

down on the wood without any play, or getting at all loose. He concluded this lecture by stating that, in the next, he would endeavor to draw a comparison between the modern heavy rail, and chair and fastenings, as used with cross timbers laid at intervals, and the rail and fastening, as above described, to be laid on longitudinal timbers, and having a continuous bearing thereon.

(To be continued.)

*Major General Pasley on the recent great Mining Operations near Dover.*

[The following letter on this interesting subject appeared from Major General Pasley, Inspector General of Railways, in the Times of Monday.]

SIR—Having had frequent questions put to me in conversation respecting the great explosions near Dover, by which Round-down Cliff, an immense projecting mass of chalk in the proposed line of the South-Eastern Railway, was thrown down, I request your insertion of the following statement, in order to correct several inaccuracies in my own letter to you of the 23d of January last, which I wrote in haste, that it might appear in time to remove the impression which I found generally prevailed, that the whole operation was under my direction, but which I considered only a vague report, until I saw it quoted from an article in a paper, which quotation did not come to my knowledge until three days before the time appointed for the firing of those great mines.

To Mr. W. Cubitt, the engineer in chief of the South-Eastern railway, is justly due the merit of having conceived the idea of removing a mass of chalk rock, nearly 300 feet in length, but of still greater height, and averaging 70 feet in thickness, by simultaneous explosions of gunpowder, instead of employing laborers to scarp it away, which would probably have cost £8,000; and the merit of success also belongs to him, inasmuch as he took the most judicious measures to insure it; but, as he informed me that he never would have contradicted the reports which ascribed the entire superintendence of that great operation to me, and as he is not likely to publish anything on the subject, I am desirous not only of correcting the inaccuracies in my first letter to you, but also of supplying the omissions in the printed accounts, by noticing the useful labors of those who contributed to his success, which I have always made a point of doing, in every similar operation that has taken place under my own direction, and which I am sure that Mr. Cubitt would do if he wrote himself, as I know from the able resident and assistant engineers of the same railway, that, instead of assuming the whole merit of the works in which they have been employed under him, he has always been ready to acknowledge their services in the most liberal manner, both officially to the directors of the company, and personally in conversation, as I have witnessed myself.

The general impression that the mines near Dover were to be su-

perintended by me, no doubt arose from its being known that Mr. Cubitt always intended to consult me, and that he would not, and did not, decide upon his plan of operation until after he had taken my opinion; and it was also known that he relied entirely upon my assistance for firing his mines simultaneously by the voltaic battery, of the use of which, as applied to mining, neither he nor his assistants had had any practical experience. Accordingly I went to Dover by his request, and introduced Lieutenant Hutchinson, of the Royal Engineers, who had been employed two summers under me in the operations against the wreck of the Royal George, and who happened, fortunately, to be on duty at that place at the time; so that I recommended him as the most proper person to superintend the firing of the proposed mines by the voltaic battery, provided that the permission of the Master-General of the Ordnance could be obtained to enable him to undertake this service, which was readily granted, on application being made to Sir George Murray by the railway company. Accompanied by this officer, I examined the drawings of Round-down Cliff, that had been prepared under the superintendence of Mr. John Wright, the resident engineer of this portion of the railway, to whom Mr. Cubitt referred me on the 10th of November last, and went with him into a drift, or small gallery, cut entirely through the cliff, and about 248 feet in length, which had originally been intended for the commencement of a tunnel through which the railway was to pass; a design that was abandoned afterwards on discovering that this part of the cliff was likely to give way sooner or later, and the plan of removing it by gunpowder was adopted in consequence. Shafts about 17 feet deep had been sunk from this gallery, and branches driven from the bottom of them further into the chalk, in order to obtain greater lines of least resistance, on the level of what would have been the bottom of the proposed tunnel, and agreeing with the position of the rails. Mr. Cubitt had previously told me, *that his rule for estimating the quantity of gunpowder for explosions in chalk was, to use half an ounce for each foot of the cubed line of least resistance.* As he talked of having charges of from 5000 to 6000 or 7000 lbs., I could not but be surprised at this unusual mode of estimating such very large charges by halves of ounces; but, on going to the spot, Mr. Wright explained the mystery by informing me that he had, by Mr. Cubitt's direction, fired four experimental mines in the course of the year, in which, having had no previous personal experience, he adopted the rule laid down by Major General Sir John Burgoyne, formerly of the Royal Engineers, and now President of the Board of Public Works in Ireland, for blasting in hard rock, which, as the line of least resistance in rock seldom exceeds a few feet, it was more convenient to determine in parts of an ounce than in pounds; and he also adopted Sir John Burgoyne's recommendation in his printed paper on blasting, by firing those mines with Bickford's fuses, which is an excellent expedient for blasts in rock, and inferior only to the voltaic battery, but such as I never would have used for mining. For example, Mr. Wright's first experimental mine, fired on the 5th of March, 1842, had a line of least resistance of 25 feet, was loaded with

