

MEMOIR
OF
JOSEPH GILBERT TOTTEN.
1788 - 1864.

BY
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BIOGRAPHICAL MEMOIR OF JOSEPH GILBERT TOTTEN.

MR. PRESIDENT AND GENTLEMEN OF THE ACADEMY:—

In conformity with a clause of the Constitution of this Academy, and in obedience to your instructions, I am here to render the tribute of a formal biographical notice in commemoration of one who was numbered among our most venerable and most honored associates. If, in the language of one of our body, on a previous and similar occasion, "it is no unreasonable assumption that public benefit and individual incentives may be derived from the history of any man whose scientific services have rendered him worthy of admittance to your number," that assumption must have a peculiar force when it applies to one who has "finished his course," and has filled a life, protracted beyond the usual term, with scientific labors of no ordinary variety and magnitude.

It is but little more than two years since we first met for the great and important work of organizing this National Academy, and with us—of our number, if not personally present—were "both the gray-headed and very aged men." But, alas! these, like autumnal leaves, are rapidly falling away, and already the places of a Totten, a Hitchcock, and a Silliman know them no more, save in the records of their lives and deeds, and in the grateful memories of their associates. What a trio of names, glorious in the annals of science, is this! Well may they be incentives to us, who yet remain to strive that we may worthily replace them, and establish for this Academy a reputation for usefulness and science which their honored bearers have acquired for themselves.

Although there may be many among us more capable than myself of doing justice to the memory of our departed colleague, I feel grateful that the lot has fallen to me. Placed under his command on my first entrance into the military service—almost in my boyhood—my relations with him, both personal and pro-

fessional, have ever since been continuous and intimate. Under obligations to him of no ordinary nature, I could not do otherwise than regard him with reverence and affection. If I fail, therefore, it shall not be because my heart is unmoved, nor because I am insensible to the magnitude of my task.

JOSEPH GILBERT TOTTEN was born in New Haven, Connecticut, on the 23d of August, 1788. His grandfather, Joseph Totten, came from England before the war of the Revolution, and engaged in mercantile pursuits in New York. Attached to the cause of the mother country, he left that city, after the acknowledgment of our independence, for Annapolis, Nova Scotia. It would appear that his two sons remained in this country, since one of them, Peter G. Totten, married in 1787 Grace Mansfield of New Haven, a very beautiful woman, who died a few years after her marriage, leaving two children; the subject of this memoir and a daughter, Susan Maria, who married Colonel Beatty, an English officer, and who is still living, a widow, in London. After the death of Mrs. Totten, which occurred when her infant son was but three years old, the father, having been appointed United States Consul at Santa Cruz, West Indies, took up his future abode on that island, leaving his son under the care of his maternal uncle, Jared Mansfield, a graduate of Yale College, 1777, and a learned mathematician. The boy continued to be a member of Mr. Mansfield's family until the latter removed to West Point, having been appointed Captain of Engineers and a teacher in the United States Military Academy, then just organized by act of Congress of 1802. Young Totten's first teacher was Mr. Levi Hubbard, brother to the Rector (at that time) of Trinity Church, New Haven; afterwards his education was carried on under the personal superintendence of his uncle. Of the period of his school-boy life we have some glimpses, through the recollections of an old friend and schoolmate, Mr. Ralph Ingersoll of New Haven, who speaks of him as a bright, noble youth, of fine mind, fond of study, and always at the head of his compeers, gentlemanly in his deportment, and greatly beloved.

Young Totten went to West Point with the family of his uncle in 1802. He was soon after appointed a cadet. He remained at West Point one term, that of 1803, and perhaps part of that

of 1804. He was promoted to a second lieutenantcy in the corps of Engineers, July 1, 1805.

The venerable General J. G. Swift, recently deceased, his brother engineer officer and life-long friend, describes him at West Point as "a flaxen-headed boy of fourteen years of age, a good scholar, and to me a most interesting companion."

Captain Mansfield, having been appointed Surveyor-General of Ohio and the Western Territories, November 4, 1803, induced his nephew to accompany him to the West as an assistant on that first systematic survey of any of the new States of the Union. Here that faculty which so distinguished him through life, of keen observation of whatever was most interesting connected with or incidentally brought under his notice by his professional pursuits, displayed itself at this early age in a noteworthy manner. The vestiges of an earlier race than the red man, which have since been made the subject of the researches of a Squier and a Davis, of a Lapham and of a Haven, and to which, during recent times, fresh attention has been directed by the developments of the high antiquity of the human race in Europe as shown by similar relics over the surface of that country and by the lacustrine remains in Switzerland, attracted his notice and were made the subjects of survey. Although these investigations were not published, they are, I believe, the first we have record of; those of Caleb Atwater, who is called by Squier and Davis "the pioneer in this department," not having been published until 1819. Full descriptions and measurements of several of these mounds, particularly that of Circleville, were made and sent to his friend, J. G. Swift. To most youths of his age those remains of structures, built

"while yet the Greek
Was hewing the Pentelicus to forms
Of symmetry, and rearing on its site
The glittering Parthenon,"

would have been passed over with vague curiosity or listless indifference. Not so with young Totten. Although not able, perhaps, to perceive all the ethnological importance which has since been attached to them, he could yet appreciate them as objects of high interest, as vestiges of the races which had inhabited the country, and give his time to their examination and measurement.

During the two years which he passed in the office of his uncle at Ludlow's Station, near Cincinnati, he was a companion of several young men who subsequently became conspicuous, among whom were Nicholas Longworth, Samuel Perry, Daniel Duke, Thomas Pierce, and Peyton Symmes, all of whom are now dead. His tastes, however, led him back to the army (from which he had resigned shortly after his promotion), and, February 23, 1808, he was reappointed a Second Lieutenant of Engineers, his commission bearing the same date as that of his subsequent friend, brother engineer officer, and professional associate, Sylvanus Thayer, of national fame as for so many years Superintendent of the Military Academy, and as the officer to whom is mainly due its present high grade among the military and scientific institutions of the world. Lieutenant Totten commenced his career as a military engineer under Colonel Jonathan Williams, the first chief of the corps, and was engaged on the construction of Castles Williams and Clinton, New York harbor.

At the commencement of the war with England Lieutenant Totten was assigned to duty as Chief Engineer of the army under Brigadier-General Van Rensselaer, in the campaign of 1812, on the Niagara frontier, and in that capacity took a conspicuous part in the battle of Queenstown. He was subsequently Chief Engineer of the army under the command of Major-General Dearborn, in the campaign of 1813, and of the army under Major-General Izard and Brigadier-General Macomb, in the campaign of 1814, on Lake Champlain. Having been promoted to a captaincy in 1812, he was in June, 1813, brevetted Major, for "meritorious services," and September 11, 1814, Lieutenant-Colonel, for "gallant conduct at the battle of Plattsburg;" his efficient services as an engineer in the defensive arrangements of that field having contributed powerfully to the successful issue.

The termination of the war may be considered as the close of one period in the life and services of General Totten, and the commencement of another; or rather it may be said, that the events of which we have traced a faint outline were but the preparation and training of his mind for the real work of his life. Reared under the eyes and guardianship of a relative distinguished for his mathematical attainments, receiving as extensive a military and scientific education as West Point at that early day could give, called by his position in Surveyor-General Mansfield's

office, not only to exercise the science which the duties involved, but to take extended views of our country as to the interconnection of its parts, and their relations to commerce or war, then practically taught the duties of a military engineer in what concerns the defence of harbors, and finally carried through the ordeal of actual war in the campaigns of armies in the field, he was now prepared for the great work of his life; the fortification of our seaboard frontier. When I call this the great work of his life, I am not unaware that it is but a *part* of that work; still the most important part, and one to which his other labors may be considered incidental.

A brief reference to the condition and progress of sea-coast defence at that period is here appropriate. Previous to the Revolution, our seaport towns had not grown into large cities, nor were there great naval establishments or military depots to invite the enterprises of an enemy. During that contest, the harbors of Boston, New York, Philadelphia, Charleston, etc., had been, to a certain extent, "fortified" against naval attack, by slight earthen batteries, or in some few cases by small and (as we would now call them) insignificant earthen forts. A work of palmetto logs and sand on Sullivan's Island, Charleston harbor, mounting but 30 guns, decisively repulsed, early in the Revolutionary war, the attack of the British fleet under Sir Peter Parker, consisting of two frigates and six sloops of war, carrying about 270 guns, destroying four of the smaller vessels, and inflicting a loss of 205 in killed and wounded (eleven times as many per gun employed against them as the English lost at Trafalgar); thus decisively demonstrating the value of fortifications, and the superiority of land batteries to ships. But with an immense sea-coast line and sparse population, it was impossible to hold our seaports against the great naval power of the mother country, and the war of the Revolution was mainly a contest of land forces. After the attainment of our independence, the importance of fortifying our harbors impressed itself on the mind of General Washington, and the political agitations which grew out of the French revolution, and which threatened to involve the new-born power of the West, prompted early action in this direction. In that day war, though a science, had not grown into one which makes tributary to it all other sciences, as it has since done. Fortification, indeed, had reached

a high degree of perfection, but the elaborate treatises on that subject scarcely touched the subject of harbor defence, so little art was apparently supposed to be involved in throwing up batteries to defend the entrances of ports. The art of a Vauban and Cormontaigne was little concerned in the war from which we had just emerged, and the circumstances were too dissimilar, the theatre too large and too thinly populated, the armies engaged too small, to afford to the precepts of a Lloyd or a Templehoff much apparent applicability. While the war developed generals of unquestionable ability in the spheres in which they acted, it seemed to be conceded, that, for military science, and especially for the art of fortification, we must look to Europe. Hence we find so many of the early harbor defences of our principal seaport towns to have been built under the direction of foreign officers who had found employment among us, and who did not always possess the knowledge of the art to which they laid claim.

The importance of a Military Academy for the training of officers for the military service, and especially for the engineers and artillery, had been acknowledged even from the very outset of the struggle for independence. We find even the Continental Congress appointing a committee "to prepare and bring in a plan of a Military Academy," and the first Secretary of War, General Knox, in an official report to the President, discusses the subject at much length. The establishment of such an institution is known to have been a favorite object of General Washington, and in his annual message in 1793 he suggests the inquiry, "whether a material feature in the improvement" of the system of military defence "ought not to afford an opportunity for the study of those branches of the art which can scarcely ever be attained by practice alone;" and in 1796 he states that "the desirableness of this institution had constantly increased with every new view he had taken of the subject."

An act of Congress of 1794 had provided for a Corps of Artillerists and Engineers, to consist of four battalions, to each of which eight Cadets were to be attached, and made it the duty of the Secretary of War to procure books, instruments, and apparatus for the benefit of said corps; and in 1798 Congress authorized the raising of an additional regiment, increased the number of Cadets to fifty-six, and empowered the President to appoint four teachers of the arts and sciences necessary to the

efficiency of this "Corps." Of the four teachers, none were appointed prior to January, 1801, at which time Mr. George Barron was appointed teacher of Mathematics, and the institution, "which was nothing more than a mathematical school for the few Cadets then in the service," was nominally established.

It was soon discovered that the regiment of Artillerists and Engineers could not combine with effect the two duties assigned to its members, and a law was therefore framed separating them into two corps, and declaring that the Corps of Engineers should be stationed at West Point, New York, and should constitute a Military Academy. This act of March 16, 1802, which is the organic law of the Corps of Engineers and of the Military Academy, provided for the appointment of a certain number of officers and Cadets¹ (not to exceed twenty in all), and declared that "the principal Engineer, or in his absence, the next in rank, shall have the superintendence of the Military Academy, under the direction of the President of the United States."

It is not my purpose here to follow further the history of that institution; I have alluded to its initiation as a step taken to provide for an acknowledged want of the period—an institution for teaching the military sciences to young men entering the army, and for creating a competent *Corps of Engineers*. It was soon found, however, that the duties of Engineer officers were inconsistent with their remaining at West Point, and themselves constituting "a Military Academy." Most of them were soon called to duties along the seaboard, in constructing our fortifications, while, as the wants of the service and of the Academy have been more clearly seen, the number of Cadets has been increased, to supply not only the Engineers and Artillery, but officers of all arms of the service, and the various professorships and departments of instruction now existing have been established.

As the duties of the Corps became more and more extensive, its chief, though charged with the administration of its affairs, could not be constantly present at the Academy, and it ultimately became apparent that the immediate superintendency of such an institution was incompatible with his proper functions. In 1817,

¹ Besides ten Cadets of Engineers, forty Cadets "of Artillery" were authorized by this law; making fifty Cadets in all.

an officer selected from the corps (Brevet-Major Sylvanus Thayer, to whom allusion has already been made) was appointed permanent Superintendent of the Academy, and made subject only to the orders of the President of the United States.

Major (afterwards Colonel) Jonathan Williams, a near relative of Dr. Franklin, whom he accompanied, as secretary, to France, where he studied the military sciences, and made himself acquainted with the standard works on fortification, was the first Chief Engineer of the United States under the law of 1802. He was an officer of decided merit, much beloved by his subordinates, and is justly styled the father of the Corps of Engineers and of the Military Academy.

While exercising his superintendence of the Academy, he devoted himself personally to the fortification of New York harbor, and most of the forts which constitute the inner line of defence of that harbor—Fort Columbus, Castles Williams and Clinton (Castle Garden), and a work similar to the last named, located two or three miles higher up the river (Fort Gansevoort)—were planned by him, and built under his immediate supervision.

