THE INFLUENCE OF THE WEATHER

ON THE

WORKING OF PADDLE ENGINES.

(Read by the Honorary Secretary).

Rather more than five years ago, the writer was chief assistant in carrying out some experimental investigations on various kinds of coal, under actual working conditions, on paddle steamers. These experiments extended over a period of five months, and being carried out on three different steamers, the number of indicator diagrams altogether taken was nearly 5,000. It naturally follows, that amongst this number, there should be diagrams at various speeds and pressures, and under very varying conditions of wind, weather, temperature, &c. Having a complete record of all the particulars taken during the experiments, the deductions from them and the actual influence of the various modifying conditions upon the engine-power exerted, may be tabulated; also the cost of the fuel used, per Indicated Horse Power per hour, in pence. Each of the different kinds of coals experimented upon, was that used at the time by all the steamers of the same line, but whereas, the steamers not subjected to the experiments used the coal exactly as it arrived from the colliery, dust and small included; the steamers on which the experiments were carried out had the coal screened before being placed aboard, at the rate of one shilling extra per ton, probably the actual cost of coal used would come to about the same.

The total number of trips made was 82; 28 being with the *Paris* (oscillating compound engines, cylinders 41in. and 72in., by 5ft., stroke); 40 with the *Normandy* (diagonal compound engines, cylinders 46in. and 83in., by 5ft. stroke); and 14 with the *Brittany* (sister ship to the *Normandy*). In the tables at the end of this paper, are grouped together the chief results from the two first steamers, but as of the 14 trips, made with the last-named, only one was a bad passage, all the others being exceptionally fine, it is not considered necessary to tabulate the results from her, as the influence of the weather would be but slight.

All the steamers belonged to the Newhaven and Dieppe Service, and at the period when the experiments were undertaken, it was often a question of waiting for water outside the harbours, the depth on the bars not being sufficient to allow the steamers to enter immediately on arrival, hence the explanation of the lines in the tables devoted to detention. When there was likely to be detention, the steamers of course were not driven so hard as if there had been none, so that those trips on which detention took place can hardly be looked upon as giving a fair result of the weather's influence. In the tables of the results from the *Paris*, there was detention on 12 trips out of 28, or nearly one-half, in the case of the *Normandy*, there were 13 out of 40, or one-third. The distance from Newhaven to Dieppe, in a straight line, is reckoned at 64 knots. It will be observed that in the *Normandy*, this distance was very closely approximated to, throughout the experiments, the run being measured by a WALKER's Patent Harpoon Log; the mean of 28 trips gave 65·1 knots, and as the distance run would probably be greater than the actual distance, allowing for starboarding, porting, currents, wind, weather, &c., but being only 1.7 % greater, it shows that the Marine Department entered thoroughly into the spirit of the trials in order to make the results as perfect as possible.

Having been under the impression, previous to these coal trials, that bad weather made a greater difference to a ship than can be concluded from these experiments, the writer was somewhat unprepared to read the records and find results so different from his expectations, hence a natural feeling almost of disappointment.

When one has a pet theory, the usual method is to compile data favouring that theory, and, if possible, construe opposing data in order to make the result seem to be also a supporter. This undoubtedly, frequently leads to the idea that the theory has a greater influence on results than is warranted, and consequently, although it may, and probably has, an influence, we expect too much from it, hence the disappointment when experiment and experience overthrow our too sanguine anticipations.

But to proceed with the experiments. The tables contain most of the data, and should therefore be consulted along with the following short notes of each trial :—

TABLE 1.

COAL—STEPHENSON CLARK'S MERTHYR.

P.S. "Paris." SMOOTH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
1	27·6	160·1	27·5	2·58 lbs.	·319 pence
4	25·8	162·0	29·7	2·57 ,,	·316 ,,
6	25·6	152·0	25·1	2·26 ,,	·254 ,,
7	26·2	151·5	24·8	2·14 ,,	·240 ,,
8	23·2	145·1	21·5	......	......
11	25·5	141·6	19·6	......	......
Average	25·65	152·05	24·7	2·39 lbs.	·282 pence

No. 1.—Newhaven to Dieppe, cargo 12 tons; mean draft, 7ft. 6in.; maximum horse-power, 664·56; minimum, 635·71. The weather being fine, and the sea calm, only 9,888 revolutions were made, giving an average of 27·6 per minute, with a consumption of 2·58lbs. of coal per I.H.P. per hour, and a paddle-wheel slip of 27·5 %. Revolutions per knot, 160·1.

No. 4.—Dieppe to Newhaven, cargo 60 tons; mean draft, 7ft. 11in.; maximum horse-power, 725·62; minimum, 599·31. The weather was fine and the sea calm, the revolutions were thus reduced to 9,275, or an average of 25·8 per minute, and a consumption of 2·57lbs. per I.H.P., about the same as No. 1. This is one of the cases in which detention took place, hence is not a fair sample, for knowing before starting that there would be detention the engines were not driven; this, of course, has something to do with the small number of revolutions, and the slip should be correspondingly small, but is as high as 29·73 %. The log probably did not register correctly in this case; 57¼ knots being too little for a 64 knot passage.

No. 6.—Dieppe to Newhaven, cargo 95 tons; mean draft, 8ft. 2½in.; maximum horse-power, 782·19; minimum, 590·43. The weather was good, and the revolutions only 9,465, an average of 25·6 per minute, about the same as No. 4, a correspondingly fine weather passage.

No. 7.—Newhaven to Dieppe, cargo 16 tons; mean draft, 7ft. 8in.; maximum horse-power, 771·87; minimum, 541·54. The weather being fine and the sea smooth the consumption was reduced to 2·14 lbs. per I.H.P. The large number of revolutions (9,770), is partly accounted for by the fact that there was three-hours-and-a-half ebb tide to stem against. The course from Newhaven to Dieppe being partly up Channel, and not straight across; the flow or ebb tide, as the case may be, often makes a difference of two or three revolutions, and a difference of a quarter-of-an-hour to twenty minutes in time.

No. 8.—Dieppe to Newhaven, cargo 65 tons; mean draft, 8ft. ½in. The indicating gear gave out on this trip, and no diagrams were taken. It was another fine passage and the revolutions were brought down to 9,140, an average of 23·2 per minute; the revolutions per knot were very small also, being only 145·1

No. 11.—Newhaven to Dieppe, cargo *nil*, mean draft 7ft. 6in; the indicator gear failed again. The high number of revolutions must be accounted for by the strong ebb tide of three hours and a half.

TABLE 2.

