

## THE ENGINEER AND HIS WAR ENGINE.

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OUR present fleet—magnificent in quality, but still small in numbers, exemplifying the marvellous ingenuity of the American mechanic and inventor, the wonderful constructive skill of the marine engineer and naval architect, and the most extraordinary of all modern combinations of accurate design with beautiful and exact construction, and demanding the highest skill of most thoroughly trained officers for its management; concentrating in minimum space maximum power, and uniting offensive and defensive power as does no other product of science and skill—is the outcome of but about ten years of work on the part of our engineers, naval constructors, and ship-builders. This fleet includes the most perfect of modern steam engines, the most graceful of hulls, the most resistant of armor, and the most penetrating of ordnance. Ships like the “Columbia,” the “Minneapolis” and their type are among the swiftest war vessels on the ocean. The fleet is the grandest triumph of the engineer and his aids that the world has seen. Its *material* is the most perfect, on the whole, yet known; it only remains to make its *personnel* correspondingly complete and effective.

In this task no difficulty can arise from lack of good men available for such a purpose. Whether in skill as mechanics, in knowledge as engineers, or in scientific preparation for their work, no nation can produce a body of men superior to that which, the right way being taken, may be readily collected to complete the requirements of a well-built and well-manned navy. The finest navy the world has seen becomes useless without an ample and well-proportioned *personnel*.

We have the ships, but we have not the men. To secure them

ways must be found and opened for their introduction, and inducements commensurate with the talent and character required must be offered to bring them into the service of their country, in time of peace, when, if ever, we must prepare for war. It is as insane to expect to secure an efficient *personnel* on call, in the event of a sudden outbreak of war, as to anticipate that ships, which require years to build, may be improvised on demand. In this respect the difference between the modern and the ancient navy is as great as in character and power. At this moment, not only have we a very dangerous deficiency in numbers of engineers for the effective manning of the fleet, but there exists no legal path by which the needed reinforcement can be brought into the navy list.

The Naval Academy cannot produce the men either in sufficient numbers or with the high training which is to-day always demanded, even in civil life, of those who enter the profession of the mechanical engineer; and the schools of engineering of the country and the profession itself are to-day helpless to serve the nation in any emergency, simply because every legal avenue of entrance has been closed by the same influences which have reduced this magnificent fleet to its present condition of threatened failure in any such emergency.

The two principal corps of officers, by the progress of events, under unfortunate influences and with inefficient legislation, are reduced, the one to the condition of an army consisting of excessive numbers of generals with few privates, the other to the condition of an army with few privates and vastly fewer generals in proportion to privates.

The work of development of the modern engine of war is mainly attributable to a few great men of science and of inventive and constructive genius. James Watt and his successors have given us the heart of the machine, its powerful steam-engines, without which all other elements of power would be helpless; Armstrong in Great Britain, Krupp in Prussia, and Broadwell, the American—honored as a prophet, except in his own country—and their followers among later inventors and engineers, have produced the ordnance of our time, capable of driving its ton of projectile through thirty inches of iron at a thousand yards range, of attaining a muzzle-velocity of a third of a mile in a second, and of sending its shot a dozen miles and over an ele-

vation, *en route*, as high as the loftiest Alpine peaks. Robert Fulton, the American engineer, in 1815, brought the steam-engine into the service of our own navy; Robert L. Stevens, the ablest engineer of his time, and Ericsson and his recent disciples, have covered the sides of the iron hull with armor, and thus the naval architect, co-operating with the engineer, has produced a ship, an instrument of propulsion, a battery and a fort combined—the greatest wonder of the whole modern world of engineering.

The ship-of-the-line of the days before the advent of the iron-clad was seldom of more than about a thousand tons rating, carried a hundred or more guns—consisting of 32-pounders and smaller calibre, with a few 8-inch shell-guns—in the later ships, had a speed entirely dependent upon wind and wave and rarely exceeding ten knots, and was penetrable by the smallest ordnance of the time. The battleship of to-day displaces ten times as many tons of sea water; carries a few, but vastly greater, guns; steams, in smooth water, over twenty knots—24 miles—an hour; crosses the ocean at two-thirds speed without regard to wind or weather; defies penetration except by the largest of modern ordnance, and her own enormous guns drive their shell and their solid shot through from one to two and a half feet of solid iron, while her automobile torpedoes, themselves marvels of ingenuity and skill on the part of the contemporary engineer-inventor and mechanic, destroy with a single explosion the noblest, grandest, and most powerful of her adversaries. The steam-engine, the motive power of this leviathan, concentrates within a small fraction of the volume of the ship the power of thousands of horses, and is itself the embodiment of the highest skill and intellect of contemporary man. In fact, to replace the thirty-thousand horse-power engines of the latest transatlantic “liner” would require the most severe exertion of forty-five thousand horses, and their constant maintenance of such power would demand at least three relays, probably more, in the twenty-four hours—a stud of one hundred and thirty-five thousand horses. Allowing ten feet to each, as a “string-team” they would stretch a distance of about two hundred and seventy miles. The actual engines doing this inconceivable work weigh but a small fraction and occupy a still less minute proportional volume of the ship. The horses would weigh not less than seventy thousand tons, and with their pro-

