EXPERIMENTS WITH THREE-PHASE ELECTRIC ARCS.

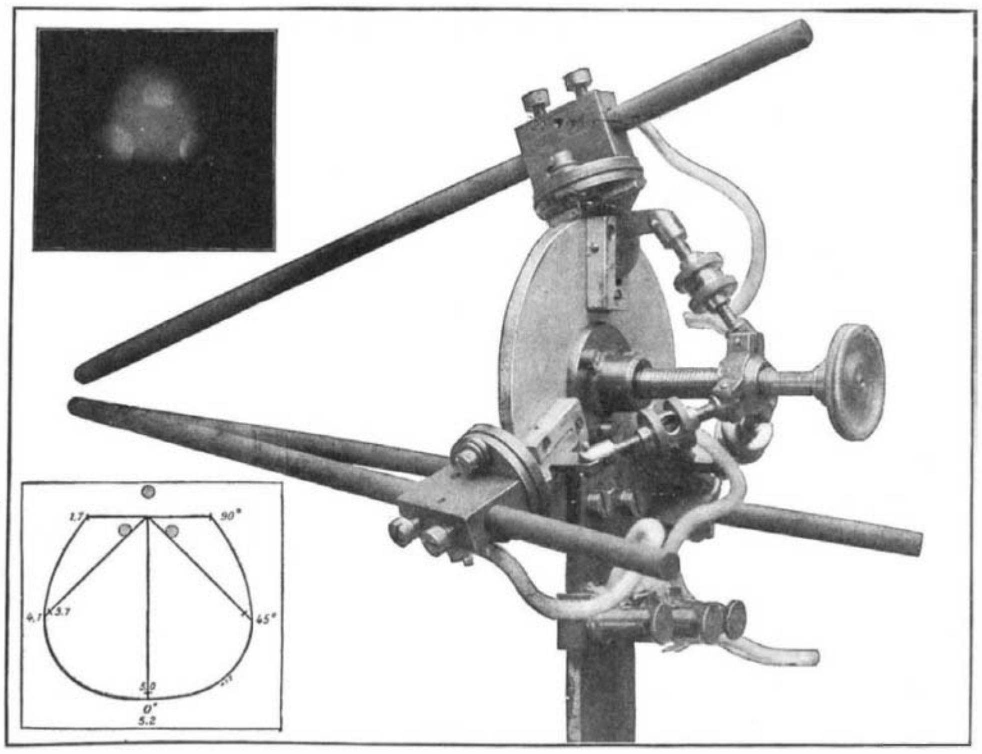
Three-phase electric arcs have recently been produced and investigated by the Italian General Electric Edison Company, at Milan, on the one hand, and by an American, Mr. Richard Fleming, on the other. Quite independently of these researches (of which he was not aware until after his work was completed), Dr. P. L. Mercanton, of Lausanne, Switzerland, undertook a number of investigations in the same direction with a view of producing powerful illuminants in a rather condensed form, and of materially lowering the frequency necessary for maintaining the arc. The principal object of this work was, however, a possible increase in the luminous output of the electric lamp.

Three-phase arcs are constituted by three single-phase arcs burning successively between each pair of carbons, each being extinguished and lit again twice per period. As these are therefore at any time at least two arcs burning, the cooling effects are likely to be considerably reduced, and the consumption of energy required per candle materially lowered. These previsions were in fact fully borne out by experimenting with the lamp represented.

The lamp contains three carbons connected each to a phase of the current, and constituting a regular triangular pyramid, on the top of which the arc is produced by virtue of electrodynamic forces. Regulation is effected by hand, and consists in inclining the carbons with respect to the axis of the pyramids. For this purpose they are supported by three carbon holders which are pivoted at three points placed at angular distances of 120 deg. on the circumference of a circular metallic disk that serves as a base plate. To the middle of this disk, on the side opposite the arc, there is fixed a strong screw, the box of which is connected to a lever system controlling the mutual distance of the carbons. By a special arrangement, the levers may be lengthened or shortened.

The aspect of the luminous focus of this lamp depends to some degree on the kind of carbon used; the latter should be rich in volatile substances. As regards the length of the arc, on which its behavior will depend to a high degree, this is always upward of some millimeters, and in most cases superior to 10 millimeters. Under these conditions, the ends of the carbon appear to the eye placed on the axis of the lamp, like three luminous points of a high brilliancy (as represented); the common angle between the carbons varies between 30 deg. and 50 deg. The lowering in the frequency necessary to maintain the three-phase arc may be readily shown by adjusting the arc for the maximum of frequency and eventually withdrawing violently one of the carbons, when the arc ceases to pass between the two remaining points. The jumping of the single-phase arc from one pair of carbons to the other is visible by the flicker in the light given off from the edges of the crater in front of each other. For a number of periods ranging between 38.5 and 51, the light is quite steady.

