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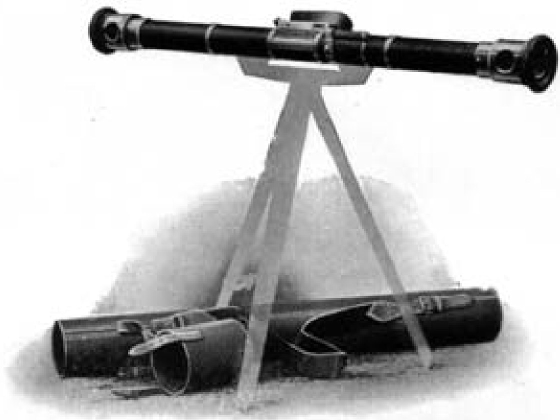


BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE.
FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

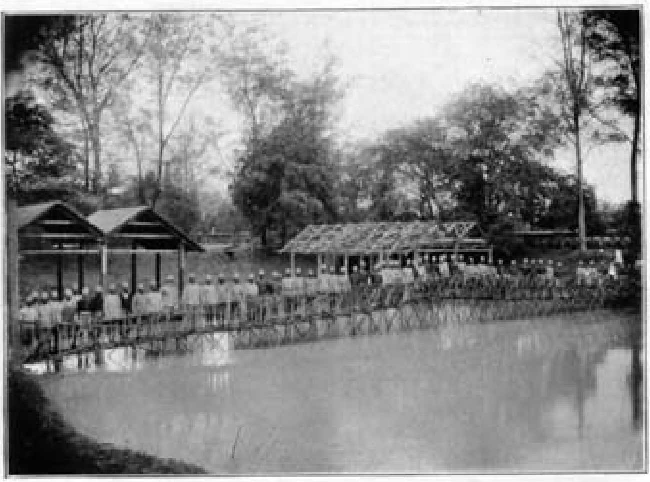
The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

Approximate uncertainty of observation:—

5 yards at 1,000 yards.
40 yards at 3,000 yards.
170 yards at 6,000 yards.

Barr & Stroud Rangefinder

1. Bridge in course of construction.



2. Completed Bridge, 106 feet long.

LIGHT BRIDGES MADE OF BAMBOOS

LIGHT BRIDGES OF BAMBOOS OR OTHER SMALL SPARS.

By BT. MAJOR R. L. McCLINTOCK, D.S.O., R.E.

IT sometimes happens that an officer is called upon to bridge a stream where there is no material at hand in the way of ropes or spars of a size suitable for the construction of any of the ordinary types of bridges.

If, however, as is frequently the case in the tropics, there is a supply of bamboos or other small stuff to be had for the cutting, a very useful bridge, suitable for Infantry in file and Carriers, can be constructed with reasonable rapidity.

This type of bridge is one which has been practised in the 2nd 'Queen's Own' Sappers & Miners for some years. But as I have never seen anything about it in any of our Military Engineering books, and had never heard of it before joining the Corps in question, I think a description of it may be of interest. A similar bridge is mentioned in *Forty-One Years in India* as having been built by some coolies in the Lushai country to cross a stream which the R.E. Officer present had professed himself unable to tackle.

The *modus operandi* is as follows (see *Photo* 1):—

The first 6 ft. or 12 ft. of the bridge, which are probably in shallow water near the shore, can best be built by men wading. When the water becomes too deep for this, work is carried on from the bridge itself, material being constantly added to the head as in "forming up" with pontoons.

The Party may consist of 12 men, 6 working on the bridge and the remaining 6 on shore, *e.g.*:—

Nos. 1 and 2 at bridge-head, placing piers.

Nos. 3 and 4 about 10 ft. in rear of them, assisting.

Nos. 5 and 6 moving between the bridge-head and shore, trimming and passing up material as required.

The remaining men in two parties, of three each, making hurdles on shore.

Nos. 1 and 2 work abreast at the bridge-head. Each has a stout bamboo or other spar, capable of bearing his weight and about 12 ft. long, laid along his side of the bridge. Nos. 3 and 4 sit on the inner ends of these spars, about 8 or 9 feet back on the bridge, and this leverage allows Nos. 1 and 2 to walk or crawl out on their respective spars some 3 ft. beyond bridge-head.

Nos. 1 and 2 then thrust good straight stiff bamboos vertically down into the bottom of the stream, about 2 ft. 6 in. beyond bridge-head and 2 ft. 6 in. apart; they throw their whole weight on them, and also hammer them down into the bottom as far as they will go. They then lash a piece of bamboo across these two uprights as a transom, at a suitable height from the water; spunyarn is very suitable for the purpose, but wire or any vegetable fibre of the nature of West African "Tie-Tie" grass would do very well.

Nos. 1 and 2 next similarly thrust and hammer down into the bottom four struts to each upright, one fore, one aft, one right, and one left, at an angle of about 45°, all meeting at the junction of the upright and transom; each of the four struts is then lashed with spunyarn to its respective upright and transom at the junction.

This completes the "Pier."

Once the transom is lashed across the uprights, Nos. 3 and 4 need no longer hold down the inner ends of the two spars, as the weight of Nos. 1 and 2 is now taken by the new pier. So they can apply themselves to laying 6 bamboos as road-bearers across the last two transoms, lashing them down with spunyarn, and to fixing hand-rails, etc., etc.

The two spars are again shoved out, Nos. 1 and 2 place another pier, and so on. Every 6 ft. a hurdle is laid on the road bearers (the road is made 2′ 6″ wide), and forms the roadway.

The usual rate of work as above comes to about 12 ft. per hour, which keeps two parties busy making hurdles. But if the water is shallow enough to allow men to work in it, the work can naturally proceed along the whole length of the bridge at once; in this case the above method would not apply, though the result would be the same in the end.

It is desirable that the bottom of the stream should not be too soft; but it is as well to be able to force the uprights into it to the extent of a foot or so, as this adds rigidity to the bridge. A current is a disadvantage.

I have not experimented as to the maximum depth practicable for this type of bridge, but I should imagine that, with bamboos 1 in. to 2 in. diameter (as in the photos), 5 or 6 ft. of water would be a maximum.

The bridge shown in *Photo* 2 was 106 ft. in length, and was constructed in water from 2½ to 3 ft. deep, with some 2 ft. of soft mud at the bottom; there was no current. After completion it was tested by crowding as many men as possible on to it, and making them jump a couple of feet into the air several times in unison. With the exception of two or three of the uprights sinking from half an inch to an inch, no deformation at all took place in the bridge, and it stood the test in the most satisfactory manner. It will be observed from the photograph that in this particular case only three struts and not four (as described above) were used for each upright, the outer struts being omitted experimentally; but I think it is advisable to put these in to give stiffness laterally.

The material actually used in the construction of this bridge (*Photo* 2) was as follows:—

Uprights (38 piers × 2)	...	= 76	bamboos.
Struts (38 × 6) ...	...	= 228*	,,
Transoms (38) ...	...	= 38	,,
Roadbearers (6) ...	...	= 60	,,
Hurdles (18 × 7) ...	...	= 126	,,
	Total	528*	bamboos 12 to 15 ft. long.

For lashings, spunyarn 40 lbs.

This works out to about 6 bamboos and $\frac{2}{5}$ lb. spunyarn per foot-run of bridge.

It may perhaps be objected that this type of bridge possesses but little interest for anyone who is not quartered in a bamboo-producing country. I am, however, sure that a modification of it would prove very useful in some parts of England, where large supplies of small spars, such as hop-poles, are available either ready cut or growing in their native copses close at hand. I should imagine that the hop-pole would prove far better than the bamboo for this purpose, as being much stiffer; and I believe that such a bridge, if made with good stout hop-poles, would carry cavalry easily, and possibly (if made of double width with four uprights in each pier instead of two as above) might even carry light carts.

It would be interesting if someone doing his Annual Field Works Course at Home in a hop-pole country would experiment in the matter and communicate the results to the *R.E. Journal.*

I am indebted to Serjt. Pickles, R.E., 'Q.O.' S. & M., for the photographs which illustrate this account.

* *Note.*—304 would be required if 4 struts were used for each upright.
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INSTRUCTION OF R.E. IN FIELD ENGINEERING.

By Capt. J. E. E. Craster, R.E.

Excellence in field engineering, as in any other subject, is produced by three distinct methods—

(1) By rewarding the efficient,
(2) By punishing the inefficient,
(3) By intelligent instruction.

The first method was adopted some years ago when service pay was instituted, but it has lately been abandoned. Service pay was abolished by the Special Army Order of the 17th September, 1906, and as regards the Engineers nothing has been substituted. Thus it appears that for them efficiency as soldiers and as military engineers will no longer be directly rewarded.

Let us pass on to the second method. The punishment of the inefficient is a matter which chiefly concerns the delinquent and his Company Commander. Probably neither would be grateful for advice on this point. Only the third method therefore is left for discussion.

Before commencing a course of field works, it is essential that every man should know that at the end of it his proficiency will be thoroughly tested. In addition he should be given some idea of how the test will be carried out. Unfortunately the whole of an officer's training tends to glorify the written examination system; every man worships the machine that has moulded him; the harrowed toad loves to sacrifice his unscarred brethren to the harrow.

Yet if we put aside these morbid prejudices, we must recognise that for non-commissioned officers and men a written examination is the worst test of all; it cannot cover the whole subject, it furnishes no record of a man's practical skill, and it gives an unfair advantage to men of clerkly trades.

The best test is a practical examination with full-sized materials. This method takes a very long time, expends a large quantity of stores, and can therefore be used to only a very limited extent. Next in order of merit comes a practical examination with model stores, but even this takes up more time than can be spared. The only other method that will give satisfactory results is a viva-voce examination conducted by an officer. In practice it will be found that a combination of these three methods will prove as thorough a test as can be devised.

Non-commissioned officers should be examined singly, sappers by Sections; the Section Commander receiving marks for the proficiency of his men. If a few competitive tests can be arranged between the Sections, so much the better. Any mistake that is made either in the practical or viva-voce work should be corrected at the time, so that the examination will also be a lesson. It must be admitted that the whole process is lengthy and tedious, and puts a great strain upon the officers who conduct the examination. Unfortunately there is no better and shorter method; there is no other way by which an officer can arrive at a just estimate of the capabilities of each individual under his command.

During the annual fieldworks Course the Section Commander should act as instructor, and should be held responsible for the efficiency of every man in his section. It is quite impossible to practise every detail of field engineering during the Annual Course, and it will therefore be necessary for the Section Commander to supplement the practical work with lectures. At the beginning of the Course the Company Commander should draw up a programme of the work for each day, giving the necessary references to the text-books, so that the Section Commanders may prepare their lectures beforehand. Occasionally a junior non-commissioned officer should be called upon to lecture. As a rule no lecture should last more than twenty minutes, as it is difficult to hold the men's attention for a longer time.

Every man should be furnished with a copy of the *Manual of Military Engineering*. To assume that any man will derive no benefit from the possession of a text-book is to cast an unmerited slur upon his intelligence and education. Even if the Company Commander has to pay for the books out of his own pocket he will find no cause to regret the expense.

So far all that has been written has referred to the instruction of trained soldiers. The training of recruits is a matter with which very few officers are directly concerned; but in order to give some idea of the standard to which recruits are trained, a synopsis of the recruits' field work Course is given below. Owing to the recent reduction of establishments, this Course has been curtailed from 88 to 71 days, and the seven days' tactical training has been abolished altogether, so that it is impossible to expect the recruits who join the service companies to be as efficient as hitherto.

For the last three or four years every recruit has been made to take notes during the fieldwork lectures. Many of the recruits' notebooks are so well kept that they form a fairly efficient substitute for a text-book. No doubt service companies would find it advantageous to adopt the system during their Annual Courses.

Probably everyone who has conducted a course of field works has felt the need of a complete and compact text-book. The *Manual of Military Engineering* was not written especially for engineers, and leaves untouched several subjects with which every sapper should be familiar. *Instruction in Military Engineering*, the official text-book for engineers, is a bulky work in many volumes, and consequently the number of copies which are issued to each company must be limited; its style and size render it a work of reference rather than a text-book for the pocket. It should be possible to produce, as a companion volume to the *Manual of Military Engineering*, a book dealing in a concise manner with sapping, mining, pontooning, field railways, telegraphs and telephones. With the aid of these two volumes every sapper should be able to tackle any engineering problem with which he is likely to be confronted.

Telegraphs and telephones should be included among the subjects which all sappers must learn. The Field Companies are occasionally called upon to manage the divisional and brigade telephones at manœuvres. What happens occasionally at manœuvres will happen often in war. The other arms regard us all as experts at telegraph and telephone work; it would be a pity to undeceive them.

SYNOPSIS OF RECRUITS' FIELDWORKS COURSE

AT THE SCHOOL OF MILITARY ENGINEERING, CHATHAM.

Subject.	Text-Book, *I.M.E.*	Number of Days.		
		Ordinary Recruits.	Tele-graphists.	Men Selected for Training as Coast Defence Sappers.
Field Geometry and use of field level	Part I.	Morning School and on works generally.		
Use of Tools	,,	3	2	3
Brushwood	,,	3	3	3
Redoubts (field) and Revetments	,,	4	2	4
Hasty field defences	,,	10	3	9
Stockades and Improvised field defences; Obstacles; Defence of houses, hedges, buildings, and improving existing Cover	,,		2	
Siege trenches	Part II.	2	—	2
Sapping	,,	2	—	2
Mining (including loading and tamping)	Part IV.	2	—	2
Connecting charges, and demolitions	,,	3	2	3
Knotting, splicing, and lashing	Part III.	2	2	2
Use of Spars	,,	4	2	4
Trestle bridging	,,	4	3	3
Heavy bridging,—railway, tension, etc.	,,	7	—	6
Single and double-lock bridges	,,	—	2	—
Rowing, Pontooning, barrel piers, bridges of casks and boats	,,	12	—	6
Railways (field)	Part VI.	2	—	—
Encampments and Water Supply	Part V.	4	5	2
Blasting rock and Road-making	,,	2	—	—
Recapitulation	—	2	—	2
Examination	—	3	2	2
Total	—	71	30	55

The Course for ordinary recruits amounts to 13 weeks of $5\frac{1}{2}$ days each.

*THE NATURE OF WAR.**

By MAJOR C. ROSS, D.S.O., *p.s.c.*, NORFOLK REGIMENT.

PERHAPS I ought to commence with an apology for selecting so vast a subject as that of the Nature of War. My excuse is that it appears to me to be a matter of vital importance, to us especially; for the British Nation as a whole has for so long enjoyed immunity from a serious war that it has come to regard war as a game, to stand aloof, and to applaud or criticise according as the players display ability and courage or the reverse. Is it not the case, moreover, that even we soldiers are still apt to regard war as of the nature of a pastime, a thing at which medals and promotion may be won, and not at all as a serious crisis in the career of a nation—a crisis which may result in defeat, to be followed by the utter misery of the whole people?

General von der Goltz, in his *Nation in Arms*, writes that "a true comprehension of the nature of war does not contribute least of all to the martial efficiency of a nation." I may therefore be pardoned, perhaps, for the presumption of my attempt to speak on this subject which is of such importance to us all.

THE CAUSES OF WAR.

Every historian who has written history has been obliged to attempt to lay down the causes of war. Numerous causes have been given us, foremost amongst which have been the ambition of kings and princes and religious or political differences.

Of the great military historians, Jomini has given no less than nine different causes of war, all of which may, however, be combined under three heads—aggression, resistance to aggression, and religion. He himself, however, is inclined to eliminate religion as a cause of war; and there is much evidence in history which supports his view that, in most cases, a political motive underlay the religious motive.

Clausewitz is inclined to avoid the subject, and is content with the assertion that war is due to the desire of one nation to impose its will on another.

These two military writers, however, lived before the great modern scientists, Darwin, Huxley, Haeckel, Metchnikoff. They had never heard of the expression 'the struggle for existence.'

