

that the less the ratio of cooling surface to volume the less the proportionate cooling loss, and therefore the greater the amount of thermal energy converted into work.

Engines that have "pockets," that is, cavities in their walls, in which to contain ignition plugs or valves, are known to be less efficient than those that have not. On the other hand, it must not be forgotten that although this loss of efficiency exists, it is at any rate partly compensated for by the greater flexibility of the engine. It has been found, particularly in motor-car engines, that "pockets" have a very useful effect in enabling very variable mixtures to fire. The ignition plug is placed in a pocket so that, even when the mixture is a very poor one, there will be sufficient local "richness" in its neighbourhood to start an explosion which, once started, proceeds throughout the mass of the gas. Another fact which may have the result of increasing "pocketing" is the recently measured temperature limit for pre-ignition. Prof. Hopkinson has found that surfaces below 700° C. will not cause pre-ignition, whilst those above may do so—if above 750° C. they are pretty sure to do so. Now the surfaces most likely to rise to such temperatures are those remote from the cooling water in the jacket. The projecting end of an ignition plug is such a surface, and when exposed to the full heat of the explosion, as it is when the plug is not pocketed, pre-ignition may well occur. Prof. Hopkinson has shown also that when once a point of metal gets hot enough to cause pre-ignition, the very ignition of the flame in its neighbourhood will tend to cause the temperature to rise still higher, so that the phenomenon grows on itself and persists. It is not everyone who is moved, however, by such considerations, and we have lately seen in the design of the new Daimler engine a clearly expressed intention to avoid pocketing and its consequent loss of efficiency without any apparent fear of introducing other features much less desirable. It is only fair to say, however, that this engine is still on its trial. The ideal plan would appear to be to pocket the ignition plug but not the valves, and so combine the good features of both systems.

This frank abandonment of the highest possible efficiency by those who use pocketed engines brings us naturally to the consideration of thermal efficiency and the laws that regulate it. One may say at once that the theory of the internal-combustion engine has, until lately, been in a chaotic condition. The standard of efficiency for gas engines laid down by an influential committee had been found subsequently to be unsatisfactory as giving an impossibly ideal figure. That such remarkable progress in invention and mechanical perfection should have gone on side by side with this uncertainty as to the true standard of performance has often struck observers with astonishment. The considerable scale of the practical side of gas-engine development is illustrated by the fact that of one well-known make of double-acting gas engines alone, no fewer than 247 engines of an aggregate output of 308,000 h.p. have been built or ordered during the last six years. This corresponds to the large figure of more than 50,000 h.p. per year for only one of the many firms engaged on the work. At the moment the total capacity of gas engines in use must be well over 2,000,000 h.p., and of petrol engines much more than 1,000,000 h.p., making a total of more than 3,000,000 h.p. in internal-combustion engines. These are striking figures. Some of these engines and plants work with solid fuel and some with liquid. It would not be possible, even were it considered desirable, to use liquid fuel to the entire exclusion of any other. The present output of petroleum over the whole world is only 20,000,000 tons, a very small figure compared with the yearly consumption of 800,000,000 tons of coal. Unless, therefore, fresh supplies of oil are discovered, there can be no development of the internal-combustion engine which would lead to liquid fuel replacing solid fuel altogether.

In the articles that will follow, the author intends to deal with the problem of efficiency, taking into account the now established increase of specific heat with temperature, its effect on rating, and the recent practical improvements in the design and operation of gas engines and gas-producing plant.

H. E. WIMPERIS.

CONTINUATION SCHOOLS AND NATIONAL EFFICIENCY.

AMONG the numerous problems now confronting English educational administrators, probably the most urgent is that discussed in the valuable and exhaustive report on attendance at continuation schools recently issued by the Consultative Committee of the Board of Education. To some extent the report covers similar ground to that traversed in the educational sections of the Majority and Minority Reports of the Poor Law Commissioners, arriving at almost identical conclusions.

The essential features of the problem are as follows:—Under the existing Education Acts, children must attend school from their fifth to their fourteenth birthdays, subject to certain exemptions (prescribed by local bye-laws) during the last three years of the school period. Local education authorities may grant (a) total exemption from school attendance at eleven years of age to children engaged in agriculture, (b) full-time or half-time exemption, or both, to children between twelve and fourteen. The "leaving age" is generally twelve or thirteen. Full-time attendance at a day school until fourteen is now compulsory over areas comprising about 22 per cent. of the population of England and Wales. The committee estimates that in the year 1907, the latest year for which full statistics were available, there were about 211,000 children under fourteen years of age who had obtained full-time exemption from day-school attendance. Of these, only 40,500 were attending evening schools in the year 1906-7, leaving 170,500 children between the ages mentioned not attending any form of week-day instruction. Further, the estimated population of England and Wales between the ages of fourteen and seventeen is 2,022,300. After deducting from this the number attending elementary, secondary, technical, or evening schools, it is estimated that nearly 1,498,000 (or approximately 74 per cent.) boys and girls between the ages of fourteen and seventeen are not receiving any form of scholastic instruction. We have therefore, about 1,668,500 boys and girls from twelve to seventeen years of age whose formal education has entirely ceased for the time being. Recent inquiries in London and Glasgow render it highly probable that a very large proportion, if not the majority, of these boys and girls, if in wage-earning occupations, are employed in purely mechanical work of a monotonous, uneducational character, of no industrial value when the child becomes an adult.

