been much studied, and some excellent results have been obtained in Scotland by Mr. Robert Drummond, the engineer of the Paisley roads, who has devised methods by which the stones forming a road surface can be wedged into position by simple and inexpensive methods, and then waterproofed by pouring a very small quantity of pitch over the wedged surface. Roads so made have stood the heaviest traffic with a minimum of deformation. It is practically certain that Mr. Drummond's method, hitherto worked by hand, can be carried out still more efficiently by machinery. This will undoubtedly be done and will greatly reduce the cost not only of resurfacing the vast mileage of roads which must now be taken in hand, but also of the great extension which must be undertaken, as foreshadowed in the early part of this article, to enable country districts to be opened up. In conclusion, if, twenty years ago, anyone had stated that the extension of roads was even more important than the extension of railways, he would have been looked upon as a visionary; but this is now actually the case.

Since the above was written, the announcement has been made that the Government, acting on the recommendation of the Road Board, has allocated 10,000,000*l.* to our roads and bridges. We are not informed whether Ireland is to share in the grant, but it is stated that the greater part is to be spent on roads, as the bridge improvements can be carried out by the local authorities, borrowing for this purpose on long-term loans. Ten million pounds is a large sum, but it will be found sufficient only to resurface about one-quarter of the main roads of England, Wales, and Scotland so as to bring them to an equality with the improved roads we have mentioned, even if the most economical methods now known are faithfully followed.

This grant is sufficient for a commencement. It will give employment to many demobilised men as they return from overseas, but it is to be hoped that the Government or the Road Board will see to it that really scientific training is given to the executive staff which is to carry out the work. The special local knowledge of climatic conditions, local road stones, and so forth, which used to form so large a part of the qualifications of our local road surveyors, will no longer suffice. As we have shown, the road engineer has now to deal with scientific questions which ought to be determined for him by the central authority, which is at present the Road Board; it is to be hoped, therefore, that the instructive experimental work commenced by it previous to the war will be at once renewed, so that the methods of resurfacing the roads of the kingdom may be to some extent standardised.

Road problems are already so specialised that our universities might with advantage follow the example of some of the American universities by instituting special courses of lectures on highway engineering.

THE AMERICAN CHEMIST IN WARFARE.

UNDER the above title Dr. Charles L. Parsons, chairman of the U.S. Committee on War Service for Chemists, communicated to the American Chemical Society, at a recent meeting at Cleveland, a paper which is reproduced in our contemporary *Science*. As the paper bears directly upon matters of national importance, and is of interest as showing the promptitude and thoroughness with which our Ally dealt with a great and critical emergency, it may be desirable to give a short summary of its contents.

Some months before the United States entered the war Dr. Parsons was sent by the Ordnance Department to study in England, France, Italy, Norway, and Sweden certain chemical processes, particularly those relating to the fixation of nitrogen. When he arrived in England he was strongly impressed with the dangerous position in which this nation stood owing to the policy of the War Office in drafting practically every available man, irrespective of his qualifications and potential value, into the combatant ranks. Perhaps at the time no other course was possible. It was absolutely necessary to stem the rush of the enemy, and men were required to do it. Meanwhile, the Government was halting between two opinions—shilly-shallying with the question of conscription, and “letting *I dare not wait upon I would.*” The consequence was that owing to the lack of technical men, chiefly chemists, the supply of munitions was greatly retarded. This was no less true of France. Everywhere the same statement was made that the greatest mistake of the Entente countries was in giving too little attention to brain power and too much to physical prowess. Germany, on the other hand, had carefully conserved her chemical strength in order to develop the new and terrible methods of warfare which her policy of “frightfulness” forced upon the world. We were ultimately reluctantly driven to fight her with her own weapons, and to better her example, if we could.

The war, in fact, entered upon a new and utterly unexpected phase for which this nation was very inadequately prepared, and with which the War Office, as then constituted, was quite unable to cope. Practically the whole chemical force of the Empire was called upon to grapple with the position. How our difficulties were at length surmounted, and how our chief enemy was eventually compelled to regret that he had ever embarked upon such a mode of warfare, will perhaps some day be made fully known. It is a chapter in the history of the war not only of present interest, but also of future value. There is no question that before this consummation was reached we were for a time in great jeopardy. Indeed, it was necessary for all the Allies to seek for chemists and chemical engineers wherever they could be found. France secured the services of Norwegians; England drew upon her colonies and her oversea possessions. Dr. Parsons, indeed, says that “the chemist who perhaps more than any

other in England is responsible for the success of England's munitions programme is an American."

