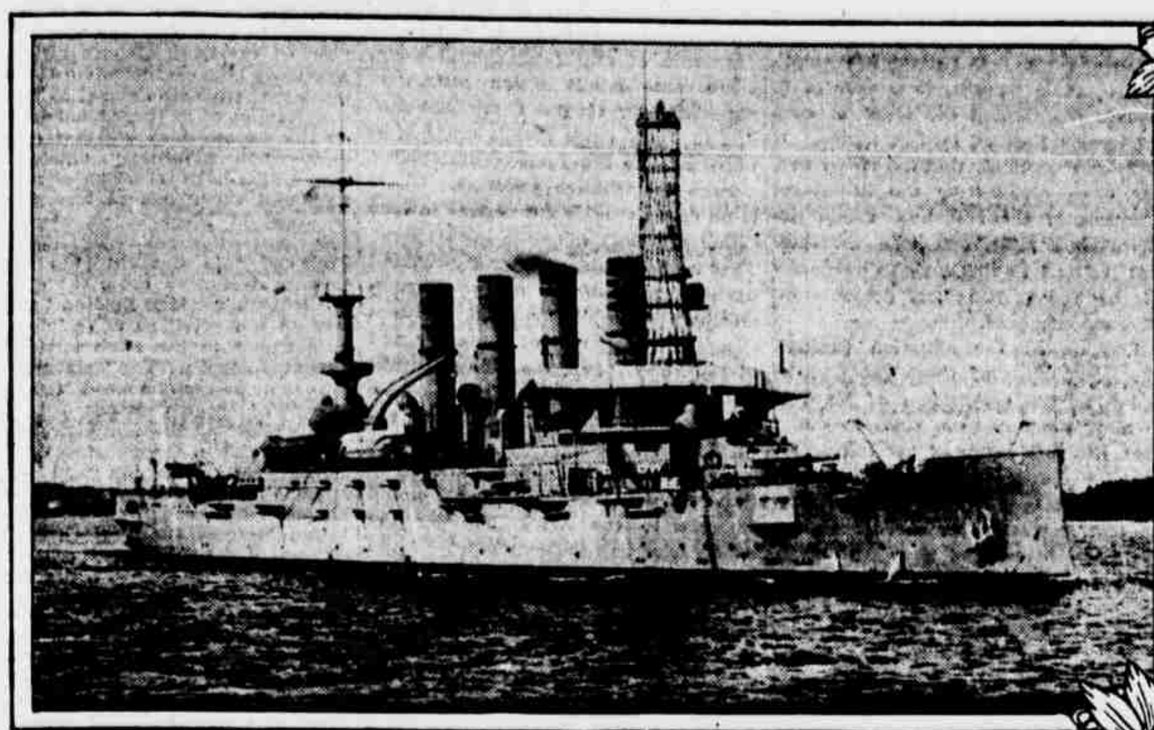
SECTION 5
TWELVE PAGES
NEW YORK, SUNDAY,
MAY 6, 1917.

The Sun.

