PART II.
EIGHT PAGES.

New-York Tribune

MISCELLANY
AND ART.

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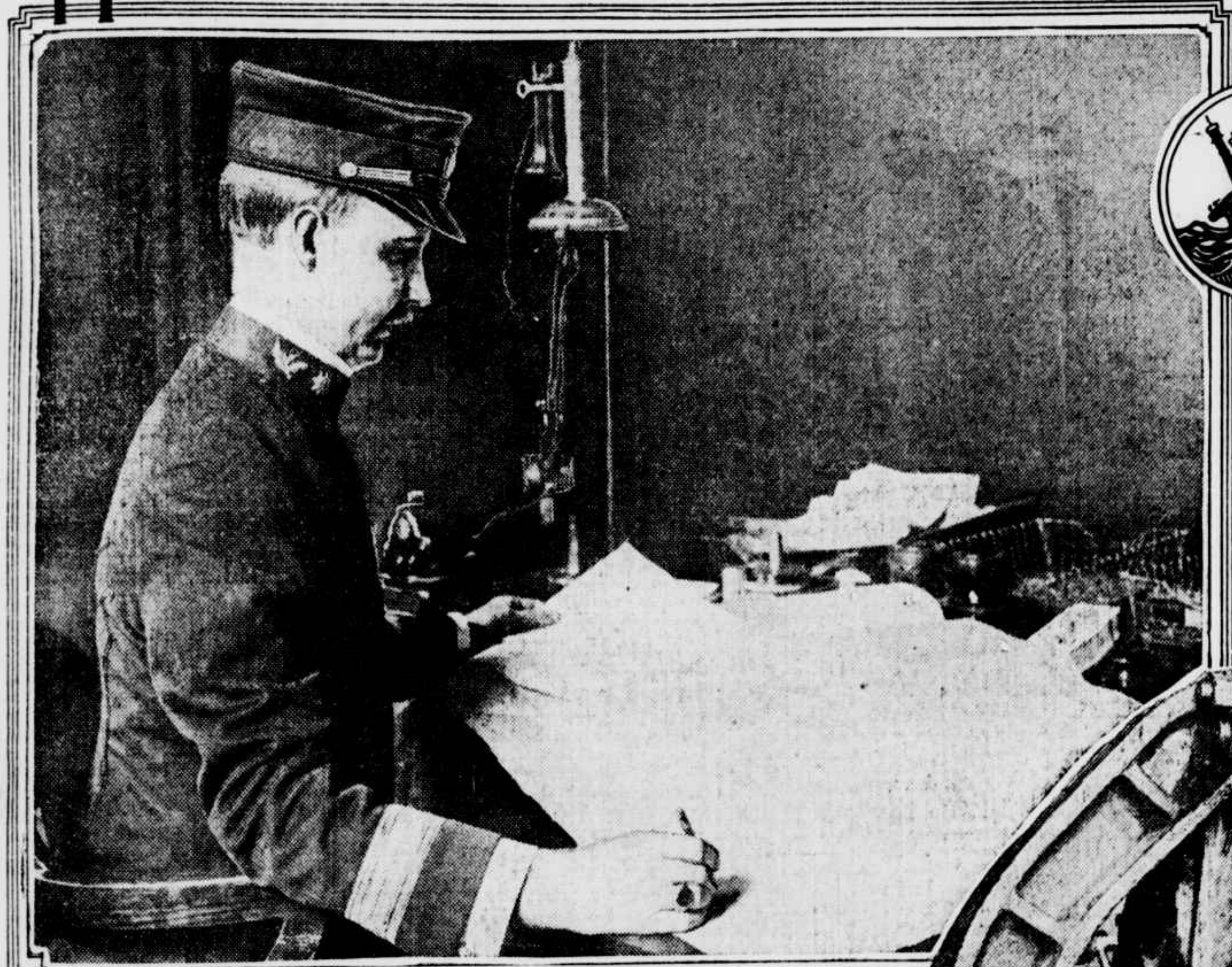
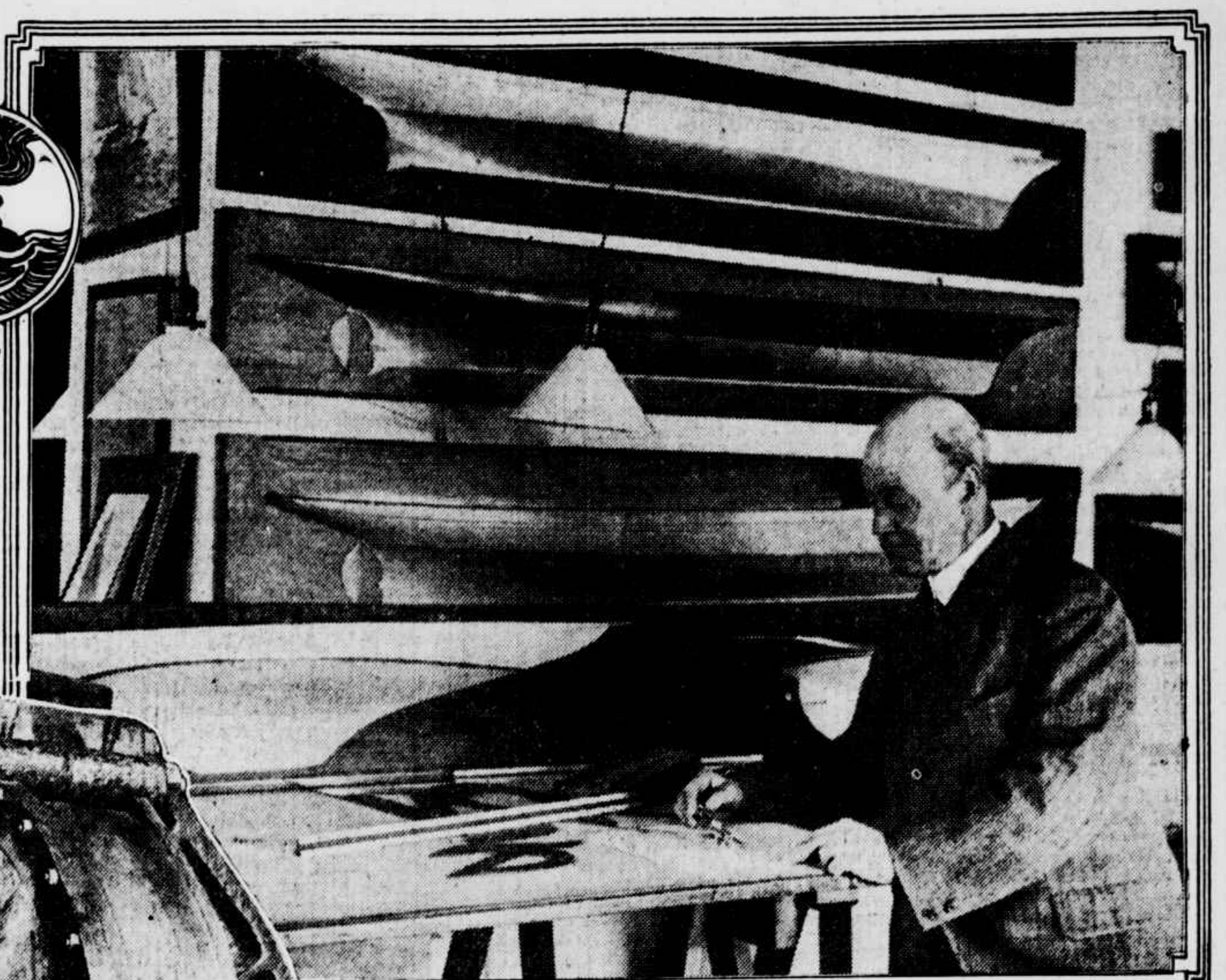
