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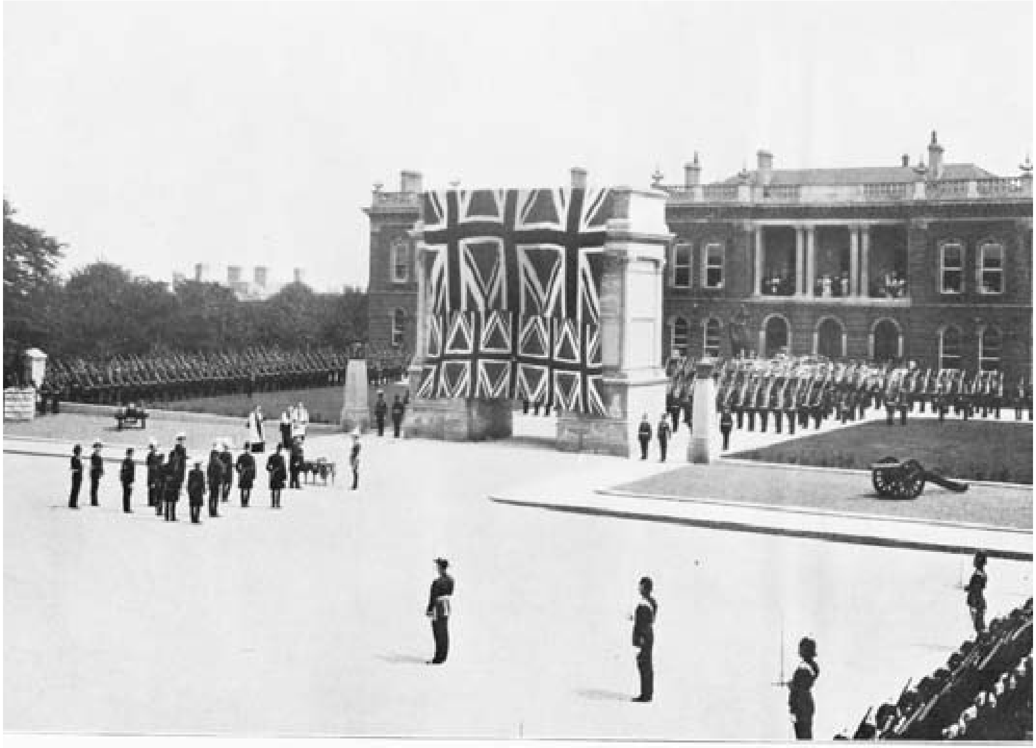

THE ROYAL ENGINEERS SOUTH AFRICAN WAR MEMORIAL.
Lieut.-Gen. Sir Wm. G. Nicholson, K.C.B., addressing His Majesty.

ROYAL ENGINEERS SOUTH AFRICAN WAR MEMORIAL

SOUTH AFRICAN WAR MEMORIAL - EAST FACE

THE R.E. SOUTH AFRICAN WAR MEMORIAL:

UNVEILING BY

HIS MAJESTY KING EDWARD VII., COLONEL-IN-CHIEF.

THE KING honoured his Corps of Royal Engineers by again visiting their Headquarters at Chatham on 26th July, 1905, when His Majesty unveiled the Memorial Arch erected by them in memory of their comrades who lost their lives in the War in South Africa, 1899—1902.

DESCRIPTION OF THE MEMORIAL.

The decision as to the form the memorial should take was entrusted to a Committee elected at the Annual Corps Meeting of 1903 and consisting of the late Lieut.-General Sir Robert Grant, G.C.B., Major-General Sir Elliott Wood, K.C.B., Colonels Robert H. Vetch, C.B., R. H. Jelf, C.M.G., W. Pitt, and H. W. Smith-Rewse, C.V.O., Lieut.-Colonel J. Winn, and Major A. T. Moore (*Hon. Secy.*). After consideration of other proposals a design by Mr. E. Ingress Bell, F.R.I.B.A., for a triumphal arch was selected.

In preparation for the proper display of the memorial a square or "Place" was formed between the inner parade of Brompton Barracks (on the side where stands the Crimean Arch) and the forecourt of the Royal Engineers Institute, the enclosure of the latter being set back to accord with the retired centre of the Barrack enclosure. In the centre of this new line of enclosure and immediately opposite the Crimean Arch the new memorial has been built. In the four re-entering angles of the "Place" the large bronze statues of Boers, lent by Lord Kitchener, have been temporarily erected on suitable pedestals, and Burmese guns have been placed on the flanks of the new arch.

The main fabric of the new arch is Portland stone of specially selected quality. A principal feature of the structure is a series of sculptured panels in high relief, showing :—(*a*) A typical blockhouse with barbed wire defences, telegraph lines, and accessories; (*b*) A movable ox-wagon blockhouse; (*c*) A pontoon bridge with a team of wagons crossing it, and a military balloon in the background; (*d*) A destroyed railway bridge, with an armoured train running over a diversion in the bed of the river. All these have an historical value inasmuch as they are based upon photographs of actual incidents and scenes. Two more similar panels, representing Paardeberg and

Wagon Hill—where the Engineers particularly distinguished themselves—are required to complete the series; and for these it is hoped that the necessary funds will eventually be forthcoming. A large panel above the Arch, on the Barrack side, bears the dedicatory inscription

THE CORPS OF ROYAL ENGINEERS
TO THEIR COMRADES WHO LOST THEIR LIVES
IN THE SOUTH AFRICAN WAR. A.D. 1899–1902.

The frieze which runs round the base of the attic is of Istrian marble, and inscriptions filled in with lead give the names of the sixteen actions for which clasps were awarded with the war medals. The broad piers at the abutments of the arch have Istrian marble tablets on which are recorded in leaded letters the names of the Officers, Warrant Officers, Non-Commissioned Officers and Men (420 in all) of the Regular, Militia and Volunteer Engineers who lost their lives in the war. On one of the inner faces of the archway a small marble tablet gives the titles of the various units of Engineers that served in the campaign; and His Majesty the King has graciously approved of a companion tablet on the opposite wall, to record the fact that the unveiling ceremony was performed by himself as Colonel-in-Chief of the Corps.

The alto-relievos are by Mr. W. S. Frith. The composite capitals to the columns, the keystones of the arch (figures of victory), and the spandrels containing representations of the medals for this campaign are the work of Messrs. Fagan & Bell. The marble tablets with leaded inscriptions are by Messrs. Farmer & Brindley, and the copper lamps on the detached pillars are by Messrs. Thos. Elsley & Co. The general contractors were Messrs. Longley and Co., of Crawley, Sussex.

The cost of the memorial (about £2,750) has been met by subscriptions from all ranks of the Corps, Regulars, Militia and Volunteers, and by donations from relatives of deceased officers and from gentlemen who served with the Engineers during the campaign.

THE UNVEILING CEREMONY.

At the request of the Memorial Committee and of the Colonels Commandant, Major-General Sir Reginald C. Hart, V.C., K.C.B., K.C.V.O., Commander, Thames and Medway Defences, and Commandant of the School of Military Engineering, undertook to make all the arrangements for the unveiling ceremony; and a local Committee was appointed which, beside Sir Reginald Hart, included Colonel G. R. R. Savage, Chief Engineer, Thames and Medway Defences, Colonel H. W. Smith-Rewse, C.V.O., Assistant Commandant, S.M.E., Brevet Lieut.-Colonel A. W. Roper, President, Headquarter Mess, Brevet Lieut.-Colonel G. M. Heath, D.S.O., Instructor in Fortification, S.M.E., Major A. T. Moore, Hon. Secy., Memorial Committee, and Major G. H. Harrison (*Hon. Secy.*).

On arriving at the site of the Memorial His Majesty, who was accompanied by His Royal Highness the Duke of Connaught, Inspector-General of the Forces, and attended by Lieut.-General Hon. Sir Neville G. Lyttelton, K.C.B., Chief of the General Staff, and two Equerries, was received with a Royal Salute by all the Royal Engineers in the Thames and Medway Defences Command. The troops, who were drawn up on the north and south sides of the "Place" and in front of the Institute, were under the supreme command of Major-General Sir Reginald Hart.

Lieut.-General Sir William G. Nicholson, K.C.B., as the Senior Royal Engineer Officer on the Active List present, then addressed His Majesty as follows:—

> May it please Your Majesty,—It is my privilege to be deputed on behalf of your Corps of Royal Engineers humbly to ask Your Majesty to be graciously pleased to unveil and open the Memorial Arch which we have erected in memory of our comrades who lost their lives in the South African War; and also to convey to Your Majesty our deep appreciation of the signal favour which you, Sir, our august Colonel-in-Chief, have bestowed upon us by coming to our headquarters for this purpose.
>
> From time immemorial it has been thought fitting to accord special honour to those who have died in the field in the service of their Sovereign and country, and no higher honour could possibly be conferred on the memory of our comrades who lost their lives in South Africa than Your Majesty's presence here to-day.
>
> And while this memorial ceremony recalls the incidents of the past—long marches, hot engagements, days of danger, nights of waking—it should also serve to remind us, Your Majesty's soldiers, of the obligations of the future. It should tend to animate and inspire us with that ancient heroic spirit which the history of former wars, and especially the history of the present war between Japan and Russia, clearly shows to be of at least as much value in the field of battle as the strictest discipline and the most perfect training. I mean that spirit of self-sacrifice, based on loyalty and patriotism, which regards ease, comfort, material advantage, family ties, life itself, as of no account whatever when compared with the claims of duty and honour. This is the spirit which, we believe, animated our comrades who fell in South Africa. This is the spirit which actuated our predecessors in the Naval and Military Forces of the British Crown who fought and won the battles by sea and land which established and extended Your Majesty's Empire; and it is only if imbued with the same spirit that we can hope, when next we have the honour of serving Your Majesty in the field, to emulate the deeds of our predecessors, to show ourselves worthy of our late comrades, and to do our duty to our King and country.

The King in reply said :—

> I have very great pleasure in coming here to-day to unveil this Memorial in memory of fallen comrades, and I am proud to be associated with the Corps of Royal Engineers. I am well aware of the courage and devotion to duty which the Royal Engineers have always shown in the past, and I feel confident that they will maintain their high reputation in the future.

His Majesty then closed an electric switch, which was in circuit with detonators attached to cords connecting the Union Jacks draped over the faces of the arch. The cords being severed by the exploding detonators, the flags fell gracefully to the ground.

The arch being unveiled the Royal Engineers on parade Presented Arms, and the ceremony continued as follows :—

Chopin's *Marche Funèbre* by the Band.
Three volleys by the Firing Party, each followed by a few bars of the "Dead March" from *Saul*.
"Last Post" by 12 Buglers.
Verse of Hymn *Onward Christian Soldiers* by Children of the Corps.
Dedicatory prayer by the Chaplain-General.
The Blessing by the Chaplain-General.
"Reveillé" by the Buglers.

On the conclusion of this extremely dignified and very impressive ceremony, His Majesty was graciously pleased to plant an evergreen oak tree in the grounds of the Institute, and to be photographed with the senior officers of the Corps.

The King subsequently presided at luncheon in the Royal Engineers Mess. The senior officers present were :—Generals Sir Horace Montagu, K.C.B., Sir Harry Prendergast, V.C., G.C.B., and Sir Richard Harrison, G.C.B., C.M.G. ; Lieut.-Generals Gordon Pritchard, C.B., Sir William Nicholson, K.C.B., and E. P. Leach, V.C., C.V.O., C.B. ; Major-Generals Hon. G. Wrottesley, Renouard James, Sir Thomas Fraser, K.C.B., C.M.G., Sir Harry Settle, K.C.B., D.S.O., Sir Elliott Wood, K.C.B., D. A. Scott, C.V.O., C.B., D.S.O., and Sir Reginald Hart, V.C., K.C.B., K.C.V.O. ; Brig.-General H. M. Lawson, C.B., A.D.C. ; Colonels G. Barker, C.B., G. R. Savage, W. Pitt, R. M. Ruck, C. A. Rochfort-Boyd, C.M.G., H. L. Jessep, H. W. Smith-Rewse, C.V.O., R. Maxwell, C.B., G. H. Sim, C.B., and W. F. H. Stafford, C.B.

(A more detailed account of the ceremony, with additional illustrations, has been published as a Special Supplement of foolscap size.—EDR.).

A SHORT SKETCH OF NAPOLEON'S CAMPAIGN IN ITALY, 1796–97.

By LIEUT. W. HYDE KELLY, R.E.

NAPOLEON'S first plan of campaign,—the invasion of Italy in 1796—was conceived by him before there was any thought of the chief command of the "Army of Italy" being entrusted to him. He had carefully studied the situation, thought out its possibilities, weighed his chances, and assured himself that there was no other soldier capable of executing the plan.

With characteristic self-confidence he sent in his scheme to the Directoire, and it found favour with Carnot. General Schérer, who at that time commanded the French army in Italy, had wasted his opportunities and made no progress; and the Directoire felt that the young general, of whose energy and forceful ability they already had had evidence, would fit the command and bring new life into the war.

It was on 21st March, 1796, that Buonaparte set out on his first campaign—confident in his own ability, and fired with his own ambition.

Northern Italy was overrun by the Austrians. The Austrian and Sardinian (Piedmontese*) forces, numbering together 52,000 men, under the command of Beaulieu and Colli respectively, held the junction of the Apennines and Maritime Alps, and the adjacent passes. The Sardinians were based on Turin, the Austrians on Milan; and the roads leading through the valleys of the Bormida and Tanaro supplied good communications with these cities. But the forces were divided into detachments to guard the passes, and the inter-communication between these was difficult.

Buonaparte's army, 42,000 strong, reinforced before the first engagement to 49,000, was based on Nice. His plan was to endeavour to thrust apart the Austrians and Sardinians, driving the former back on Milan, and the latter on Turin; and then, holding the Austrians, to compel the Sardinians to come to terms. The leading idea was precisely that which Napoleon conceived when he formed his plan of campaign in 1815. He knew that the point of junction between the two forces was the weakest spot, and he accordingly made for that point.

At the beginning of April, 1796, Buonaparte concentrated his forces at Savona; and, with the idea of drawing the attention of the Austrians, pushed a brigade as far as Voltri, so as to threaten Genoa. Now the French line of communications was strategically in a very dangerous position: Buonaparte's front was actually parallel to his

* Sardinia and Piedmont were at this period united under one crown.

communications with his base. But his enemy could not attack through the mountain passes in any large numbers, and it was this fact alone which made the French positions possible.

Beaulieu, fearing that a strong movement was about to be made against his left, sent off a large detachment towards Voltri, where the French brigade was met. This was exactly what Buonaparte's plan required. The Austrian commander, always hampered by imperative orders from Vienna, commenced the attack all along his line, but his main efforts were directed against Voltri. Argenteau, commanding the weakened Austrian centre, attacked a French detachment posted on the slopes of Monte Legino; but the defence was stubbornly maintained until Buonaparte, on the next day, brought up strong columns under cover of a mist to assault the Austrian position.

At Voltri, meanwhile, the French brigade was driven in by Beaulieu with some loss. The attack on the centre was vigorously pressed, but the Austrians made a fine defence. Masséna, moving against their right flank, drove them back in disorder; their crumpled wing, falling back on the centre, compelled the rest to give way, and the whole line fled precipitately. This was the deciding movement of the campaign. It forced the Austrians in a north-easterly direction, and away from their allies the Sardinians, who meanwhile were held back by demonstrations from Ormea and Garessio, on their right flank.

The Austrians, not wishing to lose Lombardy, fell back towards Milan. At Millesimo, a village on the right bank of the Bormida, they endeavoured to make a stand, but Buonaparte vigorously attacked, and they were driven back with a loss of 1,200 men. They then fell back to Dego, a village on the road to Milan, which they had strongly entrenched. Here Masséna again turned their flank, and drove them back; but at the dead of night, 3,500 Austrians surprised the French troops pillaging the houses, and recaptured the position. Here was Beaulieu's opportunity to retrieve his fortunes. He should have rallied and brought up more troops, with which the surprise could have been turned into a serious disaster for the French. But he was an old man, past the energy requisite in a general in such a position; furthermore, he was hampered by absurd instructions from Vienna, and the results were the natural consequences of such evil control.

Buonaparte, on the other hand, enraged at this unexpected check to his triumphal march, threw his whole energy into the situation; and with his marvellous grasp of circumstances, hurried fresh troops to the attack, which was renewed next morning with vigour. The five battalions of Austrians, who had dared the surprise, were driven out with loss, and Dego was once more in the hands of the French.

On the west, the Sardinians, now hopelessly separated from their allies, withdrew to a strong position at Ceva, where they successfully checked the French for a time. But their situation was no better than Beaulieu's at Dego; and neither force could help the other.

Buonaparte hurried up with two French divisions, and Colli retreated towards Turin, the Austrians, in their turn, being prevented from offering any assistance by a French division at San Benedetto and a brigade at Cairo.

Thus in four short days, Buonaparte had brilliantly carried out the first part of his plan of campaign. He had wedged himself in between the allied armies, and defeated each in turn. He had, furthermore, prevented all possibility of their junction south of Milan and Turin. He had, in fact, accomplished successfully in his first campaign what he so nearly succeeded in doing in his last. Had his enemies of 1796 possessed the greater qualities displayed by Wellington and Blucher, he might have suffered defeat at the very outset of his brilliant career. But Beaulieu was no Blucher, and Colli's Sardinians thought only of Turin. Buonaparte knew his opponents' characters and acted upon his knowledge.

Negotiations for peace were now opened between Turin and Paris. Buonaparte, through whom all the preliminaries were arranged, stipulated for the surrender of three important strongholds—Alessandria, Tortona, and Coni—as the primary conditions of peace. These fortresses at once gave Buonaparte a great strategical advantage, and enabled him to transfer his line of communication with France from Nice and the coast to the route through Monte Susa to Turin. This line was both shorter and safer; for now, in his further operations against the Austrians,—who, although deserted as they believed by their allies, were by no means disposed to let Lombardy go,—his front would be perpendicular to his line of communications. The fortresses also gave him a new base of operations. All this was the outcome of a sound application of the first principles of strategy. At the very beginning, the dispersion of the allies, and their inability to securely hold their extended front, offered a tempting object to a vigorous young general of Buonaparte's intellect. Secondly, the mountainous country screened the movements of the French. Thirdly, there was no real cohesion, no subordination of their movements, in the allied armies. Fourthly, the position originally held by the Austro-Sardinian armies was a weakness in itself, owing to the entire lack of lateral communication. These were defects which would at once attract the attention of an able opponent, and Buonaparte was not the man to lose sight of them.

To return to the coming campaign against the Austrians. Their shattered army had withdrawn beyond the Ticino; and, taking up a strong position at Pavia (where the road from Genoa to Milan crossed that river), with detachments patrolling towards Valenza and Piacenza, they awaited the attack of the French.

In the rich plains of Lombardy, Beaulieu expected to be able to use his superior cavalry with effect, but he was so completely out-manœuvred by his able opponent that he had no chances of realising his hopes. Moreover, a general who has been beaten back in continuous rout, and who has not had time to revive his demoralised troops, cannot expect his forces to suddenly become excellent fighting material; every defeat deprives him of any power of manœuvring that he may hope for. With Buonaparte, on the other hand, the troops were young, and flushed with the joys of victory; worshipping their brilliant commander, and eager to be led to further glory. All this moral influence counts heavily in the stress of war, and the backbone was gone from the Austrian resistance.

Buonaparte, always well-informed of his adversaries' whereabouts, chose Piacenza as his point for crossing the river Po; and in order to delude Beaulieu, he demonstrated towards Valenza. His real advance was from Tortona. He pushed rapidly with his main force to Piacenza, where Lannes, crossing by the ferry, drove back a small party of Austrian cavalry, and the troops poured across the river. Beaulieu, aroused too late, sent off 5,000 men, under Liptay, to strengthen his left; but Liptay, meeting practically the whole force of the French, was speedily crushed, and withdrew eastwards in the only direction left to him. Here again Buonaparte's fine strategy forced apart the enemy's columns. Beaulieu, coming up later with his main body, met a similar fate at Fombio, and, thoroughly beaten, drew off to Lodi, where there was a bridge over the Adda. Here was another masterstroke; Milan was thus exposed without defence.

But Beaulieu, who saw that a retreat across the Adda would still give him chances of further resistance if he did let Milan go, still had a force which, although shattered beyond hope of immediate recovery, was a danger in the rear of an army.

On May 10th Buonaparte seized the bridge at Lodi, the possession of which a small rearguard of Austrians hotly contested. Beaulieu retired behind the Mincio and rallied his crumbling forces behind the walls of Mantua. The next phase of the campaign resolves itself into a series of struggles for the possession of that fortress.

The Austrian position at Mantua was of great strength; and as reinforcements were promised from the Tyrol, Beaulieu still had hopes of a turn of the tide. Buonaparte, too, gave him a respite by halting to settle the affairs of the newly-conquered territories and to refill the Paris treasury-chests with heavy indemnities in cash and in kind from the ancient cities of Turin and Milan.

In May, Brescia, although in Venetian territory,—which was then neutral ground—was seized by Buonaparte as a punishment to the Venetians for permitting Austrian troops on their soil; and the possession of this town gave the French an important advantage in the future operations for the capture of Mantua. The strategical situation had indeed reversed itself, for now Beaulieu's communications with the Tyrol ran parallel to *his* front; and Buonaparte at once took advantage of this fault. He threatened the enemy's positions on the western bank of the Adige; and caused the Austrian general to weaken his centre, by despatching troops to guard Rivoli, to such an extent that Lannes, crossing the Mincio at Borghetto on the 30th May, easily forced the Austrians from their positions, from which they withdrew to the northern valley of the Adige, leaving a garrison in Mantua.

Here was "the beginning of the end" of the Austrian resistance; for, Masséna having been sent to hold them in the Adige valley, Buonaparte was able to close round Mantua, which had been freshly provisioned by Beaulieu just before his retirement northwards.

Beaulieu's last retreat took an extremely perilous direction, although it was along his line of communications. A beaten general retiring along a line parallel to his enemy's front is in the very worst strategical position; and it is a matter of some wonder that Buonaparte did not push home his attacks on Rivoli —(which, it will be remembered, were the cause of the weakening of Beaulieu's centre),— attacks which would have taken the Austrians in the rear, or at least in flank. But against this it must be remembered that Buonaparte's forces were none too large for the work in hand. His great length of communications needed secure guarding, and he had scarcely sufficient men to invest Mantua.

The Emperor of Austria, determined not to lose Italy, now put forth fresh efforts to drive out the invader. He could not afford to let Buonaparte advance and unite with the French armies from the Rhine; Vienna would be too seriously threatened. Moreover, the French (he supposed) were widely scattered, and were rapidly losing their reputation, and suffering in *morale* through endless plundering in the conquered cities. Towards July, 1796, he appointed Wurmser in place of Beaulieu, and gave him another 25,000 men, which he detached from his forces on the Danube. With the shattered fragments in Italy Wurmser's troops now numbered 48,000, and with these he was ordered to relieve Mantua and repel Buonaparte.

