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Proceedings

AT

Ordinary General Meeting, August 18, 1906.

The Ordinary General Meeting of the Society was held in the Chamber of Mines, on Saturday, August 18th, Mr. E. H. Johnson (President), in the chair. There were also present:—

43 Members: Messrs. W. A. Caldecott, Dr. James Moir, Prof. J. Yates, R. G. Bevington, T. L. Carter, W. R. Dowling, A. Heymann, A. McA. Johnston, A. Whitby, H. A. White, Prof. J. A. Wilkinson, D. J. Arkell, A. J. R. Atkin, G. B. Adeney, W. Beaver, P. Browne, M. H. Coombe, J. M. Crofts, E. H. Croghan, W. M. Evans, J. Gray, J. Higham, Dr. L. G. Irvine, H. H. Johnson, W. H. Jollyman, J. Kennedy, J. Lea, Hy. Lea, M. P. Lee, A. Lichtenstein, J. D. Low, W. P. O. Macqueen, J. McLennan, G. Melvill, C. F. Parry, H. F. Roche, C. E. Rusden, C. B. Saner, S. Shlom, Prof. G. H. Stanley, F. B. Stephens, H. Warren.

12 Associates and Student: Messrs. A. E. Adams, H. C. F. Bell, J. W. Carter, J. Chilton, W. M. Coulter, W. H. Graham, O. Harrison, J. Hiddleston, G. A. Lawson, C. G. J. Moore, A. G. Rusden and Hy. Rusden.

10 Visitors, and Fred. Rowland, Secretary.

The minutes of the last general meeting, as published in the *Journal*, were adproved.

NEW MEMBERS.

Messrs. Croghan and Jollyman were elected scrutineers, and after their scrutiny of the ballot papers, the President announced that all the candidates for membership had been duly elected as follows:

ADENDORFF, JOHN ERNEST, South Randfontein G. M. Co., Ltd., Randfontein. Assistant Assayer.

CANNON, ARTHUR BEAUFOY, Luipaardsvlei Est. & G. M. Co., Ltd, P. O. Box 53, Krugersdorp. Cyanider.

GILES, H. SCUDAMORE, New Rietfontein Est. & G. M. Co., Ltd., P. O. Germiston. Cyanider.

GOSNEY, PERCY, Nicholson, Rhodesia. Mill Manager.

HOLMSEN, SVERRE, French Rand G. M. Co., Ltd., P. O. Box 25, Luipaardsvlei. Assistant Surveyor.

LAWRIE, EVERATT, May Consolidated G. M. Co., Ltd., P. O. Box 50, Germiston.

MACKENZIE, JAMES HAY, French Rand G. M. Co., Ltd., P. O. Box 25, Luipaardsvlei. Surveyor.

MCEWEN, MOSES THOMAS, Clifton Mine, Belingwe, Rhodesia. Mine Manager.

ROSS, OSWIN DOUGLAS, Robinson Deep G. M. Co., Ltd., P. O. Box 1488, Johannesburg.

STOUT, WILLIAM HENLEY, Luipaardsvlei Est. & G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Mill Foreman.

THOMSON, ROBERT WALKER, Rand Victoria Mines, Ltd., P. O. Box 168, Germiston. Mining Engineer.

TIPPETT, J. M., Portland G. M Co., Colorado Springs, Colo., U.S.A. Chief Chemist and Assayer.

TURNER ARTHUR HAROLD, Luipaardsvlei Est. & G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Cyanider.

The Secretary notified that the following Associates have been admitted by the Council since the last meeting:—

ATKINSON, JOHN, Geldenhuis Deep, Ltd., Cleveland. Cyanider.

CAMPBELL, HUGH, Luipaardsvlei Estate and G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Amalgamator.

DAVIDSON, JOHN LINDSAY, Express Mine, Battlefields, Rhodesia. Amalgamator.

DENNEHY, MICHAEL JOHN, Crown Reef Ltd., P. O. Box 1145, Cyanider.

EDGINTON, DAVID, Luipaardsvlei Estate and G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Amalgamator.

EVANS, ALBERT CHARLES, Belingwe, Rhodesia. Merchant.

FINLAY, NORMAN WALKER, Geldenhuis Deep, Ltd., Cleveland. Cyanider.

GREATHEAD, CYRIL HARDING, Simmer & Jack Proprietary Mines, Ltd., P. O. Box 192, Germiston. Mine Surveyor.

