

THE JOURNAL

OF THE

Chemical, Metallurgical & Mining

SOCIETY OF SOUTH AFRICA.

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to Members.

THE CHEMICAL, METALLURGICAL & MINING Society of South Africa.

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**THE JOURNAL OF
THE CHEMICAL, METALLURGICAL & MINING
Society of South Africa.**

BYE - LAWS.

(ADOPTED BY THE COUNCIL, 8th AUGUST, 1903.)

1. Annual General Meetings will be held on the third Saturday of the month of June in each year.
2. Ordinary General Meetings will be held on the third Saturday in each month.
3. All meetings, unless otherwise provided for in the notice convening the same, shall be held in the Council Chamber of the Chamber of Mines, Johannesburg, at 7.45 p.m.
4. Any Member or Associate may introduce a visitor to the Ordinary General Meetings; visitors may, with the consent of the Chairman, take part in any discussion and read papers.
5. Every paper which it is desired to bring before the Society shall be clearly written on one side of the paper only, and shall be lodged with the Secretary at least fourteen days before the date of the meeting at which it is proposed to be read.
6. The Council shall decide what papers shall be read at meetings of the Society.
7. All contributions communicated to the Society, with their illustrative drawings, shall become the property of the Society unless stipulation be made to the contrary; and Authors shall not be at liberty, save by permission of the Council, to publish or cause to have published such contributions until they have either appeared in the Journal of the Society, or a period of three months shall have elapsed since the date of their being handed to the Secretary.
8. Members and Associates whose subscriptions for the current year remain unpaid after the 1st day of October may be denied the privileges of the Society pending payment of the same; Members and Associates whose subscriptions for the current year remain unpaid after the 15th day of November may be removed from the roll of the Society.
9. At Annual General Meetings the election of officers shall take place in the following order:—1. President; 2. Vice-President; 3. Treasurer; 4. Members of Council.
10. All Deeds, Documents and Writings requiring execution on behalf of the Society shall be signed by the President and Treasurer, or in the absence of either or both, by Members of the Council duly authorised, under authority of a Minute of the Council.
11. The Minutes of all Special General Meetings shall be read and confirmed at the next convenient Council Meeting.

NOTICES.

The next ordinary General Meeting will be held in the Council Chamber of the Chamber of Mines, Market Square, Johannesburg, on August 20, 1904, at 7.45 p.m., preceded by the Monthly Social Dinner, at the Corporation Restaurant, at 6 p.m.

PAPERS AND DISCUSSIONS.—Country and Foreign Members and Associates unable to be present at the Meetings of the Society are invited to send in Papers to be read and also to contribute, in writing, to the various subjects under discussion. Papers should be clearly written on one side of the paper only, and be sent to the Secretary at least 14 days before the date of meeting.

On account of the great expense of reproducing diagrams, authors of papers are requested not to submit for publication in the Journal any other than those absolutely necessary to illustrate the text.

Detailed large scale diagrams or drawings and photographs, samples or models are invited for exhibition at the meetings to illustrate contributions.

All contributions to this Journal should be addressed to the Secretary. Special attention is drawn to Bye-law No. 7.

SUBSCRIPTIONS.—Members and Associates are reminded that Subscriptions for the year 1904-1905 ARE NOW DUE, and should be remitted without delay to the Hon. Treasurer, P.O. Box 4375, Johannesburg. Attention is drawn to Bye-law No. 8, above.

PROPOSAL FORMS.

Forms for proposal of intending Members, and application forms for Associates and Students, may be obtained on application to the Secretary.

PROCEEDINGS AND PERIODICALS.

The following periodicals are received regularly.

v. Weekly. *m.* Monthly.

- African Review, The (London), *v.*
 Proceedings of the American Inst. Mining Engineers (New York).
 Proceedings of the American Philosophical Society (Philadelphia, Pa.)
 Proceedings of the Australasian Inst. Mining Engineers (Melbourne).
 Australian Mining Standard, The (Melbourne), *v.*
 British and South African Export Gazette (London), *m.*
 Canadian Engineer (Toronto), *m.*
 Proceedings of the Canadian Mining Inst.
 Canadian Mining Review, The (Ottawa), *m.*
 Cassier's Magazine, *m.*
 Chemical News, The, *v.*
 Proceedings of the Chemical Society (London).
 Chemist and Druggist (London), *v.*
 Coal and Iron (London), *v.*
 Colliery Guardian, The (London), *v.*
 Proceedings of the Colorado Scientific Society (Denver, Colo.).
 Compressed Air (New York), *m.*
 Electrical Engineer, The (London), *v.*
 Electro Chemical Industry (New York), *m.*
 Electro-Chemist and Metallurgist (London), *m.*
 Engineering and Mining Journal, The (New York), *v.*
 Engineering Magazine, The (New York and London), *m.*
 Engineering Press Monthly Index-Review (Brussels), *m.*
 Engineering Review, The (London), *m.*
 Engineer, The (Cleveland, Ohio), *bi-m.*
 Proceedings of the Federated Inst. of Mining Engineers (Newcastle-on-Tyne)
 Proceedings of the Franklin Inst. (Philadelphia).
 Indian and Eastern Engineer, The (Calcutta), *m.*
 Indian Engineering (Calcutta), *v.*
 Proceedings of the Inst. of Mining and Metallurgy (London).
 Iron and Coal Trade's Review (London), *v.*
 Journal of the American Chemical Society, *m.*
 Journal of the Society of Chemical Industry, The (London), *m.*
 Proceedings of the Liverpool Engineering Society.
 Mines and Minerals (Scranton, Pa.), *m.*
 Mining and Scientific Press (San Francisco), *v.*
 Proceedings of Mining Engineers of Peru (Lima).
 Mining Journal, The (London), *v.*
 Mining Reporter, The (Denver, Colo.), *v.*
 New Zealand Mines Record (Wellington, N.Z.), *m.*
 New Zealand Mining, Engineering and Building Journal (Dunedin, N. Z.), *v.*
 Page's Magazine, *m.*
 School of Mines Quarterly (Columbia Univ., New York).
 Science and Art of Mining, The (Wigan), *bi-m.*
 Proceedings of the Smithsonian Instn. (Washington).
 South Africa (London), *v.*
 South African Mines, etc., The, *v.*
 Proceedings of the State School of Mines (Golden City, Colo.).
 Technology Quarterly (Boston, Mass.).

Associates Admitted June 1, 1904.

- BATESON, LISTON RICHARD, New Heriot G. M. Co., Ltd., P. O. Box 10, Cleveland. Mechanical Engineer.
- ROWN, ARTHUR HENRY, Daly Reduction Co., Hedley, B. C., Canada. Metallurgist.
- HOLT, CHARLES, E. M., 42 Broadway, New York City, U. S. A. Mining Engineer.
- MINNOW, ISHMAEL, c/o F. & A. Swanzy, Ltd., 147, Cannon Street, London, E. C. Mining Engineer.
- SEEAR, HERBERT CHARLES, Goldfields of Matabeleland, Ltd., Salisbury House, London Wall, London, E. C. Assayer and Surveyor.
- WESTON, EUSTACE MORTARTY, A. S. M. (Bal.) c/o W. Tyson, P. O. Box 1096, Johannesburg. Mining Engineer.

Associates Admitted July 6, 1904.

- DONALDSON, THOMAS, Dynamite Factory, Modderfontein. Analytical Chemist.
- HEELEY, ALBC WILLIAM, Wemmer G. M. Co., Ltd., P. O. Box 1097, Johannesburg. Mine Surveyor.
- MEESER, J. N., Village Main Reef G. M. Co., Ltd., P. O. Box 1091, Johannesburg. Contractor.
- STEELE, WILLIAM H., Bonanza, Ltd., P. O. Box 1338, Johannesburg. Cyanider.
- WOODLEY, REGINALD C., Bonanza, Ltd., P. O. Box 1338, Johannesburg. Cyanider.

Student Admitted July 6, 1904.

- WITHYCOMBE, JOHN HERMAN SURRAGE, P. O. Box 3544, Johannesburg. Student.

Members Elected July 16, 1904.

- ALLEN, HENRY, A. I. M. M., c/o Standard Bank, Johannesburg. Mine Manager.
- ARMSTRONG, ALEXANDER WILLIAMSON, Ferreira Deep, Ltd., P. O. Box 5977, Johannesburg. Sampler.
- CHEW, ROBERT WITHERS, Geldenhuis Deep, Ltd., Cleveland. Mill Manager.
- COTTER, ARTHUR JOHN, Ferreira Deep, Ltd., P. O. Box 1056, Johannesburg. Mine Secretary.
- CRANK, ALBERT FILMORE, Messrs. Fraser & Chalmers, Ltd., P. O. Box 619, Johannesburg. Engineer.
- GORDON, WILLIAM SHERVINTON, Village Main Reef G. M. Co., Ltd., P. O. Box 1091, Johannesburg. Assayer.
- HEAD, JAMES EDWARD, Ferreira Deep, Ltd., P. O. Box 5977, Johannesburg. Mechanical Engineer.
- JARMAN, EDWIN ARTHUR, Crown Deep, Ltd., P. O. Box 1056, Johannesburg. Mill Foreman.
- JOHNSON, HENRY HOWARD, Village Main Reef G. M. Co., Ltd., P. O. Box 1091, Johannesburg. Engineer.
- KERN, PERCIVAL ERNEST, Ferreira Deep, Ltd., P. O. Box 1056, Johannesburg. Assayer.
- LAMONT, CYRIL HOWARD, Village Main Reef G. M. Co., P. O. Box 1091, Johannesburg. Amalgamator.
- LASCHINGER, EDGAR JACOB, Consolidated Gold Fields of South Africa, Ltd., P. O. Box 1167, Johannesburg. Mechanical Engineer. (*Transfer from Associate Roll.*)

- MITCHELL, BENJAMIN MERWIN, Messrs. Fraser & Chalmers, Ltd., P. O. Box 619, Johannesburg. Engineer.
- SACK, LEO., Ph. D., M. A., P. O. Box 6341, Johannesburg. Analytical Chemist.
- WILKINSON, ARTHUR, Village Main Reef G. M. Co., Ltd., P. O. Box 1091, Johannesburg. Amalgamator.
- WILLIAMS, JOHN OWEN, P. O. Box 1659, Johannesburg. Sampler.
- WILLIAMS, SAMUEL, Robinson Deep G. M. Co., Ltd., P. O. Box 1488, Johannesburg. Miner.
- YULE, JAMES ALEXANDER, Langlaagte Estate and G. M. Co., Ltd., P. O. Box 98, Johannesburg. Mechanical Engineer.

Changes of Address.

Members and Associates are requested to notify the Secretary immediately of any change in address, otherwise it is impossible to guarantee the delivery of Journals or Notices. The Secretary should be at once notified of non-receipt of Journals and Notices.

MEMBERS.

- ANTROBUS, C. H., 1/0 P. O., P. O. Box 6523, Johannesburg.
- DIXON, CLEMENT, 1/0 Johannesburg; General Manager, West Bonanza, Ltd., Klerksdorp.
- DOWLING, W. R., 1/0 Germiston; Robinson Deep G. M. Co., Ltd., P. O. Box 1488, Johannesburg.
- JOHNSON, EDWD. H., 1/0 Randfontein; May Consolidated G. M. Co., Ltd., P. O. Box 50, Germiston.
- PENCIER, H. P. DE, 1/0 Loveday Street; P. O. Box 1081, Johannesburg.

ASSOCIATES.

- BAWDEN, F. A., 1/0 Robinson G. M. Co., Ltd.; New Heriot G. M. Co., Ltd., P. O. Box 10, Cleveland.
- DESSAUER, A. VON, 1/0 P. O. Box 1032; P. O. Box 2083, Johannesburg.
- JOHNSON, J. H., 1/0 Richmond Road; Talana, Warwick Road, Olton, near Birmingham.
- MICHIE, J., 1/0 P. O. Box 1238; P. O. Box 1122, Johannesburg.
- THOMAS, JOSEPH, 1/0 Johannesburg; Ginsberg G. M. Co., Ltd., P. O. Box 16, Knights.
- VINEY, A. D., 1/0 Johannesburg; Coronation Syndicate, Fortuna Siding.
- WARRINER, R. C., 1/0 Bonanza Ltd.; French Rand G. M. Co., Ltd., P. O. Box 25, Luipaardsvlei.

Addresses Wanted.

Correspondence and JOURNALS for the following members, addressed as under, have been returned marked "Not known" or "Gone away." Will any member kindly supply the Secretary with present address?

- E. W. L. BATHURST, Meyer and Charlton G. M. Co., Ltd., P. O. Box 1127, Johannesburg.
- LAWRENCE, E. J., P. O. Box 5075, Johannesburg.
- POWELL, O. P., Witwatersrand G. M. Co., Ltd., P. O. Box 1, Knights.
- YOUNG, H. H., Ginsberg G. M. Co., Ltd., P. O. Box 16, Knights.

Proceedings
AT
Ordinary General Meeting,
July 16, 1904.

The ordinary general meeting of the members of the Society was held on Saturday evening, July 16, in the Council Room of the Chamber of Mines, Mr. J. R. Williams in the chair. There was a total attendance of 73, as follows:—

55 Members: Messrs. E. H. Johnson, F. F. Alexander, R. G. Bevington, P. Carter, A. McA. Johnston, J. Littlejohn, Dr. Pakes, C. B. Saner, M. Torrente, A. Whitby, Prof. J. A. Wilkinson, J. R. Williams, J. A. Allen, R. C. Atkinson, J. Arthur, D. J. Arkell, R. K. Bath, J. A. Burrus, Dr. Bay, W. Beaver, P. Billyard, G. S. Cochrane, G. A. Darling, Clement Dixon, W. Dowling, R. L. Edmiston, J. M. Eaton, C. T. Gardiner, H. R. Grix, H. L. Harland, S. H. Hart, W. H. Jollyman, W. Leyson, C. W. Lee, H. H. Morrell, P. T. Morrisby, Dr. J. Moir, G. Melvill, J. F. Mitchell, R. Ovendale, A. E. Payne, Prof. Prister, H. F. Roche, A. L. Spoor, S. H. Steels, R. G. Stokes, H. G. Sellon, T. W. Simmons, W. Taylor, J. E. Thomas, W. O. Williams, G. W. Williams, John Watson, J. B. Wilson.

7 Associates: Messrs. A. E. Adams, J. W. Carter, A. M. Ferguson, R. W. Leng, A. G. Rusden, H. Rusden, A. L. Wright.

10 Visitors, and Fred. Rowland, Secretary.

The minutes of the last general meeting, as printed in the June *Journal*, were unanimously adopted.

The Chairman: I have much pleasure in introducing to you this evening Mr. Caldecott. He was one of those who were present at our first meeting, when our number was about nine, whereas now it is over one thousand.

Mr. W. A. Caldecott then took the chair.

The President: At the last Council meeting the matter of re-printing our proceedings as hitherto was discussed, a procedure involving a considerable amount of expense. It was thought inadvisable to follow the practice in future, and that it would be better to bind up the monthly numbers of the *Journal* at the end of the year. In view of this it has been decided to print 800 additional copies, so that members will be able to get them in the ordinary way and bind them up. I may point out that this new departure will not allow us to correct clerical errors or mistakes as in the past, and we must request all members or others submitting anything for publication to exercise great care, as the errors once passed will remain.

In answer to questions, the President said that no doubt it would be possible to get covers from home, so that the monthly numbers could be bound up in uniform style. An index was indispensable, and would be provided.

The President: I am very pleased to be able to announce that all the candidates for membership have been unanimously elected.

The Secretary notified the names of gentlemen who had been admitted as associates and students since the last meeting.

**THE PRESIDENT'S INAUGURAL
ADDRESS.**

GENTLEMEN,—In addressing you this evening, I wish once more to express my appreciation of the honour you have conferred upon me by placing me in the distinguished and onerous position of your President. My diffidence in accepting such a position in succession to the distinguished workers who have occupied the Presidential chair would be still greater did I not realise that in your Vice-Presidents and Council you have a body of men who are both able and willing to maintain and even enhance the reputation our Society has won during the past decade.

The inspiring inaugural address of our Past-President, Mr. S. H. Pearce, dealt with the many opportunities for industrial progress, which awaited us in our varying capacities as units of this great community. I propose to-night to exercise my privilege of addressing you mainly by reviewing some of the possibilities for our mutual advantage, which present themselves to us as members of this Society.

The objects of a Society such as this may be viewed from various standpoints, but I take it that in brief our main object is simply to learn from each other. With this view you have never suffered the utilisation of the Society's membership to further the private or pecuniary interests of individuals. Nor has anyone been debarred admission to the privileges of membership on account of the professional exclusiveness of those who were already within the fold. On the contrary, in the words of one of our past-presidents, anyone is eligible for membership who takes sufficient interest in our proceedings to be desirous of joining us. This liberal attitude has brought its own reward in the variety and interest of our proceedings, whilst the continually increasing number of our members has enabled us to correspondingly increase the sphere of the Society's usefulness. A glance through the Society's list of members displays cosmopolitan

characteristics upon which we may well congratulate ourselves. No other inducement than the intrinsic value of our proceedings could induce workers in countries so far remote as Chili or Borneo to join with men engaged in most diverse professions and occupations here—professors, physicians, miners, financiers, analysts, engineers and many others.

But though we have accomplished much, yet still more remains to be done. When one looks at our extensive membership roll and then at the list of those taking any part in our proceedings, there is a great and evident discrepancy. I think our constant endeavour should be to reduce that discrepancy to the irreducible minimum. It does not seem to me, gentlemen, that those of our members actively engaged in technical work have quite paid all their debt to the Society and to their fellow members when they have posted cheques for their subscriptions to the Treasurer. Financial support is no doubt indispensable, but, after all, it merely serves to keep the necessary machinery of the Society in motion. The soul of the Society and the reason for its existence lies in the interchange of knowledge, and, to my mind, we should each of us, by contributing our mite of information, endeavour to repay in some measure the hundredfold return we receive from the knowledge of others. Knowledge is the one thing we can afford to give without being rendered poorer, and it is immaterial whether our contributions to the common stock take the form of papers, discussions, notes, comments, extracts, replies to queries or abstracts. Possibly some members may be debarred by the apparent insignificance of a useful device or fact from rendering it public, but I may be permitted to remind such that in many branches of industry few but improvements in detail are now possible, and also that, through the publication of some apparently trivial circumstance, other members may be enabled to develop the idea and render it relatively important. Some of those present to-night will remember the time fifteen years ago when an additional $\frac{1}{2}$ dwt. of gold per ton milled meant no more ounces of gold added to the Rand monthly output than does a grain of gold per ton now. A florin per ton additional profits was no unwelcome thing in those days, and I take it that at present its equivalent in the aggregate is just as desirable. Hence the possibility for increased skill to greatly offset, through the ever-enlarging scale of operations, the continual contraction of the margin for possible improvements.

In our daily work problems of all kinds are liable to continually occur, and the knowledge of all our members should be at the disposal of any one of us needing information. If one turns to

the records of other societies, one finds the short paper, dealing solely with one matter, a good deal more frequent than with us, and I think we might cultivate this branch of 'contribution' with considerable mutual advantage. And this, even though it frequently involves less labour to write a lengthy, discursive paper than to prepare a concentrated product expressing the same essential ideas with equal or greater lucidity. To our younger members who may possibly be diffident of presenting elaborate papers, I may be permitted to commend this form of contribution and also to point out that succinct articles or contributions to discussion, placing on record fresh and useful matter will certainly not retard the winning of that reputation which is the professional man's equivalent of the merchant's working capital. The prize scheme further offers us, through the far-sighted liberality of the donors, additional inducements to fulfil our destiny as an intellectual, co-operative association. Many matters, however, of great value and interest are, from their very nature, incapable of returning direct material rewards, and yet these may be so dealt with as to reflect well-deserved credit upon the man imbued with the truly scientific spirit, who brings them forward.

As a technical Society, in contradistinction to one dealing mainly with pure science, utility and novelty to all or part of our members should be the chief touchstone whereby to test the value of contributions. Truth is many-sided, and we should gain a broader and truer view by studying the clearly and concisely expressed opinions of ten competent judges upon any subject than from the same amount of matter expressing in very great detail the views of any one man.