His task seemed to offer very fair chances of success. His enemies were widely dispersed, both for subsistence and plunder, and their long line of communications swallowed up a great many troops. The presence of the garrison in Mantua could also be reckoned upon to impede their movements. The way in which Buonaparte extricated himself is highly instructive.

Wurmser, compelled by the narrowness of the valley through which he advanced to separate his columns, committed a great strategical blunder by sending Quosdanovitch with 18,000 men down the western side of Lake Garda to seize Brescia and cut Buonaparte's communication with France. This move, although its success would have seriously hampered the French, was extremely hazardous for the Austrians, for Quosdanovitch's force would be completely cut off by the Lake from Wurmser's main body, which, consisting of 24,000 men, was to advance down the valley of the Adige and attempt to relieve

Mantua. Davidovitch, with another division of 5,000 men, was sent from Fiuli towards Vicenza to threaten the French right. The Austrians seemed fond of dispersing their forces in the face of the enemy without the means of uniting them on the field of battle. However successful the main body might be, neither of the detached forces under Quosdanovitch and Davidovitch could offer assistance or expect assistance. The plan entirely ignored the lessons so recently learned at the hands of Buonaparte.

Towards the end of July, the Austrians advanced on the French positions, drove in the outposts at Rivoli, and threatened Buonaparte's communications by their move on Brescia. The latter, at once realising the situation, ordered his scattered forces to concentrate on the centre, at the south end of Lake Garda. Here he could attack either of the Austrian columns, and still cover the siege of Mantua. His strategy was very different from that of Wurmser.

But when Brescia fell into the hands of the Austrians on July 30th, he ordered Sérurier, who was besieging Mantua with one division, to withdraw westwards, destroying his guns if he could not save them. He now saw that it was of more importance to defeat the armies in the field than to attempt the capture of a stronghold, the possession of which could not be used to full advantage until those armies were disposed of. Augereau, strengthened by a part of Sérurier's division, recaptured Brescia on August 1st; and the main French force fell back behind the Mincio. Wurmser, following up, fully believed that Buonaparte was retreating at last; and when the important point of Castiglione fell into his hands, he thought he had triumphantly broken the French centre. But Buonaparte entrusted the recapture of Castiglione to the dashing Augereau, who carried out his task with great vigour. This was a serious check to Wurmser, who now had not only lost the ground he had gained but also the chance of joining hands with Quosdanovitch on the west of the Lake.

An attack on Masséna at Lonato met with some success at first, but Buonaparte came up with reinforcements and drove back the Austrians, who withdrew in confusion. The French now pursued, and the beaten enemy were roughly handled in their rush towards the southern end of the Lake. Acting once more under rigid instructions from Vienna, Wurmser confronted the French in a strong but attenuated position, stretching from Médole to Solferino; but his anxiety to lend assistance to, and join hands with, Quosdanovitch so weakened his centre and left that Marmont rolled up this flank, while Masséna and Augereau charged the centre. On his left, Buonaparte had skilfully "refused" and had kept his divisions slightly withdrawn to lure on the Austrian right. The result was the total defeat of the Austrians. It was a conflict of manœuvres rather than a soldier's battle. Buonaparte's skilful moves against Wurmser's left, while he purposely weakened his own left, could not be met by the Austrian dispositions. Once their left was engaged, any attempt on the part of their centre to change front was prevented by the divisions under Masséna and Augereau.

But in spite of this defeat Wurmser still had the advantage. He had so far succeeded in his plan as to relieve Mantua, for the time being, and he had also captured Buonaparte's siege-train (Sérurier's retreat). The French general, moreover, was prevented from advancing through the Tyrol to join Moreau, with whom Buonaparte desired eventually to march on Vienna. But the Austrians had suffered in battle losses far more severely than the French.

At Bassano Wurmser lost many more men at the hands of Masséna, who pursued him hotly; but, turning at bay, he managed to get into Mantua where he could rally his troops. A short respite followed, during which Buonaparte strengthened his position in the newly-conquered states behind him; and Austria, gaining great victories over Moreau and Jourdan on the Rhine, poured more troops into Northern Italy and again changed the command from Wurmser to Alvinzi, a veteran with an honoured name but no strategical skill.

Alvinzi promptly marched westwards, with his forces more or less concentrated, and took up a position at Caldiero, east of Verona, where Buonaparte's army was assembled. On November 12th, the French attacked, but so skilfully did the Austrians dispose their guns that the attack was repulsed with heavy loss. Buonaparte withdrew to Verona; and it seems as if the tide of French victory was about to turn at last. Making another attempt against Alvinzi's position on the 15th, Buonaparte secretly sent the divisions under Masséna and Augereau to Ronco, on the right bank of the Adige and south-west of Verona. Here a bridge of boats was thrown across, and the French columns passed rapidly over, Augereau making for Arcola to take the Austrians in rear and Masséna moving up towards Caldiero. At Arcola, however, some Austrian troops, despatched by Alvinzi, checked the advance and, being rapidly reinforced, drove back the French divisions. On the following day, the French gained ground, but were still vigorously opposed by Alvinzi's left wing, where his troops fought splendidly. In the third day's fighting a ruse gave Buonaparte the victory. A small detachment of cavalry was placed behind a hill, and a fierce blare of trumpets sounded the charge. The simultaneous appearance of a few troops in rear of Arcola caused the Austrians to flee panic-stricken, and the position at Caldiero was won.

On the Austrian left, Davidovitch had gained some success at Rivoli, but Alvinzi had neglected to keep his subordinates informed as to the general situation and to gather information for himself; consequently a grand opportunity had been missed. While the French were checked at Arcola, why did not Wurmser move out against their rear from Mantua? or why did not Davidovitch press his attack on the right? Because neither of his subordinates knew anything of Alvinzi's position. Ignorance, in this case, was paid for very heavily. There was no cohesion or unity of movement among the separate Austrian columns. Failure was bound to ensue in the face of so skilful and vigorous a foe as Buonaparte, who had thoroughly studied the moves of war and practically applied the principles of strategy in each case as it arose. He had not read history for nothing.

Now followed another respite while Buonaparte was engaged in affairs of diplomacy.

At the opening of 1797, the Emperor Francis of Austria made a further and last effort to relieve Mantua and save Italy. Still the council at Vienna drew up rigid plans for their Commander in Italy. The plan now formed was briefly :—Alvinzi was to join forces with a column advancing from the Tyrol, drive the French out of Rivoli, and force them back on Mantua; Provera with 9,000 men was to advance from Legnago; and another force of 10,000 was to attack the French at several points along their front. Here again was the fatal error of dispersion. The Austrians clung obstinately to their favourite plan of endeavouring to envelope their enemy, and Buonaparte once again saw his opportunities.

At first the French were in doubt as to which was the enemy's real line of advance, but reconnaissances soon removed the difficulty. It was at Rivoli that the main blow would fall. Here there were 10,000 men under Joubert. But the rapid advance of the Austrian main body was discouraging the French, whose commander, though a man of great bravery, was already thinking of falling back when Buonaparte hurried up reinforcements and, in the nick of time, saved the strong position.

Situated on the western bank of a very sharp bend in the Adige, the village of Rivoli offered a very secure position against a force advancing from the north. Steep mountains close in the bend of the river, but on their north-western side a gentle slope falls to the valley of a small stream called the Tasso. Across this again is the height of Monte Baldo, whose spurs jut out into the little valley. On the western bank of the Adige runs the road leading from Verona to Trent, but north of Rivoli this road runs down the slopes and along the river. It was an ideal position, as any attack along the river would be easily repulsed by a determined defence on the heights; and an attack from the north-west, from Monte Baldo, would require a very large number of men, whilst a small force would suffice for the defence. Certainly the position could be turned by a wide flanking movement on the west, and this was, in fact, partly what Alvinzi attempted to do; but his numbers were too small and his tactics too faulty to ensure success.

The Austrians, numbering 28,000 men, found it an easy matter to drive in the French outposts, Joubert having only 10,000 troops all told. So threatening was the situation that Joubert was preparing to retreat; but Buonaparte hastened up with reinforcements during the night and, making an attack on the Austrians then and there, he recovered the lost ground.

The Austrian plan of attack took the old form of an attempt to envelope the enemy. No less than six columns were to attack the French. One was to move up the eastern bank of the Adige and bombard the heights at Rivoli—a dangerous move, for by no chance could any close communication be kept up with the remaining five columns; another, with the rest of the artillery and cavalry, was to take the road along the western bank and try to assail the French in rear; three were to attack frontally; and the sixth and last column was to make a wide detour and attack the enemy's left flank. The practical impossibility of keeping up inter-communication between these separate bodies was the chief cause of failure.

In the battle that followed the column on the east did little more than make a noise with its artillery. The column moving up the winding river-side road was received with a very hot musket-fire as it ascended the steep slopes. The three bodies attacking from Monte Baldo, although at first very nearly successful, were afterwards assailed by Masséna's fine troops with a charge of French cavalry to support them; some of the Austrian troops receiving the charge, broke and fled, shouting to their neighbours to save themselves; the panic, once started, soon spread, and all fear of a fresh assault from the direction of Monte Baldo was dispelled. But the westernmost column of the Austrians worked their way cleverly round, and threatened to fall on the French rear; there was, for a time, great consternation even among Buonaparte's best officers, but at the right moment reinforcements arrived from Verona.

The other attacks having failed, Buonaparte could afford to give most of his attention to the position of affairs in his rear, with the result that the last Austrian column was beaten back with loss. This was the end of the battle; Alvinzi, hopelessly beaten like his unfortunate predecessors, fell back into the Tyrol.

The battle ought never to have been lost by the Austrians. If the western column had timed its attack on the French rear to fall simultaneously with the attacks from Monte Baldo and the river road, even Buonaparte could scarcely have avoided defeat; for there was no retreat left to him. Reinforcements from the south could have made their attack much more difficult for the Austrians, but the western column should have carried out its plan before such reinforcements could arrive. Further, Provera was working his way successfully towards Mantua, and the French forces south of Rivoli would have had their work cut out to avoid being taken in rear themselves. As it was, Buonaparte, after despatching Joubert in pursuit of Alvinzi, hastened back to Augereau in the south, fell upon Provera's army near the walls of Mantua, and destroyed it completely (January 16th, 1797). Mantua fell on February 2nd, when Wurmser surrendered with 20,000 men.

This ended the campaign of 1796—1797 in Italy. It is an interesting campaign in a number of ways. It was the first undertaken by Buonaparte, and also the first since Frederick the Great's time in which the principles of strategy were soundly applied. It was the first, too, in which the new spirit of republicanism fired the French soldiery. It was the dawn of a great career.

In nine months Buonaparte, who had begun with a reputation for skill in artillery matters only, obtained for himself the position of foremost general in Europe. He had begun the campaign with a small base and a hazardous line of communications along the coast from Nice to Savona; and he had pushed his front northwards and eastwards until he had behind him a secure line of communications with France and also a number of strong cities and fortresses—Turin, Milan, Tortona, Alessandria, Coni—which he used as an advanced base for his operations against Mantua.

He always kept his forces concentrated for fighting, and he often knew more about the enemy's position than they did themselves. He was backed up by brave and intelligent subordinates, and his troops were as enthusiastic for him and the glory he gave them as they were for the new spirit of republicanism.

The campaign shows the great influence of an initial success leading on to further triumphs by the inspiration given to the victorious army. Had Buonaparte's troops suffered defeat at the outset, their *élan* might have died out, and nothing but a great victory can restore nerve and discipline to demoralised troops. But Buonaparte led victorious troops to fresh victory, and against him he had an enemy weakened and demoralised by continual defeat.

The Austrians failed:—(1) because the great mountain barrier of the Tyrol separated their armies from their ultimate base; (2) because all their plans of campaign and movements in the field were dictated by a council sitting in Vienna, nothing being left to the commander on the spot; (3) because none of their generals had made a proper study of war; (4) because the Italians were anxious to try the new republicanism.

The war continued after the fall of Mantua, but it became a procession of triumphs towards the heart of Austria; although the Archduke Charles, one of the ablest generals his country has produced, took command to retrieve his nation's honour. His shattered and broken-spirited troops could not withstand the advance of the victorious French, gaining in glory with every fresh triumph. An armistice was declared at Loeben, almost within sight of Vienna, and peace was afterwards signed at Campo Formio. Austria gave up Belgium, the Ionian Isles, and her share of Bresgau; she gained the greater part of the Venetian territories, as well as Istria and Dalmatia, strips on the coast of Illyria.

*MILITARY EDUCATION IN THE UNITED STATES OF AMERICA.**

By BT.-COLONEL H. J. FOSTER, *p.s.c.*, R.E., *Military Attaché at Washington.*

EDUCATION has always been a cherished ideal of the American, who is rather inclined to regard its processes with an almost superstitious reverence and perhaps to exaggerate its effect. States and Cities, Counties and Townships, vie with each other in the extent and elaboration of the educational facilities provided for their sons and daughters. In the Philippines for instance the formation by methods of American education of a higher type of citizen, ripe for self-government, has been the leading idea of the administration of the islands; and this, moreover, to the neglect—until recently—of the more practical needs of improved communications and public works.

In the military world, this ideal, which a hundred years ago was responsible for the founding of an admirable military school at West Point, has recently developed a complete scheme of military education, covering the whole ground from the instruction of the private to that of the officer of the General Staff and even of the General. In this curriculum the technical officers of the Engineers, of the Coast and Field Artillery and of the Submarine Mining service have not been overlooked.

For the Privates there are "Post Schools," where the ordinary primary education of civil life is given, with some algebra and trigonometry for advanced pupils.

For Non-Commissioned Officers there are schools in each battalion and squadron, as well as in the artillery. In these the instruction is given by selected officers through the medium of lectures, problems for solution, and practical exercises. The subjects include :—Army regulations affecting the men, the drill of their arm, simple tactics, hasty sketching and reconnaissance. Mounted men are also taught "Hippology," by which useful word is meant a general knowledge of horses, the art of good horsemastership, and veterinary science. Lectures are given on the history of the Pupils' Corps and its achievements in war; and when practicable Spanish is taught.

As regards Officers, it must be explained that the supply is derived from several sources. Besides the influx every June of some 60 to 90 cadets from the Military Academy at West Point, commissions are granted to candidates from the ranks or from civil life, who pass a

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qualifying examination. During or shortly after a war this latter method of entry is largely taken advantage of by officers and men from the volunteers enrolled for that war. Although the examination includes the elements of history, algebra, geometry, trigonometry and topography, as well as a knowledge of the Constitution and of International Law (and not one half of the candidates as a rule are successful), these officers of course have not the education or training of the West Point Cadets. For their benefit therefore, there has been established a system of Garrison Schools throughout the country, at which all Lieutenants and Captains under ten years' service must attend until they have passed. West Point Officers are excused attendance at the "Recitations" (described below) in the theoretical portion of any subject they have qualified in.

As indicated above, the chance of getting a commission in peace time except through West Point is a remote one. When vacancies exist that cannot be filled from West Point, open competitive examinations are held, open to candidates with two years' service in the ranks and to persons in civil life.

As a rule Commissions to candidates from the ranks and from civil life are granted only in the Infantry and Cavalry, seldom in the Artillery, and never in the Engineers. Latterly the candidates from civil life have only been offered commissions in the Philippine Native Scouts.

This leads us to the system of allotting commissions in the various arms to Cadets who graduate at West Point.

A graduating class now usually consists of from 100 to 120 cadets. The Cadets occupying the first 10 places on the final passing-out list almost invariably elect to serve in the Engineers. Formerly the Cavalry, with its chances of service on the Indian frontier, was the next most popular branch; but latterly the Field Artillery has shared the next 30 or 40 places on the list, with a few Infantry commissions interspersed. The Coast Artillery is unpopular, owing to its remote and often unhealthy stations, and therefore usually claims the wooden spoon.

As the pay of all arms is practically identical, it is difficult to assign a cause for the preference shown for commissions in the Corps of Engineers. It may be attributed to the very important—but not any more highly paid—positions, open to officers of the Engineers, under Government in the branch of the Engineer Department which is responsible for the construction, maintenance and improvement of all the harbours and waterways of the United States and its foreign possessions.

All officers of the Engineers have now to do at least one tour of four years, as a Lieutenant or Captain, with the Engineer Battalions. They thus retain touch with the Army, and at the same time keep up to date with all the latest developments in Civil Engineering.

WEST POINT ACADEMY.

Admission to West Point is obtained under a system of nomination, subject to passing a qualifying physical and mental examination. Two candidates are nominated annually by the Senators of each State and Territory of the Union, and a certain number of vacancies are allotted to the United States at large. The number of candidates thus admitted each year amounts to close on 150.

The course of instruction lasts 4 years. The age of the cadets at entrance is 17 to 21 years, and consequently the commissioned class varies in age from 21 to 25 years.

The standard required at the entrance examination is not a high one; and this accounts for what would otherwise seem a waste of time in the large amount of study devoted during the first year to branches of purely general education.

The avowed object of the U.S. Military Academy is to give some 500 cadets a thorough education in all subjects directly or indirectly suitable to the corps of officers of a Regular Army; to implant in them a spirit of discipline, soldierly feeling, and a sense of duty; to work up their physique by drill, riding, athletics and gymnastics; and, remembering that the cadets come from every class of the nation, to bring them up to a uniform standard of social habits, good manners and *savoir vivre*, in which points many are deficient on joining. The latter object is of course tactfully undertaken; and is attained unobtrusively by the advice and example of the officers, by absence of all bad influences or surroundings, and by a surprising amount of feminine society. Constant dances are given, dancing is officially taught, and the cadets are always about the Academy with their young lady acquaintances, which is said to humanize them and keep them out of mischief. This is contrary to English habits, and leads to early marriages.

To turn to the actual instruction given, we find the field very wide even for a four years' residence. The mathematical course is a thorough one. The scientific course includes optics, acoustics, and heat, as well as chemistry and electricity, which are of more obvious use. The artillery course teaches internal and external ballistics. Geometrical drawing is carried further than at Woolwich. Surveying, theoretical and practical, is of course thoroughly taught. Instruction is given in military law, and even international law. Some popular astronomy is taught in an observatory, and there is an original and useful little course by the Librarian on the use of a library, on general reading, and on works of reference. English is a most necessary course, as many cadets have only a very elementary education. French and Spanish are taught by Army officers, the former only to read and not to speak! All instructors are West Point graduates.

The classes are small. They consist of 8 to 12 cadets, each of whom is obliged by the recitation system to stand up and recite the lesson he has studied, giving written explanations, definitions, etc., on the blackboard. The pupil thus shows daily how far he is learning his work, and cannot depend on mere success in examination to obtain marks.

The above is in addition to purely military subjects, such as tactics, military history, army sanitation, fortification, riding, gymnastics, drill, musketry, and field work. The latter are taught during the ten weeks summer camp and not during the rest of the year, which is devoted to indoor work; but the daily sunset "dress parade," with the manual exercise and a march past, keeps up military bearing, correct turn-out, and stiff drill in great perfection.

There can be little doubt that the best result of the four years at West Point is the formation of character in the sense of enthusiasm for the army and the position of an officer in it, and of a high sense of duty, discipline and military virtue. The strictest veracity is learnt, and the integrity of a West Point officer has rarely been questioned among the 4,000 cadets who have entered the Army. Another excellent result is the homogeneity of the quality of the officers of the U.S. Army, and their unrivalled camaraderie, which continues till the end of their career. West Point is a religion deeply implanted, and common associations unite officers of all ages and of all arms of the service.

The training in drill, dress, habits of order in barrack rooms, and punctuality is very thorough. The cadet undergoes the private's training, only much more strictly; nothing is omitted. The curriculum includes guard duty, cleaning of rifles and belts, saluting cadet officers, grooming horses, driving guns, making beds, keeping rooms clean. No servants are allowed, except for scrubbing floors and cleaning boots.

There is, however, no attempt to teach more than the ground work of the duty of an officer. "The cadet is not supposed to be a thorough officer when he graduates, but to be fitted by his education to become one." His training as an officer takes place in the regiment or in the Service Schools.

An obvious drawback to West Point is the absence of ground for field training, which is only slightly attempted. There seems to be too much parade, stiff drill, marching past, and ceremonial. All this is a relic of the past century and is due to the great conservativism of the Academy.

The course of four years also seems too long for young men between 18 and 25 years old, subjected as they are to a high degree of restraint and confinement and hard work with their brains. The fact that a half, or even two-thirds, of those who enter are removed during their course shews the inexorable nature of the curriculum. But while severe on the individual, it accounts for the high standard of discipline and education attained.

GARRISON SCHOOLS.

Garrison Schools are administered by the Commanders of the various Garrisons, who detail some of the senior officers as instructors. These teach by hearing "Recitations" and by practical work, but also give lectures and set problems for solution on paper or on a map.

"Recitations" play such an overshadowing part in military schools in the United States that they must be more particularly described. The student stands to attention, facing the instructor, at a black-board, whereon he has written as a heading his own definition of that portion of the subject of the day which he has been ordered to "recite." He then recites or states as clearly and fluently as he can, and with as little prompting as may be from the instructor, what he knows of the subject. By this means it is seen whether he has learned his work, and care is taken that his pronunciation and language are correct, his ideas clear, and his expression lucid. In fact the student is taught to lecture to his instructor, while the rest of the class listen and learn. Two hours a day are devoted to recitations, and considerable time is needed for their preparation.

The theoretical course takes place between November and March, the practical during the other months. The whole course extends over three years, there being seventy-five school days in each year.

The course includes :—Drill and musketry, field service and tactics, administration, army regulations, discipline and law, field engineering, topography and sketching, international law, military hygiene, and hippology, in which latter mounted officers have a more extended education. Officers of Coast Artillery are, in addition, instructed in artillery material and explosives, ballistics, coast defence and permanent fortification ; while Engineer Officers undergo a highly technical course which it will be of interest to the reader to learn in some detail.

The course for Engineers consists of only two annual terms, each comprising 180 hours' instruction. Before the officer joins the school he must pass a theoretical examination in drill, tactics, hippology, hygiene, and military and international law. A practical course in these subjects is carried through in the first year, that in law taking the form of Court-Martial duty and problems in diplomatic situations. In the first year, too, instruction is given, as in the Infantry course, in administration, musketry, field service, topography and sketching ; while an advanced course of field fortification, surveying, and the construction of roads and railways is also laid down. The special drill regulations for Engineers, including pontooning, are also taught. Field engineering includes the design, and the superintendence of the construction of, rifle pits, shelter-trenches, loopholes and obstacles ; the use of mines and demolitions ; the making of revetments ; the employment of working parties ; tracing trenches and works with reference to the ground; and making fieldworks in model.

