Nigeria for the period 1903-1913, about £20,000, or a total of approximately £88,700. Thus the total profit to the Government from this one discovery by a Government geologist is more than five times the total cost of the geological and mineral surveys.

Gold Coast.—The specially important discoveries made by the geological survey of the Gold Coast are huge deposits of manganese ore and bauxite (aluminium ore), and widespread alluvial deposits of diamonds. The manganese deposits were found in 1914 before the War, but not exploited until 1916, when the vital need for high-grade manganese ore caused the development of these deposits. Production of ore commenced in 1916, and the total production to Mar. 31, 1928, is 1,785,643 tons of high-grade ore, valued at £3,350,706, free on board ship at Sekondi.

Diamonds were first discovered in February 1919. These diamonds, though small, are of very good quality, and have a ready sale for industrial purposes and jewellery. Since mining operations were commenced in 1921 there has been a large progressive increase each year until, for the year ended Mar. 31, 1929, the figures are: production, 648,343 carats; value, £538,860; export duty paid, nearly £27,000. The total weight of diamonds produced is 1,824,630 carats, valued at £1,758,348, on which the Government has received roundly £87,900 from the export duty of 5 per cent on the total value.

The Gold Coast has a great potential asset in its huge deposits of high grade bauxite—the total conservatively estimated quantity being upwards of 250 million tons. These deposits are not yet developed, owing mainly to the high cost of transport of bauxite to a port of shipment. Bauxite is an ore of low value and so cannot bear heavy charges for freight, but, with extension of railway communication and reduction of freight charges, the Colony should see a great development of this particular source of wealth, and a further mineral example be added to revenue from Geological Survey discoveries.

Sierra Leone.—The Geological Survey of this Colony is much younger than those of Nigeria and the Gold Coast. The Director has discovered large

deposits of iron ore (haematite) of good quality, and considerable deposits of alluvial platinum and gold—all now being developed—besides occurrences of chromite, corundum, ilmenite, rutile, manganese, and graphite, all of them also minerals of economic value. If found on further examination to occur in promising quantities, these deposits should prove to be of commercial value.

The West African geological surveys have no offices and laboratories in the Colonies. During the dry and tornado seasons of the year, the geologists are engaged on geological surveys and examinations of various kinds in the Colonies, but during the rainy season field work is suspended and the staffs return to England. In these respects their organisation differs from that of the other Colonies. The specimens of rocks and concentrates collected are then examined and distributed for various modes of treatment, and reports not made or completed on the Coast, as well as microscopic examination of thin sections of rocks, are done in London. The greater portion of the chemical work, such as assays and analyses, devolves upon the Imperial College of Science and Technology and the Imperial Institute under special arrangements.

A country difficult to examine because of its natural features cannot be certainly expected to yield its mineral secrets, or confess its paucity of mineral deposits, in the course of a few months, or even years of effort. Let it be borne steadfastly in mind that spectacular discoveries of valuable mineral deposits are not the only benefits that a geological survey can bestow upon a country, however important they may be, and however valuable may be their contributions to the revenue and prosperity of the country.

In this address an attempt has been made to show the value of geological surveys to young countries, and the application of scientific knowledge and methods, both theoretical and practical, to the discovery of the valuable inorganic and organic resources of Nature, as opposed to the search for them in a more or less haphazard manner. To-day science plays the predominant rôle in these revelations, and is steadily forcing a recognition of this fact upon the peoples of the earth, for their common benefit.

The Public Regulation of Wages in Great Britain.¹

By Prof. HENRY CLAY.

A GREAT change has taken place during the last twenty years in the methods of negotiating wage-changes. In 1910, when the Labour Department of the Board of Trade published the result of an inquiry into collective agreements, it was estimated that 2,400,000 workpeople worked under conditions specifically regulated by such agreements. It is not possible to compute a figure for a recent year to correspond with the 2,400,000 of 1910, because the status of collective bargaining

in certain important industries is obscure; but if we add together the numbers covered by trade boards, agricultural wages boards, joint industrial councils, and unions in certain industries, which, like coal and cotton, have adopted none of these forms of organisation, we get a total of eight millions out of a wage-earning population, which, excluding domestic service, numbers something less than fourteen millions. When we remember that the influence of an agreement or a determination, reached by a representative body, tends to go beyond the limits of the membership of the organisations, and even trades, directly represented,

¹ From the presidential address to Section F (Economic Science and Statistics) of the British Association, delivered at Johannesburg on Aug. 2.

we may safely conclude that there are few important gaps left in the provision for the settlement of wages by collective bargaining in Great Britain. Before the War, outside the organised industries, the adjustment was made by the individual action of the employers, who first felt the need; to-day the process of general wage-changes has, we may say, been constitutionalised.

