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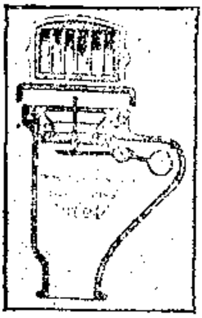

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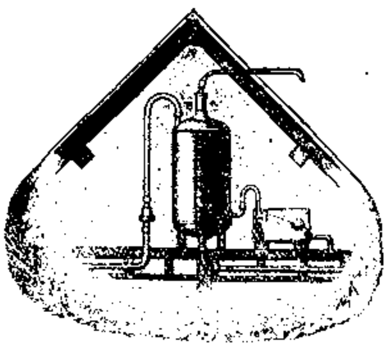

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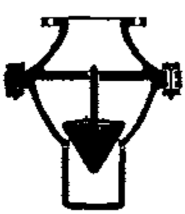

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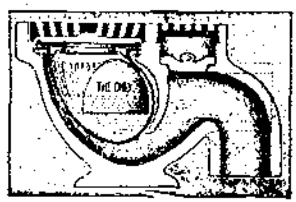

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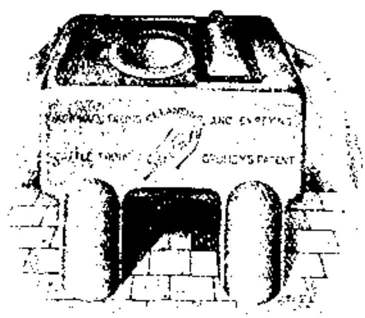

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Subject Index.

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NEW MESS AT POONA

THE NEW MESS AT EAST KIRKEE, POONA.

SINCE 1891 when the Officers of the 3rd (late Bombay) Sappers and Miners were first ordered to reside on the same bank of the river as their men, the Mess has been located in a Bungalow rented from the native landlord who owns most of the Officers' Bungalows in East Kirkee.

Although in 1905, a liberal Estimate of the original cost of the Bungalow, gave a figure somewhat lower than that representing the total rent paid for it from the date of its first hiring up to the date of making the estimate, the Corps was as far as ever from possessing a mess of its own. Added to this the increase of 5 Officers to the strength of the Corps in 1903, had given birth to a growing feeling for the need of a larger and more suitable building. A scheme for the erection of a fine building, to eventually become its absolute property, with spacious grounds containing a racquet court, a stické court, and a range of stables for Polo ponies, began to be discussed. But such a scheme was beset with innumerable difficulties, chiefly financial. Nevertheless, "necessitas etiam timidos fortes facit," and towards the close of 1905, with the invaluable assistance of Colonel Glennie, R.E., and Major Kemp, R.E., a design and estimate were made for a Mess House and two separate blocks containing a kitchen, an office, store-rooms and servants' quarters. The estimate amounted to about Rs.30,000 (£2,000) and how to obtain this large sum of money at a fair rate of interest and favourable terms of repayment was a serious problem to be solved. For its solution the Corps is for ever indebted to the kindness and influence of Sir Edmund Ellis, then Military member of the Viceroy's Council, to whom is due the fact that Government consented to regard this as a special case and to issue a loan of Rs.25,000 (£1,666) towards the realisation of the scheme.

The terms of the loan are that it is to be repaid in 15 years by annual instalments of Rs.2,184 (£146). These instalments are to be made up of the refund to Government of its annual Mess allowance of Rs.1,440 (£96) and also of Rs.744 (£50) paid annually by private subscriptions. This part of the instalments is covered by an annual subscription from each of the 21 Officers of the Corps of Rs.36 (£2 8s.). In accordance with these terms the fortunate Officers serving with the Corps on the 1st of April, 1921, will find themselves absolute possessors of a fine Mess and will in addition draw the Mess allowance of Rs.1,440 (£96) per annum from Government.

The site selected for the building will be remembered by those who have served in the Corps since 1891, as being the "Maidan" crossed on the way from East Kirkee Mess House to the Parade Ground and to the Park.

Those who served prior to that date will identify it by its being about 400 yards east of the old "Rosherville" summer house on the left bank of the river, and also to the S.W. corner of the Parade Ground overlooking the lower end of the Field Works ground.

Sound rock close to the surface was perhaps one of the reasons that first suggested this site. But apart from this it may confidently be stated that it would have been difficult to obtain a finer one, as the building stands in 14 acres of ground, with an ornamental cast-iron railing immediately around it so as to secure to the members of the Mess that privacy which the wandering native of India so delights in invading, and it has besides a magnificent view over the river towards Government House and the "ghauts" bordering on the Malabar coast.

The building is solidly constructed on a high plinth of coursed stone in lime, covering an area of 7,250 sq. ft. Its roof is of Mangalore tiles on corrugated iron sheets carried on steel trusses and purlins, or on rolled steel beams.

The hall is paved with Italian marble, and the Mess room is floored with teak planks on rails resting on masonry pillars. The remaining rooms and the verandahs are floored with cement concrete slabs.

All the walls of the rooms are covered with lime plaster, those in the Mess room being moulded in the Doric Mutular style with a frieze of Triglyphs above grooved pilasters. The remaining walls are for the present, coloured with various shades of Hall's distemper which will, it is hoped, be replaced by oil paint when the walls are thoroughly dry and funds permit.

The building was begun in April, 1906, and was occupied on the 31st of March, 1907, notwithstanding serious delays caused by the death from plague not only of the contractor's foreman of works, but also of the contractor himself. The cost was some Rs.27,000 (£1,800), the two blocks of out offices and servants' quarters not being included in this amount. The excess of Rs.2,000 (£133) over the Government loan was provided from a decoration fund generously subscribed to by old Officers of the Corps and was expended on the addition of such luxuries as the marble floor, the boarded floor and the moulded plaster, except in the two or three cases where the donors specified a sporting picture, table, or chair.

The Corps now possesses its own Mess and home. With time and careful management the furniture, which, though in keeping with the old hired building, now looks strangely out of place in its new surroundings, will be gradually replaced. The saplings already planted along the drive will in time form a shady avenue ; the lawns and gardens either in contemplation, or already in process of construction, will recall amidst the glare of hot weather, the flowers and green turf of England, and it may not be rash to prophecy that the next generation of Sappers and Miners at East Kirkee will be the happy possessors of the finest Mess in India.

Much yet remains to be done, but at present the inelastic, unaccommodating rupee controls the situation. "Spes bona dat vires."

BARRACK POLICY.

By COLONEL SIR CHAS. M. WATSON, K.C.M.G., C.B.

IN a work by Mr. Arnold-Forster,* recently published, many subjects of great interest concerning the British Army are discussed at considerable length, and, in the preface, he has invited criticism in the following words:—

> "To those of his readers who bring to the perusal of these pages "knowledge, and the consequent power and right to criticize "and condemn, he would make one appeal. It is his earnest "desire that whatever is here written should be judged upon its "merits only; that the fact that a statement is made, a proposal "submitted by one who has been and is a party politician, shall "not be allowed to have weight in any judgment that may be "formed with respect to the statement and proposal itself."

Having regard to these words, I venture to offer some observations with reference to one of the subjects dealt with by Mr. Arnold-Forster, a subject, which during the course of my service in the army, I have had considerable opportunity of studying carefully. This is the question of Barrack Policy, which forms the substance of Chapters 26, 27 and 28, and is also alluded to incidentally in other parts of the book.

The question of providing good accommodation for the British soldier is a very important one, and has received much consideration during the past half-century, but a perusal of Mr. Arnold-Forster's work would lead the ordinary reader to suppose that the matter was quite neglected until he was appointed Secretary of State for War in 1903. The criticisms with which he deals with the subject of Barracks may be summed up briefly as follows:—

1. Barracks, at the present day, are similar in essentials to those constructed in the reign of George III.
2. Although some improvements have been made in barrack accommodation from time to time, the question of the best form of barrack, from a large point of view, had not been considered prior to 1903.
3. The Corps of Royal Engineers, from their education and training, are not so competent to construct barracks as civil architects.

* *The Army in 1906—A Policy and a Vindication*, by the Right Hon. H. O. Arnold-Forster, M.P.

As regards the first of these propositions, I would remark that the only essential point in which barracks built in accordance with modern designs resemble those constructed in the reign of George III. is that they also are built for the accommodation of troops, and, in this respect, no change can well be effected. But even those barracks, which were built in the time of George III. and which still remain, have been so much altered, that the original designers would hardly recognise them. Of this, the Cavalry Barracks at Leeds is an example. Originally completed about 1820, it has been improved from time to time, and was completely reconstructed under the Barracks Act of 1890, so as to make it conform to modern ideas, so far as was possible in the case of an old barrack. It is, no doubt, rather a difficult task to convert an ancient into a modern barrack, but it is not probable that there is a single barrack in the United Kingdom which remains as it was in the days of George III., and could be taken as a standard of comparison with modern barracks.

As regards Mr. Arnold-Forster's second and third criticisms, it is better to consider them together, and, in order to do this, it is necessary to give a short resumé of Barrack Policy in the past.

From an early date in English history, fortifications and other military buildings were under the charge of the Board of Ordnance, of which the chief officer was the Master General, who held a position of great authority. The construction and repair of all military buildings was conducted by the Principal Engineer, one of the important officers of the Board, whose duties were defined by a Royal Warrant of Charles II., issued in 1683. The title of this officer was altered to that of Chief Engineer, and to that of Inspector General of Fortifications in 1802, but his duties remained practically the same until 1904, when the office was abolished. Up to the year 1792, the Chief Engineer had charge of the construction and maintenance of barracks; but, at that time, the Government of the day took away the barracks from the Board of Ordnance and established a civil barrack department, which was placed in charge of an official subordinate to the Secretary at War, who was called Barrack Master General. An account of this new system is given in Clode's *Military Forces of the Crown*, which is well worth perusal by those who are interested in the subject. A number of barracks were built, but the department did not work satisfactorily, and the Commission of Military Enquiry in 1807 reported strongly against it. The department was then re-organised and the Barrack Master General was replaced by a Barrack Board consisting of three Members. In 1817 the Board was in its turn done away with, and an Official termed the Controller of Barracks was nominated to reconstruct the department. But this arrangement did not last very long, as, in 1822, the Duke of Wellington, who was then Master General of the Ordnance, being dissatisfied with the manner in which business connected with barracks was conducted, arranged that they should be placed once more under the Inspector General of Fortifications, and that the work of construction and maintenance should be carried out by the officers of Royal Engineers as had been the case prior to 1792. The reasons which led the Duke to take this course are described in a Memorandum written by the late Field Marshal Sir John Burgoyne in 1856, part of which is as follows :—

> "The first duty of the Corps (*i.e.* of Royal Engineers) is to plan, "construct and maintain all fortifications and works of defence, "with their casemates, magazines and other essential buildings, "as well as all stores and premises that are necessary for the "Ordnance Branch; to which the Duke of Wellington, when "Master General of the Ordnance, in the year 1822, added the "barracks in the United Kingdom, to the great advantage of "the public service and to a considerable saving. The con- "struction and regulations of the barracks had been until then "conducted by a distinct Barrack Board, which had its separate "establishment and was worked entirely by civilians. The "system was expensive, the barracks usually very bad, and "many held under very objectionable tenures. These evils, "except the expense of the establishment, might have been "removed; but, having a Corps, which must be maintained on "other accounts, and which it was most desirable to retain in "strength sufficient to meet the contingencies of war, and for "reliefs to foreign stations (because it takes a long time to raise "them) there was much advantage in breaking up a separate "establishment, and in adding its duties to that of a military "service that required similar qualifications."

It would seem from the above that Sir John Burgoyne did not quite realise that the Duke of Wellington's proposal was not a new idea, but only a return to the state of affairs prior to 1792; but this was natural, as Sir John did not join the army until 1798, when the civil barrack department had been six years in operation.

The question of Barrack Policy was again raised by the Parliamentary Committee on Army Estimates in 1828, and some interesting evidence was given on the subject. For example Sir Henry Hardinge, the Clerk of the Ordnance, stated that he was not of opinion that it would be more economical to employ civil architects rather than Military Engineers in the Ordnance Department, and he considered that the construction and repair of barracks could be carried out cheaper by Engineer Officers than by any system of civil architects and clerks of works. He gave it as his opinion that Engineer Officers displayed the singular instance of being the only Officers, who, by their services in time of peace, repaid to the public the whole of their maintenance, and he also stated that he considered it would be even more impracticable to build barracks abroad by civil architects than at home, because men of talent would not be tempted for the salary that could be given to them.

The Parliamentary Committee appears to have been satisfied, and I have not been able to find any attempt to make a change in Barrack Policy up to 1855, when the Board of Ordnance was abolished, and the Inspector General of Fortifications and his duties were transferred to the War Office. The years preceding the Crimean war were quiet ones from the barrack point of view. Economy was the order of the day and few new barracks were constructed. But the war directed public attention to the army, and, on its conclusion, the question of accommodation for the British soldier was taken up with vigour. In 1857, Lord Panmure, the Secretary of State for War, appointed a Commission to enquire into the improvement of barracks and military hospitals. The Report of this Commission, issued in 1861, was very complete and may be regarded as the basis of modern improvements in barracks. Not long afterwards, Mr. Sidney Herbert, who had succeeded to the office of Secretary of State, appointed a Committee to report on the system of construction and repair of military buildings other than fortifications. The Committee went fully into the question and recommended that, upon the grounds of military policy, the construction and maintenance of works and buildings under the jurisdiction of the Secretary of State for War should continue to be conducted by the Royal Engineers as a Military Corps. The recommendation of the Committee was approved, and no change in the system of constructing and maintaining barracks was made until 1904, when a radical alteration was introduced. The office of Inspector General of Fortifications was abolished and the construction of barracks was handed over to a civil architect with the title of Director of Barrack Construction, who was made subordinate to the Parliamentary Under Secretary of State. This was a return to the policy of 1792, which, as I have already shown, was tried for a number of years and proved a failure. The reasons for this drastic change in Barrack Policy have not, so far as I am aware, ever been made public. In the Report of the War Office Reconstruction Committee of 1904 there is an allusion to a Committee of 1902 on the Construction of Barracks, and to the fact that it had recommended the formation of a new Barrack Department. But as the Report of this latter Committee has never been published, and the evidence taken has also been kept confidential, it is impossible to give the reasons upon which the recommendation was based, or to say how far it was supported by the evidence. It is to be regretted that the former precedents of having an open enquiry upon such an important subject was not maintained.

But to revert to history. Mr. Sidney Herbert in 1862 reconstructed the Barracks Improvement Commission, formed it into a Standing Committee, and invested it with full authority to examine and criticise all barrack and hospital plans, in order to ensure that they were in every respect satisfactory as regards sanitary requirements. The Committee was composed of the Quarter Master General, as President, two Royal Engineer Officers and two Military Medical Officers, to whom were added, on behalf of India, a Member of the Indian Council, a Military Medical Officer for India and a Civil Engineer, one of the Inspectors of the Local Government Board. This Committee, which received the name of "The Army Sanitary Committee" in 1865, has done most useful work, and many of the improvements carried out with regard to barracks and military hospitals were due to its action. The Committee has been reconstructed from time to time, but has continued to exist up to the present year, when it has been abolished, and its duties have been transferred to the Army Medical Advisory Board, a body composed of five Military Medical Officers, five civil Medical gentlemen, and one Officer of Royal Engineers.

Since 1862 the action taken in providing better accommodation for the British Army has been steady and continuous, and it would be impossible for anyone who had a knowledge of the subject to concur in Mr. Arnold-Forster's opinion that the barracks recently built are, except in minor details, reproductions of old designs; on the contrary, they are the result of the experience of many military experts, quite exclusive of officers of Royal Engineers. The latter, though they have had to prepare the plans and execute the work, have been entirely in the hands of the higher military authorities as regards sites, the accommodation to be provided, and indeed almost every question of importance. Every plan has had to be approved by the Army Sanitary Committee, the General of the District in which the building was to be erected, the Quarter Master General, and, in important cases, by the Commander-in-Chief and Secretary of State. So far from having a free hand in designing barracks, as Mr. Arnold-Forster seems to think, the Royal Engineer Officers have been watched and criticised from first to last, and it is well that this should have been the case, as the object was to arrive at the best result.

Mr. Arnold-Forster criticises a number of old barracks, but there is nothing he mentions with regard to them that has not been known for years; unfortunately, money was not always available in unlimited quantities, in order to bring old barracks up to date, or to replace them with new ones, and the money that was provided by Parliament was not sufficient for known requirements.

