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THE EDITOR, R.E. JOURNAL,
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By Bt. Major R. L. McClintock, d.s.o., R.E.

In the August number of the *R.E. Journal* last year, an article appeared entitled "Experiments with Palm Trees as a Bridging Material," and showed that this timber—usually regarded very much askance by the military engineer—is really quite capable of useful employment in temporary bridges, and other fieldworks expedients.

At the time the article was written, experiments with these spars had only been made as regards their use for road-bearers, trestle legs, suspension-bridge piers, and field observatories, for all of which purposes the material had proved satisfactory. The timber had not however been subjected to the very severe test of use in a cantilever bridge, as funds would not permit of the purchase of sufficient palm trees.

But this test was not forgotten, and during the next field-works course of No. 10 Company, 2nd (Q.O.) S. and M., the experiment was carried out with entirely satisfactory results, as can easily be seen in the accompanying photographs.

The cantilever bridge shown, was of 72′ span between shore transoms and was calculated for infantry in file. Each cantilever projected 21′ from the shore transom, the centre (30′) being occupied by three trussed girders, each constructed of two overlapping pontoon gunnels, braced with fencing wire. In each cantilever there were three layers of logs, the lowest projecting 6′, the middle 7′, and the upper 8′ from the last point of support. Each layer carried back 15′ from the shore transom into the bank, and was there lashed down to an anchor log buried 4′ at the far end. In addition to this, each of the three layers was covered with boards and about a foot of rammed earth.

It will be seen from the photo that the top layer only of each cantilever was made of palm trunks. Expense prohibited the purchase of the large number of trees required for the whole bridge, but as the stress was calculated equal in each log of each of the three layers, the fact that the top layer stood the test answers for the whole.

It will also be observed that the point of the left-hand cantilever sank about 1′, and had to have the transom built up accordingly. This was due to inadequate foundations having been provided for the shore transom on that side, which accordingly, when subjected to the

load, sank to this extent in the somewhat soft earth of the bank. Equilibrium was however reached at this point, and no further subsidence took place.

The provision of sufficiently strong foundations to the shore transoms is, perhaps, the most important and difficult point connected with this type of bridge.

In connection with the use of palm trees in field work, the smaller photos show palm trunks in use :—(I.). As a single derrick. The palm trunk is 35′ long, and was used as a single derrick to raise one of the trestles of a trestle suspension bridge on to the cables. Weight of trestle about 1,600 lbs. (II.). As a field observatory. A field observatory 107′ high, made by lashing two palm trunks together. The graceful curve seen in the top spar is the natural shape of that particular tree, and not a sign of weakness.

INSIDE AND OUTSIDE PORT ARTHUR.

By Colonel J. F. Lewis, late R.E.

Up to the present almost all we knew of the Siege of Port Arthur had been from the point of view of the Japanese attack. We have now a book, *The Truth about Port Arthur*, written by a newspaper correspondent, Mr. G. K. Nojine, who was inside. This has been translated by Capt. A. B. Lindsay and Major E. D. Swinton, D.S.O., R.E. His account appears truthful and is often supported by official documents. A comparison of his account with that of a good observer on the other side, such as that which Mr. Ashmead Bartlett has given us in *Port Arthur: The Siege and Capitulation*, seemed likely to be interesting, and has here been attempted.

It may help readers to warn them that Russian time differs from Japanese time by one hour. Consequently, if Mr. Ashmead Bartlett says that an operation began at 10 a.m., Mr. Nojine will time it at 11 a.m.

A notable point about the Battle of Nanshan, brought out by a comparison of the Russian and Japanese accounts, is that it was so very nearly a Russian success. The Japanese estimated (A.B., p. 18) that 11,000 men were defending the position, while Nojine makes the statement on p. 11 that there were 16,000 men of the 4th Division alone behind the next line of hills. He adds, though, that they were never brought into action! Their general, Fock, wished to reserve them for the defence of the fortress, not realizing that the real defence of the fortress was here and now at Nanshan. As a result the 5th Regiment, which mainly defended the position, was worn out and exhausted by the end of the day and could not resist the last Japanese advance. The same misunderstanding of the situation had led to the defences being only half executed and only partly provided with accessories, such as electric lights and materials for bombproofs, and to a defective supply of ammunition.

Notwithstanding all these deficiencies, the brave Russian troops held on to the position through 12 hours of desperate fighting, repelling repeated Japanese assaults, until at length the fire of their batteries and gunboats enabled the latter to wade through the shallow water of Kinchau Bay and to turn the Russian left flank.

It appears to be generally admitted that a better position than that of Nanshan is to be found on the hills about 2 miles behind it, called by Nojine the Tu Fashin Heights (p. 75), but no attempt was

made by the Russians to hold these heights even as a support to Nanshan.

After the Battle of Nanshan, Dalny was evacuated in so much hurry that there was no time to destroy the docks, and the defenders of Port Arthur fell back almost into the fortress. An advance by General Nogi would probably have taken him nearly up to the glacis; but he did not know the disorganized state of the Russian forces, and was actually inferior in numbers to them, so he contented himself with covering Dalny, preparing it for use as a base, and sufficiently clearing Talienwan Bay of mines to allow of the use of the harbour by the Japanese transports.

The Russians, wishing to gain time for further works at Port Arthur itself, occupied the Green Hills position, about 7 miles in advance of the fortress, which was more or less fortified and was very strong in itself.

According to Nojine, the Japanese, on obtaining possession of Dalny, immediately began using it for the landing of stores (p. 89); but this could not have been the case, as the Bay had first to be cleared of mines, which was a slow process, and not sufficiently accomplished until the middle of July, according to Ashmead Bartlett (p. 31).

As part of the preparations for using Dalny, General Nogi was anxious to get possession of Kinsan Hill, a point in advance of the main Green Hills position, but one from which it was possible to see both Dalny and the environs of the Fortress of Port Arthur. It was therefore of importance to both sides.

On 26th June it was assaulted by a battalion, assisted by mountain guns, and stormed. According to the Japanese account, it was defended by two battalions (A.B., p. 29), but Nojine (p. 93) says there was only one company there, and considering the nature of the ground there can be little doubt that his statement is correct. On July 3rd the Russians made a desperate effort to retake it, but failed.

General Nogi was now able to utilize Dalny without fear of being overlooked, and by the third week in July felt himself once more in a position to assume the offensive. In the meantime the Russians—with the exception of the one attack on Kinsan Hill—made no attempt at a forward movement, although for some time they were in superior numbers to the Japanese.

The mental attitude of both sides towards forward movements is of interest to note. The Russian idea of such a movement seems to have been to take up an advanced position and to hold on to it. They do not seem to have thought of pressing forward to an attack except locally for a particular purpose.

The Japanese were ready to advance, but not until the balance of advantages was in their favour. When they had the right quantity of men and guns and ammunition then they went forward, and were delighted to do it.

Neither side seemed ready to take many chances. The Russians did not take up covering positions nor stop at points good for checking the enemy, if these had not been previously decided upon; nor did they advance even when they had the advantage, as was the case when the Japanese first occupied Dalny.

The Japanese, when they had gained the point they were aiming at, did not attempt to go further. A vigorous continued forward movement after Nanshan might have led to the destruction of a large portion of the retreating force, as they seem to have been in a very disorganized condition. Similarly, after the capture of Kinsan, further pressure on the line of the Green Hills would probably have broken it, and the Japanese, having forced the enemy's right flank, would have been in an advantageous position to roll up his centre and left.

Such a result was not possible later on. General Kondratenko was put in charge of the right flank and soon got it into better order.

This was seen in the fighting of the 26th, 27th, and 28th July, when the Japanese succeeded in forcing the position. The troops on the right flank retreated in good order and occupied the Taiho Heights immediately in rear, thus preventing the Japanese exercising more than direct pressure on the troops retreating on the Russian left.

The latter occupied the Wolf Hills just outside the fortress, but these were only imperfectly fortified, and were attacked and carried by the Japanese on the morning of the 30th July. The Russians also evacuated the Taiho Heights, which were too advanced to be held.

The accounts of the capture of Ta-ku-shan and Hsiao-ku-shan Hills are in agreement. The Japanese evidently expected a very obstinate defence of positions of such importance to the fortress, and made a powerful assault, which indeed was not on too extensive a scale. If the positions had been carefully fortified beforehand, they would not have fallen for a long time.

The capture of these hills marks the commencement of the actual investment of the fortress. It will be interesting at this point to note the state of the works and the manner in which they had been evolved.

At the time of the siege the Russians had been in occupation of Port Arthur for over six years. At first they seem to have been zealous about fortifying it, but apparently had slacked off afterwards, until General Kuropatkin visited the place in 1903 and set the work going again, making also some modifications in the design. However at the outbreak of war the defences were far from complete.

Out of the five "Forts," one was incomplete and one was not begun. This did not seriously matter, as these works were on the western side, which was not attacked.

The five "Fortifications," so named by Nojine, were complete; three of these were really forts. No. 3 is better known as Sung-shu-shan. Besides these, several of the intermediate batteries and redoubts were finished, some of them in a very solid manner in concrete. Besides the Russian works there were remains of the old Chinese redoubts, such as East and West Banrusan (Redoubts 1 and 2), and the Chinese wall, a continuous mud parapet running along the whole of the eastern defences and part of the western, which proved to be of the utmost value. It was never seriously damaged nor permanently passed by the enemy until the end of the siege.

None of the advanced positions had been taken up, such as Ta-ku-shan, the Suishien plateau, the "Mètre" Hills, or Liao-tieh-shan. After 9th February, 1904, when the Japanese made their first naval attack, the fortress was put in a state of siege, and work was carried on with more energy; but there was an immense amount to be executed, as not only had the fortress itself to be completed and developed, but the advanced positions at Nanshan, Green Hills, and Wolf Hills had to be prepared. As a consequence, nothing was quite strong enough when it came to be used.

According to Nojine, General Stössel, who was the evil genius of the defence, insisted on beginning with the Central Wall, an inner continuous line of entrenchment close to the town. This absolutely useless work, commanded by heights all round, absorbed an amount of labour which would have been most profitable if expended elsewhere. Stössel also at this time allowed the fortress to be depleted of supplies, a course which eventually led to the place running short of provisions and to an outbreak of scurvy. The want of any balloon equipment in the fortress is explained by M. Nojine, who tells us that the transport containing the balloons and other stores was captured by the Japanese.

On March 17th General Smirnoff, appointed commandant of the fortress, arrived there. General Stössel was really in command of the district of Kwantun, and was not entitled to interfere in the actual defence of the fortress itself, although he did so with evil results. Smirnoff at once inspected the place and, aided by the engineer, General Kondratenko, and others, set to work to get it into order. He had to finish the existing works and to arm them. He quite rightly devoted much attention to the N.E. section of the defences, where the main attack afterwards came off, and built many trenches and batteries. Not much was done on the west front, which was not exposed, but guns were mounted on Liao-tieh-shan to prevent the Japanese fleet bombarding the town from dead water to the westward, as it had done on 10th March.

He developed the works in the Suishien Valley, such as Temple Redoubt ("B" Lunette) and Water Supply Redoubt (Fort Kurapatkin), and commenced an extensive series of works in the

"Mètre" Range. According to Nojine, General Smirnoff wished to restrict the works there to 203-Mètre Hill and its immediate neighbourhood, but Stössel insisted on advancing to Angle Hill (174-Mètre Hill), and this involved holding more foothills to the front of that again. As a result, none of the works were quite strong enough. 174-Mètre Hill fell at an early period of the siege, and 203-Mètre Hill did not get the attention which the importance of its position deserved. Something was done to strengthen Ta-ku-shan and Hsaio-ku-shan (Shakozan), but not enough to enable them to resist a determined attack. Probably this was due to want of available labour, and also to the fact that the main line behind them was very strong; as a matter of fact, it was never attacked by the Japanese. It should be realized that an enormous amount of work was done under General Smirnoff. Miles and miles of trenches were cut in rocky ground, and hundreds of guns mounted. Besides the land front the coast batteries had to be attended to, and here additional guns were mounted, and greater effectiveness given to the original armament by increasing the arcs of fire and the angles of elevation.

There is not much fresh to be gleaned about the great assault of 19th—25th August. On both sides it seems to have appeared to be a sort of pandemonium lit with the glare of search lights, pointed with flashes of flame, and full of the roar and rattle of shells and rifles. The finish of it left both sides exhausted and the ground piled with thousands of corpses, many of which lay there till the end of the siege. The Russians lost the Banrusan Redoubts and 174-Mètre Hill, but the latter was not of high importance, and the former proved a barren acquisition to the Japanese.

The assaults on 203-Mètre Hill in September and the capture of Water Supply Redoubt (Fort Kuropatkin) and the Suishien Redoubts do not call for any remarks.

On 31st August and afterwards, Stössel issued orders which, according to M. Nojine, had the effect of checking the delivery of sorties. This must have rendered the task of the Japanese much easier when they got their approaches close up to the works. It was partly justified by the limited numbers of the garrison. Men could not be wasted.

At this time a third line of works was being constructed in rear of the N.E. defences, a line running about east and west from the front of Quail Hill.

It is interesting here to read a Russian criticism on the trenches made on 203-Mètre Hill, which were similar to those used elsewhere (see Nojine, p. 200). It is by Colonel Raschevsky. He points out that the loopholes are so close up under the roof that it is difficult to fire out of them at all, and impossible to fire down a steep slope. This was a general fault in the case of the Russian works. He also objects to the deep, narrow, boxed-in form of the trenches. This

was not altogether the opinion of the Japanese. They found it difficult to storm a trench from one end, as it was impossible to advance with any width of front. At the same time it was dangerous to pass over the trench and attack it from the rear, as they would be so terribly exposed to the fire of collateral works. Besides this, the trenches were as safe as they could be made from artillery fire. It is however absolutely necessary that such trenches should be well supported by fire from behind and from the flanks.

We now begin the serious work of the siege, properly so-called, when the permanent forts were attacked step by step and when the heavy howitzers were brought into use.

These howitzers were of 11″ calibre and fired a shell weighing 550 lbs., and had been previously used on coast defences. The first one arrived at the besiegers' lines on September 9th, and on 1st October they began firing into the town. It is noted as "an epoch in the history of the defence of Port Arthur." The shells broke through any bombproof or casemate that they struck; no one felt safe anywhere, and the permanent forts were no more secure against them than the trenches.

The Japanese were now sapping towards the forts on the N.E. front, and in particular were close to Chi-kuan-shan. Here, on arriving at the end of the glacis, which finished in a 1/1 slope, they began mining to blow in the back of the counterscarp gallery.

The Russians became aware of this, and started countermining from the gallery so as to get under the Japanese mine and destroy it. They intended to fire a camouflet (Nojine, p. 215), which would destroy the enemy's gallery without producing any effect at the surface.

The Russian mine was fired with some enthusiasm by the commandant of the fortress, General Smirnoff, himself, but there seems to have been some miscalculation of the charge, as a quantity of *débris* was thrown into the air, and a crater was formed which was rather of advantage to the Japanese than otherwise, as it formed a lodgment for them and a point for starting a new mine.

Nojine does not say much about the fighting in and about the counterscarp galleries of Chi-kuan-shan. It probably did not come to the notice of a newspaper correspondent, as there was very little visible sign of it, but for awful desperation it must be unmatched in the history of warfare. Ashmead Bartlett tells one something about it in Chapter XVI.

There seems to have been an idea about Chi-kuan-shan (Nojine, p. 215) that the whole fort was mined and might be blown into the air. The same idea later on was held about Fort Sung-shu-shan. It was of course quite unfounded. Such extensive galleries as this would require could not be cut in the rocky soil of Port Arthur without the expenditure of more time than could be given to them, even if such an explosion could have been practically brought about.

There is not much to be made by a comparison of the accounts of the fighting on 29th and 30th October. There is a terrific bombardment, a daring assault, the reserves pour in upon it from the flanks, the Russians begin to use their diminishing stock of shrapnel; after a time the remains of the assaulting columns drift back again; both sides settle down to recover themselves, and the Japanese have made a slight advance.

Nojine says nothing about the mining attacks on the counterscarp galleries, Erh-lung-shan (Nirusan) (Fort No. 3), or on Sung-shu-shan (Fortification No. 3), notwithstanding their great importance in the progress of the siege. The different steps of the gradual Japanese advance were not very visibly dramatic, and probably so escaped being recorded. On the Japanese side the value of each little forward movement was more clearly appreciated.

We have a picture of General Nakamura's wild assault from both sides. He led a charge of volunteers—2,000 of them—against the supporting battery (Tumulus battery) behind Sung-shu-shan. The advance was over a perfectly open grassy slope, exposed to the Russian fire in all directions. The columns were shown up by the search lights before they started, but they came on all the same, climbed the hill—and never arrived at the top. They were all shot—all—and the grassy slope remained carpeted with corpses till the end of the siege.

The capture of 203-Mètre Hill reads much the same from both sides. The absolute determination of the Japanese to take it at any cost of men enabled them to wear down the defensive strength of the Russians till their reserves were exhausted and there was no one left on the hill to defend it. The bombardment was such that it is difficult to believe that any troops in the world could stand it—except the Russians, who have proved that they could. The Japanese lost over 9,000 men killed and wounded on these slopes.

It appears to be agreed on both sides that if 203-Mètre Hill had had a permanent work on it, it could not have been captured. It would have had to be attacked by sap and mine as the other permanent forts were, but the approach at 203-Mètre Hill is much more difficult than it is on the N.E. front. At the beginning of the siege there was however an immense amount that had to be done, and there was in addition a large quantity done for which there was no real necessity, so that there was no possibility of putting an adequate amount of work into 203-Mètre Hill. If Stössel had only put the rock-cut ditches of his Central Wall on the hill!

The day after the capture of 203-Mètre Hill the Japanese began to shell the Russian warships, directing their fire from the hill. The ships were mostly scuttled in the harbour by the Russians to reduce the effect of the shells upon them, with the idea that if they held the place they might be raised again. The *Sebastopol*, which was the

only uninjured one, went out of the harbour, but was eventually sunk in deep water. Admiral Togo himself landed and went to 203-Mètre Hill to be satisfied that he had seen the last of the Port Arthur fleet, and that he could now devote all his energies to preparing his ships and crews to meet the Baltic fleet, which was on its way out.

The fleet being thus disposed of, the Japanese were able to concentrate their attention on the capture of the fortress, and the centre of interest again shifts to the N.E. front.

Here the chief event, though of course the Japanese did not know it at the time, was the death of General Kondratenko on 15th December. He was killed with several other officers by an 11″ shell in one of the casemates of Fort Chi-kuan-shan, where he had gone to see how matters were progressing. He was Smirnoff's right-hand man, and with his tact as well as his skill had managed to keep things going. Now that he was lost the end was not far off.

On the 18th inst. the Japanese exploded their mines under the front parapet of Chi-kuan-shan. Their position is shown in the plan at p. 232 of Mr. Ashmead Bartlett's book.

It was more or less expected by the Russians, who do not however appear to have countermined. The Japanese charged almost into the explosion and occupied the craters, but could for the time get no further. The garrison was retrenched, and a tremendous fire was opened on the fort from the adjacent works. In the evening fresh troops were sent in, and the place was carried. It appears that the garrison was worn out, and no reinforcements were sent. General Kondratenko's successor had not the same ideas as to a defence as he had.

The next great event was the capture of Fort Erh-lung-shan (Nirusan) (Fort No. 3) on 28th December. The accounts differ as to how this came off, but on the morning of that day the Japanese exploded mines laid under the front parapet, similarly to those at Chi-kuan-shan (see plan, A.B., p. 240). They then occupied the craters, where they built some sandbag parapets, and after reconnoitring the rest of the work, stormed it, and finally captured it before daylight next morning, killing a number of the garrison in the concrete casemates of the gorge. According to the Russian account, the fort was simply evacuated, as the men had lost heart, notwithstanding that reinforcements had been sent to them immediately after the explosion. The Japanese account is more complimentary to the Russians, who, they say, fought desperately, and the large Japanese losses, amounting to 1,000 killed and wounded, show that there must be much truth in it.

While these operations were going on, Sung-shu-shan (Fortification No. 3) was waiting to be blown up, and on the 31st December the expected explosion occurred. As with the other forts, the front parapet was destroyed, but there was a different sequel. As the garrison was

rushing to the front through a gallery of communication, to repel the expected assault, another explosion occurred in the centre of the fort—in the gallery, not in the gorge—which killed a number of men, and drove the rest back into the gorge gallery itself, where they surrendered.

Both books, Nojine's and A.B.'s, say that a mine gallery was run by the Japanese from the front to under the gorge, in order to blow up the whole fort. This I have every reason to believe is incorrect; as a matter of fact, the gorge casemate was not blown up, it remained intact when the fort was captured, but the middle of the communication gallery was blown to pieces. There is little doubt that a mine laid by the Russians, to be exploded if the fort was taken, went off prematurely. They laid such mines in Chi-kuan-shan (Fort No. 2), but these were discovered by the Japanese in time to prevent them doing any harm.

The mining attack on these three forts is of considerable interest. In all cases the Japanese mined the front face, successfully stormed it after the explosion, and secured their position on the crest of the crater. In all cases the Russians continued their resistance, and in the case of two of the forts it was several hours before they were completely occupied. In the case of the third, the second unexpected explosion killed many of the garrison and imprisoned the rest in the gorge casemates, so that further resistance was impossible. At Chi-kuan-shan the garrison was exhausted and was not reinforced. When Erh-lung-shan (Fort No. 3) was taken there is little doubt that the heart had been taken out of the men by the progress of the siege, and they did not resist in the way they had before.

It seems therefore that the explosion of these mines did not with certainty advance the Japanese beyond the edges of their craters. If the garrison had been in good form the assailants would very likely have had to mine their way into the gorge before they could have completely mastered the works.

The fall of Sung-shu-shan gave Stössel what he considered sufficient excuse for surrendering. Orders were given to abandon some of the advanced works, which were occupied by the Japanese on the night of the 31st December, and on 1st January they stormed Eagle's Nest (Bodai). This was the key of the second line; no attempt was made to defend the third line.

On the afternoon of 1st January Stössel sent a letter to General Nogi proposing a capitulation. As soon as this got known the soldiers, relieved from the intense strain of the last months, got out of hand and no further defence was possible, even if it had been attempted.

