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(Illustrated articles are marked with an asterisk.)

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SCIENTIFIC AMERICAN SUPPLEMENT

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PROGRESS OF OUR NAVY.

It is gratifying to note the very substantial progress which has been made, as evidenced in the annual report of Secretary Tracy, in the building up of our new navy. It is, as the secretary says, "a progress both in ships and in ordnance, by which the United States has emerged from its condition of helplessness at sea, and, by the employment of its own resources, has distanced its more experienced competitors, marking an epoch in the naval development not only of this country, but of the world."

On March 4, 1889, there were in our navy only three modern steel vessels, with an aggregate tonnage of 7,863 tons, and mounting thirteen 6-inch and four 8-inch guns, the forgings for which last, as well as the shafting for the vessels, had been purchased from abroad, as they could not be made in this country. On the 4th of March next it is expected that there will be twenty-two modern vessels in commission, while nine additional vessels, none of which in speed, armor and armament has a superior in any foreign navy, promise to be ready for launching within the next twelve months. The nineteen vessels thus added to the navy in four years have an aggregate tonnage of 54,832 tons, mounting altogether two 12-inch, six 10-inch, sixteen 8-inch and eighty-two 6-inch guns, all of which, with the exception of five of the earliest, have been manufactured in this country. Three new steel tugs have also been constructed and put in service during this period.

Our new navy, including all vessels built or authorized, now consists of the following vessels: One seagoing battleship (first-class)—Iowa; three coast-line battleships (first-class)—Massachusetts, Indiana, Oregon; two battleships (second-class)—Maine, Texas; six double-turreted harbor defense vessels—Puritan, Monterey, Miantonomoh, Monadnock, Terror, Amphitrite; two armored cruisers—New York, Brooklyn; one ram; two protected cruisers of extreme speed—Columbia, Minneapolis; fourteen cruisers—Olympia, Baltimore, Chicago, Philadelphia, San Francisco, Newark, Charleston, Boston, Atlanta, Cincinnati, Raleigh, Detroit, Montgomery, Marblehead; one dispatch vessel—Dolphin; six gunboats—Yorktown, Concord, Bennington, Machias, Castine, Petrel; one dynamite vessel—Vesuvius; one practice vessel—Bancroft; two torpedo boats—Cushing, No. 2. Making a total of forty-two vessels.

The three great first-class battle ships have a displacement of over 10,000 tons each, are protected by 18 inches of armor, carry 13-inch guns, and throw an aggregate of over three tons of projectiles at a single discharge, while the armored cruiser New York, formerly declared by the Secretary to be "the best all round vessel of any type," is now to be outdone by the new Brooklyn, of 9,150 tons, greater coal endurance and greater battery power. The two triple screw protected cruisers, Columbia and Minneapolis, with their maximum speed of 22 knots and sustained sea speed of 21 knots, with a very large radius of action, represent the highest type thus far attempted in this class of vessels.

A *resume* is given of the experiments and tests undertaken to obtain the best possible protective armor, resulting in the development of Harveyized nickel-steel for this purpose, from which our armor plates are now made, "far superior to any hitherto known, and destined to furnish the standard, both of quality and manufacture, for the great naval powers of Europe."

Although all our new vessels, as well as the torpedo boats especially, have been designed to use torpedoes, the kind of torpedo to be employed has for a long time been a most perplexing question, nothwithstanding that there have been many valuable American inventions and improvements made in this line. It was finally decided by the department to domesticate in this country the manufacture of the Whitehead torpedo, whose use in actual war had proved an assured success, and a factory was accordingly built for the purpose in Brooklyn, N. Y., under an arrangement with the foreign manufacturers. A number of these torpedoes, of the best modern design and of American manufacture, are now nearly ready for use.