COAL—STEPHENSON CLARK'S MERTHYR.

P.S. "Paris." ROUGH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
2	27·9	149·7	24·0	3·11 lbs.	·381 pence
3	26·7	157·4	27·7	2·31 ,,	·281 ,,
5	26·2	154·0	27·5	2·53 ,,	·310 ,,
9	26·5	158·7	25·3	2·50 ,,	·281 ,,
10	28·7	149·1	23·8	2·57 ,,	·289 ,,
12	28·2	148·8	27·4	2·90 ,,	·326 ,,
Average.	27·36	152·95	25·95	2·65 ,,	·311 pence

No. 2.—Dieppe to Newhaven, cargo 68 tons; mean draft, 7ft. 11in.; maximum horse-power, 754·43; minimum, 710·68. There was a choppy head sea, bringing the revolutions up to 10,520, or an average of 27·9 per minute, and the consumption to 3·11lbs. per I.H.P., the slip being 23·98 %, thus giving less slip in bad weather. The revolutions per minute are ·3 greater than in No. 1, owing to the fact of the engines being driven harder to make the passage in reasonable time, owing to an intuitive idea that the weather would reduce the speed. The revolutions per knot are 149·7, less than in No. 1, the slip being less.

No. 3.—Newhaven to Dieppe, cargo 18 tons; mean draft, 7ft. 7½in.; maximum horse-power, 729·84; minimum, 603·79. There was a choppy head sea again, the total revolutions being 10,150, an average of 26·7 per minute, and 157·4 per knot. The consumption of coal was only 2·31lbs. per I.H.P., less than should be expected, but in this case the engines were not driven to the full extent of their power, as some waiting for the tide was reckoned on, which, however, the length of the passage rendered unnecessary.

No. 5.—Newhaven to Dieppe, cargo 14 tons; mean draft, 7ft. 8in.; maximum horse-power 804·85, minimum, 525·17. The sea was choppy again, bringing the revolutions up to 9,950, an average of 26·2 per minute, and 154 per knot. The consumption was only 2·53lbs. per I.H.P., or nearly about the average.

No. 9.—Newhaven to Dieppe, cargo 54 tons, mean draft 8ft. ½in., maximum horse-power 819·36, minimum 604·64. In this case there was four hours flood tide to start with, which materially helped to reduce the total revolutions, but in spite of this they mounted up to 9,640 in consequence of the rough sea. The consumption per I.H.P. kept to about the average of 2·5lbs.

No. 10.—Dieppe to Newhaven, cargo 29 tons, mean draft 7ft. 7in., maximum horse-power 817·11, minimum 725·32. The choppy head sea brought the revolutions up to 9,900.

No. 12.—Dieppe to Newhaven, cargo 37 tons, mean draft 7ft. 9½in., maximum horse-power 793·27, minimum 617·32. In this case the state of the sea affected the consumption, bringing it up to 2·91lbs. per I.H.P.

These twelve trips finished the trials on the *Paris* with Stephenson Clark's Merthyr, the results, tabulated into two groups of smooth sea and rough sea, being both given.

Notes on Tables 1 and 2:—With the smooth sea the average revolutions per minute are 6·2% less than with the rough sea, the reason being that the engines are driven harder in bad weather in order to make the passage.

The revolutions per knot are almost identical under both conditions. The slip works out different to what may be expected; as in rough weather one would look for the slip being less than in fine, these two tables show the reverse to be the case. Those of our members who have not had experience with Paddle Steamers may not be aware that rough weather brings the engines up, instead of causing them to race like screw engines, owing to the rolling of the ship immersing first one paddle and then the other very deeply, whereas pitching has no effect on them.

The coal used per I.H.P. per hour is 9·8 % less in fine than in bad weather, and the cost of the coal per I.H.P. per hour is 9·3% less in fine than in bad weather. Strictly speaking these two percentages should be the same, but the difference is accounted for by the cost of the coal per ton placed on board varying under certain conditions.

TABLE 3.

COAL—LEWIS MERTHYR.

P.S. "Paris." SMOOTH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
14	24·4	140·9	19·22	......	......
15	26·4	150·0	24·15	2·72 lbs.	·295 pence
16	23·2	141·9	19·8	2·58 ,,	·279 ,,
17	29·7	151·2	24·7	2·77 ,,	·300 ,,
18	28 0	149·7	22 05	......	......
20	27·9	147·2	22·8	......	......
21	26·1	143·6	20·72	......	......
23	27·3	149·0	22·75	2·76 lbs.	·299 pence
Average.	26·6	146 68	22 02	2·71 lbs.	.293 pence

No. 14.—Dieppe to Newhaven, cargo 54 tons; mean draft, 7ft. 10½in.; maximum horse-power, 693·26; minimum, 508·49. The total revolutions very small again, due to the fine weather. The average horse-power, however, is very small for one reason or other, being only 587·63, and the consumption per I.H.P. per hour 3·53lbs. There is manifestly a mistake here, the consumption and cost are therefore omitted from table No. 3, as it would only vitiate the result to consider them for the average.

No. 15.—Newhaven to Dieppe, cargo 17 tons; mean draft, 7ft. 9½in.; maximum horse-power, 759·93; minimum, 581·16. Fine weather.

No. 16.—Dieppe to Newhaven, cargo 66 tons; mean draft, 7ft. 11½in.; maximum horse-power, 769·20; minimum, 539·58. The strong ebb tide reduced the revolutions to less than 9,000, and the slip was also small.

No. 17.—Newhaven to Dieppe, cargo 15 tons; mean draft, 7ft. 7½in.; maximum horse-power, 878·82; minimum, 838·91.

No. 18.—Dieppe to Newhaven, cargo 57 tons; mean draft, 8ft. Indicator gear failed.

N.B.—These last two trips were fast sailings, which will account for the high average revolutions per minute.

No. 20.—Dieppe to Newhaven, cargo 71 tons; mean draft, 8ft. 1in. Indicator gear failed. This was a fast sailing, bringing the average revolutions per minute up to 27·9.

No. 21.—Newhaven to Dieppe, cargo 12 tons; mean draft, 7ft. 9½in. Indicator gear gave out. Oscillating engines are rather difficult to indicate, and one requires a great deal of patience to watch with equanimity, the indicating gear failing time after time.

No. 23.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 6in.; maximum horse-power 857·44; minimum 583·99.

TABLE 4.

COAL-LEWIS MERTHYR.