The second year is devoted to the civil or peace side of the profession. During this period are taught:—Particulars of water supply, sewage disposal, masonry, concrete, cement and mortar, roofs, bridges, heating, and ventilation. A thesis, or essay, has to be written on one of the subjects, selected by the instructor; and a practical course in military bridging also forms part of this year's training. In considering the instruction in building work it should be remarked that barrack construction in the United States is not carried out by the Engineer Corps, but by the Quartermaster-General's department, most of the Engineer Officers being employed on fortification and "river and harbour" works. As the Engineer Officers are, however, much in request for important public works, they are allowed to undergo the examination without following the courses.

It should be noted that in all Garrison school courses school duties take precedence of all others, but the officer students are employed when not at school on their military duties. No leave is granted to officers under instruction. A written examination is held in each subject, on a paper prepared in the War College, under the superintendence of a Board in each garrison; an officer who does not obtain 75 per cent. of the marks must attend the course again in the following year, when, if he again fails, he is reported to the Military Secretary and will probably be tried by Court-Martial for neglect of duty.

THE POSTGRADUATE COURSE.

After passing the Garrison School all officers undergo a further course in connection with each year's work in the school. In the first year an essay is written on a "suitable military subject" selected by the officer; the best of these essays is read to the assembled officers of the garrison, and any of marked merit are sent to the General Commanding and may be transmitted to the Chief of Staff for publication if desirable. During the second year's course the officers of the postgraduate class, as well as any field officers selected by the Commanding Officer, are required to solve a tactical problem prepared by the War College and also answer one paper in military and another in international law. During the third year they make a reconnaissance map of a route from 5 to 10 miles long. In this Postgraduate Course the student officer is allowed to discuss his work with his brother officers and consult any books; but he must draw his map and write his essay or the solution of his problem without assistance, and has to certify that this is the case. After passing this course the officer is not liable to any further school work or examinations, unless he joins one of the "Service Schools" to be now described.

THE SERVICE SCHOOLS.

These consist of the following :—

The Cavalry and Infantry School at Fort Leavenworth, Kansas.

The School of Application for Cavalry and Field Artillery at Fort Riley, Kansas.

The Artillery School at Fort Monroe, Virginia (for Coast Artillery).

The Engineer School at Washington, D.C.

The School of Submarine Defence at Fort Totten, New York Harbour.

The Army Medical School at Washington, D.C.

The Signal School at Fort Leavenworth, Kansas.

The object of these Schools is defined as "to instruct selected officers in the duties of their arm in war and in the general military knowledge needed for the proper exercise of the higher grades of command."

Each School is administered by a Commandant, assisted by an Adjutant or Secretary, with a body of Instructors and Assistant Instructors. Each is located at some army post or garrison, with sufficient troops to enable the practical work to be carried out; but the Post Commander, although under the Commandant of the School, corresponds direct with the General Commanding so as to relieve the Commandant of the administrative duties of the Post. The Commandant and the Instructors form the "School Board," which arranges the programme of instruction, prescribes the examinations, and has the final decision as to the proficiency of the students. In all the Schools, except that at Fort Riley, where the work, being chiefly practical, goes on all the year round, the term is from September to July, with a short holiday at Christmas; the winter months are devoted to theoretical work indoors. The students are below the rank of Major, and the instructors above that of Lieutenant.

As in the Garrison Schools, instruction is usually limited to very small classes, of less than a dozen; and is mainly based on recitations, which ensure that the student has thoroughly prepared his lesson for the day. There are also lectures to the whole class together, and an individual course of reading is prescribed. Essays on subjects connected with the course, and theses on specified problems, are set from time to time. Great stress is laid on practical work, which forms wherever possible a large portion of all the courses. In field work with troops note is taken of the smartness and punctuality of the students, their ability to command and to give directions and instructions, their resourcefulness and powers of observation. The instructor satisfies himself of the proficiency of each student in the recitations and practical work in each subject, and reports to the Commandant any that are deficient; but no marking takes place except at the examinations, which are held in each subject on its completion as well as at the end of the course. At these examinations the Student must obtain 75 per cent. of the marks, failing which he must undergo re-examination, when, if he again fails to pass, he is reported to the War Department.

THE CAVALRY AND INFANTRY SCHOOL.

This school is the most important and also the largest, and is intimately connected with the Staff College, being carried on in the same building and under the same Commandant and Instructors, with, however, a separate body of Assistant Instructors. The students are selected by the Chief of Staff of the Army from two names sent in by each colonel of a Regiment; and great care is taken by the latter to select his most promising officers and not those he wishes to get rid of.

The present class includes 91 officers, divided into sections of 12 under an Assistant Instructor, so as to allow of personal attention being given in the recitations and practical work. These officers, mostly married, live in excellent roomy quarters near the school.

There is a large body of troops in the Post, comprising a unit of each arm, and including a battalion of engineers (nearly 280 officers and men) and batteries of field, siege and mountain artillery. Thus, with the students at the Staff College and the instructors, the station is a very large one, and the students are thrown with a number of brother officers of every rank and arm and experience; this cannot fail to be an education in itself, as officers who have been at our own Staff College will agree.

The course lasts one year, and embraces the following subjects, each group being superintended by one Instructor with his Assistants:—

(*a*). *Military Art.*—Tactics, organization, hippology, riding, field exercises with and without troops, strategy, signalling, telegraphy.

(*b*). *Engineering.*—Military topography, surveying, sketching, field fortification, engineering (*i.e.*, demolitions, roads, and camping grounds).

(*c*). *Law.*—Law in general, military and martial law, with practice in mock courts formed of the class.

(*d*). *Sanitation and Hygiene.*—The care of the health of the soldier, both in his own person and as regards his camps, quarters, drains, water supply, clothing, and the cooking of his food.

(*e*). *Spanish.*—This includes not only reading and writing the language but also a thorough conversational knowledge.

In the most important subject of *Military Art*, the practical work in the field is preceded by problems to be solved on paper, where the student marks his dispositions by a brush on ground glass laid over the map. This subject includes advanced and rear guards; patrolling and scouting; reports on positions and communications; outposts; marches; tactics of each arm in attack and defence, and of all arms combined. Similar problems are also solved in the field with imaginary troops, and later with troops. Great attention is paid to writing orders. The theses, or essays, include such subjects as "The best method of training non-commissioned officers," or the production of a set of problems for the instruction of a small Post. In these, as well as in the examinations, note is made of spelling and correct use of language and punctuation, as well as of clear and concise expression. The course of strategy is elementary, consisting of a dozen lectures, of an hour each, on various campaigns, followed by recitations and questions on them. Lectures on arms and ammunition are also given.

In the *Engineering* course the instruction is chiefly practical, and the fieldworks are carried out by the students unaided. It is interesting to note that this course is largely based on our text-books.

The course of *Law* is an extensive one, going far beyond military law and courts. It is considered that service abroad often results in officers having to become administrators and judges over the civil population, whereby they may at times be placed in positions of international delicacy.

THE SCHOOL OF APPLICATION FOR CAVALRY AND FIELD ARTILLERY.

This school includes one for Cavalry, one for Field Artillery, and one for Farriery. Its object is to give practical instruction to these two arms in their field duties, separately and in combined operations.

It is situated at Fort Riley, in wide rolling prairie country, where the War Department has some 20,000 acres un-enclosed, forming an excellent ground for mounted troops to work over. At the Post there are three strong squadrons of different regiments, forming the equivalent of one cavalry regiment, and five batteries of field artillery, two of which are being transformed into horse artillery. Some of these units are relieved yearly in order that the instruction received may benefit the whole army gradually; and the officers and non-commissioned officers of the units present, together with certain attached officers, form the School,—under a "director" for each arm. The course lasts for three years, and is as follows:—

CAVALRY SCHOOL.

In the first year elementary work and horse training are taken up, and in the next two years the following course, both theoretical and practical: —

Hippology or horsemastership, including:—knowledge of age, soundness, conformation, suitability for service; veterinary science; forage; shoeing; bits and bitting; saddles, and transport harness. Riding: in school, out of doors, and across country. Cavalry drill and tactics;

campaigns with reference to cavalry. Reconnaissance and sketching; perspective sketching. Cavalry pioneer instruction; explosives; transportation; entraining and detraining.

THE FIELD ARTILLERY SCHOOL.

All Lieutenants of field batteries go through the following course of three years:—

First year: recitations in hippology, drill, and topography; organization and tactics (for First Lieutenants only). Second year: special studies for artillery; study of campaigns with special reference to artillery; topography. Third year: advanced course in field artillery, especially in practical work.

Experiments in field artillery material are also made at this School.

There is also a course for non-commissioned officers and selected privates of both cavalry and field artillery. This includes hippology, the drill of their own arm, reconnaissance and map reading; and for cavalry, in addition, drill and army regulations, elements of sketching, and field engineering, tactics, and shoeing.

An advanced course for artillery non-commissioned officers comprises telescopic sights, march tactics, demolitions, forage, care of *matériel*, road making, bridging, gunnery, artillery command, and target practice.

Both schools frequently unite for combined operations of the two arms.

THE ARTILLERY SCHOOL.

This school is at Fort Monroe, where there is a large armament of 12-inch and 10-inch guns on disappearing carriages, a battery of 12-inch howitzers,* and also 6-inch and smaller Q.F. guns, the whole manned by a garrison of 6 companies of Coast Artillery. There is an elaborate system of fire command, with lofty observing stations, as the site is low and does not allow of depression range finding. It is thus an excellent place for the study of Coast Artillery in practice, as well as a remarkably lively and pleasant station.

The course lasts one year, and corresponds somewhat to our "long course" at Shoeburyness. It has three branches, each under an Instructor with his Assistants;—

(*a*). Ballistics, theoretical and practical; coast fortification. (*b*). Electricity and its application to power; the use of submarine mines. (*c*). Artillery; explosives; coast defence.

Instruction is given by a course of private reading, by lectures, recitations, and the practical use of instruments and machines, as well

* *Known as "mortars" in the United States.*

as by work with artillery *matériel*. Papers are also written by the students on specified points of the course.

In connection with this school is one for *Master Gunners*, where the course lasts from October to June, and includes :—

Algebra ; geometry ; trigonometry ; range tables ; coast fortification ; artillery methods and *matériel ;* mechanical drawing ; photo-printing.

THE ENGINEER SCHOOL.

The object of this school is not only to instruct the junior officers of Engineers in their profession, but also to make research into such branches of science as relate to the duties of the Corps and to disseminate the information thus obtained. Experiments are therefore made here in Engineer equipment, in field and permanent fortification, and in field engineering.

The school is located at the barracks of the battalion of Engineers at Washington, where there are some 400 men in 4 companies under a Major, who is Commandant of the School.

The course lasts for one year, except in the case of officers who have not passed the Garrison School for Engineers, for whom there is a preliminary course of one year in which the Garrison School course is undergone. There are four branches of instruction, namely :—

(*a*). *Military Engineering.*—Coast defences, their types, construction, attack, and defence ; submarine mines and torpedoes ; influence of sea power on land operations, including combined naval and military movements ; tactics and strategy.

(*b*). *Civil Engineering.*—Mechanical engineering ; hydrographic surveys ; triangulation ; field astronomy ; photography ; river and harbour engineering ; lighthouse construction ; contracts, specifications and estimates.

(*c*). *Electricity.*—Generation, transmission and application of electricity for lighting, heating and power ; military uses of electricity.

(*d*). *Ordnance and Armour.*—Guns, projectiles and explosives ; the use of fortification ; and some knowledge of vessels of war.

The vast field to be covered in one year cannot fail to be noted, as well as the exclusion of field engineering from the course, which is limited to coast defence and civil work. It should be understood that only some forty Engineer officers are doing duty with Engineer troops, of which there are 3 battalions of 4 companies of 104 men. The rest of the Corps, amounting to 146 officers, are employed exclusively on coast fortification, "river and harbour" works, and on lighthouse construction, besides one or two on civil work for the Federal Government at the Capital and one always acting as Controller of the President's Household.

THE SCHOOL OF SUBMARINE DEFENCE.

Submarine mining has lately been transferred to the Coast Artillery. This school exists to instruct officers and men allotted to this duty in the use of the *matériel*, and to keep the service abreast of improvements in the electrical and steam plant of modern fortifications.

The course lasts one year, and comprises three branches :—

(*a*). Electricity, mines and mechanism.
(*b*). Chemistry and explosives.
(*c*). Special subjects approved by the War Department.

Instruction is given by a course of private reading, by lectures, and by the practical use of machines, instruments and apparatus. The students also write papers on specified subjects. At the end of the course the instructor reports on the proficiency of each student; and those who are not satisfactory are re-examined, and, if still deficient, reported to the War Department.

In connection with this school, there is a subsidiary one to qualify men for the position of Electrician Sergeant. Specially recommended men are examined at their station by an examination paper prepared at the School; those thus selected join the School in September for a six months' course, after which, if certified proficient, they are appointed Electrician Sergeants.

THE SIGNAL SCHOOL.

This school is being formed to prepare junior officers of the Signal Corps and certain attached officers of other arms for their duties, which comprise signalling, military telegraphy, ballooning and photography. Experiments will also be made in these matters in the school.

The students include 5 from the Signal Corps, 4 from the Artillery, and 12 graduates of the Cavalry and Infantry School.

The course will be of one year, and will include :—Signalling and telegraphy; ballooning; photography; topography; Spanish. Instruction and graduation will be regulated as in the other schools.

THE ARMY MEDICAL SCHOOL.

This establishment trains the Medical Officers of the army, and being of a highly technical nature will not be described in detail here. It is ably officered, lavishly equipped, and holds a high position in the profession. The army medical equipment is designed in it; but the training of the field units is carried out in two "companies of instruction," one with the school at Washington, the other at San Francisco.

THE STAFF COLLEGE.

The above are the Special Service Schools for the different arms. We now come to the Staff College, which provides the higher military education for officers of all arms. It is situated at the same station (Fort Leavenworth) as the Cavalry and Infa ntry School, and is under the same Commandant and Instructors, but with separate Assistant Instructors.

The students are selected by the Chief of Staff from the highest graduates of the last class graduated from the Cavalry and Infantry School, 9 to 15 in number, to whom are added 3 to 5 Artillery and 2 Engineer Officers; all are below field rank, and with more than 5 years' service.

The present Commandant, Brigadier-General Bell, is considered one of the keenest and most efficient soldiers in the army, and is credited with the honour of being designated for the command of any expedition that the United States may send abroad. The Instructors are carefully selected; and are deeply interested in the work of training officers for the duties of the General Staff in war, as well as for the other object for which the College exists, namely to investigate the development of military science and to make recommendations for the improvement of the efficiency of the various arms of the service.

The course lasts two years, the terms beginning annually on the 15th of September and lasting till the following 30th of June, with a fortnight's holiday at Christmas. There are three departments of study, each under an Instructor with a staff of Assistants, namely :—Military Art—Engineering—Law. The subjects taught are :—

(*a*). *Military Art*.—Service of security and information. (This is taught by the preparation of problems, and by umpiring at and criticising the work of the Cavalry and Infantry School). Organization, mobilization, and concentration of forces at home and abroad. The movement and supply of armies. Tactics. Lectures on military history and strategy. Lectures on military geography, especially that of America and the East of Asia. Lectures on the duties of the General Staff. "Staff Rides," which are hardly what we should call staff rides but are merely exercises on the ground without troops in various staff duties, such as preparing orders for marches, manœuvres and battle, writing reports, and making maps of positions and route sketches. Lectures on navies and naval warfare, especially in combination with military operations, by a naval Officer. Campaign studies, by visits to battlefields.

A course of private reading is prescribed in these subjects, and recitations and practical lessons in instructing are also insisted on. The greatest attention is paid to the work in the field, during which note is made of the student's military bearing, punctuality, and even his personal smartness. He is taught to form up and inspect, and give his orders to, his troops in a soldierly manner; to pay attention to accurate estimates of time for marches and combined movements; and to write orders clearly and concisely.

(*b*). *Engineering.*—Surveying, levelling and sketching, especially including combined work covering large areas; processes for reproduction of maps; the supervision of the topographical work in the Cavalry and Infantry School. Lectures on permanent and provisional fortification; attack and defence of fortresses. Lectures on bridging and making dams. Superintendence of the field engineering in the Cavalry and Infantry School. Field astronomy; determination of meridian, latitude, longitude, and time.

(*c*). *Law.*—Constitutional law, martial law and military government, but not *military* law, which is taught in the lower schools. The idea is that Generals and staff officers may find themselves in positions where they have to administer civil law and government.

There are no examinations, as the students are all taken from those specially selected for the lower schools, and are sure to be of undoubted zeal and ability. The Academic Board makes a report on the qualifications of each student; the report is sent to the Military Secretary, and the graduate is distinguished in the Army List by the letters G.S.C. to his name.

The course of two years at Leavenworth is undoubtedly a very severe one to undergo, and it is said that the men there work 15 hours a day at times. It would seem that it covers too much ground for the time, for all the students can hardly have the indefatigable energy and concentration of the present Commandant. The College, however, has only recently been initiated, and it is possible that modifications may be made in its working.

THE WAR COLLEGE.

Above the Staff College comes the War College, the highest of the institutions of military education.

This consists essentially of the Third Division of the General Staff at Headquarters, to which is attached a small body of specially selected officers. The actual college is under construction at Washington, and will be a splendid building when completed.

The work to be done here may be described under two heads;—(1) the treatment in detail of actual problems which confront the Staff in preparing for War, and (2) the supervision of the military education of the Army.

Under the first head come:—The preparation of strategical problems for specially selected officers. Projects involving organization, mobilization, concentration, strategic plans and preliminary operations. (These no doubt will form the actual mobilization plans for various wars that may be possible). Analyses of foreign military systems, or parts of them. (These would be published from time to time, and would tend to the education, in addition to the army itself, of the Government, of Congress and of the public, with a view to facilitating the introduction by legislation of reforms deemed necessary by the Chief of Staff). The regulation and conduct of manœuvres.

The educational work consists of:—The preparation of tactical problems for officers at large Posts, and the examination of their solutions. The preparation of tactical problems for the post-graduate course in the Garrison Schools, and the examination of the essays written during that course. The direct supervision of the courses and instruction in the Post, Garrison and Service Schools and at the Staff College. The supervision and annual classification of the civil schools and colleges where army officers are detailed as pro fessors of military science.

The above are undertaken by the permanent *personnel* of the War College, which consists of a General as President, a Colonel and a Lieut.-Colonel as Directors, a Secretary, and of all the officers of the Third Division of the General Staff.

The students are to be from time to time detailed by the Chief of Staff. There is no special time for the course, nor any examination or graduation.

The course of study comprises :—

(*a*). A critical study of an approved plan of operations, with a view to its confirmation or modification.

(*b*). The assumption of the original conditions on which an approved plan of operations was based, and the preparation of an independent plan, the two to be subsequently compared and discussed.

The above two items of work might, and probably would, be made use of to effect the periodical revision of the plans of campaign of the United States.

(*c*). A minute study of certain days' operations at an important period of the plan; involving the preparation of every daily order directing the movements of the wagon trains, the tactical arrangement of the marches (assignment of roads to columns, arrangement of the columns on the roads, etc.), length of marches, tactical arrangement of camps, bivouacs, etc.

(*d*). In connection with the above the discussion of the special problems which face the technical troops, of the tactical use of the three arms, the supply of ammunition, the disposal of the wounded, etc.

(*e*). A War Game, in which an actual campaign (of the Civil War for instance) will be taken, but under present conditions of armament, equipment, organization and tactical methods.

(*f*). Informal lectures and discussions on current military events and developments.

It is thus in the War College that the actual elaboration of the organization and plans for War will be carried out, by the General Staff there employed, assisted by the ablest officers of the army selected for this purpose. In working out these problems much will be learned, which will qualify the officers at the War College for the highest duties of the General Staff in the field and further for the responsibilities of the higher commands. It will thus answer to its name as in a real sense a school for War, and will form the crown of the structure of military education thus systematically built up.

But it is right to preferably regard the manœuvres as the war school for all officers, especially for the Staff Departments, the Staff, and the Commanders. As the Secretary of War says in his last annual Report, "They accustom officers of the higher grades to the command of troops under service conditions; they familiarize officers of all grades with the handling of their organizations in unexpected and varied situations, thus cultivating resourcefulness and military judgment; they give officers of the Staff Departments practical experience in the transportation and supply of troops"; and, most important of all, he might have added that they teach the Staff to compose orders, to distribute them with certainty and despatch, to arrange marches and combine movements, to be watchful, prompt and resourceful, and to relieve their chief of the detailed work so that he is free to form his strategical or tactical decisions.

This description of the system of military education laid down so comprehensively in the United States cannot fail to shew that the army is resolved to learn its work, and ready to go to school with that object. There is no doubt that the value and necessity of education has been taken to heart by all ranks; and that as a rule all officers, whether students or instructors, regard their school work as one of their highest duties. Were this not the case the wisest educational curriculum must fail in its purpose.

(Those who are interested in this subject are recommended to read:—an address on "The Present Military Educational System of the United States," delivered by Lieut.-Colonel A. C. Sharpe, U.S. Army, before the Colorado Commandery of the Military Order of the Loyal Legion of the United States, and printed in the April, 1905, number of *The United Service*; and also "The United States Army," a paper read at the Royal United Service Institution by Colonel Sir Howard Vincent, K.C.M.G., C.B., A.D.C., M.P., and published in its *Journal* of April, 1905.—*EDR.*)

RIFLE RANGES.

By CAPT. A. B. CAREY, R.E.

ORDINARY CLASSIFICATION RANGES.

THIS type of range is dealt with somewhat fully in the official *Care and Construction of Rifle Ranges*, 1905, now in the printer's hands. It is therefore only necessary to refer briefly to one or two points regarding the danger area.

The size of the danger area as laid down has, on level ground and under normal conditions, usually proved sufficient; and instances of bullets escaping beyond the danger area have been generally due to ricochets and not to direct shots. The explanation of this is that bad or indifferent firers comparatively seldom miss over the target; more frequently their shots strike short and ricochet over the butts; and if by chance a stray direct shot does clear the butt, it seldom clears it by more than a few feet, and it consequently strikes the ground within 1,000 yards in rear of the targets and becomes a ricochet. The danger area does not therefore depend so much on the extreme range of the rifle as on the ranging power of the bullet after ricochet; and the majority of dangerous ricochets will rise from where the greater number of bad shots strike the ground, *i.e.*, just below the targets.

Experiments were carried out at Hythe to see what range and deviation might be expected from ricochets occurring on level ground off different natures of soil. The result of these experiments was to show that the nature of the soil had little to do with the extreme range of the ricochet, though it affected the lateral deviation considerably; and that our ideas of the maximum range of ricochets had to be considerably enlarged. Ricochets clearing 2,000 yards in one bound were not infrequent; while in one series of experiments the average range of the ricochets traced was over 1,500 yards. Very few fell short of 1,000 yards, and these would as a rule clear some hundreds of yards in their second flight. Angles of lateral deviation of 20° and over occurred; but off level homogeneous soil large angles of deviation are infrequent.

These results were checked by a few cases occurring in actual practice. On one range, which was very unfavourably situated, ricochets diverging laterally at 21° fell 1,600 yards behind the butt and 600 yards left of the axis of the range. In another case, on rising ground but smooth homogeneous soil, ricochets constantly cleared the 2,000 yards limit, although this was some 350 feet above the level of the targets.

