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THE TRAGEDY OF LORD KITCHENER: BY REGINALD VISCOUNT ESHER.

By Colonel E. M. Lloyd.

In July, 1916, the *National Review* contained a sketch of "Lord K," written by Lord Esher, and this was reprinted in the *R.E. Journal* of December. The sketch has now been enlarged and turned into an elaborate study of the last two years of Kitchener's life. The title is prompted, not by the tragic circumstances of his death, but by the painful ordeal of his work at the War Office. "To the poet's vision the tragedy of Hamlet lay in the hero's consciousness of his own irresolution, and not in the holocaust of death amid which the play ends. Lord Kitchener's tragedy was not dissimilar, inasmuch as he realized that the qualities of mind and character which had served him well through life were under these entirely new conditions out of place." That he found himself at a disadvantage as a Cabinet Minister with nimble-witted and voluble colleagues cannot be questioned; but considering what he did towards winning the war, the parallel with Hamlet is not a happy one.

In most respects Lord Esher is very well qualified for the task he has set himself. He was an intimate friend of Kitchener and had a large acquaintance with the politicians who played a leading part in the war. Living in London or Paris, and semi-officially employed, he had opportunities of learning much that was hidden from the world at large. He kept a journal, and his book is based on entries in it, "gathered into something like a coherent form, but uncorrected and unrevised." He writes pleasantly and skilfully, eschewing tedious detail, and it is not surprising that his book should have been well received. As *The Times* remarked the other day:—"The present age loves historical biography, and under the plea of frankness takes a rather mischievous amusement in seeing idols overturned." It would be unfair to suggest that Lord Esher has had any such aim. He tries to give a true picture, without partiality, favour or affection, but he and his subject were not sympathetic; and probably many readers will say as they put the book down: "I always thought so, a much overrated man."

Tennyson said to J. R. Green, the historian, "You are the most vivid man I ever met, you are as vivid as lightning"; but Green was charged with inaccuracy. The artistic temperament forms its pictures, and is apt to ignore facts that do not fit in with them. At the outset of his book Lord Esher tells us:—

"*Arabia deserta* seems to me to be the key of Lord Kitchener's character and methods. . . . The Spirit of the Sand, like the Spirit of the Sea, puts an unconscious constraint upon the nature of man. Lord Kitchener's aloofness, patience, slowness if you will, were the outcome of life lived in solitude where the passage of time counted for very little. . . . The slow processes of the Orient were burnt into him by the Egyptian sun."

This suggests an anchorite of the desert rather than one of the most strenuous of British soldiers. But Lord Esher finds in it a clue to his action as War Minister in the much-vexed question of high-explosive shells. The staff at the War Office were surprised at the demands made by Sir John French, and could not realize the actual conditions. "It was all so utterly unlike the unbroken desert over which Lord K. rode to the Atbara or the clean gradients of the Veldt." This "curious lack of imagination and flexibility" was the cause of the delay in supply. He ignores the statement made in the War Office letter of 19th January to Sir John French:—"The Council desire to emphasize the fact that the orders for manufacture are not being limited by what they think it necessary to supply, but are entirely conditioned by the highest possible output of the ordnance factories throughout the Empire and the trade of England, and the Allied and neutral countries of the world." But the contractors, at home and abroad, were unable to fulfil their contracts, and of the H.E. Shells ordered (half a million) only about one-tenth were supplied by the dates agreed upon.

Another point on which the War Office laid stress was that shrapnel was still needed, and that to convert shrapnel into H.E. factories would mean that there would be no output of either for ten weeks. Lord Esher takes no account of this, and contrasts France with England without making any allowance for the difference in the scale of their armaments before the War. To improvise an army of millions and at the same time provide it with new kinds of guns and projectiles in vast quantities was a staggering task. No doubt there were failures and mistakes, but the blame for them must fall not so much on the men then in office as on their predecessors. At all events, before a man passes judgment on them he ought to show that he has been at pains to read what has been said on both sides instead of trusting to entries in his journal.

The question of munitions was soon followed by the question of men. In the first twelve months of the war the army had been brought up to two and a half millions by voluntary enlistment. It was a wonderful achievement, but the stream of volunteers was beginning to fail, and it could be foreseen that to maintain and increase the forces in the field compulsory service would soon be inevitable. But the opposition to it was strong in the Cabinet, in the country, and especially among the working-classes. In the autumn of 1915 Kitchener conferred with Mr. Arthur Henderson, and obtained assurances that if it was necessary for victory, and was not to become a permanent practice, it would not be opposed by the Labour Party as a whole. Kitchener thought it best to acquiesce in giving the voluntary principle a last trial by means of the Derby scheme. It meant a delay of three months, but during those months the machinery was created which enabled compulsion to be put in force, and the yield of Derby volunteers was not inconsiderable. Lord Esher blames Kitchener for not giving his colleagues of the Cabinet a clear lead and says he " appeared vague and unsettled." But the Compulsory Service Bill, so adroitly piloted by Mr. Asquith through Parliament in January, 1916, might have suffered shipwreck if the pace had been forced.

Lord Esher tells us that " the position taken up by Lord Kitchener, supported by Sir William Robertson, was that every available man was now required for the army overseas, but that it was not the business of the War Office to fix actual numbers required, or suggest the method by which the men should be obtained. They had convinced themselves that the political conditions of the struggle over compulsion were such that it would be the height of imprudence to give the opponents of that solution of the recruiting problem, which was the only possible solution left, the advantage they would derive from a cry of ' militarism ' which would be raised immediately if the protagonists of the proposal were found to be soldiers."

Who shall say that they were wrong ? The mere passing of the measure had a great effect in France and Germany; its defeat would have been disastrous.

There is much in this volume that is of interest in relation to the question of " unity of command." It was mooted by the French again and again, of course on the assumption that the directing chief would be a Frenchman. But the occasional divergence which made it seem so necessary was apt to arise in cases—such as the autumn offensive in 1915 and the Salonika expedition—in which the French view was largely governed by political considerations, and the balance of parties in the Chamber. What answered admirably in the special circumstances of 1918 and under the leadership of Foch would have been harmful in the earlier years of the war.

Lord Esher is apt to be inexact about details. Kitchener's familiarity with the French language was gained by two years of school in France and Switzerland, not by his brief service under Chanzy. Lord Roberts is spoken of as over seventy years old when the war began; he was close on eighty-two. The staff which Kitchener found at Whitehall hardly deserved to be described as consisting almost wholly of " aged and tired men." His account of the first meeting of Kitchener with Lord Morley differs materially from that given by Lord Morley himself in his "Recollections." Kitchener was most anxious to go to India as Viceroy, an appointment which rested with Morley, as Secretary of State for India. Lord Esher arranged a dinner to bring them together. But things went ill. "Lord Kitchener, either from shyness or pride, shocked the political sensibilities of his principal host, showed himself at the worst, and ruined in a short hour his prospect of attaining his heart's desire. That night, supposed to be guarded and silent, he was lush of talk, with a copiousness of indiscreet opinion, praise and blame, that made Lord Morley say afterwards, 'Never, never shall he go to India.'" Lord Morley's account is less dramatic. He had made Kitchener's acquaintance before this dinner, having had a visit from him at the India Office. He found him "the most cheerful and cordial and outspoken of men, and he hammered away, loud and strong, with free gestures and high tones. . . . We got on very well indeed, he and I, for nothing was said about his going back to India as Governor-General." Evidently Lord Morley's decision was not due to shock, but was a settled purpose, based on quite other grounds than Kitchener's volubility.

But details are of less importance than general truth of characterization. Lord Esher says most aptly: "Just as Lord K. saw things in a truer light from afar off, so his was a figure that loomed larger and in truer perspective at a distance. For this reason his character and aptitudes were more accurately judged by the masses of the people than by his colleagues." Lord Esher himself stood too near to his subject, and was more impressed by blemishes than by the figure as a whole.

PONTOON EXPERIENCE IN MESOPOTAMIA.

By CAPTAIN AND BREVET-MAJOR F. V. B. WITTS, C.B.E., D.S.O., M.C., R.E.

1. Now that the re-design of the Service Pattern pontoon is under consideration, experience gained in Mesopotamia may not be without general interest.

2. It is first necessary to explain what the special conditions out there were, and then how they were met.

(*a*) Bridging sites on the Tigris and Euphrates were anything up to five hundred yards long.

(*b*) During the winter and spring both rivers are liable to sudden fierce floods, involving rises up to ten feet in the twenty-four hours and over twenty feet in all. On these occasions the current rises to 6 or 7 knots. Many bridges were washed clean away or swamped where they stood: the only safe course, if sufficient warning was obtained, was to completely dismantle the bridge.

(*c*) Violent gales frequently endangered a bridge even when the current was not at its highest. If the wind was blowing downstream, a bridge would be completely hidden by a sheet of spray. If upstream, the bridge would be so violently thrown about as to be impossible to stand on; the sappers on duty were known to be seasick, and occasionally the superstructure worked loose and was thrown into the river.

(*d*) Arrangements were necessary to permit of regular river traffic. A broad river steamer with a large barge lashed on each side, coming down with the stream and often swinging round corners close above the bridge, required a cut of one hundred yards: even then serious accidents were frequent.

(*e*) A light armoured car was the heaviest load provided for in bridge. On occasions when the few heavier guns or lorries in use in the country had to be moved across, rafts were built for ferrying.

(*f*) Circumstances necessitated the material of the bridging trains being used for semi-permanent bridges during the long halts after each stage of the advance upriver—during months on end in the hot weather.

(*g*) There were no roads worthy of the name in the country.

(*h*) Conditions did not permit of the locking up of the large amount of bridging transport required. When not actually required for bridging work, it was frequently in use for general transport.

(i) The material supplied was of the standard pattern but often made in India, and then proved very inferior in every way.

3. (a) To meet the above conditions, "Bridging Trains," of which there were four with the Force, were equipped with five hundred yards of pontoon material, and the personnel consisted of one hundred sappers, with N.C.O.'s, etc. additional. Two of the bridging trains were known as "Mobile Bridging Trains" and were fully equipped with land transport; the other two were towed about by tugs supplied when necessary. There were no Pontoon Parks.

(b) These bridging trains were self-contained. The personnel was sufficient for construction or dismantling of a bridge, and for its maintenance—including forming large cuts at frequent intervals, and safeguarding the bridge in storms and floods. On certain occasions, to ensure rapid work, the personnel was supplemented by that of Field Companies.

(c) To get out anchors quickly in the strong current and for help in various other ways, each bridging train had two motor launches. In the Mobile Bridging Trains these were carried on specially fitted Indian pattern pontoon wagons drawn by siege train bullocks. In the first instance these motor boats were heavily armoured, but the armour was rapidly discarded to reduce weight on both land and water.

4. Turning to the pontoons themselves, which really prompted this article, a different construction in both shape and material would have met the conditions better.

(a) Their bow resistance was too great for the very strong currents. The bows were occasionally drawn clean under and the belaying cleat of the anchor cable sometimes gave way. A semi-scow bow with parallel sides would have been better.

(b) Their material was not durable enough, and a well constructed steel pontoon would have had many advantages. But it would also have had its disadvantages. Owing to various causes replacements were difficult to obtain: after a serious smash wooden pontoons could nearly always be recovered and soon used: steel pontoons would never have been seen again—the depth was often over fifty feet. Similarly, damage from enemy fire was speedily patched.

(c) A completely decked-in pontoon would have been a great boon, but the decking should be removable to enable the pontoons to be used as open boats for ferrying purposes, particularly when forcing the passage of a broad river. In Mesopotamia some of the advantages of a decked-in pontoon were obtained by the use of two removable 6 ft. 6 in. by 6 ft. 6 in. tarpaulins fixed on the bow and stern of each pontoon by a light bamboo and wire framework.

5. Certain other additions were made to the equipment.

(*a*) The absence of a handrail was a difficulty in a country where no local supplies of any sort exist, particularly in view of the great length of the bridges. One was improvised and adopted formed of oars and anchor cables. An iron hoop was fixed on the kelson of each half pontoon so as to come practically under the ribands when in bridge. The handles of two oars, fitted into each hoop, and the oars inclining outwards were attached to the ribands by the racklashings nearest the saddlebeam. The cable was fixed to each oar by a clove hitch at a height of about three feet. While affording no screen from view and little material support, this arrangement gave just the requisite moral support to the drivers, and prevented them getting the wind up, which was usually the cause of accidents, particularly in rough weather. It is considered that something similar should form a definite part of the equipment.