Now I will ask you to indulge in a flight of fancy, to let your imaginations run riot with me, and to consider the probable causes of war in prehistoric and ancient times. Let us conceive the first few

* Lecture delivered at the School of Military Engineering, Chatham, on 18th October, 1906.

families of man, each of them consisting of a patriarch with his sons, grandsons, and perhaps great-grandsons, with their wives. These, as we know, lived principally on the proceeds of the chase. A hunting ground, the fishing in a river, would form a bone of contention between two or more such families. That one which possessed the greater number of bold and energetic men would hold a great advantage over the others; and that advantage would be greatly increased if its possessor could attack its neighbour unawares, at night time, while the victims slept. We can imagine, moreover, that two or more of these families might combine, that is form an alliance, in order to withstand the depredations of a powerful neighbour or to attack unexpectedly and destroy him. An offensive alliance would offer certain obvious advantages—it would afford a prospect of the surprise of the adversary and his destruction by overwhelming force; while a mere defensive alliance, especially if it came to the knowledge of the opponent, would hand over the initiative, together with the power of surprise and the power to strike at each of the allies in turn, to the enemy.*

And now let us turn to the consideration of the first communities, formed of a conglomeration of families welded together by a community of interest, the necessity for combination against the depredations of their neighbours. These communities would naturally seek to establish as their boundaries great natural features—rivers, seas, deserts, and mountain ranges—as obstacles behind which they might defend themselves. We find that throughout history those communities which have been separated by rivers and seas have always been more prone to war than those which have been divided by sterile mountain ranges or deserts. The reason appears to be simple. The communities bordered by waterways have attained to a certain degree of civilisation; they are too large to live entirely on the proceeds of the chase, the game has long since been killed off; they keep herds of cattle; they are driven to agriculture and commerce. The waterway, the river or the sea, becomes a means of communication; the valley of a river is valuable as pasturage or arable land. The more powerful community seeks to control the waterway, to gain possession of both banks.

Is this a farfetched conclusion? The Romans, having conquered Italy, pressed over-sea to the conquest of Sicily, the north coast of Africa, Spain, Greece, Palestine, and Egypt. It was not the mere ambition of a king which caused this struggle; it was national ambition.

The Saracens were not content with Asia and Africa: they forced their way across the Mediterranean into Europe, into Spain, through

* We have an example in the fatal defensive alliance formed between the Babylonians and the Lydians against the Persians.

Turkey to the very gates of Vienna, into Italy and the south of France.

The Spaniards, controlling the Netherlands, found it essential to control the opposite bank of the North Sea, the British Islands, in order to retain their supremacy on the main land. The English and the Dutch combined to resist the attempt in the innate conviction that the final subjugation of the one country must mean the ultimate subjugation of the other. Thereafter the four western nations of Europe—England, France, Holland, and Spain—fought indiscriminately with each other for the control of the narrow waters, as well as for the control of the Atlantic and of its further shore.

At the end of the 16th century the Danes had practically established their control over the outlet to the Baltic, exacting dues from all other nations which sought to obtain either ingress or egress. The Swedes wrested this control from the Danes; but not content with this success, sought to convert the Baltic into a Swedish lake and to conquer and annex the territories which surround it.

The Russians, since their rise to power as a great nation (which was only possible with the destruction of the Polish Empire), have sought to convert the Black Sea into a Russian lake; and the intention to deal similarly with the Baltic, in time, has been ascribed to them.

Since the destruction of the Russian fleets, fears have been expressed that the Germans may, in the future, endeavour to establish control over the Baltic; the expedition of a British fleet into the Baltic shortly after the destruction of the Russian fleet may perhaps be regarded as a hint that, so long as the British fleet existed, a German claim to control the Baltic would not be admitted.

The French and the Germans have fought for some centuries for the control of both banks of the Rhine. The French, having in 1870–71 been driven from the Rhine, have forced their way into North Africa; and apparently seek to substantiate their power over the western Mediterranean by the establishment of judiciously placed naval bases.

The Japanese have lately forced their way across the narrow waters into Corea and Manchuria.

Is it the case that these great wars have been due to the mere ambition of kings or statesmen? Are they not rather due to the ambition of nations or to vital necessity? Was it ambition or vital necessity which impelled the Japanese to strike for a footing on the mainland? Was it ambition or vital necessity which impelled the Spanish Empire to the attempt to conquer England? The Spaniards failed; and from that day commenced the gradual decay of the nation. Will it be ambition or vital necessity which will, in the future, impel the Germans to strike out for the control of seas and of new territories?

History seems to teach that when a community is cooped up within narrow boundaries it becomes overcrowded; and that then the decay of the people and revolution are inevitable. For an overcrowded people means a vast percentage of the people on the "verge of starvation"; and starving men sooner or later wrest the means of subsistence from the wealthier classes. That is revolution.

Can we not say that war is as often due to vital necessity as to ambition; that it is sometimes due to a combination of both; and that it is almost impossible for us to judge which of these two motives is the one by which a nation is actuated? Should we not say that war arises from the struggle to exist?

If that be so, then our whole conception of the nature of war becomes altered. It is not a game at which the bulk of the people, having paid their gate money in the shape of the salaries to sailors and soldiers, should stand aloof and look on to applaud or criticise; it is a serious matter in which every man, woman, and child of a community is deeply concerned; it is a fearful thing which passes the bounds of our comprehension; a thing of divine origin; a terrible weapon employed, possibly, to ensure that nations, like all animals and vegetables, shall display efficiency or cease to exist. Who knows but what it may be the only means to ensure progress. We, with our limited understanding, cannot fathom the designs of Providence; we cannot solve the riddles of the universe; we can merely assert that such riddles exist.

But, as regards the making of war, we can study history, we can ascertain the means by which nations have won victory in the past, and we can infer the means by which nations may win victory in the future. We can also say that war, that is the outbreak of hostilities between nations, is the decisive phase of the struggle for national existence; and that it is by victory in war alone that a nation can establish its right to exist. There is no single case of a nation which has died a natural death; they have one and all been destroyed by their neighbours. The same is said, by naturalists, to be true of wild animals.

THE CONDUCT OF WAR BY THE ANCIENTS.

In order to understand the manner in which the ancients made war it is necessary to endeavour to trace the gradual development of a nation from one of the early communities I have already mentioned.

Such a community, so far as we can judge from the meagre records left to us and from the condition of savage tribes of the present day, consisted of a conglomeration of numerous families who combined for purposes of offence or defence. Some man who was celebrated for his physical prowess on the battle-field was appointed chieftain; but he was deposed by any other who could prove himself to be the better man of the two. For not only was the community, as a whole, at constant war with its neighbours, but each family, or even each man, had to be prepared to defend his life and property at a moment's notice against his neighbours. The community was thus composed of fighting men, who slept or laboured in the fields with their weapons by their sides.

Sooner or later there arose a great man who became the law-giver. His first concern was to establish law and order amongst the people, and to support the authority of the law by a police force. Men were then enjoined to lay aside their arms when employed on peaceful avocations; but every man was still a warrior who must come to the place of rendezvous when war threatened with a neighbouring community.

Thus was formed a nation of warriors, with a rude but fairly efficient organisation for war. Of such a type were, so far as we know, all the great nations of antiquity when in their infancy. As examples we may mention the Hebrews in the time of Joshua and David, the Assyrians, the Persians, Medes, Athenians, Spartans, Macedonians, and Romans, the Germanic races which broke the Roman Empire, and finally the English, Scotch, and Irish up to the 15th century. Every nation indeed, so far as we know, except the Phœnicians, Chaldeans, and Carthaginians, were at one time or another a nation of warriors pure and simple.

In almost every case there sooner or later arose a great man of action, who struck down the neighbouring communities with fierce and sudden blows, either destroying them utterly or making slaves of them and seizing their property.

With the subjugation of the neighbouring nations, however, the necessity for constant readiness for war seems to have sunk into abeyance. The whole available force of the nation was no longer necessary; a small percentage of the manhood of the nation sufficed to suppress the attempted risings of the neighbours. At first, proved men of valour were chosen to go forth to war; but the injustice of such a course soon became apparent. The warriors demanded payment for their services; while rich men claimed the right to pay others to take their places in the ranks. In a short time, as might be expected, we find the armies composed of the dregs of the nation; thus the Persian armies, which numbered millions of men, consisted principally of slaves, who were whipped into action by their Persian officers. War quickly came to be disregarded by the nation as a whole; the use of weapons was forgotten; the national organisation for war disappeared; energy and vigour were replaced by luxury; and, very often, progress ceased.

The great martial qualities, which the nation had formerly displayed in a pre-eminent degree, and by means of which it had triumphed over its neighbours, were lost. The discipline and patriotism or unity of purpose had gone, and had been replaced by disunion and discord arising from the conflicting interests of the various sections of the community. Where an universal training to arms was absent it was inevitable that the national leadership in time of war should suffer. The great men of the nation no longer studied war and the methods by which victory might be won; they sought to achieve their ends by intrigue rather than by force; they enjoyed unbounded luxury and magnificence, and lost that mental and physical vigour which is the very essence of the trained warrior. They thought only of their own interests and quite disregarded the interest of the nation. The study of war was left to the mercenary sailors and soldiers. We have examples in the Babylonians, Persians, Athenians, and Romans, and, in later days, the Spaniards, Venetians, and Poles.

Mercenaries can never be trusted to fight to a finish. A man may risk his life for pay; but it by no means follows that he will deliberately sacrifice it. War is won by men who, actuated by the highest ideals, will deliberately march to certain death. Patriotism! Why should mercenaries display patriotism when it is non-existent in the nation at large? Courage! Why should a man face death in order that those who fear to fight may benefit? The object of the mercenary is gain. As notable examples, we have the intricate campaigns of Wallenstein and Tilly; they only fought battles in defence of their plunder; they far preferred to sack a defenceless city; their chief object was to live at the expense of the inhabitants and to amass wealth. Mercenary troops have never won victory except against mercenaries, or against an opponent utterly inferior to themselves in power, or against barbarians.

In ancient history we find two distinct types of nations, the nations of warriors, and the nations of civilians who employed mercenaries. In every case the nation of civilians went down before the nation of warriors. As examples we may mention the Babylonians and Lydians destroyed by the Medes and Persians, the Athenians by the Spartans, the Persians by the Macedonians, the Carthaginians by the Romans, the Romans themselves finally destroyed by the German barbarians. In every case we find the same qualities displayed by the victors, the determined energy of a vigorous people resolute to win at all costs; the enemy was never 'fended off' but was 'smitten down' by the application of force at a vital point. That superior force did not consist of mere numbers only; it was made up of the martial qualities—scientific leadership, national discipline and organisation for war, patriotism or unity of purpose or the spirit of self-sacrifice, and, finally, the training of the whole manhood to arms.

THE CONDUCT OF MODERN WAR.

Systems of mercenary standing armies, composed of a small percentage of the people, were in vogue throughout Europe at the time of the French Revolution. These systems were smashed to pieces by Napoleon with his armies of patriotic and enthusiastic Frenchmen. The bitter experience of defeat induced the Prussians to lay the foundation of their present system of universal training to arms. Their startling successes in 1866 and 1870 induced all other nations of the world, with the exception of the Anglo-Saxon races, to follow their example. There are now two distinct types of civilised nations in the world, nations in arms, and nations of civilians.

A nation in arms appears to be merely the modern scientific form of the nation of warriors of antiquity. Every man is trained to arms, has his place in the national organisation for war, and is liable to be called out to fight for his country if the necessity arises.

But so complex is the nature of the modern civilised community, so important is it that the people, in time of war, should, as far as possible, continue their peaceful avocations unchecked, that it is quite impracticable to call out the whole manhood simultaneously. It has been found necessary to so arrange the organisation that only the numbers necessary shall be called out, and that the whole force of the nation shall only be employed when absolutely essential or in the last resort. Men, on attaining a certain age, the able-bodied age, are therefore trained in the active army or navy and in the active reserves for a certain term of years; they then proceed to the sedentary reserves.

In the most advanced types of nations in arms, every man, except those who are physically or mentally useless or who are criminals, have their place in the national organisation. In France, indeed, certain classes of criminals even are expected to fight for their country. In Russia, on the other hand, only a comparatively small percentage of the men are placed in the national organisation: there is a vast untrained civilian element. To what extent has this civilian element been responsible for the present revolution in Russia and therefore the immediate cause of the defeat of that country by the Japanese? It is an interesting point, and well worthy of study.

A large untrained and unorganised, and, for these reasons, uncontrollable, section of the people constitutes a serious weakness to a nation in time of war; those precipitated over the verge of starvation strike for the means of subsistence, and we have revolution. There will be found none to deny that revolution in the time of great national danger may well prove fatal to a nation. It is the Russian revolution, and not the mere defeat of the armed forces, that has brought Russia to its knees.

The armed forces of the modern nation in arms constitute vast national schools in which the martial qualities—leadership, patriotism, unity of purpose, the spirit of self-sacrifice, and discipline—are taught. These are the qualities which, in conjunction with an efficient organisation and a sufficient number of trained men, have always won victory in war. Nations in arms seek earnestly to render themselves superior in these qualities to all possible opponents; but as their leaders recognise that this is a matter of difficulty, they ensure that every man of the nation shall at least be available. "Numbers alone can annihilate."

But there is a yet more significant fact as regards the nation in arms. The General Staff by which the armed forces are directed constitutes a body of experts whose opinion must carry such weight that it cannot be disregarded when the national policy or strategy is under consideration. Though all will admit that the leadership of a genius is the best possible, yet it will also be admitted that the genius is seldom forthcoming at the required moment. It is evidently an unwise proceeding for a modern nation to place its trust, like the ancients, in the fortuitous rise of a genius at the critical moment. A carefully trained staff of experts is the best possible alternative to a genius; it is the scientific form of national leadership. It seems probable that, as the years pass, the General Staff of the nation in arms will gradually assume greater power, and that it will be recruited from the best men available irrespective of their social status in life.

It seems that we are justified in the assertion that the modern nation in arms is primarily a machine of war, far superior to its prototype the nation of warriors. It is organised with a view to putting into effect the first principle of success in war—the concentration of superior, or if possible, overwhelming, force at the vital point of the adversary at the decisive moment. It is recognised that the decisive moment occurs at the outbreak of hostilities, when the enemy is still unready or, possibly, asleep. We consequently see methodical and scientific preparation for war with a particular adversary carried out through a term of years with the object of bringing overwhelming force to bear at the outbreak of hostilities. It is also advisable to precipitate hostilities at the auspicious moment.

The importance of the first blow is, in fact, fully recognised; and it is the case that a first crushing blow will generally disorganise, and upset the equanimity of, the adversary, and bring ultimate victory clearly within view. As an example let us mention the attack of the Japanese fleet on the Russian fleet in Port Arthur.

A first blow to be really effective must be a surprise. But surprise is only possible with secrecy in preparation and rapidity in execution. Secrecy and rapidity are both of them impossible except with discipline and organisation. The plan for the delivery of the first blow demands the highest qualities of leadership—as, for instance, Napoleon's destruction of the Austrians at Ulm. A nation of which the leadership is unscientific, and of which the people lack discipline and organisation, can by no means strike the first blow.

But the avoidance of a first crushing blow also demands these very selfsame qualities. A nation which lacks the martial qualities can by no means hope to avoid it. A nation which lacks these qualities cannot make scientific preparation for war. Discord, under various names, reigns supreme; the national leaders and the people have so many things to think about that they have no time in which to give attention to the study of war; the nation, as a whole, like Mrs. Easy, sits with hands folded in the lap, awaiting the millenium. A nation of such a type can no more hope to win and retain command of the sea, than it can hope to win and retain command of anything else that demands energy, courage, patriotism, discipline, organisation, and vast numbers of trained fighting men. Like the Poles in the 18th century, it is obsolete, an earthenware pot jostling iron pots.

Since the dawn of history the civilian nations have met destruction at the hands of the fighting races; the sea-power of the Athenians and Carthaginians could not save them against the vigour of the two nations of land warriors, the Spartans and Romans. Nations which will not train to fight invite attack, and must expect defeat. There seems no reason to believe that a modern nation of civilians, with its inept methods, its lack of scientific leadership and preparation for war, its lack of the martial qualities and of the national schools of patriotism and discipline, its lack of trained warriors, will be able to hold out against the onset of a modern nation in arms which has made preparation for war.

