

Building the Perfect Ship—How the Model Basin Is Used in Designing Modern Vessels

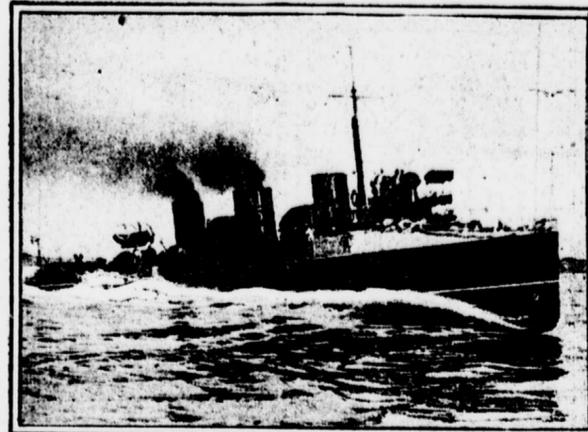
Four years ago the figures of the Mauretania startled the world. To the average mind it did not seem possible that we should see any advance for a good many years to come. However, the engines of the Mauretania had hardly settled down to smooth running before the decision to build the Olympic was announced, and now still bigger ships are planned. So too the Oregon has given way to the Delaware, and the limit of warship size has not yet been reached.

The basis of these undeniable achievements is the preliminary work that is now done in the experimental model basins both in this country and abroad. Each shape of hull, the under water body, has its own form of wave when going at the speed at which it can be best

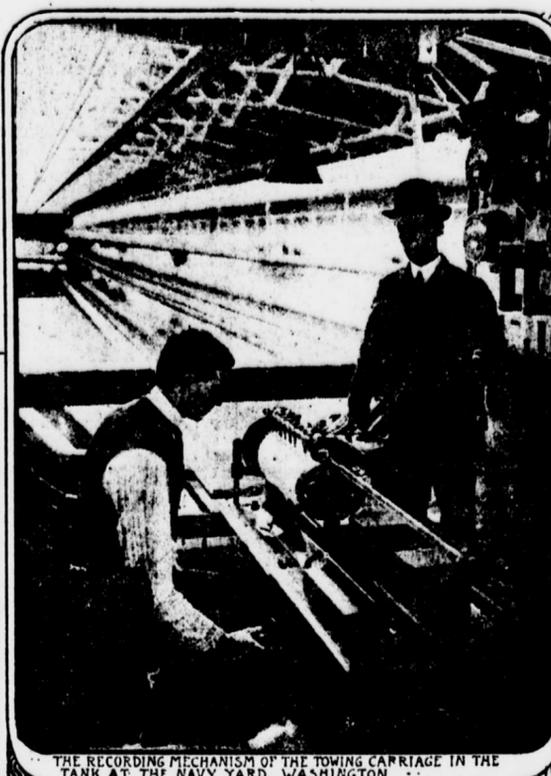
law of comparison." It has taken years to fully evaluate the significance of this law and it still provokes a great deal of investigation, each year adding to our knowledge of its refinements.

Up to the time of Froude's discoveries the naval architect and his brother in the work, the marine engineer, believed that a ship in moving through the water had a double operation to perform, to push aside her own weight of water at the bow and to draw it in again at the stern, and it was commonly believed that this called for far more powerful engines than Froude proved to be necessary. Their idea of the operative cycle of the water's resistance was almost entirely wrong.

