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(OF TRANSACTIONS)

Suggestions as to the Prevention of Corrosion of Tail End Shafts,

BY

Mr. JOHN BODDY

(MEMBER).

READ AT 3, PARK PLACE, CARDIFF
On MONDAY, NOVEMBER 18th, 1901,
AND AT
THE INSTITUTE PREMISES, 58, ROMFORD ROAD, STRATFORD,
On MONDAY, NOVEMBER 25th, 1901.

PREFACE.

58, Romford Road,

Stratford,

Nov. 25th, 1901.

A meeting of the Institute of Marine Engineers was held here this evening, presided over by Mr. W. C. Roberts (Chairman of Council), when a paper on the Means of Preventing Corrosion of Propeller Shafts and a System of Lubricating them was read, in the absence of the Author, Mr. J. Boddy (Member), by the Hon. Secretary.

The paper was read at 3, Park Place, Cardiff, before the Bristol Channel Centre, on November 18th, when Mr. T. A. Reed (Member of Committee B.C.C.), presided.

JAS. ADAMSON,

Hon. Sec.

INSTITUTE OF MARINE ENGINEERS

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SESSION  1901-1902.

President:
JOHN CORRY, Esq.
Local President (B.C.C.): Sir Thos. Morel.

SUGGESTIONS AS TO THE PREVENTION OF CORROSION OF TAIL END SHAFTS,

BY

Mr. JOHN BODDY (Member).

READ AT 3, PARK PLACE, CARDIFF,
On MONDAY, NOVEMBER 18th, 1901.
Chairman:
Mr. T. A. REED (Member of Committee B.C.C.)

AND AT

THE INSTITUTE PREMISES, 58, ROMFORD ROAD, STRATFORD,
On MONDAY, NOVEMBER 25th, 1901.
Chairman:
Mr. W. C. ROBERTS (Chairman of Council).

In placing a short paper before the Members of this Institute, it is not my intention to raise a discussion on the causes of failures of tail end shafts, but rather to describe the appliances which I have used for the prevention of corrosion, together with the system of lubricating such shafts, and the actual results attained.

The importance of the prevention of corrosion of

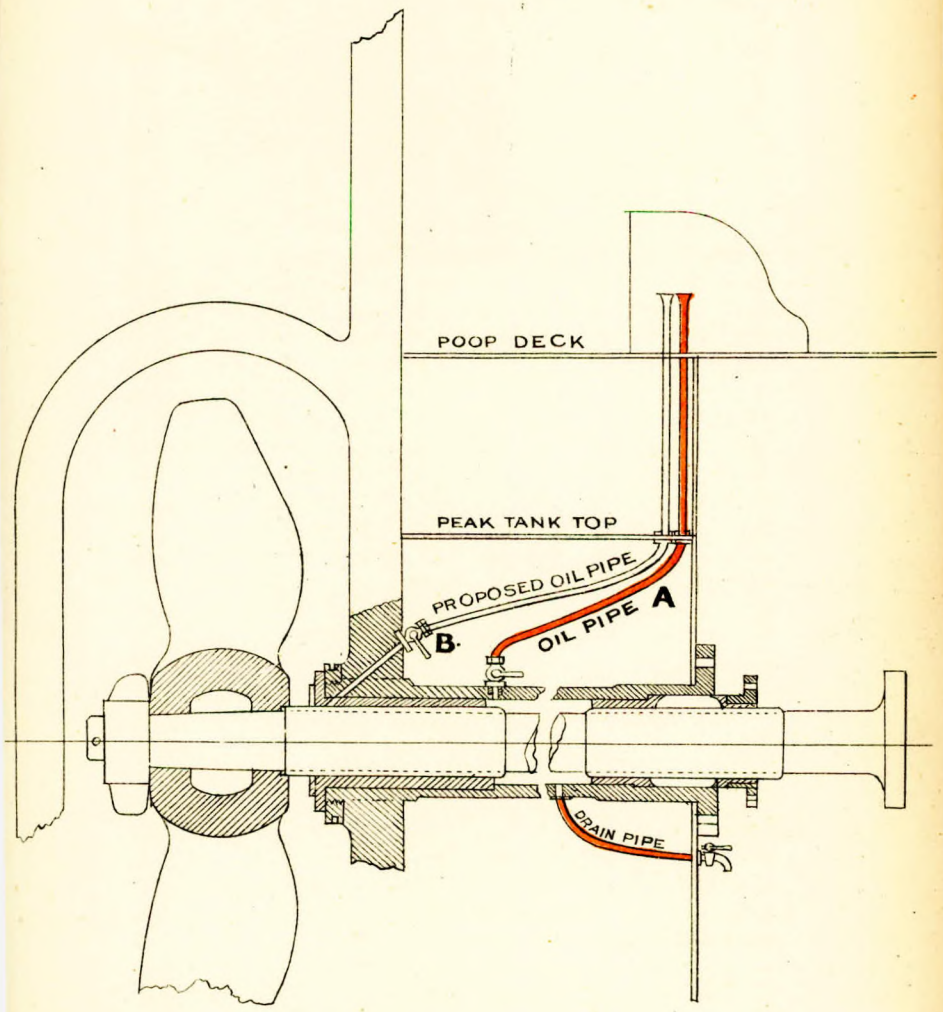
tail end shafts, and the necessity of lubrication in the stern tube, stern bush, and neck and gland bushes, will, I am sure, be agreed by all.

If some of our members who have used, and are still using, appliances for preventing corrosion of tail end shafts and for lubricating stern bushes, will kindly give us their experiences, I am sure we shall one and all derive some benefit.

