

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. All papers brought before the Society shall be read, discussed and replied to within a period of four months, subject to the Council having power, should they deem it desirable, to extend that time.
9. 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.
10. 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.
11. 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.
12. 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 December 17, 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.

Owing to 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.

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

Associates Admitted November 8, 1904.

THOMAS, HENRY TRENEAR, Minas do São Bento, Santa Barbara de Matto Dentro, Minas Geraes, Brazil. Metallurgist.

WOMBLE, LLOYD ALEXANDER, Witwatersrand Deep, Ltd., P. O. Box 5, Knights. Mining Engineer.

Members Elected November 19, 1904.

BAYLON, H. C., Northern Copper (B.S.A.) Co., Ltd., Rhodesian Copper Co., Ltd., Ninga Camp, Kafue District, N. W. Rhodesia. Manager and Acting Superintendent.

BLACKIE, JOHN, Northern Copper (B.S.A.) Co., Ltd., Rhodesian Copper Co., Ltd., Ninga Camp, Kafue District, N. W. Rhodesia. Chief Assayer.

COBB, DANIEL, Consolidated Rand Brick, Pottery and Lime Co., Ltd., P. O. Box 77, Boksburg. General Manager.

HYND, JOHN, Consolidated Gold Fields of South Africa, Ltd., P. O. Box 67, Bulawayo, Rhodesia, Mechanical Engineer.

NORMAND, JAMES NORMAND, Surprise Mine, Selukwe, Rhodesia. Mine Manager.

TAGGART, JOHN, Crown Deep, Ltd., P. O. Box 1056, Johannesburg. Amalgamator.

TILGHMAN, HENRY ASHE, British South Africa Co., Ltd., Bulawayo, Rhodesia. Assistant Consulting Engineer.

WILSON, J. KITCHENER, May Consolidated G. M. Co., Ltd., P. O. Box 50, Germiston. Cyanider.

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.

AULSEBROOK, ERNEST E., *l/o* Benoni; New Unified G. M. Co., Ltd., P. O. Box 5, Maraisburg.

CRANFURD, A. J. F., *l/o* Roodepoort; Van Ryn G. M. Estates, Ltd., P. O. Box 22, Benoni.

LEA, J., *l/o* Germiston; Robinson Deep G. M. Co., Ltd., P. O. Box 1488, Johannesburg.

MELVILL, GEO., *l/o* P. O. Box 108; P. O. Box 1140, Johannesburg.

O'HARA, J. D., *l/o* Gekkenhuis; Nigel G. M. Co., Ltd., P. O., Nigel.

SOLLY, B. C. TRAVERS, *l/o* Randfontein; Lancaster G. M. Co., Ltd., P. O. Box 347, Johannesburg.

TAYLOR, H. E. HUME, to H. E. Hume, P. O. Box 25, Luipaardsvlei.

ASSOCIATES.

HILL, J. WHITELAW, *l/o* Macequece, P. E. A.; 26, Newark Drive, Pollokshields, Glasgow, Scotland.

LOCKE, A. N.; *l/o* P. O. Box 108; P. O. Box 1140, Johannesburg.

PARRY, C. S., *l/o* Johannesburg; Robinson Randfontein G. M. Co., Ltd., Randfontein.

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?

BATESON, L. R., Knights Pietersburg G. M. Co., Ltd., Pietersburg.

DONALDSON, R. T., Roodepoort Central Deep, Ltd., Roodepoort.

FAIRBAIRN, J. G. W., Rand Central Ore Reduction Co., Ltd., P. O. Box 1891, Johannesburg.

HAMPSON, O. R. R., P. O. Box 312, Johannesburg.

HILTON, M. J., Robinson Randfontein G. M. Co., Ltd., Randfontein.

HOLMES, R. M., P. O. Box 4491, Johannesburg.

JAY, R. E., P. O. Box 1078, Johannesburg.

KAYSER, R. M., Simmer and Jack G. M. Co., Germiston.

KELLY, C. F., Wolluter G. M., Ltd., Johannesburg.

KING, O. H., P. O. Box 3889, Johannesburg.

LAMB, T., P. O. Box 191, Germiston.

LUCKE, P. K., P. O. Box 6042, Johannesburg.

PEARCE, JOHN, Esplanade Buildings, Durban.

POWYS, C. H., Jumpers G. M. Co., Ltd., Cleveland.

PRAETORIUS, A. E., Ferreira Deep, Ltd., Johannesburg.

ROBB, G., P. O. Box 590, Johannesburg.

ROBINSON, D. R., Kraal Station.

SHIMMIN, W. R., Jubilee Gold Co., Ltd., P. O. Box 1122, Johannesburg.

SMYTH, E. P., P. O. Box 13, Cleveland.

TAYLOR, H. K., Wolluter G. M., Ltd., Johannesburg.

WAITES, T. P., Lone Star G. M. Co., Gadzema, Rhodesia.

WAYNE, T. H. B., General Mining and Finance Corporation, Ltd., P. O. Box 4181, Johannesburg.

WILSON, R., City and Suburban G. M. Co., Ltd., Johannesburg.

Proceedings
AT
Ordinary General Meeting,
November 19, 1904.

The ordinary general meeting of the members of the Society was held on Saturday evening, November 19, in the Council Room of the Chamber of Mines, Mr. W. A. Caldecott (President) in the chair. There was a total attendance of 80, as follows:—

56 Members: Messrs. W. Bradford, E. H. Johnson, P. Carter, T. L. Carter, Dr. W. C. C. Pakes, M. Torrente, Prof. J. A. Wilkinson, J. R. Williams, J. A. Allen, K. D. Anderson, D. J. Arkell, J. F. Bagshaw, Dr. B. Bay, G. L. Burnett, J. B. Carper, E. H. Croghan, J. B. K. Dodds, W. Dowling, J. M. Eaton, R. L. Edmiston, J. E. Eisenstaedter, E. F. Evans, P. L. Evans, M. J. Farrell, A. Fraser, N. M. Galbreath, H. Gerlings, A. Gillies, W. S. Gordon, J. Gray, W. T. Hallimond, J. H. Hughes, G. M. Hunter, W. H. Jollyman, J. A. Jones, E. J. Laschinger, C. W. Lee, H. Leupold, H. L. Leupold, W. W. Louttit, H. Monckton, H. H. Morrell, C. B. Nicholls, Prof. A. Prister, J. F. Pyles, H. F. Roche, A. F. Rose, I. Roskelley, G. Seeton, J. Thomas, J. R. Thurlow, J. P. Ward, H. Warren, H. A. White, G. W. Williams.

12 Associates and Students: Messrs. A. E. Adams, T. Angus, F. A. Bawden, A. M. Ferguson, J. E. Lapping, R. W. Leng, A. N. Locke, W. Rigg, A. G. Rusden, H. Rusden, C. B. Surmon, C. Schertel.

11 Visitors, and Fredk. Rowland, Secretary.

The President: I beg to propose that the minutes of the previous meeting, as printed and published in the *Journal*, be adopted.

This was carried unanimously.

Messrs. Laschinger and Croghan were then appointed scrutineers, and after the scrutiny of the ballot papers, the President announced that the eight candidates for membership had been duly elected.

GENERAL BUSINESS.

Mr. Laschinger brought to the notice of the Society the fact that the Philosophical Society of South Africa, domiciled in Capetown, had applied to His Majesty the King for a Charter of Incorporation under the title of "The Royal Society of South Africa."

Prof. Wilkinson then read the following extract from the *Times* weekly edition of October 29 last—

"PROPOSED ROYAL SOCIETY OF SOUTH AFRICA.—Tuesday's *Gazette* contains the following:—

"PRIVY COUNCIL OFFICE,
"October 24, 1904.

"Notice is hereby given that a petition has been presented to His Majesty by John Dow Fisher Gilchrist, M.A., B.Sc., Ph.D., President of the South African Philosophical Society, praying for a grant of a Charter of Incorporation to that Society under the name of "The Royal Society of South Africa," and His Majesty, having referred the said petition to a Committee of the Lords of the Council, notice is further given that all petitions for or against such grant should be sent to the Privy Council Office on or before the 5th day of December next."

Dr. Pakes: In view of this unexpected action of the Philosophical Society of South Africa, it is proposed to send a cable to the Privy Council stating that, amongst others, The Chemical, Metallurgical and Mining Society of South Africa objects to the Philosophical Society of South Africa being granted this Charter; and, in order to get in our objection, this cable should be sent forthwith, as the 5th of December is the last day on which objections can be received. It is proposed also by this Society that at a Special Council Meeting of the Society the co-operation of other Transvaal, if not South African, societies be invited to oppose this particular Society, the Philosophical Society of South Africa, which, I understand, is practically limited to a few members in Capetown, from obtaining the title from His Majesty of "The Royal Society of South Africa." What society or combination of societies should eventually receive this title will have to receive further consideration, but there is a very general feeling, I believe, that this particular Philosophical Society should not be able to claim for itself as a title that of "The Royal Society of South Africa," and certain members of this Society, in their private capacity, have subscribed to send a cablegram to the Privy Council, in order to lay an objection, which will be forwarded in due course in writing. As the 5th of December is the last day upon which objections can be received, we have taken this course of sending a private cablegram so that the matter may afterwards be thrashed out by this Society and other societies, who may possibly have done just as useful work as the Philosophical Society of South Africa.

The President: In reference to the very interesting news we have had announced to-night, you have heard the course of action recommended, and I think it would be desirable if any

other members of the Society who may wish to express their approval or disapproval of this course of action were to do so now.

Dr. Pakes : I beg formally to propose that the sending of this cablegram be ratified, and that the consideration of this question be referred to the Council of our Society, which should invite the councils of other societies to co-operate in the matter and forward their objection to the Privy Council.

Mr. J. R. Williams : I have much pleasure in seconding the proposal.

The President : Is there any amendment?

There being no amendment, the motion was put to the meeting and carried unanimously.

The President : It gives me very great pleasure to announce that the Adjudicating Committees have now completed their labours with reference to the Prize Scheme, and their Report has been adopted by the Council. The Committee and the Council have come to the conclusion that the special prize and Gold Medal of the Society should not this year be awarded, as also, in addition, the prize under section "Mining and Milling"; that the remaining prizes should be awarded as follows: Metallurgy Section, medal and £50, Mr. J. Higham, for his paper, "An Automatic Pulp Sampler"; Chemistry Section, medal and £50 to Mr. G. W. Williams, for his paper, "The Determination of Constants in Working Cyanide Solutions"; Cyaniding Section, medal and £50 to Mr. E. J. Laschinger, for his paper, "The Decantation Process of Slimes Treatment." The last prize of £50 comes under the heading of the Agricultural Chemistry Section, awarded to Mr. E. H. Croghan, for his paper, "The Analyses of Some Witwatersrand Soils."

The applause with which you have received these announcements renders it unnecessary for me to say much. By it I conclude that you indicate two things—in the first place, satisfaction with the decisions of the Adjudicating Committees, which you elected to act in conjunction with the Council, and secondly, your appreciation of the goodwill and generosity of the donors, who have rendered this Prize Scheme possible.

Mr. J. R. Williams : I rise with a good deal of pleasure to congratulate those gentlemen to whom the Adjudicating Committees and the Council have awarded this year's prizes. I can truly say, having given a good deal of time and attention to the papers, that some of them would grace any society in the world. That the prizes have been given on absolute merit is proved by the fact that while we had at our disposal seven prizes, we have only seen fit this year to give

four. I also very much regret we had to withhold the Gold Medal of the Society. Although many of the papers were of great utility and value, yet there was no paper that merited the Society's Medal. I think this is much to be regretted. I know there are several members of this Society—we number well over a thousand—who have got the unfortunate knack of hiding their light under a bushel, and I think I am but re-echoing the wishes of the Council in asking them to come forward and try, during the current year, for the Gold Medal of the Society. I ought to say that, as every member of the Council is eligible for that one prize, I can hardly blame the members as much as I blame the Council for not having won it this year. When I first went round to get this Prize Scheme established, at least six mining houses offered me the full amount, which I refused, preferring that all should have the chance of subscribing to the amount which I required. I may state that I met with not a single refusal, showing how willing the mining houses are to help any object that will contribute to the success of our main industry. I hope that during the coming year some fortunate member of the Society will be able to go away from one of these meetings with the happy knowledge that he has won the Gold Medal of the Society.

NOTES ON SAFETY FUSE :

ITS MANUFACTURE, TESTING AND USE.

By JAMES THOMAS (Member).

Now that the name of your Society includes "Mining," safety fuse should demand a portion of our attention, especially as human life depends in a very great measure upon the quality of the material placed in the miners' hands, and in the proper use, and not abuse, of the fuse by the miner himself.

I regret to remark that, in some quarters the idea of cheapness comes before quality, but I maintain that a so-called cheap, unreliable fuse is dear at any price. I could give instances where, to ensure a charge exploding, two lengths of fuse and two detonators were used—a cheap fuse that, forsooth, costing at the rate of nearly 8d. per coil! I am convinced that if the general opinion of the manufacturers and importers were taken, it would be in favour of a good class of fuse at a fair price. At present the price is unreasonably low for a good and reliable fuse suitable for the requirements of the mines. Below cost should not be expected from any manufacturer or importer.

The manufacture of safety fuse has until the last few years been kept in the hands of a few. How to succeed in getting the powder so evenly laid, enclosed so nicely and burn so regularly is regarded by those not in the know as wonderful. A gentleman of high standing in the explosives world explained to a friend of mine not long since that to get the powder so continuous for such a great length the centre cotton was passed through a solution of glue and, while wet, passed through a vessel containing powder, which, in passing through, carried with it a good layer of powder, which was then covered with yarn and dried. That the ordinary safety fuse is not so made I need not stop to explain. I have seen one illustration of a machine for making fuse which, I am convinced, would not manufacture to compete in this market. The said illustration was as much like the machine of to-day as the tricycle of, say, 1860 resembles the present-day motor car. There is a story told that the real inventor of the manufacture of safety fuse was a Frenchman. Coming down to Cornwall, he boasted that he could make an article that would convey fire through water to a charge of blasting powder, which in its action was more certain than anything yet invented.

For the benefit of the junior members, I may explain that, previous to this, the method usually adopted to convey the fire was as follows:—the hole was charged with the blasting powder to the strength required, a piece of wire was then inserted to act as a kind of needle, the point of which entered well into the charge; a small wad of hay or straw was then placed on the charge and gently tamped: then on this the usual tamping piled until sufficient; then a little moist clay added on the top; the wire or needle was then gently withdrawn, and the hole thus made by the wire filled in with fine powder. Sometimes a good reed or straw was split open on one side and filled with powder, then inserted in the hole; a piece of touchpaper, or paper dipped in sulphur, was attached to the open end, set on fire, and the operator had to run as fast as possible.

For short holes a piece of paper, twisted into the form of a "spill," similar to those in use before matches became so cheap, was employed. This spill enclosed a specially prepared slow burning powder, and the tip of the spill was dipped in sulphur. These spills were used in some parts of Wales in the nineties. The firm with which I was then connected had an inquiry from the Principality about that time for these spills at so much per 100, which was declined.

