

## CHAPTER VI

### AMMUNITION SUPPLY<sup>1</sup>

**A**MONG all commodities, none bristled with so many difficulties and required such unremitting attention as ammunition. In point of bulk, food and fuel certainly ranked higher, occupying greater space and requiring more transport ; but apart from this the problem of feeding the soldier was altogether simpler than that of providing for his next most vital need. Food was consumed daily in the same quantity as in peace, and to estimate the requirements over any given space of time was a fairly simple calculation. The needs of every man and horse were similar, should some one item going to make up the ration be short another might be substituted, and in case of breakdown there was always the possibility of getting temporary assistance from France.

For ammunition, the conditions were the reverse. Expenditure was on a scale undreamt of and irregular in the extreme, not only at different times but in different sectors of the front. As each arm had its own special types, no substitution was possible ; and no assistance could be got from the French. The hazard of a temporary interruption in our communications with England could never be ignored and this, combined with the huge consumption when hostilities were active, made it necessary to hold gigantic stocks in France, where there was always risk of this highly dangerous and valuable materiel being destroyed by air raid or even gun fire.

Food-stuffs are comparatively simple to deal with ; to understand the technicalities of ammunition requires expert knowledge, and the officers and men of the new Army engaged in this line of work had to be specially trained.

From only one aspect does food present a difficulty not inherent in other commodities—perishability. But even here the ammunition made in the Great War was at a discount compared with that normally manufactured. The substitutes for our ordinary explosives that had to

<sup>1</sup> In writing this chapter I have been helped by Colonel Oldfield, D.S.O., R.A.O.C.

be improvised to obtain the vast quantity required were subject to rapid deterioration, and it was impossible to protect them adequately from the effects of damp or high temperature by packing in special hermetically sealed cases as in peace times. War time packages were flimsy and barely waterproof. Even covers for time fuzes had for long to be dispensed with so as to speed up production, though the rate of burning and consequent accuracy of the fuze was bound to suffer unless it was promptly fired.

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The arrangements for supply, as we left them in the first chapter, were as follows. The base stock was held at Boulogne, the port of entry, which fed two trains, staffed by Ordnance personnel, situated at Arques and Aire. At these railheads ammunition was transferred to mechanized ammunition parks which carried the supply as far as the refilling points where they replenished the horsed wagons of ammunition columns—these latter being divisional organizations. The whole arrangements for supply up to the refilling points were controlled by the D.D.O.S. G.H.Q. under instructions from the Q.M.G.

The formation of Armies led to a modification of this system. The ammunition trains were moved rather further forward to St. Venant and Strazeele which became respectively the railheads of the 1st and 2nd Armies who were each allotted certain of the ammunition parks, so that G.H.Q. control now ceased at railhead. The other parks remained under G.H.Q., forming, together with three trains stabled at or near St. Omer, a mobile reserve available to reinforce either Army. In the spring of 1915 each Army was provided with a second subsidiary railhead train, mainly for use during active operations.

The French system of ammunition supply provided for an *en cas mobile*, a first reserve on rail, being held at the regulating station; and we greedily adopted and extended this plan, every round of ammunition in France, even at the base, being at first on wheels, with a golden

rule, that each truck should contain complete rounds—cartridges, shell, tubes and fuzes. This packing was adopted so that if any trucks were cut off owing to a hot axle-box or other cause, the remainder had each its full complement of rounds ready for immediate use. Indeed this extreme fluidity followed almost as a matter of course. So scanty was the stock that what arrived at Boulogne one afternoon would as often as not go forward the same evening to be issued from railhead and perhaps fired the next day.

By the summer of 1915 however, when a slightly better stock had been accumulated, the French began naturally enough to take exception to so many railway trucks being permanently locked up, and the stock at Boulogne was placed under shedding. But as intelligent advanced loading was still permitted in anticipation of orders, a good quantity of what was wanted from day to day was always available on rail. At the same time the increasing stocks at railheads began to be dumped under cover, and the ammunition parks off-loaded their contents, which were stacked partly at the divisional refilling points and partly at Arques where a 2000-ton reserve depot was built.

There has been acrimonious discussion as to the responsibility for the stringency of ammunition in the early days of the war, to which it is unnecessary to add beyond saying that no one in France concerned with its supply but was acutely aware of the shortage from as early as October 1914. In particular, trench warfare created a quite unexpected demand for high explosive shell.<sup>1</sup> Shrapnel, till then the sole projectile of our field gun, was comparatively harmless against troops in trenches, and nothing could be more distressing for infantry than to be exposed day after day to a harassing fire, to which our artillery was unable to make any effective or adequate reply.

So meagre was the supply that the expenditure of every single round had to be watched. The midday stock at each railhead and the base was telephoned to D.D.O.S.

<sup>1</sup> It was actually in September 1914 that high explosive shell were first demanded for field guns and half and half H.E. and shrapnel for 4.5-inch how, and 60-pdr,

G.H.Q., where a tabulated statement was prepared showing the complete situation ; and, with this before him, the Q.M.G. would himself decide how many rounds could be spared for the following day, at first not more than half a dozen per gun as a rule, or it might be even none if the position were worse than usual. The railhead Ordnance officer was originally allowed to increase the figure should the situation seem to warrant such action, but even this latitude was withdrawn as it was found that he was apt to succumb to the blandishments of a staff officer pleading the dire need of a little extra. At the same time as the D.D.O.S., who had advice of what was on the way from England, transmitted the Q.M.G.'s orders to railhead, he would instruct Boulogne what quantity to send up in replacement, which would often come straight from the ship's hold.

Unremitting attention was needed to ensure that the supply at railheads did not actually run dry and at the same time conserve some small quantity in hand in case of emergency, especially when any heavy fighting was in progress.<sup>1</sup> As late as the 15th May, 1915, there was not one

<sup>1</sup> The following extracts from Colonel Mathew's diary as D.D.O.S. G.H.Q. convey some conception of the constant anxieties, curt and bald though they be. "9th May, 1915. Attack started 5 a.m., immediately followed by large demands for ammunition. Instructed Ammunition Train Officers not to send to reserve train without authority from me. At 9 a.m. finding stocks at St. Venant running low, diverted ammunition parks to Berquette [reserve train], and arranged for special train from Boulogne. At 10 a.m. informed by 2nd Army of heavy attack on salient. At 11 a.m. Abeele [the second train formed in 2nd Army] wired for 4.5" lyddite, but none available except a small supply in reserve parks and reserve trains which C.G.S. has directed be reserved for 1st Army. At 11.30 a.m. ascertained stocks at Abeele and Strazele were getting low, and arranged with Director Railway Transport for a special from Boulogne, and sent loading instructions to C.O.O. At 1 p.m. rung up by 1st Army, agitated about supply as two first attacks had failed, gave them the position. The ammunition train for St. Venant left by about 2 p.m., but that for Strazele had not left Boulogne at 11 p.m. C.O.O. wired to say loading hampered as all lights extinguished on account of Zeppelin scare."