The first occasion after the Crimean war when a considerable sum was provided for the construction of barracks was in 1873, when it had been decided to localise the infantry and to establish regimental depôts; and a sum of £3,500,000 was voted by Parliament for the construction of the Barracks required. But this expenditure was for the erection of *new* barracks to enable a *new* scheme of organisation to be carried into effect, not for the improvement of existing barracks. The sums provided for the bare maintenance of the latter were too small, while the wooden huts, erected as a temporary measure after the Crimean war at Aldershot, the Curragh and other places, but which had come to be regarded as permanent barracks, were falling into decay. The Barrack question again came before Parliament in 1883, and received much consideration from the Select Committee on Army Estimates in that year. The Inspector General of Fortifications estimated that a sum of £8,913,000 was required in order to bring the accommodation for the army up to date. As a result of the evidence given before this Committee, a sum of £4,100,000 was voted by the Barrack Loan of 1890, but this was less than *half* of what was wanted to put existing barracks in a satisfactory condition, and, before the expenditure under the Barrack Loan had been completed, the question had become far more difficult in consequence of the large increases in the British Army, provided for in the Army Estimates year by year. Further sums were provided in the Military Works Loans, but a considerable part of these had to be used for the construction of new accommodation. It is believed, however, that a large proportion of the funds voted by Parliament under these Loans is still unexpended, and it is rather difficult to understand why Mr. Arnold-Forster, when Secretary of State for War, did not take up seriously the question of the improvement of old barracks, as this would have been a more practical course than criticising the actions of his predecessors after he had left the War Office.

Mr. Arnold-Forster points out the want of continuity in Barrack Policy, and explains how this has been caused by changes in Army Policy. It is perhaps unfortunate that barracks cannot be mounted on rollers and constructed of india-rubber, so that they could be moved about and altered in size in order to keep pace with the alterations in Army Policy. But as matters are at present, where a barrack is built, there it has to remain whether its situation suits the new Policy or not, and it is therefore absolutely necessary that a continuous system should be followed as regards the accommodation provided for the Army. Change in this respect leads to useless expenditure, and a good instance of this is mentioned by Mr. Arnold-Forster. It is the case of the barracks at Tidworth on Salisbury Plain where it was decided to build a military station complete in all particulars. The matter was most carefully considered and part of the buildings were provided. But Mr. Arnold-Forster tells us that it has now been decided that Tidworth is *not* the proper place for barracks, and the works have been stopped. Whether the original policy was right, or whether the present policy is right, is a matter on which I would not venture to give an opinion, but the fact remains that a scheme which had been approved by the highest authorities has been stopped before it was nearly completed.

Mr. Arnold-Forster is of opinion that modern barracks are not in accordance with modern requirements, but he only deals with one definite point. This is the question of the provision of cubicles, as opposed to the ordinary barrack room in which a number of men live together. Now the provision of cubicles is a matter which has been under consideration for many years and respecting which there are different opinions. It is naturally of great importance that there should be uniformity of accommodation in barracks, because battalions and other units are moved about from place to place and from home to stations abroad; but if cubicles were provided in new barracks, and existing barracks left without them, there would be an undesirable difference between the two classes of barracks. On the other hand, the provision of cubicles in all existing barracks would cost a very large sum, as the fact of turning ordinary barrack rooms into cubicles would entail the loss of from 25 to 30 per cent. of the accommodation. To use cubicles is out of the question in warm countries, where it is necessary to have as much air in sleeping rooms as possible. The main object of providing cubicles would appear to be, according to Mr. Arnold-Forster, to induce a better class of recruit to join the army than now enlists. But it is evident that if only a small proportion of barracks are fitted with cubicles, the chance of any individual recruit being quartered in one of these barracks would be very small, and it would be simply unfair to induce a man to enlist on the chance. Mr. Arnold-Forster bases his arguments in favour of cubicles on the experience gained in the Rowton Houses. Now the Rowton Houses are admirable institutions for the purpose for which they are intended, but the conditions of life of the inhabitants of a Rowton House, and of soldiers in barracks are not identical, as, in the former case, the inmates have to leave their cubicles in the morning and are not allowed back to them until the evening. During the day, a staff of professional cleaners take the cubicles in hand and put them in order. But I do not think that the British soldier would like to be kept out of his barrack room all day or that the Secretary of State for War would be prepared to pay a civilian staff to keep barracks clean. On the whole I am inclined to believe that cubicles for soldiers, however beautiful in theory, cannot be regarded as practical, and that to spend money upon them, having regard to the many far more important requirements of the army, would be quite unjustifiable.

Mr. Arnold-Forster gives a block plan of a barrack which was designed on the cubicle principle for the accommodation of a regiment of cavalry at Norwich, and which he considers a great improvement on any barracks hitherto designed. This plan, however, is not a new one, and it is in opposition to the elementary principles of barrack construction in a very important point, as it is in the form of a hollow square with dead angles at the interior corners. It is difficult to believe that Mr. Arnold-Forster is right, and that all the sanitary authorities, who have considered the question for many years are wrong; but the latter have always been of the opinion that there must be no dead angles in barracks, and that there must be complete ventilation round the ends of barrack buildings. In old barracks such angles were not uncommon, but whenever an old barrack has been reconstructed, as in the case of the Royal Barracks in Dublin, the first thing done was to cut out the angles. Mr. Arnold-Forster expresses his regret, and instances it as a case of want of continuity in Barrack Policy that, shortly after his departure from the War Office, his successor, Mr. Haldane, and the Army Council, decided that this barrack should not be built. This however was certainly a wise decision, and it is to be hoped that it will be adhered to, as it would be a retrograde step to build the proposed barrack.

It would be an advantage if Mr. Arnold-Forster's interesting book were to direct the attention of Members of Parliament and the public to the important question of Barrack Policy and it is to be desired that this subject, should, as in past days, be submitted to a Parliamentary Enquiry. If this could be followed by an Act of Parliament fixing definitely where new barracks were to be built and what old barracks were to be maintained, there could be no change of policy without the consent of Parliament, and much money would be saved to the country. It would then also be impossible for a Secretary of State to revolutionize the whole system of barrack construction without the matter receiving careful consideration from some authority outside the War Office.

MODERN ARTILLERY IN THE DEFENCE OF OUR SOUTH COAST.

By Colonel S. A. E. Hickson, d.s.o., R.E.

It is gratifying to see the name of Walker once more associated with the subject of Coast Defence. Nothing can conduce more towards a satisfactory solution of the thorny questions which surround this subject than a clear annunciation by individual officers of the manner in which such questions present themselves to their view. The consolation I offer to those who hesitate to enter upon such dubious paths is that which I endeavour to derive myself from the reflection that an R.E. Company which I once had the honour to command on active service was chiefly employed in removing thorns to clear the way for others—a duty of which I still bear the marks. But in a matter of such vast importance as the Coast Defence of our country none can possibly fear getting a few scratches, and few will care to inflict them. The scheme, however, which Capt. Walker has propounded in the September number of this Journal, seems to me to take the form rather of a scheme for Imperial Defence than of a "scheme for the Coast Defence of England" which is only a special branch of Imperial Defence. He takes generally, as I do, the orthodox view as to the main requirements of Imperial Defence, *i.e.* (1) A powerful navy, (2) A striking force, (3) Fixed coast defences for naval bases and ports and (4) A home army for protection against raids. The particular points to which I have myself endeavoured to invite attention are the last two of these—how best to defend our naval bases and ports and protect this country from raiding forces "which may elude the vigilance of the Navy." This I regard as the special sphere of Coast Defence, or say home army as apart from that of the Navy and striking force, which we might call the Imperial Navy and Army.

My aim has been not so much to advocate any system of Coast Defence of universal application as to investigate in particular the defence of our south coast as a strategic point of infinite importance in its relations to our Empire as a whole. In a lecture which led up to my previous articles—given to the Plymouth Garrison at which the officers present belonged mainly to the artillery and Navy as well as to the R.E.—I had asked "Have we fully considered what is likely to be the effect of the increased accuracy and range of modern artillery on Coast Defence?" This question I have repeated in both my previous articles in the *R.E. Journal*, and the same question is being discussed abroad. In fact in the *R.E. Journal* for August a

German officer has stated that the German coasts could be efficiently protected at the cost of one battleship. I myself estimated the cost of defending our south coast from the Nore to the Lizard as equivalent to that of two battleships or £4,000,000, additional to existing coast batteries, the object being both to defend the land fronts of our naval bases and to liberate for free action at sea our Channel Fleet, worth some £30,000,000, so that it need have no anxiety for the defence of our coasts.

We are, I think, all in agreement with Capt. Walker and the discussions of twenty years ago and more, that the functions of the Naval and Land Services are more or less "complementary, and that the one has to provide for the weaknesses of the other." This, however, only means that either should do just so much of the work of Coast Defence as it is best fitted for, with regard to economy and efficiency. It is, as Capt. Walker says, a question of relative value and fitness. Having regard to the economy of modern artillery for Coast Defence, as compared with ships, my desire is to see more attention given to those points in Capt. Walker's article in which he says :—

"The increased power and range of mobile artillery, and the increased volume of fire which can be developed by modern arms of all kinds, greatly enhance the difficulties of the invader; for he will have to anchor his transports further from the land, perhaps in exposed positions, and the distance over which the troops will have to be brought in small craft will be very much increased. It is during this last phase of the landing operation that the troops will be most liable to heavy loss.

"These considerations emphasize the necessity for the defender receiving early and accurate information as to the locality of the attempted landing, and of possessing ready means for assembling troops there at short notice. It may even be desirable to have permanent garrisons, and possibly fixed defences, at certain points on the coast other than large ports, where landings would be easy and to which it might be difficult to get field troops with sufficient rapidity.

"In working out the disposition of the troops told off for the defence of the intervals between defended ports, the coast should be divided into sections, as is done in any other defensive position; the general reserves in this case being concentrated in such situations as will enable them to strike at any force which may break through the coast line."

To what extent ought we practically to recognise the fact that "the increased power and range of mobile artillery and the increased volume of fire that can be developed by modern arms of all kinds, greatly enhance the difficulties of the invader"? Are we taking full advantage of these most recent developments, or are we not at the present time throwing on the Navy work much better and more cheaply done by artillery on land? This question has not been definitely answered, though Capt. Walker admits that "It may be desirable to have permanent garrisons and possibly fixed defences at certain points on the coast."

The answer to this important question I should myself formulate briefly as follows:—

Where, as in the case of our south coast, the distance between the naval bases or defended ports averages under 60 miles, the most efficient and economical manner of protecting their land fronts lies in taking full advantage of the accuracy and range of modern artillery fire, and going forward to the coast line to occupy the curtain between those naval bases or ports. To surround these with works on their land sides, and to attempt to be strong all round, on a circumference of some 30 miles or more, is far more difficult and costly than to defend 30 miles of coast naturally strong, since there accurate and long range artillery fire has every advantage of field of view and fire. Moreover it is far more easy to support a coast defence force thus distributed by an interior field force in rear, resting on strong flanks.

I propose in this discussion still to confine my remarks especially to our south coast, which may be described as the belt of armour protecting our very vitals. Behind it lies the source of our Imperial strength, whilst it is itself the sea base of the British Empire beyond, for warlike operations over the whole surface of the globe, and therefore of supreme, nay, incalculable importance. Are we bestowing sufficient attention upon it?

A glance at the map of England will show that our south coast consists of a series of bays separated by promontories, and closely resembling the bastioned front of a large fortress. At intervals along this coast line lie our strongly fortified naval bases, to each of which is assigned its specific garrison.

In my previous article on the economy of Coast Defence I estimated the cost of filling the intervals between these naval bases with land batteries—so as to entirely liberate our Navy from all anxiety for the defence of this coast—at four million pounds, which is probably excessive. The actual number of guns which would be required at each station, and the actual length of each section, would of course vary according to circumstance, but may for purposes of argument be taken, as I before calculated, for each 10 miles, at:—

1 battery of two to three heavy fixed guns (9·2″ or 12″).
1 battery of heavy mobile 5″ guns.
2 batteries of field guns, 15-pr. or 18-pr.
4 batteries of machine guns.

Probably in some cases medium (6″) fixed guns may take the place of heavy 9·2″ or 12″ guns—or be required in addition. For escorts

I reckon 50 men per battery, or say 400 per station; the continuous system of defence advocated, which I will now describe in greater detail, should not only prove the means of efficiently and economically protecting our south coast against all possibility of successful raids, but would at once obliterate the sense of insecurity created, of recent years, by treating what seems "improbable" in matters of warfare as "impossible."

The system put forward would, moreover, not only protect our coast against raids, but would also in time of war afford to our trading vessels a high degree of security, at such times as our Navy might be temporarily absent, just as Napoleon made his stores secure on the Riviera in 1795–6, and again at Boulogne in 1803–5, by means of batteries within range of one another.

Fig. I. is drawn to illustrate the system graphically. In it A^1A^2 represents roughly a certain bay on our south coast, throughout the whole length of which a beach landing could without difficulty be effected on soft sand. The five-fathom line comes to within half a mile of the beach, and the cliffs rising from the sands are, in the majority of cases, easy to ascend if not defended, or if not held by a small alert force. Of great importance is the fact that at two or three places, by no means far apart, where roads run down along valleys opening on to the beach—troops landing on the beach, if not defended, could, as in other places on our coast, march into the interior in large numbers with a view to attacking our naval bases on their land fronts. The roads are shown in plan practically as they exist in nature. If now the mobile artillery be stationed in normal times at H^1H^2 in rear of the heavy fixed batteries A^1A^2, which may be 10 to 12 miles apart, it is evident that by moving from 2 to 4 miles, either to the east or the west of these home stations, the movable armament can with ease, within less than an hour, be so deployed as to command and effectually sweep a whole bay with their fire from selected positions B_1, C_1 and B^2, C^2. Each battery would, where necessary, be accompanied by a machine-gun battery and 50 riflemen. Most advantageous of all, however, is the fact that the necessary amount of ammunition can by such an arrangement be collected beforehand at the selected sites and there stored, so that no ammunition columns are necessary, thus obviating one of the chief difficulties of inland artillery warfare. Moreover the approximate amount of ammunition desirable can be calculated on the assumption that a landing would take at least an hour to effect from the time the transports came within range of the heavy guns, on a basis somewhat as follows:—

12″ guns,	1·6 rounds per gun per minute.			On fixed platforms.
9·2″ gun,	5	do.	do.	
5″ gun,	4	do.	do.	On field carriages.
18-pr.,	8	do.	do.	

From which it will also be seen that the enemy's vessels, in attempting to approach the shore, would become liable to a volume of fire per minute as follows, if the number of guns were as given below :—

6 9·2″ guns at A^1 A^2	...	30 rounds per minute.
8 5″ guns at B^1 B^1	...	32 rounds per minute.*
16 18-pr. guns at C^1 C^1	...	128 rounds per minute.
Total volume	...	190 rounds per minute

over and above the fire of the machine guns and magazine rifles, which would move to the most favourable places as the enemy drew near. It will be seen that the two stations A^1 A^2 practically command some 30 miles run of coast.

Passing now to *Fig.* II., Y represents a port or naval base defended by works Y^1 Y^2 Y^3 Y^4 on a radius of about 5 miles. C.D. is a bay lying 10 miles to the west of it, and defended on the above principles. Manifestly by this means an enemy may be compelled to seek a landing at least 30 miles distant from Y, and there be faced by the field army before it can march inland to attack the land fronts of the fortress Y.

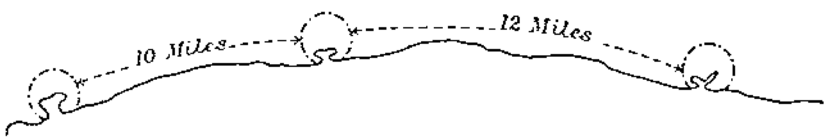
If the principles under discussion be now still further extended as shown in *Fig.* III. to two naval bases X and Y, 60 miles apart, and three intermediate stations H^1 H^2 H^3 be armed as above, then, as will be seen, we obtain at once a complete system of continuous defence, which it should be far more difficult to force, than it is possible to make the land fronts of our fortresses with our limited garrisons. Such a screen of defence works, besides giving a feeling of confidence to our inhabitants, would give time for the field army to hasten up in support. The advanced territorial brigades of the field army mobilized 5 miles in rear could, even without railways, be in position on the coast in under two hours, and railways on our south coast are everywhere available; whilst the reserves of the territorial army from say Exeter, Salisbury, Aldershot, or Tunbridge Wells, would be held ready to entrain, mobilization being frequently practised in time of peace.