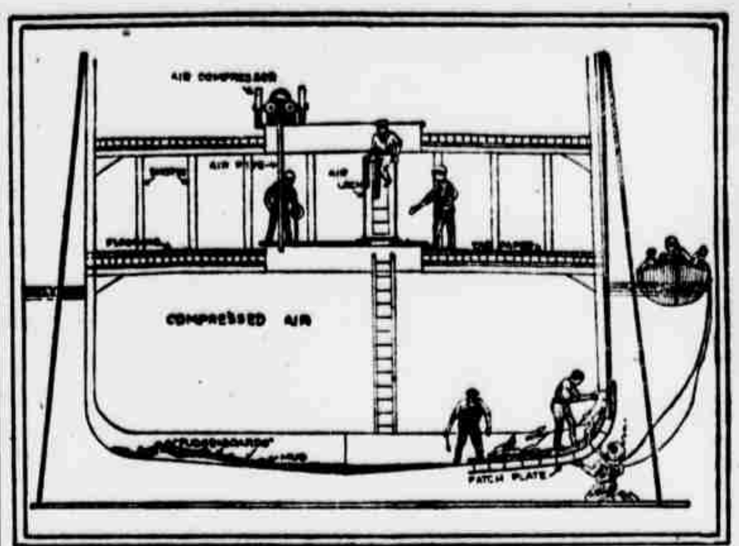
SPECIAL FEATURE
SUPPLEMENT

AIR NEWEST DEFENCE OF DREADNOUGHTS

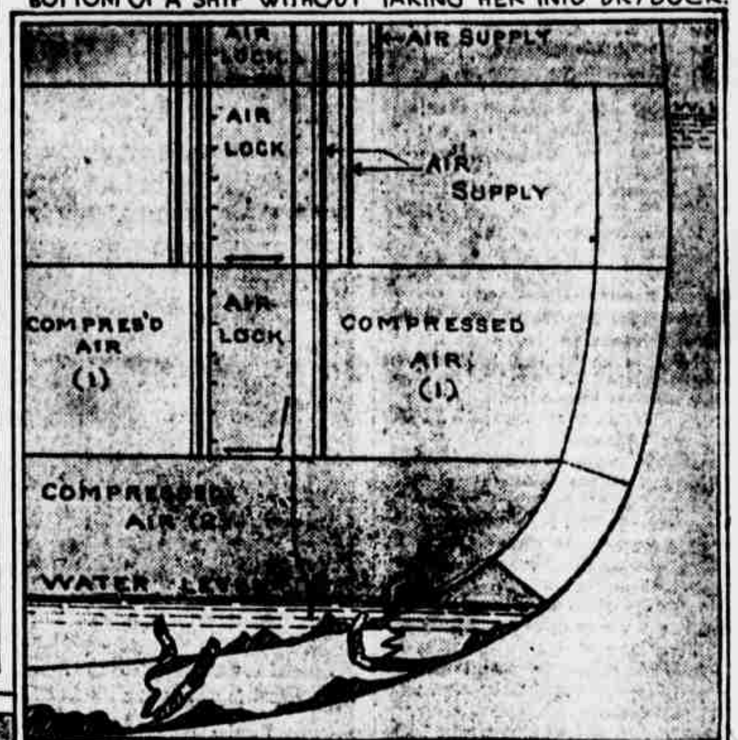


THE U.S.S. NORTH CAROLINA, THE FIRST SHIP TO BE EQUIPPED EXPERIMENTALLY WITH THE SELF-SALVING SYSTEM

THE NUMERALS WITHIN CIRCLES INDICATE THE COMPARTMENTS CHARGED WITH AIR AND THE PRESSURE IN POUNDS PER SQUARE INCH. THE HEAVIEST PRESSURE IS IN CONTACT WITH THE WATER IN THE DAMAGED COMPARTMENTS AND IS PROGRESSIVELY REDUCED TOWARD THE REMOTER SUBDIVISIONS.



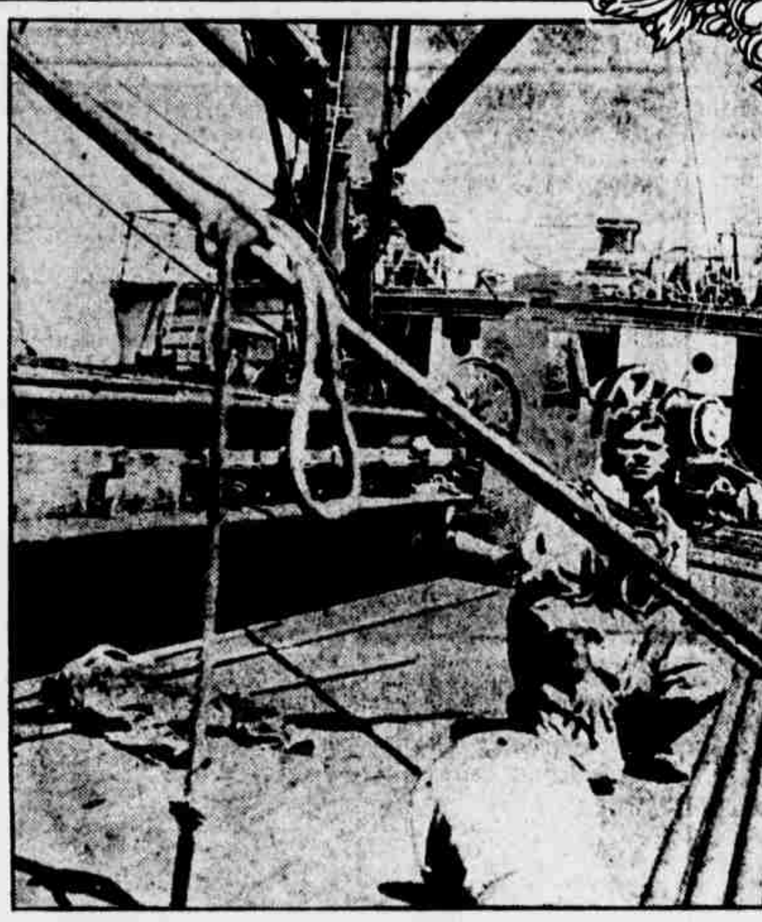
SHOWING HOW IT IS POSSIBLE TO REPAIR THE DAMAGED BOTTOM OF A SHIP WITHOUT TAKING HER INTO DRYDOCK.