At the surrender, besides other provisions, there were 700 tons of wheat flour and 1,920 horses. There were also 6,000 cases of scurvy in hospital, besides others still on duty. If these men had had the wheat

and the horses to eat they would probably have been in an efficient condition. A reinforcement of 6,000 men would have materially delayed the Japanese advance. Nojine states that on 8th December it was proposed to increase the meat ration, but that this was vetoed by Stössel.

The comparison of the two accounts of the siege shows that if the courage and devotion of the Japanese had not been seconded by muddle and mismanagement inside the fortress they would have been very much longer in taking it than they were.

Even supposing the place to have been in the state it actually was on the outbreak of war, and that no more had been done before that time, it could have been made enormously stronger—work could have been concentrated on vital points, provisions could have been accumulated, and proper hospital accommodation arranged for. This would have practically added several thousand men to the fighting strength of the garrison, and would have put much further off the day when they would have had finally to surrender from starvation. It is questionable if under such conditions anything else would have turned them out of the place.

THE ITALIAN OPERATIONS IN ABYSSINIA, 1894 TO 1896.

By Capt. F. D. Irvine, R.E.

The Italian operations in Abyssinia have not, I think, received that attention from the military student which they deserve. The disaster of Adowa is usually regarded rather as an inexplicable fact, than as the logical outcome of previous action.

General Baratieri is remembered as the loser in the last great battle, while his victory at Coatit, the pursuit of Senafé, and the gallant defence of Mekeleh are forgotten, and in their successes against the Dervishes—operations which are as brilliant as those of British troops in the Sudan—the Italians display no signs of weakness.

To what causes then should we attribute their ultimate failure against the Abyssinians? It is customary to class these warriors on a par with other savage nations of the African continent, whereas the Ethiopian, to give him his true title, is possessed of a civilization far ahead of the Zulu or the Dervish. He is a remnant of the patriarchal days of the Old Testament, and his kings claim, with every right, direct descent from Solomon.

It is true that at the date of the British Expeditions which ended at Magdala, King Theodore's troops were not armed with the weapons of modern warfare, but when the Italians encountered Menelik they met a host of fierce warriors, some 120,000 in number, the majority of whom were armed with modern rifles which they knew how to use, and who were, in addition, embued with the reckless courage of the Zulu or the Dervish. In fact they may be better compared to the hill tribesman of the N.W. Frontier of India, or to the Afghan, though I doubt whether these cautious customers possess the same ability to charge home in the face of an overwhelming fire as—on countless fields—the African has shown himself able to do. Nor has it ever been the lot of British troops to encounter in country similar to—if not more difficult than—Afghanistan, such enormous hosts of well-armed fanatics, so that possibly we have condemned the Italians too lightly for their failure, and have not sufficiently studied the difficulties of the situation.

A brief account therefore of some of the salient features of the various Italian operations in Abyssinia may, perhaps, serve to interest the student.

In 1889 Menelik, King of Shoa, seized the throne of Abyssinia,

which was vacant by the death of the Emperor John on the battle-field of Matamma, where he had signally defeated the Dervish hordes. This battle is mentioned merely to show that at that time, the Abyssinians were superior from a military point of view to the Dervishes, then at the zenith of their power. John was King of Tigré—Shoa and Tigré being divisions of the Abyssinian kingdom—and Menelik, who is a politician rather than a warrior, having refused to join John against the Dervishes, after his death ousted Mangasha, who was a minor and who was heir to the throne of Tigré.

In January, 1890, the Italians formed their "Colony of Erithria," and had to select which of the two, Menelik or Mangasha, they would support as paramount in Abyssinnia. Rightly or wrongly, they decided to support Menelik. In return for the concession of acknowledging an Italian protectorate, Menelik was allowed to borrow four million lire (£150,000), half of which sum he at once expended on rifle cartridges.

After endless negotiations, and on the arrival of these cartridges at Addis Abeba—the Shoan capital—in February, 1893, Menelik repudiated all treaties and sent a circular note of independence to the Powers of Europe. However negotiations still continued, and in the meanwhile the raw Italian native troops were blooded against Dervish raiders at Agordat and Kassala. In all the negotiations it was invariably the unfortunate province of Tigré, the property of Mangasha, which was divided between the Italians and Menelik, until at length in June, 1894, the Prince of Tigré, in despair of receiving help from Italy, joined Menelik, and with the assistance of that monarch commenced to collect forces with which to recover his kingdom.

At this point it is necessary to give a brief description of the opposing forces. The Italian native troops were recruited from the borders of the Red Sea, and from Tigré and the surrounding chiefs. The officers were Italians at roughly 1 officer per 100 men. The *esprit de corps* and fidelity of these native troops, called Ascari, is undoubtedly as great as that of our Indian troops, and there are numberless instances on record of their loyalty and devotion under the most trying circumstances. The cavalry arm was practically non-existent, but the artillery, of mountain guns only, was manned by Sudanese and was most efficient. The total garrison of the colony in 1894 was some 13,000 Italian and native troops, with two squadrons of native cavalry and two mountain batteries.

As regards the leaders, General Arimondi, at Agordat, signally defeated a Dervish host of four times his strength, and the Governor-General, Baratieri, by a sudden dash with 2,500 native troops, had captured Kassala—a Dervish stronghold—which became the outpost of the colony.

The numbers of the Abyssinians depended somewhat on the

support accorded to the Negus Nagasti, or Emperor, but at this time Menelik could actually dispose of some 200,000 men. About two-thirds only of these were armed with rifles, breechloaders of various sorts, but every man knew how to use the rifles taken from a dead comrade. They were fair marksmen, and every warrior carried the six-foot Ethiopian spear. The cavalry, from Galla in the south, were not the least efficient portion of the force, which was completed by the possession of artillery in the shape of mountain guns.

Like most semi-civilized nations, they had no organization in battle and had a dislike to night operations. At the halt there was no service of protection, and they were accompanied by enormous numbers of followers; an army on the move was like the emigration of a tribe. The matter of supply therefore was their vulnerable point; each district was soon eaten bare, and then if a move was not made, the army disbanded itself.

In operations against such an enemy it is necessary to deny them the fertile districts, either by means of forts built and occupied in peace, or by placing the regular forces in such a position as to cut the enemy off from his next means of supply, thereby forcing him to attack or to disband, when vigorous action will turn his retreat into a rout.

To resume. In December, 1894, Mangasha, with a force of 18,000 men, took up a menacing attitude at Entisho. Baratieri, with 3 battalions and a battery, made a sudden dash from his base at Adis Ugri and occupied Adowa and Axum, the Tigrian capital and sacred town.

The effect of this stroke however was less than he expected, and in January he returned to Adis Ugri to watch Mangasha. The latter was bent on invading Okulé Kusai, the north-eastern portion of Tigré, and was thus liable to attack on his flank. Baratieri therefore moved to the heights of Kenafena, where he would be in a secure position and within striking distance. On January 12th, 1895, on secret information, he crossed the river Mareb to Adis Adi, and from the heights of Mount Toculi the enemy's column could be descried moving northwards on Coatit.

Baratieri decided to cut him off, and marched on the same day to Coatit, which he occupied in the evening, unknown to the enemy, with a strength of 4 battalions and 1 battery, all native troops. Mangasha camped some 4 miles to the south-east, and Baratieri, after a night march, attacked at dawn, 13th January. The Abyssinians made vigorous efforts to envelope the Italian left and reach Coatit, but they were foiled, and at 10 p.m. Mangasha retired with enormous losses. The pursuit was taken up at dawn on the 14th January, through the Cascassé Pass to Senafé, where, after a distance of 30 miles had been covered, the Abyssinians were found camping at sunset, and were absolutely routed, abandoning everything. This is

a prodigious pursuit for infantry, and any small body of cavalry would have been of incalculable value.

So far the war was over, and when the disparity in numbers is considered, the operations afford undoubted proof of the ability of General Baratieri and of the staunch character of the native troops. The total Italian loss was 600 out of 4,000, while that of the Tigréans is estimated at 3,000. The only drawback to the success achieved was that possibly too low an estimate was formed of the opposition likely to be encountered from Menelik.

The Governor now proceeded to consolidate his position in Northern Tigré; but in Italy the Crispi Government was in power, and the strictest "economy" was the order of the day. Consent was given to the fortification of Adigrat, a position of immense strength and importance, but all the Governor's applications to build a fort and to occupy Adowa were in vain. He was compelled to give in on the point, and in doing so rather than resign, he, without doubt, in a measure sealed his future fate. He and his advisers saw that further operations were inevitable, that the line of mountains between Adigrat and Adowa formed the strongest line of defence for the Italian Colony, and that they also barred the way to the fertile districts of northern Tigré. Italy however could not afford war, and a backward policy was adopted.

Meanwhile Menelik had been busy consolidating his empire, and at the end of September prepared to take the field by sending reinforcements to Mangasha at Debra Aila as an advanced guard. The Governor determined to strike this force before Menelik could come up, and concentrating at Adigrat moved swiftly down to Dolo. He had been reinforced from Italy, and was now in command of 9,000 Italian and native troops, 2 batteries, and some irregulars. Mangasha evaded the blow and retired southwards to Lake Ashangi. Here again a body of cavalry on the Italian side, could probably have cut off and arrested the Abyssinians until the infantry arrived, and at any rate would have been useful in pursuit.

Baratieri, having occupied Mekeleh with 4½ battalions under General Arimondi, and having sent 1½ battalions under Major Toselli with 4 guns and the irregulars to Amba Alagi to watch Mangasha, returned himself to Adigrat to settle his communications, receive reinforcements, etc. Amba Alagi is a mountain pass 36 miles to the south of Mekeleh, and was merely a post of observation not intended to be defended. In fact it was eminently suited for occupation by cavalry, whereas infantry in such an isolated position are always liable to be caught by a mobile enemy. Moreover, a mutilated telegram from Arimondi led Toselli to think that his duty was to hold the pass and that he would be reinforced.

On December 7th Mangasha with 30,000 troops advanced on Toselli, who had only 1,200 regulars and 4 guns. The position is a

fine one, but the numbers of the defence were totally inadequate, and after six hours' stubborn fighting the Italian troops were overwhelmed, their leader killed, and a column of 300 fugitives reached Arimondi at Mekeleh. Some 3,000 Abyssinians fell, but the loss of prestige was a heavy blow to the Italian cause. Fortunately, like most half-disciplined troops, the Abyssinians failed in pursuit, and Arimondi was given time to make his plans. He left a garrison of 1,200 men and 4 guns under Major Galliano at the half-finished fort of Mekeleh, and with the remainder rejoined his chief at Adigrat. While admitting the virtue of an endeavour to check the enemy's advance and keep some hold over Southern Tigré, the wisdom of exposing a second detachment in this manner is very questionable, and Arimondi was censured by Baratieri for his action.

The Abyssinians waited for Menelik and gave Galliano 14 days' grace in which to finish his fort and make his preparations. On December 20th Menelik arrived with a host of 70,000 men and 20 guns, and the siege commenced. It lasted for 32 days, during which, at one period, a determined assault was kept up for five consecutive days with intermittent fire from the guns at night, a terrible strain for the tiny garrison. On January 19th water had run short and the end seemed near, when unexpected news arrived that the surrender of the fort had been agreed upon between the Italian Government and Menelik, and the gallant defenders were to march out with all the honours of war.

As a matter of fact, Menelik's host had exhausted the supplies of the district and it had become necessary for him to make a move. He wished to move to Adowa, thus making a flank march within striking distance of Adigrat. And, though he knew that a few days must decide the fate of Mekeleh, his cunning suggested a plan by which he could make his move with safety and certainty, and at the same time appear to be magnanimous. Under pretence of fears for the safety of the garrison, on their march out he insisted on sending with them a large escort. Mekeleh to Adigrat is 40 miles, and to Adowa 50 miles. When the escort reached Dongolo, about half-way, they and their prisoners moved in a north-westerly direction to Hausien, which is half-way between Adigrat and Adowa. Under cover of this screen Menelik effected the move of his main force to Gundupta, near Adowa, and on his arrival there, the escort screen retired, and the survivors of the siege were allowed to proceed to Adigrat.

The folly of the abandonment of Adowa was now apparent, but it was too late. Menelik was now nearer the Italian line of communications, through Asmara, than Baratieri, and the latter in order to cover them moved to Sauria, some 7 miles from Gundupta. Menelik however at once retired to Adowa, 4 miles to the west.

The Italians were in an extremely difficult country, full of

mountains, precipices, and deep nullahs. Their line of communications took 10,000 men for protection, and lay through Adigrat, Senafé, Adi Caji, where it divided, one line through Maio, and another by Sanguinetti and Asmara to Massowah. This line was double, extremely long and difficult, and very vulnerable, lying as it did through the mountains. In fact, it was cut on several occasions and caused constant anxiety.

Baratieri, in place of an advance through the mountains, would have done far better to garrison Adigrat and Adagamus strongly and move his main force to the river Belesa, with his communications shortened, simplified and comparatively safe, for the northern districts had long been under the Italian sway, and the chiefs were friendly. He could then have awaited the further movements of the Abyssinians, with the prospect of reinforcement by the two divisions now on their way from Italy. But with his lack of cavalry he had to watch the Abyssinians with his main body of infantry, and he also made the fatal error of underestimating both the numbers and fighting qualities of his enemy. Menelik, superior though he was in numbers, was far too acute to attack the Italians in a prepared position, and so on February 3rd the two sides sat down to watch one another. Baratieri now had a force of 21,000 Italian native troops and 50 guns. While however the inaction, combined with scanty food and bad supply arrangement, affected the *morale* of the Italian troops most adversely, Menelik, by means of spies, was kept aware of every plan and intended movement.

Daily the situation on both sides became more critical; on several occasions Baratieri ordered and again countermanded a retirement, until at last, on February 28th, he saw that he must make some move. Had he known that Menelik was also at his wit's end, Baratieri might yet have won his game of passive defence. Unfortunately all the Italian generals were unanimously in favour of an advance, and the Governor allowed his own judgment to be overruled. On February 29th therefore an advance by night to Gundupta was determined on, and he hoped that the Abyssinians would attack him there.

His force now consisted of:—

8 regiments of Italian infantry	...	...	...	8,000
7 battalions of native infantry...	...	...	...	7,000
9 batteries of Italian mountain artillery,				
1 battery of native „	„			

a total of 15,000 rifles and 56 guns, but no cavalry. Besides this there were some 1,500 irregulars and a mixed force of 3,000 as guard to the camp at Sauria.

The Abyssinian forces are estimated at 80,000 rifles, 8,000 cavalry, and 42 guns, with 20,000 men variously armed, but capable of using rifles when they should get them. This is a comparative strength of

6 to 1. At Omdurman the Dervishes were only 2 to 1, and had no rifles nor guns. At Tel-el-Kebir the numbers were again 2 to 1, though Arabi's troops had rifles and guns. In Tirah the total enemy encountered at all times never amounted to 50,000, in fact, it is safe to say that such a host as that of Menelik is unique in the history of uncivilized wars of modern times.

To resume our account of the ill-fated Italian force. It was divided into three columns and a reserve. The mountain tracks, though numerous, were extremely difficult to traverse in the dark. The maps were bad, and in his instructions to the left, or south, column General Baratieri made an error in the name of the heights which this column was to occupy. The place which he named lay in reality 3 miles further west and in front of the position selected. In spite however of all the difficulties, which included the unforeseen crossing of two columns, also due to the defective map, the various columns arrived on the ground allotted them in plenty of time to take up their positions. The left column however, marching quickly, arrived so early at its correct rendezvous that General Albertone, in command, after waiting some time for the centre column, which had been delayed by the crossing, to come up, concluded that he had made a mistake, and accordingly advanced to the place which was named in the map, 3 miles to the front.

At 6 a.m. on March 1st this isolated column met the enemy, who had news of the move, in force. It was Mangasha and his Tigréans, burning for revenge, and by 10 a.m. the Italians were overwhelmed and almost annihilated, the Sicilian gunners dying at their posts. At 7 a.m. Baratieri, who had been busy on the right, heard of the predicament of his left, and at once, in order to extricate Albertone, issued orders to the right column, under General Dabormida, to advance a short distance to a spur, and to hold out a helping hand to the hard-pressed left.

Owing to the difficulties of the ground however the advance was slow, and General Dabormida, losing his way among the ravines, strayed further and further away to the west and north. A huge column of Shoans, interposing between the right and left columns, rushed down upon the unprotected right of the centre column, which was in position under General Arimondi, and at this moment the victorious Tigréans, following the routed left, also attacked the centre. The reserve was brought up as quickly as possible to occupy both flanks, but they were defeated as they came on the ground, and a fresh column having enveloped the left of the centre at 2 p.m., the rout of the latter and the reserve became general. The Galla cavalry headed the fugitives off from the camp, but only pursued for some few miles. On March 3rd the remnants under General Baratieri reached Adi Caji, and the bad news was sent to Italy.

Meanwhile General Dabormida and the right column were busily

engaged with other forces of the enemy. At 9 a.m. he was heavily attacked, and by noon the enemy was completely beaten off. Now however the victorious Shoans and Tigréans returned from their successes on the centre and left, and General Dabormida was surrounded.

Momentarily expecting reinforcements, or at least some news, he fought bravely until 4 p.m., and then commenced to retire in good order. All the efforts of the Abyssinians failed to turn this retirement into a rout, and at sunset a tropical storm put an end to the fighting on both sides. General Dabormida was killed, but the survivors of this right column, covered with glory, made good their retreat to Adi Caji. Thus ended the Battle of Adowa.

The total loss on the Italian side was 4,000 Italians and 2,000 Ascari dead, 1,500 wounded, and 1,500 Italians and 1,000 Ascari taken prisoners. The Italian Army had ceased to exist, with 60 per cent. of its strength *hors de combat*. The Abyssinian losses are estimated at 17,000, or about double the Italian killed and wounded. Of the Italian officers, out of 400 some 300 were killed and wounded. The Governor was the only general who survived, to his misfortune.

On March 6th General Baldissera arrived to take over supreme command, and bent every effort to the organization of a force with which to stay Menelik's victorious advance. That monarch however, after advancing to Gura, suddenly drew off all his forces into Shoa. As a matter of fact he showed a wisdom above the average in resting content with his success and not pressing the Italians too hard. He had vindicated his statement that he only wished to recover the limits of his own empire, and he displayed great command over his heterogeneous force.

Peace was arranged in May, and the ancient line of the rivers Mareb, Belesa, and Muna became the recognized boundary, while the independence of Ethiopia was universally recognized. It only remained for General Baldissera to clear the northern portion of Erithria, which was threatened by the Dervishes under Osman Digma, as Menelik's ally. Kassala was relieved on April 3rd, and the Dervish Army routed at Tucruf. We have now come to the end of the operations, and it only remains to make a few comments on them and to bring out some of their salient points.

In all operations against a comparatively uncivilized foe, the civilized power possesses certain advantages. The first and foremost of these is the command of the sea or other avenues of approach to the enemy's country, so that it is possible to transport forces at will, to shorten lines of communication, or to relieve pressure on any point by a stroke from a new direction. This advantage was in no way utilized by the Italians in these operations. By shifting the base from Massowa to the Bay of Arafali, the line of communications would have been shortened and simplified, while an expedition landed

at Assab Bay to move through Danakil straight on Shoa could not have failed to draw Menelik from the north. This latter point indeed was considered, but the point and route chosen lay through the British and French spheres, and leave could not be obtained to make use of them.

Again, the power to look ahead and make preparations in peace is a factor on the side of civilization. In these operations, as in so many others, a policy of false economy was adopted, and the Government, in refusing the plain warning of the man on the spot, must shoulder their share of responsibility for subsequent mishap. How many similar monuments to the fatuity of party government in military matters might be erected in various parts of the globe.

Generally speaking, in uncivilized warfare, though the advantages of strategy lie mostly with the savage races, in tactics the reverse is the case.

These campaigns afford decisive proof that, even in mountains, the Regular forces cannot dispense with cavalry, the only arm with which the superior mobility of the savage can be counteracted. In artillery too the Italians seem to have been content with too little. Possibly the nature of the country rendered the employment of field guns impossible, in any case mountain guns are but a poor substitute, unless the enemy has no artillery.

In the service of intelligence the Abyssinians, as is usually the case, completely outwitted the Italians, but there is nevertheless no excuse for mutilated telegrams and the lack of maps.

The use and abuse of night marches is well illustrated. At Coatit the night march was successful because the enemy were surprised and were struck at dawn. At Sauria, on the other hand, General Baratieri was in a false position. He had 11 miles to traverse before he could strike the enemy, who were fully aware of all his movements. He should at any rate have moved to Gundupta by day and left 4 miles only for his march that night.

In 1898, at the attack on Mahmud's Zeriba on the river Atbara, the Sirdar, who was encamped 11 miles from the Dervish position, moved, first to Umbabia, then that evening to Mutrus, 3 miles from the zeriba, which he attacked at dawn after a night march. In this case, as at Adowa, the enemy were not indeed taken by surprise, but they were attacked at an hour which the savage particularly dislikes, and the assault was well prepared by artillery fire.

The Italian tactical formation is a shoulder-to-shoulder advance of the infantry in line, with reserves in echelon to protect the flanks. Though eminently suited both to a good development of fire and to meet an enveloping attack, such a formation presents a fine target to hostile marksmen. Still it is something of a problem to devise a means of meeting a savage marksman, supported by artillery, an enemy who charges with reckless boldness covered

by fire, either his own or that of his friends, and who, while almost your equal with the rifle, is far your superior in a hand-to-hand fight. The Regulars cannot always fight on their own ground or in entrenchments, so that some tactical formation to meet the above requirements is necessary.

That the Abyssinians, and Menelik himself in particular, were entirely underestimated by the Italians is obvious from the whole story of both the negotiations and the operations. Such a fault however is not peculiar to the Italians, though its results in their case were perhaps more strikingly disastrous than in others.

In conclusion, the contrast between the various Italian operations against the Abyssinians and the Dervishes, brings out well the marked inferiority of the latter. In the study of British successes in the Sudan let us not condemn too lightly the failure of others.

I venture to think that in the study of such failure, more is to be learnt than from the perusal of successful campaigns, in which the difficulty lies in properly appreciating the exertions by which the war machine was made to run so smoothly.

TERRITORIAL FIELD COMPANIES, ROYAL ENGINEERS.

By Major F. E. G. Skey, R.E.

