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Title: Deeds of a Great Railway

Author: G. R. S. Darroch

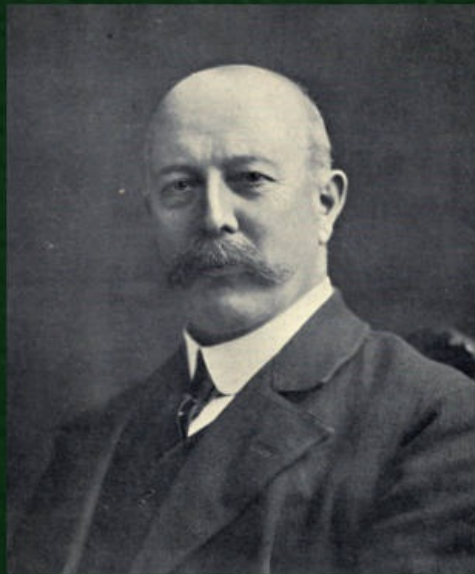
Release date: May 2, 2014 [EBook #45563]

Language: English

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*** START OF THE PROJECT GUTENBERG EBOOK DEEDS OF A GREAT RAILWAY ***

Deeds of a Great Railway



G. R. S. Darroch

DEEDS OF A GREAT RAILWAY



[*Frontispiece.*

A handwritten signature in cursive script, reading "L. J. Maxse", written in black ink on a light-colored background.

CHIEF MECHANICAL ENGINEER, LONDON AND NORTH-WESTERN RAILWAY.

DEEDS OF A GREAT RAILWAY

[i]

A RECORD OF THE ENTERPRISE AND ACHIEVEMENTS
OF THE LONDON AND NORTH-WESTERN
RAILWAY COMPANY DURING
THE GREAT WAR

By G. R. S. DARROCH
(CROIX DE GUERRE)

ASSISTANT TO THE CHIEF MECHANICAL ENGINEER L. & N.W.R.

WITH A PREFACE BY
L. J. MAXSE

With Illustrations

"The Railway Executive Committee have
been too modest, the public do not know
what they achieved."—*Engineering.*

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1920

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ERRATA.

[Page 120](#), footnote, *for* said the Tsar, *read* said of the Tsar.

[" 149](#), line 22, *for* Walschaerte valve appertaining, *read* Walschaerte valve gear appertaining.

[" 162](#), line 23, *for* mileage of permanent available *read* mileage of permanent way available.

FOREWORD

"Let thy speech be better than silence, or be silent," is a golden and an olden precept, one moreover that may, or may not, impel the aspiring rhetorician to beware the pitfalls which ever and anon threaten to ensnare his footsteps; and in compiling this little work the present Author has not been unmindful of at least two dilemmas with which he has felt himself to be faced; one, the danger of toying with that "little knowledge" which in the course of his professional duties he has been at pains—in fact could hardly fail—to acquire; the other, the debatable policy of presenting to a public, however indulgent, a subject of which, at the moment of writing, and in common with the majority of people, he is heartily tired, namely that of Munitions of War.

Prompted, however, by an ardent and innate love, dating from his earliest school-days, for railway-engines, trains, and everything appertaining thereto—a love, moreover, so compelling that at the romantic age of thirteen he applied for an engine-pass with which joyously to ride home for the holidays, and without which, owing to a polite but firm refusal, he suffered many a pang of disappointment—feeling, too, that railway enthusiasts, whether amateur or professional, cannot fail to evince a certain degree of interest in the truly amazing rôle enacted during the war by the locomotive departments of the great railway companies of the country, he has ventured to touch upon what may best, perhaps, be termed the "war effort" of the London and North-Western Railway, the premier British line, of which the locomotive G.H.Q. are, as is well known, to be found at Crewe. [vi]

In treating this subject, the Author has, as will be seen, refrained as far as possible from wearying the reader with interminable statistics, with technical dissertations descriptive of methods of manufacture, and other tedious prosaics. His aim has been rather to recall the hair-breadth escapes to which the nation was subjected; to show by means of various and authentic extracts from public utterances recorded in the Press of the day, and from recent publications, the necessities which arose contingent upon the trend of military operations and upon the arena of political pantomimes; and to illustrate the manner in which the London and North-Western Railway, predominant amongst the great railway and industrial enterprises of the British Isles, not only was able, but did, rise to the occasion, providing those sorely needed and essential "sinews" of war which were so largely instrumental in extricating the country from an extremely awkward predicament, as well as from a situation that was both ugly and menacing. [vii]

Gratia gratiam parit, but the Author regretfully feels that in the present instance he is debarred from showing, in any practical manner, his appreciation of the kindness of those who have assisted him in his task. Ingratitude is not infrequently held to be the "worst of vices," and undoubtedly "words are but empty thanks"; nevertheless the Author finds it a pleasure as well as a duty to acknowledge his deep sense of indebtedness to those members of the staff at Crewe Works for their spontaneous assistance in regard to information supplied.

He also takes this opportunity of tendering his sincere thanks to the following Editors for their kind permission to reproduce various extracts from the columns of their respective newspapers: The Editors of the *Daily Mail*, of the *Morning Post*, of the *Pall Mall Gazette*, of the *Times*, of *Engineering*, of the *Engineer*, of *Modern Transport*.

His best thanks are also due to the Managers of the following firms of Publishers, who have been good enough to allow reproductions of extracts from well-known books which, respectively, they have produced: Messrs. Blackwood, "An Airman's Outings," "Contact"; Messrs. Cassell, "The Grand Fleet, 1914-1916," Lord Jellicoe; Messrs. Constable, "1914," Lord French; Messrs. Flammarion, Paris, "Enseignements Psychologiques de la Guerre Européenne," M. Gustav Lebon; Messrs. Hodder & Stoughton, "Winged Warfare," Captain Bishop, V.C.; Messrs. Hutchinson, "My War Memories, 1914-1918," General Ludendorff. [viii]

He is equally indebted to Mr. C. J. Bowen-Cooke, C.B.E., for permission to reproduce extracts from his work "British Locomotives"; also to Mr. L. W. Horne, C.B.E., M.V.O., and his personal staff at Euston, who so kindly supplied statistics in regard to war-time traffic. Last, but not least, are due the Author's thanks to Mr. L. J. Maxse, Editor and Proprietor of the *National Review*, whose readiness to pen a few prefatory remarks is now most gratefully acknowledged.

Whilst in no way seeking to underrate the intelligence, or to disavow the knowledge, already possessed by those readers who may be sufficiently patient to bear with him, the Author would beg that at least they may not see cause to classify him with those who "wishing to appear wise among fools, among the wise seem foolish."

CREWE, 1920.

PREFACE

The British cannot be accused, even by their bitterest critics, of blowing their own trumpet. Indeed, they fail in the opposite direction, and, as a general rule, carry their modesty to a point when it positively ceases to be a virtue, because it causes credit to go where it is not due. If we are unpopular as a nation—of which we are continually assured, though whether we are more disliked than other nations may be doubted—it is certainly not on account of boasting by our men of action and achievement. Occasionally, it is true, we suffer under the extravagant claims of Talking Men—chiefly politicians—who are possibly inspired by the apprehension that unless they were their own advertisers mankind would remain oblivious and therefore ungrateful as regards the services they are supposed to have rendered.

The events of the Great War will gradually emerge in proper perspective, and things will then seem somewhat different to what they do to-day, when there is a certain and inevitable reaction which both enables pretenders to pose as saviours of Society, and encourages us to overlook much of which we may be legitimately proud because it has demonstrated afresh to a world that was forgetting it that the British are essentially a great people with a genius for everything appertaining to war, however lacking in the supreme art of making durable peace. In that day we shall want to know a great deal more than we do at present concerning the origin of a conflict which has been to some extent obscured by interested parties on both sides of the North Sea who have enveloped the palpitating pre-war crisis in a curtain of misrepresentation. It is common ground that Germany willed the war for which she was super-abundantly prepared, while Great Britain willed peace for which she was no less eager. Not for the first time in our history were we taken completely unawares—neither Government nor public having the faintest inkling of any impending storm, still less that civilisation was on the eve of a cataclysm of which it would feel the effects for more than one century.

As we look back on the Dark Ages of 1914, so graphically recalled by the author of this book, we can only marvel at our blindness and wonder how it could be that so many highly trained observers and experts on current events could entirely ignore a danger that, in the familiar French phrase, "leapt to the eyes." Of this strange phenomenon there has so far been no attempt at any explanation, no amende from those "great wise and eminent men"—not confined to any particular political party—whose business it should have been to see what stared them in the face, altogether apart from the fact that the Government of the day commanded that abundance of accurate inside information concerning international affairs, which, from generation to generation, is at the service of His Majesty's Ministers. It would be some consolation and compensation for all we have endured during this portentous period were there any guarantee that no such catastrophe could recur because the terrible lesson of 1914 to 1918 had been assimilated by Responsible Statesmen who ask so much from the Community that we are entitled to expect something from them in return.

If we cannot afford to forget the political aspect of that crisis, it is infinitely more agreeable to contemplate the miraculous manner in which "England the Unready" buckled to and transformed herself into the mighty machine whose hammer blows on every element ultimately turned the scale, and with the aid of Allies and Associates converted what at the outset looked like "World Power" for Germany into her "Downfall."

Of the part played by the Fighting Men we know a good deal, and the more we know the more we admire. Of the wonderful organisation largely improvised, that placed and kept vast forces in the field all over the world, we know next to nothing, partly because the more dramatic aspects of the war have naturally attracted the attention of its historians, partly because those with the necessary knowledge have been too busy re-converting the machine to pacific purposes to be able to write its war record.

In this attractive volume, Mr. Darroch, Assistant to the Chief Mechanical Engineer in the Locomotive Department of the London and North Western Railway Company at Crewe,—who has enjoyed the advantage of two full years' active service overseas,—tells us in so many words how our premier Railway Company "did its bit." Every factor in that great organisation was subordinated to the common object, and the Works at Crewe as urgency arose became a Munitions Department. It is a wonderful and stimulating story—made all the more interesting because the author continually bears in mind that it is part of a still larger whole and breaks what is entirely new ground to the vast majority of the reading public.

There is a desire in some quarters to banish the war as an evil dream—to bury its sacred memories, to forget all about it. If we followed this shallow advice, we should merely prove ourselves to be unworthy of the sublime sacrifice, thanks to which we escaped destruction, besides making a recurrence of danger inevitable. To our author, who is an enthusiast in his calling, this book has been a labour of love, and he has certainly made us all his debtors by this brilliant and entrancing chapter of the history of the London and North-Western.

L. J. MAXSE.

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DEEDS OF A GREAT RAILWAY

[1]

CHAPTER I

BEING MAINLY HISTORICAL

"England woke at last, like a giant, from her slumbers,
And she turned to swords her plough-shares, and her pruning hooks to spears,
While she called her sons and bade them
Be the men that God had made them,
Ere they fell away from manhood in the careless idle years."

Thus it was that on that fateful morning of August 5th, 1914, England awoke, awoke to find herself involved in a struggle, the magnitude of which even the most well-informed, the most highly placed in the land, failed utterly, in those early days, to conceive or to grasp; in death-grips with the most formidable and long-since-systematically prepared fighting machine ever organised in the history of the world by master-minds, ruthless and cunning, steeped in the science of war. England awoke, dazed, incredulous, unprepared; in fact, to quote the very words of the Premier, who, when Minister of Munitions, was addressing a meeting at Manchester in the summer of 1915, "We were the worst organised nation in the world for this war."

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The worst organised nation! And this, in spite of repeated public utterances and threats coming direct to us from the world-aggressors, as to the import of which there never should, nor indeed could, have been any shadow of doubt.

"Neptune with the trident is a symbol for us that we have new tasks to fulfil ... that trident must be in our fist"; thus the German Emperor at Cologne in 1907. "Germany is strong, and when the hour strikes will know how to draw her sword"; Dr. von Bethmann-Hollweg, in the Reichstag, 1911. Or to burrow further back into the annals of the last century, one recalls a challenge, direct and unmistakable, from the pen of so prominent a leader of German public opinion as Professor Treitschke, "We have reckoned with France and Austria—the reckoning with England has yet to come; it will be the longest and the hardest."

The reckoning came, swiftly and with deadly purpose. Necessity knew no law, Belgian territory was violated, Paris was threatened, the Prussian spear pointing straight at the heart of France.

Unprepared, taken unawares, and, but for the sure shield of defence afforded by her Fleet, well-nigh negligible, England awoke.

Happily, the nation as a whole was sound; though hampered as it was by a Peace-at-any-price section of the Press, and honeycombed though it had become with the burrowings of the "yellow English," that "lecherous crew" who, naturalised or unnaturalised, like snakes in the grass, sought, once the hour had struck, to sell the country of their adoption, the man-in-the-street little knew, and probably never will know with any degree of accuracy, how near England came to "losing her honour, while Europe lost her life."

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To reiterate all that was written at the time with the one object of keeping England out of the fray, of making her desert her friends, and of causing her, "after centuries of glorious life, to go down to her grave unwept, unhonoured, and unsung," is naturally beyond the scope of this necessarily brief *résumé* of the *status quo ante*. But, lest we forget, lest we relapse once again to our former and innate characteristics of sublime indifference and of complacent *laissez-faire*, heedless of that oft-repeated warning, "They will cheat you yet, those Junkers! Having won half the world by bloody murder, they are going to win the other half with tears in their eyes, crying for mercy,"¹ a cursory glance through one or two of the more glaring and self-condemnatory essays at defection from the one true and only path consistent with the nation's honour and integrity, may not be held amiss.

Literæ scriptæ manent, and so he who runs may still read the remonstrance of a high dignitary of the Church, to wit, the Bishop of Lincoln, as set forth in the *Daily News and Leader*, August 3rd, 1914—"For England to join in this hideous war would be treason to civilisation, and disaster to our people"; or this reassuring sop from the Archbishop of York on November 21st, 1914—"I have a personal memory of the Emperor very sacred to me." The strange views of a leading daily newspaper are typical of the "Party of dishonour." In its columns in August, 1914, we read, "The question of the integrity of Belgium is one thing; its neutrality is quite another. We shall not easily be convinced ... that the sacrosanctity of Belgian soil from the passage of an invader is worth the sacrifice of so much that mattered so much more to Englishmen." "Cold feet" was an affliction from which the same journal was evidently suffering on the same date, for "from all parts of the kingdom we are hearing of businesses that are about to close down if Great Britain goes to war. It is going to be an appalling catastrophe." In this respect, too, the Parliamentary correspondent of the *Daily Chronicle* doubtless felt that the spilling of ink was likely to be more profitable than the shedding of blood, as evinced by his inspiring little contribution on August 3rd: "Whatever the outcome of the present tension, I believe the Cabinet have definitely decided not to send our Expeditionary Force abroad. Truth to tell, the issues which have precipitated the conflict which threatens to devastate the whole of Europe are not worth the bones of a single soldier." This policy of "scuttle" must ever remain as shameful as it is unintelligible to the ordinary self-respecting Britisher; but as to the nature of the plea put forward by the *Daily News*, August 4th, there can be no vestige of doubt: "If we remained neutral we should be, from the commercial point of view, in precisely the same position as the United States. We should be able to trade with all the belligerents (so far as the war allows of trade with them); we should be able to capture the bulk of their trade in neutral markets; we should keep

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our expenditure down; we should keep out of debt; we should have healthy finances."

It has been said that "each country and each epoch has the Press which it deserves"; but although God may have given us our Press just as He has given us our relations, at least let us thank God that we can choose our Papers just as we can choose our friends.

On "Black Saturday" (August 1st, 1914) the position was literally "touch and go," as may be gathered from the following:—"Powerful City financiers, whom it was my duty to interview this Saturday (August 1st) on the financial situation, ended the Conference with an earnest hope that Britain would keep out of it" (Mr. Lloyd George, Chancellor of the Exchequer, in an interview with Mr. Henry Beech Needham, *Pearson's Magazine*, March, 1915).

Clearly, international finance had all but succeeded in winning the day for the Fatherland. S.O.S. must assuredly have been the signal subconsciously sent out by the staunch little minority in the Asquith Cabinet; for when the tide was at its lowest ebb, when England's honour literally hung in the balance, and while Mr. Asquith was still waiting and wobbling, there came Mr. Bonar Law's memorable letter as voicing the opinion of the Government Opposition, and of which the plain, outspoken meaning may be said to have had the effect of definitely turning the scale:—"Dear Mr. Asquith, Lord Lansdowne and I feel it our duty to inform you that in our opinion, as well as in that of all the colleagues whom we have been able to consult, it would be fatal to the honour and security of the United Kingdom to hesitate in supporting France and Russia at the present juncture, and we offer our unhesitating support to the Government in any measures they may consider necessary for that object. Yours very truly, A. Bonar Law."

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The tonic effect of this dose of stimulant was as immediate as it was invigorating, for "on Sunday (August 2nd)," as Sir Edward Grey announced the following day in the House of Commons (cp. the *Times*, August 4th, 1914), "I gave the French ambassador the assurance that if the German Fleet comes into the Channel or through the North Sea to undertake hostile operations against the French coasts or shipping, the British Fleet will give all the protection in its power." Further, although "we have not yet made an engagement to send the Expeditionary Force out of the country" we were not letting the grass grow under our feet, for "the mobilisation of the Fleet has taken place; that of the Army is taking place." All self-respecting Englishmen were able to breathe again; we were at least to be permitted to do our bare duty towards our neighbour; we could, in fact, once again look him in the face. But the Almighty indeed "moves in a mysterious way, His wonders to perform," and it needed the blatant blundering of the bullet-headed Boche, which throughout the prolonged agony has proved one of the greatest assets of the Entente cause, more often than not being instrumental in saving ourselves in spite of ourselves, finally to ensure that we fulfilled our treaty, as well as our moral, obligations. Our erstwhile "checker" of armament expenditure took very good care, subsequently, to remove the possibility of any doubt lingering on this score—"This I know is true.... I would not have been a party to a declaration of war, had Belgium not been invaded, and I think I can say the same thing for most, if not all, of my colleagues.... If Germany had been wise, she would not have set foot on Belgian soil. The Liberal Government then would not have intervened" (Mr. Lloyd George, in an interview with Mr. Harry Beech Needham, *Pearson's Magazine*, March, 1915).

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Wednesday, August 6th, is a day that will remain "momentous in the history of all times," for owing to the incursion within Belgian territory of German troops "His Majesty's Government have declared to the German Government that a state of war exists between Great Britain and Germany as from 11 p.m. on August 4th" (cp. the *Times*, August 5th, 1914).

Thenceforth eyes became riveted on the North Sea, thoughts centred on Belgium. Liège, the first stumbling-block in the path of the invader, was holding at bay the oncoming enemy hordes, thousands of whom advancing in close formation were made blindly to bite the dust.

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Eagerly the newspapers were bought up; every fresh message ticked off on the "tape" was greedily devoured. A French success in Alsace, a German submarine sunk, fighting on the Meuse and in the Vosges, Lorraine invaded by the French—these and other announcements, acting as appetiffs to whet the appetite, added to the excitement of the hour. Pressure of public opinion had ousted Lord Haldane from the War Office; Kitchener, "with an inflexible will, a heart that never fails at the blackest moments, a spirit that time and again has been proved unconquerable," becoming Secretary of State for War. With the approval of His Majesty the King, Admiral Sir John Jellicoe assumed supreme command of the Home Fleets, Field-Marshal Sir John French was nominated to the command of the British Expeditionary Force. Yet as day succeeded day and little or nothing became visibly apparent, vainly on all hands, but with increasing persistence, was asked the question, "Why did not England move?" Why this inaction, this seeming hesitation? The Fleet had been as if swallowed up by the waters. All was silence everywhere. At midnight on August 12th we were at war with Austria, and although "the general attitude of the nation is what it ever has been in time of trial, sedate, sensible, and self-possessed," the *Times* of August 15th, anxious, no doubt, to ease the existing tension, openly commented on the fact that "all sorts of absurd and unfounded rumours have been circulated by light-headed and irresponsible individuals," throwing ridicule on "dire reports of mishaps suffered by the Allies, of German victories, of insurrections in the French capital, and even of heavy British casualties by land and sea." Three more days "petered out," however, before all doubts were dispelled, and these "dire reports" shown to be totally void and without foundation. On Tuesday, August 18th, or exactly a fortnight from the declaration of war, it was with mingled feelings of gratitude and of relief that we read in our morning paper, "The following statement was issued last night by the Press Bureau—'The Expeditionary Force, as detailed for foreign service, has been landed on French soil. The embarkation, transportation, and disembarkation of men and stores were alike carried through with the greatest possible precision, and without a single casualty.'"

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Only those who had been intimately connected with, or actually concerned in, this the first move in the great drama were aware of the intense amount of activity that had been crowded

into the breathless space of those two short weeks. The ordinary man-in-the-street, the strap-hanger, the lady in the stalls, the girl in the taxi, all were purposely kept in the dark; the great British Public knew nothing.

Those of us who happily foresaw the historical interest and value that must surely accrue in the years to come from the preservation of the newspapers of the day may yet ponder in reminiscent mood headlines and paragraphs, descriptive of events and portraying emotions, current and constraining, throughout those August days.

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On August 18th, the *Times*, habitually dignified, lucid and exemplary, touches on the occasion in a vein deserving as it is decorous: "The veil is at last withdrawn from one of the most extraordinary feats in modern history—the dispatch of a large force of armed men across the sea in absolute secrecy. What the nation at large knew it knew only from scraps of gossip that filtered through the foreign Press. From its own Press, from its own Government, it learned nothing; and patiently, gladly, it maintained, of its own accord, the conspiracy of silence." It was true, in fact inevitable, that "every day for many days now mothers have been saying good-bye to sons, and wives to husbands," but "until Britain knew that her troopships had safely crossed that narrow strip of water that might have been the grave of thousands, Britain held her peace." However, "now that we are at last allowed to refer to the dispatch of a British Army to the seat of war, we may heartily congratulate all concerned upon the smooth and easy working of the machinery. The staffs of England and France who prepared the plan of transport, the railway and steamship companies which carried the men, the officers and men who marched silently off without the usual scenes of farewell at home, and last, but not least, the Navy that covered the transports from attack, all deserve very hearty congratulations."

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Comparisons are odious, and it is obviously without any desire to detract from the laudable performances of others in the accomplishment of this, "one of the most extraordinary feats in modern history," that reference of a special character is here made to the singularly high state of efficiency obtaining on the great British railway companies, which alone rendered possible so remarkable an achievement as that of marshalling at a moment's notice, and dispatching, the many trains necessary for the conveyance to the different ports of embarkation within the United Kingdom of the four Divisions of all arms and one of Cavalry of which the original British Expeditionary Force was composed.

It is true that on the outbreak of war, the State, at least in name, assumed control of the railways, and this by virtue of an Act of Parliament passed in 1871 (34 and 35 Victoria, c. 86) "for the Regulation of the Regular and Auxiliary Forces of the Crown," section XVI. of which enacted that "When Her Majesty, by order in Council, declares that an emergency has arisen in which it is expedient for the public service that Her Majesty's Government should have control over the railroads of the United Kingdom, or any of them, the Secretary of State may, by warrant under his hand, empower any person or persons named in such warrant to take possession in the name or on behalf of Her Majesty of any railroad in the United Kingdom ... and the directors, officers, and servants of any such railroad shall obey the directions of the Secretary of State as to the user of such railroad ... for Her Majesty's service."

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A previous "Act for the better Regulation of Railways, and for the Conveyance of Troops" (5 and 6 Victoriae 30th July, A.D., 1842, cap. LV. section XX.), similarly declares—"Be it enacted, 'That whenever it shall be necessary to move any of the Officers or Soldiers of Her Majesty's Forces of the Line, Ordnance Corps, Marines, Militia, or the Police Force, by any Railway, the Directors thereof shall and are hereby required to permit such Forces respectively with their Baggage, Stores, Arms, Ammunition, and other Necessaries and Things, to be conveyed at the usual Hours of starting, at such Prices or upon such Conditions as may from Time to Time be contracted for between the Secretary at War and such Railway Companies for the Conveyance of such Forces, on the Production of a Route or Order for the Conveyance signed by the proper Authorities."

Hence it will be seen that, always subject to the provisions of the National Defence Act of 1888 (51 and 52 Victoriae, c. 31), which simply ensured that naval and military requirements should take precedence over every other form of traffic on the railways whenever an Order for the embodiment of the Militia was in force, the actual working of the various departments of the different railway companies when war was declared remained, to all intents and purposes, identical with that prevailing in the piping times of peace, that is to say in the hands of the individual "directors, officers and servants" of the respective railways, with the result that in the absence of all attempt at interference on the part of official bureaucracy, "all went merry as a marriage-bell"; staffs worked day and night; confusion was conspicuous by its absence; smoothly, yet unrehearsed, proceeded the unparalleled programme, until the last man had been detained, the last gun hauled aboard the transport lying in readiness at the quay; and in due course, as has already been mentioned, "the Contemptibles" were landed in France without a single casualty.

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Whilst touching lightly upon the evident and praiseworthy preparedness and consequent ability of the great railway companies to deal with "the emergency" the moment it arose, it will perhaps not be uninteresting to inquire briefly into the circumstances dating back to the "fifties" of the last century from which were evolved and brought gradually to a state as nearly approaching perfection as is humanly possible the organisation necessary for the speedy and safe transport of troops by rail in time of war.

History ever repeats itself, and it has invariably been the case that the imminent peril of invasion rather than any grandiose scheme of foreign conquest has been the determining factor in arousing that martial spirit, so prone to lying dormant, but which, handed down to us by our forbears, undoubtedly exists in the fibre of every true-born Britisher, and which has assuredly been the means of raising England to her present pinnacle of greatness.

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The three more obviously parallel instances in modern times of the manifestation of this trait so happily characteristic of the nation are to be found, first and foremost perhaps in connection

with the present-day world conflict, when in response to the late Lord Kitchener's first appeal for recruits thousands flocked to the colours. Apposite indeed was the following brief insertion to be found in the personal column of the *Times*, August 26th, 1914: "'Flannelled fools at the wicket and muddied oafs at the goal' have now an opportunity of proving whether Mr. Kipling was wrong." They seized the opportunity in no uncertain manner; incontrovertibly they proved him wrong, "The first hundred thousand," or "Kitchener's mob" as they were affectionately termed, being speedily enrolled, and forming the nucleus of the immense armies which eventually took the field.

Analogous to this effort may be taken the crisis occurring in the middle of the last century, when, in the year 1858, out of what may best be described perhaps as a "storm in a tea-cup," there loomed the threat of invasion by our friends from across the Channel, resulting in a scare the immediate outcome of which was the formation of the Volunteer Force, which quickly reached a total of 150,000 men.

Although this particular crisis must be considered as bearing more directly on present-day matters of interest in view of the fact that the importance of steam-traction by rail relative to warlike operations commenced at that time to make itself felt, the extent to which the nation seemed likely to be imperilled was, nevertheless, scarcely to be compared with the danger that threatened during what may be termed the closing phase of the Napoleonic era, when in the year 1805 massed in camp at Boulogne was the flower of the French Army equipped with quantities of flat-bottomed boats ready for its conveyance across the Channel. To counter this formidable menace was mustered in England a force of 300,000 Volunteers, imbued with the same fervent ardour, the same spirit of intense patriotism and self-sacrifice that has ever been evinced by the country in her hour of peril. How the menace was in fact averted, and the last bid for world-domination by the Emperor Napoleon Bonaparte frustrated, is common knowledge, the memorable action off Cap Trafalgar determining once and for all the inviolability of England's shores. "England," exclaimed Pitt, "has saved herself by her courage; she will save Europe by her example."

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The average historian of to-day, who mentally is as firmly convinced that the genius of Nelson won the Battle of Trafalgar as he is ocularly certain that the famous admiral's statue dominates Trafalgar Square, will, on the other hand, in all probability deny that the use of steam as a motive force was contemporaneous with the period in which Nelson lived. But although it is somewhat of a far cry from the latter part of the eighteenth century to the "eighteen-fifties" when steam was to become a factor of no mean importance in the waging of modern war, there is, nevertheless, conclusive evidence to show that dating so far back as the "seventeen-seventies" individual efforts of admittedly a most elementary, albeit utterly fascinating, kind were already being made with a view to solving the problem wrapt up in this "water-vapour," and so compelling the elusive energy to be derived therefrom as a motive agency for rendering facile human itinerancy. No sooner had the first self-propelled steam-carriage made its appearance on the road, than speculation became rife as to the range of potentialities lying latent in the then phenomenal invention; well-nigh limitless seemed the vista about to unfold itself to human ambition, and looking back over the past century and a half how strangely prophetic sound these lines from the pen of Erasmus Darwin, who died in 1802!—

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"Soon shall thy arm, unconquered steam! afar
Drag the slow barge, or drive the rapid car;
Or, on wide-waving wings expanded, bear
The flying chariot through the field of air!"

Evidently the "Jules Verne" of his day, Erasmus Darwin was physician as well as poet; his ideas, so we are told, were indeed "original and contain the germs of important truths," to which may, in some measure, be attributed the genius of his grandson, the famous Charles R. Darwin, discoverer of natural selection.

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It is true the petrol engine has latterly proved its more ready adaptability to the purpose of road locomotion and of aviation, but the fact remains that steam to this day eminently preserves her predominance in the world of ocean and railway travel.

Seldom does one find the evolution of any one particular branch of scientific endeavour traced in so alluring as well as instructive a manner as proves to be the case, when, taking down from the nearest bookshelf that delightful little volume "British Locomotives," one pursues the author, Mr. C. J. Bowen-Cooke (now C.B.E. and Chief Mechanical Engineer of the London and North-Western Railway), with never-abating interest through his treatise on the early history of the modern railway engine. He tells us that "the first self-moving locomotive engine of which there is any authenticated record was made by a Frenchman named Nicholas Charles Cugnot, in the year 1769. It was termed a 'land-carriage,' and was designed to run on ordinary roads." Although we learn that "there are no particulars extant of this, the very first locomotive," this same Cugnot designed and constructed two years later, a larger engine, "which is still preserved in the Conservatoire des Arts et Metiers at Paris." The French are a people ever prone to looking further than their noses, hence the fact that the French Government not unnaturally "took some interest in this notion of a steam land-carriage, and voted a sum of money towards its construction, with the idea that such a machine might prove useful for military purposes." Man proposes, but God disposes, and as luck would have it the vehicle seemed fore-ordained to end its brief career somewhat ingloriously, for after it "had been tried two or three times it overturned in the streets of Paris, and was then locked up in the Arsenal." A lapse of ten or a dozen years supervened before England began looking to her laurels, but "in 1784 Watt took out a patent for a steam-carriage, of which the boiler was to be of wood or thin metal, to be secured by hoops or otherwise to prevent its bursting from the pressure of steam"! It was not long, however, ere the

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steam road carriage was superseded by a locomotive designed to run on rails, of which the earliest "broods," embracing such "spifflicating" species as the Puffing Billies, Rockets, Planets, etc., and "hatched" from the brains of eminent men such as Stephenson and Trevithick, were necessarily original and quaint to a degree. It is, unfortunately, impossible here to do more than skim the copious wealth of interesting data through which Mr. Bowen-Cooke so admirably pilots us, and which evidently he has spared no pains to collect; suffice it to add that the succeeding years bear unflinching witness to that intense earnestness which, sustaining the early locomotive pioneers unwearied in their well-doing, was so largely instrumental in the attainment of that perfection of which we, their beneficiaries, now in our own season reap the benefit.

It was not until the opening of the Liverpool and Manchester Railway in 1830, when the directors of that line offered "a premium of £500 for the most improved locomotive engine," that any real tendency towards modern design and external appearance began to make itself apparent. The stimulus afforded by this offer, however, was rousing in effect, engines becoming gradually larger and more or less powerful, until in the year 1858 Mr. Ramsbottom designed and built for the London and North-Western Railway Company at Crewe an express passenger engine known familiarly as the "seven foot six," in that its single pair of driving wheels measured 7 feet 6 inches in diameter. Bearing the name of "Lady of the Lake" (for, whilst sacrificing perhaps a certain amount of power for speed, it was "certainly one of the prettiest engines ever built"), this engine and others of the same "class" remained in the service of the London and North-Western Railway until quite recently, thus forming a link between the earth-shaking events of the present day and that period of anxious calm, when the scare (to which reference has previously been made) became the occasion in 1858 for centring public opinion on the possibilities of, and the advantages likely to accrue from, transport by rail in time of war.

The Crimean struggle of 1855 had done little enough to enhance England's military prestige, only to be followed, two years later, by the nightmare horrors of the Mutiny.

Throughout the first and second Palmerston Ministries, the reading of the European barometer remained at "stormy," and an attempt in 1858 to assassinate the Emperor Napoleon III., which was believed to have had its origin in England, served as a prelude to the "blowing-off" of a considerable volume of steam, especially when a year later, the war between France and Austria having terminated and the kingdom of Italy being created, the French people found themselves free to devote their then bellicose attentions, as had so frequently been their misguided and regrettable wont, to our insular selves. It is, however, an ill wind that blows nobody any good, and the very fact that the tone, particularly of the military party in France, was violent and aggressive to a degree, had the salutary effect of serving as a mirror in which was accurately reflected our own deplorable unpreparedness for war.

Commenting on the situation, the writer of a leading article in the *Times* of April 19th, 1859, openly deplores the fact that "the Englishman of the present day has forgotten the use of arms"; not merely this, but "the practice of football or of vying with the toughest waterman on the Thames is of little service to young men when their country is in danger."

Mercifully enough, perhaps, the pernicious sensationalism of the cinema, and the vacant thrills afforded by the scenic railway, were magic lures unknown in those mid-Victorian days, manly and open-air forms of sport already being considered sufficiently derogatory to the inculcation within the minds of the younger generation of that fitting sense of duty, of self-sacrifice, and subservience to discipline.