(*b*) When a continuous stream of traffic was using a bridge, the racklashings were occasionally cut by the steel tyre of a wheel; a following wheel forced its way through the joint of the ribands and over the edge. To guard against this without interrupting the stream of traffic, a small rectangular collar fitted to slip over the riband joint and made of ordinary bale hooping was introduced and found effective.

(*c*) Trouble was also experienced with the tendency of baulks to turn partly over out of the vertical under heavy traffic particularly in rough weather. This led to breakages and interruptions in the traffic. To guard against it, a "button chess" was introduced in the centre of each bay and proved effective. It consisted of an ordinary chess with 2-in. battens fitted across underneath so as to fit over the baulks and hold them vertical.

(*d*) To enable armoured cars to use the bridge freely seven baulks per bay were carried and put into bridge on original construction.

(*e*) To meet the rough weather conditions diagonal bracing under the roadway and direct bracing between bows and sterns of adjacent pontoons was found essential, and further was of considerable assistance in forming up in a strong current with a bottom giving treacherous hold to anchors. Breastlines were carried accordingly ready fixed on each pontoon.

(*f*) Another point was the large reserve of anchors and cable necessary. A firm hold against floods could often only be obtained by allowing anchors to sink in the mud to such an extent that it was impossible to recover them—even with steam winches. The top layers of mud—and any anchors in them—were carried away by a sudden flood.

(g) All ranks were supplied with lifebelts for wear in very rough weather or other emergencies.

6. Modifications were also introduced in the method of carrying the equipment.

(a) In the first instance, for various reasons which need not be gone into here, but of which the absence of roads was one, pontoons were carried in separate halves on two-wheeled carts—the ordinary Indian A.T. cart, provided with a long axle to admit the pontoon between the wheels. The superstructure was then carried on G.S. wagons, which would be well suited for the purpose if only somewhat stronger. The pontoon cart gave a light load, but an awkward one, owing to the difficulty of balance and the extremely wide wheel track. This combination resulted in vehicles suitable for transport of supplies.

(b) Later the ordinary pontoon wagon was brought into use, but certain modifications were found necessary and quickly introduced. The fore carriage is weak and one particular member was always breaking and was replaced by a bigger piece. But its chief drawback was its unsuitability for ordinary transport purposes. To meet this, the chess-well was given a flooring of three movable chesses supported in their centre, wooden sides were fixed to it and movable endpieces. The front part of the wagon was floored with open work hoop iron and provided with angle iron side rails, and a movable front piece was fitted. The arrangement was designed not to interfere in any way with the proper use of the wagon for bridging material and to add a minimum of additional weight, but to admit of ordinary common supply loads being handled at any time without any further special preparations.

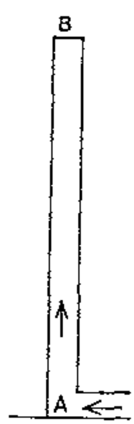
7. Detailed drawings of all these various alterations to pontoon, superstructure, and wagon, were made at the time and should be available in India, but may not have reached this country.

NOTES ON THE DESIGN OF TALL CHIMNEYS AND THEIR FOUNDATIONS.

By LIEUT.-COLONEL J. M. WADE, B.Sc. (London).

HAVING had experience in the construction of tall chimneys, and having known of instances of serious mishap owing to subsidence of foundations, I write these notes in the hope of giving useful information.

HEIGHT.—The height and internal dimensions will generally be fixed by the authority requiring a chimney, but should it be necessary for a Royal Engineer officer to settle these details, the information contained in these notes will enable him to do so. Draught is the pressure causing flow, the following is the physical explanation of the reason why there is a current of air up a chimney.



AB represents a chimney, inside the shaft of which the products of combustion are at a higher temperature than the external air, and being able to expand will do so; the density of the column of gases inside the chimney is therefore less than that of the air, and the weight of the column consequently also less. The pressure therefore at level A is also less than the external pressure at that level, and the outside air being able to enter will do so through the furnace, causing a flow up the chimney. An average sample of coal produces about 95,000 cub. ft. of CO and CO_2 per ton and requires about 300 cub. ft. of air per lb. for combustion.

According to these data the discharge from the chimney will be

700,000 cub. ft. of air and gases for every ton of fuel consumed, the volume being calculated at the temperature of 60° Fahrenheit (*vide* Appendix 1).

Much useful information on the draught of chimneys is contained in a treatise on *Tall Chimney Construction* by R. J. Bancroft, Past President of the Institutions of Civil and Mechanical Engineers, from which the following formulæ have been extracted.

In these formulæ the symbols have the following meanings:—

- t is the temperature of the air in degrees Fahrenheit;
- T is the temperature of the heated air inside the chimney, stated to be generally 580° at or near the summit;
- d is the density of the heated air inside the shaft, that is, the weight of 1 cub. ft. of air at temperature T°;
- D = ·0765 lb = weight of a cubic foot of air at temperature 60° Fahrenheit, barometer 30 in., the average temperature and pressure of the external air;
- H is the head of the external air in ft., which is defined to be the difference between the height of the chimney and that of a column of the external air, which at the temperature inside the shaft would fill it;
- h is the height of the chimney in ft.;
- v is the theoretical velocity of cold air entering the furnaces in ft. per second;
- V is the theoretical velocity of hot air at the summit;
- W is the theoretical draught of the shaft in inches of water.

Then

Volume of gases at temp. $T^\circ = \text{Vol. at } t^\circ \times (459+T)/(459+t)$

$d = D \times (459+t)/(459+T)$

$H = (D-d) \times h/D = h(T-t)/(459+T)$

$v = \sqrt{2gH} = 8\sqrt{H}$

$V = 2v$ on the assumption that velocity is proportional to volume and that the volume of air entering the furnace is doubled when it reaches the shaft.

$W = 12H/817$

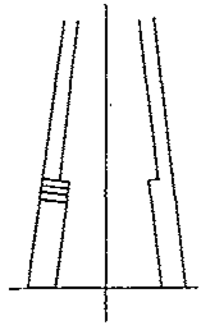
The above formulæ are merely a simple application of elementary physical laws.

The actual velocity is in Bancroft's treatise stated to be generally $\frac{4}{10}$ of the theoretical velocity.

The relation between V and v is based on the assumption that the volume of air entering the furnaces has doubled by the time it has reached the shaft, and this will very nearly be the case if the external and internal temperatures are 60° and 580° F. respectively, but since velocity is proportional to volume the calculation of V for other conditions is not of any difficulty. A specimen calculation for the internal dimensions of a chimney is given in Appendix 2.

DESIGN.—Chimneys are usually built of brickwork but occasionally of iron or concrete.

At the summit the walling should not be less than one brick thick, and at every 20 ft. below the top it is usual to increase the thickness by half a brick exclusive of any firebrick-work, but this rule is only applicable to shafts of moderate height and internal diameter, say 150 ft. height and 4 ft. diameter. A table is given (*vide* Appendix 3) showing the particulars of some existing shafts as described in Bancroft's treatise already referred to. The face batter is usually one in 48, but should not be steeper than one in 60, and the planes of the courses are invariably arranged so that they are perpendicular to the face, the walls leaning inwards as shown on an exaggerated scale in the *Sketch*.



The horizontal section of chimneys may be square, hexagonal, octagonal or circular. The shaft is built from a base often square in plan, the design of the base is governed by the arrangement of furnace flues and by the question of stability, a system of dampers is necessary to regulate the draught, and a manhole at the base of the chimney is necessary for examination purposes.

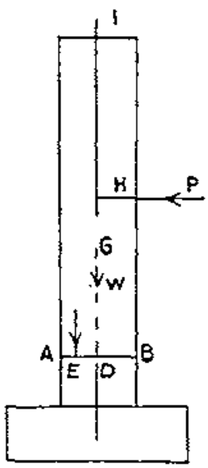
A firebrick core half a brick thick at least is necessary at the lower portion of the chimney, and this core is never bonded into the walls of the chimney, but is built separated from them by an air space, so as to admit of free expansion under the high temperature obtaining at the base of the shaft. (Particulars of the cores of some existing chimneys are given in Appendix 3).

It is advisable when building a tall chimney to fix a light iron ladder outside from base to summit so as to admit of subsequent examination and repairs, and for the same reason an iron pulley should be fixed at the top, clear of the cornice.

CALCULATIONS.—The calculations necessary to secure stability are amply dealt with in *Notes on Masonry Structures* from which I have extracted the following brief outline to make this article more complete.

Considering the stability of a chimney supposed to be symmetrical with respect to a vertical ID, about a horizontal joint AB, the forces acting are (*a*) the horizontal wind-pressures, the resultant of which passes through H, the centre of inertia of the portion of the structure above AB considered as a thin shell.

(The point H may be considered without much error to lie midway between AB and the summit.) (*b*) the weight W of the structure which may be supposed concentrated at G, the centre of inertia which of course lies in ID.



(*c*) The upward pressures along the joint AB.

The effect of P is to tend to overturn the chimney about A and to shift the resultant vertical pressure, which of course is W, and which would pass through D, the centre of the base if there were no wind, to a point E, the distance DE which is termed the excentricity, and which will be denoted by e, is given by the formula—

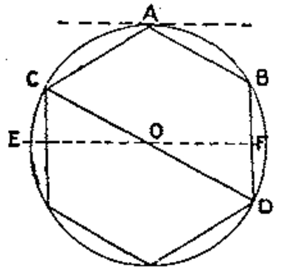
$$e = \text{M, the moment of P about A} \div \text{W} \quad \ldots\ldots\ldots\ldots (1).$$

The displacement of the line of action of the resultant vertical force to an excentric position causes an unequal distribution of pressure over the joint AB, the minimum intensity being of course on the windward side, and it is explained in *Notes on Masonry Structures* that, if the distance DE exceeds a certain maximum denoted by e_c the edge of the joint on the windward side will be in tension, which of course is inadmissible, if DE is exactly equal to e_c, the stress is zero at the edge on the windward side.

An essential condition therefore is that the ratio of $e : e_c$ should be less than unity. The formula for e_c is as under—

$$e_c = \text{I} \div (\text{Area of section} \times y) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2).$$

Where I is the moment of inertia about a horizontal axis through the centre of inertia parallel to the edge of the joint and y is the distance from the centre of inertia to the edge; thus, in the case of a hexagonal section, if AB were considered the edge, I would be calculated about CD and the distance y would be the perpendicular from O to AB; if, however, it were considered necessary to consider the stability about the point A, then the axis would be EF, the parallel to the tangent at A to the circumcircle, and the distance y would be OA.



The necessary and sufficient conditions for stability are:—

(i) The excentricity e as already defined must be less than e_c; this condition ensures that the resultant of P and W will fall sufficiently within the base.

(ii) That the maximum intensity of pressure is less than that which the material can safely bear.

(iii) That the structure will not slide.

The maximum and minimum intensities of pressure are given by the formulæ:—

Y maximum intensity = Mean intensity $\times (1+\rho)$.........(3).

X minimum intensity = Mean intensity $\times (1-\rho)$.........(4).

Where ρ is the ratio $e : e_c$.

For sliding not to occur, $P \div W$ must be less than μ the coefficient of friction, but as it is usual to introduce a factor of safety, 2, the condition for non-sliding may be written:—

$P \div W$ must be less than $\mu/2$ ....(5).

For the complete investigation of stability it will therefore be necessary to compute and tabulate the values of P, W, the moment M, the excentricity e, e_c, the ratio of $e : e_c$, the weight W, the mean pressure and the values of X and Y at foundation level and at every level at which there is an essential change of shape. In *Notes on Masonry Structures* the wind pressure in lbs. is stated to be as under (*see* p. 39).

Square shaft of length of side b, $30 \times b \times h$;
Circular shaft of diameter d, $20 \times d \times h$;
Octagonal shaft diameter of circumcircle d, $21{\cdot}5 \times d \times h$;
Hexagonal shaft diameter of circumcircle d, $22{\cdot}5 \times d \times h$;
Where h is the height.