Few branches of the Service can boast of more honourable duties than can the Engineers of the present time, by the light of the experience gained in South Africa and Manchuria; for not only have they still to maintain the character for technical skill and enterprise which they have inherited from many generations of their predecessors, but they also now possess new and very important duties in the field of battle, and especially in the attack, which have added very considerably to their responsibilities. As partakers in these duties and responsibilities, all members of our Corps will cordially welcome the newly raised Territorial units.

In the *R.E. Journal* for December, 1908, Capt. J. H. Robinson, R.E. (T.), has asked for the views of officers as to the best mode of organizing and training a Territorial field company, and the following suggestions are offered in compliance with this request.

It is probable that in the matter of technical skill the Territorial units of the Corps will prove superior to their Regular brethren. The large and valuable class of skilled mechanics, of which the country is so justly proud, supplies, as is only natural, but few recruits to the Regular Army. And yet it must undoubtedly contain many men who, from a love of manly occupations and the honourable desire to take a part if required in the defence of their homes, would willingly spend part of their leisure in military training, and to these men Engineer units might be expected to offer a more congenial field of occupation than other branches of the service. With this class taking service freely in their ranks, the Territorial companies, in *personnel*, would have a great advantage over the Regulars.

It is suggested that it would be unwise to lay down very strict rules as to the details of trades. Each section should have a minimum of ordinary trades, but the majority might depend on the peculiar conditions which exist in its special district. Thus a section, half-company, or even a whole company, may draw its members from some large engineering or mining works, and such a company, or part of one, should be encouraged to pride itself on its special craft, even to the extent of bearing a nickname calling attention to the fact, which would be known throughout its division. It is not hard to imagine contingencies in civilized warfare, where a general would have

reason to congratulate himself if he found in his command a company of men used to building up girder bridges, or to work with corrugated iron, or at heavy earthwork, roadmaking, quarrying, or mining. In addition to this, it would be well if young men under training as civil engineers could be induced to join the ranks, with a view to rising through the non-commissioned ranks to eventual commissions. Such men would aid the officers by a solid backing of intellectual skill, which would go far towards raising the technical standard of the Corps generally.

In an even greater degree should these considerations count in the selection of the officers. Engineering qualifications should be a *sine qua non* for all Engineer officers, and the more highly qualified men who can be induced to support the Territorial branches of the Corps, either by actual service or at any rate by their cordial interest, the better. If they cannot serve they might at least associate themselves with the different units in various ways, such as patronizing lectures which may be arranged for their instruction, and taking part in the subsequent discussions.

An additional advantage to be gained by thus attracting the heads of the civil profession to take interest in the military branches is that it is a well-known lesson of history, and not the least of the principles of the great Napoleon, that all fresh science should be drawn into the service of war. If, through the Territorials, men of science can be attracted to an interest in military matters, much advantage to the State would undoubtedly accrue.

As regards the equipment of the Territorial field companies, that of the Regular units should of course serve as a guide. But the bridging equipment might with advantage be discarded, partly because it adds a quite embarrassing bulk to the train of a small and otherwise compact unit, and partly because in a civilized country, field companies should be able to improvise with planks and barrels, or such-like stores, rafts or bridges the necessity for which can easily be foreseen.

As to bicycles, the more men who can be equipped with this useful form of conveyance the better, for everything should be done on service to husband the strength of the men and bring them to their destination fresh and ready for any heavy work which may be found for them. An elementary knowledge of equitation among the men would not come amiss, and among the officers a good knowledge is essential. The driving and repairing of motor cars is a useful knowledge in modern times.

Having now collected our Territorial unit, with its high standard of intelligence, both natural and technical, we will proceed to discuss the lines which might be followed in its limited opportunities for military training. For the majority of the men this training will fall roughly under two headings, dependent chiefly on the season of the year, namely, practical and theoretical.

It is suggested that a large proportion of the practical training should consist of purely military training. The men must learn to march, and to understand march and camp discipline as well as, if not better than, infantry, for they must not only keep their place in column, but must be prepared to work at any time before, after, or during a march. Next, they must be able to shoot, and their skill at skirmishing and moving over country must be practically as good as that of infantry. This last is a most important accomplishment, and one on which their whole success in clearing the line of approach for an assaulting column, or in obtaining accurate information on the state of the hostile defences, may depend. Furthermore, each Sapper must be prepared to carry with him some tool in addition to his rifle, and which of the two, tool or rifle, is carried, and which is slung, must depend on the practical requirements of the work in hand. As a part of the field training, the general soldierly habit of scouting, seeing without exposing oneself and gaining information without giving any away, should be trained and encouraged in every way; and, as engineers, the men should be taught to notice and collect information about natural objects and the resources of the neighbourhood in which they are operating, which might be technically useful to them in any emergency.

As regards military engineering, ordinary trenchwork is nowadays an essential part of infantry training, and the Sapper should be able to do something rather better, traversed, with head cover, and carefully concealed. Simple obstacles should be learnt, and to some extent the preparation of casemated cover, but the main instruction in this subject might be given by means of full-sized models, which should be made as practical as possible, especial attention being paid to irregularity in outline and concealment.

In bridging, the men should learn knotting and lashings, with trestle bridging and the preparation of barrel piers. One or two of the simplest expedients, such as floating a wagon in a tarpaulin, might be taught should opportunity offer, and much advantage would be gained by varying materials in the work already mentioned, substituting wire for rope lashings, or squared timber for round, or small barrels for large ones. The great object is to make the men handy and ingenious in the use of available materials. The building of crows' nests in trees is another useful service, which will be much required in future wars. The making of fascines might also be taught, they are useful in many ways.

To the above list must be added instruction in the use of the explosives carried in the equipment, with their application to various kinds of demolitions, and the erection and working of the water-supply equipment. A knowledge of semaphore signalling would also be useful to all ranks, and could be practised as a kind of "stand easy" in intervals between more fatiguing exercises.

The above remarks apply to the sappers only—the drivers should of course be taught riding, driving, and the care of horses in stables and on the picket line—and while the whole list might be tackled in peace, there should be no additions to it in view of the contemplated period of six months' training which is assigned in theory to Territorial units on the outbreak of war. The perfecting of the instruction contained in this list would give abundant employment for the early days of the course, and, besides this, at such a time Engineers are in great request, provisional works may have to be put in hand for the defence of various important localities, and this period of training may take a practical turn which may not now be contemplated by the authorities.

As regards the theoretical instruction, it is suggested that the best form for this would be weekly lectures during the winter months, forming entertainments of the free-and-easy, smoking type, which are always popular. The lectures should be short, each dealing with some branch of training, and discussions should be encouraged. Historical incidents relating to the work of the military engineer should also find a place among these lectures, and no efforts should be spared to make them interesting. There might at first be some difficulty in finding lecturers, but the demand would soon secure the supply, of which the chief source would be the officers and non-commissioned officers who may have attended courses at Chatham and at other schools of instruction.

In conclusion, much good might possibly result if the field companies belonging to certain divisions of the Regular Army were associated with those of certain divisions of the Territorials. These units might be encouraged to take mutual interest in one another's work and play, programmes of coming events might be exchanged, and possibly it might even be arranged for the Regulars to lend assistant instructors to the Territorial camp, and the Territorials to send men under instruction to their associated companies on manœuvres and such-like occasions. Interchange of thought by means of correspondence, and possibly also interchange of lecturers, might prove interesting and advantageous to both units, and the mutual knowledge and sympathy thus engendered could not fail to assist in binding together the various branches of our Corps to the advantage of all concerned.

TERRITORIALS OF THE 1ST CENTURY, B.C.

By COLONEL O. E. RUCK, LATE R.E.

IN the *R.E. Journal* for November, 1908, records from official correspondence, dated Gravesend, 1780, are quoted, describing how certain Volunteer Bargemen were rapidly trained to perform artillery duties on the Thames Defences, thus showing that the principle of employing economical civilian substitutes for Regular soldiers had been already thought out there.

Unfortunately these records omit to make mention of the closing of this experimental transaction, by the bestowal of any "Pecuniary Gratification" being awarded to those "efficients" of these Bargemen-Artillerists, each and all of whom, after six weeks' training on the 27th April, 1780, had been inspected and reported on as smart and good-humoured experts in the art of great gun exercises.

Those of our latter-day savants, who enjoy the time and inclination to delve into the works of some of the comparatively early writers, will find a rare treat in the large amount of carefully detailed matter, descriptive of the organization and administration of the Territorial troops and auxiliaries of the Roman Empire.

Pay, food, clothing, and equipment are minutely described therein, as well as the corellation of these ready-to-hand troops with the Regular Roman Army.

About the time of the 1st century, B.C., various outlying Territorial provinces and states were admitted to the rights and privileges hitherto enjoyed by the Roman citizens only; amongst these was included the *Jus Militiæ*, or the right to take up arms when called upon in attack or defence by the Roman Empire.[1]

The Territorials then furnished at least an equal number of infantry with the Romans, and double the number of cavalry, sometimes more.[2] Moreover these troops were paid and clothed at the expense of their own states.[3] They received nothing from the Roman Army Headquarters but a ration of corn, by reason of which they had their own Territorial paymasters, or Quæstors.[4] The troops supplied by the outside states were called *Auxiliaries Milites*, each district having to furnish, when required, a certain number of men, in proportion to its extent, population, and opulence.[5]

[1] Zosim., IV., 30, 31. [2] Livy, VIII., 8, XXII., 36. [3] Livy, XXVII., 9. [4] Polybius, 6. [5] Cicero, Att., VI., 5, Varr. and Fest.

The question of "Pecuniary Gratification," or personal pay, appears to have been at first a matter of quite secondary importance; originally there was no pay, every Regular soldier serving at his own private expense, pay being first given about 300 B.C. The pay in the times of the Republics was two eboli or three asses (about 2½d. English) a day to a foot soldier, subject to the usual stoppages for uniform and a deduction for his daily ration (*dimensum*) of corn at 4 bushels per mensem. Julius Cæsar doubled the pay to 5d., Augustus raised it to 7½d. per diem, but Domitian increased it still more by adding an annual bonus of three small gold pieces per head.[1]

In its palmy days no cooks were provided in the army, each man cooking and dressing his own victuals. Two meals a day were partaken of; a stand-up dinner of a light description, and a sit-down supper of a slightly more indulgent nature. Poska, or water mixed with a modicum of vinegar, was the customary drink indulged in by all.[2] Sometimes, on an occasion of special bravery, a soldier received as a reward a double issue of corn (*duplex frumentum*), which he was permitted to share with a friend.[3]

The load which a Territorial, if called up for service, would have to carry was by no means a light one.[4] Rations (corn) for 15 days,[5] sometimes more,[6] usually corn, sometimes dressed food (*coctus cibus*),[7] *utensilaria*, one saw, one basket, one mattock (*rutrum*), one axe, one billhook and leathern thong, one chain, one pot, etc.,[8] stakes, usually 3 or 4, sometimes as many as 12,[9] the whole figuring up to a grand total of 60 lbs. weight, exclusive of arms, which weapons the Roman legionary is supposed to have looked on, not in the light of a burden, but as a visible and integral part of his own personal self.[10] Under this load, from continuous training, the soldier marched 20 miles a day, sometimes more.[11]

The form of oath for the Territorial differed; before assembly the *Sacramentum*, a voluntary oath to obey their commander and not to desert the standards, was taken.[12] No man was permitted to enrol his name under the age of 17, but it is reported by Livy, XXV., 5, that in order to be legally fit to fight the common enemy, many youths under that age had taken the oath as a Territorial. After embodiment the military oath, or *Jusjurandum*, exacted by the military tribunes, in which the name of the Emperor was inserted, was taken. This oath was renewable on each anniversary of the soldier's birthday, and always on the occurrence of a mutiny.

[1] Domitian, 7, Suetonius. [2] Plaut., Mil., III., 2, 23. [3] Livy, II., 59. [4] Virgil, G., III., 346; Horat., Sat., II., 2, 10. [5] Cicero, Tusc., II., 15. [6] Livy, Epit., 57. [7] Livy, III. [8] Livy, XXVII., 45; Horat., Epod., IX., 13. [9] Livy, III., 27. [10] Cicero, Tusc., II., 16. [11] Vegetius, I., 10; Spartian, Adrian, 10. [12] Livy, III., 20.

LIME AND CEMENT MIXTURES.

By MAJOR A. H. D. RIACH, R.E.

THE engineering and building journals have, of recent years, contained many references to the practice of adding lime to cement mortars, or, in the case of cheaper work, of adding cement to lime mortars. The advantages in the former case are that the colloidal lime makes the cement mortar of a fatter consistency and therefore more workable, and also that the lime particles fill the interstices which exist between the particles of sand and cement, and so cause the mortar to be less porous. In the latter case the addition of cement to a mortar of fat, or feebly hydraulic, lime expedites the initial setting of the mass, presumably by quickening the process of crystallization, which is the essence of all setting of mortars, it being suggested that each particle of cement, setting rapidly, forms a nucleus about which the insoluble crystals of carbonate or silico-aluminates of lime can readily arrange themselves.

Many engineers are averse to the idea of combining two materials which require different treatment, but while the writer has seen no arguments to show that the principle is unsound, both practice and laboratory tests go to prove that the benefits claimed can be realized, and further, that better results can be thus obtained at a less or, at all events, no greater cost.

Some again have gone further by substituting certain kinds of earthy matter for lime as a material to fill the cavities and obtain denser cement mortars. To those who have been trained to believe that all sand and ballast must be scrupulously freed from all mud if the best results are to be achieved this will sound a dangerous doctrine, but here again the testing machine and the finished work can be called in to testify to the fact that there is much to be learned in this direction.

The chemist can perhaps explain the apparent contradiction, but it certainly appears from personal observation that while certain qualities of clay or mud kill the cement, those of another chemical composition do no harm, and may even be beneficial. The distinction suggested is that all earths of an argillaceous nature, such as might be used for the manufacture of cement or for brick-moulding, unless calcined, are injurious to cement, and must be washed out of the sand and aggregate, but that the same earths after calcination, and also those which, while making a slimy mud, are of no use for brick

burning, are harmless, and in some instances advantageous, if present in cement mortars up to a limited proportion.

A better understanding of the subject is very desirable; perhaps some reader will supply a fuller explanation. Meanwhile the following notes taken from recent periodicals may be of interest.

In *The Engineer* of 6th September, 1907, Mr. Challoner advocates the use of lime, trass, and sand mortar in place of low grade cement mortars, when time can be given for the strength to develop. Starting with a sharp sand, with grains well graded so as to lie compactly, with a volume of interstices equal to 40 per cent. of the total volume, he argues that cement mortars of less than 1 cement to 2½ sand (by volume) are not dense (mortars he describes as dense when the proportion of the volume of the binding materials to that of the hollows is greater than unity, and *vice versâ*). Mortar which is not dense is porous and absorbent. He finds that the addition of trass to cement mortars makes them dense, *e.g.*, 1 cement, 1 trass, and 4½ sand is equal in density to 1 cement, 2 sand, and as regards strength, after three months, is nearly equal to 1 cement, 3 sand. Again 1 cement, 1 trass, and 4 sand is stronger, after three months, than 1 cement, 2 sand. Moreover mortars of trass and cement continue to increase in strength after one year, which is not the case with cement and sand mortars ordinarily.

He then describes the results of tests of mortars of trass, lime, and sand, which show as follows :—

At 28 days old and upwards :—

1 trass, 2 lime, 5 sand is stronger than 1 cement, 5 sand, and more than twice as dense.

1 „ 1 „ 2 „ is stronger than 1 cement, 4 sand, and nearly three times as dense.

1 „ 1 „ 1 „ is nearly as strong as 1 cement, 3 sand, and more than four times as dense.

1½ „ 1 „ 1 „ is nearly as strong as 1 cement, 3 sand, and more than five times as dense.

Mortars all machine ground.

Mr. Challoner further points out the need for the aggregate for concrete to be graded, like the sand for the mortar, so as to reduce interstices. If it is not to be water resisting, the concrete need not necessarily be dense, but mortar should always be so, that is, use good mortar rather than a larger quantity of a poorer mortar.

The addition of trass* is said to prevent much of the interior

* Trass is one of the substances known under the general name of Pozzuolana; these are clayey earths, usually naturally calcined by volcanic action, which when added to fat limes confer on them hydraulic properties; "surkhi," or calcined brick earth, is employed in the same way in India, while in China a natural earth is employed for the same purpose.

movement of masses of wet concrete, so that fewer hair cracks result. Also the use of trass in cement mortar makes it fat, and saves labour in laying.

The Architect of September 25th, 1908, prints a Paper on "Hydrated Lime and Cement Mortars," read before the American Society for Testing Materials, by E. W. Lazell, Ph. D., Chemical Engineer, Philadelphia. This Paper demonstrates that mortars made of suitable mixtures of dry hydrated lime, cement, and sand are better in many respects than richer (and more costly) mixtures of cement and sand. (The hydrated lime referred to is fine lime powder prepared from freshly-slaked quicklime, of a fat nature such as might be used for making lime paste for ceilings and fine lime plaster). Cement mortars are short, that is they do not spread easily under the trowel, but have great strength and develop this strength quickly, and it is found that the addition of lime makes them work smoothly. Also, the lime being bulky as compared with cement, its addition considerably increases the volume of the mortar.

A series of tests to ascertain the best proportions to use, show that briquettes of a mortar of 0·85 cement, 0·15 lime, and 3 sand are as strong at all lengths of time up to 12 months as those of 1 cement to 3 sand; also that with 0·6 cement, 0·4 lime, and 5 sand the tensile strength compares favourably with 1 cement and 5 sand.

The lime-cement mortars, being plastic, can be far more easily worked than cement-sand mortars.

These results were obtained from briquettes stored in air and moistened once a week.

To demonstrate the effect on the lime-cement of water, a series of briquettes were kept in water, after three days in air, and it was found that considerable additions of hydrated lime to the cement mortars caused only a small reduction in tensile strength when setting took place under water, as compared with cement-sand mortars, and also that lime-cement mortars are more impervious to water than those without lime. This latter characteristic was conclusively proved by a series of percolation tests; for instance, while pats of mortar of 1 cement to 5 sand allowed 3,000 c.c. and 1,090 c.c. of water to pass through per hour, after 28 and 42 days respectively, similarly treated pats of 0·85 cement, 0·15 lime, and 5 sand showed no measurable percolation. The inference as stated by the author is as under:—

"The tests would indicate that in hydrated lime we have a suitable material to add to cement mortars to render them plastic, thus increasing the sand-carrying capacity and the ease of working without materially reducing the strength; 1:5 mixtures containing an amount of hydrated lime equivalent to 35 per cent. of the cement used are amply strong for all purposes, and are practically impermeable to water. These mortars should also increase in strength, if exposed to

air, through the absorption of carbon dioxide, as is the well-known case with lime mortars.

"It would therefore seem to be advisable for architects, engineers, and builders to give this material careful consideration in view of its many desirable characteristics."

The two articles cited above serve to show the trend of opinion and the diversity of practice, and suggest means of obtaining a more water-tight and workable mortar, without sacrifice of strength or increase of cost, which will be of the greatest service, especially to those working in reinforced concrete, when impermeability is desirable, or when a rendered or moulded surface is required.

If engineers generally, throughout the world, would communicate to the technical papers the results of their efforts to thus usefully combine the materials at their disposal, the somewhat nebulous theories now held would soon be established on the substantial foundation of observed practical results.

THE R.E. HEADQUARTER MESS.

(*Continued*).

By Lieut.-Colonel B. R. Ward, R.E.

Grouped round the full-length picture of Sir Charles Pasley are smaller portraits of the following officers:—General Sir Henry Harness, Colonel C. C. Chesney, General Sir Lothian Nicholson, and Lieut.-General Sir Gerald Graham.

General Sir Henry Drury Harness, K.C.B.* (1804—1883), was gazetted Second Lieutenant in the Corps in 1827. His only war service was in the Mutiny, where he acted as C.R.E. under Lord Clyde at the Siege and Capture of Lucknow, and in the subsequent operations in Rohilcund and Oudh. He was however a most able administrator, and held many civil appointments of great prominence and responsibility. From 1846 to 1850 he was Secretary to the Railway Commission at a time when railways were beginning to develop with startling rapidity; from 1850 to 1852 he was Deputy Master of the Mint, and from 1852 to 1854 he was Commissioner of Public Works in Ireland.

The work however for which he will always be best remembered in the Corps, was his reorganization of the Engineering School at Chatham during the years 1860 to 1865.

"No man," writes General Collinson in the *R.E. Journal* for 1883, p. 86, "could have been more fitted to carry out such a matter than Harness. The vigour and the grasp of his mind and his knowledge of the different branches of work, enabled him to map out the principles on which such a school should be conducted, and the general scheme for each branch of the practical education of a Military Engineer; while his personal character and his established influence in the Corps stamped all his proposals with an authority that carried them through with ease and rapidity. Loyal to the revered founder, whose pupil he himself had been, the great idea on which it was all based was carefully preserved; namely, that the education of the Corps in military science was as much a Corps duty as its military drill; and therefore that it should be carried on by the senior officers teaching the juniors, and by the non-commissioned officers teaching the recruits. So that officers and men, working and learning together on the same class of work, would commence their career with the feeling that, however varied their duties and scattered

* *Dictionary of National Biography*, Vol. XXIV., p. 414.

their individuals over the world, they are one united body, who, officers and men together, have the duty of applying all branches of science to the defence of the country. Harness's ambition for the Corps was that the officers should be acquainted with the principles of all physical sciences, so that the Government might feel that they had in them a body of advisers they could depend upon in all such matters, and in the men a body of trained artificers, equally to be depended upon for carrying out any such work on an emergency."

After leaving Chatham he was put on the Council for Military Education, and later on he became a member of the Defence Committee under the presidency of Sir Harry Jones. His last appointment was that of president of a temporary Government department instituted to take measures to combat the cattle plague which broke out with great virulence in 1866.

A man possessing great administrative ability and charm of manner, his influence over his contemporaries was very great, as can be seen from General Collinson's Memoir and from the *Life and Letters* published by the R.E. Institute in 1903.

Colonel Charles Cornwallis Chesney* (1826—1876) made his reputation as a military essayist. Many have since followed up the line he first struck out for himself when, as a Captain and Professor of Military History at the Royal Military College, in 1863, he published a volume entitled *A Military View of Recent Campaigns in Virginia and Maryland*. The series of essays published in this volume gave a new impetus and direction to the scientific study of war. In the hands of men like the late Colonel G. F. R. Henderson, Chesney's method has been still further developed and utilized as a means of military instruction. Chesney however may fairly claim to be a pioneer in this work. In 1864 he was appointed Professor of Military History at the Staff College, and brought out a second volume entitled *Campaigns in Virginia, Maryland, etc.*, continuing the history to the end of the third year of the war, when Grant was made commander-in-chief of the Federal forces.