But above all other inducements of which we have to take our share in the Society's work, there is the higher satisfaction of having endeavoured to add our stone towards building up the great edifice of scientific knowledge which, viewed as an aggregate, constitutes the most stupendous achievement of the human race.

At more than one of our meetings appreciative references have been extended towards the Transvaal Technical Institute lately established here. We rejoice in the fact that our younger brethren, and future co-workers in developing the natural resources of this great country, enjoy far greater educational privileges than fell to the lot of many of us. At the same time, our Society may be able to enforce the lesson that technical work in this work-a-day world involves a great deal besides abstract principles, and that education should only cease with life. It has been said that a man of book-learning only is worth nothing from an industrial standpoint, that the rule-of-thumb worker may be

worth a pound a day, but that the value of a man with a firm grasp of both principles and practice, is unlimited. If I might offer a suggestion, based on a good many years' life on South African goldfields, to those now coming in contact with the actual realities of life, it is this: To keep abreast of other than local practice one must be continually acquainted with what is published upon one's own subject in the technical periodical literature of other countries. To do this, a set of duly classified articles and cuttings is indispensable, and after a few years becomes even more valuable to the possessor than most text books which usually deal more in generalities than in details. In the ever-increasing flood of literature upon all subjects thus alone it seems possible to carry out the spirit of Pope's maxim

"For index learning turns no student pale
Yet grasps the eel of science by the tail."

A single idea per annum from the proceedings of some technical society or from some technical periodical may be worth its cost for many years. As one of Nelson's most famous captains, Sir Alexander Ball said, a century ago: "The Press is the means by which intelligent men now converse with each other, and persons of all classes and all pursuits convey each the contribution of his individual experience. . . . The use and necessity of personal experience consisted in the power of choosing and applying what had been read, and by discriminating by the light of analogy the practicable and probability from mere plausibility. Without a judgment matured and steadied by actual experience, a man would read to little and perhaps bad purpose; but yet that experience, which in exclusion of all other knowledge has been derived from one man's life, is in the present day scarcely worthy of the name—at least for those who are to act in the higher and wider spheres of duty."

For some of our members the Society's *Journal* possibly forms the sole technical literature, and I look forward to the time when, besides our own transactions, it will contain abstracts of all technical articles of interest to us wherever published, and even reprints in full of technical papers of pre-eminent value.

It has been our constant pride that, owing to the fixed price of gold and the liberal attitude of those controlling the gold industry on the Rand, we have no secrets in metallurgy here. This freedom lends peculiar value to our transactions, both in the prompt antidote provided in discussion to ill-considered assertions, and also in the fact that any local method referred to at our meetings can be seen in actual operation by those interested. Whilst we all hope, that the vivacity and interest of our proceedings will never be

lessened, I feel that I have equally your support in expressing the desire that our discussions will never degenerate into mere personal controversy wherein participants endeavour to prove each other wrong rather than simply to elicit the actual truth, which alone interests us as a body. The rough and tumble of daily life may have case-hardened some of us to vigorous criticism, but the fear of too rough handling is at times likely to keep more diffident members from publicly expressing views and experiences which we should all profit by learning.

Among the valuable suggestions made by your last President in his inaugural address was that of the investigation by sub-committees of this Society of certain methods of industrial analysis. There is, no doubt, a great field in the direction of establishing recognised tests for the quality of the millions of pounds' worth of stores and supplies bought annually by mining companies in this district alone. Our colleagues, the engineers, would, I am sure, welcome methods of examination which provide them with means of testing periodically materials such as fuel, lubricants, water, and steel in various forms. Already, regular analyses and tests of coal and explosives are carried out by one of our mining corporations, but the system generally is in its infancy, and its future extension promises much in the regions of economy and efficiency. One result will be that the mine assay office will tend to develop more into the laboratory, and that while more than a knowledge of one branch of the art will be asked of that most hard-working number of the mine staff, the assayer, yet his status will be correspondingly raised and the monotony of his present ordinary duties greatly relieved.

Among the possibilities of future progress two things stand out. Of our total working expenditure on gold mining companies, three-fifths or more is roughly consumed in actual mining costs alone; metallurgical costs in all amount to little more than one-quarter of the whole. Our mining members have here opportunities for economies which are denied to their less fortunate fellow workers on the surface. The other object to be sought for lies in the fact that whilst with years our metallurgical methods have improved in the directions of continually increased percentage recovery and continually reduced working costs, yet this has been attended by equally continuous increasing of initial capital expenditure. At present our capital expenditure on existing or future deep level mines amounts to very large sums indeed, and though this is even now most amply repaid, yet to achieve our present or better results and yet lock up less capital is an object fully as desirable as any we have striven for and achieved in the past.

Mr. E. H. Johnson: I would like to propose a very hearty vote of thanks to our new President for his very instructive and interesting address. Our past-presidents have dealt mostly with the field of operations outside. Mr. Caldecott has shown us what internal developments we can make with that mutual co-operation which has obtained so largely in the past amongst cyanide workers, whence our old soubriquet of "The Cyanide Club." Matters have been brought up and discussed here which have been of mutual benefit, and I am pleased to see that the millmen have also adopted the same course, and before very long I trust that we shall see the mining men on their legs frequently.

Dr. W. C. C. Pakes: I have pleasure in seconding the vote of thanks. I feel that this address which we have heard to-night is one which, like a good many addresses we have heard, we want to read over perhaps once or twice before we all fully realise all that it contains. One or two of these points I have been reading over, and there is a great deal more in what Mr. Caldecott has said than appears to some of us when we merely hear it read. Although we have all heard it, it will be read with great interest when it appears in the *Journal*. There is one point, namely, the suggestion Mr. Caldecott has made as regards short papers. I am certain that is really an invitation to the younger members not to be as diffident as I understand they have been in the past in bringing before the Society those apparent trivialities which, as Mr. Caldecott has said, may be trivialities, but which, on the other hand, may lead to great developments, and, in so far as this invitation has been expressed, I am saying what other members of the Council feel, that the Council hopes the younger members will accept this invitation and will bring forward even quite short papers before us.

The President: I beg to thank you for the vote of thanks which you have been good enough to pass.

UNDERGROUND HANDLING AND TRANSPORT OF ORE.

CHIEFLY IN REFERENCE TO THE RAND.

By C. B. SANER and GEO. CARTER (Members).

REPLY TO DISCUSSION.

Mr. Chas. B. Saner: The criticisms of, or rather contributions, to, our paper have been so favourable that there is very little for us to reply to, and the various experiences given go to prove that we were well within the mark when showing

the labour-saving qualities of the different devices mentioned by us.

Mr. Sawyer, in his book, gives illustrations of some of the contrivances which we mentioned. Undoubtedly, these are well known and have been in use for some time, more especially in coal mines, but, at the same time, we would remind Mr. Sawyer of the old saying, "There is nothing new under the sun," and often with a slight modification or local adaptation of an old idea a very useful device can be made, the application of which may prove of great value to current operations.

To obviate Mr. Hutton's difficulty when in washing down his old stopes (he got his pump choked up with slime), a small sump could easily be cut close to the cross-cut to the shaft. The cleaning out of this should not entail much trouble, as this washing down operation should only be carried out every now and then.

Mr. T. Lane Carter is quite correct in saying that it is better to have a large quantity of rock broken in a stope, as the more continuous the running of any labour-saving appliance the greater becomes its efficiency; it would scarcely be economical to put up a large shaker when there is little or nothing to shake.

Air-hoists for use in hauling stuff from winzes are certainly good; equally good, and less expensive are light skips made of $\frac{1}{16}$ in. iron stiffened, running on rails worked by a hand windlass.

In this connection, also, good work is being done by a modification of the aerial gear described. This modification consists of small, detachable buckets, which run down the winze on a wire rope suspended along the hanging wall, and which are worked by hand power.

A shaker has lately been used for keeping flat rises clear of stuff, and has been found to work admirably in this respect. In answer to Mr. T. Lane Carter, we think 9 in. in 100 ft. a good working grade; it is advisable to have the rails of deep web laid well above the floor of the level, and always kept clean. A few "umfaans" employed in cleaning the tracks would soon pay for themselves in easier and speedier tramming.

Mr. Lawrie Hamilton's example, illustrating the portability of a shaker, serves to show how careful we were not to exaggerate its usefulness. Mr. Hamilton's remarks seem to imply that we claimed originality for the shaker, but originality for any of the appliances described was not claimed, as is shown by the publication on the photographs of the names of the mines in which they were taken. Furthermore, our figures were taken over a long period, the work being under normal conditions and not being merely exhibition tests.

The object of the test described is surely quite clear, viz., that by the use of the shaker more rock could be loaded into a truck from a distance of 90 ft. than could be supplied by hand even by first-class Cape boys working in the immediate vicinity of the truck.

Shaking chutes have been in continuous use on the Nourse Deep for ten months, and so far as can be seen, they are still in good working order, and can yet be used for some considerable time.

The longest chute is 225 ft.; the average length from point of filling to discharge = 180 ft.; angle of dip = 25°; length of time working to date, six months; tonnage handled = 6,557. We may mention that the Nourse Deep is now using about 1,200 ft. of shakers.

The aerial gear test mentioned was an exhibition one, and therefore the running was at top speed, with no stoppages. The second part of the paragraph has no connection with the first, and simply illustrates that by using this gear fourteen boys per shift were saved.

The excessive wear and tear in the case of the mechanical haulage was mainly caused (as will be seen from the sketch plan) through working in such a crooked level.

We are very glad to hear that automatic lubricators are used on the Rose Deep, but still maintain that a general adoption of this plan is advisable. Ball-bearing wheels are also conducive to good and easy running.

The numerous examples of tests given by Mr. Hamilton are very interesting and instructive, and help very materially to emphasize the usefulness and efficiency of the shakers and aerial gear over ordinary hand shovelling.

The aerial gear at Rietfontein A, described by Mr. Hay, is very ingenious, and when seen by us worked excellently.

In conclusion, we would take this opportunity of drawing the attention of those interested to the Report of the Government Mining Engineer for the year ended June 30, 1903, in which very interesting illustrations, drawings and descriptions are given of several mechanical labour-saving devices actually used underground, and some of which are mentioned both in our original contribution and in the subsequent discussion thereof.

The President: I think, gentlemen, the Society has been very fortunate in having such an able paper read by Messrs. Saner and Carter, and equally so in the discussions which followed and in the reply. I trust we shall have, as Mr. Johnson has stated, many more equally valuable mining papers brought before us.

NOTES ON SMELTING AND CUPELLATION.

By F. L. PIDDINGTON (Associate).

REPLY TO DISCUSSION.

Mr. F. L. Piddington (read by Mr. C. T. Gardiner): In reading the remarks of those members who took part in the discussion on my paper, or, rather, on the Tavener process, I have been chiefly struck by the almost unanimous admission of heavy gold shortages due to furnace absorption. As anything I have to say on this matter has a general bearing, I will first consider the other points raised by various speakers.

Mr. Graham puts forward an interesting cost sheet, which should convince the most sceptical of the economic advantages of the process. Apparently, he also finds the technical advantages equally marked. His objection to the use of a cupel for smelting gains force from his experience of furnace bottoms. But in those cases where the bottom has not been notorious for long life, the extra time and labour in smelting would be fully compensated for by the reduction in the "furnace repairs" bill and the smaller "lock up." The use of a water-cooled cupel for refining would certainly add to one's troubles.

With Mr. Burnett's view that acid is unnecessary, I quite agree, but I certainly was not aware that the object of dissolving zinc was to preserve the furnace bottom. A little thought will convince anyone that long before the zinc can do any damage the bottom is covered with molten lead, which, *per se*, has no corrosive action.

Messrs. Melvill and Tavener have threshed out their differences so thoroughly that there is nothing left for the onlooker to object to, though he may wonder why Mr. Melvill set up so many lay figures, only to have them knocked down, for the reasons he himself gives. These men of straw, however, called forth some interesting criticism and data from Mr. Tavener, and so served a useful purpose. The only positive loss in cupellation I know of occurs through fumes. Shortages may and do occur through any or all of the causes mentioned by Mr. Tavener. The fume loss is not heavy, and in some large establishments is lessened by filtering.

Furnace absorption has reached serious proportions when a "lock-up" of gold up to 700 ozs. is admitted, and in such cases re-building and repairs to furnaces must be responsible for a large share of the cost of the process. There will always be some shortage due to absorption, but

it should not be so great as to necessitate a new bottom every two or three months, and a hearth should not "float up" in the same time. It is difficult to build a satisfactory bottom without a mason experienced in this special line, the average mason being much too fond of his trowel to make a good job of this particular work. I believe that faulty construction is largely responsible for this absorption, and Mr. Graham's experience bears out this view. A possible cause may sometimes be found in neglect to slacken and tighten the tie rods as the furnace warms up or cools down. If a crack is once started, lead will soon do the rest. I have had no experience of a smelting hearth such as Mr. Tavener mentions, but I should think that the shrinkage of this bottom from the sides and ends of the furnace would be a source of weakness.

I have had no personal experience of lead poisoning in refinery work, though it is common enough among men employed on blast furnaces.

The President: Gentlemen, I think that this paper by Mr. Piddington illustrates very well the matter I happened to touch upon in the course of the address just read, namely, the advantage the Society derives from its cosmopolitan membership. Mr. Piddington has had considerable experience in Australia, and we are fortunate enough to benefit by it. The next paper on the agenda is Mr. Durant's paper, "Notes on the Limitations of the Cyanide Process." This paper hardly calls for discussion. It is rather for your information as to the working of certain ores outside the Rand, which we gratefully receive from a gentleman of Mr. Durant's experience in other parts of the world. As there is no reply necessary for Mr. Durant's paper, the next paper before us is that of "Ankylostomiasis: A Forewarning," by Dr. Pakes. Dr. Pakes informs me that his paper is of the same class as Mr. Durant's, and there being no discussion, no reply is necessary.

NOTES ON MILL CONSTRUCTION, MILLING AND AMALGAMATION.

By I. ROSKELLEY (Member).

DISCUSSION.

Mr. R. C. Atkinson: In reading over Mr. Roskelley's paper and the subsequent discussion thereon, one thing struck me as rather remarkable, and that was the general satisfaction and definite opinions expressed by some of your most experienced millmen as to the efficiency of the Challenge feeder. In fact, it seemed to me that their general verdict was, "that it is the best up

to date, and we do not think it can be improved upon."

Now, I am not a millman, never was, and I do not feel competent to criticise the paper on the details of milling generally, but must say that, although the Challenge feeder has up to date held its own, it has always seemed to me a very complicated device for the work it has to do, and its greatest drawback, viewing it as an outsider, seemed to me to be its number of parts, the excessive wear and tear due to friction, and the cost of up-keep this entails.

It seems to me that the success of your mill depends in as great a measure on your feeder as anything else in the mill.

Speaking of the feed, Mr. Roskelley says this should be kept even; uneven feeders cause banking at the end of the box, and both this and high feeding impede crushing.

Now, I should think he might have added here that bad and intermittent feeding is in a great measure responsible for stoppages, for does it not cause the breaking of stems of shaft cams, as well as excessive wear and tear on your shoes and dies?

I think most of you will agree with me that though the Challenge feeder may be the best up to date, it still leaves a great deal to be desired. We could do with having a feeder with less parts and doing even better work by spreading the ore over a greater portion of the box.

Mr. Bevington, in his contribution on this subject, refers to a feeder of very simple construction, and of few parts, now being tried in one of our mills. I may say that I think I know the particular one to which he refers, and have here some particulars which may interest members generally and millmen in particular.

The feeder to which I refer is patented in the name of "Hunter;" it has been working over a period of five months altogether, over one month of which a thorough test was made of it to see its capabilities as a feeder. Five stamps were partitioned off, and a careful measurement kept of stuff being crushed by these five stamps. At the end of this test it was taken up by one of the principal firms of machinery importers in town.

I think, therefore, I am perfectly justified in giving you the results of the test. I would like to add that I am not personally interested in this feeder, *i. e.*, to say in a financial way.

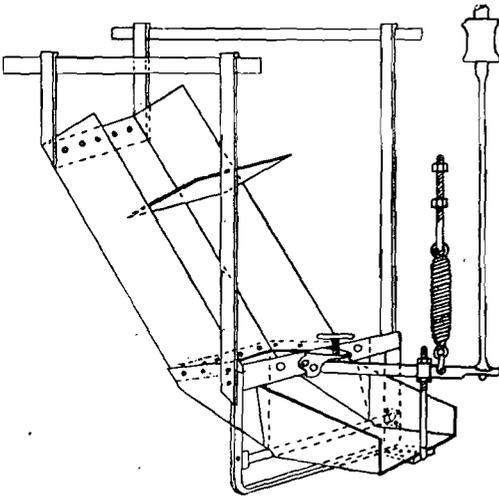
The feeder consists of a cast iron frame, slung from timbers connected to a battery. A cast iron hopper, bolted to frame and to shoot connected with ore bin. An oscillating tray is hinged by means of bearings on each side of the frame, and fits into a groove under front edge of hopper, making a perfectly watertight knuckle joint, and allows no dirt or moisture to pass through on to

the feeder floor. The tray is operated by means of a lever hinged on to the frame, and connected to the tray by an adjustable connecting rod and worked by a rod off the tappet of the centre stamp. A cast steel spiral spring, slung from the ore head framework of battery returns the tray to its original position after the blow of the tappet. There is a screw fitted to adjust the feed to the required fineness. The points of superiority claimed for it over all existing feeders are:—

Firstly—Small initial cost. It has a fewer number of working parts, and in construction is simplicity itself.

Secondly—Repairs reduced to a minimum.

Owing to its simplicity of construction the upkeep is very small indeed, and there is none of the lost motion usually in the other feeders. The existing feeder has been running five months



THE HUNTER ORE FEEDER.

without a repair being necessary. The estimated cost of upkeep is about 30s. per annum.

Judging by a month's test, this feeder seems to lend itself to a higher crushing duty per stamp per twenty-four hours. The reason of this is claimed to be that, whereas the Challenge feeder feeds all on one stamp, the ore then being spread over the box by the other stamps, this feeder distributes the ore evenly over the whole of the box, and prevents the objectionable banking of the stuff at one side of the box, as is the case with other feeders, if the box should be overcharged.

Better Running Time.—Fewer stoppages for repairs is another of its advantages. During the five months it has been running, there has not been a single case of a broken stem or a choked box. It has never been stopped for repairs, and the shoes and dies have worn more evenly.

Amalgamators of over ten years' experience have testified to me the good and efficient working of the feeder, and say it requires no attention, with the exception of occasionally setting the feed to the requirements of the different qualities of the ore.

Record of Test with Bins Partitioned off.—Test conducted from May 10 to June 8, thirty days inclusive: Screening used, 700; shoes and dies about half worn down at beginning of test; 24 ins. by 9 ins.

Total running time, 631 hrs. 41 mins.

Total ore crushed, 870·7 tons.

Duty per stamp per twenty-four hours, 6·61 tons.

Average duty per stamp per twenty-four hours for the rest of the mill filled with Challenge feeders over the same period, 5·90 tons per stamp per twenty-four hours.

Battery fed with Hunter's feeder crushed 71 tons more per stamp per twenty-four hours than those filled with Challenge feeders.

On a 120-stamp basis, Hunter's feeders would give us an increased crushing of over 2,000 tons per month.

The feeder has been so constructed that it can be readily fitted to existing shoots of any mill without necessitating alterations.

To again come to Mr. Roskelley's paper, I cannot resist referring to his 14-lb. fines; the grizzlies certainly do get broken at times or bent. I think the opinion of the resident engineer concerned would be worth hearing, though, perhaps, scarcely fit for publication.

Re-crushing in One or More Stages.—Mr. Roskelley is quite right, and I think no one will dispute the necessity or advantage of finer crushing.

This is also the time, as he remarks, to put your crusher plant on a better basis, so that when the time comes we shall be ready. But Mr. Roskelley must remember that labour is scarce, profits are low, and money is tight. I take it, that when we are crushing all we can with our stamps and want to do more, a gradual and effectual change will be effected at our crushing stations where possible.