In the above formulæ the direction of the wind is supposed to be normal to one face.

It will be found that a chimney designed according to the rules laid down, that is to say, with walls one brick thick at the top, battered at one in 48, will probably be stable at the ground level and higher, but if this is not the case the necessary adjustment of dimensions is not a matter of difficulty. The design above ground having been settled the question then arises how wide and how deep must the portion below the ground be. The course to follow is to assume a set of trial dimensions, and investigate the stability according to the rules given.

In all treatises on construction the necessity of arranging the design so that the resultant pressure is near the centre of inertia of the base area at foundation level is very rightly emphasized, but this is often difficult and it may be impossible without abnormal foundations, to avoid a considerable difference between the maximum and minimum pressure intensities on the ground below the concrete. Now a pressure of two tons per square foot may be a perfectly safe pressure to apply uniformly over the whole area, but it by no means follows that there might not be appreciable unequal subsidence if the pressure were two tons per square foot at one end of the base, diminishing to one ton per square foot at the other. In such a case practical experiments of the nature described on p. 77 of *Masonry Structures* to determine the bearing power of the soil should be made and, should the experiments show a material inequality of subsidence under the maximum and minimum pressure intensities, the question of piling the area will be a matter for serious consideration, but the design of the foundations in this eventuality is outside the scope of these notes.

The term "safe intensity of pressure," when applied to a rigid joint has a quite definite meaning, but when applied to an earthen foundation it merely means that the subsidence is uniform and not very considerable so long as the pressure intensity is less than a certain limit. Misapprehension on this point can lead to serious mishap. I have had occasion to examine many tall chimney shafts, and I cannot recollect a case in which some deviation from the perpendicular was not noticeable.

PRACTICAL DETAILS.—To ensure the perpendicularity of a shaft special arrangements are necessary, as the average bricklayer is quite unable to build a shaft in plumb if left to himself. The following method will be found to answer:—

The base of the chimney having been marked out, a template should be made of the exterior shape of the chimney five or six feet above the base level and securely fixed in that position in space at which its shape is coincident with that of the chimney, by stretching strings between the corners of the template and those of the base. The bricklayers will have lines to work on and can scarcely go wrong.

When the template has been built up to, the process should be repeated until completion.

STRAIGHTENING SHAFTS.—It occasionally happens that a chimney tilts so much owing to unequal settlement that its stability is endangered.

It can be straightened by cutting out in one or more places about five courses of brickwork a little more than half-way round and on the side opposite to the direction in which the structure is leaning.

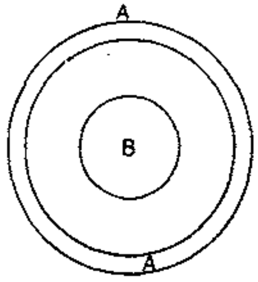
As the brickwork is cut out, short powerful screw-jacks are inserted until the jacks have taken a little more than half the weight, when they are screwed down until the shaft is straightened. When perpendicularity has been attained, the jacks are taken out one by one and the portion hollowed out is refilled with new brickwork.

When the deviation from the perpendicular is but small, it is often sufficient to cut out a single course halfway round the chimney at suitable levels, and to refill the gap with bricks of a slightly lesser thickness; as the old bricks are cut out the new ones are laid, care being taken to keep the gap as small as possible. Of course, the further this is done from the top, the greater the effect on the tilt.

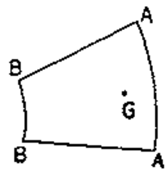
I have tried the second of these methods on two occasions.

Several interesting operations in connection with the straightening of chimneys are described in Bancroft's treatise; both the methods mentioned are described therein.

INSTANCE OF MISHAP.—Among the mishaps which occur, those which are due to the subsidence of foundations are perhaps the most common. I will now give an instance of some interest. No R.E. officer was responsible. The structure concerned was the brickwork base for the support of a circular iron reservoir. After the lapse of 23 years I cannot give dimensions, but the size was quite abnormal and the height of the brick base was about 40 ft. The base was of a pattern often adopted for such structures. It consisted of a circular wall A A with numerous openings in it and a circular stem B, the space between A A and B being arched overwith a massive semi-circular arch.



In calculating the foundations it had been assumed that half the weight of the arch plus reservoir would be borne by A A, and half by B. Shortly after the base had been completed, and just after the bottom plating of the reservoir had been laid, a crack developed right round at the crown of the arch connecting A A and B, and examination showed that the crack was due to the outer periphery having settled more than the central stem. It is obvious that this is only what might be expected under the circumstances, for consider a slab such as A A B B, then G, the centre of inertia being much nearer to A A than to B B, the total load on A A is greater than that on B B and not the same as had been allowed in the calculations.



The injury in this case, though serious, was not irreparable, and an equal settlement was, I believe, obtained by temporarily loading over the stem B.

CHURCH SPIRES.—It occasionally happens, as, for example, in churches, that a spire or tower forms part of a structure ; the problem of the foundations in such a case is nearly the same as for a chimney, but there is this difference : that whereas the latter is never bonded into adjacent walls, a spire must of necessity be an integral part of the structure to which it belongs.

In such a case the foundations of the spire will need very careful consideration if cracks in the adjacent walls are to be avoided, which, though not endangering their stability, are unsightly, and discreditable to the designer. In all probability in a case such as this the foundations of the spire or tower, in order to obtain the bearing area would probably have to be considerably deeper than those of the remainder of the structure, and, should a test be made, it would probably be found that the deeper foundation has the greater bearing capacity.

It must be remembered that the soil at any level has been subject during an immense period of time to an intensity of pressure greater than that at a higher level by an amount equal to the weight of a column of earth, the height of which is equal to the difference between the two levels. In the case of structures the foundations of which are at widely different depths, allowance should, I think, be made for the difference of level.

I mention this point as I know one very able officer of exceptionally wide and varied experience who holds a contrary opinion.

Appendix 1.—Calculations of Gases Formed by the Combustion of one ton of Coal.

The changes occurring in the furnace are exceedingly complex, but ultimately the greater part of the carbon in the coal becomes CO and CO_2, the relative proportions depending on the completeness of the combustion.

Assuming that the coal contains 90 , 5 , 5 proportions by weight of carbon, nitrogen and oxygen, and that the chemical change is represented by

$$63C \times 3N \times 21H_2 \times 65O_2 = 40CO_2 \times 23CO \times 3NO_2 \times 21H_2O,$$

95,300 cub. ft. of gases would be produced, the temperature being reckoned as 60° F. per ton of fuel burnt.

To supply the necessary quantity of oxygen a considerable quantity of air will have to enter the furnace. In Bancroft's treatise, p. 28, it is stated that 300 cub. ft. of air are required, temp. 60°, for the combustion of every pound of fuel.

The chemical equation above given necessitates 71,000 cub. ft. of oxygen, temp. 60°.

Hence in the burning of one ton of coal 2,240 × 300 + 95,300 — 71,000 cub. ft. of gases will have to leave the chimney, or 700,000 cub. ft. in round numbers, this volume being calculated for a temperature of 60° F. In the equation above NO_2 has been entered to account for the nitrogen, but I do not think it likely that this gas (nitrogen peroxide) would be formed, but this is a point of no importance.

When temperatures are stated it does not necessarily mean that the gases are at the stated temperature, but as the volume of a gas varies with the temperature, whenever a volume is stated the temperature at which the volume was calculated must also be given. The volume V at temperature T really means the volume is V on the assumption that the temperature is T.

Appendix 2.—Calculations for Height and Outlet of a Chimney for Furnaces Consuming Two Tons of Fuel per Hour

Vol. of gases at temp. 60° is 2 × 700,000 cub. ft.

" " " 580° is 2 × 2 × 700,000 cub. ft. nearly
= 2,800,000 cub. ft.

∴ as this is the discharge per hour the efflux per second will be

$$\frac{2,800,000}{3,600} \text{ cub. ft.}$$
$$= 780 \text{ cub. ft. nearly.}$$

If the outlet is 3 × 3, 4 × 4, etc., the velocity of efflux will be :

Section 3 × 3	...	velocity	87 ft. per second.
,, 4 × 4	...	,,	49 ,, ,, ,,
,, 5 × 5	...	,,	32 ,, ,, ,,

temperature assumed as 580° F.

With heights of 50 ft., 60 ft., etc., the theoretical velocity at the outlet is:

Height	50 ft.	...	velocity	81 ft. per sec.
,,	60 ,,	...	,,	88 ,, ,,
,,	70 ,,	...	,,	95 ,, ,,
,,	80 ,,	...	,,	102 ,, ,,
,,	90 ,,	...	,,	108 ,, ,,
,,	100 ,,	...	,,	113 ,, ,,
,,	120 ,,	...	,,	124 ,, ,,
,,	150 ,,	...	,,	139 ,, ,,
,,	175 ,,	...	,,	150 ,, ,,

and as the actual velocity is in practice about one-third of the theoretical velocity it follows that a shaft 4 × 4 at the top and 175 ft. high would suffice.

In Bancroft's treatise, p. 29, it is stated that many existing chimney shafts are larger than is necessary.

Two tons of coal an hour is a very heavy coal consumption, but I have purposely chosen an extreme case.

APPENDIX 3. PARTICULARS OF EXISTING SHAFTS

	Shape.	Height ground to summit.	Depth of foundations.	External dia. summit.	External dia. base.	Thickness at summit	Thickness at base.	Foundation area.	Height of internal core.	Thickness of core.	Remarks.
Townsend's Chimney, Glasgow	cir.	454′	14′	13′4″	32′	1′2″	5′7″	50′dia.	60′	9″	
Tennant's Chimney, Glasgow ..	cir.	435′	20′	13′6″	40′	1′2″	2′8″	50′dia.	243′	14″ to 22½″	
Wesenfeld's Chimney, *Barmen, Prussia	oct.	331′	—	11′	20′ × 20′	1′6″	5′3″	—	—	—	Square and 20′ × 20′ to a height of 40′ above octagonal.
Edinburgh Gasworks	cir.	329′	11½′	14′6″	26′3″	15″	3′	40½′ sq.	90′	20″ to 35″	The diameter of 26′3″ is at a height of 65′. The base is 30′ square up to this height. The thickness of core includes fire-brick 4½″ to 9″
Chimney at Brooks & Son's Works, Huddersfield	cir.	315′	15′	12′	20′4″	1′6″	3′2″	36′ sq.	150′	—	The diameter of 20′4″ is at a height of 70½′ above ground, the thickness of 3′2″ is at this level, below the shape is octagonal, increasing to 27′ diameter at ground.
Chimney, Adam's Soap Works, Birmingham	cir.	312′	15′	5½′	27′2″	9″	—	—	—	—	
Chimney, Dean Clough Mills, Halifax..	oct.	300′	—	15½′	30′	3¼′	—	32′ dia.	—	14″	Built of stone and founded on rock. Inside diameter of base is said to be 9′.
Chimney, Johnson & Co., Greenhithe	cir.	297′	7′	11′	25′	1′1½″	3′9″	30′ sq.	no	core.	At the ground line external shape is square to a height of 41′.
Chimney, Merrimac Co. Works, Lowell, U.S.A.	cir.	282′	—	14′	28′	12″	24″	—	280′	4″ to 16″	This chimney has 2 cores, the first inner shaft the walling of which is 8″ thick extends up to 75½′ where it is merged in the outer shaft; innermost shaft is 12′ diameter throughout, 280′ high, 16″ to 4″ thick.
Chimney, Works of Storey Bros., Lancaster	oct.	250′	20′	10′8″	25′	9″	4½′	28′ sq.	250′	4″ to 16″	
Chimney, Fox & Co. Works, Sheffield	oct.	186′	15′	8′1″	14′9″	1′2″	—	19′3″ sq.	90′	9″	The internal diameter at ground line is said to be 5′9″, allowing 2′ for fire-brick core including cavity the thickness of walls at ground level would be 3½′.

PROFESSIONAL NOTES.

ERECTION OF STEEL TOWER AT YANTLET

(CONTRIBUTED BY THE DIRECTOR OF FORTIFICATIONS AND WORKS.)