Castle Williams was the first "casemated" battery erected in this country (built in 1807-10), and was planned after the system of Montalembert, with which, as we have seen, Colonel Williams had made himself acquainted in France. This and other works of Colonel Williams, though they have been superficially and ignorantly criticized, were really meritorious and do not suffer by comparison with European structures of the same or even much more recent dates.

The indications of an approaching war with England, and the obvious inadequacy of existing fortifications, had led to renewed exertions, and prompted the works just mentioned and others at all our seaports, so that when the war broke out there was not a town of any magnitude upon the coast not provided with one or more batteries. But most of the works so thrown up, before the subject had been studied and systematized, as a whole, were defective in design, small, weak, and being built, for present economy, of cheap material and workmanship, very perishable. In the main, however, they answered their purpose—more, perhaps, through an undue respect for them on the part of our foe than through their intrinsic strength. It was not till after the close of the war with England that a permanent system of coast

defence was entered upon by our government. Indeed, without the experience of that war it is doubtful whether a measure, always so unpopular, and generally so little understood as a national system of fortifications, could have gained the support of Congress, and of the people. A "Board of Engineers" was constituted in 1816, with instructions to make examinations of the sea-coast, and to prepare plans for defensive works, subject to the revision of the Chief Engineer and the sanction of the Secretary of War.

Up to this period the Military Academy had maintained a sort of embryo existence, without definite form or a prescribed system. The annual term of study lasted from April to November, all the intermediate months being vacation. No fixed number of terms was necessary to graduation, nor was it prescribed what should be studied. Some Cadets remained but a single term before being commissioned; others, several years. Although this period produced officers who afterwards became highly distinguished in engineering (as well as in other branches of military art), it is not surprising that the government yet entertained the common notion that only in Europe, and especially in France, could high military science be found; nor that, in undertaking so vast and costly a work as the fortification of our sea-coast, distrust should have been felt in the unaided abilities of our own engineer officers. A distinguished French engineer, General Simon Bernard, was invited to this country, and as "Assistant" in the Corps of Engineers (an office created for the purpose by Congress), made a member of the board which, as first constituted, November 16, 1816, consisted of himself as President, Colonel William McRee, and Lieutenant-Colonel J. G. Totten. In 1817, Colonel Totten was relieved, and appears to have been stationed at Rouse's Point, Lake Champlain, in charge of fortifications at that place, and the board to have been composed of Brigadier-General J. G. Swift, Chief Engineer, Brigadier-General Bernard and Colonel McRee; but Colonel Totten was again made a member in 1819, and (both General Swift and Colonel McRee having resigned) the permanent board came to consist of Bernard and Totten alone, and the labor of working out the fundamental principles of the system, and of elaborating the projects of defence for the great seaports, thus devolved mainly upon these two officers, though

naval officers of rank and experience were associated with them whenever their examinations included positions for dock-yards, naval depots, or other objects which concerned the naval service.

Though the advent of a foreign officer, and his assignment to this duty, under the anomalous designation of "Assistant" in the Corps of Engineers, naturally caused some feeling, yet it can scarcely be doubted that the influence of the proceeding was beneficial. If in Swift, McRee, Totten, Thayer, and many others, were found high engineering abilities and acquirements, it is no less true that professional association with such a man as Bernard was calculated to stimulate to higher attainments and more zealous exertion. The spirit of emulation alone would induce our own officers to prove to the country that they were not inferior to others. To high military and scientific acquirements and great experience in his professional duties, General Bernard united to the qualities of an amiable and accomplished gentleman the tact to adapt himself to his peculiar position without wounding the pride of those with whom he was thus associated. The prestige of his name aided powerfully in sustaining, with the administration and with Congress, the measures which the board found necessary to recommend, and in establishing firmly, as a part of our national policy, the system of sea-coast defence by fortifications. In recounting the origin and growth of the system, it is but just to give that name an honorable mention.

By the Board of Engineers of which I have been speaking a series of reports was drawn up, which, mostly from the pen of our departed associate, form his best memorial, and exhibit in a masterly manner the principles of sea-coast and harbor defence, and their application to our own country. In a paper of this kind it will not be out of place to give some idea, at least, of the arguments and views contained in these documents. An elaborate report of 1826, from which I quote, gives a general *résumé* of the principles which have guided the labors of the board, and of the results arrived at.

"The means of defence for the seaboard of the United States, constituting a system, may be classed as follows: First, a navy; second, fortifications; third, interior communications by land and water; and fourth, a regular army and well-organized militia.

"*The navy* must be provided with suitable establishments for

construction and repair, stations, harbors of rendezvous, and ports of refuge, all secured by fortifications defended by regular troops and militia, and supplied with men and materials by the lines of intercommunication. Being the only species of offensive force compatible with our domestic institutions, it will then be prepared to act the great part which its early achievements have promised, and to which its high destiny will lead.

“*Fortifications* must close all important harbors against an enemy, and secure them to our military and commercial marine; second, must deprive an enemy of all strong positions where, protected by naval superiority, he might fix permanent quarters in our territory, maintain himself during the war, and keep the whole frontier in perpetual alarm; third, must cover the great cities from attack; fourth, must prevent as far as practicable the great avenues of interior navigation from being blockaded at their entrances into the ocean; fifth, must cover the coastwise and interior navigation by closing the harbors and the several inlets from the sea which intersect the lines of communication, and thereby further aid the navy in protecting the navigation of the country; and sixth, must protect the great naval establishments.

“*Interior communications* will conduct with certainty the necessary supplies of all sorts to the stations, harbors of refuge, and rendezvous and the establishments for construction and repair, for the use both of the fortifications and the navy; will greatly facilitate and expedite the concentration of military force and the transfer of troops from one point to another; insure to these also unailing supplies of every description, and will preserve unimpaired the interchange of domestic commerce even during periods of the most active external warfare.

“*The army and militia*, together with the marine, constitute the vital principle of the system.

“From this sketch it is apparent that our system of defence is composed of elements whose numerous reciprocal relations with each other and with the whole constitute its excellence; one element is scarcely more dependent than the whole system is on any one. Withdraw the navy, and the defence becomes merely passive; withdraw interior communications from the system, and the navy must cease in a measure to be active for want of supplies, and the fortifications can offer but a feeble resistance for

want of timely reinforcements ; withdraw fortifications, and there only remains a scattered and naked navy."

The relation of the navy to fortifications is one of those subjects not always well appreciated, and hence the cause of mischievous notions and much misrepresentation. No pains are spared in these reports to make this subject clearly understood. After the quotation just given, Colonel Totten remarks:—

"It is necessary to observe, in the first place, that the relation of fortifications to the navy in a defensive system is that of a sheltering, succoring power, while the relation of the latter to the former is that of an active and powerful auxiliary ; and that the latter ceases to be efficient as a member of the system the moment it becomes passive, and should in no case (we allude to the navy proper) be relied on as a substitute for fortifications. This position may be easily established.

"If our navy be inferior to that of the enemy, it can afford, of course, unaided by fortifications, but a feeble resistance, single ships being assailed by whole fleets ; if it be equal, or superior, having numerous points along an extended frontier to protect, and being unable to concentrate, because ignorant of the selected point of attack, every point must be simultaneously guarded : our separate squadrons may therefore be captured in detail by the concentrated fleet of the attacking power. If we attempt to concentrate under an idea that a favorite object of the enemy is foreseen, he will not fail to push his forces upon the places thus left without protection. This mode of defence is liable to the further objections of being exposed to fatal disasters, although not engaged with an enemy, and of leaving the issue of conflict often to be determined by accident, in spite of all the efforts of courage and skill. If it were attempted to improve upon this mode by adding temporary batteries and field works, it would be found that besides being weak and inadequate from their nature, the most suitable positions for these works must often be neglected, under a necessary condition of the plan, that the ships themselves be defended ; otherwise they must either take no part in the contest, or be destroyed by the superior adversary."

It is hardly to be expected that a system affording so much room for discussion, and by its importance inviting it, should, especially in this country, escape adverse judgment. Military and naval men, congressmen, and even cabinet officers have as-

sailed it, called in question the principles on which it is based, or denied the judiciousness of their application. The forms and sources of assault have been varied, but there has been really no great difference in the substance, of which, perhaps, as good an expression as any may be found in these dogmas, forming the pith of a criticism from no less a source than the Secretary of War, Mr. Cass, approved by the President, General Jackson:—

“ 1st. That for the defence of the coast the chief reliance should be on the Navy.

“ 2d. That in preference to fortifications, floating batteries should be introduced wherever they can be used.

“ 3d. That we are not in danger of large expeditions, and consequently,

“ 4th. That the system of the Board of Engineers comprises works which are unnecessarily large for the purposes which they have to fulfil.”

Owing to these strictures, the House of Representatives, by resolutions of April 9, 1840, called upon the War Department for a report of a full and connected system of national defence. The duty was committed by the Secretary of War to a board of officers of the army and navy, among whom was Colonel Totten, and by whom the report was drawn up. It was entirely approved by the Secretary of War, Mr. Poinsett, and is universally admitted to be one of the most able and comprehensive expositions of the whole subject of sea-coast defence extant, and a complete refutation of the objections made to our existing systems. The discussion of the first and principal proposition—that of defence by the Navy—is so interesting and instructive, that, though long, I venture to quote it:—

“ The opinion that the navy is the true defence of the country is so acceptable and popular, and is sustained by such high authority, that it demands a careful examination.

“ Before going into this examination, we will premise that by the term ‘ navy ’ is here meant, we suppose, line-of-battle ships, frigates, smaller sailing vessels and armed steamships, omitting vessels constructed for local uses merely, such as floating batteries.

“ For the purpose of first considering this proposition in its simplest terms, we will begin by supposing the nation to possess but a single seaport, and that this is to be defended by a fleet alone.

“By remaining constantly within this port, our fleet would be certain of meeting the enemy, should he assail it. But if inferior to the enemy, there would be no reason to look for a successful defence; and as there would be no escape for the defeated vessels, the presence of the fleet, instead of averting the issue, would only render it the more calamitous.

“Should our fleet be equal to the enemy’s, the defence might be complete, and it probably would be so. Still, hazard, some of the many mishaps liable to attend contests of this nature, might decide against us; and in that event, the consequences would be even more disastrous than on the preceding supposition. In this case the chances of victory to the two parties would be equal, but the consequences very unequal. It might be the enemy’s fate to lose his whole fleet, but he could lose nothing more; while we in a similar attempt would lose not only the whole fleet, but also the object that the fleet was designed to protect.

“If superior to the enemy, the defence of the port would in all respects be complete. But instead of making an attack, the enemy would in such case, employ himself in cutting up our commerce on the ocean; and nothing could be done to protect this commerce without leaving the port in a condition to be successfully assailed.

“In either of the above cases, the fleet might await the enemy in front of the harbor, instead of lying within. But no advantage is apparent from such arrangement, and there would be superadded the risk of being injured by tempests, and thereby being disqualified for the duty of defence, or of being driven off the coast by gales of wind; thus for a time removing all opposition.

“In the same cases, also, especially when equal or superior to the enemy, our fleet, depending on having correct and timely notice as to the position and state of preparation of the enemy’s forces, might think proper to meet him at the outlet of his own port, or intercept him on his way, instead of awaiting him, within or off our own harbor. Here it must be noticed that the enemy, like ourselves, is supposed to possess a single harbor only; but having protected it by other means, that his navy is disposable for offensive operations. If it were attempted thus to shut him within his own port, he, in any case but that of decided inferiority,

would not hesitate to come out and risk a battle ; because if defeated, he could retire under shelter of his defences to refit, and if successful, he could proceed with a small portion of his force—even a single vessel would suffice—to the capture of our port now defenceless, while, with the remainder, he would follow up his advantage over our defeated vessels, not failing to pursue into their harbor, should they return thither.

“Actual superiority on our part would keep the enemy from volunteering a battle ; but it would be indispensable that the superiority be steadily maintained, and that the superior fleet be constantly present. If driven off by tempests, or absent from any other cause, the blockaded fleet would escape, when it would be necessary for our fleet to fly back to the defence of its own port. Experience abundantly proves, moreover, that it is in vain to attempt to shut a hostile squadron in port for any length of time. It seems, then, that whether we defend by remaining at home, or by shutting the enemy’s fleet within his own harbor, actual superiority in vessels is indispensable to the security of our own port.

“With this superiority, the defence will be complete, provided our fleet remains within its harbor. But then, all the commerce of the country upon the ocean must be left to its fate ; and no attempt can be made to react offensively against the foe, unless we can control the chances of finding the enemy’s fleet within his port, and the still more uncertain chance of keeping him there ; the escape of a single vessel being sufficient to cause the loss of our harbor. Let us next see what will be the state of the question on the supposition of numerous important ports on either side, instead of a single one ; relying on our part still exclusively on a navy.

“In order to examine this question, we will suppose our adversary to be fortified in all his harbors, and possessed of available naval means, equal to our own. This is certainly a fair supposition ; because what is assumed as regards his harbors is true of all maritime nations, except the United States ; and as regards naval means, it is elevating our own strength considerably above its present measure, and above that it is likely to attain for years.

“Being thus relatively situated, the first difference that strikes us is, that the enemy, believing all his ports to be safe without the presence of his vessels, sets himself at once about making

our seas and shores the theatre of operations, while we are left without choice in the matter; for if he thinks proper to come, and we are not present, he attains his object without resistance.

