ICE BREAKERS IN POLAR EXPLORATION.

BY EDWIN SWIFT BALCH.

Polar exploration, if divided in accordance with the ships employed, may be classified into three periods. The first covers four centuries, from the great voyage in 1596 of the pioneer, Willem Barentz, of Holland, to the building of the "Fram." During this period, ships were almost defenseless against the Arctic ice, and when they were pushed into it, they practically lost all means of independent locomotion, even after the advent of steam. They would be crushed or stay on top, in accordance with the movements of the ice, and in utter disregard of the wishes of the men on board. Curiously enough, however, no one seems to have given any thought to the models of ships for polar exploration. Any old ship was considered suitable for the purpose, after she had received some extra strengthening. Whaling and sealing vessels were not constructed on the best lines to resist ice pressure, for their main object was to permit the stowage of large quantities of oil. Experience gradually fostered the belief that no ship could be devised strong enough to resist a real pressure from the ice in the winter months, even if it might be fortunate enough to escape in the summer ones.

The second period begins and ends with the voyage of the "Fram." This reversed all previous notions on the subject, and proved conclusively that a ship can be built of sufficient defensive power against ice floes, to drift in safety across the Arctic Ocean. The "Fram" was designed * with the idea of making "the shape of the hull such as to offer as small a vulnerable target as possible to the attacks of the ice;" and to build her "so solidly as to be able to withstand the greatest possible pressure from without in any direction whatever." To accomplish these aims, she was

* "Farthest North," by F. Nansen, Vol. I.

built with extremely sloping sides, which enabled her to rise in response to every increase of ice pressure. When the pressure became great, the "Fram" was lifted by the ice and rode on top of it; until, with a diminution of the pressure, the weight of the ship caused her to settle down again.

The third period may be said to begin with an address delivered some time in 1898, before the Russian Geographical Society, by Vice-Admiral Makaroff, of the Imperial Russian Navy, in which he proposed to reach the pole by means of ice breakers. An abstract of his paper was published in the *Geographical Journal* for October, 1898. He succeeded in having a large ice breaker built, not for Arctic travelling, but for commercial purposes, and the story of this ice breaker is told at length in the *Geographical Journal* for January, 1900.

The "Yermak" was built in England by Armstrong, Whitworth & Co., according to the designs of Admiral Makaroff. She was intended to clear the way in winter time through the ice to the port of St. Petersburg, and in summer time to help the navigation to the Siberian rivers flowing into the Kara Sea, barricaded by ice almost during the whole summer. She is a steel ship, with a double bottom and double sides, and is divided into forty-eight compartments. She is 305 feet long, and 71 feet broad. With 3,000 tons of coal aboard, her displacement is 8,000 tons, and in this condition she draws 25 feet. Her bow is inclined 70° from the vertical; her stern is 65° , and her sides are 20° from the vertical. In whichever direction she moves in the ice, she is bound to rise on it and break it with her weight. She has four engines, working four independent propellers, one in front and three at the stern. Each engine develops 2,500 horse-power, so that the total force of the engines is 10,000 horse-power. Each propeller is supplied with an extra auxiliary engine, so that the main engine can be disconnected if necessary; this was meant to save fuel under certain conditions.

The "Yermak's" maiden voyage was from Newcastle to St. Petersburg in the winter time, on which occasion she

forced her way with ease through 160 miles of ice. In June, 1899, under the command of Admiral Makaroff, she was given a trial in the polar ice west of Spitsbergen. After this, she steamed back to Newcastle, where she was strengthened and the forward propeller taken out. On August 6th, she again entered the polar ice north of Spitsbergen. This time she was in the ice two weeks, "covering in that period 230 miles in eighty-seven hours."

No attempt was made at exploration, although it is believed that land was discovered to the northeast, as evidenced by the refraction of the air. The time was devoted to studying the ice, the ship herself, and her behavior in the ice. The trip was, in fact, a shipbuilder's trial trip. In heavy ice, where there was considerable pressure, it took four hours to make 2 miles. In moderately thick ice, the ship made $2\frac{1}{2}$ miles or more an hour. It was found that the conditions of the ice were so different in the Baltic and in the Arctic, that to get the best results in the latter, a special ship would have to be constructed. Admiral Makaroff came to the conclusion that strength of construction was the main point and that even the "Yermak" was not strong enough, but that the engine power could be reduced without disadvantage; in fact, he thought 2,500 horse-power would be sufficient for fairly good progress through the ice. The room gained by reducing engine power could be utilized to carry more fuel, and about this it was also concluded that liquid fuel would be preferable in all respects to coal.

These experimental voyages of the "Yermak" prove conclusively, what was never suspected before, that a vessel may be constructed of sufficient offensive power and sufficient defensive power to force her way through the Arctic pack. The problem of how to penetrate the unknown regions of the Arctic and of the Antarctic appears solved at last. It means discarding the old methods of wooden vessels, sledges, dogs, etc., wherever the sea extends and adopting the resources of the modern naval engineer, of steel, steam and electricity. The change is complete, and the results may prove a lasting benefit to scientific geography.