500 lbs. of powder, had a tamping of 50 feet, and was fired with 100 feet of Bickford's fuses, in two lengths. His three other mines, the largest of which had a charge of 1100 lbs., were each fired by 50 feet of Bickford's fuse. It is difficult to conceive anything more tantalising than these arrangements must have been, for I calculated that 100 feet of Bickford's fuse would burn nearly an hour, and that 50 feet of the same would burn nearly half an hour, before the explosion took place. Nothing can be more teasing than such suspense. Our practice in the Royal Engineers, before we began to use the voltaic battery, was very different, as we never allowed a greater interval between the lighting of the portfire, or fuse, and the ignition of the charge, than from one to two minutes, being just enough to allow time for the officer, or non-commissioned officer, who fired the mine, to retire to a distance sufficient for his personal safety. In all his experimental mines, which were fired singly, and independent of each other, Mr. Wright found that the rule deduced by Sir John Burgoyne with great care and skill from numerous experiments tried by his direction, in order to ascertain the proper charges for blasts in hard rocks, which had heretofore been left to the discretion of the miners, or quarrymen, and which, in practice, seldom exceed a few ounces, were equally appropriate for mining in solid chalk; in which the charges, calculated according to the above rule, produced moderate demolition, without throwing the fragments to a distance—an object always desirable, except in military mines, having not merely demolition, but destruction, in view.

After having had this matter explained, I again inspected the plans and sections of Round-down Cliff, and, considering the length of the gallery and the proposed lines of least resistance, two of which were to be about 56 feet, I was of opinion, from my own repeated experience in conjunct mines, which had not as yet been attempted by the engineers of the South-Eastern railway, that two mines only, with charges calculated to effect moderate demolition, could not possibly throw down the whole of the cliff. I therefore approved of three charges, to be placed at equal distances from each other, but the two extreme charges to be nearer to the ends of the gallery than to the intermediate charge in the centre of it; and as I thought that Sir John Burgoyne's formula must be calculated rather for very moderate, than for moderate, demolition, I was of opinion that the distances between the three charges should be somewhat less than two-lined intervals, which our own experiments on conjunct mines had established as the most proper for moderate demolition. In case of using three charges, Mr. Wright informed me that, whilst the line of least resistance of each of the two extreme mines would be 56 feet, that of an intermediate mine between these two would be about 62 feet, which lines required two charges of about 5,500 lbs., and one of 7,500 lbs., if calculated according to the above formula, without reference to their distances apart. This last point had not yet come under the consideration of the engineers of the South-Eastern Railway, who had only fired single and independent mines, as was before observed.

On giving my opinion first to Mr. Wright, and to Mr. Hodges, his

assistant, and afterwards to Mr. Cubitt, the latter objected, and, as I admitted, on good grounds, to the extreme mines being moved nearer to the ends of the gallery, although this arrangement had been adopted by me with perfect success in all my conjunct mines, because he apprehended that this would cause the fragments from those two mines to be thrown out laterally on each side of the Round-down Cliff, in the direction of the gallery, prolonged so as to obstruct the proposed line of railway, more than if the whole were projected forward towards the sea. At the time when this conference took place, I did not know how many mines were prepared, as I had only gone down one shaft, and into one chamber, to examine, but did not walk through the whole of the gallery, so that the impression upon my mind was that three chambers were then in readiness for the explosion, which was confirmed by my afterwards hearing that three charges corresponding with the lines of resistance then mentioned to me, had actually been adopted; and, therefore, when I wrote to you on the 23d of January, it was natural for me to believe, not only that every arrangement had then been previously fixed by Mr. Cubitt, subject to my approval, but that all the three chambers were actually ready for receiving the gunpowder, and only waited for the voltaic apparatus, which had all to be made, as I recommended, in preference to borrowing.