Such a system, on a clearly defined coast line, would be especially suitable to our half-trained volunteer force, to which field manœuvres present many difficulties. It is put forward as very largely the outcome of a careful study of the evidence given by Sir John Burgoyne before the Parliamentary Committee of Defence of 1859. The possibility of accurate artillery range of 8,000 yards or more being reached had just then begun to come into consideration. It became at the same time evident that with such ranges the radius

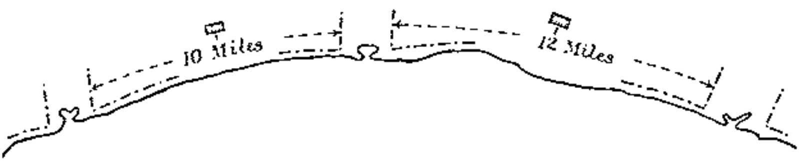
* It is important to note how slow is the fire of mobile as compared with fixed artillery of the same calibre. Thus out of the 6″ fixed gun even 11 rounds per minute is got.

of the circle of forts necessary to surround a defended harbour on the land side must be very great, and would entail a very large garrison. Likewise it became evident that in this country at that time the large garrisons necessary would not be available, and for this specific reason Sir John Burgoyne concurred that a considerable number of the forts contemplated in a particular case round one of our ports might as well be omitted. At the same time he pointed out the growing importance of being strong on the flanks of defended ports, because, with long range weapons, the enemy might thus be forced to land at a considerable distance from a defended harbour, and be compelled to enter upon a species of operations quite other than attacking forts, namely—marching inland and making a detour, before it could get at their land fronts, and so having to face the field army and engage in field manœuvres before investing the fortress.

From the above considerations, it is easy to deduce the following principle in cases where, as in the case of our south coast, the defended forts are within a reasonable distance, namely, that if instead of constructing forts in circles round their land fronts thus—



we neglect the land fronts, more especially on the faces furthest from the sea, and extend the defences on the sea fronts on either flank, thus*



we compel the enemy to land in the interval, which interval it is easy to close with the field army. From this to continuous coast batteries within range of one another—on the system adopted by Napoleon on the Riviera—is with the long range of modern heavy and medium artillery but a short step further.

At Trafalgar we overcame the last Navy capable at that time of challenging our supremacy on the sea. Numerous and powerful fleets are now once more springing into existence, and it becomes daily more certain that before long the conditions of the eighteenth century will be reproduced. We were compelled at that time to

* The harbour defences remaining as now.

fight simultaneously the Navies of France, Spain, and Holland, and so, in all reasonable probability, shall we, before long, have to fight once more a combination of naval powers against us. It is imperative then that we should bear in mind such conditions as compelled the surrender of the British Army at York Town under Cornwallis. For two months only did the French then gain command of the sea under Admiral de Grasse—largely owing to the faulty arrangements for imparting information and other mistakes of our own Admirals—not excluding even the great Rodney himself. Thus was Washington enabled to capture our whole force and inflict the final blow to our continued union with America.

Wireless telegraphy has, doubtless, improved the facilities of imparting information, but, wondrous as this system is, it has not eliminated the liability of man to err. Is it possible that we can reasonably expect to be paramount at sea everywhere and always, or is it wise to assume that our Admirals and country will never make mistakes? Writing recently to the *Morning Post*, the distinguished foreign professor, Dr. Emil Reich, stated his conviction as regards our vaunted power to build two ships to one of another power in somewhat remarkable language, maintaining that "the whole argument of two to one is cachetic with the anæmia of mere formal logic. History is not logical but psychological." Our learned critic and admirer may not be an expert strategist, but he gives us an opinion from a historic point of view, on which we may well ponder, and shows that whereas the interests of Britain are infinite and her responsibilities widely scattered, those of every other great power are comparatively confined; and that in a combination against us one of them may easily become locally paramount at sea with disastrous results to us. Ships at the present day cost millions; we shall require, in case of a great combination against us, to free every one that we can spare for active defence, calling upon our inhabitants to defend our shores with fixed or passive defences.* In deeming that our naval power, however great numerically, can be all supreme and successful everywhere and always, are we not disregarding the historic lessons of the past—Aegispotami, the Norman Conquest, York Town, and many others? Men wage war, not machines, and men are mortal and make mistakes, as the Athenians too learnt in their day, but too late.

To sum up—is it not true that

(1). England resembles a fortress of which the south coast is the most exposed front, and is strategically a front of most decisive importance.

(2). The coast line is at the present day the natural parapet of our island fortress on that front, the sea its natural glacis, as well as its natural wet ditch.

* See Mahan's *Influence of Sea Power*, p. 87.

(3). By going forward to man that parapet, we can most economically and most effectually defend the land fronts of our naval bases; not by handing it over to the enemy, and allowing him to land, whilst we ourselves recede into the interior.

(4). By manning that coast, and having guns and ammunition ready at suitable positions, we leave our naval squadrons free to combine for the active defence of our eastern and western fronts, and our communications, without needing to give a thought for our greatly exposed south coast.

(5). History shows that the land defence of an exposed coast against raids is in time of war a politico-strategic necessity, which, it neglected, leads to agitation and hampers the strategic and free movement of the Navy.

(6). Foreign navies grow daily, and, since every ship should be free for active defence, everything economically possible should be done by the land forces—*i.e.* the territorial forces and inhabitants of our coast line.

Men are wanted more than machines.

* * * * *

Since the above article was written, I have read Major Fuller's paper in the *R.E. Journal* for November, which I much appreciate, though he, too, seems not to have read me very closely. The above remarks will perhaps now sufficiently enlighten him. As he very truly says, "It is necessarily a fundamental principle of Admiralty policy that *sufficient* force shall at all times be maintained in home waters." The italics are mine. We cannot know what, at any time, may be *sufficient*, and as we lost command of the sea and York Town in 1781, so, during oversea operations, we might conceivably even lose, temporarily, the command of the sea in home waters, and a naval base be threatened. Our territorial Army, which cannot take to the sea under any circumstances, or manœuvre with facility in the field, should then be our stand-by, and in a position to protect the inhabitants of these parts of our coast which are most exposed, including our naval bases. My proposals are the natural result of the development of artillery in accuracy, range, and rapidity of fire; and the question raised is nothing "revolutionary," but merely whether under the new conditions the best line of defence against land attacks may not be on *the flanks* of our naval bases, instead of *round* them.

To make it quite clear I will give the far-seeing words of Sir John Burgoyne in 1859. Considering then the question of forts *round* our naval bases, he said: "It is one of the contingencies, which I think is the consequence of the new rifle gun, that the extent of fortifications to secure you from bombardment would be so great that it is almost impracticable ever to reach it. * * * I do not like absolutely to say that it is better not to attempt it, but I think that it is not to be put in comparison with other measures which you may adopt, considering the great expense and difficulties. * * * The great advantage of occupying *the flanks* is that it throws an enemy upon a different operation altogether; he must plunge into the interior of the country to approach any other part."

As I have shown, if the works on the inner flanks of two adjacent ports be sufficiently extended, the curtain between them is closed altogether.

As regards fogs, Generals Amherst and Wolfe waited a week, rather than attack Louisberg during a fog, and such risk is incalculable. Even in broad daylight, and in those days of smooth-bore defences, Wolfe, who led it, thought the attack rash and ill-advised, and its success very fortunate, and due only to the want of a few alert men in the right spot, as was the case also at Quebec.

Finally, may I be permitted to draw attention to a few points which appear to have escaped the attention of some of your readers. I have never at any time suggested, or intended to suggest, either the use of fixed defences *alone*, or the adoption of a continuous line of defensive works *round* the British Isles. My desire has been to consider how to defend our exposed south coast, and especially our naval bases therein, most effectually and economically with modern weapons, and how in their own interests the local inhabitants of our coast might best make use of modern developments. "Occasional heavy fixed batteries, with movable artillery, machine guns, etc., to move up rapidly between them, is the suggestion." * * * "My desire is to inculcate the lesson that the defence of our coasts is the defence of our homes, and that it takes but a little sacrifice of time to learn to manipulate a gun", (see *R.E. Journal* for March, 1907). I have endeavoured also to show that land attacks on our naval bases may, with modern weapons, be best checked on the coast line, and to save those interested the trouble, I calculated the number of fixed, mobile, and machine guns, and even the number of men that might be needed for purely Coast Defence, an art so especially suitable to troops unskilled at manœuvre, but easily trained to man fixed defences.

By economy I mean getting the greatest value out of the best weapons and men the times afford, and *developing our Imperial resources for offence to the utmost, by making the most profitable possible use of the territorial troops efficiently armed*, as a security against raids which may, in times of stress, evade the vigilance of our Navy. The inhabitants of our coasts are the best suited to defend those coasts, *i.e.* such of them as do not join the regular forces.

To use the recent words of Lord Roberts—"However powerful and strong our Navy, circumstances might arise over which the sailors might have no control, which would prevent our fleets being on the spot at the critical moment. It is essential for the safety of the country, therefore, that in addition to the Navy, we should have a sufficient, efficient, and thoroughly organised land force." And again Sir Ian Hamilton, speaking this week, quoting Clausewitz, says: "If a weak state opposed to a powerful one cannot take refuge in a general call of the male population or in a militia system resembling it, then the *increase of its artillery* is certainly the shortest way of bringing its weak army nearer to an equality with that of the enemy, *for it saves men and intensifies the essential principle of military force*, that is the destructive principle."

DESIGN FOR AN INDIAN TROOP STABLE.

THE question of the provision of reasonably good troop stabling at a moderate figure is a matter that is constantly occupying the minds of those responsible for getting the best value out of the works estimates.

The veterinary and regimental authorities are continually urging claims for greater space, better flooring, improved ventilation, additional conveniences such as expense forage stores, litter sheds, etc., all of which are no doubt desirable. The result is that our standard plan of troop stable at home (Standard Plan No. 29), with its high-class fittings, blue brick-paved floor, and ample cubic space (1,500 c. ft.), is a model of what such buildings should be; but it costs on the average £60 per horse to erect.

Cavalry regiments going out to India are apt to look askance at the simple shed consisting of nothing but a roof carried by a number of pillars, with perhaps an earthen floor, and a total absence of all the fittings and accessories to which they have been accustomed.

Good stabling is of much importance to the health of horses in a trying climate, but it must be borne in mind that what is suitable in England is absolutely unsuitable in a tropical climate. In India the chief essential is roof covering that will be sufficient to protect both the horses and men working in the stables without topees from the fierce rays of the sun; next in importance is the freest possible circulation of air through the stable and a liberal spacing of the horses; walls are therefore best omitted, and protection from glare given when necessary by bamboo screens, which can be rolled up in the morning and evening.

Horses are best arranged in all tropical climates in stables that are practically open to the air, with their heads towards a central feeding passage, thus reducing the glare in their eyes, giving greater protection from the sun, and simplifying the work of feeding and watering.

The materials of which the stable is built need to be carefully chosen. A stable with an earthen floor, pillars of sun-dried brickwork, and roof of country tiling carried on wood framing will be much cooler than one built of burnt bricks and with a steel-trussed roof and superior hard burnt tiles, especially if a brick-paved floor is given to add to the heat-absorbing surfaces; it does not therefore follow that the more expensive stable is in all respects the best.

The Government of India some years ago decided to put a check on the erection of expensive stabling for troop horses, and issued an arbitrary order that no troop stable should cost more than Rs.100 per horse. This figure has now been altered to Rs.125 (£8), and a number of designs have been made to meet the conditions. The design shown in the illustrations has been prepared by Major E. R. B. Stokes-Roberts, R.E., and Capt. W. H. Evans, R.E., and promises to be the cheapest and most suitable. Economy has been effected by an ingenious arrangement of roof timbering, and the full authorized clear standing of 14′ × 8′ per horse with a 5-ft. feeding passage has been provided.

ON METHODS OF ANGLE MEASUREMENT IN PRIMARY SURVEY.

By G. TYRRELL McCAW, M.A., F.R.A.S.

ALTHOUGH with the publication in 1858 of the *Account of the Principal Triangulation of Great Britain and Ireland*, the subject of Practical Geodesy ceased to be considered a matter of importance in the United Kingdom itself, the same can by no means be said of India and the Colonies. The Great Triangulation Survey of India was then in full progress, and although the great scheme of Everest was finally completed in the early eighties of last century, the acquisition of new territories on the frontiers of the Peninsula necessitated considerable extensions of the original scheme which are still in progress. In 1883, through the efforts of Sir David Gill, K.C.B., the Geodetic Survey of South Africa was instituted under the direction of Colonel (now Sir William) Morris, R.E., and has been carried on by Royal Engineer and Civil Surveyors more or less continuously ever since. When the African Arc of the Thirtieth Meridian is complete, the whole, with the exception of 7 degrees in German East Africa, will have been carried out under British direction. When the vast extent of this work is considered, it will be seen that Great Britain and her Colonies will have contributed more to the measurement of the geoid than any other country.

Not so much has been accomplished in this country in the realm of theoretical geodesy, though the names of Maclaurin, Stokes, Airy and Clarke will remain conspicuous. Nor in recent years have we advanced at equal pace with the Germans and French in the improvements of instruments, or with the Americans in the most efficient means of field procedure. There can be no doubt of course that a given course of procedure, founded on correct lines at the outset and uniformly pursued, as for example in the Indian Survey with its magnificent record of over 100 years, should not be changed without grave consideration; but this argument cannot apply to more modern surveys. Further, those methods should be adopted which, after investigation, prove most adaptable to the conditions in a given country: it by no means follows that the procedure suitable in temperate or civilized lands is that best adapted to the sub-arctics or tropics.

Among the more recent developments in field procedure which have not yet received sufficient attention in this country may be mentioned the more complete study of the most efficient methods of angle measurement.

In all methods it has been for a long time the custom to measure each angle a certain number of times on different arcs of the circle; and it is obvious that to eliminate periodic as well as accidental errors of the division traces, these arcs should be symmetrically disposed round the circle.

Theodolites with two micrometer microscopes are generally employed; yet there is much to be said in favour of the older type with three micrometers, in spite of the greater amount of observation entailed. It is obvious from *Fig.* 1 that, when the instrument is reversed from "Circle Right" to "Circle Left" by transiting

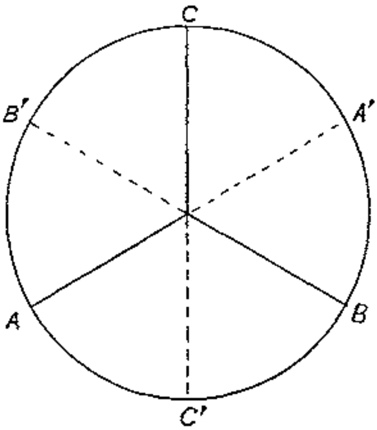


FIG. 1.

the telescope (without changing the zero of the circle), the three micrometers read on totally different parts of the circle, while with an even number of micrometers the same reading divisions are repeated. Thus, suppose that there are 8 arcs, the following programmes indicate the effect of systematic change of zero for both types of instrument.

INSTRUMENT WITH TWO MICROMETERS.

	CIRCLE RIGHT.								CIRCLE LEFT.							
Arcs.	I.	II	III.	IV.	V.	VI.	VII.	VIII.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Micro. A...	0	22½	45	67½	90	112½	135	157½	180	202½	225	247½	270	292½	315	337½
,, B...	180	202½	225	247½	270	292½	315	337½	0	22½	45	67½	90	112½	135	157½

INSTRUMENT WITH THREE MICROMETERS.

	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Micro. A...	0	22½	45	67½	90	112½	135	157½	180	202½	225	247½	270	292½	315	337½
,, B...	120	142½	165	187½	210	232½	255	277½	300	322½	345	7½	30	52½	75	97½
,, C...	240	262½	285	307½	330	352½	15	37½	60	82½	105	127½	150	172½	195	217½

Thus, while in the first case the setting divisions repeat themselves, in the second no two are alike. In the first programme each signal is read on 8 separate divisions per micrometer, in the second on 16. No doubt with the former instrument we might change the zero by $11\frac{1}{4}^\circ$ between "Circle Right" and "Circle Left" without destroying the symmetry, since with two micrometers we need only consider one-half of the limb. There is however a slight advantage in the check on the accuracy which is afforded by simple reversal without change of zero—a control moreover which is only possible with an even number of micrometers, and which is the only test of the consistency of his results which the surveyor has at his disposal. Further certain instrumental errors are eliminated by simple reversal of the telescope, but as these errors arise in far greater measure from parts of the instrument other than the limb of the circle, there can accrue no appreciable error from the mere change of the zero at the same time as the reversal—unless, indeed, in the operation of changing one should distort the circle. This however is a danger to be avoided in any case at every change of zero.