The disadvantages of a rising line of sight are very fully dealt with in the new issue of *Care and Construction of Rifle Ranges*, and I need not therefore enlarge upon this subject here.

The following conclusions may be drawn as to the conditions which govern the size of danger area required on a favourable site :—

(*a*). Accidental shots are just as likely to be directed in any other direction than that of the targets ; but they occur very infrequently and may therefore be neglected.

(*b*). Comparatively few direct shots clear the butts ; and these as a rule strike the ground at a fair angle of descent within 1,000 yards, and lose a considerable proportion of their velocity on impact.

(*c*). Large numbers of ricochets occur off the marker's gallery and the ground immediately in front of the targets, and these ricochets chiefly govern the size of danger area required.

(*d*). As appreciable numbers of ricochets range 2,000 yards in one bound, and as these ricochets must follow a more curved trajectory than that of a direct shot ranging a similar distance, a hill of 200 feet in height cannot be considered an efficient substitute for a 2,000 yards depth of danger area.

Fig. 1 is interesting as shewing the danger area laid down for a classification range by the German Rifle Range Regulations for 1904. They allow for a depth of 2,500 mètres from the shortest range firing point, that is 2,350 mètres behind the butts ; and further state that an extra 500 mètres should be obtained when possible. As regards width they consider that ricochets may occur at 100 mètres in front of the firer, and diverge as much as 30° laterally. This 30° lateral deviation is presumably made up of 6° deviation allowed for a direct shot, and 24° extra for the ricochet (see also page 221).

PROTECTED RANGES.

The provision of a large danger area constitutes the chief expense incurred in obtaining a classification range. Many attempts have therefore been made to design systems of bullet-proof screens or walls so as to stop all chance of direct shots or ricochets escaping from the range either laterally or beyond the stop butt. Unfortunately none of these attempts has been entirely successful. I believe that the Belgians were the first to take up the question of protected ranges ; and they have now very fine ranges, magnificently fitted up, in many of their large towns. Other powers have followed the Belgian lead in experimenting with protected ranges, but it is now recognised by most continental powers that screened ranges do not provide immunity from ricochets unless they are practically tunnelled. As however different countries have followed different types of design, I propose to give a brief description of each of the main types.

BELGIUM.

The Belgians (*Fig.* 2) site their protected ranges in the outskirts of large towns, directing the line of fire towards the open country. Firing at various distances from 200 to 600 mètres is usually provided for. A considerable number of targets are erected, perhaps 30 or more.

The system of screening consists of :—first, an iron-plated embrasure, in which the muzzle of the rifle is placed when firing; second, a transverse loopholed wall some 15 or 20 mètres in front of the firer, with a loophole just large enough to allow the firer to see the targets and to allow for the rise of the trajectory of a high shot fired by a tall man directed at the top of the targets. To avoid the very high stop butt that would be required to catch a bullet fired by a short man in such a way as to pass through the upper part of this loophole, one or more overhead screens are usually provided further down the range at 40 to 80 mètres from the firer.

In *Fig.* 2, A is the building in which firing takes place, B the roof of the embrasure; the function of this roof is to catch direct shots which might clear screen C. Screens C, D, and E are also utilised to catch direct shots and consequently to reduce the height of stop butt required. In calculating the height of stop butt the Belgians usually allow for the curve of trajectory of a direct shot which just passes under screen D. The supports of screens D and E are not always out of the line of direct fire and consequently are productive of ricochets. This arrangement of screening is not a good one, the main reason being that owing to the curve of trajectory the bottom edges of screens D and E come very near the path of well-aimed shots directed at the long range targets; consequently numerous shots strike these lower edges and rebound again from the ground. Screen E is also usually of such a height as to catch those ricochets off the bank under C which just escape under screen D, but the possibility of finely grazing shots from the same source escaping under E and over the stop butt is not contemplated.

There are several rows of targets at different distances from the one row of firing points, and a stop butt is provided only behind the last row. The firer is therefore able to see most of the ground from 200 mètres to the longest range; and consequently the ground can be struck almost anywhere by a badly aimed shot, and ricochets may occur which will escape from the range. An attempt is made to minimise the chance of ricochets by keeping the ground soft by frequent ploughing or by laying down tan, but these remedies are not entirely successful.

As regards ricochets off the face of the loophole, these are mostly caught by small splinter proofs close behind the loophole, but no provision is made for catching bullets which graze the edges of these cheeks. Such grazing shots escape in a variety of ways, either by clearing the stop butt direct from the bottom edge of the loophole, or by ricochetting from the ground and then out after having grazed the top or a side edge of the iron cheeks.

Sometimes ricochets off the edges of the controlling loophole will strike the edge of a screen or of one of the uprights or stays of an overhead screen further down the range, and be deflected out by that.

In cases where there are several rows of targets, bullets escape off the crest of the markers' galleries, easily clearing the stop butt in spite of the careful raking over of the soft tan. It is almost impossible to keep the tan free from bullets, and bullets lying there are sometimes struck by another bullet and thus cause a bad ricochet. Besides this, tan, though it undoubtedly stops a great many shots from becoming ricochets, does not stop all, and sometimes bullets will leave tan with a very considerable deflection.

In a lateral sense these ranges leave much to be desired, and double edgers and curlers are not considered probable. But a careful examination of the supports of the ricochet screens showed that double edgers undoubtedly occur.

There are many complaints in Belgium from the occupiers of land in rear of these ranges; in 1903 I was informed that one range had had to be closed on this account and that another range was going to be moved further out into the country. There can be little doubt that the life of ranges of this description is a short one, and terminates directly building operations begin in rear of the butts.

FRANCE.

The French experimented at some length with the Belgian type of protected range, several of which were built in the vicinity of large towns. They were unable however to obtain a sufficient degree of safety until they eventually closed them in entirely.

Their type range is a four-section 200-mètre range on Belgian lines, but with a larger opening to the controlling loophole. To the system of screening originally adapted from the Belgians, but considerably modified as the result of experiments, longitudinal walls of concrete have been added. These side walls extend from firing points to butts on either flank of the range; and support a nearly flat roof, made of concrete where it is most liable to be struck by ricochets, the rest being of a double thickness of stout corrugated galvanised iron sheets.

Transverse ricochet banks of from two to three feet in height are provided along the floor of the range. Narrow openings, protected by wings, are left in the side walls to admit some air and light to the interior. The arrangements as regards firing platforms and window openings at the firing point are much the same as in Belgium, except that a small open shed takes the place of the large buildings of the latter country.

ITALY.

Experimental work was carried on in Italy between 1897—1900 with a view to obtaining a satisfactory protected range; and the conclusion arrived at as the result of these experiments appears to be that the most suitable type of range was one limited to about 200 mètres in length, provided with a large stop butt and side wings and with a special apparatus for controlling the movement of the firer's rifle. This apparatus consists of a telescopic stand, about 6 feet in height, having a small brass ring which can be adjusted to suit the height of the firer's rifle. The firer inserts the muzzle of his rifle in this ring, which is of such a size that, so long as the firer occupies the correct firing position, the muzzle of his rifle cannot deviate laterally or vertically enough for him to miss the stop butt.

A somewhat similar apparatus has been tried in France and Germany, but does not appear to have been accepted in either country as suitable for general use. As the value of the ring depends entirely on the immobility of the butt end of the rifle, it is somewhat doubtful whether it would be of much practical value with recruits who flinched or otherwise allowed their bodies to move while pressing the trigger. On the other hand the ring would certainly reduce the proportion of dangerous shots arising from jerky trigger pulling, which causes the muzzle of the rifle to be deflected either in a lateral or downward direction.

GERMANY.

There are two types of semi-protected range in Germany. Type A is that employed where ranges are adjoining one another and lateral space is restricted. It consists of a system of earth banks, some 2 mètres in height, so arranged as to defilade each range from that next to it from danger of direct shots; transverse ricochet banks are also provided as a rule on the floor of the range.

Type B (*Fig.* 3) is a design with screens, but very different to the A pattern, and provides only protection against accidental direct shots escaping from the range.

The firing positions are shewn on the plan by small arrowheads; in the sectional elevation two short horizontal lines give the highest and lowest positions of the rifle for each firing point. The plan shews the method in which converging lines of fire are used, so that one target serves all three firing positions and yet the screens for the short distances do not interfere with the line of fire from the long range firing point. The shaded portions in the plan are the traverses which defilade the ground floor of the range from direct shots.

In Germany ranges are often constructed in a forest, each section having its own firing way cut through the wood and being separated from the next by a narrow belt of trees. This arrangement requires a great deal more lateral space than would be required for the same number of sections arranged according to the English custom; but the Germans claim as an advantage that the firers are not incommoded by the noise of the firing on the sections to their right or left, and also that each section is independent, *i.e.*, that firing may be carried out at 150 mètres on one target while the man on the next section is perhaps firing at 300 mètres.

Each section has positions and screens provided for firing as a rule at three consecutive distances, *e.g.*, 150, 200 and 300 mètres, or 400, 500 and 600 mètres. These screens are of shingle between boards backed with steel plates. They are about 2 mètres square, and are built on stout posts so that the bottom edge of the screen is some $1\frac{1}{2}$ mètres above the ground level. An opening about 1′·6″ square is cut in the centre of the lower part of the screen, through which the firer can see the target. The screens therefore afford no protection against low shots striking the ground and ricochetting out of the range; but the German regulations lay down that no man will hit the ground within 100 mètres of the muzzle of his rifle, and to defilade the rest of the floor of the range they provide traverses topped with sand boxes. These sand boxes, if well looked after, form a fairly efficient preventive against ricochets; but they are not an absolute safeguard, as any bullet striking a sand box within about 6 inches of the top edge has a chance of getting out, a chance which improves as the distance from the top edge decreases.

At the firing point platforms are provided so that the rifle shall always be at approximately the same height from the ground whether the firing is being carried on in the standing, kneeling or lying position. The openings in the screens are large enough to allow for differences due to varying heights of individuals.

The size of the screens varies with the distance they are apart, the second screen being large enough to catch any wide or high direct shots which pass through the opening of the first screen. Similarly the third screen is large enough to catch bad shots passing through the opening in the second screen, and the stop butt is large enough to catch bad shots passing through the opening in the third screen.

No provision is made against ricochets off the edges of these openings; the degree of protection afforded by these ranges is therefore strictly limited.

The main lesson to be learnt from these ranges is the extraordinarily good shooting of the men who use them; there were extremely few bullet marks on the screens of the ranges I visited, although these had been in use for some years and the screens had had no repairs done to them. The screening of protected ranges in other countries usually shews a large number of bullet marks within a year of being taken into use.

The conclusions of the Germans with regard to the value of protected ranges are given in the following extracts from their Rifle Range Regulations of 7th October, 1904 :—

"*Classification Ranges.*—Screened ranges are costly and make instruction in shooting more difficult. Their employment therefore should be limited to districts where roads, railways, villages or canals, etc., might be made dangerous from direct shots, or where no other means of protection would provide sufficient safety. Screens can in no wise stop danger caused by *ricochets* diverging either to the side or beyond the targets; therefore, whenever complaints are raised about danger, and before any plan is drawn up for erecting screens in consequence of these complaints, the most careful enquiry must be made to see whether the danger was caused by direct shots or by ricochets."

"*Field Practice Ranges.*—If the ground is 4,000 mètres in depth, then no means need be taken for protection against ricochets. Since on Field Practice ranges it is impossible to protect villages, railways, etc., from direct shots, therefore 4,000 mètres depth of danger area is necessary."

ENGLAND.

The first protected range of importance to be built in this country was that at Wormwood Scrubbs, on Belgian lines but considerably improved. This is a range of 200 yards. It has firing points at different levels, so that the firer's rifle is always at approximately the same height; a controlling loophole with iron cheeks; a splinter screen and also an overhead screen further down the range, and two ricochet banks to stop grazing shots off the top edges of the loophole; also a very high brick wall stop butt built close up to the targets, and doubtless the range owed its fairly long life to this as much as to the screening.

The principal improvements in this range over the Belgian type are :—

(1). The loophole is so sited that the firer cannot strike the ground unless he raises his rifle to such an extent that he loses sight of a considerable portion of the target.

(2). The overhead screen is so cut away that its bottom edge cannot be hit by direct shots, and is therefore not productive of that type of double ricochet which rebounds from the ground and so out of the range.

(3). Ricochets off the marker's gallery are prevented by the fact that the range is for one distance only, and the stop butt is very high and rises almost vertically behind the targets.

(4). Curling shots (in a vertical sense) are largely, but not entirely, prevented by the large excess of height in stop butt and screens over that which would be required to catch ricochets rising with ordinary trajectories from the bottom edge of the controlling loophole.

In a lateral sense the range is not nearly so perfect in design and there are many opportunities for bullets to escape the range, especially if fired from firing points close to the flanks of the range. I do not however think that these defects were the most serious cause of complaint. The chief defect lay in the very low controlling loophole, giving rise to numerous shots grazing the top edge and then striking the ground further down the range; these would rebound at a very steep angle and clear any stop butt.

From 1902—1904 experiments were carried on with a view to determining what degree of safety could be obtained on a protected range, and eventually a 3-section range, 300 yards in length, was built at Hythe in a safe position where experiments could be carried out without danger to the public. The principle on which the design was got out was on Belgian lines; but with the provisos that no direct shot could possibly strike any object beyond the controlling loophole except the marker's gallery, targets or stop butt; and that no grazing ricochet travelling from an edge of the controlling loophole in a curve approximating to that of a direct shot could escape the range, unless:—

(1). It grazed a second edge further down the range, or

(2). Was considerably deflected in its flight by extra resistance of the air caused through unsteadiness of the bullet after grazing.

Some experiments with ricochets, made prior to the drawing up of this design, had led to a false conclusion that bullets grazing an iron edge were never deflected at a less angle than 1 in 40, and this minimum angle of deflection had been confirmed by independent experiments made away from Hythe. The design was therefore so drawn up that the edges of the opening in the last ricochet screen were within the deviation of 1 in 40 from the edges of the controlling loophole although outside the widest lines of direct fire. It was therefore hoped that the possibility of double edgers had been avoided. When the expert rifle shots at Hythe were able to set to work methodically to prove or disprove the possibility of curling shots, double edgers and the like, this minimum deflection theory fell to the ground; and after a time they were able to obtain very finely grazing shots at the rate of about 3 per cent. of rounds fired, whereas ordinary grazing shots occurred at a rate of about 15 per cent. Many of these finely grazing shots travelled steadily down the range and struck the gallery or stop butt, and some even went through the target, but the fact that they occurred showed that the possibility of a double edger off the last screen was not improbable. The first graze on the controlling loophole was frequently most difficult to trace, and a most careful examination of the edges of the loophole had to be made in order to determine whether the bullet had touched or not.

The most frequent causes of bullets escaping were, however, double edgers off the openings in the nearer ricochet screens and curling shots. These latter appeared to strike in the most extraordinary places, where it seemed impossible for a bullet to reach without going through a screen containing a 6-inch thickness of shingle. After a time however the mystery was traced out by putting up thin paper screens. A bullet, after finely grazing the controlling loophole edge, was only slightly, if at all, deflected in its flight; it was however rendered unsteady in flight, its nose and base wobbling like a gyroscope that has received a blow while spinning. The bullet however gradually steadied down again (sometimes in 20 yards, sometimes in 60 yards, and at times taking more than that); but when steady its nose was no longer pointing in the direction of its flight, but more or less at an angle to it, either up, down, to one side or diagonally. The consequence was that the air resistance came into play on the side of the bullet, and apparently brought two forces into play, one tending to make the bullet follow the direction of its nose and the other tending to make its nose turn back into the direction of its flight. As a result the bullet appeared to compromise, and its final direction, as shewn by the last screen which it struck, was usually at a somewhat less angle of deviation than the angle through which its nose was deflected when it was first steadying down. The largest angle of deflection satisfactorily measured was 1 in 17 between the chords of the trajectory as taken at 3 points, viz., 1st where the bullet grazed the controlling loophole, 2nd a thin paper screen, 3rd a thick paper screen 60 yards from the loophole. Larger angles of deflection undoubtedly occurred, but the bullets cleared the last screen and it was therefore impossible to take measurements.

In this connection it is interesting to note that the penetration of a ricochet, though comparatively small while the bullet is wobbling, increases again as it steadies down in flight; and it would seem very possible that the explosive effect sometimes noticed with the service bullet at very short ranges is due to unsteadiness, which is highly accentuated on meeting with resistance.

For these experiments firing was carried out by expert shots from the lying position with a sandbag rest, and the edges of the loophole were deliberately aimed at. The proportion of hits obtained on the actual edge of the loophole varied from 20 to 40 per cent. of rounds fired, of which number about one-third to one-half would be finely grazing shots. The number of bullets escaping from the range was as a rule about 1 per 200 rounds fired, or 1 per 35 edge hits obtained. The proportion of edge hits probable on a range of this description used by average troops, as calculated from an actual diagram fired by a half company of a line battalion, is about ·5 per cent. of rounds fired; from this it would appear that about 1 bullet would escape from the range for every 7,000 rounds fired on it in ordinary use.

In the sectional diagram of the Hythe 300 yards protected range (*Fig.* 4) the vertical lines 1, 2, 3, 4, 5, shew the bullet-proof screens and openings in them. No. 3 is the main screen, containing the controlling loophole; its function is to prevent any but well-aimed direct shots travelling down the range. No. 1 is a subsidiary screen to prevent badly-aimed shots missing No. 3. No. 2 catches the ricochets off the edges of No. 1 loophole. No. 4 catches the more widely diverging ricochets off the edges of the controlling loophole in No. 3 screen, and No. 5 catches the more finely grazing ricochets from the same source.

The chain-dotted lines represent direct shots, one fired from the lowest possible firing position with the highest possible elevation, the other fired from the highest possible position with the lowest elevation consistent with the bullet going through the controlling loophole. It will be noted that the edges of the openings in the 4th and 5th screens are clear of these direct shots.

The lines drawn in groups of 3 dashes each represent the most diverging single edgers that can escape through the opening in the 5th screen; it is these single edgers which determine the size of the butt.

There are thus two main objects in this design:—Firstly the arrest of badly aimed direct shots (by screens 1 and 3); secondly the arrest of ricochets arising from bullets which have grazed the edge of one of the openings in those two screens (by screens 2, 4 and 5). It is evident that a third system of screening can be devised, which would give protection against double edgers and incidentally a considerable degree of protection against curlers. A design was drawn up on these lines, but was abandoned on account of the expense involved and the fact that, even with the addition of this third system of screens, absolute safety would not be obtained.

Many forms of controlling loopholes were tried with a view to minimising the number of dangerous ricochets; but no other form gave such good results as those obtained by the Belgian pattern of steel plate, sloping at about 25° to the line of fire and with the edge carefully rounded over so as not to be rapidly destroyed by bullets grazing it.

As regards the edges of the openings in the ricochet screens, these were at first of wood. But double edgers were so frequent, owing to the fact that the whole thickness of the wood facing was productive of ricochets, that these edges were lined with angle steel so fixed that one face was nearly at right angles to the path of ricochets from the controlling loophole, the other face being defiladed from them. By this means the amount of edge productive of ricochets was reduced from about 2½ inches to ·3 of an inch, and a considerable reduction in the number of double edgers resulted.

THE ENGINEERS OF THE SPANISH ARMY.

DUTIES.

THE Engineers of the Spanish army form one corps, the Cuerpo de Ingenieros, and their duties are very similar to those of the British Royal Engineers.

In war time they execute the works of fortification that are required, and supply the means of communication necessary to the army (viz., roads, bridges, railways, telegraphs, visual signalling, and pigeon post). They are also responsible for ballooning, for field electric lighting, and for the destruction of communications.

In peace time they are charged with the construction and maintenance of all military buildings, including fortifications and barracks. Submarine Mining is in the hands of the Navy.

ORGANIZATION.

The Engineers, in common with the rest of the Spanish army, have just been reorganized, and from the 1st January, 1905, their organization is as follows :—

Troops Quartered in the Peninsula :—

7 Mixed regiments of Sappers and Telegraphists.
1 Company of Telegraphists for the Madrid telegraph system.
1 Regiment of Pontoniers.
1 Railway battalion.
1 Balloon and Field Electric Lighting company.
1 Topographical brigade.
1 Company of workmen.
7 Reserve depôts.

Outside the Peninsula :—

*Balearic Islands.**

2 Companies of Sappers	One of each at Palma and
2 „ „ Telegraphists	one of each at Mahon.

* The Balearic Islands are divided into two groups, one consisting of Mallorca, Ibiza, Formentera and Cabrera, the other of Menorca. Each group has a Commanding Engineer, who has command of the engineer troops in his district and is in charge of the technical work of the corps.

*Canaries.**

2 Companies of Sappers 2 „ „ Telegraphists	One of each at Santa Cruz de Tenerife and one of each at Las Palmas.

Ceuta and Melilla.

1 Company of Sappers	Ceuta.
1 „ „	Melilla.

The Regiment of Pontoniers, Railway Battalion, Balloon Company, Topographical Brigade, and Company of Workmen do not form a part of any particular army corps; but they are attached to the corps in whose district they are quartered, and are, for instructional purposes, under the orders of the Corps Commanding Engineer.

Mixed Regiments. Each mixed regiment consists of 2 depôt and 6 active companies, of which 5 are sapper companies and the 6th a telegraph company.

The sapper companies preserve the same organization as under the old system.

The telegraph company consists of three distinct sections, two of which are electrical, viz., a field telegraph section, a mountain telegraph section, and a visual signalling section consisting of the men and material required for 8 stations. Each brigade of Cazadores (rifles) has a mountain telegraph section attached to it.

The depôt companies have duties analagous to those of the third battalions of line regiments, *i.e.*, they deal with the active reserve.

These 7 mixed regiments have been formed from the 4 previously existing regiments of Sappers and Miners and from the telegraph units which they replace, utilizing their men, animals, clothing and material. Each of the new mixed regiments numbered 1 to 4 is formed from the corresponding regiment of the old organization and is quartered in the same place (viz., No. 1 at Logroño, No. 2 at Madrid, No. 3 at Sevilla, No. 4 at Barcelona), and they are considered as in every respect the successors of those regiments. The 3 remaining regiments, numbered 5, 6 and 7, are quartered respectively at San Sebastian, Valladolid and Valencia, and are being organized at those places. Detachments from these regiments are sent out from the headquarter station to other places in the command; thus the 3rd Regiment at Seville furnishes the detachment of engineers in the Campo de Gibraltar.

Transport.—The animals necessary for the pack sections of 2 of the sapper companies of each mixed regiment, the field section of the

* The Canaries are divided into two military governments, the western group consisting of Tenerife, La Palma, Gomera, and Hierro, the eastern of Gran Canaria, Lanzarote, and Fuerteventura. Each government has a Commanding Engineer.

telegraph companies of the 2nd and 4th Regiments, and the mountain section of the telegraph companies of all seven regiments appear in this year's estimates. The rest will be provided later.