In order to determine the candle power of three-phase arcs, Dr. Mercanton undertook photometric measurements for various carbons and different directions of the light rays, by means of a Lummer and Brodhun photometer.

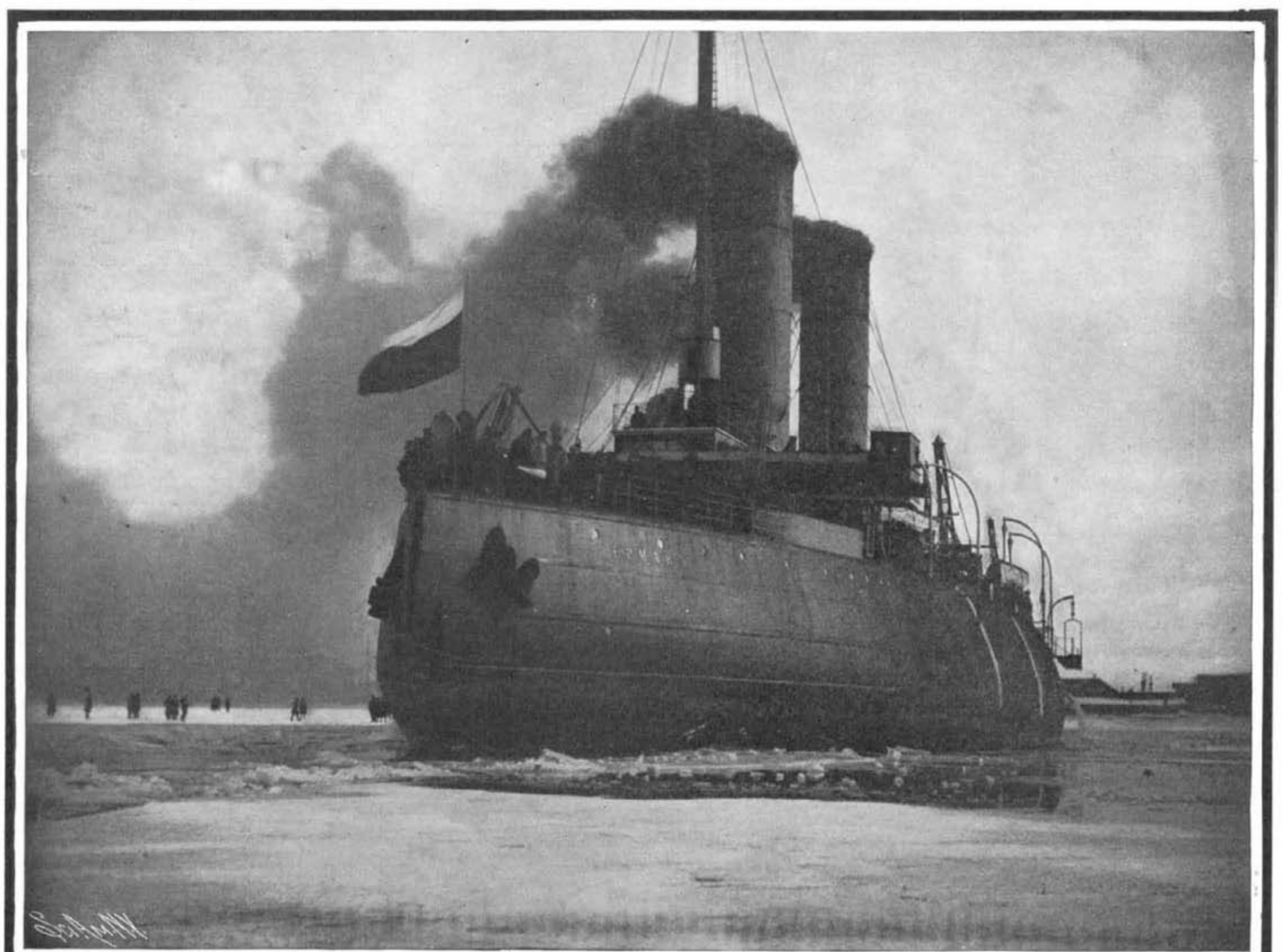


A THREE-PHASE ELECTRIC ARC.

From the results recorded, it is shown that three-phase arcs have a much better luminous output than monophase arcs between the same carbons.

While the previsions of the experimenter were thus borne out fully, Dr. Mercanton is however somewhat doubtful as to whether the saving afforded will warrant the difficulties inherent in the design of a regulating mechanism. On the other hand, there is the necessity of using three wires instead of two, and of replacing the single-phase lighting transformers by three-phase transformers. Wherever regulation by hand is practicable, and especially in connection with luminous projections, three-phase arcs seem however likely to render materal services, in virtue of the steadiness and brilliancy of the triple illuminant.