DETAILS OF THE SELF-SALVING SYSTEM, AREAS NOS. 1 and 2 SHOW ZONES OF DIFFERENT AIR PRESSURE, NO 2 BEING THE HIGHER ONE

Latest American Battleships Equipped With System of Protection Against Torpedoes Which Is Expected to Make Them Nearly Unsinkable by U-Boat Attacks—The Device Already Put to Practical Test in Saving Wrecked Steamships

By ROBERT G. SKERRETT.



WILLIAM WALLACE WOTHERSPOON ON THE JOB

THE sinking of 1,600,000 tons of shipping in the course of two months is evidence of the potency of the submarine. True, a large part of this tonnage has been sent to the bottom by gunfire and by bombs placed aboard defenseless merchantmen, but unquestionably the lion's share of this destructive toll has been due to sudden and unexpected torpedo assaults directed by U-boats that have thus made their presence first known.

From these achievements it is plain that the battle craft of Germany's enemies have every reason to be wary, and that it is necessary for us to give serious heed to the peril that will confront the ships of our fighting fleet when they take over the work of real war which is bound to be theirs in the near future. It is not to be denied that Great Britain has deemed it wise heretofore to be doubly careful how she sent her dreadnought squadrons out because of the danger presented by the German submarines. Therefore we are justified in asking, Are the big ships of our main battle line any better able to withstand the torpedo's attack than England's? Just how our men-of-war are circumstanced in this particular is the reason for this article.

No other naval casualty since the beginning of the present war has so stirred the Admiralties of the principal maritime Powers as the sinking of the British dreadnought Audacious on October 27, 1914. The mere loss of that ship was not the thing that startled, for that sacrifice was an incident of conflict such as was to be expected; but the fact that that superb example of the naval architect's cunning could be sent to the bottom by mine or torpedo seemed to sound the knell of other giant battle craft.

Just what actually caused the foundering of the Audacious has never been made public by the British censors and the fact that she was damaged at all was withheld from the people for quite two weeks after she went down. Even then Admiralty officials gave out from time to time that the Audacious had really not been lost, but despite her injuries had been towed into port and was expected soon to be again ready for active service. One of our naval experts after his return from England announced, however, that that dreadnought had disappeared below the waves off the northern coast of Ireland on that fateful 27th of October. The best that could be said of the matter was that the ship sank so slowly that it was possible to save substantially the whole crew.

Why the persistent deception on the part of Great Britain's naval officialdom? Principally because the vulnerability of that supposedly well protected dreadnought meant that three of her great sister ships, newly finished, were alike without a really effective defence below water. How many others were similarly circumstanced, if not worse off, only the Admiralty knew; and the realization added suddenly to the grimness of the odds against which England's main reliance upon the sea had to fight. And what the British naval authorities felt well nigh all responsible officers of other navies felt; because the sinking of the Audacious established beyond question the nature of the modern submarine mine and the automobile torpedo, and the latter, as a corollary, carried with it the real meaning of the submarine.