It is the system resulting from this change that I refer to as 'the public regulation of wages'. It is only partially due to the direct intervention of the State, although the legalising of trade union activity was essential to the development of effective collective bargaining without the State's direct intervention. Whether, however, wage-changes are negotiated by voluntary industrial councils, spontaneous negotiations between trade unions and employers' associations, or statutory trade boards and agricultural wages boards, the result is the same. A change cannot be effected without public discussion between representatives; when effected, it applies generally to the trades and occupations represented; it is the outcome of an attempt to allow for all the economic factors in the situation, not of an attempt to impose *a priori* principles of social justice upon industry; it is a procedure for adjusting wages by agreement, rather than a policy aimed at overriding the commercial considerations that have determined wages in the past. It is 'public' in the sense that it involves formal discussion by representatives, and results in publicly formulated standards; it is 'regulation' only in the sense that it provides in this way for the formal consideration of the factors affecting wages by the representatives of employers and wage-earners, and the embodiment of the result in a formal agreement.

The extension of public regulation of wages in this sense from a part to the whole of the field of commercial wage-employment could scarcely be without some effects upon the general industrial situation. In their classic study of collective bargaining, Mr. and Mrs. Webb (now Lord and Lady Passfield) laid chief stress upon its influence in increasing the efficiency of industry. They drew a sharp distinction between restricting numbers in a trade and imposing common rules. Their survey showed that the former policy, anti-social and self-defeating, was adopted by a smaller and smaller proportion of trade unions, and was becoming more and more difficult of application; the discarding of any attempt to restrict numbers, and the concentration on the policy of imposing standard or minimum rates and conditions, was growing, and was the chief characteristic of trade unionism in the expanding industries.

This policy increased industrial efficiency in two ways, by its reaction on the workman and by its reaction on the employer. The workman, prevented from securing employment by accepting a lower rate of pay than his competitors, was compelled to improve his efficiency, and was enabled to do so by the increase in income and security that trade unionism usually brought. More important were the reactions on the employer. Stopped from

taking the easy but dangerous path to lower costs of cutting wages, he had to find other means of increasing output in relation to wage-payments. Hence trade unionism encouraged an increase in the scale of production, a more extensive use of mechanical equipment, a more eager search for technical improvements, and, generally, the economy of labour. It did not extinguish competition, but diverted it from wages to other factors in costs.

The rapid expansion of the unionised coal, cotton, and engineering industries in the decade following the publication of this analysis seemed to confirm its soundness. The decline and stagnation of the same industries in the last eight years prompts the inquiry whether this influence has exhausted its potentialities.

Whether the influence on efficiency has continued and is general, the abnormal condition of British industry makes it difficult to decide. The large amount of short time, the increase in other costs, and the financial difficulties which prevent large numbers of firms from installing improvements, which they would like to install, all obscure the issue.

Contemporary experience of America shows that collective bargaining is not a necessary condition or the only means of stimulating an increase in efficiency. In so far as the extension of collective bargaining does stimulate or compel economy in labour—and, if it has not done so on any large scale at present, it may do so in the near future—it may maintain wages at the expense of increasing unemployment. In the great export industries of coal and cotton, for example, demand for British production appears to be inelastic, and considerable reductions in cost have not resulted in any substantial increase in employment. Moreover, much of the employment at present given is given at a loss.

A reorganisation that made it possible to maintain present wage-rates without loss would probably, therefore, involve a reduction in the numbers to whom employment could be given. Such an extrusion of unwanted labour, as a result of improvements in the technical processes or organisation of industry, is a normal incident of economic progress; and the hardship it may involve need be only temporary, provided that the expansion of industry as a whole is great enough and rapid enough to absorb the extruded labour. When all the industries of the country adopt collective bargaining, and all begin to adopt the policy of holding up wage-rates, leaving it to the employers to tune up industry to the pitch at which such rates can be paid, the numbers of extruded workers for whom the new and expanding industries have to find employment is likely to be increased, and the rate of expansion of industry as a whole becomes a factor of much wider and more pressing interest in wage-negotiations than before.