vender would load several ships such as their steel and iron representatives propel. It is this almost automatic machine, designed, constructed, and operated under the direction of the engineer that makes the modern war-ship possible.

The revolution which constitutes the evolution of the past generation has attracted the attention of every statesman. As the matter is stated by Rear Admiral Colomb, R. N. :

"What we have to do in the navy is really to welcome the coming, speed the parting, guest. The parting guest is the seamanship of the past, that which confined itself to the management of the ship under sail alone. The coming guest is steam, mechanism, and forces of all kinds other than the winds. Now, instead of frankly going out, shaking hands and bidding good-bye to the parting guest and wishing him well, and going down the steps to meet the new one and bring him in, we are holding on to the coat-tails of the old one and trying to shake hands with the coming one with the left hand, or perhaps with only one finger."

Senator Squire, addressing his colleagues, recently remarked when speaking of his visit to a lately constructed iron-clad :

"Going through the vessel, below the water-line, I observed the vast amount of machinery, the complicated elements that enter into its construction, making the care of a modern vessel of war very important as regards the future of steam engineering. One passes through compartment after compartment and is almost lost in bewilderment in the mazes of the complicated machinery around him. It occurred to me that not enough attention has been paid to the *personnel* as respects steam engineering. Truly the propelling power is the soul of the ship! Without it the ship cannot be handled and is perfectly useless. This power is under the supervision of the engineer officers; therefore it is needful to have a high order of *personnel*, a larger number of officers, and those of great attainments and proficiency." . . . "We are building in this country vessels such as were unknown in former times, and we need adepts in the art of engineering and of marine architecture. There is no way of obtaining a suitable class of men except by preparing them in the various educational schools. Ships can be built, but men cannot be built. . . . The only way to have such men is to educate them in advance."

When the first "Monitor" was battling with her comparatively gigantic antagonist, the "Merrimac," in Hampton Roads, her engineer staff took the greatest risks in the fight of the Ericsson machine with the larger craft, and the handling of her guns by Chief-Engineer Stimers saved the fleet and the coast to the country.\* When the ironclad "Tecumseh" sank, torpedoed in the

\* In a letter from the late Admiral David D. Porter, addressed to Engineer-in-Chief W. W. Wood, the former wrote "I have had more than two thousand engineers under my command during the rebellion, and I have never known them to shrink from any service."

harbor of Mobile, it was the engineer corps which suffered most, in proportion to numbers. When the British "Victoria" sank, she carried to the bottom her whole engineer department.

As Engineer-in-Chief Isherwood wrote of the States' insurrection in 1861-65 :

"Our antagonists had neither engineering skill nor resources in themselves, nor could they, owing to the efficiency of our navy, obtain them from others, and the want was fatal. They had despised the mechanical arts and sciences, and by those arts and sciences they fell.

"During the four years of the war, 115 of the officers of the engineer corps are recorded as having died in service, the majority of them being killed in battle or having died from wounds and exposure incident to their duty. In proportion to the numbers employed, it is believed that no other corps suffered so severely. The facts of the history of the corps during the War of the Rebellion are unquestionably sufficient to redeem from error every fair-minded person who may have been led to believe, from partisan arguments, that the engineer officers of the navy occupy a non-combatant status, or that the engineer corps is not a necessary and essentially military arm of the service. The truth of this must be known to even those who imagine it to be to their interest to deny it. It was freely admitted by scores of commanding officers, who had experience in war and who did not hesitate to do honor to whom it was due, in their official reports, irrespective of corps."\*

When the engineer corps was organized, the engineer officer, not unnaturally, was regarded by the older class of sailor-officers as an interloper. His machinery excited dismay and disgust, as occupying space which had been available for other purposes, restricting the storage, the conveniences, above all the comfort of the men who felt that their rights of possession were not nine-tenths but ten-tenths of the ship. The new officer was designated on the books as "an idler," although then, as always, the most business-like and most unintermittedly busy of all the members of the uniformed list.

