BRISTOL CHANNEL CENTRE.

DISCUSSION

ON

PADDLE WHEELS.

MARCH 1st, 1898.

CHAIRMAN:

PROFESSOR A. C. ELLIOTT, D.SC. (PRESIDENT OF THE CENTRE).

Mr. D. GIBSON, in opening the discussion, congratulated the author on his most interesting contribution to the proceedings of the Institute, and said it was most pleasing to leave the screw for a while, and discuss the earlier method of propulsion. He did not claim any particular knowledge or experience in the paddle wheel, as he had always been engaged with the screw form of propelling vessels, and he preferred rather to listen to the remarks of those experts who were more competent to discuss the question than himself. The paper showed that great pains had been taken in its preparation, and it contained some valuable information and practice. The present paddle wheel as shown in Mr. Mills' drawing and those fitted on Messrs. Campbell's boats appeared to be splendid wheels, and did not leave much, if any, room for improvement. He had seen it stated that floats fitted slightly inclined to the axis, so as to go through the water from the ship's side, gave good results, by reducing the skin friction; but in a reasonably good designed boat he did not think it at all necessary, as it only put a side thrust on the wheel, for which it was not designed. If the author had made reference to the early paddle boats and their work, also to the American practice, it doubtless would have been most interesting from a historical point of view, as well as to have noted the advance made in this method of propulsion. As far as he had been able to gather, there had been very little indeed written on this subject, which made Mr. Mills' paper most interesting, attractive and welcome.

Mr. ROBERT H. STRONG said: Mr. Mills has only dealt with three out of the many different floats that have been tried on paddle wheels. Of course, we all know that wheels with fixed floats are as a thing of the past; but I remember a Clyde passenger steamer being tried with both fixed and feathering floats on a 14-ft. wheel, eight floats being used in each instance, and the speed of the vessel being nearly identical in each instance, but not so the vibration. With regard to the shape and material used for feathering floats, for all purposes I certainly prefer the plain wood float, which, if set to enter and leave the water at the proper angle, is as effective as the steel curved float, and not so liable to damage. Referring to the experiments made by Mr. Rennie with H.M.S. *Africa*, these experiments were made in April, 1841, with the trapezium floats, and a full account of the same can be had from Tredgold's works. Mr. Mills gives the spacing of floats as between 3 ft. and 4 ft. apart. The old proportions for radial wheels was one float for each foot in diameter of the wheel. This in the feathering floats was increased to one float for each 1½ ft. diameter of wheel. The best results have been obtained from wheels pitched one float for each 2½ ft. diameter of wheel, and the float hung at two-fifths of the depth of the float from the lower or entering edge. Some years ago I tried the experiment of taking away four floats from a 12 ft. 6 in. wheel which had eight floats 6 ft. 6 in. long and 2 ft. 4 in. wide, with the result of an increased engine speed of four revolutions per minute and one knot per hour in the speed of the vessel, but the shock on the wheels with such a great pitch was tremendous, so we had to replace as before. Mr. Mills seems to think that a little extra weight in a wheel is detrimental, and that the scantlings might be reduced. This has not been my experience, for I have always found that the feathering wheels have given most satisfaction when made as strong and rigid as possible.

Mr. WILLIAM EVANS and Mr. T. W. WAILES also took part in the discussion.