At this point it will be well to refer to a confusion which may sometimes arise. The word "arc" is sometimes applied to a single *round* of observations, sometimes to a double round of "Circle Right" and "Circle Left," when there is no change of zero. We shall employ it in the latter sense, though the signification is by no means clear when there is an odd number of micrometers. It would seem better to use the English word "setting" or the French word "*mise*." The U.S. Coast Survey employs the word "position" in this sense.

The directions of angles of all the signals should be measured the same number of times at all the stations, so as to avoid the necessity of the laborious "station adjustment." This uniformity is not however always possible, as for example in the case of the recent Russo-Swedish Survey in Spitzbergen, where the meteorological conditions were exceptionally adverse.

There are three methods by which a series of angles or directions may be measured: (1) the method of full rounds; (2) the method by bearings; (3) the method of angles in all combinations.

I. THE METHOD WITH FULL ROUNDS.

It is important here to distinguish angle-measures from direction-measures. The distinction is at once apparent from the relation (*vide Fig.* 2):

$$\text{Angle } 1O2 = \text{Direction } 2 - \text{Direction } 1.$$

This distinction is necessary in considering the manner in which the surrounding signals are to be read, also the method by which the local adjustment is to be made. Thus, where direction-measures with full rounds are made, as in Great Britain and Ireland, the United States, etc., it is only necessary to observe in rotation the signals 1, 2, 3, 4, 5; while for angle-measures with full rounds, one must observe in succession 1, 2, 3, 4, 5, 1, that is, one must return to the initial signal. This is the method used in India and in part of South Africa.

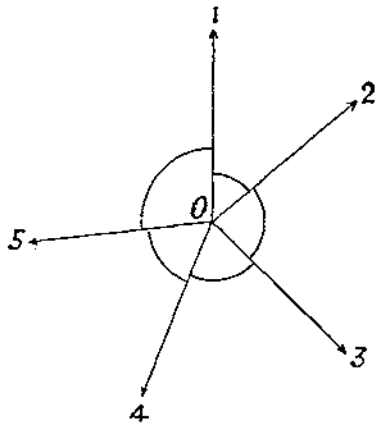


FIG. 2.

There has been considerable difference of opinion as to the question of measuring full rounds in terms of angles or directions. It would appear at first sight that, when angles are measured and the initial signal is always the same, the initial direction must carry double weight. It seems also to the writer that, supposing the surveyor is to attach weight to his observations, the natural course is to weight the directions, and that the weight of an angle-measure can only justly be estimated from that of the two enclosing direction-measures.

Whether angles or directions be measured, the method with full rounds is open to serious objections on practical grounds. In nearly all primary work, since the distances as a rule exceed 15 miles, it is necessary to use illuminated signals, such as heliotropes, spheres of polished copper (as employed by Bessel), selenotropes, projection lanterns. Where night observations can be made, one can as a rule depend on detecting all the lights unless rain, fog or haze supervene; it is however far otherwise when sunlight or moonlight is utilized. Accordingly the missing direction should be remeasured on some future occasion, or else, the division errors of the circle having been determined, the missing value should be interpolated in the series of arcs so that we may not upset that symmetrical reading of the circle on which we depend for the elimination of the periodic errors. Where the missing direction is read later, the angle so measured enters with greater weight than if it were measured in the round, for instrumental reasons. In the Indian triangulation this was allowed for, but the introduction of weight into the measures should be avoided if possible, as it adds considerably to the work of compensation. In Bessel's method of compensation where certain observations were missing the local adjustment of the observed angles around one station alone was a calculation of some difficulty. Unfortunately too it oftens happens that several signals may fail to show up during the course of a round, so that it becomes a question whether it is worth while observing the remainder.

There is however another objection to this method which is often more serious than the above. Especially when the number of signals is comparatively great, not only does the risk of losing many measures increase, but the time which elapses during one round of measures is considerable. This element of time becomes very important in two cases. In some level countries stations have to be established on the top of specially constructed wood-trussed towers or even in certain places on very high trees. Here it becomes imperative to carry through the observations as quickly as possible, particularly where a watch telescope is not used, for these lofty perches are, geodetically speaking, very unstable. Again in tropical countries, the sudden changes of temperature which take place set up most perplexing changes in the instruments themselves, especially in theodolites with prisms. These instruments, largely used in Germany and on the Continent generally, are extremely convenient for various kinds of work, but where observations are extended over half an hour or even less when the temperature is rapidly changing, considerable discrepancies are likely to arise due to temperature effects on the prism. The best test of this is afforded by observations for the determination of the collimation constant; the writer found that by loosening the screws by which such a prism was held in its cell, as far as could be done without fear of losing contact, the effect of temperature was considerably reduced.

These objections to the method of measurement with full rounds are not academic, but present themselves very forcibly to the surveyor in the field. To overcome them, the second method, that of bearings has been used.

II. METHOD OF BEARINGS.

In this method all the signals are referred to a single object, which may be one of the signals; but, as there are objections to this course, it is advisable that a Referring Object, or *Mire* if the mark is in the meridian, should be constructed, and all measures made to it. Thus for one setting of the instrument, only two objects need be observed; if only one signal be visible, work may proceed none the less; and the time of observing the two directions is so short that instrumental errors are strictly limited. Against the fact however that work can nearly always proceed, even in the cloudiest weather, must be set the disadvantage that the number of observations is considerably increased. To keep the number as low as can be, the stations should if possible be read in pairs thus: Circle R., 1 M 2; Circle L., 2 M 1, M being the *mire*. The reduction of labour is not so apparent when the number of signals is odd. Even with this reduction, the number of measures is still considerable as a table later on will show. For this reason, and the trouble of constructing a *mire*, the undoubted advantages of this method are somewhat negatived. The number of observations in one case in the table is increased $37\frac{1}{2}\%$. Nevertheless in very cloudy weather the work will progress more rapidly than if the first method were utilised, and it is certain that the work will be more accurate and every mean measure will enter into the compensation with precisely equal weight. It may be added that perfect fixity of the *mire* is essential, especially if the latter is comparatively near the station.

III. METHOD OF ANGLES IN ALL COMBINATIONS.

The third method has been developed in Germany by General Schreiber and is a method of angle-measurement like II. Thus, suppose there are four signals (*vide Fig.* 3). Measure the angles

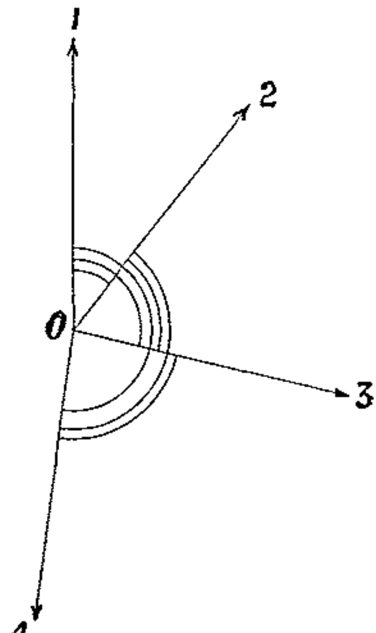


FIG. 3.

1O2, 1O3, 1O4; 2O3, 2O4; 3O4. There are thus 6 measures of 3 independent angles. In general, if the number of signals be *n* there are $\frac{n(n-1)}{1.2}$ combinations in the group, and the number of independent angles is $n-1$. Accordingly there are $\frac{n}{2}$ angle-measures per independent angle. Again it is easily proved that each independent angle in the group is measured an equal number of times. This can be shown in three ways. In the first place, it is obvious that the number of measures of direction of each signal is the same; in our example this number is 3. Again one can argue from considerations of symmetry that there is no reason why any one signal should be chosen as the initial in preference to any other. Or again, the proof can be obtained directly; for, in our example, $\widehat{14}-\widehat{13}=\widehat{34}$; $\widehat{14}-\widehat{24}=\widehat{12}$; $\widehat{24}-\widehat{34}=\widehat{23}$. The proof by this last method appears not so obvious when the number of signals is odd, but by setting out two groups instead of one, it will be found easy to get the independent angles in equal numbers.

Though the weight of every angle in a group of combinations has thus been shown to be the same, the weight nevertheless changes with the number of signals, and (as we have seen) varies as $\frac{n}{2}$, that is to say, is directly proportional to the number. Consequently, as the observer moves from one station to another, the weight in general will change. If however we can find some constant integral number N, of which n is an aliquot part, and if we repeat the group of combinations $\frac{N}{n}$ times, it is obvious that the mean of the series of groups will always have the same weight, since we shall then always have at all stations the same number of measures of the independent angles. Suppose then that a scheme of triangulation is such that the *maximum* number of signals to be observed at any single station is 8, it is required to find the least common multiple of all the numbers up to 8. This L.C.M. is 840. But this is an impossible number, since it would mean that in case of two signals, each group of combinations must be repeated 420 times; if the signals be 3 in number, the combinations must be repeated 280 times; if they are 4 in number, 210 times, etc. It is therefore obvious that in general it is not possible to secure equal weighting by this method. Let us however for a moment neglect those stations at which the number of signals is either 5 or 7; we shall consider later the effect of this omission. The L.C.M. of the remaining numbers, 2, 3, 4, 6, 8, is only 24—a workable number. Accordingly

the combinations of angles	between	2	signals are to be measured	12	times
do.	do.	3	do.	8	,,
do.	do.	4	do.	6	,,
do.	do.	6	do.	4	,,
do.	do.	8	do.	3	,,

ARTILLERY IN COAST DEFENCE

Fig I

Artillery deployed along a bay 12 Miles long

Scale 3¼ Miles to 1 Inch

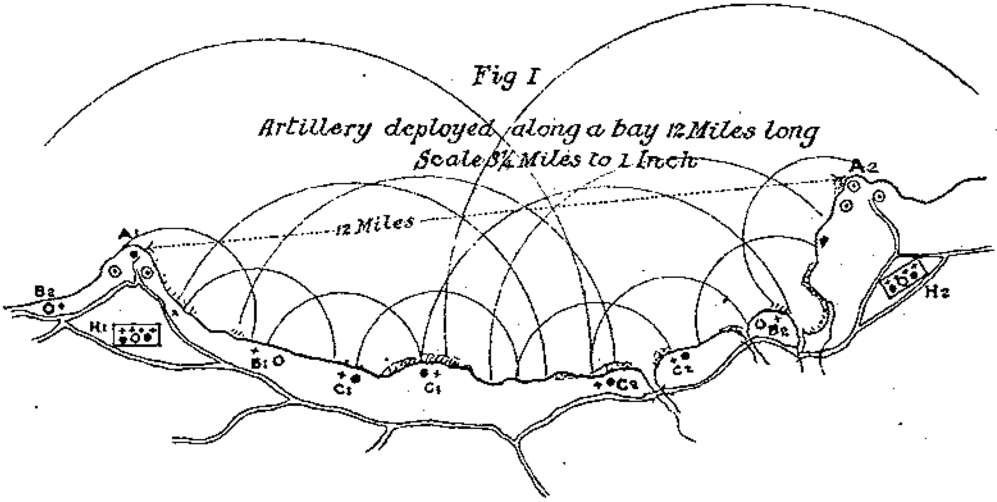


Fig II

Artillery on the flank of a Fortress

Scale 6¼ Miles to 1 Inch

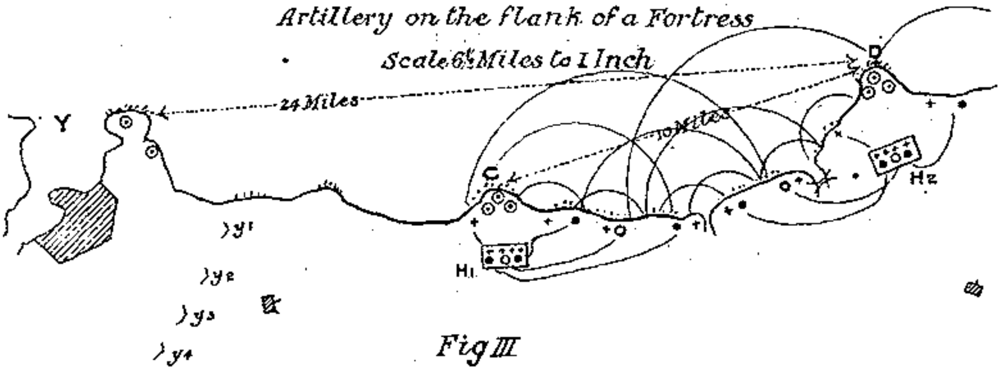
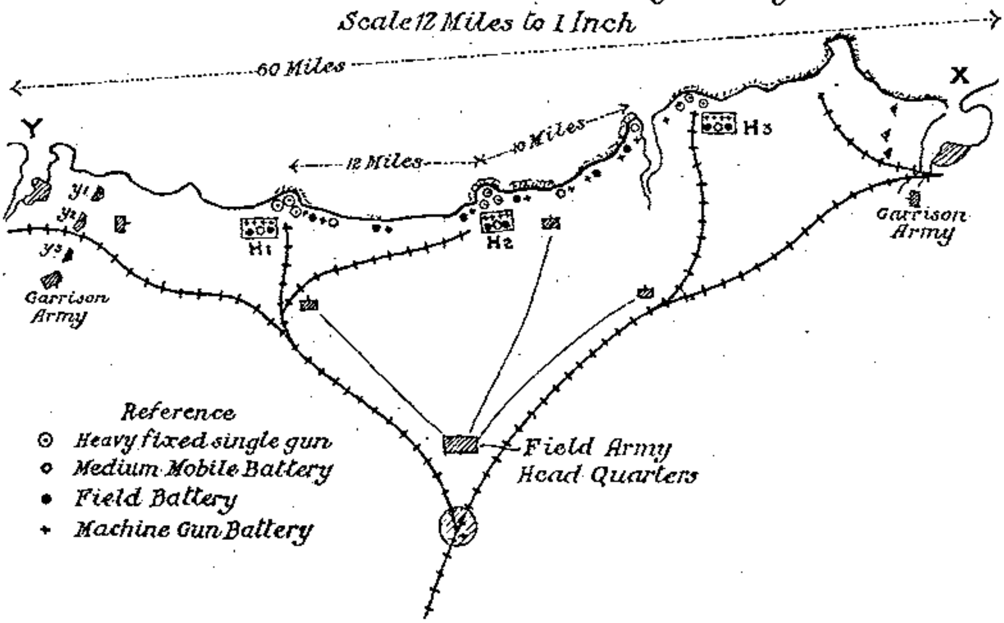


Fig III

Interval between two Fortress closed by Artillery

Scale 12 Miles to 1 Inch



Were it to happen then that the triangulation were such that at no station did their exist either 5 or 7 signals to be observed, there would be under the above scheme perfect weighting of all the angles throughout the survey.

The special cases, where the signals are 5 or 7, cannot however be rejected. Suppose that, the signals being 5 in number, the group of combinations is repeated 5 times. The equivalent weight then of each angle is 25 as against 24 in the general case; this difference in weight is practically negligible. Should the number of signals be 7 and the group of combinations formed therefrom be repeated 4 times, the equivalent weight is 28; this is after all only one-sixth greater than the standard 24, and the discordance is not very great; in general it is unlikely that it would be necessary to attach a special weight to this special case, as it is not likely to occur often in lines of single chain.

To obviate the discrepancies in these two special cases, we may divide up the signals into two sections. Thus, where the total number of signals is 7, we may reconsider the number as divided into 2 sections of 4 signals each, one signal being common to each section; or we may read the two sections in groups of 6 and 2. Where the number of signals is 5, it will not as a rule be worth while to divide this number into sections; yet it may be desirable to split up the signals for other reasons, in which case the two sections will contain 3 signals each or 4 and 2.

The scheme then for observing the angles is that described above, with the addition that the directions must be uniformly distributed over the circle.

