Southwark, at the suggestion of Sir William Hart Dyke, to appoint a joint committee of the Spectacle Makers' Company and the London Chamber of Commerce to study the questions at issue in all their bearings.

THE GOVERNMENT SCHEME FOR THE ORGANISATION AND DEVELOPMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

WE gave in our issue of May 20 a detailed report of speeches made in the House of Commons when the Government scheme for the formation of an Advisory Council concerned with industrial and scientific research was outlined by Mr. J. A. Pease, then President of the Board of Education. Since that time Mr. Arthur Henderson has succeeded Mr. Pease at the Board, and he has just issued as a White Paper (Cd. 8005, price ½*d*.) a statement of the need and nature of a scheme which will secure scientific foundations for national industries in the future. The paper is here reprinted.

(1) There is a strong consensus of opinion among persons engaged both in science and in industry that a special need exists at the present time for new machinery and for additional State assistance in order to promote and organise scientific research with a view especially to its application to trade and industry. It is well-known that many of our industries have since the outbreak of war suffered through our inability to produce at home certain articles and materials required in trade processes, the manufacture of which has become localised abroad, and particularly in Germany, because science has there been more thoroughly and effectively applied to the solution of scientific problems bearing on trade and industry and to the elaboration of economical and improved processes of manufacture. It is impossible to contemplate without considerable apprehension the situation which will arise at the end of the war unless our scientific resources have previously been enlarged and organised to meet it. It appears incontrovertible that if we are to advance or even maintain our industrial position we must as a nation aim at such a development of scientific and industrial research as will place us in a position to expand and strengthen our industries and to compete successfully with the most highly organised of our rivals. The difficulties of advancing on these lines during the war are obvious and are not under-estimated, but we cannot hope to improvise an effective system at the moment when hostilities cease, and unless during the present period we are able to make a substantial advance we shall certainly be unable to do what is necessary in the equally difficult period of reconstruction which will follow the war.

(2) The present scheme is designed to establish a permanent organisation for the promotion of industrial and scientific research.

It is in no way intended that it should replace or interfere with the arrangements which have been or may be made by the War Office or Admiralty or Ministry of Munitions to obtain scientific advice and investigation in connection with the provision of munitions of war. It is, of course, obvious that at the present moment it is essential that the War Office, the Admiralty, and the Ministry of Munitions should continue to make their own direct arrangements with scientific men and institutions with the least possible delay.

(3) It is clearly desirable that the scheme should operate over the kingdom as a whole with as little regard as possible to the Tweed and the Irish Channel. The research done should be for the kingdom as a whole, and there should be complete liberty to utilise the most effective institutions and investigators available, irrespective of their location in England, Wales, Scotland, or Ireland. There must therefore be a single fund for the assistance of research, under a single responsible body.

(4) The scheme accordingly provides for the establishment of :—

(*a*) A Committee of the Privy Council responsible for the expenditure of any new moneys provided by Parliament for scientific and industrial research;

(*b*) A small Advisory Council responsible to the Committee of Council and composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research.

(5) The Committee of Council will consist of the Lord President, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education (who will be vice-president of the Committee), the Chief Secretary for Ireland, together with such other Ministers and individual Members of the Council as it may be thought desirable to add.

The first non-official members of the Committee will be :—The Right Hon. Viscount Haldane of Cloan, O.M., K.T., F.R.S., the Right Hon. Arthur H. D. Acland, and the Right Hon. Joseph A. Pease, M.P.

The President of the Board of Education will answer in the House of Commons for the sub-head on the Vote, which will be accounted for by the Treasury under Class IV., Vote 7, "Scientific Investigations, etc."

It is obvious that the organisation and development of research is a matter which greatly affects the public educational systems of the kingdom. A great part of all research will necessarily be done in universities and colleges which are already aided by the State, and the supply and training of a sufficient number of young persons competent to undertake research can only be secured through the public system of education.

(6) The primary functions of the Advisory Council will be to advise the Committee of Council on :—

(i) Proposals for instituting specific researches;

(ii) Proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades;

(iii) The establishment and award of research studentships and fellowships.

The Advisory Council will also be available, if requested, to advise the several Education Departments as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research.

Arrangements will be made by which the Council will keep in close touch with all Government Departments concerned with or interested in scientific research and by which the Council will have regard to the research work which is being done or may be done by the National Physical Laboratory.

(7) It is essential that the Advisory Council should act in intimate co-operation with the Royal Society and the existing scientific or professional associations, societies, and institutes, as well as with the universities, technical institutions, and other institutions in which research is or can be efficiently conducted.

It is proposed to ask the Royal Society and the principal scientific and professional associations, societies and institutes to undertake the function of initiating proposals for the consideration of the Advisory Council, and a regular procedure for inviting and collecting proposals will be established. The Advisory Council will also be at liberty to receive

proposals from individuals and themselves to initiate proposals.

All possible means will be used to enlist the interest and secure the co-operation of persons directly engaged in trade and industry.

(8) It is contemplated that the Advisory Council will work largely through Sub-Committees reinforced by suitable experts in the particular branch of science or industry concerned. On these Sub-Committees it would be desirable as far as possible to enlist the services of persons actually engaged in scientific trades and manufactures dependent on science.