In the manufacture of high power guns, eighty-two have been completed during the last year. The greatest progress has been made with the rapid-fire gun, of which twenty-eight 4-inch and eleven 5-inch have been completed since the last report. These guns, upon which little had been done up to last year, owing to the time required to perfect a suitable breech mechanism, are now rapidly approaching completion. The difficulties experienced in the manufacture of suitable metallic cartridge cases have now also been overcome. Of the 6-inch guns, the manufacture of which was most advanced, 135 have now been completed. Contracts have been made for forgings for six new 6 inch guns of forty calibers in length, to be used with brass cartridge cases as rapid-fire guns, and to be supplied to the fastest cruisers. Of the 8-inch guns, twenty-three are now completed and twelve partly completed. All the 10-inch guns, twenty-five in number, have been completed and are ready for installation on the ships for which they are intended. Five 12-inch guns have been completed, of which two have been proved and are being installed on the Monterey. The first 13-inch gun is approaching completion, and the forgings of the second have been received.

The development of a new smokeless powder, and of a safe high explosive for the shells in high-power guns, and the manufacture of armor-piercing projectiles equal or superior to those of any other nation, are each the subject of a discriminating and most satisfactory notice by the secretary. As to smokeless powder, it is said that the department, "by independent investigation and experiments, conducted by its own agencies at its own establishments, has succeeded in developing a smokeless powder which in efficiency and endurance gives better results than any known powder abroad." In conclusion, the secretary expresses the opinion that there can be but little doubt, in view of the progress of naval science, that the advance toward higher and higher types will continue steadily in the future, a progress in which American inventors will, doubless, be full participators.

THE USE OF PHOTOGRAPHY IN PHYSICAL RESEARCH.

This is the title of a very interesting and instructive lecture delivered before the Physical Department of the Brooklyn Institute of Arts and Sciences, Dec. 13, by Prof. Edward L. Nichols, of Cornell University.

The lecturer began by stating that photography is now used in almost every branch of physical research; that it is often used advantageously as a substitute for drawing when making observations. Prof. Nichols projected upon the screen a number of views, illustrating the exploration of the magnetic field, showing the lines of force, and of various phenomena which have heretofore been illustrated by drawings made by the hand of the observer. In some cases the hand-made drawings compared favorably with the photographs, while in others they appeared to be incorrect. The lecturer spoke of the value of photography in making long-continued observations; also in making observations of phenomena developed instantaneously, as in the case of lightning flashes, electrical discharges, sound vibrations, etc. He also showed upon the screen a plate illustrating diffraction fringes formed by a small triangular aperture in a piece of tinfoil, the figure being very intricate, and altogether different from what might have been expected.

An interesting illustration was that of photographs of the manometric flame, the flame for this purpose being produced by a concentric burner, the illuminating gas being supplied to the central orifice while the oxygen flowed through the annular orifice. The photographic flames produced in this way were very bright, clear, and sharply defined, and although drawings heretofore made compared favorably with the photographic record, they were not, of course, as accurate as the photographs.

Interesting views of the electric arc were shown, with which the hand-made drawings heretofore used compared very favorably. The photographs, however, revealed some phenomena which had not been observed by the eye. Among these were the brilliant particles thrown off from the arc, also the superior actinic quality of the light given by the incandescent copper covering of the carbons. A photograph of an arc on an alternating circuit showed a succession of light flashes, proving the intermittent character of the arc when produced by an alternating current. Other peculiar features were shown, among them an illustration of the arc oscillating from one side of the carbon to the other. This the lecturer supposes to be due to the attraction and repulsion of the earth's magnetism. He stated that the singing of the arc was clearly due to rapid intermissions, and that the pitch of the sound proceeding from the arc was what would be expected from the rate of the reversals of the current.

An attempt has been made to produce a photographic record of the alternating current by means of a telephone having attached to its diaphragm a mirror, the incident beam being projected on the mirror, the reflected beam being received on a moving sensitive plate. The result showed that the fundamental vibration of the telephone diaphragm interfered with the production of a correct record. For this method was substituted one in which a stream of mercury carried the alternating current, the apparatus being so arranged as to allow the stream to pass between the poles of a magnet. The mercury was oscillated by the attraction and repulsion of the magnet, the movement correspondingly exactly with the reversals of the current. The mercury stream was photographed through a slit located at the point of greatest amplitude of vibration, and the curve produced was the sinuous curve expected from an alternating current produced by a machine working normally.

One of the most interesting illustrations of the evening was that of sun spots taken by means of the spectroscope. This method of investigation appears to have shown conclusively that the fecula around the dark portion of the sun spot correspond with the flames projected from the sun.