General Lee, the great Confederate commander, who died in 1870, read Chesney's volumes soon after the war, and commented on them as follows:—"It is a remarkable fact that the best history of the war that has yet appeared has been written by an English officer, who must have got all his information from our opponents."

Chesney's *Waterloo Lectures* (1868) and his *Essays in Military Biography* (1874) form a brilliant continuation to his *Campaigns in Virginia*, but it would be difficult to add to the reputation of a military author with a criticism to his credit, such as the one quoted above, from the lips of "the greatest general who ever spoke the English tongue."

General Sir Lothian Nicholson,† K.C.B. (1827—1893), was gazetted

* *Dictionary of National Biography*, Vol. X., p. 195.
† *Dictionary of National Biography*, Vol. XLI., p. 21.

Second Lieutenant in 1846. He commanded the 4th Company of the Royal Sappers and Miners during the last month of the Siege of Sebastopol, and subsequently commanded the same company as the 4th Company, Royal Engineers, during the Indian Mutiny. Possessing a good constitution, and being full of energy, he did excellent work throughout the latter campaign, being five times mentioned in despatches by Lord Clyde, Sir James Outram, and Sir Hope Grant. He was rewarded by a Brevet Lieutenant-Colonelcy in 1858, and was awarded a C.B. in the following year.

In 1877 he was promoted Major-General, and in 1878 he was appointed Lieutenant-Governor of Jersey. In 1881 he was promoted Lieutenant-General, and in 1886 he succeeded Sir Andrew Clarke as Inspector-General of Fortifications. In 1887 he was made a K.C.B. In 1891 he was made Governor of Gibraltar, where he died, after a short illness, in 1893.

Lieut.-General Sir Gerald Graham,* V.C., G.C.B. (1831—1899), obtained his first commission in 1850. During his 40 years' service he maintained a reputation for courage and coolness in action that has probably never been surpassed. He was one of those rare individuals in whose make-up the element of fear seems to be totally wanting. It was therefore in accordance with the fitness of things, that at the inaugural ceremony, celebrating the institution of the Victoria Cross, Gerald Graham should have been one of the recipients of the coveted decoration. The Queen had instituted the new distinction by a Royal Warrant of the 29th January, 1856, and on the 26th June, 1857, the inaugural ceremony took place in Hyde Park. Sixty-two officers, warrant officers, non-commissioned officers and men were on that day personally decorated by the Queen.

Graham's cross was given for "determined gallantry at the head ot a ladder party at the assault of the Redan on the 18th June, 1855, and for devoted heroism in sallying out of the trenches on numerous occasions and bringing in wounded officers and men."

In a letter to his father he describes the ceremony as follows:— "We were formed in line, and then advanced singly to the Queen, who remained on horseback. She pinned on the cross with her own hand to our coats. She stuck the pin fairly into me, so that I keenly realized my momentary interview with Royalty."†

In after years, when Graham commanded a brigade in the Egyptian Campaign of 1882, and later on in 1885, when he was in command at Suakim, the quality of personal courage was still his most prominent characteristic. Lord Wolseley constantly refers to it in his despatches.

In an article entitled "Courage," contributed by Lord Wolseley to the *Fortnightly Review* of August, 1888, he mentions five men of his

* *Dictionary of National Biography*, Supplement, Vol. II., p. 334.

† *Life, Letters, and Diaries of Lieut.-General Sir Gerald Graham, V.C., G.C.B., R.E.*, by Colonel R. H. Vetch, C.B., 1901, p. 139.

acquaintance in whom this quality was pre-eminent. Three of the five are represented in our Mess Portrait Gallery—Graham and the two Gordons. The following is his reference to Gerald Graham :—

I have heard it said that small men are generally braver than tall men, but one of the most stolidly and immovably brave men I have ever known is several inches over 6 feet in height. I have often seen him, from pure laziness, when relieved from duty in the advanced trenches before Sebastopol, step out calmly in rear of the parallel where he happened at the moment to be, and take a bee-line for camp, exposed for many hundred yards to a heavy rifle fire from the advanced works of the Russians. He might have walked home through the trenches in safety, but he was too lazy or too careless of his life to go so far round. I remember a curious instance of his imperturbability some years afterwards, when I met him in China. In the assault of the Taku forts we had to cross two ditches filled with water. One of these was sufficiently wide and deep to require a bridge to be thrown over it. In carrying up a light-infantry pontoon bridge to launch into this ditch, a round shot went through one of the pontoons. To launch it in that condition would have caused it to sink, and we had great difficulty in getting the injured pontoon out of the bridge under the close, severe fire to which we were exposed from the works behind the ditch. In common with all the other mounted officers, I had left my horse at a safe distance behind under some cover. I was therefore astonished when, upon standing up after working at this little bridge on the ground, to see beside me a very tall man on a very tall horse. The position was actually comical, and as well as I remember, I laughed as I saw my cool friend there at the edge of the ditch, a regular cockshot for every Chinaman near him. He said something to me which, owing to the great din and noise at the moment, I could not hear, so moving nearer to him I carelessly put my hand on his leg. He winced a little as I touched him, and calmly saying "Don't put your hand on my leg, for I have just had a bullet in there," went on with his conversation as if only a mosquito had bitten him. That man is now known to all as Lieut.-General Sir Gerald Graham, V.C., who commanded a brigade at Tel-el-Kebir, and who was afterwards in chief command at El-Teb and the many other bloody engagements which took place near Suakim.

At the Annual Corps Meeting held on the 5th June, 1884, it was decided that Graham's portrait should be painted. The portrait, which represents him in the red service dress of the period, was painted in 1886 by Sir E. Poynter—now President of the Royal Academy.

In the recess at the west end of the Mess Room hangs the portraits of the Duke of Wellington and of General Sir James Browne, K.C.B., K.C.S.I. In point of artistic merit neither portrait is at all commensurate with the fame either of the Iron Duke or of "Buster Browne."

As already pointed out in last year's February number of the

R.E. Journal, the Duke of Wellington's urgent representations as to the necessity for trained Sappers were the immediate cause of the Royal Warrant of the 23rd April, 1812, authorizing the formation of the R.E. Establishment at Chatham. In Gurwood's *Despatches of the Duke of Wellington*, edition of 1837, Vol. IX., p. 49, is a letter from General the Earl of Wellington, K.B., to Lieut.-Colonel Torrens, Military Secretary to H.R.H. the Commander-in-Chief, dated Camp at Badajoz, 7th April, 1812. The letter opens and closes with the following sentences :—

"My dear Torrens,

"I send by this occasion the accounts of our success before Badajoz. * * * * Our loss has been very great; but I send you a letter to Lord Liverpool which accounts for it. The truth is that, equipped as we are, the British Army is not capable of carrying on a regular siege.

"Believe me, etc.

"WELLINGTON."

In a note on the same page Gurwood writes: "A search, hitherto unsuccessful, is being made for this letter. From the *précis* of it in the Index of 1812, as well as from documents in the Ordnance Office, it appears that this letter recommended the formation of a Corps of Sappers and Miners, the want of such an establishment with the army being the chief cause of the great loss in the sieges."

For 77 years this letter remained hidden amongst the Earl of Liverpool's papers. In 1889 Mr. C. Leeson Prince, of The Observatory, Crowborough, Sussex, found the missing letter tied up with others of a very unimportant character. The letter was first published in the *Athenæum* of the last week in April, and was subsequently reprinted in the *R.E. Journal* of the 1st June, 1889, Vol. XIX., p. 132. The letter runs as follows :—

"Camp at Badajoz, April 7, 1812.

"My Dear Lord,—My despatches of this date will convey the account of the capture of Badajoz, which affords as strong an instance of the gallantry of our troops as has ever been displayed. But I anxiously hope I shall never again be the instrument of putting them to such a test as that to which they were put last night. I assure your lordship that it is quite impossible to expect to carry fortified places by *vive force* without incurring great loss, and being exposed to the chance of failure, unless the army should be provided with a regular trained corps of sappers and miners. I never yet knew a head of a military establishment or of an army undertaking a siege without the aid of such a corps, excepting the British army. There is a body of sappers and miners attached to every French corps; and each of the armies in the East Indies has one; and every army in the world except ourselves. The consequence of being so unprovided with the people necessary to approach a regularly fortified place are—first, that our engineers, although well educated and brave, have never turned their minds to the mode of conducting a regular siege,

as it is useless to think of that which it is impossible in our service to perform. They think they have done their duty when they construct a battery, with a secure communication to it, which can make a breach in the wall of a place; and, secondly, these breaches are to be carried by *vive force* by an infinite sacrifice of officers and soldiers. To this add that storming a breach, or attacking a place by escalade, is an operation of a very different description from fighting a general action. In the latter every man, generally speaking, has an equal chance; but in the former the officers, the bravest and best of the non-commissioned officers and soldiers, go first. The loss falls upon these; and five minutes after the breach is carried women and children might enter it instead of men. You see in the attack of Badajoz we had six out of seven general officers employed, all their staff, and a very large proportion of the officers killed or wounded. In the attack of the *Picurina* it was the same, and we lost 200 out of 500 men employed. These great losses would be avoided, and, in my opinion, time gained in every siege, if we had the properly-trained people to carry it on. I declare that I have never seen these breaches more practicable in themselves than the three in the walls of Badajoz; and the fort must have surrendered with these breaches open if I had been able to approach the place. But when I had made the third breach on the evening of the 6th I could do no more. I was obliged then to storm or give the business up; and when I ordered the assault I was certain that I should lose our best officers and men. It is a cruel situation for any person to be placed in, and I earnestly recommend to your lordship to have a corps of sappers and miners formed without loss of time.

"Believe me, my dear lord,

"Ever yours most sincerely,

"WELLINGTON."

It is interesting to note that the Duke's letter is dated 7th April, the Royal Warrant authorizing the R.E. Establishment at Chatham being dated the 23rd of the same month. Cause and effect are seldom so closely related!

The life of General Sir James Browne, K.C.B., K.C.S.I. (1839—1896), has been recorded by Lieut.-General J. J. McLeod Innes, V.C. It was a life well worth recording, both on account of what he did and also on account of what he was. It is hard to decide whether his deeds or his personality were the more remarkable.

His great engineering feat was the construction of the Harnai, or Sind-Peshin, railway from 1883 to 1887.

As a soldier it was no small triumph to have been selected by Lord Roberts in 1889 for the post of Quartermaster-General in India.

As an administrator he made his mark from 1892 until his death four years later in the arduous and responsible position of Agent to the Governor-General in Beluchistan.

Colonel G. K. Scott-Moncrieff, who was his Personal Assistant during the construction of the Harnai railway, wrote a review of

General Innes' biography in the *R.E. Journal* for 1905, Vol. I., p. 356, from which the following extracts are taken :—

Among the many distinguished men who left Addiscombe to join the Indian Engineers, amalgamated in 1861 with the Corps of Royal Engineers, probably there has been none of such varied attainments as the subject of this memoir. There have been great soldiers like Lord Napier of Magdala, great engineers like Sir Arthur Cotton, and great administrators like Sir Henry Durand; but Sir James Browne was distinguished in all three branches. He was, moreover, a man of marked scientific attainments, a linguist of wide range, a mathematician of no ordinary calibre, a wise and far-seeing statesman. When we add to the above that nature had endowed him with a herculean frame, a rich and sonorous voice and good ear for music, and a peculiar power of attracting the regard and affection of his fellow men, it will be admitted that his biographer has indeed a difficult task to perform in presenting an adequate picture of so varied a character from the *embarras de richesse* of the subject.

As a subaltern Browne did good work in the Mahsud Waziri Campaign of 1860 and the Umbela Campaign of 1863.

As Executive Engineer, first of the Kohat and then of the Kangra Divisions on the frontier,

the bridges he designed and built were of every variety, and some indeed are among the finest specimens of the art of the *pontifex maximus* that are to be seen anywhere. Stone bridges of a greater span than 140′ are, indeed, to be found in other parts of the world; but Browne is, so far as we know, the only engineer who has built bridges of that span with bricks burnt in his own kilns,—a bold feat for a sapper subaltern! It was no mere guess work. Every step he took was founded on thorough mathematical investigation coupled with careful practical experiment, and, as he often told the writer, each successful step he thus took gave him fresh confidence for other and further designs. He delighted in scientific engineering, it was to him a charming combination of mind and matter, a conquest of nature by study of her laws, a subject of infinite variety and infinite expansion. And in this his great mathematical powers were of incalculable value. He had not the mere bowing acquaintance with the calculus that some of us have; he grasped it as a valuable tool, and used it with the skill of a master.

* * * * *

But the greatest work he ever accomplished was the making of the Harnai—or, as it is more correctly called, the Sind-Peshin—railway.

* * * * *

The story of the construction of the Harnai line has already been told in the *Royal Engineers Professional Papers*, in the columns of *Engineering*, and in the *History of the Royal Engineers*, but no words can describe it adequately. Such a record of difficulties from pestering interference from above and pestilence, cholera, scurvy, and fever from below, strikes of work-

men, unusual floods and landslips, insufficiency of food and transport—added to the stupendous task of pushing through in 3 years, 165 miles of a railway which combined every natural obstacle with the most trying of climates—such an undertaking few men have had to face and fewer have carried through with success.

Towards the close of the work, when physical and mental energies had been taxed almost beyond endurance, Browne was further worried by carping criticisms in the Press. There was about that time a flood of misrepresentation concerning the officers of the Royal Engineers, and some of the Indian papers took up this question with peculiar virulence. Invidious comparisons were made between the Harnai and Bolan railways, and some of Browne's brother-officers urged him to take notice of these attacks; and although he systematically kept silence, there is no doubt that they annoyed him. Time has vindicated his action with overwhelming force, for, as has already been stated, his work remains as sound as ever.

To-day the traveller whirls in a comfortable first-class carriage over the great bridges and plunges into the tunnels which were then built, and perhaps there is astonishment at the boldness which designed and the skill which executed these works; but only those who took part in the struggle can have any conception of the toil and pains involved, of the courage necessary to persevere, when cholera and scurvy were raging, when nature seemed to gather all her forces against man's puny efforts, and each day seemed to bring forth some new and unexpected difficulty. As one looks back on those times after the lapse of 20 years, one sees in the midst of it all the splendid personality of the Engineer-in-Chief, always cheery, always plucky, always full of resource, a man among ten thousand, towering above his fellows.

An article published by Colonel G. K. Scott-Moncrieff in *Blackwood's Magazine* for May, 1905, gives a better idea of the personality of Sir James Browne than anything in General Innes' book. The book is an appreciation of the man and his work by an older and senior officer. The *Blackwood* article glows with the enthusiasm of a whole-hearted admirer and disciple. Those who have read the article can hardly be surprised that the German Emperor, after reading it, ordered it to be translated into German. "Buster" Browne, indeed, "was grand," as Lord Roberts once tersely put it.

Many officers who worked under Sir James Browne have since made their mark both as soldiers and engineers. Among the more distinguished of these may be mentioned Colonel Sir Buchanan Scott, K.C.I.E., Major-General Sir Ronald Macdonald, C.B., K.C.I.E., and Colonel G. K. Scott-Moncrieff, C.B., C.I.E., all three of whom served with him on the Harnai Railway, and most probably learnt from him there the lessons which have proved of such use to them in their after careers.

TRANSCRIPTS.

THE NEW FOOT-SOLDIER.

THE following article is taken from the *Matin* of the 27th September, and is one which very closely concerns every foot-soldier, dealing as it does with the reduction of the weight which he has to carry:—

The French "piou piou" at present carries 26·4 to 27·35 kilogrammes, *i.e.*, nearly one-half of his weight in the case of a small man (54 kgrs.), or one-third in the case of a large man (80 kilos.). These fractions are excessive when one considers that a horse, which normally weighs 400 kilos., seldom carries 100 kilos., *i.e.*, one-quarter of its own weight.

This abuse of the infantryman's strength and goodwill is a result of campaigns in Africa, but since 1903 the reduction of the pack has been the object of many experiments and the subject of many discussions.

The recent manœuvres of the 9th Division of the Vth Army Corps, under General Millet, who is President of the Infantry Technical Committee, have given complete satisfaction, and have finally vindicated views which have hitherto been held as theoretical. The division was equipped with the new pattern uniform, equipment, tools, and transport, and these had to satisfy two conditions imposed by the French War Office, viz.:—(1) The maximum weight carried per man was not to exceed 20 kilos., and (2) each man was to have at his disposal 200 cartridges and provisions for two days, either on his back or in the 1st line transport. The detail of this new equipment, etc., is as follows:—

Comparative Table.

Detail.	Old Weight in Kilogrs.		New Weight in Kilogms.
Uniform	6·175	... ...	5·290
Equipment	3·550	... ...	3·230
Contents of knapsack	7·350	... ...	3·050
Weapons	4·840	... ...	4·840
Cartridges (120)	3·438	88	2·220
Divers necessaries	0·300	... ...	0·900
Common load of food, etc. { From... / To ... }	0·750 / 1·700	Individual share of food, etc.	0·150
Weight carried per man. { From... / To ... }	26·400 / 27·350	... ...	19·980

The actual ways of reducing the weights of the items are as follows:—

Clothing.—The tunic, a mere ceremonial garment, and the round service jacket used in the field, are both to be discarded in favour of a pea jacket very similar to that worn by the Alpine troops. The great-coat remains, but is shorn of one row of buttons, and weighs 1,500 grammes instead of 2,160. Moreover it is to be provided with a light hood for use in wet weather.

Equipment.—By the use of tawny-coloured leather it is hoped to be able to devote to instruction or to rest, the many hours hitherto spent in blacking boots and pipeclaying belts. The stiff, square black knapsack is deposed in favour of a soft rectangular one, and 1,100 grammes are thus saved. The contents are to be :—

1 clean shirt	...	...	335 grammes,
1 fatigue cap	...	...	100 ,,
1 pair slippers	...	...	600 ,,
1 day's provisions	...	...	960 ,,

and finally an aluminium cooking pot, weighing 400 grammes, is slung outside the knapsack. The remaining clothes, packed in the company valise, are carried in the 2nd line transport.

The common enamelled iron mess tins and cooking pots are replaced by individual cooking pots weighing 400 grammes, whilst by making water-bottles in aluminium instead of enamelled iron 4·5 grammes are gained.

Provisions.—Instead of carrying both days' food, the soldier carries one, the company 1st line transport the other. Rice and dry haricot beans (which necessitate much cooking) are replaced by more sugar and coffee, whilst the number of bread biscuits has been cut down from 12 to 6. Finally, common boxes of tinned food have been replaced by a tinned ration per man, weighing 250 to 300 grammes.

Ammunition.—The reduction from the 120-mm. to 88-mm. cartridges gains 960 grammes, the balance of cartridges from 200 being carried in the company 1st line transport.

Entrenching Tools.—Portable tools have been replaced by a single tool per man, which can be used as a spade, shovel, pickaxe, axe, or sickle. The entrenching tools, which are now of the engineer pattern, are to be carried in two special carts per regiment, which follow the 1st line transport of the regiment.

The net result of all this saving of weight is an increase in 1st line transport, and the 1st line transport of a company now is :—

(*a*). 1 light, 2-wheeled cart, carrying one day's food, the men's jackets, arranged by squads in special bags, and the baggage of the company, including that of officers.
(*b*). 1 light, 2-wheeled S.A.A. cart.
(*c*). 1 moving kitchen.

One medical stores cart is allowed per battalion.

The regimental transport consists of :—

(*a*). 1 light, 2-wheeled cart for headquarters baggage.
(*b*). 1 kitchen on wheels.
(*c*). 1 forge.
(*d*). 2 tool carts.

All the vehicles are 2-horsed with the exception of the medical stores cart, which has one horse only.

Thus the total 1st line transport of a regiment, exclusive of spare horses, consists of 45 carts and 89 horses, which, although cumbersome, is absolutely necessary if the men's loads are to be materially lightened.

A. H. SCOTT.

DR. SVEN HEDIN'S EXPEDITION IN TIBET.

By MAJOR C. H. D. RYDER, D.S.O., R.E.

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DR. SVEN HEDIN has returned from another two years spent in explorations in Tibet, and as I have had the opportunity of hearing from him a fairly full account of his work, I am sending this Paper, which has been authorized by him, for publication in the *Geographical Journal*.

After a preliminary journey through Persia and Seistan, Sven Hedin arrived in India, and after overcoming rather more than the usual difficulties, left Leh on August 14th, 1906, with the strongest caravan he has ever had: 25 men and 94 ponies and mules, as well as 30 ponies he hired for the first month; of the 94 ponies, only 6 completed the journey. He was accompanied by a babu Robat, who proved of much use in assisting in scientific observations, as well as Mahomed Isa, who acted as caravan bashi; this man had accompanied Younghusband in his travels, and to Lhasa, was with De Rhins when he was murdered, and was with Rawling and myself in 1905. Sven Hedin speaks in the warmest terms of the invaluable services of this man. He also constantly refers to the kindness he received from the Maharaja of Kashmir, the state officials, Sir Frank Younghusband, Capt. Patterson at Leh, and others.

After leaving Leh, Sven Hedin travelled north-east over the Marsimikla, crossed the Karakorum east of Changlung-yogma, traversed Lingshi-tang and Aksai-chin, crossed Deasy's, Rawling's and Wellby's routes; he then kept east and east-north-east, and turned south-east between the routes of Bower and De Rhins. On the heights of the Buka-mangna route 9 mules were lost in one day, but to the south the country became more and more hospitable, with plenty of grass and water. After 83 days they met nomads for the first time; but then their black tents were visible most days, and they were able to buy yaks to replace the ponies they had lost *en route*. They left De Rhins' Ammoniac Lake to the east, and continued straight south to the Bog-tsang-tsanpo, which they followed for a couple of days to get a connection with Sven Hedin's map of 1901. Turning again south-east, they crossed two considerable ranges, from one of which a small portion of the Dangra-yum-tso could be seen to the south. Sven Hedin reached Ngangtse-tso on December 28th, and here he was met by Hladje Tsering, governor of Nak-tsang, who had already stopped him on his previous journey, and who, though at first inclined to stop him, allowed him to continue south-east. With great good fortune, or probably with the instincts of an experienced Tibetan traveller, Sven Hedin hurried on, and, without halting, and making long

marches, struck the Tsanpo 50 miles west of Shigatse, and, following down the left bank, crossed the river and reached that town late on the evening of February 9th, 1907. Two days later a lama and official arrived from Devashong; they had received orders to stop Sven Hedin at Ngangtse-tso. Not finding him there, they had followed him to Shigatse; but it was now too late, Sven Hedin had reached that town and accomplished one of the objects of his journey.