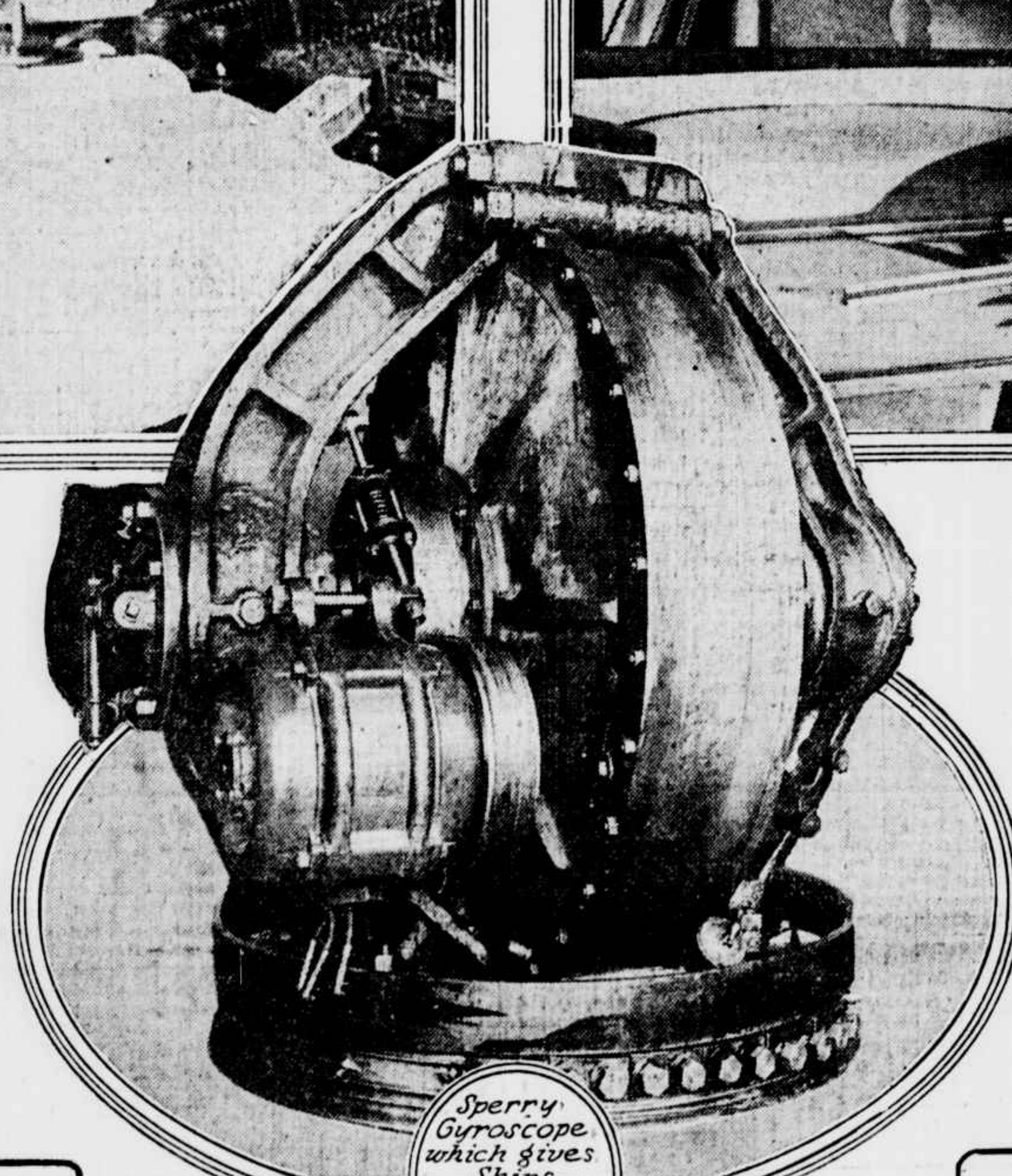
HOW FAR CAN SHIPS ROLL WITH SAFETY?