I have since been informed by Lieutenant Hutchinson, that I was so far mistaken, that only two chambers were prepared at that time, so that the third shaft, with the branch and chamber leading from it, were excavated subsequently to my visit to Dover; and also that the position of one of the first two chambers was altered after the same period. Eventually the three chambers were placed at only 70 feet apart, thus dividing the length of the gallery into four equal parts; but the line of least resistance of the central chamber, on placing them all in the same allinement, proved to be 72 feet, which would have required a charge of nearly 11,700 lbs., according to Sir J. Burgoyne's formula; and yet the original quantity of powder calculated for 62 feet was not altered. These arrangements were thus definitively made, not before, but after, my visit to Dover, at the suggestion of Lieut. Hutchinson, after he (by permission of Sir G. Murray) had been placed in charge of the proposed mines; and were very judicious, because the chambers, being only 70 feet apart, were at much less than two lined intervals, even in reference to the shortest of the lines of least resistance (56 feet) above mentioned; and, in this case, if the central charge had been estimated according to the same formula as the others, violent demolition would have been produced, which was not desirable. In short, the same rule invariably adopted by us in the royal engineer department, in respect to conjunct mines, was here followed—namely, to diminish the regular charges, which are known to be capable of effecting moderate demolition, whenever they are placed at much less than two-lined intervals apart. Though this term is very generally understood, yet, perhaps, it may not be superfluous here to explain, that, in speaking of conjunct mines, the term "two-lined intervals" implies that the central distance between

adjacent charges is twice the line of least resistance of each, the latter being the distance from the charge to the nearest surface of the rock, or mass, that is to be removed by the explosion.

The whole of the arrangements for firing these great charges by the voltaic battery, were made by Lieutenant Hutchinson, assisted by Lance Corporal John Rae and private Thomas Smith, of the Royal Sappers and Miners, and by two naval pensioners, John Leary, a blacksmith, capable also of working in tin or copper, and William Gordon, a rigger; all of whom had been employed under the same officer at Spithead, and who, in their several capacities, understood thoroughly every thing relating to the preparation of charges, and to the mode of firing them by the voltaic battery. Leary, who is an excellent workman, and who distinguished himself, some years ago, whilst under the command of Captain Dickenson of the Royal Navy, by converting ships' tanks into a diving-bell, by means of which that enterprising and intelligent officer recovered the treasure sunk in the Thetis frigate on the coast of Brazil, was employed, on his arrival at Dover, in making voltaic batteries for the proposed explosions, nine in number, each consisting of six cells of Professor Daniell's constant battery, such as had been used by me in all my mining operations; and he also put together the wires for three conducting apparatus, each 1000 feet in length, and, consequently, composed of 3000 feet of copper wire. Each apparatus consisted of a pair of wires attached to a strong rope, and secured and insulated by Pensioner Gordon in the same substantial manner that had been adopted by us at Spithead; for, though there was little necessity for guarding against the action of water, yet the letting it down and dragging it up the high chalk cliffs, exposed this apparatus to a good deal of wear and tear; and it might also have been injured by the hob-nailed shoes of railway laborers, to which it was continually exposed, as I observed particularly on the day it was used, when every person that came near it trod upon it, and which, had it not been thus protected, might have destroyed the connexion, and prevented the explosion, of which I have known instances in the course of our former experiments. As soon as the batteries and conducting apparatus were complete, Lt. Hutchinson tried experiments to ascertain whether he could fire all the three charges simultaneously by one powerful battery, *as had been done by Dr. Hare, of Philadelphia, who first applied voltaic electricity to practical purposes, by using it for blasts in rocks, to obtain stone for building, in 1831; as minutely described in Silliman's American Journal of Science, vol. xxvi, page 352, and also briefly noticed in the transactions of the British Association for the Advancement of Science, held in Bristol in 1836.* From his own experiments, tried with this object, Lieut. Hutchinson drew the same inference that I had done about three years before—namely, that one cannot depend upon more than two charges exploding simultaneously, for though, by a battery of extraordinary power, he succeeded in firing twelve small experimental charges at the distance proposed for the great mines under his direction, yet there was a perceptible interval of time between the reports, which resembled a volley of musketry rather