During the month of February, 1897, one of the steamers under my superintendence was lying in dry dock undergoing repairs after grounding. The tail shaft at this time was uncoupled and drawn in for the purpose of being examined. It was then found to be in good order, with the exception of some slight corrosion which existed between the brass sleeves adjacent to the forward end of the after brass liner, and the lignum vitæ in the stern bush was worn down about $\frac{1}{8}$ in. This tail shaft and stern bush were the same age as the vessel, viz.:—two years. Owing to the corrosion that existed I decided to fit appliances by means of which the shaft and stern bush would be supplied with a lubricant at any time, either when the ship was laden or in ballast trim, and by this means I hoped that further corrosion of the shaft would be prevented.

A hole was drilled through the top of the stern tube, just clear of the forward end of the stern bush, to which was fitted a stop cock and a copper pipe, $\frac{1}{2}$ in. bore, leading from top of stern tube through the peak tank, after storeroom and poop deck, and terminating in the cabin companion. This pipe is shown at A on the sectional drawing herewith appended, and was fitted for the purpose of conveying a lubricant to the tail end shaft and stern bush.

This copper pipe was fitted with bends in the peak tank and after storeroom to enable it to better adapt itself to any working or vibration that might take


POOP DECK
PEAK TANK TOP
PROPOSED OIL PIPE
B.
OIL PIPE A
DRAIN PIPE

place, and secured with clips in the peak and store-room. In order to facilitate oil being poured into the pipe, it was made funnel shape at the upper end, which was left open.

The object in drilling the hole in the stern tube close to the forward end of the stern bush was that the oil, after entering the stern tube, would, in addition to lubricating the stern bush, be conveyed the whole length of the shaft by the outside water pressure, and by this means the shaft between the sleeves would be coated with grease.

At the underside of the stern tube a drain pipe was fitted and led through the peak bulkhead with a stop cock fitted on the forward side of bulkhead; this pipe was for the purpose of draining the stern tube clear of sand, grit, or other foreign matter.

The Chief Engineer's instructions were that, at the earliest possible opportunity after the vessel left a port, and when the engines were in motion, he himself must empty into the funnel at the top end of the oil pipe one-half of a pint of engine oil, and repeat this every morning whilst the machinery was working. The oil used for this purpose is the same as that in use for lubricating the engines.

About four months after this oil pipe was fitted the vessel was chartered to proceed from Newport, in ballast, to Barry Dock to load outwards. I then took the opportunity of making the trip with her, and before leaving Newport the bent copper pipe was disconnected from the stern tube and a temporary straight length of iron pipe substituted. After the vessel was clear of the port, and when the engines were running full speed ahead, I emptied one-half of a pint of oil into the top of the iron pipe. About ten minutes later I passed a sounding rod down the pipe and rested the point on the top of the tail shaft. On withdrawing the rod I found it indicated a depth of $1\frac{1}{2}$ in. of liquid, the shaft at this

point being immersed about two feet. After the vessel was moored in Barry Dock, and the engines at rest, the sounding rod was again passed down the iron pipe, when it indicated a depth of about two feet of liquid; this corresponded with the shaft's immersion. During the run from Newport to Barry I went along the tunnel and saw that a soapy lather was oozing round the shaft in way of the stern gland. The Engineer informed me that when the engines were working there was always a soapy lather at the stern gland.

At intervals during the past four and a half years this vessel's tail shaft has been drawn for examination, and on each occasion it has been found thickly coated with grease the whole length between the brass sleeves, and quite clear of corrosion or water marks of any description. The lignum vitæ in the stern bush showed very little, if any, further signs of wear since the oil pipe was fitted, until the examination was made, viz. :— During the month of March this year, when, owing to the vessel having grounded badly, she was placed in dry dock, and, in addition to other parts of the engines being opened out, the tail shaft was recommended to be drawn in for examination.

On examining the tail shaft it was found, as on previous occasions, to be thickly coated with grease between the brass sleeves, and no corrosion or water marks of any description existed; the lignum vitæ in stern bush was found to be badly cut and damaged, and a quantity of sand and grit was found inside the stern tube. The stern bush, after having been in use for six years, was taken out, relined with lignum vitæ (end grain), machined, and replaced. The stern tube was cleared of sand and grit and washed out, and the tail shaft, which had also been in use six years, was refitted and coupled.

Other steamers under my superintendence are fitted with appliances similar to the one I have described in this paper, for the purpose of lubricating the tail shaft,

stern, neck and gland bushes, and so far have given satisfactory results. To prevent corrosion of tail shafts at the forward end of the cone, the best means I have found is to have the propeller recessed, and the brass sleeve on the tail shaft fitted and projecting into a recess about $\frac{3}{8}$ in., with an india rubber ring fitted in the recess fairly tight, between end of brass sleeve and end of recess in the propeller. On the accompanying sectional drawing of tail shaft and stern tube, you will observe, as shewn at B, a suggested oil pipe arrangement for conveying oil from the deck to the stern bush, delivering the oil about 2 ins. inside the after end of bush. I have not tried or tested this means of lubricating the stern bush, but I am of the opinion that if oil was conveyed and deposited at the after end of stern bush, the outside water pressure would be sufficient to prevent the oil escaping outwards, and force it the whole length of stern bush and tail shaft, and thus the stern bush would be lubricated, the tail shaft protected from corrosion between the sleeves, the neck and gland bushes would also be lubricated, and the lifetime of each would be considerably prolonged.

DISCUSSION

AT

3, PARK PLACE, CARDIFF,

ON MONDAY, NOV. 18TH, 1901.

