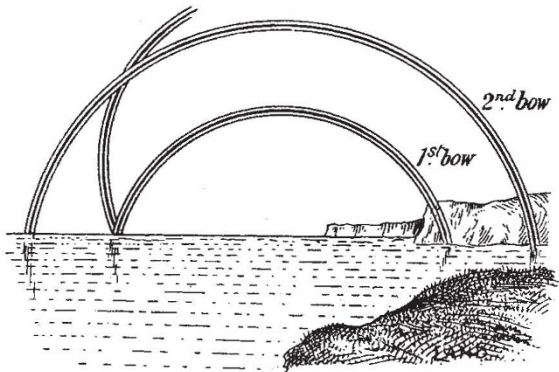


and also a mock sun 7° below it, caused by reflection. The primary and secondary bows caused by the latter as source would occupy exactly the positions indicated in the sketch with the appropriate colour arrangement. As the intensity and definition of the mock sun, good at grazing incidence, would fall off rapidly as the angle increased, only the lower part of the bows would be distinctly visible; this also is suggested in the sketch. The calmness of the sea is not specifically mentioned, but seems to be implied by the other weather conditions stated.

F. W. ASTON.

South Farnborough, August 31.

THERE was observed over the Medway estuary on August 18 (7.15 p.m., B.S.T.) an extremely brilliant rainbow. In addition to secondary bows concentric with the primary (all less than a semicircle), there was seen a bow of considerable brightness having an arc greater than a semicircle. This "anomalous bow" appeared to be of the same radius as the primary bow, had its colours in the same order (*i.e.* red outer-



most), and cut the horizon at the same point. It was, in fact, the remainder of the circle of which the primary arc formed a part.

The bow in question presumably originated from the image of the sun reflected in the still water of the foreground, and thus the right-hand end of the primary bow, which stretched overland, was unaccompanied by the eccentric arc. The phenomenon should not be an uncommon one, yet I do not remember to have observed it previously.

W. NEILSON JONES.

Grain, Kent, August 18.

The Sounds of Gunfire.

THE recent correspondence in the *Times* referring to the audibility of the reports at great distances induces me to record my experiences here. I have a garage, built of corrugated iron and lined with match-board. It stands on a concrete base, and the floor is cemented. Its dimensions are 20 ft. by 10 ft., by 15 ft. to the ridge. I can hear the sounds of the guns inside the building on days when they are inaudible outside. When audible outside they are considerably accentuated within.

The same thing occurs in the case of a smaller shed, of similar construction, about 100 yards away.

A structure of corrugated iron and wood upon a concrete base appears to act as a resonator, collecting and intensifying the sounds. It might be possible to record the sounds on wax cylinders (phonographically) by using an abnormally large megaphonic trumpet directed towards the source of the disturbance.

C. CARUS-WILSON.

Strawberry Hill, Middlesex, August 27.

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EDUCATION AND INDUSTRY.

DURING the early part of 1916 the Higher Education Sub-Committee of the Education Committee of the London County Council devoted a great deal of time to interviewing representative employers with the view of obtaining their views on the efficiency of the work done in the various types of educational institutions under its control, and a frank discussion of the relations which should exist between the education given in them and industrial and commercial life. The results of these interviews are summarised in a report recently presented to the Council, which has roused a good deal of comment in the Press, much of it of a very superficial character.

Most of those interviewed were concerned with the distribution and transport of goods or with financial undertakings, but, in addition to these, three groups of employers dealing with what may be said to be the three main London manufacturing industries, engineering, printing, and the chemical trades, were also interviewed.

While the inquiry was generally directed to the possibility of establishing a closer relationship between education and industry than at present exists, the main lines on which it proceeded may be summarised under four heads:—

(1) The methods adopted by business men for recruiting their staffs and the qualifications demanded from applicants.

(2) General defects in the education given by the schools as revealed by the experience of business men.

(3) The possibility of greater assistance being given to employers in making a suitable selection and in providing better material.

(4) The encouragement given by business men to further education of their staffs, and the desirability or otherwise of compulsory further education.

With the criticisms of the representatives of commerce we do not propose to deal beyond remarking that they are largely criticisms of the character and *moral* produced by the schools, and the most sweeping of them have been shown by the events of the last three years to have very slight foundation. For many of the others the conditions of employment, and particularly of the methods used for selecting employees, which in too many cases pay far too little attention to the selection of the really able and intelligent boy and far too much to personal influence, are much to blame. If a boy in his last years at school feels that someone whom he knows will get him into a post and that it matters very little whether he does his school work well or badly, he has little encouragement to put forth the best that is in him.