The most important geographical discoveries on this journey were (1) the discovery of a very high and complicated mountain system, and (2) south of it the Mu-chu, which joins the Raga-tsanpo; the latter is the smaller of the two, and most of the water which joins the Tsanpo just west of Pindzo-ling comes from the Mu-chu. The discovery of the high mountain system set Sven Hedin thinking, and it very soon struck him that this must be a continuation of the Nien-chen-tang-la range south of Tengri Nor, the highest peak of which I fixed from near Lhasa at 23,900'. The Khalamba-la, on the road from Shigatse to Tengri Nor, is also on this range. Thus was forged the first link in what Sven Hedin regards as his greatest discovery.

Sven Hedin stayed one and a-half months at Shigatse, during which time he made great friends with the Tashi Lama, and constantly visited the Tashi-lunpo monastery. Although so close to Gyantze, he did not think it advisable to visit Capt. O'Connor there, but speaks in the warmest tones of the kindness he received from that officer. After much difficulty he obtained permission to go up the Raga-tsanpo route, and, turning northwards, re-crossed the main range by the Chang-la Pod-la Pass, thus fixing another 50 miles of the range. His next objective was the Dangra-yum-tso, discovered by Nain Singh; but when within two marches, and in sight of the lake, he was stopped by a force from Shan-sa Dzong and forced to go down south to Raga-tasam, but he was able to fix the position of Targo-gangri, Targo-tsanpo, and Sershik-gunpa, all three heard of but not visited by Nain Singh. The Shuru-tso was also discovered, a rather big lake at the northern foot of the main range, another 60 miles of which being also fixed, as the range had to be once more crossed. At Raga-tasam Sven Hedin touched our route for the first time since leaving Shigatse. Dangra-yum-tso is much too big on Nain Singh's map; and his Mun-tso, two small lakes, are situated not south but west of the southern Dangra-yum-tso. The latter lake, and Targo-gangri, which Sven Hedin describes as one of the most magnificent snow-mountains with glaciers he has even seen in Tibet, are both holy, and form the same combination as Mansarowar and Kailas in the west, and Nam-tso and Nien-chen-tang-la in the east. Sershik-gunpo is inhabited by monks of the Pombo (non-orthodox) sect. From Raga Sven Hedin went to Saka-dzong; needless to say, not by the route followed by our party, but round the north side of the beautiful snows of Chamo-uchong. At Saka Mahomed Isa died, to the great grief of Sven Hedin and his followers, and to all those to whom he has been of such assistance in the Tibetan explorations.

Sven Hedin again wished to strike north, but could not get permission

to do this, although he sent messengers to Lhasa. He however turned north from Saka Dzong up a western tributary of the Chaktak (called Charta on our maps) Tsanpo, behind the hills north of our route to Tradom. He then kept south of the river, touching our route at Laktsang, and marching up the main branch of the Brahmaputra to its source, which he located accurately and surveyed. In the *R.G.S. Journal*, Vol. 38, p. 146, Nain Singh mentions being in sight of the gigantic glaciers which give rise to the Brahmaputra. On our journey we surveyed, though only roughly, the main branch; but as Sven Hedin was the first to actually follow the main branch to its source, we obtain a survey much more accurate than mine, which was only a distant sketch. Crossing the watershed, which is very low, Sven Hedin proceeded to the Mansarowar Lake, where he spent some weeks making careful soundings. Owing to dangerous gales, it was impossible to sound the Rakas Tal, but both lakes were carefully surveyed. Following down the bed of the old outlet, Sven Hedin found several springs, which probably are underground channels from the lake. There was no sign of these when Rawling and I were there in December; but as the Rakas Tal was then frozen over, doubtless the springs were also frozen. This however proves that the lakes are still connected, though underground, with the Sutlej system. After an interesting circumambulation of the holy peak of Kailas, Sven Hedin managed to get permission to go north, where he discovered the source of the northern or main branch of the Indus, returning *viâ* Yumba-matsen to Gartok.

The gap of 300 miles in his exploration of the main range north of the Tsanpo called Sven Hedin for yet another long journey. All attempts to go north-east from Gartok failing, he decided to make a long *détour* and come into the unexplored country from the north. He gave out that he was going to Khotan, in the meantime arranging for an entirely new caravan, with new men, to be organized at Leh. He met his new caravan at Durguh, and left that place on December 4th, 1907. Several caravans from Yarkand were used, the members of which advised Sven Hedin to wait till the spring. However, although winter had set in, he passed on. At Burtse he discovered that, owing to the stupidity of his headman, only a supply of eight days' corn for the ponies was left. It was not till at the crossing of the Dapsang that he gave orders to turn due east, leaving the Karakorum Pass to the north. On January 11th they camped on the shore of the Aksai-chin Lake. By January 18th a quarter of the caravan ponies had died, and the cold was intense. To improve matters a storm arose, which lasted for weeks; the caravan however pushed forward steadily, but very slowly. On the northern shore of the Shemen-tso they were nearly snowed up, no meat was left, and the ponies shared the men's rice rations. On February 8th the first hunters were met with, after 64 days' loneliness, and they were able to buy sheep, milk, and butter. Here Sven Hedin burnt all his European clothes, and appeared as a Ladkhi; this entailed blacking his face and hands every morning, and forbade washing. Passing the Lemchung-tso, they now entered unknown country. On February 24th

three ponies and seven mules only were left, a quarter of the caravan. On the 29th they reached Lumburringmo-tso, where nomads were met with; these men, although at first suspicious of the presence of a European, soon made friends, and sold 12 sheep to carry loads. For several days the storm was so bad that a move was impossible. On March 7th Sven Hedin camped on a river flowing to the south-west, but frozen over.

On March 16th they pitched camp on the Tong-tso, and turned south, leaving the beautiful Gangri Shakang-sham to the east, and crossed two small passes. They here heard that Karma-Pun-tso, the governor of the Bongba province, was near, but they avoided him, and proceeded through a labyrinth of mountains, crossing the Kang-shan-tsanpo, Chaklam-la, Sangchen-chu, Sangchen-la, and Ladung-la. On April 1st Sven Hedin crossed the Satsot-la, and came down to the Chunit-tso, following its western shore for one day. Here a large salt caravan was met with coming from Tabié-tsaka, from whence most of Central and Eastern Tibet obtain their supply of salt. Still keeping straight south, Sven Hedin crossed the Nima-lung-la, and reached the district of Kemar. From here, once more, he was in sight of the range north of the Tsanpo, a beautiful sight of great snow-fields and glaciers. He now turned south-east, having the magnificent Hlunpo-gangri on his right, and for six days followed the big river Buptsang-tsanpo up to the Samye-la, a pass in the main range. It was here that the name Trans-Himalaya struck him as most suitable for this range. Although Tibetan names are obtainable for every conspicuous peak in this range, the Tibetans have no name for the whole range, and I therefore think the name proposed by Sven Hedin should be accepted. Until Sven Hedin has had time to work out his observations and plot his map, it would be advisable to postpone any discussion as to the extension of this range east and west; but Sven Hedin has very thoroughly explored it throughout that region marked "Unexplored" on the R.G.S. map of Tibet, and there is no possible doubt that the range exists, and is the watershed between the Brahmaputra on the south and the lake region on the north.

Sven Hedin now carried out a thorough exploration of the Chaktak (called Charta on our maps) Tsanpo; however, near Raga he was met by Tibetan soldiers, and considered it advisable to reveal himself. He at once became great friends with the Tibetans, who allowed him once more to select his own route. It was arranged that Abdul Karim, his headman, should go with the main caravan *viâ* the Samye-la, to meet him again at the Buptsang-tsanpo, while Sven Hedin himself, accompanied by only five men, left his Saka friends on May 6th, 1908, and went straight north, to what he describes as the most interesting of his crossings of the Trans-Himalaya range.

By the Gyegong-la he crossed the Kanchung-gangri range, which is not the head range, but broken through by the Chaktak-tsanpo. In the Lapchung-tso, situated to the north of this range, many rivulets coming from the main range collect and form the headwaters of the

river. On May 12th Sven Hedin crossed the Sangmo-bertik-la, surrounded by glaciers, and the Soma-tsanpo, which he describes as the biggest river in the interior of Tibet, emptying itself into the Teri-nam-tso. On May 19, after crossing the Teta-la, a most brilliant view unfolded itself of the whole Teri-nam-tso, Trans-Himalaya range, Targo-gangri, and Shakang-sham, the latter a particularly magnificent mountain. The lake has been almost correctly placed by Nain Singh, although only from native reports; but his Ngangon-tso nobody had heard of. Two days' march took them to the western end, and following the Soma-tsanpo past Mendong-gunpa, they crossed the Goa-la, and leaving the little Karong-tso to their left, struck one of the great salt roads leading from Raga to Tabié-tsaka. Chunit-tso was left to the right, and a junction should have been made with the main caravan on the Buptsang-tsanpo, in Bongba-kebyang; the caravan however had disappeared. On June 5th Sven Hedin said good-bye to his escort and followed the river down to where it joins the Tarok-tso. He was not allowed to visit the great salt depression of Tabié-tsaka, but turned west, past the Lunkar-gunpa, crossing the Nyapchu-tsanpo, flowing from the Men-la in the Trans-Himalaya range to the Poru-tso. West of this lake they crossed the ice and snow-covered Sur-la range to Rigi-changma, then down the Pedang-tsanpo, a big river, to Shobo-tso. From the Tayep-parva-la one can see nearly the whole of the Nganglaring-tso (wrongly called Chalaring-tso on the map), on which there are five islands, but no monasteries on them as marked on the map. The shape is also wrong, as its length is from east to west, not north to south. They skirted this big salt lake for two days, and reached Selipuk on June 26th. Here Sven Hedin was received with the greatest hospitality by the lamas, and, the main caravan rejoining him, he made his way south-west to Tokchen, crossing the Trans-Himalaya range for the tenth time by two passes, Ding-la and Surnye-la. Sven Hedin had at last had enough of Tibet, and he made his way down the Sutlej to Simla, keeping however while in Tibetan territory somewhat north of our route.

The geographical results of his journey may be summed up as follows:—

(1.) The discovery and careful exploration of the Trans-Himalaya range, and the filling in of the large white space on our maps north of the Brahmaputra from Gartok to Shigatse, and the discovery of the provinces of Bongba and Chokcu, which he has been the first to discover, that of Dokthol, on the map, not being in existence.

(2.) The discovery and exploration of the source of the main branch of the Indus.

These, I believe, are two absolutely new and most valuable discoveries.

(3.) Sven Hedin also visited and surveyed the true source of the Brahmaputra. This however had been approximately located, I think, by Nain Singh, and fairly well surveyed by Rawling and myself, though Sven Hedin having actually visited the real source, his map will be more accurate. I hope this Paper, written in a great hurry, may give the readers of the *Geographical Journal* some small idea of the value of Sven

Hedin's discoveries and the treat in store for them when he delivers his lecture. He has brought back with him innumerable observations and maps, which will enable him to draw a map of the whole of Tibet and Turkestan on the 1:1,000,000 scale. Some years must elapse before his scientific report and results can be published, but they should exceed in interest those of his 1899–1902 journeys. In the meantime he will publish as soon as possible a popular account of his travels.

Sven Hedin is not responsible for any opinions expressed in this Paper.

RAILWAY SIGNALLING.

ITS DEFECTS AND SUGGESTIONS FOR REMOVING THEM.

From a Lecture delivered before the Leeds local section of the Institution of Electrical Engineers by Capt. A. Gardiner, R.E.

The method by which control over the movement of trains is secured by the semaphore is too well known to need any detailed explanation.

We are all acquainted with the square-ended arm which in the horizontal position denotes that its post may not be passed by a train; and with the fish-tailed "distant" which merely warns the driver that he is approaching a "stop" signal, and indicates its condition at the time that he is passing the "distant," so as to ensure as far as practicable that if it be at danger he may be ready to stop before the square-ended signal is reached.

The system, despite all the scientific thought and attention that has been devoted to it, is still unsatisfactory. Its first and every-day difficulty arises at nightfall, when lights usually of the same colours do duty for both "stop" and "non-stop" signals, and a driver has therefore to interpret the meaning of the red or green lamp in front of him with the aid of its surroundings, and of his memory of the road, and of his position upon it.

Attempts, it is true, have been and are being made to remedy this obvious defect; but, for all the years that the semaphore has now been used for traffic control, no method has as yet been sufficiently successful to lead to its general adoption. The principal difficulties lie in the lack of certainty with which colours at all approaching each other can be identified under untavourable circumstances; and in the serious objection, that obviously arises, to any further complication of the maze of lights already formed by the signals of any important junction.

Apart from this defect however the system is in itself inefficient For although, with the aid of electricity, we can secure almost absolute immunity from error in the signal that it is desired to convey to a train, compliance with that signal, and hence the safety of the train, still remains entirely dependent upon a sequence of effects which that signal has to produce upon a human intermediary over whom we have little possible control. It has to be seen by the driver of the train, it has then to be correctly interpreted, and then to be promptly complied with.

In each item of this sequence there lies an element of chance which has but too frequently produced appalling disasters, and must continue to do so, so long as we have to rely wholly upon the human element for giving effect to the order which the signal is intended to convey. One instance of this element of chance is brought out by what is a

constant recurrence during every year, viz., fog, rendering the semaphores and their lamps either invisible, or visible only with the greatest difficulty. We endeavour to meet the danger that this state of the atmosphere gives rise to by detonators, which however may or may not explode. Injury in the fog to the signalman, or other failure to get the detonator on to the line, or to get it there in time, or to explode it when there, may still result in the semaphore being passed unseen.

Again, particularly on our busier roads, the concentration of attention imperative to ensure safety is incessant. A moment's wandering of the mind and a train may be again, as many have been before, doomed. Disasters unconnected with any atmospheric conditions have recently been prominently before us both in England and elsewhere in the Empire.

With the present external semaphore and lamp, each road and each branch from a road requires a separate signal; there are signals for stopping and signals for starting; signals as "advanced homes" and signals as "advanced starters"; each "home" with its attendant "distant," and but too many of the rest with repeaters or other auxiliaries, until the mass of semaphores and lights at a large station makes the interpretation of any one of them even on the brightest day, leave alone the finest night, a matter requiring a high degree of skill and memory. Yet out of this mass the driver is required to pick out promptly and accurately the one semaphore or lamp of each group that alone refers to his particular train.

The difficulties and dangers sketched briefly in the foregoing are so great that a recognition is undoubtedly growing of the need for some means of bringing the state of the signal emphatically and unmistakably to the notice of the drivers on their cabs, and making the neglect or unobservance of signals necessitate deliberate action on the part of the driver, so as to transform inertness into activity, and ensure that it is no dead man's hand or eye to which the safety of the traveller is entrusted.

Thus on the Metropolitan District Railway we see a description of actual train control, whereby a train running past a signal at "danger" has its brake applied automatically through the impact of an arm on the track against a lever carried on the train.

The adjunct points the direction in which railways are undoubtedly moving, but that is all. For with the train stop placed where it is, viz., at or near the "home," it applies too late—at all events for anything but slow traffic and light trains. Once a "stop" signal has been passed, a train may be in desperate danger, for the obstruction may be close beyond; and a train at high speed, tripped by the train stop while passing the "home," must travel considerable distance before it can be brought to a stand, much further than any permissible "overlap," such as may be suitable for the traffic of the District Railway. On the other hand, were the train stop placed sufficiently far in advance of the signal to ensure that the train will have been stopped before the signal is reached, its operation becomes necessarily one of every-day occurrence, and the blow of the arm against the lever then rapidly destroys one of

them or both. Even were a situation as on the District Railway otherwise possible, an impact device would not be practicable for trains travelling at 45 to 70 miles an hour.

On the Great Western Railway train control is not attempted, but they also disclose the craving for something more efficient than the semaphore in the cab signal, which they have substituted for the ordinary "distant" on some sections of that line. And there again, while the invention, excellent as far as it goes, appears to be too limited at present in its scope for it to be the last word in cab signalling, we see another tendency of the new movement.

For immediately a really reliable substitute for one of our existing semaphores is discovered that semaphore *disappears*. The Great Western cab signal is not a signal repeater—it is a signal; and the semaphore being no longer required for the particular indication that their cab signal provides, it has begun to be abandoned as far as that indication is concerned, as it will undoubtedly be abandoned for every other indication once a really efficient substitute is found. No half-and-half system will stand the test of time. If a cab signal is reliable, the driver will pin his faith upon that, and the semaphore becomes superfluous. If it is unreliable, the driver will adhere to his present signal, and the equipment in his cab will fall into disrepute and disuse. The regard in which mere repeaters are held receives illustration in almost any cabin containing them on any railway in the world.

A mixed system of signalling, such as one with the "distant" in the cab and the "home" on the track, contains, moreover, a new element of danger, for the "distant" is not a final signal. Even though the "home" be off when the "distant" is passed, the signalman has the option of throwing it to "danger" before its post is reached by the train, and may thus possibly avert an accident. But such occurrence is comparatively rare, and there is therefore risk of the driver learning to treat the "safety" indication in his cab as full permission to proceed, and relaxing his look-out for the signals on the track, thus overlooking a possible confliction between the actual state of the "home" signal and the indication of its state as previously given to him on his cab.

This danger appears to have been recognized by the North-Eastern Railway, and in their signal they seek for something more than the single indication, and instal a series of signalling points, each of which confirms, or may cancel, the indication previously given.

The North-Eastern Railway system goes much further in many ways in the desired direction of a complete system of signalling on the cab than does that of the Great Western Railway; but unfortunately its signal has a "gravity" safety position, being operated by a magnet that is "dead" for the safety position, and requires to be excited in order to show danger. The result is that any failure in the signal magnet circuit can but mean a failure to remove the safety indication; and although the equipment provides auxiliary detection for certain causes of such failure, still the defect is sufficiently grave to, it would seem, limit the scope of this system strictly to repeating the external signals. For the reasons already given this is an undesirable handicap,

making the system fall far short of the ideal that railways are seeking for.

Another respect in which our present system of external signals woefully breaks down is as regards reductions of speed; for a railway cannot always be built so that from end to end it is fit for speeds that are perfectly safe over the greater part of it. Even if so built, portions will occasionally require replacement or repair, and during the execution of these works will not be fit for the maximum speed, and the unusual presence of a man upon the line with a green flag or lamp is commonly taken (although the green flag is in itself merely the opposite to the red) to indicate the necessity for proceeding with unusual caution. The efficiency of the system is again of the lowest, for safety once more depends wholly upon human obedience; and obedience, moreover, in this case of a high moral order, for it is almost invariably impossible to ascertain at what speed any particular part of line has been passed over, and the driver risks a larger measure of blame for any delay that may result than he ensures praise for strict compliance.

With signals on the cab, not only is it possible to give a "reduce speed" indication that cannot be confounded with any of the other indications, but it becomes possible also to make that signal act directly on the motive power of the engine, and so enforce compliance; and further, by providing for the automatic removal as well as the automatic exhibition of the signal, it becomes possible to obtain a record from which the actual speed over the restricted section can be indisputably established.

Reference has been made to the systems in force or being tried upon the District, the Great Western, and the North-Eastern Railways, chiefly as evidence of the fact that weak points are recognized in the present system of railway signalling, and that the idea of a system of cab-signal control of trains is not merely a visionary theoretical scheme, but one which in some form or other has for some time been engaging the attention of practical men. I propose now in the first place to outline what appear to be the main essentials of a perfect system of train control with its resultant effects, and then to explain how it is suggested practically to secure their fulfilment.

A perfect system of train control by cab signals should, to meet all the requirements of traffic working, fulfil at least the following conditions:—

1. It must comply with the essential principle that any breakdown of the apparatus that can impair its accuracy shall completely remove the "safety" indication and produce either a "danger" or a "disabled" signal.
2. It should be wholly in the cab, and not depend partly upon signals in the cab and partly upon signals on the track.
3. It should signal, not at one point or several points, but at every point, so that a train shall be continuously in receipt of a positive signal.
4. It should simultaneously act directly upon the motive and brake power of the train, so that it shall be automatically obeyed, and not having been at great expense automatically given, depend wholly upon human compliance.

5. It should provide an audible as well as visual "danger" signal, as an additional safeguard against momentary inattention on the part of the driver.
6. It should enable an automatic record to be maintained of all signals received and of the exact time of receipt.
7. It should provide that, automatic control having been set up, it shall be practicable for the driver to reassume his control over the motive and brake power of his train without interfering with the efficiency of the apparatus in delivering further signals.

This last requires, perhaps, special consideration. Writing recently in the *Times Engineering Supplement*, Professor Ayrton advocated the shutting of power off a section of electrified line whenever the signals are against a train. Professor Kapp, in his still more recent lecture on the "Electrification of Railways," delivered at the Royal Institution, explained how this is actually done on the Valtellina Railway.

With a system of cab signals and control complying with the requirements set forth above it would be easy on a steam line, as it is already attractively simple on an electric one, to cut the power irrevocably off the train, when that train is desired to stop, and to restore the power automatically only when it is desired to permit the train to resume its course.

With a manually controlled system of signalling, such a step is not altogether impracticable. The driver's duties on a steam train would then be of a very limited order, while on an electric one his presence at all conceivably becomes *theoretically* unnecessary.

A purely manual system of signalling is however, as compared with the automatic, both deficient in safety and incapable of dealing expeditiously with a dense traffic. With automatic signalling, as far as indicating the condition of the track is concerned, manual control is not only superfluous, but even undesirable. It is essential however that if any derangement or irregular occurrence shall affect any automatic signalling appliance at all, its interference shall take the form of the danger indication, and while the better of the approved systems have reached such a degree of perfection that derangements are rare, and of the order of 100,000 movements per failure, still it is out of the question from the point of view of general railway working that it should be possible for such a derangement, however occasional, to hold up indefinitely (as it would were the complete cycle of the system irrevocably automatic) the whole of the traffic over a considerable length of line. Moreover, apart from derangements of equipment, it is sometimes necessary in railway working to break through normal rules, such as, for instance, when two trains are brought to one platform, or into close proximity with some block or breach, the existence of which must however essentially cause an automatic equipment to give the danger indication.

