SCIENCE

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THE CIVILIAN ELECTRICIAN IN A MODERN WAR.[1]

I BEG to propose for your consideration this evening a plan by which, in time of war, all the electrical resources of New York, both in supplies and in men, will become at once available for the defence of the country and the city.

It is well known to all here that electricity has come into use as one of the great factors in warfare, both on sea and on shore; not as an adjunct merely, as for lighting ships and forts, but as a vital element in the handling of weapons in actual battle, and in the construction of new instruments which accomplish things heretofore impossible.

I desire to recall to your recollection a few of the most important uses to which electricity is now put in warfare, to indicate some of the probable paths of future development, to show that it would be impossible for our navy and army to adequately handle the vast electrical work that would have to be instantly done in time of sudden war, and to suggest a plan for coming to their assistance.

The science of electrical engineering is now recognized as one of the most necessary of the practical sciences of the world. It stands out as distinct and well defined as the science of medicine or the science of astronomy. It enters into thousands of the departments of daily life, but in no other department is it used in so various and so important ways as in warfare. This is so much the case that the prophecy is sometimes ventured that in the near future nations will fight by electricity. Though this, like all extreme statements, requires modification, yet the number of ways in which electricity has come to be applied within the last eight years, is calculated to inspire the liveliest anticipations as to the developments of the next eight years. No vessel pretending to modern equipment goes to sea without a complete electric plant for furnishing light. This light is so much more suited to ship life than any other light, that we now wonder how we ever went to sea without it. The electric motor is coming into use for ventilating ships, and it is beginning to be used for training guns and the hoisting to the deck of shot and shell. The best and the most accurate results at target practice are attained when the guns are fired by electricity. Range finders give the gunner constant knowledge of what he must know; i.e., the distance of the enemy. The best means of night signalling, and the one adopted in nearly every navy in the world, is by means of incandescent lights. The electric search-light is almost as much a feature of the equipment of a modern war-ship as are her guns and her torpedoes. In the actual use of the Whitehead and the Howell torpedoes, electricity plays an important part. The telephone is now coming into use for ship-work, and will unquestionably supplant the speaking-tube, which is acknowledged in all navies to be unsatisfactory. In fact, we find all through modern war-ships an increasing use of electricity. The reason is clear. The modern war-ship is the most intricate, tremendous, and powerful machine existing. In no other equal space can be found so many, so various, and so important kinds of apparatus. Every thing must be done which will put her absolutely within the grasp of the captain. She must respond at once to his command, and her whole strength and power must be his, as though she were a part of him. Ensconced in his armored conning-tower, he must be the brain of the gigantic body. Electric wires must convey instant tidings to him from her innermost recesses, and electric wires flash back from him the inevitable command. In this way only can a modern ship, no matter how large, how strong, how heavily armored, or how swift, completely fulfil her mission and be a perfect fighting-machine.

What is true of ships is equally true of forts. The power of ships' guns has so increased that it has become essential to protect shore batteries by iron and steel instead of masonry as in the days not long gone by, and, in addition, to use disappearing carriages wherever it can be done. Disappearing carriages, as is well known, are so arranged that the gun disappears below the parapet of the fort when the gun is fired, and remains out of sight and safe during the operation of loading, so that it is exposed only for a short time when it is raised to fire. Now, without the aid of electricity, a very considerable time would elapse, even after the gun was raised, before it could be fired; because the gun would have to be trained in the proper direction, and be elevated to the proper degree, for propelling its projectile over the distance between it and the enemy. To estimate this distance and make the proper adjustments would entail delay, and would be absolutely impossible if smoke obscured the target, as would be the case during a great portion of the time. But electricity, acting through the medium of the position finder, gives the gunners continuous information of the distance and direction of the enemy, no matter how thick the smoke; so that the gunners know exactly what to do, before the gun is raised to fire.

Electricity, furthermore, gives the commanding officer complete control of all the different groups of guns and mortars in his fort. Noting the progress of the action from a station aloof from the smoke and noise, he can direct the concentration of as many batteries as he thinks best on one ship, or can disperse the fire as much as circumstances from time to time dictate.