Thirty-five miles of roadway have been constructed within the World's Fair grounds.



THE RUSSIAN ICE-BREAKER "ERMACK." CAPABLE OF FORCING HER WAY THROUGH ICE TWENTY-FIVE FEET THICK.

THE RUSSIAN ICE-BREAKER "ERMACK."

To Admiral Makaroff, who went down with the ill-fated "Petropavlovsk," is due some belated tribute for his skill and enterprise in familiarizing the Russian marine with ice-breaking steamers of more pretentious size than the small craft of this type that had been used for thirty years in the harbor of Cronstadt. The "Ermack," if not actually designed by him, is at least a product of his energy and the embodiment of the best features of the American ice-breakers, which he had made the subject of an exhaustive study during a visit to America. She carries, moreover, many an appliance which Makaroff himself invented.

The problem of keeping open the ice-bound ports of the Baltic and of the Siberian Pacific coast is somewhat more difficult than the task that confronts the American engineer of the Sault Ste. Marie region. Russian ice is thicker; it lasts longer; and the longer it lasts, the more difficult it is to penetrate. For that reason Admiral Makaroff was compelled to design a vessel which, although in principle it did conform with the best American practice, still embodied features that would enable her to cope with the difficulties presented by the ice-bound harbor ice of Cronstadt and Vladivostock. What these features are will appear more fully from the following description:

The "Ermack" is 335 feet in length, 71 feet beam, and with her coal and stores on board has about 8,000 tons displacement. Her propelling machinery consists of four sets of triple-expansion engines of 2,500 horse-power each, steam being generated in six very large double-ended boilers built for 160 pounds pressure. She has three stern propellers and one bow propeller. Her speed with 8,000 horse-power is nearly 15¼ knots. The speed with the three after engines working ahead is about 15½ knots, and the speed with all the engines running ahead is about 16¼ knots, the power in each case being at the maximum. The highest indicated power developed is 12,000, corresponding with the speed of 16¼ knots.

Each propeller has a set of main engines of the triple-expansion type for driving it when the full power has to be exerted. At the side of the shafting of each screw is a pair of ordinary compound engines which drive the propeller by tooth gearing. The cylinders of the main engines are 25½ inches, 39½ inches, and 64 inches in diameter by 3 feet 6 inches stroke. The boilers are double-ended, and six in number, 15 feet in diameter, and 20 feet 6 inches long. The grate area is 800 square feet, while the heating surface is 27,600 square feet total. The propellers are made with nickel-steel blades containing 3 per cent nickel, having a tensile strength of 40 tons; the stern propellers are 14 feet in diameter, the wing propellers being 14 feet 6 inches pitch, and the center propeller 14 feet pitch. The forward propeller is 13 feet in diameter and is 13 feet 6 inches pitch. The

(*Continued on page* 362.)

equal to the depth of two wires. Now comes the process of wire winding. One end of the wire is driven into a hole bored into the segmental tube at the first step from the powder chamber, and the wire, which is one-seventh of an inch square, is wound upon the gun under a tension of 2,500 pounds. The thickness of the winding varies from seven thicknesses, or one inch, at the muzzle to 21 thicknesses, or 3 inches, over the powder chamber. A trunnion jacket, extending from the breech to beyond the trunnions, a distance of about 12 feet, is then shrunk on with sufficient tension merely to prevent its rotation upon the segmental tube. A sheet-steel tube is also placed over the chase of the gun for the purpose of giving it a finish and protecting the wire wrapping. It should be noted that no reliance is placed upon the trunnion jacket or the chase covering, for the strength of the gun. By a study of the sectional view of the breech, it will be seen that the thrust of the breech-block is taken up jointly by the lining tube, the segmental tube, and the trunnion jacket, and a very even distribution of the longitudinal stress is thereby secured. The advantage of using a segmental built-up tube to carry the tension of the wiring is that the plates, being rolled down to a thickness of one-seventh of an inch, the danger of hidden flaws existing in the metal is practically eliminated; whereas when the solid tube is used, as in the built-up guns, there is sufficient thickness of metal for such flaws to exist without being detected. Moreover, in the segmental tube, should a flaw exist and a fracture occur in any one plate, it could merely extend through the thickness of one-seventh of an inch, and would not, as in the case of a solid tube, extend radially through the whole thickness of the tube.