Not only, it will be observed, were railhead stocks exhausted and G.H.Q. reserves largely depleted as well, but the 2nd Army, attacked in the Ypres Salient, had to be refused any further quantity of howitzer ammunition.

round of 4.5 inch or 18-pr. high explosive left on the lines of communication and only 24 rounds of 18-pr. shrapnel per gun.

Thereafter a slightly better stock was gradually accumulated by careful hoarding. The 3rd Army was formed in the summer of 1915, its ammunition railhead being installed at Flesselles, with a reserve stabled further to its rear at Abbeville, the regulating station.

Even so early as December 1914 however the decision to duplicate the line of communications, combined with the risk of having all our eggs in one basket, made it advisable to look out for a second port of entry and ammunition depot in the Southern zone to correspond with Boulogne in the North.

From the outbreak of the war all the elaborate peace precautions for the storage and movement of explosives, whether governed by War Office, Home Office or Board of Trade regulations, were ignored to conform to the dictates of military operations. Necessity knows no law and risks had to be faced. No attempt could be made to isolate explosives; they were dumped at the ports of entry. Moreover high explosive shells were in their infancy, no piece greater than the six-inch howitzer existed and no one had the faintest conception of the vast scale on which ammunition would come to be stored.

The quantity that it was originally estimated would be held at Boulogne was 5000 tons, which it was proposed to house in sheds on the quays together with other stores; and in the same way the site selected for the second depot, at Rouen, was that employed at the time to provide local troops with stores and clothing. This had its quay on the river and possessed railway sidings, and it was proposed to store the ammunition cheek by jowl with other commodities, by the process of building a few extra sheds and railway lines. The ammunition depot at Rouen in fact, like that at Boulogne, was determined upon at a time when nothing was contemplated but the holding of a small stock of ammunition of a comparatively high degree of safety, mainly small arm ammunition and

shrapnel, with a few thousand lyddite shell at the most ; all manufactured to strict specification by trained hands and carefully inspected by experts before leaving the factory.

By the summer of 1915 however, long before the stock was sufficient to divide between two depots, the advent of heavy high explosive shell, with a variety of new bombs and grenades, made it necessary to explore a fresh site for a depot on the southern line. At Boulogne certain precautionary measures had been taken by removing explosives in bulk to an isolated area and storing heavy shell apart under bomb-proof cover ; but nothing of this sort was possible at Rouen, where the depot was in the heart of the town and incapable of expansion, so that an accident might do incalculable damage.

It was then decided to prepare a new depot at Quevilly, some four miles down the river on the left bank. This entailed the erection of sheds, laying of railway lines, and building of wharves ; and Quevilly was thus the first depot specially planned to deal with ammunition on a large scale in the most rapid manner possible. At the wharf were sorting platforms to facilitate the assembly of complete rounds and the railway lay-out was very carefully thought out. Quevilly however was an isolated site, there was much less danger of an air-raid than at Boulogne, and no special precautions such as the erection of bomb-proof cover were undertaken. The depot merely consisted of a series of sheds at such distances apart as to admit the laying of running lines and sidings alongside of each.

The new munition factories once at work, output began to increase very rapidly, and in December 1915 forecasts of what might be expected by the following spring caused new schemes for storage and supply to be prepared on a greatly extended scale. It was calculated that by the next summer what seemed then the incredible figure of 100,000 tons of ammunition might have to be stored in France, and 5000 tons despatched to the front in 24 hours. On the northern line it was decided to build a new inland depot at Audruicq to hold 20,000 tons and

capable of sending up 2500 tons a day which would become the issuing depot, fed from Boulogne where approximately the same quantity would be held in reserve. On the other line the depot at Quevilly had a capacity of 44,000 tons and could deal with 2500 tons a day; and the French were approached with a view to our acquiring an additional central site in the neighbourhood of Abancourt for a further reserve.

Audruicq marks a further stage in progress. Hitherto the principle had been to hold the entire stock at the port whence it could be quickly evacuated in case of need. The plan was also convenient when supply was very limited and the contents of a ship might have to be hurried forward. But with a more plentiful supply and a position of greater stability, it was preferable to hold such dangerous goods away from the docks in areas selected on account of their sparse population and where new constructional work presented no great engineering difficulty, the planning of the depot being largely governed by the need of ample railway facilities on account of the very large amount of traffic constantly passing through. At Audruicq the congeries of railway lines, or "trriage," where all the marshalling of traffic took place, was in the centre of the depot, the most convenient spot from this aspect; and spurs ran off to each group of sheds, of which those intended to hold heavy shell had their floors raised to truck level. In deciding on the plan of this depot there were two opposing considerations; speed of work which implied concentration, and safety which involved dispersion; and though the latter was not disregarded, for the sheds were separated by what were then considered adequate intervals and provided with sandbag protection, no experience had been gained of the effect of ammunition explosions and it was the former factor rather than the latter that received the most attention.

Increased output also resulted in greater decentralization of supply, Armies being given control of their railhead stocks on the 1st January 1916. The Senior Ordnance Officer at the main Army railhead then joined the

D.D.O.S. of his Army where he supervised the technical side of the work, controlled and co-ordinated the work of the Ordnance officers at the railheads which began to increase in number, got daily returns of their stock, and settled in conjunction with the " Q " staff what quantities should be demanded daily for each.

At G.H.Q. the extent to which these demands were to be met was worked out by an officer of the Q. Staff (Col. Lyon) in conjunction with the D.D.O.S. G.H.Q., who had the ammunition statement in front of them shewing the situation of every round up to and including railheads—G.S. being consulted when necessary.

Meanwhile supply had improved sufficiently to allow part to be diverted to Rouen, where it was stored temporarily in the old depot in the town until the beginning of March 1916, when the new depot at Quevilly with its wharves, sheds and railway lines was in a sufficiently advanced state of construction to handle ammunition.

On the 10th March, when unloading the second train-load to enter the new depot, a box of 4.5-inch ammunition exploded ; and, in spite of efforts to extinguish the flames, the fire spread, wrecked a considerable part of the depot and resulted in the loss of three lives.<sup>1</sup> It was afterwards found out that ten rounds of this ammunition had been dropped when loading the ship at Newhaven, and the accident was probably due to a faulty No. 100 fuze, the first specially designed for the new high explosive shell, and one which led to trouble on several other occasions.