P.S. "*Paris.*" ROUGH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
13	26·7	138·1	17·55	2·74 lbs.	·297 pence
19	27·9	147·8	22·98	......	......
22	29·1	146·9	21·33	2·84 lbs.	·307 pence
24	26·0	147·3	19·77	2·88 „	·312 „
Average.	27 4	145·02	20·41	2·83 lbs.	·306 pence

No. 13.—Newhaven to Dieppe, cargo 19 tons; mean draft, 7ft. 8in,; maximum horse-power, 820·25; minimum, 654·16. A large number of revolutions again, due to the choppy head sea, but the slip was only 17·55 %.

No. 19.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 6in.; Indicator gear failed.

No. 22.—Dieppe to Newhaven, no cargo; mean draft, 7ft. 6in.; maximum horse-power 853·82; minimum 698·86. The bad weather brought the revolutions up to 10,130.

No. 24.—Dieppe to Newhaven, cargo 99 tons; mean draft, 8ft. 1½in.; maximum horse-power 728·93, minimum 606·44. Another choppy sea passage.

These twelve trips finished the trials on the *Paris*, with Lewis Merthyr coal, the results, tabulated into two groups of smooth sea and rough sea, being given.

NOTES ON TABLES Nos. 3 & 4 :—Comparing the averages of the two tables, the revolutions in fine weather are 3 °/₀ less than in bad, and the coal per I.H.P. per hour, and cost of coal per I.H.P. per hour, are 4·2 °/₀ less.

The remaining four trials on the *Paris* were with Cwrn Bran and Abercarn mixed coal, and being so few in number are not sufficient to strike an average.

NOTES ON TABLES Nos. 1 to 4 :—Taking tables 1, 2, 3 and 4, as a fair sample of the usual results of the weather on oscillating paddle engines, it follows that in bad weather they require driving from 3 to 6 °/₀ faster than in fine, to keep up the speed of the ship, and the actual result of this is that the cost of coal used will be from 4 to 9 °/₀ more, the higher percentage being a serious one to a shipowner, and taking the average of the two tables together, the cost of coal used comes to 7·3 °/₀ more in bad weather than in fine.

In tables 5 and 6, constituting the results from the *Normandy*, all those trips on which there was detention, are omitted, as, being a much faster steamer than the *Paris*, she could take it much easier if there was to be any waiting for tide, and thus annul any effect due to the weather. Under these circumstances I considered it better to omit them, as they would entirely alter and spoil the results aimed at.

TABLE 5.

COAL—STEPHENSON CLARK'S MERTHYR.

P.S. "Normandy." SMOOTH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
36	41·8	149·7	22·49	1·66	·186 pence
37	41·3	144·9	21·85	1·90	·224 ,,
38	41·8	153·3	25·80	1·96	·230 ,,
42	40·8	150·3	24·27	1·89	·222 ,,
44	40·6	148·6	23·41	1·64	·184 ,,
56	42·4	... ..	......	2·11	·218 ,,
58	43·4	150·0	24·08	1·93	·217 ,,
60	40·6	151·6	24·65	2·18	·245 ,,
61	42·3	145·7	21·86	1·86	·219 ,,
62	41·5	149·4	23·80	1·91	·225 ,,
Average	41·6	149·3	23·47	1·90	·217 pence

No. 36.—Dieppe to Newhaven, cargo 6 tons; mean draft, 7ft. 9½in.; maximum horse-power, 2,381·01; minimum, 1,912·32. The coal used per I.H.P. per hour is to be particularly noticed, being only 1·66 lbs., a very small amount for a compound paddle engine.

No. 37.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 10in.; maximum horse-power, 2,589·58; minimum 1,963·60. When taking the maximum horse-power the revolutions were 46 per minute.

No. 38.—Dieppe to Newhaven, cargo 17 tons; mean draft 7ft. 11in.; maximum horse-power, 2,498·40; minimum, 1,714·25.

No. 42.—Dieppe to Newhaven, cargo 46 tons; mean draft, 7ft. 11½in.; maximum horse-power, 2,544·68; minimum, 2,041·42.

No. 44.—Dieppe to Newhaven, cargo 13 tons; mean draft, 7ft. 9in.; maximum horse-power, 2,662·12; minimum, 2,125·06. The small amount of coal per I.H.P. per hour, 1·64 lbs., was very small again, less than in No. 36.

No. 56.—Dieppe to Newhaven, cargo 23 tons; mean draft, 7ft. 10½in.; maximum horse-power, 2,691·89; minimum, 2,093·15.

No. 58.—Dieppe to Newhaven, cargo 22 tons; mean draft, 7ft. 10in.; maximum horse-power, 2,724·12; minimun, 2,101·87. This maximum power was taken at 46½ revolutions per minute.

No. 60.—Dieppe to Newhaven, cargo 31 tons; mean draft, 7ft. 10½in.; maximum horse-power, 2,388·68; minimum, 1,922·15.

No. 61.—Newhaven to Dieppe, cargo 7 tons; mean draft, 7ft. 9in.; maximum horse-power, 3,164·82; minimum, 2,100·01. This maximum power was at 48 revolutions per minute, and was the highest ever obtained from these engines, being some 400 horse-power higher than on her trial trip before she left the Builder's Hands.

No. 62.—Dieppe to Newhaven, cargo 47 tons; mean draft, 8ft. 0½in.; maximum horse-power, 2,524·91; minimum, 2,263·42.

TABLE 6.

COAL—STEPHENSON CLARK'S MERTHYR.

P.S. "Normandy." ROUGH SEA.

No. of trip.	Revolutions per minute.	Revolutions per knot.	Slip per cent.	Coal per I.H.P.	Cost of Coal per I.H.P.
29	35·0	....	....	......	......
30	32·8	....	....	......	......
39	40·0	145·3	20·17	1·91	·222 pence
40	36·9	141·0	19·25	1·85	·218 ,,
41	37·5	141·2	19·38	1·90	·224 ,,
43	37·3	....	....	1·87	·210 ,,
45	37·7	....	....	2·02	·238 ,,
46	38·8	....	....	1·95	·229 ,,
47	37·2	....	....	2·07	·243 ,,
48	41·0	....	....	2·00	·235 ,,
49	41·2	....	....	1·91	·225 ,,
50	41·4	....	....	2·18	·256 ,,
54	43·1	....	....	2·32	·273 ,,
59	39·8	146·7	22·39	2·23	·250 ,,
Average	38·5	143·6	20·3	2·02	.235 pence

No. 29.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 9½in. The indicator gear and harpoon log were not in use on this and the next trip.