HAMILTON, WILLIAM, 156, Hammersmith Road, London, W. Mining Engineer.

JANE, WALTER HOOPER, Luipaardsvlei Estate and G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Amalgamator.

SHAW, JOHN FREDERICK, Cassilis G. M. Co., Tongio West, Victoria, Australia. Assayer.

STEVENS, THOMAS B., Hazelmere, Devonshire Road, Colliers Wood, London, S.W.

THOMAS, DAVID LEWIS, P. O. Box 108, Johannesburg. Cyanider.

TOOMBS, CHRISTOPHER, Meyer & Charlton G. M. Co., Ltd., P. O. Box 11 Assayer and Analytical Chemist.

URQUHART, WILLIAM GRAHAM, Luipaardsvlei Estate and G. M. Co., Ltd., P. O. Box 53, Krugersdorp. Amalgamato

WATKINS, H. T., Glynn's Lydenburg, Ltd., P. O. Sabie. Surveyor.

WHITTINGHAM, JAMES, New Primrose G. M. Co., Ltd., P. O. Box 193, Germiston. Cyanider.

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GENERAL BUSINESS.

The President: In the first place I should like to draw the attention of members to the fact that it has been decided after some discussion at the last Council meeting, in view of the lapse of the period for which prizes were originally given by the different mining houses, to abandon the scheme for the time being; so that for the coming year there will be no prizes other than the Society's gold medal which has always been available.

At the meeting of the Association of Engineers on Wednesday last, when the Messrs. Denny's paper was under discussion, the manager of the Meyer and Charlton G. M. Co. very kindly extended an invitation to the members of the Association of Engineers and also of this Society to visit the mine. The actual date has not been fixed, but I think it will probably be on the afternoon of the 15th of September, *i.e.*, the date of our next ordinary general meeting. I think it will prove an interesting visit, as there are a great many innovations to be seen. I hope that members will read Messrs. G. A. and H. S. Denny's paper and accept the invitation of the Association of Engineers to criticise it, as it is a matter which affects our Society possibly equally with theirs.

Mr. C. W. Lee: I cannot allow this opportunity to pass without a protest on behalf of assayers on the Rand against certain aspersions thrown out against the assay departments of the mines by Mr. T. Lane Carter in his discussion on Mr. Whitby's paper. I think if there is one department on a mine which thoroughly appreciates the value of the material handled it is the Assay Department. I take it that no man in charge of such a department ever relegates his charge of the bullion, no matter in whatever form, to any junior, whether black or white. I consider it an insult to assayers in general to allow such remarks to pass unchallenged.

Mr. T. Lane Carter: I am sorry Mr. Lee has taken this view. When I made the statement I was unfortunate in having to speak from actual experience in the past. I was an assayer for a long time on a large mine on the Rand, and I once had the misfortune to find things disappearing from the assay office. I suspected a certain Kafir, who was a better sleight-of-hand artist than any Chinaman I have met yet. We could not catch him ourselves so we obtained the services of a detective; then one day I opened the retort and pretended to look very closely at it. I drew out the retorted gold and purposely let drop a few pieces, and pretending that I had not seen them, left the room for about ten minutes. There was about 1½ oz. of gold left amongst the ashes on the floor. I came back, looked down, and saw the yellow colour and concluded the fish had not bitten; but on examining the floor a little more closely I found that the 'cute Kafir had taken up the gold and in
the gold had been he had very carefully put pieces of orange peel. We seized the boy and found the gold on him. Now, when I made those remarks about pilfering, I had absolutely no desire to cast any slur on any one, especially assayers. I know how conscientious they are, but no matter how careful a man is, there is always a danger with Kafirs and coolies, and the more I see of it the more I believe that we should try to get rid of our coloured labour and only have men whom we can absolutely trust in the assay office, the mill and the cyanide works. We know, and the daily press proves that pilfering goes on, and my remarks were made with the idea of endeavouring to minimise the danger and with no intent whatsoever of casting a slur on assayers.

Mr. W. A. Caldecott: I should like to refer to the report, which was issued as a supplement to our last *Journal*, of the Chamber of Mines Standardisation Committee on battery screening. This report was the work of various members of the Society, and I think other members, who have occasion to use screening such as millmen, will find it advisable to order their screening by the system described in the report. We cannot expect the screening manufacturers to make screening according to our system unless they know that there is a demand for it. By ordering screening in accordance with the suggestions contained in the report it is possible to specify the exact aperture and wire required, and on receipt of the screening to ascertain whether these definite requirements have been fulfilled or not.