Naval Constructor Henry Williams at the Brooklyn Navy Yard



William Gardner, Naval Architect, at Work



Sperry Gyroscope which gives Ships Artificial Stability

Father Neptune Has Been Pushing Transatlantic Liners Almost to the Limit of Their Hurricane Resistance in the Last Few Weeks, but Scientific Construction Has Triumphed Over the Rage of Wind and Wave.

Old Devices to Check Rolling, Such as Water Tanks, Bilge Keels and Moving Weights in the Hold, May Be Superseded by the Gyroscopic Stabilizer, Which, It Is Declared, Will Keep a Ship "as Steady as a Church."

FATHER NEPTUNE had a high old time with the transatlantic liners in the first two weeks of the new year. He juggled them as a Jap artist juggles glass balls. He tossed them skyward and let them down almost far enough to scrape the ocean's bottom. He made them pitch fore and aft like fractious broncos. He slapped them and pounded them and made them jump like cats taken with a nightmare concerning bulldogs. He caused their mighty engines to slow down and parts of their steel bodies to quake and groan and scream under the punishment. And chiefly he tipped and rolled them down, down until the highest decks were only a few feet above the maniac sea and everything loose was smashed or carried away and the most hardened travellers tried to remember how to say their prayers.

One great vessel, the President Grant, had to put in to Halifax to replenish her coal bunkers, emptied in the playful struggle with Father Neptune. She was nineteen days in crossing from Hamburg. The Carmania, whose captain reported the worst voyage in forty years' experience, met a full-fledged hurricane in the late afternoon of January 2. She heeled over to starboard and kept heeling until every upright passenger grabbed for a hold or sat down or was hurled against something or somebody. In the bar the tragic spectacle was seen of choicest liquors spilled from broken receptacles. In the galley Monsieur le Chef wept as he saw a cataract of soups and an avalanche of meat dishes flowing to the scuppers.

Outside, the ship's bridge end, usually fifty feet or more above the sea, leaned over for a long, Bernhardtesque osculation of the briny. It looked like a death kiss to the few lay observers who had the disagreeable privilege of witnessing it. The vessel seemed to be lying on her side at an angle of 53 degrees. A torturing time she spent on that unholy, gurgling, slavering buss of the deep ere she recovered consciousness and slowly staggered to the upright path. There was no dinner for the passengers that night, and they did not need any.

A question of interest and importance, presented at first as one of mere curiosity, was suggested by the reports of Father Neptune's pranks. The question is, how far do steamships usually roll and how far over can they roll without capsizing?

IN DEEP WATER.

This innocent query was taken by the writer to a naval architect, who, when he had fully comprehended it, stared reproachfully at the interlocutor and answered in the following vein:

"My boy, you've got hold of something that is beyond your depth. It is beyond the depth of the public. If I told you and the public all about it, maybe you wouldn't know any more afterward than you did before. The subject is so abstruse, complicated and tied up to the higher mathematics that there are only three or four men in this country who can talk intelligently on it. 'Safact. Have a cigarette and ask something easy."

"Isn't it a fairly simple and worth while question?" demanded the writer. "Isn't a common layman, who takes a chance as a passenger, entitled to know the answer?"

"If you put it that way," said the naval architect with sudden kindness, "I'll try to enlighten you. I simply wanted to warn you that, like the fellow in the Norse fable who tried to lift the cat and found she was hitched to the earth, you had hold of a large subject."

After obtaining a quantity of fairly understandable data, and declining with thanks a lot of mathematical material which looked like a cross between a Chinese laundry ticket and a Greek ode, the writer went to another naval architect and stumbled upon an astonishing fact.

"Since the safety of ships at sea," propounded the interviewer, "depends on stability—apart from fire, collision and accident—can you give me a table of the standards of stability in use?"

"No."

"Well, if you have the official figures of a ship's construction, you can calculate the stability?"

"We have no official figures. Those figures are known only to the builders and owners."

"Do you mean to say that while boilers and engines and lifesaving equipment and other features of a steamship are subject to governmental regulation and inspection, there is no official cognizance of the elemental factor of stability?"

"Correct," said the architect, and he hastened to extenuate. "You must remember that when a builder or a steamship line has produced a fast, efficient craft they don't want to give away the secret of her construction to a rival. It's a business secret, involving a reward to the successful builder to which he is entitled."

"And where does the public come in?"

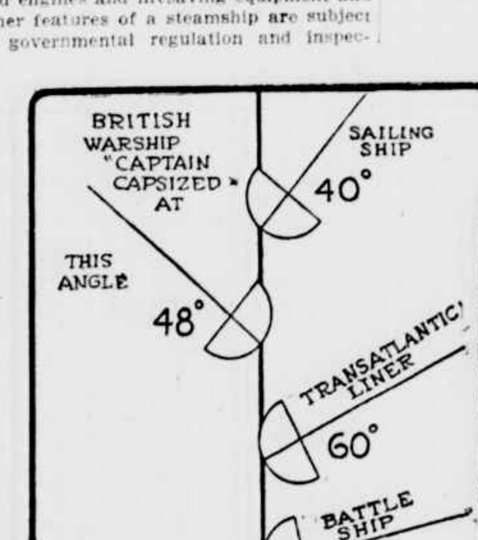
It does not matter much what the architect answered. He may have said that the public would get theirs by putting a decent trust in the reputable builders, as heretofore, and remembering that while most ocean casualties are legally classed as acts of God no successful company can afford to overdraw a providential credit.