No. 30.—Dieppe to Newhaven, cargo 1 ton; mean draft, 7ft. 9in.; a particularly bad passage. On fast sailings, if this steamer was over four hours and a quarter, the weather might be assumed to be pretty nearly a gale.

No. 39.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 7½in.; maximum horse-power, 2,482·36; minimum, 1,635·23.

No. 40.—Dieppe to Newhaven, cargo 3 tons; mean draft, 7ft. 7½in.; maximum horse-power, 2,674·85; minimum, 1,893·52. A very bad passage.

No. 41.—Newhaven to Dieppe, cargo 16 tons; mean draft, 7ft 8½in.; maximum horse-power, 2,381·48; minimum, 1,864·10. These last three passages had very little slip.

No. 43.—Newhaven to Dieppe, no cargo; mean draft, 7ft. 7in.; maximum horse-power 2,317·61, minimum 1,892·83.

No. 45.—Newhaven to Dieppe, cargo 11 tons; mean draft, 7ft. 8½in.; maximum horse-power, 2,460·20, minimum 1,836·94.

No. 46.—Dieppe to Newhaven, cargo 20 tons; mean draft, 7ft. 8in.; maximum horse-power, 2,811·91; minimum, 1,960·42.

No. 47.—Newhaven to Dieppe, cargo 14 tons; mean draft, 8ft. 1in.; maximum horse-power, 2,642·91; minimum, 1,936.94.

No. 48.—Dieppe to Newhaven, cargo 16 tons; mean draft, 7f. 9in.; maximum horse-power, 2,530·90; minimum, 2,100·02.

No. 49.—Newhaven to Dieppe, cargo 18 tons; mean draft, 7ft. 10in.; maximum horse-power, 2,652·40; minimum, 2,085·32.

No. 50.—Dieppe to Newhaven, cargo 33 tons; mean draft, 8ft.; maximum horse-power, 2,781·71; minimum, 2,129·36. On the last six trips the log was out of order, hence no record was kept of the distance run.

No. 54.—Dieppe to Newhaven, cargo 18 tons; mean draft, 7ft. 11½in.; maximum horse-power, 2,523·63; minimum 2,250·74. Log out of order again in this trip and No. 56.

No. 59.—Newhaven to Dieppe, cargo 2 tons; mean draft, 7ft. 9in.; maximum horse-power, 2,558·34; minimum, 2,022·00.

Tabulating these trips into two groups of smooth and rough sea, as with the *Paris*, the results are also shown.

The revolutions per knot are omitted, also per centage of slip out of No. 43, as the log registered 60½ knots, which was evidently a mistake.

The coal used per I.H.P. per hour is 9% less in fine weather than in rough, about the same result as was obtained with the same Coal on the *Paris*; the cost of the coal used was 7·7% less in fine than in rough weather, about the same result as was obtained by grouping tables 1, 2, 3, and 4 of the *Paris* together.

The revolutions per minute are 8·2% more in fine weather than in rough, naturally giving a greater slip. This is different to the *Paris*, and can be accounted for in this way:—The *Paris* was employed on the night service, and was allowed six hours for her passage; in fine weather she could do it easily, and did not require to drive, but in bad weather she had all her work cut out, and had to be pushed along as hard as she could go, hence the revolutions per minute were more than in fine weather. The *Normandy* was employed in the daily service, and was only allowed four hours for her passage; she could not do the passage much under this in the best of weather, and hence was always driven, the result being that in bad weather her revolutions per minute were reduced, owing to the sea bringing her up at times, due, as previously explained, to the deep immersion of the wheels caused by rolling.

As there were only six trips on the *Normandy* with Tredegar steam coal I have not taken them into account.

The conclusions to be drawn from those coal trials are, therefore, three :—

(I.) The coal used per I.H.P. per hour will be from 4 to 9 % more in bad weather than in fine.

(II.) The cost of coal used will be from 7 to 8 % more in bad weather than in fine.

(III.) Supposing a steamer can do the passage easily in the time allowed her, she will make more revolutions per minute in bad weather than in fine, but it will be the other way if she has only just sufficient time to do it in if driven at her hardest in fine weather.

The following tables, Nos. 7 to 11, give the complete results from the two steamers, and it should be particularly noted as to the small slip and small consumption per I.H.P. in the *Normandy* on her long passages, *i.e.*, those in which there was detention, waiting for water to enter.

One might almost imagine from this that it would always pay to have engines too large for their work, so that they would never have to be driven at their hardest.

TABLE 7.

COAL—STEPHENSON CLARK'S MERTHYR.

P.S. "Paris."

No. of Trip	1	2	3	4	5	6	7	8	9	10	11	12
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Time on Passage	5 58	6 17	6 21	6 0	6 20	6 10	6 12	6 32	6 7	5 45	6 31	5 43
Total Revolutions	9888	10520	10150	9275	9950	9465	9770	9140	9640	9900	9950	9670
Detention in minutes	17	......	......	10	......	......	25	72	......	......	41	......
Cause	......	......	......	water	......	water	water	water	......	......	water	......
Weather	fine	breezy	fresh	fine	fresh	fine	fine	fine	stormy	fine	fine	fine
Sea	calm	choppy	choppy	calm	choppy	smooth	smooth	smooth	rough	choppy	smooth	choppy
Average I.H.P.	650	739	692	678	672	692	700	......	759	765	......	709
Coals used per hour—cwts.	15	20·5	14·2	15·7	16·6	14·1	16·7	15·5	17	17·6	15·2	18·3
Cost of Coal per I.H.P.	·319	·381	·281	·316	·310	·254	·240	......	·281	·289	......	·326
Coal used per I.H.P.	2 58	3·11	2·31	2·57	2·53	2·26	2·14	......	2·50	2·57	......	2·90
Distance run—knots	61·75	70·25	64·5	57·25	64·63	62·25	64·5	63	60·75	66·25	70·25	65
Slip per cent.	27·5	24	27·7	29·7	27·5	25·1	24·8	21·5	25·3	23·8	19·6	27·4
Vacuum—average	25	23	23	23·5	24	23·5	24	24	24	25	24	24·5
Temp. of feed from	110	114	99	90	100	100	102	100	100	120	116	122
Temp. of feed to	115	118	115	116	118	110	118	122	122	124	125	138
Temp. of uptake from	......	......	......	......	......	......	775	850	940	925	1050	950
Temp. of uptake to	......	......	......	......	......	......	1035	1000	1000	1050	1175	1075
Barometer	30·2	29·7	29·8	29·95	30·25	30·25	30·12	30·08	30·07	30·12	30·13	30·13

TABLE 8.