Of all the martial qualities, national leadership is of pre-eminent importance; for without it a nation cannot be expected to display the remaining qualities. Of all systems of national leadership, that which is termed 'responsible government' is perhaps the worst; its real name would appear to be 'irresponsible government.' For everybody shirks responsibility; the party government awaits a 'mandate' from the people which is never forthcoming; while the people are always hopelessly muddled by the conflicting views of its numerous untrained leaders.* The history of Athens affords strong evidence that party government must, in the end, lead almost inevitably to defeat in war and to the destruction of a nation. The British nation appears to have copied very closely the Athenian system of leadership, copied the nation which lost its empire in the most foolish manner conceivable, copied more particularly the Athenian hatred of discipline and military efficiency, which are now known by the name of 'militarism.'

In the mind of every patriotic Englishman of the present day certain questions must obtrude themselves.

How, it will be asked, are reform and military efficiency to be introduced?

* Reduction of taxation is the only 'mandate' a nation ever gives willingly. Sometimes, in the moment of defeat, a nation gives a mandate to fight hopelessly to the last, and sometimes to make peace at any price.

Is it not the case that compulsory universal service is the only method by which military efficiency can be obtained, as well as the only proved panacea for national degeneration? It has saved Prussia, France, Turkey, Abyssinia, and Japan.

Can voluntary universal service, which appears to be the latest idea, take the place of it? Is there any reason to hope that the 'wasters' and 'hooligans' of society will voluntarily place themselves under a strict course of discipline?

If these questions are carefully considered, the next question which a man will ask himself is—How can compulsory universal service be introduced into a nation of civilians?

And the next—Is it not the duty of every patriotic man to move heaven and earth to introduce reform in time?

How many years will be given us in which to accomplish it?

How long does it require in which to organise and render efficient a machine of war?

What action, if any, are the fighting men of a nation, the only men, in a nation of civilians, who know what war means, to take?

Are they also to sit with hands folded in the lap, awaiting the millenium?

In this connection, I would venture to recommend those of you who have not already done so to read Ruskin's lecture on 'War,' which he delivered to the cadets at Woolwich in 1865, and is to be found in his *The Crown of Wild Olive.* Having read this, soldiers will probably ask themselves one more question,—What are we to do, and how are we to save our country? It is a difficult military problem which must inevitably come up for solution before many years are passed.

SOME NOTES ON RECENT DEVELOPMENTS IN FIRE APPLIANCES.

By Capt. E. H. Harvey, R.E.

The following short notes on recent improvements in fire-extinguishing and life-saving apparatus are intended as a supplement to a paper on "Fire Protection" written last year.*

Some of these improvements and advances in fire appliances may be found worthy of note by Division Officers in charge of large establishments where fire-protective measures need particular attention; and they are, in any case, deserving of record as showing progress in an important branch of mechanical engineering.

In continuation therefore, of my former notes, I may briefly point out a few instances of recent advances in this line of work.

Motor Apparatus.

During the last three years the practical utility and reliability of "motor" (*i.e.*, self-propelled) fire-apparatus have been thoroughly established. The English-built machines resolve themselves into two chief classes:—(*a*) Self-propelling steam fire-engines, burning oil fuel; and (*b*) petrol motor vehicles, fitted either as escapes and hose-tenders combined, with a chemical engine attached, or as fire-engines with or without the life-saving appliance in addition. A very notable machine built by Messrs. Merryweather, and known as a "Motor-combination," includes in one vehicle all the appliances named, and well merits the description applied to it in a daily paper of "An Encyclopædic Fire Appliance."

MOTOR STEAMERS.

Since the first general introduction of these motor fire-appliances some 2 or 3 years ago, great improvements in "anti-skidding" devices have been adopted, which have rendered their use practicable under all conditions of weather. No better proof of their reliability can be found than the fact that Messrs. Merryweather's standard type of motor-steamer ("The Fire King") was first tried in the

* Paper No. 9, *Professional Papers of the Corps of Royal Engineers*, Vol. XXX., 1905.

London Fire Brigade early last year, and that since then the London authorities have put two more in active service, and have two on order, making a total of 5, besides two petrol-driven escapes. The Liverpool Fire Brigade, also well known as one of the best equipped in the country, have 4 motor machines in use; and many other English cities and towns at home and abroad have adopted this type. In tropical countries their usefulness is particularly great, owing to the natural difficulties (due to climate) in effectively horsing other types of engines.

In the Malay Peninsula three of these engines are now in service, and are highly spoken of. I refer to the following places:—Kuala Lumpur (the seat of the Federal Malay States Government), Penang, and Singapore. The Singapore engine is successfully steered by Chinese firemen, and is able to arrive at its work long before the horsed steamers.

The time necessary for turning out with these self-propelling steamers will be from one to two minutes, if merely a low pressure of steam is kept on the boiler (by means of a gas-ring when standing). In London it has been found desirable (in one or two stations at least) to keep the engine under a full head of steam, so that a start may be made instantly. To do this will, of course, be seldom found necessary in most places.

It is often argued that, for very short runs (*i.e.*, ½ to 1 mile) the motor steamer has no advantage over a smartly turned-out horsed engine, especially in crowded localities. But on the other hand there is the certainty of the former arriving with a working head of steam; and for longer distances and in hilly localities the superiority of the self-propeller is evident, a speed of from 20 to 30 miles an hour being obtainable on clear roads on the level, and 12 or 15 miles an hour up considerable gradients.

As to cost, though the prime cost of themotor-machine is considerably more than that of the horsed engine, there is little to pay for its upkeep besides the cost of the gas burnt; while in providing station accommodation for it much less space is needed, for the reason that stables and forage stores are unnecessary. Moreover the fireman who steers the engine to its work is, on arrival, available for duty with the hose, etc., instead of having to stand by in charge of horses during the progress of the fire.

In concluding the remarks about these engines it may be mentioned that they have hitherto been built in 3 sizes, pumping 300, 400, and 500 gallons per minute. No special type of boiler is employed, other than the standard fire-engine type with cross (and circulating) water tubes, fired by petroleum. The same engine that works the pumps also propels the machine on the road.

For the special requirements of the Liverpool Brigade these engines have been fitted with "chemical cylinders" or "first-aid appliances" in addition to their ordinary equipment. This provides, in one vehicle, the means for dealing with the smallest or the largest fires.

PETROL MOTOR APPLIANCES.

Turning to the petrol-driven machines, these usually comprise a hose-tender propelled by a petrol engine of some 20 to 50 H.P., fitted with chemical cylinder and with seats for an ordinary horsed-escape "crew." If an escape is carried, this is placed "fore and aft" between the men, with its wheels to the rear in the same manner as in the ordinary horsed escape.

The fire pump in Messrs. Merryweather's machines is of the "Hatfield" type; a 3-cylinder short-stroke pump, running at high speed from gearing connected with the propelling motor.

The petrol-driven fire-engines have been made up to a power of 450 gallons per minute, being equal to that of a fairly large steamer. From 1,000 to 1,500 feet of canvas hose can as a rule be carried, besides necessary connections, tools, etc.

With regard to the utility of the foregoing appliances a recent report from Leicester may be quoted, in which it is stated that 85% of fires were extinguished by the use of the petrol-propelled chemical engine and hose-tender.

QUICK STEAM-RAISING DEVICES.

Turning to improvements in the standard steam fire-engine, one of the latest is a means for facilitating the quick raising of steam. Messrs. Shand & Mason have recently brought out an arrangement which can be fitted to any engine, and from which very good results are obtained. This consists of an exhaust fan revolving horizontally, which, with its casing, is fitted when required on top of the funnel, and is driven at high speed by an endless belt and a light hand fly-wheel attached to the engine-framing. When the boiler fire is well started the fan can be quickly removed. This device appears particularly suited to engines stationed permanently for the protection of Institutions, Works, etc., where the engine will be standing still while getting up steam, and will probably be kept with its boiler cold. A very material saving in time is claimed by the use of this fan, which has been already adopted to a considerable extent.

Messrs. Merryweather obtain the same result of quick steam-raising, if desired, by a small blower attached to a cylinder of compressed gas.

STEAM-EXPANSION GEAR.

A less recent improvement is the adoption of variable steam-expansion gear (which is fitted to the London Brigade engines and many others). This enables the engine to perform its work with greater economy of coal, which is a matter worthy of attention in large cities where fires are heavy and frequent. It is further claimed for this gear that it renders the work of the stoker less difficult, especially where, as in small towns, opportunities for practice are not great.

The arrangement is a simple one, in which, by means of a rocking lever, the effect of the eccentric can be varied so as to alter the amount of expansion.

HIGH-PRESSURE STEAMERS.

With the general increase in the height and size of buildings in large cities a new departure is the building, for special orders, of steamers capable of working to a much higher water pressure than the normal maximum of 100 to 140 lbs. per sq. inch. These engines are designed to work against "heads" of over 500 feet; and it may be remarked that for some situations portable steam pumps of this type might have their value for military purposes, *e.g.*, in supplying camps on very high ground.

APPLIANCES FOR PRIVATE USE.

In the matter of fire-appliances for private use, one of the most striking of recent developments is an invention of Messrs. Merryweather, by which the power of an ordinary motor-car can be utilized to work a portable fire pump of some 100 gallons per minute capacity. A light trailer to the motor-car carries an arrangement of detachable ramps with a "Hatfield" pump and hose, the pump being fitted with friction wheels as driving pulleys. On reaching the scene of action the ramps and pump are dropped on the ground, and the motor-car backed up on the former till its driving wheels are in contact with the friction wheels of the pump. Proper means for taking the weight of the car and holding it in "gear" while running the pump are of course included.

LIFE-SAVING APPARATUS.

In life-saving apparatus no very notable fresh departures present themselves, except the more general introduction of horsed escapes and of very large ladders (some motor-propelled) for high buildings in great cities, and the use of "hook" or "Pompier" ladders by English brigades as an emergency appliance. These ladders are now made, if desired, with a joint in the centre, so that they can be doubled up for easier stowage on an engine. One point to be observed about these ladders is, that, their use being attended with more or less danger, they are only suitable for emergency work by steady and cool-headed men well accustomed to them. Their use in drill competitions against time is hardly advisable, and has led to accidents without any compensating advantage being gained.

MINOR APPLIANCES.

In the matter of the smaller appliances there is no striking advance to record. The "chemical engine," or "first-aid appliance," is now in very general use, combined with the hose-tender and escape. The necessary pressure with this apparatus is obtained in some cases by a connection with a small cylinder of compressed air, instead of by the chemical action of soda and acid. This method has the advantage that the pressure can be cut off when required.

The manual engine (except in small country towns and institutions, such as barracks, where men are instantly available for pumping) is now practically obsolete in England, though used as a vehicle for carrying spare men and hose. Old "manuals" can be converted into hose-tenders, etc. In those machines which are still built for private use, one of the chief recent improvements is the placing of the delivery-hose outlets at the rear of the engine, clear of the men pumping.

FIRE STATIONS.

In modern Fire Stations the adoption of quick-hitching harness, sliding poles, etc., has much advanced in England. Stalls for the horses are now preferably built so that the horses stand with their heads in the same direction in which the machine they have to draw will leave the station. This enables them to trot forward at once to their places beside the pole, and avoids awkward turns, such as occur where the stables lead by a central passage into the rear of the engine-room.

A good modern arrangement of the station, with the best time-saving appliances, enables a turn-out to be made in some 17 seconds; while equally smart men with a less well-planned station will take 35 to 45 seconds.

For keeping the boilers of steamers hot when standing, the long-established gas-ring and flexible tubing is naturally in most general use; but for places where gas is not used, petroleum oil heaters can be obtained. Messrs. Shand & Mason have a new and useful arrangement of this kind.

A large "hood" and extracting flue in the Fire Station are particularly necessary over the standing place of a motor-steamer, to draw off the fumes on first lighting up to turn out.

For giving warning of the approach of fire-apparatus on the road the use of gongs and large bells is now becoming more general, owing to the increase in noise and volume of traffic in great cities.

OPPIDA CANTIANA.

NOTES ON BIGBERRY CAMP AND THE PILGRIMS' WAY.

By COL. O. E. RUCK, R.E., F.S.A., SCOT.*

DESCRIPTION.

THIS Pre-historic British Oppidum in Bigberry Wood has long been known to exist. It has been described by Hussey in *Archæologia Cantiana,* and is said by him to stand in direct relation to the antient ford over the River Stour at a place now called Tonsford about half a mile to the south-east. It lies in the parish of Harbledown, two miles west of Canterbury.

The work has also been mentioned by Payne and other writers on the antiquities of Kent.

In the year 1861 iron implements were found in its interior, such as a ploughshare, coulter, cattle goad, horse bits, and tyre of an antient wheel; all these are now deposited in the Canterbury Museum.

In 1895 the Oppidum was examined by Professor Boyd-Dawkins, F.R.S., who at that time obtained other finds from workmen excavating gravel from the encroaching gravel pits on the south side of the Pilgrim's Way, here passing through the camp and within the area of the entrenchments. Some of these other finds are now to be found in the Manchester Museum.

The Professor states that the objects which had been found marked the age (archæologically) of the Bigberry work, and also tend to prove that the Pilgrims' Way is an antient road of the same age as that of the above-mentioned settlement.

In July, 1906, the Oppidum was inspected by Colonel O. E. Ruck, R.E., and Capt. A. M. Henniker, R.E.

The works as they now stand consist of a partially circumferential trace of double rampart with intermediate fosse; these are rarely more than 4 feet above or below the cutting line, whilst on the south side much agricultural scarping has destroyed the symmetry of the original trace, if on that side any rampart ever existed; this is a very doubtful point, owing to the fact that the approach to the work from the south is steep and long, whilst the fosse, like that at Cobham Oppidum, runs out to lower ground at the south-west corner.

* The acknowledgments of the author are due to Professor Boyd-Dawkins, F.R.S., and to Messrs. Hussey & Clinch.

These low ramparts lead to the supposition that, in common with other Kentish examples, the remains are those of a defended Oppidum, and not those of a Pre-historic Fortress of great strength.

The main work is situated on a plateau, averaging some 230 feet above sea-level, and resting on a bed of gravel overlying the dry Thanet sands. It overlooks the valley of the Stour to the south, but is divided from the heights of Harbledown to the north by a broad valley.

Its internal area within the ramparts measures about 1,000 feet east to west and varies from 500 to 1,000 feet from north to south, and closely follows the 200-contour line. A crescentic-defended Annexe (marked G on *Plan*), possibly used for retainers and cattle, is appended to the north-west face, thereby strengthening a vulnerable side; this face slopes rapidly downwards to a much lower level; its measurements are about 1,000 feet from east to west, and some 500 feet from north to south.

The whole of the works are sited in a dense tract of scrub and hop-pole plantations, of which large wooded tract, extending many miles west, it occupies the eastern end. In general plan Bigberry (old form—Bigbury) resembles the Romano-British village of Woodcuts, explored so laboriously by the late General Pitt-Rivers. Of entrances there appear to be three, two of which seem to have been main approaches, and one subsidiary, perhaps subsequent to the others.

The main approaches are those marked C and E on the *Plan* of July, 1906; the (supposed) subsidiary one is that marked F. The entrance E is in continuation of the deep-sunk winding Pilgrims' Road from Canterbury, and is the more interesting owing to its two worn-out very deep cart tracks which appear to have been both used successively as the previous track got impracticable for use. The most southerly way D is the deepest by some 10 feet; it is considerably lower than the line of entrenchments which it penetrates, about 25 feet below the bank on its southern margin; and must be the oldest of the alternative exits on this eastern side.

The Pilgrims' Road, after passing through the works, emerges on the west in the direction of Chartham Hatch. On looking at the *Plan* it will be seen that another old track exists, passing from the eastern entrance northwards towards China Farm and thence to join Watling Street. This antient way runs in a deep cutting through the Thanet sands in a north-west direction. Professor Boyd-Dawkins states that "it is obvious that Bigberry stands in the closest connection to the roads under consideration, and that both roads and camp were used by the same people, and may be referred to the same date." It seems also to be quite possible that the old main trackways may have already been in existence at the time that the works were originally thrown up.

The subsidiary entrance F is not quite so evident; but a grooved depression in the surface leads one to anticipate such an entrance for the purpose of gaining the old British road of Watling Street from the west without going downhill to the bottom of the east entrance and then round north-west by the sunken road in the cutting.