The fuse known as Bickford's safety fuse was first patented September 6, 1831, and granted to

Mr. Bickford, of Tuckingmill, Cornwall, England. It was described and termed—

"An instrument for igniting gunpowder when used for blasting, and termed 'miners' safety fuse,' and described as a cylinder of gunpowder or other explosive enclosed within a hemp cord, which is first twisted and afterwards overlaid with another cord to strengthen the casing thus formed, then varnished to preserve the contents from injury by moisture, and finally covered with whitening or other suitable matter to prevent the varnish from adhering."

An up-to-date definition, adopted by the Explosive Office of the Mines Department of the Transvaal, is as follows:—

"The term 'safety fuse' means a fuse for blasting which burns and does not explode, and which does not contain its own means of ignition, and which is of such strength and construction and contains an explosive in such quantity that the burning of such fuse will not communicate laterally with other like fuse."

Safety fuse is constructed as follows, beginning at the centre and working outwards:—

Running through the centre of every brand of fuse there are one or more threads, answering a two-fold purpose—

(1) Ensuring continuity of the powder, for without this thread or threads it would be impossible to ensure evenness of the column.

(2) Acting as a trade or distinctive mark of each brand, *e.g.*—

| | | | |
|--------------------|-----|---|--------------------------------------|
| Bickford Smith's | has | 2 | separate threads, |
| Crown Brand | " | 3 | " white threads, |
| Divers Brand | " | 3 | " " |
| Lion Brand | " | 1 | thread, white and green, |
| Lion Extra Special | " | 1 | " green, |
| Double Lion | " | 1 | " pink and white, |
| Sun Brand | " | 1 | " yellow, |
| Horse Brand | " | 1 | " white, |
| Elephant Brand | " | 1 | " " |
| Pike Brand | " | 1 | " yellow and white, |
| Empire Brand | " | 3 | threads, red, |
| Unity Brand | " | 1 | thread, black, |
| Anchor Brand | " | 1 | " tricolour, red, white and blue, |
| Magic Brand | " | 1 | thread, red and white, |
| Arrow Brand | " | 1 | " red and yellow, |
| Snail Brand | " | 1 | " " " |
| Lightning Glance | " | 1 | " " " |

The foregoing are most of the brands introduced into this market, not necessarily made at different works, but imported under the name given.

The powder used should be of fair quality, and free from chlorate, a powder slightly glazed being more suitable than a dead unglazed one. The graphite used in glazing not only helps the powder to work smoothly, but also assists it to resist moisture. I need scarcely explain that all gunpowders are not equally suitable for the manufacture of safety fuse. All else being equal, the larger the grain, the faster the burning of the fuse. In England manufacturers can obtain powders to suit almost any particular requirement, and, in fact, make their mixing of powder every day or oftener, varying their mixing to suit the weather. A powder that burns to the required time, say, on a day with a South wind, would possibly give trouble on a day with a strong, dry East wind. In fuse making my most troublesome days have been those of the latter kind. To know how to obtain good results when the weather is changeable is not the least of the secrets held by the manufacturer, each one having his own little dodges. In countries where the manufacturer can only get his powder from the Government, and has to take what is given, other ingredients have to be introduced, but, as this is not a society of manufacturers, I need not go further into details. I only mention the foregoing in order that you may understand that, even in the making of safety fuse, attention is required in the very smallest details.

The yarns used to enclose the powder are usually of jute, $3\frac{1}{2}$ or 4 Lea jute, and are termed the "spinning." In the United States cotton and tow yarns are sometimes substituted, making the finished article much more expensive. A jute containing over 5 per cent. of oil of any kind should be used with caution. One containing over 3 per cent. of fixed oils should not be used—the more, free from oil of any kind, the better. The less the oil, the less the variation in the time of burning, and the less "slowing down" in time after manufacture. I have seen fuse which, at the date of manufacture, would burn at 75 secs. per yard, in a few months after slow down to 150 secs.

The next layer of thread is termed the countering. In the English brands it is composed of seven threads, except in a few special varieties. Continental brands usually contain six threads. This layer of thread should be of fairly strong material, its purpose being to hold the spinning threads firmly together, so that the powder may not escape while being handled and while burning. No. 1 is a sample of fuse with a weak thread but fair quality jute. Submitted to a tensile test, it broke at 165.5 lbs. No. 2, a sample of fuse with a good strong thread, submitted to the same test, broke at 224.4 lbs. This, of course, is not a recognised test, nor is it a necessary one,

but it gives you some idea of the strength of the material used.

Upon this countering the principal waterproofing material is laid. The quality of this latter is governed in a great measure by the price paid for the finished article. When the price admits, gutta-percha is preferred and mixtures of varnish and gutta-percha. In some brands asphalte is the principal ingredient. Whatever the kind of waterproofing used, if you ask the manufacturer, you will find that the material he uses is the best. In considering the quality of the material used for any brand, the waterproofing should receive first attention, for a fuse weak here is no stronger or superior than its weakest spot. The second countering will be found to be twisted the opposite way to the first, and the threads used are a little heavier and bind the others tighter together, their principal work being to protect the waterproofing against the effect of tamping, etc. In some brands this is coated with black varnish or asphalte and then given a coat of white, blue or other varnish; in others a coat of white varnish only, composed of china clay and glue, etc. The foregoing is a general description of safety fuse, as used in this Colony.

This leads us to our next point—testing of safety fuse.

5. *Deviation permitted.*—"In the tests specified below a deviation of 10 per cent. over or under the guaranteed rate of burning per yard will be permitted, and the fuse must burn uniformly throughout its length."

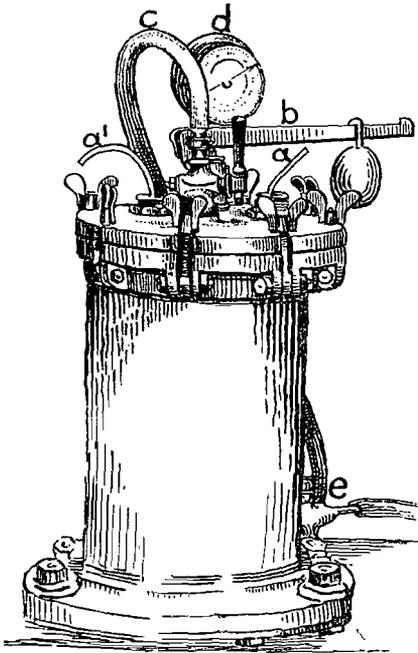
6. *Quality of Material and Ingredients.*—"The fuse may be opened and the various materials examined to ascertain that they are of good quality."

7. *Tests.*—(a) "A piece of fuse 4 yds. long shall be immersed in water except for 6 ins. at either end and subjected to a pressure of 10 lbs. per sq. in. for 20 mins., when one end of the coil shall be ignited."

The apparatus in which this test is carried out is illustrated in the following sketch. (a) and (a') are holes through which the ends of the safety fuse to be tested are passed. (b) Safety valve. (c) Water inlet connected to town water main. (d) Pressure gauge. (e) Outlet pipe.

This test, we admit, is not a popular one with the manufacturers, but, in my judgment, is the test of the series. It tells us not only of the water-resisting power of a fuse, but also in a marked degree whether the fuse has been firmly and well put together. A loosely made fuse, even if the waterproofing stands the 20 mins., burns from 15 to 30 per cent. faster under pressure than in the open up to a certain point,

but after that point is reached, water follows the air and damps the powder, with the inevitable result—a misfire.



Actual results of tests made—

No. 1 sample is of a brand very firmly made, with a strong thread used in the first counterering.

Result: This fuse burnt in the open at the rate of 82 secs. per yd.; under pressure, as per test (a), at the rate of 82 secs. per yd.

No. 2 sample is of a brand loosely spun, with a very weak thread used in the first counterering.

Result:—

Burnt in the open at 92 secs. per yd.

„ under pressure as per
test (a) 67 „ „

„ re-tested 66 „ „

Re-tested again, failed to burn.

The next sample is of a fuse strongly made and well put together; but the waterproofing very indifferent.

Burnt in the open at 114 secs. per yd.

„ under pressure as per
test (a) 83.5 „ „

In a re-test, failed to burn.

It will thus be seen that this test is a good indicator, both of the waterproofing and firmness of the fuse being sampled.

It has been suggested that, in place of this test (a), the sample to be tested should be placed in a tank of water for, say, 12 or 24 hrs., but that will only give you an idea of the water-

proofing without the extra force exerted by the hole being tamped. I have placed lengths of fuse in a $\frac{3}{4}$ in. glass tube, about 10 ft. long, filled with water. For some time after immersion little globules of air could be seen on the outside of the fuse. While those globules remained the water could not get in.

While interested in safety fuse as a manufacturer, in consultation with a mining engineer of some standing, an apparatus, similar to the one now used by us, as shown in the photograph, was the result. And as a manufacturer, I was accustomed to submit all safety fuse that was expected to be used in wet mines or places to this test. Were I a manufacturer again to-morrow, I should adopt this test.

Test (b).—A piece of fuse 2 yds. long shall be pressed flat in a vice fitted with wooden jaws and burnt whilst so compressed.”

This is a test almost universally applied to safety fuse. In practice, however, it is a little difficult to apply in such a way that each sample shall be submitted to the same pressure. The one we have adopted is that of a parallel vice, pressing the jaws close home upon the fuse and then bringing the lever round to about the same spot. It may not be known to all present that if a piece of fuse is screwed up tight between iron jaws, the flash passes through almost instantaneously, with a slight detonation. By using wooden jaws, and the pressure being applied by the same person, the results are fairly good. Should there be any chlorate in the explosive used, this test will, as a rule, tell the tale.

The object of the test is to see that the fuse will stand the usual tamping and burn evenly while so tamped, and that the powder used burns without detonation.

Test (c).—“Pieces of fuse 2 yds. long, taken from different coils, shall be bound together at one end, and those ends ignited simultaneously. The difference in the time of burning of any two of them must not exceed in seconds one-half of the total deviation allowed under Article 5 of these regulations (*e.g.*, in the case of fuse burning at the rate of 90 secs. per yd., a difference in time of 18 secs. would be allowed in the 2 yds. test).”

The object of this test, I think, will be apparent to all—uniformity. A fuse that at one time burns at 80 secs. per yd. and at another 120 secs. is a dangerous article and, further, most wasteful, for the miner never knows how long to make his fuse, or how long he will have to wait before the charge goes off. This particular object is not attained without great care

and attention on the part of a manufacturer, especially in a country with a climate that is changeable. The manufacturer is making fuse in Europe, say, on a particular day when there is a strong East wind blowing. The next day it rains, and the whole atmosphere is damp. I need not explain what the result would be.

Test (d).—"A piece of fuse 2 yds. long will be folded up and thrust into a piece of iron piping $1\frac{1}{2}$ in. in diameter and burnt both in the open and under water (the former to test for lateral communication, the latter to test the waterproofing)."

This test was added to the series at the suggestion of several mining experts. The test first proposed by the writer was that of bending the fuse a certain number of times backwards and forwards, and then placing the fuse, after being so bent, under water for, say, 10 or 15 mins., and burning it while so immersed. Another suggestion was made by one of the leading manufacturers, namely, the winding of the fuse in a spiral form round a piece of wood about 1 in. or $1\frac{1}{2}$ in. in diameter. Those most intimate with the usage of miners themselves on the Rand favoured the first suggestion, to which we agreed.

The object of this test will, I think, be quite clear. Miners have at times for various reasons to use long pieces of fuse, and in so doing roll up, bend and re-bend the fuse, and place it in the entrance of the hole—I am not defending the practice, but merely state what is done. We want, then, a test that will guarantee that the fuse can be so treated and yet not give a misfire in water or short circuit in a dry place. I have been informed that short circuiting has been known, or, at least, accidents have occurred by premature explosions which point to the cause being short circuiting, but I do not remember a case coming under my own observation.

Experience being the best teacher, this test has been adopted to guard against the possibility of such an accident. The test, it will be observed, is a double one:—

- (1) 2 yds. burnt in the pipe in the open.
- (2) " " " under water.

Up to the present I have found that a fuse that stands test (a) gives a good result in this test (d).

Test (e).—"The flash from the end of a piece of fuse shall be such as to ignite another piece of fuse at a distance of 1 in. (For the purpose of this test a short length of fuse will be inserted into either end of a piece of glass tubing and one length will be ignited. The flash must ignite the other length of fuse.)"

In the application of this test, in passing I may point out that when a piece of fuse is cut with a sharp knife, the powder column will sometimes be glazed in such a manner that the flash will not ignite it. This glazed surface should be slightly roughed. A good flash will then rarely fail. It is, of course, a well-known fact that a gloss on powder retards ignition, and in many cases glazing is used quite as much for this purpose as to prevent the effect of moisture. This test I consider a fair and reasonable one, for although I would not care to be too near a charge that had a fuse that would not ignite another fuse 1 in. distant, I should not, however, consider a fuse good that would not do so. Since I have been in this country, I have seen a piece of fuse said to have misfired, but the fuse had burnt through, and for some cause or other had not ignited the detonator. Either the fuse had not been inserted far enough or there had been sawdust left in the detonator, or there might have been other causes, but, if the fuse will give a flash of 1 in., these little obstacles are in a measure overcome.

My paper is, I am afraid, already too long, so that I have only time and space for a few words on the use of safety fuse. I am rather afraid that the miner himself is at times to blame for many of the misfires, because of careless handling. I hail from a county which, in the opinion of many better able to judge than I am, produces some of the best miners of the world, yet I have seen fuse used by Cornish miners to bind the tools together and carry them below. Fuse is sometimes allowed to lie about underground in damp places, which cannot but be detrimental to the burning. I have also seen the end of a piece of fuse inserted in the detonator without having been freshly cut off the last thing before insertion.

I believe that, if more attention was given to these three points, viz.:—

- (1) More careful handling,
- (2) Fuse never to be allowed to stand in a damp place,
- (3) Fuse to be cut clean the last thing before insertion into the detonator,

the result would be less misfires.

I trust that the result of this paper will be a discussion which will—

- (1) Give the manufacturer to understand that too much care cannot be given to the manufacture of safety fuse for this market.
- (2) Imbue him and the public generally with a better understanding of the tests and their application.
- (3) Ensure a better treatment of the fuse by the miner himself.
- (4) And, lastly, impress most emphatically

upon the managers and those concerned that a good fuse is worth its money any time, but a poor fuse is dear at any price.

The President: We have all heard with a great deal of pleasure and profit this paper by Mr. Thomas. He is personally known to a great many of you, as is also his long experience and connection with explosives. It seems to me that papers dealing with explosive materials are of peculiar interest. They are of very great importance from an industrial standpoint, as, of course, the cost of explosives in mining operations is a considerable item. But, still more, it seems to me these papers are of humane interest, as it is only by having the best explosive materials and skill in using them that mining accidents can be reduced to a minimum. As we are fortunate in having with us Mr. Pollitt, of the De Beers Explosives Factory, Cape Colony, I trust he will give us his views on the important matters raised by Mr. Thomas.