Be that as it may, stability is a big question mark in the art and theory of navigation. It is a problem by no means solved, after all the labors of science and mariners' experience of thousands of years. It is a dark query put forward in cases of mysterious disappearance, where ships go to sea and are never heard from. By eliminating all other likely causes, as ice, derelicts, ship collision and fire, we are driven to an inescapable surmise. There was the transatlantic liner Naronic, which sailed into the unknown some years ago. Only a lifeboat was picked up, and that told no tale. Ask the sea sharps what became of her. They wag their gray heads and reply:

"She was crank." . . .

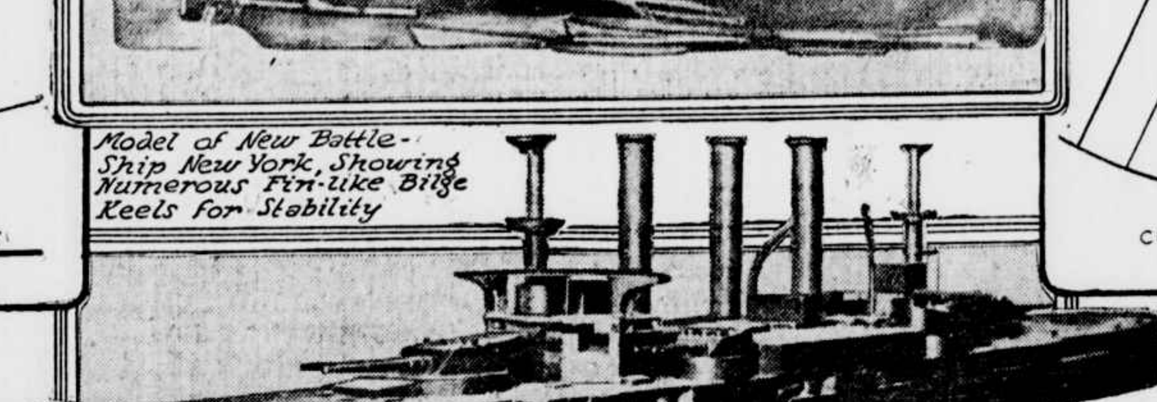
That is, she was unstable, and somewhere on the broad Atlantic, whether under stress of much or little weather, she capsized and went to join the ghostly fleet that rests on the ooze of ocean's bottom.

The testimony in such cases is generally negative, and necessarily so. But when a ship is known by her behavior to be unstable and she disappears and the other likely causes are fairly eliminated, it is reasonable to suppose that she capsized. The roll of vessels of all kinds fitting this category is not short.

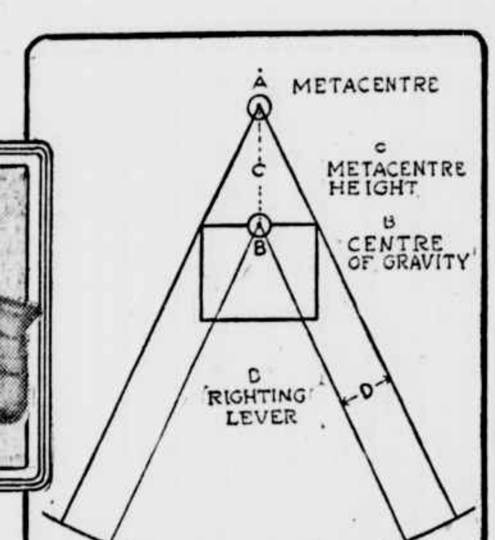


Ships of Various Types can roll to these extreme angles without capsizing

Model of New Battle-Ship New York, Showing Numerous Fin-like Bilge Keels for Stability