FINDS INSIDE THE SETTLEMENT.

The finds consisted of the following:—Socketed spear heads of iron, tanged iron dagger, iron axe, iron adze, 2 iron hammers, 2 iron sickles, 2 iron billhooks, iron coulter, 2 iron ploughshares, iron chisel, 2 iron pothooks, 2 pair of iron shackles, iron chains, iron snaffle bit plated with bronze, iron ring bronze plated, and some brown pottery.

The two spears are of the same type as those found in the settlements of the Pre-historic Iron Age at Hunsbury near Northampton and in the lake village of Glastonbury. Other articles are similar to those found at these two places. A massive iron hook found at Bigberry is of the same form as the hook described under the head 'Aratrum' in Smith's *Dictionary of Antiquities*. The ploughshares are similar to those of the Pre-historic Iron Age at Hunsbury and at Mount Caburn near Lewes, described by the late General Pitt-Rivers. The two pairs of iron shackles, too large for handcuffs, were probably used either for hobbles for horses or fetters for men; the finest of the two is 15·5 inches in length. The chains with intermediate iron circles or rings were possibly used in connection with a body of prisoners or to control the movements of a chain-gang (the rings being too large for the feet of horses and cattle, and too small for their necks). The snaffle bits plated with bronze belong to the late Celtic period of art. The pottery is similar to that met with in the usual finds of the Pre-historic Iron Age.

The remains from Hunsbury are to be seen in the Northampton Museum, those from Glastonbury in the central museum at that place. With regard to the latter, recent explorations by Mr. Arthur Bulleid, L.R.C.P., F.S.A., point to the commencement of the Glastonbury Settlement at or about 300 B.C. and closing with the Roman invasion. Great gamblers and cock fighters were the prehistoric lake dwellers of Glastonbury, as is evidenced by the finds of loaded dice and fighting cocks' spurs buried beneath the débris; as long-headed struggling agrarian and pastoral tribes they rode or drove country horses with iron snaffle bits, fighting at long range with slings and at close quarters with daggers, billhooks, and halberts; vast numbers of clay pellets for slings, both of the burned and unburned variety, have recently (1905) been met with, for constant danger of attack from neighbouring predatory communities had to be guarded against.

A prehistoric cooking pit, exposed in the extension of the gravel pits at Bigberry, was discovered by the writer at point X, section

A′B′, in July, 1906. It is of well-known type, similar to others found in prehistoric works at Hayes Common, Kent, and at Wallington, Surrey. This method of hot earth cooking is still in use by gypsies for cooking hedgehogs, and has this year been re-invented and elaborately experimented on by the American army *chefs* with the object of cooking food in portable boxes for troops whilst on the line of march.

THE PILGRIMS' WAY IN RELATION TO BIGBERRY.

If Bigberry belongs to the Pre-historic Iron Age, its position at the junction of the Way with the antient track connecting up to Watling Street, the former Way passing through the work, tends to show that it is likely that the Pilgrims' Way may be assigned to the same remote period and may even be considerably older. The Pilgrims' Way, as it leaves Canterbury for the west country, avoiding the Wealden Forest on its left, keeping to the dryest land on its route, and connecting up by transverse antient British tracks with Watling Street (the main road to the north of England), traverses much Pre-historic ground. Near Aylesford, at a distance of some half a mile on its left, it passes a Pre-historic cemetery of the Iron Age, whilst on its right is the well-known Kits Coty House. Passing on, it fords the Darent at Otford, thence runs through Chevening Park to Merstham and Reigate, crosses the River Mole to the east of Dorking, then on again to Guildford and over the River Wey, then along the Hog's Back to Farnham, to join still further to the west the great network of trackways linking up Surrey, Hampshire, and Berkshire with the far west and Cornwall. It certainly seems to belong to the same class of roads which in other parts of the country have been clearly proved to belong to the Pre-historic Iron Age.

It was undoubtedly used by the Canterbury Pilgrims long after the Settlements which it coupled up together had utterly perished. Throughout its length it is represented by fragments of existing roads and tracks, locally known as Pilgrims' or Travellers' Ways. Its route would naturally follow the easiest lines of travel, such as are wont to occur on the veldt of South Africa and in little civilised countries. As in the Icknield Way from Bury St. Edmunds following the edge of the chalk downs on into Berkshire, the line of track selected would be a dry one without touching forest or morass.

So far as can be diagnosed the Pilgrims' Way formed part of a system of antient roads made to connect Settlements and Fortresses of the Pre-historic Iron Age, the very names of which had vanished prior to the so-called English conquest of Britain. In this connection it is instructive to note that the old trackway known as "the Welch Way," passing by Hunsbury Camp, Northamptonshire, and thence on by the Cotswolds into Wales, has even been used by the Welch drovers within the last half of the 19th century, although it is in some portions of its course a mere track through open fields, and this use is in spite of the existence of good roads as alternative routes.

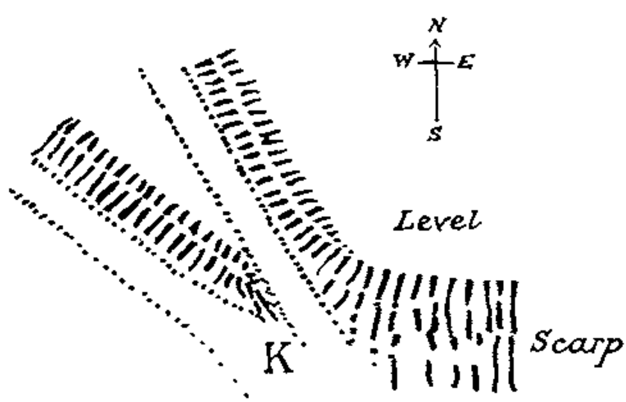
The Pilgrims' Way at Bigberry (east end) is at the present date in use for the telegraph poles of the G.P.O., thus avoiding more circuitous routes and the built-over sides of modern Watling Street. For all that is known to the contrary the same old trail may have been in use by the Phœnicians, as a route protected from piratical raids, to carry tin from the Cornish deposits for exportation purposes from Richborough (the antient port near present-day Sandwich) to Massilia and Boulogne. For Massilia was, about 600 B.C., a great emporium and distributing centre for merchandise destined for the eastern world.

Portions of the existing network of transverse British trackways from the Pilgrims' Way to Watling Street pass in almost every instance which can be called to mind the Oppidums such as at Joydens Redoubt, Bexley,* at Cobham Park† and at Bigberry; the first-named work possibly dating from the neolithic to the bronze period. The inference is that it is quite possible that the best known of the Pilgrims' Roads may be of very remote origin indeed, perhaps extending into the early bronze period of the Pre-historical geography of Britain.

NOTE BY CAPT. A. M. HENNIKER, R.E.

The 25-inch Ordnance Map does not show the rampart and ditch accurately.

Starting at the point marked 241 on the west side, south of the Pilgrims' Road the section is as shown on A′B′. This section continues eastward to a point marked K, except that the level between the two ramparts gets narrower and dies out at K. The outer rampart also dies out and the intermediate ditch runs into the lower ground.



* See *R.E. Journal* for July, 1906.
† See *R.E. Journal* for May, 1906.

East of K there is no rampart at all. The level interior ends in an abrupt scarp, very similar to that on the other side of the Road, shown in section AB. The Ordnance Map makes it look as if the earthwork stopped abruptly at the point L.

East of L the ground is arable and the scarping is almost invisible now; but I think it continued right round to the point 188 on the road and even north of that, and the map shows traces of it along the south-east side. There is no rampart from K to L, and there is no very abrupt stop in the work at L, in both of which points the Ordnance Map is misleading.

North of the point 241 I give another section, on AB. If there had been a rampart here it would have been cut away by the gravel pit, but I do not think there was one. I think the north and south sides of the work were scarped and a double line of rampart drawn across the col, the angle at M being somewhat similar to that at K.

The sketch of the section exposed in the gravel pit may give an idea of the original depth of the ditch.

TRANSCRIPTS.

MARTELLO TOWERS.

Below is a cutting from *The Times* of October, 1806, on the construction and armament of Martello towers; it was written to give to the public of that day a "proper idea" of the value of Martello towers as defensive works.

In September, 1793, a tower on Cape Martella in Corsica was bombarded for a short time by two of our frigates; it was then deserted by its little garrison, and occupied by a landing party of 30 men. We soon abandoned it to the Corsicans and it was afterwards retaken from them by the French.

On the 7th of February, 1794, 1,400 English troops were landed and the tower was attacked by land and sea. The fire from the batteries on the shore produced no impression. The frigates *Fortitude* and *Juno* kept up a bombardment for 2½ hours and then hauled off, the former being on fire and having 62 men killed and wounded. Finally, a hot shot set fire to the "bass junk with which to the depth of 5 feet the immensely thick parapet of the tower was lined." The French garrison of 33 men under Ensign Le Tellier then surrendered. The armament consisted of only two 18-pounders and one 6-pounder, and the strong resistance offered by these guns seems to have led to the conclusion that towers of this description were specially formidable. Consequently, as a result of the invasion scares, which it was Napoleon's policy to promote and maintain, Martello towers were built in large numbers on our exposed coasts.

W. E. Warrand.

Extract from *The Times*, October, 1806.

"The construction of the Martello Towers having been much misrepresented, I wish that, through the medium of your Paper, a proper idea of them may be given to the public.

"It is well known that the coast of England is easily accessible through a tract commencing at Sandgate, extending over Romney Marsh, and terminating with the chain of chalk hills which rise to the west of Winchelsea and are continued through Sussex and a considerable part of Hampshire. In this line above sixty of these military posts have been formed.

"Three of them are in the immediate neighbourhood of Folkestone, and protect the exuberant vale below the serrated rock of Shorncliffe. Two of these are of small dimensions, and consist merely of a circular tower, with parapets cut into embrasures, and mounted with cannon. The other is of much larger proportions; and the principal materials for this massive structure have been supplied from the ruins of the ancient castle of Sandgate, on the site of which it is erected. Both the central tower and advanced bastion are circular; so that a cannon-shot, striking against any part of it, is carried off in an angle proportioned to the direction given to the ball and the diameter of the building on which it strikes. It includes a battery composed of eight 24-pounders on the parapet, and a piece of artillery, of a prodigious calibre, on the summit of the tower; all these are supported on pivots; the equilibrium, during motion, being preserved by wheels attached to the carriages which run in grooves. Nothing conduces more to the perfection of a machine, especially such as is massive and ponderous, than great uniformity of motion, so that the *inertia* of the several parts do not act in opposite directions; and the coincidence by these expedients is in this case happily preserved. The pressure at the impelled and working points, in course, determines all the rest. Thus a battery is obtained, which involves the complex advantages of the battery *d'enfilade, en echarpe, de reverse,* and *camarade.* The whole is bombproof; and in the interior is sufficient space for the accommodation of sixty men, and a covered way is also provided in case of the necessity of retreat. What is to be the magnitude of the piece of artillery for which the pivot at the summit is prepared, I cannot tell; we know there have been bombards which would carry a ball of 300 lbs.

"From such an edifice, on the near approach of the assailants, bombs might be used without mortar-pieces, as was done by the Venetians against the Turks before Candia: the latter having possessed themselves of the ditch, the bombs were rolled down upon the enemy on sloping planks provided with ledges.

"The whole history of modern war has shown the utility of these minor fortifications, while the more extensive, by the number of men required for their defence and the quantity of provisions necessary to the support of the garrison, have often in the sequel been more beneficial than injurious to an invading enemy. The obstinate resistance of General Provera, at the defiles of Milesimo, even in a ruinous castle, against all the military talents and superior force of General Augereau, will illustrate this observation."

LARGE TANK OF ARMOURED CONCRETE FOR THE MILITARY HOSPITAL AT ROME.*

I. GENERAL STATEMENT.

UNTIL the beginning of the year 1905 the water required for the various needs of the Celio Military Hospital at Rome flowed into a metal tank with a capacity of about 55 cubic mètres,† placed on a masonry tower the top of which was about 14 mètres above the level of the ground. From this tank the water was distributed to the buildings of the Hospital according to their various requirements.

These requirements having recently increased, principally owing to the addition of two ward blocks, it was recognised that the tank had not sufficient capacity for a larger supply of water. During the night hours it was re-filled a long time before the distribution began, and therefore a large quantity of water was lost by overflow; there was consequently a deficiency of water at some hours of the day, precisely when it was most needed. This inconvenience, which was the cause of no slight disturbance in the regular service of so vast a hospital, demanded a well-considered remedy, to be devised also in relation to the presumably greater needs of the future.

The idea which first presented itself was to construct a second tank, with a capacity of about 100 cubic mètres, the structure as well as the supporting tower to be of armoured cement. The estimated cost of the whole construction, including the foundations and the system of pipes, was about 13,000 *lire*.‡ Eventually, in considering the possibility of reducing that figure, it was determined to substitute for the metal tank a single tank of armoured cement, with a capacity of 150 cubic mètres, placed on the masonry tower. This project, which presented the advantage over the former one of a considerable economy, was approved, and in the month of January, 1905, the works were begun.

II. DESCRIPTION OF THE TANK.

The tank-tower (*Fig.* 1) is a hexagon with sides of 3·40 mètres; the centre is a hollow cylinder with a diameter of 3·50 m. (*Fig.* 3).

A cylindrical form being adopted for the tank to be constructed (so as to obtain a smaller area of wall-space), and a height of 5 m. (so as to limit the maximum pressure), we get a circular base of 30 sq. m. with an internal diameter of about 6·20 m., somewhat greater than the diameter of the circle inscribed in the hexagon. It follows that, at the middle of

* Translated by permission from an article by Carlo Gini, Lieutenant of Engineers, in the *Rivista di Artiglieria e Genio*, Vol. 1, 1906.

† 1 mètre = 3 feet approximately.

‡ About £520.

each wall of the tower, the tank overhangs, and the maximum projection is about ·43 m. (*Fig.* 2). Even if the projecting parts were not supported, it is probable that the stability would not suffer, since they would be firmly embedded in the principal mass. However, for greater safety, there were disposed, along each side of the hexagon and corresponding with the projecting segment, four brackets with props made of rolled iron (*Fig.* 4), the dimensions of which are calculated on the basis of the maximum strains without taking into account the resistance due to the embedding. The projection of the brackets is rather more than the maximum overhang of the tank, and is equal to the projection of the cornice. Other brackets, made with irons of smaller dimensions, are placed laterally to the principal ones, and with them serve to form the framework of the cornice underneath the tank. The structure and the method of construction is briefly described below.

The bottom of the tank consists of a spherical dome, corresponding to the central hollow of the tower, and a circular ring. The dome has a rise of ·25 m., and the thickness of the concrete increases from a minimum of 6 c.m.* at the highest point of the curve to a maximum of 13 c.m. at the impost, exclusive of the thickness of the internal plastering (*Fig.* 8). The metal armouring of the dome is double, and consists of rods of 6 m.m. diameter disposed along the parallels and the meridians; the distance between the former, measured on the meridian arc, is ·175 m.; and the distance between the latter, measured on the circumference of the impost,† is about ·15 m. (*Fig.* 9).

The vertical section along the diameter of the circular ring of the bottom of the tank is a rectangle of $\cdot 13 \times 1 \cdot 55$ m. The armouring is double, and consists of 28 rods of 10 m.m. disposed along concentric circumferences at equal distances from one another; in the direction of the radii, the armouring is formed by prolongations of the rods of the dome which lie in that direction; and these rods are continued in a curvilinear direction till their ends are adjusted with the vertical armouring of the walls of the tank (*Figs.* 7 and 9).

The vertical section of the wall of the tank has the form of a trapezium (leaving out of account the thickened part at the base to a height of ·70 m.) with the inner side vertical and with the base less than 6 c.m. (*Fig.* 8).

The metal framework is formed of two sets of rods disposed along cylindrical spirals of varying and increasing pitch for each mètre of height; the diameter of the rods is 7 m.m. for the first three mètres and 6 m.m. for the two remaining mètres. Along the generating lines of the cylinder and in contact with the spirals are 6 m.m. rods, connected with the radial armouring of the bottom and about ·25 m. apart. At their upper ends these vertical rods are curved to connect with the armouring of the roof-dome (*Fig.* 6).