MINING EDUCATION.

By PROF. J. A. WILKINSON, M.A. (Member).

In dealing with that particular kind of education which is to produce students fully equipped for a definite and specific profession, it will be as well to consider the subject broadly from several points of view. The first is the preliminary training of the school, the second is the real training in the college, whilst the student is still attending lectures and laboratory practice, and the third the post graduate course during which problems are being investigated and solved. In addition to these, we might, under such a broad title, include the education of

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those students who are engaged in mining and metallurgical operations throughout the day and desire to take advantage of instruction during hours of leisure. It is not, however, my intention to deal with the latter class, as they form a totally separate and individual section, as was clearly pointed out by Professor Lawn in his criticism on Mr. Daniell's paper, read before this Society nine years ago.* This paper, and the discussion consequent thereon, dealt with the pressing needs of this community for instruction in those subjects, which are reqnired for a thorough perception of the problems and questions a mining engineer is called upon to solve, and that the author and his critics were completely justified has since been shown in the reception which was given to the evening classes held prior to the war, and to that success which has met the efforts of those who have conducted the fortunes of the institution created since the war. Concurrently with the rise of the latter, we have also seen the establishment of primary and secondary schools throughout the country, and it is upon these that we must rely for what has been termed above "the preliminary training." Four years, however, is but a small period in the educational life of a new country, and when that life must practically be a commencement from the lowest stage upwards, the difficulties which have to be faced and even surmounted are of no mean order. For those who are interested, the tale of these is told in the various Education Department reports.†

This preliminary education should consist in a broad and liberal training in languages and science, and I should up to this stage deprecate any undue specialisation in any one branch. On the other hand, I would strongly insist upon the fact that science should take its proper place among the subjects of the school curriculum, and, further, that it should be taught not merely by word of mouth, but by the aid of practical demonstration. The cost of such an undertaking has hitherto been somewhat of a nightmare to even enthusiastic educationalists, but for ordinary school purposes the cost is not great if care be exercised, firstly, in the selection of experienced people to carry out the work, and, secondly, in the purchase of proper material.

The coping stone of this training is now generally admitted to be success in the matriculation examinations of the various colleges and examining bodies in the world, the more modern of which place all languages on the same level, thereby delivering themselves from that fetich, which for so long has been worshipped, the dead languages of Rome and Greece. For the mining, and indeed for any scientific profession, it may here be stated that the living languages of France and Germany will be found much more useful than the others, if the mining engineer has any desire to keep in touch with the work of his confrères in those countries. Moreover, from the teacher's point of view, instruction in these languages, if carried out by the modern methods evolved by the modern language schools in European and American universities, can be made as useful a means of culture to the pupil as the long-established and often deadly routine of Latin and Greek. As far as scientific subjects are concerned, no doubt will occur to one as to what is most required as an introduction to a career in mining, and under this heading I include mathematics.

Assuming then a complete preliminary training on the broadest lines, the student then enters upon his professional training as a mining engineer. As to the subjects which are required from him during this period, there is no conflict whatever, as can easily be determined by a perusal of the syllabus of any good mining school throughout the world. The time, however, which is devoted to the whole course or the several portions thereof is a matter on which there is considerable diversity of opinion, as will be shown later.

The subjects recognised as forming the integral portions of a mining course are fortunately not open to question, and these, in all proper mining schools, are as follows:—Mathematics, chemistry, physics, geology, engineering, mining and metallurgy. Considering these subjects as a whole, we see that they fall naturally into two divisions, the first consisting of the first four subjects mentioned, and the second of the rest. Another classification one might propose is that of fundamentals and essentials, each supporting and being necessary to the other. In all mining schools of repute stress is laid on a thorough training in mathematics, chemistry, and physics, as without this sure foundation further progress in the technical branches is rendered abortive. The latter words connote not merely the successful issue of prescribed examination tests, but the true solution of the problems presented to a mining engineer in the course of his after experience.