“The next difference is, that while the enemy (saving only the opposition of Providence) is certain to fall upon the single point, or the many points he may have selected, there will exist no previous indications of his particular choice, and, consequently, no reason for preparing our defence on one point rather than another; so that the chances of not being present and ready on his arrival are directly in proportion to the number of our ports, that is to say, the greater the number of ports, the greater the number of chances that he will meet no opposition whatever.

“Another difference is, that the enemy can choose the mode of warfare as well as the plan of operations, leaving as little option to us in the one case as in the other. It will be necessary for us to act, in the first instance, on the supposition that an assault will be made with his entire fleet; because, should we act otherwise, his coming in that array would involve both fleet and coast in inevitable defeat and ruin. Being in this state of concentration, then, should the enemy have any apprehensions about the result of a general engagement, should he be unwilling to put anything at hazard, or should he, for any other reason, prefer acting by detachments, he can, on approaching the coast, disperse his force into small squadrons and single ships, and make simultaneous attacks on numerous points. These enterprises would be speedily consummated, because, as the single point occupied by our fleet would be avoided, all the detachments would be unopposed; and after a few hours devoted to burning shipping, or public establishments, and taking in spoil, the several expeditions would leave the coast for some convenient rendezvous, whence they might return, either in fleet or in detachments, to visit other portions with the scourge.

“Is it insisted that our fleet might, notwithstanding, be so arranged as to meet these enterprises?

“As it cannot be denied that the enemy may select his point of attack out of the whole extent of coast, where is the prescience that can indicate the spot? And if it cannot be foretold, how is that ubiquity to be imparted that shall always place our fleet in the path of the advancing foe? Suppose we attempt to cover the coast by cruising in front of it, shall we sweep its whole

length?—a distance scarcely less than that which the enemy must traverse in passing from his coast to ours. Must the Gulf of Mexico be swept as well as the Atlantic? or shall we give up the Gulf to the enemy? Shall we cover the Southern cities, or give them up also? We must unquestionably do one of two things; either relinquish a great extent of coast, confining our cruisers to a small portion only, or include so much that the chances of intercepting an enemy would seem to be out of the question.”

The report then goes on to discuss the uses for defensive purposes of gunboats, floating batteries and steam batteries, as distinguished from the navy proper. Admitting their usefulness, and even, in some cases, their necessity, it argues, with great force, that they are not a substitute for, and cannot supersede fortifications, and it sums up its argument concerning naval defence with the following broad propositions, to which it challenges opposition:—

“1st. If the sea-coast is to be defended by naval means exclusively, the defensive force at each point deemed worthy of protection must be at least equal *in power* to the attacking force.

“2d. As from the nature of the case there can be no reason for expecting an attack on one of these points rather than on another, and no time for transferring our state of preparation from one to another after an attack has been declared, each one of them must have assigned to it the requisite means; and,

“3d. Consequently this system demands a power in the defence as many times greater than that in the attack as there are points to be covered.

“There has been but one practice among nations as to the defence of ports and harbors, and that has been a resort to fortifications. All the experience that history exhibits is on one side only; it is the opposition of forts or other works, comprehended by the term fortification, to attack by vessels, and although history affords some instances wherein this defence has not availed, we see that the resort is still the same. No nation omits covering the exposed points upon her seaboard with fortifications, nor hesitates in confiding in them.”

The most prominent cases of such successful attacks, viz.: Copenhagen, Algiers, San Juan de Ulloa, etc., are then described and discussed, to show that the deductions drawn from them are erroneous, or that they are not cases in point, or that the disas-

trous result has been owing to the neglected condition, imperfect armament or unskilful and inadequate defence of the forts.

The report, of which I have given some of the main points, may be said to have silenced opposition to our system of fortifications for the next ten years; but, in a form modified by the alleged changes in the condition of the country, increase of population, construction of railroads, etc., it again found expression in a resolution of Congress in 1851; and the Secretary of War, to enable himself to respond, called upon numerous distinguished army and navy officers for an expression of their opinions. The following questions were addressed to several of the principal Engineer officers, among whom the Chief of Corps, General Totten:—

“1st. How far the invention and extension of railroads have superseded or diminished the necessity of fortifications on the seaboard?

“2d. In what manner and to what extent the navigation of the ocean by steam, and particularly the application of steam to vessels of war, and recent improvements in artillery, and other military inventions and discoveries, affect this question?

“3d. How far vessels of war, steam batteries, ordinary merchant ships and steamers, and other temporary expedients, can be relied upon as a substitute for permanent fortifications for the defence of our seaports?

“4th. How far the increase of population on the northern frontier and of the mercantile marine on the northern lakes obviates or diminishes the necessity of continuing the system of fortifications on these lakes?”

General Totten's response to these critical interrogations is, as usual with him when this great subject has to be dealt with, full and exhaustive. The following pithy paragraphs exhibit his views on the influence of railroads.

“Suppose a hostile fleet to lie in front of the city of New York,—which nothing would prevent, if the channels of approach were not fortified—in what way could the 100,000 or 200,000 new men poured into the city and environs by railroads, although armed with muskets and field-pieces, aid the half-million of people already there? It seems to me very clear that these additional forces would, like the population of the city, be utterly powerless in the way of resistance, with any means at their com-

mand ; and, if resistance were attempted by the city, would but serve to swell the list of casualties, unless they should at once retreat beyond the range of fire. If the enemy's expedition were intended, according to the second supposed mode of attack, for invasion, or occupation for some time, of a portion of the country, then, in many places, this resource of railroads would be of value, because then the duty of defence would fall upon the army and militia of the country ; and these communications would swell their numbers.

“But of all circumstances of danger to the coast, this chance of an attempt by an enemy to land and march any distance into a populous district is least to be regarded, whether there be or be not such speedy mode of receiving reinforcements, and our system of fortifications has little to do with any such danger. In preparing against maritime assaults, the security of the points to be covered is considered to be greatly augmented whenever the defence can be so arranged as to oblige an enemy to land at some distance ; for the reason that opportunity is thereby allowed, in the only possible way, for the spirit and enterprise of the people to come into play.

“Instead of being designed to prevent a landing upon any part of the coast, as many seem to suppose, and some allege in proof of extravagant views on the part of the system of defence, the system often leaves this landing as an open alternative to the enemy, and aims so to cover the really important and dangerous points as to necessitate a distant landing and a march towards the object through the people. It is because the expedition would easily accomplish its object without landing, and without allowing the population to partake in the defence, that the fortifications are resorted to. For instance, without Fort Delaware, or some other fort low down on Delaware Bay, an enemy could place his fleet of steamers in front of Philadelphia by the time his appearance on the coast had been well announced throughout the city. And in spite of all New Jersey, Delaware, and lower Pennsylvania, he could levy his contributions, and burn the navy-yard and shipping, and be away, in a few hours. But being obliged, by the fort above mentioned, to land full forty miles below the city, the resistance to his march may be safely left to the courage and patriotism that will find ample time to array themselves in opposition.”

Concerning the application of steam to vessels of war he says:—

“The application of steam to vessels of war acts upon the question of sea-coast defence both beneficially and injuriously. It acts injuriously in several ways; but chiefly, first, by the suddenness and surprise with which vessels may fall upon their object, and pass from one object to another, in spite of distance, climate, and season; and, secondly, by their ability to navigate shallow waters.

“The first property, by which squadrons may run into our harbors, outstripping all warnings of their approach, affords no chance for impromptu preparations; accordingly, whatever our preparations are to be, they should precede the war. It seems past all belief that a nation having in commission—as France and England always have—a large number of war steamers, ready for distant service in twenty-four hours, receiving their orders by telegraph, capable of uniting in squadrons, and in two or three days at most speeding on their several paths to fall upon undefended ports—it is not to be expected, I say, that they should delay such enterprises until temporary resorts could be got ready to receive them. And yet there are those who insist that we should leave defensive measures to a state of war, that we should let the day supply the need!

“Inadequate as all such measures must prove, there would not be time to arrange even these. By the second property, due to their light draft of water, these vessels will oblige the defence to be extended in some form to passages or channels or shoals that were before adequately guarded by their shallowness. The bars at the mouth of the Mississippi formerly excluded all but small vessels of war, and the strong current of the river made the ascent of sailing vessels exceedingly uncertain and tedious. Now these bars and currents are impediments no longer. And all the armed steamers of Great Britain and France might be formed in array in face of the city of New Orleans before a rumor of their approach had been heard.

“Had the English expedition of 1814, attended by a squadron of armed steamers, arrived at the mouth of the Mississippi, a few transports might have been taken in tow, and in a few hours the whole army would have been before the city. Or twelve or fifteen such steamers could have carried the whole army up in half a day, without the delay of transports. Will it be contended that

the attack in that form would have been repulsed with the means then in General Jackson's hands? Would the landing, or even the presence on board these steamships, of the British troops have been necessary to burn the city or put it under contribution? Is there anything now, but the existence of forts on the river, to prevent the success of such an attack by fifteen or twenty steamers of war, allured there by the vastly increased magnitude of the spoil?"¹

While the enemy's means of attack are thus enhanced by the use of war-steamers, General Totten contends that they cannot be relied upon, as a substitute for fortifications, for defence.

"I do not assert," he says, "that armed vessels would not be useful in coast defence. Such an idea would be absurd. I shall even have occasion to show a necessity for this kind of force, in certain exceptional cases. It is the general proposition, viz., that armed vessels, and not fortifications, are the proper defences for our vulnerable points—a proposition the more dangerous, because seemingly in such accordance with the well-tryed prowess and heroic achievements of the navy—that we have now to controvert.

"Boston, New York, Philadelphia, Baltimore, Charleston, and New Orleans are, we will suppose, to be guarded, not by forts, but by these vessels, on the occurrence of a war with a nation possessing large naval means. We know that it is no effort for such nations to despatch a fleet of twenty line-of-battle ships and frigates, or an equal number of war steamers, or even the combined mass—both fleets in one.

"What, then, shall we do at the above-named ports severally? Each is justly felt to be an object worthy of an enemy's efforts, and each would be culpable in sending elsewhere any part of the force required for its own defence. Each, therefore, maintains a naval force equal, at least, to that the enemy is judged to be able to send promptly against it. Omitting any provision for other places scarcely less important, what is the result? It is, that we

¹ The experience of the Rebellion has proved the truth of General Totten's words. The moment the *forts* were passed, the city of New Orleans was, notwithstanding the land forces under Lovell, at Commodore Farragut's mercy. I have alluded elsewhere to the failure of the forts.

maintain within the harbors of, or at the entrance to, these places, chained down to this passive defence, a force at least six times as large as that of the enemy.

“He does not hesitate to leave his port, because it will be protected in his absence by its fortifications, which also afford him a sure refuge on his return. He sails about the ocean, depredating upon our commerce with his privateers and small cruisers, putting our small places to ransom, and in other ways following up appropriate duties; all which is accomplished without risk, because our fleet, although of enormous magnitude, must cling to ports which have no other defence than that afforded by their presence. They cannot combine against him singly, for they cannot know where he is; and must not, moreover, abandon the object which they were expressly provided to guard.

“It would really seem that there could not be a more impolitic, inefficient, and dangerous system, as there could not certainly be a more expensive one.”

I have thus extensively quoted from the reports of General Totten, because they are themselves the best expressions of the life labors and services of the subject of our memoir, and because I think they treat of matters which should be, in an eminent degree, interesting to the members of this National Academy, and which, moreover, should demand its attention.

To preserve the continuity of my subject, I have followed these reports down to a late date. It is necessary now to revert to an earlier period. It has already been observed, that as soon as the original Board of Engineers had sufficiently matured the general system of defence, and completed plans for the works first required, its members applied themselves to the duty of construction. In 1828, General (then Colonel) Totten took charge of the construction of Fort Adams, Newport harbor, and continued on this duty, making his residence in the town of Newport, until December, 1838, the date of his appointment as Chief of the Corps of Engineers. This work, the second in magnitude of the fortifications of the United States, is one of the best monuments of genius as a military engineer. From its peculiar relations to the land defence, it called for the application of most of those rules of art, and many of those special arrangements which form the themes of treatises upon “fortification,” and which, generally, have but a very limited applica-

tion to works of harbor defence. In these respects it has no parallel with us, and in the treatment of the case and happy adaptation of means to the end, Colonel Totten exhibited a mastery of all the details of the art, which proves his technical skill and minute knowledge to be fully equal to the power of broad generalization I have already endeavored to illustrate. But Colonel Totten found here yet another field for professional usefulness—another tract to explore. The art of the civil engineer (I use the phrase in its application to mere *construction*, whether it be of a military or civil work) was yet in its infancy in this country. Our resources in building materials were almost unknown, their qualities and adaptabilities to different purposes of construction undeveloped. Thus far the matter had excited little attention; the building material, whether brick or stone, lime or timber, nearest at hand was indiscriminately used, and its aggregation left much to the skill of the mechanic. In commencing constructions on so great a scale, it was of the first importance that the work should be both durable and economical; a result only to be attained by the most careful selection of materials, and the most skilful manipulation. Besides, our forts called for arrangements unknown in other branches of building—arrangements for which the execution and the most suitable materials had to be studied out *ab initio*, since on many of these points there were neither experience nor extant rules to guide.

In the years 1830 and 1831 a series of experiments was instituted by Colonel Totten at Fort Adams, on the expansion and contraction of building stone by natural changes of temperature, and the effects of these variations on the cements employed to secure the joints of stone copings. An account of them was prepared under his direction by Lieutenant (now Professor) W. H. C. Bartlett, a member of this Academy, and published in the *American Journal of Science* for July, 1832. The methods employed were at once simple and ingenious, and the result was such as to leave no doubt that in this climate the joints of copings formed of stone of four or five feet in length will always be insecure, no matter what description of cement may be employed to close them.