The opinion was further expressed that "there can be only one true defence of a nation like ours—a large and permanent volunteer force supported by the spirit and patriotism of our young men, and gradually indoctrinating the country with military knowledge," the article concluding with this ominous reminder—"We are the only people in the world who have not such a force in one form or another."

"Si vis pacem, para bellum" was the obvious corollary drawn by all sober-minded people and seriously inclined members of the community, and on the 13th of May, 1859, the *Times* had "the high gratification of announcing that this necessity (that of home defence) is now recognised by the Government," for "in another portion of our columns will be found a circular addressed by General Peel to the Queen's Lieutenants of counties sanctioning the formation of Volunteer Rifle Corps." At the same time the war in Italy was made to serve the purpose of bringing out in full relief the importance of steam as a novel factor in strategical operations, for we further read (cp. the *Times*, May 13th, 1859) that "steam—an agency unknown in former contests—renders all operations infinitely more practicable.... Railroads can bring troops to the frontier from all quarters of the kingdom.... It is in steam transport, in fact, that we discover the chief novelty of the war."

Thenceforward matters began to assume practical shape, and in the following year 1860, on September 15th, we come across a reference to the Volunteer movement "which has so signal a success as to produce a costless disciplined army of 150,000 marksmen," springing from "a unanimous feeling of the necessity of preparing for defence." Conspicuous amongst this "costless disciplined army" figure the 1st Middlesex (South Kensington) Engineer Volunteers, "numbering now," as we find, on October 23rd, 1860, "over 500 members," and "daily increasing in strength is making rapid progress in its drills, etc." The 1st Middlesex was evidently the original corps of Engineer Volunteers to be formed, and thus became the precursor of other and similar corps which sprang into being in other parts of the country; a fine example of which (although entirely distinct in that it was the sole Engineer Corps to embody railway engineers) was later to become apparent in the 2nd Cheshire Engineers (Railway) Volunteers.

Formed in January, 1887, the battalion was recruited entirely from amongst the employés of the London and North-Western Railway, comprising firemen, cleaners, boilermakers and riveters, fitters, smiths, platelayers, shunters, and pointsmen. The nominal strength of the establishment was six companies of 100 men each, but in addition 245 men enlisted as a matter of form in the

Royal Engineers for one day and were placed in the First Class Army Reserve for six years, forming the Royal Engineer Railway Reserve, and being liable for service at any time. During the South African War 285 officers and men saw service at the front, and the military authorities were not slow to appreciate the invaluable aid rendered by this picked body of men. On the inception of Lord Haldane's scheme of Territorials in 1908, the battalion was embodied therein, and continued as such until March, 1912, when for some inexplicable reason it was finally disbanded.

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How valuable an asset from the professional point of view were deemed, originally, these Engineer Corps, may be gathered from the *Times* of November 23rd, 1860, which congratulates the 1st Middlesex, as being the parent corps, on having been "most successful in obtaining skilled workmen of the class from which are drawn the Royal Engineers. Every member of the corps goes through a course of military engineering in field works, pontooning, etc.," with the result that the Volunteer Engineers "will therefore form a valuable adjunct to the Royal Engineers in the event of their being called into the field."

The ball once started rolling, it was not unnaturally deemed advisable to form some central and representative body of control, and the *Times* of January 10th, 1865, gives an account of an "interesting ceremony of presenting prizes to the successful competitors of rifle practice of the Queen's Westminster (22nd Middlesex) Rifle Volunteers," when Colonel McMurdo, then Inspector-General of the Volunteer Forces, "who was received with loud and long-continued applause," in the course of a speech referred to the formation of a new corps, "a most important one both for the Volunteer Force and the Regular Army. He would tell the objects of this corps," which would consist of 30 Lieutenant-Colonels, and would enlist other members down to the rank of sergeants:—"In order that the Volunteers and the Army of England should be able to move in large masses from one part of the country to another they would have to depend upon railways. In all the wars of late years—as in the Italian war, the war in Denmark, and in the American war—the railway had been brought into service, to move armies rapidly from place to place, and this new corps, which at present consisted of the most eminent railway engineers and general managers of the great lines, had the task of bringing into a unity of action the whole system of railways of Great Britain; so that if war should visit England, which God forbid, this country would be placed on an equality with countries whose Governments possessed the advantage—if advantage it might be called—of carrying on the business of the railways. And the importance of this they might estimate when he assured them that with the finest army in the world, unless they had a system by which 200,000 men could move upon the railways with order, security, and precision, efficiency and numbers would be of no avail upon the day of battle; and that unless we had order, unless we had certainty in the moving of large masses, the day of battle, which might come, would be to us a day of disaster."

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Accorded the title of "The Engineer and Railway Volunteer Staff Corps," this select little group, combining some of the best brains and ability to be found in the engineering and managerial departments of the railways, acted in the capacity of consulting engineers to the Government, from the time of its formation until the year 1896, when a smaller body composed on similar lines and known as the "War Railway Council" was introduced for the purpose of supplementing, and to some extent relieving, the original Railway Staff Corps.

As has already been seen, although in accordance with the provisions of the Act of 1871 the Government would assume control of the railways in the event of "an emergency" arising, the directors, officers, and servants of the different companies would nevertheless be required to "carry on" as usual, and to maintain, each in their several spheres, the actual working of the lines.

The final adjustment of any minor defects that may have been apparent in the rapidly completing chain of organisation was speedily accelerated by the Agadir crisis of 1911, resulting in the inception in the following year of that unique and singularly thorough institution, the Railway Executive Committee, which in turn superseded its immediate predecessor, the War Railway Council.

On the outbreak of the world conflict in August, 1914, and following on an official announcement by the War Office to the effect that Government control would be exercised through this "Executive Committee composed of General Managers of the Railways," Sir Herbert Walker, K.C.B., General Manager of the London and South-Western Railway, who was forthwith appointed Acting-Chairman of the Railway Executive Committee, issued in concise form a further and confirmatory statement, in which he drew attention to the fact that "the control of the railways has been taken over by the Government for the purpose of ensuring that the railways, locomotives, rolling-stock, and staff shall be used as one complete unit in the best interests of the State for the movement of troops, stores, and food supplies.... The staff on each railway will remain under the same control as heretofore, and will receive their instructions through the same channels as in the past."

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Indelibly imprinted though the memory of those fateful August days must remain in the minds of every living individual, days brimful of wonderings alternating with doubt, expectancy, ill-foreboding, and occasional delight, coupled with an all-pervading sense of mystery completely enshrouding the movements of our own forces, few indeed were aware of the extent of the task imposed upon the Railway Executive Committee. Yet so swiftly, so silently, was the entire scheme of mobilisation carried through, that it was with a sense bordering on bewilderment and with something akin to a gulp that the public found itself digesting the news of the safe transport and arrival in France of the Expeditionary Force. On the occasion of his first appearance in the House of Lords as Secretary of State for War, the late Lord Kitchener referred in brief, but none the less eulogistic terms, to the successful part played by the railway companies (cp. the *Times*, August 26th, 1914): "I have to remark that when war was declared mobilisation took place without any hitch whatever. The railway companies in the all-important matter of railway transport facilities

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have more than justified the complete confidence reposed in them by the War Office, all grades of railway services having laboured with untiring energy and patience. We know how deeply the French people appreciate the prompt assistance we have been able to afford them at the very outset of the war." Nor has Sir John French neglected to record his own appreciation of so signal a performance, for, in describing the events leading up to the concentration of the British Army in France, he writes (cp. "1914," p. 40): "Their reports (*i.e.* of the corps commanders and their staffs) as to the transport of their troops from their mobilising stations to France were highly satisfactory. The nation owes a deep debt of gratitude to the naval transport service and to all concerned in the embarking of the Expeditionary Force. Every move was carried out exactly to time."

So far so good, it will be opined. Certainly from the chief points of disembarkation, Boulogne and le Havre, there were "roses, roses all the way," surely never before in the annals of warfare have troops from an alien shore been greeted with such galaxy of joy and enthusiasm, though perhaps most touching tribute of all was that of a wayside impression, the figure of an old peasant leaning heavily on his thickly gnarled stick, with cap in hand outstretched, his wan smile and glistening tear-dimmed eye indicating in measure unmistakable the depth and sincerity of his silent gratitude.

"On Friday, August 21st, the British Expeditionary Force," Sir John French tells us, "found itself awaiting its first great trial of strength with the enemy," and the childish display of wrathful indignation evinced by Wilhelm the (would-be) Conqueror, who is credited with having slapped with his gauntlet the face of an all too-zealous staff officer, bearer of so displeasing an item of intelligence, is not devoid of humour. The nursery parallel is complete—"Fe, fi, fo, fum," roared the giant, "I smell the blood of an Englishmen." "Gott im himmel," snarled the Kaiser, "It is my Royal and Imperial command that you concentrate your energies, for the immediate present, upon one single purpose, and that is that you address all your skill and all the valour of my soldiers to exterminate first the treacherous English and walk over General French's contemptible little army." Head-quarters, Aix-la-Chapelle, August 19th, 1914, (cp. the *Times*, October 1st, 1914).

"Up to that time," however, as Sir John French asseverates in his further reminiscences, "as far as the British forces were concerned, the forwarding of offensive operations had complete possession of our minds.... The highest spirit pervaded all ranks"; in fact "no idea of retreat was in the minds of the leaders of the Allied Armies," who were "full of hope and confidence." In this wise, then, did the Regulars, the flower of the British Army, enter the fray, little dreaming that the entire nation and Empire were to be trained in their wake, or that upwards of four years, instead of so many months, involving sacrifices untold, must elapse ere we were destined to emerge (or perhaps muddle) successfully from out the wood.

For the moment, as it transpired, "nothing came to hand which led us to foresee the crushing superiority of strength which actually confronted us on Sunday, August 23rd"; neither had "Allenby's bold and searching reconnaissance led me (Sir John French) to believe that we were threatened by forces against which we could not make an effective stand." How completely the strength and disposal of the enemy forces had been veiled, no more than a few brief hours sufficed to disclose; disillusion quickly supervened. "Our intelligence ... thought that at least three German corps (roughly 150,000 men)² were advancing upon us," and following on a severe engagement in the neighbourhood of Charleroi in which the French 80th Corps on our left suffered heavily, a general retirement commenced. Namur had fallen on August 25th, and there was no blinking the truth, it was the Germans who were advancing, not we! Thenceforward, the retreat, the now historic Retreat from Mons, orderly throughout, set in along the whole line of the Allied Armies; of respite there was none, day in day out, 'neath the burning rays of an August sun the enemy pressure increased rather than relaxed.

The following narrative set down by an eye-witness, temporarily *en panne* during the afternoon and evening of August 27th on the outskirts of the little provincial town of Ham, depicts briefly but with some degree of vividness the tragic nature of the scene that was being enacted. After making some slight preliminary allusion to the pitiable plight of refugees who everywhere helped to block the roads, "there commenced," so the narrative runs, "this other spectacle of which I speak; at first, as it were, a mere trickle, a solitary straggler here, a stray cavalry horseman there, until the trickle grew, grew into a strange and never-ending living stream; for, down the long straight route nationale from Le Cateau, and so away beyond from Mons, they came those 'broken British regiments' that had been 'battling against odds'; men bare-headed, others coatless, gone the very tunic from their backs; tattered, blood-stained, torn; now a small detachment, now a little group; carts and wagons heaped with impedimenta galore, while lying prone on top of all were worn-out men and footsore. And all the time along the roadside fallen-out, limping, hobbling, stumbling, came stragglers, twos and threes, men who for upwards of four days and nights, without repose, had fought and marched and trekked, till sheer exhaustion well-nigh dragged each fellow to the ground. Yet on they kept thus battling 'gainst the numbness of fatigue, that mates more broken than themselves should ease, in measure slight, their sufferings in the bare comfort of thrice-laded carts. All but ashamed to poke the crude curiosity of a camera in the grim path of war-worn warriors such as these, from where I stood, as unobtrusive as could be, I snapped three instantaneous glimpses of this gloriously pitiful review, stamped though it was already ineradicably in the pages of my memory. Twilight fell, and night, and still the stream flowed in and ever onward."

The news in London, heralded by a special Sunday afternoon edition of the *Times*, came as a bolt from the blue, for not since the announcement of the landing of the Expeditionary Force in France had anything of an authentic nature been received as to its subsequent doings or movements; in fact, as the *Times* pointed out on August 19th, "the British Expeditionary Force

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has vanished from sight almost as completely as the British Fleet"; further, as if to complete the nightmare of uncertainty, "British newspaper correspondents are not allowed at the front; ... the suspense thus imposed upon the nation is almost the hardest demand yet made by the authorities,—with some misgivings we hope it may be patiently borne."

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The British public, however, in spite of occasional qualms and momentary misgivings, ever confident of success and sure in its inflexible belief that the British Army could hold its own against almost any odds (the prevailing logic being that one Britisher was as good as any three dirty Germans), had bidden Dame Rumour take a back seat in the recesses of its mind.

Incredible then the news that broke the spell: "This is a pitiful story I have to write," so read the message, dated Amiens, August 29th, "and would to God it did not fall to me to write it. But the time for secrecy is past. I write with the Germans advancing incessantly, while all the rest of France believes they are still held near the frontier." What had happened? How could it be true? Sir John French wastes no time in mincing matters:—"The number of our aeroplanes was limited." "The enormous numerical and artillery superiority of the Germans must be remembered." "It (the machine gun) was an arm in which the Germans were particularly well found. They must have had at least six or seven to our one." "It was, moreover, very clear that the Germans had realised that the war was to be one calling for colossal supplies of munitions, supplies indeed upon such a stupendous scale as the world had never before dreamed of, and they also realised the necessity for heavy artillery."

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The time for secrecy was past; but how to stem the tide? The situation was, and indeed remained, such that a year later Mr. Lloyd George (then Secretary of State for War) was moved to make this astounding admission in the House of Commons: "The House would be simply appalled to hear of the dangers we had to run last year." And again at a subsequent date when as Minister of Munitions he exclaimed in the House, "I wonder whether it will not be too late. Ah! fatal words on this occasion! Too late in moving here, too late in arriving there, too late in coming to this decision, too late in starting enterprises, too late in preparing. In this war the footsteps of the Allied forces have been dogged by the mocking spectre of "Too late."

In this connection it would be amusing, were it not so utterly tragic, to compare a slightly previous and public utterance from the lips of this same "Saviour of his Country":—"This is the most favourable moment for twenty years to overhaul our expenditure on armaments" (Mr. Lloyd George. *Daily Chronicle*, January 1st, 1914).

Happily however, "il n'est jamais trop tard pour bien faire," and this good old adage as to it being never *too* late to mend was perhaps never better exemplified than when, the Army Ordnance authorities having realised that the Government arsenals were in no position to cope fully with the demands likely to be made by the military authorities in the field, that other army of "Contemptibles," the staffs and employes of the great engineering concerns of this country, came forward in a manner unparalleled in the history of modern industry, and forthwith commenced to adapt themselves and their entire available plant to the process of manufacturing munitions of war.

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Foremost amongst firms of world-wide repute must be mentioned the great London and North-Western Railway Company, whose Chief Mechanical Engineer, Mr. C. J. Bowen-Cooke, C.B.E., realising from the outset the import of the late Lord Kitchener's forecast as to the probable duration and extent of the war, and in spite of ever-increasing demands on locomotive power which he found himself compelled to meet for military as well as for ordinary civilian purposes, threw himself heart and soul into the problem of adapting the then existing conditions and plant in the Company's locomotive works at Crewe to the requirements of the military authorities.

Forewarned as it was to some extent by the hurricane advance of the Hun, the Government was also forearmed in that it was empowered by the provisions of the Act of 1871 not merely to take over the railroads of the United Kingdom, but, should it be deemed expedient to do so, the plant thereof as well. The Government might even take possession of the plant without the railroad; though how the railways could have been maintained minus their plant, any more than the Fleet could have remained in commission minus its dockyards, is doubtless a problem that was duly considered by those who framed the wording of the Act in the year of grace 1871.

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However that may be, as soon as the really desperate nature of the struggle began to dawn upon the Government, and it was seen to be a case of "all or nothing," the then President of the Board of Trade, Mr. Runciman, M.P., was not slow to espy the latent, yet none the less patent, possibilities which surely existed within the practical domain of railway workshops.

In certain circumstances it may be regarded as fortunate that not a few of those happy-go-lucky individuals, whose leaning is towards politics, are gifted with the convenient art of adapting themselves and their views to that particular quarter whence the wind happens to be blowing. "I must honestly confess," as this same Mr. Runciman had expressed himself when in 1907 he was Financial Secretary to the Treasury, "that when I see the armaments expanding it is gall and wormwood to my heart; the huge amount of money spent on the Army is a sore point with every one in the Treasury."

Particularly galling, therefore, must have seemed the rate at which expenditure on armaments was increasing by leaps and bounds in 1914; yet so ingenuous is the manner in which politicians are calmly capable of effecting a complete *volte-face*, that on October 13th we find Mr. Runciman positively engaged in seeking out the late Sir Guy Calthorp, then General Manager of the London and North-Western Railway, and Mr. Bowen-Cooke, for the purpose of eliciting their views as to the extent to which the railway companies might be relied upon to assist the Government in spending still more huge amounts of money (incidentally thus adding a further dose of wormwood to his heart), especially in regard to the output of artillery.

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Without knowing for the moment what actually were the more immediate and pressing requirements of the Government, Mr. Cooke suggested an interview with the late Sir Frederick Donaldson, then Director of Army Ordnance at Woolwich Arsenal, with whom he was personally

acquainted; the result being that Sir Frederick was able to point out in detail the difficulties with which he was faced, handing over to Mr. Cooke a number of drawings of gun-carriage chassis, etc., which he (Mr. Cooke) went through, tabulating them in concise form, so that at a forthcoming meeting which had been called at the Railway Clearing House for Tuesday, October 20th, the Chief Mechanical Engineers of the Midland, Great Western, North-Eastern, Great Northern, and Lancashire and Yorkshire Railways who were present should have every facility for noting and deciding what they could best undertake in their respective railway workshops.

The rapid growth of this Government work necessitated arrangements being made for orders to pass through some recognised channel, and in November 1914, an offshoot of the previously-mentioned Railway Executive Committee, consisting of the Chief Mechanical Engineers of the principal railway companies, together with representatives from the War Office, was created, to be called "the Railway War Manufacturers' Sub-Committee."

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Briefly the duties of this sub-committee were to consider, to co-ordinate, and to report upon various requests by or through the War Office to the railway companies, to assist in the manufacture of warlike stores and equipment. All applications for work to be done in the railway workshops, either for the War Department or for War Department contractors, were submitted to this committee by one of the War Office members. On receipt of any request the railway members of the committee decided whether the work was such as could be effectively undertaken by the railway companies, and if their decision was favourable, steps were taken to ascertain which companies could and would participate in the work, the amount of work they could undertake to turn out, and the approximate date of delivery. The War Office members decided as to the priority of the various demands made upon the railway companies. The actual order upon the railway companies to carry out any manufacturing work was given to such companies by the Railway Executive Committee.

To detail the manner in which the London and North-Western Railway Company's locomotive Works at Crewe became, in great measure, as it were, a private arsenal subsidiary to the Royal Arsenal at Woolwich is the aspiring theme of the succeeding pages of this narrative.

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¹. Carl Rosemeier, a German in Switzerland, to the Allies. Cp. *Daily Mail*, June, 1919.

². The German army corps of two divisions has 44,000 men, and a combatant strength of 26,900 rifles, 48 machine guns, 1200 sabres, and 144 guns. The German army corps of three divisions is approximately 60,000 strong (cp. the *Times*, August 29th, 1914).

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CHAPTER II

ARMoured TRAINS

"The armourers,
With busy hammers closing rivets up,
Give dreadful note of preparation."

SHAKESPEARE.

Actually the first "job" to be undertaken in Crewe Works, with a view to winning the war and kicking the Hun away back across the Rhine whence rudely and ruthlessly he had pushed his unwelcome presence, was the hurried overhaul of a L. & N.W.R. motor delivery van which, destined for immediate service overseas and in conjunction with other and similar vehicles volunteered by such well-known firms as the A. & N. Stores, Bovril, Ltd., Carter Paterson, Harrod's Stores, Sunlight Soap, etc., *ad lib.*, formed the nondescript nucleus, unique and picturesque, but none the less invaluable, of the mammoth columns of W.D. lorries which eventuated in proportion as the Country got into her stride.

Thereafter the "fun" became fast and furious; orders succeeded one another in quick succession, and in ever-increasing numbers, with the result that men who till then had been accustomed to living, moving, and having their being solely and entirely in an atmosphere of cylinders, motion rods, valves, and all the like paraphernalia of locomotive structure, suddenly found themselves "switched over" on to then unknown quantities, such as axle-trees, futchels, wheel-naves, stop-plates, elevating arcs, trunnions, and other attributes of "war's glorious art"; until from bolt shop to wheel shop, fitting and electric shops to boiler shop, foundries to smithy and forge, one and all became absorbed in the tremendous issue which threatened the ordered status, the very vitals, of the civilised communities of the world.

One, if not indeed *the*, centre of wartime activity within the extensive domain of Crewe Works may be said to have been the mill-shop; for, although of necessity "fed" in respect to integral parts by other—and for the time being subsidiary—shops throughout the Works, it was here that were assembled and completed in readiness for dispatch to that particular theatre of war for which they were destined numerous "jobs" of anything but "Lilliputian" dimensions, and evincing characteristics of exceptional interest and unmistakable merit.

So immersed in munition manufacture did the shop become that, always—even in the everyday humdrum round of peace-time procedure—a source of delight and information to the visitor, professional and amateur alike, entry within its portals perforce assumed the nature of a privilege which Mr. Cooke, bowing to the dictates of D.O.R.A., but none the less regretfully, felt constrained to withhold from all save the few legitimate bearers of either Government or other similar and indisputably genuine credentials.

Employing none but men possessed of considerable technical knowledge conjointly with the highest degree of mechanical skill and ability, the mill shop might, not without reason, be termed a "seat of engineering"; a "siège," that is, not simply productive of new machinery, but responsible for the repair and maintenance within the Works, as well as for the repair throughout the Company's entire so-called "outdoor" system, of a plant of infinite variety, embracing machinery evincing qualities so diverse as are to be found in air-compressors, gas engines, hydraulic capstans, lifts, presses, etc.

Fitly enough, however, in spite of these habitually peaceful proclivities, the soul of the millwright from the very outset of the war became infused with the spirit of Mars, and pride of place should perhaps be accorded the two armoured trains which, during the late autumn and early winter months of 1914-15, claimed the combined energies and ingenuity of those who were called upon to construct them.

Invasion was a bogey which, rightly or wrongly, undoubtedly throughout the whole period of the war never failed to exercise the minds, not only of competent military and naval authorities, but of amateur and would-be "Napoleon-Nelsons" as well, and right up to the spring of 1918, when every available ounce of weight was flung across the Channel to counter what was destined to prove the final and despairing enemy offensive, large forces had been kept at home, if merely as a precautionary measure.

True enough, a certain degree of material damage accompanied not infrequently by a sufficiently heavy toll of human, and usually civilian, life resulted from perennial air raids, and an occasional *ballon d'essai* smacking of "tip and run" on the part of some small detachment or flying squadron of enemy ships might momentarily upset the resident equilibrium of one or other of our East-coast seaside resorts; but nothing approaching the semblance of any actual or serious attempt at invasion was ever known to occur; in fact, Mr. Lloyd George, when speaking at Bangor in February, 1915, went so far as to "lodge a complaint against the British Navy," which, he reminded his hearers, "does not enable us to realise that Britain is at the present moment waging the most serious war it has ever been engaged in. We do not understand it." There was no disputing the fact, those at home never really understood the war; almost equally self-evident was the truism that they seldom if ever really appreciated to the full the natural beauty and charm of their native shores. It needed the grim reality of the former, and the aching sense of void created by enforced and prolonged absence from the latter, to bring home the unadulterated meaning of each in its true perspective, as may be seen from that poignant little plaint, pencilled from the hell of a front-line trench:—

"The wind comes off the sea, and oh! the air,
I never knew till now that life in old days was so fair,
But now I know it in this filthy rat-infested ditch,
When every shell must kill or spare, and God alone knows which."

Very similar, too, is the strain reflected by the French "poilu," who, drafted out to distant Macedonia, and languishing 'midst the fever-stricken haunts of the mosquito, plagued everlastingly besides by sickening swarms of flies, suddenly exclaims,—"*Où est notre France? la chère France, qu'on ne savait pas tant belle et si bonne avant de l'avoir quittée?*" From fighting men at the front and from them alone could realistic portrayals of pent-up emotions such as these emanate; they alone were capable of expounding the naked definition of the word "War;" the people at home "do not understand it."

Whether it was by good luck or by good management that "this sweet land of liberty" of ours, England, remained unmolested, immune from the horrors that were being perpetrated just across the narrow dividing line afforded by the waters, within sound of the guns, within range of modern projectile, must be left to the realm of conjecture; although some idea of "the dangers we had to run" may very well be obtained by a perusal of a few of the several and extremely cogent observations which no less an authority than Admiral Viscount Jellicoe has to make on the subject in his notable work "The Grand Fleet, 1914-16."

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In comparing the relative strength of Great Britain and Germany he insists that "the lesson of vital importance to be drawn" is that "if this country in the future decides to rely for safety against raids or invasion on the Fleet alone, it is essential that we should possess a considerably greater margin of superiority over a possible enemy *in all classes of vessels* than we did in August, 1914," and one of the four cardinal points which he cites as being the *raison d'être* of the Navy is that of preventing "invasion of this country and its overseas dominions." Conditions had, moreover, undergone such a complete change since the Napoleonic era, that whereas one hundred years ago "stress of bad weather was the only obstacle to closely watching enemy ports, now the submarine destroyer and the mine render such dispositions impossible," with the result that "throughout the war the responsibility of the Fleet for the prevention of raids or invasion was a factor which had considerable influence on naval strategy." Thus although, as we learn, certain defined patrol areas in the North Sea were watched on a regular organised plan by our cruiser squadrons, it was not a difficult matter for enemy ships to slip through. For "the North Sea, though small in contrast with the Atlantic, is a big water area of 120,000 square miles in extent," and whilst the Fleet was based at Scapa Flow it was not only impossible to intercept ships, but equally impossible "to ensure that the enemy would be brought to action after such an operation" as that of a raid.

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ARMOURED TRAIN.

[To face p. 45.]

Bearing these considerations in mind, it is not altogether surprising that the military authorities awoke to the fact that the policy of having two strings to one's bow is not usually a bad one; and so, rather than "rely for safety against raids or invasion on the Fleet alone," they bethought themselves of the secondary line of defence which would readily be afforded by armoured trains.

Any serious attempt at landing by the enemy was, in Viscount Jellicoe's opinion, "not very likely in the earliest days of the war, the nights were comparatively short, and the Expeditionary Force had not left the country. It was also probable," so he thought, "that the enemy had few troops to spare for the purpose." But in proportion as "we denuded the country of men, and the conditions in other respects became more favourable," so did the anxiety of the home authorities increase, resulting in an urgent order being received at Crewe in October, 1914, for the first of the armoured trains. Even when so undoubted an authority as Mr. Lloyd George affirms (cp. the *Times*, July 1st, 1915) that "those who think politicians are moved by sordid pecuniary considerations know nothing either of politics or politicians," some people there may be who require a grain of salt wherewith to swallow so glib a declaration. Statesmen, possibly yes; but politicians—well, the least said is often the soonest mended. But even our belief in the sincerity of statesmen is apt to be a little shaken when we find a former Prime Minister, none other than the revered Mr. Balfour, devoting himself to the A.B.C. of the Little Navyites and solemnly declaring in the House of Commons (cp. the *Times*, May 11th, 1905) that the "serious invasion of these islands is not an eventuality which we need seriously consider." One has only to contrast this expression of a complacent and false sense of security with the dogma which has ever imbued the soul of the insatiable Hun:—"The condition of peaceableness is strength, and the old saying still holds good that the weak will be the prey of the strong" (Dr. von Bethmann-Hollweg in the

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Reichstag, March 30th, 1911), and we can never feel too grateful for the knowledge that in spite of politicians and statesmen, the problem of home defence was never relegated to the dust-bin by those whose obvious duty it is to preserve our shores inviolate. As evincing the serious amount of attention devoted to the subject, a perusal within the library of the Royal United Service Institution of a paper read by—then 2nd-Lieutenant, now—Major-General Sir E. P. C. Girouard, K.C.M.G., R.E., on "The Use of Railways for Coast and Harbour Defence" as long ago as 1891, and published in the journal of the Institution, is of exceptional interest, as the following few extracts reproduced through the courtesy of the Librarian of that Institution tend to show.

Speaking from the point of view of the "gunner-engineer," Sir Percy Girouard lays particular stress on the primary need for gun power. "Gun power to ward off the raider from our unprotected towns and ports; gun power to ward off any attack until the Navy reaches that point, and gun power to prevent landings upon our shores." Alluding next to the utter impossibility of extending "fixed fortifications of a modern type for the defence of every exposed point of our coast" for the obvious reason that "the cost of such an extension would be enormous," Sir Percy goes on to draw attention to the systems of railways in Great Britain and Ireland "which are the admiration of the world." These he contends "suggest the truest and most economical basis for resistance to any aggression or insult to our shores," for whereas "ships and fortifications under modern conditions rapidly become obsolete, our railways are always kept in excellent working order by the Companies concerned without any expense to the Government"; in fact "such would be the elasticity of the system that an enemy would have opposed to him at any exposed point of the coast the armament of a first-class fortress."

Obviously a lapse of nearly twenty years cannot fail to witness the introduction of new methods, novel ideas, and alterations in design, and, just as the practical experience gained or bought at the expense of a few weeks of actual warfare went to prove in August, 1914, the worthlessness of modern forts and fortresses which literally crumbled and crumpled under the weight of high-angle high explosives and were quickly superseded by trenches and dug-outs, so, too, it would appear that the engineer and gunner experts were led to rule out of court anything of so cumbersome a nature as would be represented by a "first-class fortress" on wheels, which, too heavy and unwieldy a mass to travel at anything but a snail's pace, could not but afford a first-class target to an approaching enemy warship. Armoured trains were, to some extent, employed during the war in South Africa, chiefly for purposes of reconnoitring, and it was from photographs of these trains which they had in their possession that the military authorities asked Mr. Cooke to evolve a train on similar, though improved, lines; a train one might say more akin to a mobile "pill-box" than a fortress, in that bristling with maxims and rifles it could be relied upon to move at least with the speed of an express goods train, and be capable of extending a "withering" welcome to any venturesome and aspiring raiding-parties at whatever point of the coast they might select as suitable for an attempt at landing.

Drawings were accordingly prepared, providing for a train which should consist of two gun vehicles, two infantry vans, and a "side-tank" locomotive; the latter a 0-6-2 type engine, with 18 inches by 26 inches inside cylinders, and 5 feet 8 inches diameter coupled wheels, supplied by the Great Northern Railway Company, was placed in the middle of the train. Both gun-vehicles and infantry vans were carried on ordinary 30-ton wagons with steel underframes and 4-wheel bogies. On each gun-vehicle at each end of the train was mounted a 12-pounder quick-firing gun (having an approximate range of 3 miles) which was fixed midway between the bogie wheels, thus ensuring an equal distribution of weight on each axle.

Apart from the gun platform, which was protected by 1/2-inch steel plate (rolled in the mills at Crewe) with loopholes for maxim gun and rifle fire, the vehicle had two further partitions, one an ammunition store, the other fitted up as officers' quarters.

The infantry vans were nothing less than luxuriously appointed caravans on (flanged) wheels, fitted with folding tables, lockers, hammocks, rifle racks, cooking stove and culinary apparatus complete, equipped with acetylene lighting and an extensive telephone installation. Loopholed with sliding doors near the top, these vans were also protected by 1/2-inch steel plating.

Beneath the frames were four reserve water tanks, each of 200 gallons capacity, feeding to the engine side-tanks, and in one of the two infantry vans were two coal bunkers, holding each 1 ton of reserve coal supply for the engine.

Access from one end of the train to the other was obtained by the provision of a suitable platform alongside the engine, but protected by armour plates, and by similarly protected connecting platforms from one vehicle to another.

Formidable "fellows" as they were, cleverly camouflaged too with grotesque daubs and streaks of dubiously tinted paint, these armoured trains, although continually on the *qui vive* within easy reach of the East Coast, were fated to be denied all opportunity of showing their mettle, and of giving the wily Hun "what for," for the very reason that the Hun was seemingly too wily ever to risk exposing himself to the sting likely to be forthcoming from such veritable hornets' nests.

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CHAPTER III

MECHANICAL MISCELLANEA

"I am more than grateful to you and your fellow-locomotive superintendents of the various railway companies for your readiness to help us in this time of pressure."

In these brief but none the less straightforward and sincere terms, did the late Sir F. Donaldson, then superintendent of Woolwich Arsenal, address himself to Mr. Cooke in the early part of November, 1914, terms expressive, not merely of his own personal feelings of gratitude, but also of Government appreciation of the assistance so spontaneously proffered by the chief mechanical engineers of the great railway concerns of the country.

Looking back over the four and a half years during which was fought out that "stupendous and incessant struggle," not without reason perhaps described as "a single continuous campaign," Sir Douglas Haig, in his final Despatch, under date of March 21st, 1919, whilst reminding us that we were at the outset "unprepared for war, or at any rate for a war of such magnitude," lays especial stress on the fact that "we were deficient both in trained men and military material, and, what was more important, had no machinery ready by which either men or material could be produced in anything approaching the requisite quantities." In short, "the margin by which the German onrush in 1914 was stemmed was so narrow, and the subsequent struggle so severe that the word 'miraculous' is hardly too strong a term to describe the recovery and ultimate victory of the Allies."

