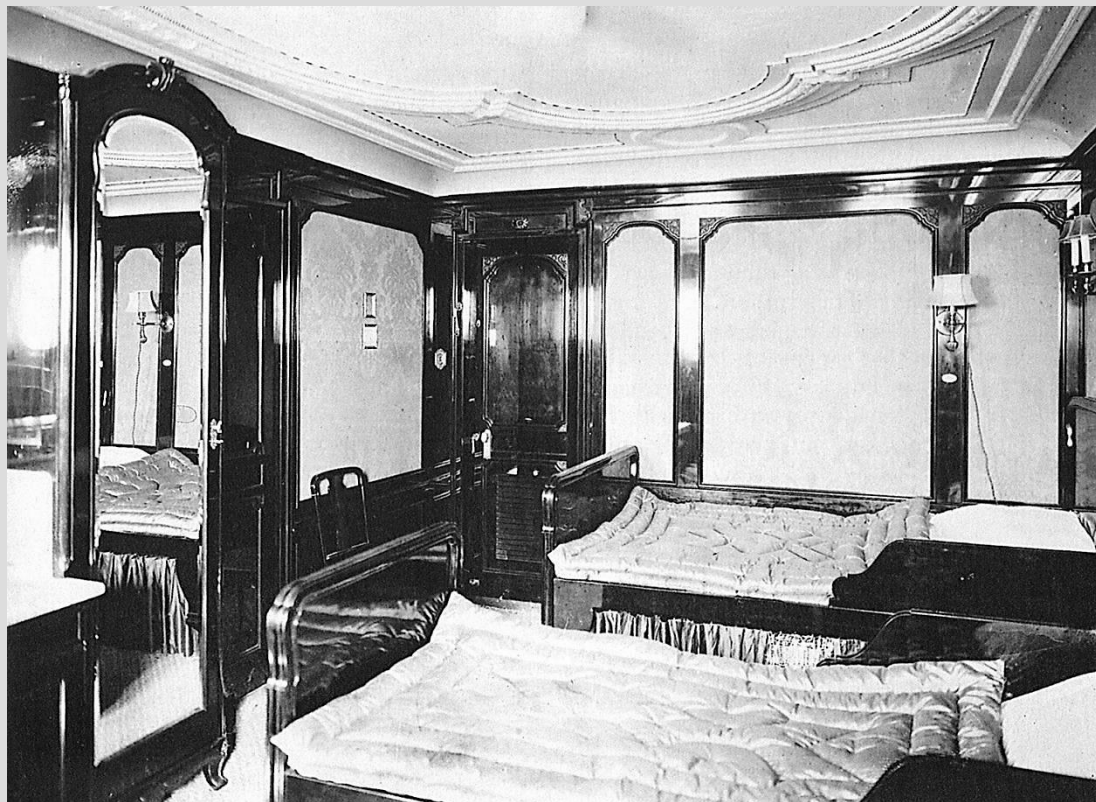


3rd class cabin

Titanic

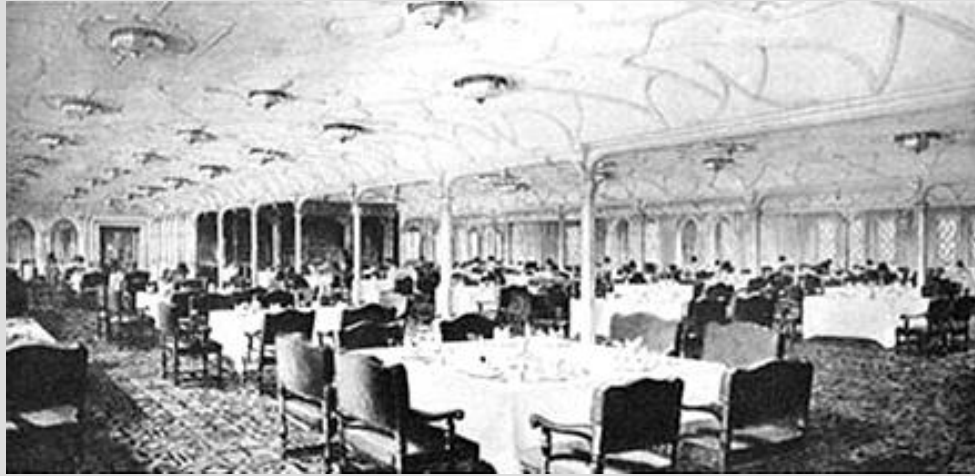


1st class suite



1st class cabin

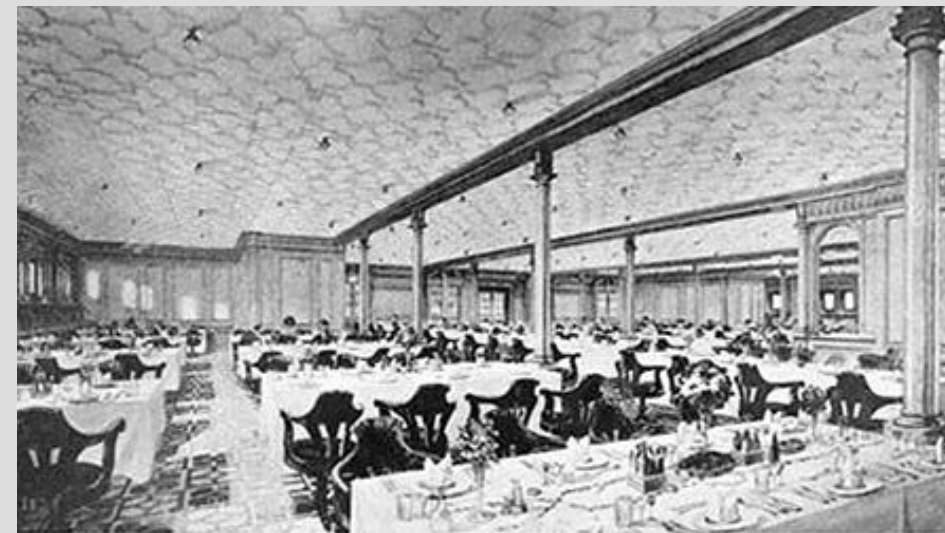
Titanic



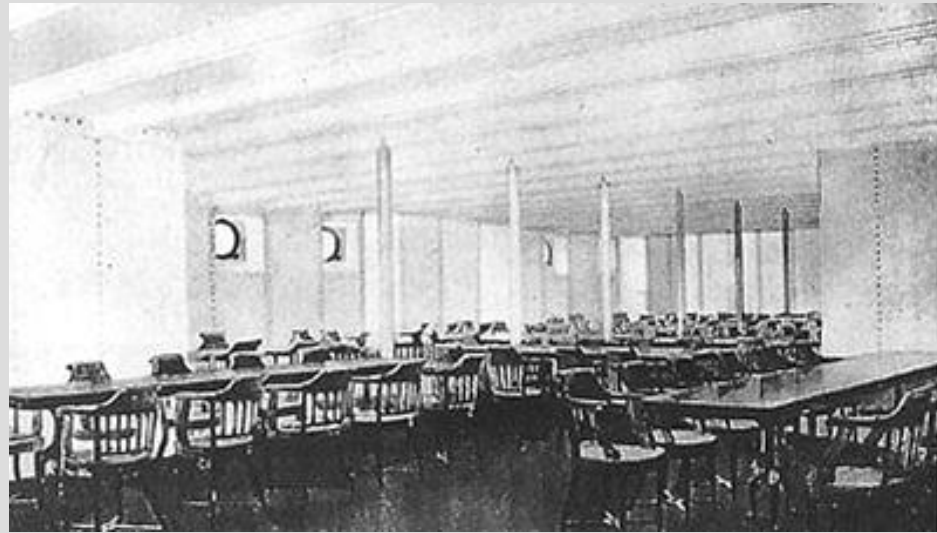
1st class dining



1st class parlour suite



2nd class dining



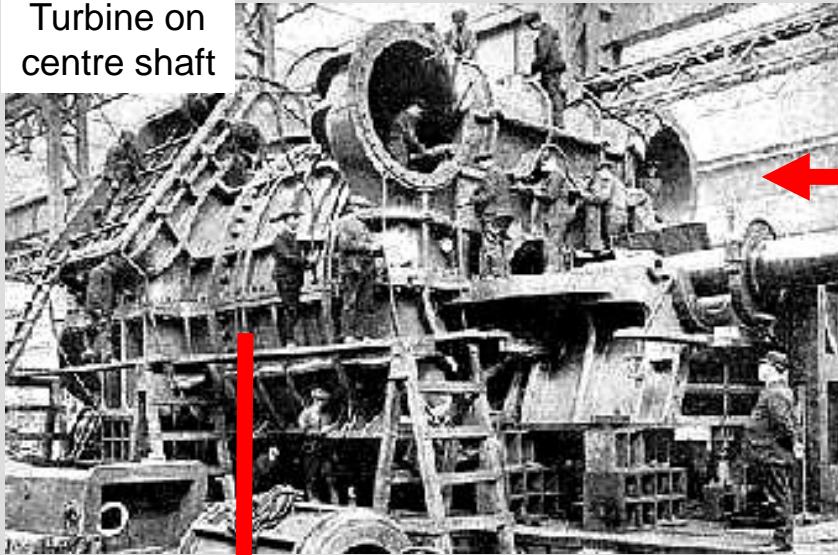