CHAIRMAN:

MR. T. A. REED (Member of Committee, B.C.C.).

Mr. W. SIMPSON said presumably the method of lubrication described answered its purpose, as it was not often they heard of a tail end shaft running for six years. Whether lubrication, however, was all sufficient was questionable. They had heard members prove to their own satisfaction that it was the fitting of sleeves on to tail end shafts that was the starting of corrosion. He was afraid that when once corrosion started it could not be stopped. Mr. Boddy spoke of half a pint of engine

oil being put down the pipe. It seemed to him it would take a long time before the oil reached the shaft and did any practical lubricating. Some time ago he adopted a similar plan to that described, but without the drain pipe. He pumped the stern tube full of vaseline, and gave instructions to the engineer to fill the $1\frac{1}{4}$ in. pipe every day until he found what quantity he required to use. Most of the systems he had seen and heard of had a stern gland outside. He should like to ask Mr. Boddy if his experience led him to think that it was quite sufficient to have the pipe without the outer gland on the stern bush, whichever way it might be fixed. The speaker's shaft ran on white metal, without sleeves. It had been running about twenty months, and he had left the outer gland off, with the idea that if he had a head of oil he could force the water out. So far he had found it work all right. If he had a gland and the thing was neglected, he would have no lubrication, whereas without a gland he still had the water, the same as he had before, only his was working to white metal, and this of Mr. Boddy's was brass to lignum vitæ.

Mr. T. A. JOHNSON said they required to first remember that the real cause of the corrosion of a shaft was galvanic action. In his experience he had come across shafts where the element of corrosion was absolutely eliminated by a patent stern tube, and the shaft broke just the same. A favourite remedy advocated was a continuous liner. A superintendent engineer had told him of the case of the *City of Rome*, where a shaft, $25\frac{1}{2}$ in. in diameter under the sleeves, of Whitworth's compressed steel, over 20 tons weight, with a very heavy propeller, had been running since 1880. No corrosion, no breaking of the shaft. With regard to the Paper, he did not know whether Mr. Boddy inferred that the stern tube was empty when the ship left the dock, or whether it was filled with oil prior to the vessel leaving. He presumed Mr. Boddy first filled the stern tube. (Mr. Boddy: No, sir.) Well, he had not come across the practice, but he could quite under-

stand that the centrifugal motion which took place in the water must mix up the oil, which would gradually work on to the shaft. Yet he should have thought it advantageous to give the shaft a start by putting the oil in direct. There were other causes of fracture which should not be lost sight of besides corrosion. As they knew, he had been located in a place which was the back door to the Atlantic Ocean, and of broken shafts which came in, their name was legion. There was, for instance, the friendly tap of the engineer to harden up the nut. This was the cause of fracture in one case. Then he had seen lots of shafts from which big pieces had come out, the size of your fist, showing that the homogeneity of the shaft had been doubtful. But the whole crux of the matter lay in the fact that shafts had been too small in diameter. With a larger shaft they would get longer lives, which would be a bad job for the poor unfortunate ship repairer. Another cause of mischief to shafts arose from the piece of india rubber which Mr. Boddy described as introducing between the propeller and the end of the liner. Great care needed to be exercised in fitting on the rubber. He had come across four cases where the slackness of the propeller was due to the fact that the india rubber could be screwed up into such a position that it had the back tendency of a very strong spring, with the result that when the propeller was hard up against it the tendency was to drive it off.

Mr. CHARLES JONES cited the case of a shaft which was in its 19th year, and no special means had been taken to prevent corrosion. In another case, an eleven months old shaft broke with a heavy fracture at the fore end of the sleeve.

Mr. BOYD could not see how a coating of grease could have the effect of preventing galvanic action. He should like to know with regard to the shaft that had been going for six years, under the conditions described, how long it was working before that. He strongly advocated a gland outside—something just to

prevent the leakage of oil. By forcing the oil through, they knew it was doing no good.

Mr. A. R. WATSON said a half-pint of oil seemed a small quantity to result in such benefit as Mr. Boddy claimed. Then he thought Mr. Boddy was wrong in the proposed lubrication of the shaft two inches from the end of the bush. He could not see anything to prevent the oil simply going straight out, unless there was a circulation of water coming back over the tube, which they could not have unless there was a very large drain cock running into the tunnel all the time. His own experience was that exceedingly satisfactory results were obtained from plain shafts running on a cast-iron bush, with an outside gland. One such shaft had been running over two and a-half years, and the last time it was drawn in it had worn barely a 32nd part of an inch. This was not guess work, but from a gauge made at the time the shaft was fitted new. In a good many cases of accidents to lubricated shafts that had come under his notice the defect was due to the faulty fitting of the lubricant. They could not expect to retain in a stern tube oil which had a natural tendency to flow outward and upward. Some of the older shafts with which he had to do, had been running in solidified oil for about six years, with satisfactory results, both as to the wearing of the shaft and of the lignum vitae.

Mr. EVAN JONES said it was evident great difference of opinion prevailed as to the cause of corrosion. About a fortnight ago the firm with which he was connected made a linerless shaft for a gentleman who had used a similar contrivance to that described by Mr. Boddy to a shaft with a liner, and it was pronounced a failure. They were now making a shaft with a liner for a gentleman who had had one without a liner, and he had been expecting to see those gentlemen present on this occasion, and hear them expound their views.