Attachment to Corps.—Each regiment is attached to the Army Corps of the district in which it is quartered, and the Corps Commanding Engineer is responsible for its theoretical and practical instruction.

Formation of Second Battalions on Mobilization.—On mobilization each of these mixed regiments will form a second battalion out of the reserve companies and the 5th Sapper Company, the telegraph company being either divided between the battalions or allotted to that one which most requires it. The Major takes command of the second battalion.

Parks and Matériel.—Under the old organization the regiments of Sappers and Miners had on charge in their barracks *matériel* corresponding to that of one company on a war footing, the remainder being kept in the Engineer parks, with the exception of that of the 2nd Regiment, which was kept in the arsenal at Guadalajara. Engineer parks and storehouses exist in almost all garrison towns and are supplied from the central stores at Guadalajara. There were fortress and field parks at Barcelona, Cadiz, Madrid, Cartagena, Zaragoza, Ferrol, Valladolid, Vitoria, Burgos, Granada, Ceuta, Pamplona, as well as the Canaries and Balearic Islands. The siege and reserve parks of the Sappers and Miners and the tools of the parks in course of formation are on the charge of the Talleres del Materiel (workshops) at Guadalajara.

For the telegraph service of the Madrid system, and for duty at the General School of Military Telegraphy, there is one company, which is organized from the previously existing Telegraph Regiment. Madrid Telegraph Company.

The Regiment of Pontoniers is quartered in Zaragoza. Its establishment is :— Regiment of Pontoniers.

	Colonel.	Lieut.-Colonel.	Majors.	Captains.	1st Lieutenants.	Medical Officers.	Veterinary Officers.		Riding Master.	Men.	Animals.		Wagons.
							2nd Class.	3rd Class.	2nd Class.		Riding.	Draught.	
Peace.........	1	1	3	7	13	1	1	1	1	400	60	115	72
War	1	1	2	11	34	2	4	4	1	1723	227	962	153

The regiment is organized in 4 companies in peace time and 8 in war time, each commanded by a captain with 3 first lieutenants and 80 men in peace and 119 in war, including trumpeters, farriers, smiths, pontoniers, and 1st and 2nd class tradesmen. Each company has the *matériel* necessary for the construction of 75 mètres of bridge. In 1897 the bridging material was changed from the Birago type to the Danish type, being constructed in the workshops at Guadalajara. The bridging material not in use by the regiment is stored at Guadalajara.

Railway Battalion.

The Railway battalion is quartered in Madrid, and works, for instructional purposes, the line between Madrid and Villaviciosa de Odon. Its establishment is :—

	Lieut.-Colonel.	Majors.	Captains.	1st Lieutenants.	Medical Officer.	Veterinary Officer.	Men.	Animals. Riding.	Animals. Draught.	Wagons.
Peace..................	1	2	7	13	1	—	397	3	4	32
War	1	2	7	18	1	1	1057	31	194	49

It is organized in 4 companies, each commanded by a captain with 3 first lieutenants.

Cyclist Section.—There is a cyclist section attached to the railway battalion. Its organization is of a permanent character, and it is charged with the service of communication in the field and at manœuvres, being then attached to Headquarters.

Railway Park.—The railway park, which was formerly a separate unit, is now attached to the battalion.

Balloon and Electric Light Company.

The Balloon and Field Electric Lighting Company is quartered at Guadalajara. Its war establishment is :—

Major.	Captains.	1st Lieuts.	Men.	Animals. Riding.	Animals. Draught.	Carts.	Wagons.
1	2	4	100	10	30	1	3

The Balloon Company is in peace time commanded by the Commandant of the Balloon Park, who is also in charge of the central carrier pigeon loft at Guadalajara (see last para. at end) and of the Military Photographic Section. Ballooning was first recognized in the Spanish army by Royal Decree of 15. 12. 84. The Balloon Park and Company are now directly under the Minister of War, and are administered by the General Staff, which is entrusted with the inspection of military communications in general.

The Balloon Park and Company has the following staff in peace time :—

C.O. of park and company	1 lieut.-colonel.
Major and Superintendent of instruction...	1 major.
For technical studies of park	1 captain.
Captain of the company, also in charge of the pigeon loft	1 captain.
Treasurer and in charge of the technical material	1 captain.
Duties of the park and company	4 1st lieutenants.
Quartermaster	1
Storekeeper...	1
Paymaster of the park	1
" " company	1

Both spherical and sausage-shape balloons are in use.

Topographical Brigade.

The duties of the Topographical Brigade are the preparation of plans of fortifications, districts, places and frontiers, and in general the execution of all classes of topographical, geodetic and lithographic work. In the field it will be attached to the H.Q. staff of the army, under the Commanding Engineer. Its Headquarters are at present at Pontevedra.

Its establishment is :—

	Lieut.-Col.	Major.	Captains.	1st Lieuts.	Men.	Animals.		Wagons.
						Riding.	Draught.	
Peace	1	1	2	2	80	2	—	—
War	1	1	2	6	224	10	8	2

It is organized in two companies, and is under the orders of the General Staff of the Army.

Company of Workmen.

The Company of Workmen is stationed at Guadalajara for duty in the workshops there. Its establishment is 1 captain, 1 1st lieutenant, 110 men.

Reserves.

The active reserve of the Engineer units is under the orders of the O.C.s of the corresponding regular units; in the mixed regiments the depôt companies deal with the active reservists.

In each army corps district there is an Engineer reserve depôt, which deals with the members of the second reserve who, having served in various units of the corps, happen to be residing in the district.

Engineer Services.

In addition to the military units already mentioned there is an organization for carrying out the Engineer Services. Commanding Engineers, with a staff of Division Officers and subordinates, are appointed to army corps and districts, and carry out the Engineer Services in a similar manner to that which obtains in the British army. The Commanding Engineer also exercises command over the Engineer troops in his district. These districts are known as Comandancias (Generales) de Ingenieros. The Comandancia General of each Army Corps district is in charge of an Engineer brigadier-general or colonel.

The Engineer Services are carried out to a certain extent by the men of the regiments of Sappers, and to a much greater extent by civilian workmen. When the latter are employed they are in charge of the Division Officers of the garrisons in which the works are being executed. Employed on Engineer Services under officers of the Corps is the "Personal del Material de Ingenieros," which consists of the quartermasters (oficiales celadores de fortification) who deal with accounts and the details of fortification and barrack services, foremen of works, clerks and draughtsmen, workshop foremen, and (in Africa) clerks of works. Of these persons only the quartermasters hold military rank (varying from captain to sergeant, according to class). The remainder only hold relative military rank for a few specific purposes.

SUBORDINATE ESTABLISHMENTS.

In order to assist it in carrying out its various duties the Corps of Engineers has a number of subordinate establishments, many of them at Guadalajara, the Chatham of the Corps. Up to 1901 they were grouped together there as the "Central Establishment," but have since become independent units.

They consist of the following :—

Central Institute of Electricity, etc.

(1). A Central Institute of Electricity and Communications, located at Madrid and attached to the Telegraph Company of the Madrid system. This is charged with :—

(*a*). The study of the water supply of the waterfalls of the river Tagus, granted to the War Department for military purposes.

(*b*). The General School of Telegraphy. In order to ensure uniformity all the telegraphists and N.C.O.'s of the telegraph units are passed through this school.

(*c*). Experiments and studies necessary for the Communications service, the workshops and central telegraph park, and the work connected with the completion of the Spanish visual signalling system.

This Centre, together with the balloon park and company, the railway battalion and all the telegraph units, is subject, as far as the special service of communications is concerned, to the Central General Staff.

(2). The Laboratorio de Ingenieros. Laboratory.

The great importance which has been attached for some years to the technical study of building materials caused a Royal Order to be issued on 14. 6. 85 for the formation of a laboratory, under the orders of the "Junta Especial del Cuerpo de Ingenieros" (Engineer Committee), in which the necessary studies could be made.

After numerous changes it was reorganized by R.O. of 22. 4. 97 and now deals with the following subjects:—Determination of the specific constants and physical, chemical, and mechanical properties of building materials. Collection of technical and economic data relative to building materials. Distribution of information as required regarding the properties and use of all kinds of machines, tools, and materials used in the engineer works and services. Purchase of such tools as cannot be made in the Central Corps Workshops. Experiments which may be required for testing the quality of materials used on the works. Construction of detonators and fuzes required by the Sappers and Miners, also of rockets and fog signals for the railways. Study of explosives from the point of view of their application and employment by the Engineers. In conjunction, if possible, with the Central School of Gunnery, the study of the effect of explosives on defence works.

It has a colonel as director, with a lieut.-colonel as executive officer, 2 captains and a quartermaster, and is located in Madrid.

(3). The Arsenal (Maestranza) and Workshops (Talleres del Material) situated at Guadalajara, with a colonel as director, 1 major as executive officer, 1 medical officer, 1 superintendent, 1 paymaster, 3 storekeepers and the above-mentioned company of workmen. This establishment consists of the workshops, where the tradesmen of the corps are trained, and where as much work as possible is done in connection with the construction, repair, and maintenance of the bridge trains, and of the war *matériel* and tools of the fortress and field parks established in the more important fortresses and garrisons. There are numerous siege, fortress, bridging, field, pack-train and other parks, and a large depôt of *matériel* in connection with this establishment. Arsenal and Workshops.

(4). The Record Office at Guadalajara. Record Office.

(5). The Engineer Museum and Library at Madrid, with a colonel as director, 1 captain, 2 quartermasters, 1 superintendent and 1 paymaster. Museum and Library.

OFFICERS.

Engineer Academy.—The Engineer Academy is situated at Guadalajara and corresponds to both the R.M.A., Woolwich, and the S.M.E., Chatham. It is under a colonel as director, with a lieut.-

colonel as second in command, 1 major as executive officer, 15 majors and captains as professors, and two 1st lieutenants as assistants; also 1 medical officer, 1 veterinary professor, and 1 quartermaster.

Admission into the Corps.—Entry into the commissioned ranks of the Corps of Engineers is made from this Academy, which is the centre of instruction for the officers of this arm of the service. Candidates for admission must comply with the following conditions:—(1). Be Spanish subjects. (2). Be within certain age limits (17 minimum and 28 maximum, the latter only in the case of men who have served at least 2 years in the ranks). (3). Be physically fit and up to standard of height and measurement. (4). Be otherwise fit for the public service. (5). Have never been expelled from a place of public instruction. The candidates petition the Director of the Academy, transmitting various certificates as to birth, etc.; they do this direct if civilians, and through their C.O.s if serving. There is an entrance examination in the spring of each year, candidates being examined in Spanish grammar, geography, history, elementary physics, French translation, freehand drawing (copying an engraving of a head), arithmetic and algebra, geometry and trigonometry.

The course at the Academy lasts 5 years; at the end of the first 3 years the students are promoted 2nd lieutenants, and they pass out finally as 1st lieutenants. On completion of the course at the Academy the 1st lieutenants visit, under the direction of their professors, such works as may be of practical value to them.

Strength in 1904.—The strength of the Corps in officers in 1904, with the ages and length of service of the senior and junior in each rank, are shown in the following table:—

	Senior.		Junior.	
	Age.	Service	Age.	Service.
Lieut.-Generals (1)	—	—	—	—
Generals of Division (0)	—	—	—	—
Generals of Brigade (7)	—	—	—	—
Colonels (34)	60	44	55	40
Lieut.-Colonels (50)	52	36	44	29
Majors (114)	45	29	42	24
Captains (236)	44	24	27	11
1st Lieuts. (167)	27	11	27	7

ADMINISTRATION.

Engineer Section of War Ministry.—The Ministry of War has an Engineer Section which deals with the following questions:—*Personnel* and all matters relating to the officers and men of the active and reserve lists of the Corps and individuals belonging to the "Personal del Material de Ingenieros." Engineer material and everything relating to its construction, acquisition and change. Projects for and construction of military works. Appropriations. Depôt of plans and instruments. Technical details and accounts. Statistics relating to buildings. Fortification works in the coast districts, on the frontiers, in the fortresses. Engineer details of defence schemes. Procedure of business relating to all the subsidiary establishments of the Corps Business of the Junta Facultativa de Ingenieros.

Engineer Committee.—The Junta Facultativa de Ingenieros (or Engineer Committee) was created by R.O. of 12. 9. 01. Its object is to inform the Minister of War concerning such technical subjects proper to the services of the Corps as it is consulted about; and especially concerning projects for and the construction of works of defence, quarters and military buildings in general, building materials, and material for the troops and parks. By R.O. of 8. 10. 01 it was directed to draw up regulations for itself, which were approved by R.O. circular of 5. 11. 03.

There is also entrusted to this Committee the duty of proposing to the Minister of War such innovations and reforms as it considers suitable, within the realm of the special technical services whose study is confided to it. It consists of a brigadier-general as president, the colonel director of the Engineer Museum, the colonel of the 2nd Regiment of Sappers, the colonel in charge of the Laboratory, the lieut.-colonel of the Railway Battalion and 1 other lieut.-colonel, with a major as secretary and 3 captains as associate members.

MISCELLANEOUS.

Garrison Duties.—The Engineers as a general rule do not perform garrison duties, except when civil disturbance or other exceptional circumstances make it necessary in the opinion of the G.O.C. of the Army Corps.

Height.—The minimum height of recruits is 1·680 m.; but for the company of workmen, the topographical brigade and balloonists this is reduced to 1·660 m.

Carrier Pigeons.—The Carrier Pigeon service is in charge of the Engineers, the central loft at Guadalajara being an annexe of the Balloon Park. The following military pigeon lofts have been approved, but it is uncertain whether those marked * are in existence:—1 at Madrid; 4 on the French frontier, established at *Figueras, Saca, Pamplona, and *Oyarzun (the previously existing loft at Gerona has probably been transferred to one of the two places starred); 2 on the Portuguese frontier at Ciudad Rodrigo and Badajoz; 2 on the coast of Morocco at Ceuta and Melilla (a new station has just been opened on the Chafarinas Islands); 2 in the Balearic Islands at Palma and Mahon; 5 on the coasts of the Peninsula at *Ferrol, *Valencia, Tarifa and Barcelona; and 3 in the interior at Zaragoza, *Valladolid and *Cordoba. The establishment of pigeons (exclusive of that of the central loft) is 400 pairs at Madrid and 100 pairs at each of the other lofts. The Societá Colombófila de Cataluña is bound to place its carrier pigeons at the disposition of the Chief of the Military Communications for manœuvres and field operations.

THE DESIGN OF TALL CHIMNEYS.

By CAPT. A. ff. GARRETT, R.E.

MAJOR AINSLIE, in his article on the above subject in the June issue of the *R.E. Journal* has called attention to the very different results obtained in tall chimney design according to whether Colonel Scott-Moncrieff's method, Messrs. Babcock & Wilcox's formula or the London County Council rules are followed.

On examining the formulæ, it is evident that the Babcock & Wilcox formula is incomplete, as it merely provides for safety against overturning, and takes no account of the stresses set up in the masonry or as to whether the masonry is strong enough to withstand the stresses so set up. It can therefore only be looked upon as giving a first rough approximation, though possibly it may give reliable results for low chimneys, where the stresses set up will not be very high.

The London County Council regulations are mere arbitrary rules, and are based neither on considerations of safety against overturning nor against excessive stresses in the masonry. They may form a good practical guide, but surely any chimney of any dimensions should be more carefully investigated.

The Scott-Moncrieff method is complete in that it ensures safety against the various ways in which failure may occur; but it appears to err on the side of excessive safety, and gives unnecessarily heavy chimneys. The reason for this lies in the nature of the assumptions made regarding the wind pressure. Thus the pressure set up by the wind is supposed to act more or less uniformly over the whole of a vertical plane drawn through the centre of the chimney, the width of this plane being taken as the mean external diameter of the chimney, and the height of the plane as the actual height of the chimney. The pressure is supposed to be the maximum observed, viz., 56 lbs. per square foot, acting on the whole of this vertical plane; and further, the centre of pressure is assumed as being situated at half the height of the chimney. The overturning moment is then obtained by multiplying the area of this vertical plane by the pressure of the wind (usually taken at 56 lbs. per square foot) and by half the height of the chimney.

Now the resulting overturning moment must be too great for the following reasons:—

(1). It is practically certain that the wind pressure can never be as high as 56 lbs. per square foot on the lower parts of the chimney near the ground.

(2). Instead of the chimney having a constant mean diameter, it tapers considerably. The moment of the wind is evidently greatest on the top portions of the chimney, and it is just here that the error of assuming a mean diameter for the chimney will make the most difference.

It therefore seems worth while to investigate the overturning moment more accurately.

Stevenson's experiments in wind pressure show that the pressure increases as the ordinate of a parabolic curve, *vide* pp. 234, 235 of *The Principles of Structural Design.* The formula $18+\frac{x}{4}$, where x is the height above the ground in feet, gives results practically identical with Stevenson's. Thus at 50 feet, it gives a pressure of $30\frac{1}{2}$ lbs. as against Stevenson's 30 lbs.; at 100 feet 43 lbs. as against 42 lbs.; and at 200 feet 68 lbs. as against 66 lbs. according to Stevenson. It is proposed therefore to assume the wind pressure as equal to $18+\frac{x}{4}$.

Even this formula will probably give an excessive overturning moment. Sir B. Baker's experiments, carried out during the erection of the Forth Bridge, indicate that the pressure per unit area on large surfaces is considerably less than upon small surfaces. Thus the highest pressure recorded during the seven years the experiments lasted was 41 lbs. per square foot on a small area of $1\frac{1}{2}$ square feet, while on a large area of 300 square feet the maximum pressure did not exceed 27 lbs. The Firth of Forth is said to be exposed to particularly high winds, so probably these figures may be taken as representing the maximum pressures likely to be met with in the British Isles under ordinary circumstances. It must be a very small chimney that does not present a surface of 300 square feet. It therefore appears that the formula $18+\frac{x}{4}$, giving pressures varying from 18 lbs. at the ground level to 68 lbs. at 200 feet, must allow for as great or a greater pressure than is ever likely to be met with in practice. In fact it is doubtful if even an American tornado would develop higher pressures.

Now suppose the chimney to taper uniformly from an external diameter B at the base to b at the top, and let the height be h.

Consider a strip dx at height x.

The width of the chimney at height x is $b+\frac{x}{h}(B-b)$. Therefore the area of the strip is

$$\left[b+\frac{x}{h}(B-b)\right]dx$$

and the wind pressure on the strip is

$$\left[18+\frac{x}{4}\right]\left[b+\frac{x}{h}(B-b)\right]dx.$$

Therefore the total wind pressure on the whole chimney is (for a round chimney)

$$\tfrac{1}{2}\int_0^h \left[18+\frac{x}{4}\right]\left[b+\frac{x}{h}(B-b)\right]dx \ldots\ldots\ldots\ldots (1).$$

To find the height of the centre of pressure. This is evidently the same as finding the centre of gravity of all the horizontal wind forces acting on the whole area of the chimney; and by the general formula for the centre of gravity is

$$\frac{\int_0^h \left[18+\frac{x}{4}\right]\left[b+\frac{x}{h}(B-b)\right]x\,dx}{\int_0^h \left[18+\frac{x}{4}\right]\left[b+\frac{x}{h}(B-b)\right]dx} \ldots\ldots\ldots\ldots (2).$$

The overturning moment due to the wind will be the product of (1) and (2) or

$$\tfrac{1}{2}\int_0^h \left[18+\frac{x}{4}\right]\left[b+\frac{x}{h}(B-b)\right]x\,dx.$$

Evaluating this, we get the moment

$$M=\frac{h^2}{8}\left\{12\ (2\,B+b)+\frac{h}{12}(3\,B+b)\right\} \ldots\ldots\ldots\ldots (3),$$

which is a fairly simple formula readily applicable to any chimney.

Computing the overturning moment by this formula, I have worked out the tension and compression (y and Y) at the base for Major Ainslie's chimneys A and B, and also for three typical existing chimneys, viz., the Edinburgh Gas Works, East London Waterworks, and Smethwick Chemical Works chimneys (see Table below). For purposes of comparison I have also worked out the tension and compression by the old formula, with the result that all five chimneys appear to be unsafe. As, however, the three typical chimneys are examples of successful works which have stood for many years, I think this is a clear practical proof that the old formula gives rise to unnecessarily heavy chimneys.

Looking at the values of Y and y computed by the new formula (3), it is seen that the Edinburgh Gas Works and East London Waterworks chimneys are safe; but that in the case of the Smethwick chimney there is a tension of 2·75 tons per square foot. This chimney, however, is 312 feet high; so that by the formula $18+\frac{x}{4}$ we are assuming a wind pressure of 96 lbs. per square foot at the summit, a pressure never likely to be approached.

I would therefore propose that formula (3) be adopted for chimneys up to 200 feet in height; that for chimneys from 200 to 300 feet $\frac{3}{4}$ of the value of M given by (3) be taken; and for chimneys from 300 to 400 feet $\frac{2}{3}$ M. Taking $\frac{2}{3}$ M, the values of Y and y for the Smethwick chimney become 15·35 and ·45, which are safe.

Considering Major Ainslie's chimneys in the light of the above, chimney A would appear to be quite safe; but chimney B shows a tension of $2\frac{1}{4}$ tons, and would therefore be risky for an exposed situation. But in a low-lying district, or if partially sheltered by trees or neighbouring buildings, it would probably be safe against most storms.

I have calculated the stresses in the masonry where failure occurred in the St. Louis chimney, which was fractured (by a tornado) 110 feet from the top, where the thickness of the brickwork changed from 13 inches to 17 inches. The result is a tension of 5 tons per square foot, which is evidently unsafe.

In the case of the three typical chimneys, I have calculated the actual weight and given the weight computed by the Babcock & Wilcox formula for comparison. It will be seen that in every case the actual weight is far in excess of that given by the formula. It appears as if the Babcock & Wilcox formula can only be considered as a rough guide for chimneys under 100 feet in height in unexposed situations.

It is claimed that formula (3) gives a method of calculating the overturning moment which is in accordance with recent experiments on wind pressure, and that its reliability is borne out by the dimensions of existing and successful chimneys.

COMPARATIVE STATEMENT OF CHIMNEYS.

All Units in Feet and Tons.