Mr. Powrie, on page 411, speaking of the speed of the mill, seems to look upon a drop of 100 per minute as wonderful, would like to see it carried out, but fears it cannot be done. I can inform him that if he will give me the pleasure of his company any time next week, I will take him over our mill where such is the case, and has been for some time, and that our duty per stamp per twenty-four hours is as high as 5·9 tons crushed. I can also reassure him, and state that the breakages are not abnormal, and no one in the mill seems to show any signs of fear.

In conclusion, I would like to point out that once we have the necessary labour to flood our mills with ore, it will behove, not only millmen, but all men to do their utmost and take advantage of anything likely to be an improvement on existing methods to get the greatest amount of work done at the smallest cost, and to win the greatest returns where we should expect to get it.

Mr. J. R. Williams : When I came here, many years ago, it was the common practice to get a Kafir to feed the ore with a shovel into the mill. The next device was, I think, the Tulloch feeder. It certainly did very good work and increased our duty per stamp very considerably. Then came the Challenge feeder, which was so great an improvement on the Tulloch feeder that there is not a Tulloch feeder on the Rand to-day. During the last three or four weeks I have been faced with a difficult proposition, whilst running some experiments on a certain mine. The duty per stamp on that mine has hitherto been 4·8 tons per stamp per day. With the various modifications introduced, we have a duty of 8, 9, 10 and up to 11 tons per day. Up to the present, the only feeder I can find to do the work satisfactorily is a Challenge feeder, with the assistance of a couple of Kafirs. Therefore, I say any feeder which can be brought forward to do what we require is something which the mining industry will need in future, and I am sure it is but echoing the sentiments of the President and those gentlemen of the Patents Committee in saying that the mining industry is quite prepared to pay anyone, patent or not, for a first and true invention. I know some of us have been challenged many times as being desirous of crushing the small man. This has been very often stated in the Press, which, I think, has been very unkind. Our desire is to assist the true inventor, and by doing so at the same time help the goldfields generally, and the members of our Society in particular.

The President : I think you will agree as to the desirability, remarked upon by Mr. Williams, of men being recompensed for improvements they introduce. That this has been done in the past for non-patented improvements can be borne out by various members of the Society, some of whom are present to-night.

Mr. R. C. Atkinson : I may say Mr. Hunter's feeder is patented, and that it is working on the Crown Reef mill, and I think great credit is due to him for making this great improvement in the feeding, about which I was at first very sceptical. There are many of us here only too pleased to hear the words Mr. Williams has spoken, and if any of us have improvements, we shall not be afraid to bring them forward.

Mr. C. Dixon : It is as well to draw attention to one point Mr. Roskelley brought out, namely, the duty per stamp and the necessity for fine crushing. I notice in reading the technical papers from other parts of the world that great attention is being given to this. Only to-day I heard that the Sheba mine, in Barberton, were about to commence intermediate crushing between the stone breakers and the mortar boxes. I believe, also, a good deal of work is being done on the Rand at the present time with tube mills, and that the prospects are very promising.

A Member : I think it would be interesting if Mr. Roskelley would tell us the best way of treating the matte derived from copper skinmings, to which he refers.

Mr. E. E. Aulsebrook (contributed) : Undoubtedly, in the last few years great improvements have been made in mill construction, and in the running of the mills after they have been handed over to the millman. But with all these improvements there is still a lamentable lack of attention to minutiae, or what a layman would consider less important particulars. But to the millman this want of attention to detail in the construction of a mill means unnecessary work, worry and, more than all, expense, and it is in this that the expense is incurred in the upkeep of a plant, and not in general design or construction.

It is my intention in writing this article to point out some of the mistakes—and a few of them most egregious—that have come under my notice during the time I have been connected with mill work as a mill carpenter and amalgamator, not from any desire to be captious but to try and amalgamate the ideas of the engineer with the requirements of the mill operator, so that these mistakes may be rectified in the future to the benefit of the millman and all concerned. I shall deal firstly with the mechanical part of the work, and secondly with amalgamation.

First and foremost, the greatest attention should be given to tying the mill together; the nuts of the tie-bolts are often put where it is almost impossible to get at them for the purpose of tightening. This is invariably the case with the tie-down bolts of the kingposts, which are, I consider, the most important in a mill; in some mills the tables have actually to be taken out to get at them. When once the kingposts start to jump and get beyond control, it is only a question of time before the best mill ever built will be converted into a "rattle-trap." Arrangements should be made so that both ends of these bolts can be got at quite easily—the upper carried quite clear of the tables and water-pipes, through a 2-in. bar running right

through the kingpost from front to back; the lower passing through the strake sill and a 12-in. by 1-in. wrought iron washer. This will, of course, necessitate a long bolt, which can be made in two halves, hooked together in the centre, so if either half wears out it can be replaced without interfering with the other. If not kept constantly drawn up the thread of these bolts must soon be stripped, and consequently the bolt becomes useless; yet no provision is made, either for prevention or cure. Wherever these bolts are hard to get at they are invariably neglected, consequently the kingposts fall out of the perpendicular, and then the trouble commences. Neglect in this respect also counteracts all endeavours to keep the stamps in the centre of the mortar. I can safely say that three-quarters of the mills on the Rand have not got their stamps centred, which means that they are not working in the centre of the mortar. This may seem a daring statement to make, but I make it advisedly and am prepared to uphold it. This mistake may be made in construction, or caused by after settlement; but, whatever the cause, it is absolutely necessary that the stamps should work exactly in the centre of the box as there is so little space room at the die level. I have worked in several mills, and have invariably found the stamps out of centre. In one, I had to pack out the guide-rails an inch and a half, and then saw an inch off some of the inner guide-blocks to get the stamps in their proper place. In another mill I had to pack out all the guide-rails an inch and a half; this I am sure was due to the fact that the centre had been taken at the top of the mortar which is not necessarily the true centre to the bottom. It is necessary that the centre of the box, taken lengthways and crossways, should be shown, the former by a saw cut on the upper and lower guide-rails, and the latter by marks on the kingposts just below the upper and lower guide-blocks. As the guide-blocks are constantly being re-adjusted, if there are no marks of this kind to guide the millwright he must surely be making these alterations by guesswork. One more reason why it is imperative that the stamps should be centred is that—if this is not the case—the liners and boxes get cut about most terribly, and the former require replacing more often than should be, and it is impossible on account of the small space in the bottom of the box to get the dies immediately under the stamps, and consequently they wear down all on one side, leaving a pinnacle on the other, which means a very uneven crushing surface as well as a very much reduced one, with the inevitable bad duty. Very frequently unnecessary blame is given to the tempering of the dies, when under

the foregoing adverse circumstances no die could stand the uneven wear.

Even if exactly centred under stamps, and all other conditions good, a die will naturally wear down fastest on the inner side, where it receives the greater portion of larger rock falling directly from the feeder. I have often noticed that the two outside dies wear down perfectly level, while the three centre ones wear down most at the back; this is entirely due to the fact that they have the larger rock to crush. To counteract this uneven wearing of the dies, I believe in taking them out once a month and reversing them. Leaving them in till they are worn out, and the bottom of the box as well, is a practice I most heartily condemn. Dies should be kept packed up with fine quartz false bottoms, or worn-out thin dies, so as to keep a low discharge of from two to three inches. This is absolutely imperative if good duty is desired, as well, also, as a fine feed. The latter idea, I am sorry to say, a great many shiftsmen do not take very kindly to. My experience has taught me that a Sandycroft die is hard to beat either for temper or life, and the same can equally be said of the Sandycroft shoe. My next trouble is the ore-feeder now in use; and yet, not the feeder so much as the friction drive operating it, which I most decidedly condemn as a piece of most amateurish mechanism. There are, to my knowledge, three friction drives which have been devised by three Rand millmen. Mr. Smart, mill manager of the Simmer and Jack, is the inventor of one; another is the invention of, I believe, Mr. Watt of the Crown Reef mill; and the other is Mr. Pearson's invention. These three drives were all designed to operate the Challenge ore-feeder with one pawl, instead of three as at present, either of which compares as favourably with the present mode as science with brute strength. My objection is not to the two extra pawls, but their inefficiency and the undue strain on the feeder. I have worked with Pearson's for the last four years, and can only compare its working to the smooth movement of a decent clock; so sensitive is it that the slightest tap on the feed-lever is sufficient to revolve the turntable, thereby ensuring a regular feed, which is necessary if good duty and good work all round is desired.

Another great improvement on the contorted feed-levers now in use, is to have one straight lever on the cam-platform, working in a stand made of 3-in. by $\frac{3}{4}$ -in. iron, bolted to the floor and stayed to the kingpost. This stand is about the height of the fingers, and resembles an elongated capital A, with a flat apex of about $2\frac{1}{2}$ in. A piece of iron of the same size is let into the stand $1\frac{1}{2}$ in. from the top, so as to form a recess to hold a 1-in. nut. A hole is drilled

through the top of the stand, and this crosspiece to take the feed-screw which is provided with the usual lock-nut, and which passes through the nut in the recess; this screw is, of course, to elevate or depress the lever. Immediately below this crosspiece, and welded to the edges of the stand, are two small brackets or lugs having on their tops a semi-circular indenture to receive the trunnions of the lever. The end of the lever which projects out to the under side of the tappet is flattened out, and protected from the blow of the tappet by a piece of belting riveted on to it. The other end, which is immediately over the arm of the friction plate, is connected to it by an adjustable chain passing through a hole in the floor. This kind of lever does away with the fearful jar of every blow of the stamp on the whole structure of the feeder caused by the levers generally in use, as well as disposes of the buffer, bumper-rod and guide, one lever and rock-shaft, centre bracket of rock shaft, fulcrum and connecting rod, and the feed of a battery can be regulated to a nicety with one hand on the feed-screw and the other on the tappets. This stand and lever can be made by any blacksmith in a very short time. They can be seen working in the Wolluter and New Unified mills, where they have given every satisfaction, and I believe in one or two other mills along the Reef.

Despite the fact that inside amalgamation with copper plates is now a thing of the past, the mistake is very often made of putting the old-fashioned mortars, with the recess at the back, into new mills, instead of the later style of straight-backed ones, thereby putting obstacles in the way of quick crushing. A mortar-box does not require to be more than 4 in. deep, and the required discharge obtained by chuck-blocks. There is a great tendency to run mills unmanned on the Rand, which, to my mind, is false economy. If a new 100-stamp mill requires two men on shift with their proper complement of boys, then an old mill, where breakages are constantly occurring, should have three men on shift, an amalgamator, assistant and greaser. I have in my mind a 100-stamp mill, which runs as well to-day as when erected 10 years ago, and I am sure the reason of this is that there has always been a plentiful supply of labour, both white and black, in the mill.

Amalgamation.—I do not intend to say much on this subject. Decidedly, for low or medium grade ores, outside amalgamation, no matter what the style, is preferable to inside. Nearly every millman has his own ideas of keeping battery plates in good catching condition, but to my mind the Wolluter style of amalga-

mation is scientific and, if carried out in its entirety, undoubtedly practically correct. A paper dealing with this style was read by Mr. Britten, late manager of the Wolluter Gold Mine, before the Association of Mine Managers, some few years ago, and was, I believe, very favourably received at the time. I do not intend to describe the Wolluter style in this article, but may on some future occasion. Undoubtedly, a weak solution of cyanide has a beneficial effect on plates when the water is alkaline and the plates inclined to scour, but an injudicious use of it is to be condemned. Nothing beats good old elbow grease for setting plates, and a judicious use of it afterwards to keep them in order.

In conclusion, I have been actuated in writing this article by a desire to improve the conditions of milling on the Rand by bringing to the notice of our engineers some of a millman's requirements, and to produce a friendly exchange of ideas between those connected with mill work, for without this interchange of ideas we are all apt to keep on running in the same old groove from year's end to year's end, and to forget that there is a more scientific side to our vocation other than thumping in a tappet key.

The President: If no other remarks are forthcoming, I think it would be advisable to take Mr. Roskelley's reply at the next meeting, and if any members desire to contribute further, would they kindly send their contributions to the Secretary for publication.

THE DETERMINATION OF CONSTANTS IN WORKING CYANIDE SOLUTIONS.

By GERARD W. WILLIAMS (Member).

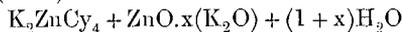
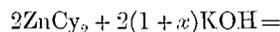
DISCUSSION.

Dr. Jas. Moir: In opening the discussion on this paper, I wish to add my quota of praise to Mr. Williams for the scientific manner in which he has carried out the practical side of his research, and to make it clear that, although I may have to criticise somewhat severely the theoretical side of the paper, and his interpretation of the results, I yield to none in appreciation of the permanent value of his figures. With this preamble I shall plunge *in medias res*.

The first thing that strikes one is the unnecessary number of mistakes and misprints in the first portion of the paper. There are, for example, over a dozen misprints of a misleading character, and mistakes in nomenclature are too frequent, *e.g.*, "ferro" for "auro"-potassium cyanide on p. 289, and "Kjeldal" for "Kohlrausch" on p. 298. As regards the ionic theory

especially, one remarks some extraordinary specimens of phrasology; for example on page 288, $ZnCy_4$ is called "the base of this hypothetical acid," where I presume *anion* or *radicle* is meant, since the base of an acid is a contradiction in terms. Again, on page 289, we are told that " $ZnCy_2$ remains in solution by virtue of the electric charge due to dissociation." I certainly thought that $ZnCy_2$ is an electrically neutral substance, and not an ion, and of course the real reason why it remains in solution is that not enough of it is present to exceed its solubility in water. Again, the phrase "normally insoluble ion" is another example of loose thinking. An ion is nothing if not soluble.

A similar source of complaint lies in many of Mr. Williams' equations, many of which do not square. In the first, on page 289, $ZnCy_2$ should be $2ZnCy_2$ and the second equation should read



It is true that Mr. Williams says that this equation cannot be taken literally; all the same, he might have made its two sides equal, if only on æsthetic grounds.

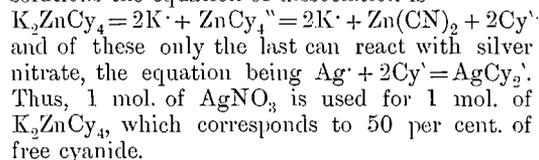
The paragraph in explanation of the impossibility of titrating all the Cy in K_2ZnCy_4 is very good, but is marred by some illegitimate assumptions. For example, the degrees of secondary dissociation of $AgCy_2$ and of $ZnCy_4$ are assumed equal, which is certainly as untrue, Mr. Williams will see if he treats pure K_2ZnCy_4 with $AgCN$, when he will find that the latter dissolves and that $ZnCy_2$ is precipitated instead; whereas $KAgCy_2$ does not react with $ZnCy_2$. Hence K_2ZnCy_4 is much more dissociated than $KAgCy_2$. The same thing is shown on adding a trace of acid or of soluble sulphide to a mixed solution of $KAgCy_2$ and K_2ZnCy_4 : in both cases the silver is precipitated before the zinc because $AgCN$ and Ag_2S are much less soluble in water than $ZnCy_2$ and ZnS respectively, and it is on relative solubility that this question really depends. Now, the concentration of Ag^+ ions in $N/20$ $KAgCy_2$ solution is only $3.5 \div 10^{11}$, from which the solubility of $AgCy$ can be calculated approximately; it is about two parts in ten million of water, and certainly very much less than that of $ZnCy_2$; in fact, the secondary dissociation of $KAgCy_2$ is almost negligible.

Mr. Williams' figures on the effect of dilution are, I think, new and valuable. I have been thinking them over, and venture with great diffidence to suggest an explanation on the lines of the ionic theory.

It is held by the supporters of this theory that just as the dissociation of the second hydrogen atom of water is immeasurably small, so the dis-

sociation of the second radicle (anion) of a sparingly soluble ternary salt is also insignificant. Thus a solution of $PbCl_2$ contains $PbCl$ and Cl^- ions and hardly any Pb^{++} ions.* Applied to this case, $ZnCy_2$ at great dilution will ionise into $ZnCy^+$ and Cy^- ions, but no further, and in strong solutions will not ionise appreciably. Now, Mr. Williams' figures show that in strong solutions 50 per cent., and in very dilute solutions about 75 per cent., of the total cyanide can be titrated with silver, *i.e.*, is ionised, which is what the theory predicts.

A solution of K_2ZnCy_4 contains chiefly K^+ and $ZnCy_4^{--}$ ions, but also a small amount of the products of secondary dissociation of the latter, *viz.*, $Zn(CN)_2$ and Cy^- ions. Therefore, in strong solutions the equation of dissociation is



On the other hand, at great dilution the $Zn(CN)_2$ dissolves and ionises into $ZnCN^+$ and Cy^- ions. The equation of dissociation becomes $K_2ZnCy_4 = 2K^+ + ZnCN^+ + 3Cy^-$ and three-quarters of the cyanide becomes available for titration.

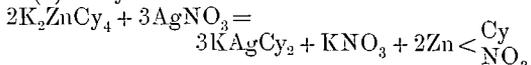
Mr. Williams finds that the final value is 77 per cent., and it is possible that the difference is due to a further dissociation of $ZnCy^+$ into Zn^{++} and Cy^- , which, however, must be very small, since the Zn^{++} ions are very few.

On this theory, the reason why the final solution is turbid in strong solutions is the precipitation of undissociated $Zn(CN)_2$, whereas in dilute solutions the zinc at the end is present as the soluble nitrate of the complex kation $ZnCN^+$, and actual experiment shows that $ZnCy_2$ dissolves to some extent in $Zn(NO_3)_2$, and probably more so in ZnI_2 . For the benefit of those who do not approve of ionic equations, I append these results in the ordinary form:—

(1) Strong solutions—



(2) Very dilute solutions—



but possibly the KI reacts, and the final product is $Zn(Cy)I$.

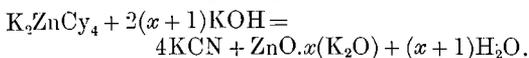
As regards Table B, there is some mysterious error in it, since the percentages given do not correspond with the data.

Mr. Williams' quantitative investigation of the effect of hydroxides on potassium zincocyanide is

* Each dot after the symbol of an element or group signifies a positive electric charge, and each dash signifies a negative one.

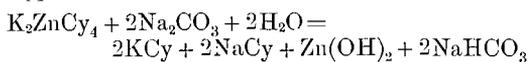
an extremely valuable contribution, and the actual results are most interesting. It is rather surprising, indeed, in view of the apparent want of system among the reactions of such complex cyanides to find that the amount of alkali required to liberate all the cyanogen up to the formation of AgI in titration is exactly the amount required by the simplest possible supposition, viz., conversion of $ZnCy_2$ into $Zn(OH)_2$ and to find that the rise in dissociation is exactly proportional to the alkali added (Table D).

However, when it comes to details, I find I cannot agree with Mr. Williams. First of all, his equation at the foot of p. 292 is incorrect, the two sides not squaring. It should read



Consequently, the numerical argument founded on it falls to the ground. Moreover, the chemistry adduced to support this argument is itself very shaky. The supposition that zinc nitrate and potassium zincate can exist together in appreciable quantities in the same medium is startling, and I should like to know how Mr. Williams confirmed it experimentally. Zinc nitrate only exists in an acid medium and the zincate only in presence of alkali, and a mixture of the two will react to form zinc hydrate and potassium nitrate.

We have another very interesting result in the action of normal alkali carbonates on K_2ZnCy_4 , viz., that they have the same effect as half the quantity of hydrate. This is exactly analogous to their behaviour as so-called protective alkali, and I have already shown in another place that its effect is due to hydrolytic dissociation into hydrate and bicarbonate, *i.e.*, that the reaction $Na_2CO_3 + H_2O = NaOH + NaHCO_3$, which ordinarily only goes to the extent of 3 per cent., goes completely if the NaOH is continuously removed. Applied to this case we have



and consequently Mr. Williams' precipitate is probably not a zinc-sodium carbonate, but zinc hydrate, which retains $NaHCO_3$ by mass-action. I fear that analysis could not definitely decide this question, but the main point is that sodium carbonate acts as it does because its solution actually contains hydrate amounting potentially to 50 per cent.