A BRACED steel tower, 210 ft. high, manufactured to designs prepared in the War Office by Messrs. Braithwaite & Co., Constructional Engineers, West Bromwich, was raised from the horizontal to a vertical position and anchored to its foundation on July 21st, 1921, by the same firm.

The tower weighed about 50 tons; its base was 14 ft. 6 in. square and its top 4 ft. square.

The hoisting arrangement consisted of two 100-ft. steel derricks, each secured by eight guy-ropes. A set of four- and three-sheave pulley blocks was fixed to each derrick, and 2½-in. steel ropes ran from these tackles to two steam winches, the tension in the ropes leading to the winches being about 4 tons.

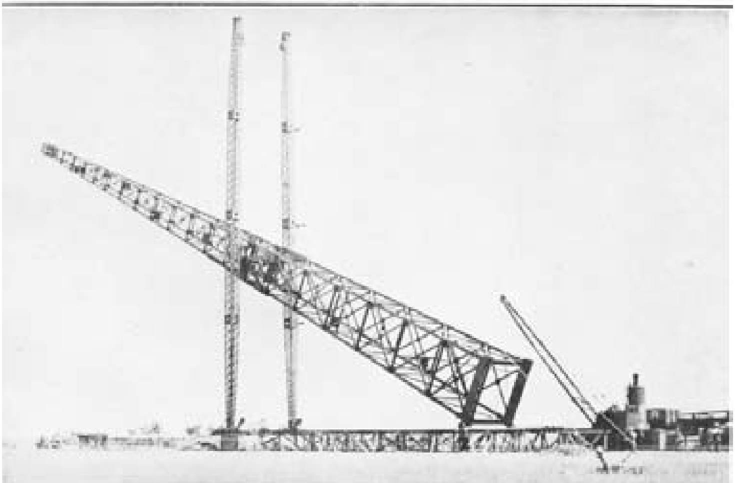
The pulley blocks were attached to the ends of a trunnion, fixed with temporary reinforcement just above the centre of gravity of the tower. Two rollers running in channel racers on a temporary staging were fixed to the base of the tower, the load on these when the tower was horizontal and the weight taken on the tackles being 2½ tons.

Lifting commenced at 1.33 p.m.; the tower was at an angle of 45 degrees by 2.10 p.m. and was resting vertical on its foundation by 3.10 p.m.

The foundation consisted of a block of reinforced concrete weighing about 140 tons and resting on ten 14-in. reinforced concrete piles. The tower was anchored down by four 2¼-in. steel bolts, each 5 ft. long. The ground is very marshy and low-lying.

There are three guy-ropes to the tower, one 4-in. anchored to a block of about 15 tons of concrete, and two 3-in. anchored to 9-ton blocks. There is a permanent strain in one direction, rendering a fourth guy-rope unnecessary.

Photographs of the erection are given.



ERECTION OF STEEL TOWER

NOTES ON REFRIGERATION.

(With Special Reference to the Ammonia Compression System).

By CAPT. L. C. REID, M.C., R.E.

GENERAL PRINCIPLE.

The operation of refrigerating machinery is best described as the opposite of the steam-engine cycle—namely: the conversion of work into heat in such a way as eventually to produce low temperatures.

DIFFERENT METHODS OF PRODUCING COLD.

These fall, roughly, under the following heads:—

(*a*) Frigorative Mixtures.
(*b*) Air-Machines.
(*c*) Evaporation under vacuum.
(*d*) Machines using a material which is alternately vaporized and condensed:—
  (1) By heat direct—Absorption Machines.
  (2) By work done on it—Compression Machines.

(*a*) *Frigorative Mixtures.*—When certain solid substances, such as ice and salt are mixed they tend to combine and form a liquid. To produce liquefaction the latent heat of fusion has to be absorbed and as this cannot be supplied from external sources quickly enough, the temperature of the mixture falls.

This principle is not applied commercially on a large scale but is used in small "sweet ice" making machines.

(*b*) *Air Refrigerating Machines.*—In this system air at a low temperature is used as the medium for cooling. It is drawn from the cold room into the compressor, compressed and delivered at a higher temperature to a condenser where it is cooled. The cool air is then admitted into an expansion cylinder where it does work in expanding by assisting the engine to overcome the compression stroke, and consequently the air loses heat. It is then returned to the cold room. Air-machines are large and of low efficiency compared with the ammonia and other compression types which are now more generally used.

(*c*) *Evaporation under Vacuum.*—This depends on the principle that water evaporates more freely as pressure is reduced. The heat required to produce evaporation will be obtained from the water itself unless it can be got as quickly as required from other sources.

The water to be frozen is put under an air-pump and the vapour, as it is formed, is absorbed by sulphuric acid.

In order to obtain ice it is necessary to maintain a very high vacuum as water at 0° C. has a vapour tension of only 4·6 mm. and the renewing of the acid is troublesome. The system is used on but a small scale.

(*d*) (1) *Absorption Machines*.—A strongly concentrated solution of ammonia in water is heated by steam coils in a still. Ammonia is driven off in the form of vapour under pressure and passes to a condenser in which it is cooled and liquefies, afterwards being allowed to expand in refrigerating coils, extracting heat from the brine or water surrounding the coils. It then passes to the absorber, where it is absorbed by the weak ammonia liquid drawn from the lower part of the still. This liquor, strengthened by the ammonia absorbed, is pumped back to the still, passing through an exchanger in which it takes up heat from the hot weak liquor on its way to the absorber.

This process is used to some extent, although the Compression system is from 2½ to 3 times more efficient. There are practically no moving parts, the plant requires very little attention, and, where low pressure steam is available the system has its advantages.

(*d*) (2) *Compression Machines*.—In this system a gas, or rather saturated vapour, is used in a closed system of piping. This vapour is drawn into a compressor and subjected to such a pressure that when it is passed through a condenser it liquefies. This liquid is then allowed to pass through a regulating valve to the refrigerating coils where it vaporizes under the reduced pressure caused by the return stroke of the compressor. In order to vaporize it has to absorb the necessary latent heat units from the medium surrounding the refrigerating coils, which is consequently cooled.

COMPARISON OF AMMONIA AND CARBON DIOXIDE.

In a large majority of refrigerating plants the vapour used is either ammonia or carbon dioxide. The table below gives a comparison of the properties of these vapours.

	Ammonia.	Carbon Dioxide.
Absolute pressure at 0°F. in lbs. per square inch	30·4	310
" " " 85°F. " " " "	167·8	1068
Heat of vaporization in B.T.U.S. per lb. at 0°F.	555·5	123·2
Volume of 1 lb. in cubic feet at 0°F.	9·04	0·277
Heat of vaporization per cubic foot	61·7	447
Critical temperature F.°	266°	88°
Relative sizes of Compressors for theoretically equal refrigeration	7·2	1
Loss due to cooling of liquid from Condenser temperature	·18%	·80%

From this it will be seen that for equal effects a CO_2 machine can be considerably the smaller and is therefore largely used on ships. On land, however, the ammonia machine is generally preferred, due, firstly, to much lower working pressures; secondly, to less loss in cooling of liquid; thirdly, to greater refrigerating effect per lb.; fourthly, to working quite efficiently when condenser temperature is high, owing to lack of water or hot climate. As the critical temperature of CO_2 is 88°F., the efficiency falls off at higher temperatures.

Owing to improvements in manufacture the danger of using poisonous ammonia in large quantities has been overcome and its pungent smell gives it an advantage over CO_2, as leaks are easily detected.

Ammonia Compression Plant.

This consists essentially of two parts :—

(*a*) High Pressure side—machinery for liquefaction;

(*b*) Low Pressure side—evaporation of liquid.

Dealing with the high-pressure side there is first the compressor. This is usually on the horizontal double-acting type with self-operating valves and in consequence it only runs at low speeds—70 to 90 revolutions per minute. A new type is now being tried, fitted with a special type of disc valve and it is hoped to run this at 200 revolutions per minute. If successful and efficient, this will admit of much smaller compressors being used for a given refrigerating effect.

Before the vapour is drawn into the compressor, it passes through a purifier on the suction side; this is duplicated so that the plant need not be out of action during cleaning. Quicklime is used to absorb any moisture that may get into the system.

On the delivery side the compressed vapour is passed through a special grease-filter which removes any oil that may come over from that used in the compressors for lubrication. This is very essential as, if oil is allowed to get into the condenser or refrigerating coils, a serious loss of efficiency will result. Special non-freezing oil must be used or the valves will gum up.

Cotton or metallic packings are used for the piston-rod, in lantern glands. Great care is required in tightening up these packings or the rod will become worn and air drawn in on the suction stroke.

The condenser is usually of the evaporative open-air type in which the vapour passes through a series of coils over which cold water is allowed to drip. Now the pressure here and at the delivery valve of the compressor is entirely fixed by the cooling which is possible by the condenser and corresponds to the pressure of saturated ammonia vapour at that temperature. The pressure, therefore, varies in summer and winter and in hot and cold climates.

The amount of cooling water must be sufficient to absorb the latent heat of vaporization and also any heat due to super-heating of the vapour.

Cocks are provided on the top of the condenser coils for removing air from time to time, as circulating air gives practically no refrigerating effect.

Clearances in the compressor must be small, otherwise very little new vapour can be drawn in on the suction-stroke. In some machines this "dead" vapour, due to the clearances, is got rid of by injecting oil at each stroke and discharging the excess through the delivery-valves, but it is questionable if there is any gain by so doing, as it produces a loss of efficiency due to the oil-pump and further complications in the removal of the oil.

For safety, some makers fit spring cross-heads, cylinder-covers or piston-heads so as to prevent the cylinder-covers being fractured if liquid instead of vapour should be drawn into the compressor.

Low-Pressure Side-Regulating Valve.

Liquid ammonia flows by gravity from a receiver placed below the condenser to the regulating-valve. The regulating-valve should be placed as near the refrigerating-coils as possible. On opening the valve (a specially constructed screw-down needle-valve) the liquid ammonia passes through into the refrigerating-coils. The pressure and the temperature fall and a portion of the liquid is evaporated. As the liquid ammonia flows through the coils, heat is received from the surrounding brine, or other medium to be cooled, and more liquid is evaporated. The resulting vapour is drawn back into the compressor.

Theoretically, the expansion-valve should be replaced by an expansion-cylinder and the liquid in expanding made to do work; thus less work would have to be done by the engine and more heat could be absorbed. This is never done in practice owing to the mechanical complications in design.

The regulation of the expansion-valve is important, as, if opened too much, liquid ammonia flows back into the compressor and may cause damage, besides lowering the efficiency due to non-vaporization.

The valve can be regulated so that the vapour at suction-side is so "wet" that after compression vapour is delivered just saturated, *i.e.*, the liquid present, in vaporizing, absorbs the heat of compression. The valve can be shut still further so that the vapour at the suction-side is practically dry, and full use is made of all its latent heat of liquefaction; the vapour will be very hot now on compression and useless work will be done.

When ammonia is used the efficiency remains approximately the same, whether or not the compressor is run superheated; a slightly less efficiency results from using a superheated system, but a greater refrigerating effect per lb of vapour circulating is obtained.

It is usual to compromise by running the compressor-cylinders water cooled and the valves so regulated that the delivery-pipe is hand-warm, when running normally. When it is desired to maintain a fixed temperature the compressor is run on full load with expansion-valve regulated to give the most efficient working. If the cooling effect is too great the compressor is stopped until the temperature rises and is then started again.

Ice making.—Owing to high freight charges less Norwegian ice is imported than formerly, and approximately some half million tons have to be made annually in this country. Ice making has therefore become quite a large industry. Good water must be used or bad ice will result ; this, besides having a " milky " white appearance, does not last any length of time. The opaqueness is caused partially by dissolved solids, but chiefly by the air in the water. In America distilled water is used, but in this country good town water is employed and de-aerated by mechanical means, such as compressed air, agitation and shaking of the cans, movement of paddles, pumping in water through jets, etc.

The four main systems of ice making are :—

(*a*) Can.	(*c*) Plate.
(*b*) Cell.	(*d*) Direct-expansion.