Symbols.	h	B	b	W or N	W		I	A	By New Formula. M	By Proposed New Formula. Y	By Proposed New Formula. y	By Old Formula. Y	By Old Formula. y	
Name of Chimney.	Height = h feet.	External Diameter at Base.	External Diameter at Top.	Weight in Tons.	Weight by Babcock & Wilcox Formula.	Inside Diameter at Base.	Moment of Inertia of Base.	Area of Base.	Overturning Moment.	Compression at Base.	Tension at Base.	Compression at Base.	Tension at Base.	Remarks.
Edinburgh Gas Works	100	10	3·5	144	85	5·5	445	54·8	315	6·17	− ·91	7·29	− 2·03	
East London Waterworks	175	18·5	6·25	760	260	11·0	5100	173	2440	8·8	− ·04	13·01	− 4·25	
Chemical Works, Smethwick ...	312	27·2	6·5	2175	755	19·2	20500	292	{ 16400	17·65	− 2·75	21·35	− 6·45	
									{ 11940	15·35	− ·45	—	—	Reducing M to $\frac{2}{3}$ M.
Major Ainslie's Chimney A.....	85	8·5	3·5	108	64	—	250	49	181	5·29	− ·85	7·14	− 2·71	
Do. do. B.....	85	7·1	3·5	79·5	73	3·3	111	29·6	156	7·65	− 2·27	10·1	− 4·7	
St. Louis Chimney, fractured 110 feet from top by a tornado.*	162	17·8	15·6	23·2	—	10·2	2030	58	1150	5·45	− 5·05			

* Above is calculated for section 110 feet from top, where fracture occurred.

PERSIAN DESERTS AND GARDENS.

By Capt. L. E. Hopkins, R.E.

Persia is a country of contrasts. There is bitter cold and snow and terrific heat; ancient ruins and fine new palaces; the latest form of telegraph instrument may be heard in an old Sassanian palace overlooked by barbaric frescoes of that age; Europeanised Persians, who will chat with you in English, German or French, rub elbows with the Ilyats or nomad tent dwellers.

But what strikes one most forcibly is the contrast between Persia's beautiful gardens and its godforsaken deserts. Anyone brought straight from England and put down haphazard anywhere between Shiraz and Quetta would probably call the place a desert offhand. But there are deserts of all degrees. The treeless barren mountains, and the long stony glacis which lie between them and the valleys and seem so endless and wearisome to cross, present a very dreary appearance for the greater part of the year; but in early spring after a snowy winter these same wastes are covered with short green grass and carpeted with red poppies, yellow tulips, blue irises and crocuses, hollyhocks and all manner of unnamable flowers. Further east, Baluchistan frequently gets no snow or rain in winter and then spring brings with it no grass or flowers; and how all this vegetation manages to lie dormant under such circumstances, sometimes for two or three years, is to all, except perhaps a botanist, something of a marvel.

The real deserts of Persia are the Kavir and the Lut. Possibly these names cover many different aspects of desert, as in all countries names have usually a local significance which varies widely in different districts. Anyone travelling between Shiraz and Kerman will cross the Saidabad Kavir at an elevation of 5,600 feet. It is during summer a plain of pure salt; and in a wet winter it may sometimes become a salt marsh. After passing the Lake of Niriz—the Persian Dead Sea—at the eastern end of which is a Kavir in embryo, one crosses an intervening range of mountains by a pass of about 9,000 feet elevation. The greater part of this range is a sort of no-man's-land, disowned by both the Governors of Shiraz and Kerman; and its few inhabitants, when times are bad, eke out a precarious existence by robbing passing caravans.

From the summit of the pass the track descends a wide valley between high mountains, whose black profiles stand out clear against what seems a great white sea stretching away from the bottom of the valley some fifteen miles distant. This is the surface of the Kavir, a pure white, like snow; it is one of the most extraordinary sights in the world and Persia's speciality. At noon, after a thirty-mile march, its shores are reached and camp is pitched near a solitary mud-walled house and enclosure, and one can readily excuse the surly manners of the people after tasting the nauseating salt water which they must perforce habitually drink. A hot salt wind blows across the Kavir, and the shelter afforded by a solitary locust-stripped tree does little to prevent one's face from being almost skinned.

A start must be made in the early morning before sunrise to get across before the glare of the white salt surface becomes too unbearable. The first four miles of the Kavir is not unlike a fallow field covered lightly with snow or a heavy hoar frost. This efflorescence of salt gets gradually thicker and thicker until, for about four miles in the centre, the salt lies in a layer about two inches thick. It has a perfectly smooth white surface, like a frozen pond covered with snow, stretching away to the horizon as an unbroken glistening plain. On the track the surface is quite solid, but it is dangerous to go far off it; one can see the tracks of camels which have strayed off the road, getting deeper and deeper in the salt slush beneath the hard surface the further they went. The solid salt ice gradually gives way again to the salt-frosted ground, and in about three miles more the fertile valley of Saidabad is reached.

The whole bed of the Kavir was no doubt at one time an inland sea, such as is the existing lake Niriz. The rainfall of Persia diminished along with the deforestation of the country, till eventually there was not sufficient to replenish the loss by evaporation from the surface of the lake.

The common Persian word for desert, whether Lut or Kavir, is *biabun*. Whatever may be the derivation of the word its very sound seems to call up visions of the most desolate place on earth. But the Lut is very different from the Kavir. The road from Kerman to Sistan or Sarhad crosses the extreme south-east corner of this great desert, which stretches many hundred miles straight away to the north of Persia. After leaving the delightful climate of Kerman the road to Sistan crosses the Hanaka Pass at a height of 9,000 feet, and then there is a long descent of nearly 8,000 feet to the bottom of the Lut at Shurgaz, the route passing Bam, a large town with a Sub-Governor under Kerman.

Fahraj is the last village on the road and a few miles further on begins the Lut, a bare plain of black gravel and grit. In direct contrast to the dazzling white of the Kavir, the general tone of the Lut is a dead black. Every ten miles or so a belt of low tamarisk jungle straggles across the plain, and here and there are dotted solitary thorn trees of grotesque appearance, perhaps a dozen in view at any one time. Track there is none, and only guides who know the landmarks can find their way, and then only in daylight. Nadir Shah, who crossed this desert on his way to and from India, built high towers, visible at a distance of 20 miles, to guide his troops; and no doubt beacon fires were lighted on them at night; they still form conspicuous landmarks.

Except near Shurgaz there is very little drift sand, and for miles one can ride in the dark without coming upon anything to make a horse stumble. During July and August a strong N.W. wind blows incessantly, driving before it the sand and grit, which beat against the side of a tent like rain. The heat probably never exceeds 115° F. in the shade, which is of course nearly 10° less than in the desert between Baluchistan and the Indus; it is a dry heat by no means oppressive, but still under the conditions it is quite bad enough.

For a hundred miles there is no drinkable water. At Shurgaz a water hole, some ten feet deep, supplies a muddy brine wriggling with insects, at which even a camel looks askance. At Maizar Ab one sees what is apparently a charming sparkling spring, surrounded by short green grass; but on a closer inspection the water, besides being salt, proves to be strongly impregnated with sulphurous gas, and the grass is too hard and spiky to sit down on. At Rud-i-Mahi, 50 miles from Shurgaz, a pleasant-looking stream turns out to be undrinkable brine. High up in the mountains of Sarhad, 4,000 feet above the sea, is the first spring of sweet water, bubbling up in the bottom of a valley and shaded by high tamarisks.

Beyond Sarhad again, on the farther side of the range of mountains separating Baluchistan from Persia, another 200 miles stretch of Lut lies on the road to Quetta. But here there is a good road, with every luxury at the staging bungalows built by the Indian Government; and as the country is seldom below 3,000 feet above the sea, the heat is not nearly so great. The water too is by no means impossible, though very upsetting to most people who drink it.

Gardens form a more pleasant subject. Persians seem to have a happy knack in designing a garden, a sort of natural artistic feeling for it. Though they have many unlovable characteristics, only to be classed with those of Armenians, they can do two things well; they make beautiful carpets and charming gardens. The older the carpets the better, and the older the gardens the more delightful.

Persians are nothing if not hospitable; and no one who has enjoyed the pleasure of camping in some rich Persian's garden, after a long hot march through that glaring dusty country, will be ever likely to forget it. You spread your carpet on the banks of the stream, and lying on your back stare up into the green depths of the chenars* above you, and so get rest for eyes that have been screwed up all day in the glare of the sun. By your side you may have a bowl of sherbet cooled by a large lump of snow from some neighbouring mountain; to eat there is a choice of peaches, cherries, apricots and melons; and you may enjoy yourself and forget that you are 5,000 miles from home.

In some gardens may be found a central pavilion with vaulted roof; the inside, by means of intricate mouldings in white plaster, is made to appear both light and cool. The floor will be richly covered with a thick white felt rug from Ispahan or Yezd, while everywhere the air is heavy with the scent of abundance of roses, such scent as you will never find anywhere but in Persia.

Such gardens as these exist all over Persia wherever a sufficiency of water can be obtained and far from the chief cities. But the most beautiful are to be found at Shiraz, where Hafiz and Sadi and Omar Khai-yam, assisted no doubt by the local wine, found inspiration for some of the best poetry that has ever been written. Shiraz still produces an excellent wine, not unlike sherry in taste and appearance; but the modern Persian prefers to jog his imagination with some of the toughest European brandy he can obtain or with the strong spirit which Armenians and Jews distil for them locally.

Persian gardens are all arranged very much on the same plan. A stream flows through the centre and at the upper end is the owner's villa. The water runs through the ground-floor rooms of the house in an open channel and keeps them cool. Just beyond the house the stream empties itself into a large stone tank, and thence flows down a central avenue of chenars, feeding on its way the small channels which irrigate the fruit garden. Round the tank are the flower beds and shady paths among cypress trees.

Of the many gardens round Shiraz, Dilgusha, which lies close to the tomb of Sadi, is one of the best. Here one is delighted by the rich colours of the house toned down by time to the most charming tints, and the air is loaded with the scent of orange blossoms, pink and white oleanders and roses. Among the other gardens may be mentioned Bagh-i-Takht, now falling into decay. Here there has once been a fine avenue of chenars along the entrance road, but now only stumps remain. The house is remarkable for being built in tiers on the hillside, the water falling in cascades through the buildings into the tank below. The tank is one of the largest in Shiraz, about 100 yards square, and on it are the remains of an English rowing boat, no doubt built by some former officer—perhaps a Royal Engineer—of the European Telegraph Company, who have a large office in Shiraz. The Bagh-i-Iram has some fine cypresses and in the cool halls of the

* The chenars of Kashmir or Persia are hardly recognisable in the stunted plane trees of the Thames Embankment.

villa one could enjoy life for a time even in Shiraz. Here too the floors are covered with immense felt rugs nearly an inch thick; the colours are dark brown with a pattern in blue wool pressed into the surface. These felts are quickly destroyed by moths and insects, or they would soon find as ready a sale in Europe as the best Persian carpets.

The above gardens all lie a short distance outside the town, and in the cool of the evening it is the fashion for the young bucks of Shiraz to ride out on their prancing ponies to one or other of them. They usually carry guns or rifles and are followed by an armed servant or two; and all the evening one is continually hearing shots fired in the air by these bloods in mere exuberance of spirits. They are really the most harmless creatures who would never shed blood except by accident. They are not, however, overburdened with manners, although they are bursting with polite phrases. They like to gallop past a *Farangi* to kick up the dust in his face if on foot, or in the hope of frightening his horse if riding. A Pathan would call them *zenani* (effeminate) without hesitation.

The older men and the rich *mullahs* will spend the afternoon visiting some friend, and then perhaps move on to some shady spot in the gardens and spend the evening over sherbet, tea and the *qualyan* (hookah or pipe) in endless rotation. Sometimes too their dinner will be brought with them by their cook, mounted on a pony with the most wonderful saddlebags in front and on each side, stuffed to bursting with plates, dishes, food and, no doubt, plenty of wine. Behind the cook comes the pipe-bearer, mounted with all his smoking paraphernalia on another pony, quite an unique sight. In front of him are two huge holsters, 5 inches in diameter and nearly 3 feet long, in which are the *qualyans;* and hanging by chains from the saddle are a brazier of live charcoal, so arranged as to prevent the charcoal falling out, and also various other implements. The *qualyan* requires lungs of brass and of large capacity; you must inflate your whole lungs with the smoke in order to get sufficient draught to make the moistened tobacco burn. The *chibouque* on the other hand is not unlike a clumsy English pipe with a stem like a desk ruler; you cannot put the stem inside your mouth, but must apply your mouth to the end where the smoke comes out; it makes a fair substitute for an English pipe, if smoked with the light Tabriz tobacco, the peculiar sweet and scented taste of which is very seductive.

Its gardens will perhaps some day, when a railway has opened it to the globe-trotter, make Shiraz one of the show places of the East. At present it is shut off by 180 miles of difficult mountain track from its seaport Bushire, than which one could probably find few less attractive spots on earth.

THE QUESTION OF WALLED ENCEINTES.

By CAPT. H. F. THUILLIER, R.E.

IN the June number of the *R.E. Journal* there appeared a translation of an article* in which the opinion was advanced that the fortress of Port Arthur could have held out longer if it had possessed a continuous walled enceinte, and the conclusion was drawn that this siege illustrates the necessity for such an adjunct in modern fortresses. The article is in the form of a review or criticism of an article by another writer in the *Cologne Times*, in which the opposite view was upheld.

The author of the review rightly emphasizes the fact that a fortress does not properly fulfil its object if it requires an army to defend it; but that its defences should be so designed that they can be held by a minimum garrison, thus leaving the great bulk of the army free to undertake the far more important duty of meeting the enemy in the field. This is eminently true, though it does not appear from the extracts quoted from the criticised article that its author was ignorant of this leading principle.

The reviewer continues to say :—" The essential difference between the tactics of a field army and those of a garrison is this :—The field army can oppose large reserves to an attack on any point, and can, by their skilful employment, render nugatory the enemy's success if he breaks through the line. The garrison has no such reserves of men; it has to use instead a reserve of fortified works in the shape of an inner line, which can be held by a relatively small number of men. This is the true function of the walled enceinte."

Here, if I may venture to say so, it would appear that the premise is unsound and further that the conclusion does not follow from it. Many high authorities consider that, however small the garrison of a fortress, a portion can, and should, always be set aside as a reserve. Even however if this were not so, it would prove the necessity for a second line of defence, but not that this line should necessarily take the form of a continuous walled enceinte.

The author's conception of the functions of an enceinte is given as follows :—" It is a mistake to suppose that the enceinte does not become useful till the girdle forts are captured, or that its only use is

* *Port Arthur and the Question of Walled Enceintes*, by Lieut.-Colonel Frobenius, in the Berlin *National Zeitung* of 11th February, 1905.

to oblige the enemy to begin his attack afresh after he has penetrated the girdle. It has long been recognised that the defender must put his whole strength into the defence of the forts, and must not attempt to reserve any portion of his force for the defence of the enceinte. The enceinte could not in any case hope to hold out for long after the loss of the forts. The principal *rôle* of the enceinte is played during, and not after, the fight for the possession of the forts." The last two sentences of the above should be noted in view of what comes after. What this *rôle* consists of is explained by the author further on. "The 'assault-proof' enceinte may be slenderly garrisoned, in view of the serious hazards to which the besieger would be exposed if he ventured to attack it. Its principal use—and that a most important one—is to strengthen the fighting line during an attack on the girdle, both by its material and moral support, and not merely as a place where the defenders can make a last stand when the girdle has been captured by the enemy."

It is difficult to comprehend what possible "material" support to the fighting line can be afforded by an enceinte which is situated 1½ miles or more in rear of it; its "moral" influence is more comprehensible, and its effect in this direction, according to the theory entertained by the author of the article under review, is illustrated by his assumption in regard to what happened at Port Arthur, which is as follows:—"The defender need not have expended so many lives on holding unimportant advanced works had not the *absence of an enceinte* kept him in a state of anxiety lest all should be lost if the besieger succeeded in penetrating the girdle. He was therefore forced to keep masses of troops in reserve behind all the outer forts, ... These troops were exposed to severe fatigues and heavy losses. As at Sebastopol it was impossible to provide them with proper protection, either against the weather or against the enemy's fire, so that they filled the hospitals with sick and wounded. As a result, the defending forces were used up more quickly than if a walled enceinte had existed. An enceinte would certainly have enabled Port Arthur to hold out longer."

In the first place it may be remarked that a state of anxiety, and the actions consequent on such a state in the mind of a commander, are the results of the mental condition and temperament of the latter, and are not necessarily dependent on the form of the works. If the defending commander is imbued with the belief that in a walled enceinte alone can salvation be found, he will doubtless be a prey to anxiety should he be so unfortunate as to be called upon to defend a fortress unprovided with this adjunct. If on the other hand he has no faith in walled enceintes, but believes that a second line of well-planned earthworks, provided with suitable obstacles in their front, together with a good organization for the concentration of force upon the threatened point and for the delivery of a prompt counter-attack by intact reserves in the event of the outer line being penetrated, are sufficient to render the heart or kernel of his fortress entirely secure from assault, he will, if he has been careful to provide all the above resources, suffer no anxiety whatever on this score.

Further, we do not know what authority the author has for his statement that the absence of an enceinte produced a state of anxiety in the mind of General Stoessel and led to the other results referred to. Indeed it is difficult to reconcile this observation with the author's opinion previously quoted that an enceinte cannot in any case hope to hold out long after the loss of the forts. Why then should its absence add appreciably to the anxieties of the defender? Is it not a good deal more probable that in the case of Port Arthur the defender's anxiety and his efforts to keep large reserves close up to the outer forts arose from a knowledge that the positions occupied by the latter dominated those of the interior works and even in some cases the town and harbour themselves. This alone,—and, as far as can be judged from the scanty information at hand, it seems to have been the case,—would be enough to cause the anxiety and necessitate the special efforts above described. The existence in such circumstances of an enceinte commanded from the captured outer works would not, after the loss of the latter, have delayed the attackers for long. In fact it seems evident that the evil to which the author draws attention, namely the losses among the reserves behind the outer works, would have been more directly and economically obviated by the provision of good covered shelters at those places rather by an enceinte.

While, therefore, we may admit, as a general principle, that a second line of defence is always desirable and often essential, it does not appear that any of the arguments advanced in the article under review are such as to convince us of the necessity for this line taking the form of a continuous walled enceinte. This question in fact is but another form of the long-contested one of the two schools of thought as regards the form of defensive works generally; the old school insisting on the necessity for masonry, concrete and steel protection, for deep ditches, walled escarps and flanking caponiers; and the new school relying on earthworks of low profile and shallow trace, on invisibility, mutual support and intercommunication, on freedom of tactical action and good organization.

We need not enter into the arguments here. So little has been published up to date of the details of the siege and defence of Port Arthur that we can hardly yet draw any reliable conclusions therefrom on this subject. There is, however, one point to which it is at least worth while to draw attention, as it tends to throw some light on the contested question referred to above. The defensive works of a land fortress have up to the present been designed to resist the projectiles fired by ordnance of siege type; and till lately the largest pieces mounted on travelling carriages in any army, and therefore the largest against which resistance was contemplated, were up to 6-inch and 8-inch calibre only. We know that the Japanese brought to bear on the works at Port Arthur weapons of 11-inch and 12-inch calibre. It is true that they enjoyed special and unusual facilities for the transport of such heavy ordnance in the possession of a sea base in close proximity to their siege lines; although, on the other hand, the difficulties to be overcome in their transport from Dalny to the places where they were used were great. But who can deny that, with the growing improvements in methods of mechanical transportation which we are now witnessing, such ordnance will be the rule in all future land sieges between first-class military powers. In that case, in the long contest for supremacy between defensive material and battering artillery, the latter will have secured an advantage which, when aided by the powerful explosives of the present day, it will be difficult, if indeed possible, for the former to neutralize.

What would have been the effect at Port Arthur of the concentration of the fire of a number of guns of this size upon the point selected for assault in a supposititious walled enceinte? How long would the defenders of the latter have remained at their posts under the showers of concrete and bits of masonry which would have been sent flying in all directions under the action of the Shimosé shells? How long would the works have remained "storm-proof" and the obstacle "insurmountable?" These reflections are not likely to convert to a belief in continuous walled enceintes, masonry ditches, etc. those who previously held opposite views. They seem in fact likely to point rather to the conclusion that, with the increased power of mobile artillery,—or the increased mobility of powerful artillery, if it is preferred to put it that way,—such forms of defence are likely to be less effective than ever.

MEMOIR.

Colonel C. H. Luard, late R.E.

Colonel Charles Henry Luard, R.E., who died on the 10th July in his 69th year at his residence in London, passed out of the Military College, Addiscombe, in 1855 as first cadet of his year, winning the gold Pollock Medal and the Sword of Honour. Sir Colin Scott-Moncrieff, his lifelong friend, writes of him: "He was the most brilliant and cleverest of all my contemporaries."

In 1857 he started for India with other cadets in a sailing ship round the Cape, and had the remarkable experience of being becalmed for 28 days between Madras and Calcutta. His service of 32 years in India was mainly in the Railway Branch of the Public Works Department; and he retired when Consulting Engineer to the Government of India in 1890, on being offered the post of Engineering Inspector to the Local Government Board, a post he held for 12 years. On occasions he was detached for special duties, viz., an expedition from Burma to China, Under Secretary in the P.W.D., and Master of the Calcutta Mint. In England he was employed by the Secretary of State for War to visit and report on a system of railway construction in Germany; and by the Secretary of State for India was appointed a delegate to the International Railway Congresses held at Brussels, 1885, and at Milan, 1887. At the time of his death he was a Director of the Southern Mahratta Railway.

The present writer was an intimate friend of Colonel Luard. The sorrow, the shock, the sympathy evoked by his sudden and beautiful death cannot be expressed in words. The regard and admiration which he inspired in those who knew him well, whether old or young, was enthusiastic. Many-sided in his interests, able and cultivated, with a firm grip upon all he knew, he was a distinct personality.

His nature was eminently social, his sympathies singularly varied and fresh; so that the younger generation found him keenly alive to their hopes and interests, and even when he disagreed they felt his views were the outcome of an active and working mind, not merely the inert opposition of an older generation to new ideas.

He was certainly critical; and very staunch to his fundamental convictions as to conduct, uprightness and integrity. "I always felt," writes a friend, "his thoroughness and whole-hearted regard for truth did one so much good"; and another writes "His example and advice were always to be followed; the latter because it was always practical and hopeful. Indeed it seemed to be his greatest happiness to try and help others."

He was tall, well-built, active, and good at all games. No account of him would be complete without allusion to his love and just appreciation of art, and to his own great power as an artist inherited from his father. In the year 1857 he had become acquainted through his brother John (who had retired from the army to become an artist) with the group of young painters the founders of the Pre-Raphaelite Society. Millais, Holman Hunt, and the Rossettis he knew intimately and gained the lifelong friendship of many of the interesting men associated with that Society, and his love of art, and the keen interest he took in all the manifestations of it, never forsook him.

Of Huguenot descent in an unbroken line he was by heredity and instinct a Liberal, and unlike most men became more Liberal as he grew older. "It always seemed to me," writes one of his younger friends, "that he had that alertness of mind which never grows old."

The following amusing incident of old Addiscombe days is told by Sir Colin Scott-Moncrieff to show Luard's readiness in an emergency. "In the spring of 1855, when he was senior cadet and first corporal, the Queen and Prince Albert with the Emperor and Empress of the French visited the Crystal Palace in State. The Crimean War was then at its height and there were French military bands and much excitement. Some 120 of us cadets were there, mere units in the crowd and powerless to get to the front to see the fun. Suddenly Luard shouted 'Addiscombe cadets, fall in.' We did so, and shoved our way through the crowd which, supposing us part of the show, made way, when he marched us triumphantly alongside the Royal carriages."