Since the number of repetitions is $\frac{24}{n}$ $\left(\text{or in the two special cases } \frac{25}{n} \text{ and } \frac{28}{n}\right)$, the shift of the zero for the repetitions must be $180^\circ \times \frac{n}{24}$. Thus if n be 4, this shift is 30°; if n be 5 it is $180^\circ \times \frac{5}{25} = 36^\circ$. But we must also consider the shift for each successive combination, which may be called the "group shift." The group shift must also be a symmetrical division between the $\frac{n(n-1)}{1.2}$ angles of the group. Further, since each direction occurs $(n-1)$ times in the group of combinations, the group shift for each direction must take place at least $(n-1)$ times. Now since $\frac{n(n-1)}{1.2}$ consists of two factors which are integers whether n is odd or even, the "repetition shift" may be subdivided into n or $(n-1)$ parts according as n is odd or even, since neither number is less than $n-1$, according to the condition above. Hence the group shift is $\frac{180 \times n}{N.n}$ or $\frac{180 \times n}{N.(n-1)}$, according as n is odd or even. Thus the programmes of observation are to be constructed according to the following scheme :—

Signals.	Repetition Shift.		Group Shift.	
	°	′	°	′
2	15	0	15	0
3	22	30	7	30
4	30	0	10	0
5	36	0	7	12
6	45	0	9	0
7	45	0	6	26
8	60	0	8	34
9	60	0	6	40

The programmes are then as follows. It will be observed that the observations are divided between "Circle R." and "Circle L."

NUMBER OF SIGNALS = 2.

Combinations.	R.	R.	R.	R.	R.	R.	L.	L.	L.	L.	L.	L.
$\widehat{12}$	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°

NUMBER OF SIGNALS = 3.

Combinations.	R.	R.	R.	R.	L.	L.	L.	L.
	°	°	°	°	°	°	°	°
$\widehat{12}$	0	$22\frac{1}{2}$	45	$67\frac{1}{2}$	90	$112\frac{1}{2}$	135	$157\frac{1}{2}$
$\widehat{13}$	$7\frac{1}{2}$	30	$52\frac{1}{2}$	75	$97\frac{1}{2}$	120	$142\frac{1}{2}$	165
$\widehat{23}$	15	$37\frac{1}{2}$	60	$82\frac{1}{2}$	105	$127\frac{1}{2}$	150	$172\frac{1}{2}$

NUMBER OF SIGNALS = 4.

Combinations.	R.	R.	R.	L.	L.	L.
	°	°	°	°	°	°
$\widehat{12}$	0	30	60	90	120	150
$\widehat{13}$	10	40	70	100	130	160
$\widehat{14}$	20	50	80	110	140	170
$\widehat{23}$	20	50	80	110	140	170
$\widehat{24}$	10	40	70	100	130	160
$\widehat{34}$	0	30	60	90	120	150

NUMBER OF SIGNALS = 5.

Combinations.	R.		R.		R.		L.		L.		L.	
	°	′	°	′	°	′	°	′	°	′	°	′
$\widehat{12}$	0		36		72		..		108		144	
$\widehat{13}$	7	10	43	10	79	10	...		115	10	151	10
$\widehat{14}$	14	20	50	20	86	20	...		122	20	158	20
$\widehat{15}$	21	40	57	40	93	40	...		129	40	165	40
$\widehat{23}$	14	20	50	20	86	20	...		122	20	158	20
$\widehat{24}$	21	40	57	40	...		93	40	129	40	165	40
$\widehat{25}$	28	50	64	50	...		100	50	136	50	172	50
$\widehat{34}$	28	50	64	50	...		100	50	136	50	172	50
$\widehat{35}$	0		36		...		72		108		144	
$\widehat{45}$	7	10	43	10	...		79	10	115	10	151	10

NUMBER OF SIGNALS = 6.

Combinations.	R.	R.	L.	L.
	°	°	°	°
$\widehat{12}$	0	45	90	135
$\widehat{13}$	9	54	99	144
$\widehat{14}$	18	63	108	153
$\widehat{15}$	27	72	117	162
$\widehat{16}$	36	81	126	171
$\widehat{23}$	36	81	126	171
$\widehat{24}$	27	72	117	162
$\widehat{25}$	9	54	99	144
$\widehat{26}$	18	63	108	153
$\widehat{34}$	0	45	90	135
$\widehat{35}$	18	63	108	153
$\widehat{36}$	27	72	117	162
$\widehat{45}$	36	81	126	171
$\widehat{46}$	9	54	99	144
$\widehat{56}$	0	45	90	135

NUMBER OF SIGNALS = 7.

Combinations.	R.		R.		L.		L.	
	°	'	°	'	°	'	°	'
$\widehat{12}$	0		45		90		135	
$\widehat{13}$	6	20	51	20	96	20	141	20
$\widehat{14}$	12	50	57	50	102	50	147	50
$\widehat{15}$	19	20	64	20	109	20	154	20
$\widehat{16}$	25	40	70	40	115	40	160	40
$\widehat{17}$	32	10	77	10	122	10	167	10
$\widehat{23}$	12	50	57	50	102	50	147	50
$\widehat{24}$	19	20	64	20	109	20	154	20
$\widehat{25}$	25	40	70	40	115	40	160	40
$\widehat{26}$	32	10	77	10	122	10	167	10
$\widehat{27}$	38	40	83	40	128	40	173	40
$\widehat{34}$	25	40	70	40	115	40	160	40
$\widehat{35}$	32	10	77	10	122	10	167	10
$\widehat{36}$	38	40	83	40	128	40	173	40
$\widehat{37}$	0		45		90		135	
$\widehat{45}$	38	40	83	40	128	40	173	40
$\widehat{46}$	0		45		90		135	
$\widehat{47}$	6	20	51	20	96	20	141	20
$\widehat{56}$	6	20	51	20	96	20	141	20
$\widehat{57}$	12	50	57	50	102	50	147	50
$\widehat{67}$	19	20	64	20	109	20	154	20

NUMBER OF SIGNALS = 8.

Combinations.	R.		R.		L.		L.	
	°	'	°	'	°	'	°	'
$\widehat{12}$	0		60		...		120	
$\widehat{13}$	8	30	68	30	...		128	30
$\widehat{14}$	17	10	77	10	...		137	10
$\widehat{15}$	25	40	85	40	...		145	40
$\widehat{16}$	34	20	94	20	...		154	20
$\widehat{17}$	42	50	102	50	...		162	50
$\widehat{18}$	51	30	111	30	...		171	30
$\widehat{23}$	51	30	111	30	...		171	30

NUMBER OF SIGNALS = 8.—*Cont.*

Combinations.	R.	R.	L.	L.
	° ′	° ′	° ′	° ′
$\widehat{24}$	42 50	102 50	...	162 50
$\widehat{25}$	34 20	94 20	...	154 20
$\widehat{26}$	25 40	85 40	...	145 40
$\widehat{27}$	17 10	77 10	...	137 10
$\widehat{28}$	8 30	68 30	...	128 30
$\widehat{34}$	0	60	...	120
$\widehat{35}$	17 10	...	77 10	137 10
$\widehat{36}$	42 50	...	102 50	162 50
$\widehat{37}$	25 40	...	85 40	145 40
$\widehat{38}$	34 20	...	94 20	154 20
$\widehat{45}$	8 30	..	68 30	128 30
$\widehat{46}$	51 30	...	111 30	171 30
$\widehat{47}$	34 20	...	94 20	154 20
$\widehat{48}$	25 40	...	85 40	145 40
$\widehat{56}$	0	...	60	120
$\widehat{57}$	51 30	...	111 30	171 30
$\widehat{58}$	42 50	...	102 50	162 50
$\widehat{67}$	8 30	...	68 30	128 30
$\widehat{68}$	17 10	...	77 10	137 10
$\widehat{78}$	0	...	60	120

Schreiber's method has much to commend it. (1) It avoids delay of waiting for signals; (2) there is no necessity to erect a R.O. as in the second method, beyond that which is required in case a watch telescope is used; (3) directions are measured two and two, so that errors arising from the instrument itself, or from insecurity of foundation, are minimised; (4) the weighting is nearly equal throughout. Further, the amount of actual measurement is less than that of angle-measures on 8 arcs with full rounds, unless the figures are complicated. The weighting under Schreiber's programme is however directly comparable with that of direction-measures on 6 arcs with full rounds, with which it should properly be compared. It is obvious also that the method involves a great number of changes of the zero of the circle. This, though it implies a slight increase of labour, is a considerable advantage, since as many circle divisions as possible are involved in the total of the readings. Thus, in case of two signals, 12 divisions are read per signal; in case of three signals, 16 divisions per signal; for four signals, 18 divisions per signal; for five and six signals, 20 per signal; etc. Where the method of full rounds on 8 arcs is employed, the number of changes of zero is only 8, involving practically only 8 divisions per signal if there are two micrometers. This number could of course be increased to 16 if the zero were shifted at the same time as the telescope is reversed.

In addition to the absence of equal weighting in case of 5 and 7 stations, another slight disadvantage of this method must be noted. In the combinations of directions, every signal enters $(n-1)$ times. Accordingly the repetition shift should strictly be subdivided into exactly $(n-1)$ parts. But we have seen that, when the number of signals is odd, it must actually be divided into n parts. It results from this that when the number of signals is odd, the group shift is not continuous throughout the limb. Thus, take the case of 5 signals, and consider signal 1; the group shift for this signal varies by $7^\circ\ 12'$ up to $21^\circ\ 36'$, but then there is a jump of $14^\circ\ 24'$ up to 36°, the next setting. Consequently for each signal there are *lacunæ* at 5 points of the limb; but as these *lacunæ* are themselves symmetrically distributed, the disadvantage is perhaps more apparent than real.

The following table exhibits the amount of work entailed with each method, in terms of the total number of direction-measures.

TOTAL NUMBER OF DIRECTION-MEASURES.

Number of Signals.	Method of Full Rounds.				Method of Bearings.		Method of Combinations.	
	Full Angles.		Full Directions.					
	6 Arcs.	8 Arcs.	6 Arcs.	8 Arcs.	6 Arcs.	8 Arcs.	Single Groups.	Single or Double Groups.
2	36	48	24	32	36	48	24	24
3	48	64	36	48	60	80	48	48
4	60	80	48	64	72	96	72	72
5	72	96	60	80	96	128	100	96
6	84	112	72	96	108	144	120	120
7	96	128	84	112	132	176	168	144
8	108	144	96	128	144	192	168	168
9	120	160	108	144	168	224	216	192

ELECTRIC SIGNALLING INSTALLATION AT CREWE STATION.

Précis by CAPT. R. C. HAMMOND, R.E.

IN the *Electrician* of the 25th of October and the 2nd of November an interesting article appeared describing the new Electric Signalling Installation at Crewe Station. I have abstracted the following account which may prove of interest to readers of the Journal; but Officers who are interested in Railway work should read for themselves the original article with its fuller information and excellent diagrams.

Railway traffic has always been identified with electricity in the form of the telegraph block signalling instrument, and now for many years railway companies have been experimenting with the object of supplementing this particular use of electricity by the electrical operation of signals and points. Now that the L. & N.W. Railway has demonstrated practically the value of electric power signalling, we may expect to see their example followed more generally on other lines.

At Crewe electric power directly applied is employed, by means of motors in the case of points, and solenoids in the case of signals; consequently the operating parts are of the simplest possible character.

The Crewe signalling is divided between four cabins, North cabin, South cabin, and two centre cabins; the latter are in the station itself. In the North cabin there are two frames which contain a total of 266 levers; these frames are allotted to the 'up' and 'down' trains respectively; this cabin controls all incoming and outgoing passenger trains to Manchester, Liverpool, and Chester and the arrangements are in charge of two signalmen. A full view of the track and signals to the towns mentioned is commanded from the cabin and each man can see every signal arm which he controls. Each of the centre cabins in the station contains 26 levers and has one man in charge; they control the traffic and operate the points between the North and South cabins. The South cabin is entrusted with the control of all passenger trains coming from or going to North Staffordshire, London, and Shrewsbury; there are 247 levers in this cabin in charge of three signalmen.

The Webb-Thompson system of signalling and point operation is in use and possesses many interesting and valuable features which merit detailed reference. With the latest application at Crewe the operating pressure has been raised to 230 volts, or double the pressure previously employed.

The operating frame is much smaller than that for manual control and the levers are placed in two tiers, thus permitting rapid manipulation and halving the space required. Each lever has a distinguishing colour. Home signals are red, distant signals green; points are black and bars blue. The locking frame by means of which the various levers are made interdependent is entirely mechanical, there is no direct electrical interlocking. The pull rods descend vertically from the levers in the frame and by means of sliding switches open and close the circuits of the point motors and signal magnets.

A feature of the operating frame is the "check-lock" on the points; the object of this is to ensure that the tongue of the points shall be "home" before the signal lever can be pulled off to admit a train to the section controlled by the points in question. The device is very simple; on first pulling the point lever the point motor is started, but the completion of the pull is delayed by the interposition of the armature of an electro magnet: as soon as the points are "home" this electro magnet is energised by the action of a switch and by its power of attraction pulls in the obstructing armature: the signalman can then pull the point lever hard over, thereby freeing the corresponding signal lever. A similar device is employed for checking the home signals in going on; this obviates the risk of a semaphore remaining "off" and giving the "ahead" signal by mistake.

The point motor and its requisite gearing are contained in a cast-iron tank sunk into the ground and partially filled with oil; the reversing switches and check-lock switches being contained in separate cast-iron boxes, the latter not being filled with oil; the covers of the tank and boxes are at about sleeper level. A worm is fitted to the armature shaft by which the drive is communicated to a worm-wheel the spindle of which carries a cam for operating the point levers. The worm and other gearing are entirely submerged in oil: the armature, field magnets, and commutator of the motor are above the oil level. The cam wheel above mentioned is provided on each side with special races giving a vertical travel to the rollers which run in them, when the disc is revolved through a complete circle. These rollers are attached to levers which respectively move the points and the motor-reversing and check-lock switches. The movement of the cam also provides for the unlocking and relocking of the rods at the beginning and end of each cycle of operations. Through the action of a pin clutch the motor is allowed to run free when the points have been moved home.

The motors employed for this duty are all bipolar machines with solid steel poles. They are rated at 3 H.P. and normally run at 1,500 revolutions per minute. The armature is slots wound and single carbon brushes are employed. The time needed to move the point over is 3½ seconds. As soon as the actual stroke of the points is completed, the motor is automatically switched off and its connections reversed for the return motion.

The signal magnets are wound for the full operating voltage and are enclosed completely in iron cases. The plunger is attached by a lever to a rod pulling directly on the semaphore. The energising of the magnet draws up the plunger, and current is maintained to hold the arm "off." The semaphore is counterbalanced by a weight, which, when the current is broken, returns the semaphore to the "on" position. In the case of "home" signals there is a check-lock on the return motion, and the switch for actuating this is on the main magnet pull rod. This switch has a central contact drum with insulated and uninsulated segments, and, upon the former, brass springs press to complete the circuit of the checking magnet in the signal cabin.

With a system of this kind it is important that the cable connections be carefully laid to avoid all possible risk of a breakdown. The wires are not laid in duplicate, reliance being placed in well-insulated properly-laid cables. V.I.R. cables are used throughout and are laid in wood troughing filled in afterwards with bitumen. The circuits are run as directly as possible to the particular points of control, and there are no intermediate distributing or sub-division boxes. All troughing is placed below ground, but the capping is an inch or two above the road bed both for accessibility and convenience in moving about the yards; there is practically nothing for a workman to stumble over. The connections to the point motors are led into the tanks through special weatherproof bushings, and in the case of signal bridges iron piping is used to conduct the cables to the various operating magnets and switches. For the new signalling arrangements at Crewe as much as 350 miles of cable have been used.

The power for the points and signals is derived from a steam station operated on the two-wire system, in conjunction with a large battery. The latter is a necessary stand-by, as, in case of failure of the power, the entire control of the junction would have to be undertaken with much labour by hand. The power station possesses no distinctive points of interest, the dynamos being small direct-driven bipolar machines, aggregating 900 k.w. capacity. The battery is of Chloride make, and has a maximum discharge capacity of 4,000 ampère hours at 250 ampères. The lighting of both the yards and signals is effected from this station. The Crewe installation is the largest example of power signalling in the world.