There were at the time only 600 tons in the depot and the actual loss of ammunition was very trivial. Strange to say a stack of 3-inch mortar bombs into which shell were actually flung by the force of the explosion failed to ignite. Nevertheless the accident was extremely disturbing. The old depot at Rouen was at the moment almost literally a solid mass of nearly 20,000 tons of explosives ;

<sup>1</sup> Lieutenant Reed, A.O.C., who was in charge, stuck to his post with great gallantry amid the continued explosions and was awarded the M.C. for his efforts to quench the fires.

an accident there would have wrecked the town, while at Boulogne a similar happening would in addition have closed one of our principal ports. Ammunition was for the first time arriving at a rate sufficient to meet all ordinary day to day needs and at the same time to begin building up a stock for a summer offensive, and it was imperative not to stop the flow even for a day. The stream could only be dammed by diminishing output, for no accommodation yet existed at home for what was made.

The first immediate step was to direct the whole supply on Boulogne, despatch as much as they could take to Army areas from the old Rouen depot, and remove the rest to that at Quevilly, much of which was undamaged, as soon as the debris could be cleared away. At the same time it was decided that Boulogne, now coping momentarily with a double dose of well over 1000 tons a day, must be evacuated of its large calibre shell with all speed; and here, fortunately, the partially built new depot at Audruicq could afford relief. Some of its sheds were ready, and shell were stacked in the intervening spaces.

The War Office experts who investigated the accident at Quevilly advised that the stock be distributed among a large number of small depots in parcels not exceeding 2000 tons, that cartridges, fuzes and tubes for the larger natures be kept at a distance from their shell, and that no shed be nearer its neighbour than 70 yards; but this was a counsel of perfection. The vast scale on which ammunition was beginning to be dealt with, and its great variety, made it out of the question to meet demands from the front through the medium of a number of very small depots—traffic difficulties, apart from any other considerations, ruled such a proposal out of court; and to store shell and their cartridges at a distance from each other would have increased the time and labour of loading up complete rounds. To site sheds 70 yards apart would reduce the capacity of Quevilly and Andruicq, and though it was decided to even increase these distances if possible, at the moment risks had to be faced and ammunition dumped wherever space was to be found.

At the same time sites for additional depots were being explored. That at Abancourt, Blargies Nord, had been demurred to by the French, who wished us to go to Critot where levelling operations alone would have taken six months; but now they agreed to fall in with our views. Constructional work was pressed on, but as it would be impossible for Blargies Nord to be ready before July, a temporary dump was formed at Blargies Sud, where a depot was being prepared to hold sandbags and other trench stores on behalf of Havre. A sugar factory at Martainville, capable of holding 15,000 tons, which would be empty till the beet crop was garnered, was also taken up.

These shifts and expedients sufficed to give temporary breathing space, for soon afterwards preparations began for the battle of the Somme, the first great operation of the war for which an abundance of ammunition was available. The 4th Army had been formed by now to conduct this offensive (in which the 3rd also shared), and was given practically carte blanche to draw what it pleased and dump it where it liked. With a warning of only three days the two depots at Rouen had to increase their daily output from 200 to 3500 tons, and Audruicq, as soon as it was sufficiently well stocked, took its share in the work, besides meeting the demands of the 1st and 2nd Armies. The scale on which ammunition was consumed in this operation can be gauged by the fact that the expenditure in one month, from the 24th June, 1916, to the 23rd July, amounted to 148,000 tons. During the same period the quantity landed in France was 101,771 tons so that the gain in space was equivalent to 46,000 tons.

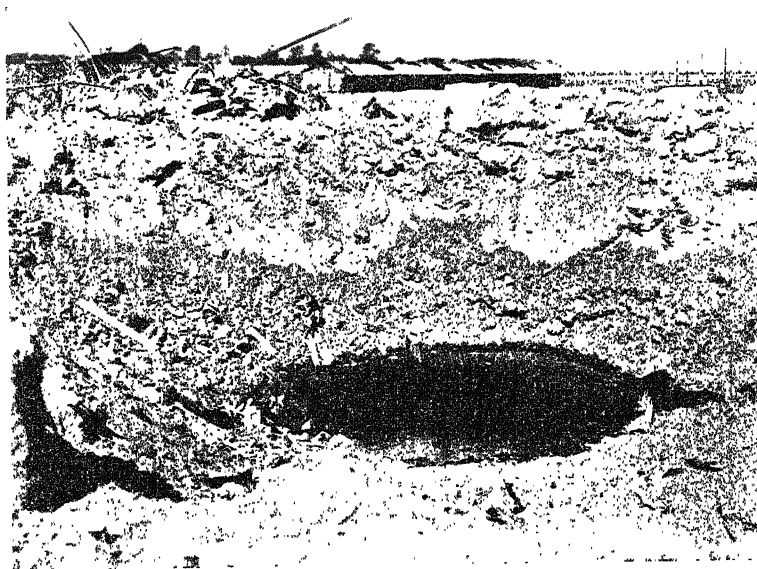
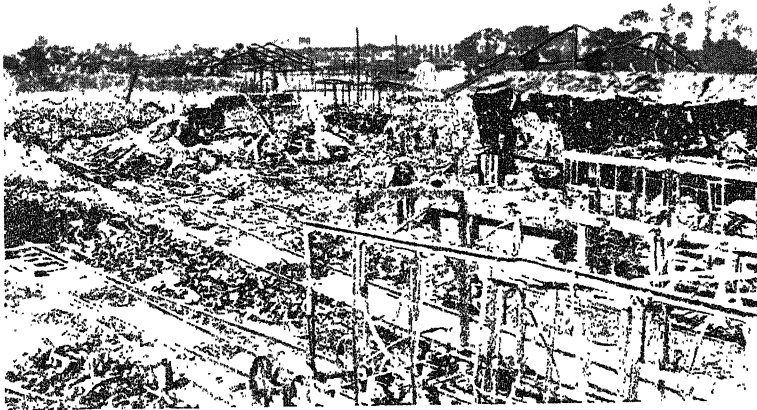
In the midst of this rush of work, on the night of the 20/21st July, 1916, Audruicq was visited by an enemy aeroplane and placed out of action by one small bomb which wrecked the entire depot. It says much for the organization that the work of feeding the front went on without an hour's interruption; the Armies suffered not the loss of a single round, every order arriving to

scheduled time as if nothing had happened. The previous day's loading had been completed and all trains despatched before the accident occurred, and when the next day's demands arrived at G.H.Q. the ammunition statement, showing the situation of every round, made it possible to order from elsewhere what would have been despatched from Audruicq; Boulogne becoming once more temporarily an issuing depot.