In an investigation of the principles of the segmental tube wire gun by Prof. Denton, of Stevens Institute of Technology, Hoboken, N. J., Mr. Denton estimated that there was no loss of longitudinal or tangential strength in the built-up tube, for the reason that the tension of the wire windings throughout the whole length of the tube will bind the segments together "with sufficient pressure to cause the frictional adhesion between its curved lines of division to exceed the shearing forces which would be transmitted along these lines in a forged tube of the same thickness, when fired with powder developing the highest current pressures." He found, moreover, that "the metal of the segmental tube, by virtue of the magnitude of its frictional adhesion" (due to a tension of 125,000 pounds to the square inch in the wire winding), "is as available as a source of longitudinal strength and transverse stiffness as the same thickness of solid metal." Prof. Denton further found that "the distribution of the wire windings secured a practically uniform compressive resistance in the lining tube throughout its length, and without exceeding about 90 per cent of the elastic strength of the tightest wire. The lining of the tube was probably compressed so that under 50,000 pounds per square inch of powder pressure it was not required to exert a tensile resistance." In other words, the principles of the wire gun had by this system developed to such a high point that when this gun is fired at Sandy Hook in the last few rounds, with a maximum powder pressure of 50,000 pounds to the square inch, and a corresponding muzzle velocity of about 3,900 feet per second, the lining tube will still be under some of the initial compression which was given to it when the wire was wound on; which means that the wire with its high elastic limit of 150,000 pounds to the square inch, will be comfortably taking care of the enormous forces developed by the powder.

The unusually high velocities secured in this gun are due to the exceptionally large powder chamber. Owing to the abundant supply of gas given off by the burning powder, the pressure on the base of the shell is maintained at a high figure even to the moment that the shell leaves the muzzle, when the pressure is no less than 23,721 pounds to the square inch. In the earlier guns, the powder pressures fell rapidly toward the muzzle and it is this high muzzle pressure that has caused the blowing off or bursting of the chase of several guns of the hooped type during the past few months. It can be seen at once that by increasing the number of windings of wire over the muzzle, this part of the gun may be made relatively just as strong and reliable as any other portion.

There were recently received at the National Museum two termitariums from Jamaica, which are regarded as the greatest curiosities which have been placed in the institution for a number of years. The termitarium is the residence of a tribe of termites, or white ants. One of these specimens was at once shipped to St. Louis, where it will form a part of one of the government exhibits at the exposition. The other was placed on view in the museum. The largest of the two nests received by the museum is about four feet long and two in diameter, being shaped a great deal like an elongated double peanut, round and oval at the ends, and with a narrower portion in the center, with a decided crook between the two ends. This was built around the limb of a tree, and in order to get the nest the limb was cut, leaving about a foot extending from each end of the nest. The construction of the nest consists of leaves overlying each other, and arranged in such order that it was likened to a bill file with bills placed in regular order one over the other.

THE RUSSIAN ICE-BREAKER "ERMACK."

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blades are enormously thick, and are calculated to be brought up by ice without breaking when running at full speed. The machinery is all designed to withstand this test.

The "Ermack" is capable at half power of putting 1,300 tons of weight on the ice to crush it down, when in her ordinary ice-breaking trim, with a draft of 22 to 23 feet. The bow is enormously strong, and for a considerable distance the frames are only 12 inches apart. The ice-belt at the bow extends to the keel. At the sides of the ship it is 27 feet deep.

The "Ermack" left the Tyne on her maiden voyage to Cronstadt early in March, 1899, under the command of Capt. Vassilieff, Admiral Makaroff being also on board. In less than a fortnight after sailing, the ice-blink was seen just before dark, the first drift-ice being met with off the western end of the harbor of Revel. In the Gulf of Finland the small drift ice is first met; this gradually grows to a paste, which, in calm weather, soon solidifies into floes. These increase in size until the solid ice is met, and it is here that the packs of ice are found. The "Ermack" proceeded by night through the ice, her course illuminated by the electric searchlight. On the rocks and islands in the Gulf of Finland the ice forms to an enormous thickness, and the noise occasioned at the bow of the vessel when breaking ice was considerable, but the vibration set up forward was very small. The "Ermack" pursued her way through the ice right up to Cronstadt. Below Cronstadt the vessel could easily break her way through the ice at 8 knots an hour, the ice field being from 18 inches to 24 inches thick, with 6 inches of snow upon it. Three days after her arrival at Cronstadt she was ordered to Revel to save steamers that were in danger of being crushed by the ice, and to open the port. Upon arrival at Revel Bay it was found that an enormous ice-pack had been formed across the entrance to the bay, 15 miles from the town of Revel. The pack had formed during a northwest gale that had blown the drift-ice from the Baltic into the bay, packing it in a dense mass 3½ miles across, about one-third of a mile wide, and from 20 to 25 feet thick, completely closing the harbor. In two hours the "Ermack" succeeded in crushing a way through this ice-pack in fourteen charges. During the limited time that the "Ermack" was on that station she was instrumental in salving eighty-two vessels that were fast in the ice.