COAL—LEWIS MERTHYR.

S.S. "Paris."

No. of Trip	13	14	15	16	17	18	19	20	21	22	23	24
Time on Passage	H. M. 6 26	H. M. 6 13	H. M. 6 18	H. M. 6 25	H. M. 5 28	H. M. 5 48	H. M. 6 3	H. M. 5 54	H. M. 6 22	H. M. 5 53	H. M. 6 3	H. M. 6 19
Total Revolutions	10320	9090	9975	8940	9750	9805	10125	9860	9980	10285	9910	9865
Detention in minutes	......	37	28	70	......	......	......	......	28	......	18	14
Cause	......	water	water	water	......	......	......	.....	water	......	water	water
Weather	dark	fine	fine	hazy	fine	fine	hazy	fine	fine	squally	fine	fine
Sea	choppy	smooth	smooth	smooth	smooth	smooth	choppy	smooth	smooth	choppy	calm	choppy
Average I.H.P.	743	588	705	663	856	......	......	......	......	790	723	664
Coals used per hour—cwts.	18	18·4	17·05	15·27	21·09	22·12	20·17	18·42	17·95	20·07	18	17·05
Cost of Coal per I.H.P.	·297	·382	·295	·279	·300	......	......	......	......	·307	·299	·312
Coal used per I.H.P.	2·74	3·53	2·72	2·58	2·77	......	......	......	......	2·84	2·76	2·88
Distance run—knots	74·75	64·5	66·5	63	64·5	65·5	68·5	67	69·5	70	66·5	67
Slip per cent.	17·55	19·22	24·15	19·8	24·7	22·05	22·98	22·8	20·72	21·33	22·75	19·77
Vacuum—average	25	24	25	24·5	24	23·5	23	24	23·5	23·5	23	23·5
Temp. of feed — from	100	110	112	82	117	120	101	120	114	114	101	106
Temp. of feed — to	140	148	148	128	126	134	122	127	148	130	148	134
Temp. of uptake — from	1000	900	1050	1025	1025	1025	1230	1150	1050	1035	1200	1200
Temp. of uptake — to	1175	1060	1375	1200	1300	1650	1350	1300	1350	1200	1380	1375
Barometer	30·12	30·11	30·04	30·03	29·93	29·7	......	30·4	30·06	30·08	30·11	30·09

TABLE 9.

COAL—CWM BRAN AND ABERCARN.

P.S. "Paris."

No. of Trip	25	26	27	28
	H. M.	H. M.	H. M.	H. M.
Time on Passage	5 35	6 30	5 55	5 53
Total Revolutions	9500	10115	9900	9720
Detention—Minutes	......	......	......	......
Cause	......	......	......	......
Weather	fine	rainy	fine	rainy
Sea	smooth	rough	smooth	choppy
Average I.H.P.	748	696	759	807
Coals used per hour—Cwts.	18·63	18·15	19·77	17·75
Cost of Coal per I.H.P.	·302	·316	·316	·269
Coal used per I.H.P.	2·79	2·92	2·92	2·48
Distance run—Knots	......	70·25	65·5	72
Slip per cent.	......	20·92	24·68	17·4
Vacuum—Average	24	23·5	24·5	23·5
Temperature of feed from	114	120	105	120
Temperature of feed to	132	146	127	130
Temperature of uptake from	1000	1150	1200	1200
Temperature of uptake to	1275	1885	1400	1400
Barometer	30·04	30·01	30·05	30·03

TABLE 10.

COAL—STEPHENSON CLARK'S MERTHYR.

S.S. "Normandy."

No. of Trip	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Time on Passage (H. M.)	4 15	4 56	6 6	4 48	6 5	6 11	6 1	3 49	3 53	3 55	3 58	4 27	4 6	3 58	4 8	4 0	4 2
Total Revolutions	8920	9733	8880	8730	9120	8620	9117	9580	9614	9813	9520	9870	9215	9715	9256	9736	9125
Detention—minutes	......	......	73	15	76	71	85	......	......	......	......	......	......	......	......	......	......
Cause	......	......	water	water	water	water	water	......	......	......	......	......	......	......	......	......	......
Weather	rainy	rainy	fine	fine	fine	fine	fine	fine	fine	fine	breezy	stormy	breezy	fine	rainy	fine	stormy
Sea	choppy	heavy	choppy	smooth	smooth	smooth	smooth	smooth	calm	calm	choppy	rough	choppy	calm	choppy	smooth	heavy
Average I.H.P.	......	......	990	1232	1180	1075	1225	2310	2267	2118	2069	2279	2108	2234	2085	2335	2182
Coals used per hour—cwts.	29·88	31	14·66	23·33	17·17	14·09	17	34·2	38·6	37·08	35·35	37·8	33·3	37·62	34·86	34·25	39·42
Cost of Coal per I.H.P.	......	......	·185	·237	·182	·164	·175	·186	·224	·230	·222	·218	·224	·222	·210	·184	·238
Coal used per I.H.P.	......	......	1·65	2·12	1·62	1·46	1·56	1·66	1·90	1·96	1·91	1·85	1·90	1·89	1·87	1·64	2·02
Distance run—Knots	......	......	68	64·5	72·5	63	67	64	66·25	64	65·5	70	65·25	64·63	60·5	65·5	......
Slip per cent.	......	......	12·83	15·89	9·5	16·8	16·44	22·49	21·85	25·8	20·17	19·25	19·38	24·27	25·59	23·41	......
Vacuum—Average	25·5	25·5	26·5	26	26·5	26·5	26·5	24·5	24·5	25	25	25	24·5	24·5	24·75	24·5	24·75
Temp. of feed from..	115	119	103	112	100	108	103	128	125	120	122	128	122	120	128	130	123
Temp. of feed to.....	128	131	118	128	124	122	126	146	135	136	139	138	137	139	133	145	141
Temp. of uptake from..	......	......	550	700	725	800	735	825	840	935	1025	1050	1025	1075	1050	1160	1206
Temp. of uptake to......	......	......	850	835	850	835	820	950	1060	1075	1110	1160	1170	1165	1250	1250	1300
Barometer	30·24	30·05	29·97	30·02	30·42	30·64	30·64	30·64	30·43	30·43	30·5	30·64	30·42	30·33	30·32	30·46	30·61

TABLE 10—(*Continued*).