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There can be no gainsaying the fact that in spite of frequent and bombastic assurances to the contrary emanating from the All-Highest, the Almighty must indeed have been on our side, for surely never in the history of mankind did a people "ask for trouble" in quite the same barefaced manner as did the great British people in the early part of the twentieth century of grace?

"Give peace in our time," might well be the prayer purred by the devout lips, year in year out, of innumerable comfortably-respectable, smug, and faithful citizens on each succeeding Sabbath day. Obviously, for there was "none other that fighteth for us but only Thou." There was never any attempt at denial; we were unprepared and well-nigh negligible, "deficient in trained men and military material." It will be argued, no doubt, that the practice of offering up prayer and supplication is a very desirable and eminently estimable form of procedure, but it is nevertheless a generally accepted theory that the Almighty helps those only who help themselves. Miracles do not perform themselves in these matter-of-fact work-a-day times, and we may pause to reflect both upon the cost at which, and the means by which, the miracle of our timely recovery and ultimate victory was performed.

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"To our general unpreparedness," writes Sir Douglas Haig, "must be attributed the loss of many thousands of brave men whose sacrifice we deeply deplore, while we regard their splendid gallantry and self-devotion with unstinted admiration and gratitude."

This then was the cost, "the loss of many thousands of brave men," this the price in blood, the sacrifice upon the altar of unpreparedness. "Can the lesson," despairingly asks the writer of a leading article in the *Times* of April 11, 1919, "of this great soldier's remarks be missed by the most reckless of politicians, or the most fanatical of 'pacifists'?" Can it be missed either, it may be asked, by those congregations of the faithful, who, repeating as of yore the old, old cry "Give peace," resemble rather the ostrich that buries its head in the sand, making no active endeavour to combat the approaching storm?

Incredible that the lesson should be missed by any, and having marked the undying tribute which Sir Douglas Haig has paid to those thousands of brave men who for us paid the price, we may turn to that other tribute which this same great soldier unhesitatingly pays to those who supplied the means by which, miraculously enough, recovery was assured, and ultimate victory achieved.

"The Army owes a great debt to science and to the distinguished scientific men who placed their learning and their skill at the disposal of their country." Such is the praise bestowed upon the distinguished heads of industry and of science as representing the vast mass of workers at the back, the backbone of the country, and undoubtedly, as the great Field-Marshal goes on to explain, "a remarkable feature of the present war has been the number and variety of mechanical contrivances to which it has given birth, or has brought to a higher state of perfection." But perhaps the most remarkable of all these remarkable features was that particular one evinced by that particular body of distinguished scientific men, to wit, the chief mechanical engineers of the great railway companies, in that, by their ingenuity and versatile ability, they succeeded in producing not the quantities only, but the varieties also, of all those mechanical contrivances which, as we know, added to the horrors of, as well as to the interest in, modern warfare.

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But just as is the case with a railway engine, of which the whole forms so commonplace, if majestic, a feature of everyday affairs that seldom, if ever, does one pause to consider the mass of detail and intricate parts which go to compose it, so, too, is it the case with a gun, an aeroplane, a ship, a road motor vehicle, or whatever other equally familiar object that chances to catch the eye. Little does one realise the extent of the detail requisite for the framing of each and every such mechanical contrivance in its entirety. It was, nevertheless, "the dauntless spirit of the people at home," as Sir Douglas Haig openly avows, which "strengthened and sustained the invincible spirit of the Army, the while their incessant toil on land and sea, in the mine, factory, and shipyard, placed in our hands the means with which to fight." Nowhere was this "dauntless spirit," the record of this "incessant toil," better exemplified than by the staff and employes of the London and North-Western Railway Company's Locomotive Works at Crewe, that great "factory"

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in which were manufactured those countless component parts essential to the whole: and without which the gun could not be fired, the aeroplane could not soar, the ship could not swim: without which, in short, the miracle of our recovery and ultimate victory could not have been performed.

Let us take first the question of gun power; and we cannot do better than digest the further comments of Sir Douglas Haig. He says:—"The growth of our artillery was even more remarkable (than other remarkable developments alluded to in his Despatch), its numbers and power increasing out of all proportion to the experience of previous wars. The 476 pieces of artillery with which we took the field in August, 1914, were represented at the date of the Armistice by 6437 guns and howitzers of all natures." In order to stimulate this remarkable growth of artillery Crewe concentrated her endeavours upon 8-inch, 4.5-inch, and 6-inch howitzer guns; upon 12-pounder quick-firing guns, and in due course upon high-angle anti-aircraft guns. In conjunction with the guns themselves gun-carriages, carriage-limbers, wagon-limbers, ammunition-bodies—all were required with feverish haste. "Kultur," as has been pithily observed, "was working overtime to crush Civilisation;" Crewe Works responded by working twenty-four hours out of the twenty-four to beat the Hun; the spirit was indeed "dauntless," the toil "incessant."

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And what, it may be asked, were the countless component parts essential, not only to the manufacture of these "attributes of war's glorious art" when entirely new, but which were further turned out in their tens, twenties, fifties, hundreds, nay, even in their thousands, as "pièces de rechange," spares, all made to standard sizes and gauges, ready to replace at a moment's notice existing parts worn out or damaged in the field? Here, in motley assembly, are just a few: arcs, axles, bands, bearings, chains, collars, connectors, crank-levers, eyes, forks, futchels, guards, gussets, handles, hooks, keys, levers, loops, plates, rings, rods, sockets, springs, stays, trails, trunnions, tumblers, with a vast array of variously assorted bolts, nuts, pins, screws, studs and washers, one and all claiming the combined skill and energy of an army of smiths, forgemen, boiler-makers, fitters, turners, and machinists.

Yet in spite of the "incessant toil" requisite for the supply of this military material, such was the extent of our unpreparedness that "it was not until the summer of 1916," as we read in Sir Douglas Haig's Despatch, "that the artillery situation (as regards material) became even approximately adequate to the conduct of major operations.... During the battles of 1917 ... the gun situation was a source of constant anxiety. Only in 1918 was it possible to conduct artillery operations independently of any limiting consideration other than that of transport."

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Once, however, the material was assured in sufficient quantity there was never any looking back, and "from the commencement of our offensive in August, 1918, to the conclusion of the Armistice, some 700,000 tons of artillery ammunition (equal to the weight approximately of 6,000 heavy express passenger engines) were expended by the British Armies on the Western Front," this prodigious expenditure of metal fully amplifying the opinion expressed by Napoleon, that "it is with artillery that one makes war."

Before finally laying aside the question of guns, and turning our attention elsewhere, a few reflections on that popular little weapon known as the high-angle anti-aircraft gun may be not altogether lacking in interest, more especially in view of the fact that the price of our unpreparedness in this as in other respects was destined to be counted in the number of lives sacrificed, of which the civilian proportion was invariably very high.

The gentle art of dropping bombs upon open towns was commenced by German airmen in the very early days of the war, and the French capital, perhaps not unnaturally, soon became an object of their attentions.

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Under the heading "German aeroplanes over Paris," the *Times'* correspondent writing from Paris on September 2nd, 1914, records, perhaps, the first air-raid of the war, although at the moment "no bomb is reported to have been dropped." How irrepressible is the innate and inimitable *gaité* of Parisien and Parisienne alike, even during the excruciating uncertainty of a raid, is delightfully brought out in the remark so typically French, "Comme il est dangereux de sortir sans parapluie." In this connection, too, one recalls the little ruse, pre-arranged between host and butler, for speeding the departure of guests, inclined to outstay their after-dinner welcome: "Messieurs, mesdames," announces the butler, suddenly appearing at the salon door, "on vient de signaler les Zeppelins."

In comparison with our own, the measures adopted by the French authorities for defence against enemy aircraft were, from the outset, on a considerable scale; in fact, prior to the time when Admiral Sir Percy Scott took over the defence of London, in September, 1915, there had been, to all intents and purposes, no defence at all; any impartial observer might even have inferred that we were doing our best to live up to the lofty notions of the writer in the *Manchester Guardian* of August 19th, 1915, who laconically decreed that we had "it in our power to turn every air-raid into a failure, simply by taking as little notice of it as possible." Whether this superior personage remained for the duration of the war so providentially privileged as to be able to take no notice of the air-raids that took place, history does not narrate. Suffice it to say that if we select at random two typical instances from the many which occurred—one on May 25th, 1917, at Folkestone, when 76 persons were killed and 174 were injured; the other on June 13th, 1917, in London, resulting in 157 deaths and 432 persons injured, without mentioning the amount of material damage effected—it is open to argument whether the public in general, and particularly those who were personally and in so tragic a fashion affected, were capable, even if they felt so disposed, of taking little or no notice of these attacks; it is also a moot point whether they or the perpetrators of these outrages regarded this particular form of "frightfulness" in the light of a failure, when attended by such undeniably telling results.

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Happily the boot was not always on the same foot, for, as we know, the marauders on occasion paid the supreme penalty themselves in the course of their aerial outings, and this, thanks in great measure to the determined energy of the gallant admiral, to wit Sir Percy Scott, who, far from taking no notice of air-raids, lost no time in organising a vigorous system of defence against

them.

But as he tells us in his reminiscences, "Fifty Years in the Royal Navy," from the very outset of his endeavours he was hopelessly handicapped; for, whereas "General Gallieni, who was in charge of the defence of Paris, had for the protection of his forty-nine square miles of city two hundred and fifteen guns, and was gradually increasing this number to three hundred; whereas, too, he had plenty of men trained in night flying, and well-lighted aerodromes, he (Sir Percy Scott) had eight guns to defend our seven hundred square miles of the metropolitan area, no trained airmen, and no lighted-up aerodromes."

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The amazing part of the whole business was, as Sir Percy Scott explains, and not without a touch of humour, the "War Office was as certain that a Zeppelin could not come to London as the Admiralty was that a submarine could not sink a ship"; hence the corollary that "London's defence was a kind of 'extra turn.'"

Nothing daunted, however, and fully determined that London should be made to wake up to the dangers she was running, he succeeded in spite of all difficulties, and after procuring suitable ammunition, in increasing the number of his guns from the initial eight to one hundred and twelve.

Herein it was that the locomotive shops at Crewe were once again called into requisition, for, as Sir Percy Scott tells us, "unfortunately mountings had to be made for these (guns)," mountings such as base rings, pedestals, pedestal pivots, as well as elevating arcs, sighting arms, etc., the manufacture of which necessarily "took a considerable time," but which were successfully evolved with a minimum of delay at Crewe.

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Then again, "the few guns we had for the defence of London were mounted permanently in positions probably as well known to the Germans as to ourselves. We had no efficient guns mounted on mobile carriages which could be moved about and brought into action where necessary."

Being anxious to secure from the French authorities the loan, as a model, of one of their 75-millimetre guns, which as he knew were mounted on motor lorries, and in order to circumvent "Admiralty red-tape methods," Sir Percy Scott promptly took the law into his own hands, and very quickly obtained what he wanted. Owing, however, to the impracticability of adapting the British 3-inch gun to the French lorry mounting, a new design was got out, the gun platform being mounted on a single pair of wheels, which, with the axle, was detachable when the gun came into action, and of which component parts, such as plates, pivots, blocks, covers, catches, limber connections, were forthcoming from Crewe.

Thanks once again to the courtesy of General Gallieni, who agreed to supply "thirty-four of the famous French 75-millimetre guns and twenty thousand shells with fuses complete," Sir Percy Scott finally had at his disposal a total of one hundred and fifty-two guns, which, although admittedly "rather a mixed lot," combined to frustrate the designs of those "airy devils" which so frequently were wont to—

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"hover in the sky and pour down mischief."

As time went on, however, and when, notwithstanding the constant alertness of our gunners and the shoals of "archies" spat heavenwards in search of these enemy marauders, the persistency of the latter showed little if any sign of abatement, the idea of retaliation, or the practice of paying the enemy back in his own coin, was mooted as likely to prove the most effective method of clipping his wings, and in spite of protests from that misguided section of the community, aptly designated the "don't-hurt-poor-Germany-brigade," the clamour for retaliation, emanating from an already-too-long-suffering public became so insistent that orders were at length placed for a supply of that special form of "mischief," or medicine, known as aerial bombs, in the manufacture of which, both petrol-incendiary and high-explosive, Crewe Works was requested to assist, and which our gallant airmen were commissioned to "pour down" on fortified positions on the further side of the Hindenburg Line.

How efficacious were deemed to be the ingredients of this medicine may be gathered from the fact that in the autumn of 1917 the chief mechanical engineers of the great railway companies assembled in conclave at the request of the Air Board, and expressed their willingness to co-operate in the manufacture of aeroplanes of the bombing order. Owing, however, to the special conditions applying to the aeroplane industry, and to the fact that those responsible for the administration of our Air-policy decided, after mature consideration, that the scope for producing these machines was actually sufficient for dealing with every emergency, this additional strain was not imposed on the already heavily taxed capacity of the various locomotive workshops after all. Crewe, nevertheless, was not to be gainsaid the privilege of undertaking at least some share in the production of our heavier-than-air machines, and in the tinsmiths' and fitting shops respectively were turned out hundreds of tiny metal pressings or discs, and knuckle joints, essential for the piecing together of the wood fuselage, and on the quality of which depended so largely the lives of our pilots, to whose intrepid instinct undoubtedly "one crowded hour of glorious life" seemed at all times "worth an age without a name," but who nevertheless had no particular wish to come to grief owing to faulty material. The airman in common with the traveller—

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"Cheerful at morn, wakes from short repose,
Breasts the keen air, and carols as he goes;"

but unlike the latter, who moves in comparative safety on terra firma, the former, throughout the length of his flying hours, literally carried his life in his hands, illustrative of which fact may be taken those vivid and realistic sketches penned by Major W. B. Bishop, V.C., who, in his little

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volume "Winged Warfare," jots down a few impressions of his own breathless experiences. "In the air," for instance, he says, "one did not altogether feel the human side of it. It was not like killing a man so much as just bringing down a bird;" and yet in diving after an enemy machine, "I had forgotten caution and everything else in my wild and overwhelming desire to destroy this thing that for the time being represented all Germany to me." Undeniably the heart of an airman must be "a free and a fetterless thing" to brave the combination of risks incidental to his magnetic calling, and Sir Douglas Haig has not omitted to refer in brief but glowing terms to the "splendid traditions of the British Air Service," the "development of which is a matter of general knowledge," and the combining of whose "operations with those of other arms ... has been the subject of constant study and experiment, giving results of the very highest value." In every direction "much thought had to be bestowed upon determining how new devices could be combined in the best manner with the machinery already working," and in laying stress upon this question of "effective co-operation of the different arms and services," he alludes, for instance, to "increase in the power and range of artillery," which "made the maintenance of communications constantly more difficult." It was in order to assist in the maintenance of a highly efficient system of communications that Crewe was asked to supply quantities of cart cable-drums, the several parts of which required forging, machining, and accurately fitting, and by means of which, when completed as a whole, wires could be run out at a speed of 100 yards per minute; in fact, as Sir Douglas Haig points out, "something of the extent of the constructional work required, in particular to meet the constant changes of the battle-line and the movement of head-quarters, can be gathered from the fact that as many as 6500 miles of cable-wire have been issued in a single week. The average weekly issue of such cable for the whole of 1918 was approximately 3300 miles."

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Summing up his observations on mechanical contrivances in general, Sir Douglas Haig urges that "immense as the influence of these may be, they cannot by themselves decide a campaign. Their true rôle is that of assisting the infantryman, which they have done in a most admirable manner. They cannot replace him. Only by the rifle and bayonet of the infantryman can the decisive victory be won."

But surely the rifle itself, it may pardonably be contended, is nothing if not a mechanical contrivance? Granted always that without the pressure of the infantryman's finger on the trigger, the thrust of his arm behind the bayonet, the rifle is incapable of deciding a campaign, equally self-evident is the fact that the infantryman is helpless to win the decisive victory without the aid of the rifle.

Side by side, too, with the rifle, and yet another mechanical contrivance to receive "a mention," is the machine-gun, of which the "immense influence" as an adjunct indispensable to the infantryman may be gauged from the statement that "from a proportion of one gun to approximately 500 infantrymen in 1914, our establishment of machine guns and Lewis guns had risen at the end of 1918 to one machine gun or Lewis gun to approximately 20 infantrymen." It was in order to bring about this enormous increase in the number of machine guns, that millwrights were sent from Crewe in the summer of 1915 at the urgent request of Mr. Lloyd George (then Minister of Munitions) to install in some newly erected works in Birmingham the machinery necessary for their manufacture. Crewe may therefore be permitted to claim a certain degree of credit for the final issue; for, in addition to furthering the output of Lewis guns which, as we know, assisted the infantryman in so admirable a manner, she was also responsible for the various extremely delicate gauges necessary for the manufacture of rifles, which in turn enabled the infantryman to win the decisive victory.

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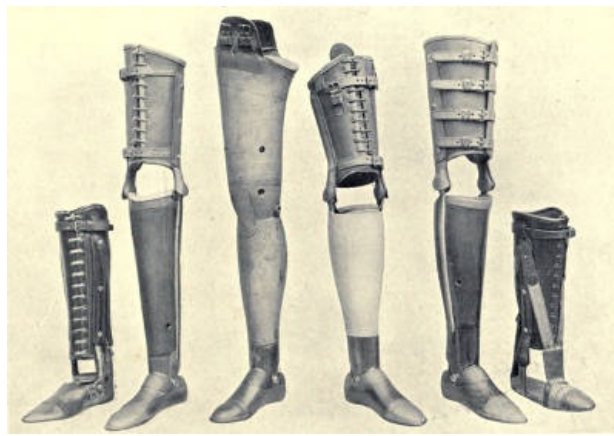
Invaluable as mechanical contrivances have been in giving "a greater driving power to war," their sinister aspect cannot in any way be veiled; for, as has been only too apparent, "the greater strength of modern field defences, and the power and precision of modern weapons, the multiplication of machine guns, trench-mortars, and artillery of all natures, the employment of gas, and the rapid development of the aeroplane as a formidable agent of destruction against both men and material, all combined to increase the price to be paid for victory."

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Sir Douglas Haig estimates the total number of British casualties "in all theatres of war, killed, wounded, missing and prisoners, including native troops, as being approximately three millions (3,076,388)."

The killed, as Napoleon has said, "are the only loss that can never be replaced." The missing—one invariably shudders when considering what may have been their fate. Significant, for instance, is the reproduction of a letter from an enemy officer who writes—(cp. the *Times*, April 11th, 1917)—"I have been entrusted with a task of which every good German should be proud. Eight days ago we left France with 400 British.... On arriving at Frankfurt we discovered that we had lost on the journey 380." As to the lot of those who, taken prisoner, were nevertheless permitted to exist, we have only to refer for enlightenment to the report of the Government Committee on Wittenberg Camp, dated April 6th, 1916. Two extracts only may be allowed to suffice. "The state of the prisoners beggars description. Major Priestley (one survivor of six sent to replace the German medical staff who abandoned the camp on the outbreak of typhus) found them gaunt, of a peculiar grey pallor, and verminous. Their condition, in his own words, was deplorable." Ultimately the Committee were "forced to the conclusion that the terrible sufferings and privations of the afflicted prisoners during the period under review are directly chargeable to the deliberate cruelty and neglect of the German officials."

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VARIOUS TYPES OF ARTIFICIAL LIMBS.

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Of the wounded, those who merit the largest share of commiseration are undoubtedly the blind. But whatever the nature of the misfortune of those afflicted, "in spite of the large numbers dealt with, there has been," as Sir Douglas Haig reminds us, "no war in which the resources of science have been utilised so generously and successfully for the prevention of disease, or for the quick evacuation and careful tending of the sick and wounded."

The experience acquired, over a period of 35 years in the joiners' shop at Crewe Works, in the manufacture of artificial limbs, for the use of the Company's own employes crippled as a result of accidents sustained in the performance of their duties, was destined to become a national asset of inestimable value during the war; models of the most approved design being demonstrated to the War Office authorities, and subsequently adopted for the use and benefit of men crippled in the service of their country.

In the years preceding the war, while the common enemy was busily engaged in sharpening the sword and toasting *Der Tag*, amongst the few so-called cranks who, even as voices crying in the wilderness, ventured to dispartiate upon self-defence, defence of country, invasion, and other similar bogies in the cupboard, one may recall the theory of "one of the most distinguished of that younger school of sea-officers who kept urging in and out of season that we must get out of the idea that naval defence is one thing and army defence another; for when war comes, success will depend upon their perfect co-ordination and co-operation."

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If in only a minor degree—for those who go down to the sea in ships are necessarily many in number, and the business which they do in great waters is of an extremely varied nature—Crewe was nevertheless called upon to put this theory into practice in the land and sea war that burst upon us in 1914; and one of the mechanical contrivances which was destined to play an inordinately important part in securing this "perfect co-ordination and co-operation" as between the land and sea forces of the country, and for various essential component parts of which Crewe became responsible, was the "Paravane;" and the paravane, being by nature something entirely novel, was *ipso facto* one of those devices which had to fight the War Office, or the Admiralty, as the case might be, before it got a chance of fighting the enemy.

Primarily devised for the purpose of subverting the submarine peril, the paravane (the invention of Acting-Commander Burney) was later adapted for the protection of vessels against mines. An extremely interesting and lucid account of this mechanical contrivance, from the pen of Mr. R. F. McKay, is to be found in *Engineering*, under date of September 19th, 1919.

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THE PROTECTOR, OR MINE-SWEEPING, PARAVANE.

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Mr. McKay tells us that there were various types of paravanes, known respectively as the

explosive, the protector, and the mine-sweeping paravane.

Briefly, the device was a torpedo-shaped body, which, towed by a suitable cable either from the bows or stern of a ship, maintained its equilibrium in the water by means of a large steel plane near its head, and horizontal and vertical fins near its tail, the thrust of the water on the plane when the vessel is in motion carrying the paravane away from the fore and aft centre line of the vessel. Depth mechanism was fitted in the tail of the paravane, and consisted of a horizontal rudder actuated by a hydrostatic valve, *i.e.* a valve which is operated by difference in water pressure due to any change in depth. The explosive paravane was towed from the stern, and the charge of T.N.T. which it contained could be detonated either by impact, or by an excessive load coming on to the cable, or by a current of electricity controlled from the ship.

The protector or mine-sweeping paravanes were similar contrivances in that they were towed, and maintained their position in the water by similar means. They were, however, towed from the bows of the ship, and instead of carrying an explosive charge, they were fitted with a bracket resembling a pair of jaws, in which were fixed two saw-edged steel blades; and it was in the manufacture of these brackets, which were forged under the drop-hammer, that Crewe was engaged.

"Two paravanes," as Mr. McKay explains, "are towed, one on either side of the vessel, ... and the action of the protector-gear is simple. The paravane towing-wires foul the mooring-wire of any mine which might strike the vessel, but misses any mine which is too deeply anchored. The speed of the vessel causes the mine and its sinker to be deflected down the 'wedge' and away from the vessel until the mine mooring-wire reaches the paravane," which wire "passing into the cutter-jaws is speedily severed; the sinker drops to the bottom of the sea, whilst the mine floats to the surface well clear of the ship, where it can be seen and destroyed by rifle fire."

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The jerky sawing action of the mine mooring-cable, on reaching the jaws of the paravane, was, perforce, extremely detrimental to the teeth of the cutter-blades; consequently it was invariably the practice to haul the paravane aboard the ship and examine the blades immediately after a mine had been trapped and destroyed. The peril of pottering about, unprotected, in a mine-field must be patent to all, particularly to those who happen to be doing the pottering; hence it was absolutely essential that brackets and blades should be so accurately machined and fitted that the latter, on being removed, could be replaced in an instant by "spares" and the paravane dropped straight back into the sea.

Speaking in the House of Commons (cp. the *Times*, March 21st, 1918), Sir Eric Geddes, then First Lord of the Admiralty, said that for the twelve months of unrestricted warfare from February 1st, 1917, to January 31st, 1918, the actual figures of vessels sunk by submarine action, including those damaged and ultimately abandoned, amounted to roughly six million tons; that the (then) total world's shipping tonnage (exclusive of enemy ships) was forty-two millions; and that the percentage of net loss to British tonnage was 20 per cent.

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Mr. McKay, too, in his article previously quoted, gives some interesting figures which tend to recall the gloomy days of rationing cards, and help us to realise how deeply we are indebted to Commander Burney and his paravanes for assuring us to the bitter end our daily, if slightly curtailed, means of subsistence. "It is computed," writes Mr. McKay, "that the total loss in shipping due to submarine warfare is about £1,000,000,000. Hence, working on the certainties, each submarine destroyed was responsible for about £5,000,000 worth of damage. Accepting this figure as a basis, it may be said that the explosive paravanes saved further damage being inflicted on our shipping to the extent of about £25,000,000." Reverting next to the protector paravane, "there were," we are told, "about 180 British warships fitted with the installation. Assuming that the value of warship tonnage is placed at the very low average figure of £100 per ton, the value of the ships saved was above £50,000,000;" and a further point which cannot be ignored is that undoubtedly "the moral effect of the loss of these vessels would have been stupendous."

Again, in regard to merchant ships, "if the ratio

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$$\frac{\text{mines cut}}{\text{ships fitted}}$$

for these were only one quarter the ratio for warships, the saving to the nation would be about £100,000,000 sterling's worth of merchant ships and cargoes." Finally, "from all the records available, the Allied countries are indebted to the paravane invention for saving ships and cargoes to the value of approximately £200,000,000. In addition, the number of lives saved must be a very large figure."

Few and far between are the prophets who have any honour in their own country, and Admiral Sir Percy Scott proved no exception to the rule when, prior to the war (cp. the *Times*, June 5th, 1914), he wrote that "the introduction of vessels that swim under the water has, in my opinion, entirely done away with the utility of the ships that swim on the top of the water."

So comprehensive a contention was bound to come as something in the nature of a shock to those who were accustomed to regard the Royal Navy of England as "its greatest defence and ornament; its ancient and natural strength; the floating bulwark of our island," and certainly the attribute "entirely" must be considered as being of rather too sweeping a nature, for, serious though the submarine menace became during the world-war, the under-sea boat cannot claim to have swept the face of the waters of anything approaching the total number of ships that swam on the top. There is no doubt, however, but that, not only from the German point of view, but from our own as well, the submarine became an adjunct of the very first importance, and herein, again, was the all-round practical ability of Crewe Works called upon to assist. Bearings for submarine propeller-shafts (commonly known as reaper-bearings) were urgently required, each shaft working in no fewer than sixteen bearings, of which the caps were to be made not only interchangeable, but reversible as well, so exacting were the demands in the Admiralty

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specification.

Indisputably Crewe was "doing her bit," and by their "dauntless spirit," by their "incessant toil," did the mass of employés engaged within the Works enable Mr. Cooke to convince the world at large that England, no longer "la Perfide Albion," was worthy rather to be named "la Loyale Angleterre."

CHAPTER IV

THE GRAZE-FUSE

"A world of startling possibilities."

DOLE.

Graze-fuses (so called from the fact that the very slightest touch or shock imparted to the fuse or foremost part of the shell by any intervening object, and against which the fuse grazes whilst in flight, is sufficient to cause the spark necessary for igniting the explosive charge) were first taken in hand at Crewe in March, 1915.

It was at this time that the late Earl Kitchener, then Minister of War, first drew attention in the House of Lords to the alarming position, generally, in regard to munitions of war, "I can only say (cp. the *Times*, March 15th, 1915) that the supply of war material at the present moment, and for the next two or three months, is causing me very serious anxiety." The persistent inconsistency of the "talking men" may here well be exemplified by the fact that in the following month of April, Mr. Asquith promptly retorted in the House of Commons that he had "seen a statement the other day that the operations, not only of our Army, but of our Allies, were being crippled or at any rate hampered, by our failure to provide the necessary ammunition. There is not a word of truth in that statement." However, as if to give an irrefutable *démenti* to this assertion, it was only a month later that there came the sensational *exposé* from the pen of the *Times* military correspondent at the front, who wrote to the effect that "the want of unlimited supply of high-explosive was a fatal bar to our success" in the offensive operations round Ypres. *Per contra* it was pointed out from the same source that "by dint of expenditure of 276 rounds of high explosive per gun in one day, the French levelled all the enemy defences to the ground."

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Hence it came about that, emanating from a modest little side-show claiming the energies of one or two apprentices and a few highly-skilled and highly-paid mechanics, the manufacture of graze-fuses developed into quite an industrial main-offensive (destined within the space of a few weeks from its inception to be entrusted to a bevy of local beauty, which became augmented as time went on in proportion as the seriousness of the military situation became apparent), pushed forward with a zeal and enthusiasm worthy of the highest praise, as the supply of shells and consequently of fuses fell hundreds per cent. short of the demand.

Trim in their neat attire of light twill cap and overall, with a not infrequent hint of black silk "open-work" veiled beneath, the ladies (God bless 'em), no sooner enlisted, lost no time in adapting themselves in a remarkable manner to the exigencies of their new surroundings. In some respects, certainly—

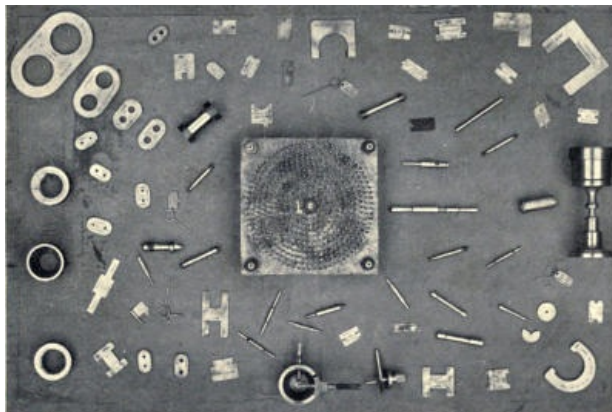
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"Women's rum cattle to deal with, the first man found that to his cost;
And I reckon it's just through a woman the last man on earth'll be lost,"

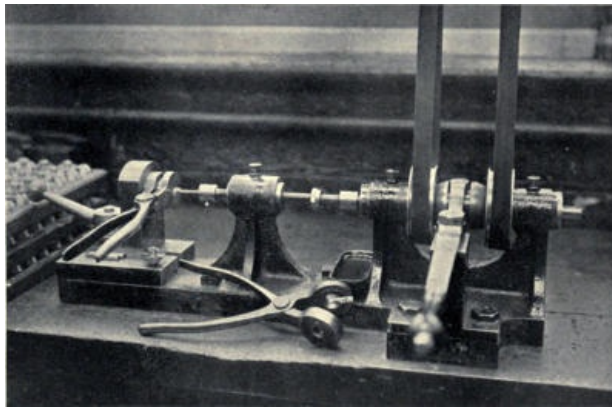
but however that may be, in respect at least of the manufacture of munitions of war the girls in Crewe Works showed themselves, not only amenable to reason and discipline, but became regular enthusiasts in the work on which they were engaged. Idling and indifference were qualities unknown, patience and perseverance became personified, and thanks to a highly efficient and praiseworthy organisation, coupled with a system of three consecutive eight-hour shifts, the output of fuses rapidly rose from a mere 150 per week to as many as 4000, or a steady weekly average of 3000, finally reaching a grand total of 250,000 on the cessation of hostilities.

A portion of the locomotive stores department, comprising an upper storey of the old works' fitting shop, familiarly known as the top shop—that one-time nursery of juvenile and maybe aspiring apprentices, many of whom have blossomed forth into full-blown engineers occupying positions of prominence in the four corners of the globe—was speedily transformed. Overhead shafting was fixed; lathes, drilling and tapping machines, and benches were lined up in positions convenient for the quick transition of the fuses, and their tiny components, passing in regular sequence through the many operations necessary for their fashioning.

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GAUGES MADE AT CREWE AND USED FOR THE MANUFACTURE OF GRAZE-FUSES.



REVERSIBLE MECHANICAL TAPPING MACHINE FOR FUSE CAPS. DESIGNED AT CREWE (cp. p. 81).

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The graze-fuse itself is an intricate and cleverly thought-out little piece of mechanism, demanding a degree of accuracy in machining such as one might reasonably have assumed would suffice to baffle even the most knowing and perspicacious little minds attributable to the fair sex. The requisite delicacy of touch may perhaps be exemplified by the fact that the pellet plug flash-hole must be drilled dead-true to a depth of almost an inch with a drill no bigger than .062, or 1/16 of an inch.

Mr. Lloyd George, when addressing the House of Commons in June, 1915, in his capacity of Minister of Munitions, held up a fuse for members to see. "This," he said, "is one of the greatest difficulties of all in the turning-out of shells. It is one of the most intricate and beautiful pieces of machinery—before it explodes, (laughter). It indeed is supposed to be simple, but it takes 100 different gauges to turn it out."

It was not, however, quite so much a question of the number of gauges required (considerable though the above-quoted figure may sound to those uninitiated in the art of fuse-making) as of the minuteness of the limits or tolerances allowed in the manufacture of these gauges.

Some reference to, or explanation of, gauge-making will be found on a later page, so that it may perhaps here be sufficient to remark *en passant* that whereas in the case of shell-body gauging, tolerances ran into fractions approximating 10/1000 parts of an inch, those of fuse-gauging were of an infinitely more exacting nature, being measured in fractions so minute as 3/1000 parts of an inch.