than the discharge of a single gun. He therefore determined to adopt the plan I had proposed to use in 1839, had it proved advisable to fire four subaqueous charges simultaneously against the *Royal George*—namely, to have a separate voltaic battery for every charge, and a person at each, with one conducting wire fixed to a pole of the battery, and the other in his hand ready to complete the circuit, according to the time marked by the chief, who was to give the words—*one—two—three*—with an interval of about one second between each, and then the word *fire*, which was to be the signal for completing the circuit; and by this mode I expected that the explosions would all take place simultaneously, on the principle of marking time in music. The powder in each of the three chambers prepared for the several mines at Dover, was contained in bags, placed in a large box, the former expedient having first been adopted in the practice of the Royal Engineers at Chatham; but we never used box and bags also, which I considered superfluous. As these boxes formed what may be called double cubes, Lieutenant Hutchinson very judiciously had a couple of short branches forking out from the lower extremity of each conducting apparatus, into two central points of the oblong charge. Very short and fine pieces of platina were placed, according to custom, near the closed ends of strong tin tubes fixed to the outside, and leading into the centre, of the powder boxes, in which tubes bursting charges of fine powder were introduced, surrounding the platina wires, on the same principle that had been used at Spithead, but without those extreme precautions that had been found necessary to resist the great pressure of water to which our charges there were subject.

In the course of Lieut. Hutchinson's experiments, an unforeseen difficulty occurred, owing to Daniell's batteries, which had been very promising, losing their power after the first frosts set in. This difficulty had never embarrassed us before, because, in our experiments at Chatham, we always took the battery out of a warm room, and it required a longer time to impair its power than our experiments there ever occupied; and at Spithead, where Lieut. Hutchinson first used the battery, it was generally kept in the cabin of one of our lighters; besides which, the work was only carried on during the summer months. He was therefore obliged to have a small wooden shed built for his batteries at Dover, and to keep fires lighted whilst using them, by which means he got rid of the difficulty.

I have since been informed that, in experiments tried at Calcutta, a very energetic battery lost half its power when the temperature fell from 120 to 60 degrees of Fahrenheit. When this difficulty occurred, a prejudice was naturally excited against Daniell's battery, and four very powerful plate batteries were ordered at Dover in consequence, which were made by an intelligent tradesman of that town. The trough of each of these contained 20 cells, according to Dr. Wollaston's construction, with zinc and copper plates, measuring 7 by 10 inches, the latter of which were only let down into the trough when the battery was about to be used; and these plate batteries were combined with the batteries made by Pensioner Leary as before men-