For the handling of the monster apparatus used in forts,—the guns, the carriages, the ammunition,—electricity is rapidly coming to the front. Some power must be used, since the muscles of men are too weak. Hydraulic power has been used hitherto, but for many purposes electricity has the same advantages that have caused its unprecedented advance in the other departments of engineering throughout the world; while for repelling a night attack from ships the search-light has been found, by repeated trials in the naval manœuvres abroad, to be simply indispensable to the land defence. For military service in the field there is not an army in the civilized world that has not its military telegraph service. One great cause of the suddenness and completeness of the German victory in 1870 was the rapid mobilization of the Prussian Army, and its appearance on the frontier ready for battle. Now, the splendid efficiency of the telegraph service in the hands of the military authorities made this possible. Nothing is more important in warfare than despatch in moving the enormous bodies of men of which modern armies are composed, with all their ammunition, equipments, and numberless accessories. To move a quarter of a million of men to the frontier in one day means a good deal; and to manœuvre so large a body in the field with such precision and rapidity that no one division shall have to wait for any other division, simply cannot be done without electricity.

But the most immediate and important use of electricity in the

[1] Paper read before the New York Electrical Society at Columbia College on Oct. 23, by Lieut. Bradley A. Fiske, U.S.N.

defence of a coast is in the submarine mine or ground torpedo. Defending a harbor with submarine mines is simply carrying out with more or less elaboration a system by which a large number of water-tight tanks, each holding from 100 to 1,000 pounds of gun-cotton or other explosive, are anchored in carefully designed positions, and connected by armored electric cables with protected operating-rooms, in which are batteries, measuring-instruments, etc. The most complete mines have usually floating above them automatic circuit-closers, in which two contact points are jarred together by a passing ship, and thus afford a passage for the electric current to the fuze in the torpedo. Now, these mines are some of them exceedingly large and heavy, and the electrical apparatus, while simple to the mind of a trained electrician, yet must be made and adjusted with great care. The torpedoes, as a system, must be constructed, laid down, and connected to the operating rooms on shore by long and heavy armored cables. The operation of practically planting and connecting the necessary submarine mines for New York would be a stupendous undertaking. Kindly bear this in mind until I recur to it again.

We have now seen, after a rough survey of the subject, that electricity has already acquired an acknowledged position in the art of war, and that the uses to which it is put are not trivial ones. Electricity is not used in warfare as a convenience, nor is it a fad of theorists: it fires the guns, it discloses the stealthy approach of the torpedo-boat at night, it directs the proper elevation of the guns,—in fact, it does good, honest, practical work. But note this point also: in every one of these applications of electricity we have to pay in one way, for what we get, by studying the ways in which electricity will work for us. We cannot expect electricity to work for us unless we treat it properly. We cannot handle electrical apparatus with carelessness and ignorance, and expect that it will work when we need it. In other words, we find in warfare, as in every thing else to which electricity is applied, that electricians are useful. This remark doubtless seems absurdly commonplace, but it is intended to suggest that, in war time, electricians, even civilian electricians, may suddenly become very useful to the government. A captain of a fine ship might lose an action from simply a lack of knowledge as to some electrical appliance, on his own part or on the part of some subordinate. Some small accident might break a circuit just at a critical juncture, which might prevent the communication of an order, the receiving of information, or the discharge of a torpedo, at a crisis; and yet the cause might be such that a man with even a very slight knowledge could remedy the difficulty in a second by the mere pressure of his finger; but, that pressure not being given, the action might be lost, and from that cause alone.

Let us now glance at some of the other uses to which electricity would probably be put in case of an attack upon New York. There can be no reasonable doubt that Lay torpedoes, Patrick torpedoes, Sims-Edison torpedoes, and Halpine-Savage torpedoes would come to the front at once. The enemy's fleet being daily expected off Sandy Hook, we should see the advocates of these systems, under authority of the general government, preparing stations at Coney Island, Sandy Hook, and elsewhere, for the launching of their dreadful missiles against his iron-clads. The question of ballooning, both for observation and for the dropping of explosives on his decks, would be taken up at once, and the electrical world would be agitated anew over the question of balloon propulsion by electricity. Electric launches to carry torpedoes would be fitted out to noiselessly steal out at night on their errands of destruction. Electric picket boats, of smaller size, perhaps, would scout the waters in pursuit of information or to convey despatches; electric submarine boats would spring into being by the dozen, and, filled with adventurous spirits, would seek the enemy, secure from detection below the surface of the sea, and carrying enough explosive to utterly destroy the proudest war-ship of the world.