Wonder was expressed by British officers present at the Jutland battle that certain of the big German vessels were able to make a home port at all. There was no doubt about the ships having suffered severely in that gruelling contest, and it was certain that the British destroyers were able to score with their torpedoes. How, then, did these wounded battle cruisers and dreadnoughts manage to limp home instead of going more or less promptly to the bottom?

The details are not available. Just how the German ships were fortified below water cannot be told, but that they represented a distinct advance in the art of shipbuilding in this essential particular is certain.

Indeed, the man responsible for this relative immunity is no other than Naval Constructor Buerkner, the chief constructor of the German Admiralty. Shortly after the Jutland battle the honorary degree of doctor of engineering was conferred upon him by the famous Imperial Institute of Technology at Charlottenburg in recognition of the work that he had done toward making the heavy ships of Germany's fighting fleet comparatively secure against subaqueous attack. The naval world has not been unaware that the Germans were working secretly along such lines, and while certain technical discussions hinted at progress, still nothing was permitted to leak out that might disclose the exact nature of this defence.

After the loss of the Audacious our own naval experts came to realize that the best of our ships in a structural sense were certainly no better off than that British dreadnought, and it is a matter of general information that the final plans for the Tennessee and the California were held up for months in order that these great craft might be better fortified below water against the submarine mine and the automobile torpedo. Indeed, actual construction was so long delayed that Secretary Daniels felt himself obliged to explain the matter to Congress about a year ago. Mr. Daniels said:

"The experience during the first months of the European war, when a number of vessels of war were sunk by torpedo attack, impressed upon the Department the necessity of improving the methods of defence against underwater attack for capital ships. For some months before the authoriza- of battleships 43 and 44 [Tennessee and California] an experimental investigation in this connection had been in progress and this had already developed the great desirability of improving this particular feature.

"Upon the urgent recommendation of the chief constructor it was determined to hold back the designs in order to introduce such improvements as the experiments might indicate. By July, 1915, the experiments had shown the possibility of very great improvement and indicated the general features of the construction to be desired."

It would not be patriotic to describe these structural features, but in a general way the primary line of defence may fairly be said to be common property both here and abroad, and consists of an arrangement of bulkheads and relatively small subdivisions or compartments which are interposed between the outer skin and the vitals of the craft. The purpose of this arrangement of steel cells is to restrict the area of damage and at the same time to furnish pockets in which the intensely hot gases of the torpedo's detonated charge may expand very quickly and thus cool and be deprived of much of their shattering violence.

In other words, the aim was really to better the somewhat kindred protection already provided by the British for the Audacious and her sister ships. The English had undoubtedly effected an improvement at the time the Audacious was built, because it is known now that that dreadnought did not sink until something like thirteen hours after she was struck. That period, however, was not long enough to make it possible to tow her into shallow water, where she might have been beached and afterward salved.

But this expedient of subdivisioning is merely one phase of the problem, and our immediate interest in the matter is that we have at our disposal a system that greatly supplements this form of underwater protection.

Some weeks ago the public heard a good deal about the boiler arrangement for our giant battle cruisers, and a hearing before the Committee on Naval Affairs of the United States Senate brought out some extremely interesting facts. The outstanding fact was that the Department's experts had elected to place half of the boiler power above the water line.

The responsible officers of the bureaus of construction and repair and of steam engineering explained that this was necessary in order to secure a maximum of internal defence against the mine or the torpedo, the plain inference being that the safeguarding subdivisioning interposed bigger and wider compartments between the outer skin and the innermost bulkheads of special steel. In so many words this meant that there was not enough space left within these vessels below water for the engines and all of the boilers, and therefore 50 per cent. of the steam plant had to be located on a deck above the normal stokehold.