This result is one of great practical importance. Previously to the experimental examination of the subject by Colonel Totten, the walls of our most expensive works of masonry were

protected by copings cemented at their joints; and while the failure of the cement was constantly noticed, the cause of the failure was not understood. The experiments showed that the changes of longitudinal dimensions of granite coping-stones, five feet only in length, under the extreme temperatures to which they were exposed at Newport, would be sufficient to pulverize the hardest cement between them, or to leave cracks in it thicker than common pasteboard. With marble as a material, these destructive effects are considerably increased, and with sandstone, nearly doubled.

About the same time, Colonel Totten caused some experiments to be made to ascertain the relative stiffness and strength of the following kinds of timber, viz., White Pine (*Pinus strobus*), Spruce (*Abies nigra*), and Southern Pine (*Pinus australis*), also called Long-leaved Pine.

These experiments, made by his assistant, Lieutenant T. S. Brown, of the Corps of Engineers, were published in the American Journal of Science and Art, and afterwards, having been revised by the author, in the Journal of the Franklin Institute, a note being added, the calculations extended, and practical inferences drawn therefrom. This memoir and additions are found in Vol. VII., new series, Journal of the Franklin Institute, 1831. Lieutenant Brown's account concludes with the following remarks:—

“In Tredgold's carpentry, and other similar works, may be found the constant numbers (a) and (c) for nearly all the kinds of wood useful in the arts; but besides that the numbers are in many instances calculated from insufficient experiments, most of the specimens used in the trials were of European growth, and of course the results obtained are inapplicable to American timber, though bearing the same name. It is much to be desired that numerous and accurate experiments be made in this country by those having the requisite zeal and opportunities; our architects will then know with certainty the qualities of the different kinds of woods they are using, and instead of working at hazard and in the dark, as they now too often do, they will be guided by the sure light of practical science to certain and definite results. If these experiments contribute ever so little to the attainment of so important a result, the object of their publication will be fully accomplished.”

A subject of such vital importance in the art of construction as the composition of mortars could not fail to invite, or rather compel, the researches of Colonel Totten. No species of masonry is subject to such severe deteriorating influences as the walls and arches of fortifications, especially in our climate; so severe, indeed, that they almost drive the engineer to despair. Next only to the importance of having the building stones or bricks of a suitable character, is that of uniting them by a strong and durable mortar. Few persons whose attention has not been called to the subject conceive its magnitude, the variety of materials it embraces, and the laborious investigations to which it has given rise. Colonel Totten commenced his researches at an early date, and continued them actively during the whole period of his connection with Fort Adams.

His work on "Hydraulic and Common Mortars" was published in 1838 by the Franklin Institute of Philadelphia. It contains, besides original experiments and observations on mortars, hydraulic cements, and concretes, translations of essays by Treusart, Pitot, and Courtois, the best French writers on the same subject, and constitutes to this day an authority relied on by American engineers. Colonel Totten's experiments extend over the period from 1825 to 1838; they are especially valuable for the variety of limes and cements, and the tests of different modes of slaking the lime, mixing the mortars, and preparing the cements and concretes. The mortars were tested, after periods ranging from five months to four years and five months, for tenacity, by the force required to separate two bricks joined together by means of them, and for hardness by the weight which they would support, applied over a small circular area. The experiments on concretes or factitious stones are equally comprehensive, being directed to the composition and consistency of the cement whether best used as a stiff mortar or a semi-fluid grout; to the effect of additions of common lime and sand or rounded pebbles and gravel, and to ascertaining the proportion of each that would be used to the best advantage. The results developed by these investigations are of the greatest value, and having been applied in the construction of the fort, have now had the test of many years' experience.

It would be almost impossible to enumerate the various objects of Colonel Totten's researches while at Newport. There is

scarce a subject connected with the art or science of the engineer, civil or military, which did not engage his attention, and of which he has not left some record. The thickness of sustaining walls, the thrust of arches, among the more important, and the composition of stuccoes, of paints, lackers, washes for stone or brick work, among the less so, may here be mentioned.

Perhaps no period of his life is so interesting and so affectionately remembered by his professional associates. Indeed, a large proportion of the young officers of the corps of those days passed a portion of their time under his command, and acquired their first professional experience in the performance of duties under his eye and direction. The disposition to cultivate science, physical and natural, led him to original researches, while his influence stimulated and led to improvement the educated young men who from time to time came into his military family. Fond of exercise, bodily and mental, he sought in natural history, as in geology, mineralogy, and conchology, objects for the long walks and drives conducive to health, while the arrangement of the specimens, their care and classification, and the study of the habits of the animals which occupied the shells, gave scope to his wonderful powers of observation. Instead of finding his young officers a trouble, he was fond of their companionship, suggesting modes and objects of experiment, and encouraging them to do so likewise, thus cultivating originality of thought. His laboratory was at their service, and his companionship and example at their disposal. After a day's labor he retired to this laboratory, glad to have with him such of the young companions of the day as desired to join him. The honored President of this Academy can recollect, year after year, the computations, under Colonel Totten's direction, of the thickness of revetments, the analysis of minerals collected in the field, classifications of shells gathered in days' walks on the sea-shore, discussions of the curious structure of geological specimens in the neighborhood of Newport, and of the curious mineralogical specimens of the upper portion of Rhode Island, which he encouraged them to find. So upon the fort itself, the various researches which I described were marked out for successive experimenting, with a generosity to his assistants which almost persuaded them that they were original with them. The determination of the measures used in laying out the fort and the practical apparatus employed

in the measurements, received his careful study. The practical character of these works impressed itself upon the minds of the young officers, and furnished the fitting complement to the theoretical training received at West Point.

Not least pleasant among the memories of this period of Colonel Totten's life, to those who had the good fortune to be associated with him, is the recollection of the social enjoyments of his house. Married in 1816 to Catlyna Pearson, of Albany, he was surrounded by a young family, among whom his happiest moments were spent, and to whom he was everything that such a relation can imply. None could be happier in his social intercourse. Genial and eminently hospitable, he cultivated as a duty those smaller amenities of society by which the cares of life are lightened, and its joys augmented. His house was the home of his friends, and was seldom without some one of them. Though dignified and courteously reserved in his intercourse with the external world, few more highly enjoyed real humor, or could with more true *bonhommie* give themselves up to the gayety of the moment. In his relations to his young officers he was kind and affable, encouraging freedom of expression, and inviting inquiry in everything that related to professional matters, while there was always that in his manner which inspired the most profound respect and forbade undue levity of conduct in his presence.

Before quitting the scene of so important a portion of Colonel Totten's official labors, it is proper to remark that, in addition to the duties of his particular charge, he as a member, and for the last six years President of the board of engineers, was engaged in the planning of the new works for which Congress from time to time made the necessary appropriations.¹ To this duty he usually devoted the winter months, during which all construction on Fort Adams was suspended. In the execution of his designs he was usually assisted by young officers of the

¹ By the Regulations, the local engineer officer, upon whom the construction of the proposed work was to devolve, was *ex officio* a member of the board. This brought together during the winter months engineer officers from various parts of the country—from the shores of the Gulf, from the seaboard of North and South Carolina and Georgia, as well as from nearer points, and added not a little to the charm of the professional and social life of the young engineer officers at Newport.

corps, who found therein a practical application of the theoretical knowledge acquired at West Point instructive and useful.

The works of harbor improvement on the seaboard and on the lakes were likewise under the control and direction of the Engineer Bureau; and Colonel Totten, though not directly engaged therein, was not infrequently called on to inspect and advise concerning them. Most of these, and especially those of the Lake shores, affording curious and interesting problems in this branch of civil engineering, and his reports and notes on these subjects, yet extant, are additional proofs of the wide range of his professional knowledge and of his powers of accurate observation and of skilful deduction from the phenomena of nature.

Colonel Totten was appointed Colonel of the Corps of Engineers and Chief Engineer, Dec. 7, 1838. At this time the construction of Fort Adams was so far advanced towards completion as to need no longer his personal supervision, and the city of Washington became thenceforth his home and the seat of his official duties. Identified as we have seen with the origin and growth of the great system of sea-coast defence of the United States, it was eminently proper that he should become the head of that bureau of the War Department to which its execution was committed, and no one could be more eminently fitted for that important station.

At the date of his appointment the system of coast defence had been for about twenty years in progress of construction, and during that period most of those ports and harbors of the United States deemed most important to ourselves or most assailable by a naval foe had been, at least, partially fortified. At many such points, indeed, no new work had been as yet constructed, owing to the existence of forts or batteries more or less adequate built before or during the war of 1812. These works, where possible, were absorbed into the new system with some repairs and alterations. Among such points may be mentioned the harbors of Portland, Portsmouth, New London, Philadelphia, Baltimore, and Charleston. New and powerful works had, however, been built or far advanced to completion, for the defence of Boston, Newport, New York, Hampton Roads, the Savannah River, Pensacola, Mobile, and New Orleans. But the strictures on the system, to which we have before made

reference, proceeding from such an authority as the Secretary of War and sanctioned by the President, had not failed to shake the confidence of Congress and of the people. For several years the annual appropriations had been wholly denied or made so inadequately that the work had languished and at some points had been wholly suspended. But however much opposition may grow up in time of profound peace, no sooner is there a probability of seeing a foe at our doors than all eyes are turned to these protecting works, and the most urgent demands are made that our seaport towns shall be speedily put "in a state of defence." Such an impulse was given by the Maine boundary and McLeod questions, soon after the advent of Colonel Totten to the Chief Engineership. In fulfilling the urgent duty which thus devolved upon him, he did not content himself with the mere issuing of orders from his office at Washington. He made it his business to inspect personally the works, and in less than two years, besides the enormous office labor he found necessary to attend to on the first assumption of charge of the bureau, he had visited every fort and battery on the sea-coast of the United States. His inspections were not superficial and hasty; they were most thorough and searching. His investigations embraced, at the same time, the general scope and purpose of the work, its adaptability to its great objects, and the minutest detail in its construction. It was now that the country derived the full benefit of his indefatigable researches while at Newport.

I have already alluded to the lack of knowledge and experience in this country of the art of construction, especially in its applications to the peculiarities of fortification. To supply this lack was a great end of Colonel Totten's labors at Fort Adams. At few other points did the locality or circumstances of the construction render practicable such researches. This remark will apply particularly to the works on the Gulf of Mexico. The regions bordering the Gulf were, at the close of the war of 1812, but recent acquisitions to the territory of the United States. Sparsely populated and isolated from the rest of the Union as (before the application of steam to the navigation of the Mississippi) they were, they would be defended, if defended at all, only by the aid of fortifications. The fact that New Orleans had been almost wrenched from our grasp, and the impression then everywhere felt that if it had been captured it would not have

been relinquished, stimulated the government to secure the possession of this important place and of other strategic points on the Gulf by immediate fortification. Accordingly designs for works—mostly prepared by General Bernard—were among the first labors of the Board of Engineers, and the forts on the river and lake approaches to New Orleans, at the entrances to Mobile Bay and Pensacola harbor, were almost simultaneously commenced. Around New Orleans especially the Engineers had to contend with formidable difficulties. The deadly climate, the treacherous soil, on which no art could build a structure so massive as a fortification that should not sink one or more feet, warping and dislocating the walls and arches, the difficulties of procuring the services of mechanics and laborers, the want of building materials, etc., all combined to make construction exceedingly difficult, to forbid any of its niceties, and to hinder all research or experiment. Some of these works had been entirely finished at the period we have arrived at, others nearly so, and left to “settle” before the weight of the earthen parapets was added.

Considering all these unfavorable circumstances, these works had been built in a manner creditable to the energy and skill of the engineers; but a few years' neglect, aided by a damp and tropical climate, had given many of them an appearance which, to the superficial observer, promised anything but efficiency. Indeed, it was a popular belief in New Orleans at this time that Fort Jackson on the Mississippi had sunk so much that its guns could not be brought to bear on the river,—a belief doubtless due to the unnecessarily high levees by which it had been surrounded to protect its site from inundation, and to the rapid growth of vegetation on and about the fort. Such was the condition of this work when Colonel Totten first visited it in 1841, and the author of this paper, who had but recently taken charge of it, has yet a vivid recollection of the thorough inspections of this and other works, the tedious voyages in open boats through the intricate “bayou” navigation about New Orleans, in company with his chief, as well as the copious and most minute instructions which he received. Destitute of American experience on such points, the designer had followed European precedents, or the constructing engineer had been left to his own devices as to much that relates to the interior arrangements. The wood-work of

magazines, inadequately ventilated, had rotted and fallen in ruins; the covering of the bomb-proof casemates, imperfectly understood, had failed to exclude water, which percolated through the piers and arches or gathered in muddy pools on the floors. The work to be done to bring the forts to speedy efficiency was vast; embrasures and floors of casemates were to be raised to compensate the settlement the works had undergone; earth to be removed from the arches, in order to repair or renew the roofing; magazines and quarters to be refitted, and all this before a gun could be mounted in a proper manner. On all these points Colonel Totten was rich in the experience of his long researches, and ready at once to give the proper directions. Following his detailed instructions, the works speedily reached such a condition of efficiency as to permit the mounting and service of their guns.¹

What the writer here relates from his own experience at New Orleans serves but to illustrate the indefatigable labors and personal agency of Colonel Totten at this period, along the whole seaboard of the United States, in bringing all its ports and harbors into a defensible condition. Nor should I confine these attributes to any particular period. During the whole time of his Chief Engineership he continued the same laborious supervision. Generally, once in about every two years, he inspected every fort of the United States, and scarcely was the local engineer officer more thoroughly familiar with each detail of his own particular works than was the Chief Engineer with those of all under charge of the Engineer Bureau. Besides attending to the routine duties of his office at Washington, he found time to design plans for new works, as well as for alterations or enlargement of old ones. An admirable draughtsman, executing his work with a delicacy and finish that defied competition on the part of his subordinates, he would be usually found, if visited at his office, engaged at his drawing-table. Indeed, if he had a fault as Chief Engineer, it was the habit of doing everything himself. It was contemplated by the Regulations that all plans of fortifications should be made by a Board of Engineers, and General Totten, in one of his reports,

¹ When Forts Jackson and Philip on the Mississippi were attacked by the fleets of Commanders Farragut and Porter, they were not provided with the armaments intended for them, and the garrisons were demoralized by a long bombardment. It is not in place to discuss this subject here.

alludes to the fact that this has *not* always been the case in these words: "In rare cases it has happened that plans have been made under the particular direction of the Chief Engineer, owing to the difficulty, at moments, of drawing the widely dispersed members of the board from their individual trusts." It may be said too, in justice to him, that when he assumed the control of the bureau, it was almost indispensable to take much upon himself, in the direction of the repairs and prosecution of many of the works, owing to the great pressure thrown upon the corps by the circumstances of the period and the want of a sufficient number of experienced officers.