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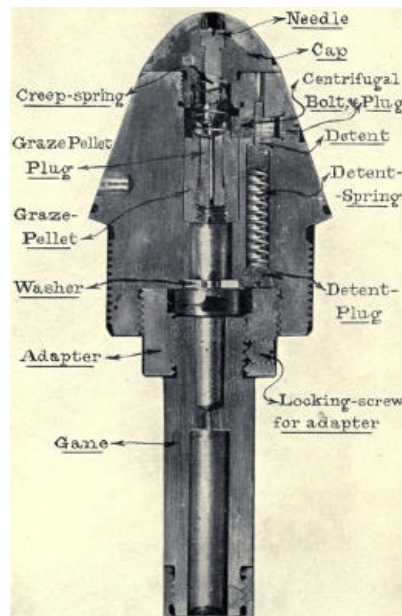
Since the ultimate success or failure of the entire shell depended to a very great extent on the combined and unfailing action, or lightning series of movements, of the tiny internal component parts of the fuse (action which was initiated by the motion of the shell itself), the *raison d'être* of dimensions measured in infinitesimal fractions of an inch becomes somewhat more apparent. The beauty of this little piece of mechanism is illustrated to some extent by the fact that it can be assembled or put together complete with its tiny internal components to the number of 10 or 12 all told, in less than a minute.

Cast in bars of brass, sections of the length required for each fuse body are cut off, and drop-forged, the probability of blow-holes being by this method eliminated as far as possible.

For the various machining operations, such as turning, boring and screwing, drilling, automatic and turret lathes played a prominent part, whilst an eminently suitable machine known as a "Sipp three-spindle drill" to which were fixed special jigs, designed for the purpose, was extensively used for the numerous small holes required.

Grooves were turned on a turret lathe round the taper-nose, these affording a grip for the fingers, when lifting the fuses out of the boxes in which they were supplied.

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THE GRAZE-FUSE, shewn in section.

Briefly, the mechanical action of the graze-fuse is regulated on the following lines: A central pellet which creates the igniting spark by striking the percussion needle, is held in position by a tiny plug, which in turn is secured by a ball-headed pin, called the detent, kept in place by a spring. On the gun being fired the sudden forward impetus of the shell causes the detent pin to exert a backward pressure of 8-1/2 lbs. on the spring, this being sufficient to enable the detent pin to withdraw itself from the plug controlling the ignition pellet.

The motion of the shell once launched in flight is rotary or centrifugal, with the result that the pellet-plug flies outward, leaving the pellet itself free to strike the percussion needle the moment the fuse-nose hits or grazes the first intervening object.

The fixing of the percussion needle securely in the fuse-cap was an erstwhile stumbling-block in not a few machine shops, it being no exaggeration to say that in numerous instances at least 50 per cent. of the fuse-caps were rejected owing to the needle not being sufficiently securely fixed in the seating.

At Crewe a simple method ensuring absolute rigidity was devised, the fuse-cap being so turned in the lathe that a slightly outstanding lip was formed, which after the needle had been inserted in the recess was spun or pressed, whilst revolving in a turret lathe, round the taper profile of the needle, the metal being in this way packed so closely and tightly all round that the protruding end of the needle, if subsequently gripped in a vice, would sooner break off than allow itself to be extracted or even disturbed in the slightest degree whatever within its metal bedding. "Solid as a rock" is the only description applicable.

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In spite of this, however, the Government either could not or would not insist on the universal adoption of so sound and simple a practice, preferring rather to standardise an entirely new method involving a more complicated and so more costly fitting, both as regards the needle itself and the fitting of it in the fuse-cap.

The cap was thenceforward drilled and tapped, and the needle which was a longer one than hitherto was screwed into the hole and joined with petman cement. Crewe, in compliance with Government specifications had perforce to toe the line, but very quickly rose to the occasion by devising an extremely neat and efficacious little tapping machine, belt driven, and reversible through the medium of a couple of hand-actuated friction clutches. The spindle of the machine ran through a guide-bush bolted to the bed of the lathe, and screwed to the pitch of the needle thread. The hole through the fuse-cap was by this means certain of being tapped to the correct pitch, without any risk of stripped or "drunken" threads ensuing. The tap itself was of a "floating" disposition; that is to say, it was held in a socket which permitted a slight amount of freedom in action, thereby ensuring perfect alignment with the fuse-cap hole.

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The final operation of lacquering (or varnishing with a mixture of shellac and alcohol which imparted a saffron or orange colour to the metal and acted as a preservative) was effected by mounting the fuse on a metal disc, which, acting in conjunction with a second disc and an intermediary ball-race, was kept spinning round by hand, the operator applying the varnish with a brush the while the fuse was kept spinning.

It was noticed at one time that a fairly large percentage of shells were "duds," that is to say they were failing to explode, and the reason for this was attributed to the supposition that on being released by the plug the pellet tended to creep towards the percussion needle, thenceforward remaining closely adjacent to it, with the result that it was no longer in a position to jerk forward and strike the needle with sufficient impetus to cause a spark. An additional spring called a "creep" spring was consequently inserted, of sufficient tension to prevent the pellet from creeping forward, and yet not strong enough to prevent the sudden contact of pellet and needle, on the shell reaching its objective. This overcame the difficulty.

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CHAPTER V

CARE OF THE CARTRIDGE CASE

"As long as war is regarded as wicked it will always have its fascinations. When it is looked upon as vulgar it will cease to attract."

WILDE.

All good sportsmen know what is a cartridge, whether for gun or rifle; they know too that the nice brightly-polished little disc on the end of it contains the percussion cap by means of which the shot or bullet, as the case may be, is fired. Beyond this they do not worry. They load their gun or rifle; if the former, they are naturally pleased supposing forthwith they wing their bird, a "right and left" raises themselves in their own estimation no end of a great deal; if the latter, and they succeed in laying low the quadruped object of their strenuous quest, a haunch of venison, maybe, is their reward, their trophy a particularly fine head, a "Royal" displaying no fewer than a dozen "points." In either event, the little cartridge once having served its purpose is in due course extracted from the breech and flung unceremoniously away to be trodden with scant courtesy underfoot, carelessly consigned to oblivion.

So too in war, or at any rate during the early phases of the Great War, when questions of expense and of economy were seldom, if ever, mooted, and when, during the great retreat and the subsequently feverish advance to the Aisne heights, transport was more or less improvisatory and problematical and every moment precious, ammunition cartridge cases (turned and finished to thousandth parts of an inch and beautifully polished), no sooner having served their immediate purpose, were hastily extracted from the smoking breech of the gun and inconsequently thrown aside.

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Distorted and not infrequently cracked or split, of what further use could they be? An occasional enthusiast would pick one up. At home, at least, it would be regarded as an authentic relic of the battle-field. Besides, any one with a spark of inventive genius could see quite a number of uses to which a cartridge case could be put; articles of domestic ornament and convenience could be evolved—anything, for instance, from a flower-vase to a lady's powder-pot.

Those were early days however, and few there were, whether at home or at the front, who realised the extent to which "the war could be protracted" or "if its fortunes should be varied or adverse" were able to grasp the import of the warning that "exertions and sacrifices beyond any which had been demanded would be required from the whole nation and empire" (Lord Kitchener, House of Lords, August 25th, 1914).

When, however, it became increasingly apparent that "the operations not only of our Army but of our Allies were being crippled or at any rate hampered by our failure to provide the necessary ammunition," and since the cartridge was one of those "particular components which were essential" to the firing of the shell, the edict in due course went forth to the effect that "all fired cases should be returned at the first opportunity," for the very reason that with comparatively little trouble and at a minimum of cost (especially when the railway companies began devoting their attention to the task) these cases could be repaired, and that not only once, but frequently as many as half a dozen times before they were finally rejected as being totally and permanently unfit for further military service, in fact dangerous.

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Cartridge cases varied, of course, in depth and diameter according to the type of shell, whether shrapnel or H.E., to which they were destined to be fitted, and to the type of gun, whether field gun or howitzer, within the breech of which they were to be fired. Thus the field gun with its long range and well-nigh flat trajectory (*i.e.* the curve described by the shell on its flight) required a heavier propellant charge with a high velocity than did the howitzer or high-angle gun, which throws a shell at a shorter range and with a high trajectory.

The "marks" of cartridge cases treated in Crewe Works were those appertaining to the 18-pounder gun and the 4.5 howitzer, and it so happened that just at the time of the formation of the Coalition Government in May, 1915, when, under the auspices of Mr. Lloyd George as Minister of Munitions, in the words of Sir J. French, "to organise the nation's industrial resources upon a stupendous scale was the only way if we were to continue with success the great struggle which lay before us," cartridge cases, bruised, and mud-bespattered, first commenced to make their appearance at Crewe. The earliest arrivals were the 18-pounder long or shrapnel shell cartridge cases, and the 30,000 odd of these cases which were repaired may be regarded as a foretaste of what was to follow, and were to some extent indicative of the then prevailing position in regard to the supply of ammunition to the B.E.F. in France. "As early as the 29th of October," writes Sir John French in his remarkable production entitled "1914," "the War Office were officially told that during the most desperate period of the first battle of Ypres, when the average daily expenditure of 18-pounder ammunition had amounted to 81 rounds per gun, and in some cases the enormous total of 300 rounds, the state of the ammunition supply had necessitated the issue of an order restricting expenditure to 20 rounds, and that a further restriction to 10 rounds would be necessary if the supply did not improve."

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Actually during the winter 1914-1915 the number of rounds per 18-pounder gun fell to less than five! Shrapnel (which it is interesting to remember was first used in the Peninsular War of 1808-14, and of which the older form of shell was filled merely with gunpowder as compared with the modern filling of bullets) was, however, "ineffective against the occupants of trenches, breastworks, and buildings," consequently guns required 50 per cent. of high-explosive shell "to destroy many forms of fortified localities that the enemy constructs, more particularly his machine-gun emplacements"; and in a secret memorandum despatched by Sir John French to the

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War Office in the spring of 1915 it was urged that "large quantities of high-explosive shells for field guns have become essential owing to the form of warfare in which the Army is engaged." Evidently the "Talking Men" at the back were beginning to feel a little uncomfortable, if nothing else, in face of the reports which the "Fighting Men" at the front were sending home with a firm persistence, for in spite of "the disinclination of the War Office prior to the war to take up seriously the question of high explosives" due to the assumption that their true nature and the correct particulars which govern their construction were not properly understood, as they (the War Office) "had too little experience of them," and perhaps because of the fact, for instance, that "the battle (of Neuve Chapelle) had to be broken off after three days' fighting because we were brought to a standstill through want of ammunition," occasional consignments of 18-pounder long cases at Crewe grew less and less until they finally ceased altogether, being thereafter superseded by the shorter cases of the 4.5-inch high-explosive shell, which, as time went on, were showered on the Works in ever-increasing quantities; in fact, a total of close on two million had been dealt with when the All-Highest finally "threw up the sponge" and accomplished his memorable "bunk" into Holland.

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To pick a cartridge case up and look at it, one would say that there was literally nothing in it; yet on second thoughts it is surprising what a number of features are embodied in its hollow and simple form.

It is solid drawn, of a substance the colour of brass called yellow metal, which is composed of 60 per cent. electrolytic copper and 40 per cent. zinc, and which costs actually £25 per ton less than brass. The base is integral and thick, with an external rim, behind which a clip automatically engages as the breech of the gun closes, for the purpose of extracting the case after the gun is fired. Into a hole in the centre of the base is screwed the percussion cap, which acts virtually in the capacity of a "sparking plug" to the gun, differing only from the familiar petrol-engine sparking plug, in that the spark which fires the propellant charge inside the cartridge case is created, not by the break of an electric current, but by the sudden shock or percussion of a striker against a cap in which is contained a thin, albeit highly explosive layer of fulminic acid and gunpowder.

The walls of the case are thin, thereby expanding against the walls of the breech of the gun, and preventing any escape of the propellant gases; and for the purpose of easy extraction they (the walls of the case) are slightly tapered to within about 1/2 inch of the mouth which fits parallel over the end of the shell.

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ROLLING OUT DENTS IN 4.5-INCH FIRED CARTRIDGE CASE.

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Upon receiving a returned, or fired, cartridge case in the Works, the primer is first of all removed, then the case is boiled in a solution of caustic soda for the purpose of removing grease and dirt. What is known as a "hardness" test follows next in order of sequence, this to determine whether the metal of the case is still good for further service, and is performed by a little instrument known as a sclerometer (derived, as our classical contemporaries will tell us, from the Greek word (σκληρός, hard), consisting of a tube marked with a graduated scale down which a tiny metal ball is dropped on to the side of the case; the ball should rebound to a point on the scale approximating a height of two inches, anything below this proving that the metal has become too soft for further use, when the case is accordingly scrapped. The cases which show a requisite degree of hardness are then annealed or suitably tempered round the mouth, this process ensuring a subsequent loose fit round the end of the shell.

Rolling the mouth to internal limit gauges is effected by means of a specially improvised apparatus rigged up on the bed of an engine lathe, consisting of two fixed housings inside which runs a belt-driven sleeve bored to the correct taper of the cartridge case, and in which the latter is carried. A duplex ball-bearing roller running on a central spindle secured in a pad fixed to a cross-slide, and operated transversely by a pedal, applies pressure against the walls of the cartridge case, the dents and bruises being thus gently removed and an even surface obtained.

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It should be borne in mind that the entire process of repairing these cartridge cases (with the

exception of brazing by coppersmiths with an acetylene flame any cracks or splits which already existed or became apparent in the repairing operations) was carried out by female labour working three eight-hour shifts, and one of the neatest of the diverse mechanical requisites which the girls were called upon to operate and which was the immediate outcome of managerial forethought and ingenuity was an adaptation of an hydraulic press for the purpose of correctly reforming the taper walls of the cartridge case to the true form of the gun chamber or breech. A cast-iron block with recesses cored in (in which are fitted a rocking lever pivoted in the centre, and two hardened cast-steel dies, one on either side) repose on rolling bearings arranged on the bed of the press.

At each end of the rocking lever is attached an adjustable ejector ram acting centrally inside the cast-steel dies, which latter are bored taper to the required shape of the cartridge case. Upon inserting a cartridge case in each die, the cast-iron block is pushed transversely by hand across the bed of the press, bringing one of the cases central with the ram, which, when applied, forces the case home into the die, thereby pressing and reforming the walls to their true and original shape. The ram being withdrawn, the cast-iron block is pulled back so that the second cartridge case in its turn comes central with the ram and the effect of pressing it home in its own particular die is to push back the pivoted arm, the other end of which, advancing automatically, expels the previous and finished case; cartridge cases being inserted and ejected in this manner *ad infinitum*.

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The cast-steel dies naturally become affected by constant use, more especially on the protruding shoulder against which the thickest part of the case (*viz.* where the walls rounded into the base) is pressed, this necessitating the shoulder being re-radiused perhaps every fortnight, and a slight readjustment of the die in the block.

To allow for expansion of the walls of the case when being ejected after compression, the dies are turned slightly smaller (say 3/1000 parts of an inch) than the required finished size.

After being pressed, the primer holes of the cartridge case (known as the plain and platform holes respectively) are rectified by a double-reamer, the case revolving in a sleeve bored to correct taper of the outside diameter of the case, this assuring concentricity of the two holes, and ensuring that the primer face and percussion cap lie flush with the base of the case. A forming tool, having a non-cutting face which acts as a depth guide against the base, corrects the outer rim and shoulder.

A hand-tapping machine clamped centrally to a suitable fixture on a bench was devised for re-tapping primer-holes. This consists of a floating bracket which accurately guides the tap into the existing thread, at the end of the tap being fixed a hand-operated capstan wheel, and on the tap a stop to regulate the depth of the screw.

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A similar apparatus fitted with a sliding screw-driver removes the primers; the cartridge case in either event being securely held and easily fixed or released in a central clamp.

Finally, after being immersed for a couple of minutes in a solution of sulphuric acid, the cartridge case is polished with sand and sawdust on a wooden pad covered with tapestry and revolving in a lathe at 300 or 400 revolutions per minute.

The result of garnering in and renovating these cartridge cases instead of turning them adrift in the battle area, reckoned in figures of pounds, shillings, and pence, was undoubtedly very considerable; for apart altogether from the saving effected in the cost of labour when repairing old cartridge cases as compared with the manufacture of new ones, the weight of metal alone contained in a couple of million cases may be taken at approximately 1500 tons; and with yellow metal costing £82 12s. 0d. per ton, the saving in metal alone amounts to no less than £123,900.

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CHAPTER VI

GUNNERY AND PROJECTILES

(RUDIMENTARY NOTES AND NOTIONS)

"The Prussian was born a brute, and civilisation will make him ferocious."

GOETHE.

The apposite nature of this moral dictum could have been exemplified in no degree more accurately, nor indeed remarkably, than in the light of events which transpired during the forty odd years intervening between the Franco-Prussian War of 1870 and the present-day world conflict; events which may, perhaps, best be summarised as comprising a persistent policy of unremittant and so-called peaceful penetration, intense warlike preparation, and provocative "braggadocio," or diplomatic bluff. Born in an atmosphere of arrogance and lust, imbued with a spirit of savagery, the Hun stood forth at last in the blood-red dawn of "Der Tag," naked, stripped of his pharisaical veneer of social development.

"Vous ne devez laisser," wrote Bismarck in 1870, "aux populations que vous traversez que leurs yeux pour pleurer," and clearly a decade of "Civilisation" had sufficed to make his countrymen indeed ferocious, to prove them obedient, albeit enthusiastic, disciples of the bestial doctrine which he had expounded. No longer was the soldier alone to be called upon to pass "half his time on the field of battle, and half of it on a bed of pain"; civilian populations too, innocent old men, defenceless women, young girls, and little children, all were to be drawn alike, pitilessly, into the vortex; naught but their eyes wherewith to weep remaining to them.

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One has but to refer again to that arresting little volume "Enseignements Psychologiques de la Guerre Européenne" (M. Gustave le Bon) to be reminded of the pre-determined methods that were to be adopted. "Notre principe directeur," Bismarck goes on to declare, "est de rendre la guerre si terrible aux populations civiles, qu'elles-mêmes supplient en faveur de la paix."

Four years of uncivilised warfare, of barbarity unprecedented in the annals of modern history, have since taught us how terrible was the meaning of these words, and if the possibility is conceded that tragedy and comedy may, on occasion, run riot hand in hand together, the climax was perhaps never more nearly approached that when in August, 1914, the arch-criminal himself, Wilhelm II, that "born actor and master of mis-statement,"³ indited an agonising epistle to his doddering confederate the Emperor Francis Joseph of Austria: "My soul is torn," so ran this apostolic lamentation—"my soul is torn, but everything must be put to fire and sword. Men, women, children, and old men must be slaughtered, and not a tree or house left standing. With these methods of terrorism which alone are capable of affecting a people as degenerate as are the French, the war will be over in two months, whereas if I admit humanitarian considerations it will last years. In spite of my repugnance, I have been obliged to recommend the former system."

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"In spite of my repugnance," however, or perhaps because of it, in spite of or because of this recommended system of terrorism, the more difficult it became to affect, to demoralise the "degenerate" French people, the more seemingly impossible became the task of breaking "those proud English hearts"; the war was not over in two months, in fact, contrary to the prognostications of the "All Highest," it lasted several years!

The nation, as it so happened, was never in more determined "bull-dog" frame of mind; this determination moreover to "see things through" "coûte que coûte" was amply voiced by Mr. Asquith, then Prime Minister, at the Guildhall on November 9th, 1914—"We will never sheath the sword until the military domination of Prussia is wholly and finally destroyed," and floating back on the breeze away from the stricken fields of France came echoing the refrain:—

"When the strife is fierce, the warfare long,
Steals on the ear the distant triumph-song,
And hearts are brave again, and arms are strong."

Dimly distant though the final victory might seem, fierce and protracted though the strife, England continued unflinchingly pouring forth her bravest and her best, while she herself, with a determination grim and set, was of a truth turning "to swords her ploughshares," for experience had taught her that the Prussian was born not only a brute but a bully, and that the only way to deal with bullies was to hit them back, to keep on hitting until they were down, and once down to keep them there and prevent them from getting on their feet again.

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But the maxim that "hesitation and half-measures ruin everything in war" had never been lost upon the "Great General Staff of (German) Imperial Supermen," who it might be opined had probably forgotten more in the gentle art of preparation for war than we ever set ourselves to learn. Gas shells, incendiary shells, tear shells, liquid fire, clouds of poison gas, aerial torpedoes, floating mines, submarines, mystery long-range guns, such were a few of the more obvious and less humanly unspeakable horrors in which the common enemy had specialised. Taken unawares, the question consequentially arose "How to hit them back?" Man for man, fist for fist, we were sure of giving as good as we received, and better.

"In bravery the French and English soldiers are the only ones to be compared with the Russians," was the verdict of Napoleon. Bravery, however, whilst being undoubtedly magnificent, is, on the other hand, in modern warfare liable to become a constraining source of suicide unless backed by commensurate means both of offence and of defence. "The machine," as Mr. Lloyd

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George pointed out, when reviewing on December 20th, 1915, the progress of events of the preceding months, "the machine is essential to defend positions of peril, and it saves life, because the more machinery you have for defence, the more thinly you can hold the line. On the other hand it means fewer losses in attacking positions of peril, because it demolishes machine-gun emplacements, tears up barbed wire, destroys trenches." Again, "What we stint in material we squander in life."

How criminal had been the lack both of prevision and of provision in regard to meeting possible contingencies may be gathered from the fact that on March 15th, 1906, Major Seely, M.P., in the House of Commons, in moving a reduction in the Army Estimates (estimates which at that time did not exceed the modest sum of sixty millions per annum), said, "We could not afford to continue the present establishment, for the House would not grant the money, and the country would not provide the men."

The folly of it all was coming home to us with a vengeance. Proportionate to the former mean and niggardly "cheese-paring" was the resultant appalling rate at which life was now being squandered. "We were short of all kinds of military weapons," Mr. Lloyd George was forced to confess, "but the lack of high-explosive shell was paralysing"; then as if in condonation of all former sins of omission, "we believe that what is being done now to provide a supply of munitions equal to all possible requirements will astonish the world when it becomes known."

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In this respect, therefore, it is, perhaps, not unnatural that interest of a widespread nature should centre round Crewe, in virtue of the quota of munitions which she, albeit unobtrusively, contributed to the "world's astonishment"; indeed a certain sense of bewilderment not untinged with pride cannot fail to supervene in the minds of that vast section of the community, to wit the travelling public, and in particular the great North-Western-loving public, when, the official veil of secrecy being drawn aside, the mental faculty is free to note and to assimilate the degree of resourcefulness, the versatility of the locomotive engineer.

There is no concealing the fact that "the place acquired by machinery in the arts of peace in the nineteenth century has been won by machinery in the grim art of war in the twentieth century," but the anomaly was strange indeed when Crewe, essentially the cradle of what may perhaps be termed the *haute noblesse* of locomotive progeny, bowing to the dictates of stern necessity, extensively adapted her domain to the novel effort of high-explosive shell production.

Manifold and great as are the instances which may be cited as evidence of the strides made during the last decade in engineering science, no other branch of that science has surely ever made appeal more alluring alike to schoolboy as to popular imagination, than that embodied in the modern British locomotive. Who in the course of his travel experience has not happened at that "Mecca" of railway bustle and romance, "Euston," the epic terminus of Britain's premier line, and focussing with his eye the hazy limit of a far-receding platform, has not traced the tapering profile of some distant-bound express, marvelling the while that, harnessed on ahead, should be pent up a force eager, impatient, yet withal so mighty that of a sudden, subservient to its call, this elongated span of motionless inertia laden with living freight should smoothly glide away, and gathering momentum on its path with ceaseless rhythm, ever along, along and along, sweep towards the far elusive line of the horizon? Yet this, in plain prosaic English, was the ennobling vista opened through peaceful years of patient toil and perseverance to the public ken, and dull must be the mind which contemplates unmoved that splendid emblem of the locomotive world, the awe-inspiring "Claughton" of that ilk, noble of mien and black of tint, with breast-plate red, toying with trains the equal of 400 tons and more, ticking aside the minutes and the miles alike.

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"PATRIOT."—A TYPICAL EXAMPLE OF THE "CLAUGHTON" CLASS OF 6 FEET 6 INCH, SIX WHEELS COUPLED EXPRESS PASSENGER ENGINE WITH SUPERHEATED BOILER; FOUR H.P. CYLINDERS, 15-3/4 INCH BORE × 26 INCH STROKE; BOILER PRESSURE, 175 LBS. PER SQ. INCH; MAXIMUM TRACTIVE FORCE, 24,130 LBS.; WEIGHT OF ENGINE AND TENDER IN WORKING ORDER, 117 TONS.

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Figuratively speaking, Crewe may perhaps be referred to as the "spill" on which the face of the London and North-Western compass pivots; the four points, north, south, east, and west, extending respectively to Carlisle, London, Leeds and Holyhead; but familiar as are the scenes of everyday activity throughout the entire length and breadth of the Company's system, foggy, for the most part, are the notions as to the phenomenal whirl of industrial enterprise daily in progress within the precincts of Crewe Works.

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Yet in these great engine Works (so menacing and unprecedented were the exigencies created by this voracious war), 'midst all the multifarious machinery and up-to-date appliances whereby is fashioned and evolved in all its amazing detail that complex piece of mechanism, the very essence of railroad itinerancy, the modern locomotive, was improvised with a speed approximating that of the mushroom which springs up in the night, a model and comprehensive plant, correlative with the multiform processes involved in the manufacture of that swift

harbinger of death, the high-explosive shell, and its complement of grim appurtenances. How paralysing was the lack of these shells may be gathered from the fact that⁴ "in the month of May (1915), when the Germans were turning out 250,000 shells a day, most of them high-explosive, we were turning out 2500 a day in high explosive and 13,000 in shrapnel." This gentle reminder to a lethargic House did actually (so we are told) evoke cries of "Oh," which latent degree of enthusiasm cannot be considered exactly vulgar or ultra ebullient, when side by side with so depressing a situation at home we endeavour to grasp the staggering figures as set forth in the following French official statement:—"Our artillery to the north of Arras fired in twenty-four consecutive hours 300,000 shells, that is to say, very nearly as many shells as were fired by the entire French artillery in the Franco-Prussian War of 1870-71. The weight of these 300,000 shells can be put at 4,500,000 kilos; or nearly 4435 tons. In other words, more than 300 large trucks were required for carrying them by rail, or roughly half a dozen complete goods trains; by road this would have meant 4000 waggons, each with a team of six horses. The monetary value of these projectiles may be put at something like £374,800."

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Prior to the summer of 1914, a shell, if not exactly an unknown quantity, was at any rate one of these obvious, even if somewhat curious things that might conceivably (in fact probably did) claim a certain amount of attention from that rather spoilt and very exclusive little clique, the professional army people. One read in the papers, too, from time to time, that the Navy (that immensely popular though slightly enigmatic asset of the Empire) was indulging in a little target practice somewhere out at sea; this would mean the firing of a few projectiles; but that was as it should be; we all liked the comfortable assurance that we could "sleep quietly in our beds;"⁵ with an innate and justifiable sense of pride we liked, when occasion permitted, solemnly to stand up and join in the refrain "Britannia, rule the waves."

Latterly, however, the "shell" has acquired so widespread a degree of prominence, proportionate to the toll of human life and of material damage that it has exacted, it has become in effect so commonplace an object, hackneyed as the very chimney-pots of a jerry-built row of houses, that a word of apology should perhaps be prefaced to any additional allusion to a subject already so often cited, which might otherwise and pardonably be regarded as superfluous.

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Before diving, however, into any details as to the methods of manufacture, it may be interesting to pause for a few moments and to inquire into the nature of the mysterious movements of the shell when, deposited by the artilleryman with tender and loving care safely and securely within the breach of his gun, it flies away, the unerring intermediary between him and the hated foe of an argument deadly and convincing.

Our gunner experts (armchair no doubt as well as professional) will, of course, tell us that the flight of a shell is gyroscopic, this possibly in lucid contradistinction from that of the convex-shaped boomerang, which, according to reliable information, is gifted with the graceful, albeit inconvenient, art of returning to its original point of departure. The shell, however, ere it quits the muzzle of the gun, thanks to what is known as the rifling or grooving of the bore of the gun, thanks, too, to the action of that indispensable little adjunct familiarly known as the copper band, is imparted with the vigorous twist, and once launched in mid-air spins round its longitudinal axis, undeterred, like the gyroscope, either by force of gravity or by atmospheric pressure.

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This longitudinal spin is rendered eminently desirable, in fact imperative, for various reasons, of which length and explosive capacity of the projectile, accuracy in flight, diminished air-resistance in proportion to weight, and finally range, may be quoted as the more obvious desiderata.

The old ancestral cannon-ball, fired as it was from a smooth-bore gun, had no means of acquiring this sudden longitudinal twist, and no sooner clear of the muzzle, it found itself involved in the performance of antics whimsical and capricious, turning over and over on its transverse axis, head over heels, side slipping, looping the loop.

Again, the cannon-ball, being round, was limited in size to the bore of the gun, so that in addition to the disadvantage just mentioned of possessing no definite material degree of accuracy whilst on its headlong course through the air, it offered the further disadvantage of containing but a comparatively small explosive charge, and the air-resistance it afforded in proportion to its weight affected adversely, and in marked degree as compared with the modern longitudinal shell, its range and potential destructive energy.

Reverting then to the modern projectile, and taking as a suitably illustrative example the 6-inch high-explosive shell (for it was on this particular type that Crewe was asked to concentrate), bearing always in mind, too, that the modern gun is rifled or grooved and that the effect of this grooving is to impart a vigorous longitudinal twist or spin to the shell as it flies away, making it gyroscopic and almost uniformly accurate, we notice that the length of this shell is eighteen inches, thus exceeding the diameter in the proportion of three to one, whence it becomes obvious that the capacity available for explosive charge is proportionately greater than that of a cannon-ball of the same diameter.

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We next find that in place of the rounded wind-resisting surface of the cannon-ball, the front end of the modern shell is pointed like a pencil, the atmospheric resistance being in this way reduced to a minimum. Decrease of wind-resistance naturally spells increase of range, and in this connection tests have in the past been carried out with shells having their bases as well as their noses pointed with a view to obviating the vacuum which is necessarily created by the usual flat base. A cigar-shaped shell, however, never proved satisfactory, for like the Rugby football it was decidedly wobbly in mid-air.

How requisite was a superlative degree of accuracy and consequently of skill in the manufacture of the modern high-explosive projectile may, to some extent, be gathered from these briefly stated considerations, and will become more apparent still when we come to glance at the series of component parts of which the whole is built up.

Premature explosions, involving loss of life amongst the gun-crew, the wrecking of the gun itself, not to mention resultant immunity from dismemberment of those previously destined to be the recipients of this unique form of greeting, are *primâ facie* contingencies to be guarded against; thus, owing to the sudden stresses to which a shell is subjected on the firing of the propellant charge whereby inertia becomes transmuted into velocity both forward and rotary, the steel of which the shell is made must be of such tensile strength that not only will the base-end withstand this transmutation, but the walls of the shell must be capable of overcoming the inertia of the front end of the shell, otherwise they will collapse, and a "premature" will be the immediate outcome.

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An output of steel adequate for all munition purposes was already a problem sufficiently acute, and there were genuinely orthodox reasons why the home output, in particular, should be maintained at as high a level as possible. For one thing, it was eminently desirable that America should keep supplied our Allies who were less well equipped in "industrial and engineering resources than ourselves." "By home manufacture," too, "we had saved in the course of a single year something which is equal to 6*d.* or 7*d.* in the pound of income tax in the metal market alone." Besides "when you order a very considerable quantity of war material abroad, there is always a difficulty which arises with regard to the exchanges and the gold supply." There was also "the difficulty that you have not the same control over the manufacturers of material abroad as you have got here" [Mr. Lloyd George, House of Commons, December 20th, 1915].

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Influenced by considerations such as these, Mr. Cooke undertook not merely to machine *in toto* a given quantity per month of rough shell forgings, but proffered the extensive steel-making plant in Crewe Works, comprising several furnaces of 20 and 30-ton capacity, both for the supply of steel requisite for the initial manufacture of these rough forgings, and if desired, for a further output of steel wherewith to supply forgings to other firms engaged exclusively in shell manufacture.

The output of 6-inch high-explosive shells from Crewe Works had, at the time of the Armistice, reached, approximately, a total of 100,000, and the corresponding weight of steel forgings may be estimated, approximately, at 6500 tons. Government specifications in regard to tensile strength and cold fracture tests were not unnaturally exacting in the extreme, and the casts obtained at Crewe came fully in these respects up to the standard ordained. But amazing though it may seem (so tightly can the reel of official red tape be wound), notwithstanding Mr. Cook's offer and ability to furnish this supply of special high-grade steel, further Government regulations to the number of seventeen and covering three pages of foolscap demanded the observance of formalities, petty and extraneous, designed solely for the purpose of securing the right of incursion within Crewe Works of every Smith, Jones, and Robinson who under the pseudonym of "Government Inspector," and as units of a hugely overstaffed officialdom, sought by hook and by crook any and every means wherewith to justify their overpaid existence.

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"Nobody but managerial and supervising engineers can quite realise what a handicap these people have been upon efficient production," writes a student of bureaucracy in the *Morning Post*, April 21st, 1919. "How the engineering industry has survived in spite of it is almost a miracle; how it has produced in spite of it is quite a miracle. At one time the Ministry of Munitions could boast of no fewer than 27,000 officials, nearly all of whose positions might be reasonably defined as "jobs." There were inspectors and inspectors of inspectors, super-inspectors, and inspector-generals, munition area dilution officers, munition area recruiting officers, recruitment complaints officers, and committees, directors, sub-directors, information bureaux, with all the usual paraphernalia; officials with and without designation, priority officials whose duties were as nebulous as their qualifications, besides an unnumbered crowd of arrogant but grossly inexpert experts. It is a splendid tribute to the industry that it triumphed over this deadly deterrent and redeemed its obligation to the nation under so cruel and undeserved a burden."