This accident was a far more serious affair than that at Quevilly. The depot held 9000 tons; and trucks, of which there were a hundred or more always under load, acted as quick-match, carrying the fire from one group of sheds to another. The destruction was stupendous. Stacks of heavy shell detonated, boxed ammunition went up in a blaze of flaring cordite and exploding shell, and the major portion of the trench munitions disappeared off the face of the earth. One crater would have served as a vent for a respectable volcano, another of oblong shape, sixty feet deep, might have docked a battleship; while barographs miles distant recorded the violent fluctuations of air pressure due to the recurrent explosions. The clearance of the debris was a highly dangerous job that took several months to effect, fortunately without serious accident.

Although ammunition to the tune of three and a half million sterling was lost, that sum actually represented less than half the value of what was being expended in a week's heavy firing; and the accident, following so soon after that at Quevilly, proved in reality a blessing in disguise. It led to the adoption of an entirely fresh lay-out for an ammunition depot on a greatly extended scale.

There were four different types of risk, or five including the triage. The danger in the case of boxed ammunition lay in complete rounds being packed in wooden boxes. Should one round explode, the fierce flame of the burning cordite would set alight the neighbouring boxes and so destroy the whole stack. For the field gun this was unavoidable, the ammunition being all in one unit; but, as a measure of safety, field howitzer cartridges,



WRECKAGE OF AUDRUICQ AMMUNITION DEPOT



which could not be fixed to the shell as the charge was variable, were from thence onwards enclosed in a separate package. For heavier gun ammunition there was not this risk, each component being a separate unit. Here the danger lay in the immensely destructive effect of the shell and the distance to which fragments would be hurled. After the explosion live shells were picked up two miles away. The third type of risk was that from trench munitions, a stack of which was a solid mass of high explosive, divided merely into compartments by the comparatively thin envelopes of the bombs, so that an accident was likely to result in the instantaneous detonation of the whole, producing a highly dangerous detonation wave. Lastly were chemical munitions, lethal, lachrymatory and incendiary projectiles, not in themselves destructive, but the first type dangerous to life and the last burning so fiercely as to constitute a very serious fire risk. The danger from the triage was that loaded trains would carry a fire from one portion of a depot to another.

As a result of the explosion at Audruicq a new design was decided on in which separate areas were allotted for boxed ammunition, component ammunition, trench munitions and chemical munitions, each distant at least a quarter of a mile from its neighbour and with its own sheds well dispersed. There were also to be separate sites for the triage, the laboratory and the magazine where explosives in bulk were held. A master switch enabled the whole of the lights all over the depot to be instantly extinguished should hostile aircraft be signalled, and another controlled those in the triage. False sites were created in some cases several miles away which were lit up when an air raid was expected, the real depot being kept in darkness; while deeply buried water mains, tanks, hydrants, extincteurs, water buckets and hand pumps were lavishly provided. Sheds for boxed ammunition were covered by sandbags which not only helped to keep out fragments of shell or bombs; but also, owing to the spilling of sand if the roof was penetrated, helped to smother a fire.

At the same time a standard size was adopted.

Boxed ammunition	16,000 tons
Component ammunition	12,000 „
Trench ammunition	3,500 „
Chemical and incendiary ammunition	2,000 „
Small arm ammunition (stored wherever convenient)	1,500 „
	35,000

Quevilly and Boulogne were now abandoned as depots ; it would have been fatal had an accident occurred at either of our ammunition ports. At Blargies Nord, now in full work, it proved impracticable to reconstruct the depot according to the latest plan ; certain modifications were made, and the danger reduced as far as was possible by the construction of gigantic sandbag traverses. At Audruicq on the other hand, which was once more functioning on a limited scale by August, the wreckage was reconstructed so as to conform fairly closely to the new safety limits.

Meanwhile the relief afforded by the fighting on the Somme would be spent by the autumn. The volume of receipts was continually on the up grade, the forecast of shipments for the summer of 1917 amounted to 8300 tons a day, and it was calculated that storage accommodation must be found for 200,000 tons. Extra ports of entry besides Boulogne and Quevilly were needed to cope with this traffic, and extra depots besides Blargies and Audruicq to hold what arrived. Armies were instructed to find sites in their back areas and build depots of some 10,000-ton capacity each, to hold a portion of the stock. These reserves, though perhaps necessary as a relief, were a great incubus. They were insufficiently close to the front to be of use to Armies, and yet not far enough to the rear for security in case of retreat. Their stocks were locked up and seldom turned over, and they absorbed a considerable staff that might have been more profitably employed in active work.

On the lines of communication it was decided to build four new depots, though to find suitable isolated sites was no easy matter. Level or easily workable ground was a necessity for railway construction and the area covered under the new restrictions was vast. In the original designs of Audruicq and Blargies the proportion of unoccupied ground to shed was as three to two, while now the figures were twenty to one. However suitable sites were found and before the end of winter of the 1916/17, when the stock once more rapidly accumulated, each line possessed three 35,000-ton depots—Audruicq, Zeneghem and Dannes in the North; Blargies, Rouxmesnil and Saignville in the South.

Dannes, situated among the folds of sand dunes and copses south of Boulogne, was an ideal site, so hard to discover from the air that it was never once attacked, and capable of almost indefinite expansion. Zeneghem was chosen owing to its proximity to a canal debouching both at Calais and Dunkirk. Ammunition usually arrived there by barge, wharves being constructed where the canal adjoined the depot, with a railway connecting the two and the French main line. The advantage of having Dunkirk as an alternative port was proved at Christmas 1916, when the entrance to Boulogne was blocked for a week by a sunken vessel. A portion of the Corps ammunition staff was transferred from Boulogne to Dunkirk where the ammunition ships were diverted, their contents being forwarded on without checking supply from home for even one day. Rouxmesnil was on the outskirts of Dieppe from which port it was served. At the request of the French this depot, owing to its proximity to the town, held no trench munitions, its capacity being reduced accordingly. Saignville, lying in the valley of the Somme west of Abbeville, could be served by either Quevilly or Dieppe. The daily supply was distributed as follows: Quevilly 3000 tons, Dieppe 2000, Boulogne 2300, Zeneghem 1000.

By the time these new depots were built further experience had been gained, and they were equipped with many labour saving devices. Sidings were laid on either

side of the sheds so that receipt and issue could proceed concurrently, and at either end of a shell store would be small sheds for cartridges, tubes and fuzes, connected with the shell store by light railways to facilitate loading. In fact in some there was a very extensive system of intercommunication by light railway with a corresponding relief to man-power. The new lay-out moreover provided all reasonable security. Information was received in January 1917 that the enemy intended to make a special feature of bombing these depots, and that so few attacks were made and so little damage done may be fairly attributed to the policy of extension and protection resulting from the Audruicq explosion. Although hundreds of bombs were rained down by night on several occasions which caused small explosions, it was rarely that the fires spread and caused serious destruction. Only once was a depot so badly damaged as to be put temporarily out of action—that of Blargies where the central area always remained congested as it was impossible to introduce the new safety distances.