The presence of the human element somewhere in any automatic system of train control for the purpose of stepping in and bringing human intelligence to bear when the machine has temporarily reached its limit, may therefore be considered an accepted postulate. This being so,

of the two component parts of such a system, the fixed or track part and the moving or train part, on either of which this human element may be located, the most advantageous, both theoretically and practically, is unquestionably upon the moving part.

A system of automatic control over the movement of trains must therefore, to be practical for general adoption, comply with the condition that while it ensures automatic obedience of the train to the signal received, it admits of being overruled without serious inconvenience when circumstances require, but overruled only as the wilful and deliberate act of the driver in supreme charge of the train and not as a matter of oversight.

The method proposed involves, as will have been already understood, the eventual entire abolition of the semaphore and its lamp, with the following immediate results :—

1. In place of the usual external signals we obtain primarily indications in the cab itself, visible, and if desired audible, at all times despite fog or storm.
2. For the operation of a human driver, liable to err in picking out which particular lights or arms of each signal group alone refer to his particular train, it becomes possible to substitute automatic selection and to present the result alone in unmistakable form before the driver in his cab.
3. For verbal evidence, frequently defective, often false, as to signals received during a run, we are enabled to secure an indisputable automatic record of the signals received, it may even be of the action taken in the case of the "danger" indications.
4. For a signal that may mean "stop" and may mean "prepare to stop," and which frequently can but with difficulty be correctly interpreted, it substitutes a "stop" signal that always means "stop," as well as a "danger" signal that always means "danger."
5. For a requirement of traffic working that has not as yet been adequately met it provides a "reduce speed" signal, disregard of which can be subsequently detected or proved.
6. Finally, we secure indications which can readily be made to act directly on the engine itself, and be automatically obeyed, in place of indications compliance with which must depend wholly upon the unchecked human element.

The means are as follows :—

Parallel to the running rails is laid a metallic "track conductor" (T.C., *Fig.* 1), probably of tee or angle iron, of section about $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$, and carried on wooden posts 6′ to 10′ apart at the maximum distance from the track that the running dimensions admit of. Better insulation may possibly be found necessary, or the conductor may be preferred between the rails—but these are details that experience will settle. The height of the track conductor above rail level must suffice to ensure that the moving contacts shall clear the top of the rails at crossings, metalling of cart roads, and so on; and in order to enable engines to run either

chimney or tender foremost with a single track conductor they must, if the conductor is placed externally, carry the contact devices in duplicate; so that the conductor is free to be placed for short lengths on whichever side of the line happens to be locally most convenient.

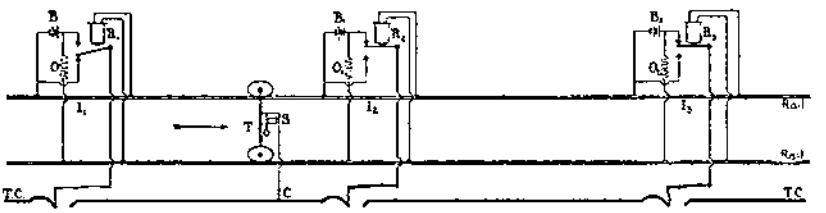


FIG. 1.

The track is split up into track circuit sections of the desired length (insulated joints I_1I_2), and the rails within the limits of these sections are bonded together on each side by one of the usual track circuit wire bonds. At one end of each section is a track relay (R_1R_2), and at the other a track battery (BB_1) or other source of power for the track relay. The relay and the source of power are each connected to the rails in such a way that when no train is on the section, the relay is excited and its armature drawn up; when a train enters the section the relay is short-circuited by its wheels and axles, and the armature falls away.

On an electric line Brown's patent arrangement of two polarized relays, as used on the District Railway, could readily be utilized to prevent any risk of operation of the signals by leakage currents.

The armature of the relay carries certain contacts, which are closed when the armature is attracted, and for the purpose of this signal it carries also other contacts, which will be closed when the armature falls away.

A resistance (O_1O_2) is inserted between the track battery and the track to prevent the battery itself being short-circuited by the trains; and a parallel circuit is then taken from the battery positive, through the contacts of the near track relay, to the track conductor, as shown in the figure. The track conductor in each section is thus, when the relay controlled by the section ahead is energized, charged with the potential of the track battery above the negative track rail, but is dead when that relay is shunted. Consequently when any track circuit section is occupied, the track conductor of the track circuit section in rear is dead.

As far as the first and principal indication to be given on the engine is concerned therefore, viz., "clear" and "stop," all that is required is some means of collecting current from the track conductor, and an electromagnet which will, when energized, show a "clear" signal, and show a "stop" signal by the action of gravity when de-energized.

The action will then be as follows:—

If the section (B_2R_2) ahead of a train is clear, its relay R_2 will be energized. The battery B_1 will have part of its current shunted through the fixed resistance (O_1) and the wheels and axles of the train (T), while part of the current will pass *viâ* the track conductor and the collecting

devices on the engine, and *viâ* the coils of the signal magnet (5), to the negative rail. The train will thus receive the "clear" signal. Should, on the other hand, the section ahead be occupied (as is the section B_1R_1), the relay (R_1) being de-energized, the track conductor will be dead, and a following train will receive the "stop" signal.

The lower contact of the relay is arranged to connect the track conductor directly to the negative rail of the section, so that in the de-energized position of the relay it will be impossible for there to be sufficient difference of potential between them to retain the signal armature in the "clear" position. Any type of collecting device found suitable can be used—brush, shoe, spring, or, if need be, even trolley and wire—and any number of such devices can, if necessary, be placed in parallel; to ensure one of them picking up the trifling amount of current that will suffice to work the signal, the collecting devices can also be preceded by a brush or scraper to clear the way, or a steam jet can be arranged so as to play upon the track conductor immediately in front of the engine contacts.

To control the motion of the train, the armature of the signal magnet is supplied with contacts placed in a local circuit on the engine, which includes electromagnetic valves on the main steam pipe and the train brake pipe; the former to shut off steam, the latter to admit air to a vacuum equipment, or release the air from a Westinghouse one whenever the circuit is opened by the fall of the signal armature.

The local circuit on the engine would also, if desired, include a whistle bell or buzzer, designed to operate when the signal falls, so as still further to attract the attention of the driver.

The cessation of the actively produced, contrary to gravity, "clear" signal would thus not only cause the "stop" signal to appear, but it would also give rise to an audible signal, and further shut off steam and apply the brake. Working with such a system, it would be the duty of the driver, on the receipt of a "stop" signal, then and there to take steps to aid the automatic control in bringing his train to a stand with all reasonable speed. This done, he will await the receipt of the "clear" signal, knowing that it will reach him, whatever his position on the track, the very instant the section ahead is clear.

The shutting off of the steam can cause no mechanical inconvenience, and the application of the brake can be made just as gradual as may be desired, while the apparatus can be designed with means to restore the steam and close the brake pipe whenever the driver elects to do so, and until such time as the engine shall have received another "clear" indication and then another "stop."

The models have been made to work without any driver, and consequently restore the motive power on receipt of the "clear" signal. This is not suggested for actual practice. The driver would be expected to close his regulator on receipt of the "stop" signal, and would be required to restore the vacuum or air pressure by his own action on receipt of the "clear."

The recorder consists of a chart revolved by clockwork under a pen, which is controlled by an electromagnet placed in a circuit of the local

battery on the engine, and arranged so as to mark the chart when the signal magnet is in the released or "stop" position.

Were it possible invariably to act up to normal rules, so that it would never be necessary for a train to proceed against a "stop" signal, nothing further in respect of the "clear" and "stop" indications would be required than has been outlined above. Such however is not the case, and it is necessary to provide that a train receiving a "stop" signal for which no obvious cause exists may be able, after waiting a reasonable period, to proceed cautiously to the end of the block reported by the automatic signals to be occupied.

A reference to *Fig.* 1 will show that a train proceeding in this manner might under suitable circumstances eventually receive a "clear" signal, although the block were occupied. It is necessary to avoid this, a necessity which fortunately there is little difficulty in providing for. The key to the situation is that part of the track conductor last passed over in the "dead" section which must always precede an "occupied" one.

A train following the train "T," and approaching from the left of the plate, will be perfectly safe up to the insulated joint I_1; should it pass I_1, its collector and its signal magnet will be in parallel with the collector "C" and signal magnet "S" of train "T."

To prevent this it is proposed to make use of a ramp to open the signal circuit of the following train on the same general principle as that adopted by the Great Western Railway. The track conductor is ramped in the neighbourhood of, and to the facing side of, each insulated joint. The cab signal has an additional "danger" magnet which controls three contacts, one for its own local circuit, one in series with the collector and the signal magnet, and one to operate an audible signal. Further, when de-energized it causes a shutter marked "danger" to drop by gravity in front of the signal window. The danger magnet is normally excited by the local battery on the engine, the circuit being through its coils and its own contacts in series.

One collector on each side of the engine is so arranged as to be normally insulated from this circuit, but, when the collector is raised by means of a ramp, it breaks the local circuit and substitutes for it another circuit from the ramp through the collector and the coils of the danger magnet to earth. If however the substituted circuit is dead, the armature of the danger magnet falls away on the opening of the local circuit, and in doing so breaks that circuit a second time at its own contacts. The local battery is consequently unable to resume control of the magnet after the engine has quitted the ramp. But the circuit of the signal magnet is also taken through the contacts of the danger magnet; and consequently the fact of the track conductor being alive beyond I does not result in a "clear" signal. The train would thus traverse the section I_1I_2 (which is either occupied in some way or else unsignalled in consequence of a breakdown of its equipment, and which is therefore in either case an extremely dangerous zone) with the "danger" signal before the driver. This would be registered on the recorder, and the length of the section being known, the speed at which he traversed it would be indisputably established. If the delay had been due to the relay (R_1) being out of order, the track conductor in the section I_1I_2 will have been alive.

Before leaving that section the engine must traverse its danger ramp, which is, however, this time a live one. The auxiliary circuit to earth which is made temporarily by one of the collecting shoes while on a ramp will now energize the danger magnet and close its contacts, enabling the local battery to resume control as the engine leaves the ramp and closing the circuit of the signal magnet. This is the normal action when quitting each "clear" section, the driver then requiring no notice whatever.

The above indications deal with the track between stations. We may now consider the approach to a station. The train may run in or through on the straight, or it may have to be turned off on to a siding or branch. In the latter case the driver should approach with reduced speed, since it is not safe for him to take points for a turn-out at the same speed as for the straight. To give the warning to reduce speed we utilize an independent ramp, placed (if the track conductor is outside) between the rails of the track.

An additional magnet is supplied to the engine equipment and an additional contact device for the "reduce speed" ramp. The magnet works on the same principle as the "danger" magnet, but it is proposed that it should merely shut off steam and not affect the brake; this is however entirely a matter of what may be desired. The "reduce speed" magnet has a suitably worded shutter, which appears by the action of gravity at a separate window placed as close as possible under that at which the "stop," "clear," and "danger" signals are shown. When the magnet is excited the "reduce speed" shutter is drawn up, and the window is blank.

The ramp circuit is dependent upon the points, and when these are set for the straight and all is clear, the "reduce speed" shutter will not drop; when set for a turn-out the driver will receive his warning, and with the aid of the recorder it will be possible to determine what action he took upon it. In India, at all events, the speed at which points and station yards are traversed is somewhat frequently a subject of interdepartmental discussion.

But points may be set for the straight when, as a matter of practice, all is not clear; for a train may be already there, and it may be desired to bring another up against it. The state of the "reduce speed" ramp will therefore depend further upon the relay of the station track circuit section, and its mechanical action will only be electrically cancelled when all is clear for the train.

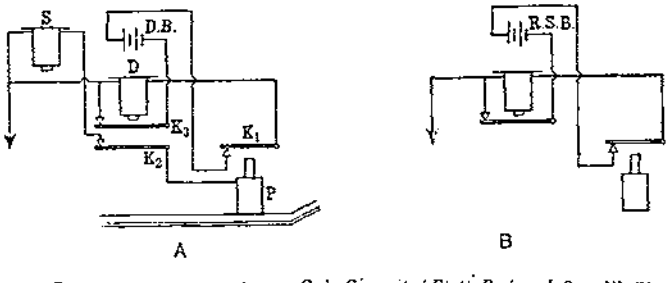


FIG. 2.—*Diagram of (A) Ordinary Cab Circuit, (B) "Reduced Speed" Circuit.*

S. "Stop" Magnet.
D.B. "Danger" Battery.
P Plunger.
K_1 K_2 K_3 Signalling Keys.

The "reduce speed" signal will, like the "danger" signal, be entirely beyond the control of the driver, and to remove it a live ramp will be placed at the point beyond which restricted speed is unnecessary.

In the "reduce speed" signal we have all that is necessary to deal with any temporarily or permanently dangerous section of line, viz., a pair of temporary or permanent ramps, the one dead to apply the signal, the other charged to remove it, coupled with a recorder to record the duration of the "reduce speed" signal. The distance between the ramps being known, this gives a permanent record, to be filed in the Locomotive Superintendent's Office or submitted to the Manager, of the regard that has been paid to the restriction.

The above has described a "clear" and a "stop" signal for normal use, and has outlined a method of train control—a "danger" signal that comes into play only when the "stop" signal has for any reason been disregarded, and a "reduce speed" signal to meet the case of ordinary speed restrictions, and of the necessity for cautious driving when leaving the straight for a turn-out.

The model shows how these signals can be subjected to manual semi-control in the neighbourhood of stations, so as to meet, it is believed, every reasonable requirement of traffic working.

It is however possibly further necessary to advise the driver of the actual route set for his train. With certain not inconsiderable limits this can readily be done by means of bars on the track which will be normally dead, but one or other of which will be charged with current according to the setting of the points. The engine will carry a set of contact springs or other device and an indicator which will show the number of the ramp which is charged with current. The indication will not be a primary signal, and the absence of any indication can be treated as a "dead end" signal. The model shows three tracks, each of which is "indicated" in this manner. It is believed that the actual number of the route he is to take is not really required by a driver, and that three indications meet every reasonable need. "No. 1" would then mean "Straight road—all clear"; the "*reduce speed" signal* and "No. 2" would mean "Points set for a clear loop line"; and the "reduce speed" and "No. 3" would mean "Points set for a dead end or an *occupied* line." Each indication would be recorded, and under instructions "no indication" would be treated as equivalent to "No. 3."

As regards the safety of such a system of signals as here advocated, the essential signal of the equipment is that which gives the indication "clear" and "stop." The "stop" signal is entirely a normal mechanical signal, and has to be held off continuously by a current received from the track conductor under the control of the track relay. Consequently, even if the conductor be carried away altogether, the only result can be to stop the train. In the released position of the track relay, the track conductor will be short-circuited, as explained, on the negative lead, so that even leakage currents cannot operate the signal. A leakage across an insulated joint merely lengthens the track circuit section. The control of the motive power and the brake can also be designed

so as to be actively prevented from acting by the presence of an electric current, the cessation of which from any cause will cause them to stop the train, and these parts of the equipment appear therefore to comply with an unexceptionally high standard of safety.

The "reduce speed" and (subsidiary) "danger" signals, according to the method proposed, are gravity signals actively held "off" by the presence of a current, and coming into operation when that current fails. Short of the actual removal of the ramp itself (the equivalent to which in semaphore signalling is the removal of the post itself), every derangement can only result in the signal giving the precautionary indication. The "danger" signal could further only be given after a "stop" signal, and after it had been decided by the train staff to proceed against the "stop" signal, so that it would only come at a time when the train would be moving very slowly and much on the alert, so that even the removal of the ramp (involving a gap in the track conductor) should in this case be detected.

As regards audible signals in the case of continuously ringing bells, buzzers, trumpets, etc., a current must be present to create the noise; where possible therefore a steam or air whistle will be a better agent for this purpose, the contrivance then being arranged that the presence of the electrical current prevents its sounding.

As regards the indications of the route, it is proposed to give these by the transmission of a current. They are not however in any respect part of the signalling system essential to safety of movement; the "reduce speed" signal would operate whenever special caution is required, and any failure to receive a route indication, as stated, be treated as indicating the most dangerous route.

For single-line working there need be no alteration whatever to the engine equipments, and it will therefore be a matter of indifference to the driver whether he is passing over double or single line. The track equipment will still consist of a single track battery and a single track relay per track circuit section; but there will also be a polarized relay, the duty of which it will be to switch the battery and relay connections over from "up" line working to "down" line working, and *vice versâ*.

The polarized relays would be in the circuit of the "line clear" instrument used for the despatch of trains, and would be arranged to work entirely automatically in connection with the issue of an "up" or a "down" token. One result of the equipment will then be that should a train, by overrunning or any other mischance, proceed in a contrary direction to that for which the track has been "set," the rear end of the train will cause the engine to get a "danger" signal, and will thus automatically bring the train to a stand. Even with the best of "line clear" token systems, since cases are not unknown of drivers accepting "line clears" that were not intended for their particular trains, collisions must remain a constant risk in single-line working. A grave accident occurred only a few months ago in India when two passenger trains collided head to head, over 100 Europeans and natives being killed.

An objection occasionally urged against giving signals on the cab is

that they are seen only by the engine crew. The presence of a self-recording instrument however gets over this difficulty as far as corroborative evidence is concerned, and the automatic application of the indication to the engine itself largely meets the objection as far as the immediate safety or working is concerned, while in most cases there would be little difficulty in repeating the signal if desired in the brake van or on any other car of the train.

Although it is practically certain that if cab signalling is adopted the semaphore will eventually be superseded altogether, it would be many years, no doubt, before the conversion of the equipment of any road and its locomotives would be entirely completed, and it is therefore essential that the cab signal shall be capable of working in conjunction with the existing semaphores. There is no difficulty on this score in regard to the proposals now made, and the cab signal can be arranged that it cannot show "clear" when the semaphore is "on," although it will show "stop" should the semaphore be improperly "off." The model provides an illustration of this feature. The period referred to during which there would be dual signalling would moreover serve a useful purpose in training the staff to the new departure, and giving them confidence in its reliability.

The two most obvious objections that can be advanced to a continuous signal on the cab are (1) the necessity for contact; (2), the cost.

With reference to the contact objection, it will undoubtedly be a very great advantage to every one—except, perhaps, those who own copper—when we can do our electrical transmission of power by "wireless"; but those days are not yet, and meanwhile the late lamentable disasters have forcibly brought home to all of us the ever-present risk of calamity to those for whose safety railwaymen are responsible, which is inherent in the present system of train control, and which cannot or should not be disregarded because the future has further improvements on what our present knowledge admits of. Therefore, while every attention is being paid to the possibilities of avoiding the necessity for actual contact in transmitting the indication to the locomotive, pending success in this direction, too much of a bogey can easily be made of such difficulties as present themselves in preserving this contact. The current to be transmitted need not, as has already been pointed out, be a large one, the contact devices (with the exception of the single one on each side required to break the local circuit of the danger magnet) need not be other than of the simplest description, and can be multiplied *ad libitum*, the voltage of the track conductor can be put up to anything found absolutely necessary, the pressure of contact need not be great, the surface of the conductor can be made to approach a knife-edge, and there are many means of clearing it of ordinary frost and snow. The height suggested for the conductor is 3″ above rail level, or some 9″ above the sleepers, which would keep it well above the actual snow level of any ordinary snowstorms, while even heavy snow can only at worst produce a danger signal, and not, as it may with the semaphore (by weighing it down or freezing it), a false "clear."

With reference to the remarks above on the subject of the contact

objection, the change to some other method of transmitting the desired indications would not in itself modify the system of cab signals advocated, but would be merely an alteration in certain details easily introduced in the event of success being met with, and it does not seem desirable to postpone taking advantage of the great gains in safety which the system offers, awaiting an improvement that is not essential.

As regards cost, comparison can, of course, only be made of an automatic cab signal with other modern automatic outside semaphore systems which all involve electric track circuits. Auto-signals in this country are mostly of the electro-pneumatic type. Up to the relay, they and an automatic cab signal have everything in common—a bonded running rail, a source of power for the track circuit, and a system of track relays. They then require a pipe to convey air, pumps to pump air into this pipe, traps to carry off the water. Under the most favourable circumstances the leakage and losses from condensation and friction in these pipes represent a considerable percentage of the air which has to be pumped in at appreciable expense. A cab signal requires a metallic conductor that need hardly carry more metal than the pipe, if as much, will be no more difficult to lay, and needs no traps. In place of pumps the existing track batteries will merely have cells added to supply the desired voltage. The degree of leakage would be practically simply a matter of the expenditure permitted on insulation, and could, if wished, be *nil*, since no useful current flows except when a train is on the section. So much for the track. As regards the signal for the outside automatic semaphores, usually at about every mile of the track, it is proposed to substitute a signal apparatus on each engine. The number of locomotives per mile on an English railway are not known to the author, but in India the standard gauge system with the largest number of engines is the Eastern Bengal State Railway, with 0·4 of an engine per mile, a figure which had not been surpassed by any other of the Indian gauges up to April, 1907.

A primary signalling equipment consisting of "clear," "stop," "danger," and "reduce speed" indicators, with the necessary contacts, etc., could probably be fitted, at a rough estimate, for about £20 per engine, which at 0·4 of an engine per mile works out to £8 a mile. This can hardly be in excess of what the automatic semaphore with post, valves, or relays, and raising and lowering mechanism, at one semaphore per mile works out to.

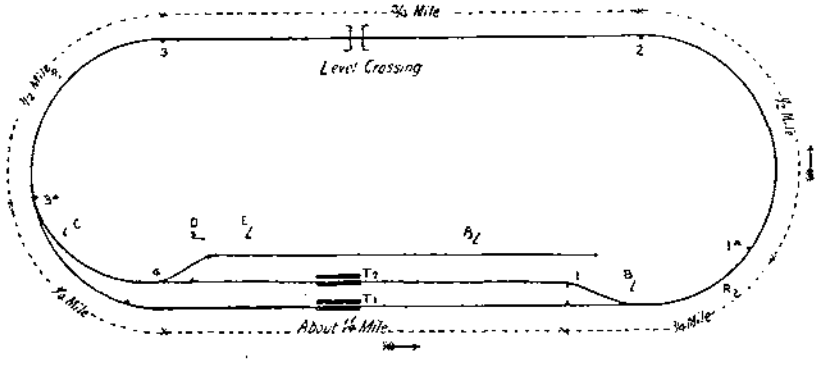
Fully equipped with train control as proposed in this Paper, the cost would, of course, exceed this figure, but it is believed that the track work between stations with half-mile sections (instead of 1 mile, as with the semaphore) need not exceed from about £140 to £160 per mile, and the engine equipments to from £40 to £50.