Mr. J. R. Williams: I should like, first of all, Mr. President, to second your vote of thanks to Mr. Thomas for his very valuable paper. I am at one with Mr. Thomas about the importance of having a good safety fuse, and I know all the miners present will bear me out in saying that the first great cost of mining is drilling the hole, and the next heaviest cost is the explosive. To have a poor detonator and fuse is really spoiling a good ship for a penny's worth of tar. I trust that our mining members will pay particular attention to it and give us the benefit of a full discussion.

Mr. Pollitt: I am placed at rather a serious disadvantage in attempting to speak on Mr. Thomas' paper, firstly, because one cannot take in the whole of its import and the valuable information it contains by simply hearing it read. One requires an opportunity of carefully considering the paper quietly and digesting all that Mr. Thomas has said. I am quite sure everyone present will realise the importance of a thoroughly reliable fuse. To you, most of whom are miners, I believe, it is a matter of supreme importance. I am not competent to discuss Mr. Thomas' paper from a manufacturer's point of view, because it is a branch of the explosives industry which has not come under my personal experience. The various tests Mr. Thomas has described are most interesting, but there is one to which he did not refer, on which I have no doubt he will be able to give us some information. It is practically a new one, brought forward by Mr. Hake, the Inspector of Explosives in Australia, in which he has applied the Röntgen rays to determine the continuity of the powder cores. The expert fuse manufacturer

claims he can tell by the feel of a fuse almost as closely as the Röntgen rays will tell him, but all of us have not got this expert touch, and I think the Röntgen ray method of testing may be worth following up. Then there is another test—the well-known one, but perhaps a little crude. The fuse is placed in an instrument and turned by a screw to a certain position, but it is a little difficult to regulate the exact pressure, and the pressure put on the fuse makes a little difference in the time of your test. It would be better to have a register, *e.g.*, a spring balance, to show what pressure you are putting on. As I am not a member of your Society and do not receive your transactions, I shall be glad if Mr. Thomas will favour me with a copy of his interesting paper when it is published.

IMPROVED SANDS AND SLIMES SAMPLERS.

By H. LEUPOLD (Member).

The exact determination of the dry weight of slimes or sands per cubic foot, as deposited in a large tank, is a matter of great difficulty. The following description and illustration of two appliances I have recently devised for the purpose may therefore prove interesting.

I.—SANDS.

Make as true as possible a cylinder, 8 ins. diameter and 8 ins. deep of 16 or 18 gauge galvanised sheet, lapping and soldering the joint.

With four copper rivets rivet a welded ring of $\frac{1}{8}$ in. by $\frac{3}{4}$ in. iron around the outside of upper edge of cylinder; this ring should bear two grip handles of $\frac{3}{8}$ in. round iron.

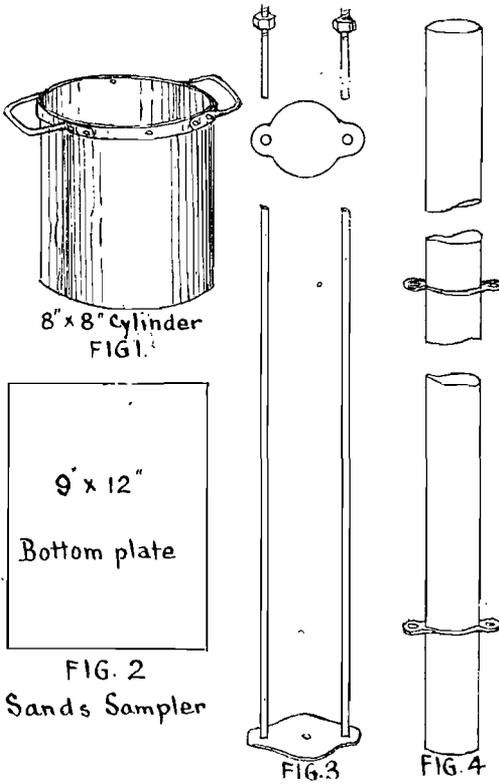
Smooth off inner and outer edges of lap joint with a file and give the lower end of cylinder a cutting edge. Determine cubic contents by pressing cylinder on a rubber pad and filling with water; it will be about 402 cub. ins. To use it, smooth and level off surface of sand in a drained cyanide tank and press the cylinder down vertically until its upper edge is flush with surface.

Now dig a hole in the sand outside the cylinder so as to free it on one side, and drive in horizontally, beneath it and in touch with its lower edge, a smooth plate of $\frac{1}{8}$ in. steel 9 ins. by 12 ins., having its front 9 in. edge sharpened on a bevel. Clear the sand around and lift the cylinder out by means of the 9 in. by 12 in. plate. Clean outside, empty into pan, dry and weigh. The same may be repeated at any level in the tank while emptying, care being taken

not to have the sand trampled where it is intended to sample.

II.—SLIMES.

Take a thin steel or brass tube $2\frac{1}{2}$ ins. inside diameter of a length equal to depth of tank and have it well cleaned and scraped inside and out. Form a dull edge at lower end, and at 6 ins. from this shrink on a forged ring of $\frac{1}{4}$ in. square iron, having two $\frac{1}{2}$ in. eyes, thus, $\circ\circ\circ$; the centres of these eyes should be $3\frac{3}{4}$ ins. from each other. Shrink on a similar ring some 5 ft. or 6 ft. further up the tube. From a $\frac{1}{4}$ in. steel plate cut an oval disc $3\frac{1}{2}$ ins. by $5\frac{1}{4}$ ins., and in the



narrow ends punch two $\frac{3}{8}$ in. holes, also at $3\frac{3}{4}$ in. centres. Into these rivet (on a shoulder) two $\frac{1}{2}$ in. rods, 3 ins. longer than the tube; screw the free ends and provide nuts. Over the rods now slip an oval disc of $\frac{1}{8}$ in. rubber insertion and push down to the steel disc, where fasten with one central copper rivet. Lower the disc and rods down to the clean bottom of empty collecting tank and secure rods in vertical position, which may be done by a wooden lath, having two holes for said rods and clamped to tank rim. When the tank is full or at any time during filling or after settling, free the ends of rods, slip the tube with its eyes on rods (which should be an easy

fit), and lower slowly to the bottom. When down, pass another oval steel disc with rubber liner and two corresponding holes over the rods, screw down and pull out. Hose off all dirt from outside, place in pan, open and empty, wash out, dry and weigh.

The dry weight of slimes in tanks is equal to the weight obtained multiplied by area of tank and divided by inner area of tube, both in square inches, plus weight of bottom stratum of slimes. This being $\frac{3}{8}$ in. thick, will weigh (dry) from 2 to $2\frac{1}{2}$ lbs. per square foot. The average inner area of tube can be obtained most accurately by measuring capacity, in cubic inches, of water and dividing this by depth in inches. It will be found most useful to mark a foot and inch scale on outside of tube, beginning at lower edge.

To conclude this short description I will now give a few examples taken from actual practice—

I.—CONCENTRATES.

Dry weight of sample taken, as described, 20.55 lbs.
 Weight per cub. ft. $\frac{20.55 \times 1,728}{402.6} = 88.21$ lbs.,
 or 22.67 cub. ft. per ton.

II.—SANDS.

Dry weight of sample, 22.66 lbs.
 Weight per cub. ft. $\frac{22.66 \times 1,728}{402.6} = 97.26$ lbs.,
 or 20.56 cub. ft. per ton.

It will here be observed that the concentrates are actually lighter than the sands, which is, of course, due to their being free from fine material which fills up the spaces in the sands.

III.—SLIMES.

Inner area of sampler, 4.96 sq. ins.
 Sample taken in 30 ft. by 8 ft. collecting tank after ten hours' settlement—
 Depth of settled slimes 26 ins.
 Weight of sample as taken 10.63 lbs.
 " washwater used inside 3.58 "

Net weight of sample 7.05 "
 Weight of dried slimes 3.77 "
 " water in pulp 3.28 "
 Proportion of liquid to dry matter, 1 : 1.15, or 46.5 per cent.
 Volume of pulp in sampler, $4.96 \times 26 = 130$ cub. ins.
 Area of tank, 101,780 sq. ins.
 Dry weight of slimes in tank—
 $3.77 \times 101,780$
 $4.96 = 77,360$ lbs.
 Add for $\frac{3}{8}$ in. bottom layer—
 $707 \times 2\frac{1}{2}$ lbs. = 1,770 "
 79,130 "
 = 39.2 tons.

The President: We have all heard with a great deal of interest Mr. Leupold's paper, which deals with a very important subject. We have discussed the matter of tonnage determination and the methods of obtaining tonnages in this Society at various times, and I think you will all agree with me in saying that we have not yet reached a method of determining our tonnages to the final degree of accuracy which we would desire. As Mr. Leupold's paper involves mathematical calculations, it will be necessary to postpone discussion.

SAND LIME BRICKS.

By H. GERLINGS (Member).

During the last few years the manufacture of sand lime bricks has developed from small beginnings in such a rapid and energetic way that there now exists, in addition to the manufacture of clay bricks, a very extensive industry in sand lime bricks, which find in Europe and America a good and ready sale. At first the new industry encountered strong opposition from the clay brick manufacturers, but now the two systems work side by side, as experience showed that in some cases the new process was more profitable, but in other cases the old method could hold its own. The cost of production, which in its turn is dependent on the accessibility and the price of the clay, coal, sand, lime and labour, are the economic factors, and objections have been silenced by the fact that good sand lime bricks are equal to and often superior to burned clay bricks.

That artificial sandstone can be produced from sand and lime is a fact that has been known from the oldest times. The cisterns near Tyre and other hydraulic works of the times of Solomon consist of a kind of artificial stone. In the ruins of Solomon's Temple, near Jerusalem, well preserved remains of artificial sandstone masonry are found, and the four colossal courses of masonry in the ruin made of this material are particularly noticeable. Thousands of years have not been able to destroy these masses of sand lime stone, which, on the contrary, have become harder and firmer in the course of time, while the old buildings of burnt brick and natural stone have long succumbed to the influence of the weather. Thus we have irrefutable evidence that the ancient understood how to produce building stone of excellent quality from a mixture of lime and sand, which has given incomparable proofs of durability and resistance to the surrounding atmospheric changes. According to Vitruvius also,

the Romans mixed one part of fine lime, one part of river sand, and one part of stone refuse, and made up in the form of bricks, which, when exposed to the air, hardened gradually.

As is the case with so many inventions, the knowledge of how to produce such artificial stone from sand and lime was lost, until inducement was gradually given by the continually increasing need for more durable and valuable building material to produce again artificial stone which would fulfil the demands of the newly developed industries and the numerous other requirements of modern building trades generally.

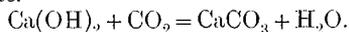
A considerable advance in the production of artificial sandstone was made by Dr. Michaelis in the year 1880. He was the first to recognise that moist hydrate of lime would form hydrosilicate of lime when placed with sand in chambers filled with steam, combining with the silicic acid, but engineering then was not sufficiently developed to produce the necessary chambers for high steam pressures and the presses for high mechanical pressure. Nevertheless, several houses were built of this artificial sandstone, and these lasted perfectly well. Further, houses built in Germany twenty years ago from bricks made of lime and sand are to be seen in perfect condition at the present time. It is said that in England also some of these buildings are to be found, viz., the Royal College of Surgeons, Lincoln's Inn Fields, some buildings in Pall Mall, and a school at Lee, near Blackheath, constructed many years ago. Most of the difficulties in the manufacture of appropriate machinery have now been overcome, and sand lime bricks are produced in Germany in more than 100 factories, with a yearly production of about 400,000,000 bricks. In America there were two factories in 1903, as against thirty in the first half of this year. Holland, Russia, Austria and France have each four; England and South Africa each two factories.

THEORETICAL OBSERVATIONS.—(a) *Carbonate of Lime as Binding Material.*—The new sand lime brick industry must not be considered as an extension or a development or a perfection of the mortar industry, though these bricks are formed from the same constituents.

The solidification is, in fact, due to quite a different chemical process. Mortar made from slaked lime and sand is a more or less pasty mass, which, after standing several days, begins to solidify somewhat, but is still soft and friable. Afterwards, the hardness increases, so that often it becomes greater than that of the bricks in the wall.

In this process the evaporation of water first takes place, followed by the formation of car-

bonate of lime by absorption of carbonic acid from the air. Hence free access of air must exist. Further, the formation of carbonate of lime sets free some water, which also must evaporate.



If the air cannot penetrate the brick wall, the mortar cannot harden, and we already know of mortar in thick walls which had not hardened in 150 to 560 years, having still a basic reaction and not having absorbed half the carbonic acid necessary for complete hardening. This explains why thick masses of mortar do not improve the stability and strength of the building, as is often believed. Again, it is generally supposed that in course of time a chemical reaction between the lime and the sand should take place. Now, it is true that many old mortars show a high percentage of silicate and great hardness, but in these cases the mortar was not ordinary lime mortar, but had from the beginning an addition of more or less silicate, chiefly in the form of "trass," a natural cement, and this yielded good results in the times of the Romans and in the Middle Ages, and the practice has been revived during the last fifty years.

A church in Brunswick, erected 560 years ago, was recently pulled down, and the mortar on analysis had the following chemical composition:—

| | |
|---------------------------|----------------|
| Sand and insoluble silica | 56.3 per cent. |
| Soluble silica | 3.8 " |
| Carbonate of lime | 20.3 " |
| Hydrate of lime | 11.1 " |
| Magnesia | 0.7 " |
| Oxide of iron and alumina | 3.5 " |
| Water | 3.2 " |

And this shows clearly that the mortar was made of white lime and ordinary sand, but not in the usual proportions.

As the carbonate of lime contains 11.3 per cent. and the hydrate of lime 8.4 per cent. CaO, 100 parts of this mortar in dry state contained 78 sand and 23 CaO. In ordinary mortar 85 sand and 15 CaO is used.

This old mortar was therefore too pasty, and the pores became so closed up by the lime that in 560 years the air has only succeeded in carbonating two-thirds of the lime.

These examples are given to make it clear that the formation of carbonate of lime is a not very rapid process, and indeed the mortar bricks made of sand with a binding of carbonate take four to six months before getting hard enough to be used for a wall. Then they have to be laid with great care, as a heavy blow is liable to destroy them, not being hardened to the core, and they could only attain the required hardness in about 1½ year.

(b) *Hydrosilicate of Lime as Binding Material.*—At present the term sandbrick is exclusively used for those bodies bound together by a network of silicate of lime, formed by the action of steam under pressure upon silica or quartz and hydrate of calcium.