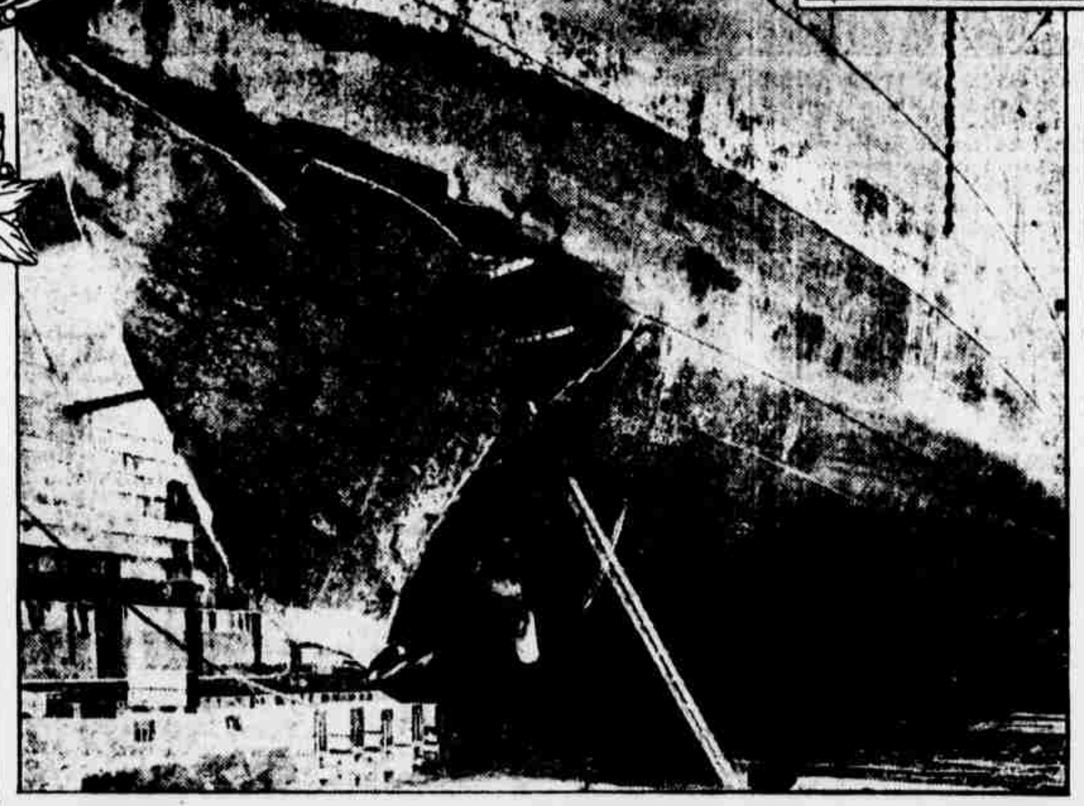
Plainly this system of protective honeycombing is an acknowledged necessity to-day, and our ships yet to be built will be the better off for this cellular defence. But none of our battle craft afloat now is so equipped, their compartmenting or minor subdivisioning being less extensive and, by parity of reasoning, not so effective against underwater attack.

One is naturally prompted to ask, then, are our dreadnoughts afloat as vulnerable as the Audacious? Happily for us the answer is no. And it is to the skill of an American civil engineer that we owe this superiority. The man that has made this possible is widely known because of a number of spectacular achievements in the salving of sunken and damaged ships; and before he engaged in that work he qualified as a "sandhog" in the driving of some of New York's subriver tubes. In fact, what he learned then about the possible uses of compressed air led to his taking up wrecking and then to the inventing of something much akin to an unsinkable ship. He is William Wallace Wotherspoon of the class of 1898 of New York University. When Mr. Wotherspoon was working under the Hudson and standing beneath the apron in front of the advancing shield he learned by personal hazard just how a slight superiority of air pressure sufficed to hold aloft the overlying blanket of mud and to keep the water at bay. Later, when he undertook to raise the steamer Bavarian, sunk in the St. Lawrence, he decided that compressed air would do the trick; and he embarked upon that job knowing that the underwriters had abandoned the liner as a hopeless wreck. He raised her, much to the amazement of well nigh every one.