3rd class dining

Titanic: 2 piston engines + 1 turbine in combination

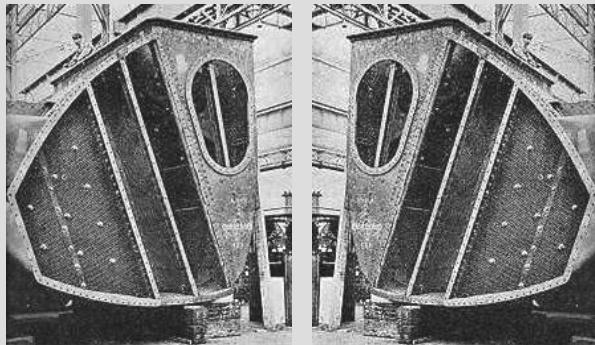
Piston engine power: 15,000 shp each

Turbine power: 16,000 shp

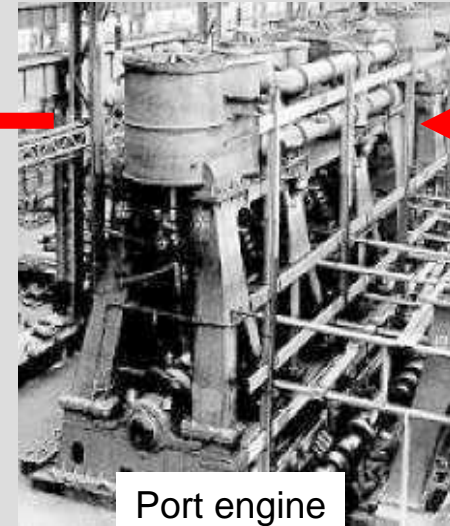
Turbine on
centre shaft



1 psia

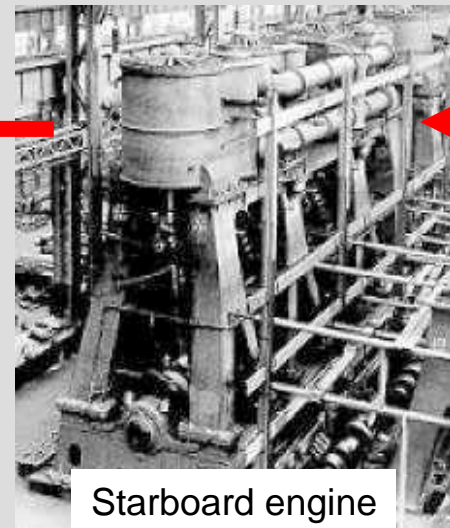


9 psia



Port engine

Steam
215 psig



