## THE MASTERY OF THE OCEAN.

The close of the nineteenth century witnesses the well-nigh complete triumph of human invention over the obstacles to speedy intercommunication presented by the vast expanse and multiplied dangers of ocean travel. It is a far cry from the little 350-ton steamer "Savannah" of the year 1819 to the 23,000-ton "Deutschland" or the 28,000-ton "Oceanic" of the present day, but the difference between the 28-day trip of the first steam vessel to cross the Atlantic and the recent 5¼-day trip of the "Deutschland" shows that the marine architect and engineer have employed the intervening years to good purpose. Not merely have they found a way to carry a complement of 2000 souls across the Atlantic at something like railway speed under normal conditions of weather, but they have so greatly increased length and beam and depth, and have multiplied boiler and engine power so liberally, that the biggest of our big liners can go smashing its way triumphantly through an Atlantic gale, opposing the momentum of giant seas with the momentum born of 23,000 tons of displacement backed by 37,000 horse power in the engine room.

The following notes were made by a representative of this journal, who had the good fortune to be on the "Deutschland" when she made her recent record-breaking passage. The outward voyage was noteworthy for the high average speed maintained, 23·36 knots an hour, the high average horse power developed, 36,913 for the whole voyage, and for the fact that the passage was the shortest ever made between any points in America and Europe, the time from Sandy Hook to the Lizard being 5 days 7 hours and 38 minutes. The return journey, in view of the highly unfavorable weather conditions, was even more remarkable; for, although head winds, varying in strength from 7 to 11 out of a possible strength of 12, with exceptionally high seas, were encountered on the first four days of the trip, the run from Cherbourg to Sandy Hook was accomplished in 6 days and 33 minutes at an average speed of 21·16 knots an hour.

The eastward record was rendered spectacular in the public eye by the fact (purely accidental, as it happened) that the "Deutschland" was scheduled to sail one hour later than the "Kaiser Wilhelm," whose fastest record of 22·79 knots an hour had been accomplished on her last eastward run. Twenty-two and a half hours after starting, the "Deutschland" was abreast of the "Kaiser," and she continued to add to her advantage at a remarkably even rate of one knot per hour. At the invitation of Mr. A. Bliedung, the chief engineer, our representative visited the engine and boiler rooms while the two vessels were abreast in the so-called race, and at a time when the "Deutschland's" engines were indicating between 37,000 and 38,000 horse power, and he was at once impressed with the quiet and orderliness with which the staff of engineers, firemen and coal-passers were doing their work. The temperature in the stokeholds and on the lower engine-room platforms was but slightly above the normal of the atmosphere, and this in spite of the fact that coal was being consumed in the 112 furnaces at the rate of 572 tons per day, and that steam at 213 pounds pressure was being expanded in the twelve cylinders of the twin, quadruple-expansion engines at the rate of 178 tons per hour. No clearer proof of the fact that steamship designing, as carried out in a first-class establishment, is an exact science, and shipbuilding a perfected art, could be asked for than was presented by the utter absence of excitement or evidence of unwonted effort in the engine and fire rooms of this fine vessel under circumstances where such excitement would have been expected and natural. That a 23,000-ton "Deutschland" with 37,000 horse power would overtake and pass a 20,000-ton smaller edition of herself with 28,000 horse power was a foregone conclusion, provided, at least, that the safety valves were just lifting at the Board of Inspection pressure of 213 pounds to the square inch.

Steam is led to two 36⅝-inch high-pressure cylinders which are placed in tandem above two 108¼-inch low-pressure cylinders, the total height from the lower platform to the top of the high-pressure cylinders being 45 feet. It then passes to a 73⅝-inch first intermediate, then to a 104-inch second intermediate, and finally to two 108¼-inch low-pressure cylinders, from which it is led to a surface condenser with 21,315 square feet of cooling surface. There is thus quadruple expansion in six cylinders, acting on four cranks, the two intermediates being above the two outside cranks, and the four high and low-pressure cylinders driving the two inside cranks. All the reciprocating and rotating parts are of massive proportions. Thus, each low-pressure piston weighs 7 tons, the piston rod 3 tons, and the connecting rod 10 tons. The crank shaft is 59 feet 3⅜ inches long, of 3 feet throw, and weighs just under 100 tons. When it is remembered that each of these mammoth engines runs at the exceptionally high speed of 77 to 80 revolutions, and that the piston speed runs up as high as 1,040 feet per minute, it can be understood that a view of the two engines from the amidships bulkhead doorway, when the ship is at full speed is profoundly impressive. The cut-off for the high-pressure cylinders is at 73 per cent, for the two intermediates at 70 per cent, and for the two low-pressure cylinders at 62 per cent. Bearing in mind the high initial pressure, the late cut-off, the length of the stroke and the high piston-speed, one can realize how the unprecedented indication of 36,913 horse power for the whole voyage could be accomplished.