The rock-like structure is shown in the photograph of the fractured surface of such a substance and also in the broken pieces on the table. The formula of this hydrosilicate is not quite settled. The lime silicates prepared by synthesis by Clifford Richardson are—

| | |
|--------------------------|-------------------------------------|
| Calcium monosilicate ... | CaOSiO ₂ |
| „ disilicate ... | (CaO) ₂ SiO ₂ |
| „ trisilicate ... | (CaO) ₃ SiO ₂ |

The two first are confirmed by Dr. Passow, but the third is still somewhat hypothetical. In all cases a large quantity of hydrosilicates can exist. From the different analyses at my disposal I was only twice able to find the composition CaH₂(SiO₃)₂, corresponding to the Wollastonite CaOSiO₂, and this formula would correspond with some zeolites, and could be named hydrometasilicate of lime. It cannot be orthosilicate, as it is very insoluble in hydrochloric acid, etc.

A better idea of the way in which the sand and lime are cemented together is given by the examination of thin sections under the microscope, such as Prof. Rinne carried out.

He found that artificial sand lime bricks did not correspond with natural freestone with lime binding, but that they were more like sandstones in which the binding is a lime silicate.

It is true that there always is a certain amount of non-combined hydrate (converted later into carbonate of lime) in the finished sand brick, but the elimination of this carbonate does not destroy the bond, as shown by treating with hydrochloric acid for 24 hours. In the slide under the microscope you will see distinctly the sand particles of different size and shape. Also that by the action of the caustic lime the surface of some of the quartz particles is corroded. The binding between the quartz is represented by a greyish, finely grained mass. The calc-spar crystals were washed out when preparing the slide, but some of the original impurities of the sand, such as iron pyrites, can be traced. Further, the pores and interstices can be seen to be regularly divided in the brick. Prof. Glasenapp has investigated the way in which the hydrate of lime acts on the soluble silica in presence of water, and how the resulting hydrosilicate of lime acts as a binding material on the quartz and sand particles. In 1900 he confirmed the pre-supposition of Dr. Michaelis, the inventor, that the crushing stress of the bricks, without taking into account other circumstances, depends on the quantity of hydrosilicate formed during the hardening process. Now,

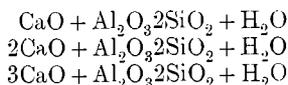
there are two different ways of hardening : (1) with steam under high pressure and (2) with vapour under atmospheric pressure. Just as in cement burning, the longer the time of burning in dome kilns at low temperatures gives the same results as the shorter time of burning in the rotary kiln at higher temperatures, so also we might expect similar phenomena in sand lime hardening.

But Prof. Glasenapp has proved that the solution of quartz, *i.e.*, the formation of hydrosilicate of lime is greatly promoted by raising the pressure in the hardening chambers. At 147 lbs. steam pressure, in a mixture with coarse sand, 7.58 per cent. soluble silica was obtained on eight hours hardening, and at 117 lbs. with fine sand, only 3.06 per cent. At atmospheric pressure and six days exposure at 99° C. with fine and coarse mixtures and the same percentage of lime only 0.68 per cent. and 1.24 per cent. soluble silica respectively was obtained—about $\frac{1}{4}$ to $\frac{1}{2}$ of the amounts obtained with high pressure. We see also in the following experiments that a very important factor is the amount of contact surface the sand offers to the hydrate of lime. 100 per cent. of hydrate of lime gave at 73 lbs. pressure, in a mixture of coarse sand, 0.43 per cent. of soluble silica, and in fine sand, 3.06 per cent. ; at 147 lbs. 3.33 per cent. and 7.58 per cent. respectively.

With coarse sand, as with fine, all the calcium hydrate is not transformed into hydrosilicate, but even at the highest temperature and with the longest exposure, a greater part of the hydrate is present as such in the finished product, and is only after some lapse of time changed into carbonate on exposure to the air, like ordinary mortar. This is, perhaps, caused by the fact that all the lime does not come into close contact with the sand particles. However, I foresee the time when by better methods all the necessary and available lime will be changed into hydrosilicate in the finished brick. In the formula $\text{CaH}_2(\text{SiO}_3)_2$, theoretically, only 3 per cent. of lime is necessary, but in practice 4 to 5 to 7 per cent. is used, and in the worst equipped factories never above 10 per cent. will be required, and any increase beyond this would only have some influence, in case exceedingly fine sand could be used, 11.14 per cent. of soluble silica being the highest figure ever obtained. In all the above experiments the soluble silica contained in the sands was removed beforehand by hydrochloric acid and potash. This soluble silica naturally occurring in the sand, in practice will act like fine sand in the mixture.

The question whether a certain percentage of alumina would have any influence on the formation of soluble silica at high steam pressure

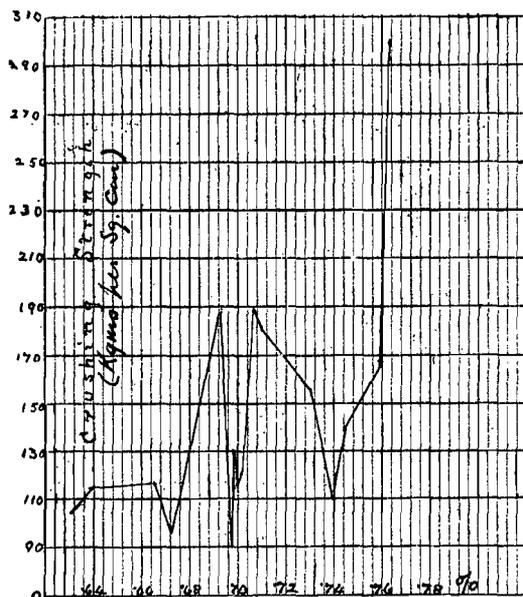
deserves some attention, as it was supposed that felspar was more easily soluble than quartz, and the question is, theoretically, very important, as it would be possible, perhaps, to make in this way a compound which would correspond to hardened portland cement containing basic calcium and calcium alumina hydrosilicates, and possessing a great hardness. To test this, kaolin, nearly pure, was mixed with calcium hydrate corresponding to the formulæ—



The pressed blocks were exposed eight hours to 147 lbs. pressure in the autoclave. but it was found that the alumina was not very much attacked; never more than 8.6 per cent. of soluble silica was found—very little higher than in the mixture of 90 per cent. sand and 10 per cent. lime under the same treatment (7.58).

Hence, notwithstanding that the clay is much more finely divided in the mixture and gives greater contact surface, it is not so easily made soluble as quartz. Prof. Glasenapp also found that the presence of clay tended to decrease the formation of soluble silica, as it surrounds the sand particles and diminishes the surface exposed to the action of the lime.

In practice the bad effect of its presence is not often noticed, as the clay is not often true kaolin, but a mixture of clay, fine sand and other finely pulverised minerals, which in most cases will be



PERCENTAGE OF SOLID MATERIAL IN BRICK.

able to combine with the calcium hydrate, so that these components make good what the true clay has spoiled. Therefore, I venture to say that it is economic to separate out the clay, when this is possible to do so at a cheap rate.

Before finishing this paper, I want to contradict the erroneous idea that the greater the mechanical pressure the greater the strength of the brick. The diagram shows clearly that there is no absolute connection between the density of the brick and its crushing strength, though, generally speaking, there is an increase of the crushing strength in the denser bricks.

The President: Mr. Gerlings, with very great modesty, commenced his paper with an apology, by saying that it was not a mining paper dealing with a mining subject. I can assure him that the apology was uncalled for, and that we thoroughly appreciate his paper. I think I can further assure him that, going back to my own experience of the Society's methods, although our official title is "The Chemical, Metallurgical and Mining Society of South Africa," yet there are very few subjects of a scientific or technical interest that we are not pleased to consider and, if necessary, to discuss vigorously. The discussion of this paper will come forward in the ordinary course at our following meeting, and, in the meantime, I should like to propose a very hearty vote of thanks to Mr. Gerlings.

Dr. Pakes: I have great pleasure in seconding the vote of thanks to Mr. Gerlings for his interesting paper, and I hope that at the next meeting I shall have an opportunity of saying something concerning this question. I think we are indebted to the author for bringing before us the possibilities of a new industry. We have sand here, and in certain parts of the country we have lime. It is considered, also, that in certain parts of the country there is clay necessary for the formation of bricks, and both industries can be carried along side by side with profit to both. As Mr. Gerlings has shown in a very complete manner, the possibilities of using up our vast mounds of residues, given the necessary amount of lime, which is to be had in this country, it seems to me that we owe him a great debt of gratitude. Now, in view of the advent of Chinese, we are going to build certain compounds, and for those compounds we shall want bricks. The ordinary ones made in this country do not happen to be made of clay weathered long enough in every case. Soon, however, an industry is to be started in this country for making our facing bricks which will stand even the South African climate for centuries. There is another question I should like to ask. Supposing these

residues contain much iron pyrites, what effect will that have on the strength of the brick or its durability?

THE ASSAY WEIGHT AND ITS RELATION TO THE BALANCE OF PRECISION.

By A. WHITBY (Member).

DISCUSSION.

Mr. J. R. Williams: I would like to make an announcement here, namely, that a certain maker undertook to supply us with an absolutely correct set of weights. I am not at liberty to give the maker's name, but he sent us a set of weights which, so far as our most delicate balances for testing go, lead us to believe that we have at least got one set of accurate weights. I think I was responsible for saying at the last meeting that we never asked makers to put a price on their weights and that we were prepared to pay whatever they required. It is a small matter to us when we spend three quarters of a million pounds upon a mining property before we can get our first ounce of gold, whether we pay two guineas or ten guineas for an accurate set of weights. I understand copies of our Proceedings have been sent to the various makers in England, the Continent and in America. There are said to be two places always infallible—the banks of the Thames and America—but I have not found them so, and I may say that the set of weights above referred to has neither come from America nor the banks of the Thames.

The President: According to the notice of this meeting sent you, the discussion on this paper will now close, and Mr. Whitby will reply at the next meeting. A good deal of the work of the Society is not done at our monthly meetings, and the matter of assay weights has been taken up by the Council, and a sub-committee is now very busily engaged in investigating it. I trust before long we shall not have only one solitary set of accurate weights in the country, but as many as we require.

IMPROVEMENTS IN SLIMES TREATMENT.

By M. TORRENTE (Member).

DISCUSSION.

Mr. A. Whitby: When reading his paper, Mr. Torrente casually referred to me for an

explanation of the differences obtained in calculated and actual assay values of slimes pulp. I do not desire to refer to ancient history on this matter, but I merely wish to give my impressions derived from actual work. My first slimes residue assays were absolute failures, and whether I re-assayed the slags or reduced 100 gm. buttons, the results were always the same—values far below what they should be. This applied particularly to intermediate slimes. Naturally, I drew the conclusion that I was not catching the soluble gold, so I adopted the plan of treating my residue as a solution and precipitating the soluble gold on to the solid portion of the pulp, using the "copper test" reagents, with the result that my assays at once became normal.

I think the difficulty is a purely mechanical one, for I remember that I was in the habit of drying my pulp in a large round-bottomed porcelain dish, and I am inclined to think some gold adhered to the dish. I now use a flat-bottomed, shallow, enamelled frying-pan, and although I still adhere to the precaution of adding my precipitants to the pulp, some experiments without these aids conducted a few months ago did not show such great discrepancies between calculated and actual values as previous work had given me. With such a wide shallow pan there is, I think, little marginal surface for the soluble gold to cling to.

Mr. E. J. Laschinger: The commercially successful treatment of slimes is to be looked at under two headings—

- (1) The Metallurgical Aspect,
- (2) The Mechanical Arrangements

Mr. Torrente, in common with other advocates of continuous treatment, does not propose to depart from the generally accepted principles of the metallurgical treatment of slimes as carried out on the Rand, the main object aimed at being to reduce capital outlay, or first cost of plant. It would appear that all considerations are therefore to be treated under the second heading of "Mechanical arrangements."

However, this is not quite the case, because it is for the metallurgist to determine for a certain grade of slimes, the number of washes to be given, the ratio of wash to slimes and the amount of solution to be decanted off after each wash; then the engineer steps in and designs the plant to perform the necessary operation.

It is usual for metallurgists to take it for granted that the engineer on the Rand is quite able to design machinery and plant, to carry out any details of process of treatment that may be proposed and to make it work successfully, but no one can go contrary to the laws of nature; the great difficulty is often in making the plant work successfully.

The physical laws governing the behaviour of slimes in suspension in water are to a great extent still unknown. Unlooked for and inexplicable things happen with slimes and sometimes upset the most elaborate calculations, but, at the same time, experience has taught us enough about the behaviour of slimes of banket ore, that if some latitude is allowed in the time element of treatment, definite satisfactory results may be confidently expected and calculated on.

In a continuous settlement process of slimes treatment, such as proposed by Mr. Torrente, we must assume that a fixed condition is reached and maintained; a certain amount of clear solution going to the decanter at the top and a fixed amount of slimes with a fixed percentage of residual solution coming from the bottom, the consistency of the slime pulp varying approximately uniformly from top to bottom of the vat. To obtain a high extraction it is evident that the sludge discharge must contain as low a percentage of solution as possible. Suppose, now, that a satisfactory discharge is obtained and all conditions established. Suddenly, without apparent reason, the slimes behave capriciously and upset the whole conditions, either by the gold not dissolving or by the slimes rising up to the top and into the decanter or by falling and allowing an excess of solution to be discharged through the bottom, so that everything has to be re-adjusted. Meanwhile, the cyanide manager is in difficulties and the gold is going to the residue dam instead of to the bank.

By using the decantation process, however, a certain mass of slimes is isolated and detained until a satisfactory extraction of gold has been obtained. In such a plant, if some reserve capacity is allowed for (which is highly advisable in all cases), sufficient time is available to do something with recalcitrant slimes. This is the secret of the success of the larger slimes plants recently installed. With the continuous process a small amount of foreign matter or slimes with peculiar properties may throw the plant out of working at any time. If someone were to find out all about the laws governing the behaviour of slimes and determine the influence of all the many factors involved, it is quite possible that uniform conditions could be established in a continuous settlement plant to give satisfactory results and with an appreciable saving in capital outlay.

In the meantime it is well to remember that the decantation process of slimes treatment has been proven by actual working to be very remunerative, giving a high extraction with low working cost when the plant is properly designed and at a capital outlay fully warranted by the large profits made.

The continuous treatment scheme has possibilities in it, but its financial efficiency is not yet a firmly established fact.

With regard to the results of the intermittent treatment of slimes, as published by Mr. Torrente, it appears that with accumulated slimes of a value of 4.5 dwts. per ton, the extraction on a three-wash basis with a ratio of solution to slimes of 4 to 1 work out at 82.40 per cent. extraction of soluble gold and 73.25 per cent. of total gold.

It seems to the writer that if the slimes were treated by using only two washes, 4 to 1 ratio, and allowing 30 hours for decantation of the first wash, instead of two decantations of 12 hours each, about 2½ tons of solution per ton of slimes might be decanted off.* If both washes were made up of precipitated solution reduced to 0.07 dwt. per ton, the extraction would be improved, giving 89.12 per cent. extraction of soluble gold and 79.20 per cent. total extraction, and the soluble gold thrown away with the residue would be only 0.445 dwt., instead of 0.704 dwt., as calculated from Mr. Torrente's figures. The working costs would also be less, as less solution would have to be circulated and passed through the zinc boxes and there would be one transfer of sludge less to perform. This is all on assuming no additional vat capacity to the existing plant.