MR. D. ROBERTS could not reconcile the figures given by Mr. Boddy as to the sounding rod and the

depths of liquid found upon an occasion ten minutes after the first. He presumed that the point of the Paper was—that by getting oil on to the shaft water was prevented coming into contact with the shaft, sea water on the brass being the prime cause of corrosion, and the effect of sea water setting up galvanic action. It might be that the action of Mr. Boddy's oil had prevented an inflow of sea water into the tube. He should like Mr. Boddy's opinion upon this point, because he had never seen the experiment tried. He knew of a shaft with a liner in white metal which had been running for a period of eight years, the ship trading in dirty water and sand. The shaft was fitted with a pipe similar to that described, but a fixed quantity of oil was not put in, the oil being kept a certain head above the stern tube, the head being proportionately reduced when the ship was in light trim. The white metal was renewed last year, after eight years. On the other hand, he had a shaft the other day, barely two years old, with a very severe fracture, although there were few signs of corrosion. He considered the quality of material had a great deal to do with shaft failures. He had examined the shaft of the *City of Rome*, referred to by Mr. Johnson, with the Board of Trade Inspector, who demanded that a hole be driven at certain points through the liner. The metal came out perfectly clean, there being no sign of corrosion. At that time there was some doubt as to the after end of the liner. The propeller was fitted with a rubber ring, and there was no sign of corrosion in the position occupied by the ring. The ring was fitted just sufficient to touch the propeller when it was up at its highest position.

Mr. SIMPSON asked Mr. Roberts if there was an outer gland on the shaft he had spoken of as running eight years? Mr. ROBERTS replied in the negative.

Mr. C. W. HANSEN asked if Mr. Boddy had the drain cock open at the first suffusion of oil. If not, how did he account for its getting down there at all?

The discussion was then adjourned.

THE DENNY GOLD MEDAL.

The CHAIRMAN caused to be passed around the Denny Gold Medal, which had been awarded to their late and deeply lamented friend Mr. J. F. Walliker. They all, he said, greatly deplored that gentleman's death, and regretted that he had not lived to receive so honourable a tribute to his abilities, and his labours on behalf of the Institute he loved so well.

The proceedings closed with a hearty vote of thanks to Mr. Boddy and the Chairman.

ADJOURNED DISCUSSION

AT

3, PARK PLACE, CARDIFF

ON MONDAY, NOV. 25TH, 1901.

CHAIRMAN:

MR. M. W. AISBITT (Vice-President B.C.C.)

The CHAIRMAN said the first point which struck him in considering Mr. Boddy's appliance was the simplicity with which the oil was applied, once it entered the stern tube, by the outside water pressure. They were told in the Paper that when the engines were running full speed ahead, ten minutes after the oil was emptied into the top of the iron pipe, the sounding rod indicated a depth of $1\frac{1}{2}$ in. of liquid, the shaft being immersed about two feet; that, after the vessel was moored, after coming from Newport to Barry Dock, and the engines were at rest, the sounding rod indicated a depth of about two feet of liquid, this corresponding with the shaft's immersion. This, so far as he knew, was the first occasion which had proved a semi-vacuum in the stern tube, the vessel going full speed ahead. Mr. Boddy put in a pipe to reduce that vacuum, so that they were led to believe that there might have been a greater vacuum even than what Mr. Boddy found. Unfortunately, the Paper did not say

whether the vessel was loaded when going full speed ahead, but whether loaded or in light trim, he was inclined to think that the semi-vacuum would not be increased to any extent, that there would be practically the same centrifugal action in the way of the stern tube. Going ahead they got the same vacuum, and going astern they naturally forced the water inward. He recalled the recent case of a vessel which had been ashore four or five hours upon a pebbly beach. She was driven astern for about six hours, with the result that the vessel picked up pebbles, and the liner was cut down from about $\frac{1}{2}$ in. to about $\frac{3}{16}$ in., thus showing the force of the propeller action was inward.

Mr. FLEMING said he was quite at one with Mr. Boddy as to his method of placing the oil in the stern tube, and as to the variation in the depths of liquid found on the tail shaft, when the engines were at full speed ahead, and when at rest in Barry Dock. He took it that the two feet which he found was the ship's light draught. (Mr. Boddy: Yes). While he agreed with Mr. Boddy so far, he considered that an outer gland was necessary. In foul waters, and in Eastern ports—he had Ceylon particularly in his mind—the stern tube became full of shells and foul matter. The proper method was to fit an outer gland, packed with ordinary hemp packing. With this they were likely to get the best results.

Mr. DARLING said Mr. Boddy had shown them how to get the oil into the stern tube, but he had grave doubts as to its ever getting on to the shaft itself. Oil was lighter than water, and unless they had a gland on the after end the oil was bound to go out. He had never found a shaft fitted in this way that had any oil upon it at all. Oil would not do this sort of thing to please them; there were certain inevitable laws of nature to be reckoned with. The best method, in his opinion, of preventing corrosion was to have a continuous liner, or a plain iron shaft run on white metal, a gland at the outer end, and proper lubrication.

Mr. SCOTT (Bute) said he superintended the fitting of the pipe described by Mr. Boddy, and he had seen three of that gentleman's shafts drawn out, when the oil had to be scraped off from end to end between the two brass sleeves. At the same time, he agreed with Mr. Fleming that, under the conditions the latter had described, a stern gland was desirable, although for ordinary voyages he deemed Mr. Boddy's plan sufficiently effective. With a ship running in Indian waters, shells and animalculæ were likely to get into the tube.

Mr. MARWOOD said he should like to know what would be the state of the hemp packing referred to by Mr. Fleming after a 30 days' run. As to corrosion of shafts, his view was that the question chiefly lay in the manufacture of the shafts. The construction of the ship itself had also something to do with it.