How Crewe Works survived in spite of this "handicap," this "deadly deterrent," is explained by the fact that Mr. Cooke would have none of these things; in fact, sooner than conform to the caprice and tyranny of these "inexpert experts" from without, he very promptly withdrew his offer of steel manufacture, politely but firmly consigning "Major MacMarkfour" and "Captain Fitzgrazefuse" elsewhere, their correspondence to the nearest wastepaper basket; a friendly chat with the late Sir F. Donaldson, then Director of Army Ordnance at Woolwich, sufficing to make it clear that at Crewe everything was strictly "above board," and that the little entourage of professional experts within justified the full and complete confidence which he, their chief, reposed in them.

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Not a few of the smaller engineering firms up and down the country, faced with previously unconsidered problems created by the unlooked-for transition from peace to war conditions, welcomed the call for shells and yet more shells, as a ray of sunshine peeping from out the lowering clouds of commercial stagnation. Hardly appreciating the fact that a shell's a shell for a' that, and approaching the task with a flippant disdain, akin to that of "selling seashells upon the seashore," some of these good people, ostensibly patriotic and avowedly disinterested, were soon asking themselves whether after all they had not bitten off as much as, if not actually more than, they could reasonably chew. The requisite degree of perfection in material, and of accuracy in machining, was at the outset a sore puzzle to the many who had never seen a field-battery in action, who had never inquired as to the why and wherefore of the flight of a shell, who, by virtue of their exemption from military service, never had occasion to congratulate themselves personally on the subtle and unfailing precision of a creeping "barrage"; and great was the vexation of spirit, many the hours thrown away, legion the shells definitely consigned to the scrap-heap (or perhaps at best set aside pending some seemingly trifling rectification), ere aspirants to this novel and exacting sphere of machine-shop art attained anything approaching the acmé of perfection.

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"It is better," wrote Napoleon, "to have no artillery at all than a bad artillery that endangers the lives of men and the honour of the nation," and selecting this fundamental principle as a basis on which to build the fabric of his excursion into the then untravelled paths of shell manufacture, Mr. Cooke made arrangements at the very outset for his leading representative of the machine-tool department to visit Woolwich, for the purpose, not only of acquiring first-hand knowledge as to the most approved Government methods of producing shells, but of making detailed dimensioned sketches from which to manufacture, in the Company's own tool department at Crewe, the multifarious gauges, or instruments, designed to verify in the most minute manner imaginable the diverse form of the shell.

The consecutive operations through which the shell passes number some thirty all told, and for each separate operation separate gauges are required. [110]

As emphasising not merely the delicacy of these all-important little instruments, but the delicate proposition "up against" which he found himself in his endeavour to discover firms who were capable of their manufacture, Mr. Lloyd George confessed that "we found that some of the shortage (of shells), if not a good deal of it, was due to the fact that, although you turn out shell bodies in very considerable numbers, you were short of some particular component which was essential before you could complete the shell. It might be a fuse, it might be a gauge. There was always some one thing of which you had a shortage!" Evidently gauges were a source of considerable anxiety because "we therefore had to set up two or three national factories in order to increase the supply of these components."

By already possessing the necessary machinery for, as well as considerable experience in, the art of gauge-making, Crewe was in a position to ease very materially the burden of those Government departments, those newly created "national factories" directly responsible for the manufacture and the issue of gauges in quantities sufficient to meet all demands, having merely to submit on completion any inspecting gauges to the National Physical Laboratory at Teddington for testing and stamping, prior to putting them into commission in the Works. Further, Mr. Cooke, as a member of a "strong committee of machine-tool makers" who were then "sitting constantly at Armament Buildings in London," was specially qualified, in view of his inside technical knowledge and practical experience, to assist in "directing the operations of the whole of the machine-tool manufacturers of the kingdom"; and finally, as Mr. Lloyd George went on to say, "the result of all this" was "to increase very considerably not merely the output of shells, but also the power at the disposal of the nation at short notice to turn out even more than we have ordered if the emergency demands" (*The Times*, July 29th, 1915). [111]

The rough forging of a shell body, rolled and pressed to suitable dimensions from a steel billet, is an uncouth-looking object, resembling as much as anything one of those upright earthenware umbrella-stands to be found in any cheap furnishing store; and with a view to licking it into shape, to turning it as quickly as possible into the smoothly finished article it was destined to become, Mr. Cooke's representative, on his return from Woolwich, having, as a preliminary, set in motion the machinery necessary for a supply of gauges, forthwith proceeded to improvise a further series of machines and tools, calculating the nature and number required for a given output of shells per month, and mapping out a plan whereby the various operations should follow one another from start to finish in correct and regular sequence. How important is the strict adherence to a regular sequence of operations is borne out by the fact that a shell might easily be ruined in the event of any operation being performed out of its turn. A convenient and suitable *locale* in which to lay out this shell-manufacturing plant was found available in a previously unoccupied extension of the new fitting shop; and as in the case of fuse manufacture at the old works fitting shop, so in the present instance, members of the fair sex were destined to figure prominently—a little band of neatly attired novices, some 150 strong, speedily responding to the call, and ranging themselves under the immediate supervision of a suitable quorum of expert mechanics of the sterner sex. [112]



6-INCH SHELL MANUFACTURE IN THE NEW FITTING SHOP, CREWE WORKS.

[To face p. 112.]

A multiple cutter-milling machine, formerly habituated to the peace-time art of facing locomotive cylinders, suddenly found itself saddled with a row of a dozen shell forgings, the open ends of which it faced to a correct distance from the inside of the base. Thenceforward, engine and turret-lathes deftly manipulated by our little friends of the fair element bore the onus of the succeeding operations.

Ordinary engine lathes were eminently suitable for operations such as centring, rough and

finished turning, grooving and external blending and turning copper bands. Then, thanks to the facility with which the various tools can be swung round in the lathe-turret and brought to bear on the work, turret-lathes were employed on operations such as rough and finished boring, internal blending, recessing and facing.

Rough turning on a fluted mandrel, rough and finished boring, and internal blending, in a concentric chuck secured to the face-plate of the lathe, are operations quickly disposed of.

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"Blending," needless to say, produces in the mind an impression of smoothness and of harmony: smoothness unscored, that is, of the walls and base; harmony complete between the two, and indispensable.

Into the finished and concentric bore of our projectile is now forced a cleverly and home-designed expanding mandrel, a taper mandrel in fact, which expands a hollow (and again concentric) bush, and on this the base is centred. Transferred to an adjacent engine-lathe the shell is fixed on a shorter three-bush expanding mandrel, and turned to the correct and finished diameter. Removed to a turret-lathe, a slight operation of counter-boring the mouth is performed; this is necessary, as medical practitioners may be astonished to learn, for the purpose of receiving the nose. The mouth is also faced, and screwed, but screwing is effected on another instrument of torture, styled a thread-milling machine; so prior to lifting the shell from the turret-lathe a recess is cut in the far cavity of the mouth, this forming a clearance for the thread-milling tool. The turret of the lathe having no transverse travel, an ingenious little tool was designed and fixed into the turret-head by means of which a transverse travel, actuated by a hand-ratchet and sufficient for the required depth of the recess, was obtained.

Anything which is at all conducive towards the saving of time, especially in war, is *ipso facto* a device of the utmost strategic and economic value. "Ask anything of me but time," once said Napoleon, "it is the one thing I cannot give you." So, in the case of our thread-milling machine, the saving of time effected is considerable. The shell is as incomplete without the screw-thread in its mouth, as it is without its nose; the thread has to be cut somehow; and by the employment of a milling-machine and thread-cutter the job can be done in about ten minutes as against an hour or more if done in an ordinary screw-cutting lathe.

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Having recourse once again to an engine-lathe, we attach a "form" (or guide) plate to the slide-rest, to the profile of which the nose and shell-body together are blended externally. As we are now nearing completion, the next item on the programme is to see how we stand for weight, and in the event of the shell being a trifle on the heavy side, we either take a light cut off, reducing ever so slightly the diameter, or else we shorten the base. There remain now the base-plate and the copper band to complete the whole; the former is either screwed or slipped with a plain circumference into a recess in the base, riveted over with a compressed air riveter, and faced to the required thickness; the latter is pressed hydraulically into a groove, then turned and grooved to the required diameter. A kind of miniature Turkish bath now awaits the long-suffering object of our commiseration, in which it is steamed and cleaned, then placed nose downwards over a tank. In this unenviable position a stream of varnish is generously sprayed with a hand pump up its inside. Thereafter it reposes in an adjacent chamber or stove until the varnish is thoroughly dried and baked; whence emerging, a pneumatic tapping machine is waiting to clear the varnish from the thread of its nose. It is then "boarded" both in regard to weight and overall dimensions, and if passed "A1" by the inspector proceeds into bond, where it remains until "called up," "reporting" at a filling factory, and in due course being "drafted over-seas."

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Prior to quitting the workshop's busy hum and reverting with our mind's eye to the "battle's magnificently stern array," where we may compare to further, if superficial, purpose the projectile and its mathematically proportioned features with the somewhat violent form of gymnastic exercise in which it is about to delight, a word or two in reference to the evolution of the copper band may not be held amiss, in view of the important *rôle* it plays relatively to the shell as a whole. The process by which these copper bands or discs were evolved was unique, and inasmuch as it was possible to effect a considerable economy by the evolution of three separate and distinct bands from one original sheet or square of copper, Crewe became responsible not only for the bands components of the 6-inch shell, on the manufacture of which she was exclusively concentrating her endeavours, but was able concurrently to produce for other firms further bands components of both 8-inch and 4.5-inch projectiles.

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Equally with the fuse or gauge, the copper band ranks as one of those "particular components which are essential before you can complete the shell," and in order to preclude in so far as lay in his power to do so the possibility of any shortage of this particular component, Mr. Cooke put in hand and had completed within a fortnight from the date of commencement an entirely new hydraulic press having a capacity of 130 tons and a working pressure of 2000 lbs per square inch, by means of which copper cups were pressed out to approximately 700 per day, and from these cups were cut and turned bands of different diameters according to the size of shell for which they were required; the total number of copper bands thus manufactured at Crewe at the time of the Armistice being upwards of 700,000.

The method was simple when once evolved. The 8-inch band being of the largest diameter of the three was the first to be dealt with, then the 6-inch and finally the 4.5-inch. A piece of flat, square copper plate was first dished in the press by means of a solid punch, to the shape of a shallow bowl; annealed, it was pressed a little deeper; annealed again, the process was repeated a third time, but deeper still, the dish becoming a cup; and in order to obviate the drawback of the walls of the cup clinging to the circumference of the solid punch, a cleverly contrived split and collapsible punch was introduced, that is to say a punch which, on being pressed downwards, was expanded by a taper wedge to the full diameter required, and which, on being withdrawn, collapsed or shrank inwardly in proportion as the taper wedge preceded and automatically withdrew the expanded and circular sides, the latter disengaging simultaneously from the walls of the cup.

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Transferred to the fitting shop, a band or disc 8-inch diameter was turned and cut off from the cup, the latter returning to the press, where through the medium of similar punches of requisite and correspondingly smaller diameters further operations resulted in the evolution of cups from which were turned 6-inch and 4.5-inch bands respectively and in sequence.

The proportionate number of bands cut from the three sizes of cups were, as a general rule, three from the smallest or 4.5-inch, eight from the intermediate or 6-inch, and one only from the largest or 8-inch, and it was in some measure due to these circumstances, due, no doubt, too, to a certain difficulty in obtaining delivery of copper sheets in sufficient quantities, that for the purpose of increasing the output of 8-inch bands and of maintaining this output on a level with that of the two smaller sizes, recourse was had to the brass foundry, where it was considered practicable to cast the bands, especially in view of the amount of copper scrap of both shearings and turnings that was available for melting-down purposes.

A certain amount of preliminary experimental work was perforce entailed, both for ensuring that the band, when cast, should exhibit an estimated degree of shrinkage (for the greater the shrinkage the sounder the casting, a shrinkage of 1/4 inch being usually accepted as a minimum), and that the metal should be capable of withstanding certain specified Government tests, the one condition, of course, being contingent on the other. Tests which were actually made proved wholly satisfactory, the average results being an elastic limit of 7.5 tons per square inch, an elongation of 45 per cent. on two inches, and finally a breaking stress of 14.5 tons.

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De-oxidisation, that is to say the process of removing oxygen from the metal for the purpose of obtaining castings that were sound, free of blow-holes and of oxide of copper, was effected by mixing a small percentage of phosphor-copper with the molten copper in the crucible.

Boron-copper was also tried as a de-oxidiser, but no real advantage was noticeable. Comparative tests, too, were made for the purpose of ascertaining the percentage of loss of copper when melted in crucibles and again in a reverberatory furnace. The former process resulted in a loss not exceeding 3/4 or 75 per cent.; whereas the latter was responsible for a 7 per cent. loss. Any saving which came within the meaning of the word "economy" as completely removed and distinct from that of "parsimony" was a precept not merely preached but extensively practised throughout the locomotive department at Crewe, and as an illustrative instance of this praiseworthy, and therefore patriotic, policy the casting of copper bands may be cited.

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Although cheaper and possibly less reliable methods of producing copper bands may have conceivably come into being during the final stages of the war, it was obvious to even the least well-informed in such matters that, provided a mixture could be obtained whereby the metal could be relied upon to pass the Government tests, the process of pouring molten copper from a crucible into a sand-cored cast-iron chill was likely to be at any rate cheaper than that involving the employment of presses, rolls, shears, and punches.

On comparing the estimated cost of manufacturing copper bands by the pressing and casting processes respectively, a difference of one shilling per finished band was shown in favour of the latter system; and although it may seem a mere bagatelle, a drop in the ocean of squandered millions, to those who not merely are encouraged, but who encourage others, in the art of reckless and profligate extravagance when handling the public purse, this modest shilling per copper band saved represented an aggregate of £1750, a sum not altogether to be sneezed at when we consider that the value of the 35,000 bands cast in Crewe Works was but an infinitesimal fraction of the total munition expenditure during the war.

We are told that "the use of travelling is to regulate imagination by reality, and instead of thinking how things may be, to see them as they are." Hence it has been, we may confidently aver, for the purpose of seeing things as they are that we have availed ourselves of this opportunity to fathom in some measure for ourselves the abstruse art of shell-manufacture as practised in Crewe Works. The imagination, however morbid and obtuse, can hardly fail to be stirred when pondering the rotund and rudimentary profile of the rough shell-forging lying with all its latent possibilities, recumbent in the lathe; ultimately in its finished form *c'est cela*,⁶ the shell we meditate, *qui va nous débarrasser des Prussiens*; thanks now to that generous impulse which prompts our gallant gunner-men, good fellows all, possessed of "mildest manners with the bravest mind," to unravel for us the all-absorbing mysteries of that sphere of "war's glorious art" in which they themselves excel, reality will regulate our questioning imagination as we follow them to the dim seclusion of some cleverly camouflaged gun-emplacement.

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We have already seen that the motion of a shell is rotary as well as forward, this rotary motion being brought about by the joint instrumentality of the grooving of the bore of the gun and of the copper band on the shell.

Another and very important function performed by the copper band approximates to that of the piston-ring of a locomotive cylinder, which prevents the passage of steam from one side of the piston to the other. Concomitantly, the copper band, turned a fit in the bore of the gun and jammed into the rifling, is designed to obstruct the passage of the propellant gases beyond the base-end of the shell; these gases are naturally imbued with a habit or hobby of gnawing away, or eroding, any metal surfaces with which they can come into contact, so that the further they can penetrate up the bore of the gun, the more material damage that will ensue, and the rifling becomes proportionately erased or eaten away. Further, owing to the fact that the degree of heat generated by the ignition of the propellant charge is obviously most intense in the area most adjacent to the base of the shell, erosion becomes patently more pronounced here than in other directions; consequently as the area in which the propellant gases are exploded increases, so the pressure exerted by these gases decreases, the net results of these considerations being loss of accuracy and of velocity.

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Different civilised communities favour different kinds of explosives as a gentle means of

attaining their ambitions, and these explosives may be solids, liquids, or gases. In this country picric acid (or, tri-nitro-phenol), and tri-nitro-toluene (or in its abbreviated and more easily pronounced form "T.N.T.") are the two kinds most extensively adopted for the filling of high-explosive shells. Owing, however, to certain unexplained caprices in which it is known to indulge, owing, too, to the fact that persons employed on its manipulation have died from the effects of trotyl poisoning, T.N.T. is less extensively employed, in spite of certain known and obvious advantages which it possesses over picric acid.

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Picric acid solidifies after being run in a molten condition into the shell, and every precaution has to be taken in order to prevent, during solidification, the formation of cavities, because the least tendency to friction that might occur due to the "setting back" of this hard explosive mass resultant on the sudden forward movement of the shell might easily give rise to a "premature." Herein we recognise the vital importance of wholly harmonious internal blending, absence of which might prove a further source of friction entailing imminent peril to ourselves as we stand beside the gun. Again, picric acid is ever seeking opportunities for combining with metal, whereby compounds of a nature most sensitive, and styled "picrates," are created, and of which the most sensitive is the lead-picrate. Hence we breathe a silent prayer that not only has the shell's inside been sprayed in the most efficacious and thorough manner possible, but that the composition of the varnish itself is entirely lead free.

Our wives, our families, our friends, we fain would turn to them as of a sudden a fresh suggestion, fraught with peril dire, creeps from out some hidden corner of our timorous mind.

On the firing of the propellant charge, the expanding gases, we are told, cause expansion of the gun, thereby simultaneously allowing proportionate expansion of the shell. We know already that erosion is most pronounced round the area within which the propellant charge is fired, that is to say, just at the commencement of the rifling of the bore; hence we see that in all probability the bore decreases gradually, even if imperceptibly, in the direction of the muzzle. We have, however, had experience of these varying and imperceptible degrees of graduation at Crewe, measuring them with our plus and minus gauges. What, therefore, if the shell, expanded in the commencement of the rifling, jams, or is momentarily checked, in its passage up the bore? A "premature"; for the pellet in the fuse is probably already free to jump forward against the detonating needle. These nightmare prematures! Thank goodness, after all, in one direction, at least, assurance has been rendered doubly sure; we used to wonder why all this fuss and trouble about a base-plate? Now we understand. Imperceptible must be our attribute again; metals are porous, imperceptibly so. Now imagine a sieve trellised with wires finely drawn as the threads of a spider's web, threads so closely woven and interlaced that only the most minute "teeny weeny" holes remain, a sieve in fact which though porous is not even transparent. Figuratively speaking this is the base of a shell-forging; a porous partition, the sole dividing line between the ignited propellant gases behind, and the high explosive bursting charge within the shell; in other words, between ourselves and "kingdom come"; hence our supplementary or protecting plate, the grains of whose metal run crosswise to those of the shell-forging base. By this method of reinforcing the shell-base, the odds in favour of a "premature" due to the penetration of the propellant gases to the explosive charge are reduced to a further irreducible minimum.

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The gun is, of course, designed to withstand the pressure within the breech and behind the shell, exerted by the firing of the propellant gases; this pressure naturally varies according to the size of the gun, and decreases proportionately as the shell shoots forward towards the muzzle with rapidly increasing velocity.

When, however, we come to consider the pressure exerted by the detonation of the high-explosive charge within the shell itself, and the velocity acquired by the resultant explosive gases, we are apt to fidget about a trifle uneasily in spite of our efforts to remain at least outwardly cool and nonchalant.

All the same, a matter of 300 tons per square inch, which is the pressure liable to be exerted by the detonation of an average charge contained within the high-explosive shell, can only be explained as "splitting"; and when our genial gunner-friends further assure us that 7000 metres or 21,000 feet per second is the velocity resulting from the detonation of "Trotyl," "staggering" is perhaps the most fitting epithet, and an American "Gee whiz" the only coherent sign of comprehension of which we are capable at the moment. For supposing a "premature" did chance to occur; well...! Mercifully enough perhaps for them and for their peace of mind, these intrepid individuals the gunners have little or no time, as a rule, to reflect upon the naked meaning of these figures and their attendant possibilities; for as Kipling has sung—

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"The moril of this story, it is plainly to be seen,
You 'avn't got no families when serving of the Queen—
You 'avn't got no brothers, fathers, sisters, wives or sons—
If you want to win your battles take an' work your bloomin' guns."

The success emanating from the working of our "bloomin' guns" has been, it may be fairly argued, in no small measure due to the excellent qualities of the high-explosive shell, and some interesting figures in this respect may be usefully quoted from the *Daily Mail* of May 16th, 1919:

"Remarkable comparative tests," runs the briefly worded paragraph in question, "have been carried out by British gunnery experts with the high-explosive shells used by both sides in the war. The shells from captured and Allied dumps were fired from the guns for which they were made at specially prepared targets. The official record of 'duds' (shells which failed to explode) was—

United States 50 percent.
German (1918) 38 " "

French	32	"	"
Italian	25	"	"
Austrian	25	"	"
British	8	"	" "

The remarkable results obtained from the British standpoint as compared with that of other and competing nationalities confirm once again the service rendered by our modest little friend the shell "gauge"; and without in any way disparaging the imperturbable *sang froid* of our gunners, or the indomitable courage and the unquenchable *flair* of our splendid infantry, it is no exaggeration to say that the superlative degree in the art of shell manufacture attained by British exponents has been largely instrumental in enabling us to fulfil the pledge that "however long the war might be, however great the strain upon our resources, this country intended to stand by her gallant Ally, France, until she redeemed her oppressed children from the degradation of a foreign yoke" (Mr. Lloyd George, October, 1917).

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[3.](#) A comment of King Edward's on the German Emperor, 1906.

[4.](#) Mr. Lloyd George, House of Commons, Dec. 15th, 1915.

[5.](#) The late Lord Fisher, Nov. 9, 1907.

[6.](#) *C'est celui-la*, etc., said of the Tsar, Nicholas II., when visiting Paris in 1896.

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CHAPTER VII

THE CREWE TRACTOR

"We often discover what will do by finding out what will not do; and probably he who never made a mistake never made a discovery."

SMILES.

A year or two prior to the war, the present writer remembers one occasion, in particular, on which he was discussing with a friend, possessing considerable knowledge and experience, the well-worn subject relating to the merits and demerits of the various leading "makes" of motor-cars. To a direct question as to what particular "make" he considered as being *the best par excellence* came the somewhat startling reply, "The Rolls-Royce and the Ford." Whether at the period referred to, and with expense no object, the average intending purchaser would have "dumped" for a Ford with the same enthusiasm as for a Rolls-Royce must remain an open question; suffice it to say that, comparisons remaining, as they always have been, distinctly odious, the two examples of automobile science just mentioned have, during the Great War, each in their respective spheres, performed prodigies of prowess, the Rolls-Royce more particularly in the matter of important Staff work, as well as in armoured car activity, the Ford in a variety of rôles, embracing the functions of anything from a compact and speedy little motor-ambulance to a water-carrier in the wilderness.

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One *rôle* allotted to the Ford, however, although of necessity accorded little or no prominence in the public Press at the time, proved far-reaching in its effects in regard to practical utility from the strictly military point of view.

Without in any way paralysing its *fons et origo* as a road vehicle, but embodying all the potentialities of a light-railway engine, there was evolved from a simple Ford chassis an entirely novel and mechanical species of animal, which one might almost say combined the respective physiologies of the proverbial hare and tortoise, and which in due course was christened the "Crewe Tractor."

The brain-wave to which this cunning little contrivance owes its existence is directly attributable to the inventive genius of one of Mr. Bowen-Cooke's talented daughters, and the incidence of the project almost whispers of romance, in that a chance encounter, a *rendezvous* continental and cosmopolitan, a cup of coffee, and an exchange of confidences, duly culminated in a conception which had as its outcome a very perceptible reduction in casualties, the percentage of which, at least in one particular respect, had tended to reach a figure lamentably high.

On the occasion in question, towards the end of 1916, having as her *vis-à-vis* a British officer (on leave in Paris at the time), Miss Cooke was digesting a dissertation on the inherent difficulties, dangers and fatigues to which men were incessantly subjected when relieving one another in the trenches; by day, an open and exposed target to alert enemy marksmanship; by night a prey to pitfalls, victims to unnumbered and water-logged shell-craters, in which, encumbered with personal impedimenta, they were often engulfed, never to appear again.

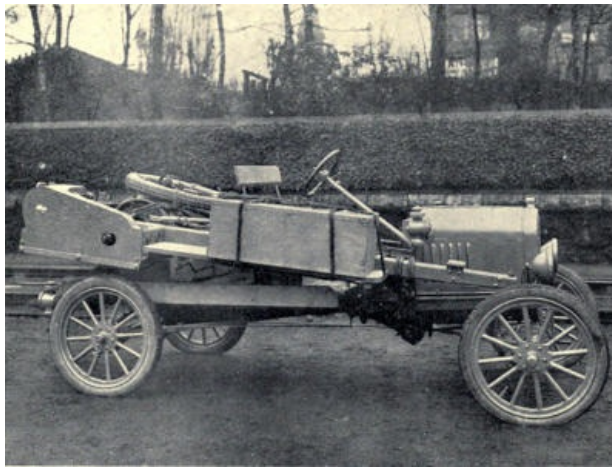
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Obviously the easiest solution would be a means of transit, a tiny metal track, ubiquitous, traceable under cover of darkness across the trackless waste, with diminutive rolling-stock available at any point. But how to achieve this end? No one could deny but that the need was both immediate and pressing.

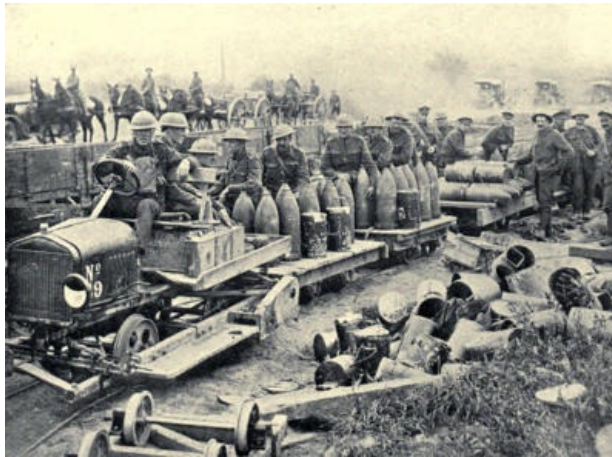
Seemingly happy inspirations, as all the world knows, succeed more often than not in theory rather than in practice, and for this reason all credit is due to Miss Cooke in that the happy notion of utilising a Ford car, pure and simple, and of converting it into a light railway tractor materialised in as short a space of time as is humanly possible to convert thought into being, to fashion fact from fancy.

Moreover, the advantages accruing from the idea were not limited to this one extent only, for quick to perceive the essential, Miss Cooke further devised a scheme whereby the vehicle, remaining entirely self-contained, was both convertible and re-convertible; that is to say, like the hare it could speed along the high-road to any given point or locality, where quickly transformed it would, like the tortoise, commence its slower and uneven progress on a diminutive line of rails, laid haphazard across some devastated area, unballasted, lop-sided, up and down, this way and that way. *Per contra*, its immediate task accomplished, and in proportion as the exigencies of modern strategy demanded further changes of *venue*, off would come the little tractor from its erst-while *voie-ferrée*, and shodding itself anew with road wheels and rubber tyres, away along the high-road once again to its ensuing sphere of tortuous rail-activity.

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A CREWE TRACTOR IN ROAD TRIM.



A CREWE TRACTOR AS LIGHT-RAILWAY ENGINE ON ACTIVE SERVICE.

[To face p. 130.]

At first sight the casual observer might reasonably have been excused for puzzling his brain as to the exact nature of the contrivance, curious if compact, and neatly secured on the familiar Ford chassis. But on closer inspection, the salient features would resolve themselves into a fairly obvious entity; nor should a due meed of praise be withheld from the draughtsmen and engineers responsible for the successful evolution of the tractors on a sound and practical basis.

At the outset, considerations such as height of centre of gravity contingent upon the loads likely to be carried over an uneven, narrow and diminutive track measuring but 1 foot 11-5/8 inches wide, length of wheel-base and corresponding ability to safely negotiate sharp curves, available tractive effort depending upon a coefficient of sliding friction between tyre and rail, all these appeared as obstacles not altogether easily surmountable.

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Official cynicism, too, coupled with an amount of adverse criticism, had, perhaps not unnaturally, to be faced and met. How for instance could a "flimsy" Ford chassis be expected to withstand loads and stresses for which evidently it had never been designed? Unlike that Government, however, which "foresaw nothing and only discovered difficulties when brought to a standstill by them," Mr. Cooke, with a quiet assurance bred of innate knowledge and experience, could well afford to go ahead "on his own"; official disdain should wait and see. Probably but few were aware for example that, whereas in regular locomotive practice a tensile strength of twenty-eight tons per square inch is considered ample margin for special axle steel, the "flimsy" Ford is built up of Vanadium steel, having a tensile or breaking strength of no less than seventy-five tons per square inch!

The somewhat undue height of a Ford chassis for light railway purposes was a preliminary problem to be tackled, and it was decided to substitute the driving road wheels with sprockets and perforated steel rail-wheels, drop-forged with flanges. The question of a suitably short wheel-base was quickly determined by the introduction of a pressed channel steel underframe of 5/32 inch plate on which the Ford chassis was secured; the leading and driving rail-wheels and axles being so arranged that a rail wheel-base of 4 feet 5 inches was obtained, as against the 8 feet 4 inches wheel-base of the road-chassis.

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Radius rods ensured a nice adjustment of the driving chains, and as a measure of precaution against any possible failure of the Ford back-axle supplementary band brakes of generous dimensions were fitted to the driving rail axles, these being additional to the standard Ford brakes. A "skefko" type of ball-bearing fitted to the original tractors, had perforce to be superseded by brass floating bushes owing to ever-increasing demands in connection with the manufacture of aeroplanes. These bushes were merely a temporary rather than a permanent substitute, for very speedily there was introduced an approved type of roller bearing, which, thanks once again to the ever-ready adaptability of the fair sex element in Crewe Works, was duly forthcoming in all-sufficient quantities, and of a quality leaving nothing to be desired.

Numerous experiments were carried out with a view to determining a rail-wheel diameter calculated to give the most satisfactory results. It was assumed that the average Ford car

attained a maximum degree of efficiency when running at a speed of 25 m.p.h. with the engine turning over at 1500 r.p.m. With a diameter of 2 feet 6 inches at the tread of the tyres, the road wheels and back axle would be revolving at the rate of 280 r.p.m. A further calculation went to show that with sprockets having a gear ratio of 30 to 40, and with the rail-wheels having a diameter of 18 inches, the latter would revolve at the rate of 210 r.p.m. as against the 280 r.p.m. of the Ford back axle, this resulting in the tractor averaging a speed of 987 feet per minute, or 11 to 12 m.p.h. which was considered adequate and suitable for the varying conditions to which it was likely to be subjected.

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In addition to ensuring a systematic means of transport for men proceeding to and from the trenches, the Crewe tractor was further requisitioned for taking supplies of ammunition to artillery emplacements in the forward areas. Suitable trolleys were attached, and the little tractor, prior to going into commission, was required to prove itself capable of hauling a dead-weight minimum load of 5 tons, not only on the level, but on an upward gradient of 1 in 20, halfway up which gradient it was further required to stop and re-start, there being in Crewe Works a track specially laid for the purpose of subjecting every tractor to this crucial test. It was found, by experiment, that by doubling the diameter of the trolley wheels, from 7 inches to 14 inches in diameter, double the load could be hauled. "Slipping," an inherent difficulty due to greasy rails, had to be reckoned with, and was in no small measure counteracted by the addition of a central driving chain, coupling rear and front axles through the medium of sprockets. The frictional resistance (*i.e.* the force at the rails when the wheels are on the point of slipping) was found to be 448 lbs. with a load of 1 ton on the carriage of the tractor, this being sufficient to enable the tractors to pass the required test. The Ford transverse rear spring was supplemented by two helical springs placed vertically between the Ford and tractor frames.

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To obviate the necessity of turning at the various termini of the track, and to enable the tractor to always proceed in forward gear, an ingenious method was devised, whereby, with the aid of a screw and ratchet, working on a transverse beam and socket laid across the rails, the tractor was raised bodily clear of the rails, and swung round, ready to proceed in the opposite direction.

Fitted with a high gear, several tractors were specially adapted for inspection purposes; in short, the extent of the ubiquitous utility, and of the universal popularity of these remarkable little machines, may be gauged by the fact that their appearance was welcomed on fronts as divergent as were those of France, Macedonia, Egypt, and Mesopotamia.

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CHAPTER VIII

"HULLO! AMERICA"

"A world where nothing is had for nothing."

CLOUGH.

In the summer of 1917, at the urgent request of the Railway Executive Committee, Mr. Cooke, in conjunction with Sir Francis Dent and Mr. A. J. Hill, chief mechanical engineer G.E.R., undertook, personally, a "mission" to the Government of the U.S. of America, as representing the unprecedented straits to which the leading railway companies of Great Britain had become reduced, and for the purpose of enlisting the practical sympathy of the great republic of the Western hemisphere, at that time but recently united to the allied cause.

Doubts were indeed entertained originally as to whether America could in fact supply material to England in view of her own entry into the arena of European conflict, and so in view of her own requirements; consequently, as will be seen from the following briefly stated remarks, the outcome of the "mission" proved to be eminently satisfactory, and this in no small measure due to the friendly intervention of the U.S. Advisory Committee, acting throughout, primarily, in the interests of the British as opposed to those of individual American railway companies.

A few cogent reasons may plausibly be advanced to account for the *impasse* to which the British railways had been brought. [136]

One cannot fail, for instance, to recall the stigma which, in the pre-war and piping times of peace, invariably attached to the despised 1s. a day man of the British fighting forces; but although, as in Kipling's immortal stanza, it was—

"Tommy this, an' Tommy that, an'
Chuck him out, the brute,"

all this sort of antiquated "flap-doodle" very shortly underwent a complete "right-about-turn," when the great ordeal came to be faced, and very speedily it became a case of—

"Please to step in front, Sir,
When the guns began to shoot."