The excitement produced by the anticipation of war with England was followed by an actual war with a weak neighbor—a war inaugurated by the same influences which, in a more potent form, produced the Rebellion, or rather of which the Rebellion was but the legitimate and natural sequel. Called on by General Scott, who reposed in his professional skill the most unbounded confidence, Colonel Totten assumed, in 1847, the immediate control of the engineering operations of the army destined to invade the Mexican capital, directing in this capacity the siege of Veru Cruz. For his successful services he was brevetted a Brigadier-General, March 29, 1847, "for gallant and meritorious conduct at the siege of Vera Cruz." Having thus successfully accomplished the special task for which he had been selected, he left the army and resumed his station at Washington.

In addition to the onerous duties of his office, involving, besides the labors described, the Inspectorship and Supervision of the Military Academy, his position and high reputation subjected him to calls for incidental labors, by the government, by the States, or by municipal bodies. A few months prior to his appointment as Chief Engineer, 1838, he was, at the invitation of the Secretary of the Navy, ordered to visit the Navy-Yard at Pensacola, and to prepare plans for dry-docks, wharves, seawalls, and other improvements. Save a wretched failure in the shape of a wharf, the place—a navy-yard in name—had been, up to this period, destitute of everything that characterizes such an establishment, except an imposing row of officers' quarters, and some few storehouses. A board of naval officers had been convened two years previously to consider the wants

of the yard, and had recommended an extensive system of improvements, involving, among other things, no less than four dry-docks. Such constructions, reaching thirty or more feet below the level of low water in the loose sand of the bay shores, were difficult, demanding all the resources of the engineer, and it was on account of General Totten's eminent abilities and high authority in such matters that the Navy Department had recourse to his services. He made a report on the manner of construction, with plans which, if I mistake not, have been a guide in the subsequent operations. Unfortunately, to this day no permanent dry-dock exists, a floating wooden one having, through some influence, been substituted, at enormous expense, for the intended masonry structure.¹

The Legislature of the State of New York having, March 30, 1855, passed "An Act for the appointment of a commission for the preservation of the harbor of New York from encroachments, and to prevent obstructions to the necessary navigation thereof," the commission so appointed invited and obtained the co-operation, as an "advisory council," of General Totten, Professor Bache, and Commander Davis, U. S. Navy. The nature of the services thus rendered is best understood by reference to the reports of the Commissioners themselves.

"The distinguished reputation of General Totten, Professor Bache, and Commander Davis for scientific attainments, their diversified experience in the construction of hydraulic works, and long observation of the influence of tidal currents in the formation and removal of shoals, indicated them as the best qualified to assist the Commissioners in the discharge of their duties, while their high personal character precluded the possibility of their advice being affected by other than the single purpose of arriving at a just decision on the questions submitted to them;" and again, after a particular allusion to the services of Professor

¹ The "questionable shape" and suspicious object of this novel craft—set afloat and towed out into the bay by the Rebels in 1861—caused anxious surmises on the part of Colonel Brown and the gallant garrison of Fort Pickens, reminding us of the famous "Battle of the Kegs" of the Revolution. The probable object was to sink it in the channel to prevent the entrance of our gunboats. But Colonel Brown's interference prevented the accomplishment of the design. It was abandoned by the rebels, and set fire to by Colonel Brown's orders.

Bache: "It is the gratifying duty of the Commissioners to present to the notice of the Legislature the important services which have been gratuitously rendered to the State by General Joseph G. Totten, Chief Engineer of the United States Army, and Commander Charles H. Davis, of the United States Navy, who, with Professor Bache, formed the advisory council of the Commissioners. Animated by the single desire of preserving the port of New York in all its usefulness, they brought to the consideration of the subjects referred to them the diversified experience of many years spent in the examination and improvement of harbors. The several reports they have made on the exterior lines, on the improvement of Hell Gate, and on the preservation of Gowanus Bay, are profound dissertations on the forces and actions of currents, and, while they evince, in some degree, the extent of the labors of those gentlemen, they demonstrate how just is the public estimate of their scientific attainments."

Following the example of New York, Massachusetts soon organized a similar commission for the port and harbor of Boston, on which the same gentlemen were invited to serve, receiving similar testimonials of the high value of their services.

Of the many scientific men of the country who were associated with him in such duties (of whom most usually was our eminent President), none exhibited greater zeal and assiduity, few took a more prominent and useful part. The resolutions of the Light House Board, on the occasion of his decease, which are appended to this memoir, would be, with slight modifications, applicable in reference to all his connections of a similar nature. Inflexible in his integrity, uncompromising in his notions of duty, and watchful to the highest degree for all the interests of the government in all that concerned his charge, it is not strange that the shameless Floyd soon found him an obstacle to his peculiar operations. He was virtually banished from his office, or at least relieved from his duties, which he did not resume until Floyd left the War Department. He took this opportunity—perhaps the very first and only release during his lifetime from the unceasing demand of duty—to visit Europe in company with Mrs. Totten, travelling through France, Italy, Germany, and England. Endued with those keen perceptions and that harmonious adjustment of faculties which render the

mind susceptible to the beautiful, whether in nature or art, he was, in the true sense of the term, an artist. For music, for painting, for sculpture, he had a high relish and a most accurate and discriminating judgment. By such a one the treasures of art and antiquity of Europe can only be adequately appreciated and enjoyed, as we know they were appreciated and enjoyed by General Totten. He did not fail, however, to take the opportunity to examine, as far as he was able, the fortifications of Europe, of the character and peculiarities of which, however, he had little to learn. On his return he was sent by Floyd to the Pacific coast, with directions to inspect the fortifications in construction, and to report on the defensive requirements of that region. This duty and the report thereon he executed in his usual thorough and exhaustive manner. It furnished him with the opportunity to acquire the same personal knowledge of all that concerned the seaboard defence of our newly acquired territories on the Pacific which he already possessed, beyond any other man, in reference to the Atlantic and Gulf coasts.

In the year 1851 General Totten inaugurated and continued through the years 1852, 1853, 1854, and 1855 a series of experiments at West Point, "on the effects of firing with heavy ordnance from casemate embrasures," and also "on the effects of firing against the same embrasures with various kinds of missiles." It will be interesting and conducive to a better understanding of the objects and results of these experiments to say a few words as to the origin and meaning of the term "casemate," and to give an account of General Totten's previous labors in connection with the "casemate embrasure." The word is from the Spanish *casa-mata* (a compound, most likely, of *casa*, house, and *matar*, to kill; though it is said also to mean a low or hidden house; but the etymology is not settled), and seems to have been used to signify a countermine as well as a concealed place, arranged in connection with a fortification, for containing and using a piece of artillery. According to Bardin¹ it appears to have been applied to the double or triple tier of uncovered gun platforms used by the early Italian and German engineers for flanking the ditch, as well as to vaulted galleries along the scarp wall. The term finally came to mean, in fortifi-

¹ Dictionnaire de l'Armée de Terre, etc.

cation, any vaulted room under the earthwork of the rampart or glacis, whether intended for service of guns or for quarters of troops or for containing stores. A *gun casemate* is such a vault abutting against the scarp or counterscarp wall through which an "embrasure" is pierced to permit the discharge of the gun; and in the naval service the term has been adopted to signify the part of an iron-clad vessel containing the guns, and which is, for that reason, especially protected by the iron-plating. Hence the essential notion of the word seems to involve one or more of the attributes of concealment, shelter, and destructive purpose.

The use of the casemate, in some of its forms, for flanking purposes goes back to Albert Durer and San Micheli, in the early part of the sixteenth century, and it was resorted to by Vauban in his second and third systems, of which the tower-bastions are casemated throughout. But it was reserved for the Marquis de Montalembert, in the latter part of the eighteenth century, to give it an extraordinary development, and to make the casemate the essential element of a system of fortification. This "most intrepid of authors upon fortification" (as he is styled by Chasseloup) boldly attempted to apply to his art the same principles by which Napoleon won his victories—the concentration of superior forces upon the decisive points. In his projects we find upon all parts where there must be a decisive contest of artillery an extraordinary concentration of guns, amounting in some cases to ten times those of the attacking batteries, the construction of which it is intended to prevent, or which shall be promptly overpowered, if constructed. This concentration he effected, and could only effect, by the use of casemates, upon which, numerous and well constructed, he bases all the strength of his fortifications.

No author on this art has displayed greater genius or a greater affluence of resources, and no author has given occasion for so much acrimonious discussion. Rejected by the French, the principles of Montalembert have been made the basis of the modern German, or "Polygonal" system.

For sea-coast fortifications the casemates of Montalembert had a singular applicability, and he has the merit at least of being the first writer who has seen in this branch of the art a

subject of particular treatment, and who had given special designs for forts and batteries "for the defence of ports."

In no warlike structure was there so great a concentration of artillery as in a ship of war, such as it was fifty or even twenty years ago. And as there is no limit to the number of ships which may be brought to bear upon a shore battery save that of the range of artillery and the area of navigable water, it is easy to see to what overwhelming hostile fire such a work may be subjected. On the other hand, it frequently happens that the site otherwise most advantageous for a battery is low and contracted, rendering any accumulation of guns impracticable, if mounted on an ordinary rampart, and exposing the unprotected gunners to the fire of the sharpshooters with which the enemy's topmasts are filled.¹

It is no small merit of Montalembert to have devised a method of mounting guns which should meet this case. Notwithstanding that the French Corps of Engineers rejected the system in its intended application, and disclaimed, as an engineer, its author, it nevertheless constructed, in 1786, for the defence of the roadstead and harbor of Cherbourg, forts which are in reality almost copied from his designs.² Following the example of the French, other European nations have adopted, for the defence of their seaports, works of the same character, of which the forts of Cronstadt and Sebastopol, once made familiar to us in their outward appearance, by the Pictorials, are recent specimens, and, as we have already seen, Colonel Williams introduced them into our country in 1807, by the construction of Castles Williams and Clinton, and Fort Gansevoort, New York harbor.

An objection urged against casemates, and a grave one, since it is aimed at one of their most important attributes, is that the embrasures of masonry are dangerous to the gunners, from their outward flaring surfaces reflecting into the interior the enemy's missiles. Montalembert was well aware of this objection, calling

¹ The topmasts of many of the vessels of Commodore Farragut's fleet in the attack on Fort Jackson and St. Philip contained boat-howitzers, destined to fire canister at the gunners of the low batteries of those works.

² The celebrated Carnot, then an officer of French engineers, but who adopted the views of Montalembert, writes to him, "You have wrung from your adversaries the admission that well-constructed casemates are a good thing," etc. (ZASTROW, *Histoire de la Fortification.*)

the embrasure, in its ordinary form, a "murderous funnel" (*entonnoir meurtrière*), and his sagacity did not fail to prescribe the best remedy by rules intended to reduce to a minimum the external opening. He directed that the throat should be no larger than necessary to receive the muzzle of the gun and to endure the shock of its discharge, that it should not be more than two feet from the exterior surface of the wall, that the cheeks should be parallel to the sides of the sector of fire; and to render practicable these arrangements, he invented the "*affût à aiguille*" (carriage with tongue), which has served as the type of nearly all subsequent casemate gun-carriages. It is strange, that, even while adopting the plans of Montalembert, European engineers should have almost wholly overlooked these maxims, and that it was reserved for our own illustrious engineer to make their application, and in perfecting the casemate and the embrasure, to become a co-worker with Montalembert, by bringing the casemated water battery to its highest degree of perfection.

I now revert to General Totten's labors in this connection, and in reference thereto I quote from his report to the Secretary of War:—

"The first casemated battery was completed in 1808. It has two tiers of guns in casemates, and one in barbette. The exterior openings of the lower embrasures are 4' 8" by six feet, giving an area of 28 square feet; and of the second tier, 3' 8" by 5 feet, area $18\frac{1}{3}$ square feet, the horizontal traverse of the guns being limited to 44 degrees.

"Within three or four years of the time just mentioned two other casemated batteries were built, each having a single tier of guns in casemates, with exterior openings of 4' 5" by 5 feet, area 22 square feet; one with horizontal scope of about 42 degrees, and the other of about 45 degrees.