Model of Upper Part of Battle-Ship



This Diagram shows how Stability of ships is Figured

Apart from the extreme eventuality of destruction, the stability of ships is a vital factor in speed, coal consumption, passengers' comfort and, in case of war vessels, effectiveness to hurt an enemy. A ship that could cross the Atlantic without rolling would break all records for speed and fuel economy. She would never have to slow down or lay to in a storm. Her performance would discourage the promoters of air craft as a means of intercontinental travel. And her passengers, standing on decks as level as the floors of an office building, would speak of mal de mer as a far-off historical ailment. This is not an idle dream of the future. The gyroscope has realized it in actual experiment. But it will be some time before the gyroscope will be commonly used to insure what may be called an artificial stability, and meanwhile we must struggle along with old established conditions and their modifications.

Before the era of modern steamships, said William Gardner, a naval architect who has an office at No. 1 Broadway, stability was not gained by scientific calculation. Shipbuilders had a cut and try method. Sail carrying power determined the stability of a vessel, and if one ship could not carry enough sail the next ship was made a little wider or otherwise different. It was all empirical work, experience mixed with a few handfuls of tradition. Up to 1880 most iron steamships carried sails and were built on the try-out plan. Some time before this the White Star Line discovered that sails did not help a steamship to progress, but simply heeled her over. So the sails were gradually eliminated. In 1870 the English man-o' war Captain, an armored turret ship, was capsized and lost at sea. It was known that she was unstable. Ten years later two merchant steamers capsized right after launching. One of these was the Daphne, which turned turtle in the River Clyde. The double catastrophe brought home the fact that something was wrong with the shipbuilder's art and that hit-or-miss methods would no longer serve.

The naval architects of several countries, especially England and France, took up the problem of stability, both in a theoretical and an empirical manner. Some of the greatest mathematicians, such as Sir William White, of England, and Marcberrier, Fontine and Daymard, of France, worked out the theoretical side of the problem and laid down certain laws which are valid to-day. The naval experts of both countries also made contributions of value. It was discovered, or rediscovered, that the stability or safety of a ship was determined by the height of the "metacentre" above the centre of gravity.

If a ship had the shape of an orange, the metacentre would be exactly in the middle; if the orange were cut in two, the metacentre would be in the centre of each cut surface. Hollow out a half orange and set the peel afloat. It is evident that the lower the centre of gravity below the metacentre point the greater the stability of the orange peel ship. The same principle applies to the greatest leviathans of the deep.

Sir William White used to illustrate with a baby's cradle set on rockers, in which baby was quite safe despite all rocking if its centre of gravity was well below the metacentre, otherwise, "down would come cradle, baby and all." The precise definition of metacentre is the point where a vertical line through a ship's centre of buoyancy in equilibrium intersects a vertical line drawn through the new centre of buoyancy when the ship is slightly listed on one side or the other. It was thought by the early investigators that a vessel would be perfectly safe if she had a metacentric height (the distance of the metacentre above the centre of gravity) of 8 inches and a righting lever of 8 inches when inclined at an angle of 45 degrees. The righting lever is the distance between parallel lines passing through the centre of gravity and the centre of buoyancy when the ship is heeled over.

The factor of safety in metacentric height has been increased in later years, as the following table shows: Battleships and cruisers have a metacentric height of 3½ to 5 feet; small warcraft, 1 to 2 feet; ocean liners, 1½ to 2 feet; cargo steamships, 1 to 2 feet; sailing ships, 2 to 6 feet. It is claimed that recently-built Atlantic liners have a metacentric height exceeding 2 feet and a righting lever of not less than 12 inches.

The new art of shipbuilding is to make theoretical calculations and then check them up experimentally, if possible, on an old ship and afterward upon the new vessel. So-called inclining experiments are made by moving weights, pig iron on deck and water in the holds, to determine the ship's centre of gravity after launching. Sometimes these experiments are made after loading a cargo. At Washington our Navy Department has a tank in which models of battleships are tried out for stability and other features and where the actions of waves are studied. Between theory and practice the results obtained are now pretty accurate. For example, there was a yacht built for King Edward by Mr. Luke, who designed the Mauretania and the Lusitania. Some naval officers started to make certain changes in the yacht. The architect said that such changes would make the craft unstable. This proved to be the case, for the remodelled yacht tipped over on her side in the dock. It was necessary to rebuild her, with due regard to the designer's admonitions.