AN OLD FRIEND.

TRANSCRIPT.

PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.*

THE United States Army has for the last few years been carrying out, at considerable expenditure, numerous experiments in reducing and preventing dampness due to condensation in magazines. Various methods have been tried in every port of the United States with, in many cases, considerable success; and, as the subject is of great professional interest, a short epitome of the experiments may be useful to officers of the Corps.

The magazines were all originally constructed of concrete; but it appears that at first no damp proof courses were laid, nor were any steps taken to prevent percolation through the concrete. These defects were remedied later and the leakage prevented.

The problem of preventing condensation, however, remained to be solved. A considerable sum of money was therefore set apart for special experiments in this direction. From the reports sent in, lining the magazines with porous brick gave the best results; various brick linings were tried, such as hollow bricks, book tiles, "Shawnee" brick (a special class of brick which is said to absorb water like blotting paper). In some cases a 4-inch air space was left between the lining and the concrete; in other cases this was omitted. Provided that the bricks or tiles were not too hard burned, all were very satisfactory.

The ceilings were in some cases lined with brick arches, but the bricks being necessarily harder burned showed traces of dampness. In one case a ceiling (below a concrete roof supported by I-beams) was made of plaster in the proportion of 1 barrel of cement to 2 barrels of slaked lime. This was laid on metal lathes, the surface of the plaster being left as rough and porous as possible, and was entirely effective in preventing condensation. Drains were usually made inside the magazines.

Copper lining with magnesia lumber did not prove effective; it was noticeable however that, when copper lining held in place with pine planking was tried, condensation was considerably reduced; and in some magazines, where the doors had been kept closed, the rooms were quite dry.

Another successful form of lining tried was as follows. A magazine was first of all thoroughly dried and cleaned; a heavy coat of bitumen

* The information is taken from the *Extracts from the Annual Report of the Chief of Engineers, United States Army, for* 1903 and is communicated by the Director of Fortifications and Works, W.O.

and tar was then applied and thoroughly rubbed in. A second coat was also applied to the walls for a distance of 2 feet from the floor. Two thicknesses of tarred paper, with magnesia boards fastened on the top, were then placed on the ceiling, which had a lining of copper; magnesia lumber was fixed to the angle irons which supported the copper roof. The magnesia lumber was painted with two coats of "Gypsine," followed by one of "cold-water paint." Floors were relaid with concrete and given ample pitch towards the drains. The magazine is said to have been sometimes dripping wet before the lining was put in; subsequently there was no condensation and the room was quite dry, except for a slight indication of moisture near the bottom of the wall where the concrete was thickest.

A lining of "Paroid" roofing paper (a species of waterproof paper) was tried, but was not at all successful and did not reduce condensation.

Compressed cork linings were unsatisfactory.

Wooden plank linings were also ineffective.

Corrugated iron and lead linings were also experimented on, but with indifferent success.

Another successful lining was that of asbestos lumber, held in place by brass screws screwed into wooden plugs driven into holes in the concrete. The ceilings and walls were first heavily coated with asphalte; the ceiling was then lined with 16 oz. copper plate and the walls with "Paroid" felt, after which the asbestos lumber was applied.

A further method, which answered well, was to place hot melted paraffin wax on the concrete roof, side wall and floors, the surface thus treated being made as hot as possible by the use of a kerosene blow torch. The iron roof beams were embedded in concrete and hot paraffin placed on the outside surface. Soft white-pine ceilings and side walls with hot paraffin on the upper surface of the ceiling were fixed, and deadening felt and white canvas were fastened to the outside surfaces with copper tacks, leaving an air space all round. New concrete floors were laid with gutters on outside edges; these were paraffined, and deadening felt and soft white pine flooring, paraffined on the outside, laid on the top. Before this lining was commenced the condensation was described as "enormous"; subsequently when other rooms in the battery were wet, this one remained dry.

The experiments bear out the general principle that there can be no condensation, if the escape of enough heat into the walls from the air in contact with their surfaces can be prevented.

The following is a nearly full extract of an interesting answer given by Major W. L. Marshall, Corps of Engineers, the officer in charge of the Defences of New York Harbour, to the question "How may we secure well-protected dry service magazines for our powder and projectiles?"

REPORT OF MAJOR W. L. MARSHALL, U.S. ENGINEERS.

"These rooms or storehouses are far withdrawn from the open air, due to the necessity for so placing them that the contents may not be reached by the projectiles of the most powerful modern guns. The rooms are caves, with the temperature of walls naturally about the same as the mean annual temperature at their location.

"In summer, on our sea-coast, the air is not only at high temperature but is also highly charged with moisture; and when admitted into these rooms, has its temperature rapidly reduced and gives up its moisture in great part as 'condensation' on the walls and on any bodies, like powder cases or projectiles, stored therein. This reduction in temperature of the air admitted from the outside and deposit of moisture therefrom are of course represented by a heating or rise in temperature of the walls of the rooms. If air in sufficient volume, or in excess of the quantity that may be cooled to below the dew point while in contact with the walls, is admitted and passed through the room before it be cooled to the dew point, no deposit of moisture will take place; while at the same time the walls of the room will be heated to an extent measured by the loss in heat units of the air passing through the room. When this current of air is sufficiently prolonged, the walls of the room will be heated up to the mean temperature of the outer air; or, if the circulation be controlled in such manner that air is admitted only during the rise in temperature after sunrise, the walls may be heated much above the mean temperature; and if this ventilation be properly managed no trouble from condensed moisture may be feared.

"On the other hand the quantity of moisture at any time contained in a room full of air is limited. Only so much moisture may possibly be derived from it. If the room be sealed to prevent any more air entering, then it will remain dry or approximately in the same condition as when sealed; no more moisture and no more heat can enter or be abstracted from it by convection. Dry store rooms then may be secured in two ways without artificially heating them:—

First. By free ventilation at the proper time.

Second. By keeping them practically sealed when condensation on cold walls is probable.

"Should the room (with its concrete walls at about the mean annual temperature) be imperfectly ventilated during the moist warm months, *i.e.*, should air be admitted at rates and in volume so small that it may be reduced below the dew point while in contact with the cold walls, the room will be kept reeking with condensed moisture so long as the conditions exist.

"In nearly all the emplacements in this district, constructed prior to 1900 and provided with ventilating pipes the ventilators are small (6 inches or less in diameter), leading vertically from the rooms. They are intended to be always open, and are therefore suited for the slow, continuous, pernicious movement just described, depending solely upon differences in density of air within and without the room. As cold air slowly passes out, warm air replaces it, generally through the same orifice, but in different directions of flow, simultaneously.

"Pure air, indeed, is provided for by such ventilators; but they act rather for irrigating than for drying the rooms, and we have been compelled to stop them up in many cases.

"This method of ventilation, due to differences in density in a column of air produced by differences in temperature, has been for years applied for irrigation in certain parts of the West, where the returns from the lands irrigated by the system justify the expense of applying it.

"This system of irrigation, as far as I have been able to trace it, was discovered by accident when drainage of lowlands near Chicago for truck gardens was attempted some ten years ago.

"In this system parallel and intersecting lines of porous agricultural tile pipes are laid, buried not too deep to be reached by the roots of vegetables, nor beyond the reach of cold penetration from above, but their ends at very slightly different levels.

"Both ends of pipes, or tiles, are left open during the winter, and the earth above and around the pipes is frozen. In spring the pipes are all closed, except so far as necessary for drainage. Drain pipes are closed at higher and opened at lower ends.

"Whenever dry weather sets in the pipes or tiles are opened. Warm air enters by gravity, and cold air flows out in equal volume at the lower end (the length of pipe being empirically fixed), and when reduced in temperature below the dew-point deposits of water are made, absorbed by the porous tile, and eagerly appropriated by the roots of growing plants above.

"In some of our works we see all this paraphernalia in somewhat different form, all intended for drying caves, but in accord with effectual irrigation schemes. There is in evidence in each case the slow ventilation by currents to and fro through one orifice, caused by changes in weight of air due to changes in temperature, with walls reeking with moisture condensed thereon. We have also the counterpart of the porous tile in the porous lining of walls, meant to absorb the condensed moisture, but we have provided no means to take up and remove this moisture. But if during the period of no condensation the previously condensed moisture be evaporated from these porous linings, and if during the moist weather condensation against these linings be readily absorbed and hidden, then such linings will be apparently dry, although when condensation is going on they are just as wet as if no absorbent had been supplied. The water is still there until evaporated, failing which removal by evaporation we will ultimately have supersaturated non-squeezable sponges filled with water and worthless as further absorbents of moisture.

"Water or moisture should not be merely concealed by temporary absorption, but should be permanently removed and all evidences of it prevented. Such removal does not merely mislead, and is believed to be possible in nearly every case.

"The rules in vogue for avoiding the defects of this method of ventilating magazines simply increase the trouble and have generally failed.

"Some insist that magazines should be opened only when the outside air is at a lower temperature than the magazines. The application of this rule increases the capacity of the walls to condense moisture by continually lowering their temperature. Others demand mathematical determinations of the dew-point temperature, and provide that magazines shall not be ventilated when the temperature of the walls is below this dew-point. The dew-point is constantly changing and the rule nearly impossible of application.

"It appears that all these methods and rules should be cast aside, at least so far as to allow methods of ventilation to be provided on the broad principle that air when not saturated will absorb and remove moisture at any temperature, and if passed over objects, masses or walls in sufficient volume will soon reduce these walls to the same temperature as the air.

"Such free ventilation has been attempted in this district, so far with sufficient success to show the principles to be correct and easy to apply, at four emplacements for 12-inch guns at Fort ——— and two emplacements for 12-inch guns at Fort ——— ; but the ventilators might have been increased in size and number advantageously. The results are vastly superior to any attempts on the other system.

"It may be observed anywhere that when a wind encounters an obstacle like a plane surface it piles up against it on the windward side, and a partial vacuum is produced on the lee side. If there be a hole in the surface the wind pushes air through it.

"If the obstacle be a house, the pressure on the windward side will push air through every crack and aperture into the house, if there be any path of egress in the direction of the wind; and this pressure, aided by the suction on the lee side of the house, will cause the air to flow from the house through every aperture and crack on the lee side, and there will be a continuous motion from windward to lee side of the house.

"If windows on windward and lee sides of the building be opened, a much stronger current will pass through the building, whatever be the relative positions of the windows. Curtains will blow inward on the windward side and outward on the lee side.

"On very cold nights, with temperatures approaching zero, without opening doors or windows on windward side of my house, upon opening quite wide a window on the lee side I have observed a stiff current outward, and that the room was cooled by air transmitted through the house from the windward side entering through various small apertures rather than by inflow of heavier air from the lee side.

"It would be instructive, on the other hand, to note the effect of ventilating a tightly closed room by a vertical pipe through the centre of the ceiling; or, on a small scale, the ventilation of a barrel through its bunghole in comparison with its ventilation through similar holes lying in the direction of the wind, one in each head; or the ventilation of the hold of a ship through a single pipe or two pipes abreast, all other openings being closed, compared with fore-and-aft ventilation through two or more ventilators separated the length or width of the ship measured in the direction of the wind current.

"The ventilator flumes used at these emplacements are 18 inches in diameter, each arranged with a tight hinged covering in order that ventilation may be controlled from outside the batteries, and so arranged that rain cannot follow the flues into the rooms. There is only one flue to each room, which has proved sufficient, but an increase in area or number is desirable and practicable.

"The movement of the air through the rooms of the batteries is from the doors and windows at the parade wall in rear to and through the flues in front of the rooms, or the reverse; and when the wind is blowing across the battery at about 10 miles an hour and the doors and ventilators opened, the air in the rooms is replaced once in about one and a-half hours and kept in motion by the 'draught.'

"In this system the rules to be followed are:—

A. The rooms to be kept closed

1. Generally throughout the winter, unless on days when there is a brisk breeze and clear weather, and the temperature well above the mean annual temperature.
2. When it is still or calm weather.
3. When the air is filled with fog or mist.
4. Generally at night and after 2 p.m.

B. The ventilation to be free

1. Whenever there is a wind exceeding 5 miles an hour blowing across the battery, and the temperature is above mean annual temperature with no fog, mist or rain accompanying.
2. When there is an appreciable movement in the air, the temperature not too low, and the days clear, the ventilators may be opened between daylight and noon.
3. After the temperature of the walls is sufficiently raised, the ventilators may remain open during all of every day in summer, when air is not unusually moist.

"Free ventilation is especially prescribed whenever a wind of proper temperature is from the land and of good force, day or night, in clear weather. No instruments or calculations required, but the ventilators must be of sufficient capacity to maintain a 'draught' or motion in the air through the rooms during a brisk wind.

"It must be kept in mind that 'ventilation' under this system means an application of the force of the wind to convey heat to the walls and to remove moisture from the rooms by absorption and convection by the air or wind currents—not simply 'aeration' or the supply of oxygen for breathing purposes.

"In providing for this system the ventilators should be of large capacity, and so placed that the rooms to be dried or ventilated, and the ventilator flues, should be as near as practicable along the direction or pathway of the resultant winds during the months from March to September inclusive, with as few changes in direction as safety to contents of rooms against fire or projectiles will allow."

NOTICES OF MAGAZINES.

MONTHLY NOTICES OF ROYAL ASTRONOMICAL SOCIETY.

June, 1905.

This number contains extracts from a report by Major P. B. Molesworth, R.E., of OBSERVATIONS OF MARS, which were taken by him in Ceylon in 1903 with the assistance of Lieut. J. S. Barker, R.E.

In consideration of the great amount of work on the details of the planet, which the report represented, the Council decided to place the complete manuscript in the Society's Library, and to print only the principal tables and general conclusions.

The extracts, which are accompanied by photographs, form most interesting reading.

NATURE.

July.

SUBMARINE NAVIGATION (*p.* 210).—Sir W. White, in a lecture at the Royal Institution, states that its first practical application to war was made by Bushnell about 130 years ago; but the type soon died out of use in consequence of the conditions which then prevailed in regard to materials of construction, propelling apparatus and explosions. Advances in engineering and metallurgy have made it possible to increase the dimensions, speed and radius of action of submarines; their offensive powers have been enlarged by the use of locomotive torpedoes and superior optical arrangements for discovering the position of an enemy. But no new design has been discovered, and it is clear that Bushnell provided for the governing conditions in regard to buoyancy, stability, and control of the depth reached by submarines. All submarines are left with a small reserve of buoyancy when brought into the diving condition, submergence being affected by the action of horizontal rudders controlled by men within the vessels. Submergence only continues so long as onward motion is maintained; the smallest reserve of buoyancy should always bring a submarine to the surface when her onward motion ceases, and, as a matter of fact, in the diving condition that reserve is very small, amounting to only 300 lbs. (equivalent to 30 gallons of water) in vessels of 120 tons total weight. Safeguards against foundering have sometimes been provided by fitting detachable ballast, the more commonplace plan being to make arrangements for rapidly expelling water from the tanks by compressed air, of which there is always a supply ready for the use of the locomotive torpedoes. When a vessel is diving under the action of her longitudinal rudders, she is extremely sensitive to changes of trim; as the under-water speed is increased the pressure on the rudders for a given angle increases as the *square* of the velocity, and sensitiveness to change of trim becomes greater and much skill is required on the part of the operators. For this reason, while speed at the surface will be increased, under-water speeds will not grow correspondingly.

Periscopes at present are not satisfactory, though it is asserted that when the lenses are subjected to a thorough washing of wave water they remain efficient.

Hitherto, submarines have only been armed with torpedoes, and are practically helpless at the surface when attacked by small, swift vessels; but it has been proposed to add guns, and this can be done, if desired, in vessels possessing larger freeboard, though, of course, at increased cost.

Surface boats resembling submersibles in many respects but without the power of diving are in favour with many persons; they would be so constructed that by admitting water into special tanks, they could be deeply immersed and show only a small target above the surface when making an attack. There would be no necessity in such boats to use electric motors and storage batteries, since internal combustion engines could be used in all circumstances.

SOLAR ACTIVITY (*p.* 279).—The "maximum" character of the present epoch is being well maintained. On 13th July two groups of spots, one of them extending over 100,000 square miles, could be seen by the naked eye, this being the second occasion during the present year on which two naked-eye groups have been on the solar disc simultaneously.

THE LATENT IMAGE (*p.* 308).—Professor Joly discusses the nature and mode of formation of the photographic image, and concludes that the recent addition to our knowledge of the electron as an entity taking part in many physical and chemical effects should be kept in sight, in seeking an explanation of the mode of origin of the latent image. The paper is well worth reading.

"THE MECHANICAL HANDLING OF MATERIAL" (*p.* 290).—This book* will be useful to all engineers and architects who have to design machinery or erect warehouses; it gives the latest knowledge as to the mechanical handling and transport of the immense quantities of raw materials used daily in our industrial life. The system of band conveying and the automatic throw-off carriage for such conveyors, now used in the Liverpool Docks, are described in detail. Vibrating trough conveyors, especially useful with any material which would deteriorate by rough treatment, are dealt with. Tightening gears, power required, and speed of travel in the different types of conveyors, and the various types of

* By G. F. Zimmer. (25s. Crosby, Lockwood).

pneumatic elevators, are discussed. Illustrations of conveyors which have been designed for special purposes, such as timber conveyors, hot coke conveyors for gas works, and casting machines for use with large blast furnaces are given. Aërial ropeways, as used in the building of the Beachy Head Lighthouse and in the rapid completion of that remarkable bridge which will convey the Rhodesian railways over the great gorge of the Zambesi, and the interesting question of the coaling of ships at sea are fully explained.

FERRO-CONCRETE (*p.* 213) is much used in Belgium. The handsome dome of the new station at Antwerp is a prominent instance. The structure, 1,800 tons in weight, rests wholly upon the columns at the angles of the glass lights; these columns are Y-shape in cross section. The external shell has a uniform thickness of 3·15 inches, relieved by six moulded ribs. The Renommée Hall at Liége is covered by three cupolas, each 55′ in diameter, placed at a height of 50′ above the ground. The cupolas are 4½ inches thick and are made of concrete composed of cement clinker finely broken; they are reinforced by a layer of expanded metal with a lattice work of bars.

A bridge, near Liége, 260 feet between abutments with a central span of 180 feet, 32·8 feet wide, was built upon a group of concrete piles driven deeply into the bed of gravel, which thus became strongly compressed. The concrete piles were reinforced by vertical bars of steel which were continued into the piers and abutments, so that the whole was solidly bound together and the bridge was solidly rooted into the earth. It had thus a resistance amply sufficient in case of an accumulation of ice which might transform the bridge into a dam.

W. E. WARRAND.

REVUE D'HISTOIRE.

July, 1905.

TWO MEMOIRS ON THE DRAGOONS, BY THE COMTE DE BELLE-ISLE.—Belle-isle was colonel-general of the French Dragoons, and these memoirs were written to call attention to their origin and true function as mounted infantry. One of his predecessors, Tassé, had done his best to turn them into cavalry, and the great increase in the number of regiments of dragoons had led to their being associated with cavalry on the wings in line of battle. But Belle-isle maintained that "dragoons are infinitely better and more sure of success when they are employed on foot than when they are mounted," and they should be handled accordingly.

THE CAMPAIGN OF 1793.—*Army of the North and of the Ardennes.*—The parts taken in the direction of the operations by the ministry, by the committee of public safety, and by the representatives on mission, are indicated; and it is shown how "the will to conquer" overcame the defects of the mechanism. On the side of the Allies, the division of interests and of aims is brought out. To the disgust of the *émigrés*, Condé and Valenciennes were taken over in the name of the Emperor Francis, not of Louis XVIII.; and similarly the Duke of York was instructed to take the surrender of Dunkirk in the name of George III. Dundas wrote: "It is just that by the progress of the campaign, we should participate in that indemnification which the belligerent Powers have ust reason to expect, and although the possession may be taken in the name of His Majesty, it does not exclude any future arrangements for putting that place in the possession of the Emperor if the events of the war should afford to His Majesty a sufficient indemnification in other quarters of the world."

THE WAR OF 1870–1871.—*The Army of Chalons.*—The fluctuations of opinion at Macmahon's headquarters between the 17th and 22nd August are described in detail. The evidence given at the Bazaine court-martial and at the inquiry into the acts of the Government of National Defence is supplemented from other sources, especially from the unpublished *Reminiscences of Marshal Macmahon.* In these he states that his decision on the 22nd to march from Reims on Montmédy, instead of falling back on Paris, was entirely due to Bazaine's message of the 19th, in which, after speaking of the battle of Gravelotte (the day before), Bazaine said that he still looked to marching northward and working round by Montmédy or Sedan. In a telegram of the 20th Bazaine hinted a doubt whether he could do this without compromising his army; but that message, though it reached Macmahon's headquarters, was not shown to the Marshal.

E. M. LLOYD.

TRANSPORT AND RAILROAD GAZETTE.

May 26th, 1905.

PROGRESS IN YARD DESIGN.—By W. C. Cushing (Pennsylvania R.R.).—(See also "Design and Operation of a Modern Freight Yard," by J. T. Richards, in the *Engineering Record* of April 29th, 1905, and sundry other recent papers).—American shunting yards are worked on three different systems:—(1) by push and pull (the ordinary familiar method); (2) by poling (where the engine runs on a road parallel to the train to be broken up); (3) by gravity (usually by pushing over a summit, and thence distributing by the cars' own weight. Gravitation pure and simple, such as is used in several places in this country, is not mentioned). The introduction of the hump, summit, or *dos d'âne*, as it may be variously called, as an expedient for the rapid distribution of trains, is comparatively modern, but it seems now to be embodied in all the more recent designs, and much thought has been expended on the lay-out of the yards. It is to be remarked that those under consideration are all what we should call "sorting and marshalling" sidings, as a "yard" proper generally appertains to a Goods depôt. Furthermore, the space occupied does not seem to be such a dominant factor as it often is over here.

The cardinal considerations to be borne in mind are :—the securing of an arrangement which will allow cars to pass through in the least possible time, continuous progress, and elimination of fouling movements whereby routes would conflict or Through trains interfere with shunting operations.

Where there are four tracks, of which the two middle lines are used for freight, the yard is generally placed in the centre ; but if the passenger tracks are in the middle, it may be necessary to elevate them, if there is likely to be much transfer between the Down and Up (or East and West bound) sidings.

The actual lay-out of the roads,—the ladder type of arrangement (*i.e.*, a straight distributing line from which the sorting roads branch off parallel) is usually adopted,—the siting of the lines for vans, for cripples and repairs, and the access for engines, are all of importance. As a rule the switches are controlled from a signal box in modern yards and moved by power, and the abolition of necessity for movement on foot by shunters is consistently aimed at. Of course one of the advantages of the "poling" system is that the men uncoupling remain with the engine and can travel on a platform provided thereon. Coupling up is automatic.