It will now be apparent, that, in the case of a sudden war,—and most wars are sudden,—there will be an immense amount of work to be done in the electrical line alone. Could our army and navy do all this work in the time allowed? It is probably known to all here that our regular army and navy are simply a nucleus around which fighting forces could be formed. They are so small, as regards both officers and men, that they can barely carry on the work in time of peace, and would be wholly inadequate in time of war. We should not have enough battle-ships, monitors, cruisers, or torpedo-boats; we should not have enough forts; we should not have enough sailors; we should not have enough infantry; we should not have enough artillery; we should not have enough electricians. Take the single matter of laying out and connecting up the submarine mines in New York harbor. This is an area covering many square miles, in parts of which the mines would be placed at frequent intervals, every mine being accurately secured in its designated place, and connected by cable to the operating room, perhaps miles away. The mere labor of constructing, fitting, and filling one mine, and afterwards taking it out into the harbor and lowering it into place, with all its connections, is no small task; and what can be said of the task of doing this with hundreds of submarine mines? Then the work of properly arranging the various cable connections, testing apparatus, firing apparatus, etc., necessary for the efficient action of the mines, would follow. The Board on Ordnance and Fortification have designed all the torpedo defences, but they will not be in practical operation probably for many years, and a war may come meanwhile. But it is certain that on the outbreak of any war an immense amount of this work would have to be immediately done, because we will never keep the submarine defences of New York harbor on a war footing in time of peace.

The Navy Department would be even more hurried. We should certainly be called upon to commission a great many war-ships, and to equip as commerce destroyers a great many merchant steamships. We should have to do all the things that we did on the outbreak of our last war, and in addition we should be confronted with the necessity of fitting all kinds of fine apparatus, the necessity of fitting electrical appliances of all descriptions, besides securing gun-circles in place with mathematical precision, and of accomplishing all the manifold fine work that is required with the ordnance, navigation, and engineering equipment of a war-ship of the present day. And as to merchant ships, who is going to fit them out? This operation requires technical knowledge. Who has it? How many of the merchant steamship captains would be able to install and manage a battery of even Hotchkiss or Driggs Schroeder guns, or could remedy an accident to either gun or ammunition?

It being apparent that the regular army and navy, in event of a sudden war, would be unable to handle all electrical work that would certainly be thrown upon them, I propose the formation of a corps of naval and military electricians to assist the army and navy in their work. Such a corps might exist in every principal seaport town on the coast; the principal corps, of course, being the one with headquarters in New York. Electricity being now a recognized factor in both naval and military war, and requiring expert electricians for its full development, there would seem to be just as much reason for an electrical corps in the National Guard of the State of New York as for infantry, artillery, or cavalry. While the members of this corps would be men of technical knowledge, and while its sphere of usefulness in war would be because of that technical knowledge, it is obvious that the organization should be a military one, and that, with some modifications, it should be governed by the same principles as govern all military bodies. Being a military body under the governor of the State, it could at once become available on the outbreak of war.

It would seem that this corps, like all other corps, should be composed of men of various ranks, subject to various duties. Many kinds of work would have to be done in war, and many kinds of men would be required to do them. On the outbreak of war, certain members would naturally elect duty in the navy, others in the army. The most obvious and immediate employment would doubtless be in the torpedo defence of the harbor, under the direction of the general commanding. And who can doubt the gratification which that general would feel, when suddenly ordered to defend New York harbor, on finding ordered to his list of subordinates a hundred or more capable electrical engineers, young, enterprising, accustomed to difficult electrical work, fully acquainted not only with electricity in its technical

features, but also acquainted with the electrical people of New York, with its factories, its places of business, and its methods of business? These men would become available in a day, and could be at once set to work in carrying out the details of a vast and complicated system. Their work need not be confined to that purely electrical in character, because every electrical engineer is by training and of necessity a mechanician, and every sort of apparatus would be readily understood by him, and a very slight training would make him master of it.

Those members volunteering for naval work would be equally useful. The ordnance officer at the Navy Yard would constantly find himself overwhelmed with a mass of work which he would be utterly unable to carry out without the assistance of some such corps as this. And for the reason that electrical engineers are of necessity mechanicians, a great deal of technical work could be intrusted to them, such as the arrangement and fitting of gun-carriages, the storage of ammunition, the assembling of guns, etc. Their more immediate and obvious field, however, would be in the installation and fitting of electric lights, motors, telegraphs, telephones, and other electrical appliances, on board the vessels of war constantly called into requisition. In the matter of fitting out merchant steamships their usefulness would be at once apparent. The number of regular officers would be found utterly out of proportion to the number of ships, and the whole navy would undergo an expansion. Only a very few regular officers could be assigned to each vessel; so that the majority of the officers would have to be volunteers, as was the case in our civil war. During the first part of the war, the command of the different vessels would naturally be intrusted to regular officers, leaving the other positions to be filled by volunteers. Now, as the commander of a ship is head of all the departments of a ship, he cannot give much personal attention to one especial department. Therefore the general arrangement and fitting-out of all vessels, both regular war-ships and merchant steamships, would have to be largely intrusted to volunteers in all that relates to the electric and ordnance equipments. Now, as the work of fitting out ships with electric and ordnance equipments calls for technical knowledge and experience of a high character, it is obvious that a corps of well-trained technical men, such as is here suggested, would be more than useful: it would be necessary.