The proportional number of officers actually required in the engineer corps and in the "line" have, since 1866, continually changed in the direction of growth to the former. The civil war, which necessarily compelled the appointment of a fairly efficient body of engineer officers, brought up the proportion to about equal numbers—2,279 to 2,463 in 1865—and this proportion was retained when the navy was placed on a peace footing—379 to 395 in 1866. Since that time the size and power, and the numbers, of steam engines and boilers and accessory machinery, great and small, have been constantly and enormously increased, and the correct proportion should probably be, for the highest effi-

\* Bennet, *Steam Navy of the United States*.

ciency of the navy as itself a great machine, one giving considerably the larger number to the engineer corps.\*

At the present time, with our great iron ships, weighing 10,000 tons, filled with machinery developing twice as many horse-power, the requirements would be about double the existing number of engineer officers, assuming the numbers apportioned for a peace footing, and the number of sailors and their officers, especially the latter, somewhat less than at present. For a war footing the numbers of both should be increased, the engineer corps to several times its present magnitude, the other corps very considerably. The proportion of the one to the other, so far as officers are concerned, should be, on such ships as we are now adding to our navy, about four engineer officers to three deck officers. The rank of the men in either corps should be practically the same for similar ages and periods of service, and the pay of the former must necessarily, for highest efficiency, be considerably larger for similar grades, as it is vastly more difficult to secure and maintain able men where competing with a lucrative and in all ways agreeable and seductive profession, than where sentiment and freedom from competition in business permit the selection of good men and their retention even at rates of compensation that prove unequal to the ordinary demands of their families.

The extraordinary and fearfully dangerous condition of naval affairs at present is seen in the fact that to-day, when we should have, for a navy of 108 vessels and of 320,000 horse-power, about 600 deck officers and 700 engineer officers, we actually have over 700 of the former and less than 200 of the latter; while the list is continually being reduced by deaths, resignations, and prostrations by nervous and physical exhaustion. The engineer officers number less than in the year previous to the outbreak of the civil war. Were we compelled to go into a war in our present condition, the consequences could not but be disastrous if not absolutely fatal, and that very promptly.

In 1896, with the "new navy" afloat, with about 100 vessels in commission, nearly 300,000 tons displacement and over that figure in horse-power of engines, the number of deck officers was double the figure for 1866; the number of engineer officers

\* It is of course to be remembered that all influences, even in time of war, have favored undue proportion of the sailor, as compared with the engineer, branches of the *personnel*.

one-half as great as then. There were about  $2\frac{1}{2}$  of the former per 1,000 tons, and only two-thirds of the latter, over four to one, where, with the quantity and power and intricacy of machinery so enormously increased, there should have been a larger proportion of the latter than in 1865. Where, in 1866, each member of the engineer corps took charge of 300 horse-power of machinery, 2,000 were assigned to each in 1896.

In March, 1896, Britain was endeavoring to keep up her quota of engineer officers, precisely the opposite of the policy so suicidally pursued on this side the ocean, and was seeking 318, while but 85 were at the time available. The British navy at that time listed 3.52 deck officers per ship, when our own listed about ten. With all conditions vastly more favorable to success than with us, that service was nevertheless experiencing serious difficulty in obtaining needed men in its now most essential corps—most essential because, were either to be extinguished, it would be vastly easier for the younger corps to learn and to assume the duties of the elder than the reverse.

For thirty years this process of emasculation of our steam navy by the constriction of its engineer corps has been going on, in spite of all protests of its best friends and the continual representation of the case to Navy Departments, Congresses and successive administrations. As long ago as 1869 the writer, then “out of the hurly burly” of the active service and with no intention of ever returning to it, and having some ambition to aid in the building up of an effective new navy, collected some figures relative to this subject, from among which are selected the following statistics:

We had before the war closed, in 1864, at a time when the exigencies of war had compelled at least some slight approximation to that correct proportion of numbers of the two great corps which, even under such circumstances, was not completely attained, in consequence of the restraining effect of the old, and still persistent, prejudices and traditions, over 2,800 officers in the line, and 1,700 in the engineer corps—a ratio of 8 to 5. In 1865 the maximum became nearly 2,500 in the line and 2,300 officers in the engineer corps—a ratio of about  $5\frac{1}{2}$  to 5, or nearly equal numbers. Had the natural demand been met entirely without prejudice, in favor of the one and against the other corps, the numbers even with the then comparatively small



displacement of sails by steam that characterized the navies of the world would undoubtedly have been reversed in their proportion. The natural numbers to-day would be unquestionably such as would still further reduce the proportion of the older, and increase in marked degree those of the newer corps.