Consequently it is eminently satisfactory to remember that within the first 365 days of the outbreak of hostilities, British railways had contributed more men to the fighting forces of the Empire than either French or German railways had done in their respective spheres. Further, prior to the introduction of universal compulsory service in Great Britain, employes of the L. & N. W. R. locomotive department had voluntarily enrolled to the number of 4,002; Crewe Works being responsible for 1,142 names on the Roll of Honour.⁷ Depletion of staff, plus a steadily increasing volume of traffic, could only spell "maintenance un-maintained." In addition, it was found necessary to adapt rolling stock for use overseas, and prior to the inauguration of the Ministry of Munitions British locomotive works and plant had been depended upon very largely for supplementing the undeniable shortage of munitions of war, which may literally be described as "legion" in quantity as well as in variety. [137]

Worse was to follow, for upon the tardy inauguration of munition factories throughout the country, the long-suffering railway companies of the United Kingdom not only found their own supplies of material very considerably curtailed, but they were called upon to perform the seemingly impossible, viz. that of maintaining a regular and ever-increasing supply of munitions in addition to contributing a novel "expeditionary force" in the shape of locomotives and tenders, wagons, and complete up-to-date workshop machinery for overseas service.

In response to the call "Hullo! America," castings, forgings, steel, and copper plates, tubes, blooms, billets, springs, etc., were spontaneously forthcoming, in all a grand total of some 15,000 tons (tyres alone accounting for 2,848 tons), involving an approximate expenditure of 3,847,042 dollars, or £800,000.

It was admitted that the prices ruling the contracts for this material were abnormally high, but at the same time it was conceded that the national urgency of British claims far outweighed in the then existing circumstances those of American railway companies, who, it should be added in fairness, would have found themselves "up against" identical prices, had they been purchasing the same material themselves. [138]

Finally, it only remains to be noted that no sooner had the financial details of this truly vast transaction been determined (a transaction that may frankly be said to have saved the situation in so far as British railways were concerned in contributing towards the winning of the war), than Mr. Cooke promptly evolved and set in motion a system of delivery at Liverpool, or any other port of discharge, whereby consignments of material on arrival were distributed carriage free by the various railway companies to their respective works.

The subsequent success of this intricate scheme of distribution may fairly be attributed to the unflinching measure of tact and resource available in the person of Mrs. Harris, M.B.E., (*née* Miss Faith Bowen-Cooke), a lady on whom devolved the exceptional and delicate task of receiving and allotting these 15,000 tons of railway equipment, and who previously, as secretary to the "mission," as much by her business acumen and practical ability as by her own personal charm, won a sure place for herself in the admiration and esteem of many of the leading personalities in the railway world of the United States of America.

7. The total number of employés in all departments of the L. & N.W.R. who joined the colours during the war was 37,742, or 34 per cent. of the entire staff. Of these, three won the V.C., and numerous others were awarded various British and foreign decorations.

CHAPTER IX

THE ART OF DROP-FORGING

"Who made the law that men should die in meadows,
Who spake the word that blood should splash in lanes,
Who gave it forth that gardens should be boneyards,
Who spread the hills with flesh and blood and brains?
Who made the law?"

Seldom, perhaps, does a plain question receive so plain an answer as that coming direct from so qualified an authority as Prince Lichnowsky, former German Ambassador to the Court of St. James, who, in the course of his confessions, which he entitles "My Mission to London," says, simply and quite candidly, "We insisted on war." Herr Harden, too, writing in *Die Zukunft* in November, 1914, even if a trifle more impetuous, more brutal, is none the less frankly outspoken: "Let us drop," he protests, "our miserable attempts to excuse Germany's action.... Not against our will, nor as a nation taken by surprise, did we hurl ourselves into this gigantic venture. We willed it ... it is Germany that strikes."

And having fixed the blame, the moral responsibility, equally plain-sailing is it to establish the blood-stained guilt; evidence of it fairly "stinks" no matter where one turns to look; from emperor to general, from statesman to author, exudes the *credo* of Teuton Kultur; no more lurid interpretation of which can perhaps be found than in the words of Herr Hartmann, a native of Berlin, who, after serving as an artillery officer, turned his attention to matters literary, being *inter alia* a believer in evolutionary progress. "The enemy country," he insists, "should not be spared the devastation, the profound misery engendered by war. The burden should be and remain crushing. Immediately war is declared, terrorism becomes a primary essential absolutely imperative from the military standpoint."

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There is, however, all the difference in the world between the transitive and intransitive senses of a verb, and if we take the verb to "terrorise" as an apposite example, the transition from the former sense to the latter, *i.e.* from terrorising to being terrorised, is apt to be very noticeable, indeed unpleasant. Granted that British and Boche ideas on the particular subject in no way harmonise, the British method ultimately of diffusing an unlimited supply of high explosive over the Boche lines nevertheless had the desired effect of "putting the fear of God" into the right individuals, at the right time, and in the right place. One employs the prefix "ultimately" of necessity, for obviously the diffusion of metal prior to the latter phases of the war was, except upon certain occasions which were few and far between, anything but unlimited; it was, in fact, at one particular period of the war of so limited a nature as to infuse into the mind of the late Lord Kitchener a fear of stalemate on the Western Front, sufficient to impel his acquiescence in that diversion, so ardently advocated by "amateur strategists" but destined to prove nothing but a prodigious and costly failure, to wit the Dardanelles expedition.

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Thanks, however, to the staying powers of the workers, to the inflexible will to win by which they were animated throughout, the crushing superiority, early attributable to the enemy, gradually became less and less apparent; in fact, after hanging for a time evenly in the balance, the scales indeed tipped the other way, eventually dipping to such an extent in Entente favour as to become a source, at first of no little astonishment, then of concern, to the German "Imperial Staff of Supermen." General Ludendorff in his memoirs ["My War Memories," 1914-1918, Vols. I. & II., Hutchinson & Co. 39s.] makes no attempt to conceal his surprise, if not indeed his dismay, at the awkward trend of events. "Whereas we had hitherto been able to conduct our great war of defence" (*sic*), so he writes (cp. page 240, Vol. I.), "by that best means of waging war—the offensive—we were now (by the autumn of 1916) reduced to a policy of pure defence.... The equipment of the Entente armies with war material had been carried out on a scale hitherto unknown"; the boot was plainly on the other leg, for (cp. page 242, Vol. I.) "the Battle of the Somme showed us every day how great was the advantage of the enemy in this respect." Evidently the one and only Ludendorff no longer had any doubt in his own mind as to the "writing on the wall," its lettering was clear, its meaning ominous and unmistakable; from the German point of view things were going from bad to worse; "At the beginning of June (1917)," he continues (cp. pages 428, 429, Vol. II.), "the straightening of this (the Wyttschaete) salient really ushered in the great Flanders battle.... The heights of Wyttschaete and Messines had been the site of active mine warfare," and ultimately, "The moral effect of the explosions was simply staggering." Again in August of the same year (cp. page 480, Vol. II.), "In spite of all the concrete protection, they (the Germans) seemed more or less powerless under the enormous weight of the enemy's artillery," and "With the opening of the fifth act of the great drama in Flanders on the 22nd October (cp. page 491, Vol. II.) enormous masses of ammunition, such as the human mind had never imagined before the war, were hurled upon the bodies of men who passed a miserable existence scattered about in mud-filled shell-holes. The horror of the shell-hole area of Verdun was surpassed. It was no longer life at all. It was mere unspeakable suffering. And through this world of mud the attackers dragged themselves, slowly, but steadily, and in dense masses.... Rifle and machine-gun jammed with mud. Man fought against man, and only too often the mass was successful." The long and the short of it, in a word, amounted just to this, the Hun had "insisted on war," and now he was "getting it in the neck."

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Napoleon is credited with the opinion that "Good infantry is beyond question the soul of an army, but"—and no doubt it is a big "but," as will be seen from the way in which he goes on to

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qualify his opinion—"but if it has to fight any considerable time against a very superior artillery, it becomes demoralised and is destroyed." In order to determine how completely has been justified this view in the light of modern warfare, one has but to turn again for the space of a brief instant to the memoirs of Ludendorff—Ludendorff who "lived only for the war," whose life had been one of work for his "Country, the Emperor, and the Army,"—the note of bitter chagrin cannot be mistaken. "Against the weight of the enemy's material" (cp. page 542, Vol. II.) "the troops no longer displayed their old stubbornness of defence; they thought with horror of fresh defensive battles."

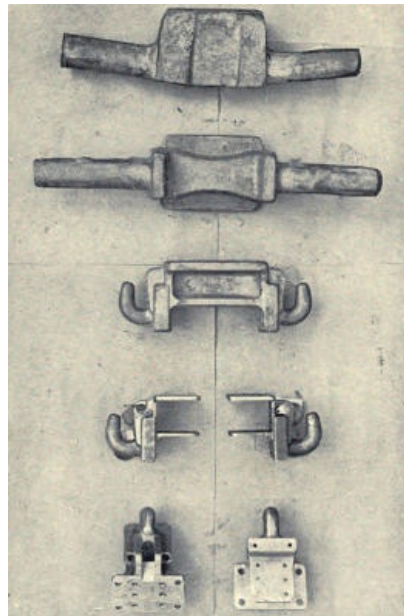
Such in effect, then, was the net result obtained by an intense application by the Entente Armies of "a very superior artillery," rendered possible by the untiring efforts of the workers, by the plant at their disposal, and by the brains which created and controlled. There can be no parallel in the whole history of international warfare to compare even approximately with the abnormally severe conditions imposed upon pieces of artillery during the present-day conflict, conditions which perforce had a considerable bearing not only on the design of integral parts, but also on the nature of the material employed in the manufacture of those parts.

One of the most remarkable features in this latter respect was the frequent necessity to substitute a steel forging where a casting had previously been considered "the last word," and if we take as a convenient and typical example so ordinary and obvious a part as is the trunnion bracket of a howitzer gun, this will afford a very good idea of the difficulties which present themselves when in compliance with Government specifications recourse must needs be had to the hammer as opposed to the mould, difficulties, in fact, which could only be overcome by the employment of what is commonly known as the drop-hammer.

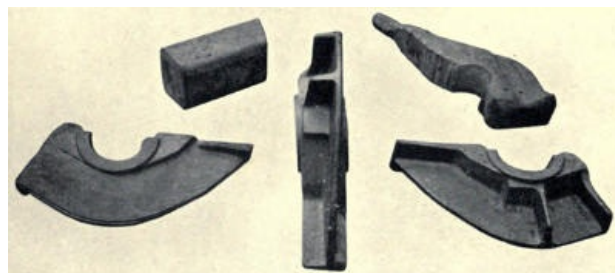
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If proof positive were ever needed in support of the argument that bread may be found again which has been cast upon the waters, not merely many days previously, but weeks, months, and years, the money sunk by the London and North-Western Railway Company in their drop-hammer plant at Crewe affords the proof; for, thanks to the existence of this plant, thanks too to the invaluable experience gained during the years following upon its installation, not only were the staff engaged in operating the hammers able, figuratively speaking to forge right ahead, literally speaking to commence drop-forging, directly they were required to do so, those sorely needed "sinews of war" which a pre-war generation of feeble-gutted politicians had neglected to provide against the evil day of reckoning, but Mr. Cooke found himself in the unique position of being able to undertake forgings which were admittedly altogether beyond the scope of firms whose speciality was none other than that of drop-forging, and of which the Directors of Army Ordnance were well-nigh at their wits' end to secure an adequate, if indeed any, supply at all.

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LIMBER HOOKS: ILLUSTRATING DUPLEX METHOD OF DROP FORGING.



TRUNNION BRACKETS FOR 6-INCH HOWITZER GUN, DROP FORGING.

[To face p. 145.]

Significant, and sufficiently expressive of appreciation, if not of actual open-mouthed astonishment, is the following letter received by Mr. Cooke from a well-known Government Department: "I have to thank you and your staff on behalf of the Ministry of Munitions for the excellent work you have done in producing stampings of trunnion brackets. The part in question

has hitherto been considered almost impossible to produce as a stamping, and the work you have now produced will add materially to the efficiency of this important equipment. I should be glad if this letter could be brought to the notice of your subordinate staff who carried out the work." From the same source, but at a later date, came this further little note of esteem: "Your previous production of the trunnion bracket has been the means of great saving to the State, and it is with great satisfaction that I am able to again congratulate your operating staff on a renewed success in your stamping department."

For the benefit of those uninitiated in the fascinating art of drop-stamping or forging, it may not be considered superfluous if a brief explanation is given of the principles embodied in the system, and for this purpose one cannot do better than read and inwardly digest the opinion which has been advanced by Mr. Brett, founder of the Brett Patent Lifter Company of Coventry and inventor and patentee of the hammer in question.⁸ "Having in mind," he says, "that the plastic or forgeable condition of wrought-iron or steel, when obtained, cannot be retained beyond limited periods, especially in the case of articles having thin or light parts, when its duration is very brief," it rests with the engineer "to provide for the forger a suitable form of power for actuating the dies or tools by means of which properly-formed forgings may be obtained." Further, "this power must be capable of instantaneous application," similar in all essentials to that produced by the smith "with hand hammer or sledge; that is to say, a perfectly elastic blow of sufficient force to produce an immediate and substantial effect upon the material."

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The secret of providing this particular form of power lies obviously in the Brett drop-hammer, and in it alone, and the method evolved consists in the raising of the hammer-head or "tup" between a pair of parallel and vertical guides to a certain height by pressure of steam exerted within an overhead cylinder; no sooner is this pressure shut off than the "tup" automatically descends by force of gravity, delivering the hammer-blow simply with the weight of its falling mass, and rebounding, is lifted once again by re-admission of the steam into the cylinder, preparatory to the next descent and the delivery of a further succession of blows. It is largely thanks to a flexible cord and strap connection between the "tup" and the piston and piston-arm working in the overhead cylinder that the blow delivered is not only "smashing" in effect, but altogether resilient, in direct contrast to that of a steam-hammer, the blow of which is more in the nature of a dull thud or a rigid push.

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It is obvious, as Mr. Brett goes on to point out, that "the vibrations from blows of sufficient power and elasticity (or sharpness) to cause metal at a moderate heat to flow completely into the impressions of the dies," *i.e.* the blocks in which are cut the impression of the required forging, "and to make clean work, are calculated to destroy any rigidly built machine." Hence the fact, which a cursory glance at the hammers cannot fail to establish, that nothing has been overlooked or omitted in regard to detail in design, "not any of the parts affected by the work are bolted together or in any wise rigidly fixed; the guides are held and the dies set in position by flexible means, *i.e.* the lower end of each guide fits into a recess into the base block, the top end passes up into a socket having sufficient clearance for wood packing, the wood is intended to absorb the vibrations which pass up the guide-rod."

The plant at Crewe as originally installed in 1899, by the late Mr. F. W. Webb, of "compound" fame, consisted merely of one "battery" of hammers, comprising two 7-cwt. stamping hammers, and one 5-cwt. "dummying" or roughing-out hammer, and although the production of small stampings for signal apparatus etc., was all that was attempted in those early days, little by little the variety of work became extended, embracing, ere long, locomotive parts of small dimensions such as brake-rod ends, joints, levers, handles, etc., with the result that as time went on and as ever-increasing experience with confidence proportionate accrued to the staff employed, jobs of still greater variety were successfully tackled.

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THE 4-TON DROP HAMMER.

[To face p. 148.]

There are at the present time no fewer than eight "batteries" of hammers "in action" at Crewe, the actual number of hammers being twenty-two, and some idea of the extent of the progress made may be gauged by the fact that the yearly tonnage output of stampings rose from 400 tons in 1902 to 1450 tons in 1917, a time when the plant was largely devoted to the manufacture of a regular "pot-pourri" of essential munitions of war.

It was primarily due to the urgent demands of the Ministry of Munitions for a supply of trunnion brackets, which, cast in steel, were proving defective, and which had "been considered almost impossible to produce as stampings," that Mr. Cooke determined on the course of laying down an additional hammer, having a "tup" weighing no less than four solid tons.

Complete with gas-producers, stationary boiler, gas reheating furnaces and cranes, the estimated cost of installation was £15,100. The hammer foundations necessitated a cavity being

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dug to a depth of 18 feet, which was filled in with 321 tons of granite and cement, and upon which repose the base blocks, cast in steel and weighing a further 58 tons. This veritable monster commenced operations during the critical days of the early spring of 1918, and no sooner had the seemingly impossible been shown to be possible and the successful production of trunnion brackets had become "the means of great saving to the State," than there followed in quick succession orders for other and indispensable gun-mountings, such as front stiffening bands, upper sight brackets, trunnion-seatings, etc., etc.

"Peace," as we know, "hath her victories no less renowned than war," and no sooner was the mantle of munition manufacture laid aside than efforts were once again concentrated on the production of locomotive parts, the whole of the Walschaerte valve gear appertaining to Mr. Cooke's latest express passenger engines, the well-known "Claughton" class, being now produced under the 4-ton drop-hammer.

Standing in the immediate vicinity of the hammers ranged in convenient positions in regard to gas furnaces, "dummying" hammers, and "finning" or "trimming" presses, the average and intelligent visitor never fails to be impressed as he witnesses the operations in process, and notes the lightning rapidity with which, as if by the magic of a magician's wand, a bar or billet of gleaming, glistening whiteness is battered and transformed into some previously determined shape, curiously contorted, maybe, with corners, elbows, and recesses, ere the dazzling brilliance dims and fades, paling imperceptibly to lemon tint and orange hue, till finally the blood-red flush of angry sunset supervenes, and nothing remains but that the finished stamping should be trimmed and laid aside, gradually to resume the slate-grey cool of dawn.

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How natural it all seems, how almost childish in simplicity! And yet on second thoughts, how come these various shapes and forms, these corners, elbows, and recesses, these well-nigh perfect surfaces, pure and clean, free from blow-holes, dirt and scale? True, we know the crashing and resilient hammer blow is there, and then a little closer acquaintance with, or examination of, the hammer is all that is necessary, for this will reveal the fact that it is the effect of the blow on a pair of "dies," one of which is held rigidly in the "tup," the other on the base-block, that causes the metal at a moderate heat to "flow" completely into the impressions which are in the dies, and which ensure the fashioning of the article required.

To cut an impression in a pair of "dies," to put the "dies" in the hammer, and to obtain a forging, sounds the simplest thing in the world. Yet in actual practice, so many are the problems which present themselves, so diverse are the obstacles to be overcome, that a volume might be written on the craft of the die-designer, whose efforts result in work of so great beauty, and whose "dies" must be capable of withstanding the punishment, and of enduring the wear, which the crashing blows of the "tup" inflict and are ever striving to induce.

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What is the most suitable metal to employ in the manufacture of the dies? and having found that metal, what is the best process of hardening? are two of the first questions to be decided. Will the forgerman bestow every care in the use of his "dies," and will he set them accurately in the hammer? Much depends on answers being in the affirmative. Whether to cast the impressions in the die-blocks, or to machine them out *in toto*, and if machined out how to do so, are further knotty propositions. Correct taper on the walls of holes, bosses, and recesses; egress for imprisoned air; size of bar or billet to be stamped, after making suitable allowance for contraction and waste; control of waste metal or "fin"; method of duplex stamping. Such are the more potent problems with which the die-designer is faced, and whilst lack of insight will assuredly foreshadow failure, ability to grasp their import cannot fail to spell success. Obviously the mind of the die-designer must ever be planning, plotting, scheming how best to make his metal "flow;" and concentrated attention, and study extending over years, are the only means of approaching that degree of perfection which in the art of drop-stamping, as in all other branches of mechanical science, the engineer is ever striving to attain.

Incredible, then, that public money should have been continuously lavished on that legion of "inexpert experts," more than one of which worthless clan, gloriously clad in khaki, was known to claim admission to Crewe Works for the avowed purpose of "satisfying himself" (*sic*) that the engineers of the London and North-Western Railway locomotive department were "making the best use of the drop-hammer plant."

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Even if we generously assume that these gentlemen were the exception rather than the rule, such glaring exhibitions of ignorance and impudence combined could not but tend to bring out in full relief the anomalies which, although possibly unavoidable, existed none the less in a system of universal and compulsory service; and with every apology to the talented soldier poet, author of the initial stanza introducing this chapter, one may be pardoned if, in conclusion, one feels constrained to put this further little conundrum:—

"Who made the law that nincompoops and asses
Should 'cushy' jobs, immune from risk, infest,
While other 'blokes,' undaunted—aye in masses,—
Naught asking, bit the dust, and so—'went west'?
Who made the law?"

8. [Extract from Paper read by Mr. Brett before the Engineering Conference of the Institution of Civil Engineers, June, 1899, and published in *Engineering*, June 30th, 1899.]

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CHAPTER X

1914-1918 PASSENGERS AND GOODS

"Unless we had order, unless we had certainty, in the moving of large masses, the day of battle, which might come, would be to us a day of disaster."—Colonel McMurdo, late Inspector-General of the Volunteer Forces, January 9th, 1865.

Der Tag, which came on August 4th, 1914, was not fated after all, as we know, to be a day of disaster. That it was not so is perhaps attributable in the main to two causes. "Miraculous" is the manner in which escape from disaster has been described; but as we have already seen (and of this fact we cannot remind ourselves too often), the miracle was performed primarily and essentially by the loss of those "many thousands of brave men whose sacrifice we deplore, while we regard their splendid gallantry and self-devotion with unstinted admiration and gratitude." A secondary, but by no means inconsiderable, cause contributory to the successful working of the miracle lay in the fact that we did possess the "order," the "certainty," in regard to the moving—not exactly of "large masses" in the more recently accepted meaning of the term, but at any rate—of that part of the Army which was detailed for home defence, and of the six divisions of which the original Expeditionary Force was composed, and which were flung across the Channel to assist in stemming the initial German onrush. And it is with regard to this "order," this "certainty," and the attendant successful working of the railways that the ensuing pages are concerned. [154]

We have already traced in some degree of detail the antecedents of the Railway Executive Committee, that body of distinguished civilian railway experts, who, from the time that the Government assumed, under provisions of the Act of 1871, nominal control of the railways, became, and throughout the war remained, responsible to the Government for the maintenance and the efficient working of the entire railway systems of the British Isles; and in order to acquire some insight into the amazing and complex detail involved in this efficient working, we cannot very well do better than probe a few of the more salient facts concerning the London and North-Western Railway, which, on the outbreak of hostilities, and appropriately enough, was deputed to act as the "Secretary" Company to the Western and Eastern Commands and afterwards to the Central Force, that is to say, the Company specified by the Army Command Headquarters, for the purpose of making arrangements with the other railway companies concerned in the Commands named for the main troop movements during the first two months of the war.

In an extremely interesting report, dated October 1st, 1914, Mr. L. W. Horne, who, prior to his appointment as secretary to the "Secretary" Company to the Commands previously mentioned, was acting secretary to the Railway Executive Committee, describes the measures that were adopted both prior to and during mobilisation, in conformity with the War Office programme. [155]

A Communications' Board "consisting of representatives of all Government departments and also the Railway Executive Committee," was instituted to consider Government "recommendations to meet their various requirements so far as the railways were concerned." Owing to the "very drastic alterations in the mobilisation time tables" made by the War Office, a staff was specially appointed to deal with the matter, and as a result of herculean efforts on the part of this devoted body of enthusiasts, involving many hours of overtime, "on mobilisation being ordered, not only was our scheme complete, but time tables and sheets numbering many thousands were ready for immediate issue."

Existing accommodation at certain stations on the line, where large concentrations of troops were foreshadowed, was totally inadequate, so that plans and estimates were at once prepared for the necessary extensions, and the Company arranged to carry out the work with all possible speed.

Special troop trains, of which 1465 (exclusive of "empties" to and from entraining and detraining stations respectively) were run between August 4th and September 30th, 1914, were "signalled by a special code of 4-4-4 beats," this code signifying "precedence over all other trains," the ordinary passenger service being curtailed as occasion demanded. Seven hundred and fifty-one was the total of special trains required for the "large quantities of stores, equipment, etc.," and "in order to ensure that such consignments should be worked forward without delay," it was agreed that "they should be given 'Perishable transit.'" [156]

As will doubtless be within the memory of most of us, already on August 3rd, 1914, Sir Edward Grey was in a position to inform the House that "the mobilisation of the Fleet has taken place," the credit for the promptitude of this precautionary measure being in due course claimed by Mr. Winston Churchill, and resulting shortly afterwards in the resignation from his post as a Lord Commissioner of the Admiralty of Prince Louis of Battenberg, eldest son of Prince Alexander of Hesse; and "at this grave moment in our national history," so ran the message spontaneously addressed by His Majesty the King to Admiral Sir John Jellicoe, "I send you, and through you to the officers and men of the Fleets of which you have assumed command, the assurance of my confidence that under your direction they will revive and renew the old glories of the Royal Navy, and prove once again the sure shield of Britain and of her Empire in the hour of trial." To enable officers and men to "revive and renew the old glories of the Royal Navy," coal, not canvas, was needed, this entailing the provision forthwith of six hundred and fifty-one special trains for the conveyance of approximately 150,000 tons of Admiralty coal from the South Wales collieries to certain points on the East Coast. [157]

Various difficulties presented themselves in regard to the "supply of rolling stock, and the making-up of the troop trains of the required composition"; in regard to the working of

Westinghouse and Vacuum stock, as the case might be; in regard to congestion of traffic, necessitating the diversion of trains by alternative routes; and in regard to the requisitioning by the Government of certain steamers, goods-vans, horses, motors, etc., belonging to the Company.

But, as Mr. Horne points out, "no hitch whatever occurred so far as the London and North-Western Company was concerned in carrying out, not only the pre-arranged programme, but also the additional movements which have been arranged at short notice. The time-keeping of the trains has been excellent both from a traffic department and locomotive department standpoint, and the entraining and detraining at the various stations on the London and North-Western line were successfully carried out in every case."

Apropos of all of which data, one cannot but call to mind once again the ungrudging acknowledgment which the late Lord Kitchener saw fit to make on the occasion of his first appearance in the House of Lords as Secretary of State for War: "I have to remark that when war was declared, mobilisation took place without any hitch whatever.... We know how deeply the French people appreciate the prompt assistance we have been able to afford them at the very outset of the war." The official announcement, too, issued by the Press Bureau on Tuesday, August 18th, 1914, itself remains a landmark in the epic chapter of events: "The Expeditionary Force as detailed for foreign service has been landed in France ... and without a single casualty."

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It is a matter of common knowledge that during the initial stages of the war the French authorities undertook the whole of the transport by rail of the British Army in France, basing their decision and ability to do so largely, no doubt, upon the opinion prevalent at the time, which was to the effect that for various seemingly obvious reasons—of which perhaps the most palpable was the unprecedented and unparalleled strain necessarily imposed upon the human and material resources of the belligerent nations—the war could not continue for a period exceeding a few weeks, or months, at the outside. We even find it stated in the *Times* of August 20th, 1914, under the heading "Peace Insurance Rate," that "for a premium of 25 per cent., underwriters yesterday undertook to pay a total loss claim should Germany ask for peace on or before September 30th next."

When, however, it began to dawn upon the parties engaged that the struggle, far from diminishing in intensity, was becoming increasingly bitter and severe, the advisability of, or perhaps rather the necessity for, easing the onus devolving upon the French railways was obvious to all. In the early part of 1915, therefore, rolling stock on a small scale was sent over from England; but in proportion as the numerical strength of the British overseas forces rose, so did the requirements in respect of means of transport increase, until towards the winter of 1916, a period synchronising with the British offensive on the Somme, matters reached such a pitch that the only solution to the difficulty seemed to lie in the appointment of a "mission" of home railway experts for the purpose of investigating the situation on the spot. With this end in view the more prominent of the two world-renowned "Geddes-Goddesses," to wit, Sir Eric, was nominated the responsible head, and as a result of his inquiry and subsequent report, there came into being the office of "Director-General of Transportation," the sound principle underlying this new departure being that of employing "individuals in war, on work which they have been accustomed to perform in peace," the immediate outcome, too, being that the important position was filled *au début* by none other than Sir Eric Geddes himself, who, as the Earl of Derby was at some pains to impress upon his noble confrères in the House of Lords (cp. the *Times*, November 30th, 1916), undertook the work only "from purely patriotic reasons."

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In the issue dated September 6th, 1919, of that practical and very-much-up-to-date weekly journal, *Modern Transport*, is to be found tabulated in full and comprehensive form the "pedigree stock" emanating from the Director-General of Transportation; numerous personalities, bearing awe-inspiring affixes such as D.G.M.R., I.G.T., A.D.G.M.R., D.D.R.T., etc., *ad lib.*; appearing on the scenes as representing the direct lineal descent of the great D.G.T. himself. And subsidiary to these personalities, or heads of sections and sub-sections, was enrolled a galaxy of assistants, engineers furnished in part by the British railway companies on recommendation from the Railway Executive Committee, in part by colonial or foreign railways, and under whom, in turn, there served a numerous personnel, whose name was "legion," recruited mostly from the home railways.

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And the reason for this gigantic scheme of organisation cannot be explained in any manner more convincing than in the words of Sir Douglas Haig, who, dealing in his final despatch with the "Rearward Services," insists that "the immense expansion of the Army from 6 to over 60 infantry divisions, combined with the constant multiplication of auxiliary arms, called inevitably for a large increase in the size and scope of the services concerned in the supply and maintenance of our fighting forces."

Some staggering statistics now stare us in the face. "By the end of November, 1918," for instance, we learn that "the number of individual landings in France at the various ports managed by us exceeded 10-1/4 million persons," and "during the eleven months, January to November, 1918, the tonnage landed at these ports averaged some 175,000 tons per week."

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One can easily imagine the resultant effect upon these different ports situated on the northern coast of France. Let us take Boulogne, as being, perhaps, one of the most familiar of all, and any one who has chanced upon a little volume, bearing as its title "An Airman's Outings," cannot fail to recall the distinctly happy vein in which the author, writing under the *nom-de-plume* of "Contact," describes the inevitable change which came over the place during the war. "It (Boulogne)," so he tells us, "has become almost a new town. Formerly a head-quarters of pleasure, a fishing centre, and a principal port of call for Anglo-Continental travel, it has been transformed into an important military base.... The multitude of visitors from across the Channel is larger than ever; but instead of Paris, the Mediterranean, and the East, they are bound for less attractive destinations—the muddy battle area and Kingdom Come."

Small wonder, then, that the strain of supplying the means of transit, not only for these

multitudes of visitors but for their personal impedimenta and food supplies as well, became too great for the French camel's back. The whole business, if such it may be termed, was assuming a degree of which the proportions were verging on the prodigious. Thus, "for the maintenance of a single division for one day, nearly 200 tons dead-weight of supplies and stores are needed," and "for an army of 2,700,000 men (the total feeding strength of our forces in France) the addition of one ounce to each man's daily rations involves the carrying of an extra 75 tons of goods."

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Again, "in the six months May to October, 1918, a weekly average of 1,800 trains were run for British Army traffic, carrying a weekly average load of approximately 400,000 tons, while a further 130,000 tons were carried weekly by our light railways." Kolossal, indeed, with a capital K, are the figures which the Field-Marshal asks us to digest.

And in order to cope with this vast volume of traffic, in order that it might move freely and speedily to the various points of distribution on the British Front, "the number of locomotives imported ... rose from 62 in 1916 to 1200 by the end of 1918; while the number of trucks rose from 3,840 to 52,600," and in addition to the already-existing mileage of permanent way available in the rearward areas, during 1918 "were built or reconstructed 2,340 miles of narrow-gauge railway."

As was reasonably to be expected, "the introduction of new weapons and methods of war" accounted largely for the "huge bulk of the supplies to be handled," and another factor further responsible for the gigantic nature of the task imposed was to be found in "the establishment of a higher standard of comfort for the troops." The force of the logic in regard to "feeding the brute" may be said to apply equally to the soldier as to the husband; "*Une bataille ne se perd matériellement*," in fact, Napoleon is said to have expressed the view that "the moral is to the material in war as three to one." Consequently "great installations were set up," not merely for the repair of damaged material, but "installations of all kinds," embracing "hutments, camps, and hospitals," and "the Expeditionary Force canteens made it possible to obtain additional comforts close up to the Front."

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Without any shadow of doubt "no war has been fought with such ample means of quick transportation as were available during the recent struggle.... It was possible to effect great concentrations of troops with a speed which, having regard to the numbers of men and bulk of material moved, has never before been equalled."

Having noted, therefore, the more salient facts and figures, set out in so lucid a manner by Sir Douglas Haig, it is only natural, perhaps, that there should follow in direct sequence a desire to fathom, in some respect, the influences which rendered animate this gigantic scheme or organisation, this mammoth conglomeration of machinery, admirably planned no doubt, then set and kept in motion; to trace the sources whence flowed these "ample means of quick transportation"; and to become acquainted with the responsible practitioners by whom they were provided.

The influences at work—as a brief reflective glance through the pages of our mind will suffice to recall—are surely to be found in that "dauntless spirit of the people at home," and in "their incessant toil." The sources are clearly indicated by the "mine, the factory, the shipyard." The responsible practitioners are personified by those "distinguished scientific men" who "placed their learning and their skill at the disposal of their country."

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Briefly, the position amounted to this; the fighting line could not be held without the support and replenishment afforded by the rearward services; the rearward services could not perform their part unaided by the people at home, and, as was only to be expected, the London and North-Western Railway Company was second to none in stepping forward and rendering that aid which was vital to the continued sustenance of the rearward services.

But charity, as we know, begins at home, and even though no effort was spared in regard to supplying the wants of the overseas forces, the Company obviously could not afford so to denude itself of its available working resources as to court the risk of failure to "carry on," to carry out the task imposed upon it by the State at home.