The engineering group of trades forms the most important group of manufacturing industries in the London area: few people realise that nearly three-quarters of a million persons are dependent upon it.

The representatives of this group showed a refreshing belief in continued education; they all

felt that elementary-school education is insufficient, and that education and workshop practice should go hand in hand; they expressed a decided opinion that to be effective any scheme of continued education for the ordinary boy must be compulsory, so as to protect the good employer. In this group of trades the provision for technical education hitherto made has been more complete than in any other, and it is in this group that the country has best held its own against foreign competition.

As regards the curriculum of the technical schools, recommendations were made to widen the scope of the training to include the colloquial teaching of foreign languages and some economics. The question of costs and estimates also needed attention.

It was stated that the ever-increasing demands of the industry called for a larger supply of suitably trained men, and that every chance should be given for the best men to reach the highest institutions, which should be well equipped and well staffed.

The representatives of chemical industries were not so completely in accord with each other. The practical man was inclined to think that works experience, aided by technical classes, was sufficient; the university-trained man believed that nothing short of a full university training was of much use. The industry was said to need three distinct classes of workers: the research assistant, the foreman and technical chemist who supervises the manufacturing operations, and the semi-skilled or unskilled labourer who does the routine work. The first class has found less employment in England than in Germany or America, and this was said to be due to several causes. In Germany research is subsidised and encouraged by the State to an extent quite unknown in England, and the chemical industry is in the hands of large firms, who are willing and can afford to incur expenditure upon research. In England, on one hand, teachers are said to be too little in contact with industry, and, on the other, manufacturers expect too much from the young chemist, and do not realise that until he has had some business experience he cannot be reasonably expected to produce startling improvements.

The printing trade group of employers also are believers in technical education, and they referred to the value of the research work in connection with the photo process industry which has been carried out at the Photo-Engraving School at Bolt Court.

As a result of these conferences two important proposals are made by the sub-committee—(1) to create an Appointments Sub-Committee, which shall do for the secondary and elementary schools what the Appointments Boards are now doing for the universities; and (2) to form consultative committees of experts chosen by the Council for various branches of commerce and industry to advise the Council upon the equipment of institutions and upon the distribution, development, and modification of courses of instruction relating to

the industry concerned. Such a committee is already in existence for the printing trades, and committees are to be formed for the engineering and chemical trades. If only the right persons are chosen, and if the Council pays proper attention to their recommendations, this step should prove fruitful of good results.

There is an uneasy feeling abroad that the present Council is not really in earnest in regard to this matter of technical education, and that many of its influential members do not look upon education as a profitable investment which will make large returns, but rather as something which they must perforce appear to attend to in order to keep faddists from troubling. The old Technical Education Board, which had a somewhat independent existence and did a great work for technical and scientific education in London, came to an end when the Council became the Education Authority in 1904. Since then the claims of technical and scientific education have been much in the background; the able officer who advised the Board in such matters was quietly shunted; and there has been a tendency to restrict unduly expenditure on equipment and, under the plea of concentration, to hinder the development of institutions doing good work.

When the Technical Education Board went out of existence plans had been prepared for an institute of technical optics, and these were left in a forward state to be carried out by the new authority, but under one plea or another their execution was repeatedly postponed. What this postponement has meant will only be known in years to come, when the full story of the present world-conflict can be told. Now, under the stress of national need, steps have been taken, but it will yet be some time before they can produce their full effect.

Similar remarks apply to provision that was contemplated for the erection and maintenance of technical institutes to serve North-East and South-East London. Both these much-needed schemes, providing for important industrial areas, have been under discussion for more than ten years, and we believe that plans have actually been prepared for the necessary buildings and equipment, but from one cause or another nothing has as yet been done in either case to carry them out. It is to be hoped that the new consultative committees will not be used as an excuse for further delay.

The root of the whole difficulty lies in the fact that the average member of the Council has little belief in education, and, if anything, less belief in the value of science; and until this attitude of mind is altered no amount of new machinery is likely to bring about improvements of any value.