"In 1815 the author of this report was called on to prepare a project for the defence of an important channel; and having been convinced, while employed as an assistant in the construction of two of the batteries just mentioned, that the principles and the details by which the embrasures and the dependent casemates had thus far been regulated were erroneous and defective, set about a careful study of the conditions to be fulfilled in providing for the heavy guns of that period, mounted on a casemate carriage that had already been approved and adopted. The

result was an embrasure, having an exterior opening of 4 feet wide by 2' 6" high at the outside line of the cheeks, and three feet high at the key of the covering arch, the throat being 1' 10" wide. This provided for all the depression and elevation of the gun that the carriage permitted, and also for a horizontal scope of full 60 degrees. Covered with a lintel instead of an arch, the height of the exterior opening might be a little less than three feet.

"The plan of this embrasure shows that the interior opening is 5' 6" wide, and that the plane of the throat is within 2 feet of the outside of the wall, which just at the embrasure is five feet thick.

"A slight modification fitted this embrasure, when applied to flanking or interior defence, to receive at first a carronade of large calibre, and of later years, a howitzer instead. When these latter were liable to be assailed by musketry, the outer cheeks were made *en cremaillière* (notched)—a long-known device.

"It was with timidity and hesitation that the cheeks and this embrasure were placed so near the track of the ball, when fired from the casemate, with the maximum obliquity, and the results of an early trial with experimental embrasures at Fort Monroe gave some sanction to the doubt. The first two under trial were built of lime mortar, and were soon shaken to pieces by the blast of the gun. Another one, however, constructed of bricks laid in cement mortar, sustained without injury several hundred discharges. These last results have been confirmed wherever there has been practice from our embrasures, which, with immaterial differences, have since 1815 been constructed in all our casemated batteries according to the preceding description."

It will be seen from the foregoing quotations how thoroughly General Totten, in adopting the casemated battery, was imbued with the spirit of its illustrious originator. If, as is likely, he was aware of the latter's rules on this subject, he was the first to appreciate their essential importance, and to prove the practicability of their application. It is probable, however, that the close study of the subject, critical observation and keen sagacity which so distinguished him on all occasions, and which taught him to accept nothing as the best which was susceptible of improvement, led him to recognize as "murderous funnels" the embrasures of routine—to create anew the rules of Montalembert,

and to make, for the first time, a successful application of them. He reduced the throat to nearly an absolute minimum : he placed it at two feet from the outer face of the wall, diminishing the external openings from eighteen, twenty-two, and twenty-eight, down to about ten square feet, while he increased the sector of fire of the gun from forty-five to sixty degrees ; thus adding one third to its field of fire, and consequently to its value.

The embrasures, thus modelled in 1815, remained unchanged until the year 1858, but the casemate continued a subject of study and experiment during most of his life. The perfecting of ventilation, the determination of the dimensions and height of the piers, of the span and rise of the arches, their thickness and manner of covering, so as to obtain perfect drainage and to avoid the injurious effects of frost, etc., were problems of prolonged research and skilful solution, establishing for General Totten the right to be considered the author of the American casemate.

In connection with these researches may be mentioned those also which were directed to the determination of the manner of mounting guns "en barbette."¹ As the dimensions of sea-coast ordnance increased, more and more elaborate structures became necessary for their mounting and management. The planning and construction of the carriages belonged to the Ordnance Bureau, but it was General Totten's task to adapt the platforms and parapets thereto. None but the engineer or artilleryman can thoroughly understand the difficulty and complexity of the problems therein involved. To provide a platform which shall support, without the slightest deflexion, the weight, and resist the shock of discharge, while it provides for the training or pointing of the gun—which is so adapted to the parapet as to allow the maximum horizontal sector of fire and to afford the most perfect cover to the gunners consistent with allowing all the depression demanded by the circumstances of the case—such are the conditions to be fulfilled, separately, for each calibre of gun. After years of experience, and after our sea-coast ordnance had attained its highest development prior to the introduction of the rifled gun and fifteen-inch columbiad, General Totten embodied his results in a lithographic sheet exhibiting to the eye of the engineer for

¹ A barbette gun is one which is fired over a parapet.

every kind of gun and for every probable case the particular solution. This single sheet exhibits strikingly the characteristics of the author's mind—the profound study which he brought to bear on every subject, the scrupulous accuracy of his determinations, which neglected no appreciable magnitude, and the thoroughness and generality of his solutions.

When the embrasure of 1815 was designed, ships' armaments contained no gun heavier than a twenty-four or thirty-two pounder. As the calibres increased, it became a matter of doubt whether the five feet thickness of wall immediately about the embrasure was sufficient. At the same time the progress made in the art of forging large masses of iron had suggested that by its use the funnel form of the mouth might be entirely done away with, and the exterior opening reduced to an absolute minimum. Nothing but *experiment* could lead to sound conclusions, and the experiments referred to on a former page were instituted, the principal objects of which were (in General Totten's own language) :—

I. "To ascertain the effects of firing with solid balls, with shells, and with grape and canister, from heavy ordnance at short distances, upon various materials used in the construction of casemate embrasures.

II. "To determine whether these embrasures might have a form that would shut out most of these missiles, and resist for a time the heaviest, without lessening the sector of fire, horizontal and vertical, of the casemate gun.

III. "To determine the degree to which, without injury from the blast of the gun, or lessening its scope of fire, the throat of the embrasure, and also the exterior opening, might be lessened.

IV. "To determine whether all smaller missiles might not be prevented from passing through the throat into the battery ; and whether the smoke of the blast might not also be excluded by simple and easily managed shutters."

Targets were constructed, representing the wall of a fortification pierced with its embrasures. All varieties of materials were employed in the walls, and every suggested method of constructing the embrasure was tried. General Totten's report shows that the minutest detail of construction was directed by himself, and that he personally superintended the experiments. They

were carried on at intervals during four successive years, the results of each year suggesting the object of experiment for the next.

It would be out of place here to follow the report through its detailed accounts of the firings, or even to attempt to sum up the conclusions arrived at, referring as they do to such a variety of subjects; but those concerning the thickness of the scarp-wall and the use of wrought-iron may be properly quoted as among the most important.

“The general conclusion from these trials is, that, whether of cement concrete, of bricks, or of hard stones, the portion of the wall at and around each embrasure having the thickness of five feet only should be no larger than is indispensable for the adaptation of the gun and carriage to the embrasure; if restricted to a small area, this thickness will suffice—not otherwise.

“The thickness of five feet will resist a number of these balls, impinging in succession on that space, provided the bond expand promptly above, below, and on each side, into a thickness greater by some two and a half feet or three feet or more. Were the wall no thicker generally than five feet, being reinforced only by piers some fifteen feet apart, it would soon be seriously damaged by battering at short distances.”

And in reference to iron it is stated: “First, It may be fairly assumed, that a plate eight inches thick of wrought iron of good quality, kept in place by a backing of three feet of strong masonry, will stop a solid ball from an eight-inch columbiad, fired with ten and a quarter pounds of powder from the distance of two hundred yards. The plate of iron will be deeply indented at the point of impact, the ball carving for itself a smooth bed of the shape and size of one hemisphere, in which it will be found broken into many pieces easily separable, and it will besides be somewhat bent generally. The masonry behind will be much jarred, and, unless strongly bonded, be considerably displaced; moreover, unless the thickness of three feet is well tied into thicker masses immediately adjacent on the sides and above and below, the general damage will be severe.

“Second, This plate will be much the stronger for being in a single mass, and not made up of several thinner plates. The continuity effected by bolts and rivets of the made-up plates is broken even by weak assaults, so that afterwards the stronger,

instead of a joint opposition, finds only a succession of feeble resistances.

“Third, A thickness of two inches is ample for shutters designed to stop the largest grape-shot. With this thickness they will be neither perforated nor deformed by anything less than cannon balls or shells. These shutters also, for the reason just given, should be made of a single thickness. The firings show the necessity of concealing entirely, even from the smallest iron missile, their hinges and fastenings.

“Fourth, A wrought-iron plate of half an inch in thickness is adequate to protect the outer margins and the offsets of embrasures from injury by grape or canister shot.”

These facts established, the effect of the form and dimensions of the embrasures in carrying in the smaller missiles was investigated; the recorded results will enable us to appreciate the force of Montalembert's expression, “murderous funnels,” as even its author could not do.

“Suppose a hundred-gun ship to be placed within good canister range of a casemated battery of about the ship's length and height, to the fifty guns of the ship's broadside there would be opposed about twenty-four guns in two tiers in the battery. The ship would fire each gun once in three minutes, or ten times in half an hour; the fifty guns would therefore make five hundred discharges within that time.

“With one hundred and fifty-six balls in each thirty-two-pound canister (weighing in all thirty-one and a half pounds) there would be thrown seventy-eight thousand balls in thirty minutes. Supposing one-half to miss the fort—which, considering the size of the object, and the short distance, is a large allowance—there would still remain the number of thirty-nine thousand balls to strike a surface of (say) six thousand square feet, that is—

“On each square foot, $6\frac{1}{2}$ balls.

“Or within the exterior opening of one of the embrasures of our second target, of which the area is 8, 9 square feet, there would fall, . . . 58 balls.

“Within the European embrasure above mentioned, having fifty-four square feet of opening,¹ there would be received in half an hour . . . 351 balls.”

¹ Reference is made to the embrasure of an European work built within the last twenty-five years.

And if the ship carried modern eight-inch guns, and fired canister of musket balls, these figures would be in the three cases *fifty-one, four hundred and fifty-three, and two thousand seven hundred and fifty-four*. These theoretical conclusions were verified by the experimental firing with grape and canister, and it is thus seen how greatly superior General Totten's embrasure of 1815, which is but little larger than that of the second target, is to the European one, and how thoroughly he had, at that early day, mastered the subject. He had indeed perfected the embrasure as far as it could be done with masonry alone.

But the quantity of small missiles which even that embrasure would receive is dangerously great, and would be much diminished if the funnel form of the mouth could be done away with, and the throat reduced to an absolute minimum. This could be accomplished only by the use of iron, and the conclusions I have just quoted furnish the data necessary to its successful application.

The throat (still placed two feet back from the outer face of the wall) being formed of iron plates, it became practicable to cut away the flaring surfaces of masonry, so as to present others parallel or perpendicular to the face of the wall, and by this change of form to exclude all missiles not directed within the limits of the throat itself. Still more completely to accomplish the object, wrought-iron shutters of two inches thickness (as determined by the experiments) were applied, by which, except at the moments of aiming and firing, the embrasure was entirely closed.

Such is the history of the casemated battery and casemate embrasure in the United States. We have seen that the perfection to which they have been brought is due to General Totten, and to General Totten alone. Nor is it to the experiments which I have been describing, laborious, skilful, and thorough as they were, that we may solely attribute such results. We must look back to the time when, a First Lieutenant of Engineers, he saw and aided in the construction of our first casemated fort, and when he, fully appreciating its merits and recognizing the defects which a disregard and want of appreciation of the illustrious projector's own principles had entailed upon it, set himself to the task of enhancing the one and correcting the other.

The ten years which have elapsed since 1855 have witnessed

changes in the character of sea-coast and naval artillery, and an increase in the calibres and weight of their projectiles, which no one at that date would have anticipated; hence some doubt may be entertained whether our casemated masonry works are adequate to contend with iron-clad vessels armed with the modern artillery. This is a question which it remains for experiment or experience to decide. It has, as yet, not been demonstrated that a masonry fort, constructed as our more recent works are, will not, armed with the powerful guns now being introduced, endure the contest quite as long as its iron-clad antagonist can protract it.

In this connection it is due to General Totten to say that he has himself been ever the most strenuous advocate of "big guns," the most urgent instigator of their production. The writer well remembers when, seated with him on the piazza of the officers' quarters at Fort Jackson, our eyes resting on the mighty stream flowing past us, upon the defence of which our thoughts and conversation had been turning, he exclaimed, "We must have a twenty-inch gun." The idea was novel to me at that time, and I exhibited some surprise. He went on to say, that, thoroughly to prevent the passage or attempted passage of an armed steamship, there must be not only danger, but almost a certainty of destruction. "Let us have guns such that (to use his own phrase) 'every shot shall be a bird.'" The invention of armored ships, not then foreseen, has increased the necessity of having such guns as he, on other grounds, so strongly advocated. He expressed the greatest confidence that a gun of the dimensions he named would yet be made and introduced into our batteries, and added the interesting statement, that in his earlier days he had found much difficulty in impressing upon the members of boards on which he had served the necessity of having guns in our harbor defences larger than twenty-four pounders. To the labors and genius of a Rodman we owe the actual invention of the art of constructing fifteen and twenty inch guns; but without the unceasing stimulus of General Totten's known and urged views, it is doubtful whether Rodman's labors would have been called for or sustained.

The preceding pages have been mainly devoted to the illustration of our departed associate's career as an officer and as the Chief Engineer of the United States. Before turning our attention to other spheres of his usefulness, it seems fitting to

quote from one of his eulogists the following summary of his official characteristics.

“In wielding the influence of his office as Chief Engineer, the prominent traits exhibited by General Totten were strict justice and scrupulous integrity. No sophistry, no blandishments, no arbitrary exercise of superior authority, could turn him in the least from his steadfast adherence to his own sense of duty. Avoiding all useless collisions with his official superiors, showing due respect to their station, he never failed to call their attention to any errors committed by them with respect to the department under his charge; nor did he ever leave them any excuse for wilful wrong-doing by remaining silent; even when he knew that his suggestions would not only be ill-received and of no use, but might be visited by the exercise of those petty vexations which official superiors can employ against those under them who thwart their misdoings.

