STRENGTH.

The strength of a structure entirely depends on its special adaptability to withstand the strains that it has to resist, and a design or form of hull that would be suitable for long trips, or for beaching to discharge her cargo, might be totally unsuited for going alongside a wharf to discharge passengers 140 times a day, as is the case with most of our ferry steamers.

In the hulls at present in use the fender piles are struck by the outer edge of the sponsons which are overhung from the vessel's side from 5 to 7 feet—the concussion from this blow and the resultant strains are communicated through the ship's knees and stringers to the top ends of the ship's frames. These frames are upright pieces of timber from 5 to 7 feet high, with a curve at their bottom end, thence extending at almost right angles to the keel. It can be seen at a glance by the model figures 7 and 8, that there is a great weakness in this design, and no direct resistance to the strains brought upon it, and it is in all cases compensated for by using more material, which of course means more weight,—helping to destroy itself, and also more expense. These boats have also in most cases two boilers, which necessarily are one on either side of the keel, and this arrangement is certainly not so well adapted for distributing the strain as would be effected by placing the weight of one boiler on the backbone of the ship, and supporting it from the side. It is also an acknowledged fact that one large boiler with two furnaces is much more effective than two small shells; it is easier kept clean, the water requires less watching, and if there is only one combustion chamber a great amount of the smoke can be consumed. With boilers placed under the deck great difficulty is always experienced (even when they are carefully lagged) in keeping the decks tight, and in most cases the oakum may be seen driven through the seams over the boilers in the endeavour to keep the water from coming through. This water softens the lagging and makes it drop off, it also rusts the boilers and is the cause of no end of dirt and discomfort. All these objections, it will be noticed, are remedied in the design before you. That the model, you will observe, differs from the

drawing in that the boiler is placed higher, for the height of the boiler is really of so little consideration as regards the stability of the vessel that in the latter design it has been placed above the shaft instead of letting the shaft run through the water space of the boiler as shown on the drawing.

It is proposed in the construction of this vessel to use hard-wood for the keel, keelson, stems and knees only, and it can be seen by the model frame before you that knees are only required for about one half the length of the ship. All the frames may be of either kauri or oregon, which would very materially reduce the weight of the vessel, and consequently the momentum of striking a wharf or fender pile. The requisite strength fore and aft is secured by placing a trussed girder on either side, which makes the bottom and deck perfectly rigid, and puts the hull for longitudinal strength in as good a position as an ordinary square-sided vessel, these girders representing her sides.

SPEED.

The usual method of arriving at the speed of our ferry steamers before the trial trip is to guess it, and it may not be out of place here to mention that the more moderate guessers often overstep by knots the actual speed attained.

As a mental calculation is of very little value, the author has in this case run it out by Seaton's rule for ascertaining the speed of moderately fine-lined ships; the rule is based upon the actual horse power and wetted surface, and he finds by this that eleven and a-half knots should be obtained, allowing the engines to work to five times their nominal horse-power.

It is admitted that this formula may not apply to a double-ended screw boat, but, at the same time, the lines are exceptionally fine and well suited to throw the wash from the forward screw into the more solid water below.

Through the kindness of the manager of the North Shore Ferry Co., the author was allowed to test their S.S. "Wallaby" under several different conditions, the stop valve being partly shut and the links being in the same position as when running on the ferry, and the following is the result, details being left out for the

sake of brevity. With the after screw pushing, and the forward one disconnected and free to revolve, 78 lbs. steam, 22 vac., 165 revolutions, time on the mile, 6 minutes, 53 seconds; screw pulling and the after one free to revolve 175 revolutions, time 7 minutes 25 seconds; with both screws connected, revolutions 148, time, 6 minutes 52 seconds. The trial, if anything, was against the efficiency of the pulling screw, as it was found the vessel took a very long time to attain her maximum speed; but the efficacy of the two screws was fully demonstrated, as the same speed was attained as with the single one on 17 revolutions per minute less. Experience has taught us that screw steamers lose very little of their speed by being loaded, whereas it is quite the reverse with the paddle. The steamer "Luna," which was one of the fastest paddle steamers in Sydney Harbour, doing thirteen knots when light, could not steam more than nine when deeply loaded, she was a much more mechanical job than our ferry steamers, for she had feathering floats, and I think that no one will attempt to deny that there is not one of our paddle ferry steamers that can attain a speed of more than six knots with her full complement of passengers, or even stand upright with them. In endeavouring to draw some conclusions as to the comparative speed of different vessels—whose midships section the wooden blocks experimented upon would represent—we find that the three factors from which the resistance of the speed of a vessel is calculated are the co-efficient of fineness, the skin friction on the wetted surface, and the area of the immersed midship section; the latter being taken irrespective of any excessive depth or beam.