If a mining engineer is to be regarded as a machine, or as a necessary cipher in the ordered regularity of a successfully working process, then it will be unnecessary to do more than pass the required tests. On the other hand, if he is allowed or even expected to grapple with the knotty problems presented during his career, then something greater than a mere diploma is required as a

* See this *Journal*, Vol. 2, pp. 156-163, and discussion by Professor Lawn, pp. 208-212, and Mr. Robinson, etc., pp. 217-222.

† See reports of the Director of Education, Transvaal, 1901, 1902, and onwards.

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certificate of his competency. The sister sciences of chemistry and physics, a real working knowledge of the laws of energy and matter and a true conception of their intrinsic value, form the surest and only foundation on which to build a training such as is required for this profession. These in turn are based on and demand some knowledge of mathematics, and if this be so for the elementary study of the subject it is infinitely more true of the higher. The technical branches of these subjects are studied later and form but an extension and application of the fundamental laws learnt during the previous years.

From this it will be understood how imperatively necessary and increasingly important becomes the need for the excellence of the training required in the earlier years of the course and for the recognition of this elementary principle. The British temperament, both at home and in the colonies, is wont to jeer at such a statement stress being laid on what are ignorantly called "practical subjects" as opposed to so-called "theory," or in common parlance the "practical man" in contradistinction to the "theorist." On every side we hear so much of the "practical man" that it will be worth while, at this stage, to examine his pretensions to a place in a scientific profession. The term as ordinarily used is generally understood to mean the person who has not had the advantage—usually in this connection qualified by the word "doubtful"—of a college training, but who has gained his knowledge by an early apprenticeship to his profession. Long contact, strenuous devotion, many hours of reflection on the past, a sturdy attempt to overcome all difficulties in the future combine to produce a man self-reliant, persevering, and in every sense worthy of the profession. But when to these is added a fundamental training, you have then one, who is as near perfection as it is possible for human effort to make. Practice alone or theory alone cannot give us the desideratum we require. "Together they are invincible," says Professor Christy, and if you will allow me to quote again from this paper,* "The purely practical man has indeed accomplished wonders but at the cost of enormous waste of money, labour and human lives. For every success that he has made there are a thousand failures which only the thoughtful notice. There is no profession where practical experience is more essential than in mining, but the necessity of a sound, scientific training is even more indispensable. A hard-headed Arizona miner once put the matter very tersely when the superiority of the 'practical man' was being strongly urged, by saying: 'I have had thirty years' practical experience in mining, and I would give twenty-five of those years to have had a good technical education to begin with.'"

That such a statement is true, I imagine no one who can speak from experience will for a moment doubt. Genius is most certainly to be found in the ranks of practical men, but for one of this class there are a thousand who can take no higher rank than that of mediocrity, and it is the latter that forms the drag on the wheels of mining progress. To the practical man's genius we owe many of our most notable advances in mining and metallurgy, and to such a genius we do respectful and even reverential homage. As Prof. Christy says of his own countrymen:* "Everyone who has mixed with American miners has met and honoured many such uncrowned kings." And the same is most certainly true of my own countrymen. If, however, the majority are mediocre in type, would they not have been better men, if they had had such assistance as is implied by a college training? I venture to think that but one answer can be given to such a question, but should anyone dream, even for a moment, of a negative, let him ponder over the statistics of, and curves showing the mineral production of the United States of America for the last twenty years, a country where this fact has been fully recognised, and he will find that these curves coincide with the numbers of college-trained men who have found their way into this and the allied profession of chemical industry, more particularly that branch known as metallurgy.

Assuming, then, that the fundamentals are an important, if not the most important, portion of the course, how much time is it necessary to devote to this preliminary period? This time will necessarily depend upon three factors, namely, the state of preparedness or otherwise in which a student enters upon his course, the minimum amount of time required during the full course for his training in the applied branches, and the full period allowed at the particular college chosen for study for the complete course. As regards the latter, after some experience, I have no hesitation in saying that four years is the period, which can be considered as the minimum. Some of the prominent mining schools of to-day only give a three years' course, but when one takes into consideration the number of subjects required to be taken and the proficiency required in each, it will easily be seen that three years is much below the minimum for adequate preparation. This fact is now being steadily recognised in all those schools which have hitherto adopted the three years' courses,

* Present Problems in the Training of Mining Engineers by Dr Samuel B. Christy, Professor of Mining and Metallurgy, University of California. Transactions of the American Institute of Mining Engineers. Vol. xxxvi., p. 424.

