## THE BRITISH ASSOCIATION AT NEWCASTLE.

### SECTION G.

ENGINEERING.

OPENING ADDRESS (ABRIDGED) BY GERALD STONEY, B.A.I. (DUB.), F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

AT times such as these the mind naturally turns to problems to be considered both at the present time and after the war, and in considering such problems a review of some of the errors committed in the past is most necessary. Such a review enables methods which should be adopted both now and in the future to be considered. As this is an address to the Engineering Section of the British Association for the Advancement of Science, only such problems will be considered as affect engineering and its allied industries.

One thing which has handicapped our industries is the reluctance of firms to utilise highly educated labour or to adopt scientific methods. In looking round the industries of the district one is struck by the small number of men who have undergone a thorough scientific training at one of the universities or at one of the leading technical colleges, and who occupy a prominent place in the firms in this district.

The general complaint is that university and college men are too theoretical and not practical. It is the usual thing for a bad workman to blame his tools, and is it not because employers do not know how to make use of such labour that they utilise it to such a small and imperfect extent?

Things are very different in some other countries with which we have competed in the past, and with which there will be in all probability still fiercer competition in the future. There we find the fullest use made of highly educated scientific labour.

How many engineering firms in this district have a skilled chemist on their staff, and what percentage of these pay him a decent salary? And how many heads of firms have sufficient chemical knowledge to appreciate the work and utilise the services of such a man? because unless there is appreciation of the work done by such a man his services are useless and he becomes discouraged, generally finding himself up against the blank stone wall of there being no appreciation of his services, and yet chemical problems are continually cropping up in engineering work. There is the question of the supply of materials; as a rule the manufacturer trusts to the name of the contractor and assumes that he gets materials of the composition and purity he ordered. Every now and then something goes wrong and the question arises, Why? Without a chemist to analyse the material it is often most difficult to say. Apart from this question of the analysis of raw or partly manufactured materials received, there is the chronic question as to the mixtures of the metals in both the metal and brass foundry, and large economies can be effected by systematic analyses.

Another direction in which scientific labour is invaluable is in seeing that instruments are in proper order, and that tests are accurately carried out. Tests carried out with inaccurate instruments and without proper scientific precautions to see that they are accurate and trustworthy are worse than useless, and, in fact, most misleading and dangerous, as entirely untrustworthy inferences may be drawn from them and far-reaching troubles caused in the future. Under scientific supervision arrangements are made to avoid such troubles and get trustworthy results which can be depended on for future designs.

What is the case with pressure gauges and the measurement of pressure applies, of course, to all other instruments and measurements. In most works it may be said with sorrow that the only moderately accurate measurements that can be made are those of dimensions and weight. It is only by accurate testing of existing plant that trustworthy deductions can be drawn enabling safe progress to be made in future designs.

One of the great things which helped forward the steam turbine in the early days was accurate and full testing of each plant as soon as it was completed and before it left the works. The late Mr. Willans was probably the first, or one of the first, to recognise the importance of accurate testing of steam plant, and the success his well-known engine had was largely due to this. From the earliest days of the steam turbine Sir Charles Parsons recognised the necessity of such testing, and the test-house has always been a prominent feature of Heaton Works. And then in the higher ranks of an engineering works it requires a scientific mind to draw safe conclusions from tests carried out and to see in what directions progress can safely be made. Such methods have enabled the steam turbine during the writer's acquaintance with it, now extending over some twenty-eight years, to grow from 50 horse-power to some 45,000 or more in each unit, and the steam consumption to be reduced from 40 lb. per h.p.-hour to about 7½ lb., or less than one-fifth.

And closely allied to such work in engineering works is the general question of scientific research, and here a trained scientific mind is of the utmost importance to see that trustworthy results are obtained and to make true logical deductions from those results. Without suitable training a man is liable to be unable to grasp all the conditions of an experiment and to make deductions from the data obtained which are totally unjustified and often lead to most disastrous results in the future.

Such research is generally carried out in four places —engineering works, private laboratories, engineering colleges, and national laboratories. The first has already been dealt with. The second is of comparatively small importance in practice.