The total coal consumption for twenty-four hours, including the auxiliaries, was 572 tons, which works out at the highly economical figure of 1·45 pounds per horse power per hour. This high economy is due in general to the all-round excellence of the boilers and engines, but particularly to the Howden's forced draught, with which the boilers are fitted, in which the air supply to the furnaces is raised by the heat of the escaping furnace gases from 70° to 270° Fah. before it enters the furnaces, the temperature of the uptake being lowered by a corresponding 200° Fah.

On the return trip to America the "Deutschland" received the first real test of her capabilities in varying conditions of wind and sea, and the result proved that, given a vessel of sufficient strength, weight and power, the full strength of an Atlantic gale is powerless to stop her. Leaving Cherbourg at 6:40 P. M. on the 17th ult., she at once encountered a fresh wind and rough beam sea, in which an average of 22·1 knots was maintained for 17 hours, or until noon of the 18th. In the next 24 hours the vessel made 440 knots in squally weather and a very rough sea, despite a lengthy detention while steaming in a circle and lowering a boat in search of a seaman who had been carried overboard. On the 19th the wind increased to a strong gale, the rollers meeting the ship on the port bow. For six hours it blew with a strength of 10 to 11 out of a maximum possible rating of 12, and the ship maintained a trifle over 20 knots against what the ship's log designates as a "strong gale, with long, heavy rolling sea, and irregular high swell," the crests of the rollers making a clear sweep of the forecastle deck and falling in a magnificent cascade far to leeward. It was only after the seas had torn loose an iron ladder and twisted the railing of the forecastle deck that the engines were slowed down to 13·5 knots, at which speed for four hours the ship rode easily across the seas without the least suggestion of a roll. The utter absence of rolling in a quartering sea of such proportions was surprising, for in the height of a gale in which the "St. Paul" had to turn and run before the seas for five hours, it was not necessary to place the racks upon the table at the lunch hour. On this day the ship ran 502 knots, an average of over 20 knots an hour. On the following day the vessel made 573 knots, and on the last day over 600 knots, although, owing to an error of calculation, the run was given as only 581 knots.

It is inevitable that the development of 37,000 horse power on the propellers of such an elastic structure as the hull of a 700-foot liner should result in a certain measure of vibration. This vibration is not due to defective balancing in the engines, which are built on the Yarrow-Schlick-Tweedy system, but is probably inevitable when two propellers are each expending 18,000 horse power upon the water. We very much question whether the application of turbine propulsion will remove a difficulty whose source evidently lies elsewhere than in the engine room.

## EXPERIMENTS ON AMALGAMS.

Messrs. Guntz and Férée have recently made a communication to the Académie des Sciences describing a series of experiments which they have made with amalgams of different metals, particularly those of sodium and potassium; they have succeeded in obtaining a series of amalgams of these metals having a crystalline form and a definite composition. The first experiments were made with sodium; when it is dissolved in mercury, the latter becomes heated, and by slow cooling fine crystals of the amalgam are formed; these have a cubical appearance, and their composition as shown by analysis corresponds to the formula $NaHg_6$. Another method of obtaining the crystals is to dissolve the sodium in the mercury as before, and then compress the whole in a chamois skin; the more liquid part filters through, and the remainder is found to have the same composition as before. The liquid part consists of mercury saturated with sodium and contains, according to analysis, 0·57 per 100 of the latter. The experimenters conclude that the amalgam $NaHg_6$ should be considered as a definite compound. In an experiment made by Kerp, in which he saturated the mercury with sodium by an electrolytic method, the mercury became heated to increasing temperatures and amalgams were obtained which contained more sodium than the formula demands; to explain this result he thought that an amalgam $NaHg_5$ existed, but could not obtain it in a pure state; it condensed mercury in its pores in variable proportions.

