SCIENCE

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APPLIED SCIENCE IN THE NAVY.

AMONG the technical reports issued from the Government Press, just now, those coming from the departments of the government most active in the war with Spain are of special interest. That of the Chief of the Bureau of Steam Engineering of the Navy Department, Com. G. W. Melville, is now published, and, though brief and businesslike, gives some interesting information of a more or less scientific nature, as well as of a kind to interest the average citizen in a more general way.

The first effect of the demand upon the Department for preliminary work was to 'demonstrate in the briefest and most vigorous manner the necessities, facilities and deficiencies' of the naval establishment. Fortunately, as it proved, the already established policy of keeping at the navy yards ample stocks of material and stores reduced enormously the risks and delays, embarrassments and dangers of a sudden call for active service of every available ship and gun. Much was necessarily done, however, before satisfactory provision could be made for all emergencies; yet it will never be forgotten that the navy never failed when called upon.

Some work was performed with marvellous despatch. Thus, the old and worn-out 'shell-boilers' of the monitors *Manhattan*, *Mahopac* and *Canonicus*, at League Island, were replaced by new constructions in thirty days. The new water-tube boilers were passed, in parts, through the hatches and the old boilers were cut in pieces below and passed up in small sections; thus saving the time, cost and risks of destruction and reconstruction of the decks which would have been necessary had the old types of boiler and ways of doing work been adopted. This necessity had been foreseen and provided for before the war actually began, and a provisional contract with the only firm known to be ready and able to undertake the task had been made. In five hours after the contract was signed the work had been commenced. The performance of these ships with the new boilers excelled the best work with the old.

The most tremendous work, in kind and quantity, was that of fitting out the auxiliary fleet of more than a hundred ships, of all sizes, kinds and duties, from tugs and ferryboats to ocean-steamers from the transatlantic lines. All were necessarily extensively altered to adapt them to their new duties, and the provision of stores, already alluded to, proved an essential element of success in securing their services promptly upon the outbreak of war. Even floating machine-shops to make repairs in the midst of the fleets were sent out and proved of inestimable value.

"There was a remarkable absence of casualty in the machinery departments of the vessels of the fighting fleet during the war. Even in action, when forced-draught conditions were in operation and the excitable natures of the men most wrought upon by the surroundings, the reports show that the machinery not only worked well generally, but that in no case was it greatly distressed. This is as fine a comment upon the personnel as upon the machinery." The statement does not apply to the torpedo-boats, the condition of which, under circumstances of operation entirely unintended in their construction, 'can only be described as horrible—boilers were burnt, cylinder-covers broken, piston and valves stuck, everything in bad shape.' This was due to absence of expert and professional supervision and to employment on duty for which these craft are not intended and for which they are unfit. No member of the Naval Engineer Corps could be spared to care for them, and the inexperienced and the inexpert young officers in charge of the boats could not be expected to succeed in keeping their machinery in order.

The amount of work performed by this Bureau, in designing new machinery, in refitting old, in construction at the navy yards and in repairs of ships, can only be realized on reading in detail the full report. Over four millions of pounds of iron and steel passed under inspection and were shipped to points at which this material was needed. All specifications and methods of inspection and test have been revised; including physical, chemical and mechanical methods and limitations of quality. Nickel-steel has been made an important and useful material for engine-construction; steel tubes are now made without weld and wonderfully perfect. New methods of shaping and welding parts give hitherto unapproachable security in use. Steel containing an unusually high proportion of carbon is now found applicable to even steam-boiler construction. Tenacities exceeding 74,000 pounds per square-inch are attained, with extensions rising above 21 per cent., and with elastic limits above 40,000 pounds. Such gains allow reduction of sizes and parts and, still more important, in a battle-ship, diminution of weights.

Water-tube boilers are unqualifiedly approved for naval purposes, and experience with those of the *Marietta*, while accompanying the *Oregon* on the long 14,000-mile voyage around Cape Horn, proves the reliability of such boilers when properly made and handled. The experience confirms the results of test in foreign navies also. Nearly all naval vessels, at home and abroad, now include in their specifications the water-tube boiler. "The tactical importance of water-tube boilers has been emphasized by the conditions which obtained in the blockade at Santiago and the great victory of July 3d. It was necessary, for a long period, that our ships should be ready to develop maximum power at a few minutes' notice; and with cylindrical boilers this involved keeping all the boilers under steam, with heavily banked fires and a large attendant consumption of coal. Water-tube boilers of the proper kind, which admit of the rapid raising of steam with safety, remove this difficulty and give the commanding officer a more complete command of his fighting machine." Giving great power with small weight, this modern apparatus of power-production is coming into use on all torpedo boats and, as a rule, on even the heavy battle-ships.

The steam turbine is referred to, but with the statement that it is not yet certain that it will find permanent place in the naval service.

The use of oil-fuels is pronounced promising in some naval work where costs of fuel are not of prime importance. Success is met with in the use of an oil of S. G. 0.85 to 0.87, a flash-point of 315° Fahr., and a burning point of 350° Fahr. This oil is entirely safe on shipboard.

Referring to the marvellous performance of the *Oregon*, her long voyage, perfect condition at its end, and later effective action with the squadron off Santiago, a record 'which has never been equaled in the history of navies,' and attributing this fact to the admirable work of designers and constructors, and still more, if possible, to the splendid character of the personnel of the engineer department of the ship, the Engineer-in-Chief says: "For the past ten years it has been my duty and a sad one to call attention to the urgent need of a reorganization of the personnel of the Engineer Corps." Its enlargement, provision for proper selection of its officers and professional training, and of suitable inducements to men of talent and genius in this branch to enter the corps, are vitally important and necessary amendments to existing provisions for its support. An efficient Engineer Corps is as essential to the efficiency of the navy as good war-engines. The engineer and his war-engine together make victories like those of Manila and of Santiago possible, with the no less essential aid of good 'men behind the guns.' The whole department is one of applied science of the most extensive and imposing character and an Engineer Corps, scientifically educated and systematically trained to its peculiarly exacting and responsible work, is the most pressing need of the 'new navy.' The report, and its conclusion regarding the lessons of the war, is most instructive from both scientific and the political standpoints.

R. H. THURSTON.

REPORT ON THE STATE OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM.

IN considering the state of the mathematical theory of electricity and magnetism at the end of the first half-century of the existence of this Association, it seems hardly possible to avoid a comparison with the state of affairs at the beginning of that period. In 1848, strange as the statement may seem, most of the great discoveries in electricity had been made. Coulomb had by his remarkable quantitative experiments with the torsion-balance and the proof-plane set the law of inverse squares once for all upon its feet, and thus opened the way for the wonderful applications of the analysis of Laplace, Poisson, Gauss and Green. The experimental discovery by Oersted of