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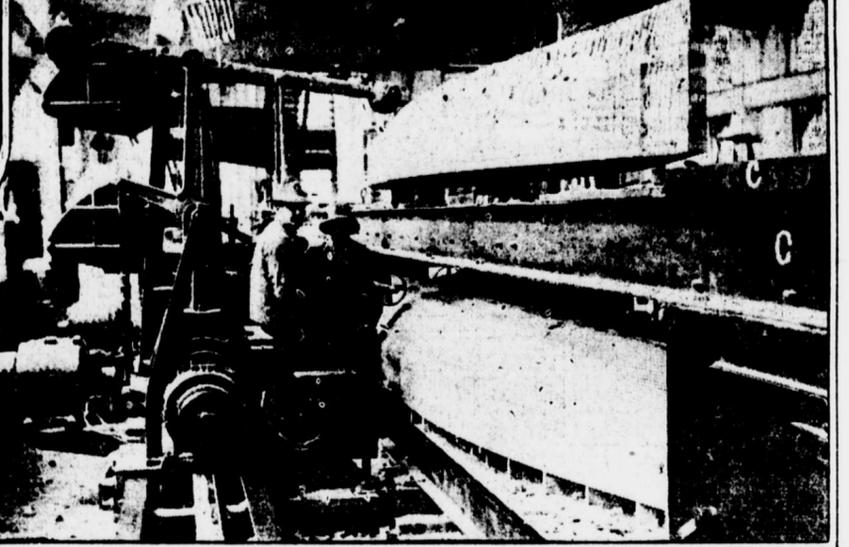
THE PARSONS TURBINE-DRIVEN TURBINE. THE PICTURE SHOWS THE BOAT GOING AT FULL SPEED. THE WAVE TOWED VIRTUALLY CAUSES THE VESSEL TO RUN UP HILL.



THE RECORDING MECHANISM OF THE TOWING CARRIAGE IN THE TANK AT THE NAVY YARD, WASHINGTON.



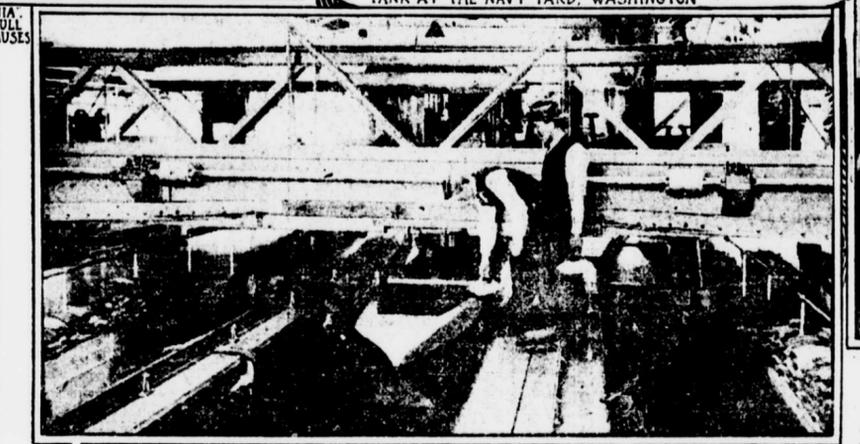
THE FIRST "MAKE-UP" OF THE WOODEN MASS FROM WHICH A MODEL IS CUT.



THE MODEL-CUTTING MACHINE. THE LOWER MODEL IS THE FORMER AND THE CONTACT WHEEL IS SHOWN BETWEEN THE TWO OPERATORS. THE UPPER ARM IS SHOWN CLOSE TO THE SURFACE OF THE PARTLY-CUT "MAKE-UP."

proposed to build a number of new warships of a more or less radical nature. A committee had the plans of these vessels under advisement and were fully aware of the difficulties of the problems before them and knew too the unreliable value of the mathematical data then available. Dr. William Froude was one of the committee. Previous to that time Dr. Froude had pursued a novel line of investigation, he had conducted a series of tests with thin planes variously coated as well as with small models of vessels of different forms. In order to do this work Dr. Froude had carried on his experiments in his garden at Torquay.

The net result of his researches was the discovery that it was necessary to consider the whole problem of ship propulsion from the outside rather than the inside of the vessel. Dr. Froude found the proper engine power to drive a given ship depended mostly upon the shape of the vessel, the smoothness of the surfaces in contact with the water and also upon the character of the waves generated by the craft after reaching a certain speed. Classifying his information, Dr. Froude was able to show how these figures could be applied to full sized vessels. Dr. Froude's associates on the committee were not disposed to accept his conclusions without question. Therefore the doctor induced the Admiralty to let him make a full sized test by towing an old ship of the service, recording by means of a machine designed for the purpose the amount of "pull" on the tow rope exerted in drawing the passive vessel at various speeds, this pull representing, in turn, true resistance which the ship's engines would have to overcome in driving the vessel under their own power. The Admiralty chose the old Greyhound for this test and the Active was detailed to do the towing. Prior to this, however, Dr. Froude had towed a small model of the Greyhound and from that model constructed a diagram or curve indicating the actual power required to overcome the external resistance to motion presented by the water at different speeds. The towing experiments of the actual ship resulted in data so closely following Dr. Froude's predictions that even the most sceptical had to surrender. Froude's researches made it plain that a small model of a full sized ship actually reproduced the individual peculiarities of a big vessel of the same form moving through the water. The foundation of all this work became commonly known as "Froude's



