Even so, the relative prices of petrol and heavy oil, when compared on an energy content basis, are approximately 3 or 4 to 1. There is thus every incentive for the development of heavy-oil-burning engines suitable for use under conditions in which the petrol driven motor has hitherto reigned supreme. A move in this direction has already been made by the introduction of the Diesel-type heavy-oil-burning engine for the purposes of motor road transport.

Diesel engines can be conveniently classified into three main types, according to the speed at which they are designed to run. Low and medium speed Diesel engines which develop their full power at speeds below 500 and 1000 r.p.m. respectively are, chiefly owing to considerations of weight per unit of power developed, practically restricted to use in stationary installations or for marine purposes, and to a less extent in railway locomotive practice. High speed Diesel engines running at speeds of more than 1000 r.p.m. have the advantage of higher power-weight ratios than those possessed by the lower running types, and are being successfully employed for heavy road transport. It is probable that the use of such engines will, in time, be extended to the lighter classes of road transport vehicles and even to aircraft.

In addition to the great saving in fuel costs, the use of the Diesel engine offers further important advantages such as greater efficiency, compression ignition, less volume of fuel carried for a given mileage, practically eliminated fire risks, and a reduction in the size and area of the cooling system. The ultimate successful application to road and air transport of the high-speed Diesel engine will, however, depend largely upon the extent to which the designer is successful in reducing its inherent disadvantages, the chief of which are low power-weight ratio, starting difficulties, the offensive nature of the exhaust gases, oil creepage, and heavy transmission stresses. It remains to be seen, if and when the heavy oil engine has been sufficiently developed to compete successfully with the petrol motor, whether the resulting demand for heavy oil will not lead to such a levelling out of prices for the respective fuels that the Diesel engine will be robbed of one of its chief merits.

These recent developments in the heavy oil engine and its uses are a strong incentive to continued improvement in the petrol motor. Until the gas turbine has become a working proposition, the main line of improvement in the reciprocating type of engine lies in the direction of an increase in the compression ratio, an upper limit to which is set by the incidence of the well-known phenomenon of 'knock.' In attacking this problem two lines are being actively pursued. Some classes of motor spirit, such as benzol and other aromatic hydrocarbons, do not give rise to knock, no matter how high the compression ratio may be; but by far the larger bulk of our petrol supplies are rich in paraffins which are notorious offenders in this respect. To reduce the trouble the chemist is engaged in studying the effect of blending these different classes of spirit and has also attacked, with considerable success, the problem of treating bad petrols with substances such as lead tetraethyl, small additions of which suffice to reduce their tendency to knock, so that the 'doped' fuel can be burnt in engines of a considerably higher compression ratio than would otherwise have been possible.

Further, the engineer has not failed to realise that correct cylinder head and piston design is an important factor in suppressing knock. It is now well known that, other conditions such as turbulence, freedom of the explosion chamber from hot spots, etc., being equal, the incidence of knock is largely controlled by the distance of unimpeded travel of flame through the explosive mixture near the beginning of the firing stroke. Thus the same petrol can be burnt without giving rise to knock at a higher compression ratio in a small cylinder than in one of a larger capacity. Likewise a central position of the sparking plug, or, better still, multiple point ignition, materially assists in its suppression.

The expenditure in Great Britain on petrol alone is about £60,000,000 per annum, and is steadily increasing. Practically the whole of these supplies are imported, and there is little or no prospect of home-produced spirit materially affecting this state of affairs. There is, therefore, a great inducement to use solid fuels for road transport purposes. That the coal or coke fired steam-driven lorry continues to hold its own in spite of its exceptionally low thermal efficiency is a clear indication of the vast possibilities open to a motor which would combine the efficiency of the internal combustion engine with the low cost of coal. Intensive experimental work and exhaustive tests on road vehicles fitted with internal combustion engines running on gas generated in suction producers are now being carried out in Great Britain and other countries with much promise of success.

The Ice Age and General Drayson's Theories.

FROM time to time theories claiming to be scientific are put forward, most frequently in the domain of astronomy, which fail to secure the recognition of the orthodox. For the most part they pass quickly into deserved oblivion and are heard of no more. The fate of Gen. Drayson's ideas is quite peculiar. They have been kept alive by a devoted band of disciples, but no qualified astronomer who has considered the theories can profess more than the mildest interest in them. This attitude has led to resentment, and the Draysonians have not been slow to make accusations of obscurantism against the astronomers. As the world owes its release from the tyranny of dogma to nothing so much as the development of astronomy, and as in no science is the co-operation

between professional and amateur so cordial, fruitful, and freely acknowledged, such accusations may well be dismissed with amused indifference.