Yards would continue to be power or manually worked on any of the well-known systems, but without semaphores or lamps, and the saving in these would go far to meet the cost of the conductor, reduce speed ramp and indication bars, and their electrical interlocking with the points. The cost of the track work at stations would thus be little, if at all, in excess of present requirements. In this Paper, in discussing cab

signals *versus* outdoor semaphores, comparison has, as stated, been made with an up-to-date track-circuited installation, such as *are now being installed* on the leading English railways. In India, where the track circuit is as yet practically non-existent, the cab signal, with its automatic indication of the condition of the section of line ahead, and automatic "stop" in the event of this being obstructed, would be of immense advantage, not only on account of the trying effects of the climate on the alertness and physical condition of the train staff, but also of the protection it would afford against the wash-aways, failures of bridges, and other damages to the roadway, which are, unfortunately, practically unavoidable in the tropical downpours and cyclonic storms with which all parts of that country are at times visited, and which have led to disasters owing to failure of the human agency to detect the damage and warn the approaching train.

The following is the description of a model exhibiting the system of train working with engine cab signals, as patented by Capt. Gardiner, and which is to be seen by appointment with Colonel Gardiner, 28, Barkston Gardens, Earls Court, S.W., or at The Accumulator Industries, Ltd., 4, White Street, Moorfields, E.C.—[ED., *R.E.J.*] :—

The model represents a length of railway laid out in an oval form, starting from a station provided with a passing siding and one dead end siding, and running round the oval to the same station again.



1 1A 2 ETC.	Limits of Signal Sections.	D	Stationmaster's Calling-on Key.
A	Stationmaster's Starting Lever.	E	Stationmaster's Admission Lever.
B	Trailing Points Lever.	R1 R2	Reduce Speed Ramps.
C	Facing Points Lever.		

The model track is wired to represent the left hand (*i.e.*, inner) track of a double line, the trains running normally as indicated by the arrows in the opposite direction to the hands of a clock.

For single line working no modification of the engine equipment would be needed, but to introduce the additional track arrangements on a model of a practicable size for room exhibition, and in which the length of the sections is necessarily out of all proportion to the size of the

locomotives, would undesirably complicate it. To exhibit the system of working proposed, the model track has been divided into six sections. Of these in actual practice none would be less than say $\frac{1}{4}$ mile in length, whereas in the model some have necessarily been reduced to two or three engine lengths only. Normally, the length of a section will usually be made the minimum in which a train running under the least favourable circumstances for control can be stopped with certainty. The figure would be decided by the locomotive officers of each line concerned, but would probably be about $\frac{3}{4}$ mile in length. At the ends of a station however short auxiliary sections will usually be introduced for the purpose of facilitating working within the yard. These are shown at 1A and 3A in the above drawing and their purposes can best be explained on the model itself.

While the system was not originally designed as one for controlling the despatch of trains from crossing stations on a single line, incidentally it affords much security against what is a fertile source of accident, viz., the departure of, let us say, a down train into a section that is already occupied by an up train. An investigation into the records of one Indian railway showed that in the space of two years there had been six detected cases in which an "up" driver had taken the line clear intended for a "down" train standing in the same station, and *vice versâ*. Though in these cases, fortunately, there were no disastrous results, India has within the past few months had two most serious collisions owing to "up" and "down" trains meeting on a single line. With the arrangements proposed, as can readily be shown in the model, it is practically impossible for a train other than the one intended by the stationmaster to start to leave the station.

To exemplify the system of working proposed, the following movements of trains will be exhibited in addition to any others that may be desired. Assuming two trains T1 and T2 (see drawing) to be standing at the station:—

(I.). The departure points B having been correctly set, the stationmaster with the lever A gives the starting signal and the train moves off. The points and the starting lever being electrically interlocked, permission to start cannot be given until the points are correctly set.

(II.). The train runs round the oval, but as it approaches the level crossing, something having gone wrong there and the gates not being properly closed against the cart road, a "stop" signal is automatically shown on the engine and its motive power is automatically cut off. On the gates being correctly closed a "clear" signal is automatically given and the train proceeds.

(III.). On reaching the point 3 (which is where the station distant signal would be situated in semaphore working), assuming the points C set in error for the loop line which is occupied by the train T2, whether the stationmaster has pulled over his admission lever or not, the approaching train receives automatically a stop signal. When the train T2 is allowed to start and has cleared the loop, the train T1 can be admitted by means of the stationmaster's admission lever.

(IV.). The stationmaster having finished with the train T1, the points

are set and he pulls his starting lever, but until the leading train has passed the point 2, T1 continues to receive a "stop" signal. When T2 clears the section 1-2, T1 receives a "clear" signal and is able to proceed.

(V.). Assuming T2 to be stopped near the level crossing by something wrong, T1, which is following, automatically receives the stop signal on entering the preceding section; after waiting the prescribed period, T1 proceeds cautiously (against the signal) to find out what is the matter. Before he can enter the occupied section his "stop" signal is automatically superseded by a "danger" signal, preventing him from receiving a "clear" signal, although T2 may be receiving a "clear" signal, and is in the same section as that into which he has now entered. After waiting a sufficient time, T1 would again proceed cautiously. Assuming T2 to have meanwhile proceeded, if the section ahead of that occupied by T1 is clear by the time that T1 is about to leave it, he then (*i.e.*, on passing the point 3) receives a "clear" signal once more, and is able to proceed.

(VI.). The trains will now be started out afresh from the station, T2 leading. On returning to the station again T2 is stopped. The points remaining set for the siding on which it is standing, the following train T1 receives a "stop" signal at the point 3 and stops. The stationmaster wishes it to draw up to some nearer point; having allowed the train to come to a stand, he depresses a "draw on" key, preferably in some prearranged manner, which the driver would comprehend to mean "draw on, but be prepared to stop"; the stationmaster can then stop the train at any desired point between 3 and 3A by releasing his "draw on" key D. Beyond 3A the control is entirely automatic, and movement against signal would have to be done by flag or verbal message.

The next two experiments are intended to show the conjoint working of semaphore and cab signals, where the former may happen to exist or be considered desirable.

(VII.). Semaphore signals will now be erected and a train started. The semaphore signals being at danger, although everything is clear for the approaching train, the signal on the cab shows "stop" as soon as the distant signal has been passed; on lowering the signals the cab signal shows "clear," and the train enters the station.

(VIII.). A train is again started. The points are set for the occupied siding, the semaphores are incorrectly lowered by mistake, the cab signal shows "stop" until the points are set for a clear line.

It having been thus shown how the cab signal can be interlocked with a semaphore system so as to prevent the cab signal showing "clear" while the semaphore signals are at "stop," without at the same time destroying the protection afforded by an automatic as compared with a manual system, the semaphores will be removed again and one of the locos. will be connected by flexible wire to the full-size equipment erected at one side of the room. This equipment comprises:—

(1). A full-size cab signal.
(2). An equipment of audible signals, viz., horn for "stop," buzzer for "danger," and bell for "reduce speed."

(3). An equipment comprising in principle the magnetic control over the steam pipe and brake pipe of a steam train. In order to show what its action would be, the electro-magnets cause two of the following four signs to be lighted up:—1, steam free; 2, steam off; 3, brake free; 4, brake on.

In practice it is not proposed to actually start a train automatically, but merely to restore to the driver the power of doing so, hence the expressions "Steam free," "Brake free." The exact method of control considered desirable will vary very largely with the views of the individual authorities of any particular line, and can be as complete or as non-existent as that particular line desires. In the opinion of the inventor the following is a suitable arrangement, and the model has consequently been designed accordingly:—

On the receipt of the "stop" signal steam will be entirely shut off (red lamp lights showing "steam off"), and the brake will be gently applied (red lamp lights showing "brake on"). The driver will now personally close his regulator and take charge of his brake so as to stop the train as speedily as reasonably convenient. This done, he will free his brake and steam pipes by pressing two buttons in the apparatus, and thus be placed again in full control of his steam and brake power. (On pressing these buttons in the model the red lamps go out and white ones light up, showing "brake free," "steam free"). Meanwhile, since receipt of the "stop" signal, the horn will have been sounding. By pressing a button the horn can be stopped, but will be automatically put ready to sound again on receipt of the next "stop" signal by the action of receiving the next "clear" signal.

On receipt of the "reduce speed" signal (hereafter explained) steam will be entirely shut off (red lamp "steam off" lights up). The driver will now personally close his regulator and, if necessary, personally apply his brake. This done, he can free his steam pipe by pressing the steam button (red lamp goes out and "steam free" lights up); he can then restore as much steam as he may require. Meanwhile the bell has been ringing, but can be stopped by pressing the bell button.

The above method of working the apparatus has been put forward as a proposal only. The principle of automatic control compelling observance of signals having been established, the detail of how it is to be applied would doubtless be varied on different lines and under different circumstances. Some consider the motive and brake power of the train should only be automatically controlled in the event of the driver failing to take proper action. It is hardly necessary to explain that to meet the requirements of those holding this view there would be no difficulty in causing the automatic control to come into action only upon receipt of the "danger" signal, which is equivalent to saying only when a "home" semaphore has been passed at danger.

In any case the driver has ultimately complete control over his train, and by taking the necessary steps can move against any signal, the inventor's intention being to make action necessary before a signal can be *disobeyed*, instead of action being necessary before a signal can be *obeyed*.

The flexible having been connected up during the following experiments, attention should be concentrated upon the full-size equipment. This will be showing "stop" and "reduce speed" at two of its windows, the bell and horn will sound, and the Control Indicator will show "brake on," "steam off." By pressing buttons the audible signals will cease, and the Control Indicator will show first "brake free" and then also "steam free." Everything is now ready for another run.

(IX.). On pulling over the starting lever the driver receives "clear," and would start his train. On passing a ramp (R2 on the print*) his "reduce speed" signal disappears automatically. We will now arrange the station for a run through on the straight line, set the points for the line, and pull over the admission and starting levers. On approaching the station No. 3 Indicator (white) will fall, indicating that the driver is to run through on the straight. Having read it he will replace it.

(X.). After he has passed through, the loop line will be cleared, and the points set for him to run in on the loop. The starting signal will then be put against the train and the admission lever for it. On reaching the point R on the print he will now receive the signal "reduce speed," his bell will commence to ring, and the red lamp, "steam off," light up; immediately afterwards No. 2 Indicator will fall, showing that he is to enter on the loop line. Having observed this, he will stop the bell, free his steam pipe, and replace his indication.

(XI.). On entering the station, the starting signal being against him, the "stop" signal will fall, both red lamps light up, and the horn commences to sound. The driver will stop, free his brake and steam pipes, and silence his horn ready for the starting signal.

The above it is believed sets forth the main features of the proposed system as it might be applied to ordinary every-day working, and shows the operation of the

Clear
Stop
Reduce Speed
Danger } Signals.

and of the route indications.

As previously stated, the method of utilizing the "controlled currents" on the engine is capable of variation to suit the system of working considered most suitable for the railway adopting the principle of such control.

* This is as the model has been made. A better situation for the removing ramp would probably be opposite the middle of the platform, so that the "reduce speed" signal may be removed before the driver starts at all.

It only remains to point out that similar pairs of "reduce speed" ramps can be placed in any position that may be desired, one of each pair, for the purpose of notifying to the driver and compelling his attention thereto that he is required to reduce his speed over any given section, and the other that he has quitted that section and may again go ahead. The value of such a control on sections of line requiring cautious driving, owing to sharp curves being under repair, etc., is incontestable. Further, it will be a simple matter to add to the engine equipment as shown a recorder which will show the exact time of receipt of every signal and the length of its duration, and thus afford not only a valuable record of the signals received throughout a run, but an accurate check upon the action of the driver on receipt of the special signals, "danger" and "reduce speed."

NOTICES OF MAGAZINES.

Bulletin.

15th October, 1908.

Grand French Manœuvres.—The chief point of interest in these manœuvres was the use of trains of motor-lorries for the purposes of supply. Forty lorries were available, the majority belonging to private firms, who supplied the *personnel*, fuel being furnished by the Government. The H.P. varied from 15 to 50, and the motive power was petrol, steam, or alcohol. The convoys were organized in sections of 10 vehicles, each under an officer. The experiment was most successful, a mean speed of 12–15 kilos. per hour being kept up without any serious breakdown over a distance of 130 kilos. The number closes by a continuation of a study on German field artillery tactics.

31st October, 1908.

Organization of Colonial Troops.—A detailed account of the Colonial forces of France, Germany, Italy, Holland, and Great Britain.

International Law. Russo-Japanese War (*continued*).—*Disposal of the Dead.*—Japanese dead were to be cremated, but their hair was cut off and sent to their homes. The enemy's dead were buried. Special instructions were issued to prevent the pillage of the dead both by the army and also by the inhabitants, who were inclined to disinter bodies to rob them. Sentries had to be placed with orders to fire on marauders. It is noted that the burial of the dead after a great battle is a work of considerable labour.

15th November, 1908.

Field Service Regulations, German Army.—*Published 22nd March*, 1908.—As much seems to be expected of the modern German officer as of his British prototype, and the present regulations inculcate every kind of relaxation, from gymnastics and bicycling to winter essays and war games. Stress is laid on exercises with troops of all arms on a war footing, and the importance of night operations is referred to. The training of officers and men should be such as to develop initiative; inaction is condemned as a far greater fault than errors of judgment. As to cavalry, its normal action is offensive, and the enemy's mounted forces must be sought out and rendered ineffective as early as possible. When charged with

reconnaissance, it should form a body independent in action and command.

INTERNATIONAL LAW. RUSSO-JAPANESE WAR (*continued*).—*Disposal of Dead Bodies.*—In the interests of sanitation cremation was occasionally resorted to in the case of the Russian bodies—notably at Port Arthur—and on other occasions when the frozen condition of the ground made interment impossible. Identification of the opponent's dead is not explicitly prescribed, but badges of identity must be collected and preserved, if such exist.

Rifle Bullets.—On both sides allegations were made as to the use of expanding bullets; these were almost invariably found to be groundless—an ordinary ricochet hit often producing a wound similar to that caused by an expanding bullet. The Russian rifle was of a slightly larger calibre than the Japanese, and it was found that wounds caused by the latter were more quickly cured than those caused by Russian bullets; on the other hand, higher penetrative power often does greater damage.

The Summons to Surrender.—All means of bringing an opponent to surrender are recognized as lawful. The Japanese frequently made use of inciting proclamations, notably at Port Arthur, where, also, graphic postcards depicting the happy life of prisoners of war in Japan were sown broadcast by means of a wooden cannon.

The Siege and Bombardment of Port Arthur.—Strict orders were issued that the hoisting of the white flag, either by a single fort or by the whole fortress, was not to be taken as a signal to cease fire until special orders had been given. The bearer of a flag of truce must not however be fired on.

GERMAN FIELD ARTILLERY TACTICS (*continued*).

'E.R.'

KRIEGSTECHNISCHE ZEITSCHRIFT.

August, 1908.

The question of automobile artillery is discussed, and a good description is given of the English Maxim-carrying autocar at Whale Island. The distinction is clearly drawn between this light type of self-propelled artillery, and what are really movable forts—such as Capt. Dayton's automobile fort (U.S.A.) and the armoured vehicle of the 1st Sussex R.G.A. The latter type is indeed merely a light armoured train which dispenses with rails.

It is suggested that a more practical use of a motor engine would be to replace the limber of a gun by a motor car of some species, and it is pointed out that this innovation would greatly reduce the length of columns on the road.

A description is also given and three plates of a new self-propelled transport wagon, made by the Swiss firm Soller, of Bâle. This car is of a new type, and, instead of a strong touring engine on a wagon chassis, consists of a wagon engine and wagon chassis. It is a one-cylinder motor, and thus lays claim to extreme simplicity combined with durability —two essential qualities for anything to be used in the field. It does not require a trained chauffeur, as it can be driven by any transport soldier.

The question of dirigible balloons and their influence on tactics is discussed. Although tactics move slowly, yet we are forced to recognize in the mechanically propelled airship, a new arm which will form the reconnoitring force of the future. Its duty, like that of the present strategical cavalry, will be strategical reconnaissance and the destruction of important tunnels and railway lines. The latter task will not be accomplished by projectiles thrown from the airship, which will merely serve as a means of transport for the necessary men and materials for the task. That encounters will take place between the hostile balloon squadrons—or even single balloons—is hinted at, but no suggestions are offered as to how these should be carried out. Whether strategical balloon reconnaissance of a country before the outbreak of war is permissible or not is a delicate diplomatic question which remains to be solved. Finally, it is stated that a balloon is of little use unless joined to the headquarters staff by some form of wireless telegraphy unreadable to the enemy.

A review of the new German manual of military engineering (*Feldbefestigungs-Vorschrift*) is given under the heading of "Technics in Field Warfare."

The book is considered under three heads:—(*a*). The reasons why a new edition was published. (*b*). New principles. (*c*). New details for individual arms.

As regards the first point of view, the reasons given are:—(1). The increased importance of fortress warfare as exemplified by the semi-permanent character of the Battles of Liao-yang and Mukden. (2). The introduction of the new recoiling field gun and the increased importance of machine guns and heavy artillery. (3). It was 13 years since the last manual had been edited.

Under (*b*) it is stated that there are no new principles, but various more or less old ones are emphasized, *e.g.*:—(1). The spade is as much a weapon as either gun or rifle. (2). The artillery is the backbone of any operation (Moltke). (3). The principle of one defensive line is adhered to, reinforced by means of obstacles and false fronts. A net distinction is however drawn between a position for the active or offensive-defensive and one for the passive-defensive. (4). The enemy must not be waited for, digging must be commenced as soon as possible. (5). Trenches are always for troops standing, except in exceptional cases. (6). The troops are to fortify their own portion of the defensive

line, the sappers being used to supervise and not actually dig the works.

Under the third heading are given the dimensions and types of trenches to be used by infantry, machine guns, heavy and field artillery, and howitzers. Although the latter will generally fight from concealed positions, yet freshly turned-up earth must be covered for concealment against observation from balloons. Finally, the special duties of pioneers and engineers are laid down.

A. H. SCOTT.

MILITÄRISCHE PRESSE.

Vienna, 3rd October, 1908.

The first number of this new Service illustrated weekly, which is published in Vienna, affords ample justification for the hopes expressed in the editor's foreword that it will not only furnish instructive articles for the professional soldier, but will prove to be of value to all those who are interested in any way with military and naval matters. The circle of readers of a paper of this description would undoubtedly be wider in a country where the fundamental idea of the citizens' military duty is already firmly established than it would be in our own, but even in England the advent of such a paper would help many to realize the military responsibilities of citizenship.

During the course of each month the editor proposes to publish technical supplements dealing with artillery, naval, tactical matters, and with the technical branches. The naval supplement appears with the first number, and its leading article deals with the question of the value of a fleet to Austria. As example of the importance of local command of the sea, the writer draws attention to the Russo-Japanese War, and then proceeds to sketch the growth of England's trade, which was only rendered possible by her maritime supremacy during the last hundred years.

Austria-Hungary formerly preserved the character of a country cut off from maritime trade through its geographical position, and this influenced its historical development. The Dalmatian Coast and Istria only came into the undisputed possession of the monarchy when it had almost lost its importance in the West in consequence of the altered conditions of communications. The writer attributes to this the failure of his nation to grasp the importance of maritime trade, while other countries closely connected with the sea recognized this importance and developed their industries with this in view. He dates his country's awakening to the opening of the Suez Canal, which offered advantages to developing trade in the Adriatic. Austria has started far behind other countries, but by the development of her ports during the last few

decades she has done much to make good the neglect of former centuries. Her object must now be to build up her sea connection, improve her harbours, increase the means of communication, and construct a suitable tariff policy.

The development of the mercantile marine has been considerable, but the lack of an adequate naval force to defend it and to prevent blockade will seriously affect not only the ports, but the centres of industry throughout the country. The enemy's ships must of course stop at the coast line, but "the armoured hand of naval supremacy reaches far inland beyond the coast line and grips at the very vitals of the country." As the Austrian Navy, by reason of the tasks falling to her in home waters, cannot spare the necessary ships for effective representation overseas, the writer states that Austrian commercial and political influence is waning. Without armoured cruisers, the means of preserving the prestige of her representatives in distant waters is lacking. Austria therefore wants a fleet equal to this task on account of its peace mission alone, and if the question of war is considered, it must be admitted that her fleet has fallen considerably below the other 2nd class navies. The importance of her trade interests and the intensity of a possible hostile attack provides the standard for the necessary navy and mercantile marine.

Security for the strengthening of her world trade is offered only by a strong fleet.

In an interesting article on the efforts of German colonization in the Pacific, by a German naval officer, attention is drawn to the dislike of the Labour Party in Australia to the German workman, who, it is said, is feared on account of his frugality. South Australia is an exception, where in certain localities the German element is to be found in large numbers. In other Australian states however the Teuton settler "unfortunately" turns into an English colonial in a terribly short space of time. The writer considers that this "fear, which produces such an unfriendly and sometimes spiteful tone," cannot be only a fear of German competition in the labour market, but that the Australian politically fears the German colonists as neighbours.

The writer describes briefly the manner in which Samoa, New Guinea, and the other German colonies came into their hands, and the rest of the article is chiefly "puff" of German colonial government, painting such a glowing picture that the editor in a note is constrained to the opinion that the conditions are so easy as to offer Austria-Hungary opportunity for competition.

In an article on the conquest in the air the advantages are put forward of combining the systems of balloons and aeroplanes, and it is urged that for one Zeppelin balloon, with two sheds, 20 small "air automobiles" for two persons each or six "air omnibuses" for 20 persons each can be constructed, and that in case of war a single small "air automobile" will destroy half-a-dozen of the giant balloons in the air.

E. G. Wace.

NEUE MILITÄRISCHE BLÄTTER.

The issues of the 12th and 16th October, 1908, contain a description of our 1908 manœuvres. The writer makes only a passing mention of the cavalry manœuvres, as they have been described and criticized in detail in the *Militär Wochenblatt*, but he ventures on the remark that the results of the training of the cavalry division were considerably overestimated by the English press, and that the praise bestowed on the work performed and the tactical training of the regiments, "can well be described as extravagant."