Later he essayed to save much in the same fashion the cruiser Yankee, and victory would have been his but for an untoward mishap. His failure, however, was not without its measure of success, because he learned then how to make success more nearly sure in the future." Mr. Wotherspoon's next effort was not so much in the direction of devising ways to raise sunken vessels as it was to provide them with self-contained installations that would make their sinking extremely unlikely. The germ of this development was born of an accident.

In July of 1909 the U. S. S. collier Nero struck Brenton's Reef, near Newport. Ordinary salvage operations failed to free her from the grip of the rocks. Then it was that Mr. Wotherspoon proposed using compressed air, and to do this certain of her decks were sealed hermetically and a number of the intervening spaces turned into closed compartments into which air could be pumped. In this way water was expelled and sufficient buoyancy furnished to float her off the reef.

Despite the fact that she had great rents in her bottom plating, through which the green sea showed in wide patches, the compressed air held the water in check and the ship was towed to the New York Navy Yard and docked in December of that year.



COMPRESSED AIR MADE IT POSSIBLE FOR THIS SHIP TO RUN FROM HALIFAX TO NEW YORK DESPITE A BADLY DAMAGED BOW AND BOTTOM.

The principle involved was virtually that of turning the collier into a great diving bell, or, to be more exact, a number of them, because each air filled chamber became in effect a caisson. The same conditions are virtually duplicated when an empty tumbler is plunged into the water bottom upward. The water can enter just so far and then the confined, compressed air has resistance enough to check further admission.

Of course, in the case of the collier Nero it was necessary to do a good deal of work in the way of sealing the decks and tying them together, and even supporting them by many wooden beams or pillars. This was done because compressed air has an explosive force, and the decks of ships are not ordinarily built to withstand a bursting stress, although they are designed to sustain heavy loads.

Now let us see how this ingenious New Yorker planned to make our battleships self salving craft so that if they were injured below the waterline they could deal promptly with the invading sea and make port under their own power despite damage which, under normal conditions, would probably send them to the bottom. His problem was to make as few structural changes as possible and to avail himself of existing facilities. He could not add materially to the weight of the vessel to instal his system.

As is well known every man-o'-war is subdivided from a point above the waterline down to her keelsons into many hundreds of separate watertight compartments for the very purpose of confining injury should the outer and even the inner bottom be pierced. All of these divisions are connected with an extensive drainage system, and powerful pumps are provided to deal with possible leakage or to fight upon more or less equal terms against the invading sea.

The mere flooding of a compartment, despite the pumps, is not in itself necessarily serious, provided surrounding bulkheads and the overlying deck hold. If they do not the water bursts through and fills other spaces, and may thus progressively destroy a ship's buoyancy, cause her to heel over more and more, and finally to fill and founder.

How does Mr. Wotherspoon make the ordinary decks and bulkheads of a fighting craft strong enough to withstand the bursting stresses set up by the sea entering through the submerged wound? This is the really ingenious feature of his invention, for it avoids recourse to heavier materials upon which the naval constructor has placed his ban.

The inventor subdivides his ship into a series of zones of compressed air, the pressure diminishing as the zone extends further away from the damaged area, and he creates these supporting zones as the emergency arises and just where they are needed to meet the particular requirements of the occasion. The difference of the pressure in adjoining zones is only a few pounds and the interposed decks and bulkheads are quite capable of withstanding it.

For instance, let us imagine that the injury is at a point where the water pressure is thirteen and a half pounds. In order to check further flooding the upper part of the damaged chamber is charged with air at a pressure of fourteen pounds. The overlying deck and the confining bulkheads would not be able to hold up against this force, and to counterbalance this outward stress Mr. Wotherspoon fills the exterior spaces immediately contiguous with air at a pressure of nine pounds. This pressure of nine pounds, with the natural strength of the walls and deck, gives the needful support, and the nine pound zone in its turn is reenforced by an outlying one of compressed air at a pressure of four pounds.

In this fashion the structure of steel is progressively backed up by compressed air so that the ruptured compartment can be charged with air at a pressure high enough to force the intruding water down and out to a point level with the uppermost limits of the hole in the hull plating. This may sound very complicated, but it is not, and this compressed air defence can be brought into service at any point below the water line of the ship a very few moments after the damage is done. Once the injured area is located the application of presure can be accomplished very quickly.