At its upper end the cylindrical wall is thickened by a moulded projection, to compensate for the thrust due to the weight of the covering. Inside

* A centimètre = ·39 inch.

† The *impost* is the circle in which the spherical dome meets the plane of the circular ring round it. (Transr.).

the thickened part there are three circular rods of 10 m.m. The covering consists of a spherical dome with a rise of ·80 m.; there is an opening at the top to give access to the interior of the tank. The least thickness is 6 c.m. at the highest part, and this increases to 8 c.m. where it meets with the vertical walls of the cylinder. The armouring of the dome consists of rods disposed as in the bottom dome, along the meridians and parallels, the former of 7 m.m. diameter and 12 c.m. apart measured on the circumference of the base, the latter of 6 m.m. diameter.

The aperture for access to the interior of the tank is a circle of 1 m. diameter, strengthened at the rim by two rods 10 m.m. thick. It is closed by means of a cover placed on a cylindrical ring ·25 m. high; the cover is pierced for the ventilation of the interior of the tank.

III. CALCULATIONS FOR STABILITY.

In calculations for pipes and tanks most constructors leave out of account the resistance to tension of the concrete, and calculate the directing lines of the metal framework so that these can of themselves resist the internal strains. However, bearing in mind the perfect preservation of the metal in the mass, experts adopt a coefficient of resistance which they carry as far as 1·5 times as much as that commonly assumed.

For the tank under consideration the calculation has been based on the resistance of both materials, iron and concrete, assigning to the latter the maximum coefficient of resistance within the limits of stability and deducing the strain on the iron by the hypothesis of plane deformation. It will be shown that the results which are obtained by the two methods here referred to do not appreciably differ.

The Bottom Dome.—The tangential force T (compression), referred to the linear unit of development of the basal circumference, is given by the formula:

$$T = \frac{P \times \frac{\pi D^2}{4}}{\pi D} \sin \alpha = \frac{PR}{2} = \frac{5000 \times 6{\cdot}25}{2} = 15{,}625 \text{ k.g.}^*$$

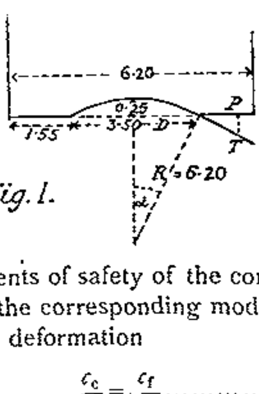


Fig. 1.

Calling c_c, c_f the coefficients of safety of the concrete and of the iron in compression, and E_{cc}, E_{cf} the corresponding moduli of elasticity, we get, by the hypothesis of plane deformation

$$\frac{c_c}{E_c} = \frac{c_f}{E_{cf}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

* 1 kilogramme = 2·2 lbs.

If Ω and ω are the sections of the concrete and of the iron, the equation of equilibrium between the forces becomes:

$$c_c\Omega + c_f\omega = 15625 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2).$$

Adopting for c_c the value 40×10^4, to which corresponds $E_{cc} = 32 \times 10^8$, we have from (1), assuming $E_{cf} = 20 \cdot 10^9$,

$$c_f = 2{\cdot}5 \times 10^6,$$

and assigning to the ratio $\frac{\omega}{\Omega}$ the value of ·01 we get from (2) $\Omega = {\cdot}037$, and

$$\omega = {\cdot}037 \times {\cdot}01 = 370 \text{ sq. m.m.},$$

and, calling s the thickness of the concrete, since Ω is referred to the unit of length,

$$s = \Omega = {\cdot}037.$$

In practice this dimension is considerably increased. At the centre of the dome the thickness of the concrete (excluding the plaster) is ·06 m., and towards the line of impost it is gradually increased until it reaches the thickness of the circular ring of the bottom.

For the metal armouring, adopting the double armouring and a diameter of 6 m.m. for the rods, their distance, measured on the circumference of the base, is

$$d = \frac{1}{\frac{370}{2} : \frac{\pi 6^2}{4}} = {\cdot}15 \text{ m. about.}$$

The metal armouring is further completed by a second series of rods disposed along the parallels.

The Bottom Ring is subjected to an internal pressure which, per linear mètre, is given by the component P of T, that is

$$P = T \cos\alpha = 15625 \frac{6}{6{\cdot}25} = 15000.$$

If the theory of cylinders is to be applied to thick walls subject to internal pressures, it must be borne in mind that tangential tensions are greatest along the internal circumference and diminish gradually towards the external; for simplicity of calculation, it is however assumed that they remain constant.

The total tension which acts on the vertical half-section passing through a diameter is given by

$$\frac{P \times D}{2} = \frac{15000 \times 3{\cdot}50}{2} = 26{,}250 \text{ k.g.}$$

Calling t_c, t_f, E_{tc}, E_{tf} the coefficients of stability in regard to tension and the corresponding moduli of elasticity of the concrete and of the iron, we have

$$\frac{t_c}{E_{tc}} = \frac{t_f}{E_{tf}} \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3).$$

$$t_c\Omega \times t_f\omega = 26250 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4).$$

Assigning to t_c the value 12×10^4, to which corresponds $E_{tc} = 30 \times 10^8$, and the value ·01 to the ratio $\frac{\omega}{\Omega}$, we get from (3)

$$t_f = \cdot 8 \times 10^6$$

and therefore from (4)

$$\Omega = \cdot 2050$$

and

$$s = \frac{\cdot 2050}{1 \cdot 565} = \cdot 13 \text{ m. about}$$

$$\omega = 2{,}050 \text{ sq. m.m.}$$

Adopting the double armouring and iron rods of 10 m.m., there are altogether 28 irons, disposed at about ·11 m. apart.

By the method of calculation based on the resistance of the metal only, assigning to the latter the coefficient of safety $8 \times 10 \times 1 \cdot 5 = 12 \times 10^6$, we have

$$\omega = \frac{26250}{12 \times 10^6} = 2{,}187 \text{ sq. m.m.}$$

a value nearly the same as the preceding one.

The Wall of the Cylinder.—The internal pressure decreases from a maximum at the base of 5,000 k.g. per square mètre to zero at the top, and therefore in the formula

$$t = \frac{pd}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

relating to the tension which is developed in consequence of the said pressure in a vertical section passing through the axis of the cylinder, the value of p and therefore of t is variable.

The height of the cylinder is therefore divided into 5 equal parts, assigning to each of them the corresponding maximum pressures; and, in relation to these, the thicknesses of the concrete and the area of the metal armouring are determined.

Corresponding to the values

$p = 5000$	4000	3000	2000	1000 k.g.

we obtain from (5)

$t = 15550$	12400	9300	6200	3100 k.g.

and from the equations (3) and (4) in which are substituted for t_c, E_{tc}, $\frac{\omega}{\Omega}$ the values 12×10^4, 30×10^8, ·01, and in the second member of (4) the values of t, we have:

$\Omega = \cdot 121$	·097	·073	·050	·025 sq. m.

and

$\omega = 1210$	970	730	500	250 sq. m.m.

A minimum thickness of ·05 m. (excluding the plaster) is adopted. With the double armouring, and a diameter of 7 m.m. for the rods in the first three zones and of 6 m.m. for those in the two remaining ones, the pitch of the spirals will be ·06, ·08, ·10, ·10, ·20 m.

Neglecting the resistance to tension of the concrete, the areas of the metal armouring would be:

$$\omega = 1291 \qquad 1033 \qquad 775 \qquad 516 \qquad 258 \text{ sq. m.m.},$$

values which approximate to those previously calculated.

The metal armouring of the walls is completed by the cross-rods of 6 m.m. disposed along the generating lines.

The Roof Dome.—This is subject to its own weight and to an eventual additional load which is reckoned at 100 k.g. per square mètre. Its mean thickness being 7 c.m., we have

$$p = \cdot 07 \times 2500 + 100 = 275 \text{ k.g.} \div 280 \text{ per sq. m.}$$

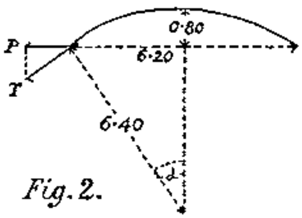


Fig. 2.

Carrying out the calculation analogously to that of the bottom dome, we have

$$T = \frac{280 \times 6{\cdot}40}{2} = 896 \text{ k.g.}$$

$$\Omega = s = \cdot 0021$$

$$\omega = 21 \text{ square m.m.}$$

In practice, a minimum thickness of 6 c.m. is adopted; and for the metal armouring a system of rods of 7 m.m. diameter disposed along the meridian planes and of 6 m.m. rods along the parallels. The thrust is given by

$$P = T \cos \alpha = 896 \, \frac{6{\cdot}40 - \cdot 80}{6{\cdot}40} = 784 \text{ k.g.}$$

This thrust produces in the ring, the purpose of which is to neutralise its effects, the tension

$$t = \frac{784 \times 6{\cdot}20}{2} = 2{,}430 \text{ k.g.}$$

Calculating the section Ω of the concrete and the section ω of the iron, we have

$$12 \times 10^4 \Omega + \cdot 8 \times 10^6 \omega = 2430$$

and from $\frac{\omega}{\Omega} = \cdot 01$

$$\Omega = \cdot 019 \text{ square m.}; \ \omega = 190 \text{ square m.m.}$$

The cornice at the top of the cylinder has a section sufficient for the required resistance, and internally the metal armouring of three rods of 10 m.m. is superior in area to that determined by calculation.

IV. METHOD OF CONSTRUCTION.

The scaffolding having been constructed, and suitable arrangements made for the water conduits, so that, during the period of the operations, there should be no deficiency in the water-supply for the hospital, the removal of the iron tank was proceeded with and also the raising of the tower to the additional height required for the plane on which the tank was to rest.

In the meanwhile the brackets were placed in position for the support of the overhanging parts of the tank (*Fig.* 4); upon them were placed slabs of cement 4 c.m. thick, and the moulds for the casting of the concrete were prepared.

For the bottom dome, the centrings for the concrete were made like those which are used for the construction of cupola vaultings, that is by a series of wood arches, disposed in diametral planes, made of planks about 45 m.m. thick, and connected together by a plank floor. They were supported by props resting against the surrounding walls of the circular hollow of the tower. On the plank floor was placed a mound of common earth mixed with water, to keep uniform the shape of the dome; and finally, to prevent contact between the earth and the concrete, canvas was placed over the earth mound.

For the vertical walls of the cylinder two moulds were constructed, one internal for the whole height of the tank, and one external, limited to about 3 mètres from the bottom (*Fig.* 12). The first consisted of 5 planks, 35 m.m. in thickness, disposed vertically and touching one another, following the run of the interior surface of the wall; these were kept in position by four internal sets of wood arches, disposed in horizontal planes and nailed together and to the vertical planks, so that each set formed a circle which prevented any deformation during the casting (*Fig.* 13); the planks for the wood arches were 45 m.m. thick.

The external mould was constructed in a similar manner, except that the wood arches were disposed externally and the whole mould was subdivided into segmental rings ·50 m. high and about 2 m. long (*Fig.* 11).

These segments, each made of one section of wood arch and of the corresponding planks, were fastened together with screws and nails; they were placed in position in succession as the casting progressed. The external mould was also propped against the spars of the scaffolding, so that it was easy to verify and correct the distance between it and the internal mould, *i.e.*, the thickness of the concrete. The external mould was limited to a height of 3 mètres; and for the remaining height of the tank, the moulds already used for the lower parts of the wall were utilised, their positions being adjusted in relation to the external diameter of the tank.

The roof dome was cast on a mould constructed like that of the bottom dome, that is with wood arches disposed in vertical meridian planes, with a plank floor nailed above them, and over all a mound of common earth covered with canvas (*Figs.* 13 and 14). The mould was supported along the base and at the top by props resting on the bottom of the tank which had already been constructed.

The circular aperture at the top of the mould was obtained by reducing the lengths of the wood arches and connecting their extremities by a closed circular frame, disposed horizontally.

The construction of the tank was carried out in the following order:—

1. The bottom centring was set up, and the first ring of the external mould was placed in position; then the whole mass constituting the bottom of the tank was cast in.

2. Then the internal vertical mould was set up and the casting of the cylinder was proceeded with, in rings of a height equal to that of the portions of the external mould, the corresponding metal armouring being meanwhile placed in position. The accurate positions of the spirals were secured by means of binding them very firmly with iron wire at their points of contact with the vertical rods.

The crowning cornice was constructed by bending the outer vertical rods approximately according to the profile of the cornice, and then fixing against them the wire-gauze netting, which was plastered with a mortar of cement and sand. When the mortar had obtained a sufficient hold, the internal hollow was filled up simultaneously with the casting of the roof dome.

3. The centring for the roof was then set up, and its construction proceeded with.

4. After allowing sufficient time for the casting to set, the timber supports were removed, beginning with the bottom dome, then taking away the internal supports of the cylinder and finally the external ones.

5. The internal and external plastering was then done, and lastly the adjustment of the aperture of the upper dome.

Amongst the accessory works must be mentioned that connected with the construction of the cornice at the top of the tower. It consists of a gutter-drain and of small brackets under it, placed to correspond with the large brackets of rolled iron which have already been mentioned (*Figs.* 4 and 5). These small brackets consist of vertical supports of rod-iron fixed to the large brackets and bent to the shape of the profile of the gutter-drain itself; these supports are connected by horizontal rods; and to this skeleton-frame is applied the wire-gauze netting and then the plaster.

The small brackets were made beforehand with rod-iron bent to shape and wire-gauze netting (*Fig.* 5), and the cement mortar was applied after they had been placed in position. The cornice was finished off with common mortar, like those of ordinary construction.

V. DETAILS OF MATERIALS.

The concrete used was proportioned in the following manner:—cement 400 k.g., sand ·5 cub. mètres, gravel 1 cub. mètre. The mortar for plastering and accessory works was composed of 1 part cement and 2 sand.

The casting of the tank alone, including the time necessary for putting together the timber moulds, took about 12 days. The plastering took 5 days.

The proofs for testing the work extended to 30 days from the date of completion, and the tank was completely filled with water until it overflowed from the aperture of the upper dome. This charge remained stationary for about 6 hours and, except for the characteristic sweating, not the slightest injury was observed. The sweating disappeared in time, and during a period of about a year nothing at all went wrong.

VI. DATA OF COST.

A. *The Scaffolding.*—In the following table will be found all that refers to labour and materials employed:—

Materials employed.	Quantities.	Cost per unit.	Total cost.	Wear and tear in ratio of	Wear and tear cost.	Labour.
		Lire.	Lire.		Lire.	Lire.
Thick beams of fir..........................m.	1,200	1·10	1,320	10°/ₒ	132	
Medium beams of chestnut ....m.	80	1·50	120	10°/ₒ	12	
Fir planks, 40 m.m. thick..............sq. m.	200	2·40	480	25°/ₒ	120	365
Fir laths, 40 × 80 ....m.	350	0·15	52·50	50°/ₒ	26·25	
Bracket-cleats and clamps ....No.	2,000	0·15	300	10°/ₒ	30	
Nails, wire-tacks, etc. ....k.g.	150	0·60	90	80°/ₒ	72	
				Total Lire	392·25	365
				Grand Total Lire ...	760	

B. *Raising the Height of the Tower.*—The total cubic content of the masonry constructed was about 40 cubic mètres. The structure is of striped sandstone (tufa), with front face dressed. The cost of materials and labour was 180 Lire, equal to 19 Lire per cubic mètre.