Under these conditions the education, such as it is, given in the elementary school is being rapidly forgotten. The boys and girls are almost entirely exempt from parental control; they are falling victims to the prevailing passion for cheap amusements and to the attractions of the streets. Any slight gleam of intellectual aspiration which may have been aroused in the elementary school is rapidly being extinguished. The enormous sums spent by the State upon the elementary education of these young people are almost entirely wasted. All that remains is a certain facility in reading, writing, and very elementary arithmetic. Even if the boys are definitely apprenticed to a trade, matters are not much better. Under the present industrial conditions, involving the minutest possible specialisation in the works, the employer cannot possibly afford, even if he wishes, to give the boy the all-round training which was given by apprenticeship under the older industrial régime. Industry now requires, in addition to manual dexterity, a general industrial knowledge and a trained intelligence which will enable the worker to adapt himself to ever-changing industrial conditions; but this knowledge and training are not now given by apprenticeship. Hence, an education outside, but concurrent with, the workshop is essential. A further important factor is that even if a boy be apprenticed to a skilled trade, he is generally not taken on until about sixteen years of age. The intermediate years, between leaving school at thirteen and commencing apprenticeship at sixteen, are usually spent in "blind alley," uneducational occupations such as that of errand boy, van boy, messenger, &c.

For many years to come the formal education given to

1 Report of the Consultative Committee of the Board of Education on Attendance, compulsory or otherwise, at Continuation Schools. Board of Education, White Paper. Cd. 4757. (London: Wyman and Sons.) Price 1s. 6d.

the bulk of the population of this country will be that imparted in the elementary school, the continuation evening school, and the evening technical (including by this term commercial, or art or craft) school. The nation, at enormous expense, has instituted a system of national education which is almost entirely confined to children under fourteen years of age. In addition to this, an elaborate system of evening technical education has been established, mainly for those above the age of seventeen; but no adequate national system of evening continuation schools, for the boys or girls between the ages of fourteen and seventeen, linking on the elementary school to the evening technical institution, has yet been developed. The boy or girl leaves the elementary school at the age of thirteen. At seventeen or eighteen the youth may realise the necessity of attending evening classes for technical instruction relating to his special industry, assuming he is engaged in some skilled occupation or other. At the technical school he finds that he is unable to profit by the instruction given. During the years between thirteen and seventeen his powers of assimilation have declined through disuse, he has lost the habit of study, and most of his previous small stock of knowledge, *e.g.* mathematics and English, has vanished. He speedily becomes disheartened and ceases to attend. As a result, the greater portion of such chances as he possesses of rising in his trade, or of even keeping his position in a few years' time, vanishes. Not only is the worker thus damaged in an industrial sense, but the community loses, first by his diminished efficiency as an industrial unit, and secondly by the lessening in the sum total of sustained intellectual effort made by its citizens. Every workman, who by systematic instruction passes from the level of the ordinary artisan to that of the trained, intelligent worker, becomes an asset of increased value to the nation.

The problem now is, What can be done to (a) carry on the education of the wage-earning youth of this country during the years from thirteen to seventeen, (b) bridge over the present gap between the elementary school and the centres of higher evening instruction, such as the technical school? The solution lies in the development and the increased efficiency of the evening continuation school. The following statistics for 1906-7 from the report are not without interest as showing to some extent the measure of success which has been obtained:—

	Number of evening schools	Number of scholars on register in evening schools	Average attendance in public elementary schools (from five years upwards)	Percentage of evening scholars to day scholars
Lancashire ...	436	49,833	230,584	21.6
Yorkshire (West Riding) ...	308	29,447	211,281	13.9
Surrey ...	132	10,788	70,047	15.4
Birmingham ...	31	12,544	77,540	16.2
Bradford ...	34	8,361	35,372	23.6
Halifax ...	15	3,578	11,334	31.6
London ...	438	175,482	599,800	29.3
Manchester ...	92	26,838	88,887	30.2
Total for all counties in England and Wales	4,506	315,522	2,846,653	11.1
Total for all county boroughs in England and Wales	1,427	420,990	2,063,569	20.4

In recent years special attempts have been made in some districts to persuade boys and girls on leaving the elementary schools to join the continuation schools without delay. Some striking results have been obtained. In Widnes about 80 per cent. of the boys leaving the elementary schools commence attendance at evening schools without a break. Halifax has secured 66 per cent. The Lancashire County Education Committee reported in

January that in the larger boroughs 37 per cent., and in the smaller boroughs 22 per cent., of the boys and girls leaving school during the year ending October 30, 1908, to secure employment, joined the evening schools immediately.