tioned, so that one very powerful battery, consisting of 40 plates of the common system, and of 18 cells of Daniell's constant battery, was to be used for each of the three charges. But here I must remark upon a great inaccuracy in my letter to you of the 23d of January last, in which I stated that the length of conducting wires about to be used at Dover was far greater than had ever been used by me either at Chatham, or at Spithead, instead of which the contrary was the fact; for, on referring back to the journal of our experiments at Chatham, I find that we fired an experimental charge on the 7th of July, 1839, at the distance of 1,950 feet, by 14 cells only of Daniell's constant battery, as recorded in the *United Service Magazine* for January, 1840; being more than twice the distance at which the great mines at Dover were afterwards fired by batteries of three times that magnitude, and at a temperature which could not have been less than that of our experiment. I said twice the distance, because the conducting apparatus for the charges at Round-down Cliff, originally each 1000 feet long, were afterwards reduced to less than 900, their former length being unnecessarily great. I thought it right to rectify this error, lest a prejudice should be excited against Daniell's constant battery by its supposed inferiority, which led to the employment of plate batteries at Dover, in addition to those of his pattern, which were first made. At the same time, I am now of opinion that the plate battery is the most convenient of the two for firing gunpowder; and the simplest that I have seen is that which is now being used by Mr. R. Davidson, of Aberdeen, in his interesting exhibition of electromagnetic power at the Egyptian Hall, Piccadilly, which I visited lately in company with Dr. Faraday and Mr. Brand. This battery, which contains 20 cells, differs from Dr. Wollaston's in using amalgamated zinc, and in substituting plates of iron instead of copper, all the plates measuring 8 by 11 inches, and the action being produced by diluted sulphuric acid, upon the purity of which, Mr. Davidson says, the efficiency of his battery chiefly depends. On inquiring who first adopted iron plates instead of copper, Mr. Davidson assured me that he had used the former metal himself for about twenty years, but that the merit of this arrangement was disputed by Mr. Sturgeon and Mr. J. Martyn Roberts, with whom he himself had not thought proper to contest it. Dr. Faraday observed, that articles published in any public or scientific journal afforded the only genuine grounds for deciding upon priority of inventions; for the same idea might occur to several persons, and the individual who worked in private must give way to those who published. On this plea, I advise those who ascribe the merit of applying the voltaic battery to the purposes of blasting in earth, or rock, or the peculiar construction and management of the first plate battery, well calculated for this purpose, to any of our own countrymen, to refer to the documents before quoted, and they will find that they are doing an injustice to Dr. Hare, of Philadelphia. But it must not be forgotten, that Mr. William Snow Harris, of Plymouth, was prior even to Dr. Hare, having fired gunpowder by electricity in March, 1823, which he effected, to the astonishment of numerous spectators, by a common electrical machine, from the cabin

of a small vessel at anchor in that port, whilst the charge was placed in another at a considerable distance, and separated from the former by the water, through which his conducting apparatus passed. But the electrical machine, though perfectly efficient, never would have superseded the common modes of firing mines, as the voltaic battery has done, because the former not only requires a much more delicate manipulation than could be expected either from civil or military miners, and would be more easily broken, or deranged; but it also requires artificial heat at all times, even in summer; whereas the voltaic battery can always dispense with this very inconvenient arrangement, even in the depth of winter, except in the case of very long exposure to a low temperature, which can seldom occur.

To return from this digression to the mines near Dover. By the 26th of January, the day appointed for the explosion, all the great charges had been placed in their respective chambers, with the two small bursting charges in the centre of each, whilst the conducting apparatus were led thence, two out of the east, and one out of the west, end of the gallery, to the summit of the cliff, about 300 yards beyond the edge of which they were united with their respective batteries. These were placed alongside of one another in the shed before mentioned, in which powerful charcoal fires were kept burning, one near each battery. The mines had been tamped by filling up the branches and shafts, and ten feet of gallery on each side of the shafts with rammed chalk, but leaving a vacant space of several cubic feet at each chamber, which had not usually been done by me, as my first experiment left me in doubt whether any advantage was obtained from this arrangement. Before the hour appointed for the explosion, the three voltaic batteries, each consisting, as before mentioned, of 40 sets of Wollaston plates and 18 of Daniell's, had been got ready by Lieut. Hutchinson, assisted by Lance Corporal Rae and Private Smith, who had been specially employed under him all last summer in preparing and firing the numerous subaqueous explosions at Spithead. Mr. Wright and Mr. Hodges, who had been present at, and assisted Lieut. Hutchinson in, his preliminary experiments, were now each stationed at one battery in readiness, whilst that officer himself took post at the third, to give the word of command.

The position of the spectators, and the signals for firing, &c., have been so well described by our own reporter, as well as by Sir John Herschell, in the *Athenæum*, and in other papers of the day, that I shall only remark that considerable anxiety was caused by the unexpectedly long intervals that elapsed between the first and second signals, which led the spectators to apprehend that something had gone wrong, or been forgotten. At last, the second signal was made, and the third signal for firing followed at the appointed interval. At this moment, the lower part of the cliff was seen to swell, or bulge, out, immediately after which the top of it descended gradually, whilst the bottom also was put in motion, and flowed slowly towards, and into, the sea, spreading out, at the same time, to more than its original width; and as it approached and filled up part of the water, a black margin was observed issuing from the extreme outline of this extra-