Mr. Torrente's figures on tests on continuous settlement, worked out, give 86.74 per cent. extraction of soluble gold and 77.10 per cent. of total gold, whereas plants working on current slimes of only 2 dwts. give by the decantation process a much higher extraction, under conditions which are, however, more favourable to high extraction.

With regard to the discrepancies in Mr. Torrente's paper between calculated and assay values of slimes residues, it would be of value to know by what method these residues were assayed.

The thanks of the Society are due to Mr. Torrente for the time and trouble taken in his experiments and for presenting his results to the members.

Mr. J. R. Williams: By the courtesy of Mr. Torrente, I have had the pleasure of seeing his plant at work on the Crown Reef on accumulated slimes. I think it is quite a new departure, and well worth the attention of the members of the Society, and Mr. Torrente will be pleased, I am sure, to show you over the plant. The difference in conditions, which Mr. Laschinger has not mentioned, is the difference between the treatment of current slimes and accumulated slimes. Mr. Laschinger

is perfectly accurate as far as solution goes, but it must be remembered that whilst you are dissolving gold at a certain rate.

The President: I am pleased to hear the announcement Mr. Williams has made on Mr. Torrente's behalf, and I am sure we are grateful to the latter for promising us an opportunity of seeing the method he has described at work.

SOME STUDIES ON "THE WHITE PRECIPITATE" FORMED IN THE ZINC BOXES OF CYANIDE WORKS.

By Prof. A. PRISTER and Dr. B. BAY
(Members).

DISCUSSION.

Mr. G. W. Williams: Prof. Prister and Dr. Bay have rightly laid stress upon the practical importance of a study of the "white precipitate" for we are all well aware that its formation retards precipitation and increases cost in clean up.

The point at issue seems to be the question as how this precipitate is formed. On this point Mr. Whitby and myself are at variance with the authors of this paper. We contend (I trust Mr. Whitby will allow me to use the first person plural) that this precipitate consists of hydrated zinc oxide, together with ferrocyanide of zinc subsequently formed in the precipitate. The authors of the paper under discussion contend that it is a mixture of cyanide and ferrocyanide of zinc together with some zinc hydrate.

Now if this is correct the formation of white precipitate is a function of the amount of ferrocyanide present in the solutions. This is not the case. I believe that the solution on the mine where Prof. Prister experimented contains over 1 per cent. ferrocyanide at the head of the boxes and 0.05 per cent. at the foot.

Arguing from this it would seem that the Professor considers that ferrocyanide is the primary cause of the precipitate. How does he account for the presence of this precipitate in zinc boxes when the solution contains a mere trace of ferrocyanide? I cannot possibly admit the presence of zinc cyanide as a primary constituent. So long as there is any alkalinity at all present $Zn(CN)_2$ cannot be formed.

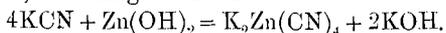
Besides, I have never found cyanide (other than as ferrocyanide) in the white precipitate, except in comparative traces.

I prefer to regard this precipitate as primarily a zinc hydrate; subsequently it becomes partially converted into basic ferrocyanides, carbonates,

* The extra six hours for decantation in this scheme is accounted for by the time of one transfer less.

etc., but certainly not into cyanide in appreciable quantities.

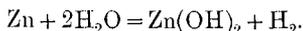
On placing zinc covered with white precipitate in the strong boxes, the hydrate slowly redissolves, according to the reaction



The ferrocyanide is unchanged and remains in the gold slimes at the clean-up.

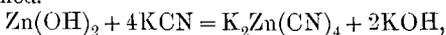
The most curious point in regard to this precipitate is that it always appears first at the head of the boxes, not at the foot, as one might expect. This I have tried to explain as under.

The precipitate is primarily due to the action of zinc on water under the influence of electric action.

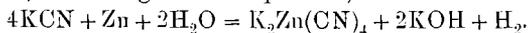


The bulk of the gold is deposited in the upper compartments, hence there is a greater state of electrical activity there and a proportionally greater decomposition of water by the zinc.

So long as the solution contains true free cyanide the $\text{Zn}(\text{OH})_2$ is dissolved as fast as it is formed.



or, combining the two equations,



Hence there is no formation of white precipitate in "strong" zinc boxes containing true free cyanide.

I have noticed that the formation of "white precipitate" appears to be greatest when the solutions are high in alkaline hydrate, and particularly in the presence of much lime, but I cannot give any definite figures to support this.

The authors have regretted that I did not publish the methods I used to determine the composition of the precipitate.

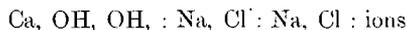
I only mentioned it casually in my paper and did not feel justified in inflicting the time-honoured methods of analysis which I used upon members of this Society, whose time and patience I had taxed severely before I came to that portion of my paper dealing with "white precipitate."

I may say that I determined ferrocyanides by extraction with hot caustic soda, precipitation with ferric sulphate, and subsequent estimation by $\frac{\text{N}}{10}$ KMnO_4 .

I also determined total iron, and the results agreed. The method is quite accurate. *En passant* I would like to say that I consider the method quoted by the authors with brominised caustic potash to be an improvement on the method I used. I intend to check its accuracy when I have time.

I find also that the decomposition of the precipitate may be effected by boiling with salt (NaCl) and lime. In this case no zinc goes into

solution. The reaction is due, I take it, to the ionisation of the two molecules $\text{Ca}(\text{OH})_2$ and NaCl , whereby we have at any moment



acting momentarily as NaOH and CaCl_2 . Caustic lime alone does not decompose the precipitate. I would be glad to hear Dr. Moir's views on this reaction. I confess that I find it a little difficult to explain, but Dr. Moir has a special gift for the interpretation of my ionic reactions. Incidentally his explanations do not often agree with mine.

To return to the question of the formation of this precipitate. The precipitation is only formed within certain limits of dilution, in solutions which contain no free cyanide, true free cyanide that is, not merely the cyanide shown by the silver test, which may be entirely due to dissociation of $\text{K}_2\text{Zn}(\text{CN})_4$.

Some time ago I experimented on the deposition of gold from water containing a mere trace of cyanide, but insufficient to test for with AgNO_3 . In the case under observation the alkalinity was .002 per cent. CaO , the cyanide about .001 per cent., or even slightly less.

A freshly prepared zinc-lead couple extracted quite a fair proportion of the gold with the formation of zinc hydrate on the zinc-lead filaments.

In slimes solution I have observed the formation of the precipitate in the presence of .01 per cent. true free cyanide. I am of the opinion that the formation of the precipitate will not take place whilst there is 0.025 per cent. true free cyanide present in the compartments where the precipitation of gold is most actively going on. In this case the $\text{Zn}(\text{OH})_2$ is redissolved, and accounts for the increase of alkalinity observed in the passage of a solution through the boxes. If this view is correct, the theoretical prevention of this white precipitate is simple. Always maintain the solution in such a state that in the boxes where precipitation is actively going on it never contains less than .025 per cent. true free cyanide. So much for theory. The practical difficulties are very numerous.

The simple method of adding the required amount of cyanide to the head of the extractor box is impracticable. The solution would become saturated, and it would tend to increase to absurd limits the amount of "total" cyanide present. In the case of "weak" solutions this would mean very increased consumption of cyanide, owing to the 12 per cent. to 15 per cent. moisture discharged with the sands.

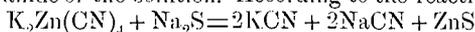
The most correct method is the removal of the zinc before it enters the zinc boxes. This may be effected by regeneration on a large scale.

Let us consider a solution having the following composition at the foot of the box:—

| | | | |
|--------------------|-----|------|-----------|
| “Free” Cyanide KCN | ... | ·06 | per cent. |
| Total | ” | ·17 | ” |
| Total Alkali NaOH | ... | ·065 | ” |
| Zinc Zn | ... | ·042 | ” |

Such a solution consists of $K_2Zn(CN)_4$ for ·042 per cent. Zn=·168 per cent. KCN combined as $K_2Zn(CN)_4$. The ·06 per cent. KCN is due to dissociation of the double salt under the conditions obtaining, and though available for the solution of gold is not able to prevent the formation of the white precipitate.

If 85 per cent. of this zinc is removed by Crosse’s regeneration process, on testing with silver nitrate the whole of the cyanide is found to be free, and 25 per cent. is true free sodium cyanide. Such a solution does not deposit any zinc hydrate in passing through a zinc box, moreover it is extremely efficient on the sands. Hence the formation of white precipitate has been prevented without increase in the total cyanide of the solution. According to the reaction



we see that 98 parts sodium sulphide can regenerate 260 parts of potassium cyanide. That is a distinct commercial gain by this process.

In order to make use of such a process, sufficient solution would have to be regenerated daily to maintain the weak storage sump at about ·05 per cent. true free cyanide. “Strong” solution would be made up in the ordinary way. The regeneration of medium solution would, when required, produce a solution almost strong enough to use as a “strong.”

I now pass to another point in connection with precipitation, viz., the expediency of obtaining a very low residue (below 0·1 dwt.) in the strong and medium solutions.

If the solution entering the box can be reduced to, say, 0·5 dwt. to 0·8 dwt. in 3 compartments, is it advisable to pass it through another two or three compartments to reduce the value to 0·07? To a large degree this question is a mathematical one. I believe that the experiment has been tried on certain mines, but subsequently abandoned.

The passage of a solution through an unnecessary number of zinc boxes implies an unnecessary saturation of the solution with zinc.

I am informed by the Cyanide Manager that at the New Comet fully 50 per cent. of the medium and weak solutions are passed direct to the sumps and only precipitated when they have been used several times. The Comet solutions, in consequence, carry true free cyanide, and during the present month not a trace of white precipitate was formed. The final weak washes are, needless to say, reduced to the lowest possible gold value.

The question I have raised is complicated; it involves not merely the question of consumption of zinc, but it involves also the efficiency of the solution and the formation of white precipitate with its attendant increased costs in clean-up. I may say that I am fully aware that I have treated this subject from a theoretical rather than the practical point of view, but if I can provoke a discussion on the limits of economic precipitation, I shall feel that I have followed the authors’ advice and treated the subject from an economic standpoint.

In this connection I trust that I shall soon be able to lay before the Society certain observations on the precipitation and saturation of solutions during their passage through the zinc boxes.

I subjoin, by the courtesy of Mr. F. Hellmann, analyses of solutions taken from samples extending over 24 hours of the top and bottom of the extractor boxes. The “free cyanide” is the cyanide value obtained by $AgNO_3$ and is obviously not the true “free” cyanide.

| | No. I. | Top. | Bottom. |
|----------------|---------------|------|---------|
| “Free” cyanide | KCN | ·06 | ·04 |
| Total cyanide | KCN | ·22 | ·21 |
| Total alkali | NaOH | ·021 | ·038 |
| Alk. hydrate | NaOH | ·013 | ·025 |
| Alk. carbonate | Na_2CO_3 | ·010 | ·017 |
| Zinc | Zn | ·047 | ·051 |
| Ferrocyanide | $K_4Fe(CN)_6$ | ·04 | ·04 |
| Sulphocyanate | KCNS | ·018 | ·018 |

Not a trace of white precipitate was forming in this box at end of month. The true free cyanide was only ·005 per cent. in the lower box. The increase of alkalinity due to zinc dissolved will be noted.

| | No. II. | Top. | Bottom. |
|----------------|---------------|------|---------|
| “Free” cyanide | KCN | ·06 | ·04 |
| Total cyanide | KCN | ·13 | ·13 |
| Total alkali | NaOH | ·034 | ·042 |
| Alk. hydrate | NaOH | ·021 | ·024 |
| Alk. carbonate | Na_2CO_3 | ·017 | ·023 |
| Zinc | Zn | ·030 | ·036 |
| Ferrocyanide | $K_4Fe(CN)_6$ | ·037 | ·030 |
| Sulphocyanate | KCNS | ·010 | ·010 |

White precipitate forming strongly at end of month. The slight decrease in ferrocyanide is noticeable. Zinc present both as $K_2Zn(CN)_4$ and K_2ZnO_2 .

| | No. III. | Top. | Bottom. |
|----------------|---------------|------|---------|
| “Free” cyanide | KCN | ·08 | ·05 |
| Total cyanide | KCN | ·18 | ·176 |
| Total alkali | NaOH | ·042 | ·051 |
| Alk. hydrate | NaOH | ·032 | ·032 |
| Alk. carbonate | Na_2CO_3 | ·013 | ·025 |
| Zinc | Zn | ·040 | ·048 |
| Ferrocyanide | $K_4Fe(CN)_6$ | ·055 | ·037 |
| Sulphocyanate | KCNS | ·012 | ·012 |

This sample was taken from a strong box containing zinc from slimes plant coated with "white precipitate." The saturation of solution at foot of box with zinc is obvious.

Ferrocyanide also reduced in passing box. As far as could be seen, the white precipitate was slowly dissolving.

Prof. Prister: Without taking part in the discussion, I should like to remind Mr. Williams that we washed the white precipitate thoroughly before analysis, and also to state that we are already studying a means of preventing the formation of this white precipitate in the boxes.

Mr. A. Whitby: The subject of the composition of the so-called "white precipitate" of the precipitation box is one of great interest to the chemist, but beyond the desire of the cyanide manager to be free of it, I do not think it appeals to many others. The authors of this paper have, however, made an analysis of mine of this substance so strongly an objective of criticism that possibly I may be excused if I deal at some length with the many points on which I disagree with them.

Now, I do not intend to return to the discussion of Prof. Prister's original analysis—of which my opinion is already recorded, and which I see no reason to change—but I do intend to take strong ground on Prof. Prister and Dr. Bay's attitude with regard to mine.

It is now a matter of two years since this analysis was made, which was carried out with the sole object of ascertaining what constituted the bulk of the substance and with no definite purpose of a complete analysis. As a matter of fact, my research went further than figures seem to show, and many things were looked for which were not recorded as being of minor importance. For instance, I started out with the idea that a large proportion would be ferrocyanide of zinc, and made a very careful search for ferrocyanides, finding 1·3 per cent. only, calculated as Zn_3FeCy_6 . The total cyanogen was then determined by boiling with mercuric oxide and a little sodic hydrate, filtering, removing the mercury with sodium sulphide in hot solution, adding a little freshly precipitated lead carbonate to destroy any excess of the sulphide and titrating the filtered liquid with silver. This method is given by James in his "Cyanide Practice," but it is referred to in many textbooks as a reliable one for determining cyanogen in all insoluble single and double cyanides. Care must be taken not to add the sodium sulphide too rapidly or in great excess. I adopt the plan of dipping a thin strip of filter paper into the hot liquid and bringing the moistened paper into contact with lead acetate solution, any slight darkening showing an excess

of sulphide. Since the authors of this paper have taken for granted the statement made by me that my white precipitate was soluble in acids, it would perhaps have been fairer if they had given me the same courtesy with regard to my cyanogen figure. Although the adjective "total" was omitted before cyanogen, it is quite clear that all cyanogen present was meant, or I should have qualified my statement. I must admit, however, that the first remark on the solubility of the compound is only relatively true, as there was a slight sediment, which would include silica and the small amount of ferrocyanide present. It was merely given as an argument to show that there could not be anything like the 10 per cent. of ferrocyanide found by Prof. Prister in his precipitate existing in mine.