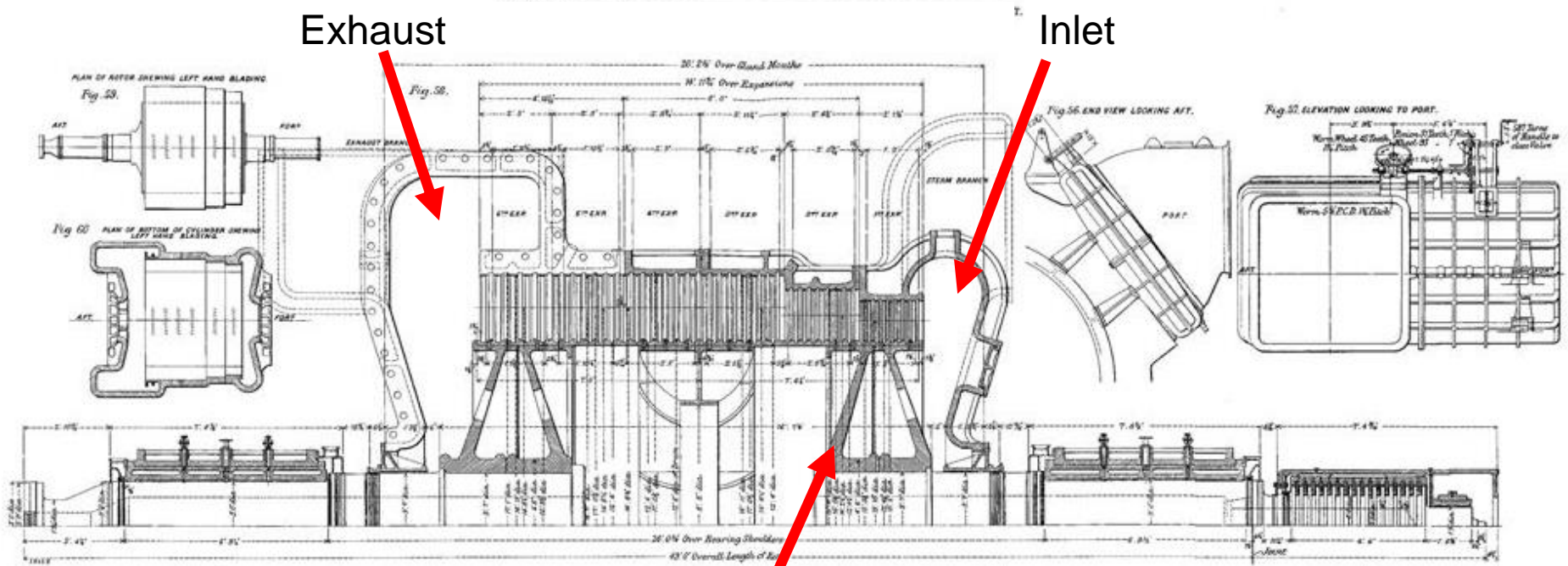
Starboard engine

There was no astern turbine, so when the piston engines were reversed, the exhaust turbine was bypassed and came to a halt.

Turbine arrangement

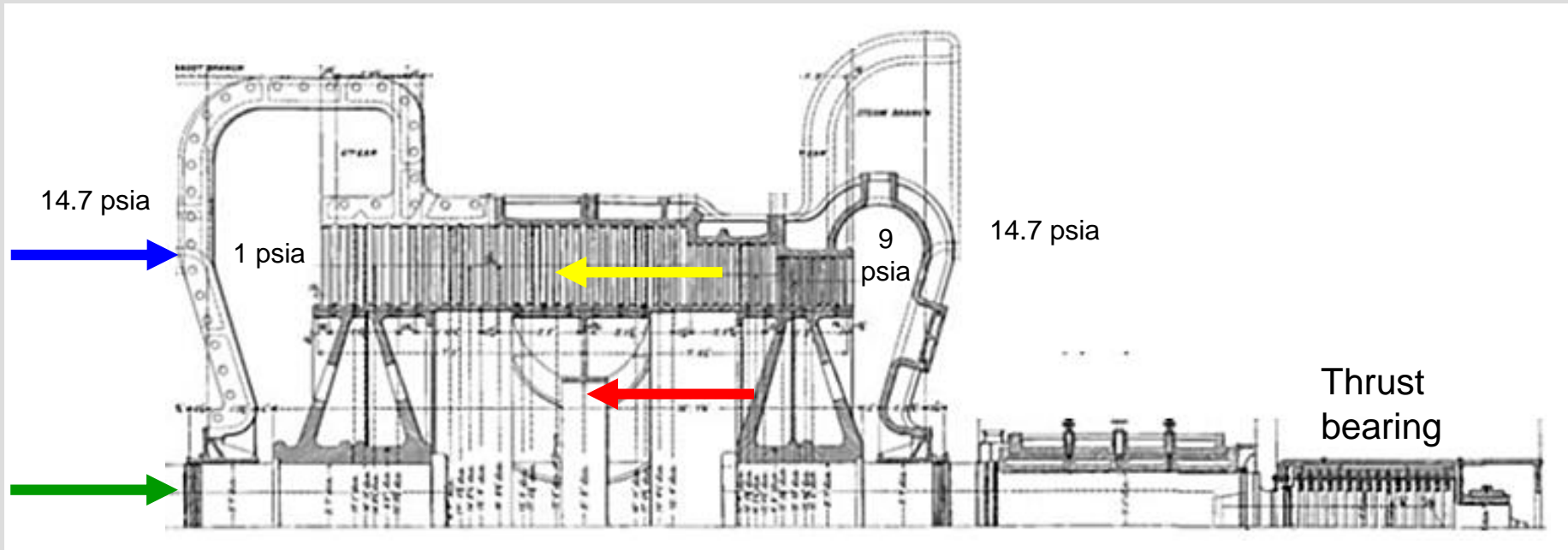
Exhaust

Inlet



Internal wall formed a gigantic dummy piston

The ship was propelled by the stationary turbine casing!

