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HARRISON HAYTER, President,
in the Chair.

(*Paper No. 2709.*)

"The Break-down of the R.M.S. 'Umbria.'"

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THE "Umbria" and her sister ship the "Etruria" are at present ¹ the largest steamers employed in the Transatlantic Service of the Cunard Steamship Company. The "Umbria" is 520 feet long, 57 feet 3 inches beam and 41 feet in depth. Her burden is 8,250 tons and she is driven by a single screw, her engines being of 14,500 I.H.P. She was launched about 9 years ago, and since then has been in regular use and has made several "record" passages across the Atlantic.

On the evening of Saturday the 17th December, 1892, she left Liverpool, bound for New York, carrying 131 saloon, 128 second-class and 121 steerage passengers. The crew was composed of the Captain, 6 Officers, 12 Petty Officers, Surgeon and Purser, Boatswain and Mate, Carpenter and Joiner, 2 Masters-at-Arms, 33 Seamen, 11 Engineers, 70 Firemen, 40 Trimmers, 102 Stewards and Cooks, including 7 Stewardesses; in all 277 persons. The entire ship's company thus numbered 657, the Author being one of the passengers.

Fairly good weather was experienced in the Irish Channel, and Queenstown was reached on the morning of the 18th December. There the ship was detained, taking in the Christmas mails, until about 3 p.m. After the Irish coast had been cleared, the wind was fresh, the sea lumpy and the vessel pitched heavily; this continued during the night and the following day. On the night of the 19th December a full gale was blowing from the south, during which one of the boats on the port side was stove in, although hoisted in davits clear of the upper promenade deck.

Bad weather continued on the 20th December; but about 3 p.m.

¹ This was written before the "Campania" was put into service.

the wind suddenly changed from south to a little north of west. It was then nearly ahead, blowing with full gale force, and the vessel had to be slowed occasionally. The barometer, which had stood at 30.3 inches at Queenstown, fell to 28.17 inches during the night. On the following afternoon the wind moderated and the passengers were able to use the promenade deck; but it suddenly changed from blowing ahead to nearly astern. It was apparent that the position of the "Umbria" was at the edge of a cyclone, the centre of which was probably to the south of her position at that time. At 11.30 P.M. the wind was again blowing with full gale force from N.W., or nearly abeam, making the vessel roll considerably. It was a bad night on board, and such of the passengers as were fortunate enough to obtain sleep woke on the 22nd December to find the gale still raging, bitterly cold weather, and heavy green seas breaking over the vessel. The rigging was frozen 1½ inch thick and the maximum reading of the thermometer on deck during the day was 27° F. The next night was also a bad one; the intense cold continued, and in the morning the rigging and the greater part of the masts, stays and halyards were frozen 9 inches thick, whilst the bulwarks carried ice a foot thick, and in some corners on deck the ice was between 3 and 4 feet thick.

At 5.30 P.M. the engines were stopped and at 7 P.M. the following notice was issued:

"R.M.S. 'UMBRIA.'"

"I regret to announce that a bad fracture has been discovered in the main shaft, which will probably require a couple of days for temporary repairs.

"In the meantime any towing-offer from vessels going westward will be accepted.

"December 23rd, 1892."

"HORATIO MCKAY,
Commander.

The chart of February, 1893, issued by the Hydrographic Office attached to the Navy Department, Washington, U.S.A., for the information, instruction and warning of captains who are employed in the Atlantic service, shows, under the title "The Hurricane of December 22nd, 1892," the track followed by the centre of the storm, and the position of the "Umbria." (Appendix, *post*, p. 88.) She was at the time of the break-down about 760 miles east of New York; but, owing to foul weather and a cloudy sky, no longitude observation had been taken since leaving Queenstown, and her position was estimated from dead reckoning. There can be no doubt she had experienced unusually severe and long-continued stress.

The wind continued blowing with half- to full-gale force, and

notwithstanding that sea-anchors were paid out with a view to keep the ship's head to the wind and oil was used to subdue the waves, she rolled very much, and the repairs were consequently effected under conditions of great difficulty.