The Can System is the oldest and most generally used. The ice is formed in tapered galvanized iron cans or moulds, made in standard sizes, holding from one-half to two cwt. of water each, producing rectangular slabs of ice from 4 in. to 11 in. thick. The moulds are filled with water and immersed in a tank of brine cooled below 32°F. The cans, when the water is frozen, are lifted out and dipped in a tank of tepid water to loosen the ice, which is then tipped out. An eleven-inch can takes 60 hours to freeze.

It is necessary to agitate the water in the cans during freezing in order to produce clear ice.

The refrigerating-coils are usually in the brine tank itself and the brine circulated by means of a small centrifugal pump.

The Cell System.—The water to be frozen is put into a large tank which is divided into a number of " cells," or compartments, by hollow walls of cast or wrought iron. The tank is also fitted with a false bottom.

Brine is cooled in a separate tank containing the refrigerating-coils, and is pumped from this through the hollow walls, thus causing the water to freeze. The water is kept agitated by means of paddles and the false bottom up to the last minute, and so better ice is obtained than with the can system.

For thawing off, hot brine from another tank, heated by a steam-coil, is circulated until all the blocks are free to be lifted out by a crane. In spite of better insulation cell-ice takes longer to form; a machine which can produce 1·1 tons of can-ice would produce only 0·9 tons of cell-ice in the same time. That is, cell-ice takes one-fifth longer than can-ice to form.

Plate System.—A large tank is divided by hollow walls in one direction only, through which walls cold brine is circulated. Ice is formed on both sides of the walls in large plates, and as it is formed outwards and removed before it has frozen solid across, very good ice is obtained without agitation, and all the impurities tend to remain in the water and can be drained off before the ice is withdrawn. It is usual to place against the walls metal plates on which the ice is formed. These are removed with the ice, which is slowly thawed off to prevent it cracking.

The best ice is made by this system, but it is much more expensive and slower than the other systems. Some ten days are taken to make a 12 in. slab.

Direct Expansion.—In this system the refrigerating-coils are placed directly in the water to be frozen.

The general principles of two direct-expansion systems are described below.

The Empire System is similar to the cell system. A large metal tank is divided into compartments by hollow metal walls. Sloping metal channels are riveted inside these hollow walls in such a way that the ammonia admitted at the top has to make a series of backward and forward paths before it can pass out at the bottom to the suction-pipe of the compressor.

The regulating-valve is placed right against the tank and not in the engine-room, as is generally done in other systems. Agitation is obtained by compressed air. The freezing is very rapid, but the quality of the ice suffers in consequence. The efficiency of the plant is increased by the absence of brine losses, but reduced owing to the working at lower temperatures.

The "Pluperfect" System has only been placed on the market recently, and promises to be the best and most efficient system.

Eight refrigerating-coils are fixed vertically and equally spaced in a wooden tank, 12 ft. by 10 ft. by 7 ft. Each set of coils consists of three groups of seven "bends," each 6 ft. 6 in. high. Each "bend" consists of two "D" section-tubes welded together and connected together at the top. The bottom of each "bend" is welded to the next so that a complete set of coils is formed.

When the regulating-valve is opened and the ammonia admitted the water begins to freeze, and as it expands the level is kept constant by providing an overflow at such a level that the top of the coils is just uncovered. Ice forms round the groups of bends and 24 blocks are made. Before the whole is frozen solid the regulating-valves are closed and by means of valves provided for the purpose liquid ammonia is passed through the coils for thawing off; the ammonia is not wasted but is passed through the regulating-valves of other tanks. As the top of the coils projects above the ice it is easy to see when thawing out is complete.

Hot water from the compressor-jackets is also passed through other pipes at the bottom of the tank to thaw off the under side of the blocks. To facilitate the lifting out of the block a special clip is placed on the top of coils before freezing commences, and is frozen into the block of ice.

This system produces clear solid ice and combines the advantages of the plate system in this respect with those of the can system as regards time of manufacture. Ten-inch ice is made in 41 hours without agitation. Another advantage is the ease of control, as freezing can be stopped and ice removed when required. Damaged coils can be cut out and the plant still worked. The replacement of coils can be carried out easily.

The ice formed has seven holes up the centre, but there is little disadvantage in this, as in most cases ice is crushed before use.

If agitation is required water is pumped through nozzles situated between the blocks, but with ordinary town water this is unnecessary, as clear ice is formed without agitation.

With compressors driven by gas-engines working on suction-gas, 25 tons of ice can be produced with one to one-and-a-half tons of anthracite coal. Taking water at 52°F., this gives an overall efficiency of

$$\frac{25 \times 162}{1{\cdot}5 \times 15{,}000} = {\cdot}18\%.$$

In the cell system, working with steam plant, the production of ice may be as low as 5 tons of ice per ton of coal.

Typical Temperatures for Cell- and Can-Ice.

Temperature of water off condensing-coils: 57°F.

Gauge pressure of ammonia in condenser: 107 lbs. per sq. in.

Temperature: 65°F.

Suction-gauge temperature: Can, 14°F. Cell, 11°F.

Brine temperature: Can, 23°F. Cell, 21°F.

Cold Storage.

Besides ice making, refrigerating plant is used largely in the storage of meat and produce at a low temperature. Cold stores are specially constructed rooms, the walls, etc. being insulated with granulated cork and lag-wool, or other non-conducting material.

Some of the methods used for maintaining low temperature in the stores are:—

1. Circulation of cold brine in coils;
2. Circulation of cold air;
3. District expansion in coils.

1. *Brine Circulation.*—Brine is cooled in a separate cooler and is pumped through a series of coils fixed to the roof and walls of the

chamber. The air, cooled by the coils, falls, and circulation is thus set up. Brine has a high specific heat and so provides a storage of "cold" which helps very materially to maintain a uniform temperature in the case of a temporary shut-down of the plant. This is a very suitable method of keeping materials just below 32°F., but it does not ensure a very good circulation of air.

2. *Cold Air.*—The air is drawn from the top of the cold chambers through ducts by a forced-draught fan and delivered through a battery of direct-expansion coils, in which it is cooled, back to the chambers through other ducts arranged to discharge downwards.

Brine is usually circulated over the expansion coils and special arrangements are provided for bringing the air into intimate contact with the cold brine. By this means the air is washed and any moisture in it is retained by the brine. As the brine solution becomes weaker by the absorption of moisture it is necessary to occasionally reconcentrate it in an evaporator.

Separate batteries may be used for each room, or one large battery only for the whole store when regulation of temperature is obtained by opening or closing the delivery-ducts in each room. The former method gives the better regulation but is expensive in installation and takes up more space.

Below are given typical temperatures at various points with this system :—

Ammonia delivery ...	... 65°F.	
Ammonia suction ...	...—5°F.	Diff. 8°.
Brine Solution ...	... 3°F.	
Air inlet (at fan) ...	... 23°F.	
Air outlet ...	... 8°F. (5° above brine).	
Rooms ...	... 22°—26°F.	

3. *Direct Expansion.*—In this system coils are placed directly in the cold chambers taking the place of the brine pipes referred to in (1). The system is more flexible but there is no reserve of "cold" as with the brine.

Snowing-up and Thawing-off.—When unfrozen or unchilled produce is placed in the chambers some of the moisture present evaporates into the air before the produce reaches a temperature of 32°F. As the air circulates over the refrigerating, or brine coils, as the case may be, this moisture is deposited in the form of snow on them. Even if only frozen produce is put into the stores snow still forms, due to "wet" air reaching the chambers from outside.

The efficiency of the system falls off considerably if snow is allowed to form to any great extent, as the coils are not so capable of taking up heat due to the poor conducting covering.

In system (2) snow causes little trouble. As there are no coils in the chambers no snow is deposited here; and the snow, which is formed, is absorbed by the strong brine circulating over the refrigerating-coils as fast as it is formed.

In systems (1) and (3), however, the snow forms in the chambers themselves and in consequence special arrangements have to be made to get rid of it from time to time. This entails passing hot brine or "hot ammonia" through the coils and collecting the melted snow in some suitable manner.

The method used in the new installation at the Royal Albert Dock is as follows:—The whole store is insulated very thoroughly on the outside walls, the ground floor and the roof, the intermediate floors and partitions are, however, all built with open-spaced planks so that there is free circulation of air throughout and the building consists essentially of one large room.

In the centre is a battery of some six sets of refrigerating coils. Warm air is drawn from the top of the building by electric fans, forced down over the coils, and led out through ducts on the ground floor. As the air becomes warm it rises and is then forced down over the coils again.

A collector connected to a drain is fixed under each set of coils. Hot liquid ammonia is passed through the coils as required for thawing off, any snow which has collected on them will melt and the water is drained away without trouble—the whole operation taking some twenty minutes.

This method appears very economical and simple, but of course cannot be applied when stores are used for keeping goods which have to be maintained at different temperatures.

Regulation of Temperatures in Cold Rooms.

The regulating-valves should in all cases be fitted as near as possible to the expansion-coils they control and not placed together in the engine-room, as is sometimes done.

Special thermometers are made in which the temperatures recorded can be transmitted to an indicator in the engine-room, and one of these should be fixed in each chamber.

The above merely touches the fringe of the subject and is of necessity incomplete. Further information could be gained by consulting one of the numerous books on the subject.

The following are suggested:—

Refrigeration, by Milton W. Arrowood; *Refrigeration, Cold Storage and Ice Making*, by A. J. Wallis-Taylor; *Refrigerating and Ice Making Pocket Book*, by A. J. Wallis-Taylor.

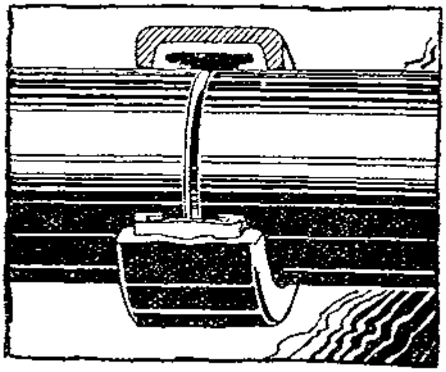
SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.

(CONTRIBUTED BY THE R.E. BOARD.)

THE following exhibits which appear to be of use to the military engineer, were noticed at the Shipping Exhibition at Olympia.

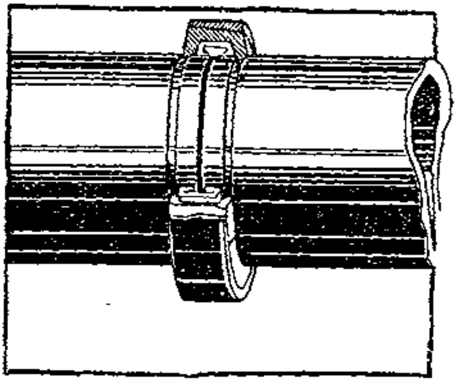
THE "VICTAULIC" LEAK-PROOF PIPE-JOINT.

This is a development of the hydraulic "U" washer which has been in general use for generations. The inner part of the joint—the leak-proof ring—amounts in effect to two opposed "U" washers, with the outer rings united but with the vital addition that the inturned lips are made to grip the pipe ends radially when the joint is pushed into position. The joint is proof against vacuum as well as pressure and may be flexed in any direction up to three degrees without leakage. It can be used with pipes conveying water, oil, steam, benzine or chemicals by the use of different types of leak-proof rings.



The "A" type (floating) joint used for low pressures or for buried or anchored pipes.

A second or "B" type form is made for special cases when pipes have to be secured against end displacement in which the locking ring or socket fits into grooves cut on the ends of the two pipes to be jointed.



The "B" type (located) joint which secures the pipes positively against end displacement under pressure.

A Combined Chain Helice Lift and Gear Force Pump.

The Boulton pump (by Boulton & Paul, of Norwich) is suitable for any depth down to 150 ft. and forces up to 100 ft. The pump can be obtained petrol-driven, electric motor-driven, or belt-driven.

The general dimensions are 30 in. by 14 in. in plan and the duty of the pump is 300 to 350 gallons per hour through a $\frac{3}{4}$-in. rising main. The force pump body forms part of the hood casing of the chain helice portion of the pump and is mounted on the same shaft. A loose circular weight is used to keep the chain taut.