It is obvious that an advance in wages secured by any one class of workpeople, if it is not covered by a corresponding increase in the efficiency of the industry in which they are engaged, must be at

the expense of someone else. The increased efficiency may be due to the workpeople or to the employers; but, if neither of them create a fund from which increased wages can be paid, the increase will be paid either by consumers or by the co-operating industries that help them to supply the consumers. If the increase is merely sufficient to keep pace with an advance in the average level of wages, it may represent no more than the industry's proportionate share in the general increase of wealth; if, however, it is greater than the average, or in times of wage-reductions the reduction is less than the average, it must involve the diversion to the favoured industry of a larger share of society's income.

Such a diversion may be effected without overt restriction of numbers. If a union—or a trade board or arbitration authority—fix wage-rates in an industry at a level which makes it impossible for the industry to employ all the workpeople seeking work, and maintains rates at that level, it will immediately restrict employment, and ultimately may so discourage entry to the industry that the number of workpeople dependent on the industry is no greater than can be employed at the rates set. The demand for the products of industry, and therefore for labour, ebbs and flows with general fluctuations in trade; a strong union can maintain rates when demand ebbs and advance them when demand rises, thus preventing both a fall in rates proportionate to the general decline in money incomes in the depression, and an expansion in numbers proportionate to the general increase in production when trade improves. On the other hand, an unorganised industry may suffer a reduction of rates when trade declines and an expansion of numbers, on the low level of wages so established, when trade improves.

The mere regulation of wage-rates may, therefore, be restrictive in its effects. Such restriction may be legitimate and socially desirable; but it destroys any sharp distinction and opposition between a policy of restriction of numbers and a policy of imposing common rules of payment and conditions. It is not even clear that the reactions upon efficiency of the two policies are necessarily different. If the supply of a certain class of labour is restricted, employers will be stimulated to devise labour-saving appliances to substitute for it, or some reorganisation to dispense with it, just as certainly as if the supply is unrestricted but expensive.

Trade union control of wages, and the analogous control by public wage-fixing authorities, may be most simply regarded as an application of monopoly price policy to labour. The monopoly is seldom, if ever, complete; but what monopoly is? It gives the seller of labour no control over the demand for his services; it merely enables him, so far as it is effective, to select the point on the demand curve at which he will hold the price, until a general rise in demand absorbs at that price all the union members, instead of allowing competition for employment always to force wages down to the point at which the whole supply of labour

is absorbed. It is a policy that can be pursued without causing more than temporary unemployment, under two conditions; first, that the wealth of society is steadily growing, so that continually higher wage-rates can be paid without causing unemployment; secondly, that it is practised only by a minority of the trades in the community. The latter condition no longer obtains.

So long as everybody was not organised to attempt it, it was always possible that favoured trades, by means of a monopolistic organisation, might secure for themselves a larger share of the final price received for industry's products. All now are organised, or provided by the Government with equivalent protection; all are able to set and hold rates of wages, as firmly as the minority of well-organised trades were able to hold them before the War.

Partial and sporadic monopolistic organisation has been displaced by universal control. Two consequences follow. First, it is no longer possible for well-organised trades, merely by virtue of their trade union organisation, to secure differential gains at the expense of unorganised or ill-organised groups with whom they co-operate; or, if it is still possible, at any rate it is more difficult. In the second place, influences upon wages that were formerly counteracted by trade union organisation have now free play.

From this point of view the intervention of the State, in establishing trade boards and agricultural wages boards and in other ways, and the contemporary extension of unionism to hitherto unorganised trades, takes on a rather different aspect from that which Mr. and Mrs. Webb put upon it. They represented it rather as an extension to the rest of industry of the principle of trade union control and of the benefits that they had shown to follow from trade union organisation. This, of course, it was; but it was at the same time a necessary corrective of trade union influence. So long as only a part of the field of wage-employment is covered by trade union organisation, the benefits secured by trade unionists may in part be at the expense of the workpeople in the unorganised part of the field; so far as those benefits are not the return of increased efficiency due to union pressure, they will almost certainly be in part at the expense of other wage-earners.

The second consequence of general control is the release of influences upon wages which were formerly prevented from exercising their full potential effect. In this release is, I think, to be found a partial explanation of the changed relations which wages in different industries bear to one another since the War. It might have been expected, for example, that wages would be high in an industry like railway transport, which enjoys a monopoly and has a relatively inelastic demand for labour. In fact, before the War they were low; since then the railwaymen have had the advantage of effective union organisation, and their wages have risen disproportionately to others, in spite of the invasion of the railways' monopoly by road transport and consequent depression of the industry.