With regard to the loss on ignition, then, in my precipitate, I am placed in such a position by the authors' statement that it consists of a large quantity of cyanogen, which, according to them, I have failed to account for, that I must perforce explain how my sample was taken and why it was collected in that manner.

It was taken from unbroken filaments of zinc at the head of the weak box, and I was so anxious not to alter its composition by overheating or exposure and also so desirous of not introducing any metallic zinc, that I dried it on a sieve at a temperature of not more than 50–70° C., detaching the white incrustation from time to time by gently shaking on to a piece of paper and immediately transferring to a stoppered weighing bottle. My note book records the fact that of the 36·8 per cent. loss on ignition no less than 16·5 per cent. was lost at 100° C., but I preferred to make my analysis on the material as I obtained it without incurring risks of alteration in drying. This leaves 21·3 per cent. to be accounted for, a much lower figure than the authors obtain in their analysis, and also makes the true percentage of ZnO 64·6, total cyanogen 3·0, and calculated water of hydration of zinc hydrate 15·5. Adopting Dr. Bay and Prof. Prister's assumption of loss due to cyanogen, there is a difference between calculated and actual loss of only 2·8 per cent. Leaving this analysis in its amended form to take care of itself, I now wish to deal briefly with the authors' methods and deductions, at the same time giving outlines of my own, where we differ.

Total Cyanogen.—The authors' first method may be good enough up to the stage of collecting the hydrocyanic acid gas, but personally I prefer to collect in dilute alkali and titrate. There is some liability to contamination of the silver precipitate with sulphates, chlorides or even cyanate in their second method. The assumption that there

exists in the white precipitate as collected by the authors sufficient zinc to effect the decomposition of the double cyanides is not borne out by their table of results, in which no metallic zinc appears. The method I have adopted with uniform success is that of James, and I find it gives higher results than any other. Feld's method of distillation with hydrochloric acid, after boiling with mercuric chloride and caustic soda depends on the same reaction and also gives good results.

Ferrocyanogen.—I do not think there is much fault to be found with Donath and Magroshe's method with brominated soda, and I have obtained fairly concordant results with it.

In their second method it is conceivable that some of the iron not existing as ferrocyanide may become locked up, since I notice that copper finds its way into the precipitate left after solution in acids. If an iron salt is brought into contact with the white ferrocyanide of zinc, I have noticed a change of colour in the precipitate to blue, showing a replacement.

This may be demonstrated in various ways, but the simplest and most applicable in this case is to take a little of the white precipitate known to contain ferrocyanide and add a drop or two of a solution of a ferric salt. On treating this mixture with any mineral acid, such as hydrochloric or sulphuric, it will be noted that the residue has taken on a decided blue colour, showing the existence of prussian blue or in effect iron both as base and as part of the acid radicle. Since we only want the latter, attempts to calculate from the iron content tend to give too high a figure, especially since the factor is excessive.

I may here refer to the misconceptions so generally obtaining of the composition of the ferrocyanides of zinc. Until further research, we must accept E. H. Miller and J. L. Danziger's exhaustive analyses, showing that in acid and neutral solutions only does the formula approximate to $K_2Zn_3(FeCy_6)_2$, whilst in alkaline solution the normal ferrocyanide Zn_3FeCy_6 separates, frequently accompanied by zinc oxide (*vide Journal of the American Chemical Society*, Sept., 1902, also this *Journal*, Nov., 1902).

Loss on Ignition.—Here I am quite unable to follow Messrs. Prister and Bay. Do they really wish to maintain that if you burn off cyanogen from their compound $K_2Zn_3Fe_3Cy_{12}$ that the metals in fine division, remain unoxidised or that zinc cyanide leaves only metallic zinc? Apart from oxygen gained, which in their case theoretically amounts to 4.69 per cent., there is the statement recurring so frequently in the text-books that the cyanides of many of the metals leave either paracyanogen or a carbide of the metal on ignition at low temperatures. This, by the way, may influence

their total cyanogen determination, since silver cyanide is also credited with giving similar products of decomposition in at least one text-book at my disposal.

This all tends to lower their theoretical loss and disturb the symmetry of their conclusions. Taking oxygen gained only, their theoretical loss is lower than their actual by 3.2 per cent.

There is yet another point which I cannot understand, especially since the authors have called me to book for negligence on this matter. If the original sample was dried at 100° C., which, I presume, was the case, whence comes their 8.07 per cent. moisture at 115° C.? Between 100° and 150° C. my loss only amounts to 3.7 per cent.

This brings me to the consideration of some of my own results recently obtained, in which I have attempted in a modest way to explain this loss on ignition. For various reasons I have not been able to make complete analyses, and the research would not have been undertaken at all were it not for Prof. Prister and Dr. Bay's altogether unaccountable statement that my "loss on ignition was not water as Mr. Whitby supposed, but most probably a large quantity of cyanogen." I am quite prepared to admit that it was not all water, but I certainly deny the large quantity of cyanogen.

A sample taken from the head of the weak box and treated in the same manner as outlined by the authors of this paper gave, after drying at 100° C., zinc oxide 61.5 per cent. (total zinc), total cyanogen 3.6 per cent., ferrocyanide calculated as Zn_3FeCy_6 1.7 per cent. Another sample taken from the slimes box gave ZnO 63.2, total cyanogen 1.08, Zn_3FeCy_6 0.68. This bears out common experience with us, since ferrocyanides are either absent or present in mere traces in our slimes solutions.

I have below tabulated the results of heating these two samples at increasing temperatures, showing the percentage loss at each stage and the cumulative loss.

| Temperatures. | WEAK BOX. | | SLIMES BOX. | |
|-------------------|-----------|--------------------|-------------|--------------------|
| | Loss %. | Cumulative Loss %. | Loss %. | Cumulative Loss %. |
| 100—110° C. . | 0.7 | — | 2.2 | — |
| 110—150° C. ... | 3.0 | 3.7 | 3.1 | 5.3 |
| 150—200° C. . | 11.4 | 15.1 | 8.3 | 13.6 |
| Incipient red ... | 5.3 | 21.4 | 5.8 | 19.4 |
| Dull red ... | 0.5 | 21.9 | 0.6 | 20.0 |
| Full red ... | 2.4 | 24.3 | 1.8 | 21.8 |
| Blast ... | 1.2 | 25.5 | 0.6 | 22.4 |

My sole excuse for these figures is that in spite of most conscientious determinations of

cyanogen, they tend to show the existence of some compounds in the material which have eluded my search. The loss at 220° C. may be fairly taken to represent water of hydration of zinc hydrate. From the slimes box precipitate I found 14.8 per cent. water by heating the substance in a current of dry air and absorption in a weighed CaCl_2 tube.

The 8 to 10 per cent. further loss could not be accounted for by loss of cyanogen, so the CO_2 in the weak box precipitate was determined by evolution with HCl and absorption in a mixture of dilute sodium hydrate and baryta water, filtering and weighing the BaCO_3 , which gave 2.3 per cent. Taking the formula of basic carbonate of zinc as $\text{ZnCO}_3 \cdot 2\text{ZnH}_2\text{O}_2 \cdot \text{H}_2\text{O}$, this gives 17.8 per cent., but since the possible combinations of CO_2 , ZnO and H_2O are so many and varied, it is not safe to pin oneself to any particular formula. The net result of my reasoning on this subject is that there yet remains something in this precipitate which eludes our search and only a thorough proximate analysis of the organic constituents may possibly place us in the right track.

Two remarks of the authors are very much to the point. The first is: "You must not forget that the products of the ignition of such a complicated product as the 'white precipitate' are not easy to separate and determine;" and the second is: "Evidently organic matter may sometimes exist in this precipitate and increase loss on ignition." As a rider to these, we may add that, owing to the disintegration of zinc and accumulation of white precipitate, the top compartment of a box may be converted into a very effective filter, with possibilities of considerably adding to the difficulties of research.

With regard to ZnO , ZnCy_2 ferrocyanides and carbonates, these are distinctly factors of the solutions, and will vary as these last are charged with one or more of the constituents under conditions tending to their deposition, but in effect my original contention has been borne out by Prof. Frister and Dr. Bay in their later analysis—that the bulk of the precipitate is always zinc hydrate.

Mr. A. L. Edwards, Barberton (contributed): On p. 417 of the *Journal* Mr. G. W. Williams is quoted as saying that "the well-known white precipitate consisted in the main of hydrated zinc oxide," but on p. 16 of the *July Journal* Prof. Frister terms the white precipitate part ferrocyanide and part cyanide of zinc. The name is quite immaterial, but not so the substance, since whenever this white precipitate occurs, bad precipitation ensues. Owing to the very weak washes used on this plant, a final waterwash is given each tank before discharge. I have had considerable

trouble with this white precipitate, and whether the solutions contained .002 or .02 per cent. alkali seemed immaterial.

It was noticed, however, that no white precipitate showed itself in the strong box, so for the past two months all gold solutions containing over .08 per cent. KC_y were passed through the extractor boxes, and all solutions containing less than .08 per cent. KC_y were run direct into the sumps without being allowed to come in contact with zinc. It was at first feared that the "tails" of the extractor boxes would show a higher gold content than usual, but no difference whatever was found in the precipitation, the outgoing solution giving 2 grms. per ton during the first 25 days, then rising to 4 grms., until the clean-up. Whether the use of a final waterwash has any bearing on our low residues is not definitely known, but the residues have not risen in value since unprecipitated solutions have been used as washes, the residues still assaying .5 dwt. per ton.

I would like to ask whether it is not possible to try the above idea on one of the large plants for a while, for if this could be done, valuable information might be gained.

The method tried here is as follows: After the water has drained off a collected charge, the following solutions were run on:—

1. 10 tons of .05 per cent. KC_y unprecipitated solution.
2. 10 tons of .08 per cent. KC_y unprecipitated solution.
3. 12 tons of .1 per cent. KC_y precipitated solution.

The charge was then allowed to leach dry and, after transfer, 25 tons of .2 per cent. KC_y pumped on and allowed to remain in contact for 6, 9, or 12 hours. The gold solution was then leached off, sand dug over, and weak cyanide solutions pumped in; all leachings from the foregoing were precipitated, provided that the Cy contents did not fall below .08 per cent. All leachings below that cyanide strength were run direct into the sump through a 2 in. pipe coupled up to the receiver by a piece of flexible hose.

We hope by this method to gain the following advantages:—

1. To maintain a good precipitation by having a lesser volume of solution passing over the same zinc area, which is kept always clean and in good condition.
2. No formation of cyanide of zinc, *i.e.*, white precipitate.
3. Lessened consumption of cyanide in the extractor boxes.
4. Less consumption of acid, there being no white precipitate.

I would also like to ask whether it is not possible to link up the pipes of the sands plant solution pump to the precipitated solution sump of the slimes plant and use a weak solution from the latter as a final wash for the sands before discharge.

The meeting then adjourned.

Contributions and Correspondence.

COBALT ORES IN THE BASKET.

It has long been known that cobalt and nickel are invariably present in our basket ores. An analysis of every working cyanide solution proves this, and these metals are also found in the zinc box precipitates. I had hitherto always thought that the nickel and cobalt were inseparably combined with the pyrites. Last week, however, I was watching the Wilfley table at work at the Driefontein-Angelo mill, and I noticed a very fine slate-blue line at the extreme edge of the clean pyritic concentrates. This was collected, and on examination shown to be a cobalt-nickel-sulph-arsenide. It was not possible to obtain complete separation of the mineral from the pyrites, but from the analysis and general physical properties of the mineral it would appear to be either cobalt glance (CoFe), AsS₂, or Speiss cobalt (CoNiFe), As₂. The presence of this mineral accounts for arsenic in the clean-up.

Nov. 25, 1904.

ANDREW F. CROSSE.

RECORD OF A PAN FURNACE RUNNING ON THE TAVENER PROCESS.

The following notes are on a pan furnace run at the Ferreira G. M. Co. :—

| | | |
|--------------------------|--------|-----|
| Cost of building furnace | ... | £75 |
| Repairs | | 20 |
| Total | ... | £95 |

The furnace was seasoned January 1, 1904, with 2,060 lb. lead, 300 lb. being absorbed by new bottom, and it was lighted up on 23 different occasions. A new fire bridge was put in January 25, 1904; also new bricks put around charging door and slag door.

The bottom first showed signs of weakness July 1, 1904, pieces of brick 1 in. thick cracking off and floating up. The bottom was clipped down smooth July 8-15, 1904, and then appeared to be in very good order. Pieces of the brick bottom again started to crack off August 1, 1904.

The channel portion of bottom floated up October 1, 1904. The life of the bottom was, therefore, about 9½ months.

Total weight of charges for period, 105·06 tons.
 " " lead bullion tapped out, 18·79 tons.
 " " (estimated) fine gold in lead, 39,106·05 oz.

Lead bullion, average % fine gold, 7·135 %
 Total weight of lead bullion cut out from old bottom = 12,160 oz.

Total weight of fine gold in this lead (actually returned), 1,040·08 oz. = 8·15 %

Total weight old bricks on hand from bottom and sides of furnace, 2,941 lb.

Total fine gold contained in old bottom and sides, 1,040·08 oz. + 37·16 oz. = 1,077·24 oz.

PALMER CARTER.

Obituary.

Intimation has been received by cable of the death of Mr. HORATIO COLLINS, M.I.M.E., formerly General Manager of the Paarl Central G. M. Co., Ltd.

Mr. Collins joined the Society in 1898, and on several occasions forwarded vigorous contributions to the discussions. The news of his untimely decease will be regretted by all who knew him.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

ANALYSIS OF PLATINUM-GOLD-SILVER ALLOYS. — "The authors find that by the usual methods for the analysis of platinum-gold-silver alloys, the results are too low for the gold and too high for the platinum and silver, but are very accurate for the gold and platinum together. The following method is recommended for the determination of the silver: The alloy, cut into small pieces or rolled out to a leaf, is dissolved in aqua regia (1 vol. of nitric acid + 5 vols. of hydrochloric acid), the solution is evaporated to the consistence of a syrup, and then evaporated to dryness three times with addition of nitric acid, the residue boiled with a few c.c. of water, 2 c.c. of nitric acid, and 2 drops of hydrochloric acid, the liquid diluted to 100 c.c., the silver chloride filtered off, washed well, dissolved in 30 c.c. of a 20 per cent. solution of potassium cyanide, the solution diluted to 150 c.c. and electrolysed. The separated silver is dissolved in nitric acid, and determined by titration with thiocyanate solution."—HOLLARD and BERTIAUX, *Ann. Chim. anal. appl.*, 1904, 9, 287-292; *Chem. Centr.*, 1904, 2, 852.—*Journal of the Society of Chemical Industry*, Oct. 15, 1904. (J. A. W.)