No. of Trip	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Time on Passage...............	4 13	4 8	3 55	3 50	3 56	7 20	5 49	5 39	3 49	3 45	3 49	3 54	3 50	3 56	3 59	3 42	3 54
Total Revolutions	9832	9230	9646	9482	9746	10410	9512	9221	9859	9245	9725	9071	9973	9389	9703	9398	9712
Detention—minutes	......	......	......	......	......	154	68	72	......	2	... ..	20	......	......	......	......	......
Cause	......	......	......	......	......	......	water	water	......	......	......	fog	......	......	......	......	......
Weather	stormy	breezy	fine	fine	rainy	rainy	rainy	breezy	fine	fine	fine	foggy	foggy	breezy	fine	fine	fine
Sea	heavy	choppy	choppy	choppy	choppy	heavy	choppy	choppy	choppy	smooth	smooth	calm	smooth	choppy	smooth	smooth	smooth
Average I.H P	2312	2257	2336	2504	2425	1180	1208	1256	2409	2190	2304	1893	2428	2310	2131	2497	2379
Coals used per hour—cwts.	40·28	41·76	41·87	43·08	47·33	14·69	17·35	16·11	50 04	45·86	43·49	36·41	42	41·19	41·67	41·62	40·77
Cost of Coal per I.H.P. ...	·229	·243	·235	·225	·256	·163	·188	·168	·273	·263	·218	·241	·217	·250	·245	·219	·225
Coals used per I.H.P.........	1·95	2·07	2·00	1·91	2·18	1·39	1·60	1·43	2·32	2·34	2·11	2·15	1·93	2·23	2·18	1·86	1·91
Distance run—Knots.........	......	......	......	......	......	70·25	64·5	64·5	......	......	......	......	66·5	64	64	64·5	65
Slip per cent.	......	......	......	......	......	9·14	15·39	12·65	......	......	......	......	24·08	22·39	24·65	21·86	23·8
Vacuum—Average............	24·5	24·5	24·5	24·5	24	25	25	25	24	24·5	24·75	25	24·5	24·5	24·5	24	24·5
Temp. of feed from..	127	128	127	126	126	120	120	120	128	125	122	128	133	123	126	136	128
Temp. of feed to......	139	140	138	142	138	135	132	140	142	140	138	142	139	142	138	140	139
Temp. of uptake from..	1144	1100	1225	1280	1400	1080	1090	1106	1344	1400	1425	1356	1450	1475	1400	1451	1437
Temp. of uptake to......	1262	1362	1400	1430	1500	1150	1219	1170	1530	1572	1537	1525	1520	1540	1540	1540	1525
Barometer........................	30·41	30·51	30·12	30·08	30·3	30·31	30·3	30·28	30·37	30·44	30·66	30·76	30·65	30·71	30·65	30·62	30·66

TABLE 11.

COAL—TREDEGAR STEAM.

S.S. "Normandy."

No. of Trip	63	64	65	66	67	68
Time on Passage	H. M. 6 23	H. M. 6 14	H. M. 6 6	H. M. 4 7	H. M. 3 57	H. M. 4 8
Total Revolutions	9276	8267	9405	9284	9023	9582
Detention in minutes	93	105	90	......	......	......
Cause	water	water	water	......	......	......
Weather	fine	fine	fine	breezy	fine	fine
Sea	smooth	smooth	calm	swell	swell	choppy
Average I.H.P.	1154	1004	1280	1952	1896	2083
Coals used per hour—cwts.	13·48	12·64	15·62	40·05	40·25	37·77
Cost of Coal per I.H.P.	·158	·171	·165	·278	·288	·251
Coal used per I.H.P.	1·30	1·41	1·36	2·29	2·37	2·06
Distance run—knots	65·5	64·5	66·5	63·5	63·5	65·5
Slip per cent.	19·10	10·56	16·35	22·02	21·5	22·2
Vacuum—average	25	25·5	24·5	25·25	25	24·5
Temp. of feed { from	110	111	119	121	125	127
Temp. of feed { to	142	141	138	142	133	139
Temp. of uptake { from	860	925	856	980	1110	1125
Temp. of uptake { to	1000	1025	1060	1230	1175	1290
Barometer	30·8	30·61	30·43	30·61	30·62	30·62

Mr. J. H. THOMSON'S Remarks.

As I had a copy of the paper handed to me a short time before the reading commenced, I had an opportunity of glancing through it, and what took my attention most was Table No. 7, where we find the slip ranges from 19·6 to 29·7 %, weather fine, sea smooth, and weather fine, sea calm respectively, this, to me, appears very high, seeing the vessel is fitted with the latest improvements in the way of feathering floats, &c. With screw propellers, if the slip exceeds 20 or even 15% the results are not looked upon as satisfactory; in some instances negative slip has been recorded. I think it would be instructive if some of our members present who have sailed with paddle engines would relate their experience. I may here mention that one of our members, who had considerable experience with paddle engines in his younger days, has informed me that in the old days they considered the results highly satisfactory if the slip was under 30%.

Mr. ROWE'S Remarks.

I have listened with great pleasure to the Paper that Mr. Buckwell has taken so much trouble to prepare. Considering his comparative youth, it is greatly to his credit to have devoted so much time to the compilation of experimental data. Possibly some of the Tables will need revising, but Mr. Buckwell was right in putting down in black and white, results shown by the instruments used. Of course the instruments might not have been quite accurate.

With regard to Mr. Buckwell's statement that the paddle-wheel vessels in which he had served, steamed as swiftly over the waves in heavy as in fine weather, the only difference being a comparatively small increase of fuel per knot, I am, for want of experience with modern paddlers, unable to controvert it. But when I first went to sea in '62, in a large paddle-wheel frigate, with engines indicating about 3,000 horse-power, and steaming about 10 to 11 knots per hour, I learnt, by actual observation, that in a storm, when steaming head to wind, do the very best we could, we could barely hold our own. I therefore think that with a wider experience Mr. Buckwell will have reason to modify his views—views fashioned by the observance of phenomena happening among comparatively short waves. One has only to suppose a vessel to be plunging heavily—as she would plunge among waves ill-suited to her length—to understand how greatly her speed would be reduced from the full speed of fine weather.

Mr. J. MACFARLANE GRAY'S Remarks.