ordinary stream of white chalk, which was at the time apparently in a fluid state. No smoke was perceived anywhere, unless the dark border, of which no trace remained afterwards, was such. I neither heard a report, nor felt a shock, myself, nor had I anticipated any, from the small quantities of powder used—that is, comparatively small, in reference to the depth at which the charges were buried; but the former was perceptible to many of the spectators of more acute hearing, and the latter was felt also, and described as a slight tremulous motion of the earth, by some of them. It was particularly noticed by those who were seated on the ground near me, at a high point of the cliff to the westward, which commanded a flanking view of Round-down. I would have preferred standing much nearer, and indeed a person at the distance of fifty yards from the edge of Round-down Cliff itself would have been perfectly safe, but it was impossible to have a good view except from a distance. Lieut. Hutchinson and his assistants lost the sight, and, as they felt no shock and heard no explosion, they were not without some apprehension that their mines had failed, until they rushed out of the battery-house, and heard the repeated cheers of the delighted spectators, amongst whom the hardy railway laborers, who are chiefly men of Kent, were not the least vociferous. The cause of the delay between the first and second signals was now explained to me by Lieut. Hutchinson. One of the three batteries, when tested by the voltameter, proved inactive, and, therefore, there was reason to fear that the conducting apparatus of one charge might have been deranged. But, on a closer investigation, it was found that a zinc rod in one of Daniell's batteries had broken by some accident; at which I was less surprised, because I had previously remarked on the very bad quality of the zinc, supplied from London, of which these rods had been made. On discovering this defect, that battery, consisting of six cells, was set aside, and the connexion was made by the remaining twelve, combined, as before stated, with forty sets of Wollaston plates—a power of battery even then far exceeding what was absolutely necessary; but it is best, on great occasions, to employ a superfluity of power, as I myself have always done.

Soon after the sort of volcanic movement caused by the explosion had come to an end, we observed from the top a great number of spectators, who had stood below at a respectful distance from the foot of the cliff, but who now ran and spread themselves over the masses of chalk that had been moved towards the sea, and covered a large space of ground. These persons appeared like pigmies from the high and distant point whence we viewed them; and the moving stream of chalk which flowed towards the sea, when seen from the same point, had previously appeared as if it had been crumbled into white powder, for no part of it seemed larger than the usual size of beach shingle, and the inequalities on its surface were imperceptible; but, on descending the cliff and examining the *debris*, we were surprised to find that they consisted of large irregular fragments of all sizes, some of which must have weighed more than a ton, and which were

heaped up, or packed, on some places, to the height of about thirty feet, but more spread out in others.

Here and there we found fragments of earth and grass that had originally covered the top of the cliff, lying upon those rugged masses of chalk below, which, when seen from above, had appeared like dark brown spots on a white ground. As it was extremely troublesome and fatiguing to walk over the *debris*, for the smaller lumps of chalk rolled under the foot, and the larger ones could not be ascended or passed without an effort, several persons went down to the beach in order to go entirely round them, it being then low water, in which they afforded some merriment by sinking up to their middle, or falling down in crossing some little quagmires of very fine chalk and mud, with small temporary streams flowing through them from the bottom of those great masses, which had prevented the whole of the water of which they took the place from escaping quickly as the tide fell. A flagstaff had been placed at the summit of the cliff before the explosion, which was found prostrate, but uninjured, at some distance from the bottom of it, and was set up again, with a flag of the same color, on the spot, by the railway laborers. I observed a considerable portion of the voltaic conducting apparatus, which had also been thrown down; when afterwards collected and opened, for very little of it was lost, the copper wires were found to be much injured by the kinks occasioned in its fall, but externally it had appeared perfect. That the ruins of the chalk cliff thrown down by this great explosion should have covered fifteen acres of ground, may appear surprising, or even incredible, to many, as, from recollection, it did to me, until I was assured that an accurate survey of it had been made by Mr. Hodges, of which such was the result. The new face of the cliff produced by these great mines was nearly parallel to the original slope, but of a more regular form, being nearly a plane surface, except at the bottom, where a proportion of small chalk rubbish, brought down by the explosion, is piled, at a greater slope, against that which still remains solid.