About the middle of the last century Capt. A. W. Drayson, R.A., after a course of study at Greenwich Observatory, was appointed to the staff of the Royal Academy at Woolwich and gave instruction in surveying and practical astronomy for about fifteen years. Sir John Herschel's "Outlines of Astronomy" had been adopted as the official textbook, and Drayson followed its teaching for a time, evidently without appreciating the nature and limitations inherent in even an admirable example of that type of work. Eventually he became dissatisfied with Herschel's exposition of the subject of precession. At that point he might have referred to the mathematical theory, of which the results were available to him only in the barest outline. Instead of doing so, and perhaps deterred by the difficulty of such a course, Drayson embarked on a geometrical reconstruction of the precessional motion as observed over a considerable period of time. In this task he showed no little ingenuity, but the outcome was doomed to futility. Everywhere in the Draysonian literature nutation is simply ignored. Now the real problem which has to be solved is the motion of the earth's axis as a whole, and the purely empirical description of a part of it can never be satisfying. Further than this, the description, such as it is, is devoid of any dynamical basis.

The attitude of Drayson and his followers to the theory of gravitation is undefined. They are not apparently in declared opposition to it altogether, but they claim to ignore its application to the problem of precession. What they overlook is that the astronomer is not free to select. He cannot remove the rotation of the earth from the operation of a natural law, and at the same time use that very law to predict the position of the sun and moon. What Drayson found was the osculating circle to the path of the earth's pole, and it represents a fair approximation to that path over a time which is quite long in one sense but short in comparison with the precessional period. The fact that it accords with the positions on which it is based affords no justification for extrapolation beyond them, and this is the fatal defect of the theory.

Here the story might have ended, for popular interest in the subject of the earth's precession would not by itself have sufficed to keep the cult alive. This vitality has been brought about by attaching the theory to the problem of an Ice Age.[1] Drayson's next step, in fact, was precisely to indulge in that process of unlimited extrapolation which lacks all valid foundation. For what is in effect the osculating circle to the path of the earth's mean pole he found the centre 6° from the pole of the ecliptic, together with a period of nearly 32,000 years. Here, then, in a large periodic change in the obliquity of the ecliptic, is an explanation of a glacial cycle ready to hand. By this means what might have passed as a crude version of astronomical data within a limited range of time was brought into a field where uncertainty as to the facts reigns supreme and any theory enjoys unwonted freedom from critical tests.

Much of course has been written on this subject from several points of view. The difficulty is that the evidence is not so precise, coherent, and complete as to present a definite problem to astronomy at all. The demands on the geologist are heavy. He must first agree on the approximate dates when the successive glaciations happened. Then, for those dates, he must define the whole areas affected simultaneously over the whole surface of the globe. Finally, he must be prepared to state what was the distribution of land and water, and more precisely what was the elevation of the land areas, for these are constantly changing, over all past geological time. It is only when a clear statement on all these points is forthcoming that the problem will reach a stage of closer interest. For then it will pass into the hands of the meteorologist, and he will state in terms of his science how far he can go in explaining the phenomena without requiring any help in the form of exceptional or overlooked astronomical conditions. It appears quite likely that he will need no assistance at all. Those interested in this phase of the subject will find it discussed in a popular form in a recent work by Dr. C. E. P. Brooks, "Climate through the Ages." If at the end of all this there is an outstanding balance for the astronomer to settle, and he has no other means of disputing it, there is always a fund on which he can draw without disturbing his account of invested theory. For when it can be established beyond doubt that there have been times when the earth's surface has received a deficiency of heat, the obvious inference will be that the sun's radiation has fluctuated in intensity. There is no reason to assume that the sun has always produced heat at a uniform rate, but rather the contrary. Unfortunately, the geological evidence at present is too ambiguous to turn a fruitful inquiry in this direction. In the meantime, this is a state of affairs which presents excellent opportunities for those casual coincidences so fatally attractive to undisciplined minds.

If, however, as suggested, the facts are neither so clear nor so detailed as to present a plain problem for solution, yet the occurrence of ice ages, though rather vague in time and distribution over the earth's surface, is common knowledge. Hence the alternative is to approach the problem from the astronomical end and to see where it may lead. The pioneer in this course was James Croll, and a very clear idea of the relevant conditions may be gained from Sir Robert Ball's little book, "The Cause of an Ice Age." A very important contribution to the subject from this point of view is due to Prof. C. V. L. Charlier in a publication from the Lund Observatory. His conclusion, as a matter of fact, is that accepted astronomical principles do point to the recurrence of conditions favouring an ice age at dates which he assigns. But it is of the essence of the astronomical explanation to find the

[1] "The Ice Age: its Date, Duration, and Astronomical Cause as Investigated by the late Maj.-General A. W. Drayson and recently confirmed by the Error in Timing the 1927 Solar Eclipse." Pp. 32. (Lewes, Sussex: W. E. Baxter, Ltd.) 6d. net.

cause in the slow changes in the eccentricity of the earth's orbit and not in large changes in the obliquity of the ecliptic. This theory also requires the ice ages in the two hemispheres to occur alternately, not simultaneously. It is hard to assess how far these acknowledged changes in the astronomical conditions have been effective, as it is to judge how far their influence may be needed to supplement all the other meteorological factors operating in past ages. If there is any reason for insisting that the ice ages have run concurrently in both hemispheres, it is far easier to find the cause in the body of the sun than in any peculiarity in the motion of the earth. H. C. P.