As regards the third, a great deal of good work has been done in engineering colleges, often under great difficulties for want of plant and money, and it is greatly to the credit of our professors and others that they have succeeded in doing so much with the very inadequate appliances at their disposal, and handicapped for want of funds. How inadequate their income is can be understood when it is remembered that Leipzig University alone has an annual income from the German Government of 100,000*l.*, as against a total Government grant to *all* the universities here of about 45,000*l.*, or less than half.

Of national laboratories we have only one, the National Physical Laboratory at Teddington, and here again the support given to it is totally inadequate. The total income from all sources last year was only 40,000*l.*, and of this 23,000*l.* was charges for work done, such as testing meters and other instruments and similar commercial work; the Government grant is only 7000*l.* a year, and besides this 7500*l.* was received for experiments in connection with aeronautics, which is really war work. The balance was made up of subscriptions, grants from technical societies, and miscellaneous receipts. Compare this with the German equivalent, the Reichsanstalt of Berlin, which has an income of 70,000*l.* a year from the Government, or ten times that given to our N.P.L. The Bureau of Standards, the similar institution in the U.S.A., has a Government grant of 140,000*l.*, or twenty times ours. In the Civil Service Estimates there is an allowance of 40,000*l.* for research, an increase of 15,000*l.* over that allotted last year. The total estimates are more

than 20,000,000*l.*, so that less than one-fifth per cent. is allotted to research.

It is difficult to realise what benefits might be gained by investigations which could be carried on by the N.P.L. if only sufficient funds were available, and of what importance they might be to industry at large. One example may suffice. Some time ago the Reichsanstalt carried out a most complete set of tests on a certain class of machine, an investigation which must have cost several thousands of pounds sterling, apart from the time it occupied. The results of this investigation are available to German manufacturers of this machine, and just before the war preparations were being made to take advantage of this, and from figures stated a large extra economy was expected. This, of course, would enable them, provided the cost of manufacture was not too high, to have an enormous advantage over such machines manufactured without this special knowledge. The Institution of Mechanical Engineers saw the importance of this problem and appointed a Research Committee to deal with the matter, but the first question met with is that of finance. Should this be the case in a wealthy country such as this that depends on its manufactures for its very existence? And that such an investigation is required is obvious from the fact that the designs of no two independent manufacturers of this machine in this country agree among themselves. Of course, each claims his is the best, but this cannot be so.

Investigations in engineering shops do not meet such a case. The question of finance has to be carefully watched, and as soon as results sufficiently good are obtained they are generally accepted, and in any case the problem is rarely thrashed out to the bottom, an almost universal defect in commercial research work. Without the help of the National Physical Laboratory the position of the aeroplane in this country would be very different from what it is, and what has been done for the aeroplane requires to be done in many other directions.

But what firm here would do what has been done in the commercial synthesis of indigo, on which it is said that seventeen years' work and more than 1,000,000*l.* have been spent by one firm alone abroad? Here in chemical investigations and manufactures the Government refuses even to give the help of allowing cheap alcohol to be obtainable, and much of such work is impossible in this country on that account, as in many cases methylated and denatured alcohol are not suitable. Recently under pressure the restrictions have been somewhat relaxed by the Government, but many manufacturers have found that the privileges granted are so tied up with red tape that the concessions are practically useless.

I am sorry to say the employer does not look after the welfare of his workmen as he might. In a small factory the head of the firm, as a rule, knows all the leading men among the workmen, many of them having been with him for years. As the place grows he loses touch with his men, and as an actual fact knows fewer of those under him when he has 1000 or more employees than he did when he had 400 or under. This state of things gets worse when the place is turned into a limited liability company, as nearly all large places are at present. The result is that a most deplorable state of things has come to pass. The workman says, "Put not your trust in employers"; the master says, "Put not your trust in workmen"; and the official who is between the master and the workman says, "Put not your trust in either."

It is difficult to say what is to be done to remedy this state of things, but one cannot help feeling much might have been done in the past to have prevented such a regrettable state of affairs as there is at present. Much of this trouble might have been avoided if employers had shown more consideration for the welfare of their workmen.