Some figures stated, of which I quote a few, give an idea of the magnitude of the traffic handled in some places. Incidentally I might remark that the Pennsylvania R.R. are reported to be reverting to smaller classes of cars for certain kinds of traffic, so as to secure quicker transit.

The Harrisburg yards have 109 miles of line and standing room for 10,000 cars (usually 40 ft. per car is allowed, and presumably connecting lines and turnouts are deducted in estimating capacity). They are worked partly by "hump" or gravitation, partly by "poling." 3,750 cars have been despatched Eastward in 72 trains, and 66 trains with 3,644 cars sent Westwards in 24 hours.

Altoona, another large yard, has a capacity of 10,000 cars. Here the average time taken in breaking up, *i.e.*, sorting, a train of 80 cars, is forty minutes (that is to say, cars of up to 50 tons capacity). 59 trains, of 2,915 cars in all, in one direction and 60 trains of 2,752 cars in the other have been handled in the 24 hours.

Mr. Cushing considers that no definite limit can be put to the size of Freight yards ; but that the question really is "what is the limit of a Freight yard unit ?" A unit may be taken as consisting of :—a receiving yard, a classification yard, a departure yard, and a proper number of car repair, van, van repair and engine roads. One set of these latter adjuncts may frequently serve two or more sets of receiving and classification tracks. (N.B.—No mention is made of how the trains are marshalled in station order, and it is not clear to what extent the arrangements aim at sorting for routes only, leaving Station distribution to be done on the road, or marshalling to be done away from the main centres). He thinks that twenty tracks is about as many as can be worked conveniently in one fan of sidings. It is of course important that where two units adjoin the movements should not conflict.

The gradients and resultant velocities attained in various yards have been calculated and are tabulated. On an average it appears that about 0·4 per cent. is sufficient to keep the cars moving, but over the turnouts and along the ladder tracks, the resistance being greater, a gradient of as much as 1·3 per cent. is sometimes used. At the neck a grade of about 3 per cent. for 100 ft. is necessary to give the vehicles a start, but this may be decreased if the descent is longer.

Weighbridges are often placed at the summit, in which case the gradient must be modified so that the speed shall not exceed three or four miles an hour, so that weighing can be accomplished.

Some particulars of working cost are given, but it would hardly be of interest to go into particulars.

While the study of these enormous yards may seem to us merely of academic interest, the same principles apply more or less to all sidings, and the diagrams, of which there are a number, deserve attentive study.

C. E. VICKERS.

CORRESPONDENCE.

SUBMARINE MINING.

Sir,—An article by Colonel E. D. Malcolm, c.b., late R.E., in the August number of *Blackwood*, together with what I have heard elsewhere, seems to point conclusively to the fact that "Military Submarine Mining," as carried out for the last 30 years throughout the British Empire, is a thing of the past.

Whether or not, in some other shape or under some other name, it will rise again is a matter for speculation.

But I venture to suggest that it would be exceedingly interesting, and also instructive, if some account were given in the *R.E. Journal* of what has been done in this direction and what, so far, has been the result. In one point alone,—viz., the organization under which Regulars, Militia and Volunteers, not only of the United Kingdom but also of the Colonies, have worked together, each in their own way, to bring about the greatest economical efficiency—furnishes an object lesson that might well be taken to heart in other branches of the Service.

Pending the production of such an account, in my capacity as the last but one of the late dynasty of Inspectors-General of Fortifications, I should like to bear my testimony to the exceedingly efficient condition of Submarine Mining as I knew it in 1898 to 1903.

Naturally few officers outside the Corps of Royal Engineers knew much about it. But those who did, whatever branch of the Service they belonged to, not excluding the Royal Navy, were loud in its praises. On the outbreak of the late South African War the only Army organization at Home that was really prepared for war was that of Submarine Mining.

Yours truly,

Richard Harrison,

The Editor, "R.E. Journal." *General.*

THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

Chatham,

17th July, 1905.

Sir,—About 6 years ago a society was formed in America, called the American Railway Engineering and Maintenance of Way Association; and since its Proceedings should be of great value, I venture to bring it to the notice of those who are interested in railway matters.

The objects of the Association are "The advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of American railroads." The means being taken to attain this end are :—

(1). The investigation of matters pertaining to the objects of the Association by standing and special committees.

(2). Meetings for the discussion of papers and reports.

(3). The publication of papers, reports and discussions.

(4). The maintenance of a library.

There are 15 standing committees on :—

I. Roadway
II. Ballasting.
III. Ties.
IV. Rail.
V. Track.
VI. Buildings.
VII. Wooden bridges and trestles.
VIII. Masonry.
IX. Signs, fences, crossings and cattle-guards
X. Signalling and interlocking.
XI. Records, reports and accounts.
XII. Uniform rules, organization, code, etc.
XIII. Water service.
XIV. Yards and terminals.
XV. Iron and steel structures.

These committees are composed of 5 or 6 members, who are, as far as possible, selected from railways in different parts of the country, in order that the various views and practices in vogue may be discussed.

One of the first objects of the Association is to bring out a Manual of recommended Practice, as soon as the most desirable methods of carrying out work have been decided by the standing committees and discussed and approved at the general meeting. This should be a most useful book.

Membership is open practically to anybody who has had five years experience in any branch of railway engineering. The entrance fee is $10 (£2) and the annual subscription $10.

The Proceedings, which are bound annually, can be purchased, the price varying from $2 to $4. The first 5 volumes, bound in cloth, price $11 (£2 4s.), can be obtained from the Secretary, 1562, Monadnock Block, Chicago.

Except for a resident in the United States or Canada I see no advantage in becoming a member, as the Proceedings can be obtained for about one-third of the cost of membership. I ventured to point this out to the Secretary when in Chicago, and suggested a reduction in the subscription for a foreign member and also the alternative of a consolidated payment to avoid annual remittances. I hope this may yet be done, but even in America it takes over a year to alter the constitution of an association.

Yours truly,

E. BARNARDISTON,

The Editor, "R.E. Journal." *Capt., R.E.*

RECENT PUBLICATIONS.

Report of the Royal Commission on Supply of Food and Raw Material in Time of War. Vol. I. The Report. (Fol. 1s. 8d. Wyman).

Report on the Engineer Operations of the Tibet Mission Escort, 1903–04. (Fol. Calcutta).

Les Torpilles et les Mines Sous-Marines, par H. Noalhat. (8vo. Paris).

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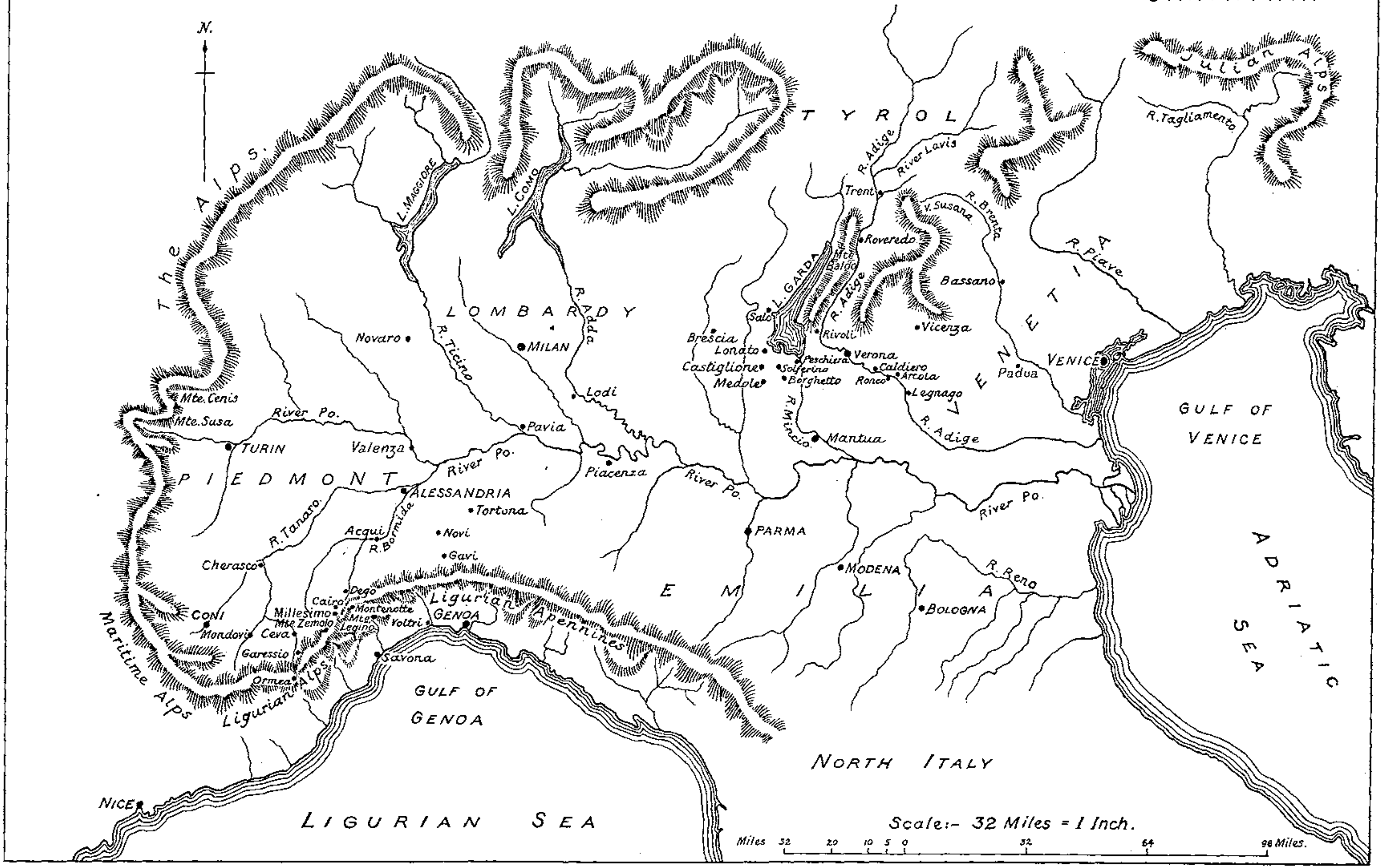


RIFLE RANGES

FIG. 1
CLASSIFICATION RANGE
GERMAN REGULATIONS of 7th OCT. 1904

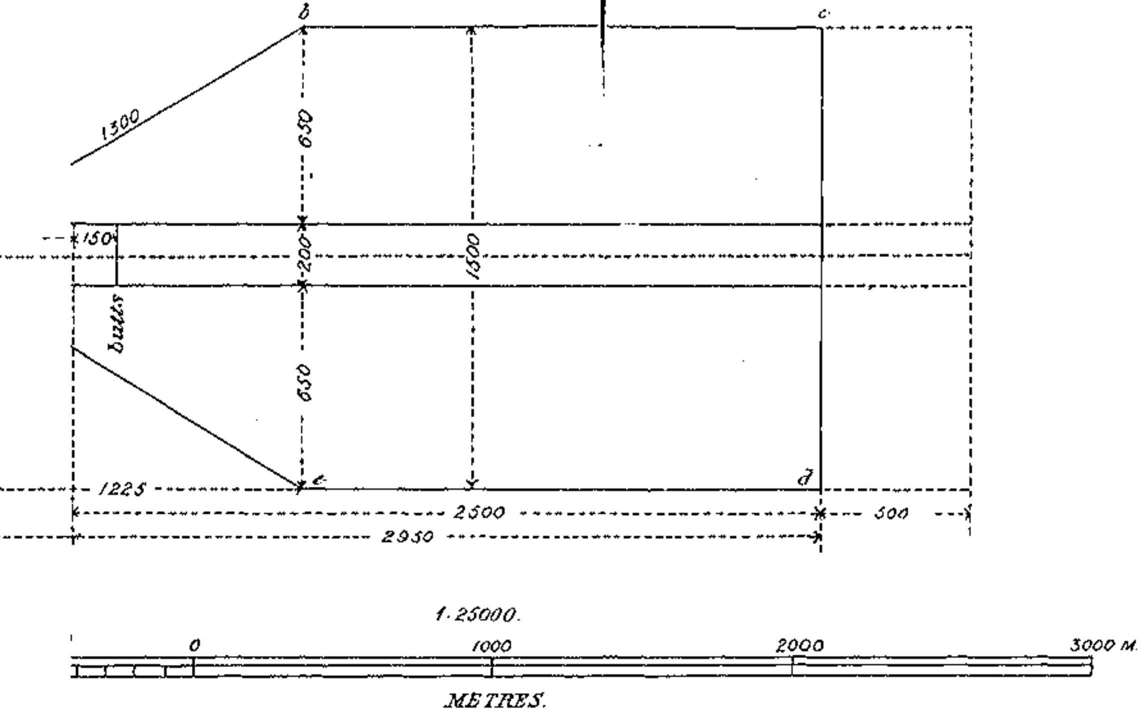


FIG. 2
PROTECTED RANGE
BELGIAN DESIGN

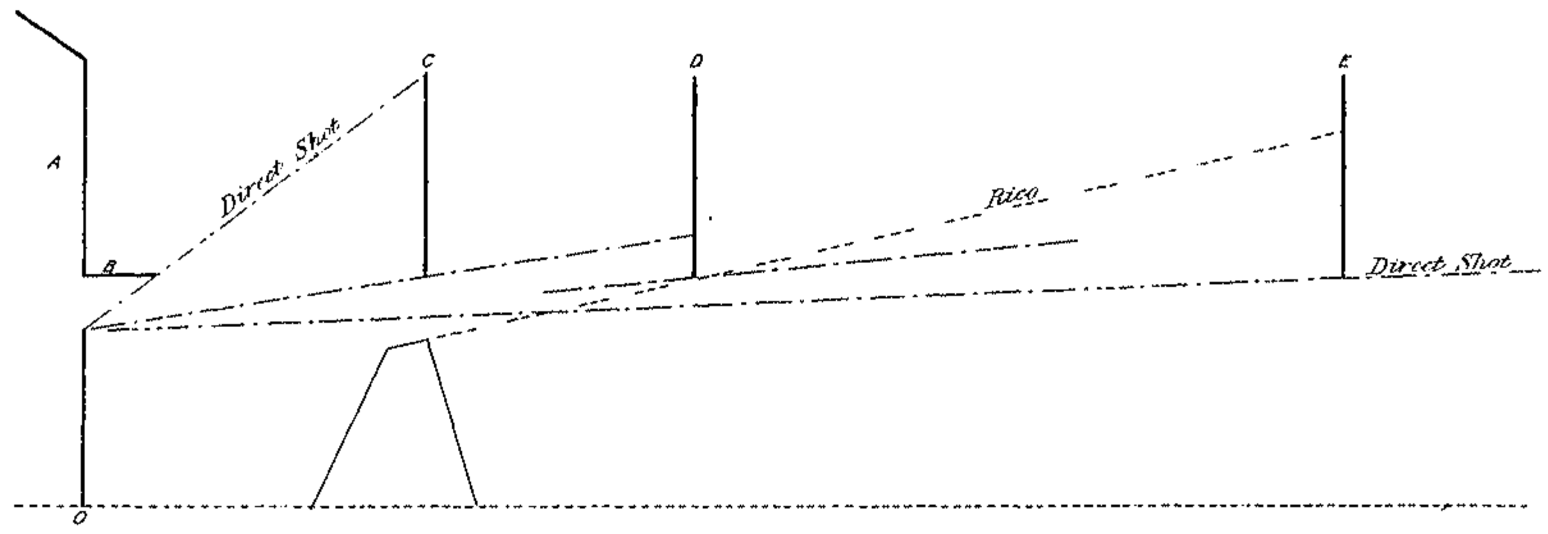


FIG. 3
PROTECTED RANGE
GERMAN DESIGN TYPE "B"

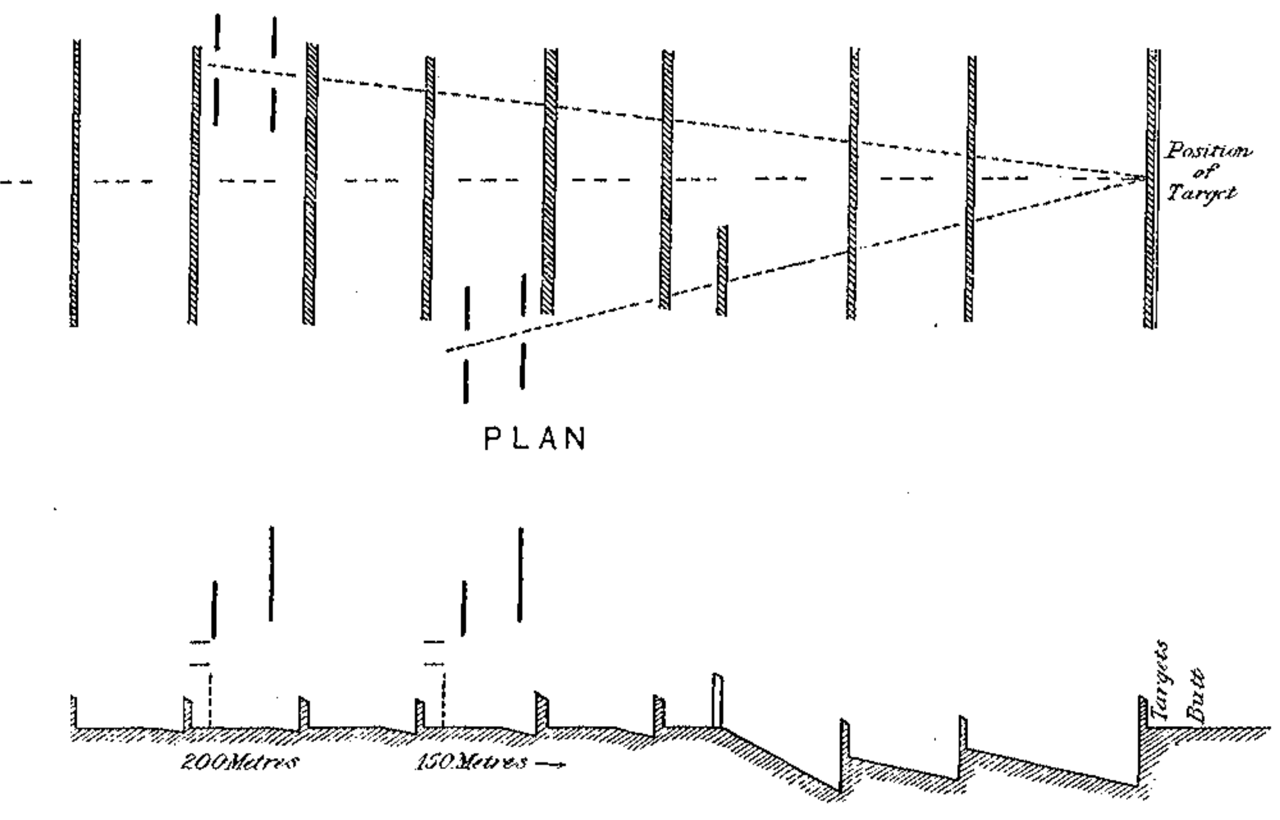
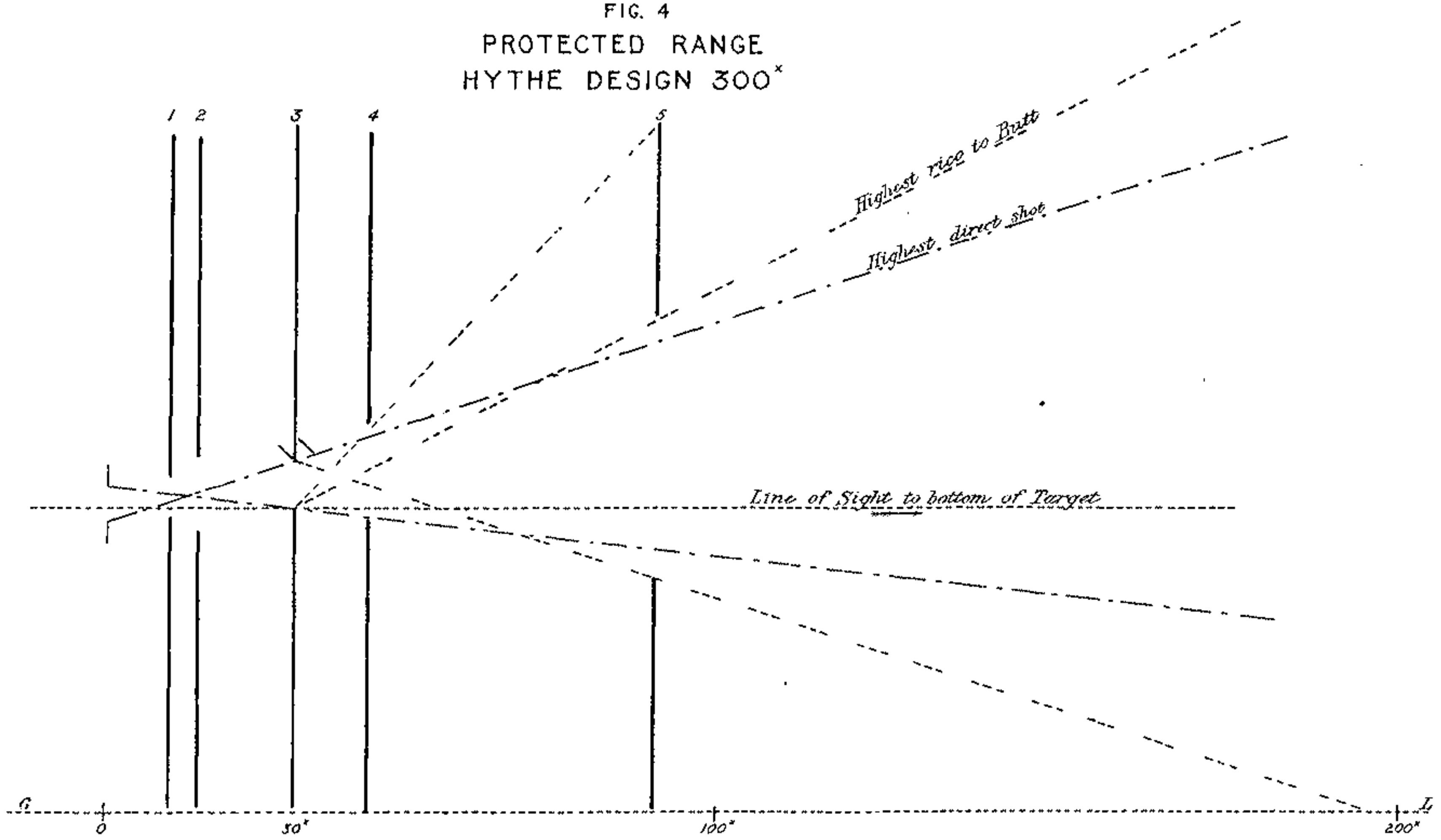


FIG. 4
PROTECTED RANGE
HYTHE DESIGN 300x



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