transmission of heat from the brake drums. At one end of the axle in the apparatus used for the test the wheels rotate against a continuous braking force applied through the normal brake rods, the braking load being shown on a spring balance. The wheels at the other end are prevented from rotating by a torque arm and a spring balance indicates the brake torque applied to them and transmitted through the differential. Temperatures are measured at various parts of the apparatus by means of copper-constantan thermocouples. For parts which are rotating, the leads are soldered to pairs of copper and constantan slip-rings. In this way frequent temperature measurements can be made at selected points in the wheel rim, the brake drum, and the brake lining.

It has been possible to indicate in this survey only the more outstanding of the tests in progress, but the full extent of the research work which has been completed can best be seen in the list of reports which have been prepared by the Laboratory. Among the latest of these are papers dealing with fuel economy and with the distressing phenomenon of brake squeak. In addition the research department abstracts and classifies technical information from English and foreign papers, and these abstracts and the full resources of the library are available to assist members in any technical problem or inquiry which may arise. In these ways the Laboratory is playing a most important part, and its new premises and equipment, used with the vigour that is apparent in its direction, give the assurance of even greater usefulness in the future.

PLANNING THE POST-WAR WORLD

IN his presidential address to the Institution of Electrical Engineers delivered on October 24, Mr. J. R. Beard reminded his audience that exactly twenty years ago, when chairman of the North-Eastern Centre of the Institution, he read a paper on "Post-war Conditions and Developments, with particular reference to the Electric Supply Industry". On re-reading it to-day, he found that purely technical achievement has fulfilled, and in many cases exceeded, the expectations then expressed. Where we have largely failed is in having no clear idea of the purpose for which these technical achievements should be used, and also in lacking ability to arrange that co-operation with non-technical people and interests which is necessary if the engineer is to produce the structure that he knows to be most efficient and useful to the community.

As a starting point, it is assumed that we all recognize that the War has brought about, and is bringing about, tremendous changes not only in our environment but also in our whole outlook on life, and that we are all prepared to agree with *The Times* that "To liberate Europe from Hitler does not mean to reverse the whole process of economic integration which has been set in motion. . . . Much harm may be done to our cause, both in Europe and oversea, by the insinuation that we stand for the old order and that our only aim is to restore the *status quo* in Europe and to maintain it at home. This charge should be emphatically and authoritatively refuted".

There is herein implied some, possibly belated, recognition that the old order is no longer producing a healthy and happy community and that, for one reason or another, apathy, selfishness and discontent, too much freedom in some directions and too little in others, were gradually undermining the character and vigour of the democratic nations. The malaise from which the democratic nations have been suffering is aptly summed up by the eminent American writer, Walter L. Lippman: "The muddle of the democracies comes from something deeper than their form of Government; it comes from the gradually accelerated destruction of all convictions about the nature of man and his destiny. . . . For how can this planet be governed by people who have ceased to believe that there is good and that there is evil ?"

Dorothy Thompson, another American writer, suggests that the primary origin of the War was the secession of Germany from Western civilization and that we are fighting a great civil war to force Germany back into it. She defines Western civilization as follows:

"It is not democracy, not parliamentary government and certainly not capitalism. All of these are merely manifestations of something else—temporary forms to express a more permanent content. Nevertheless, Western civilization is definable. It is the synthesis of three things: the Christian ethic; the scientific spirit; and the rule of law. The essence of the Christian ethic is that the weak have rights as well as the strong, and that the strong must set limitations on their own power. The essence of the scientific spirit is that the search for truth transcends the State and may not be limited or suppressed by the State. It presumes the separation of State and culture, that is, the separation of culture from force. The essence of the rule of law is that contract is superior to arbitrary force, it presupposes a continuity of relationships . . . from whose sovereignty no one is exempt, not the King, not the President, not the powerful, not the weak".

Mr. Beard concluded by considering electrical planning in the Empire. Where central or national generating authorities have been set up, the functions of supervision have usually been carried out by them—as in Eire, Victoria and most of the Canadian provinces. South Africa, Quebec and Southern Rhodesia have followed more closely the example of Britain in establishing a separate supervising authority, but on a narrower basis and with little control of municipalities. Similar bodies, with varying powers and functions, also exist in British India, New South Wales, Queensland and Kenya, but elsewhere in the Empire supervision is usually exercised directly through Government departments, which are in many cases primarily devoted to some allied activity such as local government or public works.