C. *Demolition of the Iron Tank.*—The cost of the labour was 180 Lire (= ·05 Lire per k.g.).

D. *Construction of the Cement Tank.*—In the following table are shown the expenses for labour and materials:—

Materials for timber framework.						Cement materials (exclusive of plasters) and metal armouring.				Cement materials for plaster.				
Items.	Quantities.	Cost per unit.	Total cost.	Wear and tear in ratio of	Wear and tear total cost.	Items.	Quantities.	Cost per unit.	Total cost.	Items.	Quantities.	Cost.	Labour.	
		Lire.	Lire.		Lire.			Lire.	Lire.			Lire.		Lire.
Fir planks, 35 m.m. thick...sq. m.	180	2·10	378	50%	189	Cement, quintale*	65	5·10	331·50	Cement, quintale*	15	76·50	For the construction of the moulds apart from the works	140
Fir planks, 4 m.m. thick ...sq. m.	50	2·40	120	100%	120	Gravel... cub. m.	16	7·00	112·00	Sand .... cub. m.	2,500	15·00	For placing the moulds in position ...	105
Fir laths ....m.	100	0·15	15	100%	15	Sand ......cub. m.	8	6·00	48·00				For working the iron	60
Nails, wire-tacks, etc. ....k.g.	50	0·60	30	100%	30	Rod-iron ......k.g.	1650	0·32	528·00				For casting the concrete	310
						Iron-wire ......k.g.	20	0·60	12·00				For plastering	200
													For removing materials	50
Totals.................. Lire					354				1031·50			91·50		865

* 1 quintale = 1 cwt. approximately.

From these figures we deduce:—

(*a*). The cost of the wooden framing was 599 Lire.

The area covered by the moulds was about 210 sq. mètres; and therefore the cost per sq. mètre was 2·85 Lire, divided into 1·68 Lire for materials and 1·17 Lire for labour.

(*b*). The cost of construction of the tank (exclusive of the metal armouring and the plastering) was 1450·50 Lire; the cost per cubic mètre of concrete was $\frac{1450 \cdot 50}{16} = 90 \cdot 70$, say 91 Lire.

(*c*). Cost of the plastering, 291·50 Lire.

(*d*). Total cost 2,342 Lire; or about 15·60 Lire per cubic mètre of the capacity of the tank.

E. *Cornice of Armoured Cement.*—Its total cost comes out at 545·80 Lire, equal to 24 Lire for each mètre of length. The figures are given in the following table:—

Materials.				Labour.		
Items.	Quantities.	Cost per unit.	Total cost.	For the construction and placing in position of the iron brackets.	For the construction of the metal framework.	For the construction of the cornice with cement materials.
		Lire.	Lire.	Lire.	Lire.	Lire.
Cement ....q.	8	5·10	40·80			
Sand ....cub. m.	1,000	6·00	6·00			
Rolled iron ....k.g.	500	0·32	160	125	45	120
Rod-iron ....k.g.	50	0·32	16			
Wire-gauze ....sq. m.	40	0·75	30			
Iron wire ....k.g.	5	0·60	3·00			
Total Lire............			255·80	290		

F. *Secondary Works.*—These amounted to 860 Lire, thus distributed:—

Increased consumption of water	200	Lire.
Laying out the water conduits	400	„
Taking down the scaffolding.................. ...	100	„
Colour washing	85	„
Sundry works	75	„

The whole work came to about 5,450 Lire;* and it is at once obvious that a considerable economy was effected in comparison with the first proposal, which was estimated at 13,000 Lire.†

* About £218. † About £520.

NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

September, 1906.

Wheel-Carrying Rail Joints (Flatfooted Rails).—This article is substantially a defence of his system by Mr. Max Barschall, the Prussian Ministry of Railways having apparently decided that joints of this description are not desirable, whereas experience in other countries tends to prove that a joint which will eventually do away with the crippling of rail ends can be devised.

The joint proposed is of the nature of a bridge between the sleepers, cambered up so as to carry on itself, not on the rail ends, the tyre at the point where it passes the break; so that "the parallel parts forming the joint should act as if the rail were severed into two alternate parts, and these parts rigidly carried over the sleepers when the inner one alone is intended to carry, and unfastened between the sleepers when both are intended to carry, and be independently and freely deflected."

It is not quite clear to what extent the sleepers are expected to do work, or how the rails and plates are to be spiked down. Certainly the large bearing given by the rail and the plates taken together should to a great extent stiffen the joint against deformation.

October, 1906.

Automatic Signalling.—This subject is considered at some length in this number, which contains a description of the systems installed on the London Underground Railways, as well as a report of the discussion which took place at the last Congress meeting in May, 1905. It may be worth while briefly to summarise the latter.

The desirability of introducing the automatic system on lines which are already signalled depends to a great extent on the reliability of the system proposed, and a comparison of the number of failures seems essential to establish its value as compared with manual signalling. Up to the present it seems that the most favourable comparative results have been obtained in America, but then many more automatic signals have been installed there than in Europe. Of course the greater cost of labour supplies a reason for this, and again there is much new construction and development of traffic going on there.

It has been claimed that with a track-circuit operated system practically any obstruction or break on the line or any vehicle left standing in a section would hold the protecting signals at "Danger"; but actually it has been found that this is not always the case, particularly with rolling stock having wheels with wooden centres. An automatic system guards against failures of memory on the part of the signalmen; but on the other hand, if anything goes wrong to dislocate traffic, the presence of signalmen to regulate traffic is of value. It seems therefore that it is not advisable to have too long lengths of purely automatic signals without provision at intervals for human intervention. On some lines telephones are provided for use in emergency; these are placed at the base of the signal post, so that in case of need the guard can communicate with the station ahead.

The broad principles which auto-signals are required to fulfil have not yet been very definitely laid down, and indeed it would seem desirable that all systems should conform to some standard.

The conclusions arrived at were:—that auto-signalling is now an effective way of protecting train and switching movements and that great improvements have been effected in the various types. It was not proposed to recommend universal adoption, but in cases of heavy and increasing traffic it was agreed that such a system might have special advantages.

C. E. VICKERS.

ENZHENERNEE ZHOORNAL.

June and July, 1906.

EXPERIENCES WITH A CABLE SECTION IN MANCHURIA.—By Staff Captain U. Pleutsinski.—The writer, who commanded the Cable Section of the Military Telegraph Company, 2nd East Siberian Sapper Battalion, during the campaign in Manchuria, gives interesting accounts of his experiences, (*a*) when accompanying two reconnaissances in the neighbourhood of Haicheng, between 30th June and 9th July, 1904, and (*b*) during the battle of Mukden, between 25th February and 8th March, 1905.

(*a*). On the first occasion he was serving with the 2nd Siberian Corps, and was employed in maintaining communication between the force under Major-General Oganovski, which was reconnoitring in the direction of the recently lost Fenshuiling (or Dalinski) position, and the main position of the 2nd Siberian Infantry Division (Lieut.-General Leverstam) in rear of Hsiakushan.

His working party consisted of 5 mounted and 2 dismounted line superintendents, 10 telegraphists, and 10 linesmen, drawn from infantry regiments, and he also mentions a driver and a storeman with each engineer two-wheeled cart. At first the chief difficulties were due to the rainy weather, that converted the low-lying fields into swamps impassable for carts and into which the men sank up to their knees; and subsequently the line was carried over very steep and rocky country.

During the ten days 10 stations were opened and closed and 75 important telephone messages aggregating 2,452 words, in addition to many less important ones, were transmitted. During this period there was not a single interruption, nor was any intentional damage done to the line. The equipment worked satisfactorily; even on the 30th June, when it rained the whole day and practically all the cable lay in water, only rarely was conversation badly heard. The micro telephones were proved to be serviceable up to 25 versts ($16\frac{1}{2}$ miles), and probably they would work at even longer distances.

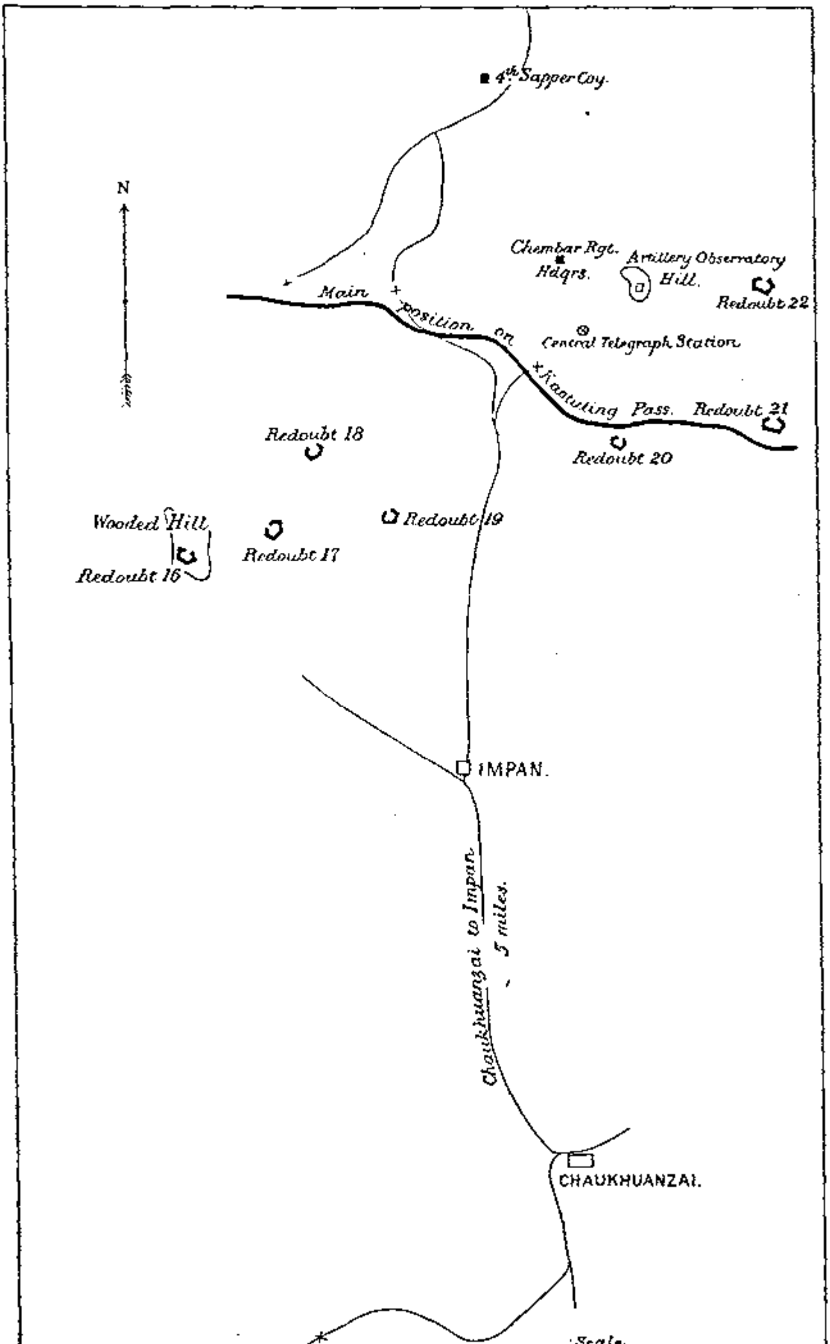
(*b*). At Mukden the Section was posted with part of the 7th Infantry Division (Major-General Nudjefski) in defence of the Kaotuling pass, near the eastern flank of the Russian line, with headquarters at the village of Patzyatza, about 4 miles in rear. At the beginning of the battle the force occupying a length of about 7 or 8 versts of the position consisted only of two battalions of the 284th Chembar Regt., 2nd Battery, 6th E. Sib. Artillery Brigade (8 guns), half the 4th Mountain Battery (4 guns), and the 4th Sapper Company, 2nd E. Sib. Sapper Battalion, in all 4,000 to 4,500 bayonets and sabres. To the south-east lay the Sib Cossack Division (Major-General Baumgarten), on the east the 6th E. Sib. Rifle Division (General Danilov) and on the west the 3rd E. Sib. Rifle Division.

With the article is given a contoured sketch of the defences (on which are also shown the various positions of Russian and Japanese artillery during the battle). On the west is a salient angle thrown forward about two miles in front of the main position. On the extreme south-west angle of the salient is Redoubt No. 16 or Wooded Hill. In rear of this are three more redoubts, Nos. 17, 18 and 19, while No. 20 is situated immediately in front of the centre and Nos. 21, 22, and 23 in rear of the left flank. About a mile in rear of the centre is Artillery Observatory Hill, and in the valley between this and the main position is the Central Telegraph and Telephone Station. About $2\frac{1}{2}$ miles in front of the centre is the village of Impan, and about 5 miles further to the south the village of Chau-huan-zai, the valley running north and south through these villages.

Five diagrams of cable communications from the central station are also given, the first of which shows the following lines:—(*a*) to Patzyatza, and from thence a main line to Haolinzai, the headquarters of the 3rd Sib. Army Corps (Major-General Kashtalinski); (*b*) to Redoubt No. 16; (*c*) to Artillery Observatory Hill; (*d*) to the headquarters of the Chembar Regt. on the position, and thence to the dug-out of the Sapper Company; (*e*) to Redoubts Nos. 22, 21 and 20; and (*f*) to Redoubt No. 23. At first there was also a telephone station at Impan, which transmitted reports sent in by despatch riders from the Cossack Division.

About midday on the 25th February, 1904, distant artillery fire announced the advance of the enemy, and at about 5.0 p.m. the Japanese debouched into the valley, moving round Kinsialing hill upon Chauhuanzai. The Cossacks retired on Yantaidzan; and as the infantry outposts were being forced back on Impan, the line from that place was dismantled. During the night it was partly re-laid, but it was finally removed about midday on the 26th February, when Impan was abandoned under the increasing pressure of the enemy's advance.

SKETCH OF KAOTULING POSITION.



At dawn on the 27th the Japanese batteries opened fire on the main position, feeling for the Russian guns, and during that day an unequal contest was maintained by 1½ Russian batteries against 2 field and 4 mountain batteries of the enemy. The Japanese shells searched the whole position to a depth of about a mile, and the telephone station with the Chembar Regt. had to be abandoned. The various lines were frequently cut by shells, and the line superintendents were kept fully occupied in searching for breaks and repairing them under heavy artillery fire.

During the day reinforcements began to arrive; they consisted of the following regiments and batteries:—4th Sib. (Verkhneudinsk) Infantry, 6th Sib. (Yeniseisk) Infantry, 7th Sib. (Krasnoyarsk) Infantry, 146th (Tzaritzin) Infantry, 10th E. Sib. Rifles, 2nd E. Sib. Rifles and 286th (Kirsanov) Infantry, the 6th Battery, 10th Artillery Brigade, the 1st Battery, 43rd Artillery Brigade, and the 5th Mountain Battery.

During the night 27th—28th the Japanese made repeated attacks on Redoubt No. 16, and by 7 a.m. on the 28th it was known to have fallen. Reports from the wounded stated that the Japanese had got in by the gorge and some 79 men of the Chembar Regt. were taken. Of the Cable Section 1 line superintendent, 2 telephone operators, 2 heliographers, and 2 attached riflemen remained unaccounted for. The fall of this redoubt was first noticed from No. 17, whence the Japanese could be seen sending semaphore messages to stop their artillery, which had been firing over the heads of the storming columns. It was decided to retake the redoubt after due artillery preparation, but the departure elsewhere of parts of the 2nd Sib. Artillery Corps did not allow of this being done.

During the 28th a line was laid to Redoubt No. 17, from which a good view was obtained of the enemy's movements. Very heavy artillery fire continued all day, the Russians shelling Wooded Hill and the Japanese shimose shells falling even as far as Patzyatza. On this day a new line was laid for the commander of the Chembar Regt., and the line from Patzyatza to Haolinzai was doubled. This last had become necessary on account of the presence at Patzyatza of the Army Corps Staff, who found it necessary to be in constant communication either with the 3rd Division or with the 2nd Sib. Army Corps at Kandolisan or with General Linevitch and the staff of the 1st Army at Shi-hui-chen.

The traffic over the single line had reached 35,000 words in the 24 hours. By adding a second line, and using one for the telegraph and the other for the telephone, the traffic on the former was reduced to 24,000 words in the 24 hours. In all the 12 days of the battle the number of words received or sent in the Central Station was 235,676. So much for the operators. As instances of the amount of work which fell on the line superintendents, it is stated that at the end of the battle there were 168 joints in the one verst of cable running to Artillery Observatory Hill and 112 in the line between Redoubts 21 and 22.

On the 1st March all the redoubts were heavily bombarded, and the Japanese, having discovered the observing party on Observatory Hill, searched every inch of the summit with shimose shells. The line superintendent is mentioned as having shown great gallantry in repairing breaks under fire.