As for the reason why calcium stays in solution in working-solutions, Mr. Williams considers that it is due to the calcium being present, not as kation, but as K_2CaCy_4 . I am rather inclined to think that this assumption is unnecessary, and that calcium is not precipitated because the carbonic acid is present as bicarbonate, *i.e.*, that a normal working solution contains only a trace

of CO_3^{--} ions, and that the precipitation of $CaCO_3$ on heating is due to dissociation of ordinary $Ca(HCO_3)_2$ and not of K_2CaCy_4 .

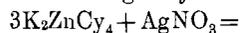
I must confess, however, that Mr. Williams' idea is not only original, but *a priori* not unlikely, but that my efforts to isolate such a compound as K_2CaCy_4 have not met with much success. I should like to describe one of these experiments as it is an interesting example of the effects of secondary dissociation. I made CaI_2 by evaporating a solution of lime in excess of HI to dryness, and then treated a solution of this with excess of moist silver cyanide. The reaction which occurs is $CaI_2 + 4AgCN = 2AgI + Ca(AgCy_2)_2$, and the filtrate on evaporation gave rather soluble lustrous flat needles of the latter salt. A solution of this was treated with K_2S solution until all the silver was precipitated, and I expected to get K_2CaCy_4 by evaporation of the filtrate according to the equation $CaAg_2Cy_4 + K_2S = Ag_2S + K_2CaCy_4$, but on evaporating to dryness in vacuo, I got merely a mixture of $Ca(OH)_2 + KCN$, and I found afterwards that my K_2S contained KOH which must have reacted with the supposed K_2CaCy_4 as follows: $K_2CaCy_4 + 2KOH = Ca(OH)_2 + 4KCy$. This in itself shows that K_2CaCy_4 must have very little stability, since in this case it behaves like a mere mixture of KCy and $CaCy_2$.

I repeated the experiment, but used crystalline Na_2S and saturated its solution with H_2S before use, so as to ensure the absence of NaOH. I evaporated to dryness in vacuo and moistened the residue with fairly strong alcohol to remove a trace of Na_2S , etc. The undissolved portion was a mixture when examined under the microscope, and when moistened with water, the solution became rapidly covered with a pellicle of $CaCO_3$, which is what might be expected of uncombined $CaCy_2$.

To come to Mr. Williams' conclusions, the equation at the top of p. 298 is misleading not merely because $Zn(NO_3)_2$ and K_2O cannot exist together, but because it cannot be made self consistent unless $x=1$, $y=1$ and $z=1$, whereas the author makes $x+y+z=1$ and yet says that z may be 3 or 9! Besides, though I do not wish merely to cavil, I must point out that the phrase "varies inversely" is only used when the product, not the sum, of two quantities is constant.

The difference in the results when KI is not used is very difficult to explain if only a trace of KI is used. Since the first turbidity of $ZnCy_2$ occurs at 16 per cent. of the total cyanide in absence of alkali and KI, we must account for this in some way. Mr. Williams puts it down to the dissociation of $KAgCy_2$ causing a sufficient concentration of Cy^- ions to prevent much dissociation of K_2ZnCy_4 , but if this were true the

end-point would be nearly 50 per cent. since KAgCy_2 does not contain many Cy ions. I am inclined to account for the effect by assuming the existence of another potassium zinc cyanide of small solubility, since I find that ZnCy_2 is distinctly soluble in K_2ZnCy_4 itself. If we assume a compound $\text{K}_4\text{Zn}_3\text{Cy}_{10}$ we can explain the above titration, for on adding AgNO_3 , $\text{K}_4\text{Zn}_3\text{Cy}_{10}$ will be formed and one-sixth of the original cyanide will be caught by the silver



and thereafter ZnCy_2 will be precipitated.

On the other hand to obtain a precipitate of AgI it is necessary to separate *all* the ZnCy_2 , therefore the end-point is at 50 per cent. of the total cyanide when KI is used. If this idea is correct, then the ordinary method of determining free KCy by the appearance of the first turbidity is not correct, as such a compound as $\text{K}_4\text{Zn}_3\text{Cy}_{10}$ is sure to have some solvent action on gold.

In conclusion, I hope that Mr. Williams will forgive me for making these criticisms, for I have no desire in the matter but to get at the truth, and I repeat that nothing which I have said will alter the permanent value of his determinations.

The President: Before calling upon any other members who may wish to contribute to the discussion, I should like to emphasise one point. Dr. Moir referred to certain misprints, and I want to emphasise the point that in future the *Journal* of the Society is going to be as the laws of the Medes and the Persians, and I hope greater attention will in the future be paid in the correction of proofs.

Prof. A. Prister: As our last President expressed to Mr. G. W. Williams what we think of his paper, it is useless for me to repeat his remarks.

I will make only a few remarks on two points. He says on page 417: "The well-known white precipitate which forms in the zinc boxes consists in the main, of hydrated zinc oxide with small and variable amounts of calcium carbonate and alumina. In addition to the above, it always contains ferro-cyanide—often as much as 8 per cent."

I must suppose that Mr. G. W. Williams has not made an analysis of this white precipitate, which is the terror of the cyanider and costs thousands of pounds to these fields.

If this white precipitate were, in the main, hydrated zinc oxide, I cannot understand how it is that when you treat a clean-up of, say, 5 per cent. gold, with dilute sulphuric you bring it only to 12-13 per cent. of gold; in other words, the bulk of the gold slimes are reduced by about

50 per cent. As far as I know, all the hydrated zinc oxides which could be precipitated in the zinc boxes are soluble in sulphuric acid. Further, it is not hydrated zinc oxide, as supposed by Mr. G. W. Williams, which forms the bulk of this white precipitate, but ferrocyanide and cyanide of zinc. Again, he finds small and variable amounts of calcium carbonate. This is true in many cases, but in different samples I assayed I could not detect traces of lime.

I append an analysis of a white precipitate, from which the zinc was separated mechanically as much as possible:—

Copper oxide	...	...	nil
Insoluble matter	...	...	6·3
(including 2·3 per cent. SiO_2)			

Al_2O_3 , Fe_2O_3	...	...	3·2
Lead	...	...	traces
Zinc (calculated as ZnO})	...	...	60·36
SO_3	...	...	4·5
Lime (calculated as CaO})	...	...	3·5

Au and Ag 61·4 ozs. per ton.

By reducing the ZnO to zinc we have 48·44 per cent. Zn, and if we calculate 10 per cent. of this present as zinc ferrocyanide, and 10 per cent. as zinc cyanide, 28·44 per cent. are left as metallic zinc, which was mixed with the white precipitate. In this case we have the following composition:—

Insoluble matter	...	6·3
Al_2O_3 and Fe_2O_3	...	3·2
Lead	...	traces
Ferrocyanide of zinc	...	26·25
Zinc cyanide	...	17·9
Zinc	...	28·44
SO_3	...	4·5
Calcium oxide	...	3·5
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If we examine this analysis, and remember the qualities of the main constituents appearing from this (ferrocyanide and cyanide of zinc 44·15 per cent.), then we understand how the treatment by dilute sulphuric acid could not reduce the bulk of the gold slimes treated before smelting, and how the Rand metallurgists were obliged to look for another treatment, and adopted "Tavener's method." The quantity of this white precipitate increases as the cyanide solutions are reduced in strength. The weaker the solutions in free cyanide, the more white precipitate, because the ferrocyanide of zinc as well as the zinc cyanide are in our working solutions kept in solution by the free cyanide existing there. But the quantity of the white precipitate formed in a box not only depends on the percentage of free cyanide existing in the solution, but is also influenced by the alkalinity of the solution. A very interesting

experiment is the following:—Take a working cyanide solution from slimes plant; add some phenolphthalein, and pass a current of carbonic acid till the solution gives a clear acid reaction, as shown by the colour. A large quantity of the ferrocyanide of zinc and zinc hydrate is precipitated. The solution tested for free cyanide gives an increased percentage of free cyanide. We may deduce from this that the ferrocyanide of zinc, as well as the zinc cyanide, are partially insoluble in a carbonic acid solution of cyanide of potassium, and that the double cyanide of calcium (CaCy_2 , 2KCy) is decomposed in presence of NaOH . We may also conclude that the cyanide of potassium in working solution is much more stable, as we should expect. This also explains how it is that we lose less cyanide of potassium from our working solutions through the action of the carbonic acid of the air than by such a secondary chemical process as the above.

Before the war I studied this white precipitate with Mr. J. Perrin of Pretoria. We found a method for treating the zinc-gold slimes with bisulphate of soda and concentrated sulphuric acid, where by attacking and rendering soluble the components of this precipitate (zinc ferrocyanide, etc) the bulk of the gold slimes for smelting is reduced by 80 to 90 per cent. of the original mass, and the gold bullion from them is increased from 5-10 per cent. to 30-60 per cent. I hope in a short time to be able to bring before you the results of the working of this method on a large scale.

Mr. G. W. Williams thinks "that the sphere of the colorimetric methods" for determining gold is limited. In this I quite agree with him. I think the copper, or De Wilde's, method is superior in exactitude to the colorimetric. But those methods are of most importance to the intelligent cyanider which render him independent of the smelting, cupelling and parting; and, secondly, the cyanider who can test his outgoing solutions understands and controls his boxes much better than he who simply reads the results sent by the assayer. Direct observation produces a greater impression on the mind than a mere survey of figures which make him think "Easy come, easy go."

The President: I may point out that the Adjudicating Committee on the various papers read during the past year has already had one meeting and are anxious to get their work finished as soon as possible. Mr. Whitby has promised us a contribution for the next meeting on this paper, and I trust any other members who are anxious to express their views will also do so, so that Mr. Williams will have an opportunity of replying and of winding this paper up at the

next meeting. The next paper for discussion is Dr. Moir's "Notes on the Composition of Tobacco Smoke." This paper seems to appeal more to our medical friends, and as Dr. Pakes has nothing to say at present, I think we may take it that unless any further contribution is sent in for publication, the discussion on this paper is closed. It simply deals with certain facts Dr. Moir has ascertained. The next item for discussion is Mr. Laschinger's, "The Decantation Process of Slimes Treatment: Its Possibilities and Limitations." I trust the discussion on this paper is not ended by the contribution which appeared in the *Journal*. It is a very important matter for us, and is likely to become still more important in the future. If there is nothing further to be said now, it will be possible to send in written contributions for publication in the next *Journal*.

AN INDUSTRIAL METHOD FOR THE DETERMINATION OF THE OXYGEN IN WORKING CYANIDE SOLUTIONS.

By Professor A. PRISTER (Member).

DISCUSSION.

Mr. G. W. Williams: There are one or two questions I would like to ask. First, how he accounts for the fact that when one boils perfectly pure solutions of distilled water and cyanide, you get a considerable quantity of carbonate? Where does the oxygen in that carbonate come from, unless some of it comes from the oxygen already present in the water? I must admit I have had no time to check Prof. Prister's paper against that method of the determination of oxygen solutions published by Mr. Crosse, but from experiments I have done in regard to decomposition with boiling solutions of cyanide, I feel convinced that quite a large percentage of oxygen in water must be taken up in the cyanide.

In a paper read some time ago, which I saw in the annals of the Society, I noticed it was stated that the results obtained by a method, in many respects similar to the one described by Prof. Prister, that the ratio of oxygen to nitrogen obtained on boiling was different to the ratio given by Roscoe as the result of his work.

Prof. A. Prister: If I understand Mr. G. W. Williams correctly, he considers that the exactness of my "Industrial Method for Determining the Oxygen in Working Cyanide Solutions" may be influenced by secondary reactions, which occur when the solution is boiled for evolving the absorbed air.

I am sorry to hear that Mr. G. W. Williams has not actually tested my method and compared it with any other.

As far as I know, no secondary reactions will occur between the constituents of the cyanide solutions and the oxygen in solution. Therefore I do not think that the exactitude of the method is impaired. The method is put forward as one for controlling the daily work of cyanide works, and as far as my experience goes it is exact to 0.1 per cent. of oxygen.

The President: If there is no further discussion on Prof. Prister's paper, we may take the discussion as closed.

THE ANALYSES OF SOME WITWATERSRAND SOILS.

By EDW. H. CROGHAN (Associate).

DISCUSSION.

Prof. A. Prister: We are much indebted to Mr. Croghan for bringing forward this most interesting subject of soil analysis.

Justus Liebig, in his "Chemische Briefe," and the rest of his gigantic work on agricultural chemistry, laid "the foundation of rational agriculture." Every chemist, and the majority of intelligent farmers, are convinced that it is absolutely impossible to make real progress in agriculture without the co-operation of agricultural chemistry. Nevertheless we see that over 999 per 1,000 of the men engaged in this industry are absolutely blind, chemically speaking, and what is more astonishing is that they make a good living from this industry.

From this we may be led into the error of thinking that agricultural chemistry may be useful but not necessary for good and intelligent farming.

But real progress is absolutely excluded in every industry when the true processes are not known. "Everything, whether plant or animal, that a farmer grows can be traced back to two primary sources—the soil and the atmosphere." If we remember this, we shall directly understand the importance of the analyses put before us.

Some daily papers during the last month have discussed the improvements, etc., which can be, and must be, introduced into farming in the Transvaal; but the basis of those discussions must be an exact knowledge of the composition of the soil upon which the plants shall grow, and the surrounding atmosphere. For my own part, I consider agriculture as one of the most difficult chemical industries, and this will be evident from the following observations:—

By comparing these analyses with those of a good European or North American soil, where agriculture is extensively carried out, we see that we have to do with relatively poor soils, requiring improvements in every direction in their chemical and physical composition (with the exception of the Bezuidenhout Valley and Klipriviersberg Estate). We are struck at a glance by their poverty in lime and magnesia. It is astonishing to find soils—formed in the neighbourhood of such big deposits of dolomites—so poor in those important elements.

The probable explanation is that the rain drains the dolomitic formation, which lies lower than the Rand, transporting the dissolved lime and magnesia to lower parts of the country. But, speaking generally, the deficiency in lime is one of the characteristic faults of the Transvaal soil, notwithstanding that the dolomitic formation forms a very large kranz round the Transvaal. The natural consequence of this upon plants and animals is easily understood. The healthy growth of the plant is hampered, and the bones of the animals are weak in consequence of the deficiency of lime. If we remember the average composition of bone meal—mostly made by grinding up bones—

Moisture	10.43
Organic matter	32.30
Phosphate of lime	48.40
Carbonate of lime, magnesia, etc.	7.20
Siliceous matter	1.67

we see directly the important rôle played by the lime and phosphorus for the animals. An addition of lime, as ground carbonate or gypsum, to those soils will undoubtedly improve them, and the beneficial effect will be both mechanical and chemical.

If you look at the high percentage of FeO (8.504 of the soil of the Klipriviersberg Estate), and compare it to the quantity of iron oxide existing in a good normal soil, then you must directly come to the conclusion that the plants the farmer is growing on this soil must either be those natural to such soils, or he must start to correct this soil by the addition of a base like lime. By merely looking at the soil an old farmer would come to the same conclusion, but with this important difference—that he does not know why.

Another characteristic of these soils is their poverty in phosphates. The small quantity of phosphoric acid existing will soon be exhausted by agriculture. Hence we see that the question of cheap phosphates is a vital one for Transvaal agriculture. If we look a moment at the chemical composition of the plants which should grow on those soils if much agriculture is carried out, then we shall better understand the absolute

necessity of a cheap phosphate. Take, for instance, the "Composition of average crops of wheat, barley, and meadow hay," per acre, given in Fream's "Elements of Agriculture." For wheat, 4,800 lbs. per acre; for meadow hay, 1½ ton per acre:—

Nitrogen	... 45·8 lbs.	... 52·0 lbs.
Lime	... 8·5 "	... 33·8 "
Magnesia	... 6·5 "	... 12·8 "
Potash	... 31·5 "	... 51·7 "
Soda	... 1·2 "	... 6·2 "
Phosphoric acid	21·0 "	... 19·2 "
Sulphuric acid	4·2 "	... 4·6 "
Chlorine	... 3·0 "	... 14·6 "
Silica	... 95·5 "	... 54·9 "

From this we see the great quantity of phosphoric acid taken from the soil every year. Hence we infer that the poverty of our soil will allow wheat only every four or five years, and would not give a good crop every second or third year. Here, where the labour is so dear, the machine we are using in this case, the soil, must give the highest results for the labour employed, otherwise we are losing money.

I have not at my disposal a chemical analysis of the veld-grass, but from the above analysis of meadow hay we can draw some conclusions which may be valuable for our veld here. The first conclusion is, that the veld burning must be condemned, with very few exceptions, since it destroys useful insects and germs, and what is done must be done at the right time. By the burning of the grass the formation of humus is prevented—humus, which is so necessary and important for the vegetation of the plants, and in which the analysed soils are so poor.

By burning the grass the soil is impoverished by the large quantity of lime, magnesia, phosphoric acid, potash, soda and chlorine, which remain as ashes on the surface of the burnt veld, and are carried away by the following rains and winds.

The farmer who thus loses these important elements for his plants, gets nothing in return; he has wasted a part of his capital, where, on the contrary, the man that transforms the grass into meat gets money for it.

We see from the analyses that the soils of the Rand are already very poor in these elements, and, if the farmer continues to burn his veld, he will make it worse, because he loses not only the elements the grass has taken up from the air but also those which have been taken from his already poor soil.

The peculiar climate of the Transvaal, a natural consequence of the geographical position of the country, the physical constitution of the coast, and the petrographical composition of the geological formations are the principal causes of

the poverty of this soil. If the rain is not distributed all over the year, but limited to certain seasons, as here, and then falling in torrents, we have everything required for washing the surface and carrying away all the soluble salts prepared by the long and slow action of the winter. The slow and gradual moistening of the surface would dissolve the salts and carry them down, ready to be absorbed by the roots; but if the rain pours down as it does here, evidently only a smaller quantity of those salts will have time to penetrate to the lower strata. Such rains will not only carry away the soluble salts brought to surface by the action of the atmosphere (carbonic acid, frosts, etc.) but also those which the roots have extracted from the lower strata, and which now are lying on the surface, unprotected, as ashes. The burning will also have the bad effect of facilitating this draining of the surface. As no grass exists, to fix a certain quantity of water, every drop is falling directly to the ground and runs away after having beaten the surface, and no time is given to the soil to absorb the water.

If you hear about big schemes of irrigation do not forget the analyses of Mr. Croghan.

A great day will dawn for the agriculture of this country when large deposits of phosphates are discovered here. The possibility of such a discovery is not excluded, notwithstanding that the largest deposits of those minerals known are in much younger formations than those forming the backbone of South Africa. The tertiary and cretaceous are the richest, but in South Africa these formations are represented and may contain the badly wanted phosphates.

It would be very interesting to get also the soil analyses of other parts of the country, to which the attention of farmers should be directed. We must take this occasion to impress on those who are directing the education of the younger generations of South Africa, that it is much more important for the progress of the country that the boys should understand a chemical formula than all the knowledge of the Greek and Latin authors put together. It is quite impossible to explain that only an infinitesimal part of the population—not only of this country but also of Europe—are capable of understanding a soil analysis, notwithstanding that they have spent years in schools. Boys who pass the best years of their life in school are unable to understand the growing of a mealie—they are as blind as the aborigines.

It is useless to claim any progress for South African agriculture, or that of other countries, as long as the farmer is running like a blind man on the surface of his farm. How will you explain to a Rand farmer the needs

of his soil when he does not understand how to distinguish chlorine from potash? The deficiency of the former is evident from these analyses. This the farmer has found out by experience—his mules will eat the harness because they cannot get the necessary quantity of salt from the plant growing on such a soil. From this we see that not only the elements we find in large quantity in the ashes of the plants play a very important rôle but also those we find only in small quantities, like the chlorine and soda.

Here in South Africa we can very well see how small the difference is of a European agriculturist, with no chemical training, and a Kafir. Evidently the more highly developed intelligence of a white farmer allows him to overcome difficulties, and introduce on his farm improvements which for the Kafir is impossible. But the distance between the two is certainly not so great as that between the manager of a modern Siemens-Martins furnace and a Kafir smith extracting iron from magnetite.