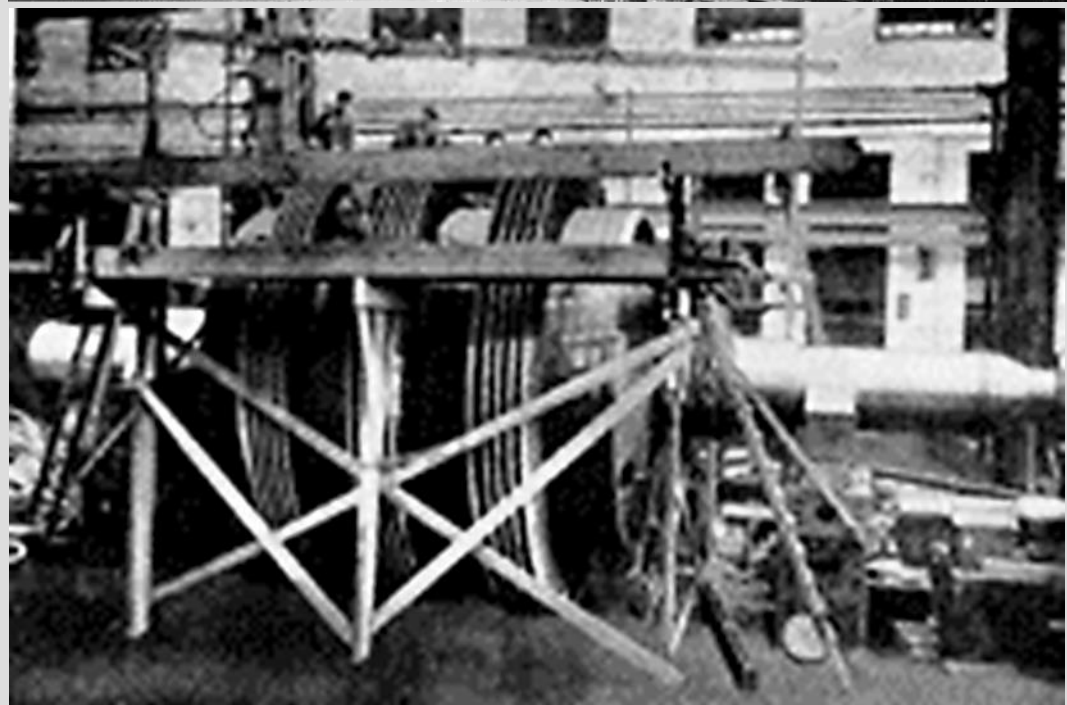
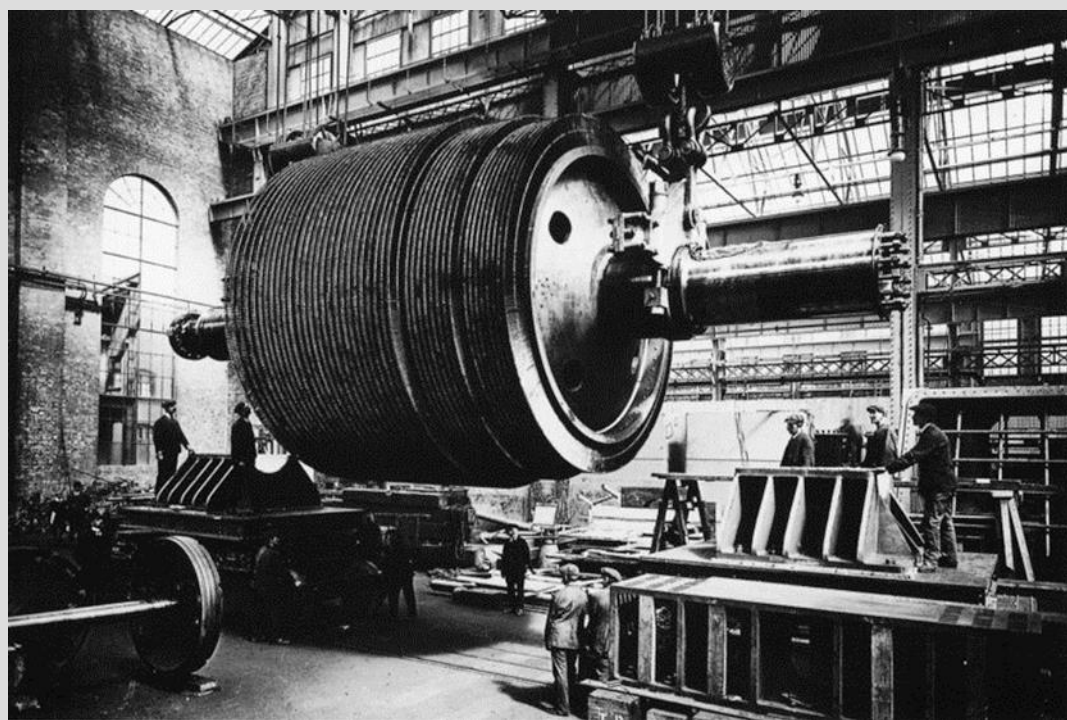
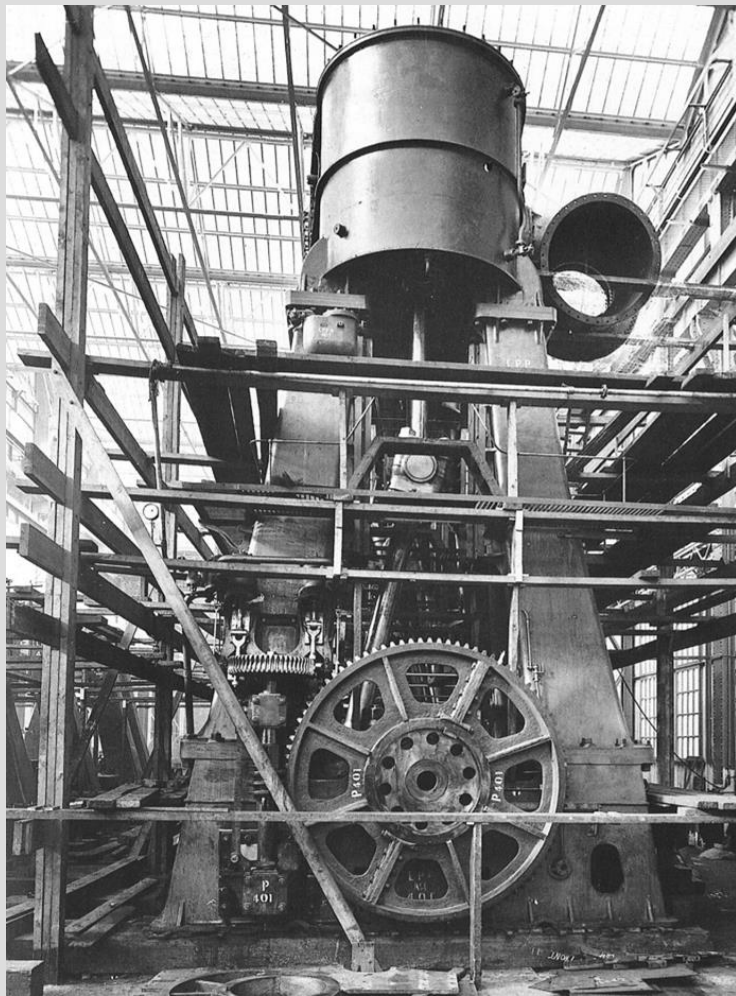


