biased scientific basis. Dr. Coffin, to bring out the importance of the air-temperature correction, assumes two cases, both with identically perfect barographs, with no instrumental errors, one ascent in summer and the other in winter to an altitude that both read 8 in. of mercury as the minimum pressure. He assumes that in the summer case the average temperature of the air is 10° C., and in the winter −30° C., which values correspond closely to actually observed figures. The true altitudes of these are 33,475 ft. (10,203 m.) for the summer instance and 30,929 ft. (9427 m.) for the winter, although the altitude uncorrected for air temperature is 36,020 ft. (10,979 m.) for both. Dr. Coffin states that the flight made by Roland Rohlfs, the test pilot of the Curtiss Engineering Corporation, on September 18, 1919, attained an altitude of 34,910 ft. (10,640 m.), partially corrected, but uncorrected for the average temperature of the air column; the true altitude was 32,450 ft. (9890 m.) corrected for air temperature. The altitude attained by Major Schroeder, similarly corrected for temperature, is 30,751 ft. (9373 m.).

In *Science* of April 30, Prof. McAdie gives as approximate values, corrected for mean air column temperature, vapour pressure, gravity, altitude, and latitude: Rohlfs, 32,418 ft. (9880·5 m.), and Schroeder, 31,184 ft. (9505 m.).

The *Meteorological Magazine* for March, in an article "The Highest Aeroplane Ascent," mentions Major Schroeder's ascent on February 27 last referred to above, and expresses the hope that it will be authenticated in due course. The record of Berson and Süring, who, it is stated, reached 35,400 ft. (10,789 m.) in a balloon on July 31, 1901, is mentioned as being generally accepted as the greatest height hitherto attained by aeronauts. The article seems to throw some doubt on the lowest temperature observed in the ascent by Glaisher and Coxwell.

Physical Problems in Soil Cultivation.[1]

UP to the outbreak of the war the farmer could generally rely upon an adequate supply of cheap labour. He had no great necessity to introduce labour-saving machinery into the routine of the farm. But the increasing demands of the Army for men and the menace of the submarine campaign brought him face to face with the difficult problem of growing more food with a greatly reduced staff. In such conditions the employment of machinery was the only solution, and although at the time it was introduced mainly as a temporary measure, it is now quite evident that economic conditions will cause it to be retained permanently. During the war the rate of progress in the industry of agriculture was necessarily forced above the normal, and the urgent need at the present time is to take stock of the position, so that future developments may be guided along the right lines. In this connection the report of the Departmental Committee of the Ministry of Agriculture on Agricultural Machinery appears at an opportune moment. The report deals with "the further steps which should be taken to promote the development of agricultural machinery," and, so far as tillage implements are concerned, falls naturally into two sections, dealing with (1) fundamental research on the physical properties of soil as affected by cultivation operations, and (2) the application of the knowledge thus gained to the design of new implements and the improvement of old ones.

[1] Report of the Departmental Committee of the Ministry of Agriculture on Agricultural Machinery. (H.M. Stationery Office.) Price 1s. net.

Taking the second section first, the Committee lays great stress on the fact that all development in the design of machinery has proceeded on empirical lines. "Although searching questions were addressed to several witnesses, we could not discover that any real attempt had been made in the past to determine the principles which underlie the design of the variety of implements in use in modern farming." As a result an enormous number of patterns of the same implement are made, one manufacturer alone having more than two hundred and fifty patterns of plough. The Committee considers that much of this overlapping and wasted effort will be avoided when the Ministry of Agriculture sets up its projected Research Institute in Agricultural Machinery.

The first section—research into the physical properties of soil—is regarded, rightly, as of primary importance. "Progress in research as regards tillage implements must depend largely upon the results of investigations into soil physics and the problem of tilth." It is clearly pointed out that this research must not be pursued with the immediate object of obtaining "practical" results. A sound theory of the interesting but complicated physical phenomena shown by soil must first be built up. Once this is achieved, the practical deductions will follow almost automatically. The very nature of this work precludes the possibility of forcing the pace, but it is suggested that, as the work has been in progress for some time at Rothamsted, it should be further developed by the appointment of additional scientific assistants.

If this were done it would be possible to pay more attention to those physical problems concerned with the soil tilth than is practicable at present. Tilth is related to the production of compound particles or aggregates in the soil, and to the factors causing plasticity, cohesion, etc. At the same time a study of the mechanical action of the plough could be started having as its aim the specification of the design of mould-board to meet different soil conditions. This is an unsurveyed field and full of promise.

The report also deals with the educational and research work which should be carried out at the projected Research Institute in Agricultural Machinery, especially from the engineering point of view. It also advocates the appointment of an Advisory Committee, composed of representatives from the research institutions, implement-makers, and agriculturists, to co-ordinate the whole of the work.

In the present article attention has been confined mainly to the sections dealing with the physical questions involved. The report covers a much wider field. It is closely reasoned and convincing, and can be cordially recommended to all concerned in the industry of agriculture.

B. A. KEEN.

The Anomaly of the Nickel Iron Alloys: Its Causes and its Applications.[1]

THE lecturer began by a reference to the work of John Hopkinson, and to his own early work on the perfecting of standards of length. His first experiments were on nickel, which had two great advantages over brass for metrological work, viz. its smaller coefficient of expansion and its greater freedom from corrosion. He would probably not have looked further but for the difficulty at the time of getting large bars of the material free from flaws. In investigating the

[1] Abstract of the Fourth Guthrie Lecture delivered before the Physical Society on April 23 by Dr. C. E. Guillaume.

© 1920 Nature Publishing Group

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

© 1920 Nature Publishing Group