LOADING THE MODEL WITH BAGS OF SHOT IN THE BALANCING TANK IN ORDER TO GIVE IT THE EXACT DISPLACEMENT REQUIRED.

driven. When the vessel is speeded above this natural limit peculiar to its own shape then the engines are called upon to develop a dissipative measure of power for every added fraction of a knot. When the ship is being driven at its highest economical speed the wave formation instead of constituting total resistance, as believed before Froude's day, really helps to push the vessel forward as it closes in under the stern.

The balance between the actual resistance at the bow of the ship and the helpful reaction at the stern is principally impaired by the diagonal waves that spread away from the ship like arrowheads and do not again exert their force against the hull. When the ship is forced to run high a speed she is partly running up hill, as we see many of the fast motorboats of to-day, and the stern wave that would help to neutralize the bow wave is too far behind to exert any helpful forward thrust. The engines must supply the power thus lost. It is a notable fact that our big ships today when running at full speed make far less disturbance than their smaller, earlier prototypes.

Dr. Froude had not worked long at his experiments before he discovered that his "law of comparison" did not cover the whole problem. This law was applicable to the resistance encountered in overcoming the opposition of the waves and the eddies which the ship form generated, but it did not apply to the resistance due to the length and the

nature of the surface of the under water body or "skin," as it is commonly called. His task was to determine how the proper values for each of these factors of opposition to the movement of the ship could be determined.

The way he solved this question was characteristic. He took very thin wooden plates, just as long as his little model, and painted or coated them so that they would be like the surface of the model or models. By towing these separately at the desired speeds and measuring their resistance he was able to find out the amount of the force of "skin friction" resistance. This figure was then subtracted from the total resistance recorded for the model of the boat and the remainder told how much of the water's opposition was due to the actual shape of the vessel. With the same length of hull and the same area of surface in contact with the water the "skin resistance" remained constant at the various speeds and the fact became that of changing the form of the boat otherwise in order to meet the conditions prescribed.

The net result of all this research, begun in 1871 and carried on to-day, is that we now know what are the outside forces that limit the economical speed of any form of ship. With this knowledge and a knowledge of the efficiency of modern engines and the internal resistance to be overcome in transmitting the horse-power from engine to propeller the modern designer is able to tell what

can be done with a prescribed shape of ship or with a given horse-power what form of hull must be adopted to insure the best results for the work demanded.

In this country we have three model towing basins, one at Cornell University, one at the navy yard, Washington, D. C., and one at the University of Michigan, but the last two are the ones from which we hear most. The tank at the navy yard in Washington deals more particularly with practical problems, both for the United States navy and for merchant ships to be built on the Atlantic coast. The tank at Ann Arbor, Mich., is more particularly engaged in research work of an extremely valuable character, adding all the while to our technical literature along this line.

If we give some idea of how the models are made and tried at Washington we shall have a pretty accurate notion of how this kind of experimenting is done in principle at the various experimental basins both here and abroad.

At most of the basins the models are made of paraffin, not only because it is easy to work and is waterproof but because the model can be melted down after it has served its purpose and the material economically used in the making of another. The climate at Washington, however, puts the use of paraffin out of the question. Therefore it is the custom at Washington to make the models of wood, and while the cost is greater the figures are apt to be more

accurate because of the rigidity of the structure.

At the Washington experimental basin the models for all types of vessels are made of a uniform length of 20 feet. The length of the model in its ratio to the length of the full sized ship gives a certain factor and this factor or figure called gives a constant which in turn is used to multiply the values obtained by towing the model. The nearer the model can approach the size of the vessel the less will be the error due to the reading of decimals. This can be more easily understood if we take the numbers 2 and 3, for instance. The cube of 2 is 8 and the cube of 3, only one unit greater than 2, is 27, and any one that wants to try it can easily figure out what would happen if the model were 15 feet instead of 20 feet long.