Another feature of the signalling system employed at Crewe, to which we have not yet referred, is a special platform indicator, by which one semaphore arm is made to answer the purpose of signalling for a number of platforms. The driver sees this semaphore pulled off for him to proceed, and directly below it he observes the indicator, which shows which number platform the points have been set for him to run into. The lever pulling off this indicator is interlocked with the platform point to which the indicator number corresponds: the movement of the indicator is performed by an electro magnet energised from the signal cabin. Similar indicators are erected facing the departure platforms, the numbers being replaced by suitable letters. Thus two of these are used at the North end of the station for starting trains to Liverpool or Manchester, the indicators showing the letters L or M, F or S, according as the train is an express or a slow train to Liverpool or Manchester respectively; and, as before, only one semaphore is employed.

TRANSCRIPTS.

THE INSTRUCTION OF SAPPERS IN FIELD COMPANIES.

(Extracts from an article on the above subject by K. N. Isakov in the *Enzhenernee Zhoornal*, November—December, 1906).

"FIELD engineering troops can never tell where or under what conditions they may be required to work, therefore they must be prepared for all contingencies and for the employment of their technical skill on all possible occasions in war time." These words are quoted from "The Instructions for the Special Training of Engineer Troops," published in January, 1899. The fundamental object of the training and education of engineering troops in peace should be to make them skilful, experienced, cool-headed and capable of adapting themselves, to every accident of war.

But in a country where universal military service is in vogue, it is important to withdraw the men for as short a period as possible from their productive peaceful avocations, and consequently every effort should be made to introduce methods which, while maintaining efficiency, would lessen the period of service. It should be made advantageous to every individual to take interest in his profession, and to use his best endeavour to learn his work rapidly. The article is divided under three headings:—(1) Courses of instruction and text-books, (2) method of instruction, and (3) means of inducing the men to study their profession.

Under the first of these headings the author criticises the text-books which are in use and the courses of instruction which they lay down (*a*) for the training of the sapper recruit, (*b*) for company training and (*c*) for the battalion schools of instruction. The text-books require revision in the light of the experience gained during the war, and by way of example a few subjects are touched upon in which alterations should be made.

The sapper might be spared long details about the weights and measurements of the various tools. A practical knowledge of their use should be enough for him and further details if required should be studied in the battalion schools.

Various devices for surmounting obstacles might be omitted in view of their uselessness when opposed by modern fire-arms. Obstacles cannot be surmounted nowadays but passages must be cut through them by axes, pyroxiline or artillery fire, etc.

In view of the large extent of the positions taken up by modern huge armies and the difficulty of transporting the various stores they require to the troops, it is important that every sapper should be able to lay out the centre line of a road at a given slope by means of a simple clinometer. This should be thoroughly practised in peace time and tracks of about a couple of feet in width actually excavated.

The text-book lays down that field defences are carried out under one of three conditions, either (1) when at a distance from the enemy, (2) when near him, or (3) when under his fire. The second condition appears to be meaningless and works should be designed to be made either under fire or not.

The distinction between 'rapid' work and 'ordinary' work is also objected to. In war everything must be done smartly, rapidly, urgently, as a matter of course. Unexpected events are sure to occur and the more quickly work can be finished the better. The 'ordinary' method which entails the use of tracing tapes, pickets, etc., is unpractical. Regularity in lines and angles is unnecessary. The configuration of the ground and the requirements of the field of fire give the lines of the faces and their angles of intersection.

To teach such a method in peace time means that you will get the same methodical slowness from the sappers in war. It is true that (if carried out exactly as shown on the plan) the work will be nicely finished, but is not such work not only unnecessary *but* even harmful?

The 'rapid' should be the only method taught and at the same time 'profiling' should be cut out of instruction in field fortification, as the expenditure of time and trouble on it is not justified by results. Profiling involuntarily leads the men into making all surfaces plane and their intersections become straight lines plainly visible from a distance. Now everything which tends to show up a work is bad, as masking is extremely important in modern fortification.

Under the heading 'methods of instruction' great stress is laid on the importance of practical as opposed to theoretical training at all times. In their summer training arrangements should be made for the sapper companies to carry out useful works such as road and railway bridges, align roads, etc., for the civil departments in various parts of the country.

The duty of finding suitable works would rest with the staff of the Sapper Brigades and the Commanders of Battalions. By the spring all preliminary arrangements should be completed so that as early as possible reconnaissance parties could be sent to sites of the proposed works to collect the information necessary for making the designs and also to arrange the methods of carrying them out. When this is done and the number of sappers required for any particular work as well as the period for which they are to be detached has been decided upon, the preparations will be made for despatching them at the most suitable time. Such detachments will tend to make the sappers mobile and handy at entraining their wagons, etc. On arrival at the site they will have to erect bivouacs and make field ovens. The company commander besides the care of the work will have to make his own arrangements for supply, in fact he will experience the same conditions as during the late war, when companies were generally detached from battalion headquarters, and detachments often consisted even of sections under separate officers.

Under these conditions the preliminary reconnaissance and design would be carefully carried out; each soldier and officer knowing that the work will be useful and that he will not be called upon to dismantle it as soon as it is finished, will work with zeal and energy and the advantage gained will be incomparably greater than is at present the case with the bridges, etc., carried out under existing conditions of summer camp training.

As a means of encouraging the rank and file to take interest in making themselves efficient, a system is proposed whereby the men would have it in their own power to diminish by industry their term of service with the colours.

In the present year the term of service has been fixed at 4 years, or strictly speaking 3 years and 9 months, as the recruit joins in the autumn and the term of service is completed in the spring. Exceptions to this general rule are allowed in the case of young men who at the time of being called out have obtained certain educational qualifications, by which their term of service with the colours can be reduced to three or even two years, while in the case of volunteers it may be reduced to one year.

These special privileges offer no reward to the industrious, and the keen soldier remains on the same footing as the idler, except that it is possible for him to obtain promotion to non-commissioned rank.

It would be to the advantage of the army if the privilege of reducing their term of service were offered to soldiers who during their time obtain a special *military* qualification, and this is especially important in the case of engineer troops *where every soldier in war-time is regarded as an instructor to the infantry, necessitating sound and thorough knowledge.*

As each year the culture of the people progresses it would seem to be a wise arrangement to revoke all the advantages hitherto given in the service to purely educational qualifications, in fact from their possessors more efficiency should be expected.

At the same time at various periods during their term of service all the men should be made to undergo practical and theoretical examinations and all who reach certain standards should be allowed to return forthwith to their homes and remain nominally on furlough during the remainder of their term of service. The standard of efficiency required for releasing men during their second year should of course be higher than for the third year and so on, while those who fail to attain the qualifications required of a trained sapper would have to serve out their full term and during the last year would be available for menial duties as they would have proved themselves to be men of inferior mental capacity.

It is believed that such a system as this would produce excellent results in raising the general level of knowledge throughout the engineer troops. Men would be induced to use every effort to make themselves efficient and the study of their profession would become a congenial occupation for their leisure moments.

F. E. G. SKEY.

NOTE ON A BALLOON STRUCK BY LIGHTNING, APRIL 11, 1907.

By COLONEL J. E. CAPPER, R.E., C.B., F.R. MET. SOC.

(Reproduced by permission from the *Quarterly Journal of the Royal Meteorological Society.* Vol. XXXIII. No. 144. October, 1907).

THE following account of a meteorological occurrence which took place at South Farnborough on April 11th may be of considerable interest.

This being one of the International Meteorological Observation days, we had a captive balloon in the air carrying a meteorological recording instrument. The balloon was attached to the drum of a wagon by a steel piano-wire; about half a mile of wire was out.

The balloon had been up since about 11 o'clock in the morning. Wind almost due East, light on the ground, and probably from 10 miles an hour to dead calm at different times 2,000 ft. above the ground.

About 3.10 p.m. a sudden thunderstorm came up from east-north-east; very thick and heavy, sulphurous-looking clouds. When the storm was noticed it was coming rapidly on, and it appeared to be too dangerous to attempt to get the balloon down. Heavy rain came overhead at 3.15; at 3.20 a sudden flash of lightning took place along the balloon wire. The flash, according to one observer, seemed to travel down the wire till it reached the wagon—there a sudden bright light appeared and ran right up the wire into the clouds in which the balloon was hidden. This light was of a reddish tinge, and as it ran up the wire was followed by thick, heavy fumes of brownish-yellow smoke (another observer called them grey), which hung about for some little time. On going to the winch we found the wire was fused, being burnt entirely away where it first touched the iron pillars which guide the wire when running out.

A portion of the fused wire was left on one of the pulleys, and this I send, together with a piece taken off what was left of the wire on the wagon, showing how completely the electric spark has eaten away the metal.

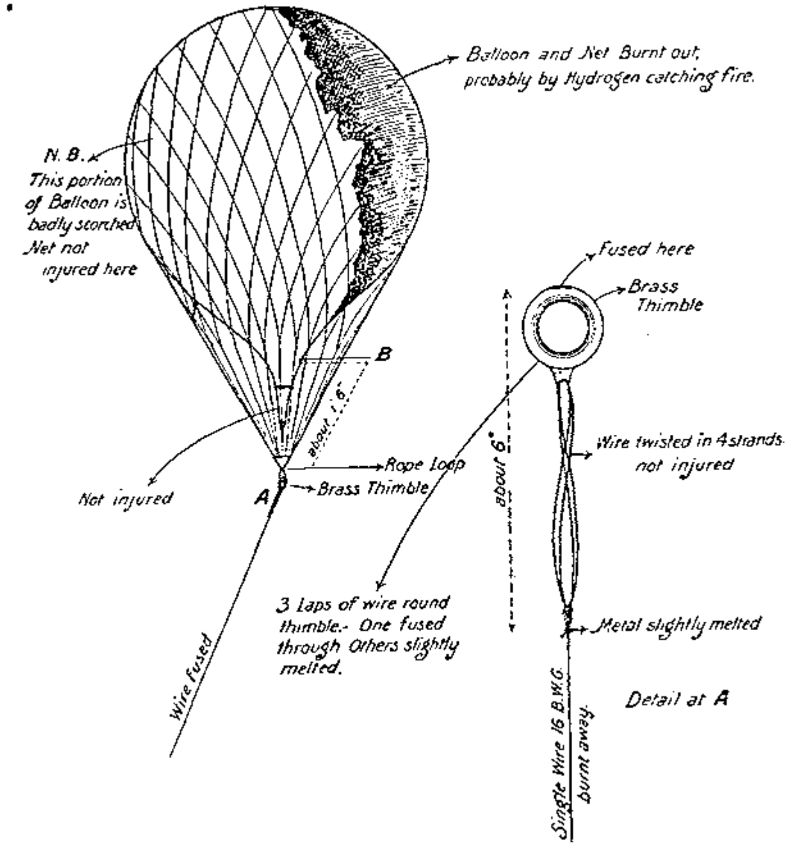
The balloon being up in the clouds at the time, I cannot say whether it also was struck and whether the meteorograph was damaged.

There were several witnesses of this occurrence, which I think is interesting as showing that at any rate in this instance the burning-up of the wire—which as far as one can see was burnt into gas throughout its whole length—took place from the earth upwards, and not downwards as has been sometimes thought was the case.

Mr. S. F. Cody saw the original flash down the wire. Two other men who were looking at the winch at the time did not, but perhaps because they were close to. I was at the exact instant not looking at the spot where the wire was, but I most distinctly saw the burning of the wire from the bottom upwards, which took an appreciable time, something I should estimate not far from three-quarters of a second; and the smoke following it made it impossible to mistake that the burning was really from the earth upwards.

Lieut. Martin-Leake, R.E., who was some distance away, distinctly saw the flash first come *down* the wire, and afterwards the smoke rise from the bottom up.

The remains of the balloon were subsequently recovered. The balloon was fastened to the wire as shown in the illustration. The wire was completely gone as far as A, where the knot was slightly fired.



B. Lightning appears to have entered Balloon here. A small hole about 3/8" dia. burnt in Balloon.

It was undamaged from A to as far as the thimble.

Two strands at the top of the thimble were fused through, and the sides of the thimble itself at the top were fired. The rope loop in the thimble, the hoop, and the lower portion of the net and of the balloon to above 1 ft. above the hoop were not damaged.

Above this point one side of the balloon and net was burnt, the other side being uninjured. I attribute the burning of the balloon to the hydrogen inside catching fire.

There was about 2,500 ft. of wire out at the time. The height of the balloon as shown by the meteorograph was about 2,000 ft. It was above the clouds and invisible. It is difficult to say how high the lower layers of cloud were, or whether more than half the wire was below the clouds. I cannot therefore positively state whether the balloon itself was struck by the original flash, and whether the wire was fused from the top downwards as well as from the bottom upwards; but I am inclined to think the whole of the fusing of the wire was from the bottom up.

A corporal near the wagon says he heard a sound like a distant gun explosion about the time the fusing would have reached the balloon (travelling up the wire), and remarked to another man at the time, "That's the balloon bursting."

I should much like to have the opinions of some of the authorities on this circumstance, which is rather revolutionary to my ideas.

I have received other letters about the occurrence. One officer 500 yards off on the golf links, who did not know a balloon was up, is certain the firing started from the bottom, as he thought it was a rocket being sent up. Others 1½ miles off who had been watching the balloon, which was invisible through clouds at the moment, thought the fusing took place from the top. They would at the distance not be able to see the red glow of the wire, and the smoke would not be seen by them until well formed, so I have no doubt they were mistaken. One thought he saw a flash sideways in a cloud to the balloon, or rather to the point where he had last seen the balloon.

NOTICES OF MAGAZINES.

ENGINEERING NEWS.

September 16, 1907.

METHODS OF MAKING CONCRETE WATERPROOF.—Ordinary untreated concrete is admittedly porous, and Mr. R. H. Gaines has instituted theoretical and experimental investigation into methods for making the mass less porous by filling the pores with finely divided insoluble material.

He comes to the conclusion that the solution of the problem lies in the direction of increasing the quantity of substances which form *colloids* when hydrated, mentioning specially metallic oxides and other inorganic compounds, such as are found in plastic clay. Other investigations with regard to the binding of road material (recently printed in this paper) have shown that the decomposition and interaction of felspars with various salts have an important bearing on the subject. It seems also established that the presence of electrolytes increases the precipitation of colloids.

It is difficult to summarise the whole of the argument, but the main conclusion arrived at is that the replacement of about 5 per cent. of the cement by dried and finely ground colloidal clay will ensure the production of a practically watertight concrete. It will be remembered that other experimenters have found that the presence of certain earths in sand for mortar increased its setting strength.

With regard to the addition of clay to cement, the editorial points out that the adoption of this method would place considerable possibilities in the hands of manufacturers of "clayed" cement. Clay is naturally cheaper than cement. *Verb. sap.*

C. E. VICKERS.

MILITÄR WOCHENBLATT.

The *Militär Wochenblatt* in a criticism on General Sir F. Maurice's official History of the South African War admits unreservedly the false judgment passed on the British troops in South Africa and also the way in which continental opinion was misled by the Press.

The article begins by saying that "seldom has public opinion been led more astray as to the true significance of Military Operations than in the South African War. Practically the entire Press of all civilised countries did everything in its power, to eulogise the military achievements and organisation of the Boer forces, whilst the English leadership and the English troops were belittled and their mistakes immoderately condemned without any foundation which could justify such severe criticism. * * * We have hitherto lacked an exhaustive and unprejudiced account from the English side as a basis for the formation of correct judgment except the *Times* History which is written from an unprofessional point of view."

The article goes on to speak of Sir F. Maurice's history as "a noteworthy achievement of Military Science and one worthy of appreciation abroad especially in Germany where the bounds of justifiable criticism have frequently been overstepped. * * * We are confronted in this work by a thoroughly sound military judgment and correct lessons have been drawn from the mistakes made."

As regards actual events the article points out that for the first time the fact is fully shown that the "widespread opinion that England was preparing for the war a long time beforehand and was only awaiting an opportunity to open hostilities, is erroneous."

"In spite of vigorous representations by the responsible military authorities in London a timely reinforcement of the garrison in South Africa was intentionally not carried out. * * * In consequence the English Military Authorities from the first were placed in an extremely awkward position. Systematic action became unusually difficult, the few troops on the spot were absolutely insufficient for the tasks which confronted them, and the reinforcements as they arrived had to be despatched at once where the need was greatest, without its being possible to accustom them to the country or the climate before leading them against the foe. The military efficiency of the troops was considerably affected by this, and the remarkable difference between the achievements of the English troops in the early battles and later on in the war may be largely attributed to this cause.