Complete the practical experience of the white farmer, with but a small quantity of chemical knowledge, then you will see the difference. Humanity has not yet understood that agriculture is a chemical industry, and therefore chemistry must play an important rôle—from analysis of the soil to the harvesting of the wheat. We are still under the mediæval impression that to be a good farmer the want of intelligence and of a trained brain is the best recommendation. Those ideas we have inherited from our forefathers. The difficulty of the agricultural industry is evident from the difficulty we meet in discussing those few analyses of the Rand soils. How many have been trained to understand such analyses? We have been crushed under the grammatical rules of languages and other useless studies, and our most vital interest—the knowledge of the ground upon which we walk and live—has been neglected.

When the day dawns of large manure factories turning out hundreds of tons of artificial manure, then we may know that the country is going ahead, their children understand soil analysis, and what is more, understand how to correct the soil which they are working.

Mr. A. Whitby (contributed): Mr. Croghan's paper being the first, so far as I know, ever read before this Society on the subject of Agricultural Chemistry, is worthy of recognition if only as serving as a basis for future discussions. It is naturally difficult, in dealing with a subject more or less unfamiliar to many of our members, to avoid the lines of the text book, and I think Mr. Croghan is greatly deserving of credit for having given us some analyses of local soil, and adapted some of the dogmas of agricultural chemistry to local

conditions. Under Mr. Croghan's description of the class to which a soil belongs, I come to the first point in his paper, which I find open to criticism. I do not know whether this classification is Mr. Croghan's own or not, but to call a soil containing over 95 per cent. of clay a "pure agricultural clay" is rather hard on the agriculturist. I do not think Mr. Croghan would like to be "the man behind the plough." Leave the "agricultural" out and it may be suitable for brick making.

With regard to the implication that certain soils accompany particular geological formations, I should like very much more corroboration than Mr. Croghan has given us before conforming to it. Then, again, "The quantity of humus present affords some guide to the amount of nitrogen present" is misleading. Personally, I should prefer to know the nitrogen present either by the Kjeldahl or any other convenient method.

Now, with regard to the still prevalent practice of veld burning, I am in entire agreement with Mr. Croghan. It cannot be too strongly condemned. Of course, it is a practice dating back to the voortrekkers when farms were unenclosed—land was cheap, and it seemed the only means of providing a sweet, green pasturage for the young sheep. I am inclined to think in this connection that the study of grasses capable of being crossed on to the South African variety is one well worthy of the attention of agriculturists. Referring now to Mr. Croghan's typical soil analyses, I find two columns for limestone and CaO. The casual reader might take this to mean that both were determined, but I observe that actually the limestone figure is derived from that of the CaO obtained. Nor do I note anywhere in his scheme of analysis any provision for the determining of these constituents separately and individually. Hence I cannot accept in good faith such remarks as "very deficient in CaCO₃, but sufficient CaO for plant food only," or "very deficient in CaCO₃ and CaO." To say the very least, such statements are misleading, and tend to throw, by reflection, considerable doubt on Mr. Croghan's conclusions.

With regard to the method of analysis employed, I find nothing particularly novel, but take exception to empirical formula such as C₂O₂H₄, which conveys nothing whatever. Dressed in this guise it is hard for the chemist to realise acetic acid. Under similar protest I place C₇H₆O, used for plain, familiar alcohol. Nor do I think the chemist is favoured by the statement that "Na₂PtCl₆ is soluble," or that so many parts of "K₂PtCl₆ contain so much K₂O." The factor is to be found in Bailey's Pocket-book.

Mr. G. W. Williams (contributed): Mr. Croghan is to be complimented upon the introduction of a

paper which not only bears the impress of much careful work but which is, moreover, of great economic, I might even say of political, importance. I trust that before long Mr. Croghan will supplement these analyses with those of samples taken from other districts. If this is done, I do not think that the average analyses will show anything very striking in the way of rich soils. This is a natural result of the chemical composition of the chief surface rocks of the Transvaal. Throughout the country there is a great dearth of basic rocks, and correspondingly we find that in the main our soils present the characteristics of soils formed from acid and highly siliceous rocks.

It is much to be regretted that the Agricultural Department has not yet succeeded in publishing analyses of typical Transvaal soils.

Although the analyses given by Mr. Croghan are taken from samples collected over a comparatively small area, the remarkable uniformity and the wide extent of the geological formations from which they are derived give them an added value, for we see that they are really applicable to a very much larger area, except in the cases of soils derived from the diabase, which, unfortunately, as surface rocks are far more local. Soils such as these can only be formed on a fairly large scale, and then only by the aid of fertilisers.

I do not observe any determinations of nitrates. This is to be regretted, for although I do not think that more than the most minute traces would be found, it would be interesting to see if this was so. Nitrates are, after phosphates and potash, the most valuable constituents of plant life. In moist, warm climates these nitrates are formed in the surface soils during the summer months by the agency of certain organisms, the process being known as "nitrification." The conditions for successful nitrification are warmth and moisture, hence in this country for at least eight months per annum nitrification must be practically at a standstill, whilst during the rest of the year the land is too often drenched with rain to allow of the accumulation of such nitrates as might be formed. It would be very interesting to obtain figures showing the seasonal variation in the nitrates of the surface soils. I quite agree with Mr. Croghan that green manuring with quick growing leguminiferae might be of great value, but it remains to be seen whether the climatic conditions would not seriously interfere with the conversion of this nitrogenous matter into nitrates and also whether in the event of its ultimate conversion the first heavy rains falling on the sun-baked earth would not wash them out of the soil.

These are points of more than mere theoretical

interest, for they have a most important bearing on the agriculture, and hence the true prosperity of our country.

The President: I am sure we all realise the intricacies of the subject Mr. Croghan has dealt with, and after reading his paper and listening to the very able contributions, I may say we are fortunate in having such matters brought before us. We have not many agricultural members at the present time, but as matter from our *Journal* finds its way into other publications, no doubt these remarks may travel outside the limits of the Society and do further good.

The meeting then closed.

Proceedings

AT

Extra General Meeting,

July 30, 1904.

An extra general meeting of the members of the Society was held on Saturday evening, July 30, in the temporary buildings of the Transvaal Technical Institute, Kerk Street, the President of the Society in the chair. There was a large attendance of members.

Prof. Hele-Shaw delivered a lecture upon—

THE STREAM-LINE MOTION OF LIQUIDS AND ITS APPLICATION TO THE INVESTIGATION OF ELECTRICAL PROBLEMS.

The Professor commenced by pointing out that in mastering the laws of the flow of electricity and the action of magnetic force, it might well be thought that the human mind had a task incapable of achievement. The motion of solid bodies themselves, and the action of light and heat, presented in the main phenomena far less difficult than the problems connected with electricity. What had been accomplished so far in the understanding of the behaviour of electricity was largely due to the fact that it was possible to consider electricity as a fluid. Whether electricity really is a fluid, as originally supposed by investigators, or whether it is merely an effect in the ether, involving a state of strain in the matter itself, is, as it ever has been, still a matter of conjecture. In what the lecturer had to say, he proposed to show in what way the analogy of electricity with fluid

movement at any rate helped them to understand what took place with the electrical transmission of motors, and had been the means of building up and bringing to its present high position the science of magnetism and electricity.

There need be no excuse for commencing a lecture of this kind with the most elementary proposition, and the lecturer proceeded to show how liquid flowing from a small orifice and distributing itself on a flat surface, or, conversely, flowing from a flat surface and escaping by a small orifice, followed a path identical with the so-called lines of force radiating from the north or south pole of a magnet. These lines of force, first employed for the purpose of discussing problems of this kind, some seventy years ago (1831) by the immortal Faraday, were clearly indicated by scattering iron filings in the neighbourhood of a magnet. If certain simple geometrical laws were applied the path taken by particles of liquid flowing into small holes, called respectively by mathematicians the "source" or "sink," could be ascertained, and were found to correspond exactly to the magnetic lines of force under various conditions, which the lecturer made clear by lantern slides and by black-board illustrations. Before the discovery that the motion of a perfect liquid can be imitated by the lecturer's method of a thin sheet of flowing liquid, it would be impossible to proceed by geometrical methods beyond certain very simple problems, or to apply these methods generally.

In a paper previously read before this Society on the motion of liquids, the electrical aspect of the question had not been in any way dealt with. Now, a number of pictures illustrating the flow of liquid, in which narrow colour bands were used, enabled it to be clearly seen how this method could be applied for problems of flow in a magnetic field, as long as only the elementary case of magnetic poles had to be dealt with. This simple method of iron filings absolutely failed when practical problems with solid bodies were studied. It was true that the portion of the magnetic field in air could be investigated by a very small magnet, which would point always in the direction of these lines; but this did not give much assistance in practice, and what was going on in the magnetised solid body itself could not be traced.

Here some account was given of the mathematical investigations, which, although it was probably the most difficult branch of mathematics and had been investigated by the most able mathematicians, left them still with very small practical results for ordinary purposes.

If, therefore, the flow of stream-lines could be applied practically to investigate the behaviour, it was evident that it was just as easy to take

complicated shapes, corresponding to the actual teeth of an armature, as the spherical and elliptical section which were the only cases possible in theory.

The lecturer then proceeded to give an account as to how these results had been accomplished, and explained that it had taken 18 months' hard work to verify the fact that the lines given by the stream-line method actually corresponded with the true lines of magnetic force.

A number of illustrations were then given of cases which had been investigated in this way (such, for instance, as the lines of force in the shuttle-wound armature with Siemens' dynamo), and numerous sections of magnetised bodies were shown of square, triangular and other shapes, the lines in force in which had never been previously investigated. The lecturer concluded these illustrations by giving results which had never before been shown to audiences, but which had formed the subject of research now in the hands of the Royal Society of London—on the exact form of the magnetic curves in the teeth of an armature of a dynamo. A remarkable fact shown by these results was that it enabled results previously unaccounted for in practice to be explained.

The lecturer concluded by saying that, although he might appear only to have accounted for known facts by this method, it was always an important step in scientific work to have achieved these results, since it was the usual rule that new methods enabled at first known facts to be accounted for, and this was in turn the first step towards practical design. He could only hope for the method he had brought before them that evening that it would be like the science of electricity itself, with regard to which Dr. Franklin in America, when asked, at the time when he was making his first experiments in electricity, what was the use of it, replied "it is an infant and it will grow."

The President, in proposing a vote of thanks to the lecturer, commented on the thorough success that had attended the Professor's experiments.

Mr. J. R. Williams, in seconding the vote of thanks, complimented the lecturer, and in reference to that gentleman's intended departure for England, expressed the hope that Professor Hele-Shaw would return to the Rand and make Johannesburg his home.

Prof. Hele-Shaw, in responding, acknowledged the compliment. This was the last lecture he would give for a time. He had made many friends here, and amongst them the members of this Society. It had been very gratifying that he had been able to show them the experiments successfully. He was indebted to Professor John

Orr and Professor J. H. Dobson for their assistance. Speaking of his forthcoming departure for England, the Professor said that he had never appreciated working anywhere more than he had in Johannesburg. He was pleased that what little he had tried to do since he came to the Rand had been appreciated.

Excursion to Works.

A large party of members of the Chemical, Metallurgical and Mining Society of South Africa visited the Boksburg works of the Consolidated Rand Brick, Pottery and Lime Company, Limited, on Saturday afternoon, July 23. The party left town by the 1.20 train from Park, and upon arrival at the works were met by Mr. Cobb, the Works Manager, and Mr. Miller, the Business Manager of the Company. After refreshments had been served, Mr. Cobb conducted the visitors over the property, which covers about 16 claims, and gives occupation to some 16 white and 120 coloured employees.

The first point of interest was an exhibit of samples of the Company's products, amongst which should be mentioned the 10 in. main sewers, with branches and inspection junctions; fire bricks of many varieties, including some special forms for protecting the boiler tubes; boiler settings; common and hard engineering bricks; tiles; and some very artistic examples of Worcester rustic ware, the first made in the Transvaal.

The party of inspection then moved on to the clay-hole, where the fine quality and peculiarly hard character of the clay were observed. Passing up the mechanical haulage-way, the party then entered the machinery department, where things were set into full swing for their benefit. This exhibition of work demonstrated how the raw clay is ground dry under edge-runners in perforated pans (whereby the usual weathering process is dispensed with), and how, after passing through the pans, it is run into mixing machines, whence it issues as a plastic mass ready to be shaped into the thousand and one articles which were to be seen about the sheds.

Considerable interest was excited by the pipe-making machine, which was fed with lumps of clay, and, after a few strokes of a steam operated plunger, delivered a moulded pipe from the bottom.

Later on the drying sheds were visited where several thousand pounds worth of pipes, bricks, etc., were seen in various stages of hardening. The accumulation of stock here was explained by the present inadequate kiln accommodation,

which, however, will soon be greatly increased. The burning department was subsequently inspected, several of the visitors closely examining the interior of a recently emptied kiln. Comment was made upon the apparently primitive furnace doors, which consisted for the most part of common bricks, iron doors having been tried, but abandoned.

At the conclusion of the visit the Directors and officials of the Company were thanked by Mr. W. A. Caldecott, the President of the Society, for the courtesy and hospitality shown to the Society's members; and Mr. J. R. Williams congratulated the Company upon their enterprise and the success they had attained.

Replies having been made by Mr. Brayshaw, one of the Directors of the Company, and Mr. Cobb, the proceedings concluded.

Contributions and Correspondence.

DESCRIPTION OF A CHEAP CYANIDE PLANT ERECTED IN WESTERN AUSTRALIA.

By E. M. WESTON (Associate).

Having observed in this Society's *Journal* of July, 1903, an inquiry as to the best method of constructing a cheap cyanide plant, I thought that a description of one I erected on Bayley's Consols G. M. Co., Coolgardie, might be of interest. More so, because the only answer appearing to the inquiry was one describing an out of date wooden plant erected in New Zealand.

The cost of any plant will of course depend, 1st, on the daily quantity of ore to be treated, and 2nd, on the time required for treatment, and the number of vats will also depend on whether the treatment is continuous or ceases during Sundays, as is sometimes the case in Western Australia.

The plant I designed consisted of eight 25-ton vats to give an eight days' treatment, no vats being filled or discharged on Sundays. This cost £800 with extractor house and washing furnace room; but another shown in the accompanying photos consisting of 7 vats to treat 500 tons a month with a six days' treatment, was, by using a certain amount of second-hand material and sacrificing some features designed for greater permanence and also requiring no excavations, erected for £350. Details of cost are given below.

The chief feature of these plants is the use of the ordinary galvanised corrugated iron for making vats and sumps, and of plain galvanised iron for making extractor boxes, etc. The vats are made of such a size as shall be suitable for emptying them by shovelling the sand up directly into trucks running on a single or double line of rails across the centre of the vat. The difference of cost between this method of discharge and that of discharging through a door in the bottom is, in cases where the quantity of stuff to be dealt with is not too large, more than compensated for by the simplification and cheapening of the plant and thus reduced capital outlay. In one case in Western Australia the contract for filling and emptying bottom discharge vats was 1s. 2d. per ton and in a similar top discharge plant 1s. 6d. per ton. In designing the vats a point to be observed, in order to obviate the cutting of the sheets of galvanised iron, is to make the vat of such a diameter that, after allowing a 3 in. overlap at each joint for double riveting, the circumference will contain an even number of 6, 7 or 8 ft. sheets. The vats are made shallow to allow of easy shovelling into the trucks. The general depth is 4 ft., thus allowing a depth of sand of about 3 ft. 3 ins. This facilitates quick and effective leaching under the conditions of a limited filter area on the bottom, caused by the necessity of nailing slats over the hessian filter cloth to protect it from the shovels. Vats may be made of 24 gauge iron for sides and 22 gauge for bottom; but though this does all right for sumps, it will last scarcely long enough without leaking and is too easily damaged by shovels, etc. Sides of 22 gauge with 20 gauge bottoms will be found very durable and satisfactory, lasting several years. Vats must be double riveted throughout and soldered inside and out. Along the top is attached round the circumference, by rivets or screws, a band of inch by quarter angle iron to strengthen the vat and preserve the edge from denting. For sumps the ordinary round wrought iron $\frac{1}{2}$ in. or $\frac{3}{4}$ in. diameter is used and the corrugated iron bent over it round the top. For vats deeper than 4 ft. a clamp of old steel rope should be added half way down to prevent bulging. The bottom is cut with an inch diameter hole, and by flanges and packing on each side, is attached a nipple and elbow piece for the 1 in. diameter drain pipe. The 1 in. pipe being sufficient for vats holding up to 40 tons and the vats are laid on the ground with 1 in. boards under them and have about an inch fall towards the drainage pipe. Sumps can be made of any size up to 15 ft. high and 30 ft. in diameter if properly built and stayed. Vats and sumps are coated inside and out with any of the well known preparations.

False bottoms in the vats are made by laying 2 by $1\frac{1}{2}$ in. soft wood bearers about 1 ft. apart covered by 1 x 1 in. soft wood slats set 1 in. apart. This filter frame is made in two halves and is 3 in. less in diameter than the vat. It is quite common now to do without cocoanut matting and to lay a double thickness of hessian (costing in West Australia about 1s. a yard) directly over the slats. This is cut 6 in. larger in diameter than the vat and caulked in the usual way by an $1\frac{1}{2}$ or 2 in. diameter manilla rope forced between filter frame edge and the vat sides. Above the hessian are laid slats of 2 by $\frac{1}{2}$ in. wood set 4 in. apart to shovel on.

The vats are placed in two rows so that one main of 2 in. delivery piping runs between them and the solution is delivered to the vats on either side by fitting double T pieces and valves. In the plant mentioned a 3 in. duplex pump with a $4\frac{1}{2}$ h.p. vertical boiler was used for pumping. The extractor box is made of 22 gauge galvanised sheet iron. In this plant there were five compartments 15 in. x 15 in. x 15 in. with channels 2 in. wide and settling boxes at both ends. There is about 18 in. fall only between bottoms of treatment vats and tops of sumps.

The trucks are carried over the vats on rails laid on two 10 in. x 5 in. stringers. The two sumps for strong and weak solutions were of 15 tons capacity each. Solutions are not pumped into storage sumps, but directly into the sand in the vats.

It must not be supposed that these cheap plants are merely for temporary use. If well made they will last for several years and they are specially suitable for mines as in Rhodesia or elsewhere away from railway communication. As they can be put together on the ground by any good plumber and the vats and sumps are so light that they can be carted many miles on a wagon.

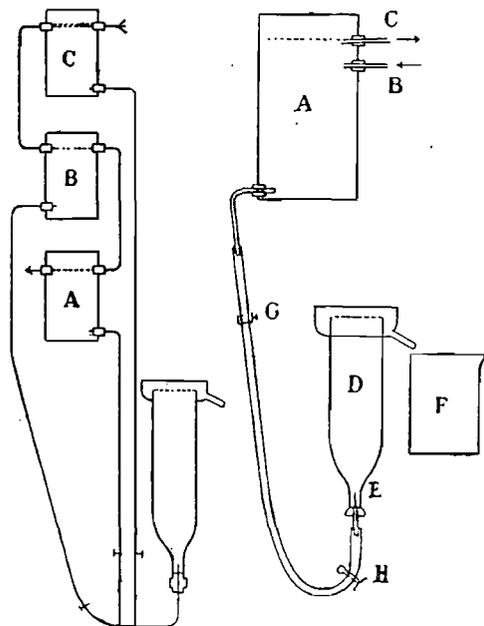
Costs of plant in West Australia were as follows—

6 vats 12' 3" x 4' 0", 24 gauge	£75	0	0
2 „ 15' x 4' 0", 2nd hand ..	15	0	0
1 „ 13' 6" x 4' 0", 22 gauge	10	0	0
1 Worthington 3" duplex pump	20	0	0
1 $4\frac{1}{2}$ h.p. Tangye boiler and mountings	50	0	0
Timber, second-hand...	20	0	0
Fittings, piping, etc....	50	0	0
Extractor box	6	10	0
Labour: 3 men erecting, 5 weeks	50	0	0
Sundries	3	10	0
Extraction house, etc.	50	0	0
	<u>£350</u>	<u>0</u>	<u>0</u>

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

LABORATORY HYDRAULIC CLASSIFIER.—“ I have found the various forms of apparatus for hydraulic grading used for clay, kaolin, and other substances in the state of fine division adopted in china, porcelain, and allied industries, quite inadequate for grading pulp. The well-known Schöne's Schlamm apparatus is clumsy and difficult to regulate. The modifications are expensive and cumbersome and unfitted for the requirements of a mine laboratory. The following piece of apparatus I have devised has given good, constant results, and has the advantage of being easily and cheaply constructed with materials everywhere at hand. The references in the diagram are as follows: A, constant level water tank; B, water supply from main; C, overflow; D, vessel where hydraulic separation takes place; E, glass tube narrowed to a fine point, leading to reservoir by means of an indiarubber tube; F, vessel to catch overflow of slimes; G, screw-clip for adjustment of flow; H, clip or tap.