This paper is one of which the Institute may well be proud. It is a great array of facts presented just as they were observed, and therefore naturally presenting many statements apparently anomalous. For example, the uptake temperature in the "*Paris*" varies in a way which leads me to think that the pyrometer must have gone wrong while the experiments were being carried out. The author may be able to explain this for 1885° seems an improper temperature for the uptake. One of the speakers has remarked upon the great amount of slip recorded, as compared with what is common with the screw propeller. What is given as the slip with the screw is always the "apparent" slip, but the "actual" slip is the sum of the apparent slip and the velocity of the wake in which the screw works. With the paddle wheel the apparent slip is almost the same as the actual slip. With the screw propeller it is always at least 10 per cent. slip less, and with full lines of hull the difference between apparent and actual may exceed 20 per cent. slip. The velocity of the wake is due to the water filling in at the stern; there is not the same action at the immersed portion of the paddle wheel. The full value of this paper can be appreciated only after the facts are weighed and compared. The author deserves our best thanks for the great amount of labour he has spent on it.

Mr. W. W. WILSON'S Remarks.

In Mr. Macfarlane Gray's remarks, he mentions that the water at the stern follows up the ship to a certain extent, and I may say that this was very plainly brought to my notice a few years ago in the Suez Canal. The ship in which I was serving was proceeding through, and in the straight path, between Kantara and Port Said, we overtook an Egyptian sailing craft. As we passed her to windward, the crew lowered the sail, and she fell aft till she reached our quarter. She was then steered so as to maintain a distance of about 10 to 12 feet from our side, and at that she came along at the same speed as ourselves, just as if she were being towed, only losing a few feet if she were allowed to get outside the influence of the following water. In this manner, she kept alongside for about five miles or so, and then apparently only parted company with us owing to our approaching a station at which we were signalled to make fast. Immediately we were well clear of her the sails were again set to enable her to proceed on her course. The circumstance impressed me very much at the time, and I think it perfectly bears out the fact which Mr. Gray mentions.

Mr. W. J. CRAIG'S Remarks.

I have little to say regarding the matter of the very interesting paper just read, which appears to be somewhat of the nature of a statistical compilation of results from much painstaking observation and is therefore difficult to deal with off-hand, or without time for specially noting the points that strike one as requiring elucidation. Some of these have already been indicated by conversational discussion among the members present during the intervals of chair orders, such as the apparent discrepancy of "funnel temperatures," the instrument or other methods used in taking the same as by metals with known fusing points, etc., involving of course the unreliability of pyrometers generally. Then there are the different ratios between the mechanical energy expended and the results in speed—or rather mileage—distance and revolutions,slip,consumption and effective work done, some of which appear to agree as little with generally-accepted ideas and practice as they seem to do with the several instances which have been given, these I dare say are somewhat responsible for the surprise felt on the first critical glance at these tabulated results, and though the state of the weather is also taken into consideration as noted in each log, it does not appear to account satisfactorily for all these differences. It would be better then, perhaps, to look well into these points of difference from the usual practice, and to do so fairly, time should be allowed for comparison, it is, therefore, useless to attempt to deal with them at present, but I really think they are worthy of our further consideration, as I learn on enquiry that these details come before us in a rather exceptional manner in so far as the author, if I am correctly informed, has not attempted to draw a "correcting curve" through all these points, by way of reconciling these differences, or even toning them down for easy digestion. It is, I believe, all the other way, and he simply takes up the position of having carefully observed and registered these as "facts" and "as he found them" and he has been at the trouble to tabulate them all in the paper just read for better comparison in going before us, and there he considers his duty has ended, leaving all points, discrepancies, or differences to be taken up and dealt with by us, and the "curves of reconciliation" drawn by those who may be able to contribute towards the elucidation of the departures from ordinary practice.

Now, I think it is very honest to put these forward in their bold and rugged truthfulness, which, in my opinion, adds to the importance of the paper. The author, who, I understand, is only a junior in active service with little time from his ordinary duties to devote to anything else, yet he has taken all this trouble, which must have been considerable, to get these interesting particulars together for our benefit. I put it as a high example to other junior members to emulate his painstaking observations and research into matters of engineering interest, by way of complimenting the author on his own, and I trust we will be benefited by a study of the points brought out in the discussion and of the other important details which add considerably to the value of the paper just read. Before closing I would suggest, if it is in order, that it would be an addition to the completeness of the work in its permanent printed form if a few descriptive particulars could be supplied by the author.

We all know how much consideration is given by builders of express paddle steamers, as to *size*, *form*, and *arrangement* of the *wheels*. I have noted a few down which I will specify by way of particularizing what would be serviceable in this way. They are as follows, viz.:—

"The kind of wheel, and if feathering floats."

"The diameter of paddle wheel at *float periphery*."

"*Length* of float."

"*Number* of floats."

"*Area* of each float."

"*Material composed of*, wood or iron, and if *plain*, *curved*, or *other section*."

"*Immersed float area*, at a given draught, or an average of those given in the paper would be better."

"*Immersed midship section area*, at same draught.

These or such of them as are accessible to the author, though they cannot be considered valuable additions to the paper, might, as I indicated, at least add to its completeness as a "Transaction" of this Institute, these being particulars which most, if not all, builders consider a not unimportant detail in the designing of a paddle steamer for express, channel, or passenger service, such as I understand the steamers referred to in the paper to be.

Mr. J. R. RUTHVEN'S Remarks.

I propose that we give Mr. Buckwell a hearty vote of thanks for his valuable Paper. Many of the details are evidently in error, such as the temperature in the up-take, which is given in one instance at over 1,800°; but he has gone through an immense amount of work; I know what experimenting is, and can sympathize with Mr. Buckwell. I hope some of our members will make similar experiments with screw engines, and on a long voyage. Most valuable information will come of it. So long as facts are carefully recorded we have something to work up into theories, or otherwise systematize the results, so that they will be of real value.

Mr. JAS. ADAMSON'S Remarks.

In partial reply to several remarks which have been made this evening, and in the absence of Mr. Buckwell, I may say a few words. The Paper simply deals with the figures resulting from the Trials of the Steamers named under the various conditions referred to in the tables and accompanying foot-notes: the deductions and conclusions drawn from these are, of course, open to criticism, and I quite agree with Mr. Craig and other members who have referred to it, that to be complete, and, indeed, to admit of true comparison between one voyage and another, and between one steamer and another, the Paper should give a few details as to displacements and co-efficients for the Hulls, and full description of Paddle Floats.

The Boilers are not, I understand, fitted with forced draught. There are several errors, I notice, in the figures, as well as in the letterpress, due probably to clerical mistakes, which will be corrected before printing the Paper in its final form.