- Dummy piston thrust ← (red arrow)
- Blading thrust ← (yellow arrow)
- Propeller thrust → (green arrow)
- Net casing thrust → (blue arrow)

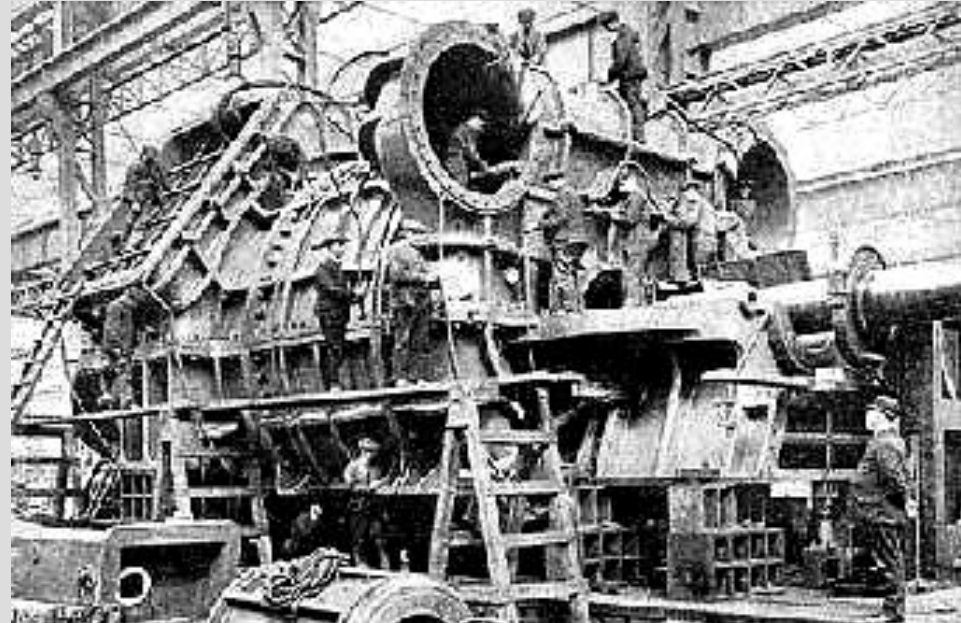
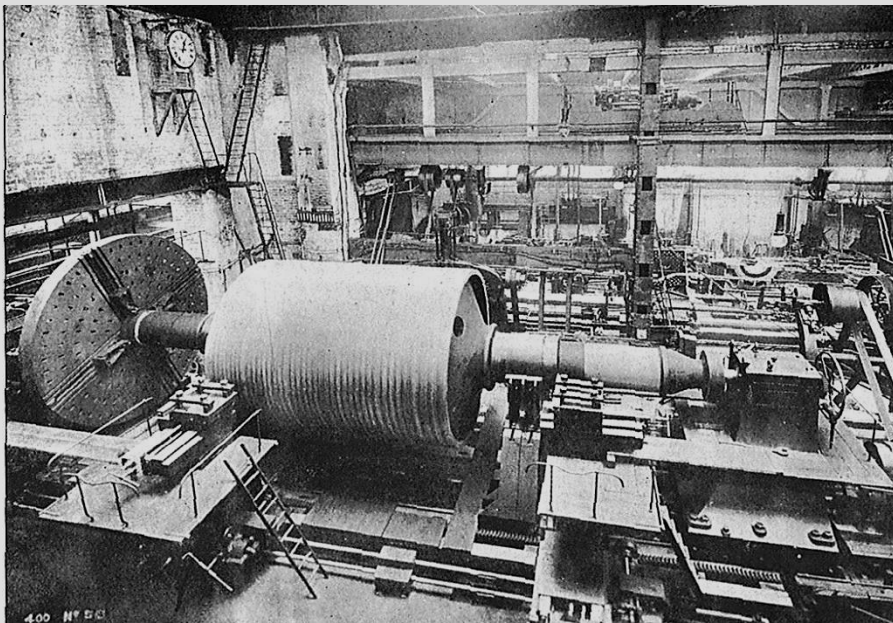
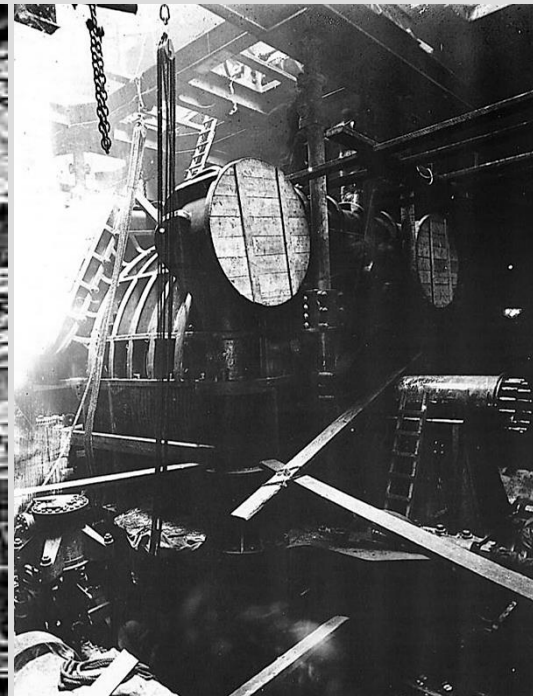
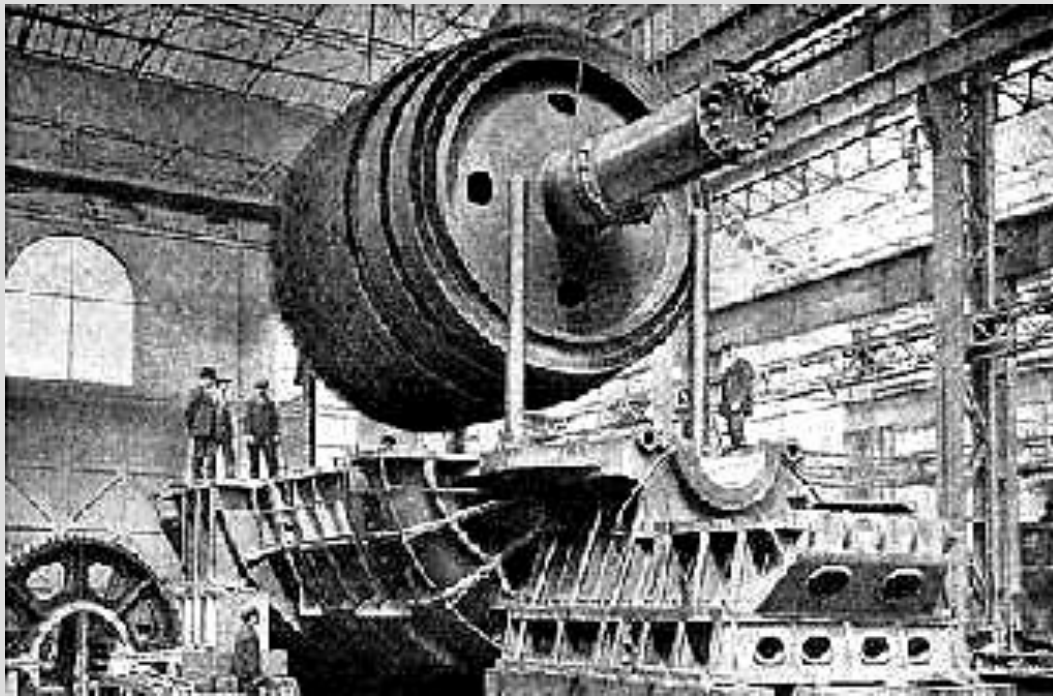
There was a net force on the casing of ~100 tons due to steam and atmospheric pressures which pushed the ship forward.