HYDRAULIC SEPARATOR.

The important part of the hydraulic separator is D. It is constructed of a conical glass vessel, which may be made by neatly cutting off the bottom of a white glass bottle which has no shoulder, but sloping sides. Some beer and spirit bottles admirably fulfil these requirements. An arrangement of tin is fixed to the top with white lead to carry off the overflow. In the neck is fitted a cork, through which is passed a glass tube drawn to a fine point to form an upcast in the bottle. The other open end outside the cork is fastened to a piece of rubber tubing connected

with the constant level tank. The receptacle F (an 80-oz. beaker) may be provided with an apron in the same way to a settling spitzkasten, but when working on a 100–250 gms. of pulp this is not necessary, as before the vessel is full, the water runs clear from the separator D, which indicates the completion of the experiment.

The tank A, with constant level may be constructed out of a clean oil drum. It is necessary for comparative experiments always to have the same pressure and volume of water for separation. Under other conditions this is impossible, and no reliance can be placed on results obtained with varying flow and pressure of water. The velocity of flow must be adjusted to the quality of the ore treated, and the method employed on the works for separating sands and slimes. I found that with a 3-ft. level of water, a flow obtained by adjusting the clip G so that 250 c.c. of water passed through a 3/8-in. orifice of E in the hydraulic separator per minute, was sufficient. Where hydraulic separation on the works obtains, this quantity would probably have to be increased.

A comparison by careful panning of the slimes from the mill (after separation) with the slimes from the experimental separator, will determine the required flow of water. Constant flow is of the greatest importance for the same series, and should be determined so that, if through accident or negligence the screw-clip has been altered, the original flow may be re-ascertained. Increased flow results in decreased percentage of sands.

Having constructed and adjusted the apparatus, the experiment consists in allowing the water to rise in the hydraulic separator till it is about half full, and then adding 100 gms. of the dried pulp, which has been broken up, to avoid lumps of slime, by passing through a 20-mesh sieve and the water allowed to run till clear, with partially slime-free samples, such as vat sands. The quantity may be increased to 250 gms. The residual sand is then washed on a vacuum filter, dried and weighted; the slime is treated in the same way. It is not advisable to take the slime by difference, but by actual weight to check results.

The same apparatus may be used for experimenting with the hydraulic classifier. For this either varying volumes or pressures are required, but so arranged that at each stage a definite volume or pressure is obtained. This may be accomplished by keeping the screw clip G always the same, but varying the pressure by means of three or more constant level tanks at various levels, say, 3, 6, and 9 ft. from the level of the liquid in D.”—WALTER A. INCE, Ph. D., F.I.C.—*The Mining Journal*, Jan. 23, 1904. (W. A. C.)

VOLUMETRIC METHOD FOR THE DETERMINATION OF MAGNESIUM.—“ In a method described by E. Rupp (*Archiv der Pharmacie*, 1903, cexli., viii., pp. 603 to 613), the magnesium is precipitated as magnesium-ammonium arsenate in the usual manner by the addition of an excess of sodium arsenate solution of known strength. After filtering off the precipitate, the quantity of uncombined sodium arsenate in the filtrate is measured by iodometric titration in the usual way, from which the quantity of arsenic acid required for the precipitation of the magnesium, and therefore the quantity of magnesium, can be calculated. The method is said to be more accurate than the gravimetric determination of magnesium by precipitation.”—*The Engineering and Mining Journal*, March 24, 1904. (C. D.)

THE SOLUBILITY OF GOLD IN CERTAIN OXIDISING AGENTS.—"The only solvents in general use for gold are the halogens and alkaline cyanides in the presence of oxygen. Of these iodine only dissolves gold when freshly liberated or under other favourable conditions.

The metallic per-halogen salts are said to dissolve it according to Nicklès, forming the lower halides and gold chloride. Hot selenic acid readily dissolves the metal, and whilst iodic acid has but slight action, according to Prat, a mixture of this acid with sulphuric acid effects solution at 300° C. The author has verified this reaction and also finds that gold is readily soluble in a mixture of hot sulphuric acid and periodic acid. Gold is also soluble in alkaline sulphides and thiosulphates.

Following the lines of Mitscherlich's research on the action of selenic acid, the author shows that telluric acid, when dissolved in sulphuric or phosphoric acid and heated, acts as a solvent.

With the fact that at the temperature of solution in these cases, both selenic and telluric acids break up into oxides and free oxygen, the author deduces that the solvent action is due to the production of this gas, and consequently gold should be soluble in acids when an oxidizing agent is present.

Concentrated sulphuric acid and manganese dioxide yield oxygen when heated, and the mixture was found to be a ready solvent, some gold being dissolved even at low temperatures. The higher oxides, Mn_2O_3 and Mn_3O_4 , as well as potassium permanganate, act in a similar way. So, also, do the higher oxides of lead, chromium and nickel in the presence of either sulphuric or phosphoric acid.

A mixture of hot nitric and sulphuric acids also acts as a solvent with production of a lower oxide of nitrogen. On dilution the metal is thrown out as a purple precipitate, but if the water used for dilution contains permanganate no precipitation takes place. Ammonium sulphate also destroys this oxide and prevents precipitation. Anode oxygen, in the presence of sulphuric or phosphoric acid, is another powerful solvent, but neither oxygen gas nor ozone has any action. In this case of anode oxygen, when the acid is dilute the oxide of gold formed does not pass through the solution and deposit on the cathode as metal, but remains on the gold anode as an incrustation. Similarly, with the acid sulphates of the alkalis. If the solution contains sufficient free acid, gold passes to the cathode, while if the solution is dilute, or contains only a little free acid, it remains on the anode as a film of oxide. In the case of an alkaline electrolyte, such as solutions of potassium and sodium hydroxide, it is possible for some gold to pass probably as aurate, although a large amount of oxide remains on the anode. With neutral salt solutions, such as the nitrates and sulphates of the alkalis, very little gold passes, and it is possible to retain pure Au_2O_3 on the anode."—VICTOR LENHER. *Journal American Chemical Society*, May, 1904. (A. W.)

DOUBLE CYANIDES OF ZINC WITH POTASSIUM AND WITH SODIUM.—"The composition of the zinc cyanide prepared was found to vary between $ZnCy_2$ and $ZnOZnCy_2$; when thrown down from dilute solutions or copiously washed it approached the latter formula, but by special precautions an almost normal salt was obtained.

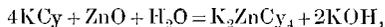
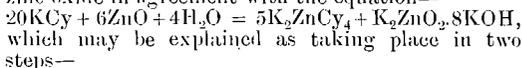
Potassium zinc cyanide (K_2ZnCy_4) was readily prepared of a high degree of purity. It was found that 11 parts of this salt dissolved in 100 parts of

water at 20° C., while organic liquids had no appreciable solvent action. Sodium zinc cyanide is extremely soluble, and could not be prepared pure: the salt obtained approached the composition $NaZnCy_3$, but in dilute solutions Na_2ZnCy_4 occurs.

Potassium cyanide in dilute solution dissolves zinc cyanide in accordance with the equation—



Potassium cyanide in decinormal solution dissolves zinc oxide in agreement with the equation—

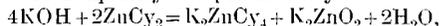


the potassium hydroxide further reacting,



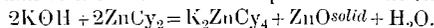
On boiling the mixed solution the zincate is partially decomposed with precipitation of zinc oxide.

Dilute solutions of potassium hydroxide dissolve zinc cyanide. If the zinc cyanide is in a less proportion than corresponds to $ZnCy_2 + 2KOH$, it is dissolved completely and permanently—



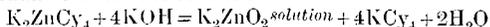
although upon heating most of the zincate is decomposed with precipitation of zinc oxide, leaving free alkali in solution. Zinc cyanide is also completely dissolved in proportions up to that of $ZnCy_2 + KOH$, but zinc oxide begins shortly to fall out. Any further excess of zinc cyanide is unaffected.

When the zinc cyanide corresponds to or is in excess of the proportion of 1 molecule to 1 of hydroxide, it is dissolved in that proportion, but one-half of the dissolved zinc separates out as oxide,



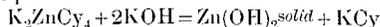
This peculiar effect is probably due to the temporary formation of compounds analogous to $NaZnCy_3$ and $Na_2Zn_2O_3$, which have been recognised but are not stable in dilute solutions.

The increase in solvent power of potassium zinc cyanide solutions toward gold on addition of caustic alkali confirms the reaction—



as taking place in dilute solution, and only to a very limited extent.

The equation—



is contrary to all observed facts.

In *dilute* solutions the action of the equivalent sodium compounds is almost identical with that of potassium cyanide and hydroxide, as noted above."—W. J. SHARWOOD.—"A Study of the Double Cyanides of Zinc with Potassium and with Sodium," University of California, April 27, 1904. (W. A. C.)

NON-PRECIPIATION OF COPPER BY HYDROGEN SULPHIDE IN THE PRESENCE OF POTASSIUM CYANIDE.—"The salts $[Cu_2(CN)_3H_3O]K$ and $[Cu_2(CN)_3]K_2$ are readily decomposed by hydrogen sulphide, copper sulphide being formed, whilst the salt $[Cu_2(CN)_3]K_6$ is not acted on in the solid state or in concentrated solution. The authors come to the conclusion that the non-precipitation of copper by hydrogen sulphide in the presence of potassium cyanide is due to the formation of ions containing more cyanogen than $[Cu_2(CN)_3]$."—F. P. TREADWELL and C. VON GISEWALD (*Zeit. anorg. Chem.*, 1904, 38, 92-100).—W. P. S.—*Journal of Chemical Society*, March, 1904. (W. A. C.)

ON THE CUPELLATION OF PLATINUM ALLOYS CONTAINING SILVER OR GOLD AND SILVER.—The experiments were made primarily to ascertain the extent to which lead is retained in the cupellation of platinum alloys, and the extent to which the platinum passes into solution during parting.

In the first series, equal weights of platinum, 100 mgrms. each, were wrapped in about 5 grms. of sheet lead, with varying amounts of silver, or silver and gold, and cupelled at a temperature suitable for gold bullion; they were left in the muffle about three minutes after apparently "finishing." After weighting they were warmed with No. 1 acid,

FIRST SERIES.							SECOND SERIES.						
No.	Platinum taken, mgrms.	Silver taken, mgrms.	Gold taken, mgrms.	Lead retained, mgrms.	Loss in parting, mgrms.	Weight after parting, mgrms.	Effect of acid on button.	Platinum dissolved in parting, mgrms.	Lead retained, mgrms.	Gold taken, mgrms.	Silver taken, mgrms.	Platinum taken, mgrms.	Colour of Solution.
1	100	0	0	37.5	0.5	137.0	None Visible.	30	11.4	0.0	105	100	Brown.
2	100	25	0	31.0	5.5	150.5	do.	63	10.9	6.0	206	100	do.
3	100	50	0	26.2	8.7	167.5	do.	0	22.0	48.0	206	100	Colourless.
4	100	100	0	25.0	48.0	177.0	Very Slight.	64	10.0	0.0	310	100	Brown.
5	100	101	48	24.0	3.0	270.0	None Visible.	89	5.0	0.0	427	100	do.
6	100	206	48	22.0	158.0	218.0	Slight.	99	2.0	19.4	470	100	Colourless.
7	100	206	6	10.0	280.0	42.0	Powdery Residue.	100	?	167.0	1,950	100	do.

washed, boiled with No. 2 acid, washed, dried and weighed. No. 7 was heated to anneal the residual gold. In every case, except No. 8, the weight of the final residue exceeded that of the platinum, or gold + platinum taken.

The "loss in parting" gives the silver and lead, or silver and lead and platinum removed by the nitric acid; "lead retained" indicates the increase in weight after cupellation, neglecting absorption of silver by the cupel.

In the second series the amounts of platinum taken varied somewhat—the weights of platinum, silver, and gold, ranging from 300 to nearly 2,000

mgrms., 5 to 10 grms. of lead being used. The buttons were rolled out to nearly uniform thickness, and 200 to 500 mgrms. cut out for parting. For the sake of comparison all are calculated to a uniform basis of 100 mgrms. of platinum. As the final residues were less in weight than the platinum or platinum and gold taken, it was assumed that all the lead and silver dissolved, and that the figures under "platinum dissolved" represent the platinum or gold and platinum taken, minus the final weight of the annealed residue. Results 6 and 7 are also included in the series for comparison.

In Nos. 7, 8, 9 and 10 the platinum was left after parting in a very finely divided condition. On filtering the brown decanted solution, very little platinum remained on the filter, but the filtrate was still brown; on standing three days a black powder separated, and the solution became almost colourless. In No. 12 the cupelled button was slightly less in weight than the platinum, silver and gold taken, the silver absorbed by the cupel doubtless exceeding the lead retained.

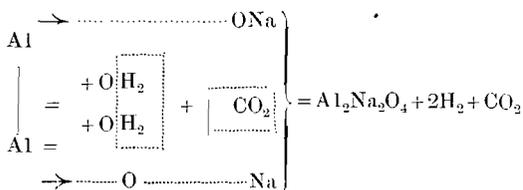
In No. 11, attempts were made to estimate the silver in the nitric acid solution by titration with potassium thiocyanate. In this and in other instances when platinum was present, titration indicated more silver than was actually present; the excess of reagent consumed corresponded very closely to 4 mols. potassium thiocyanate for each atom of platinum in solution, but the end of the reaction is rendered very indefinite by the platinum.—W. J. SHARWOOD. *Journal of the Society of Chemical Industry*, April 30, 1904. (W. C.)

ELECTRONS IN METAL.—"Mr. A. Schuster proves, in the *Philosophic Magazine* for February, that 'the number of free electrons in a metal is equal to the number of metallic atoms in the same volume, or exceeds that number not more than three times.' This law may be deduced with considerable confidence from optical considerations. With the aid of Drude's equations regulating the transmission of light through metals and the supposition that the whole of the electro-magnetic energy is equal to that taken account of in the usual formulae with the addition of the total energy of the moving electrons, the author deduces for a number of metals the value of the factor p , indicating the ratio of the number of electrons to the total number of atoms. In nickel, mercury and bismuth the factor closely approaches unity, meaning that the number of free electrons is practically the same as the number of atoms. Though the extreme electric conductivities differ in the ratio 63 to 1, the extremes of p are only in the ratio of 3.5 to 1. The factor p is less than 3 for all metals except aluminium, which in comparison with other metals is very opaque compared with its conductivity. Cobalt, silver, copper and gold have values under 1.6, and in the other metals examined the factor increases in the order—magnesium, platinum, lead, cadmium, antimony, tin, zinc, aluminium. The opacity due to selective molecular absorption is neglected in every case, so that the values of p are upper limits. But it is significant that the list contains no value sensibly less than unity, or, in other words, that in all probability no metal contains less than one free electron for every atom. The simplest explanation of metallic conduction would appear to be that each atom has one, or possibly two or three, negative electrons which are easily detached and follow freely the electric force, even for such rapid oscillations as those of light."—*The Australian Mining Standard*, April 7, 1904. (C. D.)

RADIO-ACTIVITY.—"EDISON, the eminent electrician, stoutly demurred to the original proposition that radium and kindred elements have the property of giving off actinic rays of peculiar chemical properties, somewhat similar to the Rontgen rays, without any apparent loss of energy or bulk. Based on observed phenomena, several new theories of matter have been put forward, all of which accept as a fact the apparent origin of the energy within the substances themselves. Mr. Edison's theory eliminates this contradiction of accepted natural laws, and indicates the possibility that the energy emitted by radium is merely reflected, as it were, from some unknown source. 'My theory of radio activity,' says Mr. Edison, 'is that the rays which the new elements emit are set up in the natural way, the substances being rendered fluorescent by some form or other vibration which is undoubtedly all-pervading, but has not yet been isolated or measured, and which may have some extra planetary origin. To accept any other theory is to declare one's belief in perpetual motion, in getting something for nothing.'"—*The Australian Mining Standard*, April 16, 1904. (C. D.)

ACTION OF CERTAIN SOLUTIONS UPON ALUMINIUM AND ZINC.—"The author describes a series of very interesting experiments on the action of certain solutions on aluminium and zinc, and in the course of these shows that certain preconceived ideas are quite wrong. For instance, organic acids appear to have very little influence on aluminium, but in the presence of sodium chloride, the effect is quite appreciable.

When the metal is treated with carbonate of soda in the heat, a most violent decomposition takes place, and both carbonic acid and hydrogen are evolved according to the equation given by the author.



Another point elicited by the author is that sodium chloride by itself has quite an appreciable action on aluminium, but a much more pronounced one on zinc. With reference to the former he says, 'Aluminium in the presence of sodium chloride attacks the water setting hydrogen free. Aluminium hydrate is thus formed, and almost instantaneously attacking the sodium chloride yields basic aluminium chloride and some free sodium hydrate. It is clear therefore that aluminium is not quite suitable as a material for cooking utensils. 15·714 grms. of aluminium foil were heated for four days in a solution of sodium chloride (6·070 grm. per litre). The loss in weight was only ·002 grm., but the metal became cooled, and this cooling protected it from further action.'

As a result of the experiments, the author makes the following practical conclusion:—

1. From my experiments with nitric acid, the great value of pure aluminium as offering such resistance to the action of nitric acid, below a temperature of 50° C. or thereabouts (not over 50° C. to 55° C.) forced itself upon me, and I would suggest that for transport of nitric acid, not glass carboys or even

earthenware vessels be used, but box-shaped vessels composed of pure sheet aluminium, protected by enclosure in wood (this *J.*, 1903, 1352). It seems to me also that storage vessels in the nitric acid factory would be most conveniently made of pure sheet aluminium.

2. If aluminium could be produced cheaply enough, it were certainly better suited than zinc for cisterns in which to store water for household purposes, and in the construction of receptacles to catch and run off rain water. It would last far better than zinc. Brackish water would rapidly act on zinc, whilst aluminium would prove very resistant. (See Norton this *J.*, 1897, 465; 1899, 497).

3. As a material for cooking vessels and culinary purposes, discrimination and caution are required. Aluminium kettles and teapots are largely offered for sale. I fear, however, in the latter case (teapots) when 'carbonate of soda' is added to get the 'tea to draw' as the old people say, that the drawing power would soon extend from the tea to the teapot itself. (See this *J.*, 1896, 118; 1899, 587).—WATSON SMITH.—*Journal of the Society of Chemical Industry* May 16, 1904. (W. C.)

MELTING POINT OF GOLD.—"The author, in 1898, determined the melting point of gold and found it to be 1065·6° C. Two determinations have since been made, Holborn & Day (1900), and Jacquered & Perrot (1904), and the author has calculated their value on the absolute scale of temperature, as compared with his result, by formulae which he had previously worked out. They give respectively 1064·3 and 1067·4° C. As he allowed for a probable error of +2° C. it will be seen that these later results verify his determination."—D. BERTHELOT. *Comptes rend.*, 1904, 138; 1153-1156.—*Journal of the Society of Chemical Industry*, June 15, 1904. (W. C.)