In order to test the capabilities of ice-breakers of large size in polar ice, the "Ermack" was sent to Advent Bay, in Ice Fjord, Spitzenbergen. She was fully provisioned for twelve months. Advent Bay was left on August 5, 1899, and on the following day she encountered the first polar drift-ice. Then the fight began in real earnest. Collisions with enormous masses of ice occurred continually. The floes became thicker and older as the ship proceeded north. It was soon a task of ice breaking and charging continually. When stopped by ice, the vessel retired 100 yards or more, got up speed to strike the strong spot, and continued to do so until the obstruction was broken down. In some of the water lanes it was strange to note how the ice had separated in a vertical cleavage, leaving the walls of solid ice on each side of the canal from 12 feet to 20 feet thick. With half boiler power the "Ermack" could force her way through polar ice 12 feet to 14 feet thick at 2½ to 3 knots an hour.

Reference should be made to the arrangement for coupling up the "Ermack" with other vessels in order to make a train of ships for more effectually dealing with thick ice. Although the "Ermack" is big and strong, there is, of course, a limit to her capacity of breaking up ice and to the speed with which she can perform the operation. A vessel pushing astern of her, therefore, would supply additional power for the work. Forward, the stem is set at an angle of 70 deg. from the vertical. In going through ice she slides up, raising her bow, and this causes the ice to break down. She might, of course, mount the ice until her forward propeller came in contact with it; but this is made of sufficient strength to withstand the shock. That, however, is not what is expected generally to occur, as the form of the bow is designed to insure a constant breaking down of the ice. This would absorb an enormous amount of power; but if another vessel, either an ice breaker or an ordinary steamer, were pushing astern, naturally the speed could be increased. Moreover, a steamer not so strongly built as the "Ermack" would be protected by following close behind her. For this reason a recess has been built into the counter. This recess is designed to take the stem of the following vessel, arrangements being made for lashing the latter in firm contact with the leading craft.

The Geographical Society of Philadelphia.

The annual reunion of the Geographical Society of Philadelphia was held Tuesday evening, April 26, at the Hotel Roosevelt, Philadelphia. President Angelo Heilprin, the noted Arctic explorer and student of Mont Pelé and other volcanoes, in his opening remarks sketched the history of the society from its organization twelve years ago to the present, mentioning the great geographical discoveries made in the period in the Far North, Asia, Africa, and the Antarctic regions, in some of which members of the society have participated. The society began in a modest way with fifty-one members and has grown so that a hall seating several hundred is now needed for the open meetings. Excursions to points within reach from Philadelphia are a feature of the summer work of the society.

Prof. Heilprin announced that the Elisha Kent Kane gold medal for noteworthy geographical achievement had been awarded to Capt. R. F. Scott, R. N., of the "Discovery," who has been in charge of the British Antarctic expedition which has recently returned in safety to New Zealand after two years of arduous work. The principal features of Captain Scott's geographical work have been the tracing of the eastern edge of the Antarctic continent for 350 miles south of Mount Erebus; the journey of the "Discovery" eastward from Mount Erebus for 640 miles along the edge of the great ice-barrier to new land, named by this expedition King Edward VII. Land, which is probably a portion of the Antarctic continent. Capt. Scott has attained a point further south than any other explorer, and the geographical results of the expedition under his care are among the most important which have been achieved in recent years.

The chief speaker of the evening was Commander R. E. Peary, U. S. N., president of the Eighth International Geographic Congress, which is to meet in this country in the fall. Commander Peary said that when he was attached to the League Island navy yard, fifteen years ago, he completed the plans for his first expedition into the Antarctic regions, and presented them to Prof. Heilprin, then the president of the Academy of Natural Sciences, who took a hearty interest in the matter and, in connection with Capt. Amos Bonsall, Mr. H. G. Bryant, and others, began the agitation which made possible the Peary South Polar expedition of 1891.

To-day Arctic exploration is not to be considered a foolish matter, but it is a broad national undertaking participated in by the President, Congress, the press, and the people. The object, of course, is the North Pole, which is the mathematical center of the northern hemisphere, where there is but one day and one night in the year; where there is no west and no north, and every wind is a south wind. It is the last great geographical prize which the earth has to offer, and in view of the work which has been carried on under the auspices of the United States, its winning belongs by right to this nation.

The undertaking divides itself naturally into two parts. The first section is the journey by ship to the north shore of Grant Land; the second section is the 420 nautical miles from Grant Land to the Pole. The journey from New York to Cape Sabine or Cape York can be made every summer in about two weeks time. Here Commander Peary would get Esquimaux and dogs, and proceed to Grant Land in from two days to two weeks, according to the season. This journey is the uncertain part of the preparatory work, but it has been made by four ships. The ship would be frozen in off Grant Land by the middle of September, and the preparatory work for the next season's dash to the Pole would occupy the time until the long Arctic night set in. About the middle of February returning light would enable the sledges to start north, and they would have three months or more in which to cover the 840-mile journey to the Pole and back before there was any chance of the ice breaking up. Commander Peary himself has made several dog journeys longer than this.