"General Maurice's description of the battles in the relief of Ladysmith and the advance on Bloemfontein shows of what devotion the English soldier is capable, and the high military qualities he possesses. The dash and endurance of French's cavalry division in the pursuit of Cronje, the gallant conduct of the Highland Brigade, and the charge of the mounted infantry under Colonel Hannay at Paardeberg, the fight of the Sixth Division at Driefontein, and the splendid stand made by "Q" Battery at Sanna's Post, are clear testimony to the capacity of the leaders, and to the ready devotion of the troops."

The criticism of Lord Kitchener's much discussed decision to bring matters at once to a head at the battle of Paardeberg, by an immediate attack is of especial interest to the soldier.

"The English official account justifies without question the heavy losses incurred by this decision losses which might have been avoided by simply shutting in and bombarding the Boers, as pointed out by some Military Authorities."

"The situation in the early morning of February 18th demanded immediate action, in view of the threatening assembly of Boer forces in the English rear. Lord Kitchener was warned in time of this danger by a letter from Lord Roberts. Lord Kitchener could not, and ought not, to have reckoned on the *morning* of the 18th on the Boer commandoes being as inactive as they actually were. Leaders cannot avoid heavy losses, and decisive success cannot be gained without sacrifice."

"The difficulty of finding recruits is the true explanation of the anxious desire of British leaders to avoid heavy losses in later battles."

The criticism ends by saying "The account clearly shows all these difficulties which confronted the English leaders, and clears up many events of the war which have hitherto been hard to understand. Though a final opinion cannot be formed until the whole work has been published, the portion which has already appeared must be classed as amongst the best achievements of modern military literature."

W. A. HARRISON.

REVISTA DE ENGENHERIA MILITAR.

August, 1907.

PREPARATION FOR HIGHER COMMAND.—By C.B.—Much of what the author says applies equally to this country as it does to Portugal, and consequently it has been thought desirable to reproduce the article at some length.

The author takes as his text a paragraph which he read in a recent number of the *Army and Navy Gazette*, calling the attention of officers of the Royal Engineers to the necessity of taking part in staff rides, of studying ground, and of solving important tactical problems, instead of confining themselves to the technical details of corps duty, as otherwise they would fail to prepare themselves to exercise the functions of superior command.

He considers that this warning is equally needed by Portuguese Engineer officers. The latter, before promotion to the rank of colonel, are obliged to serve for at least a year either with troops or at the engineer school of instruction. They then have to pass an examination as to their tactical fitness for general's rank. On this occasion for about two hours they command in the field a mixed detachment, strength about one brigade. For many, if not for all of them, this is the only moment in their careers on which they find themselves handling troops of the different arms on their own responsibility. Many reach general's rank after having had no experience whatever of the three arms, as for many years they have been exercising professional functions, generally sedentary, and have never taken part in combined operations, since the distant days when they were captains or subalterns of the regiment of Engineers.

Once promoted colonels they either return to their previous duties, or else are entrusted with others connected with their profession, in the majority of cases purely bureaucratic. It is exceedingly rare for an effective command to be given to a general of brigade who has come from the corps of engineers. The command of the entrenched camp of Lisbon has always gone to an artillery general, and even that of the fortress of Elvas is usually given to an artilleryman, when, as is often the case, it is not held by an ex-cavalry officer.

Later on these senior officers of the corps, if fortune favours them, obtain the command of a division. How are they prepared to exercise this command and to manœuvre troops of the three arms? Only by having had two hours' practice on the day on which they passed their tactical fitness examination.

It may be said that there are at the present moment officers of our army commanding divisions with notable distinction, who have never had any better preparation. We reply that one should not argue from exceptions, and that those men are rare to whom it is given to reach the highest rank at a sufficiently early age and with the necessary capacity for work, with the requisite physical vigour, and with the habits of responsibility necessary for the exercise of command. It is only by a miracle that such qualities are to be found, if they have not been formed and developed by a proper education, and they can never logically be presupposed unless they have been cultivated.

Thus we assert that a general of division, who has never had under his orders troops of the three arms, nor even commanded a regiment of his own corps, even if he possess exceptional gifts, will find himself obliged to an intensity of work and study which will involve much sacrifice, when he comes to be placed at the head of a division and desires to command it properly.

Now that we have pointed out the evil we will show, what, in our opinion is the remedy.

We have found examples of its application in various and successive periods of our military career. Are not all lieutenants, captains, and majors compelled to serve for a definite period with the troops of their corps, or in a corresponding position at their school of instruction? Yes, and before promotion to field rank captains must serve as majors in a unit of their arm of the service.

Very well, let us apply the same principle to colonels selected for promotion to general's rank; let them command brigades for the whole of one instructional year, from the time of the incorporation of the recruits to the autumn manœuvres; let them be obliged to interfere directly in the instruction and to direct it personally; and above all let them be compelled to superintend the instruction and military education of the officers of their brigades.

The weakness of our effectives never permits of the realization of combined exercises with brigades at proper strength all over the country, but it would be neither expensive nor impossible, nor even difficult to hold them either with imaginary forces or with units at reduced establishments. This would suffice to develop a knowledge of the ground, to educate the eye, to cause colonels on the selected list to acquire the habit of making long excursions through the mountains and valleys, and to overcome the reluctance of some of them to brave sun, rain, and cold, and, let it be said with all reserve, the antipathy that some of them have to getting on horseback.

This preparation, lasting for at least a year, should be an indispensable condition of entry to general's rank; it should apply, without any exception, to colonels of all arms.

Those selected colonels that most need practice in command (and none require it more than those of the engineers) should be given commands on the frontier, on the lines followed by past invasions. They should be put where they can study on the very ground the lessons of history; they should be obliged to keep the officers under their orders acquainted with the results of repeated reconnaissances carried out with the limits of their districts, whose territory they should know better than anyone. We do not believe that any new legislation is required, it will be sufficient to interpret the present regulations according to their spirit.

On the day on which these measures are decreed, and are applied to the officers of the corps of engineers, the latter will have attained the means of worthily exercising the highest military functions, for which they have certainly not been properly prepared by twenty or thirty years' work in an office, two or three years' duty with the troops of the corps, and two hours in command of a mixed detachment, equivalent to a brigade, on the day of their tactical fitness examination.

SOME REMARKS ON THE FIELD BALLOON PARK BELONGING TO THE MINISTRY OF MARINE.—By Lieut. d'Almeida.—The whole of the material was supplied by the English firm of Spencer & Sons. The balloons are pear-shaped, of silk-finished cambric, and have a capacity of 368 cubic mètres. The present number contains a full description of the balloon, its valves, etc. In future numbers descriptions will be given of the apparatus for generating gas, etc.

TECHNICAL MILITARY ACADEMIES.—By A.V.—A description of the Kriegstechnische Akademie at Charlottenburg, formed on the 1st July of this year by the union of the Mixed Artillery and Engineer School with the Military Technical School. The object of the Academy is to secure to the officers of all arms the possibility of acquiring scientific instruction in questions relative to armament, engineer and communication services. Also to give professional instruction to the officers of the foot artillery, engineers and pioneers, as well as to those of the communication troops.* The Academy is under the command of a general officer and has a large staff of both military and civilian professors. There is no entrance examination but the students are selected by army corps commanders or by the inspectors of their arms of the service. They must have a competent knowledge of mathematics and have from three to nine years' service. They are attached at first for one year, and if they then pass a good examination they are retained at the Academy to complete the full course in the subject in which they have matriculated.

* *Note by the Reviewer.*—In Germany Telegraphs and Railways have been taken away from the Engineers and Pioneers and handed over to a special body of Communication troops (Verkehrstruppen).

There are five courses of instruction:—

(1). Armaments: lasting three years; in the last year the students are divided into two branches, one of which studies ballistics, and the other, the manufacturing departments.

(2). Engineering: lasting three years in addition to the one year of the Pioneering course, which all officers of the corps have to attend. Officers of other arms who wish to be transferred to the engineers or pioneers are admitted to the course after having been attached for at least one year to a pioneer battalion.

Those officers who desire to serve in the corps and have the necessary aptitude pass from the pioneer course to the first year's course of the Engineering division; then those that are approved serve in an Engineer district for a certain period, and then return to the Academy for the second and third year's courses in engineering, each of which is confined to ten students. It is from the officers that have passed these courses that the professors of fortification at the military schools, and the members of the engineer committee are chosen.

The programme of the courses comprises mathematics, mechanics, physics, electro-mechanics, tactics, military history, fortification, drawing, construction, machinery, armour, and military electro-technics.

(3). Communications: lasting three years. 20 officers are permitted to attend the first year's course, and 15 those of each of the two succeeding years. Officers of the Communication troops follow the courses of this division, if there are not enough of them, their places may be taken by officers of other arms.

The course comprises mathematics, mechanics, physics, electro-mechanics, chemistry, metallurgy, explosives, drawing, machinery, bridging, railways, field communications, ballooning, telegraphs and telephones, mechanical transport and the principles of field and fortress warfare.

(4). Foot artillery: confined to officers of that arm, all of whom have to pass through the first year's course; a further course is open to a small number of specially selected officers.

(5). Pioneering: obligatory for all pioneer officers. The course comprises mathematics, physics, chemistry, guns and small arms, tactics, fortress warfare, military history, pioneer services, fortification, drawing, the principles of construction, topography, foreign languages, fencing and equitation.

PRINCIPLES TO BE OBSERVED IN THE CONSTRUCTION OF NEW BARRACKS IN FRANCE.—By J.O.—On the 30th May last the French Government issued a circular on the above subject. Type drawings were issued simultaneously, but these drawings do not descend to details so as not to take away from the initiative of Engineer officers who may be called on to design new barracks. The cost of barracks, exclusive of the purchase of ground, is not to exceed 1,800 francs (£72) per man. The circular is too long for reproduction here, but the following details are extracted. It is worth reading in the original.

1. The maximum force to be quartered in one barrack should not exceed one regiment.

2. Each company, squadron, or battery has a separate barrack block.

3. Reading rooms are provided.

4. Electric light should be used for preference.

5. Each battalion or group has a separate dining hall, divided into as many compartments as there are companies, squadrons, or batteries.

6. Whenever funds are available a large hall will be provided for regimental conferences, etc.

7. Hot water laid on to the baths. In addition to ordinary baths, about 12 shower baths are provided per regiment.

8. Latrines, 1 seat per 70 men.

CHRONICLE.

BIBLIOGRAPHY.—Notice is drawn to a useful book on portable entrenching tools for infantry (Ferramenta portatil de infanteria) by Capt. Simões, Lisbon, 1907.

'M.'

REVUE MILITAIRE SUISSE.

July, August, and September, 1907.

THE RE-ORGANIZATION OF THE SWISS ENGINEERS.—At present the Swiss Engineers amount to only 3·55 per cent. of the whole army. In other European armies the percentages are:—Germany 6·7—9·3 for the 1st, 15th and 16th Army Corps,—Austria 4·7, and France 3·0, but the last figure does not include telegraph, railway, and balloon troops. The average works out to 4·6 per cent. As all modern wars have necessitated an increase in the number of engineers, it is clear that the proportion of engineers in the Swiss army is too small. The writer suggests that the proper proportion is one engineer to fifteen infantry. This would raise the percentage of engineers to 5·05 of the whole army. As few engineers as possible should be devoted to special duties, such as bridging, railways and telegraphs, but a large quantity of technical stores should be provided for them, so that they shall never be idle for want of material.

The duties of the engineers may be divided into two classes: fortifications and communications. In Germany the first are allotted to the pioneers, and the second to the communication troops. This is an unnecessary complication. It is more economical to have a single corps, and to allot special sections to the various duties.

The staff of the engineer commanding-in-chief should consist of—

(*a*). A department dealing with personnel, under a military secretary.

(*b*). A fortification department.

(*c*). A technical department to deal with changes in equipment and material. There should also be an engineer committee consisting of seven officers. The engineer-in-chief would be president, with a senior officer as secretary, and the members would represent the field engineers, bridging, railway, telegraph, and balloon sections respectively. This committee should be provided with funds for carrying out experiments with new appliances.

(*d*). An instructional department to deal with:—

(1). The training and instruction of engineer officers.
(2). The supervision of the instruction of the non-commissioned officers and men.
(3). The inspection of engineer troops.

All engineer officers not serving with troops should be attached to the fortification department.

Owing to the short training that the Swiss sappers receive it is impossible to teach them more than one duty, and it is therefore necessary to divide them into sappers, bridgers, railway, telegraph and balloon troops, miners, and fortress sappers. There are plenty of civil engineers in Switzerland who would make good engineer officers. Unfortunately the majority of them prefer to join the artillery.

Each division should have three field companies. One of these the author would divide up among the infantry, an engineer officer and 40 or 50 sappers being attached to each three-battalion regiment. In this way the engineers would be associated more closely with the infantry. The other two companies would belong to the divisional troops. There should be an engineer park with each army corps. The author does not consider that mounted engineers are required in Switzerland. There should be a bridging company with pontoons for each army corps, and a bridging train, with light trestles for preference, with each division.

The railway troops should consist of four construction companies of 180 sappers each. Their duty would be to supplement, not to supersede the ordinary railway staff. (Operations outside Switzerland are not contemplated).

One telegraph company should be allotted to each army corps. It should consist of four sections, one to maintain communication between the army corps and the divisions, two to connect the divisions to the brigades, and one to dismantle lines no longer required. The officers and men should be recruited from the civil telegraph departments. A telegraph office with a staff of three men should be attached to each cavalry brigade, so that communication may be established by tapping the civil wires. Visual signalling should also be entrusted to the telegraph companies.

A search light section consisting of 32 men with two large search lights should be provided for each army corps.

A wireless telegraph company should be organised with an establishment of 104 rank and file, and 16 officers. This should provide 5 field, and 3 permanent stations; the latter being at Rigi, Andermatt and St. Maurice.

Three balloon companies with a total of 6 balloons are required.

The existing Swiss engineer equipment dates from 1874, and is therefore not of the latest pattern. Its improvement should be undertaken by the engineer technical department in consultation with the engineer committee. The sappers with the infantry battalions should carry axes, wire, and technical tools rather than entrenching implements, the latter should be carried by the infantry. Each engineer section with an infantry regiment should have a light four-horse tool cart. At present the sappers of the divisional companies are overloaded as they carry entrenching implements as well as a pack. It would be better if they were provided with light cutting tools, and their packs carried on carts.

The present method of training the Swiss engineers is unsatisfactory, in that it fails to give the recruits confidence in the officers, or the officers confidence in their own powers. This is due to the fact that the training and instruction of recruits is given by officers of the corps of instructors, instead of by the officers of the engineer companies. The remedy suggested by the author is to make the engineer officers responsible for the training of recruits, and to give them an instructor of inferior rank to assist them.

The following is a recapitulation of the principal reforms suggested :—

1. The formation of a third company of engineers per division one section to be attached to each three-battalion infantry regiment.

2. Engineer subalterns to be mounted.

3. The number of engineer officers to be increased.

4. The organization of the telegraph companies in four equal sections with a company staff.

5. The formation of four search light sections.

6. The formation of a wireless telegraph corps.

7. An increase in the establishment of the railway companies.

8. The formation of a small telegraph detachment for each cavalry brigade.

9. The formation of two additional balloon companies.

10. The formation of an engineer experimental section.

The provision of the following matériel :—Telephones for use in the outpost line ; travelling soup kitchens ; eight divisional bridging equipments ; carts to carry material for obstacles ; 8 search lights and waggons ; two bicycles per field company and sixteen per telegraph company ; field telephones for the telegraph companies ; stores for 5 wireless telegraph field stations ; balloon stores. Also an increase in the engineer reserve equipment.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

September, 1907.

THE ENGINEER OFFICER OF THE FUTURE.—By Rocchi (Colonello del Genio).—Every one of the great campaigns of recent times is an example of the power of offensive methods in warfare, either new in themselves or brought to perfection in the manner of their employment. The campaign in Bohemia in 1866 by means of the needle-gun showed decisively the efficacy of portable weapons. The campaign of 1870–71 demonstrated the value of artillery in great masses, and the recent campaign in Manchuria revealed the use of the spade, not only as an instrument of defence, but also as a means of offence. The spade is the new arm of offence taking the place of the rifle in the attack.