Mr. HENDERSON, while agreeing that lubrication was a very good thing, believed that the best method of preserving shafts was to fit a continuous liner, with a very short tube, and cover the shaft and the tube all over with one liner. In this way they got practically a parallel shaft. He was not in favour of running any shaft on a white metal bush. As to Mr. Boddy's appliance, he did not think it was a good one without an outer gland.

Mr. EVAN JONES quite agreed that Mr. Boddy only needed to make his liner continuous, and he would want no oil at all, and would have a much stronger shaft. Lignum vitæ was introduced because it would run better with water lubricant than with oil. If they must use oil, let them run their shaft on white metal, without any liners at all; but they must have something to hold back the oil at the stern—some sort of stuffing box. The Chairman had spoken of a vacuum. If this was the case, how could any oil get in?

Replying to a question, Mr. BODDY said the diameter of his shaft was $9\frac{1}{2}$ ins.

Mr. ROBERTS said Mr. Boddy was the first to take steps to ascertain what really had been going on in the tube. He thought Mr. Boddy's experiment of testing the depth of liquid on the shaft confirmed what the Chairman had said about a partial vacuum taking place. In some experiments conducted some years ago to ascertain whether the propeller was effective or not, it was found that a partial vacuum was formed at a point in front of the propeller, apparently due to the screwing action of the propeller giving a tendency to draw the water away from the shaft through the effort of propulsion. This would account for the sudden drop in the tube which Mr. Boddy fitted, and also explained the oil getting down to the shaft. It would be naturally expected, that when the oil was placed in the tube it would, by its specific gravity, float on to the water, but Mr. Boddy had discovered that the water left the tube, and the oil followed its way downwards. Mr. Boddy had proved that there was a certain body of dead water remaining in the tube, and this water revolving with the shaft attacked the zinc, and galvanic action was set up, which attacked the iron shaft near the coupling. He did not agree that an outer gland was necessary. In the first place, he did not think it was possible to keep the gland perfectly tight, and when they stopped the engines and the supply of lubrication, the hydrostatic pressure would force its way inwards. Mr. Fleming's experience was partly due to the action of the propeller, when the ship went astern, throwing the shells from the boss of the propeller into the tube. Mr. Boddy's appliance was fitted to an existing shaft without any alteration of the stern tube. With the ordinary shaft running in lignum vitæ, his method to prevent corrosion was a good one, and effective, unless, as Mr. Jones indicated, it was intended to prevent the corrosion of the iron of the shaft, and not the brasses, which was a secondary consideration compared with the longer life of a shaft. His own opinion was that the continuous liner was a good thing, but the difficulty was as to the length of the shaft. A long brass liner was very deceptive, and

a jointed liner was not reliable. A short shaft was a solution of the trouble. This was being adopted on the north-east coast, with the result that they had been able to put in a shaft with one continuous liner, approximately nine feet over all. This liner was run in a lignum vitæ bush; the lignum vitæ had not to be renewed so often, and a steadier shaft was got all through; and, of course, the corrosion question was eliminated. They had too long taken it for granted that there had been a separation of water there. Certainly, oil would float to the surface, but it could not float if there was no water to float on.

Mr. T. W. WAILES said if they could introduce, as Mr. Boddy had shown them, a lubricant into the stern tube, it was a good step in the direction of preventing corrosion in tail end shafts. Not sufficient attention was paid, perhaps, to the incessant work ef metal and its effects. Those who had to use chain hooks often knew this to their cost—knew how they would lift heavy burdens one day and fail under a light weight the next. It had been the practice at the establishment with which he was connected to anneal the slings, and very good results had followed. Did they not expect too much work from their shafts? For his part, he was inclined to think that shafts were made too long to withstand the jars.

Mr. GEO. WALLIKER, on the question of vacuum, said some years ago he was in charge of some experiments for the late Mr. Parker, of Lloyd's, who was specially interested in the fitting of propeller blades. A small copper plate was fitted down the stern post to the body opposite ahead of the propeller, with a vacuum gauge. It was a cargo boat trading between London and Hamburg, and on the trial run they got from seven to ten inches of water showing on the gauge. So that there was certainly a vacuum at the stern tube end, in front of the propeller.

Mr. KENDALL said a shaft fitted with Mudd sleeves

had turned out well. Some eighteen months ago an ordinary pump lubricator was fitted to the after peak tank, and the engineer used to put about a pint of oil in every morning. When the shaft was drawn in, there was a scale of about $\frac{1}{16}$ in. thick, as if it had been coated with tar, and no sign of any greasy matter. He expected to find the lubricant there. However, the shaft looked in excellent condition after eighteen months, and he was still using the simple pump lubricator. Latterly they had gone in for a continuous sleeve, the last one about twenty feet long, but it had not yet been drawn in.

Mr. HANSEN thought that the question of cost weighed with many owners. He had often thought that paint was put on to shafts at the wrong time. It should be put on when the shaft was hot, and immediately after the sleeves had been shrunk on, or after the shaft had been heated in the lathe by gas jets, so as to open the pores of the metal. With paint thoroughly in the metal, a great deal would have been done to prevent corrosion. The paint mark put on ship plates at the rolling mill always remained.

Mr. W. SIMPSON did not think the marks referred to would stand on a constantly moving tail end shaft. He should like to know what sort of lubricant Mr. Boddy used, and whether the shaft was found to be coated with grease?

Mr. SCOTT said on the point of the outer gland being made tight, about which there seemed to be a doubt, he saw a short time ago a shaft drawn on one of the Stag Line boats which had been round the Cape, and there was not the least sign on the stern gland, and the shaft was as bright as if it had just left the lathe, although it was about two years old. That gland must have been perfectly tight.