Professor A. C. ELLIOTT, D.Sc., said it was a great pleasure to welcome their brother engineer and fellow member from Bristol. After all, the name of the centre bore that of the ancient port which in the early days of steam navigation had shown a capacity for adaptation to the new order of things then inaugurated, quite in keeping with its traditions of glorious enterprise which dated back to the time of the good Queen Bess and even far beyond. But Bristol was not required to build itself anew on the ashes of a dead past; on the contrary, it was very much alive, and any day, by a feat of civil engineering, might leap again into its proud position of not so many years ago. They would be glad to see the membership of the Institution extending in Bristol, and even if the outcome were in time a separate centre for Bristol, so much the better. Their desire was, let engineering flourish, come what will. The paper, if it had a fault, was a little too terse. The matter could not be better, but it wanted a little expansion, for in the present intense devotion to screw propulsion, engineers were in danger of forgetting even the elementary principles of the paddle wheel, and the considerable amount of study and experimental research of which it had been the subject. There was a mistaken popular notion that the question of screw *v.* paddle propulsion had been settled once for all by a trial made long ago of two similar ships of H.M.'s Navy, one screw and the other paddle, lashed stern to stern and driven full speed ahead, resulting in the victory of the screw ship. As a mechanical problem paddle, screw, and jet propulsion were all on the same level; the effort on the ship was equal to the momentum of the volume per second of the water driven astern, and conversely as the effort on the ship was transmitted to the hull an equal momentum was communicated to the water driven ahead. This sounded like a paradox; it was not a paradox, but a simple fact. If a man pushed a heavy pendulum with a long suspension, the momentum communicated to the pendulum was equal to the resulting opposite momentum of the man's body, together with that given to the earth through his feet—the pendulum moved backwards, so to speak, while the man gave way forwards. But if the man stood in a boat pushing successive pendulums in such a manner that the man and boat acquired a uniform speed, then (making abstraction of viscosity) the backwards momentum of the pendulums was equal to the forwards momentum communicated to the water. Now, the pendulums themselves might be masses of water, and the man might be likened to a propeller. In that case the momentum of the water driven astern was equal to the momentum of the water driven ahead; yet the boat must move, which was the essence of the whole matter, considering the reservation about viscosity introduced skin friction, but the skin friction in question was not that so named by Dr. Froude. The fact was, that so far as the proposition was concerned skin friction had nothing to do with the skin of the ship, it referred to the skin of the river or the ocean. In shallow waters this phase of skin friction was important—it was known practically as "biting the bottom"; in deep waters it had no significance. Paddle, screw, and jet (when properly managed), on bare principle, had the same efficiency, viz., velocity of ship divided by velocity of ship plus slip. Mechanically each form of propeller had its own special features, good and bad. What was wanted was to drive astern a large volume of water at a low velocity, i.e., with as small a slip as possible. To begin with, a large driving area was required; this was the weak point of the jet. In shallow draught steamers a large area could not be got with the screw. Here was a well-recognised habitat for the paddle-wheel —river, and in some instances cross-channel, traffic. For ocean and cargo boats the difficulty of variable immersion was, as the author pointed out, greater with the paddle than the screw; nevertheless, there were nautical men who declared for the paddle in a stiff head sea. Vibration in the fast cross-channel boats had got beyond all reasonable limits; dearly as the British public loved swift travel, a section of it was even now deliberately preferring the slower and steadier boats. The marine engineer had, on the whole, been neglectful of the running balance problem; he had adopted the triple engine without taking much account of the fact that it was ever so much better balanced than the compound, though by no means perfect as ordinarily built, and he frequently discussed four crank engines without reference to the greater possibilities for a still better balance. A large part of the vibration was due to the engines, part to the propeller. Paddle propellers and engines gave less vibration than screw propellers and engines. First, because paddle speed was mainly a question of wheel diameter, and the engines were in general run slow, giving small inertia forces; secondly, because the paddle vibration was directed mainly about the ship's longitudinal axis, which was not very susceptible; and thirdly, because what inertia forces paddle engines developed were in general diagonal, partly resolving into the longitudinal direction, which was the ship's axis of abundant strength. On the other hand, the screw propeller tended to vibrate the ship about her axis of greatest susceptibility. From all which it appeared that unless the engineers and shipbuilders of the fast channel service on the twin-screw principle altered their ways there would be a new movement in favour of the paddle—a thing that was by no means to be deplored. He was a firm believer in curved steel floats feathered in the best way possible, even at the risk of a little more complication; and he was glad to note that the author had described their adoption in the cases of the two *Prinses* and the *Brighton* and *Victoria* as a complete success. The diagrams exhibited by the author were well worth a more detailed description in the paper; showing on them what the author had called the rolling circle, added to the interest. He trusted that this was by no means the last of the author's contributions to the proceedings of the Institute.

Mr. MILLS, in replying to the discussion, said: Mr. Gibson speaks of floats being used which are slightly inclined to the axis in order that the water may be thrown away from the ship's side, and so reduce the skin friction; but in doing this not only is there a side thrust on the wheels as pointed out, but there is also a loss of momentum equal to the momentum of the water acted upon, multiplied by the sine of the angle which the water makes with the direction of the vessel, which may possibly counteract any good attained in the reduction of the skin friction. The paper did not directly consider the many different forms and arrangements of floats which have been used, as it was intended more as a theoretical and practical one than historical, but there does not appear to be any advantage derived in the use of floats other than rectangular, to judge by the experiments of Rennie with H.M.S. *Africa*. As regards the Clyde passenger steamer spoken of by Mr. Robert H. Strong, there may have been many reasons why an increase of speed was not obtained by the feathering floats; perhaps the spring of the floats caused excessive friction, or the bluff bows caused waves, or the angle of entry may not have been the best. It would have been interesting to have had the results of progressive trials with this boat, so as to have compared the horse-power developed and the speed obtained. The reason a curved float is preferable to a flat wooden float is that the flat surface has different forward velocities, due to the inner part being nearer to the centre of wheel than the outer. The resultant angle between the velocity of the ship and the velocity of the different parts of the float must vary; consequently the float ought not to be straight. In other words, as the revolutions and the velocity of the ship is constant, the angle of the piece of float just entering the water should vary in proportion to its radius from the centre of the wheel, in order to prevent shock and consequent waste of energy. The old rule of spacing the floats for radial wheels was one float for each foot in diameter, or, which is the same thing, between three and four feet apart, but now with feathering floats the pitch is made about six feet. In order that a feathering wheel should work well and give good results the suspension should be, generally speaking, as near as possible to the lower edge, in order to prevent heavy twisting moments; and as the twisting moments are counteracted at the outer parts of the wheels, it follows that the outside set of arms and the outer rings should be made stronger than the inner set; as a proof of this it is generally found in practice that the bolts in the outer arms themselves give more trouble than the inner ones do. In conclusion, I wish to thank Messrs. P. and A. Campbell for kindly giving the many particulars concerning their well-known fleet of paddle steamers, and also the members for the manner in which they have received and discussed the paper.

A very hearty vote of thanks was accorded Mr. Mills for his paper, on the motion of Mr. D. Gibson, seconded by Mr. J. Fleming.

The honorary secretary (Mr. George Sloggett) announced that Mr. J. F. Walliker (member) would read a paper entitled "Notes on Marine Boilers and Steam Pipes," at the next meeting of the centre, on March 9.