In September, 1896, the newspapers recorded the fact of the breakdown of one-half the force of engineer officers on board the "Indiana," one of our most formidable war vessels—*two* good officers! A little later news came from the Asiatic squadron of the disablement of two of its engineer officers, leaving but ten in that whole fleet, on the other side of the globe. They are compelled at times to stand watch twelve out of the twenty-four hours; while the deck officers stand watch but four hours in the twenty-four. The magnificent iron-clad "Minneapolis" was sent to sea with but three engineer officers and three boys—cadets under instruction—to manage her engineer crew and her ninety steam-engines, of a total of 21,000 horse-power. Contrast with these facts the similar statistics of, for example, the merchant steamer "St. Louis," a ship of about the same steam-power, on board of which are to be found twenty-four engineers and a half-dozen cadets. It has been sought, contrary to the advice of all those who are competent to understand the necessities and the risks of the case, to make up the list on the warship by putting seventeen enlisted men in the engine-rooms; but even these men are not paid respectable wages, and neither the rank nor the pay provides inducements sufficient to bring into these trying positions and responsible berths a valuable and reliable class of men. Able and reliable men will not submit to the hardships, the annoyances, and the dangers attaching to such work under such circumstances. Good pay and proper respect are the only inducements that can be offered to good and self-respecting men. Consequently the "Minneapolis" was sent to sea with vacancies in these berths of about twenty-five per cent. of the assigned numbers.

The most extraordinary fact in connection with this aspect of the whole sad and threatening situation is that, even here, the pay and ratings are fixed, not by the bureau of steam engineering of the navy or by appointed boards composed of engineer officers, but by officers of another corps, and, as shown by the very



wording of the orders issued, by men having not even an amateur knowledge of the requirements, and having absolutely no conception of the tremendous responsibilities and dangers for which they are thus assuming a personal responsibility. Not an officer can be placed in the fire-rooms in charge of boilers; and machinery worth a million and a half of dollars, and hundreds of lives, depends upon the securing of competent management by the employment of men glad to accept \$40 to \$55 a month.

So far depleted has become the engineer corps that not an officer can be detailed for duty to inspect the iron and steel furnished for ordnance; only one is detailed for inspection of armor; but two are to be found at the Boston Navy Yard, only seven at League Island, and a baker's dozen or so at the New York Yard. Not an engineer officer is on the list of lecturers at the War College at Newport, and not one at the torpedo-station. Meantime, of the deck officers, 338 were, at the time when these figures were gathered, at sea, and nearly 400 were on shore duty, of whom *ninety* were in the city of Washington. The iron and steel inspection boards, altogether, include but one-seventh engineer officers. The remainder are professionally inexpert.

The tremendous strain which has come upon this splendid body of officers, through the gradual increase in the extent and difficulty of its work and the decrease in its numbers, is reflected in the following instructive and pathetic figures: On the first of January, 1886, there were only 293 officers in the corps, and of these 71, or one-fourth, were already on the retired list; but by January 1, 1896, the previously terrible record had become 173 on the active and 104 on the retired list—nearly two-thirds as many on the latter as on the former list. No such startling statistics are to be found in the annals of our own or of any other navy. At this rate the retired list will soon become longer than the active list, and destruction of a faithful and patriotic body of men must, under existing circumstances, go on with continually increasing rapidity, until a final crash disables the whole naval service more completely than would the explosive destruction of all its guns.

The greater transatlantic "liners" are the most highly-powered class of ships in the world at present, and they may, perhaps, be fairly taken as illustrating the necessary provision of officers and men in the engineers' department. In such

ships, when carrying a total of about 400 officers and men and 1,600 passengers, there are found twenty-five engineer officers ranking with the half-dozen deck officers who are sufficient to care for the navigation of the ship and for the orderly conduct of routine outside the machinery departments. These great steamships are owned and operated by business men for the purpose of making a profit, and were it safe and practicable to replace this body of officers by enlisted men at so much less a month it would certainly be done. These officers are not employed as a matter of pure sentiment. On the "contractor's trial" of the United States iron-clad "Minneapolis," the builders employed 232 men, of all classes and grades, in the engineers' department. Her speed was 23.073 knots, which exceeds that of any transatlantic liner. But this ship was sent to sea by the United States Navy Department with but three commissioned engineer officers on board.