With the growth in strength of the Trades Unions, which at first were for the legitimate object of seeing that the workman got fair play, and providing out-of-work and old-age benefits, etc., has grown up a system of Trades Union officials who live by agitation, and whose jobs would be gone if there were no supposed grievances to agitate about. These men keep the labour world in a constant state of agitation, and make the employers' and officials' existence a burden to them by constant demands of all sorts, many of them utterly impracticable and unfair. When they cannot agitate against the employer they agitate against another Trades Union, and thus endless disputes spring up on the demarcation of work. Some of the worst strikes in the past have been due to disputes between two Trades Unions.

Unless something can be done to bring master and man together and make both work for the common good, English trade must inevitably go down, and the supremacy that England has in the engineering of the world will come to an end.

Nothing ever was a truer statement than that recently made by Lord Joicey that this country, unless it produces as cheap as, or cheaper than, other countries, cannot in the long run keep her trade, and this is true in spite of any tariff walls which may be set up. And if the present state of affairs is maintained of unscientific management and obsolete machinery, combined with limitation of output and high wages, or, in other words, high cost of production, we must, sooner or later, go to the wall.

What is really wanted is common honesty and common sense on both sides, for one side is as bad as the other at present.

Apart from the considerations set out above, combinations among the firms employed in any one trade are most essential for the well-being of that trade. It is by such combination that much of the progress made of late years by our competitors has been effected. Some of these combinations have been international, and at least two such in the engineering trade were so before the war. These now, of course, are, and it is expected will be after the war, confined to the Allied and possibly to neutral countries, but such combinations, whether among all the engineering firms in one district or among firms employed in one particular trade, to be successful must be worked fairly to all members, and the larger firms must not override the smaller, as, it is regrettable to say, has been done in combinations of employers in some districts. For example, in a district where there is one firm very much larger than any of the others, it is not unknown for it to act the bully and insist on everything being done as would suit its requirements, regardless of the rights of others. And, further, such combinations are, unless directed by men with broad minds and able to take a wide view of things, liable, especially in case of emergency, to do much harm.

If the armament ring in this country had taken such a view when it was found what an enormous supply of munitions was required, it is doubtful if there would have been such a shortage as there has been. Hundreds of firms were willing and anxious to help in the production of munitions, but when they offered their services they were met in many cases with a blank refusal, and in all cases with little encouragement. And when, under pressure from the Government, the ring accepted outside help, in many cases the conditions imposed on the sub-contractors were unfair in the extreme, apparently the whole idea of the ring being to make all the profit they could out of the troubles of the Empire. It has been just as difficult to persuade the armament ring to give up

what they thought was their monopoly and to bring in outside works to help in the production of munitions as it has been to persuade the Trades Unions to forgo trade customs and to enable outside sources of labour to be employed, such as women and other unskilled labour. But both have had to do it. In other words, "dilution of works" has been as difficult to effect as "dilution of labour," and the position both of the armament ring and of the workman would have been very different if they had consented freely to it when it became obviously necessary for the safety of the Empire.

The necessities of research work have already been dealt with, and by the pooling of such research work enormous advantages in any one trade could be obtained. Such pooling of information has been effected with most beneficial results, especially in the chemical trade abroad. Any workable scheme which would enable this to be done and get over the jealousies between one firm and another would be of enormous benefit to the trade in general.

Another thing that must not be lost sight of is the urgent need of improving our educational system. It is little short of a disgrace that the older universities are closed to those without a knowledge of Latin and Greek.

Languages are of the greatest importance to an engineer—not dead languages, but living ones. And these should be properly taught, so that the student should be able not only to read and write them, but also to speak and understand them when spoken. It is quite a different knowledge of a language to be able to read, write, speak, or understand it. Many people can read a language without being able to write, speak, or understand it when spoken, and conversely it is not uncommon to meet people who can speak and understand a language without being able to any large extent to read or write it. And it is only in living languages that a man is trained to speak and understand a language.