The thrust from the propeller was restricted to the limit of the thrust bearing.
The remainder of the propulsive force came from the casing.

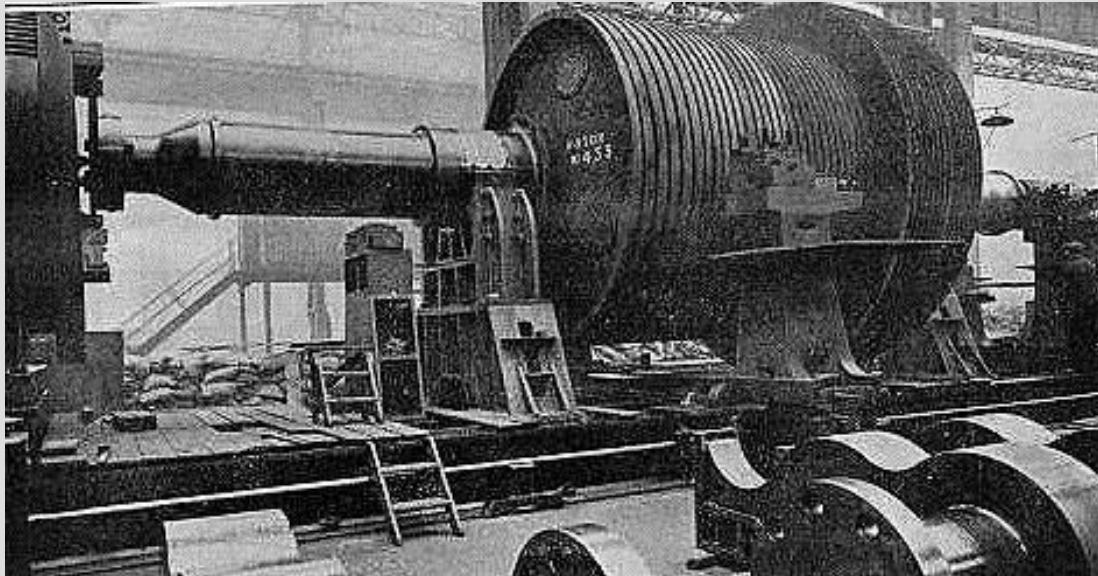