The present experimenters consider that it is the result of a mixture of two amalgams, $NaHg_6$ and $NaHg_5$, and in fact have obtained the latter in a pure state by the following process. The crystals of $NaHg_6$, obtained as above, are melted in a porcelain capsule; to this is added a small quantity of amalgam richer in sodium, containing 3·5 per 100. When the whole is dissolved at 200° C. it is slowly cooled and the temperature observed by a thermometer; when 140° is reached, the temperature remains stationary for some time, with formation of crystals of amalgam. At 138° the liquid part is poured off, and prismatic crystals are found to remain; these give by analysis the formula $NaHg_5$. The liquid portion solidifies entirely by cooling to 96° C., and is found to be $NaHg_6$. The solution of sodium in mercury is thus separated into two amalgams of definite composition. The experimenters have formed two other amalgams; by submitting one or the other of the above compounds to strong compression, from 3,000 to 12,000 pounds per square inch, they are found to lose mercury with the formation of a new amalgam, $NaHg_4$. The mercury which escapes is always saturated with sodium at 0·57 per 100; when this solution is cooled to a low temperature, 19° below 0° C. it forms crystals of another amalgam, $NaHg_8$. This new compound, separated from the excess of mercury, melts partially when it reaches the ordinary temperature, giving crystals of $NaHg_6$ and mercury saturated with sodium. It is thus demonstrated that sodium forms with mercury four definite compounds of crystalline form, corresponding to formulæ $NaHg_8$, $NaHg_6$, $NaHg_5$, $NaHg_4$. With potassium similar results have been obtained. By slowly cooling the solution in mercury, crystals of $KHg_{12}$ are formed. These, when compressed, lose a portion of fluid amalgam, and the remainder has the formula $KHg_{10}$. By cooling the liquid portion to −19° C., crystals of $KHg_{18}$ are formed.

## OPERATION OF WELSBACH BURNERS.

A new system of operating Welsbach burners from the gas works has been established at Emmerich on the Rhine; by this arrangement the burners are automatically lighted and extinguished by the use of compressed air; and about two hundred burners are thus operated in eighteen seconds. The apparatus used, known as the Lenze system, consists of a kind of cylindrical box placed in each lamp; the box is divided into two chambers which are separated by mercury. One of these chambers serves as a reservoir for compressed air, and the other for gas. Into the inner chamber a gas pipe penetrates, which is united by a float to a valve closing the passage of the gas, or on the other hand giving it access to a burner placed on the cover of the apparatus. A small auxiliary flame remains always lighted, according to the method generally employed. When compressed air is sent into the apparatus from the central station, it first opens the passage of gas to the burner and afterward lights it. The system works with a rather low air pressure. The installation costs $12.50 per burner in most cases; the expense of lighting by hand is gained, and it is found that the burners last longer, owing to regularity of their illumination.

## A CACTUS IN THE BOTANICAL GARDEN AT BERLIN.

In the botanical garden of Berlin is to be seen a cactus which has grown for seven years in a glass flask sealed by fusion; it was presented by a German pharmacist, Ludwig Rust. He explains the growth of the plant by the fact that the soil in which it grows contains a certain quantity of spores of fungi, which germinate from time to time and cover the sides of the flask with a greenish layer. These, in dying, furnish the carbonic acid necessary for the life of the cactus. This explanation appeared satisfactory at first, but it was then asked from whence came the carbonic acid for the fungi; again, the phenomena of nutrition which take place in the green parts of the plant require an excess of carbonic acid. This seems, in fact, to be furnished by the process of putrefaction which takes place in the soil. Another question which is more difficult to answer is the origin of the water which is necessary to maintain the life of the plant; this may be derived from the decomposition of the cellulose. However these questions may be answered, the fact remains that the plant lives and develops in a hermetically closed medium. The experiment is not difficult to carry out, and its study may lead to interesting results.

## PARIS EXPOSITION AWARDS.

The Jury of Final Appeal in the Exposition awards has finished its work. The statement prepared for the United States Commission shows that America received a higher total of awards than any other nation save France, and that she also received more awards in each classification, except grand prizes, in which Germany secured a greater number. The figures, excepting for France, follow:

Grand Prizes—United States, 215; Germany, 236; Russia, 209; Great Britain, 183.

Gold Medals—United States, 547; Germany, 510; Russia, 346; Great Britain, 406.

Silver Medals—United States, 593; Germany, 575; Russia, 411; Great Britain, 517.

Bronze Medals—United States, 501; Germany, 321; Russia, 321; Great Britain, 410.

Honorable Mention—United States, 348; Germany, 184; Russia, 206; Great Britain, 208.