The features which promise success for a new expedition are that the explorer would take an especially constructed ship which would depend primarily upon steam power for propulsion and would have auxiliary sail, rather than a sailing ship with auxiliary steam, as has been done heretofore. The second feature would be the extensive utilization of the native Esquimaux, which would be possible through the personal influence which Commander Peary has obtained with the tribe during his previous expeditions. The third feature would be Commander Peary's intimate personal knowledge of the coast. The nervous strain due to the long winter night, is the great drawback to work in the polar regions. The cold, which is easily provided against, is only relative in any case and is therefore a negligible factor. The value of the attainment of the Pole lies in getting many geographical data which need not be enumerated, farther than that they lie in pendulum observations which would be invaluable for determination of the exact shape of the globe, and in observations bearing upon terrestrial magnetism and the meteorology and the economics of 300,000 square miles of unknown land. For this great enterprise, Commander Peary needs $200,000. If the expedition were accomplished in one year without the loss of the ship, the cost would be only $100,000, but a larger guarantee is necessary, because two years' time or more might be consumed and the ship might not be brought back. This great geographical prize therefore can be obtained for much less than the sum expended in defense of a single challenge for the America's cup.

Other speakers of the evening were Capt. T. C. McLean, U. S. N., commander of the cruiser "Cincinnati," who rendered great services to the stricken island of Martinique directly after the eruptions of 1902, and who was in command at Colon at the time of the last revolution at the Isthmus of Panama; Major W. R. Abercrombie, U. S. A., who had charge of the surveys along the Copper and Tanana rivers, Alaska, in the search for an all-American route from the coast to the Yukon; Dr. A. Donaldson Smith, who has carried on important investigations in Abyssinia; Capt. Amos Bonsall; Dr. E. O. Hovey, who studied the eruptions of Mont Pelé and the Soufrière for the American Museum of Natural History; Mr. George C. Mercer, who is one of the very few men who have stood upon the summit of the South Dome in Yosemite Valley; Mr. Gilbert H. Grosvenor, editor of the National Geographic Magazine; Miss Dora Keen, who has traveled extensively in Asia and has been almost the only white person to witness (in Teheran) the religious ceremony of the Mohammedans which corresponds to the Passion Play of Oberammergau; and Mr. Henry G. Bryant, who has recently returned from the wilder portions of Mexico, and who is the president-elect of the Geographical Society of Philadelphia.

GROWTH OF OUR NAVY.

In response to several requests from correspondents that we would publish another general view of the new ships that have been authorized, or are under construction, for our navy, thereby supplementing the double-page engraving published in our last Naval Supplement of December 14, 1901, we present the accompanying double-page inset. The engraving in the special number referred to represented all the ships that were authorized or under construction at the close of the year 1901. The double-page inset in the present number includes every warship contracted for and under construction since that date. In looking through the official records, we were much interested to note that the whole of this very formidable fleet was authorized by Congress in the brief period of eight months, from July, 1902, to March, 1903. It includes five of the largest and most formidable battleships ever designed, vessels only slightly smaller than the British "King Edward" class, and more powerfully armed than they; two smaller battleships of about the size of the Russian "Czarevitch" or the new "Borodino" of the Russian Baltic fleet; two armored cruisers which will be the largest vessels of that type ever built, and two gunboats. This is a most remarkable addition to be made in so short a space of time, and if it were not that the contractors for our warships are so slow in completing their contracts, the vessels being at times from one to three years behind their contract date of completion, it would indicate we were rapidly moving forward to the second position in strength among the great naval powers of the world.

BATTLESHIPS.—The most important vessels of the fleet are five large battleships of the "Connecticut" class, the first two of which, the "Connecticut" and "Louisiana," authorized by Congress July 1, 1902, are sister ships. The other three ships, "Kansas," "Minnesota," and "Vermont," were authorized on March 3 of the following year. They are practically identical with the "Connecticut" and "Louisiana," the chief points of difference being that the thickness of the waterline belt has been somewhat decreased, and that of the upper main belt somewhat increased over that on the earlier ships. The "Louisiana" is being built by a private firm, the Newport News Shipbuilding Company, and the "Connecticut" is being constructed at the New York navy yard, Brooklyn, where a rate of progress has been maintained that has already gone far to prove the truth of the naval constructors' assertion, that work can be done as expeditiously and satisfactorily at the government yards as it can at private establishments.

