ferro-nickel alloys, his first experiments were on their magnetic properties, as these were easier to investigate than the coefficients of expansion. Dr. Guillaume showed and explained curves representing the variation of magnetic properties, and of the coefficients α and β in the expansion equation $l=l_0(1+\alpha\theta+\beta\theta^2)$ for alloys in both the irreversible and reversible categories, and showed from the curves how it was possible to obtain alloys with any desired coefficient. The anomalous magnetic behaviour of some of the alloys was illustrated by demonstration experiments of the effect produced on the magnetic condition of bars of the materials by dipping in hot water or liquid air. The lecturer then dealt with the properties of ternary alloys containing iron, nickel, and a third element. Manganese alloys were those most extensively used. He exhibited a cardboard model of Guthrie's three-dimensional diagram for ternary alloys. The addition of the third element raised the minimum expansion. In the case of carbon and chromium the elastic constant is raised. The curve connecting Young's modulus with the percentage of nickel in ferro-nickel alloys also showed an anomaly in the same region as the expansion.

The chief weakness of the alloys from the point of view of the metrologist was instability. If a piece of invar was cooled from a high temperature in air at 100° C. its length reached a steady value in about 100 hours. If it was then cooled to 50° C. its length would increase to another steady value, reached in about 1000 hours or so. If it were then cooled to zero it would still further lengthen, a steady state not being reached for a very long time. If the temperature were then raised again to 100°, the length would diminish to its initial value for 100°. The total change of this character between 0° and 100° amounted to about 30 millionths of the length.

With increasing carbon content the instability very rapidly increased. It was possible from the amount of the instability to estimate the carbon to 1/100th per cent. Moreover, the curve connecting the instability and the carbon content passed through zero, showing that the instability was due to the carbon. It was therefore possible to get an invar of perfect stability.

Among the applications to which invar had been put, the lecturer instanced pendulum rods, leading in wires for electric lamps (an alloy being chosen from the curves so as to have the required coefficient of expansion), wire standards for base measurements in surveying, etc., and showed curves of the variation of height of the Eiffel Tower with temperature, as measured relatively to invar wires.

Another important application of these alloys was in chronometer construction. The temperature coefficient of the rate of a watch was due to variation of the elasticity of the hair-spring. This was corrected in the Graham compensation by a variation of angular momentum of the balance wheel, depending on the difference in expansion of two metals; but it was possible to choose for the spring a nickel steel having a temperature coefficient of elasticity nearly zero. If chosen to give the same rate at 0° and 30°, there would be a secondary error of only 20 seconds per day at 15°. But a more important chronometric application was the correction of the secondary error of 2 seconds in Graham's compensation. This error, discovered by Dent in 1832, is due to the fact that the variation of elasticity of the hair-spring is not a linear function of the temperature, whereas the variation of angular momentum of the balance wheel is. If however, for one component of the bimetallic compensator a nickel steel of negative β be chosen, it is possible to get a curve connecting the momentum with temperature which exactly compensates the elasticity variation over the whole range.

Reverting to the curves for Young's modulus, the lecturer predicted that an alloy would shortly be produced having a practically constant modulus over a range of 200° C.

Technical Education and Mind Training.

THE proceedings of the annual conference of the Association of Teachers in Technical Institutions, which was held in the Polytechnic, Regent Street, London, on Whit-Monday, were full of interest. The president, Mr. E. L. Rhead, of Manchester, gave a stimulating address, in the course of which he reviewed unfavourably the attitude of the Workers' Educational Association towards technical education as tending to narrow the workers' educational outlook, and as merely serving to create a human tool better calculated to promote the interests of employers and the sordid aims of industry. He claimed, on the contrary, that, rightly presented, technical education has in it all the elements of mind training and of a wide view of life and its problems. It may, in short, be, properly interpreted, constituted as the pivot of a liberal education. He deprecated the exclusive devotion of much of modern higher education to dead languages, dead history, and ancient philosophy, but that is surely to ignore a prime element in the evolution of mankind—the progress of man in his endeavour to search into and to solve the phenomena of Nature. Mr. Rhead went on to consider the status of the technical teacher as compared with that of the secondary-school teacher, and contended that the former should be at least as liberally considered as the latter, not only by reason of his long and arduous practical training in the processes of industry, but also in respect of the claims of industry itself upon his services. He urged the desirability of transfer from lower to higher schools at different periods in the course of the educational life of the capable pupil, and especially dwelt upon the value of the junior technical school, which he would in no wise desire to convert into a trades school, and pleaded that restrictions on their present aims and curricula should be removed. A far more liberal system of scholarships, including maintenance, should be established in co-operation with widely extended administrative educational areas, which should have regard not only to the pupils in day institutions, but also to the equally urgent requirements of the promising evening students, enabling them to devote themselves to whole-time study in their special vocation. There should likewise be an efficient representation of teachers on all education authorities, so that the present and future problems of technical education should be better considered. Resolutions were passed urging a large increase in salaries for the several grades of technical teachers; that all works continuation schools should ultimately be provided by the local education authorities and the present schools be open to inspection by the local and central authorities; and that a national Whitley council for teachers should be set up.

University and Educational Intelligence.

CAMBRIDGE.—Prof. J. T. Wilson, professor of anatomy in the University of Sydney, has been elected to the chair of anatomy rendered vacant by the death of Prof. A. Macalister.

We are informed by the secretary of the Cambridge Philosophical Society that the adjudicators of