would be no falling off in total yield, in spite of the diminished area.

Mr. Bainbridge gave an account of the experiments by Dr. Stead and Mr. Jackson on the solubility of basic slag in citric and carbonic acids. The reason why fluorspar makes the phosphoric acid in slag insoluble is that a reaction occurs between fluoride and phosphate, producing an artificial apatite, which, as regards insolubility, resembles natural fluorapatite. Even the most soluble phosphatic slags undergo this change and become insoluble on melting with fluorspar. Carbonic acid, after long-continued attack, generally dissolves out more phosphoric acid than a single attack by the standard citric acid.

Mr. G. Scott Robertson gave details of the field tests made to compare the effect of various types of open-hearth basic slags on grassland. These experiments were made in Essex on London clay, Boulder clay, and chalk. They show that all the phosphatic slags are effective fertilisers; but there are important differences in the agricultural effects, which are not connected with solubility according to the citric acid test; indeed, this test affords no indication of the fertilising value of open-hearth slags. Details of the botanical examination of the plots showed the striking effect of the basic slags in reducing the amount of bare space and in increasing the amount of clover.

Mr. Daniel Sillars made an important contribution from the metallurgical side, discussing the formation of basic slag in the manufacture of steel. The phosphide of iron, Fe_2P, in which state of combination phosphorus exists in molten iron, is oxidised by reactions of the type—

$$5Fe_3O_4 + 2P = 15FeO + P_2O_5$$
$$5Fe_3O_4 + 8P = 15Fe + 4P_2O_5.$$

The P_2O_5 formed may combine with FeO to form $Fe_3(PO_4)_2$, which, however, is unstable in the presence of a large excess of iron, and a reaction such as $Fe_3(PO_4)_2 + 11Fe = 8FeO + 2Fe_3P$ results, and it is in consequence of this reaction that the acid process of steel-making is unable to remove phosphorus. In the basic process the presence of lime affords an opportunity to the phosphoric acid to form a stable body by the reaction—

$$Fe_3(PO_4)_2 + 4CaO = Ca_4P_2O_9 + 3FeO.$$

The calcium phosphate formed is only feebly attacked and decomposed by the metallic iron, but manganese and carbon attack it more vigorously and cause the phosphoric acid to be reduced and the metal to be re-phosphorised. These reactions are, of course, proceeding concurrently, and it is necessary to maintain a certain concentration of ferrous oxide in the slag to minimise, so far as possible, the tendency to re-phosphorisation. Re-phosphorisation is probably due to the reaction between ferrous phosphate and lime being slightly reversible, whereby a small concentration of ferrous phosphate is always present, which is reduced by the carbon unless a source of oxygen is supplied by ferrous oxide in the slag.

In ordinary practice the open-hearth process is carried out by allowing the slag formed by the oxidation of the silicon, phosphorus, and manganese to flow over shutes made in the fore-plates into slag-pots under the furnaces, and no attempt is usually made to remove more slag than that which flows out naturally when the level of the slag in the furnace is higher than the level of the fore-plate. The slag left behind is carried on, and forms part of the finishing slag, which latter is therefore much greater in volume, and therefore lower in phosphoric acid, than the slag removed in the middle of the process. By this method of operation the time spent in tapping the furnace for separation of the slag and for the formation of a new slag is saved, but the slag is inferior both in richness and in citrate solubility if that still forms a criterion of excellence to the agriculturist.

Mr. Ridsdale took part in the discussion, and exhibited specimens of slags examined in the classic investigations by Stead and Ridsdale; and Mr. W. S. Jones contributed a paper on the improvement of low-grade basic slags.

As a result of the discussion it was decided to ask the Ministry of Agriculture to form a Committee which should study possible practical steps to effect improvement in quality and in quantity of the phosphatic slags.

Verification of Screw Gauges for Munitions of War.

THE *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (November–December, 1919, No. 6) contains an article by M. Cellerier, of the Conservatoire des Arts et Métiers, on the verification of screw gauges, with particular reference to the methods advocated by Mr. Bingham Powell, who was engaged in the United States during the war as Inspector of Gauges and Standards for the British Ministry of Munitions. These methods related chiefly to the measurement of the full, effective, and core diameters; the verification of pitch was neglected until quite a late period of the war, owing to the lack of instruments possessing the requisite precision and rapidity.

Extreme accuracy is of the highest importance in measurements of pitch, as any error in the pitch makes it necessary for the maximum limit of effective diameter to be reduced by double the amount of this error if the gauge is to be accepted as correct. Where the permissible deviations are very small, an error in pitch of a few ten-thousandths of an inch may thus completely annihilate the tolerance on effective diameter. Inaccuracies of pitch are often regarded as essentially progressive; but this is not always the case, as deformations due to hardening may introduce variable errors of quite appreciable magnitude. The method frequently adopted of verifying the pitch by measurements made on a length comprising a number of threads is accordingly much less trustworthy than the practice, long in vogue in France, of testing separately a number of consecutive threads.

For the latter process measuring machines of the pattern used at the National Physical Laboratory are particularly suitable, but at the time when the demand for extreme accuracy in screw gauges for war-work first became pressing it was impossible to obtain one of these machines in America without considerable delay, and accordingly Mr. Powell found it necessary to devise an instrument on the spot. He dispensed with the optical contrivance which forms an essential feature of the laboratory machine, and substituted for the spherical contacts a lever terminating in a small sphere which rests freely in the screw and can be guided conveniently in the axial plane from one thread to another. The lever consists of a very light needle, arranged in such a way that the apparatus can also be used for testing internal screws or nuts by means of appropriate casts taken by an ingenious and delicate method, but only a small segment of the internal thread can be obtained in this way for testing purposes.