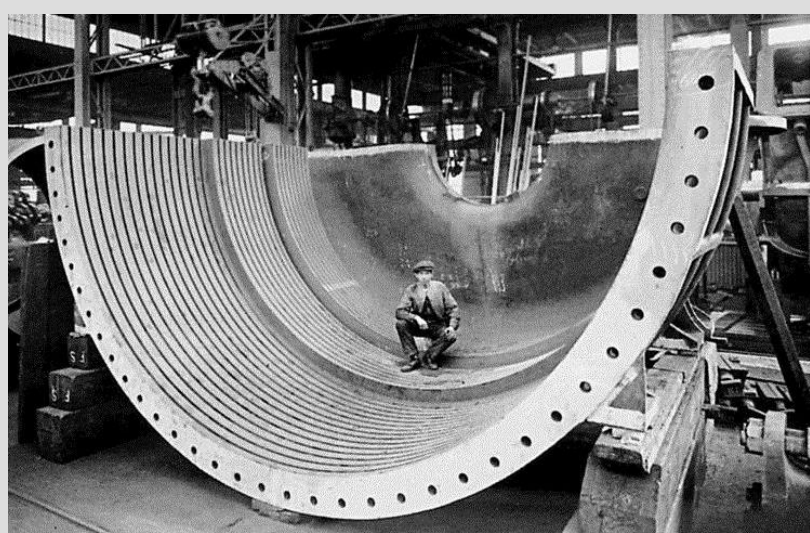
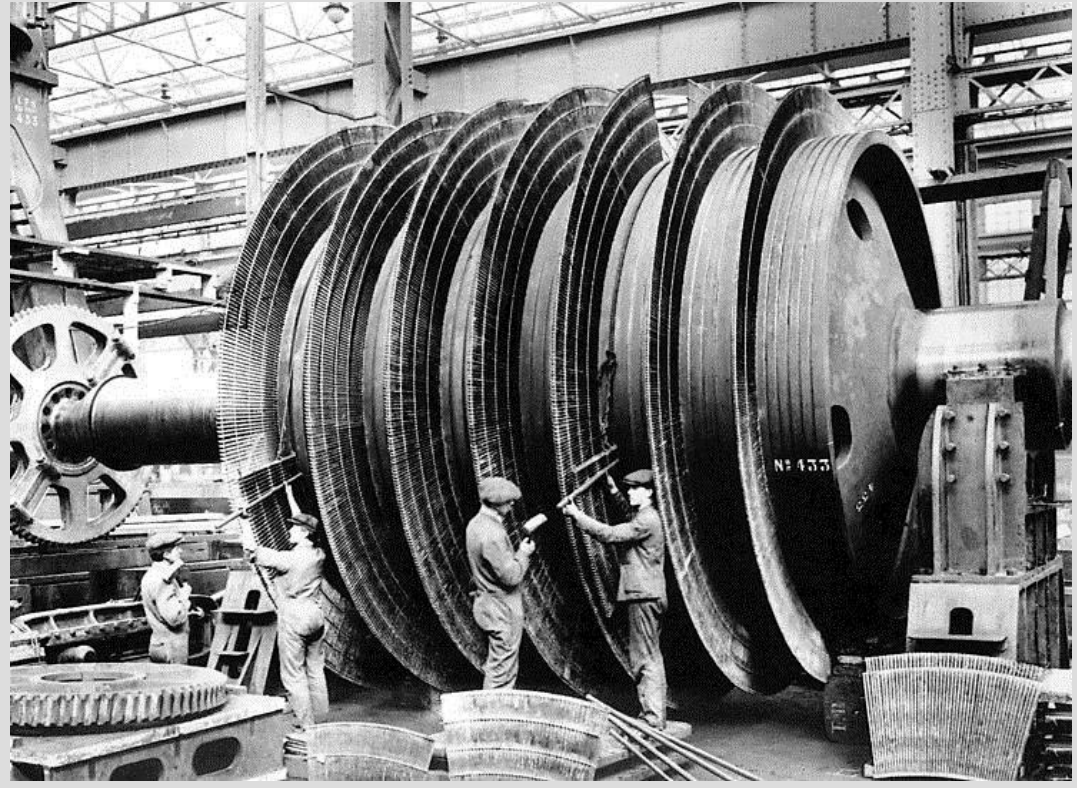
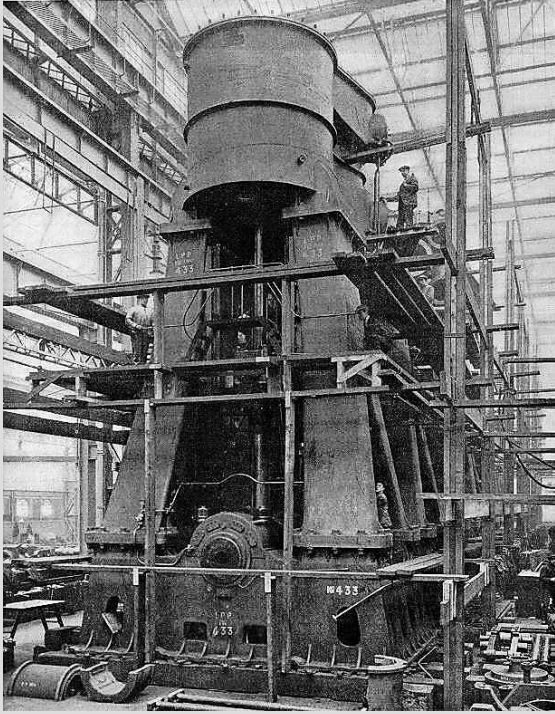
Titanic's engines