These six 35,000-ton depots, however, by no means represented finality, each in turn was enlarged by the addition of one or more extensions. By 1917 a maximum daily intake of 10,000 tons had to be provided for and Dunkirk was added as a regular ammunition port.

The accommodation eventually available was :

Audruicq	44,000 tons
Zeneghem	49,000 „
Dannes	65,000 „
Blargies	64,500 „
Rouxmesnil	49,000 „
Saignville	60,000 „
	<hr/>
	331,500 „

If to this be added what was held in depots and dumps in Army areas, the stock of ammunition in France was in the neighbourhood of half a million tons. And even

then sites for additional depots were being explored, one at Bourbourg and another at Conteville being in process of construction at the time of the Armistice.<sup>1</sup>

Stated in bald terms of tonnage, to cope with this volume of ammunition may not seem so difficult, but when the great variety in types is taken into account, to arrange for distribution in the correct proportion first from England among the ports of entry, next from these ports among the depots, and lastly from the depots among the numerous railheads, was a very complicated business.

In examining the procedure the reader will do well to consult Appendix VI which gives the first ammunition statement ever prepared in France and a specimen of the daily balance sheet later compiled by Captain Warde, a temporary officer and bank clerk in civil life, whose gift for figures and speed in calculation were truly marvellous. This document would be ready at about 5 p.m. by which time demands from Armies, based on their own stock returns and figures of expenditure, would also have been tabulated out, showing what was required at each railhead; there being eventually some 120 railheads, though it was seldom that a quarter were in active operation at the same time.

To get the maximum efficiency in haulage, supply was limited to complete train-loads of 370 tons, and another limiting factor was the maximum number of trains that could be worked on any line of rails. This was not a fixed quantity, it depended on whether the route was a straight run or involved a cross-country journey; thus a depot might be able to despatch eight trains to one Army, plus six to a second and two to a third, but the numbers would be different if the destinations were changed. Each depot had its limits, with interlocking combinations depending on the output of trains from others. A further complication was that trains from Rouxmesnil could only take 290 tons, being on a light

<sup>1</sup> The tonnage shipped to France, month by month, is given in Appendix V.

branch line, and that no demand for trench munitions could be met from this depot.

Each nature of ammunition had its code letter and was dealt with on a truck-load basis, i.e. 1.A. signified one truck of 800 rounds of 18-pounder shrapnel, and 2.B.X. two trucks holding 900 rounds of 4.5-inch high explosive. For natures such as these there was no great difficulty; all that had to be aimed at was to try and distribute the work evenly between the six depots, a little more or less to make up complete train-loads being immaterial.

The difficulty in framing the daily programme occurred in the case of specialities such as long-nosed shell giving extra range, reduced charges to save the life of the gun, or those with no flash which were used by night from exposed positions, special fuzes or gas shell, etc., of which the stock was insufficient to ensure each depot always having its quota. For instance, after fitting in everything nicely, it would be found that one railhead required a few 9.2-inch shell of some particular type held only at Dannes from which the maximum number of trains was already earmarked. This would entail the transfer of some other train—say to Audruicq—only to find that this was destined to carry some lethal shell of which Audruicq was deficient. To supply this would involve a call on Blargies, introducing a fresh combination of trains that upset everything. Then the whole programme, involving the building up of perhaps forty trains, would have to be considered afresh and recast. It was like solving a jig-saw puzzle.

Another intricate job was to adjust the supply from home so that each depot maintained its fair share; for, with the best will in the world, there was always a drain at some one or other to be corrected. And here it was not enough to alter the proportions in which one type of ammunition was being distributed from home; as the ports of entry were working to their full capacity, any increase had to be balanced by an equivalent reduction in tonnage of other species.

Turning next to those who had to carry out these

elaborate programmes. On each of the two lines of communication was a C.O.O. Ammunition responsible for the whole organization, Colonel Bainbridge on the north and Colonel Oldfield on the south—Tweedledum and Tweedledee, to give them their nicknames.

At the outbreak of the war, ammunition came out in complete rounds, but once the new munition factories got busy this ceased except for boxed ammunition, as the various components were made by different factories. Shell, cartridges, fuzes and tubes would arrive in varying quantities, their marriage taking place when loading up at Boulogne and Quevilly. In time this complication disappeared and the marriage was consummated at the home port.

But now there were other ties to be made to ensure that each group of guns should get ammunition ranging as closely as possible alike. Boxed ammunition was sorted by type of propellant and for fuze setting correction in the case of shrapnel ; for heavier natures cartridges were sorted not only by propellant but by the lot or group of manufacture and shell by their type of driving band and fuze hole, the same lot or type being earmarked for the same railhead. Further, once supply became plentiful, it became important to issue the oldest ammunition first to guard against deterioration. For these various reasons the practice of loading up trucks on the wharf for delivery direct to railhead ceased.

Here it may be said that the Docks Directorate, though it essayed to do so, found it impossible to take over ammunition work at the port as it did for other classes of goods. Sorting began in the hold and was continued on the quay side, the markings on ammunition packages were meaningless to the uninitiated, and the services of an Ordnance staff were essential to supervise assembly and consign the right sort in the proper proportion to the correct destination. Of 9·2-inch shell alone there were eleven different types.

The ammunition depot was divided into groups, each in charge of an officer—one for boxed ammunition,

one for medium, one for heavy, etc.—and the officer in charge of the depot allotted each group its daily programme of work, according to the orders received from G.H.Q. and advices of what was due from the port. Then the group officer had to arrange for trucks and labour to fulfil his programme through the Ordnance Traffic and Labour officers, whose operations were a very important factor in the work.

A close liaison was needed with the Railway Operating Staff to ensure that incoming trucks were shunted to the right shed to be off-loaded, and empties placed at the right spot and right hour to meet the daily orders. A time table for marshalling and despatching the trains was drawn up and each group had to see that its trucks were ready at the appointed hour.<sup>1</sup> After loading, each truck was sealed and labelled with the code letters representing its destination, and a telegram sent to the railhead Ordnance

<sup>1</sup> The following table shows the day's work at Blargies on the 4th April, 1917, a heavy programme.