A further report issued from the office of the Superintendent of the Line, dated July 8th, 1919, and retrospective of the strenuous times experienced by the Company during the war, describes how "the ramifications of the London and North-Western Railway system were quickly appreciated by the naval and military authorities," for being, as it was, "the main trunk line, the direct route to and from London and the west of England (viâ Crewe) with the west, north and north-east of Scotland," it also afforded every facility to passengers travelling "between the north-east of England and the west and south-west of England." But apart from this it is an incontrovertible fact that the Company did absolutely "lay itself out," and in a manner unparalleled in any other quarter, to study the convenience, and to relieve the anxieties, of the military from the lordly "Brass Hat" to the humble Tommy with his tin helmet; with the result that, instinctively as it were, Euston became the quest of all, a haven of refuge to many thousands of war-worn warriors, home for a few days' leave.

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As evidence of this, we may note that a total of 7,300,000 officers and men "on leave" were conveyed in "special trains"; that a further 2,864,000 specified as "small units of troops and pre-arranged by ordinary services," were accommodated in the ordinary trains; and that, in addition to these figures, there were many thousands of troops conveyed "every week in small units by the ordinary existing services, of which actual figures are not available," but of which most of us, retaining vivid recollections of overcrowded compartments and the crush of corridors, will no doubt be able to form some vague if inadequate estimate.

Luggage evidently was not in the habit of getting lost or left behind, as the figure "89,745 tons of baggage conveyed" will go to prove; 45,517 cycles received careful handling in transit, and the necessary accommodation was provided for the safe journeying of 500,000 horses, plus the rolling-stock necessary for the conveyance of 5,476 guns.

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Then, in spite of a number of the vessels comprising the London and North-Western fleet

being commandeered by the Admiralty, "a fairly regular service both for passengers and cargo" was maintained viâ Holyhead and Dublin, "the principal route between England and Ireland"; the two other sea routes viâ Fleetwood and Belfast, and Larne and Stranraer, respectively, assisting materially in the working of this "very heavy passenger and cargo traffic."

Turning next to "the requirements of the Fleet on the east and north-east coast of Scotland, there was a continuous coming and going of personnel, and movement of supplies, between the depôts in Scotland and those in the south and west of England, and the Admiralty concentrated the whole of this traffic on the west coast route." In this connection (and incidentally we may note the strict observance by the naval authorities of the Fourth Commandment) for two consecutive years, and on every day of the week except the seventh, which is the Sabbath, a special train provided exclusively for the use of the Admiralty, was run "between Euston and Thurso (serving the Rosyth depôt), the total number of men so conveyed being 500,000 and the mileage incurred over the L. & N. W. system alone being 388,700 miles." Then, "owing to the position of the Fleet, rail-borne coal was conveyed from the South Wales coalfields to such points as Newcastle, Grangemouth, Burntisland, etc., entailing an average of about twenty trains per day, in each direction, of loaded and empty wagons."

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A further, and by no means inconsiderable, call to be made upon, as it was gladly accepted by, the Company, was that of tending the wounded on arrival in "Blighty." Special ambulance trains of the most approved design were supplied, and run with unflinching precision and regularity. Refugees were catered for; and in direct contrast to the treatment meted out by the enemy to our own men, enemy prisoners and captives in our own hands were shown such pity that special trains were actually provided for their conveyance by rail. When all is said and done, however,

"Be England what she will,
With all her faults she is my country still."

Fresh still in the minds of most of us must be Mr. Lloyd George's memorable "for-God's-sake-hurry-up" message, calling upon the United States of America, at the time when the hammer blow of the final and despairing German offensive fell with full force upon the British Army in France, "to send American reinforcements across the Atlantic in the shortest possible space of time," and whatever may be the opinion held "pace" Mr. Wilson and his famous "too-proud-to-fight" utterance, there is no doubt but that at long last the great American people realised to the full the nature of the menace which threatened from the German aspiration to world-domination.

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Speaking at Spartanburg (cp. the *Times*, March 26th, 1918), General O'Ryan declared that "the only distressing feature of the news (of the German offensive) was the fact that the British had been obliged to make such enormous sacrifices because American assistance was not yet fully at hand. We have been galvanised now," he said, "into realising the immensity of our obligations."

Telegraphing to Sir Douglas Haig on the same date, President Wilson deigned to express "to you my warm admiration for the splendid steadfastness and valour with which your troops have withstood the German onset." And in the meantime, the complicated problem of transportation was occupying the keenest brains on the other side of the Herring-pond, for as the *New York World* (cp. the *Times*, March 30th, 1918) pointed out, "it (transportation) certainly cannot be solved by the kind of people who for ever wring their hands crying, 'For God's sake do something.' Godsaking will not drive a single rivet in a ship, or transport a solitary soldier across the Atlantic."

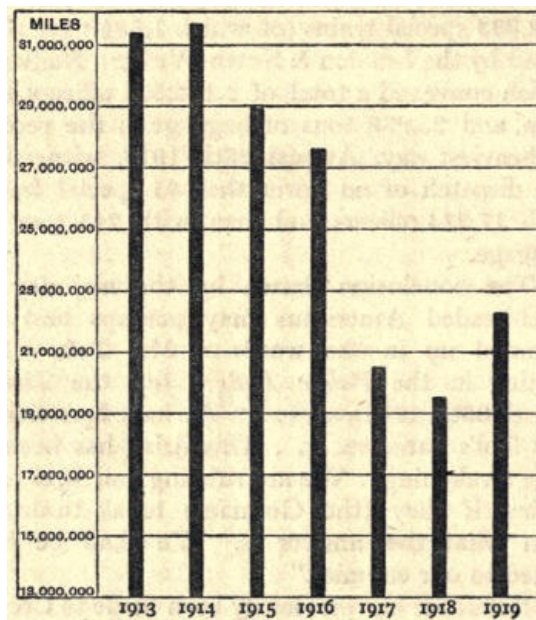
Having realised, then, the menace, "the Yanks" without doubt set to work and responded with a will, and the effect of their coming was felt, not only by the enemy, but—even though in a different manner—by the London & North-Western Railway Company as well, for "the majority of American troops which passed through England," as Mr. Home goes on to narrate, "were dealt with through the Port of Liverpool, the whole of the arrangements being in our hands," these necessitating "the running of 2,333 special trains (of which 1,684 were provided by the London & North-Western Railway) which conveyed a total of 1,182,505 officers and men, and 25,978 tons of baggage"; the record or heaviest day, August 28th, 1918, witnessing the dispatch of no fewer than 35 special trains with 17,274 officers and men, with 245 tons of baggage.

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The conclusion drawn by the majority of level-headed Americans may perhaps best be summed up in the words of Mr. Taft, who, writing in the *Public Ledger* (cp. the *Times*, March 30th, 1918), says:—"We have been living in a fool's paradise.... This drive has been a rude awakening. We are rubbing our eyes and asking if they (the Germans) break through, then what the answer is. We shall be left naked to our enemies."

Reference has previously been made to Crewe being, figuratively speaking, the pivot of the London and North-Western Railway compass: and the Company's system being, as Mr. Horne points out in his report, "the main artery running through the centre of England, and serving so many of the important centres of industry in the country," necessarily "carried an immense amount of traffic of varying character."

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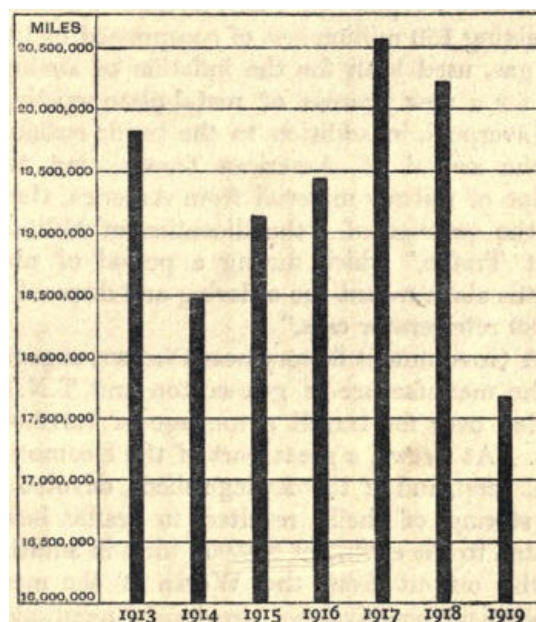


PASSENGER TRAIN MILEAGE—L.N.W.R.

In this respect the two accompanying diagrams are of no little interest, showing as they do in manner unmistakable how, in proportion as the volume of passenger traffic decreased, as a result of the abolition of excursion trains and cheap tickets, the general curtailment of services, and the increase of ordinary fares, so, owing to the exigencies of the war, did the amount of goods traffic show in direct contrast an enormous increase.

Increase of mileage obviously implies a corresponding increase of tonnage carried, and in this connection we may select at random a few out of many "interesting facts and figures," which have been compiled in regard to the "new traffic created, which passed in goods trains over the L. & N. W. system," facts and figures, in short, which clearly speak for themselves.

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GOODS TRAIN MILEAGE—L.N.W.R.

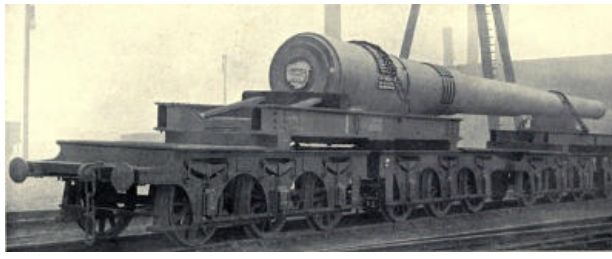
Over 100,000 tons of timber and sawdust were put on rail at Penrith by the Canadian Forestry Corps. Leeds, Huddersfield, and Manchester were responsible for the delivery of immense quantities of raw material, in addition to manufactured articles, such as army clothing and blankets, and other kinds of munitions. From Warrington were sent 323,188 miles of wire, barbed, telegraph, and telephone. Runcorn supplied 630,000 vessels containing poison and weeping gas; also 384,000 cylinders containing 150 million feet of compressed hydrogen gas, used both for the inflation of airships and for a new process of metal-plate cutting. At Liverpool, in addition to the traffic entailed by the arrival of American troops, and the receipt of railway material from America, there was the question of "the allocation of Military Meat Traffic," which during a period of nine months alone meant the ordering and disposal of 21,989 refrigerator cars.

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A Government factory near Chester, engaged in the manufacture of gun-cotton and T.N.T., handed over for transit a tonnage of 1,513,000 tons. At Crewe, a great part of the locomotive paint shop, and of the carriage sheds, devoted to the storing of shells, resulted in traffic being created to the extent of 330,000 tons, in addition to the output from the Works of the many mechanical contrivances previously mentioned. In the Birmingham district, one firm alone turned out 965 large tanks, each "over gauge" and approximately 30 tons in weight. Another firm being responsible for an output of about 1800 sea mines.

Sheffield was busy with the supply—*inter alia*—of 2000 tons of knives, forks, and spoons.

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NAVAL GUN WEIGHING 68 TONS. A TYPICAL INSTANCE OF WAR-TIME TRAFFIC.

[To face p. 173.]

The Coventry Ordnance Works dispatched 40,000 tons by the London and North-Western route, and the town of Coventry, being the centre of sixty-two Government owned and controlled establishments, sent out 300,000 tons of war munitions and Government stores.

Northampton forwarded an aggregate of 11,641,920 pairs of boots, weighing 36,881 tons.

In the London area "practically every firm of any size was engaged upon the manufacture of war stores of various descriptions, involving in most cases enlarged premises and increased output; and herein the North London Line—an offspring of the London and North-Western Railway—was destined to fulfil a *rôle* of no mean importance"; it was, in fact, "throughout the whole of the war an exceptionally busy section of the railway systems of the country," being "the main artery between the northern trunk lines and the railway system south of the Thames, in addition to forming the connecting link between the Great Eastern and the Great Western Companies."

Speaking generally, amongst "exceptional articles of national importance" which were conveyed by the London and North-Western Railway may be said to figure heavy guns; large cases of aeroplanes; ships' boats, propellers, frames, rudders, booms; armour plates; boilers; tanks; tractors; girders; etc., etc., and a vague idea of the truly enormous amount of goods traffic dealt with may perhaps be had when it is stated that the "approximate number of munition works, Government factories, aeroplane depôts, and camps," situated on the London and North-Western system was 1269, in addition to which there were a further "1237 factories, quarries, shipbuilding yards, etc., opened or extended during the war."

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Such in brief outline was the task performed at home by the London and North-Western Railway Company during the world struggle, and in face of everything the marvel perhaps was that the indefatigable staff never ran the danger of "ruining all, by trying to do too much."

The force of the argument, however, that "a wise man can ask more questions in a minute than a fool can answer in a year," becomes apparent when we reflect that, although nominally under State control, the staff on each railway remained during the war under the same control as prior to the war, and received their instructions as previously also; the result being that, undisturbed by an "unnumbered number of inexpert experts," and free from any such "deadly deterrent," unmolested, too, as they were by any kind of official bureaucracy, the railway companies were able to, and did, carry through the stupendous programme apportioned to them by the State.

In the knowledge of this happy circumstance, the country may indeed congratulate itself, for not only did the London and North-Western Railway perform its allotted task at home, but, as will now be seen, the staff of the Company's locomotive department at Crewe further succeeded by their "incessant toil" in rendering a very large proportion of that material aid, without which the "rearward services" of our overseas forces could never, in their turn, have enabled the fighting men at the front to bring the war to a successful conclusion.

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CHAPTER XI

INDISPENSABLE

"With the rearward services rests victory or defeat."
SIR DOUGLAS HAIG.

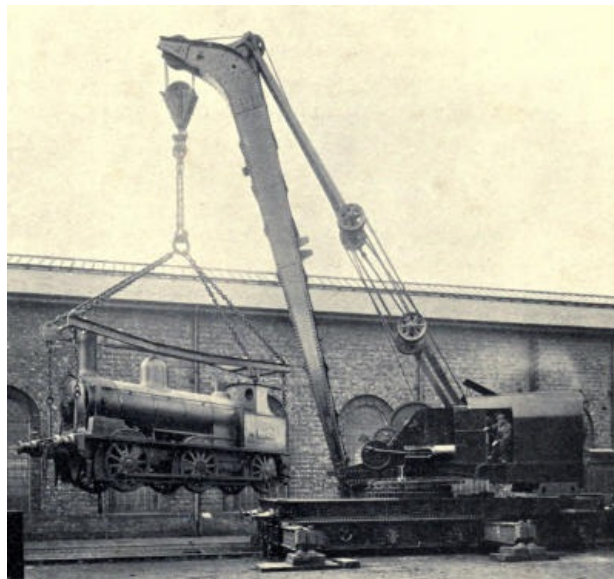
In the preceding chapter we have been able to digest a few of the more interesting facts and figures gleaned, in the one case from Sir Douglas Haig's final dispatch, and having reference to the task performed by the rearward services of the British Army in France; in the other, from the two reports issued by Mr. L. W. Horne, and dealing with the working of the London and North-Western Railway in the interests of the State, at home.

Most of us will probably retain some recollection of the scriptural parable of the virgins, five of whom were wise, and five foolish. Whilst hardly being perhaps quite fair to liken the rearward services of the Army to the latter five, who, lacking oil in their lamps, begged the necessary illuminant from the former, the London and North-Western Railway Company's locomotive department may nevertheless be said to resemble the wise virgins, in that, figuratively speaking, lamps were kept trimmed and full of oil, ready for any emergency; not only this, however, but going one better than the wise virgins, who, seemingly a trifle selfish and stony-hearted, turned a deaf ear to their foolish sisters in distress, the London and North-Western Railway locomotive department never hesitated to extend a helping hand to the rearward services of the Army, rendering possible in part that "wonderful development of all methods of transportation," which, as Sir Douglas Haig avers, "had an important influence upon the course of events."

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We have noted the extent of the goods traffic which was dealt with at home during the fateful years of the world war, and of which the mileage rose from eighteen and a half millions in 1914 to no less a figure than twenty and a half millions in 1917, and it was during this period, when Mr. Bowen-Cooke, in his capacity as chief mechanical engineer of the premier British railway company, was concentrating his endeavours on the maintenance of a supply of locomotive power sufficient to cope with this ever-increasing figure, that he was called upon to assist in that other and extraneous supply of similar power, by means of which the rearward services of our overseas forces were enabled to solve the immense problem of transportation by rail in the various theatres of war in which we were engaged, a problem which as we know, ultimately involved on the Western Front in France alone the running of "a weekly average of 1,800 trains, carrying a weekly average load of approximately 400,000 tons."

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BREAKDOWN CRANE AND LIFTING TACKLE FOR SHIPPING SMALL GOODS ENGINES.



AN OVERSEAS LOCOMOTIVE PANEL "SEVERELY WOUNDED."

[To face p. 178.]

Obviously the only method by which locomotive power could be made available for the

rearward services lay in the transference of engines overseas, in other words, depletion of available stock at home, depletion which was effected in compliance with Government demands, and in spite of the many difficulties which presented themselves and were contingent upon so unprecedented a situation.

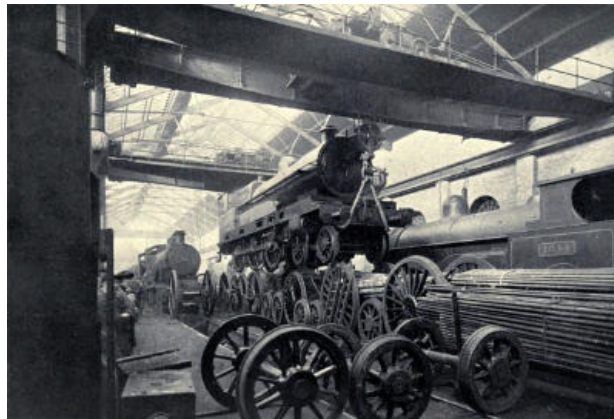
The first batch of recruits to be "called up" at Crewe was selected from that very stable little group, or "class," known as the "4 feet 3 inch, six wheels coupled coal engine"; these engines were specially fitted with tenders having a water-tank capacity of 2500 gallons, and nine were sent originally to serve on the Western Front, further recruits of this "class," numbering seventy-six altogether, seeing overseas service in Egypt, Salonica, and Mesopotamia respectively. These hard-working little engines, which in ordinary practice do not refuse a load of fifty-five wagons or approximately 600 tons, were nevertheless deemed incapable of contributing sufficient power in proportion as the size, or "feeding strength," of our overseas forces increased; the result being that the "power" limit was raised, and a sturdier form of recruit, found available in the well-known "G" class, or "4 feet 3 inch, eight wheels coupled coal engine," was summoned to the colours. These engines, of which a total of twenty-six found their way across the water, were fitted with tenders of 3000 gallons capacity, in addition to having (as was the case with the smaller engines) a special form of water lifter whereby water could be obtained from wayside streams or other occasional sources of supply. Capable of "walking away" with a load of eighty wagons, or approximately 900 tons, these powerful goods engines proved themselves a valuable asset, and so a determining factor in influencing the course of events.

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Hand in hand with "running" goes the question of maintenance and repairs, and in this connection installations on a large scale were set up in France as elsewhere, Audricq, Berguette, and Borre, situated in the Pas-de-Calais and Nord districts, being the main depôts for the repair of carriages and wagons, light railway engines, and locomotives, respectively; and in this connection Crewe once again was well to the fore in the provision of the requisite machinery and plant incidental to the fitting out of the modern railway repair shop. Briefly, a few of the outstanding features of this plant may be said to have comprised mechanical contrivances such as hydraulic pumps and accumulators, stationary boilers, electric motors, overhead travelling cranes, Goliath cranes, an hydraulic wheel-drop, a wheel turntable, a case-hardening furnace, a boiling bosh, levelling blocks, and a great variety of machine tools, details of all of which would in themselves suffice to complete an entire volume.

It was entirely thanks to the provision and installation of this machinery and plant that during the year 1917, for instance—as we learn from statistics published in the issue of *Modern Transport* of September 20th, 1919—143 heavy and 675 light repairs were carried out on locomotives; and in the following year, 1918, these figures were increased to 246 and 809 respectively; while the number of ordinary shed, or "running," repairs amounted to no less a figure than 5,487.

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TYPE OF OVERHEAD TRAVELLING CRANE, BUILT AT CREWE AND SUPPLIED TO THE OVERSEAS "REARWARD SERVICES."

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The complex and duplex task of maintaining simultaneously both the home and the overseas rail services was further augmented by the acceptance within Crewe Works, for general repairs, of numerous engines doing duty in the various military camps which sprang up in different parts of the country, namely those situated at Kimmel Park, Oswestry, Prees Heath, Cannock Chase, Milford and Brocton, etc., etc.

Heavy repairs were also effected in the case of two massive Belgian engines, which were sent to England, and in addition to this superabundance of work which was undertaken conjointly with the repair programme incidental to the London and North-Western Railway Company's own requirements, there was a continuous demand for the supply of locomotive spare parts incidental to the working of the overseas services.

In yet another respect was Crewe in a position to hold out a helping hand to that friend in need, the overseas rearward services. Enemy aircraft activity necessitated special precautions being taken to ensure the maintenance of communications, precautions which involved the construction of certain "deviation" lines of railway. Further, additional permanent way was required for sidings, and for double and quadruple tracking: and during the final Allied offensive many miles of new line were laid for the purpose of following up the enemy, and of bringing relief to the civilian populations left destitute in the districts which the enemy had evacuated.

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The London and North-Western Railway Company claims, and is renowned for, the finest

permanent way in the world, and the rails are for the most part rolled in, and supplied from, Crewe Works.

During the war the customary relaying of track was considerably curtailed, as may be gathered from the fact that, whereas during a normal year an average of 32,500 tons of rails are supplied, approximately half that tonnage only was supplied per annum while the war lasted. Consequently the average relaying of track during a normal year was reduced from roughly 140 to about 54 miles per annum. At the same time, rails sufficient for 56 miles of track were taken from stock and sent for use overseas.

The rail-mill in Crewe Works was, however, kept busy in other directions as well, turning out in the four years 1914-1918, partly for British railway companies, partly for use overseas, 38,844 tons of rails, equal to a length of 260 miles, besides which were supplied a considerable number of points and crossings complete.

Certain crises of the war will surely never fade from the memory of living man or woman, crises during which it may be said that—

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"There was silence deep as death,
And the boldest held his breath,
For a time,"

the while the fate of the Empire, of the whole civilised world, hung in the balance.

Such a crisis, and one that had far-reaching effects upon the organisation of the rearward services, occurred in the spring of 1918, consequent upon the collapse of Russia. Dwelling on the issues at stake, devolving the necessity on the German people to give "all it had," General Ludendorff claims [cp. "My War Memories," 1914-1918, page 600, Vol. II.] that their (the German) offensive was a brilliant feat, and will "ever be so regarded in history." Such it may have been, "for a time," backed as it was [cp. page 577, Vol. II.] by "twenty to thirty batteries, about 100 guns, to each kilometre (eleven hundred yards) of front to be attacked," which were "figures such as no man had ever credited before." But "the battle was so vast that even these quantities of steel," which the German guns discharged, "did not destroy all life" and although the effect on the Borre locomotive repair Works in the end was crushing to a degree, there as elsewhere, as Ludendorff finds himself forced to confess, "the infantry always found far too much to do," the result being that, thanks to the heroic resistance put up by our own men, and in spite of the fact that the Boche was within 1,500 yards of the place before the evacuation of the shops was commenced, nearly the entire plant and machinery were safely got away, and forthwith installed in some newly erected shops at Rang-du-Fliers, a tiny hamlet situated on the main Paris-Boulogne line, a few miles south of Étaples.

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It was about this time that the warrior War Lord, flushed with momentary success, saw fit to dispatch what was probably destined to be the final of his many "victory" telegrams. "My victorious troops," so he wired to the Empress at Berlin (cp. the *Times*, March 26th, 1918), "are pressing forward from Bapaume westwards.... The spirit of the troops is as fresh as on the first day. Over 45,000 prisoners, over 60 guns, 1000 machine-guns, and enormous quantities of ammunition and provisions, have been taken. May God be with us!" (signed Wilhelm).

Whether this royal and auspicious message, when published officially, had the desired effect upon a war-weary and demoralised people, it is hard to say; but even Wilhelm, the would-be Conqueror, must surely have begun to realise at long last that even if "you can fool some of the people all of the time, and all of the people some of the time, you cannot fool all of the people all of the time."

Getting down to solid facts then, the battle, in Ludendorff's opinion, "was over by April 4th," and although "thereafter there was bitter fighting ... our (the German) war machine was no longer efficient" [cp. page 684, Vol. II.].... "The Entente began the great offensive, the final battle of the world war, and carried it through with increasing vigour as our decline became more apparent."

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It is not uninteresting to note the second-in-command, or, as some believe him to have been, the actual commander-in-chief, of the great German fighting machine paying a tribute to the energy of the foe, the one foe hated and feared of all others by the entire German people, namely England; and this energy was at the time in question very properly brought to the notice of a representative gathering of Colonial, American, and English journalists by Mr. Winston Churchill, who, speaking on behalf of the Ministry of Munitions (cp. the *Times*, March 27th, 1918), told these gentlemen of the Press that they must "recognise that the strength of the British armies rests not only on the superb courage of the soldiers, but on the gigantic output which their countrymen at home are contributing from week to week, and from hour to hour, after all these years of strain, never at such a pitch of efficiency and energy as at the present time."

Few people there are, probably, who have ever realised what "the years of strain" have meant to the workers in mine, factory, and shipyard; it is in fact the exception rather than the rule to find in public utterances reference to the drudgery, the monotony, involved in the manufacture, frequently of a repetition nature, hour after hour, week after week, month after month, of all those countless mechanical contrivances of which the diverse component parts are essential to the whole. The tendency has been rather to decry these people as shirkers, money-grubbers, worthy only to be labelled with epithets unsavoury to the palate. In every branch of a profession or trade, in every walk in life, there are of course bound to be exceptions, but in common fairness to those innumerable and genuine "indispensables" who perforce remained at home, let us not forget that to the many of these who would gladly have gone was denied the experience, the excitement, the novelty, attaching to the open-air life of movement incidental to an overseas campaign.

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Obviously enough, closely allied to, in fact interwoven with, production is the question of cost,

a question which in war as in peace could not fail to afford a loophole for difficulties and disputes, either of a minor character, or aggravated perhaps by the continued years of strain and monotony.

Mr. Churchill, however, was undoubtedly on the right tack when he went on to insist that we should "not assume that because from time to time they (the workmen) put forth their sectional aims, these aims were the only things they care about. They have a sort of feeling," he declared, "that they have to push forward their class interests, and I am not blaming them for it, but in the main our strength rests upon their loyal, resolute support, and we can count on that."

As a single instance of the reliance which could be placed in the work-people's resolute support, we have only to note the loyal adherence by the men in Crewe Works, which they maintained to the bitter end, to a resolution which they passed themselves, to the effect that "We, the working men of Crewe, will do all that is humanly possible to increase the output of munitions, and stand by our comrades in the trenches"; and this resolution was the outcome of a series of meetings organised and held in the summer of 1915, in the various shops within the Works, when Mr. Cooke, having emphasised the paramount importance of keeping up the great railways, "which have to deal with the transport of soldiers and munitions, that keep together the life of the country," went on to remind his hearers that "it is to those who produce the material for the making and repairing of locomotives who have this all-important matter in their hands."

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"WE, THE WORKING MEN OF CREWE, WILL DO ALL THAT IS HUMANLY POSSIBLE TO INCREASE THE OUTPUT OF MUNITIONS, AND STAND BY OUR COMRADES IN THE TRENCHES."

[To face p. 180.]

Appropriately enough, Mr. Craig, M.P. for the constituency, having already wired the terms of the resolution to Mr. Lloyd George, was able on behalf of the latter to "thank you, the men of Crewe Works, for the splendid efforts you have put forward in the past;" adding, that he had peculiar satisfaction in so doing, for "never either in the House of Commons or out of it have I heard a word of reproach levelled against the men of Crewe. Their patriotism has never been impeached."

That this outspoken tribute contained nothing from which could possibly be construed anything in the nature of what is commonly known as "gush" is easily apparent from the fact that Mr. Craig had only just previously appealed to the men to "allow nothing to interfere with the production of munitions of war. You are asked," he said to them point-blank, "to relax for the time being all trades union rules and regulations, and to compete with one another in order to produce the largest possible amount of munitions."

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With the exception, then, of an insignificantly small minority of juvenile and inexperienced would-be firebrands, who in nine cases out of ten could not boast of ever having ventured beyond their native shores, if indeed beyond reach of their mothers' apron-strings, the attitude of the men of Crewe was, throughout the protracted struggle, loyal to the core, and that this was so must ever redound to their undying credit.

Let us compare for a moment the condition of things prevailing at the time in Germany, for although "other countries possessed an army, in Prussia," as we know, "the army possessed the country," and probably because of this inflexible régime, possibly in spite of it, everything was not exactly "couleur de rose." In order to sustain the rearward services of this ruthless "juggernaut," Ludendorff "went nap" for universal conscription, industrial as well as military, for all persons between the ages of fifteen and sixty. Another point he was always striving to enforce was the raising of the pay of the fighting man, and a corresponding reduction in the pay of the workman. "The enthusiasm of the moment passes," so Ludendorff argues (cp. page 331, Vol. I.), "it must be replaced by discipline and understanding." But the law which the German Government resolved to introduce in November, 1916, for conscripting auxiliary labour was in his opinion, (cp. pages 332, 333, Vol. I.) "neither fish nor fowl. We wanted something wholesale. The bill departed, too, from the principle of universal liability to service, and gave no security that the labour power obtained would be so employed as to produce the maximum results. It was not merely insufficient, but positively harmful in operation. It had a bad effect on the soldiers;" for "troops withdrawn from the heavy fighting at the Front saw auxiliary workers and women workers working in peace and safety for wages far higher than their own pay. This was bound to embitter the men who had to risk their lives day by day, and to endure the greatest hardships, and of necessity increased their dissatisfaction with their pay." In the circumstances, can anyone marvel that:—

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"Reason frowns on war's unequal game,
Where thousands fall to raise a single name?"

The war-profiteer, too, was "a repulsive phenomenon," who (cp. page 342, Vol. I.) with the

"corruption of his influence has done us incalculable harm."

That our own Government of the day adopted and pursued a policy, if not exactly of killing, at least of spoiling, the goose that laid the golden egg—a policy, moreover, which could not fail, here as in Germany, to have the effect of discrediting the fighting man in the eyes of his mate privileged to remain at home—was certainly no fault of the railway companies or of their own employés; in fact one branch at least of the railway service, the staff of which had no particular reason to bless the Government, or indeed the war at all, was the locomotive accountants' department at Crewe; for those who were employed in this particular department, that is to say those of them who were left at home—and the fact should never be overlooked that the percentage of clerks who joined the Forces was not surpassed by that of any other grade of employés on the railways—were involved in the few years of the war in hard work, changes, and readjustments of one kind and another, such as ordinarily would not have been their lot to experience, in the whole course of a lifetime.

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It is true that at the commencement of the war efforts were undoubtedly made to curtail office work as far as possible, the Board of Trade assisting in this direction by suspending Statistical Return 12 of the Railway Companies' Accounts and Returns Act. Statistics, too, relating to shunting, extraction of mileage in districts for rating purposes, and certain sub-divisions of mileage, were discontinued.

Then again, the Government having guaranteed the nett receipts of the railways, although charges affecting capital and stock still operated, the Railway Executive Committee decided to put in abeyance the practice of rendering accounts as between one railway company and another, for work or services rendered on revenue account, whether on personal account or at joint stations, junctions, etc.

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As against all this, however, obligations commenced, increased, and multiplied in other and different directions. At the very outset of the war, for example, in order to separate the Government control period from the pre-control period, extensive stock-taking was necessary, as well as a complete making-up of accounts as from midnight August 4th, 1914.

Then, as can easily be imagined, no sooner did the Government issue their appeal to the railway companies for assistance in the manufacture of munitions of war, than an immense amount of clerical work followed suit, the clerks responsible having immediately to conform with Government requirements. Again, owing to scarcity of raw materials, which were placed under Government control, numerous statistics had to be prepared in regard to actual requirements; reports, too, had to be sent in periodically as to scrap metal, especially copper, and particulars furnished in regard to the output of iron and steel.

On the top of all this came the introduction of the war-wage with its periodical increase to meet the increasing cost of living; and the subsequent inauguration of the District rate of wages, accompanied as it was by the regrading, according to their duties, of every single workman, skilled or semi-skilled, entailed an enormous amount of clerical work; the timekeepers were almost incessantly occupied in dealing with arrears of payment under the National awards, this necessitating many hours of overtime, Saturdays and Sundays not excepted. In fact, so great did the pressure of work become throughout the department that, in order to counterbalance the depletion of staff occasioned by so many clerks joining the colours, recourse was had to the employment of females, who, to the number of 162, assisted materially in easing the burden which devolved upon that section of the permanent male staff who remained in harness and without whose expert knowledge and experience an interregnum of complete chaos must inevitably have supervened.

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Sir Douglas Haig in his final dispatch does not neglect to extend his thanks, which were "especially due," to those "responsible for the efficient work of the various rearward services, and administrative services and departments" of the British Army in France, amongst whom may be noted "my Financial Adviser," and "my Pay master-in-Chief"; and in direct proportion to the nation at large owes a debt of gratitude to those prominent personalities, incidentally, too, to the members of their subordinate, but none the less loyal and devoted, staffs who gave their services, and in some instances their lives for their King and Country—so, too, must the public in general ever remain indebted to the heads of the administrative departments of the great British railway companies—the Financial Advisers, the Paymasters-in-Chief—amongst whom may be cited the Chief of the Accountants' department of the London and North-Western Railway Company's locomotive department, Mr. T. Ormand, together with the members of his subordinate, but none the less indefatigable, staff at Crewe.