The detailed description which we now give of the "Connecticut" and "Louisiana," both of which, by the way, will probably be launched toward the close of the present year, will also serve for the three later vessels of this class in all particulars except that the main belt amidships will be 9 inches instead of 11 inches thick, and that the upper main belt will be 7 inches thick instead of 6 inches as in the "Connecticut." The particulars of these five battleships then are as follows: Length, 450 feet; extreme breadth, 76 feet, 10 inches; depth, 24 feet, 6 inches; and the displacement at this draft, when the ship is fully equipped ready for sea, with all her stores on board and a normal coal supply of 900 tons, is 16,000 tons. The ships will be driven at a speed of 18 knots by twin-screw, triple-expansion engines of 16,500 indicated horse-power, to which steam will be supplied by Babcock & Wilcox water-tube boilers. The protection will consist of a complete belt of Krupp steel armor at the waterline, extending from stem to stern, which will vary in thickness from 11 inches amidships to 4 inches at the ends. Associated with this armored belt is a complete protective deck 2¾ inches on the flat and 4 inches on the slopes. Above the main deck, throughout that portion of the ship amidships between the main barbettes, is a wall of 6-inch Krupp armor extending from the main belt to the upper deck, and protecting the central battery. The turrets for the main battery 12-inch guns will be protected with a maximum thickness of 12 inches of Krupp steel, and the barbettes upon which they turn will be protected with 10 inches of Krupp steel. The 8-inch turrets will have 6 inches of armor in the case of the "Connecticut" and "Louisiana," and 6½ inches of armor in the "Minnesota," "Kansas," and "Vermont."

The armament of these ships will be the most powerful of any vessels at present designed. It will consist of four 12-inch rifles, calculated for a muzzle energy of over 46,000 foot-tons, eight 8-inch guns with a designed muzzle energy of 13,600 foot-tons, and a battery of twelve 7-inch guns with a designed muzzle energy of 9,646 foot-tons. There will also be twenty of the invaluable 3-inch rapid-fire guns, which have a designed velocity of 3,000 feet a second, and an energy of 874 foot-tons. Four of the latter are mounted on the gun deck, firing through casemates, two of them forward and two aft; six are mounted on the upper deck in broadside between the 8-inch gun turrets; and ten are mounted in the open upon the superstructure deck, three on each broadside, and one at each corner of this deck. There will be also twelve 3-pounder semi-automatic guns and eight 1-pounder automatic guns, and eight machine guns scattered throughout the bridges and fighting tops. They will carry also two 3-inch field guns. Although no provision was made for submarine torpedo tubes in the original design of these vessels, the plans have been changed since the construction commenced, and the ships will be fitted with two forward submerged torpedo tubes. On such large dimensions the vessels will be able to give ample accommodation for the complement of 42 officers and 761 men.

Speaking of the ships as a whole, we think that they represent about the best combination of speed, armor, and armament to be found in any of the latest battleship designs of the various navies; although there can be no question that the increase of the armor protection above the main belt from 6 to 7 inches in the three later ships, at the expense of a reduction of the main belt amidships, is a decided improvement of the defensive qualities of these ships.

At the same time that the three later ships of the "Louisiana" class were authorized, Congress made provision for the construction of two battleships of 13,000 tons displacement, which were to have the maximum speed and offensive and defensive qualities practicable on these dimensions. Working under this restriction as to size, our naval constructors have turned out two admirable ships, the "Mississippi" and "Idaho," which may be termed smaller editions of the "Connecticut." The dimensions are as follows: Length, 375 feet; beam, 77 feet; mean draft, on a displacement of 13,000 tons, 24 feet, 8 inches. The ships will be driven at 17 knots by twin-screw, triple-expansion engines of 10,000 horse-power, steam being supplied by Babcock & Wilcox boilers. The main battery will consist of four 12-inch guns carried in turrets protected by 12 inches of Krupp steel, and barbettes of 10 inches of steel. The intermediate battery will consist of eight 8-inch guns mounted in four turrets protected by 6½ inches of steel, the barbettes being protected by 6 inches. There will be a central battery on the main deck of eight 7-inch rapid-fire guns, protected by 7 inches of Krupp armor, and there will also be twenty 3-inch rapid-fire guns, twelve 3-pounder, semi-automatic guns, eight 1-pounder automatics, and two 3-inch field guns. They will also carry two submerged torpedo tubes. The waterline belt will be 9 inches amidships, tapering to 4 inches at the ends. The conning tower will have 9 inches of armor, and the conning-tower tube 6 inches, while the ammunition tubes will be protected by 3 inches of armor. The vessels will have a full coal capacity of 750 tons, and at 10 knots cruising speed they will have a radius of 5,750 nautical miles.