Railhead	Army	Ready for Marshalling	Time due to leave
O.C.A.	3rd	8.30	12.03
Bapaume	5th	8.30	13.23
O.C.	3rd	8.30	13.53
O.C.A.	3rd	8.30	14.33
O.C.A.	3rd	10.15	19.03
O.P.C.	1st	24.00	0.23
O.P.B.	1st	14.30	1.33
O.P.B.	3rd	19.00	2.53
Scarpe Valley	1st	19.00	3.23
O.C.	3rd	24.00	4.33
O.C.A.	3rd	24.00	6.43
Bapaume	5th	23.00	6.43
O.P.D.	3rd	23.00	8.03
O.P.D.	3rd	7.10	11.03
O.C.A.	3rd	23.00	12.03

The first railhead trains were O.A. and O.B.—the series being extended. When a main railhead, such as O.P. threw out offshoots they were christened O.P.A., O.P.B., etc., as shown in the table above. Bapaume and Scarpe Valley would be temporary railheads not so far allotted code letters.

officer and repeated to army headquarters giving the contents of each train, saying when it was due and quoting the number of the truck in which the waybills would be found.

The distribution of labour was another matter that called for close regulation according to the fluctuating needs of each group. As soon as man-power became short, the sturdy A.S.C. Labour Companies were replaced by coloured labour of a very mixed character—Kaffirs, Cape boys, Egyptians, Chins, Manipuris and in particular Chinese. Besides a supervisory staff of 4000 of the Corps some 12,000 hands were eventually employed. All classes, black or yellow, worked well ; though the Chinese, once language difficulties were overcome, were the best. They required careful handling, having an independence of their own and a considerable trade union spirit ; but when their idiosyncrasies were studied and they were treated courteously though firmly they proved most responsive, and showed great ingenuity in devising means of reducing work and increasing output.

For this miscellany of races task-work was usually employed, the gang being allowed to knock off when it had done its allotted job. Once the advantages of this plan were realized it was extraordinary how quickly the Chinaman in particular found he could get through his task, though a close supervision was needed to ensure that such dangerous goods were handled with a proper care.

No sooner had one gang finished its job than it would be relieved by another ; work, in times of pressure, being continuous throughout the 24 hours ; and there developed a very keen inter-gang emulation, each trying to beat the other in point of time. It was wonderful also how adept these native races became in deciphering the very intricate markings that distinguished similar packages containing different marks of fuze or types of propellant.

Ledgers have three main uses. They serve as a record of quantity, as a safeguard against loss, and as a statistical record from which various information can be obtained,

such as average expenditure ; but for ammunition in time of war their compilation proved to be a waste of time.

The stock of every nature had to be available at any hour of the day or night, and changed so constantly that the only reliable record was that in which every incoming or outgoing train was at once booked up. By the time a voucher charging off a consignment from some establishment in England could be dealt with the ammunition itself might have been expended against the enemy ; and to raise a discrepancy on a supposed shortage was out of the question, for it was impossible to say from which of the numerous factories at home any one particular round originated. Ammunition was not liable to pilferage, it was safe to say that what arrived reached the proper hands, and statistics of consumption were to be had from figures of the numbers of guns in the country and their expenditure.

With the concurrence of the Financial Adviser, the daily ammunition statement prepared at G.H.Q., which showed the stock and the balance of profit and loss, was accepted as a consolidated ledger record, a process that saved much useless clerical labour and beating the air in trying to square individual transactions with their documentary evidence.

So far ammunition has only been dealt with from the point of view of supply and demand, receipt, storage and issue ; the technical side of the work remains to be described.

The first trouble occurred at the very outbreak of war, due to our pistol ammunition having a flat nose which made it resemble an expanding bullet, a type banned by the Geneva convention owing to the ugly wound caused by its setting up. A rumour spread that the Germans were shooting prisoners found in possession of this ammunition and, though unsubstantiated, ammunition with a pointed nose was adopted to restore confidence and because the enemy might adopt a bullet that set up in retaliation.

The next trouble was far more serious, an epidemic of prematures with high explosive shell, bursting guns and causing loss of life to their crews. The first outbreak, in March 1915, was traced to the No. 4 graze fuze, which had to be modified by attaching a small brass disc to the end of the centrifugal bolt to prevent play between the bolt and detent plug. In the following August there was a more serious outbreak caused by fuzes improvised for the new amatol filled shell. To render these safe necessitated the removal of the time pellet ; by now the stock was more plentiful, special tools were made and the work of conversion pressed on with at top speed, not only at the base and railheads, but also further forward under supervision of the railhead Ordnance officers.

While this defect was actually being investigated, there arrived at G.H.Q. a report from the Third Army that a certain make of small arm ammunition gave trouble in extraction from rifles ; the fault was confirmed and all of this nature had to be withdrawn. Six days after this came to light, the War Office telegraphed for all igniters for one of the new grenades to be sent home as they were defective ; and from this time onwards it may be said there was never a time when some type of ammunition was not under suspicion. One day it would be found that a phosphorus bomb was liable to spontaneous combustion, and the whole stock would have to be emptied and refilled; the next would disclose that a particular mortar cartridge gave rise to prematures ; on another it would be a fuze mechanism made in Switzerland that was defective, or a flare whose chemicals were liable to decompose ; one serious matter requiring constant attention in summer being the liability of the filling of heavy shell to exude owing to heat, the exudation forming a dangerously explosive film that needed care and skill to remove.

It would be unfair to blame the Ministry of Munitions for these defects. Designers were constantly called on to produce some novelty at a moment's notice which there was no time to test properly, and production was on an unprecedented scale with amateur staffs. But the result of these failures was that laboratory operations were in

constant progress at each of the base depots<sup>1</sup>; besides which there was always work to be done in the way of reconditioning and effecting minor repairs to ammunition returned from the front.

In time of peace work of this sort was conducted solely by officers and N.C.O. laboratory foremen trained as ammunition specialists. But the supply of trained men quickly ran dry, and France had to educate its own ammunition staff, schools being set up at Zeneghem and Blargies. The instruction was both theoretical and practical. Types of German ammunition were described so that it might be known how to treat it when captured, and pupils were taught how to blow up blind shell. In all 432 officers passed through these schools, including those from Canada, Australia, New Zealand and the United States, besides far more numerous junior ranks.

Over and above the ordinary laboratory with which each depot was provided, two much more extensive repair factories were created, capable of undertaking operations which, in time of peace, were attempted nowhere outside of Woolwich Arsenal. The first of these

<sup>1</sup> The extent of the work can be judged by the following list of major operations carried out during three months of 1917.

(1) 1,040,000 rounds of 3-inch Stokes mortar ammunition examined to discover pistol heads with unflanged levers.

(2) 1,000,000 rounds 3-inch Stokes mortar ammunition examined to discover and set aside Mark I bombs.