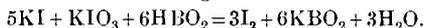
METHODS FOR THE RAPID ESTIMATION OF BORIC ACID.—"The method most in favour at present is due to Gooch, and consists in liberating boric acid from its compounds by acetic acid and heating with methyl alcohol, thus forming the volatile ester trimethyl borate which is completely removed by distillation. Collect the distillate over weighed calcium oxide or sodium tungstate by which the ester is decomposed. The boric acid is thus fixed and after ignition is calculated from increase in weight. This method requires great skill to obtain accurate results.

Berzelius method was selected by Thaddeeff after an extended investigation of other methods. The boric acid is isolated by distillation with sulphuric acid and methyl alcohol, collected in an aqueous solution of KOH, then treated with hydrofluoric acid, potassium acetate and alcohol to separate potassium borofluoride, which is then weighed. The latter, however, is not entirely insoluble in the mixture used, and so this method lacks accuracy.

The most recent attempt at gravimetric estimation is that of Mylius and Meusser. An aqueous alcoholic solution of boric acid is treated with ammonia and phosphoric acid, evaporated to dryness and finally heated in an atmosphere of steam to assist in removing the excess of phosphoric acid before weighing as boryl phosphate BPO_4 . The results show approximate accuracy, but the method has not yet been perfected.

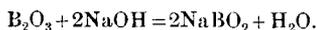
The above show that gravimetric methods are at present wanting, and so volumetric methods must be used if possible.

As is well known, aqueous solutions of boric acid are but slightly dissociated, and alkalies have an uncertain action in the presence of phenolphthalein as indicator, while methyl orange is practically not affected and solutions containing free boric acid react neutral with it. Thomson observed that glycerine increases the acidic properties sufficiently for titration with phenolphthalein. Jones showed that the alkyl compound with mannitol acts quite as energetically on a mixture of KI and KIO_3 as a mineral acid in liberating iodine thus:—



This reaction has been used as the basis of a method for the iodometric determination of boric acid. The author's method is to use methyl orange to indicate when all the boric acid in a borate solution has been liberated and then add glycerine for the titration of the acid in presence of phenolphthalein, thus:—

1. To about 50 c.c. (=1 to 2 grms. borax), add 1 to 2 drops methyl orange solution and standard acid until all the boric acid has been liberated, when the indicator will react acid. In the presence of a carbonate the acid solution is heated a short time with a reflux condenser until the CO_2 is removed, cool, make exactly neutral to methyl orange, add neutral glycerine equal to fully one-third the volume of the solution at the finish, and about 5 c.c. phenolphthalein solution. Then titrate with standard alkali free from carbonate. Calculate according to equation:—



Borates insoluble in water are dissolved in dilute HCl in the cold or with a reflux condenser and then treated as above.

This method will not give accurate results when Al salts are present, as the solution, when neutral to methyl orange, will contain free alumina, which will combine with the alkali when titrating with glycerine and phenolphthalein. Also Fe salts

obscure the colours of the indicators. Hence both these must be removed before titration.

The author finds that if $BaCO_3$ in excess is added to a solution containing free boric acid with Al and Fe salts, all the latter are precipitated and can be filtered off, and if a slight quantity of the acid should pass into solution as borate, this can be decomposed by adding acid. On this is based method

II. A convenient mass of the substance is placed in a flask with an excess of dilute HCl and heated with a reflux condenser. After cooling, the solution is brought to a definite volume and filtered. 100 c.c. of the filtrate (= 2 to 4 grms. substance) are brought almost to neutral point of methyl orange with alkali, 2 to 3 grms., barium carbonate added, and solution warmed on the steam bath half-an-hour, cooled, brought to 200 c.c. and filtered. The solution is then titrated as in I. This method is a good one for the rapid assay of various natural borates which usually contain small amounts of alumina, silica, iron, magnesia and gypsum.

In cases where it is desirable to have the boric acid free from other substances before titration, the author finds that distillation with methyl alcohol and titration of the distillate can be accomplished with rapidity and accuracy and that the interference of volatile mineral acids or carbon dioxide can be eliminated thus,

III. Take a long wide-necked 200 c.c. Kjeldahl flask fitted with a stopper carrying three tubes, one connected to a condenser to prevent any acid liquid being carried over during the distillation, another to supply the methyl alcohol vapour and prevent bumping, and the other to introduce the methyl alcohol needed to form the mixture with the sulphuric acid and the substance, and fitted with a valve to equalise the pressure when necessary. The receiver, which is to be connected with the condenser, is trapped with a Mohr's bulb. For the estimation a weighed amount of the dry finely pulverised substance is placed in the decomposing flask, none being allowed to adhere to the neck. Then sufficient strong H_2SO_4 is added to make a thin paste, and the flask gently treated to expel CO_2 and other volatile acids and cooled. About 60 c.c. of water are placed in the receiver and the Mohr's bulb is also filled. The apparatus is then fitted together and the distillation started by adding methyl alcohol equal to about 20 times the amount of H_2SO_4 present. The current of methyl alcohol vapour is then passed until all the boric acid has passed over. The distillation takes about 30 minutes, and to ensure complete removal of the boric acid, a further distillate can be collected and tested. The water from the Mohr's bulb is added to the distillate, neutralised with alkali when necessary using methyl orange test paper. The titration is then carried out as in I., using neutral glycerine and phenolphthalein. The examples given show accuracy of the method."—Dr. MILTON F. SCHAACK.—*Journal of the Society of Chemical Industry*, xxiii., 13, 609. (J.A.W.)

ACTION OF BEER ON METALS.—"Cold brewery wort, left for some time in contact with sheet-iron, dissolves some of the latter, which can be readily detected in the liquid. When such wort is fermented, a considerable proportion or, in some cases, all of the iron is removed and passes into the yeast. The presence of iron in the beer injures the head-retaining properties. Also, beer in which iron, copper, or tin is immersed, becomes turbid, the action being especially rapid with the first two metals; with lead no turbidity is obtained. With practice, the

author's palate became very sensitive to iron in beer, so that he was able to detect quantities of this metal too small to be recognised by direct chemical tests. These small proportions of iron give to the beer a certain dryness and thinness of taste. The author's experiments show that beer should never be allowed to come into contact with an iron surface, and that contact with bright copper or brass should be as limited as possible. Tinned iron, which is so frequently used in beer filters, racking apparatus, etc., is especially dangerous, and should never be employed. Only well-tinned copper and brass are allowable, and these must be previously treated for some time (at least 24 hours) with beer residues, so that the white surface of the tin becomes slightly yellowish. Such apparatus should never be vigorously brushed or treated with alkalis, otherwise the thin protective coating may be removed. In general, thorough washing, first with cold, and then with hot water is sufficient. But when the wire gauge of the filter becomes stopped up, and it is necessary to clean it thoroughly with brushes and alkali or acid, it should be subsequently soaked in beer residues before being used again. The whole of the tin present in the beer may be readily precipitated in the following manner: 1 litre or more of the beer is rendered faintly alkaline with sodium carbonate, and heated to 60° C, by which means a flocculent precipitate, which readily settles, is formed. The clear supernatant beer is siphoned off and the residue filtered, dried, and ignited, the ash thus obtained being tested for tin. It is probable that the precipitate formed consists of a compound containing tin, phosphoric acid, and protein.—H. SEYFFERT, *Woch. f. Brau.*, 1904, 21, 398-400.—*Journal of the Society of Chemical Industry.*—(A. W.)

RAPID METHOD FOR THE DETERMINATION OF TOTAL SULPHUR IN IRON BY EVOLUTION.—

Two gms. of the sample of iron, mixed with 1 gm. of pure iron dust, are placed in a porcelain crucible and covered with a layer of 1 gm. of iron dust. The whole is covered with a disc of filter paper, the crucible lid is put in place, and the contents roasted strongly for ten minutes by means of a blow-pipe flame. When nearly cool, the mass is decomposed by hydrochloric acid, and the evolved gases passed through a standard solution of cadmium chloride, which is subsequently titrated with standard iodine solution. The results obtained by this method (which occupies less than half an hour) agree closely with those obtained by slower methods, which have been proved to be accurate.—S. S. KNIGHT, *Amer. Chem. Journ.*, 1904, 32, 84-85.—*Journal of the Society of Chemical Industry*, Aug. 15, 1904. (A. W.)

ATOMIC WEIGHT OF TUNGSTEN.—“This has been carefully determined by the authors, who had previously prepared pure tungstic acid, pure hexachloride and pure metal. The methods used were (1) decomposition of the chloride, WCl_6 , with water and weighing the resulting WO_3 , (2) oxidation of pure metal to WO_3 . The mean atomic values were from (1) the hexachloride, 184.04, (2) the oxidation, 184.065, giving 184.05 as average, which may safely be regarded as the atomic weight.—EDGAR F. SMITH and F. F. EXNER.—*Journal of the American Chemical Society*, Sept., 1904, pp 1082-1086. (J. A. W.)

A NEW VOLUMETRIC METHOD FOR THE DETERMINATION OF LEAD.—“The basis of the method is to oxidise lead to peroxide by means of ammonium

persulphate in an alkaline solution, thus removing Fe along with the lead, washing with dil. NH_3Aq (1 : 5) until the blue colour due to the copper disappears from the filter and, finally, four or five times with hot water. Chlorides and sulphates are not permissible, excepting sulphates resulting from the decomposition of the persulphate; manganese interferes, and a small amount of Fe is harmless, but a large quantity would hinder complete oxidation. The PbO_2 obtained is dissolved in a measured excess of acidulated H_2O_2 and the excess titrated with standard $KMnO_4$. The PbO_2 yields $Pb(NO_3)_2$ and O_2 . Hence $2KMnO_4 = 5H_2O_2 = 5Pb$. The theoretical factor $\frac{5Pb}{10Fe} = 1.851$ gives too low results, and the empirical factor 1.92 is therefore used instead, and yields concordant results. The method is not very suitable for high percentages of lead, owing to the tendency of the peroxide to go through the filter, thus oftentimes necessitating re-filtration.”—E. J. ERICSON.—*Journal of the American Chemical Society*, Sept., 1904, p. 1135. (J. A. W.)

METALLURGY.

DISTILLATION OF ZINC FROM CYANIDE PRECIPITATE.—“Mr. G. Howell Clevenger, in a valuable paper read at the New York meeting of the American Institute of Mining Engineers, discusses the nature of the zinc precipitate in the cyanide process and the various methods for its treatment. The entire paper is highly interesting, but in the present abstract the idea is merely to summarise the general conclusions and describe a suggested new process.

Mr. Clevenger concludes that gold and silver are precipitated from cyanide solutions by zinc as alloys or intimate mixtures of those metals with zinc. Of the present methods of refining, smelting with lead after removal of the zinc is the best. It is possible to remove the zinc more completely, and probably at a less cost, by distillation than by acid treatment, and most of the zinc can likely be recovered in a form at once available for use as a precipitant.

It is proposed, therefore, that the precipitate should be dried, mixed with lead and charcoal, and retorted. If mercury be present, it can be recovered at the beginning of the distillation, the zinc being later condensed as dust suitable for further use as precipitant. The residuum containing the gold and silver should be smelted with lead in a furnace like the ordinary cupellation furnace, iron ore and silver being added in such proportions as to give a fluid slag, from which the lead separates. The slag should be skimmed off and the lead cupelled in the usual way, the resulting litharge being used in the next operation.

There is precedent for the distillation of zinc from material high in gold and silver in the crusts of the Parkes process. It appears, therefore, that cyanide precipitate may be treated in a similar way, adding to it a certain percentage of lead to alloy with the gold and silver and charcoal to reduce zinc oxide and carbon dioxide, and through the formation of carbon monoxide to maintain a reducing atmosphere in the retort. Snelman and Teed have, in fact, retorted the precipitate obtained by their bromo-cyanide process at Deloro, Can., but the bullion produced there was very base, containing about 69 per cent. Au and 25 to 29 per cent. Zn. Experiments at the Golden Gate mill, at Merens, Utah, were also unsuccessful, because of failure to reduce the large amount of zinc oxide present. The trouble seems to have been insufficient heat.

Clevenger made experiments with a precipitate containing 16.639 per cent. Au, 23.166 per cent Ag, 14.510 per cent. zinc (as metal), and 10.060 per cent Zn as oxide. This was distilled in a gas-fired graphite retort. In No. 1 a mixture of 300 gms. of precipitate, 500 gms of test lead and 50 gms. of charcoal was heated six hours. Of the zinc, 85 per cent. was recovered; it assayed 7.2 oz. silver and 0.8 oz. gold per ton. In No. 2 a mixture of 400 gms. of precipitate, 1,200 gms. of test lead and 100 gms. of charcoal were heated six hours, beginning at temperature of 22°C. and finishing at 1,414° C. The first sign of zinc was noted 45 minutes after the beginning, when the temperature was 671° C. In this experiment there was a smaller loss by volatilisation than in No. 1. In No. 3 a mixture of 200 gms. of precipitate, 200 gms. of test lead and 50 gms. of charcoal was heated for five hours. The first zinc appeared at 671° C. At 866° C., 30 minutes after the beginning, 9.2 per cent. of the zinc had been distilled. At 1,055° C., one hour after the beginning, 16.1 per cent. had come over. The percentage increased rapidly with the time and elevation of the temperature, until at 1,225° C., three hours and thirty minutes after the beginning, 95.4 per cent. had been distilled. Finally, at the end of five hours, the temperature being then 1,281° C., the distillation amounted to 99.1 per cent. In No. 4 a mixture of 150 gms. of precipitate with 40 gms. of charcoal was distilled five hours, at the end of which time 99.6 per cent. of the zinc was driven off, the temperature at the end being 1,296° C. The first zinc appeared at 750° C.

These experiments showed that there must be ample carbon present to reduce the zinc oxide, and that best results were obtained by raising the heat to the proper degree at once and maintaining it there until distillation is completed. It is desirable to heat to about 1,300° C. to remove the last of the zinc.

Zeitschrift für Angewandte Chemie, 1903, XVI., xii., 269-271.—*The Engineering and Mining Journal*, Sept. 22, 1904. (G. W. W.)

NOTES ON GOLD BULLION.—“It is in the interest of mining companies exporting gold to this country to endeavour to raise the fineness of the bars as much as possible, due attention being paid to economy in the operation.