At night time some Japanese, disguised in the uniforms of the Chembar Regt. and unarmed, pretended to run away from Redoubt No. 16 towards the 11th Sib. Rifles, who were in position on the west of Kaotuling. They were followed by supports, but the ruse was discovered and they were received with magazine fire.

During the night a party succeeded in removing about a verst of the cable running towards the captured redoubt, the Central Station was moved into the Sapper dug-out, and a new line was laid to the headquarters of the Krasnoyarsk Regt. at West Kaotuling.

Towards morning the Japanese attacked Redoubt No. 17, and took it about 8 a.m. (2nd March) after the casualties among the defenders had amounted to about 85%. No. 18 was taken at the first assault, and No. 19 was abandoned as being no longer tenable. No one of the Cable Section was captured in the redoubt, but the instrument was destroyed. A considerable amount of the cable was recovered by a gallant effort on the part of the section commander.

Later on the 2nd, Redoubts Nos. 20, 21, and 22 were heavily bombarded, and the line superintendent in No. 20 repaired no less than 43 breaks under fire during the course of the day. During the night 2nd—3rd a new line was taken to Centre Kaotuling, otherwise Cross Hill (so named from crosses on the graves of dead Cossacks), the headquarters of the Yeneseisk Regt.

Redoubt No. 20 was attacked at 8 a.m. on the 3rd, and after two attacks had been repulsed it was taken soon after 10 a.m., when all the officers had been placed *hors-de-combat*. The defenders lost heavily in retiring. As in the case of Redoubts Nos. 16 and 17, reinforcements were sent but arrived too late. An attack was also made during this day on Cross Hill, but was repulsed by the men of the Tzaritzin and Yeniseisk regiments with heavy loss to the enemy.

During the night 3rd—4th the 10th E. Sib. Rifles repulsed nine separate attacks on the main position. The lower trenches were lost and the Japanese were within 20 or 30 paces of the top when a battalion of the Yeniseisk Regt. arrived in time to turn the scale. Vivid details of the bayonet fighting are given, and also friendly remarks shouted out in excellent Russian by the Japanese on their retirement. Shortly before this a telegram had been received, stating that the attack of Kaotuling was only a demonstration, the real attack being directed against the extreme right, and that consequently Kaotuling not only could but must be firmly held in order to relieve the pressure on the right flank.

At dawn on the 4th a line was taken to East Kaotuling, to the headquarters of the 10th E. Sib. Rifles. About noon the Colonel of the 2nd Battery, E. Sib. Artillery Brigade, was killed by a shimose shell on Observatory Hill. The fire of the three field batteries was regulated from this hill, the orders being taken in the Central Station by an Artillery officer and carried by orderlies to the batteries. A similar arrangement for the mountain batteries was run from an observatory in the area of the 3rd Division.

On the night 4th—5th the main position was again furiously assaulted, and again the fighting took place at close quarters and the lower trenches were captured. A feature of the fighting was the horrible crackling of the hand grenades, the Russian ones being manipulated by the Volunteers of the 4th Sapper Company. The attack was again unsuccessful. The author saw the dead next morning, and comments on the horrible wounds caused by the grenades and also by the Japanese bayonet, which was apparently used more for cutting than stabbing. The Japanese dead had been stripped of their uniforms, which had been sent to the Corps Staff for identification. They were believed to belong to the Japanese Guards newly arrived from Port Arthur.

After this there was little more fighting. The Japanese had evidently decided to waste no more men in useless attacks, and the Russians were contemplating a counter-attack, when, on the evening of the 8th March, they received the order to retire.

The total casualties in the Cable Section amounted to 1 killed, 4 wounded, and 8 missing.

The last diagram shows the Central Station, in the Sapper dug-out. connected with :—(*a*) West Kaotuling; (*b*) Centre Kaotuling; (*c*) East Kaotuling; (*d*) Artillery Observatory Hill; (*e*) Redoubts Nos. 22 and 21; and (*f*) Patzyatza, which is also connected direct to Redoubt No. 23 and by a double line to Haolinzai.

F. E. G. SKEY.

KRIEGSTECHNISCHE ZEITSCHRIFT.

9th Year. Number 9.

NOTES ON THE CONSTRUCTION OF DEFENCE WORKS ROUND PORT ARTHUR.—From *The Diary of an Engineer* by Capt. von Schwarz.—The Russo-Japanese War has shown that, whatever improvements in armament the last few years have brought in their train, military engineers are still able to provide efficient protection from the heaviest artillery fire.

It is true that the Japanese in the attacks on Port Arthur did not possess that superiority in artillery as regards both quality and quantity which is considered desirable for offensive tactics; but on the other hand it must also be admitted that the Russian artillery also reached no very high standard.

Moreover the Russians suffered from the fact that, at the outbreak of hostilities, they had no forts really completed and were compelled to make up their deficiency with hastily constructed fieldworks.

The duration of the struggle round Port Arthur under these conditions supports the belief that a capable and energetic garrison is of more value than an elaborate system of permanent forts.

The following are the chief lessons learnt from the engagements round Port Arthur, as far as defence works are concerned :—

POSITION OF WORKS.

The forts of Port Arthur lie about a mile beyond the trench defences, which are from 1 to $1\frac{1}{2}$ miles from the centre of the town.

The Japanese artillery, 2 to 3 miles away, were able to shell the town with their heavy guns from the first, and later on with their lighter guns also. As the 15-c.m. guns employed against Port Arthur have an effective range of 10,000 yards the distance of the forts from the town should not have been less than this.

INTERVAL BETWEEN WORKS.

The interval between Forts II. and III. was 2,700 yards and this was found to be too great.

Such a distance may be allowable in flat and open ground, swept by the fire from the works on each side; but in broken ground the works must be sited to thoroughly command the intervals on either side.

LATERAL COMMUNICATION.

Covered communication between the gorges of adjoining works is most desirable, and should be supplied if possible.

COVER.

Overhead cover is essential for the men serving the guns. Experience during the siege shows that the conventional parapet without overhead cover has only a traditional value. Even splinter-proof cover and small sandbag traverses were found of very little value, owing to their rapid destruction by the heavy guns of the besiegers.

The value of invisibility is therefore increased.

Covered communication from gorge to parapet was found very necessary, as was proved by the exceptionally heavy losses in Fort III. where no such covered communication existed at first.

It was found that the ground immediately in rear of each work was always under a hot fire, and therefore a covered way into the gorge from some spot on the flanks was required.

CASEMATES.

Living casemates must be as roomy as possible, well-lighted, and well ventilated. In Fort III., where the casemates were simply long corridors about 10 ft. wide, and where no attention was paid to lighting, dryness, or ventilation, disease was very prevalent.

Where wooden casemates were made, several serious fires broke out; and it appears that wood should not be used for these purposes, if it can be avoided.

The value of concrete in defence works can hardly be over-estimated, but it must always be well covered with earth. One casemate with concrete roof and 5 ft. of earth was hit several times by 28-c.m. shells without being seriously damaged.

All exposed angles must be carefully rounded off.

DITCH.

In Fort III. the deep ditch with perpendicular escarp and counterscarp proved an unsurmountable obstacle.

The ditch must however be swept by a cross fire. Machine guns and light guns firing case shot were found most efficient in protecting the ditch.

A system of countermining should be prepared in advance.

The doors and window shutters should be covered with steel, $\frac{1}{10}$ in. thick, as this protects them from fire and makes them splinter-proof against small fragments of shell.

GARRISON.

The garrison of a fort should not be under 400 men if it is to be self-supporting.

ARTILLERY.

Heavy guns should not be mounted in the forts, as they draw the fire of the enemy's heavy artillery and this conduces to a rapid destruction of the fort itself.

The heavy guns should be mounted in separate batteries; but the forts should possess lighter Q.F. guns to assist in repelling an assault.

The intermediate batteries at Port Arthur lay for the most part on the crest of the hill in order to get the best field of view. Most of them had a good field of fire at long ranges, but not at close quarters. A few were very conspicuous, and their guns were dismounted before long in consequence.

The experiences of the siege as regards the use of artillery may be epitomised as follows:—

The heavy guns destined to engage with the enemy's artillery should not be mounted in the forts but in supplementary works echeloned about 100 yards in rear of the line of forts.

In order to offer as small a target as possible, batteries of a temporary nature should only contain two guns, and permanent works only four.

There should be four permanent batteries between forts, each with a small infantry garrison. Machine guns should also be mounted in these works to assist in repelling assaults. These works would be usually constructed and the guns mounted in peace time.

Between the permanent batteries two or three semi-permanent works should be prepared in peace time, the guns being mounted on the outbreak of hostilities.

The important part played by howitzers and mortars in the siege points to the desirability of providing as many as possible, up to 50% of the total armament. The experiences of the siege prove that the destructive and moral effect far exceeds that of high velocity guns.

Although the guns in the Russian works were always at least equal in number to those at the disposal of the Japanese, yet the latter were able to concentrate a superior fire on any section of the defensive position, which may of course be considered as one of the assets of offensive tactics. On the other hand this superiority might have been greatly reduced if the Russian guns had been more mobile and if they had previously prepared alternative works.

The artillery positions must of course be concealed as much as possible, and therefore works with low commands should always be built if the local conditions permit.

As soon as the direction and point of attack is evident, the intervals opposite this point must be provided with:—

(1). Batteries of Q.F. guns to repel assault.
(2). Alternative batteries for guns which may be moved from other sections of the defence.
(3). Works to accommodate the reserve artillery, if any.

Finally, special batteries should be constructed to shell the covered approaches and saps made by the attacking force. For this purpose howitzers and mortars, firing 16-lb. to 30-lb. shell, are considered most suitable.

The attacking force was always able by concentration of fire to put some of the Q.F. batteries out of action and to interrupt the service of the other guns, and finally under cover of his shrapnel fire to bring his troops to the assault. In order to make the concentration of fire more difficult for the attacking force it is considered advisable to have a greater number of works and to mount fewer guns in each of them.

An assault was always preceded by an artillery fire of more or less duration according to the importance of the objective. This fire was continued until the assaulting columns were within 30 to 50 yards of the works.

The attacking troops naturally suffered at times from their own artillery, but this was not considered to outweigh the great advantages of artillery support to the last moment.

TELEGRAPHS, ROADS, AND RAILWAYS.

The telephone and telegraph wires should always be insulated and laid in pipes well sunk in the ground. It was found that air lines and cables laid in shallow trenches were being constantly damaged and rendered unserviceable.

For observing purposes two revolving armoured towers were found necessary, and these were connected by telephone with different parts of the fort.

The construction of roads to forts and other defence works must in future wars be constructed on very different lines to those which have obtained hitherto. The roads leading to the works round Port Arthur were impassable during the siege operations.

Sunken roads thoroughly concealed from view will be found essential, and where the road crosses a prominent rise tunnelling will generally have to be adopted.

Railway communication between works was not provided at Port Arthur, and it is questionable whether it would have been of much advantage.

Present opinion appears to be that railways for these purposes may be of little service, as their position can be located with great accuracy and they will be shelled by night and day.

Tram lines laid in the connecting trenches between works would be serviceable for conveying light guns to different points where assault was threatened.

SEARCH LIGHTS.

These were found of little use where the ground in front was undulating or broken. Over open country they were found valuable up to a range of 600 yards.

Fixed beams required strong concrete emplacements, and movable lights were found far better.

Very little damage was done to the search lights by shell fire, but they suffered considerably from rifle fire when the besiegers came to decisive ranges.

C. OTLEY PLACE.

MILITÄR WOCHENBLATT.

No. 112, 1906.

MAPS FOR AERONAUTS.—This number contains a short article by J. W. L. Moedebeck, in which it is argued that special maps will be necessary for the use of airships, which the writer assumes will take part in the wars of the future.

It is pointed out that with the advent of motor balloons the use of free balloons, except at night, will be impossible, and that there are at present great difficulties in the orientation of any balloon at night. The aeronaut at night is compared to the mariner at sea; both must depend on the senses of sight and hearing. But, whereas for the guidance of the latter there is an organised system of lighthouses so differentiated and charted as to be distinguished from one another, nothing of the sort exists for the aeronaut.

The mariner, when out of sight of land is forced to fix his position astronomically. This is out of the question for the aeronaut (though it has been suggested), for it would mean the use of instruments of precision by highly trained men, a system specially inapplicable to the soldiers of two years service who would probably man the balloon service in time of war.

It is suggested therefore that the existing illumination on land, which, viewed from above, now only leads to confusion, owing to the number and variety of the maze of lights, would, if properly tabulated and recorded on maps, perform much the same service for the aeronaut as the lighthouses do for the mariner. Attention is drawn to the permanent "light patterns" made on the dark earth's surface at night by large towns, streets, railways, factories, blast furnaces, etc., which only need tabulation and recording to be recognisable and serve as landmarks. It is suggested that aeronautic maps could be prepared easily if such information were enfaced in red on existing maps, thus converting them into a kind of light chart. The assistance to be derived from the movement of lighted passenger trains, and from road, motor, and bicycle lamps in deducing the directions of railways and roads is touched upon.

Other information which should be at the same time tabulated and noted in red on these charts, is:—The existence of high-tension electric conductors, which at present form *the greatest danger to airships*, and the position of spots where shelter can always be found from certain winds. The latter would form havens of refuge or airship harbours, and possible landing places.

It is suggested that the projected industrial census of Germany, to be carried out in 1907, would form a suitable occasion for the collection of a certain amount of the above information (more especially the presence of high-tension electric wires), which could be enfaced upon existing maps.

An obvious reply to the article is that most of the lights that exist in peace would not exist in the theatre of operations during war; and that therefore even carefully made "light-charts" based on peace conditions would be quite erroneous. Moreover, it would not be difficult to mislead aeronauts by the use of bogus lights and the transference of well-known light patterns to quite fresh spots.

E. D. SWINTON.

REVUE GÉNÉRALE DES CHEMINS DE FER.

October, 1906.

INCANDESCENT GAS LIGHTING FOR TRAINS.—For some time, as was noted in these columns, experiments with lighting of trains by incandescent gas have been in progress on the Eastern Railway of France; and this article now summarises the results of experience with the upright mantle burner—the type originally introduced—as compared with the inverted incandescent burner with globular mantle which has been adopted on the Western Railway of France. It may be remarked that our L.N.W.R. have also tried the inverted type.

The lighting comparisons were conducted by photometer tests and by figures as to the endurance of the mantles in ordinary working.

Although the inverted style is neater in appearance—not being supported underneath—it is first to be remarked that this nature of burner is specially suited to burn poor gas, *i.e.* of small illuminating power, whereas the Eastern Railway Company have in existence plant for the production of rich gas which can be conveniently used with the upright mantle.

The photometer results show that, while the inverted burner gives a more brilliant light directly underneath, it does not cast such good illumination into the parts of the compartment further from the lamp, and it is the corner seats that are usually favoured by passengers. There are a number of diagrams showing the intensity of the light in candle-mètres.

Again, the endurance of the inverted mantles is not great, though of course it may be that a tougher type may yet be produced which will last longer. Actually 67·2 per cent. perish within 15 days of work, whereas the upright mantle averages a life of 65—70 days in fast trains and 100—110 days in suburban traffic.

C. E. VICKERS.

REVUE DU GÉNIE MILITAIRE.

October, 1906.

TELEPHOTOGRAPHY.—Conclusion of the article which was commenced in the September number.

DIRIGIBLE BALLOONS.—Details are given of various experiments that have been made from time to time to ascertain the most suitable form of propeller for aerial navigation. The efficiency of a screw working in air is much increased if it is allowed to move forward, so that each blade comes in contact with an undisturbed mass of air. For this reason all experiments made with fixed propellers are misleading. It is not as yet possible to calculate the most efficient form of propeller for any particular case; but generally for a motor of given weight the best results will be obtained from a screw of large diameter, with few blades, turning comparatively slowly. The article will be continued.

J. E. E. CRASTER.

RECENT PUBLICATIONS.

Feldbefestigungs-Vorschrift vom 28 Juni, 1906. Entwurf. (12mo. Berlin).

Field Service Regulations, India. Provisional. (8vo. Calcutta).

Le Siège de Port-Arthur, par Col. Clément de Grandprey. (8vo. Paris).