With torpedoes, experiments have clearly demonstrated that the resistance is equal to all depths, but with regard to vessels the author is unaware of any trials that would bear on the relative speeds of the sections before you, and it is only two small requirements, namely, time and money, that prevent the carrying out of some elaborate experiments in the matter. The bow of the V model would certainly have a more decided tendency to ride over the water than to divide it, as is done in the case of a square sided vessel, and the fact of torpedo launches rising up when

approaching their greatest speed, bears out to some extent the assumption that the V boat is likely to be easier driven than the other shapes. In fact one of our leading shipbuilders makes bold to state that the International Sailing Cup will ultimately be wrested from the hands of Brother Jonathan by a yacht built on the V principle.

SHEAR.

In pictures of the vessels with which the ancient Romans invaded Britain we find the curve of the gunwale is drawn to about a circle from a centre situated about the masthead. We also find the same in the vessels of the Spanish Armada; and our Celestial friends always constructed their junks in the same fashion. The moving idea was no doubt that the vessels should not take water over the ends when riding on two seas. But the lengthening of our sea going ships, and modern experience, has moderated the fashion to a very great extent. Shear is no doubt still very desirable in our sea-going ships, but one has great difficulty in seeing where there is a necessity for it in smooth water vessels. This is so thoroughly understood in America that some of the river steamers have actually been sheared the reverse way, or cambered fore and aft, being deeper in the centre than at the ends. Taking into consideration that this change has taken place in a country where invention and improvements make the greatest strides of any place in the world, it might be honestly concluded that we should profit by their experience and be also gradually losing the shear in our harbour steamers; it therefore leads to a certain amount of wonder when we see our latest production with even more shear than those previously built. The result of this unnecessary construction can easily be understood from what has before been said, that is, it raises the centre of gravity and makes the vessel less stable. The only real object to be attained by shear in such a boat is to gratify the eye, and that is at the expense of efficiency, the result is to cultivate our taste in the wrong direction, and really it is a difficulty, with short trip ferry steamers, to see any justification for continuing the custom.

STEERING GEAR.

The model shows that the steering gear is similar to that generally in use, with the exception that the steel wire ropes or rods running through gas pipes led along under the floating upper deck upon the stationary beams; but a novelty has been introduced in the locking gear of the rudders that will have the effect of keeping the forward one perfectly rigid. This gear is so fitted that the tendency of the vessel's progress through the water will be to lock the forward rudder tighter, and to unlock the one in use; both the locking rods are connected to a lever on the funnel casing, and while the captain is walking from one wheel to the other, he has only to move this lever over and the work of unlocking one rudder and securing the other is performed in one act—one operation cannot be done without the other. In the model these details are somewhat clumsily made, owing to the small scale, but it is quite sufficient to explain the principle to persons who could not, perhaps, see through its working on paper.

ACCOMMODATION.

The seats in the model show that they are intended to be much more comfortable than those usually provided in such boats, the width of the double seats being about 3 feet 9 inches, and the single ones about 2 feet, with more sloping backs than usual. The stairs are also each four feet wide, on an easy gradient, being 7-inch rises and 9-inch treads, the awkward steps in many of our harbour steamers being of a most objectionable nature.

Special attention has also been paid to the cloak-room requirements for ladies in the cabin and for gentlemen in the fore-end, the openings being clear through the deck to the water outside. This meets a great and often expressed want that is felt in some of our ferry boats, and at the same time the arrangement obviates any accompanying nuisance.

VENTILATION.

The author has long been of opinion that the system of ventilation on these steamers is carried out in opposition to natural laws.

As an instance, cold air is blown down to promote the draught of the furnace, while the hot air is allowed to come up on deck, to the discomfort of the passengers, and should the stoker happen to throw some water on the ashes, a volcano of steam and dust is thrown on to the passengers in the neighbourhood. In the steamer before you a large up-cast shaft surrounds the funnel, the heat of which, together with that of the engine and boiler, will so lighten the surrounding air that a continuous draught will be passing up, through, and out above the upper roof; this will cause a strong current of air to be always passing into every opening to the engine and boiler, and thus allow no heat or smell to come among the passengers. This casing is 11 feet long by 5 feet wide, and is equal to the area of the openings leading inwards.