Referring to the cancellation of the manœuvres of the 3rd and 4th Divisions, the writer of the article observes that public opinion was at first considerably agitated, owing to the report that unexpected bad news from India necessitated the preparation of both these divisions for a possible immediate departure. The real cause of the abandonment of these manœuvres is however stated, and "the public mind was set at rest" when it was observed that the Aldershot command manœuvres commenced according to programme. The general idea is given, and the writer then proceeds to describe the capture of Colonel Gough's cavalry force. He has no more to say about the events of the first four days (13th to 16th September), but remarks that the operations were more realistic than formerly, though unrealities were still to be found. Red's lame attack on the 15th September in difficult country, which ought to have been declared by the umpire staff to be impossible, and Blue cavalry's loss of touch with the enemy, which caused General Grierson's advance to be made in a wrong direction, "etc," are quoted in support of the statement. The events of the last three days are similarly lightly touched upon, and serve only to introduce the comments which appear to have been framed in Germany and not in England. They were apparently based on the accounts in the *Army and Navy Gazette* and the *United Service Gazette* (? magazine), which are freely quoted, but characterized by the critic as "high flown." After these quotations the writer of the article proceeds:—"The cause of peace is certainly not served by such almost comical exaggeration with respect to the capabilities of an army, which—in spite of however much individual ability and bravery it may contain—is, according to the unanimous judgment of Europe, only to be reckoned as very 'middling,' when taken as a whole and regarded as a weapon of war. The war party in the country . . . as well as the '*entente*' fanatics in France, derive therefrom only a fresh impulse, and the waverers are encouraged to allow themselves to be won over." The writer concludes by saying that it is therefore no surprise to find Mr. Carnegie's famous appeal to the German Emperor to finally establish universal peace by an alliance with Great Britain, France, and the U.S. of America scornfully answered.

Brief articles appear in the issues of the 16th and 24th October on the military forces of Turkey, Bulgaria, Servia, and Montenegro. These have an especial interest in view of recent political events. Referring to the Turkish Army, the writer of the article gives some numerical details,

and proceeds to observe that almost nothing is known of the number and organization of the army corps to be formed in the event of war, as no *ordre de bataille* exists. The whole of the military forces of Turkey are estimated at 1½ millions, of whom, in the most favourable circumstances, only a half can be counted on for a European campaign. Only the three strong army corps in Constantinople (the Guard), Adrianople, and Salonika were available in case of the possible immediate operations in the Balkans. The cavalry are deficient in horses and the artillery deficient in guns. The infantry is armed with three different kinds of rifle, viz., the Mauser, Martini-Henry, and the Peadbody. The cavalry have different models of carbines, while the artillery have got mostly 75 mm. Krupp quick-firing guns.

After detailing the strength of the Bulgarian Army, the total of which he puts at 354,000, the writer points out that the infantry is armed with the Austrian Mannlicher rifle and the cavalry with Mannlicher carbines. "The former difficulties in the way of obtaining remounts have been regarded as overcome by the recent introduction of Hungarian horses. The equipment is extraordinarily practical, the officers good, and, like the men, are, to all appearance, excellently trained."

The Servian Army is composed of three levies (Bans), the first two of which are estimated at an outside total of 150,000 rifles, 6,000 horse, 264 field and 42 mountain guns, 22 howitzers, and about 100 siege pieces. The 3rd Ban can, according to the writer, only be used for garrisons and lines of communications. The training of the army is deficient by reason of the short time the men are with the colours, which, although nominally 1½ to 2 years, is actually not more than 15 months for mounted and 10 months for dismounted. The officers are said not to be up to modern requirements, appear unreliable, politically divided, and torn by party passions.

The Montenegrin Army, on mobilization, numbers about 35,000 in 1st Line and about 15,000 in 2nd Line, which consists of men from 46 to 60 years of age. The infantry is armed with several different kinds of rifles; the artillery have 18 new 7·5-cm. Krupp field guns, 36 old Krupp cannon, 30 mountain guns, 2 15-cm. mortars, and 4 12-cm. siege pieces.

The issue of 16th October contains an article on the great French manœuvres, which ended on 18th September. Attention is drawn to the arrangements made for the work on the lines of communication. A mechanical transport "park" of 80 vehicles undertook the replenishment of provisions for the VIII. and IX. Corps of the "Trémean" force, while both cavalry divisions of the "Millet" force carried out the reception of provisions at reception stations from routes manned under service conditions with the nucleus of "mobile authorities." The writer praises the advance made in these manœuvres towards the realization of service conditions, and says they (the Germans) are forced to realize that in a possible conflict they would in any case no longer find "the old Frenchmen," and then proceeds to say that the French infantry is a weapon schooled on sound lines for modern war; the lightening of their pack has increased their already good marching powers; they turn to excellent

advantage the accidents of the ground, are quick and adept at entrenching, almost always choose the most suitable formations, and evince excellent discipline. In addition to this the close co-operation of the infantry and artillery—an indispensable condition of success in modern fighting—was a very noticeable point in their training, and one in which the writer considers the Germans are a long way behind the French. The writer however finds fault with the work of the French cavalry, which he considers lacking in dash. He observes that even in Napoleon's time the French cavalry soldier was a bad horse manager, and that he seems to have remained true to this tradition.

In the issue of 24th October appears an article on the introduction of universal military service in Australia, in which the writer observes that "the widespread secret fear of Japanese attack threatening in the future, together with the bad results experienced under the volunteer system (their number only amounted to 20,000 out of 800,000 male inhabitants), convinced the nation of the necessity of a better and much more extensive organization for defence." The scheme is briefly described, and particular attention is drawn to the consideration given to married men, who are not called out in case of war until the 1st and 2nd Classes, *i.e.*, unmarried men from 18 to 35 and from 35 to 45 years of age respectively, have been found insufficient for the occasion. It is also noticed that the new law enables the Commonwealth to arrange for field artillery on a regular basis, instead of on a militia basis with the other arms.

The opinion is expressed that the minimum period of training allowed by the scheme will not be able to produce a really efficient (*leistungsfähiges*) army of defence, especially against the Japanese, and this has not been understood by a nation "which has grown up in antiquated British ideas regarding the military value of a militia army."

E. G. WACE.

REVISTA DE ENGENHERIA MILITAR.

July and August, 1908.

FORTIFICATION FOR HOME DEFENCE.—A lecture delivered to the Regiment of Engineers by Lieut. R. A. Esteves. After a short summary of the campaigns from the time of the war of the Spanish Succession down to that of the Peninsular, the author proceeds to consider the three courses of action which it is possible to take in the defence of the country, viz.:—(1), To await the enemy on the frontier; (2), to invade the hostile territories; and (3), to await the enemy in the interior of the country.

He comes to the conclusion that in view of the small force which would be available, the third course is the only one which could be adopted.

The frontier should be defended by barrier forts placed on the main lines of invasion, and the enemy should be delayed as long as possible on the frontier, so that time may be gained for mobilization, and for the organization of the defensive position. The troops would then fall back from the frontier, first onto the lines of the Mondego and Zezere, which would be strengthened by the fortifications of Coimbra, Tancos, and Santarem, and finally on the lines of Torres Vedras, which must always form the last stronghold of the defence of Portugal.

Provisional works should be constructed at Coimbra, Tancos, and Santarem, forming entrenched camps which would be used as bases for offensive operations against the flank of an enemy advancing against the capital. It would not however be possible to hold them to the last, and the army must be prepared eventually to retire within the lines of Torres Vedras. These latter consist of a triple line of fortifications resting on the sea on one side, and on the Tagus on the other. The so-called entrenched camp of Lisbon forms the third or inner line.

The enemy in advancing against the outer line would be compelled to divide his forces into two parts, by the configuration of the Serra do Montejunto which runs perpendicularly to that line.

The hills which form the successive lines are naturally strong and difficult of access, so that the fortifications should be concentrated at those points which block the passage of the defiles. The remaining works should be disposed in such a manner as to favour counter-attack.

Under modern conditions it is necessary that the lines of Torres Vedras should be supplemented by fortifications on the south bank of the Tagus; this line should run through Moita, Palmella, and Setubel, and its defence should be combined with the maritime defence of the port of Setubel. In fact the whole land defence should be most intimately connected with the maritime defences, for the sea must be looked upon as the true base from which Portugal would draw the supplies and reinforcements which would enable her to carry on the campaign.—(*To be continued*).

Metol and Hydroquinone.—By Lieut. Jayme Pinto.—This is a long article on the value of these substances as developers in photographic work. It does not appear to contain any novelty, though it will be of considerable use to many amateur photographers.

Harmonic Synthesis of the Tides (*continued*).

Some Projects and Works Executed in the Province of Moçambique.—This instalment contains a description of the construction of the lighthouse at Macuty, and is illustrated by several photographs, as well as by detailed diagrams of the Chance lamps and lenses.

Reviews of Books.—*Hypsometric Map of Portugal*.—This map, of a scale of 1:500,000, was published by the Geological Commission in 1906.

'M.'

REVUE DU GÉNIE MILITAIRE.

September, 1908.

WELLS IN SENEGAL.—The district between the Senegal and Gambia Rivers is devoid of surface water during the dry season. The tribes inhabiting this region are therefore compelled to wander long distances with their cattle in search of water. As long as they are nomads they remain uncivilized and the development of the country is impossible. The first work to be done therefore is the construction of permanent wells, to form the starting point for permanent settlements. For the most part the soil is sandy and treacherous and the native wells rarely survive a rainy season. The French have tried various methods of lining wells, and have finally rejected all others in favour of ferro-concrete, 2″ thick, made on ·16″ iron wire lattice-work of 4″ mesh. This lining can either be sunk on a curb or constructed *in situ*, as the nature of the soil demands. When a solid stratum is passed through, material is economized by reducing the thickness of the ferro-concrete from 2″ to ½″. A well is sunk in this way by a gang of four natives, visited once a day by an European overseer.

THE FOREIGN MILITARY ESTABLISHMENTS IN CHINA.—The conclusion of the previous articles. The Italian, Russian, American, Dutch, and Belgian barracks are dealt with in this number. They call for no special notice.

October, 1908.

FOUNDATIONS OF BARRACKS AT AVIGNON.—The subsoil at the site of the barracks consists of treacherous, waterlogged clay, and sand. At a depth of 14′ a solid bed of gravel was found. The foundations were made by sinking a number of large bore-holes down to the gravel. These were afterwards filled in with concrete, and joined together at the top with concrete arches. A heavy boring tool actuated by a pile-driver was used. The tool consisted of a steel cone 27″ in diameter at the base and weighing 3,300 lbs. The concrete was mixed dry and rammed by another heavy tool. Each well took only from 40 minutes to an hour to sink; the filling in and ramming took from three to three and a-half hours. The barracks were finished in December, 1904, and so far the foundations show no sign of settlement.

The reproduction of plans by electric light is also dealt with in an article which consists of a description of various electric lamps and apparatus used for printing photographically from plans and tracings.

J. E. E. CRASTER.

Revue Militaire des Armées Étrangères.

October, 1908.

The narrative of the Russo-Japanese War is continued, the portion described being the operations of July, 1904.

A review of the new German Felddienst-Ordnung of March, 1908, is given with com ments.

The history of the military ballooning troops in Germany (Luftschiffer-Batallion) forms the subject of an article which also describes the "Drachenballon" used by the Germans for captive ascents. The advantage claimed by this particular form of balloon over the round type is that the car remains still whilst in the air and thus facilitates observation. The balloon, which is cylindrical with hemispherical ends, is divided internally into two parts by a membrane. The gas in one of these expands as the balloon rises—thus nearly filling the whole envelope. When however the pressure becomes too great a cord attached to the movable membrane opens a valve, thus avoiding all risk of explosion. This balloon also has a rudder (stewersack) at the rear of the balloon, composed of a bag filled with air and provided with a valve, and a tail (Drachenschwanz), or rope, carrying hollow frustra of cones, whose larger base is turned in the direction of the wind.

The Luftschiffer-Batallion consists of three companies, one of which is for experimental purposes; 15 lieutenants are annually attached to it to receive instruction.

The Schwarzlose machine gun which has been adopted by the Austrian Government is described. Its chief advantage is the small number of moving parts of the lock (11) and spring (1) as for example compared with the Maxim, which has 35 and 14 parts respectively.

The rate of fire is 400 rounds per minute, maximum range 2,400 yards, and angle of lateral dispersion 35°. 10,000 rounds per gun are carried by the infantry and 15,000 per gun by the cavalry. The infantry gun only is provided with a khaki-coloured steel shield, which is covered by a green cloth when firing in front of a dark background.

The organization and probable war strength of the Turkish Army in Europe is given :—

(*a*). 1st Army Corps (Ordou), Constantinople.
1st and 2nd Infantry Divisions (Nizam), 25 battalions.
1st Cavalry Division (Nizam), 32 squadrons.
1st Artillery Division (Nizam), 39 batteries.
1st, 2nd, and 3rd Divisions (1st Class Redif), Asia Minor, 64 battalions and 16 squadrons.
Nizam means 1st line troops, Redif reserve.

(*b*). 2nd Army Corps, Adrianople (Thrace).
3rd, 4th, 20th, and 21st Infantry Divisions (Nizam), 52 battalions.
2nd Cavalry Division (Nizam), 35 squadrons.
2nd Artillery Division (Nizam), 53 batteries.
6th, 7th, and 8th 1st Class Redif Divisions (Asia Minor), 48 battalions and 12 squadrons.
25th and 26th 2nd Class Redif Divisions (Thrace), 40 battalions.

(*c*). 3rd Army Corps, Saloniki (Macedonia), 5th, 6th, 9th, 17th, 18th, 22nd, and 23rd Infantry Divisions (Nizam), and the 47th Infantry Brigade (Nizam), *i.e.*, $7\frac{1}{2}$ divisions or 126 battalions.
3rd Cavalry Division (Nizam), 47 squadrons.
3rd Artillery Division (Nizam), 55 batteries.
12th Division and 22nd Brigade (1st Class Redif), Asia Minor, 24 battalions and 16 squadrons.
28th, 29th, 30th, 31st, 32nd, 33rd, and 34th 2nd Class Redif Divisions (Macedonia), 120 battalions.

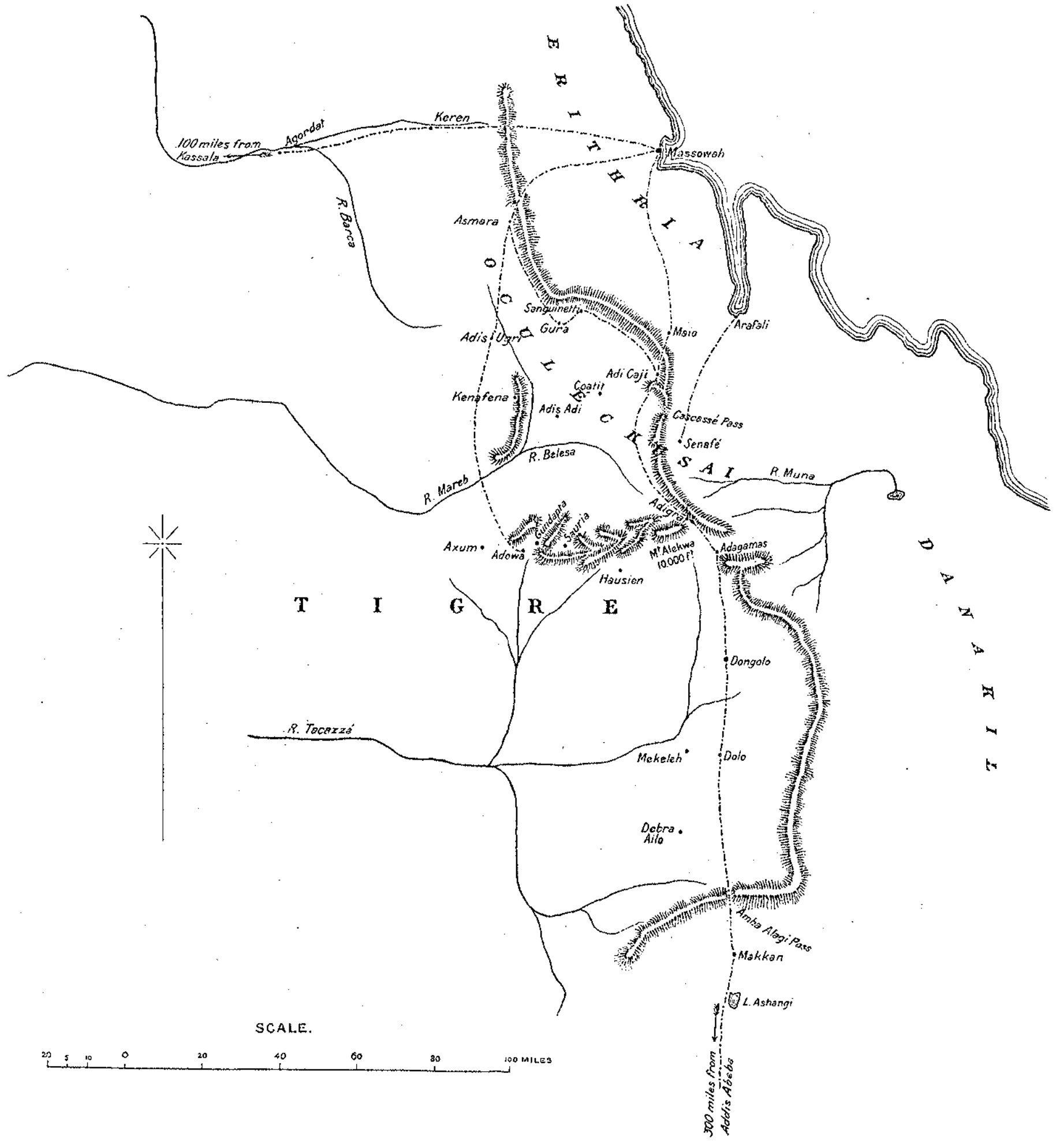
Thus there are in Europe 203 battalions, 114 squadrons, 147 batteries of the permanent or 1st Line troops, and 160 reserve battalions (2nd Class Redif).

In Asia Minor 136 battalions and 44 squadrons of the 1st Class Redif or reserve.

A battalion at war strength is 800 strong and a squadron 150.

A. H. SCOTT.

PLAN ILLUSTRATING THE ITALIAN OPERATIONS IN ABYSSINIA BETWEEN THE YEARS 1894 & 1896.



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" J. Knowles, 15th Hussars.
" C. R. Newman, Royal Field Artillery.
" P. E. Lewis, Royal Field Artillery.
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" A. F. U. Green, Royal Garrison Artillery.
" C. G. Fuller, Royal Engineers.
" G. R. Frith, Royal Engineers.
" T. C. Mudie, Royal Scots.
" I. L. B. Vesey, Royal West Surrey Regiment.
" H. G. A. Thomson, Royal Warwickshire Regiment.
" E. T. Humphreys, Lancashire Fusiliers.
Capt. D. S. Robertson, Royal Scots Fusiliers.
" H. L. Alexander, *Dorsetshire Regiment.*
Lieut. A. P. Wavell, Royal Highlanders.
Capt. H. C. Johnson, D.S.O., King's Royal Rifle Corps.
" R. M. Tyler, Durham Light Infantry.
Lieut. A. J. McCulloch, *Highland Light Infantry.*
Capt. L. C. Sprague, Royal Irish Rifles.
Capt. L. F. Renny, Royal Dublin Fusiliers.
Lieut. C. M. Davies, Rifle Brigade.
Capt. R. D. Barbor, Army Service Corps.
" C. L. Norman, M.V.O., *Indian Army.*
" G. L. Pepys, Indian Army.

The following obtained nominations:—

Major S. R. Kirby, 6th Dragoon Guards.
Capt. R. Hutchison, 11th Hussars.
" E. F. Calthrop, Royal Field Artillery.
" and Bt. Maj. A. J. Turner, Royal Field Artillery.
" and Bt. Maj. C. B. Thomson, Royal Engineers.
" and Bt. Maj. A. J. G. Moir, Royal Scots.
" and Bt. Maj. A. McN. Dykes, Royal Lancaster Regiment.
" A. D. Green, D.S.O., Worcestershire Regiment.
" T. H. C. Nunn, D.S.O., Royal West Kent Regiment.
" H. L. Knight, Royal Irish Fusiliers.

WOOLWICH.

June, 1908.

THIRD	G. B. Stallard	7,629
22nd	L. F. Page	6,564
23rd	G. E. W. Franklyn	6,559
29th	G. A. Cammell	6,437

November, 1907.

THIRD	F. N. M. Mason	7,441
FIFTH	R. J. Moorhead	7,236
SIXTH	C. W. R. Tuke	7,166
24th	J. R. Pinsent	6,493
27th	H. W. Crippin	6,411
32nd	L. H. King-Harman	6,372
35th	R. B. Pargiter	6,339

This is the second time in two years we have passed THREE out of the first SIX for Woolwich.

SANDHURST.

June, 1908.

FOURTH	H. T. Rohde	5,307
27th	W. G. Maxwell	4,937
44th	H. L. Mood	4,775
45th	H. S. F. Cosens	4,761
79th	J. M. Ponsford	4,473
89th	B. H. Bonham-Carter	4,399
105th	L. B. Rundall	4,312
127th	J. A. Batten-Pooll	4,183
161st	A. E. Lawrence	3,985
162nd	M. Alexander	3,981
167th	R. W. Russell	3,940
171st	G. W. Mackintosh	3,897
191st	R. H. Broome	3,733
—	C. S. Hilton*	3,563
—	W. N. Shipster*	3,221
—	J. V. Dawson*	3,148

*Subsequently admitted.

INDIAN POLICE, JUNE, 1907.

THIRD	F. W. Toms	6,886
27th	H. W. Waite	5,980

ARMY QUALIFYING, SEPTEMBER, 1908.

NINE were successful from us.

MILITIA COMPETITIVE EXAMINATION, MARCH, 1908.

Douglas Scott, Kent Artillery.
D. G. Gunn, 3rd P.W.O. West Yorkshire Regt.
A. L. Cooper Key, 5th Middlesex Regiment.
W. C. Loder Symonds, Lancashire Fd. Artillery.
R. G. Atkinson, West Surrey Regiment.
R. W. Leach, Cambridge Volunteers.
G. W. Courtney, Cork R.G.A.