The first work of course is the general planning of the lines or shape of the vessel under consideration. These lines are modelled as nearly as possible in accord with some other vessel of approximate character which has been built and the performance of which is known and tabulated, both for its full size and for its model. The lines of the new craft are altered to suit the new conditions as nearly as judgment and recorded information can indicate as wisest. The plans of these lines are spread upon a large glass covered table and by means of a pantograph are transferred to the model scale upon stout pieces of yellow paper. These lines represent cross sections like the slices of a loaf of bread, cut at various points across the proposed vessel's body. From these paper patterns thin wooden sections are cut as shown in the photograph and over these thin wooden strips of sheathing are laid, forming a light wooden duplicate of the external shape of the ship. This is purposely slightly larger than the external dimensions of the model. This is what is known as the "former." In the wood working shop the carpenters have made a rough blocked mass of successive layers of white pine planking bound together by waterproof glue.

This makeup is next put in the model cutting machine—a two storied affair—over the former which we have just described. The operator guides one arm with a wheel at its end over the body of the former and by a reciprocating connection another arm having at its end a rapidly revolving cutter duplicates the movement and digs away into the makeup on the platform above. In this way the model is roughly formed. Next the interior is carefully measured to see that the former are true and then placed in a special frame containing numerous pencils that trace the water lines from keel up to a point representing several feet above the proposed draught. This being done the model is taken to the experimental tank and placed in the balancing basin, where it is loaded with bags of shot until

the proper draught is reached. These preparations being completed the model is now ready to be attached to the towing platform. This platform reaches from side to side of the model basin and has a total run from end to end of 300 feet. This towing platform is driven by four motors—one at each corner—so that the movement is uniform and without jar. The towing platform or carriage can be run at a speed of twenty knots an hour, but the scale upon which the models are is such that it is not necessary to run the carriage at a speed of more than five or six knots for the equivalent speeds of the full sized vessels going at their intended maximum.

On the towing carriage are recording instruments which mark the speed of the carriage—incidentally that of the model—as well as the number of pounds of pull or drag exerted by the model being towed. The model is run down the tank a number of times and from the resultant readings of the recording instrument a diagram or curve is constructed which shows the amount of power required to tow the model at each change of speed. If this curve indicates an undesirable pull at the desired speed, then the model must be modified and again towed to observe the results. This goes on until the readings are satisfactory. At the same time thin planes similar to those employed by Dr. Froude are towed to determine the amount of skin friction due to the underbody surface of the model quite apart from its shape. These planes are just as long as the model and have an identical area of wetted surface. In this way at an outlay of only a few hundred dollars the probable performance of a full sized ship can be predicted with remarkable precision.

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Champ Clark's Early Law Practice

Reminiscences of David A. Ball, Former Law Partner of the Speaker

LOUISIANA, Mo., Aug. 5.—For two hours and a half he poured into the ears of the jury and of the packed audience an uninterrupted stream of marvellous oratory. It was one of the most powerful and convincing efforts ever heard in a Missouri court room. And owing to that feat of wisdom, flow of soul or what ever you want to call it, he never touched the case side, edge or bottom.

David A. Ball was speaking about his old friend and law partner, Champ Clark, Speaker of the House of Representatives. When Ball was a candidate for the Democratic nomination for Governor in 1908 Mr. Clark said:

"Thirty-five years ago Dave Ball took me in when I was penniless and divided his crust with me. I was slim picking, God knows, but seen law business as he had succeeded with me. Now he asks my aid and he will get it in Scriptural measure, heaped up, pressed down and running over."

This legal partnership to which Mr. Clark referred was the subject upon which Mr. Ball was speaking.

It was on a noted murder case, involving several prominent families of Hannibal, he said "Clark and a number of well known attorneys were on the side of the State. To Clark was given the honor of making the close for the prosecution and of cross-examining the defendant. The case was tried at Bowling Green.

"In his examination in chief the de-

pendant had said that he was with the famous Gen. Morgan's cavalry during the civil war. At this a cold glitter came into Clark's eyes. Not a soul in the court room remotely suspected that Clark himself had ever ridden with the noted partisan of the South and that all of Morgan's operations were like a well studied book to him. When Clark began quizzing the defendant about Morgan you could see the sparks fly.