La Guerre Russo-Japonaise: Historique, Enseignements, par Chef d'Escad., R. Meunier. (8vo. Paris).

Cavalry in Future Wars, by Lieut.-General Frederick von Bernhardi, VIIth Division, German Army. 3rd edition, translated by C. S. Goldman, with an introduction by Lieut.-General Sir John French, K.C.B. (9 × 6. 10s. 6d. Murray).

Cavalry on Service. Illustrated by the Advance of the German Cavalry across the Mosel in 1870. Translated from the German of General von Pelet-Narbonne, by Major D'A. Legard, 17th Lancers. ($8\frac{1}{2} \times 5\frac{1}{2}$. 7s. 6d. Rees).

Les Travaux de Fortification de Campagne et l'Armement actuel, par Lieut.-Colonel Clergerie. (2 fr. Boyer-Levrault, Paris).

Der Festungskrieg, von F.M. v. Brunner. 9th edition. (8vo. Vienna).

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West African Warfare, by C. Braithwaite Wallis, The Cameronians. ($7\frac{1}{2} \times 5$. Harrison).

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Naval Battles in the Century, by Rear-Admiral F. J. Higginson, U.S. Navy. ($8 \times 5\frac{1}{2}$. 5s. Chambers).

Recollections of a Lucknow Veteran, 1845—1876, by Major-General J. Ruggles, Colonel, 19th Punjabees. (9 × 6. 5s. Longmans, Green).

Völker Europas! Der Krieg der Zukunft, von ⁰⁰⁰⁰. (8vo. Berlin).

The Smith and Forgeman's Handbook of Practical Smithing and Forging, by Thomas Moore. ($7\frac{1}{2} \times 5$. 5s. Spon).

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Structural Steelwork. Useful tables, data, and formulæ for Engineers, Architects, and Contractors, by Edward Wood & Co. ($6\frac{1}{2} \times 4$. 5s. Edward Wood & Co.).

Attrition Tests of Road-making Stones, by E. J. Lovegrove, M. Inst. C.E., with Petrological Descriptions by J. S. Fleet, D.Sc., and J. Allen Howe, B.Sc. ($11\frac{1}{2} \times 9$. 5s. St. Bride's Press).

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Electricity Meters: Their Construction and Management, by C. H. W. Gerhardi. ($8\frac{1}{2} \times 5\frac{1}{2}$. 9s. *The Electrician*).

Manual of Wireless Telegraphy, by A. F. Collins. ($7\frac{1}{2} \times 5$. 6s. 6d. Chapman, Hall).

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The Cambridge Modern History. Vol. IV. The Thirty Years' War. ($9\frac{1}{2} \times 6\frac{1}{2}$. 16s. Cambridge University Press).

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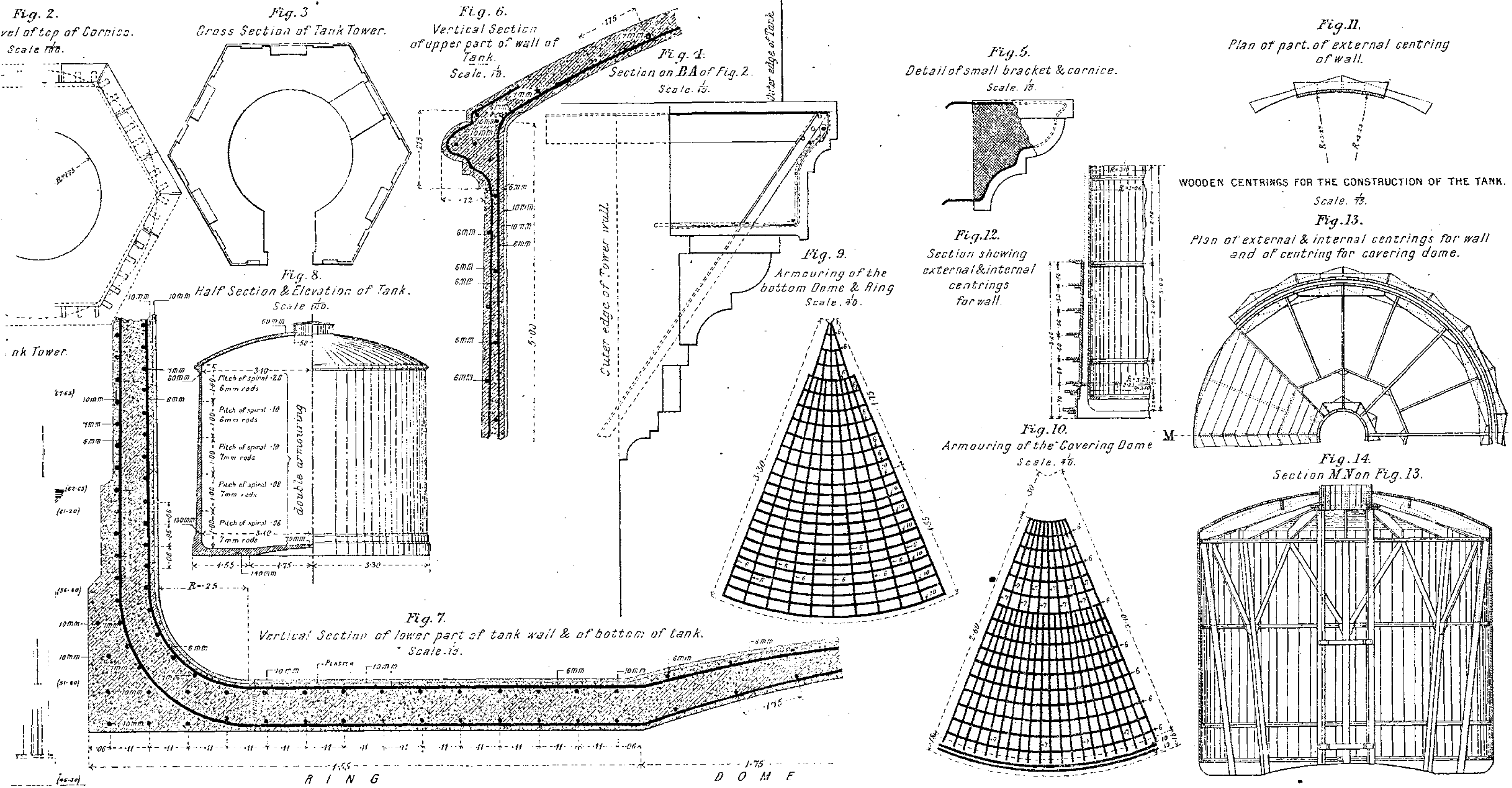
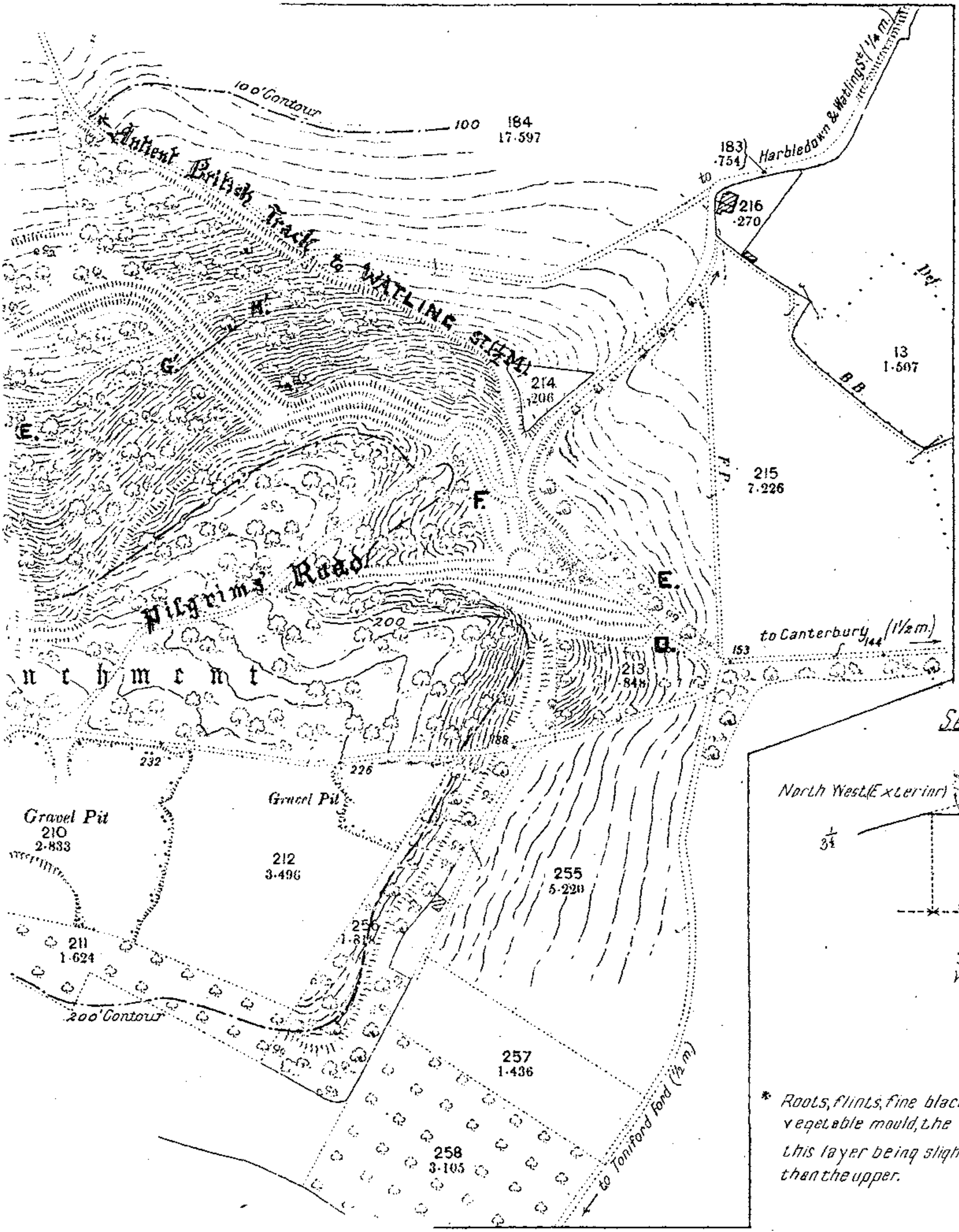
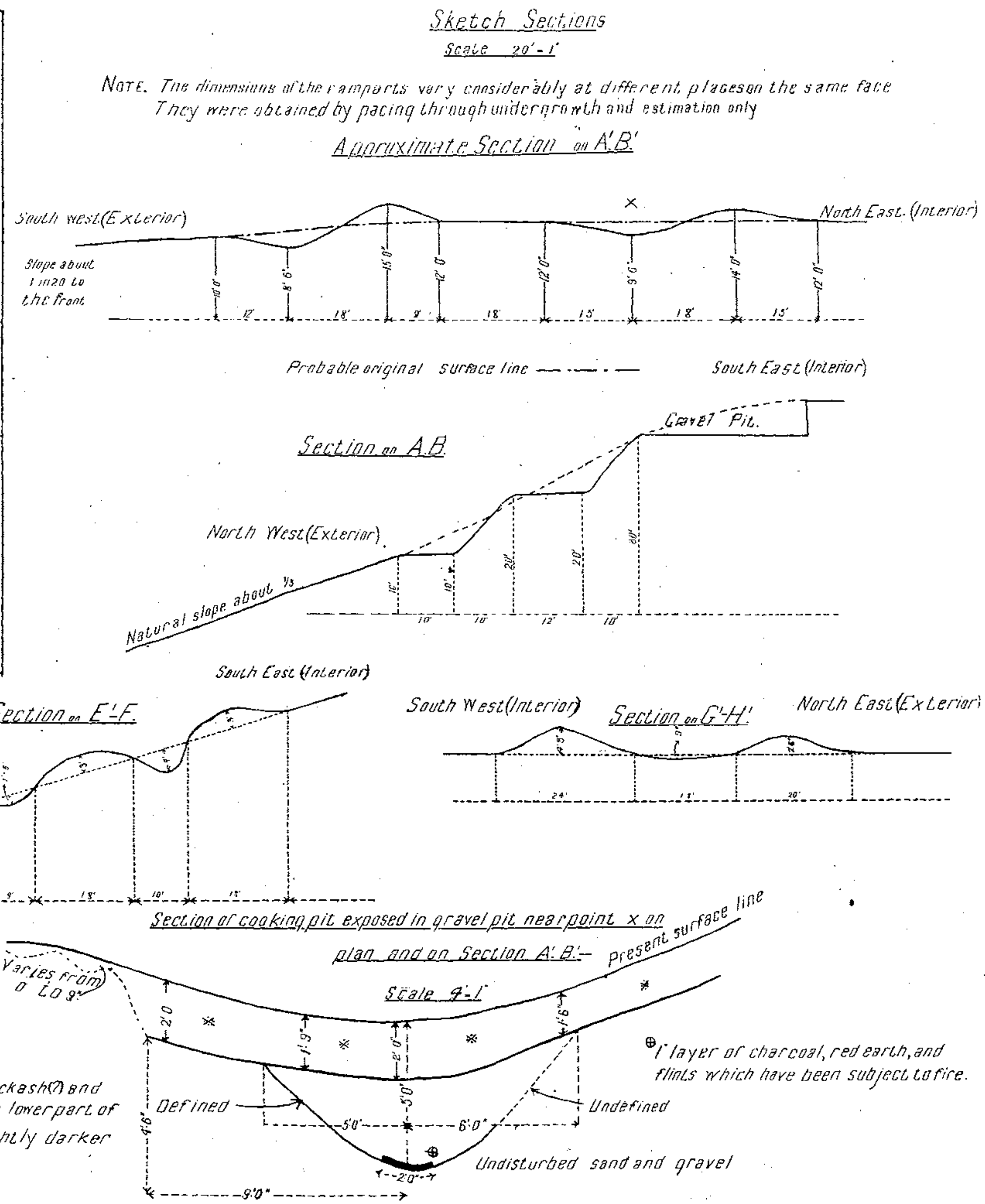
Modern Sporting Gunnery, by Henry Sharp. (9×6. 7s. 6d. Simpkin, Marshall).

LARGE TANK OF ARMOURED CONCRETE FOR THE MILITARY HOSPITAL AT ROME.




100' Contour
100
184
17·597
Antient British Track to WATLING STREET (1M)
183
·754
Harbledown & Watling St (1/4 m.)
to
216
·270
G.
H.
E.
214
·206
13
1·507
B.B.
F.P.
215
7·226
F.
Pilgrims' Road
E.
200
to Canterbury (1½ m.)
144
153
D.
213
·848
188
232
226
Gravel Pit
Gravel Pit
210
2·833
212
3·496
255
5·220
256
1·81
211
1·624
200' Contour
257
1·436
258
3·105
to Tonford Ford (½ m.)


Sketch Sections
Scale 20' - 1"
NOTE. The dimensions of the ramparts vary considerably at different places on the same face
They were obtained by pacing through undergrowth and estimation only
Approximate Section on A'B'
South west (Exterior)
North East (Interior)
Slope about 1 in 20 to the front
10'0"
8'6"
15'0"
12'0"
12'0"
9'0"
14'0"
12'0"
12'
18'
9'
18'
15'
18'
15'
Probable original surface line
South East (Interior)
Gravel Pit.
Section on A.B.
North West (Exterior)
Natural slope about 1/3
16'
10'
20'
20'
30'
10'
10'
12'
10'
South East (Interior)
Section on E'-F.
North West (Exterior)
1/3½
9'
18'
10'
15'
South West (Interior)
Section on G'-H'.
North East (Exterior)
24'
11'
20'
Section of cooking pit exposed in gravel pit near point x on plan and on Section A'B'.
Present surface line
Varies from 0 to 9"
Scale 4' - 1"
2'0"
1'9"
2'0"
1'6"
5'0"
4'6"
Defined
Undefined
5'0"
6'0"
2'0"
9'0"
Undisturbed sand and gravel
⊕ 1" layer of charcoal, red earth, and flints which have been subject to fire.
* Roots, flints, fine black ash(?) and vegetable mould, the lower part of this layer being slightly darker than the upper.