ACTION OF RADIUM ON METALS.—"Mr. N. Orloff, as stated in a recent communication to the Russian Physico-Chemical Society, covered in April, 1903, an ebonite capsule containing 0·03 grm. of radium bromide with an aluminium plate 0·01mm. in thickness instead of the mica generally used. In the course of July the author, having opened the capsule, noted on the surface of the aluminium turned towards the radium some protuberances of the same aspect as the surrounding surface of the aluminium and resembling small drops of melted metal. These protuberances proved to be radioactive, producing a photographic image on acting for some minutes through black paper, and even after six months they were found to emit invisible radiations without any appreciable weakening. The author thinks that a stable alloy is formed by the accumulation of material particles given off from the atomic systems of radium around small aluminium nuclei."—*Electrical Engineer*, May 13, 1904. (C. D.)

APPARATUS FOR REGULATING THE ACTION OF VACUUM PUMPS.—Through a cork fitted into the wider end of an adapter is inserted a glass tube closed at the end and having a hole blown in the side. The latter is closed with a ½-in. band of rubber tubing. The narrow end of the adapter is attached to the pump and the inner tube to the vessel to be evacuated. The principle is the same as that of a bicycle valve.—[Original paper in *Comptes rendus*, 1904, pp. 693-4.]—*Journal of the Chemical Society*, 1904. (J. M.)

PREVENTION OF BOILER SCALE.—"A very small quantity of graphite added to water used for boilers will prevent scaling, and if the boiler already has scale it will not only prevent further deposition, but the minute particles of graphite will penetrate the old scale and soften it, so that it will drop to the bottom and can be taken out inexpensively. This assertion is based upon fact. Having used water taken from the mine, which was only slightly discoloured by graphite, the softening of the scale was accidentally discovered. The water apparently contained nothing else which might have produced the same result."—*The Australian Mining Standard*, Feb. 11, 1904. (C. D.)

STABILITY OF STANDARD SOLUTIONS OF POTASSIUM PERMANGANATE AND AMMONIUM OXALATE.—"A statement is often found in standard text-books on analysis that a solution of potassium permanganate gradually becomes weaker on exposure to light, by slow decomposition of the salt; and that it is necessary on this account to re-standardise the solution at frequent intervals. In the course of some recent work involving the use of this reagent (see this *J.*, 1903, 731), we found occasion to doubt the accuracy of this statement, and have, therefore, made experiments extending over a period of twelve months. These have established the fact that, both in the solid state and in solution, pure permanganate retains its strength if kept in well-stoppered bottles, even when exposed to light. On March 30th, 1904, a solution of permanganate prepared from the specially purified salt described in the paper above referred to, was made decinormal by weighing, and the accuracy of the solution was confirmed by titration of pure ammonium oxalate and pure ferrous ammonium sulphate. On October 28, 1903, *i.e.*, seven months afterwards, the factor of the solution was found by titration to be 0.997, and on April 15, 1904, the same solution gave precisely the same factor. A similar N/10 solution of permanganate was prepared on October 28, 1903, from the same lot of solid re-crystallised permanganate of potash preserved during the seven months in a closely stoppered bottle. The solid permanganate had attained its original strength, and the second solution re-standardised on April 15, 1904, after an interval of six months, was again found to have the factor 0.997. The above results show that a solution of pure permanganate may be considered to retain its original strength for all practical purposes for at least twelve months, if pure water is used in its preparation and the solution kept in a closely stoppered bottle; and it is not necessary to keep such a solution in the dark."—WALTER M. GARDNER and B. NORTH—*Journal of the Society of Chemical Industry*, June 15, 1904. (W. C.)

METALLURGY.

METALLURGICAL TERMS.—"At one time it was usual in metallurgy to employ the word 'tank' for a receptacle erected to hold either water or solution, while a 'vat' was an excavation made in the ground; but this distinction no longer obtains. It would seem better to consider 'tanks' as receptacles for water; they become 'vats' when they are filled with chemical solutions; in other words, 'vat' is the metallurgical equivalent of 'tank.' One does not speak of a vat of drinking water, although a 'wine vat' is a distinctly recognised institution, nor should

one speak of a tank of cyanide solution. Words are rendered useful, like men, by giving each an allotted task.

'Slimes' and 'sands' are excessively plural, like a Mormon's household. 'Slime' and 'sand' serve the same purpose; the plural, as commonly employed, is a careless colloquialism; one may as well always speak of the 'ores' of a mine, when no differentiation is intended. The practice becomes inconvenient when compounding; thus, 'slimes plant' and 'sands vats' are evidently clumsy as compared to 'slime-plant' and 'sand-vats.' Where no distinct varieties or grades of slime or of sand are in question, why use the plural? This carries the idea that there are several kinds of slime or sand undergoing treatment, and if such be the case, the plural has a meaning; but if the plural alone is to be adopted as a generic term, it precludes differentiation on those rare occasions when such a suggestion is required, and it is a sloppy use of words without any apparent excuse. The same can be said of 'concentrates'; the singular is better, unless it is intended to convey the idea that the material consists of several varieties of mineral, which is sometimes, but by no means always, the case."—*The Engineering and Mining Journal*, June 16, 1904. (W. A. C.)

ZINC IN SLAG.—"It is probable that zinc in slag from a lead blast furnace exists chiefly as silicate, a small percentage possibly as sulphide, partly free and partly combined with other sulphides. Lead occurs as metal, as silicate and as sulphide. Oxidation of the sulphide produces some sulphate, which gives rise to the white fume so commonly noticed. Silver exists in the slag as a constituent of the entrained matte. Silver cannot exist in slag in the form of silicate."—*Mining and Scientific Press*, April 23, 1904. (C. D.)

RISE AND FALL OF DRY CRUSHING ON THE HAURAKI GOLD-FIELD. (A paper read before the Australasian Institute of Mining Engineers.)—"The author first gives a general description of the dry crushing practice as established in the district. He then deals with the evils arising from the presence of dust in dry crushing batteries, namely, (1) loss of ore; (2) injury to machinery; and (3) injury to health of workmen, and the means adopted for lessening the dust nuisance. The latter consisted in closely housing in of the stamps, conveyers; etc., in utilising the natural ventilation as much as possible, in the use of exhaust fans connected to the stamp housings, etc. As chief disadvantages of the dry crushing process, the author mentions the following: (1) cost of kiln or furnace drying; (2) loss of ore in form of dust; (3) low stamp duty as compared with wet crushing; (4) injury to machinery from dust; (5) injury to health of workmen, necessitating also a higher scale of wages than in wet crushing batteries; (6) lowered efficiency of workmen by reason of the unpleasant conditions of work; (7) the depth of the ore which could be satisfactorily leached in a vat, was limited to from 20 to 30 inches; (8) practical impossibility or difficulty of concentrating the ore or of separating it into sands and slimes. This last disadvantage is stated to have principally caused the abandonment of dry crushing in New Zealand, the replacement of the process by wet crushing being not a matter of regret either to mine shareholders or employees."—MORGAN. *New Zealand Mines Record*, March 16, 1904. (W. A. C.)

GRIT MILLS V. WHEELER PANS.—The December (1903) volume contained some most interesting and instructive particulars of experiments conducted on the Ivanhoe mine with a view to determining the relative efficiency of these two classes of pulverisers. Briefly, the conclusion arrived at was, that one 13-ft. grit mill was equivalent, in working capacity and in cost of running, to two and a half 5 ft. grinding pans. The following data collected from the work being done on the Hannan's Star and Boulder Main Reef mines will, I think, tend to prove that, in certain circumstances, one grit mill of rather larger size than that at the Ivanhoe, when running at its maximum capacity, is more efficient and decidedly more economical than two and a half and even than six 5 ft. pans of the ordinary Wheeler type.

Hannan's Star.—The Hannan's Star milling plant consists of two No. 5 Krupp ball mills and one grit mill, 16 ft. long and 4 ft. in diameter, running at a speed of twenty-nine revolutions per minute, charged with an average load of $5\frac{1}{2}$ tons of flint nodules. The grit mill is fed by the underflow from a spitzkasten, the overflow from which passes on to the next stage in the process. The whole product from the delivery end of the mill is returned by an elevator to this same spitzkasten and re-classified, the sands returning in the underflow to be re-ground in the grit mill. As this system is somewhat different from that adopted in the Ivanhoe experiments, comparisons in the tests are scarcely possible; however, if the grading of the product leaving the ball mills be taken as the basis to work on, the fines passing a sieve with 150 holes to the linear inch may be assumed already slimed, and, with these deducted, we have left a product, sands, upon which the grit mill has to perform its function.

The following is an average of a large number of ball mill gradings from the Hannan's Star ore:—

Remaining on 40 mesh	10.0 per cent.
Passing 40, remaining on 60	21.3 " "
Passing 60, remaining on 100	13.7 " "
Passing 100, remaining on 150	3.7 " "
Passing 150 mesh sieve	51.3 " "

The output of the mills over this period averaged 78 tons per twenty-four hours.

Deducting the 51.3 per cent., which passed the 150 mesh sieve, we have left the coarser material to be ground in the grit mill, which will now grade as follows:—

Remaining on 40 mesh	20.5 per cent.
Passing 40, remaining on 60	43.8 " "
Passing 60, remaining on 100	28.1 " "
Passing 100, remaining on 150	7.6 " "
Passing 150 mesh sieve	0.0 " "

Of this product the grit mill would have to deal with 48.7 per cent. of 78 tons, or 38 tons per day, which is an identical amount with that dealt with by the smaller grit mill on the Ivanhoe. These 38 tons are, however, ground very much finer than the 38 tons on the Ivanhoe, the results being:—

Before Grinding.—

	On 40 mesh.	On 60 mesh.	On 100 mesh.	On 150 mesh.	Through 150 mesh
	per cent	per cent	per cent	per cent	per cent
Ivanhoe sands	38.4	41.6	15.4	1.8	2.8
Hannan's Star sands	20.5	43.8	28.1	7.6	0.0

After Grinding.—

Ivanhoe 13 ft. Grit Mill	0.3	10.14	39.63	9.63	40.30
Hannan's Star 16 ft Grit Mill	0.0	0.0	0.7	4.0	95.3

or approximately there is left a final product, after grinding 38 tons per day in each case, of which at the Ivanhoe 50 per cent. remains on the 100 mesh sieve and 50 per cent. passes, whilst at the Hannan's Star 1 per cent. remains on the 100 mesh sieve and 99 per cent. passes it. The actual amount of sands passed into the Hannan's Star grit mill in twenty-four hours, including the returns for re-grinding, amounted to 268 tons.

Boulder Main Reef.—Through the courtesy of the management of the Boulder Main Reef mine, comparative figures for the grinding of six Wheeler pans, on roasted ore, and the 16 ft. grit mill, on raw ore, have been obtained. It will be generally admitted that the roasted ore is considerably more friable than the raw, so that, from this point of view, the Wheeler pans have an advantage in comparative figures. The Boulder Main Reef milling plant consists of two No. 5 Krupp ball mills and six Wheeler pans 5 ft. in diameter running at sixty revolutions per minute. Owing to the use of coarser screens the product from the ball mills contains a larger proportion of coarse material than that from the Hannan's Star mills, the respective gradings being:—

	Hannan's Star.	Boulder Main Reef.
Remaining on 40 mesh	10.0 per cent.	26.0 per cent.
" " 60 "	21.3 " "	4.3 " "
" " 100 "	13.7 " "	20.2 " "
" " 150 "	3.7 " "	10.4 " "
Passing 150 "	51.3 " "	39.1 " "

At the Boulder Main Reef the ore, after roasting, passes direct to a spitzkasten, the underflow from which goes to six Wheeler pans, the overflow passing on to the agitators. The whole product on delivery from the pans is elevated back by a tailings wheel to this same spitzkasten and re-classified, the sands passing back, in the underflow to the pans. This portion of the treatment is therefore precisely similar to that at the Hannan's Star, the six Wheeler pans taking the place of the one 16 ft. grit mill.

At the Hannan's Star 268 tons of sands with about an equal quantity of water pass per day into the grit mill, and at the main reef 308 tons of sands pass to the six Wheeler pans, including, in each case, returns of sands.

The grading of the products at entrance is:—

	16 ft. Grit Mill.	Six 5 ft. Wheeler Pans.
Remaining on 40 mesh	4.5 per cent.	0.6 per cent.
" " 60 "	9.6 " "	0.7 " "
" " 80 "	6.8 " "	8.9 " "
" " 100 "	13.1 " "	7.9 " "
" " 150 "	19.0 " "	21.2 " "
Passing 150 "	47.1 " "	60.7 " "

And on delivery from the grit mill and pans before returning to the spitzkasten for re-classification, the grading is:—

	16 ft. Grit Mill.	Six 5 ft. Wheeler Pans.
Remaining on 40 mesh	0.1 per cent.	0.2 per cent.
" " 60 "	2.0 " "	3.0 " "
" " 80 "	4.2 " "	4.8 " "
" " 100 "	12.3 " "	10.8 " "
" " 150 "	20.3 " "	18.1 " "
Passing 150 "	62.8 " "	63.2 " "

The gradings of the finished product passing over to the next stage in the process, in each case, is:—

	Hannan's Star.	Boulder Main Reef.
Remaining on 40 mesh	0.0 per cent.	0.2 per cent.
" 60	0.0 "	0.3 "
" 80	0.2 "	4.1 "
" 100	0.5 "	5.1 "
" 150	4.0 "	4.6 "
Passing 150	95.3 "	85.7 "

Although the ore crushed by the ball mills at the Boulder Main Reef contained a larger proportion of coarse to fine particles than did that of the Hannan's Star, yet the feed to the grit mill is coarser than that to the pans. This would appear at first sight to be an anomaly, but it must be remembered that the quantity of sands returned for re-grinding greatly exceeds that of the original sands entering the mill or pans, so that, it is evident that the coarser particles of sands—i.e., those remaining on 40 and 60 mesh sieve, have been very much reduced in size on their first passage through the pans, whereas this is not so evident in the case of the grit mill. The conclusion is that the pan is a more efficient pulveriser for coarse material than a grit mill.

The comparative grading of the products from the delivery end of the grit mill and pans respectively shows that the fines passing the 150 mesh have been increased by travelling once through the grit mill to the extent of 16.1 per cent.; on the other hand, one passage through the six pans has served to increase the fines of this same grade by only 2.1 per cent. From this it is apparent that for further reducing the finer grade of sands the results show decidedly in favour of the grit mill.

The grading of the finished product shows that, for about a similar output per month, the fine grinding of one 16-ft. grit mill, on raw ore, is considerably more efficient than that of six 5-ft. Wheeler pans on roasted ore. It is true that the pans had initially a larger proportion of coarse to fine particles to deal with, but this is material on which it has been shown the efficiency of the pans is greatest, and is also somewhat compensated for by the greater output of the Hannan's Star mills.

Cost of Grinding per ton of Original Ore.—The indicated horse-power required by each 5-ft. pan on the Boulder Main Reef is 5 I.H.P., whilst that required by the Hannan's Star grit mill is 30 I.H.P.

For the purpose of comparison the costs have both been worked out per ton of original ore milled and not per ton of sand entering the mill as were those of the Ivanhoe. The respective costs are as follows:

ONE 16 FT. GRIT MILL.			Cost per ton.
Power, 30 H.P.	...	...	11.53d.
Flints and Liners	...	...	1.85d.
Labour	...	...	3.50d.
Repairs and Stores	...	...	0.99d.
Total	...	...	1/5.87d.
SIX 5 FT. WHEELER PANS.			Cost per ton.
Power, 30 H.P.	...	...	11.11d.
Shoes and Dies	...	...	3.80d.
Labour	...	...	4.00d.
Repairs and Stores	...	...	2.50d.
Total	...	...	1/9.41d.

The working cost of one grit mill on raw sands is therefore less than that of six ordinary 5-ft. grinding pans on roasted sands.

To sum up, it would appear that the grinding pan is the more efficient pulveriser for coarse sands, and has the advantage that it is an excellent amalgamator; on the other hand, the grit mill is cheaper to

run, and for the purpose of fine grinding or sliming material which is already finely ground, is much to be preferred to the pan. The functions of these two forms of pulveriser are entirely different, and, probably, the best results could be obtained by a combination of the two, arranged in such a way that the coarse sands and bulk of the free gold would pass to the pans, whilst the fine sands were delivered direct to a grit mill.—O. B. WARD.—*The Mining Journal*, May 14, 1904. (C. D.)

TREATMENT OF GOLD-SELENIUM-SILVER ORES.—“A long article, dealing with the commercial treatment of an ore found at Lejong-Donok, Sumatra. This is a typical case of a gold-selenium-silver ore, which is very much inclined to the formation of slimes and is very finely disseminated through the country rock. The present method of treatment consists in crushing the raw ore, which contains about 10 per cent. of moisture, after which it is fed by an automatic feeder to wet-crushing stamps. The pulp passes over copper plates for the purpose of amalgamation, and flows then into spitzkasten, to separate the sands and slimes. The former go to the cyanide plant, where they are treated by percolation and the precious metals in solution are precipitated with zinc. The slimes are conducted into reservoirs, where they are deposited, after which they are treated in a filter-press plant. The author criticises this method on account of the low extraction of the precious metals obtained, there being 10.34 gms. gold and 108.07 gms. of silver per ton left in the sands, and 17.79 gms. of gold and 289.48 gms. of silver per ton left in the slimes. He shows that none of the methods in use at the present time is directly applicable to the ore and that it needs a special treatment (1) on account of the high amount of selenium present; (2) on account of the large amount of slimes formed; (3) on account of the high silver contents; (4) on account of the small amount of gold which can be amalgamated; (5) on account of the extremely fine division of the gold, silver, selenium, and manganese. He holds that the whole of the ore has to be pulverised very fine, as only then is it possible to obtain a quick, cheap, and high extraction of the precious metals. The process proposed by the author, consists in crushing the ore to pass through a sieve of between No. 16 and No. 20, and passing the pulp over amalgamating plates. It then goes to the concentrating apparatus, where it is separated into concentrates and pulp. The latter passes through a small spitzluten and spitzkasten plant for the separation of sands and slimes. The sands go to a pulverising apparatus for conversion into slimes, and then together with the slimes from the various operations into spitzkasten for sedimentation. The slimes deposited there pass into a reservoir, for the purpose of getting rid of some more water. When the reservoir is full, its contents are washed with cyanide solution into the cyanide agitation vats. Air is blown in during the period of agitation on account of the high silver contents of the charge. The treatment lasts for 3 to 5 hours, after which the suspended particles are allowed to settle for 6 to 8 hours and the clear solution drawn off. A second or third similar treatment with weaker solutions follows, which in turn is followed by a water wash. The advantage of this system of treatment as compared with the one used at present are set forth by the author at length.”—“*Metallurgy of the Metals, except Iron*,” MERZ.—*Oest. Zeit. f. Berg- u. Huttenwesen*, Jan. 30; Feb. 6, 13, 20, 1904. (W. A. C.)

TUBE BALL MILLS: THEIR WORKING AND MECHANICAL EFFECTS.—“If it had not been for a series of patent law suits, which set Germany’s engineers to the task of studying the interior working of ball mills, we should be to-day at the same point where we were fifty years ago.

Up to the time of the test we are going to describe the popular belief regarding the working of ball mills was as follows:—

The revolution of the drum and, accordingly, the rising of one of its sides, sets the balls rolling down the incline, which movement communicates itself to the ore. The latter is ground between the balls and slowly transformed into dust. The inlet of the ore being situated higher than the outlet, caused, as was generally believed, the ore to move slowly towards the latter.

To set all doubts at rest, the firm of Fried Krupp, of Magdeburg-Buckau, decided to investigate the matter in a thorough fashion, and for this purpose special ball mills were constructed. Some of these were made of glass, whilst others had movable gratings, which allowed the interior to be continuously watched while the mills were at work. As a result, photos could be taken at all stages of the work, and these pointed to the fact that in a tube-mill the balls do not grind the ore, but crush it by being flung in an inclined direction from the side of the tube to its bottom, and that the higher position of the inlet had no influence whatever on the motion of the ore towards the outlet.

The diameter of the drum amounts to about 3 ft. 4 ins. Flint stone balls were put into the drum and the drum was then slowly set in motion till the first balls began to stir. At 21-23 revolutions per minute the balls nearest the centre rolled slowly down the incline, whilst their bulk crept higher up the side of the drum. When rotating at 28, 30, 32 revolutions, the movement of the rolling balls became more lively, and a marked increase in the spaces between the balls which lay next to the centre became apparent. The bulk of them had again crept higher; it will be seen that those balls which are close to the walls of the drum and touching it apparently adhere to it and move up the side of the drum until they reach a certain height, when they are flung to the bottom of the drum, describing an arc in their line of flight.