There are indications that the necessity for encouraging research is likely to be more appreciated in the future than it has been in the past. It is to be hoped that in making important staff appointments, especially appointments to principalships of large technical schools, more attention will be

paid than hitherto to proved ability of this character; that the staffs of technical institutions should be not merely allowed, but expected, to undertake original research; and that they should not be so overburdened with other duties as to leave them little time and energy for such work.

NATIONAL WORTH OF CHEMICAL LABORATORIES.

WE have on several occasions during the past few months directed attention in these columns to the strenuous efforts America is now making to take the fullest advantage of the opportunity afforded by the present condition of things in Europe to improve and enlarge such of her industries as are directly dependent upon chemistry. On all sides we see the evidence of her determination to render herself independent of the hold which Germany, by means fair or foul, has sought to obtain over her, to the detriment of her commercial development. But energetic and far-sighted American manufacturers have even a wider outlook than the supply of their home markets. They are out for wresting from Germany the pre-eminence she has hitherto been able to secure by combinations and financial arrangements of a shady complexion in the markets of the world, and there is no question that the industrial magnates of Germany are now seriously alarmed at the prospect. The recent political crisis in Germany is a sure sign of this fact, and the industrial and military autocracies have still further cemented their union in the effort to meet it. The present struggle will inevitably develop into an economic warfare of the most bitter and relentless character. All this is clearly foreseen by all the more important industrial communities. The very method by which Germany is conducting her share of the war is an indication of what she intends her economic policy to be in the immediate future.

In an address delivered at the dedication of the chemical laboratory of the University of Oklahoma, reproduced in our contemporary, *Science* (July 6), Prof. W. A. Noyes, of the University of Illinois, has admirably defined the relation of the research laboratories of the American universities to the coming struggle. They are the training schools in which the prospective combatants must receive the equipment upon which success alone depends. Economic warfare, in the long run, is a far more complicated business than a military campaign, and its ultimate and permanent triumph rests upon many factors. But, under modern conditions, it fundamentally depends upon the efficient application of scientific principles and upon the aptitude to turn the knowledge gained by scientific research to practical account.

Prof. Noyes illustrates these facts by examples, familiar enough to all who are cognisant of the course of industrial development during the past six or seven decades, but which cannot be too

often dwelt upon. They are lessons to be instilled into each succeeding generation, and which they must never be allowed to forget. He begins with the creation of the Giessen laboratory, and traces its influence upon the growth of scientific chemistry all the world over, and its special influence upon the development of applied chemistry in Germany. Incidentally he contrasts the difference in the trend of events in England. We had an enthusiastic and inspiring teacher in Hofmann, actuated by the spirit and example of Liebig, who had unquestionably a powerful stimulating effect here; but much of the good seed fell upon stony ground so far as it permanently affected the character of our chemical industries, and the stimulus of Hofmann died with his recall to Berlin. The manner in which we threw away our opportunity in discarding the new industry which Hofmann and the associates he gathered round him created is one of the saddest stories in our economic history. We are now realising only too bitterly what the loss of that industry has meant, not only to our manufacturing supremacy, but also to the rapid and successful prosecution of the war. The moral of this lesson will, we may hope, not be lost upon the young community to which it is addressed.

Prof. Noyes then rapidly deals with these questions as they affect his own countrymen. He points to the extraordinary development in the means of instruction in chemistry which the United States has witnessed in the course of a generation, to the spread of admirably equipped schools for higher instruction and research, and to the growing recognition on the part of the industrial community of the importance of scientific training in the conduct of manufacturing operations. But the full fruition of such efforts is, as with us, occasionally impeded by unwise legislative action, and Prof. Noyes gives examples of such action on the part of Congress, apparently at the instigation of persons acting in the interests of foreign firms. The practices of these firms are in direct contravention of the principles of the Sherman law, which forbids combinations intended to prevent real competition in the manufacture of staple products. But these combinations are deliberately fostered by the German Government, and branch establishments of powerful German firms settled in America are avowedly working against the spirit of the law in the effort to strangle the rapidly growing development of American chemical industry. There is an amusing story of how a characteristic instance of Teutonic bullying was effectually checked by a manufacturer who was largely concerned in the production of American bromine. The proverbial astuteness of our American cousins is frequently more than a match for the somewhat clumsy blundering of their German competitors. Show a firm front to the bully and he speedily collapses. But America wisely learns what she can from her enemies, assimilating the good and rejecting the bad, in her determination to organise the world on the basis of justice instead of force.