Whilst in former campaigns the infantry advanced by help of a heavy fire, in Manchuria the Japanese advanced with the spade, as this was the only possible way by which troops could advance without being completely annihilated before arriving under the enemy's position. The trench at the close of the sixteenth century was one of the many inventions of the Italian military engineers. It was by degrees imitated by all the armies of Europe, and has now become the new arm adopted by the Japanese.

In the same way also as both the employment of quick-firing rifles and artillery in mass modified the tactics of their day, so the introduction of this new arm has caused in its turn important modifications in the methods of war.

In every direction there is a new development of tactics which without changing the principles changes the methods, and this new development requires special study and preparation for war.

As long as the ground was considered not only an arm of defence but more especially as one used as an impediment to advancing troops, the study and employment of its uses were reserved to the engineers. Now however that it has risen to the grade of a combative weapon all arms which may need to work with it should study its use. It is obvious that every soldier should thoroughly understand the use of his rifle, and in the present day it is no less necessary that he should learn fortification technically, so that he may equally extract both from the soil and the rifle the greatest use possible.

In the XVIth century all soldiers including volunteers, studied both the use of improvised fieldworks and also the best way of providing for the wants of troops in the field; and further all the officers were versed in the various methods of construction and defence. These latter methods were however a matter of mediæval tradition handed down unchanged from generation to generation, but the tactics of the revolution evolved by Napoleon entirely changed this state of things.

General Coseur declared long ago that the entrenching tool designed by Colonel Spaccamelo was indispensable and now at last the latter is able to foresee its final triumph.

But now that the infantry troops are provided with light entrenching tools they should be rationally exercised in their use. It is not sufficient to carry an instrument for removing the earth; its value should also be grasped by the minds of all. In the military schools instruction is given not only in tracing out the trenches, but also in constructing them in the simplest manner.

Infantry officers should study, travel, visit battlefields and fortresses. They should further accustom themselves to tracing lines of defence on the ground so as to be able to instruct the troops. In addition to their military manœuvres they should know how to construct trenches and parapets.

The artillery also should consider that the shields which they are accustomed to use in the schools of gunnery are not sufficient; and besides knowing how to serve their guns they should be able to dig and remove the earth. The engineer troops too must remember that in the great strategic battles of the future extending over a frontage of many dozens of miles they may have to rapidly extemporise on the flanks of a position obstacles of barbed wire and other materials suited to the exigencies of the moment.

To each infantry regiment an engineer officer should be assigned whose duty it should be to supervise all technical work, in the same manner as a medical officer conducts all matters of hygiene connected with the troops.

The engineer officer should be the organiser of all technical matters connected with the regiment and with the assistance of a small nucleus of sappers he should be able to provide for any small works of maintenance and repairs to barracks in peace times, and also for the works of entrenchment on the field of battle.

We do not believe that we are far wrong in asserting that the renewal of this tactical idea may be a means of increasing the good feeling which should exist between the troops and the officers of engineers.

Without entering into details, it may be observed that the engineer officers on a campaign should be completely acquainted with the strategic and tactical situation.

RUSSIA.

THE COST OF THE WAR WITH JAPAN.—*La Revue Militaire des Armes Étrangères* of July states the following sums to have been expended by Russia on account of the war with Japan:—

Army, 1904	Rubles*	676,841,005
,, 1905	,,	987,401,220
,, 1906	,,	467,575,775
Total ...	Rubles	2,131,818,000

This sum comprises the additional expenses for mobilization, maintenance, and demobilization, caused by the war, independently of the normal balances. If there should be added to this sum the capital corresponding to the pensions, and the expenses for the reconstitution of the navy, and of war material the conclusion is arrived at that the cost of the war to Russia was about two milliards, and four hundred millions of rubles (£256,000,000).

JAPAN.

LOSSES OF THE JAPANESE ARMY IN MANCHURIA.—In the temple of Yasukuni jinsha at Tokio the deaths of 24,421 officers, soldiers and marines are recorded during the campaign in Manchuria or from the consequences thereof.

* The English sovereign is equal to 6·4 rubles.

This was the third ritual celebration of this kind made in Japan.

In the first (1905) there were honoured 29,550 victims of the war; and in the second (1906), 30,877.

The total losses thus amounts to 84,848 comprising the non-combatants to whom the Emperor by a special favour has accorded posthumous honours.

EDWARD T. THACKERAY.

VOËNNYI SBÓRNIK.

July, 1907.

THE REORGANIZATION OF THE CORPS OF ENGINEERS.—The writer complains that the duties of Engineer officers in peace time have for the most part little in common with their duties in the field; hence their special knowledge which has been acquired in training colleges is very largely forgotten, and on the outbreak of war a serious want in thoroughly trained officers is found to exist.

General Todleben proposed to abolish from the duties of Engineer officers all work in connection with military buildings other than fortresses, and to institute a special department for the direction of such work.

Engineer officers on finishing their courses in the academy are either sent to serve in fortresses or to superintend divisions; in the former case the officer is able to put into practice something of what he has learnt, in the latter he becomes a sort of architect and has no opportunity to make use of his special training.

A total of 674 Engineer officers was shown in 1906; of this number 132 were serving in fortresses, 163 in divisions, 69 were employed in Government departments, 15 with troops, 64 on the Engineer Headquarter Staff and Engineer Committee, 38 in the Engineer Academy, and 193 on the Engineer staffs of districts. This analysis proves that a large percentage of officers are employed on work demanding no call on their special knowledge as military engineers, and this in spite of the fact that the late war revealed a deficiency in officers both as regards training and numbers.

Though in general officers acquitted themselves with credit during the war, a considerable want of practical experience was frequently shown. This points to the necessity for the employment of an officer during peace time having a direct bearing on his work during war: "Officers had not the knack of quickly organizing works with materials at hand in the field. Service in our Engineer divisions does not contribute to a development of this habit, since, owing to our usual practice of carrying out work by contract, our Engineer officers have no need to trouble about the organization of works or where and how to procure material and workmen. They buy everything ready from a contractor and their rôle is limited merely to that of supervisor."

The writer relates how wanting were infantry officers and men in knowledge of how to entrench themselves or how to get through artificial obstacles. He considers that troops in general should in these and like respects be able to help themselves and suggests that every infantry regiment should include a small command of sappers who would carry out all simple engineering works, such as the superintendence of trench work, making and destroying obstacles, minor demolitions generally, building small bridges, and laying telephone cables. A specially trained regimental officer would be in charge of these sappers, and during the winter would conduct a sapper class. During the training season the sappers from different regiments would be united for instruction by an Engineer officer. More highly technical Engineer duties would be carried out by the regular sapper battalions.

It seems from the writer's remarks that the post of an Engineer officer serving with troops, *i.e.* in a sapper battalion, is not a desirable one, as officers employed in this capacity get none of the advantages in promotion and advancement in the service which their brother officers enjoy. Hence the training of sappers is handicapped by a scarcity of officers; this should be remedied by granting certain advantages to make this service more popular.

As regards the more profitable employment of Engineer officers during peace, the writer considers that useful experience can be gained in the several departments of military communications which are under the control of the following:—

(*a*). Chief Director of Military Communications.
(*b*). Directors of Communications in military districts.
(*c*). Rail and water transport superintendents. These posts are all at present filled by officers of the General Staff, who do not possess the necessary special knowledge; they could more advantageously be filled by Engineer officers.

Similarly in time of war the G.O.C. Lines of Communications has under him four main executive departments under the following heads:—

(1). Director of camps; who has to look after the construction and management of rest camps along the lines of communications, performs the duties of provost-marshal, administers the conquered territory.
(2). Director of road construction; whose duty is to maintain existing and construct new roads, bridges, fords, and passes, and to administer the railways in the conquered territory.
(3). Director of transport.
(4). Director of posts and telegraphs.

Again the writer maintains that officers of the General Staff are not best suited by their training to fill these posts; (2) and (4) could be more profitably handed over to Engineer officers; the administrative duties of (1) should be carried out by a Governor General; telegraphs should be united to the road construction department and placed under the control of the Engineer Inspector (E. in C.) of the army, while postal arrangements should come under the director of camps; the post of director of transport should be filled by an officer of the commissariat.

As regards field railways and railway battalions, there exists under the management of the Engineer Headquarter Staff a special section dealing with field railways, but all questions of stores and plant are dealt with by a branch of the General Staff, viz. the Direction of Military Communications mentioned above. The construction of railways and railway battalions are under the same management; even the officers of railway battalions are not Engineer officers.

The training of these battalions is not as good as it ought to be. It could in the writer's opinion be much improved by handing over to a battalion a portion of a civil line to work. A military railway, of which there are several in Russia, does not afford sufficient scope.

The writer ends up by repeating that officers in peace time can most advantageously be employed either serving in fortresses, serving with troops, on the staff of the Director of Military Communications, managing field railways, or serving in railway battalions. The number of officers employed in divisions should be reduced to a minimum.

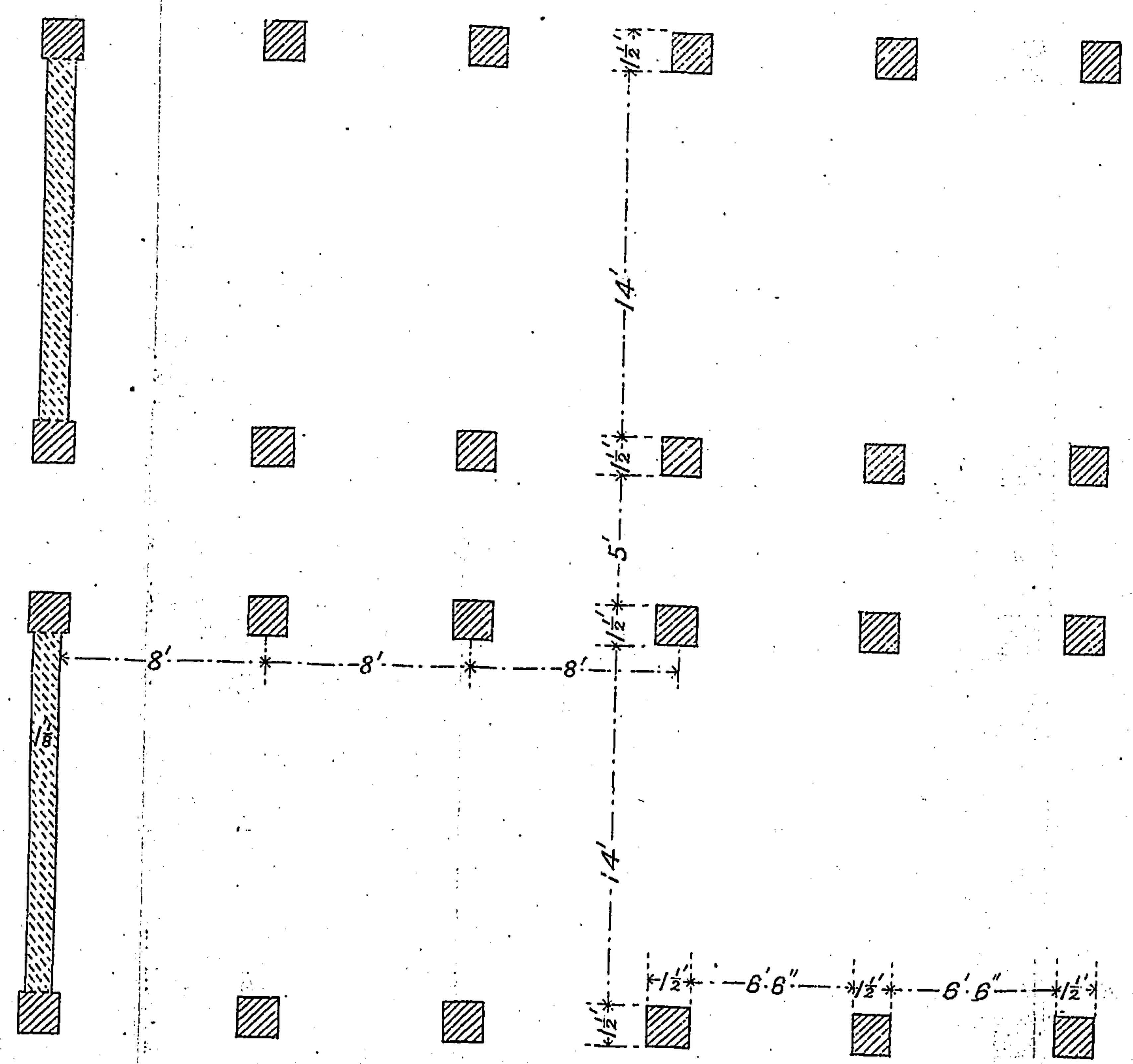
September, 1907.

TELEPHONIC COMMUNICATIONS IN FORTRESSES.—The writer of this article discusses in great detail the best method of arranging "command lines" in fortresses and how existing systems in fortress towns can be utilised for military purposes in time of war. He lays stress on the necessity for having a sufficient staff of trained men with a large reserve to replace casualties. Judging from his experience in Port Arthur he asserts that to every fort, battery, and fortified position there should run three entirely different lines, quite independent of each other, one for ordinary conversation and as a reserve, the second for the fortress commander's use, and the third for the C.R.A.

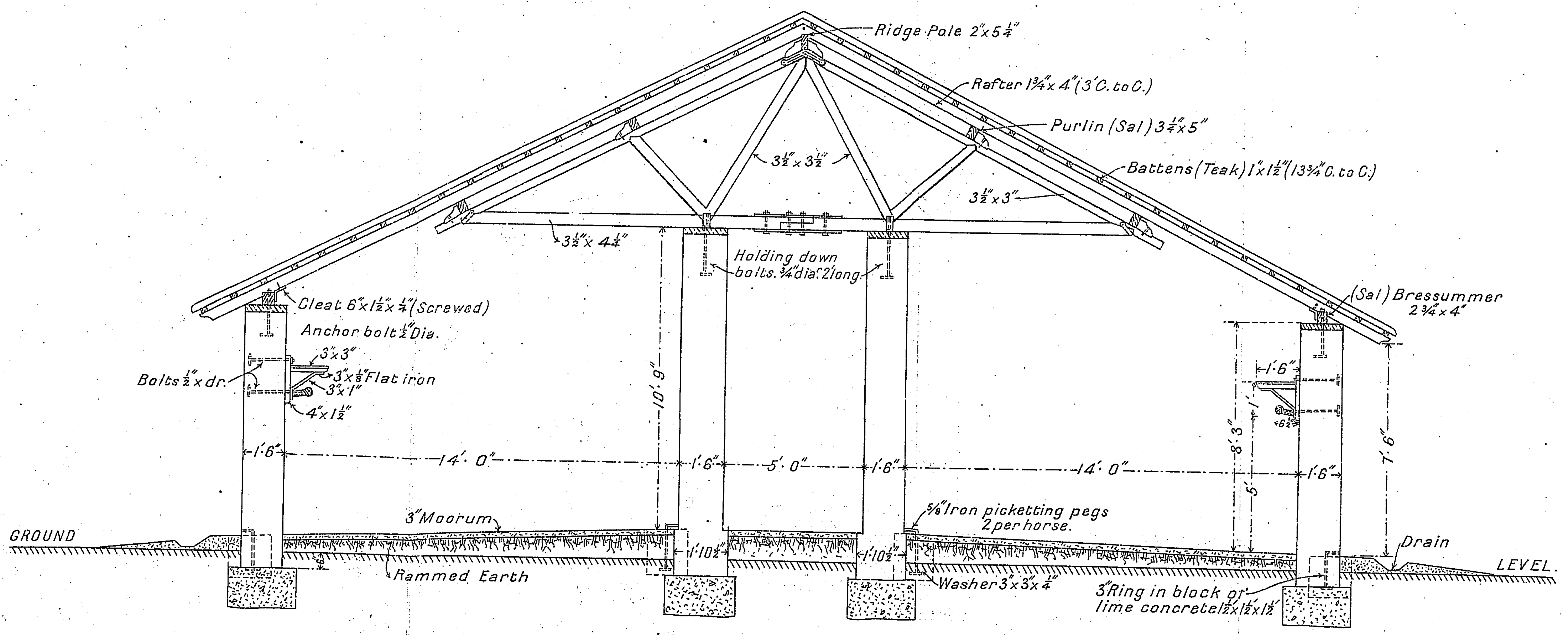
A. H. BELL.

Design for Stables—India.

Plan.



Cross Section.



Scale 8' to 1 inch for Plan.

10' 5' 0' 10' 20' 30' feet.

5' 0' 5' 10' 15'

Scale 4' to 1 inch for Section.