By raising the speed to 35 revolutions, the formation of the balls gets looser still, consequently the height they attain in the drum is again increased. The arc described by the balls in their line of flight can be clearly seen, as even the balls which lie closest to the centre are seen to detach themselves from the heap in series to take up the movement. At the bottom of the drum the dropped balls rejoin the rest which are creeping up the side, so that a free space appears between the line of flight of the falling balls and those resting against the walls of the drum. This space resembles a kidney in its shape. Furthermore, the falling balls do not come down in clusters, but in series, the balls of each row keeping to their own line of flight according to their distance from the wall of the drum whilst mounting up. This movement was so marked that the spaces between the different series could be actually counted, whilst the balls when mounting seemed comparatively closely packed together.

A further increase in speed resulted in the balls adhering during the whole of the circuit to the side of the drum.

It appears that the correct number of revolutions lies between 32 and 35 revolutions per minute, and that the speed should never exceed 42 revolutions.

Further tests were made with the same drum of 3 ft. 4 ins. diameter, but this time a quantity of crushing material of a kind emitting no dust was thrown into the drum. As was to be expected, the ore behaved in exactly the same way as the balls. Whilst mounting the side of the drum it filled the spaces between them, and when dropping described the same arc with them. When it had reached the bottom of the tube, which in this case represented the point of impact of a stamping mill, it met with the balls which were remounting the side of the drum, and between these and those balls, which had followed it in its line of flight and now dropped on it, it was crushed and splashed in all directions.

The line of flight may be computed for each ball, if we omit the resistance of air and the friction caused by other balls and the crushing material.

A ball will drop from the side of the drum at the moment that the part of the ball which is nearest to the centre and limited by the line of velocity, $mg \sin \psi$, equals the rotary force $\frac{mv^2}{r}$. The arc line of flight may then be reckoned by this formula:

$$y = x \frac{\cos \psi}{\sin \psi} - x^2 \frac{g}{2v^2 \sin^2 \psi}$$

The vertical force of the movement is reduced until the ball reaches the apex. Of course, a reduction of speed in the direction of the line of flight results, and the balls approach each other at the apex. It follows that the balls at this point push the crushing material aside, and at the same time influence each other’s flight. But if we omit this disturbance, we shall see the ball continue in its flight and the distance between it and its followers increase. At this point the crushing work is really carried out.

From this it results that to get the maximum work out of a ball mill the mill must be set to work so that it affords the best line of flight to the balls.

We come now to the second conclusion of these remarkable tests, namely, that the higher position of the inlet has no influence whatever on the motion of the crushing material towards the outlet.

This result was reached by further experiments, which proved that the crushed material is pushed sideways at the apex and therefore may leave the drum at an even much higher point than the inlet.

A detailed description of a tube ball mill as used in these experiments may prove of interest. The interior dimensions of the drum are as follows: width, 47 ins., length, 16 ft. 5 ins., number of r.p.m., 29.

The drum is manufactured out of sheet-iron of about $\frac{1}{2}$ -in. diameter, the flat ends being made of cast steel, and the interior of the drum is fitted out with hardened iron plates, a specialty of the firm.

The balls are filled in through a manhole, whilst the hollow trunnions of the drum are used for admitting the ore, and allowing the crushed material to escape.

The ore is first thrown into a funnel, in which a shaft studded with pins revolves. It then drops into the drum which regulates the quantity of material admitted to the main drum, being mounted and geared separately from the main drum and driven by a five-stepped pulley. In its interior some balls are used which by shaking the drum ensure the passage of all material and prevent any of the same adhering to the walls. The ore is then conveyed by means of an endless screw to the main drum, from whence it passes to the outlet through a grating. The diameter of the meshes of this grating amounts to about an inch.

From here the material enters the distributor, which passes it to the sieve; here all properly crushed material is allowed to pass, whilst insufficiently ground pieces, chips of the stone balls, etc., are kept back and fall through an opening. The sieve is completely encased; the case has an opening, through which air is continuously sucked, so that wherever there may be a leakage in the mill no dust can escape, being met by the rushing air. This advantage is mainly derived from the use of hollowed-out trunnions.

The mills are being built up to 9 yds. length of drum, and up to a diameter of 5 ft.—Extracts from *The Engineering Times*, June 2, 1904. (W. A. C.)

MINING.

DETERIORATION OF HOISTING ROPES.—"Deterioration of hoisting ropes may take place in two ways: (1) The wear may be superficial, so far as the individual wires are concerned, resulting from abrasion, rust, or corrosion from acid water. An actual reduction of effective cross-section is caused. The inner portions of the wires are worn by chafing together, while the outer parts are subjected to friction in winding around drum and sheave. Also, in hot, damp shafts, the hemp core may decay, to the serious injury of the rope. (2) Another kind of deterioration is produced by shocks and repeated bendings in winding and unwinding. The metal is "fatigued;" flexibility and elasticity are reduced, the wire becomes brittle and finally breaks."—*Mines and Minerals*, April, 1904. (C. D.)

MINERAL RESOURCES OF KOREA.—"Near Chemulpo, Scon, and Songdo, there are several varieties of granite, which are quarried for building purposes. Going east and north from Pingyang we find argillaceous schists, containing anthracite, which, at the outcrop, is worked in very primitive fashion by the natives. The direction is north and south. The dip is 50 degrees east. The anthracite yields 5 per cent. ash, and contains some sulphur. The Koreans work the seams in the open, proceeding from above downward, without leaving pillars or supporting the sides. The consequence is the collapse of the working and its speedy abandonment. The natives do not use coal in their fireplaces, so that the only market for it is at Chemulpo, where it is sold to foreigners for domestic use. To the north of Pingyang, granite-gneiss surmounted by limestone, quartzite, and various argillaceous schists appear. In this formation, in the district of Unsan, auriferous alluvial deposits are found. The gravel is situated at a depth of only two or three yards, and the thickness of the layer is about 20 in. It is first passed through a rough sort of sluice-box, about 3 ft. in length, through which a current of water flows. It is then washed in a wooden bowl. These alluvial deposits are found, to a certain extent, all over Korea. Near Unsan there is gold in the lower limestone situated above the granite and the gneiss. The gold mine at this place is owned by an Anglo-Belgian company. In addition to this there are two other concessions in Korea, one of which is at Wonsan, near the northern frontier, where three beds of auriferous quartz are worked by an American company with two batteries of 40 stamps and one battery of 20 stamps. The other concession is that of the Oriental Gold Mining Company, which extracted in the year 1900 gold of the value of about £300,000. Iron in the form of oligist and limonite is common, and some of the deposits are worked by the natives, and in many places smelting furnaces

can be seen. These are 6 ft. high and elliptical in shape, the axes being respectively 60 in. and 32 in. The fuel is charcoal. The metal is subjected to a double smelting. In the first, which is effected in a furnace near the mine, limestone is added to the ore, which is converted into pig-iron, and the latter is sold to works at a distance generally situated near a river, in which, after a second fusion, it is transformed into ploughshares, cast-iron saucepan, etc. Korea has, however, been so little explored that, as regards its mineral wealth, it must be considered virgin territory, and a definite opinion as to its resources can only be arrived at after a systematic prospecting of the country."—*Iron and Coal Trades Review*, Dec. 11, 1903. (J. A. W.)

AUTOMATIC TRUCK TALLY.—"An automatic tally for checking the number of cars of ore run into a mill can be made by the blacksmith at the mine, it only being necessary to have a flat disc provided with teeth somewhat like those on a circular saw. These teeth must be of uniform depth and spaced exactly the same distance apart. This wheel may be placed beneath the track on which the car runs, the best place being in the trestle, which is found at most mills. It should be so arranged that by shimming up under one of the rails at two cross ties the rail may be slightly raised above an intermediate third tie. Beneath the rail and at the side of the tie should be fixed an upright rod which connects with a lever below. On one end of this lever is a pawl which engages the toothed disc, causing it to move forward one notch whenever a loaded car passes by. The notches being numbered consecutively, the number of loaded cars passing over is registered and may be read off by the superintendent. The rail must be sufficiently stiff to support the empty car without bending enough to cause the device to register on the return trip. Where it is considered advisable, the counter may be enclosed in a locked box, with a glass front."—*Mining and Scientific Press*, May 14, 1904. (W. A. C.)

CELLULANEOUS.

NOTE ON THE RELATIVE EFFICIENCY OF HEAT INSULATING MEDIA—II. Steam Pipe Covering.—"The author describes how he abandoned the idea of covering parallel pipes with the different coverings, and subsequently measuring the condensed water, and goes on to describe a very ingenious electrical apparatus, in which the loss of heat was determined by simply observing the quantity of electrical energy which must be supplied to the apparatus and transformed into heat in order to maintain a uniform temperature. The heater consisted of a very fine platinoïd wire wound round a porcelain core which was in turn placed inside a steam pipe about 2 ins. in diameter, and about 2 ft. long. Apart from details which are most essential, the general principle involved is that this steam pipe is covered with the various insulating materials the efficiency of which is being tested, and the current required (in amperes) to keep a constant temperature noted. This, it might be mentioned, was rather difficult, on account of the different thicknesses in which manufacturers supplied the covering (see Column 'b'). The results as shown in Column 'g' are most interesting and quite justify the increased use of 'sectional magnesia' in Europe. Perhaps the most outstanding feature of the table is the position in which asbestos finds itself, as it has always been looked upon as an excellent insulating material."—S. H. DAVIES, M.S.—*Journal of the Society of Chemical Industry*, May 16, 1904. (W. C.)

(a) Description of Covering.	(b) Mean Thick-ness.	(c) (d) (e) Temperatures.			(f) Current requir'd to keep temperature constant.	(g) * Calories lost per sq. ft. per 250° C. difference between the sides.	Remarks.
		Inside Pipe.	Surface of lagging	Cold Water Jacket.			
1 Magnesia, sectional, thick	1½ ins.	253	51	14.5	amps. 2.05	55	A thin layer of powdery material formed on the hot surface by disintegration of the fibre. The fibre is charred for ⅞ in depth. This is about the limit of temperature at which remanit can be used.
2 Slag wool, sectional ...	1⅞	236.7	49	15.7	2.05	60	
3 Remanit (waste silk rope)	⅞	249.5	50	19	2.1	60	
4 Mica, sectional double ...	2	254.5	52	17.5	2.15	61	It consists of slag wool, surrounded by layers of hair, felt and compressed fibre covered with painted canvas. The cotton-fibre bag containing slag wool charred, and the contents were scattered. Hair felt, badly charred.
5 Morley's composite ...	1¾	220	50	21	2.0	63	
6 Mica, flexible, thick ...	2	248	53	13	2.25	68	
7 Mica, sectional, single ...	⅞	251.5	61	17.5	2.35	74	
8 Mica, flexible, thin ...	1½	247	64	14	2.35	74	
9 Magnesia, sectional, thin ...	⅞	230	66	12	2.4	83	
10 Remanit and slag wool ...	1½	240.5	[67]	23	2.5	90	
11 Asbestos board and hair felt	1	233	65	17.5	2.5	91	
12 Asbestos rope filled with magnesia	1⅞	252	71	12	3	118	
13 Asbestos cloth, ribbed ...	1⅞	251	75	15	3	120	
14 Asbestos rope filled with slag wool	⅞	248.5	75	15.2	3	121	Behaves like No. 12.
15 Leroy mixture, thick ...	1¾	254	[77]	11	3.15	128	Owing to scarcity of material, this result was obtained with 18 ins. of asbestos rope, plus 7 ins. of magnesia sectional covering, but the result has been calculated for a complete covering of asbestos rope.
16 Asbestos cloth containing sections filled with magnesia	1⅞	247.5	[76]	14.7	3.1	130	
17 Plastic slag wool, covered with black pitch ...	1½	255	78	11.5	3.2	132	
18 Asbestos rope, filled with asbestos fibre	1¾	250	[79]	13.5	2.95	142	
19 Leroy mixture, thin ...	⅞	254	[80]	18.7	3.37	151	
20 Creswell's plastic asbestos, No. I.	1	230.5	85	23	3.25	160	
21 Creswell's plastic asbestos, No. II.	1	240	89	23.5	3.35	163	
22 Leroy asbestos, plastic ...	1	230	89.5	24	3.4	176	
23 Bennett Lawe's plastic ...	1	212	87	22	3.4	191	
24 Bare pipe ...	—	177	—	18	3.45	242	

NOTE.—Figures in brackets are interpolated, not experimental figures.

* Last column is calculated as follows:—Calories lost = $C^2Rs \frac{0.2387}{1000}$. The resistance of the heater = 14.6 ohms. Calories lost per hour per difference of 250° between the sides = $C^2 \times 14.6 \times 60 \times 60 \times \frac{0.2387}{1000}$
 $\times \frac{250}{(e)^v - (e)^v}$. The probable experimental error does not exceed 4 per cent. of the calculated heat losses.

APPLICATION OF ALUMINO-THERMICS.—"The reactions discovered by Dr. Goldschmidt, of Essen, upon which this is based, is as follows:—If a mixture of pulverised aluminium and a metallic oxide be ignited at a single point, combustion proceeds without further supply of external heat without any combination with the atmospheric oxygen and with the development of a temperature estimated at 3000° C. The reaction reduces the oxide, yielding the metal pure and free from carbon, and leaves a scoria of aluminium oxide or artificial corundum. In industrial practice the oxide of iron is naturally the one most often used, and the mixture of Al and Fe₂O₃ has been given the commercial name of "thermit." On combustion, it yields a soft homogeneous iron, which, on account of the high temperature to which it is raised, has the property, when poured on a metal part which is to be repaired, of softening the surface over which it flows and uniting intimately with it. The reaction is carried out in sheet iron crucibles lined with magnesia, and the iron may be poured from beneath by unstopping a previously prepared hole. A little is first placed in and then fired by a powder of powdered Al + BaO₂. The reaction begins at once and is complete in less than a minute. Ferrosilicon, Mn or Ti may be added to improve the iron. 100-250 gms. pig-iron per kgm. thermit yields a hard fine-grained malleable steel. Besides iron, it may also be used for the preparation of many alloys and other metals free from carbon, e.g., Mn, Cr, ferro-titanium, ferro-boron, ferrovanadium, manganotitanium, etc., and the corundum produced finds use as a grinding powder. It has been used to weld iron and steel pipes, rails, for intercalary castings, etc., etc. The beauty of the method lies in the fact that a small amount of apparatus is required, giving ease of transport and range of adaptation."—EMILE GUARINI. —*Engineering Magazine*, January, 1904. (J. A. W.)

OIL IN BOILER WATER.—"Mr. P. W. Clements said that one of the most important points raised by the author treated of the presence of emulsified oil in feed-water. It was important because only comparatively recently had any great attention been given to it, consequently the remedies were probably not very generally known. The effects of oils in any quantity in feed-waters were quite as bad as those brought about by contained minerals, and were even sometimes worse; the presence of a thin layer of greasy matter on a furnace crown being several times more dangerous than the presence of a much thicker layer of solid mineral scale. A comparatively recent method of getting rid of the emulsified oil might be mentioned, which the author had not dealt with in his paper. An electrical system had been commercially introduced lately, called the Davis-Perett system, and from the published specifications it appeared that the inventors pass the hot well water between a series of wrought-iron plates, and injected a small stream of slightly alkaline water into the water under treatment. It was claimed that coagulation was effected with a minimum of energy, and that not more than one Board of Trade unit was required per 1,000 gallons of water. If this claim could be substantiated in actual practice, we had, in the electrical, one of the cheapest methods probably existing, for if the cost of a unit be taken at 1d., it would only cost so much to treat 1,000 gallons. Where an electric installation already existed, the cost of coal and oil per unit need only be considered, and the cost of these items should range below 1d."—*The Australian Mining Standard*, May 19, 1904. (W. A. C.)

"MESH" AND "SCREEN."—"Having regard to the fact that the Chemical, Metallurgical and Mining Society of South Africa has done—and is doing—such splendid work, it is a pity that its publication should be disfigured with the repeated confused use of the word 'mesh' in describing mill-screens. In the Society's *Journal* for February there appear in the same article references to "900 mesh" and "900 standard screening"; from the context it is evident that this refers to 30-mesh, which is 30 holes per linear inch or 900 holes per square inch. It is hopeless to discuss technical questions unless terms of precision are used intelligently, and we mention this particular misuse of the word 'mesh' because it has appeared persistently in the Society's invaluable transactions."—*Engineering and Mining Journal of U.S.A.*, May 26, 1904. (E. H. J.)

Scientific and Technical Literature.

NOTICES AND REVIEWS OF NEW BOOKS AND NEW EDITIONS.

(Reviews will be published of any new works on Chemistry, Metallurgy and Mining sent to the Secretary for that purpose.)

ALLBUTT, T. C. (Regius Prof. of Physic, Camb.).—"Notes on the Composition of Scientific Papers"; pp. 151. *Macmillan*; net, 3s.

BERSCH, J.—"Cellulose, Cellulose Products, Rubber Substitutes; Compr. Preparation of Cellulose, Parchment-Cellulose, Methods of Obtaining Sugar, Alcohol, Oxalic Acid from Wood-Cellulose; Production of Nitro-Cellulose and Cellulose Esters; Manufacture of Artificial Silk, Viscose, Celluloid, Rubber Substitutes, Oil-Rubber, Faktis." Auth. translation by W. T. BRANNT. *Philadelphia*. 41 Illustrations, 8vo, pp. 326. 15s.

Board of Education Examination Papers, 1894-1903.—"First Stage Theoretical Inorganic Chemistry." Cr. 8vo, pp. 28. *Clive*. 3d.

Board of Education Examination Papers, 1894-1903.—"First and Second Stage "Practical Organic Chemistry" Papers. Cr. 8vo, sewed. *Clive*. 3d. each.

BOYCOTT, A. E.—"Ankylostoma Infection, Report on Diagnosis of, with Special Reference to Examination of the Blood." (2066.) *Eyre & Spottiswoode*. 1½d.

BOYNTON, W. P.—"Applications of the Kinetic Theory to Gases, Vapours, etc." Cr. 8vo. *Macmillan*; net, 7s.

CURIE, Mme. SKŁODOWSKA.—"Radio-Active Substances." Thesis presented to the Faculté des Sciences de Paris. Reprinted from the *Chemical News*. 2nd Edition. Cr. 8vo, pp. 94. *Chemical News Office*; net, 2s.

HUGHES, S.—"Gas Works; Their Construction and Arrangement, and the Manufacture and Distribution of Coal Gas. 9th Edition, Revised, with Notices of Recent Improvements. 12mo, pp. 428. *Crosby Lockwood*. 6s.

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- “Mines and Quarries: General Report and Statistics for 1902.” Part IV. Colonial and Foreign Statistics. Persons Employed, Output and Accidents. (2084.) *Eyre & Spottiswoode*. 1s. 8d.
- MOIL, A.—“Mining and Mining Investments,” with Diagrams and Plans. Cr. 8vo, pp. 200. *Methuen*; net, 2s. 6d.
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- NEWSHOLME, A.—“School Hygiene.” The Laws of Health in Relation to School Life. New Edition. (1903.) Re-written by the above and W. C. C. PAKES. Cr. 8vo, pp. 320. *Sonnenschein*. 6s.
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- VASEY, S. A.—“Guide to Analysis of Potable Spirits.” Cr. 8vo, pp. 88. *Balliere*; net, 3s. 6d.

Selected Transvaal Patent Applications.

RELATING TO CHEMISTRY, METALLURGY AND MINING.

Compiled by C. H. M. KISCH, F.M.Chart.Inst.P.A.
(London), Johannesburg (Member).

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- (P.) 303/04. Ernest Edward Schmidt. Automatic clutches. 26.7.04.
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- (C.) 308/04. Frederick Ray. Improvements in centrifugal turbine and similar pumps. 29.7.04.
- (C.) 309/04. Heinrich Flottmann. Ball actuated valve controlling device for rock-boring machines compressed air hammers and the like. 29.7.04.