For some hours previous to the stoppage of the engines a certain irregularity had been observed in the motion of the thrust-shaft. At 5.30 p.m. one of the thrust-block shoes began to jump violently: this was probably owing to the action of a small piece of metal which had become detached from the fractured portion of the shaft. The engines were immediately stopped and three or four of the thrust-block shoes were removed, when a serious fracture was discovered between Nos. 3 and 4 collars at the end nearest to the engine. The fracture extended round the collar A, Fig. 1, Plate 3, for nearly the whole circumference of the shaft; it then took a lateral direction to collar B, following close against the shoulder of this collar for about 17 inches. Thus, although greatly weakened, the shaft was not completely severed. Mr. Lawrence Tomlinson, the chief engineer, lost no time in beginning the repairs. His difficulty was not confined to determining what ought to be done, but he had to decide the more pressing question of what could be done under the circumstances. There were no machine-tools on board and the repairs had to be effected by hand. Among the stores were the usual number of spare bolts for connecting the different sections of the screw-shaft, and three of these were made use of. The diameter of the shaft, which was of steel, was 25 inches.

Three slots were cut in collars A and B, which were $3\frac{1}{4}$ inches thick and projected nearly 6 inches from the shaft. The slots were $4\frac{1}{8}$ inches broad by $4\frac{1}{2}$ inches deep, and the bolts were thinned down to fit them. The bulk of the metal was removed by drilling holes with a ratchet-brace and afterwards chipping away the remainder with hammer and chisel. The labour required of the engineering staff was great, and was not only severe in its nature but had to be accomplished in a rolling ship, in a confined space and under a high temperature. During many hours a spell of from fifteen to twenty minutes was as long as a man could work continuously. Whilst this was being performed on the shaft, the preparation of the bolts was proceeded with; and for this, a vice, hammer and chisel were the only appliances available. It soon became apparent that the nut of each of the bolts would have to be reduced in thickness; because there was not sufficient clearance for it to pass the cast-iron stiffening-ribs on the bed-plate of the thrust-blocks.

This entailed heavy labour, for the nuts had to be bored through by numerous small holes, to separate the superfluous metal. When the bolts or keys were fitted in place, it seemed to the Author that, provided there was some strength left in the broken shaft, the bolts would resist such stress as would be applied to them when the vessel was propelled at a rate of 5 knots or 6 knots; but the heads looked weak and disproportioned to the strength of the bolts. The chief engineer, doubtless for good reasons, was not disposed to destroy any portion of the permanent structure of the vessel by cutting away those portions of the ribs in the bed-plate which prevented him from putting in bolts with nuts of full strength. The work was crowned with complete success; for instead of only 5 or 6 knots it was found possible to drive the ship at 10 knots. The repairs, which enabled the vessel to reach New York, consisted essentially of a strong hoop over the fracture in the shaft, and the bolts already described, with an outer hoop to keep the latter in place.

The repairs were commenced on the evening of the 23rd December, and were continued day and night until 3 A.M. on the 27th December. The engines were then started, but after working about two hours, one of the bolt-heads gave way. The engines were stopped whilst the defective bolt was replaced by another and at 9 P.M. on the same night were again started and continued to work without interruption until 9 A.M. on the 31st December, when the vessel reached New York. The speed was increased from 4 knots to 10 knots, as confidence was gained in the efficiency of the repairs. The precaution was taken of attaching a chain and buckle to the screw-shaft, between the fifth and sixth collar-blocks, which were considered able to hold up the shaft abaft of the fracture in the event of rupture occurring. In actual work the repairs looked equal to what was required of them to take the vessel into New York. There was a slight "wobble" of perhaps $\frac{3}{4}$ inch in the shaft abaft of the fracture; in other words, the shaft at that point seemed to be out of truth to that extent. The deflection of the bolts or keys from their proper line in the axis of the shaft did not exceed $\frac{3}{8}$ inch.

The Author was allowed to spend many hours in the engine-room at the scene of the repairs. Inasmuch as the accident which befell the "Umbria" may happen to other vessels, he would direct attention to any alternative which can in future come under consideration in a similar emergency.