As regards the measurement of diameters, although an ordinary micrometer will suffice for the external dimension, it is not suitable for determining either the effective or the core diameter. Before testing the effective diameters it is necessary to know the errors of the pitch, in order that the appropriate reductions may be made in the maximum limit of tolerance. A micrometer with point contacts should never be used alone for the effective diameter, as it bears only on projecting parts, and, further, the points wear down quickly. Even when new, its contacts for screw-threads rarely have the correct angle. It is, however, a useful check on results obtained by the aid of wire contacts, especially for investigating anomalies which may be apparent in these results.

Mr. Powell has made a special study of wire contacts for testing effective diameters. He employs systematically two series of wires for each pitch of screw. One series is such that the wire bears exactly on the theoretical effective diameter of a perfect screw; in the other series the wire bears on the sides of the screw not far from the outer edge, but so as to avoid the rounded-off part in Whitworth threads. The correct diameters for the series are calculated from a simple formula. The wires, which are finished by grinding, must be perfectly cylindrical, and their diameters have to be ascertained to an accuracy of 0·00001 in.; any error in the diameter of the wire is multiplied threefold in the result obtained for the effective diameter. They are made of hardened steel, and are about 2 in. in length, or longer for very large screws; but their exact adjustment is only necessary over about half an inch in the centre of the length.

The verification of internal screws may be effected simply by employing either an external screw having the correct dimensions for external, effective, and core diameters, or a screw correct for maximum and effective diameters, but slightly small for core diameter. A plug is also used in this case for verifying the minimum diameter of the internal screw. If these gauges enter the nut, the test is regarded as satisfactory; but, in reality, this is not always the case, as the external screw may appear to give a good result even if it bears on only one diameter of the nut; while the other diameters may be far outside the limit of tolerance. A large number of different gauges are necessary in order to verify separately every diameter of an internal screw.

Mr. Powell has drawn up a list of equipment required in the verification of screw gauges. This includes a pitch-measuring machine, an apparatus for obtaining casts of internal screws, a projecting arrangement, an instrument for measuring the three characteristic diameters of external screws, a collection of suitable wire contacts, small triangular prisms for verifying core diameters, standardised micrometers, Johansson gauges, and a complete set of standards for measuring diameters, pitch, and form of internal threads.

A theoretical explanation of the principles of the methods employed would have been of interest. In its absence some doubts arise, for example, as to the practical value of profiles of screw-threads projected on screens. Again, the contacts of small cylindrical wires on the helicoidal surfaces of threads cannot be regarded as the same as that of a circle and two intersecting straight lines, although the formulæ employed, which are stated without proof, appear to be founded on a consideration of this kind. In conclusion, Mr. Powell's methods are by no means entirely novel, but they were very successful during the war, and will no doubt be found instructive by all those engaged in the manufacture and verification of screw gauges.

The Composition of Salvarsan.

When salvarsan was first introduced for use in medicine the German manufacturers stated that it contained "about 34 per cent. of arsenic," which is the percentage calculated for a pure dihydroxydiaminoarsenobenzene dihydrochloride, $C_{12}H_{12}O_2N_2As_2,2HCl$. This statement was afterwards altered to "the arsenic content of the preparation corresponds to the formula $C_{12}H_{12}O_2N_2As_2,2HCl,2H_2O$ as a result of Gaebel's observation that the drug loses 7·6 per cent. by weight on drying, and contains only 31·5 per cent. of arsenic." Last year Kober, in the United States, ventured the opinion that the combined solvent in salvarsan is not water, but methyl alcohol, and suggested that the latter might be the cause of variable toxicity in salvarsan—a suggestion which is rather far-fetched in view of the fact that, even on Kober's assumption, a maximum normal dose of salvarsan could contain only 0·04 gram of methyl alcohol.

This and other questions connected with the composition of salvarsan have been investigated in the Wellcome Chemical Research Laboratories, and in a paper contributed to the meeting of the Chemical Society on March 18 Messrs. Fargher and Pyman showed that the combined solvent in salvarsan is water; and though small quantities of methyl alcohol may also be present, due to the use of this alcohol in the liquid from which the drug is precipitated, the amount never exceeds 1·4 per cent., and is frequently *nil*. It was also found that the sulphur always present in commercial salvarsan as a result of the use of sodium hyposulphite as a reducing agent in its preparation, occurs in at least two forms: (1) as a sulphaminic acid, probably "salvarsan" monosulphaminic acid hydrochloride, and (2) attached directly to arsenic; whilst a third portion may be in physical association with salvarsan, which has certain colloidal properties.

These results support the conclusion expressed in the recent Special Report (No. 44) of the Medical Research Committee, that though salvarsan is not a chemically pure substance, there is no known chemical impurity with the presence or proportion of which its varying toxicity can be brought into relation. In this connection it is interesting to note that a specially pure salvarsan free from sulphur, prepared by Messrs. Fargher and Pyman, was tested by the Medical Research Committee and shown to be more than normally toxic. Chemical testing alone is, therefore, insufficient to determine whether any particular batch of salvarsan is suitable for medical use, and it is on this account that the Medical Research Committee has elaborated the system of biological testing, described in the Special Report already referred to, to control the issue of salvarsan in this country. It is satisfactory that the Committee is able to report that, from the point of view of permanence of effect, the British and French salvarsan preparations are therapeutically as good as the German.

University and Educational Intelligence.

The governors of the Huddersfield Technical College have received a gift of 2000*l*. from Mrs. Mary Blamires, widow of Alderman Joseph Blamires, in memory of her late husband, himself a former student, and afterwards a governor, of the college. The scholarship is to be used for the promotion of research in chemistry.

The headquarters of the Yorkshire Summer School of Geography, now being organised by the University of Leeds, will this year be the County School, Whitby