This lesson was not lost upon the authorities of the United States when it was recognised that they would be forced to take their part in crushing the great conspiracy against the freedom of the world. How they took it to heart is the purpose of Dr. Parsons's paper to show.

In the first place they at once instituted a census of American chemists. It was started in February, 1917, and was kept up without interruption. By July, 1917, some 15,000 chemists had sent in particulars of their address, age, place of birth, lineage, citizenship, dependents, places of instruction, chemical experience at home or abroad, military training, publications, research work, etc. The data obtained were indexed and cross-indexed by the American Chemical Society working in conjunction with the Bureau of Mines. When America entered the war every chemist was directed to keep the society informed as to his military status and duties. The president of the American Chemical Society had already offered without reservation the services of its members to President Wilson in any emergency that might arise. The society recommended the use, in their respective fields, of all trained chemists, and urged that those of special ability should be held to the work they could best perform. Influential committees of representative men were formed to consider how the war service of chemists could best be made, and a plan for the "Impressment of Chemists and for the Preservation of the Supply of Chemists" was drawn up, and the aid of the technical Press was enlisted in making known the procedure. A large number of the chemists engaged on war work were obtained by means of the classified list. Practically all the chemists who early entered the Ordnance Department with commissions were obtained through the American Chemical Society or its officers. The list was equally useful to the Bureau of Mines when it entered upon the subject of gas-warfare. All the bureaux and departments in Washington consulted it from time to time as the necessity arose.

From the first (says Dr. Parsons) the chemical *personnel* of the Army and Navy and the civilian bureaux was partly civilian and partly military. As the war progressed the proportion of chemists in uniform naturally increased as the men were taken from the Army and assigned to chemical duty. The question is still a disputed one—to be settled probably only when the war is over—as to whether a chemist can serve best in a civilian or a military capacity. Certainly in both capacities the demand for chemists has been unprecedented, and the development of chemistry in modern warfare to those in touch with the advancement made seems almost a fairy-tale.

Considerations of space forbid the attempt to follow in detail Dr. Parsons's account of the various organisations for co-operative research which were instituted in practically every university and polytechnic throughout the States, nor can we deal fully with the story of how the various

sections and sub-sections of the chemical warfare service were eventually organised and co-ordinated. This service was ultimately established as a unit of the national Army, being, Dr. Parsons claims, "the first recognition of chemistry as a separate branch of the military service in any country or any war."

Dr. Parsons pays a well-merited tribute to the zeal and sense of duty with which practically the whole of the chemical profession in America entered upon this work. "The organisation was rapidly built up and contained the names of the most prominent chemists in the country, as well as those of hundreds of young chemists who will later become prominent."

In reading this interesting story it is impossible to avoid being struck with the evident ease with which the civilian element was promptly merged into and made to co-operate with the bureaucracy when the necessity arose. It may be that in a democracy like America public departments are more in actual touch with the public than with us. There is seemingly less of that aloofness and jealousy of outside interference and advice which are apt to characterise our public offices. The Civil Service of America is not less highly organised than our own, and as regards its knowledge and appreciation of modern necessities and conditions it is, perhaps, in some respects, better equipped. That our Government offices have something to learn in this respect is evident from the considerable importation of "business men" into the Government service that it has been necessary to make during the last four years. It cannot truthfully be said that all our public departments have invariably risen to the emergencies with which they have had to deal, and certain of those most directly concerned with the conduct of the war, and with the conditions which have arisen out of it, have been most faulty in this respect. It may be, to adopt the Prime Minister's phrase, they have too many "vested prejudices" to contend with.

We have now had the story of the American chemist in warfare from one who is well qualified to tell it. May we not hope that before very long someone equally well qualified to deal with the experiences of his English *confrère* may give us a similar account? The record may not be quite so satisfactory in all respects, as our cousins had our mistakes to warn them and our experiences to guide them, as Dr. Parsons admits. But in spite of mistakes, and of a certain tardiness on the part of those entrusted with the conduct of the war to realise the importance of chemistry in modern warfare, and to welcome the skilled assistance which was offered them, the story is highly creditable to us, and will bear comparison with that of which a short account has been given. As already stated, it constitutes a chapter in our section of the history of the war, and should be made known for the satisfaction of those who have lived through the anxieties of the past and for the instruction and benefit of those who come after us.

T. E. THORPE.