"He inquired about the age, size and general appearance and the manners of Morgan; how before he discovered the sort of weapons they carried, the tactics they followed, their way of fighting, the passwords and counter-words, the details of battles and frays, the thousand and one things that a man who had been with Morgan could not help but know but about which the defendant, under Clark's insidious cross-examination, went down helplessly. The defendant could not suspect until confronted by the ordeal that he would be handled by a man who knew all these things by actual experience. As a boy of 11 or 12 Clark had been with Morgan in some of his campaigns.

"When Clark had finished speaking that jury had a profound admiration for Morgan's men, and it did not believe the defendant had been one of them.

"While it was not a controlling issue in the case Clark played it up big and made it appear like one. He was a past master on such things. The small technicalities

of the law did not appeal to him. He always hunted around until he dug up something vivid and full of human interest, and then used it with irresistible effect.

"The case referred to was the only one of note so far as I recall now where Clark and I were on opposing sides. He was associate counsel for the State, while I assisted in the defence.

"All who know the Speaker of the House will have noted as a marked characteristic his homely backwoods philosophy, which strongly suggests that of Lincoln. His convincing illustrations spring from the primitive, the people of way back yonder. He studied them with a great deal more enthusiasm than he did his law books, and it was at close range.

"As fine an effort as I ever heard Clark make was down in Lincoln county before a blacksmith who was a justice of the peace. It was a bitter cold day; we had driven twenty miles, and all the warmth we received at the end of the journey was the ritual glow of the charcoal on the blacksmith's forge. The brawny justice sat on one side and listened with becoming gravity to our exposition of the law. It was a preliminary examination, the defendant being charged with murder. When the evidence and arguments were concluded the smith said:

"'Fur the man loose, that's all, gentlemen. Now I must get back to work.'"

"I don't suppose it ever occurred to the smith that day was the future Speaker of the House, but it had to Clark, who from my earliest acquaintance with him declared he was going to Congress one of these days. He treated that as something absolutely settled, even in the happy-go-lucky times when he was wondering where the money would come from to square up with his landlady.

"Clark came to Pike county from the clover fields of Kansas in 1875, when he

was 25 years old. He said out there his most exciting diversion was ploughing corn and pitching hay, with now and then writing an "extemporaneous" speech for some local spellbinder. He left Kansas, he said, to get rid of the hot winds and grasshoppers.

"The principalship of the Louisiana High School was Mr. Clark's first employment here. He was a good teacher. I've read where he taught in district schools and heked knowledge into his pupils. But here he adopted an entirely different method. When anything went wrong he'd call the refractory students before him and appeal to the best that was in them, never scolding or harsh, but kind and encouraging.

"His students loved him, and it is a fact that every one of them, as far as my observation goes, turned out well. Clark's purpose seemed to be to inspire those he taught with the same ideals he entertained himself. He managed to impress his personality on some of the boys so strongly that they became distinguished along certain lines of ambition.

"During these days Clark taught a large Sunday school class, and while he was an ardent student of the Bible he would more than likely choose his topics from some metropolitan newspaper, discuss its editorials or some big event of political life, and work around to the proper moral, inculcating practical religion from every day life you might say. Anyhow, the members of his class were always talking about the interesting things they had heard at Sunday school.

"In one of the lyceum debates we had Clark proved to everybody that the Bible ought to be taught in the public schools. It was Clark's guiding principle that the Bible was the most helpful friend an ambitious man could have and that it laid down a rule of conduct covering every line of worthy human endeavor. In his jury speeches he would cite the Bible more frequently than he did the law, and from his manner of handling it was more effective. He argued that the Bible was the foundation of law and justice

and that he preferred to go to the source for his authority.

"Clark and I became associated as law partners in 1877, and in 1878 I ran for prosecuting attorney. The same year Clark ran for the Legislature. Of course, being new beginners at law, we weren't overly rich, my partner thought if I was made prosecuting attorney the job would support both of us.

"He was defeated for the Legislature, but I went in as prosecuting attorney, while he continued the practice of law. Clark and I were on the same side of every big case we tried, with the exception of the one of which I have spoken.

"Clark liked to get hold of a case involving a study of the human heart and emotions. We had this sort of a case to defend, brought here from St. Louis on charge of venue.