The Turbo Cornelle Lift and Force Pump.

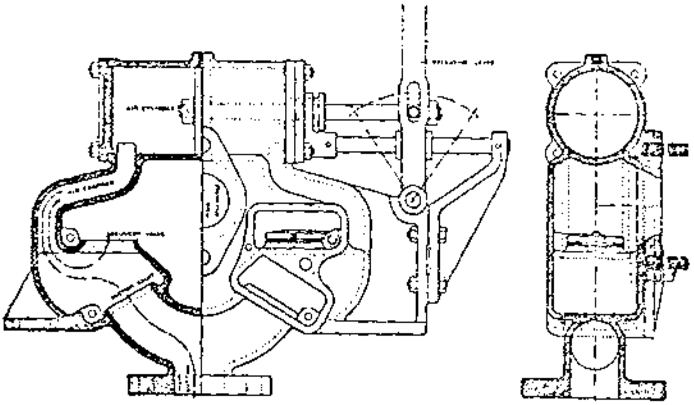
This pump is also made by Messrs. Boulton & Paul and is an extension of the canvas belt pump used in France. It will raise 5,500 gallons per hour 200 ft. and force an additional 80 ft.

The pump differs from the old canvas belt pump in having corrugated metal strips rivetted on to the outer side of a composite canvas belt.

These strips run about 1 in. wide and are close together, but the indentations line up across the belt to render it flexible. The general arrangement of the pump is similar to the Boulton pump described above.

Finney Pump.

These pumps are of the reciprocating piston type, and are double-acting. As will be seen by a glance at the sectional drawing reproduced below, a new principle has been introduced into reciprocating pumps by arranging the valves and also the discharge of all *below the cylinder*. It has been demonstrated that this arrangement adds considerably to the volumetric efficiency as compared with that of all other types of pumps, and has the further great advantage of securing a *dry cylinder* when the pump is operating within certain limits, thus effecting great economy in the life of the pump. It is, of course, more particularly desirable to preserve the dry cylinder when dealing with corrosive, gritty or heavy liquids.



PARTICULARS OF STANDARD HAND PUMPS.

1. No. of Pump.	2. Diam. of Suction and Discharge in Inches.	3. Quantity of Water in Gallons per Hour.	4. Limit of Vertical Section.	5. Dry Cylinder obtained at Suction of:— (see Footnote*)	6. Weight.
1	1	500	22 ft.	13 ft. 6 in.	28 lbs.
2 D	2	1,000	9 ft.	always dry	90 lbs.
2 E	2	1,500	23 ft.	18 ft.	73½ lbs.
3	3	—	—	—	—

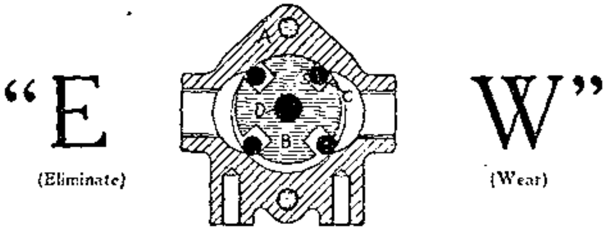
* A dry cylinder is not obtained until the vertical suction reaches the figure quoted in column 5, but is then retained with any delivery head.

The capacities quoted in column 3 are those obtained on a 3-foot vertical suction.

A new design of 3-in. pump is being prepared to deal with heavy duties.

THE E.W. PUMP.

This little pump consists of a four-slotted disc with a loose roller in each slot rotating in an eccentric drum. It appears very suitable for cooling water services or for suds on machine tools. The No. 1 size giving 170 gallons at 1,200 revs. per minute is only 6 in. long, including the pulley. A sketch is attached.



A Housing. C Rollers.
B Rotor. D Shaft.

Pumps for Oil or Water.

(Four models made : 2 for oil or suds, 2 for water, etc.)

Advantages.

1. The simplicity of principle and design gives utmost reliability and maximum life.

2. The Rotor " B " has four free rollers " C," which automatically take up what little wear occurs, so that when wear takes place the suction remains unimpaired, and capacity is only slightly reduced.

3. Runs equally well in either direction.

4. Does not get stopped up. The rollers, which are perfectly free, ride over any small obstruction which then is carried to the discharge.

5. Ideal for cooling water service and for suds on machine tools.

6. The smallest, lightest and cheapest pump for the output on the market.

The Silent Record Engine.

A two-cylindered sample of this engine was shown running. It is practically vibrationless, as a glass of water standing on the engine was practically free from ripples.

The engine is two-stroke and has a piston valve which admits air to a compressing chamber and then to a twin-coupled cylinder mounted on the top of the compressing chamber. The piston is made up of—

(i) twin firing pistons, a compressing piston and a trunk guide.

The twin firing pistons are so arranged that the exhaust port on the one cylinder opens before the end of the stroke. The inlet port on the other cylinder opens later and the compressed charge rushes up the one cylinder and down the other, and so scours the firing cylinders.

This engine is made in 14 sizes from 1½ b.h.p. to 225 b.h.p.

Rust Proofing by the Galeco Process.

The samples of work shown are interesting and it is claimed that this is superior to ordinary galvanizing, as the alloy deposited is not plain zinc but an alloy with a greater resistance to corrosion, which forms an absolutely contiguous coating without the uneven finish which generally is obtained with ordinary galvanizing.

A lustrous polish can be obtained or the finished article can be painted without the use of a mordant. The uses for which it is recommended by the Company include screws, bolt nuts, water pipes and fittings, pulleys, ironmongery, etc.

NOTES ON ALDERSHOT-COLOGNE W/T SERVICE.

CONTRIBUTED BY THE R.E. BOARD.

THIS service was installed primarily for military telegraphic traffic and partly in order to provide a practical and prolonged trial of the High Speed W/T apparatus developed at the Signals Experimental Establishment at Woolwich.

The High Speed service was installed and operating in October, 1920—though brief experimental periods had been worked at a much earlier date.

From October, 1920, in addition to purely military traffic, the daily press news was regularly transmitted to Cologne for publication in the local English newspaper.

After working for some time a system of remote control was installed which enabled the W/T apparatus to be operated from a distance.

A demonstration of the capabilities of the system was given to representatives of the G.P.O. to enable them to form an opinion as to the value of the system and its possibilities in regard to relieving the wires of some of the commercial traffic. The P.O. authorities were sufficiently impressed to arrange for a trial for commercial working under their control. This trial began in February, 1921 and resulted in the G.P.O. commencing regular operation on 24th August last.

Since that date a varying number of words have been dealt with daily according to P.O. requirements, which, generally speaking, are not nearly sufficient to fully employ the station.

Certain hours in each day are allotted to the G.P.O., other hours being reserved for military traffic.

Urgent military messages have priority and may be transmitted at any time.

The High Speed Service normally works at 90 to 100 words per minute, but is capable of much greater speeds.

The Post Office traffic is transmitted from London by machine telegraph and reaches Aldershot by wire; it is there automatically transferred to wireless and is radiated. It is received at the wireless station outside Cologne and there automatically transferred to the German underground cable by which it is carried to the German Post Office in Cologne, where the messages are recorded on paper slip. The traffic in the reverse direction follows the same route, but is finally printed out in Roman characters in the Central Telegraph Office, London, practically simultaneously with its transmission from Cologne.

The following approximate figures may be of interest:—

During September the traffic at the Aldershot end was:—

	Words sent.	Words received.
Civil traffic	41485	33971
Military traffic ...	15379	904
	56864	34875

The big predominance in the military working of words sent over those received is due to the daily transmission of the press news, which ranks as military traffic in this connection.

During this period the total cost of electric power to run the electrical machinery and also including lighting and heating the station amounted to just under £22, while the value of the traffic handled based on 3d. a word—the official telegraphic rate to Germany—comes out at a little over £700.

The best day for traffic recorded to date was 28th September, when the figures for civilian traffic were:—

Words sent	3390
Words received	1590
Total	4980

On this day the Post Office used the station for 5½ hours, but the traffic output might have been far greater.

CORRESPONDENCE.

To the Editor of the R.E. Journal.

Sir,—In Lieut.-Colonel R. P. T. Hawkesley's article on "Water Supply to Armies in the Field," published in your September issue, he points out that "Tanks, waterproof, canvas, 2,300 gallons" and "Troughs, waterproof, canvas, 600 gallons" hold only about 1,500 and 350 gallons respectively and suggests that it would be interesting to ascertain how the registered contents were originally arrived at. May I offer the following as a possible solution?

The official in question (obviously not an R.E. officer) measured up the articles and found they would hold 230 and 60 cubic feet. He remembered vaguely that a gallon weighed 10 lbs. and that 6¼ went to the cubic foot—or was it the other way round? He tossed for it and fate decided that a cubic foot should contain 10 gallons. Had the coin fallen the other way he would have found the contents to be about 1,450 and 375 gallons, which are approximately the figures given by Lieut.-Colonel Hawkesley.

I am, Sir,

Yours faithfully,

J. S. Baines, *Capt., R.E.*

REVIEWS.

ECONOMICS OF BRIDGE BUILDING.

By J. A. L. WADDELL.

(Price, 36/-. Chapman & Hall, Ltd. 1921.)

This volume gives a summary from the economic point of view of the vast experience gained by the author during his life of bridge building in all its branches. It contains much useful data for comparing the probable costs of bridges of all known types and spans constructed in various materials, and gives the author's opinion as to the most economical way of carrying out the numerous operations involved during ship work, erection and subsequent maintenance. There is a chapter in general terms devoted to military bridging, where saving of time is usually of greater importance than reduction of cost. The book is perhaps more useful to those confronted with large bridging problems than to the military engineer, but is of undoubted value as being the final work of a bridge builder of exceptionally wide experience and world fame.

E.F.T.

LA PRISE DE CARENCY PAR LE PIC ET PAR LA MINE.

By CAPITAINE THOBIE (Paris, Berger-Levrault, 15 francs).

The author is an officer of Engineers and his book, which describes the capture of Carency in May, 1915, is of considerable engineer historical interest. Apart from the text, the 87 reproductions of photographs give an extraordinarily good idea of trench warfare in 1915. The first hundred pages contain a general description of the French divisional organization, the instruction of infantry in field fortification, the organization of offensive and defensive sectors, the trench warfare material, the maintenance of trenches and German organization. Then follow an account of the failure of the French *attaque brusquée* on 20th December, 1914, and the settling down to siege warfare—by literal sap and mine. The greater part is devoted to the mining, which is described in detail with a good plan. The final attack on the 9th May was preceded by the successful firing of 17 mines. The charges only of the nine prepared by the 20/11 Engineer Company are given; each group of three containing a little over three tons of cheddite. The assault made apparently some time after the explosion of the mines, and four hours of bombardment, was a complete success.

J.E.E.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 10.—*The Leipzig Trials.*—The *M.W.B.* has commented very little so far on the Leipzig trials, but in this number Col. Schwertfeger says that the completeness of Germany's collapse is indicated, more than anything else, by the fact that the Allies have compelled her herself to place members of the Army on their trial.

He remarks that, before the war, training in the German army was directed towards encouraging all ranks to take responsibility up to the full limit of their powers. A frequently quoted paragraph of the German Field Service Regulations says, "Everyone, from the highest to the lowest must remember that failure attributable to inaction or delay is far more blameworthy than when it is due to action, however mistaken." The writer says that no one, brought up on that principle, could ever have imagined that his action could be the subject of a civil prosecution, though he does not wish to imply that war justifies all kinds of action, or that, during hostilities, all feelings of common decency and sympathy should be put aside. He admits, however, that the severity and length of the war, combined with the necessity for taking every possible measure of self-protection did tend to push these feelings into the background; but whatever was done, was done from patriotic motives, which by Germans, as well as by other civilized nations, are placed among the highest that influence human action.

He next considers what should be the attitude of past and present officers towards those sentenced at Leipzig, and begins by disclaiming any desire to criticize the judges, who performed a most difficult and distasteful task as well as anyone possibly could, as was admitted in the English parliament. In past days the code of honour of Army and Navy officers forbade any intercourse with those sentenced to imprisonment and there was no place for them on the public service.