The bollards in the model have the appearance of being somewhat disproportionate; they are 2 feet high and 6 inches in diameter, and are not likely to be stumbled over from being lost sight of. The principal reason for this is that the present double hooks now in use are very destructive to the ropes, caused by the short nip; they are also unhandy, and undoubtedly a heirloom from our primitive times.

COMPARISONS.

It is now proposed to endeavour to show, by comparison, the absurd shape of the hulls of some of our ferry steamers. This may be considered an objectionable proceeding by some persons, but it is only by comparison that the relative merits of such matters can be judged. Although names may be given in the case of a success, the author will be careful to conceal the identity of any failures.

Some three years ago, Mr. Rock Davis took the contract to carry from Sydney to Brisbane Water the whole of the bricks and cement required for the tunnels on Blunt's section of the Newcastle Railway, and he built a steamer for the purpose—the "Emperor." She was 82½ feet long by 23 beam, by 7 feet 4 inches deep. She was 108 gross tonnage and 74 tons register. This vessel carried 85 tons of bricks in boxes, making a total of about 90 tons. She took them a voyage of eighteen miles outside the Heads, and

maintained a speed of about six knots per hour. You will here note that she carried 83 per cent. of her gross tonnage, and she did it easily and satisfactorily. She has since had her machinery taken out of her, and is now a lighter in Sydney Harbour.

We will now compare with this one of our ferry steamers—120 feet long, 21 feet beam, 7 feet deep, 200 gross tonnage and 126 tons net—licensed to carry 750 passengers. Taking the passengers at ten stone each, we find the greatest weight she is allowed to carry is about 46 tons, or only 23 per cent. of her gross tonnage. This is carried in anything but a satisfactory manner, for in nearly all cases the centre of gravity has become so high that the vessel is in unstable equilibrium, and will remain in any position but on an even keel, with even far less than her full load of passengers. This was very conspicuous lately, on the night of the Jubilee illuminations, when so many crowded steamers were out, and it could be seen that the sharp-bottomed screw-boats were nearly upright, while most of the paddle-boats had their sponsons very near the water.

I may here mention that the midship section of this brick lighter is almost identical with that of some of our ferry steamers, and the other lines are as close as the dimensions would allow, although the one was for carrying a full cargo inside her hull, while the others are built to carry only a quarter load, and that on deck.

Some of our ferry steamers carry ballast to give them more stiffness, others have a large quantity of fresh water in tanks, and even in our newest ones they have very heavy machinery and boilers below the decks. All extra weight carried must, as a matter of necessity, be a loss of power and speed, as it increases the immersion and wetted surface, and, as a consequence, the resistance. Another important point is that the heavier the body is the longer is the time it takes to get it into motion and to stop, which is a very great consideration in short runs.

When we come to consider what is required to make our ferry steamers what they should be, the following, among other points, are worth consideration :—

The screw is more effective than the paddle. This is conceded by all engineers. It has superseded it in every case with very few exceptions, and in these exceptions the machinery is of the most improved modern type.

It is doubtful if in any other port of the world that primitive appliance, the common float, is being perpetuated as it is in Sydney.

The centre of weight of screw engines is much lower than that of paddle engines, they are one-third lighter, and these points are of great importance in a vessel built to carry a deck load.

The deck of the North Shore ferry steamer "Wallaby" is about 24 inches above the water, and it has not been found to be inconveniently low, while that of some of our paddle boats is as high as four feet, having doubtless been put so high to prevent the shaft from coming too far above the deck and also to enable a wheel of moderate diameter to be applied, this raised deck throws the centre of gravity of the ship and its load very high, and is one of the causes of the want of stiffness which is seen when a fair complement of passengers is on board one of them.

It will have been noticed that in many of these vessels only the bridge between the paddle boxes is available for passengers, the two ends being covered with galvanized iron, this has been found to be necessary with several boats to prevent too many passengers from going on the upper deck and making the vessel unstable, and it certainly points very clearly to the ignorance and rule of thumb that was employed in their design. One large vessel had to get her upper deck accommodation removed after completion. Seeing that in our largest ferry steamers not 23 per cent. of their gross tonnage at most is made use of to carry passengers, does not common sense suggest that some of that floor or bilge which is always tending to turn the vessel upside down should be cut off and be replaced on the hull where it will give more strength, finer lines, less weight, and more stability; and that the machinery should be so modified as to give increased power and economy, while the weight is brought much lower down, and a fine clear deck is secured for accommodation.