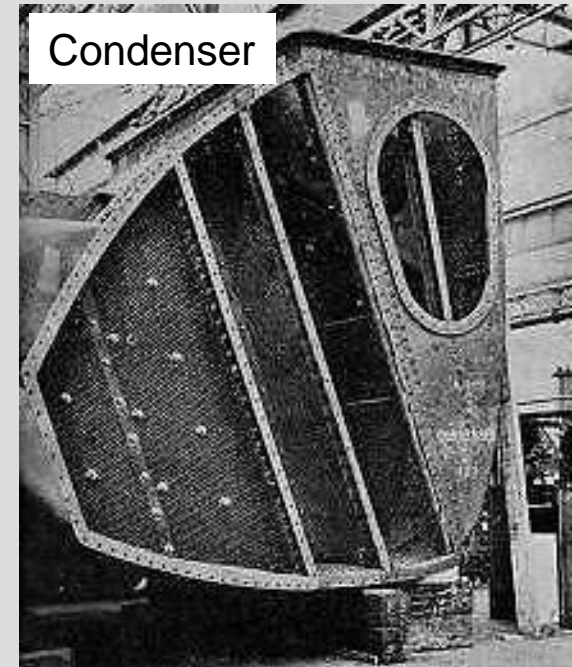
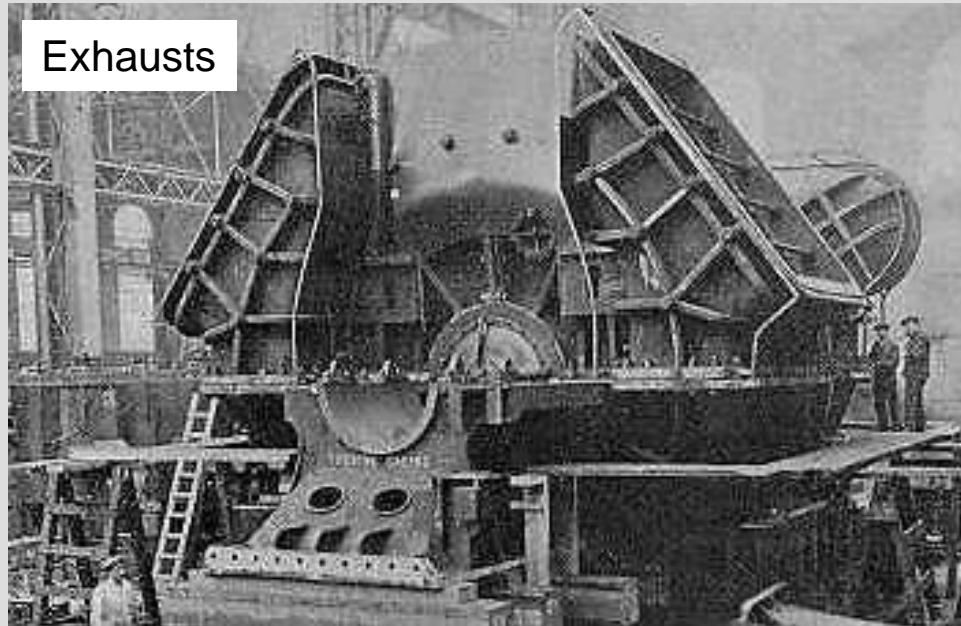
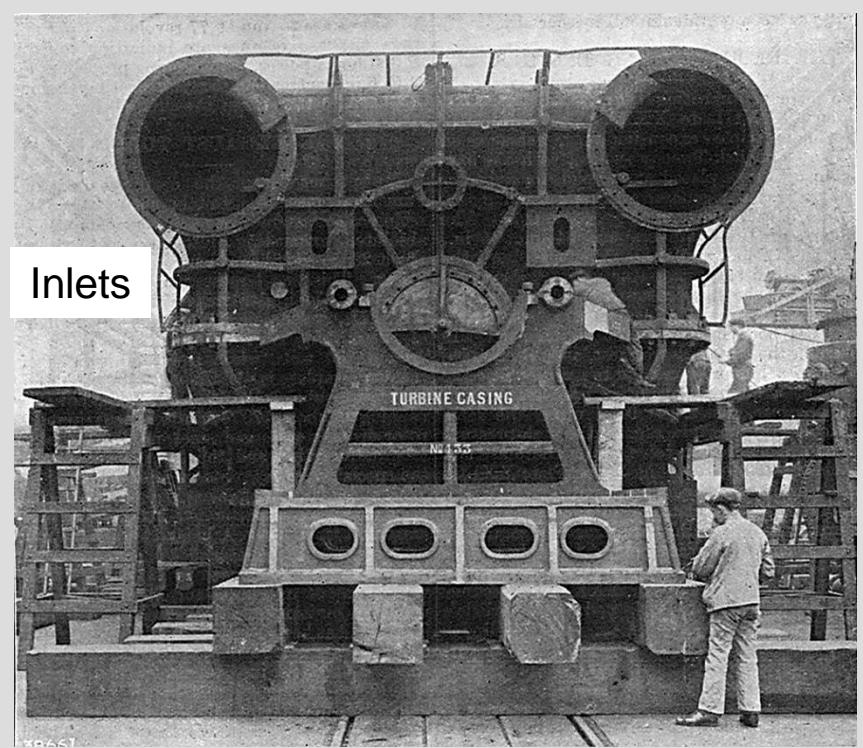
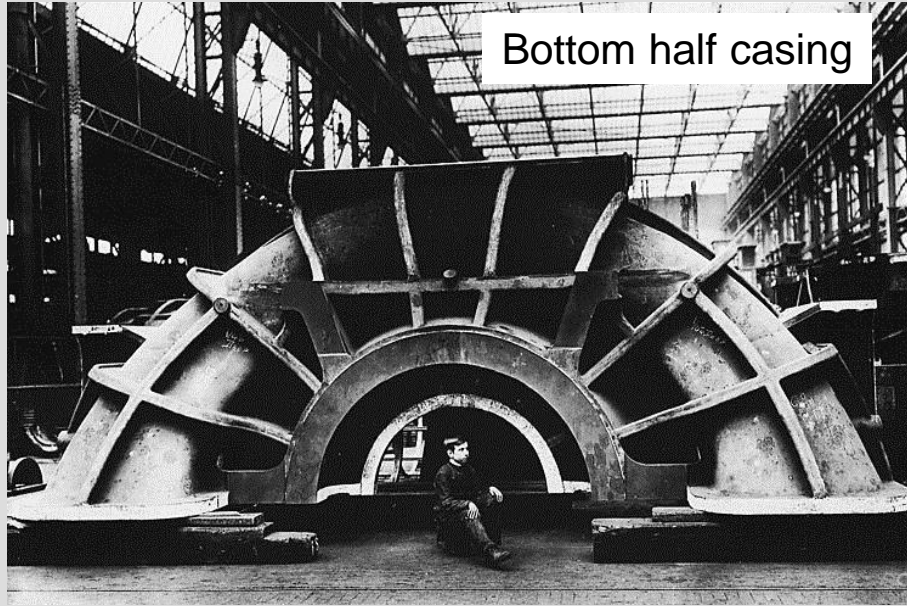
Titanic



Britannic



Britannic



Many more fantastic turbine liners followed

These were the first super liners to use turbines.

In 1909, gearing for ships was developed and applied to giant ships from 1915.

Steam pressures and temperatures increased.

Turbines became more efficient, powerful and compact.

The most powerful Parsons marine turbines produced 157,000 shp per ship and were fitted in RMS Queen Mary and Queen Elizabeth in the 1930s.

The engines of Queen Mary can still be seen today in Long Beach, California.

The heritage of
Turbinia



Thank you for your attention!