ARMORED CRUISERS.—The two armored cruisers "Tennessee" and "Washington" are, like the battleships above mentioned, among the very latest and most powerful of their class in any navy. Moreover, they are extremely handsome vessels, with a clean-cut outboard profile, and an excellence of proportioning and placing of masts and smokestacks, that renders them comparable in appearance to the modern Atlantic passenger steamship. These cruisers are nearly a thousand tons larger in displacement than the six armored cruisers of the "California" class, and although the length, 502 feet, is the same, they have about 3½ feet more beam, or 72 feet, 10 inches, and about a foot more draft, the draft on a mean displacement of 14,500 tons being 25 feet. They will be driven by twin-screw triple-expansion engines, with an indicated horse-power of 23,000, at an estimated speed of 22 knots an hour. The normal coal supply will be 900 tons and they will have a bunker capacity of 2,000 tons. They will be protected by a continuous waterline belt, which will be 5 inches in thickness amidships and 3 inches at the ends. This is an inch less than is carried by the California" class; but what is lost at the waterline is gained in the protection of the main battery, which consists of 9 inches on the turrets, as against 6½ inches in the "California," and 7 inches on the barbettes, as against 6 inches in the earlier ship. Associated with the belt will be a protective deck, 1½ inches in thickness on the flat, and 4 inches on the slopes, with the armored citadel amidships, and 3 inches on the slopes toward the ends outside the citadel. The sides of the vessel from the main belt to the upper deck, and extending for the length of the ship between the main barbettes, will be protected by 5 inches of Krupp steel. The armament of these vessels is particularly powerful, consisting of four 10-inch breech-loading rifles in two turrets forward and aft, and sixteen 6-inch guns mounted in broadside. Twelve of these are on the main deck, and four on the upper deck. There is also a battery of twenty-two 3-inch rapid-fire guns, of which six are mounted on the gun deck within the central battery, six on the gun deck in sponsons outside of the battery, two forward and four aft, and ten on the upper deck in broadside between the 6-inch gun casemates. Twelve 3-pounder rapid-fire guns, four 1-pounders, two machine guns, and six Colt automatic guns are distributed throughout the superstructure, the bridges, and the fighting tops. There are also two 3-inch field guns to be used for landing purposes. This, it will be observed, is for a cruiser a tremendous battery, its most distinguishing feature being the four 10-inch breech-loading guns, which will be capable of piercing the heaviest armor of battleships at the nearer fighting range. There are altogether no less than sixty-eight guns. It must be confessed that the armament of these ships appears to be relatively heavier than their defensive qualities, and we wish that the side armor of the central redoubt had been 6 inches instead of 5 inches in thickness. The vessels will be provided with two broadside submerged torpedo tubes forward and probably another pair aft. Splinter bulkheads of nickel-steel, from 1½ to 2 inches in thickness, will be worked in between the 6-inch guns of the central battery, and the 3-inch battery on the main gun deck will be given also 3 inches of nickel-steel protection. The 6-inch guns in the broadside battery will be mounted in recessed ports, which will allow the guns to be swung around until their muzzles are flush with the side of the ship, thus obviating the inconvenience which arises from the great length of modern broadside guns. Altogether, we must confess to the conviction that these are about the most effective large armored cruisers to be found afloat or under construction to-day, the only vessels which compare with them, being the latest armored cruisers of the British navy, which carry a much lighter armament, and have no better system of protection.

GUNBOATS.—The two gunboats "Dubuque" and "Paducah" are vessels of the unarmored composite class, to which such vessels as the "Marietta" and "Vicksburg," the latter now at Chemulpo, Korea, belong. Both vessels are being built at Morris Heights, N. Y. They are constructed with steel framing and wood planking, and have an over-all length of 174 feet, an extreme breadth of 35 feet, and 1,085 tons displacement on a mean draft of 12 feet, 3 inches. They will be driven by twin-screw, triple-expansion engines, and steam will be furnished by Babcock & Wilcox boilers. On an indicated horse-power of 1,000 they are to have a speed of 12 knots per hour. They will carry an armament of six 4-inch rapid-fire guns, four 6-pounders, two 1-pounders, and two Colts. They are schooner-rigged and have a stump bowsprit, and a modified clipper bow, a combination which, it must be admitted, does not add anything to the beauty of the vessels. However, as the bow is full and lofty, no doubt they will prove to be excellent sea boats, well suited to their particular duties.

In a recent address before the Michigan Municipal League, Dr. Victor C. Vaughn estimated the annual loss in this country due to typhoid fever at $50,000,000. He said the total number of cases of this disease in the course of the year was about 500,000, of which 50,000 terminated fatally. Placing a valuation of one thousand dollars on each life, he arrived at the total given above. The doctor said that this terrible death list should have no existence, for by the exercise of proper care and precautions, all of these lives might be saved.

The construction of a harbor to the north of the city of Kiel is being planned.