The principal recommendations of the Consultative Committee are the following:—

(1) The leaving age should be raised to thirteen years, and after a short period to fourteen years.

(2) Full-time exemption from the day school should only be given to boys and girls under sixteen when the parents or guardians can show that the children in question are suitably employed.

(3) It should be the statutory duty of each local education authority to make suitable provision of continuation classes for the further education of young persons up to the age of seventeen.

(4) Local education authorities should be empowered to make bye-laws compelling attendance at continuation classes for young persons up to the age of seventeen, and employers should be compelled to make provision enabling such young persons to attend the continuation classes.

(5) Employers should be forbidden under penalty to employ any young person under seventeen years of age who fails to attend the evening continuation classes regularly.

(6) The curricula of the continuation schools should be such as to continue the general education given in the primary school. It should have reference to the crafts and industries in the district, and prominence should be given to practical and manual instruction.

Most educationists will heartily support the above recommendations. Numbers (3) and (4) of the above are taken from the Scotch Education Act of 1908. The committee points out that in Germany attendance at continuation schools is compulsory in portions of twenty-two out of twenty-six of the constituent States of the Empire, and in Switzerland in portions of nineteen out of the twenty-five cantons of the Republic. The committee is of opinion that there is now a strong and rapidly increasing body of public opinion ready to support its recommendations. The committee estimates that the total cost (imperial and local) of "maintenance" which would follow from raising the leaving age to fourteen would be about 490,000*l.* per annum. The corresponding cost of compulsory continuation classes (exclusive of new buildings) would be about 2,600,000*l.* per annum.

The proposals of the committee, if adopted, would have important educational and sociological results. Thus for example, one of the main causes of unemployment would be eliminated. Educationally the proposals would have a far-reaching effect upon the development of a complete national system of education. As has been before indicated, the continuation schools would take the boys and girls from the elementary schools, continuing without a break their general education, while specialising to a limited extent in either commercial, agricultural, technical, or domestic work, depending upon the requirements of the pupils. At the age of seventeen the boys and girls, after this preliminary training, could then be drafted on to technical, or commercial or art schools. The continuation schools would thus link on directly, and coordinate with, the elementary schools on the one hand and the technical institutions on the other.

The direct and indirect gain to the community from (a) the improvement of the general education of the masses, (b) the increased technical efficiency of the workers, would be incalculable. In this connection the following extracts from the report may be given:—

"An increasing stock of practical ability in a nation enlarges the range of its economic abilities and rapidly adds, through all the gradations of directive responsibility, to the number of well-remunerated posts which could never have existed if men had not been forthcoming to fill them."

"A rising level of education among the mass of workers increases the real level of their wages, though this may not be accompanied by a rise in their nominal amount. It conduces to wise expenditure of income and to the avoidance of thoughtless or harmful waste."

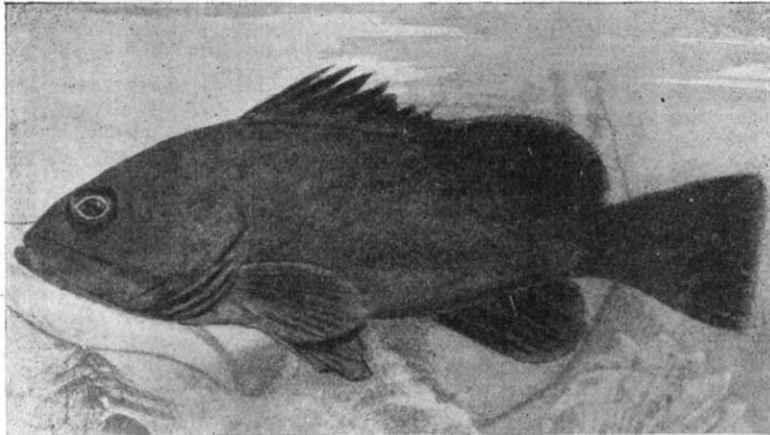
"Improvements in educational opportunity make possible

forms of government which give to the working class in the community an effective voice in policy and administration."