Mr. A. JOHNSON was inclined to doubt the desirability of the Institute judging, with regard to the driving out of the water in the stern tube, after one

experiment. No doubt Mr. Boddy might be right. The centrifugal action might eventually remove the water, and leave a mixture of oil, water, and air, which got down to the shaft. As to the efficiency and long life of the shaft, he considered they needed to look in the direction of larger diameters. The continuous liner was not absolutely perfect, because he had seen such a liner fracture, and the shaft to fracture below it.

Mr. A. S. JACKSON wrote that the only suggestion which he could make as being, in his opinion, an improvement on Mr. Boddy's method would be to fit a ratchet pump in the tunnel, actuated by the vessel's own machinery, and which would automatically work when the shafting revolved, and thereby regularly force a constant supply of lubricant into the stern tube.

Mr. T. D. WIDDAS asked, if centrifugal action operated in the tube, how came it that the water was reduced in the pipe when the engines were running? It was probably by friction that the oil was drawn down, but surely it would not be the centrifugal action of the water.

The CHAIRMAN apprehended that Mr. Boddy referred to the centrifugal action of the fans of the propeller.

Mr. DARLING: If that is the case, and the water is drawn down the pipe and out, why does the oil stop in and the water go out? That is what I cannot understand.

Mr. BODDY, in reply, said, with reference to the observations of Mr. Simpson at the previous meeting, that the shaft alluded to in the Paper had been running for six years and nine months, and the oil pipe arrangement was fitted about four and a-half years ago. As to the advocacy by several members of an outer gland, in his opinion the oil pipe was sufficient, when fitted as near as possible to the after end of the stern tube, so that the outside water pressure might force the oil

forward. The outer gland was not only unnecessary, but might be a source of danger where the lubricant had been neglected, when the shaft would be practically running without any lubrication whatever. His experience showed him that the oil was driven from the point at which it was put into the tube right through to the stern gland, where there was always a soapy run. With regard to the question of Mr. Johnson, the oil pipe was first fitted before the vessel was re-floated out of dry dock, and about half-a-gallon of oil was poured down the pipe, since which he had found that half-a-pint used daily was sufficient. If the shaft was immersed when the oil was put down the pipe, the oil would go no further until some motion took place. With regard to the rubber ring fitted in the recess of the propeller, if it was fitted just sufficiently tight there was little fear of its forcing the propeller away. As to Mr. Watson's remark, oil certainly had a tendency to float outward and upward, but he failed to see how it was going either way against a pressure. As to similar appliances to his being fitted, and proving a failure, as mentioned by Mr. Evan Jones, he should like to know how the appliance was fitted. Mr. Roberts could not reconcile the figures as to the depth of liquor. In his opinion the difference was attributable to the centrifugal motion of the shaft, combined with the scooping action of the propeller, forming the vacuum of which they had heard so much. As to Mr. Darling's remarks, all he could say was that he knew that the oil did get to the shaft; it had been seen several times when the shaft had been drawn in, the shaft being thickly coated with grease, not only the full length, but also through the stern gland, indicated by the lather there while the engines were at work. As to the continuous liner, so long as the liner could be kept tight he did not suppose there would be much corrosion. Mr. Kendall spoke of the Mudd sleeve. They all knew sufficient of this without discussing it. Sometimes it was all right, at other times it was all wrong. As to the kind of oil used, it was the same as that used for lubricating the machinery—viz., Vickers'.

DISCUSSION

AT

58, ROMFORD ROAD, STRATFORD,

ON MONDAY, NOVEMBER 25TH, 1901.

CHAIRMAN:

MR. W. C. ROBERTS (Chairman of Council).

The CHAIRMAN: This paper has already been read before the Members at the Bristol Channel Centre, at Cardiff, where Mr. Boddy, the Author, is resident. The subject is now open for discussion.

Mr. J. B. JOHNSTON said he should like to ask how the oil was going to get down this copper pipe provided by Mr. Boddy? Oil floated on the top of water, and unless they used a pump, or some form of pressure, he failed to see how the oil was to get down into the stern tube. The oil must be forced in by some means.

Mr. W. MCLAREN suggested that a partial vacuum was formed in the stern tube.

Mr. GEO. SHEARER said he thought the plan described in the paper a very fine idea, and the effective lubrication of tail shafts was a thing that had been long wanted. At the same time, Mr. Johnston's question was very much to the point, and it was one they could not get out of. He had the same idea—that it would be absolutely necessary to force in the lubricant by pressure, and he could not see how otherwise it was possible for the oil to find its way down. Personally, he had never had much trouble with tail shafts, although he had seen some very bad cases of corrosion. He believed he was the first chief engineer of a first-class ship to run a tail shaft that was covered from end to end. That was the case of the *Orient*. Her shaft was covered from end to end. The sleeve was in three sections, and they were shrunk on in the first place, and fitted with feather and groove. After

being put together the shaft was taken to the brass-foundry, and those joints were burned round, but they were only burnt three inches at a time. Of course, if they had attempted to burn the whole circumference, or even the half of it, expansion would have taken place to such an extent that the metal might not have recovered itself. Therefore they only burnt three inches at a time until the whole round was solid. That shaft was in the ship now, so far as he knew, and, if so, it was 21 years old. There had been many devices for preventing the corrosion of tail shafts. Mr. Mudd, for instance, provided an india-rubber sleeve, but a very simple method was, when the tail shaft was drawn, to have it thoroughly cleaned, and then properly coated with a hot solution of tallow and wax. He thought that that would prove quite as good as an india-rubber sleeve, and be very much cheaper. The life of india-rubber was but short; and in his experience rubber lost all its elasticity in something like 18 months. The suggested vacuum in the stern tube was, he thought, quite an impossibility. With regard to the plan described in the paper, he thought that Mr. Boddy made the mistake of putting in the oil at the wrong end, and that if the oil was injected at the bottom instead of the top the result would be far more satisfactory.