Should the comrades, who have been dragged by the Entente before a German court, and sentenced by a German judge, be also outcast?

Before answering this, he points out that it was impossible for the court to enter fully into the atmosphere of war, with its terrible physical and mental strain. Under this strain natures completely changed and normal thoughts were often completely absent. He claims that it is to the materialist form, which the war so soon adopted, that the guilt of such crimes as were committed must be ascribed. The usual counter-accusations against the allies follow; and though he goes further than most, and admits that sometimes Germans did do things they ought not to have done, yet, in view of the fact that the trials were insisted on, chiefly to drag Germany's name in the dust, and not to punish wrong-doing, he holds that those sentenced should not be cast out;

rather should they be made to feel that, in their time of trouble, they have with them the sympathy and respect of all their comrades.

Col. Schwertfeger has made the best of a bad job.

Roumania's Preparation for the Great War.—Some figures, obtained from a Roumanian source, are given to show how preparations were pushed forward from the beginning of 1914. The greatest difficulty lay in finding officers; of these there were in 1914 only 4,150, increased by July, 1916, to 6,900; at the latter date the number of officer cadets was 1,606, actually under instruction, with another 1,604 in reserve. Credits were voted without stint, and the country was self-supporting in most of the material essentials.

There seems to have been an inconvenient variation in types of small arms, which included 180,000 Martini rifles of 1879 pattern. The grand total of all ranks, including all reserves, amounted, on the declaration of war, to 1,250,000 as compared with about 400,000 in 1913. The magazines were full, equipment and clothing was good and ample, and hospitals with 76,000 beds were organized and, as regards material at any rate, everything in any way possible seems to have been done.

Emigration.—Organizations have been set up in Germany to assist and advise intending emigrants. If their first advice is followed they will have little to do, for in the case of almost every country the advice to those about to emigrate is "don't." Only in South America do there appear to be any openings for Germans, and even there the capital required is within the reach of very few.

Obituary Notice.—The death of Field-Marshal Karl von Bülow is announced. He commanded the 2nd German Army in the beginning of the war and it was probably largely because of his appreciation of the situation on the 9th of September, 1914, that the retreat of the Germans took place. With his death one of the principal actors in the Hentsch drama is lost.

No. 11.—*Russia and Poland.*—The Russian Army is undergoing a re-organization which, according to the *M.W.B.* renders it temporarily unavailable; eventually however its efficiency will probably be increased. A course of instruction for regimental and divisional commanders seems to have revealed an unheard-of degree of ignorance and the course has had to be extended. These higher officers are much discontented with their pay and there is a suggestion of abolishing the equal pay system.

At present the only troublesome fronts are in South Russia and Western Siberia, though the friendly "Republic of the Far East" feels itself threatened by Semenov. The extent to which actual support has been given to Mustapha Kemal is said to be doubtful and the *M.W.B.* does not believe that anything has really been done. The economic situation is hopeless.

Poland.—Polish action in Upper Silesia is, of course, heartily condemned. It is stated that seven Divisions of the Polish Army are stationed round about the district and that the skill with which the Poles form, organize, and control irregular and secret bands among the villages, is a great danger to Germany. Little hope is felt that the Vilna question will reach any permanent settlement in the near future.

Training is going on vigorously; it follows French lines and is directed by a French mission under General Niessel.

Prohibition of Uniform.—Demobilized officers are no longer allowed to wear their uniform, and a Major Anker finds this most unjust; not, of course, on political, but merely on economic grounds. Numberless officers have been accustomed to wearing their old uniforms on all festive occasions. When the civilian at funerals or small gatherings wears his tail-coat or "smoking," at weddings and christenings his "frock," or for visiting, for parties and such like his "cut-away" and "cylinder," the officer has worn his uniform. This was not from militarism or because he was a re-actionary, but merely because he possessed neither "frock" nor "smoking," "cut-away" nor "cylinder," and could not, in these days, pay the thousands of marks necessary to acquire them.

And so Major Anker will no longer be able to attend the funerals of his friends, nor the weddings of his relations, and, incidentally, one more difficulty has been placed in the way of that maintenance of military traditions, which is so strenuously sought for by many in Germany.

No. 12.—*Germany's Casualties in the War.*—General Altrock has collected the following figures showing the numbers wounded during the war. The information is from official sources, but does not allow for those who were wounded more than once.

Generals	1
Generals of Infantry	5
Lieut.-Generals	20
Major-Generals	61
Colonels	145
Lieut.-Colonels	267
Majors	1312
Captains	6,900
Lieutenants	5,650
Sub-Lieutenants	76,271
Ensigns	4,776
Naval Officers	799
Total	96,207
Medical officers	2,200
Veterinary officers	158

For other ranks the figures are:—

Serjeants and upwards	144,790
Rank and file	3,969,852
Others	1,283
Total	4,116,825
Colonial (White) Troops	964
Navy	30,286
	4,148,075

The grand totals of casualties work out as follows :—

	Officers.	Medical Officers.	Vety. Officers.	N.C.O.'s and Men.	Officials.	Total.
Wounded ..	96,207	2,200	158	4,148,075	503	4,247,143
Killed	53,323	1,675	183	1,751,807	1,555	1,808,545
Total casualties ..	149,530	3,875	341	5,899,884	2,058	6,055 688

In addition the deaths among native troops are estimated at 14,000.

Ludendorff and the Armistice.—The *Berliner Tageblatt* has written an attack on G.H.Q. saying, " Why did not Ludendorff himself conduct the Armistice negotiations, after he had so strongly demanded them? Why did not G.H.Q. send one of its leading personalities to carry through this military operation? All these gentlemen simply wriggled out of the unwelcome task, in order to avoid the responsibilities which the collapse of their military plans had thrown on their shoulders."

General Ludendorff writes to the *M.W.B.* to point out that the facts of the case are as follows :—

In the beginning of October, 1918 a commission representing the Army and the Navy assembled at Spa to deal with Armistice questions as soon as the negotiations with President Wilson had made sufficient progress. It was expected that the Secretary of State, von Hintze, would then join the commission. It is well known that G.H.Q. proposed to offer nothing more than the evacuation of the occupied territory in three or four months, but the Chancellor and the Cabinet went further and surrendered the U-boat point before negotiations began, in spite of the protests of Ludendorff and Scheer. The former did his utmost to influence the proceedings and to insist that Wilson should be asked to state exactly what he required. He tried also to get a good foundation for the negotiations and begged the Chancellor to make a declaration to the nation, pointing out the consequences of peace at any price, so as to raise its moral courage for further resistance.

On the 25th October Ludendorff resigned before the negotiations began, and in any case would not have been acceptable to the Entente as a negotiator, for it is reliably reported that at French G.H.Q. the first paragraph of the conditions stated, " There shall be no dealing with Ludendorff or other members of G.H.Q. but only with a commission chosen by the Reichstag."

On the 6th November Erzberger was nominated as member and General von Gundell as president of the commission, but on the 7th the former claimed the leadership and von Gundell stopped at home. Erzberger left a large number of the experts behind and only took General von Winterfeldt and Captain Vanselow with him.

The *Berliner Tageblatt* is therefore quite wrong. Experts were ready and G.H.Q. was not trying to avoid any responsibility. Erzberger was not content with a secondary rôle, but pushed himself to the top and deliberately thrust aside the expert help which was offered to him.

Officers' and Men's Associations.—The *M.W.B.* continues to insert notices regarding these free of cost, and their number is certainly not diminishing. In this issue 25 meetings are announced.

No. 13.—*Accusations against Officers.*—The *M.W.B.* says, truly enough, that it never indulges in anti-semitism, but that, when the old officers' Corps is attacked it must be defended, even if the attack comes from a Jewish source. This time a Hamburg Jewish paper writes :—

"Nothing so shameless has ever been seen as the cowardice of the regular officers. The slightest injury or indisposition was welcomed as an excuse to hurry to the rear and spend months and years in the Depôt, carrying on the distant war from its comfortable officers' mess. In particular did the regular medical officer delight in sending the Jewish doctors to the front line, while they themselves remained in divisional headquarters."

It has been decided that no statements defamatory to the old corps of officers can be made the subject of libel action, and so many are seizing the chance of working off their spite, but it seems curious that the *M.W.B.* should, by repeating them, give such absurd statements the publicity which they desire more than they deserve.

Hindenburg and the Armistice.—Since Erzberger's murder it has been stated that he was warmly thanked by Hindenburg for his services in the Armistice negotiations.

Hindenburg now writes to say that he did not thank him warmly, and that the ordinary forms of politeness have been given an importance that does not belong to them.

Regimental Re-unions.—In consequence of the murder of Erzberger many applications have been made, by the organizations of the left, to the authorities, asking that regimental re-unions may be prohibited. In most cases the governments have given way and have forbidden the meetings, at any rate while feelings are so excited, but the *M.W.B.* is glad to see that the Würtemberg government declines to do so and says that freedom of meeting must be given to both sides alike.

Coloured Troops in the French Army of Occupation.—It is noted that a number of young Moorish officers from the Officers' School at Mekinez will soon be joining the Army of Occupation. The hope is expressed that they will succeed in tightening up the discipline of their men which has, it is said, been recently deteriorating. (There is other evidence, from a neutral source, showing that the discipline of the coloured troops is very good, but "the black shame" is a thing the Germans cannot get over.) These young officers are apparently to have the same responsibilities and rights as any other French officers and will draw the same pay.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

April, 1921.

Events in Upper Silesia.—This letter embraces the period Dec., 1920 to Feb., 1921, and tells of the increasing impatience of the Poles due to the continuance of German administration. This has led to incidents such as the blowing up of statues of the Kaiser etc., but lurid accounts of terrorism published in the German press rather tended to dissuade German residents from returning for the plebiscite, and had to be acknowledged as exaggerations.. Unfortunately for the latter purpose the Berlin correspondent of the *Manchester Guardian* stated that "the Polish terror is not an invention of German propaganda," adding that he had lately been travelling in the country. If he did so he was luckier than Mrs. Buxton, who, on reaching Oppeln was politely provided with a seat in the next train for Breslau, and several other possibly undesirable visitors were deported. Small stores of firearms were found in Polish houses, but large stocks have been discovered in German workshops, and entire wagon loads of German rifles and machine guns, issued from Neisse, and some dated 1920, were seized on the railway. The *Ostdeutsche Morgenpost* of 31st Dec., announced a Polish insurrection for January. On 14th January, M. Korfanty warned the Poles to beware of *agents provocateurs*. Each nation accused the other of making military preparations, and the Poles were alarmed at the creation of the "Central Co. of Auto-transport" whose huge lorries seemed designed to support armour.

The plebiscite regulations did not altogether satisfy either party. It was a great relief when the Pope decided that oaths of allegiance to Germany or the Emperor would not be considered binding on voters. There was great excitement in German circles when the press announced that a great landed proprietor, Count Oppersdorf, had attended a Polish political meeting, at which other German officials were also present, which passed a resolution in favour of handing over the left bank of the Oder to Poland. The *Deutsche Volkspartei* censured the count, and matters were not improved when it was remembered that his wife was a Princess Radziwill. The Kasino Gesellschaft removed the count's name from its list of members. The interest of this and similar cases lies in the fact that certain influential Germans evidently have no blind faith in Upper Silesia remaining within the Empire, and that the German public realizes this and resents it. Many municipal elections have gone in favour of the Poles and even Polish mayors have been elected, a thing unheard of previously.

Germans maintain that the output of coal must diminish when their directors and managers leave, to which the Poles reply that enough will stay to tide over the period until successors will have been trained in their own schools. Polish workmen declare that the output will diminish if the mines are given to Germany. It is stated that Upper Silesia supplies only 10 per cent. of the German consumption of coal and coke. Poland has no intention of not supplying what is prescribed for Germany in the Versailles Treaty, all that she asks is that she may supply her other neighbours. It would be easy to connect up the metre gauge railway to a large station at Myslowitz, whence canalization of the Brynica for 25 miles would connect with the Vistula.