It should be noted that the stability of large vessels refers almost exclusively to the lateral motion of rolling. The fore and aft pitching of a large ship is negligible, being about 2 per cent of the sidewise motion.

A ship may be built with sufficient stability and yet may be imperilled by improper navigation or bad loading of cargo. It is important that cargo should be distributed with a fair evenness, neither the light weights on the bottom and the heavy on top, nor vice versa. If a lot of heavy machinery is put above a cargo of cotton, for example, the centre of gravity may be raised above a safe point. The height of a cargo does not matter, merely its weight distribution. A provision against overloading is made by the load line, indicated on the outside of a ship by a round circle with a cross. The responsibility for the proper loading of a ship is usually left with the port captain or dock superintendent. These officials are not always up to their jobs, either through lack of knowledge or otherwise.

Many accidents are due to bad loading, and it is said that almost every case of a ship being lost can be attributed to the same cause. A badly loaded ship behaves ill at sea. Her cargo is likely to shift and become damaged, not to mention danger and discomfort to passengers. Mr. Gardner recalled a case where he told the captain of a tramp steamer leaving England for Brazil that his boat had the quality of "negative stability" because of bad loading. The strong minded captain would not heed the suggestion. He and his boat went to sea and were never heard from again.

Some of the blame for improper loading may be put directly on "commercialism." A light cargo is stowed away, and then at the last moment a lot of heavy stuff arrives. For the sake of the profit it is accepted, shoved on top of the light material and becomes an element of peril. Denny Brothers, a firm of Scottish shipbuilders, are credited with a precautionary system regarding loading which should be generally followed. For each ship constructed by them they furnish to the captain a complete chart on the handling of water ballast in rolling and the proper method of distributing cargo in that particular vessel. There is no dangerous guesswork where such a chart is provided and adhered to.

STABILITY AND BEAM.

The landsman wonders at the narrowness of the transatlantic liner compared to her length. She is so narrow and so high above the water that he thinks she may be unstable. And if he sees a vessel rolling heavily, especially if he is a passenger, it seems to him a dangerous condition. These notions, of course, are superficial and incorrect. A wide-beamed ship may be unstable, while a narrow-beamed vessel may be absolutely stable. It depends on the metacentric height, as described above. Nor does a certain amount of rolling indicate instability. A ship may be so constructed or loaded that she is unstable when in a vertical position and only finds her equilibrium when rolling 15 degrees from side to side. Having reached the natural limit of her inclination on either side, she strongly resists the forces of wave and wind that would send her further over. She swings like a pendulum in an arc of 30 degrees or more and is quite safe in doing so.

The stability of a vessel heeling over may increase up to a certain point and then gradually or suddenly diminish to zero, which means capsizing. A flat-bottomed rowboat is stable until it reaches a point of inclination, where it suddenly flops over; a round-bottomed craft rolls more and loses equilibrium more gradually. The English warship, Captain, referred to above as having capsized, was safe at small angles of inclination, but her stability rapidly declined at 17 degrees and vanished around 48 degrees. On the other hand, the Monarch, of similar type, could withstand more than 50 degrees without capsizing. A high freeboard or gunwales allow more inclination with safety.

Racing yachts and other completely decked sailing craft, which have weighted keels, may lay over on their beam ends at an angle of 90 degrees or even more and right themselves. When the gunwales touch water the danger may be not from instability but from the flow of water into the vessel. It is stated that the deck edge should not be awash at an angle less than 20 degrees, although some small centreboard boats take water at 12 or 15 degrees. Full rigged sailing ships usually wet their gunwales at 20 to 25 degrees. An American torpedo boat destroyer which was caught in a storm on the Atlantic about a year ago was said to have heeled over so that her deck was at right angles with the water, and she came into port as if nothing had happened. Naval Constructor Stocker, who is supervising the building of war craft at the Brooklyn navy yard, informed the writer that Uncle Sam's new battleships could be safely tipped from 80 to 90 degrees. The average transatlantic liner will stand for a slant of 60 degrees and recover her position. It is

Continued on seventh page.