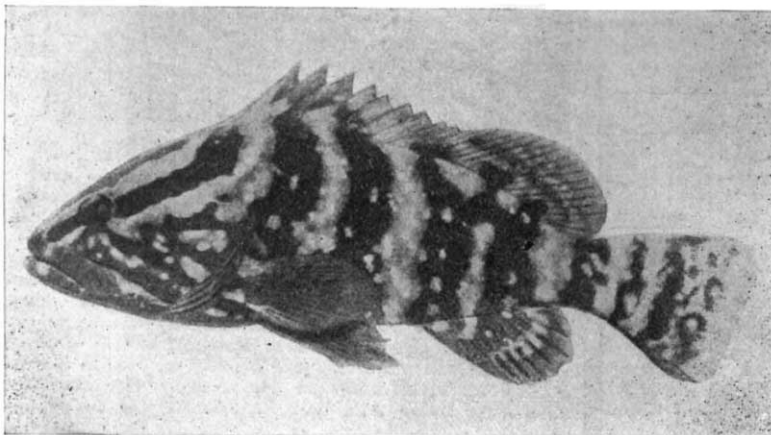
"The temper, the outlook, the recreations, and the ideals of a nation may be so refined and raised by the right kind of training as to secure for the mass of the people a more choiceworthy life." J. WILSON.

CHANGES IN COLOUR AMONG TROPICAL FISHES.

THE Zoological Society of New York recently issued a very interesting paper written by Mr. C. H. Townsend on the instantaneous changes of colour among tropical fishes (thirteenth annual report, 1909). The specimens came from the Bermudas, and are kept under favourable



Dark Phase.



Banded Phase.

Two Colour-phases of the Nassau Grouper (*Epinephelus striatus*).

conditions in the aquarium of the society. The changes of coloration "begin to be in evidence within an hour of the arrival of new specimens, or as soon as they recover from the alarm produced by handling, and are produced as long as the fishes live in the tanks, which, in some cases, may be several years."

The phases of coloration are illustrated by a striking series of photographs, two of which are reproduced. From these it will be seen that the fish can pass from a uniformly dark (plumbeous) colour to a banded phase with white markings. Four other phases can also be assumed, including a uniformly creamy-white one. This plasticity of coloration is characteristic of most of the fish dealt with, which include Serranidae, Scaridae, Teuthididae, and Scorpaenidae. There is frequently a pale and a dark monochrome

phase when the fish is at rest. Under any excitement, such as the presence of visitors, the fish assumes a parti-coloured aspect. This paper clearly shows how inadequate and misleading are many of the descriptions of colour hitherto accepted, and is a very suggestive and attractive piece of work. An error occurs on p. 3, where it is said that "their different colours result from muscular action upon one or more kinds of cells." The mechanism of colour-change is not muscular, but nervous.

MINERAL OUTPUT OF THE UNITED STATES.¹

THE well-known publication referred to below now appears in a form slightly different from the one to which we have hitherto been accustomed, being issued in two volumes, the first devoted to the Metallic products and the second to the Non-metallic products; this is done in consequence of a recent legislative enactment (Act of May 27, 1908), and presents some advantages, though it might be well to submit, with all respect, to the Government of the United States, that these (and sundry other) publications of the United States Geological Survey stand in far greater need of condensation than they do of expansion. When a work becomes unwieldy, there are two obvious remedies, either to issue it in two volumes or to compress the information it conveys into smaller compass; the latter is no doubt the more difficult proceeding, though the one that best serves the interests of the readers, and it is a matter of regret that, in this case, the line of least resistance has been followed. In the present instance it leads also to a few anomalies, as, for instance, the inclusion of crushed steel (as an abrasive) and of certain other metalliferous materials, such as arsenic, manganese, chromite, &c., in the volume devoted to non-metallic products.

It is greatly to be regretted that the mineral statistics of the United States are issued in a form that makes comparisons with the mineral output of other nations difficult; for example, the various values of the metals are reported, not in the form of ore, but in the metallic state, though obviously the value in this form includes the cost of reduction of the metal, and leads to very serious duplication, which the compilers appear to have overlooked, although the introduction lays stress on the statement that "all unnecessary duplication has been excluded." To take an example, the production of iron ore is not given, but instead of it that of the pig-iron smelted from it, namely, nearly 26 million tons, valued at about 530 million dollars. Now the production of coke for the same year was 40 million tons, produced from 62 million tons of coal, valued at nearly 73 million dollars. Practically the whole of the pig-iron produced was made with coke as fuel, and, in the absence of exact figures, it will probably be a near approximation to the truth if we assume that three-fourths of the coke production, or, say, 30 million tons, was consumed in the production of the above pig-iron, so that coal to the value of, say, 55 million dollars was utilised in this way, and this sum is accordingly included in the above valuation of the pig-iron production; it is, however, also included in the sum total of the value of the coal production, and thus enters twice

¹ Mineral Resources of the United States, Calendar Year 1907. Part I., Metallic Products. Pp. 742. Part II., Non-metallic Products. Pp. 897. (Washington: Government Printing Office, 1908.)