“The individual traits of General Totten were strongly marked. Powerfully built, of a constitution of the most vigorous stamp, cool, potent, and persevering, of sound judgment and variety of intellectual capacity, Nature seemed to have endowed him for the profession that he had chosen. His attention to the performance of his professional duties amounted to a devotion.

“Whilst steadily adhering to what had been well settled by experience, and withstanding the ill-directed efforts of that class of men, of whom some are to be found in all bodies, who seize upon every novelty and press it into the service of their own crude notions, he was far from rejecting well-reasoned projects of improvement, and encouraged, as his own immediate works show, every step towards real progress. Although not belonging to the class of mere inventors, he had that invaluable faculty to one holding a position of so great public responsibility, of detecting the fallacies with which this class too frequently deceive themselves as well as others.”

In 1863, under the law uniting into one the two Corps of Engineers and Topographical Engineers, General Totten was advanced to the full grade of Brigadier-General. A few days before his death the Senate unanimously confirmed his nomination by the President to be “Major-General by brevet, for long,

faithful, and eminent services." Never were such distinction and such commendation more fitly bestowed.

Giving the precedence in order to duties most intimately connected with his profession, I now turn to General Totten's important labors in establishing and maintaining our present lighthouse system.

The attention of Congress having been called to the pressing necessity for introducing certain reforms, administrative and executive, into the lighthouse system of the United States, that body, after full discussion of the subject, passed an act (approved March 3, 1851) stipulating that from and after that date, in all new lighthouses and all lighthouses requiring illuminating apparatus, the lens or Fresnel system should be adopted.

Another chapter of the same act provided for the appointment of a commission to be composed of two officers of engineers of the army, and such civil officers of high scientific attainments as might be under the orders or at the disposition of the treasury department and a junior officer of the navy as secretary, whose duty it should be to inquire into the condition of the lighthouse establishment of the United States, and to make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection, and superintendence.

The board, as constituted by the President, consisted of Commander W. B. Shubrick, General J. G. Totten, Colonel James Kearney, Captain S. F. Dupont, U. S. N., Professor A. Dallas Bache, Superintendent U. S. Coast Survey, and Thornton A. Jenkins, U. S. N., as secretary.

Its labors were directed first to demonstrating the evils, irregularities, and abuses which had crept into the lighthouse service under the management of the Fifth Auditor of the Treasury (the late venerable and highly respected Stephen Pleasonton), among which were found to be those arising from defective principles of construction, renovation, and repair of lighthouses, inadequate protection to sites and badly planned and poorly constructed sea-walls. It may readily be understood how the peculiarly practical mind of General Totten, brought to bear upon these and kindred subjects of inquiry, developed and demonstrated the necessity of at once employing proper scientific systems and plans of construction. His assistance in collecting

data was found invaluable, and his lucid, clear mind was equally to be trusted in detecting faults and in devising the remedy.

Without entering into a detailed account of the labors of this Board of Inquiry, it is sufficient to state, that the mass of evidence collected by it was so irresistible in proof of existing errors, that Congress, under date of August 31, 1852, passed an act which created a permanent Lighthouse Board, to which were confided all the duties of the establishment. General Totten was appointed to this board, and served as a valued and honored member, with but a short interruption, until his decease. Its early labors were arduous and onerous. A new system was to be founded where before had been none—order should come from chaos, error was to vanish before science, economy to succeed to wastefulness, darkness to give place to light. The task, great as it was, fell upon no shrinking hearts or feeble brains. The work was accomplished; and long before his lamented death General Totten had the satisfaction of witnessing the labors of himself and his associates crowned with full success. The board in its deliberations derived great benefit from his presence and participation, and relied with entire assurance upon the correctness of his judgment upon all subjects concerning which he would express an opinion. He served almost continuously as chairman of the Committee of Finance, and the decisions of that committee owe not a little of their sound wisdom to the searching scrutiny joined to the generous and liberal views of its chairman. He was also a member of the Committee on Engineering, in which department his peculiar merit was most conspicuous. The principal works with which his name is associated and which claim our attention, are the lighthouses on Seven-Foot Knoll, near Baltimore, Md., and on Minot's Ledge, off Cohasset, Mass.

The former is an iron pile structure standing in some ten feet of water. It was erected at a time when the science of iron pile construction was in its infancy, and was one of the first works of the kind undertaken by the board. Hence it was a matter of deep interest and solicitude. It was successfully completed, and the lighthouse stands to-day a signal reward for the thought and labor bestowed upon its conception and construction.

The lighthouse at Minot's Ledge was a work of far greater difficulty, and to its proper location and plan General Totten

lent the resources of his great experience and exhaustless knowledge. As his intimate acquaintance with the whole coast of the United States, acquired while acting as a member of the Board of Engineers, and during his annual inspections as Chief Engineer, enabled him, with the aid of the Coast Survey, to indicate with almost unerring certainty the proper location and character of all new lighthouses, so his practical knowledge of construction, in laying the foundation of our sea-coast fortifications and the sea-walls by which the sites of many of them had to be protected, prepared him to grapple with the difficulties of constructing a masonry tower in this exposed situation, and to bring to their solution all the known and tried resources of engineering.

Minot's Ledge is situated about twenty miles southeast of Boston. It is the outer rock of a very dangerous group called the "Cohasset Rocks," lying at the very wayside of navigation to the harbor of Boston. A lighthouse of iron had been erected here a few years previous to the organization of the Lighthouse Board, but it was carried away in a fearful storm which swept along the coast of New England on the 16th of April, 1851.

Not only the commercial interests of the country, but humanity demanded that it should be replaced, and Congress promptly made an appropriation for this purpose, stipulating that the tower should be erected on the outer Minot, and confiding its construction to the Topographical Bureau. This bureau, having publicly advertised, received sixteen distinct proposals to erect the proposed structure, but finally recommended, in view of the difficulties to be overcome, and the fearful fate of its predecessor, that it should be located on one of the inner rocks. In accordance with this recommendation, an act of Congress was passed authorizing the Secretary of the Treasury to "select instead of the outer Minot's Ledge, any more suitable site." Before further action had been taken, the whole subject fell into the hands of the newly created Lighthouse Board. A joint resolution of Congress was then passed (1854) giving to this board the decision as to the location and the mode of construction.

The question of location being thus widely reopened, a committee of the board was sent to make a personal examination of the locality. General Totten was, of course, a member of this committee, and was not long in making up his mind that

the outer and not the inner Minot was the proper site. His arguments on this subject proved conclusive with the board. He urged that if the light were placed on any of the inner rocks the desired object would be but partially accomplished, since in a dense fog or thick snow-storm vessels might approach within a few hundred feet, without being able to see it, and thus be lost upon the outer ledge.

When the question of practicability was broached, his professional pride seemed to be roused. He argued that, after what had been done on the coast of England in the erection of the Eddystone lighthouse a century ago, and more recently of the Bell-rock and Skerryvore lights, it would be a humiliating admission that the requisite science and skill were not to be found in this country to erect a similar structure where, as all admitted, one was so much needed.

He carefully studied the accounts of the construction of the Eddystone, Bell-rock, and Skerryvore lighthouses, by Smeaton, Robert Stevenson, and Allan Stevenson, but the fact that the Eddystone was begun at high-water mark, that the ledge of the Bell-rock was extensive and elevated several feet above low-water, and that the Skerryvore presented still less difficulties, while the surveys show that the outer Minot's ledge was very contracted and that the proposed structure must commence even below low-water, did not deter him from advocating and designing a work for this formidable position, more difficult to accomplish than anything which had ever preceded it.

The plans which he prepared were drawn with his usual minuteness of detail. The problem was one peculiarly fascinating to engineers—the uniting into a single mass the several component stones of the structure so that no one can be detached from the rest, that each shall be a bond of connection to those adjacent, that the whole shall be an integral, having a strength ample to defy the most powerful foe to human structure, the fury of the ocean's winds and waves. Though not himself the constructor of the work, yet to have insisted against authoritative adverse opinion on its practicability, to have planned the building and selected the engineer who should rear it, and to have overlooked the work from its commencement to its completion, entitles him, even were this his only work, to recognition among

the Smeatons and Stevensons and Brunels, as one of the great engineers of the age.

For the execution, he selected Captain (now Brevet Brigadier-General) Barton S. Alexander, of the Corps of Engineers, an officer whose experience, energy, boldness, and self-reliance eminently fitted him for the task. It is for him to recount the history of the work, to give to the world the interesting narrative of difficulties met and overcome, of patience requited and energy triumphant. General Totten watched its progress with unflagging interest, making frequent visits to the superintending engineer, aiding him with his counsels and encouraging him in his difficulties. He lived to enjoy the proud satisfaction of inspecting the finished structure; and when at last from its towering summit flashed o'er the troubled waters the beacon-light of safety to the tempest-tossed mariner, he might well exclaim, with the Latin poet, though in a nobler sense and in a less boastful spirit: "Exegi monumentum ære perennius."

General (then Colonel) Totten was named in the act of Congress organizing the Smithsonian Institution in 1846 as one of the Regents to whom the business transactions of that celebrated establishment are intrusted. At an early meeting of the Board of Regents he was appointed one of the Executive Committee, and was continued in these offices by repeated election to the time of his death, a period of nearly eighteen years. He evinced a lively interest in the organization of the institution, and after a careful study of the will and character of Smithson, gave his preference to the programme prepared by Professor Henry, which was finally adopted. His advocacy of the plan was the more important since he was well acquainted with the scientific character of James Smithson, and had himself, as we shall see in a subsequent statement, been engaged in a line of research similar to one of those pursued by the founder of this institution.

In the reconstruction of the interior of the main part of the Smithsonian building which had partly been completed in wood, but which had given way, he strongly urged the employment of fire-proof material, to the adoption of which the preservation of the valuable collections of the institution is indebted. In the discharge of his duty as one of the Executive Committee, he acted with the same conscientious regard to the sacredness of the trust which characterized all his official labors, and critically examined

all the accounts, assured himself as to the proper expenditure of the fund, and advised as to the general policy to be pursued. In him the Secretary ever found a firm supporter, a sympathetic friend, and a judicious adviser. Unostentatious, unselfish, and only desiring to advance whatever cause he might be connected with, he gave the most valuable suggestions as if they were of little moment, and in such a way that they might appear to be deductions from what others had said or done, being more anxious that his suggestions should be properly carried out than that they should be accredited to himself.

As a recreation from the more arduous studies of his profession, he devoted in the early part of his life his spare hours to Natural History, paying much attention to the Mollusca of the Northern coast of the United States; and he was perhaps the first, or at least one of the first to introduce into this country the use of the dredge for the search of these animals, thus not only obtaining many species which would otherwise have escaped attention, and getting fresh and un mutilated specimens of species previously known only from dead imperfect shells, but enabling us to learn something of the habits and associations of the animals—information of much greater scientific value than the discovery of a few new species. His observations and studies in conchology were embodied in an article entitled "Descriptions of some Shells belonging to the Coast of New England," published in the American Journal of Science and Arts for 1834 and 1835, and Dr. A. A. Gould was largely indebted to him for material employed in his "Invertebrata of Massachusetts," many of the species of shells contained in which were first found to inhabit our coast by General Totten; others were new species discovered by him, though described by Dr. Gould, while some nine or ten specimens were not only discovered but described by him. The descriptions of species and remarks evince his powers of observation and critical acumen, and almost all of the forms described have stood the test of subsequent examination, and the validity of their specific distinction been confirmed; although several of them are among the most common shells of the coast, on account of their small size, they had been previously overlooked or neglected, but their insignificance in size did not diminish their interest in the eyes of one who viewed nature in all her manifestations as worthy of contemplation. One of the

most beautiful and almost the smallest of the bivalves of our coast, called by him *Venus gemma*, has since been dedicated to him under the name of *Gemma Tottenii* by Mr. William Stimpson.

General Totten collected principally on the shores of New England, and his explorations with the dredge were almost entirely made in the vicinity of Newport, R. I., and of Provincetown, Mass. A list of the shells of Massachusetts was contributed by him to one of the preliminary reports on the Natural History of that State. The principal species described by him are as follows: *Madiola glandula* (now known as *Mytilus decussatus*), *Venus gemma* (*Gemma Tottenii*), *Solemya borealis*, *Bulla oryza*, *Natica immaculata*, *Turbo minutus* (*Kissoa minuta*), *Turritella interrupta* (*Chemnitzia interrupta*), *Acteon trifidus* (*Chemnitzia trifida*), and *Pasithea nigra*. This last-named species he described from young shells, and afterwards finding the adult shell, which is very different, called it *Cerithium reticulatum*. It has for many years been called *Cerithium Sayi*, but a late author has again credited it to him, under the name of *Brittium nigrum*.

A species of *Succinea* (*S. Totteniana*) was dedicated to General Totten by Mr. Isaac Lea, of Philadelphia.

Conchologists are also indebted to General Totten for the discovery of means for the preservation of the epidermis or periostraca of shells, which is in many species so liable to crack, and this recipe has been received with much approbation by many collectors who have found it to supply a want much felt. The valuable collection of rare shells which he made at this period of his life he presented to the Smithsonian Institution, without the usual condition that it should be preserved separately, but to be used most advantageously for the advancement of science to complete the general collection of the Museum, or for distribution as duplicates to other establishments.