Gratified, as they could not fail to be, by the splendid results of an operation that probably did not save less than £7,000, the Chairman and Directors of the South-Eastern Railway Company addressed a letter of thanks to the Master-General and Board of Ordnance, on the 16th of February, "for having allowed Lieut. Hutchinson, of the Royal Engineers, assisted by Lance Corporal Rae and Private Smith, to make the arrangements for, and superintend the firing of, the great mines at Dover, on the 26th of January, by which the entire removal of Round-down Cliff was completely effected;" and further observing, "that the important operation referred to having been accomplished by the voltaic battery, with a degree of skill as gratifying to the Directors of the Company, as creditable to the talents of Lieut. Hutchinson and those acting under his directions, they solicited the permission of the Master-General and Board, that Lieut. Hutchinson might be allowed to receive from the Company a piece of plate, which the Directors were desirous of presenting him with, in token of the

high estimation in which his valuable services on the memorable occasion referred to, were held by them."

This proposition having been acceded to by the Master-General and Board, "as a special case," for it is contrary to etiquette that the services rendered by an officer of the army should be noticed by any mark of approbation, except by his own superiors, if performed as a part of his military duty, or by their permission, if otherwise,—as soon as this was communicated to them through Mr. Byham, the sum of fifty guineas was expended by the Chairman and Directors of the South-Eastern Railway Company in this testimonial of their gratitude to Lieut. Hutchinson.

Finding the immense benefit of this great explosion, Mr. Wright and Mr. Hodges, by the approbation of their chief, have since fired several other mines with equal success, in the same range of chalk cliffs, by the voltaic battery, of which they acquired a thorough knowledge, as well as of the general principle by which conjunct mines ought to be regulated, whilst under Lieut. Hutchinson—viz., two mines of 750 lbs. each on the 10th, and two of 900 lbs. each on the 14th, of February; after which, on the 2d of March, they fired eight conjunct mines, all in the same line, in which they expended 6,440 lbs. of gunpowder, along a range of cliff of such very irregular outline that they varied their charges from 200 lbs. to 2000 lbs. Mr. Hodges has contrived a simple and ingenious apparatus for completing the circuit of several voltaic batteries at the same moment, by one operator; and they propose to fire more than 12,000 lbs. of powder, distributed amongst fifteen or sixteen conjunct mines, in order to remove another portion of the same cliff, on the 18th instant. In short, these gentlemen, who had no knowledge of this art a year ago, have profited so well by their opportunities, that I consider them capable of planning and executing any mining operation, however extensive, with skill and success.

In respect to conjunct mines calculated for a scale of moderate demolition, I shall here remark, that it is not absolutely necessary that they should all explode at the same moment of time, (which is difficult even by the voltaic battery, but, by all the former methods of firing gunpowder, absolutely impossible, though the contrary has been asserted by writers copying from the old French authors on military mining.) For example, in the course of our experiments at Chatham, before we knew the use of the voltaic battery, we first demolished a brick wall, about four feet thick, by blasts fired successively by a very small powder hose leading along the back of the wall, and connected with each charge, one end only of which hose was ignited. In like manner, Lieutenant (now Captain) James, of the Royal Engineers, acting under my direction, demolished 466 feet in length of the brick revetments, or retaining walls, of an entire front of the old fort of Sheerness, with the exception of one of its flanks, but including its ravelin, with such complete success, on the 14th of July, 1827, that the brickwork was, as it were, just turned over nearly on the same spot, but crumbling into pieces as it fell, without any of the fragments being thrown to a distance, although no two of the explosions were

simultaneous. In this operation, 15 charges, generally of 84 lbs., but some of 90 lbs., in barrels, were used against the demibastion and curtains, whilst 23 charges of 25 lbs. each, placed in bags, were used against the ravelin. The former were grouped by twos or threes as conjunct mines; the latter were all fired one after another, at intervals of several seconds of time, by igniting one end of a longitudinal hose laid along the top of the wall, and communicating with separate vertical hoses leading down into the several charges. But though simultaneous explosion is thus evidently unnecessary in conjunct mines, having their charges calculated to effect moderate demolition—yet, in the case of violent demolition, absolute precision is indispensable, otherwise the explosion of the first charge may derange the others, and either diminish the general effect of the whole, or even cause some of them to fail altogether, of which I have known instances.