The Poles are trying to induce many German functionaries to remain, and will welcome them as long as they do not pursue an anti-Polish policy. Germans point out the advantages of joining an economically sound Germany, instead of an impoverished Poland with a future of warfare opening before her (but who supported the Bolshevists last summer?) and as regards peace attending Germany, those are curious pacifists who have such a fancy for rifles that they will not surrender them and enrol themselves in various Orgeshs. Whatever the result of the plebiscite may be one cannot but admire the way in which the Poles of Upper Silesia have regained their national consciousness in the last 20 years, have recognized in M. Korfanty their most influential representative, and have disciplined themselves to follow the advice of that remarkable organizer.

July, 1921.

The Revision of the Regulations and our War Doctrines.—The study by Lucius, extracts from which have already appeared in the *R.E. Journal* for July and September, 1921, is continued in this number. Dealing with what he calls the second phase of the third period, Lucius discusses the offensives in Artois (9th May and 18th June, 1915), and Champagne-Artois (on 25th Sept, 1915). The first, an attack by five Army Corps on a front of 15 km., was only of real effect in the centre, where the infantry in less than an hour was able to reach the Vimy Ridge, 4 km. from where they had started. On the right the first line trenches only were captured with difficulty, having been insufficiently bombarded, and the reserves were unable to take full advantage of the success gained in the centre, since the breach was so narrow that the enemy was able to close it again; and the later attack on 18th June was only a partial success and dearly won. The lessons learnt by the *attack* were:—that a single position can be pierced if the requisite number of heavy guns is available to demolish the works of defence on a sufficiently wide front; Infantry reserves were still too far back, and the troops who penetrated the furthest into the enemy's position were not reinforced in time. This was dealt with in an Amendment dated 26th May, which also insisted on the value of surprise, which might be secured during the general bombardment preceding the attack by bursts of fire separated by silences, the end of each being marked by a lengthening of the range so as to suggest the imminence of the attack, and so might induce the enemy to man his trenches prematurely. Every possible step must be taken beforehand to complete the success of a break-through, and a Supplement to the Instructions, issued on 18th June, suggested that here was a great opportunity for cavalry. The enemy's artillery must be captured in the first rush in order thoroughly to dislocate his powers of resistance. It was becoming evident that the artillery of the defence must be destroyed or neutralized, and counter-battery work was to be one of the most important duties of the artillery. The lessons in *defence* learnt by the French were that the existing order that not an inch of ground must be lost led to needless loss of life by holding front trenches too strongly, and so greatly weakening the supports that they could not check a successful attack until it had penetrated some distance. A Note of 8th July pointed out that as a line could always be pierced, given the necessary expenditure of heavy ammunition, it was wiser to reduce the strength of the first line and hold more troops in hand for manœuvre. Continuous trenches should be replaced by centres of resistance, separated by intervals defended by fire alone. This organization was applied in particular to the defence of Verdun. The construction of second positions was begun along almost the whole of the front.

From the German point of view, the danger they had run during the offensive in Artois showed the necessity for second positions. It was laid down that at least two positions were necessary, separated by such distances that the capture of the second would require an entirely new attack, and consequently a change of position of the attackers' artillery. The first position must be held strongly so as thoroughly to exhaust the attack, but this was not to imply that supports and reserves were to be drawn upon to hold the first trench, which was to be held by the necessary minimum, and counter-attacks relied upon to recover lost ground.

The plan of attack on 25th September embraced two simultaneous attacks, in Champagne and Artois (French 10th and British 1st Armies), success in which should produce important stragetic results—as on 1st September the Allied force exceeded that of the enemy by some 30 divisions, while the German reserves amounted to six divisions only, but on 25th September these were reinforced by two corps from Russia. The front in Champagne measured 35 km. with 900 heavy and more than 1,000 field guns. The Artois front was only 9 km. with 250 heavy guns. The preparations gave the enemy ample warning, and in Champagne he withdrew a large proportion of big guns to the north bank of the Dormoise, where he had prepared a second positioh on a reverse slope, five to six km. in rear of the first. Here the infantry attack progressed rapidly near Souain, to right and left the breach was widened to 20 km., and the enemy's batteries between the first and second positions were captured, but after an advance of three to four km. the attack was broken against the second position, the defences of which were intact. A fresh attack on 6th October, against an enemy who had had time to recover, met with little success. In Artois the French attack was only successful near Souchez and soon came to a halt; the British took Loos and Hulluch, forcing a breach six km. wide by three in depth, when they were checked by the German second position. In neither case was the enemy's front broken.

The chief lesson learnt by the *attack* was that the final check resulted from the powerlessness of an attack, split up by the first assault, to gain possession of a second position, either because its reserves were not at the required spot or because they were unable to intervene at the critical moment. The G.O.C.-in-C. blamed (1) the fresh troops for coalescing with the attacking line and causing a disorder which rendered them incapable of exerting an effort against the second position; (2) the artillery for want of method in observation and communication and so failing to destroy the accessory and flanking defences of the second position; and (3) the higher commanders for failing to set in operation in due time the means for efficient preparation for the attack on the second position. The advance of the artillery during an attack is of the utmost importance, and will occupy some time, but the attack must be rapid to ensure the maximum of surprise and demoralization. Yet no consideration can over-ride the fact that obstacles must be destroyed before they can be surmounted.

From the French point of view the lessons in *defence* were shown in the orders for the period which must now elapse before the expected spring offensive. Second positions were to be concealed in woods and along reverse slopes, and behind them were to be fortified areas, to guide a hostile attack along defined routes, and to serve as supporting points for the counter-offensive. In order to save time later and realize surprise as far as possible, all works which would require time to prepare and the execution of which could not be concealed, such as communication trenches, places of arms, emplacements for batteries and trench mortars, etc., were to be put in hand all along the front, to create uncertainty as to the point to be actually chosen for attack. A Note, dated 5th December, 1915, pointed out that the power inherent in the attack did not permit of absolute reliance on the resistance of fortifications. The first line, generally continuous, held lightly and covered with well-concealed obstacles, was the *combat position* of the outposts to hold the enemy during the preparation of the counter-offensive, in maximum strength, in the *offensive battlefield*, which had been prepared in rear of it. The artillery was to reply to the enemy preparation fire and at the moment of assault to concentrate on the enemy's infantry.

The conclusions drawn by the Germans from the defensive point of view, and revealed by captured documents, were that they considered that the second position was capable of stopping a break-through so long as the first line held long enough to allow of the occupation of the lines in rear by the reserves. Holding the first line to the death and absorbing the supports and reserves into it should be strictly avoided if continuous opposition was to be offered to the enemy. Owing to the demoralizing effect of more than three days' bombardment, several units had been surprised in their shelters. The effect of gas did not come up to expectation. Commanders experienced the greatest difficulty during the battle in keeping themselves informed of the situation, and means of communication must be increased. The German artillery action was essentially defensive—barrage fire, as opposed to destructive and counter-battery fire—in this respect they were less advanced than the French. On the other hand, as a rule, the artillery gave the greatest support to the infantry, only failing when ammunition ran short, which emphasized the importance of accumulating large stocks near the guns during the artillery preparation. The Germans also recognized the difficulty of obtaining surprise in the attack on a large scale.

The conclusions drawn from the events of 1915 were, therefore, as regards the offensive, two opposing ones, one referred to in the Note of 2nd January, pointing to the limited effect of the French artillery and advocating successive attacks, the other expressed in the Instructions of 16th April and based on the rapid attack carried through to open ground. The attack of 9th May showed that if the artillery was imperfect it was at least capable of breaching a fortified position of limited depth. By the 25th September the second position came into being, and the principles of 2nd January, *i.e.*, the slower development of the operations, or successive attacks, were re-established. The impossibility of surprise is note-worthy. But there may be, besides *strategic surprise*, which leaves the enemy uncertain of the region to be attacked, and prevents him from concentrating reserves at that point, *tactical surprise*, which leaves him uncertain of the moment of attack and the particular front selected in a region already known. The Notes and Instructions implicitly admit of the impossibility of securing the first in a war of position, but the latter is possible at any rate as regards the actual moment of attack.

Preparation for launching an offensive carried out long previously along the whole front, as proposed in May, 1915, might lead to the possibility of effecting a stragetic surprise ; a real tactical surprise could only be attained by the possession of heavy quick-firing guns sufficient to reduce the artillery preparation to a matter of a few hours. Owing to the number of their heavy quick-firers and ruthlessness in the employment of asphyxiating gas, the Germans were in a better position than the Allies to effect surprises of both natures, and constantly strove to do so.

But stragetic surprise could also be obtained by *manœuvre*. Experience had shown that to oppose attacks the enemy immediately diverted behind the menaced front the supports from the neighbouring unthreatened sectors, until he had time to concentrate his reserves. Profit might be taken of the weakening of other sectors to attack one of the points of least resistance. Two or three successive positions might be carried if the enemy had not at his disposition troops to defend them. To realize such a conception numerous points of the line must be prepared in advance as jumping-off points, and infantry, artillery and ammunition be available to feed simultaneously the several offensives That the High Command saw the possibility of this has been shown above ; that it was not carried into effect is doubtless due to lack of effectives and material.

The 1915 offensive entailed heavy loss of life, and unfortunately it was not recognized that this was due to too dense formations, however the partial successes achieved raised the *morale* of the troops. At the same time they drew attention to the probable length of the war and led to organization to that end, and for a war of position. Aviation advanced in efficiency and in the scope of its activities, especially *liaison* with infantry and artillery, the heavy artillery increased in numbers and skill. The influence of General Pétain began to make itself felt.

A. R. Reynolds.

(To be continued.)

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The Evolution of Methods of the Offensive.—The article by Lieut.-Colonel H. Corda on the above subject begun in the April number for the *Revue* is concluded in the number under notice ; he deals in this part of his paper with the methods adopted to take the enemy by surprise. Surprise, he points out, may be both strategical—as in cases in which an attack is delivered in a region in which insufficient reserves are held by an enemy—as well as tactical—as in cases in which an attack is made unexpectedly on a particular front with great suddenness. In a general way surprise is effected :—(1) by taking the initiative ; (2) by observing secrecy in relation to projected attacks ; (3) by rapidity in carrying out an attack. However, to obtain the effect of surprise attention has to be paid to a vast number of details ; these were dealt with in Instructions, dated October 30th, 1917, issued to the French Army. The main points requiring attention are touched upon by Colonel Corda in his paper under seven headings dealing with the following matters :—(i) observance of strict secrecy, and the avoidance of any measures likely to attract the attention of the enemy's espionage service ; (ii.) no new works to be carried out, preliminary to the surprise attack, on the selected front ; (iii.) the deception of the enemy with regard to preparations in progress ; *e.g.*, by strict control of all movements on the front—which should be carried out at night only—and by a judicious use of camouflage ; (iv.) care to be taken not to disclose prematurely the extent of the aeronautical services (*e.g.*, captive balloons should not be sent up as a preparatory measure) on the selected front ; (v.) "formations" intended for the attack should not be moved forward until the preparations are completed ; (vi.) need for the "artillery preparation" being reduced ; and (vii.) necessity for rapidity in the delivery of two successive attacks.

The events of 1918 are examined and discussed by Colonel Corda, who deals at some length with the subject of the "artillery preparation" under three main heads :—(*a*) the placing of the artillery in position, including the execution of the necessary works in connection with the entrenching, etc., of the guns, the rate at which additional artillery can be conveniently "absorbed" in the selected front and the ammunition supply ; (*b*) the duration of the "artillery preparation," including the "density in artillery" on the selected front, the use of poison-gas shells, and the employment of tanks ; and (*c*) the advance of the artillery from its first positions.

Colonel Corda in conclusion expresses the opinion that in future wars it is not likely that battles will take place on "stabilized fronts" as was the case during the three years of trench warfare in the Western Theatre ; continuous progress in the field of industry is likely greatly to modify the methods of war. However, whilst the evolution of the art will assuredly continue, it will do so without affecting the fundamental principles either of strategy or tactics, which will remain unchanged.

Colonel Corda refers further to the fact that during the Great War, whilst the artillery and engineers in the French Army were practically doubled, the numbers of the cavalry and infantry were reduced ; in view of modern developments, the importance of the technical troops will continue to increase as time progresses, and armies will require a large proportion of men of high intellectual capacity, men who, moreover, are imbued with a scientific spirit.

W. A. J. O'MEARA.