In the "Annals of the Lyceum of Natural History of New York" for 1824 (vol. i. pp. 109-114) he published "Notes on some new Supports for Minerals, subjected to the Action of the Common Blowpipe." These researches on the use and power of the blowpipe appear to have been incited by an article of James Smithson, the subsequent founder of the Smithsonian Institution, and the memoir of Totten commences with a reference to and rehearsal of the experiments of that gentleman, as

detailed in a letter to the editor of the *Annals of Philosophy*. Smithson, it was remarked, had communicated several ingenious modifications of Saussure's process with supports of splinters of sapphire, which process, he observes, "has been scarcely at all employed; owing partly to the excessive difficulty, in general, of making the particles adhere, and in consequence of the almost unpossessed degree of patience required and of the time consumed by nearly interminable failures." Detailing the processes of Mr. Smithson, three in number, and the success of that gentleman, he adopted a modification of Smithson's third process, having recourse, as a support, to a portion of the mineral itself, which he designed to expose to the action of the flame. "Instead, however, of taking upon the point of platinum wire a very minute portion of the paste made of the powdered mineral," according to Mr. Smithson's method, he "formed a paste by mixing the powder with very thick gum-water and rubbing a little of it under the finger, formed a very acute cone, sometimes nearly an inch in length, and generally about a twentieth of an inch in diameter at the base." To the apex of such cones, the most minute particles would adhere under the strongest blast of the blowpipe, and being insulated by the destruction of continuity of the particles of the cone, the flame could be directed upon it with undiminished fervor. Experiments were made on a number of minerals, confirming those of Mr. Smithson, and greatly extending the power of the blowpipe, and he was thus led to add to the three classes divided in relation to this instrument a fourth, namely, "such as are fusible, *per se*, in microscopical particles."

The attention of the inhabitants near the shores of the great lakes of the North had often been arrested by the sudden disappearance in the spring of the ice on the surface. The lakes would be covered with a continuous sheet of solid ice in the evening, and in the next morning all would have vanished. Wild speculations had been entertained as to the explanation of this phenomenon previous to the investigation of the subject by General Totten, who presented an article on the subject to the American Association for the Advancement of Science at the Springfield meeting in 1859.

From this it appears that his attention had been directed to it forty years before at Plattsburg, N. Y. Ice is composed of a

congeries of prismatic crystals, whose axes are at right angles to the surface of the mass. "Examinations then and afterwards made of floating fresh-water ice have shown that the natural effect of the advancing year is gradually to transform ice, solid and apparently homogeneous, into an aggregation of these irregular prismatic crystals, standing in vertical juxtaposition, having few surfaces of contact, but touching rather at points and on edges, and kept in place at last merely by want of room to fall asunder. Until this change has somewhat advanced, the cohesive strength of ice of considerable thickness is still adequate to sustain the weight and shock of the travel it had borne during the winter, but becoming less and less coherent by the growing isolation of the prisms, or more and more 'rotten' as the phrase is, though retaining all its thickness, the ice will at last scarcely support a small weight, though bearing upon a large surface; the foot of man easily breaking through, and very slight resistance being made to the point of a cone." The points of contact of the particles being destroyed, each will drop into the position in the water below required by the place of its own centre of gravity—that is to say, it will be upon its side, exposing large surfaces to the action of the warm water. With the ice in such condition, a heavy wind will cause the disruption of the particles and the speedy disappearance would be the consequence. This remark of General Totten as to the crystallization of ice has since been extended to nearly all substances, which in becoming solid assume the crystallized form. The axes of the crystals tend to assume a position at right angles to the surface of cooling.

As illustrative of the mind of General Totten, it may be stated, that he seldom failed to give valuable hints for the improvement of processes or inventions which were brought before him in the course of the discharge of his numerous official duties. Among these was an instrument for ascertaining the daily amount of evaporation from a given surface by means of the descent of water contained in an inverted graduated tube, the open end of which was immersed in the basin from which the evaporation took place. With a slight correction for variation in barometrical pressure, this instrument gives, with more precision than any other with which we are acquainted, the amount of evaporation.

I have, Gentlemen, thus faintly and inadequately sketched the life and services of our departed friend and associate; but, faint and inadequate as my sketch may be, I feel confident that every one will recognize in it the lineaments of a great and true man. Labors so protracted, results so important and varied, it is the destiny of but few to achieve, and for him who achieves them may justly be claimed a high niche in the temple of Fame, and the grateful homage of the patriot and of the seeker after Truth. One of the oldest of the incorporators of this Academy, it was permitted him only to contribute his past labors and his shining example. But these are indeed a rich legacy. Proud, indeed, may this youthful institution be that it can enroll among its members the name of Joseph Gilbert Totten—proud too, may each one whom I now address—each one of its members—be, if he shall achieve but a far less claim to recognition among men of science. To the aged among us—to those who were young with him, and like him have crowned a life of toil by honorable achievements—I need not speak. *They* require no example, and they may feel in contemplating his history an additional assurance that their own works too “shall praise them.” To the more youthful or to the middle aged, who have just commenced, or but partially accomplished, the steep ascent which leads to honorable fame, his life is precious in its teachings.

He was a patriot in the broadest and best sense of the term. To his country he had given himself, and every faculty of his being was devoted to her honor and welfare—realizing almost literally the thought of Rousseau, “the child on entering life ought to see his country, and to the hour of his death to see but her.”

Like all who have left lasting results for the benefit of their country or of mankind, he was a hard worker. But ill-regulated labor, however arduous, could never have accomplished what he accomplished. Beyond all men I ever knew, he was *systematic*; and few indeed are the examples of a life, in *all* things, so perfectly regulated. The beautiful *order* which pervaded all that he did is scarcely less worthy of study and admiration than the achievements to which it so materially contributed.

He was no trifler with the realities of life, who dallied with them for his pleasure or who wielded them as instruments of ambition or self-interest. To him, as to all true men, the mean-

ing of life was concentrated in one single word, DUTY. This "chief end of man," which is to glorify God by obedience to his laws in the use of the faculties he has bestowed, was his ruling principle—the celestial cynosure to which his eye was ever directed, and from which no allurements of lower motives could divert it. Nor was his sense of duty of that frigid, repulsive nature which reduces the conduct of life to a formula, and, substituting rules for emotions, seems but a refined selfishness. He was warm and sympathetic, finding his chief happiness in the pleasures of domestic and social intercourse, but singularly susceptible to everything that ministers to innocent enjoyment.

Perhaps no more striking illustration than his history affords could be found of the truth that the path of duty is the path of happiness. His life was eminently a happy one, and his, indeed, was that "peace of mind which passeth understanding." Though devoted from his youth to the military service of his country, and doomed to the vicissitudes of a soldier's lot, he was permitted to a greater degree than most men to enjoy the blessings of the domestic circle. There, indeed, he sat enthroned, the idol of a family of whose supreme affection and immeasurable devotion he was the object. Nor dare we call those blows by which a Heavenly Father reminds us that this world is not our "abiding place," and teaches us to look beyond to "an house not made with hands, eternal in the heavens," as sources of unhappiness to him who receives them as from the hand of One "who chasteneth whom he loveth." One by one he lived to see all his three sons, two of his four daughters, and finally the companion of the joys and sorrows of so many years, precede him to the grave.

Beautiful beyond all else that earth presents is that conjugal companionship, so touchingly depicted by Burns, which, beginning in youth, is permitted to continue unbroken till the Psalmist's period of life is overpassed. During the later years of their lives, Mrs. Totten, no longer bound to the domestic hearth by the cares of a growing family, became truly an inseparable companion. Never, when it was at all practicable to have her with him, did he ride or walk, or make a journey, or perform one of his periodical tours of inspection, without her companionship; nor could one see them together without feeling that they presented a model of whatever is amiable and lovely in the conjugal

state. If he was to her the embodiment of all that is most worthy of respect and love in man, not less marked was his deference to her. In her own sphere—as woman, wife, mother—she was supreme, and her judgment his law. When, but two years before his own death, she was somewhat suddenly called away, it seemed as if he regarded it as a message from on high, “set thy house in order, for thou shalt die and not live.” No murmur escaped his lips, and no long-continued sadness clouded his brow, but there was an unwonted gentleness and quietude in his demeanor—a softening as it were of his nature—which revealed how deeply “the iron had entered his soul.” His health and bodily strength seemed to continue little impaired, and his devotion to the duties of his office undiminished. But once, during a life protracted beyond the usual span, had that powerful frame submitted to the sway of sickness, and he seemed to have unusual promise of a still further protracted life. But such promises proved deceitful. Early in March, 1864, he was attacked with pneumonia. His illness was not at first deemed alarming, and, indeed, at one time he was supposed to be convalescent, but a relapse ensued, and on the 22d of April he expired, having borne the sufferings of his sickness with cheerfulness and resignation, and retained to the last the perfect use of all his mental faculties. He had long been a member and communicant of the Episcopal Church, and died in the Christian’s hope of a joyful resurrection.

Gentle, kind, and good; mild, modest, and tolerant; wise, sagacious, shrewd, and learned, yet simple and unpretending as a child—he died as he had lived, surrounded by hearts gushing with affection, and the object of the respect and love of all with whom he had ever been associated.

The greatest of sculptors, the greatest of painters, a man unsurpassed in boldness and originality of thought, and whose name is among those of the few whose genius overpasses the limits of country and claims homage from all mankind—Michael Angelo—in a work stamped with the maturity of his powers, carved a figure known to the world as “*Il Pensiero*,” or *Thought*. There exists in art no other personification of meditation—no other type of self-collectedness and profound thought.

The sculptor arrayed it not as a philosopher, as a monk, as

an artist, as a theologian, as a scholar, nor even as a pope. And yet these different types of thinkers were not wanting in the past or present of the age and country of a Raphael, of a Correggio, of a Leonardo da Vinci, of a Dante, of a Savonarola, of a Marco Polo, of a Columbus, of a Machiavelli, of a Galileo, of a St. Francis de Assis, of a St. Thomas Aquinas, of a Julius II., of a Leo X., and of a Clement VII.

How, then, has Michael Angelo arrayed his personified "Thought"? In the garb of a SOLDIER, upon the breast the cuirass, upon the brow, wrapt in meditation, the iron casque of the man of war. The great sculptor has divined the mysterious cause why, among all people, among all classes, and in all epochs, the soldier is honored. Instinct teaches the people, and genius taught Michael Angelo, that among so many glorious examples, among so many immortal victims, so many illustrious martyrs or devotees of thought, illustrating an age or a country, the soldier stands forth pre-eminently, in all ages and in all countries, the victim always ready, the defender always armed, the servant, the apostle, and the martyr.

It is the Christian version of the ancient allegory which made Minerva issue from the brain of Jupiter: Minerva, or *wisdom armed*, the helmet upon her brow, the sword in her hand.

Will the foregoing paragraphs, which I have translated somewhat freely from the "Soldat" of Joachim Ambert, a work devoted to the illustration of the Soldier's career, be deemed an immodest or extravagant glorification of the profession of arms? Far be it from me to exalt unduly that profession, but I would at least make a claim for it, the more necessary since popular apprehension tends to lose sight of the thinker in the man of force and of blood, that, more than any other, it embraces all sciences and all branches of human knowledge, and leads its followers into vast and diverse fields of thought. Let the illustrious dead be our witnesses; that idea which the genius of a Michael Angelo inspired and embodied in marble, that idea which the lives of a Cæsar, a Frederic, a Washington, a Napoleon, and a Wellington have justified; the union of FORCE and THOUGHT finds yet another and a varied illustration in the accomplished soldier and profound thinker whose life and works we now commemorate.

APPENDIX.

RESOLUTIONS OF THE LIGHTHOUSE BOARD.

Resolved, That the members of the Lighthouse Board feel most deeply the loss sustained by the branch of the public service under their charge in the death of Brevet Major-General Joseph Gilbert Totten, who has been one of the most useful and active members of the Board from its first appointment in pursuance of law in 1851, under the Secretary of the Treasury, as a temporary Board of Inquiry into the Lighthouse Establishment of the United States, through all the years of organization of the establishment and of its executive duties.

Resolved, That the high scientific attainments, the admirable administrative qualities, the perfect knowledge of general principles, and attention to every minute detail of the system, impressed the mental and moral qualities of General Totten upon his associates in a way to make his mind eminently a leading one of the Board, while his suavity, patience, perfect amiability, and retiring modesty rendered him one of the most charming of associates in executing work to which he was so much more than sufficient.

Resolved, That in the discharge of the duties of inquiry of the first Board, the resulting organization, the adoption of the present system of lighting by lenses, the subject of construction, theoretical and practical, and the use of materials, the experience and experimental knowledge of General Totten were of the highest value to the Board, and his careful application of the sciences was of the greatest importance to the Lighthouse System; and that in the large qualities of common sense in all the transactions of the Board, general as well as technical, and in his high sense of justice directing great mental power, the Board constantly felt the support of General Totten as one to be relied upon for guidance in all difficult questions of administration.

Resolved, That the affectionate qualities of General Totten's heart so endeared him to his colleagues, that in now expressing themselves in regard to his death, they are fully prepared to

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share to the utmost the deep grief of his family, to whom they offer their sincere condolence for the loss of one not to be replaced, but to be ever mourned as the true, devoted, and sincere friend.

Resolved, That a copy of these resolutions be transmitted to the family of General Totten, and to the Honorable Secretary of War, and to the Honorable Secretary of the Treasury.

Resolved, That these proceedings be published in the Washington newspapers.