The accident and the means adopted to repair it have been

extensively commented upon by the American and English Press, especially in regard to the efficiency of the repairs; and it must be admitted that they were greatly deficient in strength compared with that originally possessed by the shaft. Here it should be said, to the credit of the chief engineer and staff of the "Umbria," that, notwithstanding the great strain they had undergone, they continued actively at work preparing duplicates of any part that might break. If it should have become necessary to supplement by others the three bolts already mentioned, that course would have been adopted and the strength of the repairs would have been thereby considerably increased. It is impossible to determine what the efficiency of the repairs really was, on account of the unknown factor represented by the strength of the broken shaft, but it may be assumed that it would not be more than 6 or 7 per cent. of the efficiency of a perfect shaft. But, whereas the perfect shaft was capable of standing, with a large margin of safety, the enormous stress required to drive the ship in all sorts of weather, frequently with a racing screw, at a rate of 22 miles per hour—the repairs were calculated for the stress necessary for a speed of 5 to 6 knots in fine weather. Such steaming-power would have been sufficient to reach land in fine weather, or to keep the ship under control with head to wind in bad weather. Fortunately the weather was fine after the repairs were completed; but the captain had a difficult task to get the vessel into port, crowded as that of New York always is with shipping and ferries. The engines, once started, had to go, and once stopped, to stay; for reversing them would not have been safe under the circumstances. The captain was equal to the occasion and the "Umbria" was smartly brought alongside the Cunard pier; and, but for previous information, no one on deck or on shore would have thought that this splendid vessel was crippled at the time.

The Author has no personal experience of the repairs effected in New York, but understands that the defective portion of the shaft was cut out and a new piece substituted. Drilling-machines which had been specially designed, and a portable steam-engine for working them, were applied to this work, which occupied three weeks.

He takes this opportunity of testifying to the admirable discipline maintained on the ship by Capt. McKay and Mr. Tomlinson under the trying circumstances described. He has also to express his thanks to Mr. James Bain, Chief of the Engineering Department of the Cunard Steamship Company at Liverpool, to

whose courtesy he is indebted for the accuracy of many of the particulars stated.

Whilst the Author's experience on board the vessel is sufficient to justify him in describing the events which occurred, he does not advance opinions beyond those he has already expressed, in a meeting where many more competent in this matter are present. He would, however, venture to deduce one moral from his experience and to give a piece of advice to others who propose to make long voyages in ocean-steamers: "Take for choice a vessel with twin-screws."

This Paper is accompanied by a Drawing, from which Plate 3 has been prepared. At the time of reading a full-sized model in wood of the repairs to the shaft was exhibited.

APPENDIX.

"PILOT CHART OF THE NORTH ATLANTIC OCEAN."

The Author desires to direct the attention of the members of the Institution to the Pilot Chart of the North Atlantic Ocean, an admirable publication issued monthly, or oftener when matters of special interest to mariners require it, by the Hydrographic Office of the Navy Department, Washington, U.S.A. The existence of the chart is insufficiently known in this country. In it the routes recommended to European passenger-steamers are laid down, varying according to the season of the year; and sailing and trading vessels are recommended by the instructions to avoid as far as possible those routes.

The position of wrecks and derelicts observed at sea are shown upon it, and the places where they may be met by other vessels are inferred approximately.

The weather, and particularly the course of the wind, during the previous month, is indicated in RED, whilst the forecast for the current month is shown in BLUE.

Fog regions observed during the past month are also shown in RED, and probable fog regions for the current month in BLUE.

Captains of vessels are requested to send returns for the preparation of this chart to the United States Consuls at all ports, who forward them free of charge to the Hydrographic office at Washington.

The chart of February, 1893—the last published—is of special interest, because it contains a map of the hurricane of the 22nd December (the day before the "Umbria" broke down); and it is to be supposed that some reliance may be placed on its accuracy, for it may be noticed that returns of observations taken at noon that day were received from no less than 91 vessels, all of which were within the storm-area.

Fig: 2.

SECTION THROUGH X. X.

Fig: 1.

AFT

A

B

Scale of Feet.

Inches 12 9 6 3 0 1 2 3 Feet

Fig: 3.

SECTION THROUGH Y. Y.