The great explosion which took place at Dover on the 26th of January last, is certainly the triumph of the art of mining in this country, but the British military engineers, by whom undoubtedly it has been brought to perfection, were not so fortunate in their first attempts as the able civil engineers of the South-Eastern Railway. Owing to the inefficient state of the Royal Engineer Department at the commencement of the present century, which was not improved until towards the close of the Peninsular war, the officers had no opportunities of acquiring practical knowledge of this important art. Hence in Sir John Moore's retreat all the mines of demolition made for the destruction of the bridges in our rear failed, excepting one, in which Lieutenant Davy, a most promising young officer, blew himself up along with the bridge that he destroyed; and I myself was one of the unsuccessful operators in that campaign, in an undertaking in which no non-commissioned officer, and very few privates of the corps would now fail. At the siege of Badajoz, Captain Stanway, a most gallant and intelligent engineer officer, succeeded in placing a charge to blow up a dam that retained an inundation, which was a great impediment to the besiegers, but the explosion failed, from the mode of securing charges against the pressure of water not being then understood; and in the attack of Burgos, the work of the British miners was obliged to be suspended from time to time, for want of air, because the simple method of ventilating military mines was not known. Towards the close of the Peninsular war, however, the distinguished engineer officers employed in it had acquired more experience, and none of their mines of demolition against bridges, &c., failed as at first.

In India, where the same defects prevailed, perhaps to a still greater extent, the first mining operations after the commencement of the present century were not merely unsuccessful, but calamitous, for at the siege of Cumoonah, an insignificant little mud fort, in 1807, the company's engineer officer, whilst preparing mines to throw down the enemy's counterscarp, was himself blown up in his own gallery, by the native miners opposed to him, and our troops were afterwards repulsed with great slaughter in an attempt to storm the place, which,

however, was afterwards evacuated in the night. About two years before, in the first siege of Bhurtpore by Lord Lake, the repeated assaults ordered by that gallant general had been repulsed, chiefly by explosions of gunpowder prepared in the ditch. More recently, the East India Company's Engineers have everywhere distinguished themselves by their superior skill in mining, especially at the second siege of Bhurtpore, in 1826, though the native miners there had lost nothing of their former energy, for they actually penetrated into one of our galleries, where a combat took place, in which a captain of the Engineers was wounded. Their efforts were, however, unavailing, for the Company's Engineers opened the way for our storming parties into that supposed invincible fortress by two great mines, one of which not only effected a broad and practicable breach, like the other, but leveled in the dust a large circular bastion, on which 300 or 400 of the enemy's bravest troops were posted, who were all destroyed by the explosion. I need scarcely mention that the East India Company's Engineers performed the same important service in Lord Keane's attack of Ghunzee in 1829. Failures on either of those occasions, such as had previously occurred after the beginning of the present century, would have shaken our Indian empire to its centre. In Europe and America, where the Royal Engineers only are employed, mining has not been required in any of our military operations subsequent to the close of the Peninsular war; so that they have not had the same opportunities of establishing their character for skill in mining, which their friends and contemporaries of the same branch of service in India have enjoyed.

If my first letter, which appeared in your columns of the 24th January last, had not been full of inaccuracies, I would not have troubled you either with the above account of the great mines at Dover, or with the observations on the progress of the art of mining in the British service, into which I was led in the course of my narrative, for the length of which I beg to apologize, and am, Sir,

Your most obedient servant,

C. W. PASLEY, *Major-General.*

*Civ. Eng. & Arch. Journ.*

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## **Architecture.**

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### *Tesselated Pavements—Ancient and Modern.*

[A work has been recently published, at a great expense, under the direction of Mr. Blashfield, who is connected with the old established firm of Messrs. Wyatt, Parker & Co., the cement manufacturers, for the purpose of exhibiting to the profession what truly beautiful patterns may be adopted in tesselated and mosaic pavements, by the aid of the small porcelain squares recently introduced by Mr. Blashfield for that purpose. The work consists of ten elaborate designs by Mr. Owen Jones, the author of the "Alhambra," splendidly printed in colours. These designs cannot fail in directing the public taste to