Complaint has sometimes been made—and with undoubtedly too much reason—of ungenerous and even unlawful discrimination in favor of the older body of officers and against the newer; but this was to be expected, and must be expected to continue, in lessening degree, as the country, the Congress, the Navy Department, and the navy officers on duty come to recognize the still unrealized nature of the evolution which is converting the older navy into the new. Off duty all officers are, or should be, alike gentlemen, whatever the rank or the corps; and the three distinguishing characteristics of the true gentleman of the day, good morals, good manners, and fine culture, will be found to be no less characteristic of the newer corps, once its proper standing is fully established, and rank and pay such as should be conferred upon so important a body of officers are assigned in such manner as to secure and preserve as high an average in all corps as is demanded by the nature of their duties. No profession compels a higher order of intelligence for its successful pursuit than that which enrolled Hero and Archimedes, Michel Angelo Buonarroti, Leonardo da Vinci, the second Marquis of Worcester, Papin, Smeaton, Watt, Fulton, Stevens, Corliss, and Ericsson among its members, and which has already furnished to the naval service men like Haswell, Copeland, Isherwood, Shook, and Melville. The writer, in four years of active war service in the fleets of Dupont and Dahlgren and under John Rogers and others, and in six years of service on the instructing staff of

the Naval Academy, under Porter and Worden, and with Luce and Walker and Harrison, and most of the later chiefs of bureau, made the acquaintance of almost all of the most famous of the great men of both corps of the past generation, and found among them a full proportion of noble men, fine tempered and cultured gentlemen, and observed little cause for criticism as to personal relations in any one of the various divisions into which the naval service is divided. Once all are given their proper standing, actual and relative, all will be found working for the common good of the service and of the nation.

The cost of educating the graduate of the United States Naval Academy is reported to be a half-million dollars for thirty graduates, or about \$16,000 per annum per graduate. At Harvard, the cost is less than one-eighth this amount for its four-years course; at Johns Hopkins the figure is about one-tenth, on the average, and at Cornell University the same total expenditure for the year graduates about fifteen times as many men.\* It would be perfectly practicable for the government to secure this class of men, with vastly better training for the purposes of the engineer corps than they could be possibly given, at ten times the cost, at the Naval Academy, and with absolutely no charge to the government for education. The country could provide more than 200 cadets to this corps for the anticipated cost of graduating at the Naval Academy the twenty that are proposed to be added to the corps annually.

The same serious problem confronts the administration of the navy department of every naval power. The same conservatism, the same traditional prejudices, the same selfish interests impede every attempt to make this mighty engine of war efficient.

The first naval engagement into which the ships of modern fleets are hereafter plunged will reveal the weaknesses of their war vessels, and that nation which has been most fortunate in providing against a weakest spot will be most fortunate in the encounter.

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\* In the year 1897 Cornell graduated about 450 students. The income of the university was slightly in excess of a half million dollars. Sibley College, its school of mechanical—including marine—engineering, graduated 130 students on an annual expenditure estimated by a committee of the Board of Trustees as about \$70,000 per annum. This enormous discrepancy, however, is partly explained by the fact that at the Naval Academy the subjects, in the usual variety, are all taught by officers of some rank and high compensation; while, at the universities, larger classes and comparatively large sections of classes are taught by men of more modest grades and with that comparative insignificance of compensation that distinguishes the professional teacher in all times and in all places.

## OFFICERS IN THE FRENCH ARMY.

BY ALBERT D. VANDAM.

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THE first Napoleon said that there were no bad regiments, but only bad colonels. After their captivity in Germany (1870-71) those generals and colonels who had been most signally beaten by the enemy, opined that the greatest captain of modern times had been wrong, that, at any rate in France, there were no bad colonels, but only bad regiments, that the defeats inflicted on France had been due entirely to the latter, and they forthwith set to work reforming them.

Nearly five and twenty years have elapsed since then, the reform is still going on, and if exercise, drilling, vexations, as distinct from well-considered discipline, finnikin concern for petty details could make an efficient army, that of France ought to be the best in the world. Very competent military authorities—neither French nor German—are inclined to think that the rank and file, if not the very best, is next to it; these same authorities are not quite so sanguine with regard to the progress of the officers in all that pertains to the higher branches of military science. The optimistic among those critics ascribe the shortcomings of the French officer in the matter of “grand tactics” and “grand strategy” to the inherent faultiness of the system of recruiting the officers and of the rules that govern their promotion; others attribute them to the nature of the French themselves, although they are by no means disposed to approve unreservedly either the system of recruitment, or of the rules that govern the promotion of officers. To begin with; they say that the Frenchman with all his incontestable intelligence is not sufficiently of a plodding nature; secondly, that he is still too much wedded to the idea that dash and devil-may-care