The references made as to the Revolutions and the Mileage in conjunction with the tidal currents, in order to obtain a fuller explanation of his meaning, I will remark upon to Mr. Buckwell, as well as the other questions which have arisen, that he may give his own explanation, in writing, to be appended to the Paper. As to the funnel temperature, it has been already referred to in former Papers, and the difficulty of obtaining a correct register has been remarked upon. The temperature seems high. I think the funnel Temperature given in connection with the "Meteor's" Trials was 800° with natural draught.

The average slip °/₀ has been referred to as high, and a comparison was made with that of a Screw Propeller: the conditions are somewhat different: however, it may be well to obtain data from other Paddle Steamers to compare with those given. The remarks made regarding Vacuum and Temperature of Feed Water come under the same heading. When I convey to Mr. Buckwell the vote of thanks which has been accorded to him for his Paper, which is full of interest and of tokens as to the author's painstaking and energy, I shall advise him of the various questions that have arisen, and thus give him an opportunity for reply.

Mr. BUCKWELL'S REPLY.

I must thank those Members of the Institute who have taken part in the discussion for the lenient manner in which they have dealt with my paper. Being the first paper I have ever had the honour to present to a learned society, it, as a maiden effort, is bound to have some shortcomings, but it was prepared conscientiously, and the data obtained during the experiments have been accurately copied into the tables, so that if those tables *should* need revision, it may be because the instrument did not record correctly, I think however, as was also the opinon of every one associated with the experiments at the time, that the data were perfectly reliable.

I beg to offer the following additional notes as in some way explaining the matters that called for discussion.

TABLE 12.

Name	"*NORMANDY.*"	"*PARIS.*"
Builder	ELDER & Co. (Glasgow)	ELDER & Co. (Glasgow)
Date	1882	1875
Material	Steel	Iron
Length	231 feet	220 feet
Breadth	27·7 ,,	25·2 ,,
Depth	10·65 ,,	11 ,,
Tonnage, Gross	578·73	483·47
,, Register	239·29	282·68
N.H.P.	350	220
Midship Area	179·4 square feet	162·06 square feet
Constructive load draft	7 feet	7 feet
Displacement at that draft	728 tons	688 tons
Co-efficient of fineness	·568	·620
Diameter of wheels	17 feet	17 feet
Radius to which floats were struck	8 feet 6 inches	8 feet 6 inches
No. of floats	9	9
Size of floats	9ft. 6in. by 3ft. 7½in.	8 feet by 3 feet 2½ inches
Immersion at ordinary draft	1 foot 6 inches	1 foot 2 inches
Material	Steel	Steel

The temperature of the feedwater was taken by an ordinary thermometer, and the temperature of the uptakes by BAILEY'S pyrometers. There was no forced draught. The temperature did not rise gradually as it appears to have done in the tables ; I have only given the highest and lowest temperatures registered, I ought perhaps to have given the average also. The high uptake temperature was due to no bridges being used in the steamers, the grate extending to the back of the combustion chamber, hence if the fires were not in proper condition, an extra amount of heat was wasted up the funnel, and under ordinary conditions the temperature was about double what is ordinarily assumed.

The temperature of the feedwater and uptake were highest when the fires were being forced hardest, and consequently when the consumption was greatest, but as to what ratio the one bore to the other I am unable to state, no accurate account having been kept of this.

In reference to paragraph on No. 7, on page 4, it certainly does read curious to anyone not understanding the service, but I may explain it thus:—the course from Newhaven to Dieppe is partly up channel; the flood tide is also up channel; hence it assists a steamer making the passage from Newhaven to Dieppe, but is against a steamer making the passage from Dieppe to Newhaven, and, as a consequence, the former will make her passage in about twenty minutes less time than the latter, the reverse, of course, being the case with an ebb tide. To make the passage in the same time, the steamer from Dieppe on a flood tide will require driving two or three revolutions a minute faster than the steamer from Newhaven, the reverse being the case with an ebb tide.

The average slip in all paddle steamers that I have had experience with, has been about 22 or 23 per cent., and it has been an exceedingly rare occurrence for it to be less than 19 per cent., but this I attribute largely to the floats being too close together, my idea being that with high speed paddles, each float, as at present arranged, works in the hollow already scooped out by the preceding float, so that in reality only one-half, say, of the float area is effective, this resulting of course in a considerable amount of slip. I believe that some arrangement of stepped float would be preferable, the floats could then be kept as close together as now, or even closer, but by being arranged, say, in three steps instead of one solid float, the water would have time to recover itself between the passage of one float and the next, and the total float area would be effective.

The comparison of a paddle-wheel frigate of 1862 with a modern high-speed paddle steamer is, I think, hardly justifiable. For a ten-knot steamer to be only just able to hold her own in a gale shows her to have been a very different class of steamer to those of the present day; they were built for safety then, and for speed now; but apart from that, doubtless, belonging to the Navy, the Steamer in question had a lot of top hamper which held the wind to a great extent, thus also helping to reduce her speed. I have spoken to an Engineer who was in a side-lever paddle Steamer at the same date (1862), running between Dundee and London, and he told me that they performed the passage regularly in 36 to 38 hours, smooth or rough, as they drove harder in bad weather. He also told me that the "City of London," belonging to the London and Aberdeen trade, was used as a transport by the Government during the Crimean War, and was in a heavy gale at Balaclava, being actually used to tow several Government vessels out of danger, as they were helpless by themselves, which shows that to compare Naval with Mercantile Steamers is rather out of the question.

THE LANGTHORNE ROOMS,

BROADWAY,

STRATFORD, LONDON, E.

April 29th, 1890.

PREFACE.

A meeting of the INSTITUTE was held here this evening, presided over by Mr. G. W. MANUEL (President), when a Paper was read by Mr. J. D. CHURCHILL (Member), on the Churchill Governor and its application to Compound and Triple Engines.

This Paper was prepared at the special request of the meeting held on the 18th Nov., 1889, when a Paper was read by Mr. CHURCHILL on the benefits derived from Marine Engine Governors.

The course of the Discussion tends very much to confirm and endorse the opinions expressed during the former discussion to the effect that the Governor, as a rule, does not receive the attention which it should at the hands of the Designer, Constructor, or Erector of the Marine Engine. It is frequently too small for its work, badly placed, and awkwardly fitted and connected, in these respects the maker of the Governor should be protected by specification or otherwise in the interests of the Shipowner and his Engineers.

JAS. ADAMSON,

Hon. Secretary.

ERRATA.

Page 16, line 1, first paragraph, *omit* the words, " Mr. P. Smith said."

Page 20, *in place* of " Mr J. G. Hudson's Remarks," *read* " Mr. J. G. Hawthorn's Remarks. '