Anyone who has noticed the alterations in the proportions of vessels' hulls and machinery all over the world during the last quarter of a century, must have been struck with the conviction that it is not only in our domestic life that the fashions alter.

Our Atlantic steamers have for many years been gradually increasing in both length and depth, the idea no doubt being that an increase of space and carrying capacity was obtained on a minimum of resistance, but such opinions have had their day, and we find, in all the ships now building, there is a very great proportionate increase in the beam.

As bearing on the subject of this paper, it might not be out of place to mention the case of the ordinary whaleboat as having maintained the same shape for at least as long as the author's memory can go back, these boats all have a great rise of floor, and are in fact only two ends, and they are very much of the V section. They have to carry their weight high, and, as everyone knows who has had anything to do with them, they are exceedingly stable, they have a great amount of shear, which is of course against their stability, but it is an absolute necessity to suit their peculiar work. For comparison with a ferry steamer, an ordinary waterman's boat will possibly make a better subject, as the class of work for which they are used is identical with that of the steamer, they vary but little in shape, and it is doubtful if any improvement could be made on them. Their size is about 22 feet long, 4 feet 9 inches beam, and 19 inches deep, and they weigh considerably under 2 cwt.; their licensed load is ten passengers, besides the man, making a total weight of at least 12 cwt. on about 13 inches draught. The people are all sitting above the water-line, and the centre of weight of the load is about two feet above it or nearly double the draught of water. With this load they are very stable, their lines are fine, and it must be admitted that, with their limited power, they have great speed. What would the public think of a waterman's boat built on the same proportions as one of our paddle ferry steamers. She would be called a coffin, and properly so, for passengers would require to lie in the bottom of the boat to keep her upright, or they would

soon be at the bottom of the harbour. Anyone who chooses to go into a very small calculation, and draw a comparison between these two models, will find it very much to the advantage of the waterman's boat.

No doubt, the designers of our screw passenger steamers are alive to the proper shape of them, this can be clearly seen by looking at some of our latest productions; they are fast approaching the V section, they have great speed, and they stand up with their full complement of passengers. No one can deny that vessels of this class are a great success, but their great draught of water aft, and having to back out and turn is a fatal objection to their use on our short ferry services. The excessive draught aft is a necessity to get the immersion for a large enough propeller to obtain the speed, to compensate for this they are so built as to draw only about one fourth that depth of water forward, and passengers in them have to ascend an angle of about one in twenty to get forward; the keel at the same time having a rise of about one in ten. To draw a comparison between one of these vessels and the V boat, we must imagine the machinery to be put amidships so as to lift the stern and immerse the bow and we then find we have not only insufficient draught for the one screw but not enough for two smaller propellers, which together equal the original one. To have a propeller at each end, we must get more immersion. and it certainly seems only a common sense conclusion that instead of putting in tanks of water or coal as an extra load to carry about in order to sink your hull deeper, you would do better to cut off the round of your bilge and thereby not only raise the centre of buoyancy, but at the same time you would get the necessary draught for your screws, more stability, finer lines, and increased speed.

COST AND RESULTS.

The first of these considerations is of the utmost importance and the second is oftentimes made too much subservient to it, But as all the timber in the hull is straight and can be cut in a mill, it must of necessity considerably reduce the cost of material and labour. This cost has been estimated by a reliable authority

at 30 per cent. below that of an ordinary hull. The machinery is 30 per cent. less in weight, and would certainly cost 20 per cent. less than paddle machinery of the same power. The speed cannot be estimated at less than 25 per cent. over the speed of our present ferry steamers, while a great saving of coal would certainly be effected by the single boiler and increased speed, and at the same time the extra deck room would entitle the vessel to carry at least 20 per cent. more passengers than any ferry steamer her length in the harbour—these claims seem excessive, but the best has been done to make it plain and intelligible, and, in conclusion, the author regrets his inability to treat the subject from a more masterly standpoint than he has taken up, or in a more scientific manner. This step is taken in the interests of the travelling public of Sydney and suburbs, as the author feels strongly that our ferry services are not keeping pace with the times, and that there is no reason why in New South Wales we should not travel with as much or more speed, comfort and security as people in any other part of the world.