News and Views.

THE report of the Right Hon. W. G. A. Ormsby-Gore, M.P., Parliamentary Under-Secretary of State for the Colonies, on his visit to Malaya, Ceylon, and the Dutch Colony of Java during the year 1928, was presented to Parliament last week. This is the fourth report on Colonial development based on personal tours of the non-self-governing dependencies of the Crown for which Mr. Ormsby-Gore has been partly or wholly responsible. In 1922 he accompanied Mr. Edward Wood (now Lord Irwin) to the British West Indies and British Guiana. In 1924, Mr. J. H. Thomas (then Colonial Secretary) appointed him chairman of the Parliamentary Commission of Inquiry which visited East and Central Africa. Two years later he toured the four British Colonies in West Africa. Reports on each of these tours were presented to Parliament. Each of them is a valuable contribution to our knowledge of the countries coming within the scope of his inquiries. Considered as a whole, they constitute an almost complete summary of the facts related to the geography, history, economic development and administration of most of the countries for which Great Britain has assumed responsibility but to which it has not yet granted complete self-government. The common characteristic of the four reports is the emphasis laid upon the education, public health, and scientific and technical services as factors in the development of the resources of the tropics. Hitherto, there has been a tendency on the part of local governments to regard such services as luxuries to be afforded only in times of their prosperity. This fallacy is dealt with adequately. The scientific and technical services are shown to be the basis of economic advance. The importance of extending the public health services to prevent the enormous wastage of life and loss of physical efficiency of the peoples of the tropics is stressed, but above all it is shown that the work of such services will be largely abortive unless our subject races can appreciate what is being done and can co-operate with us. Hence it is imperative to build up greatly improved education services throughout the colonial empire.

ON his last tour, Mr. Ormsby-Gore took the opportunity courteously offered to him by the Governor-General of the Dutch East Indies to make himself acquainted with the work done by the Dutch in the colony of Java, the most densely populated part of the East Indies. He is thus able to compare Dutch with British colonial administration, and it must be confessed that the comparison does not show up British administration in a favourable light. It would appear that the Dutch administration has a greater appreciation of the beneficent influence of scientific research than we have. In the island of Java alone there is a Government central research institute at Buitenzorg and several other well-staffed and well-equipped research stations wholly maintained by the industries concerned in different parts of the island. Of the system of agricultural education in force, Mr. Ormsby-Gore speaks with the highest admiration. The public health services are also highly developed, but in this respect the British efforts to combat malaria in Malaya are warmly commended. The whole report is worthy of the closest scrutiny, and we hope to discuss it in detail in later issues of NATURE.

A MEMORANDUM has recently been issued by the New International Association for Testing Materials (N.I.A.T.M.) concerning the present position and activities of the Association and some recent decisions arrived at by the permanent committee of the Association held in Paris on June 21 last. The main object of the Association is to hold periodical congresses, but experience has shown that it is not satisfactory at a single congress to discuss subjects concerning the whole range of the testing of materials. It has therefore been decided to confine attention at each congress to a relatively small number of specially important subjects in each of the sections. On the other hand, undue specialisation in international discussions is to be avoided. To solve the task of selecting subjects for the next congress, to be held in Zurich in 1931, all participating countries were asked to forward suggestions. Sixteen countries have responded, and the outcome of their suggestions is an invitation to each country to prepare a number of preliminary summary reports on a small number of selected subjects and to appoint reporters. It is proposed to publish these preliminary reports early in 1930, in either English, French, or German. When the permanent committee receives these preliminary reports it will be in a better position to consider the final selection of subjects for the congress of 1931. The British committee, the offices of which are at 28 Victoria Street, S.W.1, is taking steps to secure widespread membership among those interested in the testing of materials, and it is anticipated that Great Britain will be adequately represented when the reports are published by the International Association.

MR. BHUDEB MOOKERJI, who has recently published the first two volumes of his work entitled "Rasa-Jala-Nidhi" or "Ocean of Indian Chemistry and Alchemy," has now issued a pamphlet entitled "Indian