A further field for the employment of such a corps in time of war is suggested by the fact that the genius of our people tends towards constant invention and improvement of all sorts of machinery and apparatus; and our history has shown that every war has brought into being many inventions in weapons of defence and offence. Can it be doubted, then, that any future war would produce more such inventions? And in view of the great progress of electrical science since the last war, and considering the great number of electricians in New York, can it be doubted that many of these inventions would be electrical in character? Under the stimulus of a national peril, and with the resources of New York at command, it is certain that important and novel warlike applications of electricity would at once spring into being. And while our regular forces of both army and navy were employed on their specific duties, what more natural than that some new Ericsson should arise, and some new Monitor or other craft startle the nations of the world? Therefore, besides the obvious uses to which such a corps as this might be placed, there are other uses, no less important, of inventing, constructing, and using weapons of defence, the nature of which we cannot as yet even faintly conceive. And as few heroes of our late war go down to history with more glory than has Ericsson, so perhaps our next war may produce some electrician, now unknown, whose fame will outlive the ages.

It would seem as if such a corps as this could be formed under existing laws, and that there would be no difficulty in enlisting members. The attractions of the Naval Reserve and of the National Guard seem sufficient to induce a large membership in the different regiments; and there is no reason why membership in an electric regiment should not be equally desirable and confer equal distinction. The qualifications for entrance as regards education and intelligence would be greater than those for any other regiment or battalion. Its military and naval usefulness would be acknowledged, and its position in all respects would be one of dignity. The larger the membership, the better; provided, of course, that due care be observed in excluding undesirable persons. The whole electrical influence of New York and of the country would be at its back, with all its millions of dollars, and its men of world-wide fame; and there is no reason why it should not acquire a national influence.

The course of instruction could be readily carried out, embracing the naval and military applications of the purely technical science with which the members are already familiar, instruction being given by regular navy and army officers detailed for the purpose. This instruction would naturally embrace the construction and care of apparatus. It being presupposed that there are different ranks in this corps, the system of instruction will naturally differ with the different ranks. With the higher ranks, it would naturally embrace the theory and practice of gunnery, navigation, including compasses, and seamanship. Steam-engineering would probably not need to be taught, it being assumed that the members require very little instruction in that branch. For the lower ranks, the scheme of instruction need not include much more than the handling and care of the different apparatus. On the outbreak of war, the members volunteering for the different services could be subjected to certain examinations, and their rank determined by the proficiency exhibited. As to the details of organization, uniform, etc., these need not be entered into here, as they can obviously be settled at any future time. My only purpose now is to propose to you a plan for meeting an emergency which may some day arise.

I would hazard the suggestion that this corps should at first comprise about two hundred and fifty members, and that it should be officered, uniformed, and drilled as are the other corps of the National Guard. I would even advocate infantry drill as a means of instilling thoroughly the military idea. Occasional runs in the torpedo-boat "Cushing," and frequent trips out to sea for target practice in some of the modern war-ships, would be essential; and while there would be considerable work, there would also be many compensating social and other advantages.

I venture all these suggestions with much diffidence, but earnestly hope that you will think them worthy of earnest consideration. My only excuse for broaching the general plan is that it has been in my mind for some years, that it has been commended by every man to whom I have spoken about it, and that I have been urged to bring it to the attention of the electricians of New York.

THE RELATIONS OF MEN OF SCIENCE TO THE GENERAL PUBLIC.[1]

JUST fifty years have passed since a small body of enthusiastic students of geology and natural history organized themselves into an association which was, for the first time in the history of this country, not local in its membership or in its purpose. As the Association of American Geologists and Naturalists, it was intended to include any and all persons, from any and all parts of the country, who were actively engaged in the promotion of natural-history studies, and who were willing to re-enforce and strengthen each other by this union. So gratifying was the success of this undertaking, that, after a few years of increasing prosperity under its first name, the association wisely determined to widen the field of its operations by resolving itself into the American Association for the Advancement of Science, thus assuming to be in title what it had really been in fact from the beginning of its existence. One of the articles of its first constitution, adopted at its first meeting, provided that it should be the duty of its president to present an address at a general session following that over which he presided. The

[1] Address delivered at the Indianapolis meeting of the American Association, August, 1890, by its retiring president, Professor T. C. Mendenhall.