We have mentioned that there is a drainage pipe for every cellular division of a battle craft. There are also ventilating ducts for each of these chambers. Their function is to guard against the accumulation of gases and foul air. This is effected by a double system of piping; one carries fresh air into the compartment and the other provides an outlet for the tainted air. Inasmuch as all of this piping extends down below the waterline, the Government specifications demand that it shall be tested and proved equal to withstanding the water pressure in case of flooding. Therefore, Mr. Wotherspoon found already at hand strong and serviceable passages by which he could lead compressed air into any compartment, and the only additional apparatus required was flexible attachments for effecting connections with sources of air supply. These are short and can be joined to their proper valves very quickly.

Compressed air on a modern fighting ship is what might be called a common commodity. The cold storage compartments are chilled by means of compressed or dense air machines; the magazines are similarly refrigerated in order to keep the powder cool and to prevent deterioration; the torpedoes are charged with compressed air and even expelled by the same medium from the submerged tubes; and compressed air is blown through all of the big guns after they are discharged in order to remove hot gases and any burning bits of the powder bags. Air for a number of these purposes is kept stored under a pressure of 2,250 pounds to the inch in special tanks, and these are immediately available in case of leak, while the air compressors stand ready to maintain a continuous supply.

A supplemental feature of the Wotherspoon system is a series of air locks extending from the uppermost watertight deck down to the lowest of the water-tight spaces; and these locks, by means of suitable traps or doors at the top, bottom and side, make it possible to pass in and out of any interdeck chamber charged with compressed air.

This permanent installation is in principle a duplication of the air locks temporarily provided when raising or refloating a ship by compressed air. These air locks represent substantially the only added weight which Mr. Wotherspoon's invention calls for.

But the curious minded will ask, Why is it necessary to get into any of these compartments?

First, to reach the wounded chamber, and also to have access, for one reason or another, to the outlying compartments so as to interfere as little as possible with the routine of the craft. The object in entering the damaged sub-division, after the admission of air, is to examine the injury and possibly to patch it up and completely drain the space of the water, and in doing this to make it safe for the ship to remain at sea or to enable her to run home to a port where she can be permanently repaired. Offhand this may sound fantastic, and yet in substance it was done in the case of the Royal George, a steamer of 15,000 tons, that went ashore in the St. Lawrence some years ago shortly before ice closed the river to navigation.

Mr. Wotherspoon undertook to refloat her, to repair her, and to get her out of the St. Lawrence before ice interfered. To do this it was necessary that the great holes in the bottom of the vessel should be patched securely without putting the steamer in dry dock. This was accomplished by resorting to subaqueous tunnel boring practice.

With the water in the injured compartments forced down to the upper limits of the holes, "sandhogs" entered the chambers and covered the wounds with boards sealed with mud, starting just above each rupture. Air pressure held the boards in place, and as these were extended downward the water was progressively forced outboard and finally each of the damaged compartments was thus drained. Of course the pressure of the air was maintained above that of the outlying water, and this pressure held the wooden patches firmly in place.

Subsequently metal patches were substituted while the Royal George floated in the river, and these were found to be secure enough when the ship was docked at Halifax to permit her to cross the north Atlantic in midwinter and to reach her home port in England without mishap.

Some time afterward the steamship Uranium went ashore upon the rocks near Halifax. She was pulled off, and like the Royal George, was blown out by compressed air and temporarily boarded up, and then made the trip to New York, where she was placed in dry dock and thoroughly overhauled. In this case plates were not fitted before leaving the Nova Scotia port, and her security in transit hinged entirely upon the continually maintained force of compressed air immediately behind the makeshift patch.

The first of our battle craft to be equipped with this self-salving system was the armored cruiser North Carolina; and so satisfactory were the demonstrations of that installation that all of our dreadnoughts planned subsequently have had this underwater protection put in them. There is every reason to believe that those ships will have far less to fear from the attack of a torpedo or the bursting of a submarine mine than the best of their rivals abroad. In fact, our naval vessels are the only craft so safeguarded, and for that reason may be justly said to be doubly protected against the peril from below water.