(9) As regards the use or profits of discoveries, the general principle on which grants will be made by the Committee of Council is that discoveries made by institutions, associations, bodies, or indviduals in the course of researches aided by public money shall be made available under proper conditions for the public advantage.

(10) It is important in order to secure effective working that the Advisory Council should be a small body, but it is recognised that even if full use is made by the Council of its power to work through reinforced Sub-Committees, its membership may be found inadequate to do justice to all the branches of industry in which proposals for research may be made or to the requests of other Government Departments for assistance. It is therefore probable that it will be found necessary to strengthen the Council by appointing additional members.

The first members of the Council will be:—The Right Hon. Lord Rayleigh, O.M., F.R.S., Mr. G. T. Beilby, F.R.S., Mr. W. Duddell, F.R.S., Prof. B. Hopkinson, F.R.S., Prof. J. A. M'Clelland, F.R.S., Prof. R. Meldola, F.R.S., Mr. R. Threlfall, F.R.S., with Sir William S. M'Cormick as administrative chairman.

(11) The Advisory Council will proceed to frame a scheme or programme for their own guidance in recommending proposals for research and for the guidance of the Committee of Council in allocating such State funds as may be available. This scheme will naturally be designed to operate over some years in advance, and in framing it the Council must necessarily have due regard to the relative urgency of the problems requiring solution, the supply of trained researchers available for particular pieces of research, and the material facilities in the form of laboratories and equipment which are available or can be provided for specific researches. Such a scheme will naturally be elastic and will require modification from year to year; but it is obviously undesirable that the Council should live "from hand to mouth" or work on the principle of "first come first served," and the recommendations (which for the purpose of estimating they will have to make annually to the Committee of Council) should represent progressive instalments of a considered programme and policy. A large part of their work will be that of examining, selecting, combining, and co-ordinating rather than that of originating. One of their chief functions will be the prevention of overlapping between institutions or individuals engaged in research. They will, on the other hand, be at liberty to initiate proposals and to institute inquiries preliminary to preparing or eliciting proposals for useful research, and in this way they may help to concentrate on problems requiring solution the interest of all persons concerned in the development of all branches of scientific industry.

(12) An Annual Report, embodying the Report of the Advisory Council, will be made to his Majesty by the Committee of Council and laid before Parliament.

(13) Office accommodation and staff will be provided for the Committee and Council by the Board of Education.

MODERN MUNITIONS OF WAR.[1]

I.—GUNS AND PROPELLANTS.

ELEVEN months of war have now passed, and certain lessons have made themselves perfectly clear. The teaching of the first six months of the war was tersely summed up by General French when he said last February, "The problem set is a comparatively simple one—munitions, more munitions, always more munitions," the special munitions meant in this case being the high explosive shells that from the time the war assumed the conditions of a field siege after the battle of the Aisne became a necessity for any advance.

By "munitions" are meant practically everything required by the Army, and it will be well first to consider the wonderful changes which have taken place in guns and propellants, and which in this war have made artillery probably the most important feature.

Napoleon, himself an artillery officer, was fond of using massed batteries in much the same way as artillery is being used in the present war, but what artillery meant in those days and in these can perhaps be best grasped by remembering that the old *Victory*, which was our most heavily armed ship in the Napoleonic days, had a broadside of 52 guns, which, when fired simultaneously, would have thrown about 60 per cent. of the weight of the metal contained in one shot from the 15-in. guns of the modern super-Dreadnoughts. We must also remember that in the Crimean War the old smooth-bore 68-pounders, using a charge of 16 lb. of black powder, were the largest guns ashore or afloat at the time, whereas now we have the 15-in. guns of our super-Dreadnoughts, weighing close on 100 tons, from which a charge of 400 lb. of MD cordite hurls a projectile weighing 1925 lb. with accuracy to a distance of fifteen miles, or with high angle firing to double that distance.

The changes commenced in the fifties of the last century, when we adopted the idea of rifling ordnance so as on firing the gun to give the projectile a spin as well as forward velocity, this being found to add to the range and accuracy of fire, and in order to do this satisfactorily the guns had to be increased in length.

The rate at which the size of the big naval guns grew may be gathered from the fact that at the Siege of Alexandria in 1882 we had the 80-ton guns of 16-in. calibre, whilst by 1886 we had afloat the 110-ton guns with a bore of 16·25 in., using a charge of 960 lb. of powder. It was soon found, however, that the lengthening of the gun when using the form of gunpowder then employed caused a strain on the breech and gave but a low muzzle velocity, this being due to the rapid burning of the powder. Attempts were then made to slow the combustion of the powder by increasing the size of the grain, and with the increase in the size of the guns the powder gradually grew to the large pebble powder, consisting of 1¾-in. cubes. Unfortunately the desired effect could not possibly be obtained by alterations of this character, as it is required of a perfect powder that when the charge is fired in the breech of the gun, the combustion shall commence comparatively slowly, so as to overcome the *vis inertiae* of the projectile without throwing too great a strain on the gun, and the combustion of the powder should then increase in rapidity so as to supply gas more and more rapidly to increase he pressure and momentum of the shot, which should leave the muzzle of the gun with the maximum velocity.

With such forms of powder as cubes or other large

[1] Abstracts of three lectures delivered at the Royal Society of Arts on July 7, 14, and 21, by Prof. Vivian B. Lewes.