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The studied opinion of Sir Douglas Haig, when he comes to summarise his views in general, certainly compels our attention. "It is hardly too much to assert," so he writes, "that, however, seemingly extravagant in men and money, no system of supply except the most perfect should ever be contemplated."

Perfection, it may reasonably be argued however, need not necessarily entail extravagance; and certainly the system of supply in operation at Crewe, efficient as it undoubtedly was, was productive of saving rather than of waste. The fact that the cost of labour, on the cessation of hostilities, showed an increase of 135 per cent. over and above that which was prevalent at the commencement of the war, cannot by any manner of means be laid at the door of the railway directorates, who, in regard to questions of wages and discipline, were controlled by the national agreements which from time to time came into being. Neither could the railway companies be classified even in a minimum degree amongst those "repulsive phenomena," the war-profiteers; for, the railways having become, as it were, part and parcel of the Government, it resulted as a natural corollary that work carried out in railway workshops whether for railway or munitions-of-war purposes became *ipso facto* Government work, and the bill for all such work when presented was made up simply and solely of the actual cost of materials, wages, and workshop expenses, plus 12-1/2 per cent. for supervision and establishment charges. The only profit with which the

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coffers of the railway companies were replenished in return for their war-time energies was in respect of munitions manufactured for private firms, and even then the profit never exceeded 10 per cent. over and above the actual cost of production.

Those were indeed "the times that try men's souls," and it was the Government policy throughout—a policy which, as happened to be the case in Germany, was "neither fish nor fowl," in that whilst inflicting untold hardship, loss, and suffering on some, it relieved others, saddling them with a minimum of inconvenience, and removing from them all "conception of the duty of universal service"—to which was attributable that extravagance "in men and money" referred to by Sir Douglas Haig.

On the occasion of the introduction of the first post-war Budget, when the Chancellor of the Exchequer, Mr. Chamberlain, suggested (cp. the *Times*, May 1st, 1919) that it would be of "interest to divide the year into the period before the armistice and the period since the armistice was signed, and to see what the average daily expenditure was in each of those two periods," Mr. Adamson (Fife W. Lab.) expressed a desire to temper his criticism with sincere commiseration for the Chancellor, whose task was to find the first instalment of the terrific obligations imposed upon the country by the extravagance, and in some respects the incredible folly, of spending departments during the war period, which had resulted in a daily average expenditure during the earlier of the two periods mentioned by Mr. Chamberlain, namely from April 1st to November 9th, 1918, of £7,443,000; in the later period, namely from November 10th, 1918 to March 31st, 1919, of £6,476,000.

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It is doubtful whether the explanation adduced by the Chancellor, in regard to this extravagance, this incredible folly, afforded any real degree of solace to Mr. Adamson or to any other honourable members, who inclined to view the financial outlook with such marked concern.

"The National Debt proper, exclusive of what we call other capital liabilities, was," as Mr. Chamberlain pointed out, "on March 31st this year (1919), 7,435 millions," or 6,790 millions more than it was at the outbreak of the war; and "of the actual debt incurred, internal debt accounts for, approximately, 6,085 millions, and the external debt, approximately, 1,350 millions." There were, it is true, "certain assets, such as obligations of our Allies and Dominions, votes of credit no longer required, and payments in respect of indemnities from our enemies." But when all was said and done, "when every proper allowance is made for these assets—the amount and value of which as well as the date at which we may expect to receive payment for them is necessarily uncertain—the burden of debt left to us is still very formidable."

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The tone predominant throughout this outline, indicative of the manner in which the taxpayers' millions were being used or misused for their especial benefit, was undeniably pessimistic. On the other hand, every cloud has its silver lining, and the occasional gleams, which illumined the lowering trend of Mr. Chamberlain's forebodings, become intensified a thousandfold when we reflect upon the horrors which we, in our insular position of security, escaped, and when we ponder over the fate that would most assuredly have been ours had the Warrior Warlord won the day.

Writing to the *New York World* in April, 1915, Mr. Gustav Roeder throws some light upon the state of mind of the German women alone. "Talk about your so-called atrocities which our men are said to have committed in Belgium," they said to me, "it would be nothing in comparison with what our men would do in England, and we women want to be there too."

As a sample of the treatment accorded to the unfortunate inhabitants of those portions of the fair land of France which the invader succeeded in over-running, we may take this deposition of the *Times'* special correspondent with the French Army as being sufficiently convincing. Writing under the date of March 21st, 1917, he says, "when the Germans left Noyon on Sunday, they took with them fifty young French girls, who, they said, were to act as officers' servants. When he (a distinguished French officer) was on a part of the Somme front now taken over by the British, he saw with his own eyes photographs, taken from German prisoners, of German officers sitting at dinner and being waited upon at table by naked women."

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Even during the earliest days of the war, evidence was not wanting in proof of the fact that German Imperialist greed was in no way to be denied. "Heavy ransoms on French towns" was the heading to a paragraph in the *Times* of September 7th, 1914, and edifying to a degree was the subjoined list of towns from whose impotent inhabitants the jubilant Hun was setting to work to exact sums of money varying in proportion to their size and population.

Thus we learn that having imprisoned the Préfet du Nord, the Germans demanded from the town of Lille "a ransom of 7,000,000f. (£280,000). At Armentières they were content with a ransom of 500,000f. (£20,000). At Amiens they have demanded 1,000,000f. (£40,000) and 100,000 cigars. Lens has been ransomed for 700,000f. (£28,000)." On yet a previous occasion (cp. the *Times*, August 22nd, 1914), the Press Bureau having obligingly announced that out of £15,000,000 of Treasury bills, for which the Treasury had invited tenders to be sent in, £10,000,000 was required for a loan from the British Government to Belgium, the Germans promptly decided that this good British gold might be turned to far more profitable account by themselves than by the Belgians for whom it was ostensibly intended, and proceeded forthwith to impose upon the city of Brussels a war contribution of eight million sterling. The All-Highest is credited with having expressed himself as being convinced that "the German people had in the Lord of Creation above an unconditional ally on whom it could absolutely rely." He must have felt, too, that his faithful subjects had in the British Government below a purblind benefactor whom they could regard as an unflinching source of revenue.

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Some idea as to the aspirations and intentions which the Germans were keeping up their sleeves as concerning ourselves may be gathered from certain observations which were drawn up by the Allied Ministers at Jassy, with regard to the conditions imposed upon Rumania by the Central Powers, and which in their own words "demonstrate in the best possible manner the insatiable greed and hypocrisy of German Imperialism."

The actual terms of the treaty (of Bukarest) required, *inter alia* (cp. the *Times*, August 10th, 1918), "the entire male population of the occupied territories, that is to say of two-thirds of Rumania, between the ages of fourteen and sixty, to carry out such work as may be assigned to them. The penalties for disobedience include deportation and imprisonment, and in some cases, which are not expressly defined, even that of death. This treaty," as the Allied Ministers observed, "is a fair example of a German peace. We should consider it all the more closely inasmuch as the German delegates informed the Rumanian delegates, who were appalled at being required to accept such conditions, that they would appreciate their moderation when they knew those which would be imposed on the Western Powers after the victory of the Central Empires."

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For the fact that "this England never did," and for the determination that she "never shall, lie at the proud foot of a conqueror," we owe it entirely to the grit of succeeding generations of British fighting men. "Wars may be won or lost," in the opinion of Sir Douglas Haig, "by the standard of health and moral of the opposing forces"; and because "the feeding and health of the fighting forces are dependent upon the rearward services, so it may be argued that with the rearward services rests victory or defeat."

In the same way, since, as we have already seen, the rearward services of the overseas forces depend for their sustenance upon the continued and successful operation of the home services of supply and transport, so it may be argued that upon the feeding and health of these latter services does the final issue hang.

Realising then, from the very outset, the import of the task devolving upon the great railways, appreciating, too, the truism that you cannot maintain an A1 engineering community any less than an "A1 Empire with a C3 population," Mr. Cooke determined on the course of inaugurating, in the immediate vicinity of Crewe Works, a canteen, which, rivalling similar establishments set up in well-nigh every Government-owned, or controlled, munition factory throughout the length and breadth of the land, was built and equipped with the most up-to-date cooking apparatus and utensils, at a cost of £3800, and this thanks entirely to the spontaneous generosity of the directors of the company, who further expressed their readiness to bear the cost of all maintenance charges, such as heating, lighting, and salaries of the kitchen staff. As a result, the men were enabled to purchase all commodities at actual cost price, at the same time finding that the meals provided were of that excellence which inclines one to "forgive anybody, even one's own relations."

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There is not a shadow of doubt but that, as regards the rearward services both home and overseas, "our supply system has been developed into one of the most perfect in the world," and after being so largely instrumental in frustrating the aims of the common enemy, the only danger against which we had to guard was lest "the Ministers of the Allied Powers should lose by their pen what the Army had gained by the sword"; in which case the peace we had striven to secure—to quote the words of that great littérateur and statesman of a former generation, to wit George Canning—"would be the mere name of peace; not a wholesome or refreshing repose, but a feverish and troubled slumber."

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CHAPTER XII

L'ENVOI

"La Mort n'est rien,
Vive la tombe,
Quand le pays en sort vivant,
En avant!"

Surely no one will deny to M. Paul Déroulède, that eminent and talented French *homme-de-lettres*, to whose inspiring enthusiasm these lines are attributable, the right of his assertion that Death in the conditions which he mentions is a negligible quantity? Supreme as has been the sacrifice of those well-nigh countless scores of officers, non-commissioned officers, and men, who now "in glory shine," bitter too and crushing as undoubtedly is the sense of void occasioned by their absence beyond recall to those of their relatives and friends who remain, "where is Death's sting?" it may well be asked, "where, Grave, thy victory?" when the Country, struggling for all that she holds most dear, finally emerges triumphant, renascent, from the darkest hours of her existence; for underlying all, there is in this straightforward challenge a tinge of pride unquenchable, a ring of scorn unmistakable.

Granted then the truth of this dogma, granted too that nothing is more "dulce et decorum" than "pro patria mori," one cannot but bear in mind the fact also that Death is not infrequently a happy form of release from some lamentably pitiable condition of mind or body to another and altogether brighter degree of existence. "La douleur est un siècle, et la mort un moment;" one may even assume that the act of "passing away" is comparable to that merciful dawn of returning consciousness, to which the dreamer wakes from the vividly realistic, albeit imaginary, torture of some agonising nightmare. For who at one time or another of his or her enigmatic existence has not experienced this imaginary torture, of which the crazy sequence of headlong unreasoning realities wracks in topsy turvy torment the momentarily unbalanced brain, until in a frenzy of despair and faced with some climax, unprecedented and unparalleled, the dreamer wakes, bathed in profuse and clammy perspiration, breathless and bewildered, yet infinitely grateful to an all-powerful and protecting Deity that imaginings of so cruel and fantastic a conception should prove to be but phantoms of the night?

Yet of all the myriad atoms of trivial humanity who have survived the nightmare of Armageddon-up-to-date, what is the proportion of such who can honestly say that the life to which we have been restored is either brimful of promise or bright indeed with prospect? "Forward" undoubtedly must be the watchword; "en avant;" but whither?

Selecting as a suitable title "Plain Speaking," the writer of a leading article in the *Times* of August 13th, 1919, urges that "Ever since the Armistice Day they (the people) have been living in a fool's paradise, as though the cessation of armed hostilities had opened the door to a state of pure enjoyment according to every man's fancy.... The inevitable result is that Europe is drawing near, not merely to bankruptcy and financial ruin, but to actual starvation."

So pessimistic a pronouncement lends itself to the assumption that we are merely jumping out of the frying-pan of international strife into the fire of internal or domestic disruption. The writer of this article is, however, not quite so pessimistic as to be unable to offer any remedy, for as an alternative he insists that "this mad orgy of spending must cease from Government Departments downwards. All classes must turn to work.... Employers and employed must give up quarrelling and work together. Economy and work are the two watchwords for the nation."

"En avant," then. But first of all "let us examine things," as Mr. Lloyd George would have us do, "in the spirit of comradeship which has been created by the war, that spirit of comradeship which arose from a common sacrifice," and then, "let us demonstrate to the world once more that Britain, beyond all lands, has the traditional power of reaching a solution of her most baffling problems without resorting to anarchy, but merely by appeal to the commonsense of most, and in a spirit of fair play." Unhappily enough everybody was, however, "suffering from the terrible strain of the war; nerves were jagged and sore; the world was suffering from shell-shock on a great scale." The position, therefore, if not indeed dangerous was none the less serious and fraught with difficulty. Put in a nutshell, "we were spending more, we were earning less; we were consuming more, we were producing less; we were not paying our way. Before the war our National Debt was £645,000,000; to-day it is £7,800,000,000" (cp. the *Times*, August 19th, 1919).

"En avant!" But how to remedy the state of affairs? How to straighten out the tangle? What invariably happens when the blind lead the blind seemed bound to occur if the Coalition Ministry continued leading or misleading the people. "I make this indictment against the Ministry of the day," exclaimed Sir D. Maclean when addressing the House on August 12th, 1919, "that in this supreme financial crisis of the nation they are failing wholly in their duty to put a stop to extravagant expenditure." The Chancellor of the Exchequer estimated the then daily average expenditure at no less than £4,442,000; the Army, the Navy, and the Air Force accounting for £1,491,000 of this amount, notwithstanding the fact that since the Armistice a total of 3,087,973 of all ranks had been demobilised (cp. the *Times*, August 13th, 1919. Statement issued by the War Office).

There can be no doubt but that the opinion prevalent on all hands was that the great ship of State was in danger of being swamped in the maelstrom of Ministerial mismanagement; yet in spite of this we read that the Transport Bill (to take one solitary if salient instance) was proposing to "create a new and costly brand of bureaucracy, headed by titled dignitaries, and naval and

military officers, with a whole Milky Way of attendant satellites" (cp. the *Times*, July 17th, 1919), and truth to tell, this "new and costly brand" seemed likely to afford as great or as little hope of salvation to the man-in-the-street as would a stone if thrown to a drowning man; it could but let him down. According to the Gospel of Experience, "State Control has never yet resulted in economy," and the present was certainly no time for "legislative megalomania."

Admittedly no inconsiderable amount of ink has been spilt over the question of transport, covering as it does so obviously wide a range. The railways, as we know, during the war and since the armistice have been run at the expense of, and under the nominal control of, the State; but even so democratic a chieftain as is the versatile Prime Minister had to confess that he had not noticed any apparent harmony under this particular régime, and the subtle note of irony is by no means lacking when he reminds his hearers in the House of Commons "we have had, I think, a few strikes; and so long as strikes are prevalent, where," he asks, "is the promotion of harmony if you have State control and State ownership? I do not see the harmony that is to come under State control" (cp. the *Times* August 19th, 1919). No sooner had the outburst of cheering which greeted this remark subsided, than an Hon. Member (Lab.), chipping in, was heard to opine "these things will happen under private ownership," a theory which impelled Mr. Lloyd George promptly to retort, "I do not say it will be any worse under State ownership, but I say it will not be any better." To the average and impartial intelligence, therefore, the most satisfactory and logical Q.E.D. to this little argument might be summed up in the three words "as you were"; indeed, the "pros" in favour of so patent a usurpation of private interests as is embodied in State control or nationalisation of railways may be said to be far outweighed by the opposing "cons." During the period in which the nation was fighting for its life, there was evidently no time "for renewing machinery, there was hardly time for repairing, and there was quite inadequate time for cleaning," but the fact remains that during this period of State control the railways were run at a loss; and that loss, largely attributable to enormous increases in wages, diminution in working hours, and mathematically proportionate reduction in output, came straight from the taxpayers' pockets. Why then, it may be asked, this persistent demand for Ministerial megalomania-to-be? What the reason for this "new and costly brand of bureaucracy," which assuming the proportions of an octopus threatens to crush every vestige of individuality and private enterprise which happens within the deadly orb of its encircling and insatiable tentacles?

The explanation is not far to seek—"Sir Herbert Walker and his colleagues on the Railway Executive Committee have been too modest, the public do not know what they achieved" (cp. *Engineering*, January 17th, 1919, "The Railway Problem"). Further, unknown to the average man-in-the-street, "the individual organisations of the Railway Companies (during the war) remained intact, and the Boards of Directors continued to be responsible for the conduct of their affairs. The desire was to get the work done—to deliver the goods—"with as little disturbance of the existing machinery as possible. The changes which were introduced and the high efficiency which was witnessed in the working of the traffic of the railways during the war was due far more to a patriotic determination on the part of all concerned to do their utmost to assist the country in a time of national emergency, regardless of corporate or personal interests, than to the direct imposition by the Government of its will upon the railway companies."

Ministerial axe-grinders, and disgruntled Labour members, were well aware of all this; they were faced, too, with the fact that "the control by a Committee of General Managers has really resulted in freeing the railways from the 'blighting effect' of State control, and the successful operation of British railways during the war is really a tribute to the efficiency of private (as distinct from State) ownership." Not only this, but a further fact which undoubtedly redounds to the credit of Sir Herbert Walker and his little band of colleagues could not be disregarded, for as we learn from the *Times* of July 17th, 1919, "the Railway Executive Committee controlled the whole railway system of these islands during the war from a few shabby rooms at Westminster with a staff of about eighteen clerks. The Committee was so modest that they did not commandeer a single hotel, or angle for the smallest honours, but they achieved wonders of transportation with steadily diminishing resources." Finally, and as voicing the opinion of the business community at large, we have only to observe that the Glasgow Chamber of Commerce emphatically records its belief that "Nationalisation (of railways) would be a national misfortune."

One misfortune not unusually leads to another, and logically enough it may be argued that one of the more immediate of the "blighting effects of State control" likely to become apparent is what may be termed "the passing of ingenuity," resulting in lack of incentive to individual enterprise, or, in a word, an inevitable stalemate. "Committed irrevocably to mass production, to specialisation, to rigs and jigs and standards, to gigantic industrial combines, to the suppression of individual merit, and the apotheosis of mass merit," a writer in the *Engineer* of April 25th, 1919, deploras the fact that "skill is being transferred from the man to the machine; knowledge is being replaced by the schedule; organisation by rule is taking the place of organisation by mother wit." Plainly too, but none the less regretfully, the same writer conjectures that "in another fifty years these things we now foresee dimly will be the commonplaces of industry"; and "oh tempora! oh mores!" let future generations beware, for "brought up in standard crèches on standard feeding bottles with standard milk, we shall pass through a course of standard education, be dressed in standard clothes, carried in standard conveyances, live in standard dwellings, behave like standard citizens, and in due course be carried in standard coffins in a standard hearse to a standard crematorium."

Undoubtedly every one is entitled to his or her own opinion, *apropos* any particular subject of debate; but without prejudice it may be asked whether any one in his legitimate senses is capable of viewing this "standard" perspective, these "blighting effects of State control," with feelings other than of revolt and dismay. "Victory is nothing," so Napoleon is reputed to have declared, "if you do not profit by success"; and having achieved success regardless of the cost, having won through "non pour dominer"—to use the words of that great Commander of the Entente Armies,

Marshal Foch—"mais pour être libre," in what way are we endeavouring to profit?

"There is evidence of slackness; the effort has got to be quickened; all must put their backs into it to save the country. Our international trade is in peril, and our home trade is depressed by reduction of output and the increased cost of production. Words must be translated into action unless thousands of lives are to be sacrificed to hunger and cold; this is no hyperbole."

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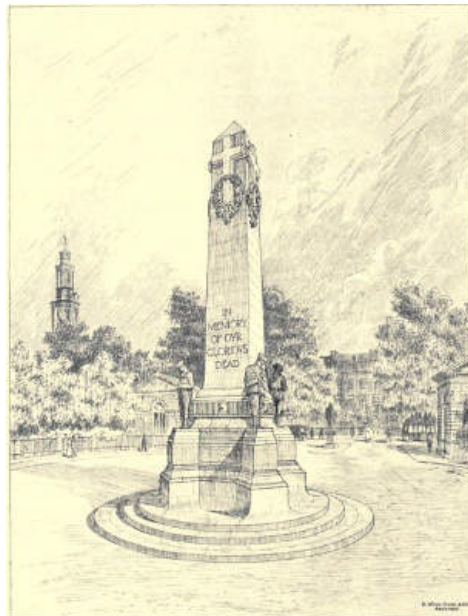
Such, as we know, are specimens of periodic if unpalatable pessimisms provided by prominent personalities. The experience of Sir Edward Grey, as he tells us, is that the difficulty is not so much to tell the truth, as to get the truth believed. Were we then really living in a fool's paradise? Could it truthfully be said that we as a community were consenting to become a "League of Dupes," as the Nations have been banded together as a League? Heaven forbid! for just as it would be idle to imagine that there will be no more strikes, no extremist incitement to anarchy, so too in the considered opinion of Mr. Lloyd George "it would be folly to assume that human nature will never give way to passion again, and that there will be no war. A nation that worked on that assumption might regret its conduct." Unfortunately, there is no denying the fact—as a captured German naval officer once tersely put it—that although they (the Germans) could never be gentlemen, we (the British) would ever be fools! Hence it comes about that at a time when "the most pressing interest of humanity is that the profit and loss account of a barbarous bid for world-power should show an impressive balance on the wrong side," it is open to argument whether the policy embodied in the Treaty of Versailles, of "tempering justice with mercy," was altogether prudent; mercy, that is, which "could not speak more eloquently than it does in the un mutilated landscape of German agriculture, and in the immunity of her civilians from all the horrors of her own practice as an invader" (cp. *Pall Mall Gazette*, June 28th, 1919).

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Be that as it may, "once bitten" is proverbially and habitually "twice shy," so that it would seem well-nigh inconceivable that a lesson of such magnitude as the Nation has learnt during the long-drawn-out agony of the world-war can readily be forgotten; and whatever the future all unknown may hold in store for us, undimmed in the minds of succeeding generations will most surely shine as a guiding light the splendid record of private enterprise and of individual endeavour as exemplified by the great railway companies of the British Isles, amongst which pride of place can scarcely be withheld from the London and North-Western Railway, to whom the country, without doubt, owes a deep and lasting debt of gratitude.

"En avant!" then, as surely those who gave their all would have us do. "En avant!" that their sacrifice supreme shall not have been in vain. "En avant!" and may our thankfulness and pride go out to them in that "great unknown beyond," where they—

"... shall not grow old, as we that are left grow old,
Age shall not weary them, nor the years condemn,
At the going down of the sun, and in the morning,
We will remember them."



WAR MEMORIAL, EUSTON.

"At the going down of the sun, and in the morning, we will remember them."

[To face p. 210.]

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APPENDIX A

THE SYSTEM OF CONTROL APPLIED TO THE ARMoured TRAINS MANUFACTURED IN CREWE WORKS

Fitted with standard vacuum brake, the train was also driven by an ingeniously devised vacuum system of control, which could be operated from either end of the train or from the footplate of the engine. On the smoke-box side, and intermediate between steam chests and main regulator valve, was fixed an additional regulator valve, actuated by a small vacuum cylinder. A 3/4-inch vacuum pipe acting in conjunction with the vacuum brake pipe and running the whole length of the train was connected to three pairs of vacuum control valves and gauges fixed, respectively, one on the footplate and one at each end of the train. When all these vacuum control valves were placed at the "shut" position, the ports were open to admit air, and no vacuum could be created; consequently the brakes remained on, and the additional regulator valve shut, so that no steam could reach the steam chests even if the main regulator valve was open.

When, however, the vacuum control valves were placed in the open position, the air ports were closed, and the driver, supposing he was at the end of the train, signalled to the fireman on the footplate to "blow up" with the usual steam-ejector, a vacuum being thereby created not only for releasing the brakes, but also for operating the additional regulator valve which the driver controlled and by means of which he started the train. Conversely when he wished to stop, all that he had to do was to bring his control lever over once again to the shut position, when the air-ports opened, the vacuum was destroyed, the regulator-valve shut, the brakes went on, and the train came to a standstill.

APPENDIX B

EXPLANATORY OF THE GAUGE

Gauges may be divided into two categories known as "working" and "inspecting" gauges; again each category is further divided into two sub-categories, designated in approved munitions' parlance as "to go" and "not to go." "Working" gauges being in more or less constant use, and subjected, not infrequently, to a certain measure of rough usage, were allowed a slightly less "tolerance" or margin, plus or minus, high or low, than were "inspecting" gauges; that is to say, given a certain specific measurement for any specific part of a shell, the gauge in proportion as it was "working" or "inspecting" was limited to a tolerance of a minute fraction of an inch either above or below the finished dimension; this was in fact considered the *beau idéal* of good workshop practice.

Let us take for the sake of argument a shell body. If after being turned to presumably the required and finished diameter it was found to slip through the hole of a "not to go" working gauge, there was no alternative other than that of scrapping it then and there, because obviously once turned to too small a diameter, not "all the king's horses nor all the king's men" could ever increase that diameter by one single iota again; as a biblical parallelism one might even add that it would be "easier for a camel to pass through the eye of a needle" than for a "not to go" shell to enter into bond. If, on the other hand, the shell would not quite enter the "to go" hole of a "working" gauge, or even if it was a tight fit in this hole, it followed that there remained a certain tolerance or margin whereby the diameter could still be reduced to a trifle, and the shell *per se* qualified as a candidate for the final examination of the "inspecting" gauge. Picking up, then, our "inspecting" gauge we find that this, in like manner, has two holes, one "to go" and one "not to go"; but the gauge-maker has perforce been wily enough to leave the tolerance of these "inspecting" gauge holes a minute fraction of an inch greater, above and below the required finished dimension, than that allowed in the "working" gauge holes, his purpose being to ensure the inspector something up his sleeve in the way of control over the machinists who use the "working gauge" only; hence the "not to go" hole of the "inspecting" gauge is slightly less in diameter than the "not to go" hole of the "working" gauge; the "inspecting" "to go" hole is a tiny trifle larger than the diameter of the finished shell than is the "to go" hole of the "working" gauge.

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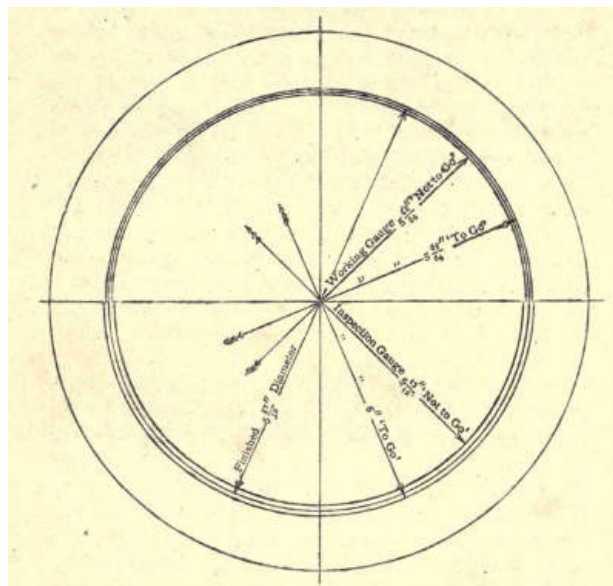
The accompanying diagram scaled to convenient fractions of an inch will perhaps help to illustrate the meaning of these tolerances.

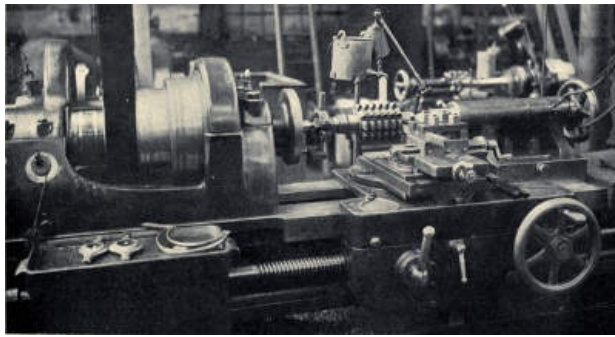
Suppose for instance that the correct finished diameter of our shell is $5\frac{31}{32}$ inches, the tolerances allowed by the Government (*i.e.* the final "inspecting" tolerances) can be represented by the two semicircles and dimensions shown below the centre line, which, as will be seen, are further from the finished dimensions than are the two semicircles and dimensions shown above the centre line, these latter representing the "working" tolerances, the difference between the two sets of figures representing the amount of margin kept up his sleeve by the Inspector by way of control over the machinists using the "working" gauges only.

In actual practice of course the fractions of an inch representing these tolerances are infinitely smaller than those shown above for the purpose of illustration only.

Some idea of the infinitely small fractions representing the tolerances allowed may be gathered by taking a sheet of ordinary thin note-paper, the thickness of which is about $\frac{3}{1000}$ parts of an inch, or $\cdot003$ inch; try to imagine this sheet of thin note-paper made ten times thinner still, and you will find it reduced to a minimum of tissue thickness, $\frac{3}{10000}$ parts of an inch or $\cdot0003$ inch; remember now that on good artillery depends not only the lives, maybe of your nearest and dearest, but the honour of the nation too; and you have firstly some idea of the imperceptible fractions of an inch to which a shell-gauging instrument is made; secondly the reason for the proportionate degree of accuracy demanded in the manufacture of artillery ammunition itself.

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MANUFACTURE OF A HOB-CUTTER, IN "RELIEVING" OR "BACKING-OFF" LATHE.

[Appendix C

APPENDIX C

THE THREAD-MILLER, AND THE "BACKING-OFF" LATHE, AS APPLIED TO SHELL-MANUFACTURE

The action of a thread-milling machine is as follows:—The cutter fixed on a mandrel, and the shell in the milling machine, revolve in opposite directions to one another. The teeth of the cutter, contrary to expectation, are simply a series of parallel rings cut the correct pitch of the thread required; consequently all that is necessary is that the shell shall travel longitudinally the distance of one pitch of the thread during one complete revolution, and the job is done.

Particular interest centres, perhaps, in the little thread-cutter itself, and in the amount of ingenuity evinced in the method of its manufacture.

In the first place a rotary form-milling cutter regulated by a dividing head is run across the eventuating hob thread-cutter in a series of spiral lengths. The profile of this form-milling cutter forms both a rounded clearance for the cutting edge of the hob cutting teeth and a "gash" or groove necessary for the clearance of the chasing tool when cutting the teeth.

The reason for these spiral gashes is that each separate tooth shall come into play individually and consecutively instead of collectively and simultaneously, the life of the teeth being in this manner very materially prolonged.

We notice then, that instead of adhering to a uniform circumference, the teeth, or series of teeth, are what is known as "backed off" from the cutting edge, a clearance being in this wise imparted, the true form of the teeth being thereby maintained in subsequent grinding operations.

This clearance is obtainable by means of the "backing-off" or "relieving" mechanism of a lathe especially designed for the purpose. A geared shaft running parallel with the bed of the lathe causes to revolve a cam. This cam, by virtue of the eccentricity of its face, imparts a transverse movement to the lathe rest through the intermediary of a transverse spindle on which is fixed a second cam also eccentrically faced.

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The revolving face of the one bearing against the stationary face of the other causes the latter to draw the lathe-rest inwards against the compression of a spring; no sooner have the cam edges passed one another than the spring relaxes, allowing the lathe-rest to jump back again to its former position.

It is during the inward movement of the lathe-rest that the form-chasing tool cuts the required clearance behind the hob miller's teeth, finishing into the cross-cut spiral gash; the outward movement has the effect of pushing the chasing tool in the nick of time clear of the succeeding row of teeth, ready to repeat a similar operation. The eccentric profile of the cam faces, needless to say, is responsible for the curved relief, or clearance, behind the edge of the hob miller's teeth, and the cams can be changed at will according to the curve required. The delaying action of the lathe-rest necessary to coincide with the spiral gash is imparted by means of a slide set diagonally to the requisite angle of the spiral; as this was a series of rings and not a screw thread, it was necessary, when cutting the teeth, to disengage the leading screw from the backing-off gear to enable the teeth to be cut while the saddle of the lathe was in a stationary position.

Far from falling within the category of those employers on the portals of whose workshops may have been inscribed the fatal words "too late," Mr. Cooke was early in the field as a purchaser of the hob thread-milling machine.

Delivered with the machine was a hob cutter, but strangely enough instead of being spiral this cutter was straight fluted. The occasion of a visit to the Works of a certain Government Tool Inspector was productive of an amusing little comedy. Noticing the backing-off lathe above referred to, and being in urgent need of a supply of spiral hob cutters, he expressed his intention of commandeering the lathe for the exclusive manufacture of these particular hobs for Government purposes, heedless of the fact that the lathe was and had been continuously employed for locomotive purposes. Being under the impression too that only one firm of expert tool makers in the country was capable of cutting spiral hobs, great was his astonishment and delight on discovering that Crewe was not only equally capable of doing so, but previously had been performing this very class of work; the net result of this little episode being that the lathe in question was immediately requisitioned for a continuous supply of spiral hob cutters which were to be sent to shell manufacturing firms, and a second backing-off lathe was speedily forthcoming, in order that the Company's own locomotive requirements should be in no way impeded.

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THE END

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Transcriber's note:

- Applied the [errata](#) to the text

- Whole and fractional parts displayed as 3-1/2
- Changed mismatched single/double quotes
- Changed obvious typographical/printer errors
- Footnotes grouped at the end of each chapter
- The transcriber created the cover and places it in the public domain.
- Spelling and word usage have been retained as they appear in the original publication, except as follows:
 - Page viii: Changed "Psychologigues" to "Psychologiques".
 - Page viii, 40: Changed "Enseignments" to "Enseignements".
 - Page 26: Changed "the same control has" to "the same control as".
 - Page 88: Changed "6 percent" to "60 percent". (The total composition of brass should add up to 100%.)
 - Page 89: Changed "are slightly taper to" to "are slightly tapered to".
 - Page 183: Changed "Rang-de-Fliers" to "Rang-du-Fliers" and "Etaples" to "Étaples".
 - Page 189: Changed "the the railway" to "the railway".

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