The variety of conditions under which electricity is generated is so great as almost to defy classification, but there has been a strong trend, particularly in the Dominions, towards some form of monopoly. For the most part this has resulted from the establishment of independent Government commissions, of which Victoria, Ontario, Eire and South Africa are the best known examples, though there are smaller organizations such as the one in Trinidad.

Frequently a Government department has built and operated generating stations, gradually becoming a monopolist in the field of generation and bulk transmission. This has happened in such varied places as New Zealand, Western Australia, some Indian States, Malta and the Gold Coast. Over the rest of the Empire private and municipal enterprise dominate the field, though the trend towards monopoly is still clear.

In failure to take account of the difficult problems ahead lies our greatest danger. It is a danger specially to be guarded against by the younger electrical engineers, who must as years go on carry more and more of the responsibilities of the profession and whose lives will, to a great extent, coincide with the years of opportunity for the reconstruction of society and the building of a better world than they have inherited. These words of Sir Philip Sidney should be their inspiration : "It is the temper of the highest hearts to strive most upwards when they are most burdened".

ELECTRICAL AND MECHANICAL TRANSMISSION OF ENERGY

THE Andrew Laing Lecture to the North-East Coast Institution of Engineers was given on November 1 at Newcastle-on-Tyne by Prof. W. M. Thornton. He chose as his subject the foundations of the electrical and mechanical transmission of energy. From the earliest times men have sought to find the 'nature of things', and of the great branches of science into which their investigations have been gathered that of physics is both the most general and the most profound. It is essentially an experimental science ; but its greatest advances have been made by the use of mathematics. The applications of physics that form the scientific part of engineering have been the most effective when experiment and theory have moved together in rapid interchange, and in no part of the subject has this been more marked than in that which deals with the transformations of energy. It is only within this century that the identity of energy, for so long a subject of debate amongst scientific workers, has been firmly established. It is as real as matter itself.

The ten years between the discovery of X-rays by Röntgen in 1895 and Rutherford's establishment of the electrical constitution of matter have been described as the most fruitful in the history of science. To this amazing period we owe X-rays, the discovery of the electron, radioactivity, radium itself, relativity, the quantum theory of radiation, the development of radio-communication and the discovery that atoms are hollow planetary systems of elemental charges of positive and negative electricity, the proton and the electron. This last, together with the relation that is a consequence of the theory of relativity, namely, that matter is a form of energy, and hence mass, electricity and energy are convertible terms, places the doctrine of the identity of energy on a firm basis of reality.

In order to possess energy, the body or system of bodies in which energy is for the time located must either be in motion, in which case the energy that it has by virtue of its motion is called kinetic, or be part of a state of elastic strain, when it is termed potential energy or energy of position. A weight when raised acquires potential energy from the added electric strain of the ether of space that carries gravitational forces. In order that energy should be transmitted from one place to another it must be transformed from one of these states to the other, and the means by which this is in general done is the problem to which Prof. Thornton directed special attention. It is a problem of great theoretical and some practical interest. It is known that there is one law governing the whole range of the transmission of energy, whether in electric or mechanical engineering. This law is little known and is rarely referred to. Though occasionally used in the solution of electrical problems, it has never hitherto been applied to the consideration of those which deal with the transfer of energy by mechanical means.

There are problems of the transfer of energy which are met daily to which as yet there is no complete answer. How, for example, does a pendulum work ? At the end of its swing the energy is all potential, in the middle it is all kinetic. There is an almost perfect conservation of energy, but no one knows how the transformation takes place from the one form to the other. Its complete solution would require an understanding of the physical nature of gravitation and of the ether that has evaded scientific research from the time of Newton onwards.

One property of gravitational force that engineers may accept without question, though there are mathematical devices to evade it, is that to hold the planets in their orbits, it must be able to support great tensile forces. How these forces are derived physically from the matter of the sun and the earth is as yet unknown, though since matter is electrical in its constitution a gravitational field must have an electrical component in order to take hold of it. For many purposes the conception and use of this component is sufficient to illustrate the universal law which has been referred to, and on the assumption that all mechanical forces are electrical in their origin it may even be used to explain the working of a pendulum.

An equally familiar property of space is that it transmits radiation, from the extremely short and rapidly oscillating X-rays, through the regions of light and heat to the relatively long and slow waves of radio. These waves are in every case electromagnetic ; they all travel at the same speed through space, which we know to be the most perfect nonconductor of electricity, and in the case of radiation from the sun they carry the immense thermal energy by virtue of which life on this earth is possible. How this transmission of energy can take place through an insulating medium was shown some seventy years ago by James Clerk Maxwell, who based his electric theory of light on Faraday's discovery of magneto-electric induction and the polarization