"E. made his way, revolver in hand, into a crowded street car. It was either a horse car or cable system, before the electric car period. Walking straight up to the conductor, E. shot him, and as he started to fall the slayer threw his arm around the conductor's neck and held him up while he emptied the remaining cartridges of his pistol into the conductor's body.

"Of course everybody hiked out and the car was soon empty save for E. and the body of the conductor. E. then drove the car out to the larns and to the astonished people there said:

"'A policeman was called and E. surrendered. When the case came up to Pike county our client was cheerfully frank about the killing and seemed dismayedly clear headed. His only excuse was that the dead man had stolen his wife.

"E. put on a policeman, a big level headed brute, to testify about E.'s surrender. The policeman said he told his trouble to him and that previous to that he had acted so queer that he had searched him.

"On cross-examination the State asked: 'Didn't you tell E. to go and get a gun and kill the conductor?'

"'No,' said the policeman, looking at the bright star on his coat, 'but if I hadn't had this star on I would have told him to get him a good galling gun and scatter that rascal all over the face of

the earth! But I had my star on, mind you!'

"Clark used that clue. The unwritten law was a new element in Missouri jurisprudence then, and we had been basing our case on emotional insanity. When Clark got through with his word painting of the home and the despoiler it was clear that was the real defence. The trial was attended by many women, and they must have enjoyed that speech of my associate, for every one of them had her handkerchief in use. The cool deliberation of the killing, the pained, stricken passengers, the cheerful admission of guilt by the accused, all were swept into the background, or else made to appear as the righteous act of a greatly wronged husband, under the matchless eloquence of the pleader.

"Clark was at his best in a case of that kind. A native Kentuckian, with his chivalrous sense of honor due woman-kind, he spoke from the depths of a primal instinct that sanctioned the right of man to avenge a mortal wrong. In five minutes after the jury went out E. was surrounded by congratulating friends, a free man.

"One man in Clark's home town, a Primitive Baptist, Hardshell, they used to call 'em, made arrangements before he died for Clark to preach his funeral sermon. Clark was in Congress at the time of the old man's death and the funeral discourse was postponed until he could get around to it. Finally Congress adjourned and the first duty Clark attended to on getting back to his district was to go out to the little Primitive Baptist church where Sam Willis was buried, and there in the presence of many sorrowing friends he officiated as the master of ceremonies for his old friend.

"An honest old Hardshell who heard Champ's sermon on that occasion said:

"'When the Lord foreordained Clark to go to Congress He left a mighty kood chance to make a preacher.'"

EDIBLE SNAILS.

Paris the Great Market, Distributing 100,000,000 Annually.

Snails are not so popular as an article of food in this country as they are in France. They are not very easily digested, according to a writer in the *Dietetic and Hygienic Gazette*, though he also says that they are "a nutritious and wholesome food, especially when kept a little time after gathering and purged of the possible injurious vegetable substances they may contain."

The great snail market of the present time is Paris. More than 100,000,000 are distributed there annually, of which over 80,000,000 pass through the Central Market of that city alone. A goodly number are exported to America. France of herself cannot supply the demand but looks to Italy, Switzerland and even to Germany to satisfy in part her requirements.

"Those experienced say snail breeding is easy and inexpensive and that fortunes have been made out of the business in France. If one takes up snails commercially it is indispensable that he breed them, and this can be very economically done.

"Showing the customs of snails nothing can be easier than to establish a small snailery for wholesale cultivation. A plot of ground in the country, a little calcareous if possible, damp or easily irrigated at discretion, for dampness is absolutely necessary to the snail, is all that is needed.

"Surround the pen with a fence of very fine weave, which must also go under the ground to a depth of 0.30 centimeters to prevent the occupants' escape. It is best to border the pen at the bottom with tared planks, preventing all possibility of the young snails especially getting away.

"Snails bring cool and shady spots, plant little shrubs, of box or anything similar, in the pen. Some odorous plants, such as thyme, serpolet, &c., will give a good favor to the flesh. In different places have vessels of water where the snails can bathe. Salad is the best food for them, lettuce, remains and so on."

Bulgarian Centenarians.

From the London Daily Mail.

Recent statistics, writes our Vienna correspondent, show 32 centenarians at present alive in Bulgaria, of whom ten are women. Ten peasants are over 125, eighty-eight between 120 and 125 and 234 more than 110 years old.