Mr. Robt. Duncan described the good results that had followed the lapping of shafts with marlin and red lead, and said that years after this method had been applied he had found the shafts in excellent condition. The read lead seemed to protect the shafts much better than the rubber. They would see from Mr. Boddy's drawing that a cock was wanted at the bottom of the stern tube as well as on the top, and to get all the water out of the tube they must open the bottom cock and draw off the water until the oil began to come, when, presumably, they would have oil all round the shaft. But the fact that all that sand and grit was found in the stern tube showed that it was not so very tight.

Mr. W. LAWRIE said the explanation of the last speaker as to the filling up of the stern tube with oil hardly fitted in with the contents of the paper. According to Mr. Boddy, half a pint of oil was put into the pipe. They did not hear of any more oil going in, and the results recorded could not possibly be due to drawing out the water and putting in half a pint of oil. The oil must have got mixed up with the water somehow. He did not think the vacuum theory was the correct one.

Mr. B. T. VICKERS (visitor) said he was very much obliged to the Honorary Secretary for sending him an invitation to attend this meeeting, and he was very glad of the opportunity of being present, because the subject under discussion was one in which he took great interest. Mr. Boddy's experience appeared to be that putting oil into the stern tube had lengthened the life of the lignum vitæ in the stern bush. In the course of his business he (Mr. Vickers) had come into contact a good deal with steamers belonging to Continental owners, and so far as the steamers of Sweden, Norway, and Denmark were concerned, there were very few which were not running their tail shafts in oil, and a broken tail shaft was a thing practically unknown. The United Steamship Company of Copenhagen owned about 130 steamers, the whole of which ran their tail shafts in oil, and they never had a break. Most of them were linerless shafts, running in cast-iron bushes, and the running of the shafts in oil was a great success. He instanced also the case of a large screw tug owned in the north of England, which was built in 1885, which had an iron shaft fitted with brass liners and running in a gun metal bush, the shaft of which had been run in oil. About two years ago this boat was overhauled, when the shaft was found to be in perfect condition, the original tool marks being still visible on the part between the two liners. The wear on the brass liners was exceedingly slight, considering the 14 years the shaft had been at work, only amounting to about one-eighth of an inch. New liners were fitted in the shaft,

and it was replaced in the steamer and appeared likely to run for many years more; the splendid condition of the shaft being undoubtedly due to the fact that it had been run in oil from the commencement. After referring to several other points of practical interest in connection with the working of tail shafts, Mr. Vickers called attention to the importance of using in the stern tube only oil which was practically free from acid. He explained that some oils contained a considerable percentage of acid, and that an acid oil was liable to set up galvanic corrosion in the same way as a solution of acid in water. He also pointed out that the action of sea water, which was a solution of chloride of sodium, upon the brass liner in contact with the shaft in the stern tube, was exactly the same as that which took place in the battery of an electric bell with two different metals in contact in a solution of chloride of ammonia, and emphasised the importance of keeping the sea water entirely out of the stern tube. He said the best way to keep the sea water out of the stern tube was to keep the tube quite full of oil, this method having the further advantage that it effectually lubricated both the stern bush and the stern gland. The difficulty then arose of keeping the oil in the tube. Mr. Vickers exhibited a new patent stern tube gland which his firm had invented for this purpose, and he described its construction and working. This fitting, he said, was attached at the outer end of the stern tube, in order to keep the oil in the tube. It was a gland which contained a "floating" gland, through which the shaft passed, and which contained a series of fibrous discs, which fitted close around the shaft. When the oil entered the fibres these discs expanded, and consequently kept close to the shaft. Being of a fibrous nature there was no friction, and they allowed the shaft to run freely. The "floating" gland was surrounded by an open space within the fixed gland, sufficiently large to allow it to rise and fall with the shaft. It was kept close up against the forward inner face of the fixed gland by the other half of that gland, the whole being made a working fit. Outside this fixed gland were

placed elastic discs made of elastic felt and oil-proof rubber, which lay along and around the shaft like the sleeve of a diver's jacket, and which effectually kept out both sand and water. These were all kept in place by the guard-ring, the whole being simple, compact, and self-contained. One advantage of this arrangement was that it could be fitted to existing stern tubes without any expense, except the lengthening of the guard-ring bolts, and the making of the necessary holes to allow the inlet and outlet oil pipes to be fitted to the stern tube. Another advantage was that the shaft could readily move inwards or outwards without interfering with the efficacy of the gland. To keep the tube filled with oil they fixed well up in the ship—sufficiently high above the water level to ensure that the column of oil inside balanced the column of water outside—a good-sized tank, containing, say, 20 to 50 gallons of oil, from which the stern tube drew its oil as it required it. From this tank they carried a pipe down to the side of the stern tube, which entered the stern tube just forward of the after liner. From the top of the stern tube, and at the opposite end, they carried a return pipe, which entered the tank below the level of the oil, thus allowing any oil which might have become warm in the stern tube to rise up into the tank, allowing fresh cool oil to circulate down to the stern tube, this being on the principle of the hot water boiler behind the kitchen fire, with its circulating pipes connected with the hot water tank at the top of the house. From these "up-flow" and "down-flow" pipes they carried testing pipes through the stern bulkhead into the tunnel, so that the engineer could readily ascertain whether his stern tube was full of oil. The pipes and tanks were so arranged that they could be readily cleaned out. To provide against any possible contingencies, they carried a pipe from the water service in the tunnel into the stern tube, so that the engineer could, in case of emergency, force water into the stern tube. This method of supplying oil to the stern tube his firm considered a great advantage upon any previous method. Hitherto oil had been usually forced into the