(3) 675,000 Mills grenades examined and iron plugs substituted in those having brass or aluminium plugs.

(4) All plugged H.E. shell examined for exudation.

(5) Final return to England of defective 18-pr. H.E. ammunition of B.S.C. manufacture. 775,000 rounds of this nature in all had to be sorted out and sent home.

(6) 64,000 No. 24 rifle grenades examined to discover if blue copper ammonium nitrate had formed in the striker way.

(7) All 4-inch Stokes mortar bombs examined to ascertain whether the percussion primer was reinforced.

(8) Leaking M.S.K. grenades emptied and 26 gallons of lachrymatory reagent recovered, a valuable product.

(9) All 112 lb. aerial bombs equipped with 52 grain exploders.

(10) Augmenting strips fitted to all 12-inch howitzer shell.

(11) Exchange of fuzes for all 3-inch 20 cwt. ammunition, H.E. and shrapnel.





was at Boulogne where a special plant was installed in the isolated area originally set apart as a magazine. The operations were of a very varied character. An immense number of rounds of fixed ammunition had damp fuzes or propellants, defective primers or dented cartridge cases. The cases were reformed and new rounds built up from components. Tight plugs were extracted and the fuze threads of the shell retapped, while broken exploder cavities were repaired with trotyl, for which purpose a melting plant was installed.

This establishment was next duplicated at Blargies to serve the southern line. A particularly valuable piece of work was done on one occasion between these two factories when three-quarters of a million percussion tubes were produced at short notice to meet a critical shortage in supply from home. These were converted from ordinary small arm ammunition by removing the bullet and charge and replacing the latter with gunpowder.

Eventually it was decided to replace both by an even more elaborate central factory at Fressenville in the Somme valley with a staff of 1600, capable of dealing with 300 tons daily, which it was estimated would save a million sterling a month. Work was barely started however, when the German advance in 1918 caused the scheme to be postponed, and Fressenville never functioned except to a very limited extent.

Under the influence of trench warfare the system of ammunition supply at the front was profoundly modified. Mobility ceased to be an essential quality, the prime necessity was to ensure that there was always an abundance close at hand—far more indeed than the horsed echelons of divisional field artillery and the mechanized echelons formed to serve Corps siege artillery could possibly hold on their wheels. Small arm ammunition, grenades, etc., were held in the trenches with further stocks in brigade and divisional reserve. Supplies of artillery ammunition were stacked at gun positions with far larger quantities at divisional refilling points and, for

heavier natures, at similar points (siege parks) intermediate between the railhead and Corps artillery. The road echelons ceased to be permanently under load and, as time went on, were replaced more and more by a network of light railways connecting railheads, dumps and guns.

The railhead itself completely changed its character. It was at first the ordinary countryside station in which lay a train of ammunition ready to advance or retire according to the progress of operations. After the explosion at Audruicq, however, the removal of all stocks of ammunition from the vicinity of villages, main lines and arterial roads was ordered; and the new railheads were nothing more than transit stations, laid out wherever convenient, to clear ammunition with the utmost despatch. They usually consisted of three to four hundred yards of siding, having a planked roadway on one side where lorries could draw up alongside the trucks, and on the other a narrow gauge line. The stock once held at railhead, with its Ordnance staff, was shifted to one or more main dumps, becoming a reserve at the disposal of the Army Commander available to reinforce any part of his front; and A.O.C. detachments were posted to railheads only according to the amount of work to be carried out for the time being.

By 1917, when these measures had fully matured, the condition of these large accumulations began to rivet attention. At Army dumps, where there was a trained Ordnance staff, the stock was well cared for and precautions were taken to avoid damage and deterioration. Different descriptions were stored at spaced intervals with sandbag protection, camouflaged and protected from the weather; flooring was laid, fuzes and propellants grouped, a plentiful supply of water buckets and hand pumps provided; in short all the arrangements of the base depots were copied as far as possible.

But the state of affairs at Corps dumps (siege parks) where there was no Ordnance staff, was very different. There the ammunition was in charge of an Army Service Corps officer of the siege train who was necessarily ignorant

of such matters. It was useless for the base to sort out cartridges with such meticulous care when they were once more mixed together on arrival at the dump, so that a battery would get a miscellaneous collection all ranging differently. Shell were allowed to get dirty and rusty, deficient of grummets and with their driving bands chipped, factors that tended to increase the rate of wear of the gun. Boxes were left in contact with the ground and exposed to the weather, so that fuzes were spoilt by damp. Fire precautions were conspicuous by their absence. It was common for men to live in the midst of their dump with fires lit for cooking and warmth.<sup>1</sup>

To some extent this evil was reflected at the divisional artillery refilling point, the position of which was more governed by the tactical situation, closer to the front and more exposed to the enemy's fire. Apart from this the problem was simpler, the types held being few and gunners in charge. But every artilleryman worth his salt was wanted to work his gun. Boxes would be opened for the issue of their contents, and should these not be wanted they would remain open. Changes in plans of operations or moves of guns would result in the return of many thousands of rounds which would be left lying about, without fuze covers, exposed to the weather and accidental damage. Quantities of boxes would be allowed to accumulate, forming conspicuous and inflammable targets, and the obvious precaution of building the stack at a distance from the live ammunition would be neglected. The boxes were also extensively misappropriated as firewood or to make floorings.

In fact ammunition of immense value to the amount of many thousands of tons, that consumed our manpower in the making and whose sole object was to destroy enemy man-power, was exposed to avoidable risk and rendered substantially less effective because there was no trained staff to look after it.

<sup>1</sup> I once came across a man collecting at a dump remnants of howitzer charges and smoking a pipe with NO SMOKING painted on a notice board over his head. Upon my expostulating he proceeded to empty his pipe among the loose cordite, having not the slightest idea of the danger.

When preparing for the battle of the Somme, extra Ordnance staff was lent to the Armies engaged to help in looking after the large dumps specially formed; and the same plan was adopted during the operation in the spring of 1917, conducted by the First Army, which resulted in the capture of Vimy Ridge. After this latter operation, which was short and sharp, the Ordnance detachments loaned from the lines of communication were distributed among the Corps of the First Army with a view to straightening out their dumps, sorting out and re-arranging the contents and generally putting them in proper fettle; and the improvements effected were very marked.

The upshot was a decision to form Ordnance Ammunition Units consisting of one officer and eleven men, and give each Corps three of these Units to look after its dumps. The plan was so successful that Corps clamoured for more, and the more open form of warfare that developed in 1918 nipped in the bud a proposal to increase the number from three to five.