Another influence is 'shelter' from foreign competition, possibly only a temporary influence, but one that has operated throughout the post-War depression.

The extension of trade union or Government control over the whole field of commercial wage-employment has cancelled an advantage, which the workpeople in the organised trades used to possess, and, by so doing, has increased the relative influence which other elements of monopoly or bargaining-advantage exercise upon wages. The extension would be an almost unqualified improvement if its effect was to confine wage-claims to amounts that could be justified by the increased efficiency of industry, to which the control of wages contributed. Since, however, there are other conditions, which enable or encourage one trade to profit at the expense of others, and since the different controlling authorities carry on the pre-War trade union tradition of considering only the needs and possibilities of their own trade, the general extension of control may result in a general attempt to secure more wages than can be paid.

The increased element of publicity and public control of wages will tend to harden wage-rates in a depression, provided that the representatives of the wage-earners really wish to resist reductions. Whether they will do so or not, however, will depend on the consequences of successful resistance. Before the War the consequence would have been unemployment; and unemployment would have involved, for the small minority of wage-earners covered by trade union unemployment insurance, a drain on the union funds; for the great mass of wage-earners, who had no such resource, early and extreme hardship. It was impossible for the representatives of the wage-earners in wage-negotiations to ignore unemployment.

To-day things are different. Successful resistance to a reduction may still involve unemployment, but unemployment does not involve the same certainty or degree of distress. Before the War the provision for unemployment relief was partial and inadequate. To-day there is a system of unemployment relief that covers all the industries that are liable to serious unemployment. Then the spokesmen of the wage-earners had to consider the employment situation, because their clients would be the chief sufferers, if their wage-policy restricted employment; now, in such a case, they may nevertheless persist in their policy, since they are conscious that their clients are not without resources, if all cannot be employed at the level of wages exacted.

This comparative disregard of unemployment in wage determinations is as distinctive a change from pre-War practice as the extension of collective bargaining, and much more significant for the problem we are now examining. It is the principal and direct explanation of the loss of plasticity in wage-rates. It should be noted, however, that the provision of unemployment relief is not the only cause of the change. The post-War depression in many industries is so much deeper and more widespread that any practicable reduction in wage-

rates would scarcely affect it. The example of the coal industry, in which a substantial reduction in wage-rates has been followed by increase in unemployment—and in losses by the employing firms—is pointed to as evidence of the futility of wage-reductions; and no attempt is made to gauge the extent to which demand is as inelastic for the products of other industries as it has proved to be for coal.

There is an explanation for the wage-earner's attitude in yet another change; wage-rates of direct labour never were the sole determinant of costs, and to-day they are probably less important than before the War. Loan charges are still proportionately much heavier than before the War; rates and taxes and social insurance contributions are much heavier; indirect costs for transport, financial services, etc., are higher; distributing costs have increased disproportionately. Hence the wage-earner, asked for concessions, fears that he is being asked to make a sacrifice, not to revive trade, but to lessen the losses, or increase of profits, of retailers, banks, loanholders, railways, and co-operating industries, that may be more prosperous than his own.

The consideration of wages is purely sectional, industry by industry and trade by trade; the need of industry, so far as wage-adjustments can meet it, is for an all-round reduction, which will affect the indirect costs, simultaneously with the direct costs, of every industry. No machinery exists for such co-ordinated and synchronised adjustment; on the contrary, the extension of collective bargaining has probably intensified and extended the influence of this sectional outlook of industry, by enabling industries, that before the War could not have resisted the pressure imposed by general trade depression, to hold up wages.

It would appear that wage-fixing authorities, acting independently of one another and disregarding the general economic situation, are maintaining wage-rates at a level at which existing industries cannot provide full employment; the considerations that explain their policy will not serve to explain away the unemployment that has accompanied it. The outlet for labour thus excluded, which was provided before the War by industries in which wages were not controlled, no longer exists. There remains for examination the possibility that new industries may provide an outlet, industry as a whole expanding sufficiently to absorb the excluded labour.