Why is it that we are so wedded to the dead languages? There is, of course, the tradition that such are necessary for a liberal education, and there is the argument that modern languages are not so good a training for the mind. Granted that they are not quite so good from the point of view of learning to read and write them, does not the fact that they can also be taught as a living language to be spoken and understood make them on the whole the best educationally for a man? This is entirely apart from the fact that modern languages are useful and ancient useless to the man in commercial work. There is, of course, bitter opposition from that most conservative man, the schoolmaster, and one great reason is that it is much easier and cheaper to get a man to teach Latin and Greek than modern languages which have to be taught orally. The teaching of Latin and Greek as they are usually taught has been standardised to the last degree, and as a result they can be taught by the "semi-skilled" man, and a "skilled" man is not necessary, to use engineers' phraseology. In fact, the teaching of Latin and Greek is a pure "repetition job." At the same time, no education is complete unless science is combined with languages, and also literature, and here lies one great danger of modern technical education.

After the boy has left school and enters the shops more facilities should be given to enable him not only to keep up but to continue his education. In the shops and drawing office too often the boy is left to pick up a knowledge of his trade as best he can. The apprentice who asks questions is often looked on as a nuisance, and requests for information are generally met by a blank refusal or worse. Often the foreman or chief draughtsman is afraid to answer questions for fear of being charged with giving away so-called "trade secrets," but an immense deal of information can be given to an apprentice without doing so.

Evening classes are all very well in their way, but more facilities should be given for the diligent apprentice to attend day classes, and this can be arranged in various ways if the employer has a will to do it. A thing that at present often prevents boys desirous of educating themselves getting on is the fact that overtime is allowed as soon as a boy is eighteen, and often he is compelled to work overtime regardless of classes that he ought to be attending.

It is important to remember that the boy of to-day is the man of to-morrow.

One complaint is that after a lot of trouble is taken about a boy he leaves after a few years and goes to another employer. The good of the trade in general must be considered, and a man who has had experience of various classes of work is generally a much more valuable man than one whose knowledge is confined to one class only. In any case, the other employer gets the benefit of what has been done by the first, and thus the trade in general benefits.

It is realised that this is a very imperfect review of things as they are at present, but if this address induces all classes engaged in engineering to consider how things can be bettered the author feels that a part, at all events, of his object has been attained.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice is given of the forthcoming appointment to the George Henry Lewes studentship in physiology. The object of the studentship, the annual value of which is 200*l.* and is tenable for three years, is to enable promising students to devote their whole time to physiological research. Candidates are requested to send a short statement of their qualifications to Prof. J. N. Langley, the Physiology School, Cambridge, by November 18.

LONDON.—At a meeting of the Senate held on October 18, the Vice-Chancellor (Sir Alfred Pearce Gould) being in the chair, the following doctorates were conferred:—*D.Sc.* (*Engineering*), Mr. E. H. Salmon, an internal student, of the East London College, for a thesis entitled "Columns." *D.Sc.* (*Economics*), Mr. P. Bandyopadhyay, an internal student, of the London School of Economics, for a thesis entitled "Public Administration in Ancient India." *D.Sc.* (*Physiology*), Miss D. J. Lloyd, an external student, for a thesis entitled (*a*) "The Osmotic Balance of Skeletal Muscle," (*b*) "The Relation of Excised Muscle to Acids, Salts, and Bases."

OXFORD.—The reports for the year 1915 of the curators of the Botanic Garden and of the Department of Botany have just been published. They contain long lists of contributors, both public and private, of specimens and other material for study to both institutions. To most of those who have sent donations to the garden a return has been made in kind. Many interesting plants have flowered in the garden during the past year. In the Department of Botany lectures have been given by the Sherardian professor and Messrs. A. H. Church and W. E. Hiley. Practical work in physiology has been conducted by Mr. Kempin. Considerable progress has been made with work on the herbarium. The accounts show that great economy has been practised in the matter of expenditure.

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THE University of Lund is founding a personal professorship in the theory of heredity for Dr. N. H. Nilsson-Ehle.