It is recommended that bars from the cyanide process assaying below 800 fine be re-melted in clay pots capable of holding 1,000 to 2,000 oz. of metal, nitre (nitrate of soda) to be added to the molten bullion, the metal to be stirred up and the nitre to be removed by skimming. Successive quantities of nitre should be added and skimmed until the nitre is colourless. The metal should then be poured into moulds capable of holding about 500 oz. This operation is technically called ‘toughening,’ and the cost of the operation of re-melting and toughening should not exceed $\frac{1}{2}$ to $\frac{1}{4}$ of a penny per oz. of bullion. The nitre slags can be dissolved and the gold collected from the residues, or can be re-melted or used in melting the cyanide precipitate in the first instance.

The refiners here have to do this toughening process themselves and would prefer it done at the mines, a course which appears to be in favour of the latter.

The following figures show what may be saved to the mining companies, and give the data necessary to understand the matter.

Total fine gold in each case is 500 oz.

Price of gold, 85s. per oz., fine.

Penalty for cyanide bullion under 800, above 700, deduct 3 mils.

Penalty for cyanide bullion under 700, deduct 4 mils.

Refining charge, 2 $\frac{1}{2}$ d. per oz., gross bullion;

Melting charge, $\frac{1}{4}$ d. per oz., gross bullion = 3d.

| Weight of Bar in ozs. | Assay. | Fine Gold Contents in ozs. | Gross Value £ | Penalty.. | Melting and Refining. | Total Charges. | Net Value. | Value per oz Fine Gold. | Loss per oz. Fine Gold. |
|-----------------------|--------|----------------------------|------------------|-----------|-----------------------|----------------|------------|-------------------------|-------------------------|
| 625 | 800 | 500 | 2,125 | Nil | £7 16 3 | £7 16 3 | £2,117 3 9 | 84s. 8 $\frac{1}{4}$ d. | — |
| 714.3 | 700 | 500 | 2,125 | £6 7 6 | 8 18 6 | 15 6 0 | 2,109 14 0 | 84s. 4 $\frac{1}{4}$ d. | 4d. |
| 633.3 | 600 | 500 | 2,125 | 8 10 0 | 10 8 3 | 18 18 3 | 2,106 1 9 | 84s. 3d. | 5 $\frac{1}{4}$ d. |
| 1,000 | 500 | 500 | 2,125 | 8 10 0 | 12 10 0 | 21 0 0 | 2,104 0 0 | 84s. 2d. | 6 $\frac{1}{4}$ d. |

The volatilisation of gold and silver is not excessive, and is of no importance, since the zinc can be used again for precipitation. Under certain conditions the zinc can be condensed as dust suitable for use as a precipitate. (Reference may be made to Ingall's ‘Metallurgy of Zinc’ and Convers and De Saules, United States patent, 695,376, March 11, 1902.) The material in the retort at the end of the distillation is in appearance the same as at the start, but close examination shows small shots of bullion all through it, and usually one or two large masses. It can be poured from the retort like sand; no trouble from sticking. The retort is easily cleaned by throwing in a little metallic lead, and shaking the metallic lead around.

Of considerable interest in Clevenger's experiments is the low temperature at which zinc begins to distil over and the large proportion which came over below the boiling point of the metal. The small loss of gold and silver in distilling off zinc is verified by the experience in distilling zinc ores, Parkes crusts, and the recent experiments of Friedrich, reported in

The above calculations are based on 500 oz. of fine gold being produced in each case, but as the refining at the mine is less perfect, so does the weight of bullion increase. Melting and refining charges on this side are levied on the ounces of gross bullion, consequently, the impurities as they increase decrease the net value per ounce fine gold realised. All other charges, such as assays and payments for silver which is paid for per ounce fine silver, and return commission, $\frac{1}{2}$ per cent., are omitted, as they do not affect the question at issue.”—ARTHUR C. CLAUDET, Institution of Mining and Metallurgy, Bulletin No. 2, Nov. 10, 1904. (W. A. C.)

FUSIBILITY OF REFRACTORY MATERIALS.—“This describes a new method of testing the fusibility of firebricks such as are required to resist the highest attainable furnace temperatures, or above 1,800° C. The Ségér system of pyrometric cones, or, rather, trihedral pyramids, is adopted for measurement, the substance to be tested being shaped into a similar

form and exposed side by side with a series of the standard test cones, varying about 20° in fusibility from each other, in a specially constructed crucible and furnace. The latter is an ordinary field forge with a central annular tuyere, and a fan-blower worked by hand or treadle up to 2,000 revolutions per minute. A platform of brown magnesite bricks is laid at the bottom, with a central plug, leaving a passage for the blast, and upon this is placed a cylindrical iron-cased jacket lined with magnesite 10 inches high and of the same internal diameter, forming the stock for holding the fuel. The test-pieces are exposed in small cylindrical crucibles bored out of solid brown magnesite bricks, which, although somewhat less refractory than those made of white magnesite, may be obtained of more uniform texture. The fuel used is a gas-retort carbon known as soft graphite, containing only 1 per cent. of ash, the blast being supplied in such quantity as to burn 20 lbs. to 30 lbs. in about 2½ hours. Fusion is considered to be effected when the top of the pyramid is softened and fallen over to one-half of the original height. In order to obtain the maximum heating effected, it is necessary to determine the place of complete combustion in the furnace, or where the supply of oxygen is still sufficient to prevent the reduction of carbon dioxide by carbon. This is found to be 2 to 4 centimetres above the tuyere, and the support for the crucible must be so arranged as to bring the test-pieces down to this level. The latter are supported on brown magnesite plates standing upon the central plug of Dinas stone, with an isolating layer of white non-ferruginous magnesite which prevents the two surfaces from binding together at temperatures below 1,770° C. The moment of fusion is determined by observing the interior of the crucible through a dark violet glass screen either direct or by reflection, the radiation from the fuel being cut off by a sheet-iron screen laid on the top of the furnace. With this arrangement a large number of experiments have been made on the fluxing power of different metallic oxides upon clays of the theoretical composition $2Al_2O_3 \cdot SiO_2$, which is known to be more refractory than either of its constituents. This was represented by a mixture of equal weights of washed china clay and the best Mussidan fire-clay, which is used for making steel melting-pots. This, however, contains about 15 per cent. of mica, giving a point of fusion 1,780°, 183° lower than that of the Ségur No. 35, which is similarly constituted, but made for a china clay with much less mica. The results of the different additions are contained in the following table:—

| Nature of the Additions to the Clay Mixture. | Proportion. | | Melting Point. |
|--|-------------|-------|----------------|
| | Per Cent. | °C. | |
| Lithium carbonate | 20 | 1,330 | |
| Calined magnesite | 10 | 1,380 | |
| Peroxide of manganese | 20 | 1,400 | |
| Carbonate of lime | 20 | 1,450 | |
| Ferric oxide | 20 | 1,610 | |
| Infusorial silica | 50 | 1,700 | |
| White glass | 20 | 1,710 | |
| Titanic acid | 20 | 1,730 | |
| Zinc oxide | 20 | 1,760 | |
| Red lead | 20 | 1,770 | |
| Fire-clay and china-clay alone | ... | 1,780 | |
| Felspar | 20 | 1,810 | |
| Alumina | 20 | 1,810 | |
| Chromic oxide | 15 | 1,810 | |

The arrangement followed is that of the order of the atomic weight of the different substances added, and their fluxing effect seems to be in the direct ratio of their equivalents. The result given for felspar is considered to be erroneous, as the amount used corresponded to an addition of 3 per cent. of potash to the mixture. That zinc and lead oxides have practically no effect in lowering the melting point is due to the circumstance that they are reduced to the metallic state by carbonic oxide and volatilised as such in the furnace."—G. T. DE SAINT-HARDOUIN (*Revue de Métallurgie*, Paris, Feb. 1904, p. 92). (W.A.C.)

PROCESS OF EXTRACTING GOLD FROM ORES, ETC. —“Crushed pyritic auriferous ores are treated with a solution of an alkali thiocyanate (sulphocyanide), in presence of an oxidising agent (including atmospheric oxygen), and the gold dissolved by the nascent cyanogen, and the hydrocyanic acid set free, are recovered. The residue of the treatment of such ores by the ordinary cyanide solution, are oxidised, to set gold free and to produce in the mass thiocyanate and thiosulphate of an alkali metal or metals, and by addition of a quantity of water in presence of air, a solution is formed by which the gold is dissolved. Or, pyritic residues of the cyanide treatment are oxidised, leached with water containing a thiocyanate, and re-leached repeatedly with the same liquor after successive extractions of the gold.”—H. S. STARK, Johannesburg, U. S. Pat. 769,280, Sept. 6, 1904.—*Journal of the Society of Chemical Industry*, Oct. 15, 1904. (W. A. C.)

MINING.

DEEP LEVEL COAL MINING.—“The author, in conclusion, emphasised the following points, which he had raised in his paper: (1) The difficulties of sinking and working at the greater depth would be, no doubt, easily overcome, as far as mechanical power was concerned. By the more extensive application of electricity underground, the problem of power transmission to the greater distances necessitated by the larger areas would be surmounted. (2) The heat of the rocks will not be so great as was anticipated, probably not more than 1° for each 120 ft. increase of depth. (3) The temperature of the air can be reduced by larger shafts and better ventilating power. (4) With better ventilation the men will be able to work as well at a depth of, say, 3,000 ft. as at 1,000 ft. The more general adoption of coal-cutting machinery, which relieves the pike-man of much of the hardest work, will enable the men at the great depths to give all the superintendence necessary to the working of the machinery. It was the author's opinion that we should be able to reach any depth that workable coal is likely to be found in this country and work the same. It will be a question of capital outlay and competition of the deeper mines with the shallow ones, but a great deal of this can be overcome by large output and also by working the mine continuously day and night, for this is one of the greatest losses we have to contend with. Often the large amount of capital in coal mining enterprise is only used eight or nine hours out of the 24, and this means that the dead charges eat up profits, whereas, if we could work, say, 16 hours, the dead charges would be greatly reduced, and this reduction would pay the interest and recoupment of the extra capital required for deeper mining, without increasing the cost of coal

to the consumer."—Extract from abstract of paper by F. G. MEACHEM, published in *The Australian Mining Standard*, Oct. 6, 1904, p. 506. (W. A. C.)

WEAKEST POINT OF A HOISTING ROPE.—"It has always been assumed that the weakest point in a hoisting rope is at the socket which joins it to the cage, and to compensate for this it is a common practice to periodically cut off a number of feet from this end of the rope and resocket it.

Recent experiments in Germany seem to disprove this and to show that the weakest point is the point that is just in front of or on the drum when the cage is at the bottom. An account of these experiments appeared in an article by Mr. Speer in *Glückauf* for July 16, in which the author gives a long table of tests for tensile strength of old hoisting ropes, made in the experimental station of the Westphalian Miners' Beneficial Association. The results make it appear as though the part of the hoisting rope, which is subjected to the greatest strain, is not, as most generally accepted, located at the lower end of the rope above the cage, but at that part which is in front of or on the rope drum, when the cage is at its lowest position, in so far as this place has to carry the whole weight of the rope besides the cage, the tubs and the hoisted load, and also this greatest possible load, has to be given an acceleration in starting. In some cases which came under the author's observation, the diameter of the ropes at this place had also more or less decreased. On the average the tensile strength of the rope at this place was 25 to 33 per cent. less than that at the cage. The author thinks that endeavours to decrease the legal requirement of a factor of safety of 6 when testing the lower end of the rope, should be resisted, inasmuch as with such a factor of 6 at the lower end, the factor of safety at the rope drum would only be from 4 to 4½.

The experiments are being continued, and will be watched with interest, for if they confirm those already made it will be necessary to revise the common practice in regard to the inspection of hoisting ropes, and to take account of their decreased strength in testing rope calculations."—Extract from *Mines and Minerals*, Oct., 1904, p. 120. (W.A.C.)

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).

(N.B.—In this list (P) means provisional specification, and (C) complete specification. The number given is that of the specification, the name that of the applicant, and the date that of filing.)

(P.) 444/04. H. Monckton. Monckton's porcelain parting dish. 3.11.04.

(P.) 445/04. Brune Schlesinger (1), Edwin George Weldon (2). Improvements in safety gear for mine skips, cages and the like. 3.11.04.

(P.) 447/04. Frederick Conde. Conde's patent boring machine. 5.11.04.

(P.) 449/04. John Henry Pickavance. Improvements in safety mechanism for mine skips, cages, elevators and the like. 10.11.04.

(P.) 451/04. Harry Denham Wedlake (1), George Russel Deare (2). A new or improved explosive and process of manufacturing same. 10.11.04.

(P.) 452/04. Brune Schlesinger (1), Edwin George Weldon (2). Improvements in guide rails or runners for the shafts of mines and the like. 10.11.04.

(C.) 453/04. Adolf Glas. Improvements in the manufacture of milk powder. 11.11.04.

(C.) 454/04. Hammersley Heenan. Improvements in appliances for separating magnetic particles from ores or other granular substances. 12.11.04.

(P.) 455/04. Charles Reeves. Improved elevator for lifting by power (steam, water or compressed air) stones, gravel, sand, tailings, slimes, earth, mud and other liquid matters. 12.11.04.

(C.) 456/04. Herman Charles Woltereck. Process for the production of hydrocyanic acid. 12.11.04.

(P.) 457/04. Thomas William Liddell. Improved means for preventing slipping of driving belts upon pulleys.

(P.) 458/04. George Pearson Wallis (1), George Fox (2). Improvements in the process of manufacture of bricks from sand, lime and other materials. 16.11.04.

(P.) 460/04. James Beatty. Improvements in apparatus for disintegrating diamond bearing earth. 19.11.04.

(P.) 462/04. Alfred Schwarz. Improvements in ore concentrating processes. 19.11.04.

(C.) 464/04. Isaac Anderson. Method of recovering precious metals from solutions. 19.11.04.

(C.) 465/04. Marie Eugenie Anne Catherine Yonek. Improvements in explosives. 19.11.04.

(P.) 467/04. Edwin Ernest Spargo. Improvements in apparatus for conveying fragmentary granular or pulverulent substances or materials. 23.11.04.

(P.) 468/04. Robert Henry Copeland. A new or improved electrical process for the smelting of gold slimes and apparatus therefor. 25.11.04.

(P.) 469/04. John Robert Thurlow. An improved discharge for spitzkastens and hydraulic classifiers. 26.11.04.

(P.) 471/04. John Care Thomas. Improvements in muffle furnaces. 26.11.04.

(P.) 473/04. Edward Thomas Pollard. Improvements in and relating to fluid pressure turbines. 26.11.04.

(P.) 474/04. Anton Ebers. Process of converting hot molten furnace slag into a spray. 26.11.04.

(P.) 476/04. James Marshall Wright. Round wire rope cleaner, examiner and (greaser) lubricator. 29.11.04.

(P.) 477/04. Gustav Adolf Ettlting. Improvements in means for mechanically sorting diamonds. 1.12.04.

(P.) 478/04. William Berthelson. Improvements in fluid driven percussive machines and tools, applicable also to other fluid-driven reciprocating engines. 1.12.04.

(P.) 479/04. Thomas Arthur Hebbard. Improvements in means for recovering gold from mill pulp by amalgamation. 1.12.04.