stern tube by hand, or pumped in by a "Mollerup" feed. Both these methods required frequent attention on the part of the engineer, and had these manifest disadvantages, that if no oil was leaking from the stern tube the oil which was forced in was simply forced through and wasted, whilst, on the other hand, if the oil was leaking away from the stern tube more rapidly than the pump was supplying it the stern tube was in danger of running dry, the consequences of which might be disastrous. By his method the stern tube only drew oil from the tank as it required it, and the quantity was sufficiently large to provide for all probable requirements. The oil tank was fitted with a gauze filter through which the oil was filled into it, and also with a sounding rod by means of which the engineer could readily ascertain the quantity of oil remaining in the tank. The gland which he now showed was one prepared for a Swedish steamer belonging to a firm in Gothenburg, and which was shortly going into dry dock, when this gland would be fitted. Early this year a set of their appliances was fitted to the steamship *Ibex*, owned by the Great Western Railway Company, a fast twin-screw steamer, having an 11-in. shaft, and running at about 145 revolutions per minute, her speed being about 18 knots. Formerly, this steamer caused her managers a great deal of trouble. She ran in sandy water, and the sand used to get into the tube; on one occasion one of the shafts "seized" the stern bush, when the heat was so great that the bush became fused to the shaft. When afterwards withdrawn it was impossible to separate it, and it had to be split off. Since the appliances of his firm were fitted to the starboard stern tube this boat had run exceedingly well, and during the seven months she had been running there had not been the slightest trouble with her. The owners were so satisfied with her working that they had just ordered the same appliances to be fitted to two new twin-screw boats which were now being built.

Mr. C. PERKINS (Member), said there was a popular

idea that lignum vitæ was used for bushes because it possessed lubricating properties, and, in the course of conversation, he recently suggested this idea to the curator at the Kew Gardens Museum. The curator was not an engineer, and did not know why lignum vitae was used by engineers. He thereupon told him it was because of its supposed lubricating qualities. The curator, however, remarked that lignum vitæ was more highly charged with resin than almost any other wood that could be named, and that the resin in the wood actually preserved it and kept the water out of it. This information was quite new to him, and might also be new to other Members.

Mr. GEO. SHEARER (Member) : It is also news to me. Resin would rather increase the friction than decrease it.

Mr. PERKINS said he was also told by the curator that whenever lignum vitæ was cut it would always ooze, and that this could always be observed with a magnifying glass.

Mr. ROBT. DUNCAN (Member), observed that with some woods water seemed to act almost as a lubricant. Lignun vitae, for instance, if used dry, wore very quickly, but if used in water, the water appeared to have the effect of a lubricant. It was very much the same with greenheart.

Mr. W. LAWRIE (Member of Council), said he thought there was something in the complaint that they were a little behindhand in their ideas as to the lubricating of tail shafts. This idea of Mr. Vickers' was a very feasible one, although he had the same doubt as had already been expressed in the discussion, that the ring might revolve with the shaft. It was possible that the ring might be free to move up and down, and yet not free enough to allow the shaft to go round. It would need a very fine adjustment. He did not say this against the idea at all, because anything

like this, going in the right direction, was a thing they ought to warmly welcome, and do all they could to push it forward. The idea looked a good one, and seemed to provide what was required to keep the oil in. He did not think himself that there was anything very serious against it.

Mr. SHEARER said that Mr. Lawrie had suggested the possibility of the ring seizing, but it would be a very simple matter to get over that difficulty by providing two stay pins in the ring, with plenty of play. He was afraid, however, that the india-rubber would soon be destroyed, and that within a month it would become like a piece of glue.

Mr. VICKERS: That rubber has been specially made to stand oil, and will stand for a year and a half.

After some remarks from Mr. McLAREN and Mr. JOHNSON—

The CHAIRMAN said the paper had given rise to a most interesting discussion, and he was sure they would desire to express their thanks to Mr. Boddy for his contribution. They were also very much indebted to Mr. Vickers for the description which he had given them of his patent stern tube gland. He was recently on a steamer that was fitted with an arrangement of this kind—it was something of this nature—and he was told that it was a very great success.

Mr. VICKERS: Most of the other systems have the fatal objection of being attached to the propeller boss. Ours is quite independent of it.

The CHAIRMAN said that he was sorry that Mr. Boddy was not able to be present to reply to the discussion, but his reply would doubtless be printed in the Transactions. If Mr. Vickers would be kind enough to give them the results of his experience, in the form of

a paper, one evening, they would all be very glad to give him every possible assistance.

A very hearty vote of thanks to Mr. Boddy was then unanimously passed, and the Chairman intimated that on Monday, Dec. 2nd, Mr. G. W. Newall would deliver a lecture, with experiments, on "Coal and its Fumes," while on the following Monday the President would deliver his address, and a large attendance of Members was especially desired. The Annual Conversazione would take place at the Stratford Town Hall, on Dec. 6th.

A vote of thanks to the Chairman, proposed by Mr. McLaren and seconded by Mr. Lawrie, concluded the meeting.