It would seem that industry has, temporarily at any rate, lost its capacity of expansion. In certain directions there is expansion, but a closer examination compels us to discount any hopes derived from it. The largest single increase in employment has been offered by retail distribution, 360,000 or 31 per cent between 1923 and 1928. The Balfour Committee brought together material that suggests that retail distributing costs rose in greater proportion than prices generally between 1914 and 1925; since then we have had a further great increase in the number of insured persons employed in retail distribution. This expansion of the retail

margin has been sufficient to neutralise much of the writing down of capital, reduction of wages, and economies of re-organisation by which productive costs have been reduced. By keeping up the cost of living, while wholesale prices are falling, these costs also make it difficult to ask for any reduction in wages. So far, then, as retail distribution provides additional employment by its expansion, it probably does not succeed in compensating for reduction in industrial employment, which the cost it imposes on industry involves.

The second group of expanding industries is the building, building material, and furnishing industries. Together these account for 211,000 increase in the five years. The War-time arrears have now been made up, so that further expansion will be limited to the needs of the increase in population and of replacement with the aid of further subsidies. The case of the third group is similar. These are industries in which expansion has been stimulated by protection, but would have taken place without that stimulus, under the more economic stimulus of technical invention; motor manufacture and artificial silk are the chief members of the group. It is difficult to estimate how much of the growth was dependent on protection and merely a diversion from unprotected industries; but the aggregate expansion of the two together would not be sufficient to compensate for half the contraction in coal alone.

It remains in conclusion to point out that the loss of plasticity, and the adverse effects upon employment that may follow, are not necessary and inevitable consequences of the extension of collective settlements, but, in so far as they are attributable to it, due rather to an obvious defect in the machinery and current practice of collective bargaining than to anything inherent in collective bargaining as such.

The defect in the machinery for wage-negotiation to which the present unemployment points is the

purely sectional character of its deliberations. It is no one's business to consider wages as a whole: there is no authority charged with the duty of reminding wages boards of their responsibility to industry in general. Collective bargaining must fail in securing an accurate adjustment of wages to industrial conditions so long as it is confined to negotiations over wages in individual trades and industries. If it is to continue, it must be supplemented by some device for ensuring that the negotiators in each trade and industry have regard to the effect of their determinations upon other trades and industries, and for compelling them to contemplate the needs of industry as a whole.

Moreover, by considering only its own needs and interests, an industry might pursue a policy that was restrictive in effect, though regulative in form. If all industries and all trades pursue such a policy—and all now have the requisite organisation—and maintain rates of wages that restrict employment, there will be excluded a mass of workers who must either be absorbed by new industries or remain unemployed. If there are new industries capable of absorbing them, well and good; but at the present time it would seem that there are not. The index or barometer, therefore, to which trade union and arbitration authorities' attention should be directed, is not solely, or even principally, unemployment in the industry immediately under consideration, but the rate of expansion of industry as a whole.

The task of co-ordinating wage-settlements in different industries, and of securing in each the consideration of such apparently remote factors as the productivity and rate of expansion of industry as a whole, may be too much for the spontaneous democratic machinery by which collective settlements are negotiated at present; but the alternative is almost certainly a breakdown of that machinery under the pressure of a growing problem of unemployment.

Obituary.

DR. E. S. BIELER.

A TELEGRAM from the Prime Minister of Australia, sent on July 26, announced the death of E. S. Bieler on the previous day from pneumonia. He died after thirty-two hours' illness at Geraldton, Western Australia, at the age of thirty-five. He was engaged with Dr. Boughton Edge and others in geophysical exploration under the joint auspices of the British Empire Marketing Board and the Commonwealth of Australia. He had received two years' leave of absence from McGill University for this important expedition.

Educated at Montreal High School, Bieler became a distinguished honour student in mathematics and physics at McGill University. Soon after the War began he joined the First McGill University Company and then served with the Princess Patricia's Light Infantry, receiving a commission in the Canadian Field Artillery. After being twice wounded he was transferred to the Anti-submarine Division and worked under Sir

William Bragg at applied research methods at Scapa Flow and on the north coast of France. After the War he received an 1851 Exhibition Scholarship and went to Caius College, Cambridge, working as a research student at the Cavendish Laboratory at a time when Sir Ernest Rutherford and Dr. J. Chadwick were bombarding the nuclei of atoms with alpha particles.

The idea of a barrier round the nucleus resulted from this work and Rutherford has spoken to me with enthusiasm of Bieler's research. After taking his Ph.D. degree at Cambridge he became assistant professor of physics at McGill, and he directed his attention to the susceptibilities of the alkali metals and the Hall effect in them, believing that the greatest progress could be made in that manner. He communicated some admirable summaries on magnetism and on the Fermi-Dirac theory to the *Journal of the Franklin Institute*; and published papers also on electrical measurements.

Bieler had, in 1917, done research work in