The result of this measure was that arrangements in the Army and Corps corresponded with those at G.H.Q. and on the L. of C. That is "Q" dealt with all matters of quantity while the Ordnance supervised storage, issue, receipt and repair. The A.D.O.S. of the Corps was also charged with the duty of seeing that divisional or brigade reserves of small arm ammunition, grenades, bombs and fireworks were properly cared for. These indeed were apt to be the most neglected of all. Grenades, especially, would become unserviceable owing to damp or dangerous from their safety pins rusting, and it needed constant effort to get the division to look after its infantry reserves.<sup>1</sup>

<sup>1</sup> Here, for instance, is a report penned by an A.D.O.S. "I well remember visiting a brigade bomb store in Ploegsteert Wood. The front room, which was about 15-feet square, was stacked from floor to ceiling (except for an open space about 8 feet square round the fireplace) with boxes of Mills grenades, Very lights and rockets mixed. The two men in charge were lying on two beds made of boxes of explosives with paillasses of straw on them, the straw being three feet or so from a roaring fire. Each used a box of Mills grenades at the head of his bed as a table

Lectures were also arranged at Army and Corps headquarters or artillery and trench mortar schools where Ordnance officers explained new types of ammunition and how to avoid damage.

The last step in this direction, in the winter of 1917/18, was to give D.A.D.O.S., by now fully conversant with equipment and clothing questions, some training in ammunition by sending him through a course at Blargies or Zeneghem ; and there is no doubt, had the war lasted much longer, that he would have become responsible to his divisional commander for the care of his ammunition on the same footing as the A.D.O.S. in the Corps and D.D.O.S. in the Army.

In spite of all precautions, however, these large stocks could not be held in frontal areas without considerable risk. Before ammunition was removed from railheads, that at Wanquetin was destroyed by a terrible explosion which wrecked the village and caused considerable loss of life, two officers and nine other ranks of the Corps being killed out of a total of twenty-five.<sup>1</sup> Another railhead, the Plateau, in which trucks of ammunition were standing, was destroyed by a direct hit from a bomb dropped on a truck of 8-inch ammunition. But the damage was more commonly due to shell fire, forward dumps being struck and exploded on a number of occasions.

The vagaries of these explosions were very extraordinary and unaccountable. On the one hand can be cited that at Audruicq where heavy lyddite shell were to

and stuck to each box was a guttering candle. There was no water or fire appliance of any sort in the building. One Colonial division became so annoyed by repeated adverse reports on its ammunition dumps and bomb stores that it requested Corps headquarters to instruct me to notify in advance of my proposed inspections, so that a staff officer could be detailed to accompany me. This was done and gave very satisfactory results, as I was able to point out what was wrong to the staff officer ; and within a month all the arrangements were extremely good."

<sup>1</sup> This, it was believed, was due to a shell being prepared with a No. 100 fuze, an operation requiring certain special precautions, and which it was contrary to orders to carry out within the precincts of the dump.

be seen in the largest crater, with pieces gouged out where they had been struck by fragments of others, yet otherwise unharmed although they must have been exposed to intense heat. On the other hand was a strange occurrence at the railhead at Hersin, where an ammunition train was hit by a shell while its contents were being transferred to a dump by light railway. An unfuzed 8-inch shell, hurled from a blazing truck, penetrated the wall of a cottage nearby and exploded inside. Seeing that a fuze with a very powerful gainé or detonator was needed to burst these shells this was very puzzling; the only explanation that could be offered was that the heat of the burning cordite caused exudation and that the exuded trotyl exploded on striking the wall, conveying the explosion to the interior of the shell in the same manner as a fuze with its gainé would have done. This was one of the occasions when the Ordnance Ammunition Units showed great gallantry. It was the front portion of the train that was struck and the party, working in the midst of the fire, succeeded in uncoupling the remaining trucks and man-handling them to a position of safety, the line being fortunately on a slope.<sup>1</sup>

Another result of this strengthening up of the Ordnance staff engaged on ammunition work at the front was that prematures and other accidents were much more closely investigated. Units were instructed to report accidents to Army headquarters, when an officer was sent out to obtain full details of the ammunition and ascertain if there was anything connected with its preparation for action or loading to account for the occurrence. Also, if the gun fell under suspicion on account of exceptional recoil, marked inaccuracy, etc., it would be examined by a workshop officer.

With the progress of the war our frontal areas became littered with derelict ammunition, mainly of our own though partly of enemy origin. Laboratories were formed

<sup>1</sup> For this plucky act Lieutenant Craighead, the Ordnance officer in charge of the party, received the immediate reward of a Military Cross and two men Military Medals.

at central points in forward areas to which this was brought in for examination by certain of the ammunition units, assisted mainly by Chinese labour. Much was in a highly dangerous condition, shell with set fuzes and grenades with detonators fixed, of which immense quantities were picked up and destroyed. Anything capable of being made serviceable by simple hand process was returned to an ammunition dump and the rest sent back to be dealt with on the lines of communication. In the Third Army area, north of the Somme, the scene of so much heavy fighting, the quantity to be dealt with was enormous, and two quite large laboratories were organized by Captain Haigh—'The Ruin' and 'The Wood.'

The normal procedure was for empty packages and brass cartridge cases to be returned to ammunition railheads through the same channels as supplied live rounds. There the course diverged, empties going to Havre and Calais to save delay to ammunition ships. When Zeneghem was opened, however, served by barge, this objection did not apply; and an area of thirty-three acres were set aside to receive empties for return to England from the northern railheads, Calais being relieved of this work. But though ammunition columns and siege park lorries were supposed to bring back empties when delivering live rounds, in the stress of active operations they had great difficulty in doing so; their time was fully occupied in feeding the guns, especially as they could often only work at night; the result being that a large amount of debris would form and be left behind each time guns changed position.

Of all forms of salvage ammunition was the most important, on account of its bulk, intrinsic value and usefulness to munition factories; especially gun cartridge cases which could be filled over and over again. It was also the most difficult to deal with, fuzed shell, misfired rounds, howitzer cordite charges, bombs and grenades containing their detonators, all of which had to be handled with care, being mixed with empty packages. This miscellany had to be carefully sorted out and each kind dealt with in its appropriate way.

With the numerous blind shell, German and British, with which frontal areas were strewn by the end of the war it was impossible to cope on any extensive scale, although it was realized that they might prove a danger when the soil was once more tilled. Most had buried themselves and, except in rare cases, all that could be done was to post a notice board 'Dud' wherever a blind shell was found, and hope that the effects of the weather would in time render the explosive innocuous. The French several times pressed us to take steps to deal with this danger; but to scour the battlefield systematically and blow up each 'dud' where it lay was impossible; and the French themselves were no more able to cope with the problem during the progress of the war in their areas than we in ours.