* *Loc. cit.*

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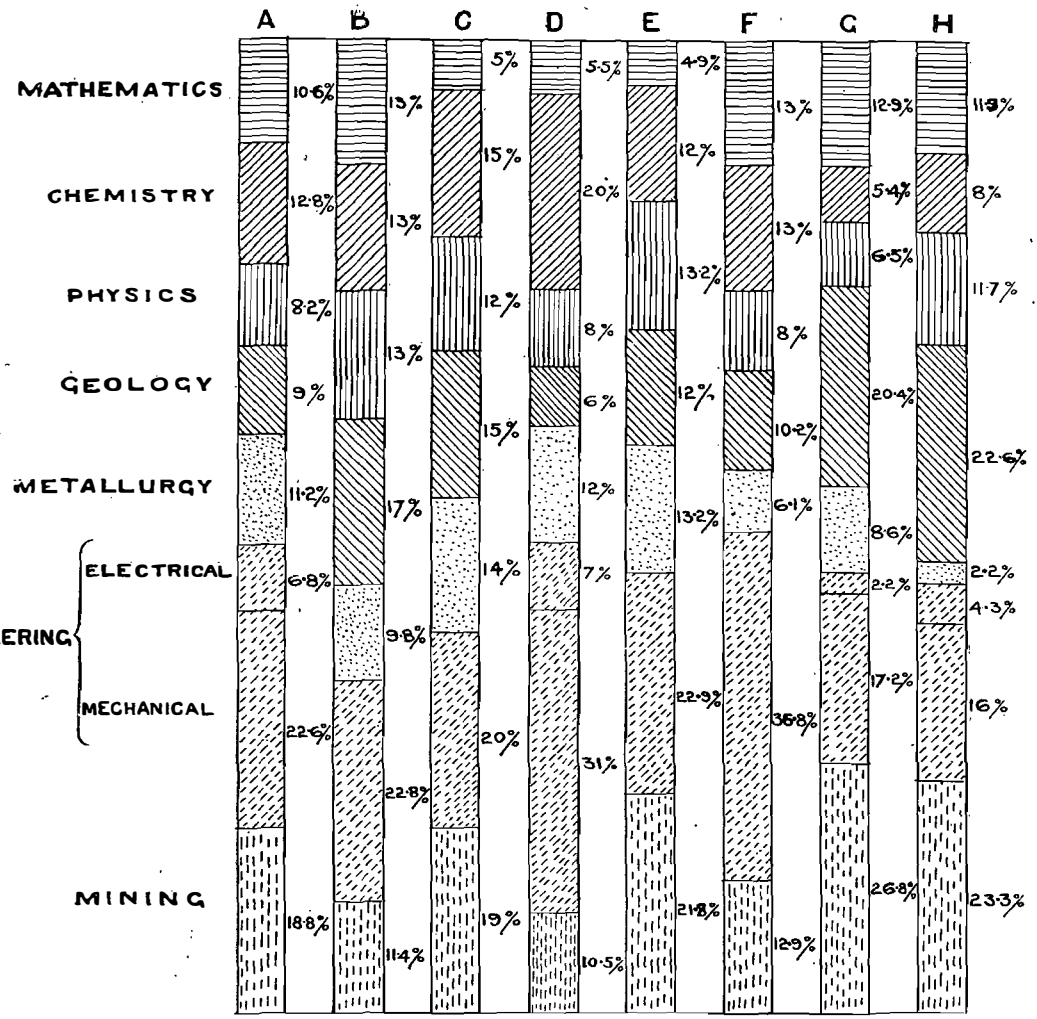
this case being similar to that of the medical profession where, some years ago, the time of preparation was increased legally to five years as the minimum.

On this assumption that a four years' course is necessary, two years of this will be required for the fundamentals, even assuming a matriculation knowledge of elementary science. The chemistry required must serve partly as a basis for that now large branch, metallurgy, and if this is to be pursued with effect, it is desirable that the elements of qualitative and quantitative analysis should be mastered, as well as a corresponding knowledge of the theoretical portions of the subject, more especially that portion commonly spoken of as physical chemistry, the importance of which cannot be over-estimated, and which is a creation of the last decade of last century. Physics will serve as a basis for its applied branch, engineering, and geology will serve as an introduction to mining proper. Mathematics, so necessary to all, finds its more practical applications in surveying. A mere superficial acquaintance with any or all of these subjects is worse than useless, and this cannot be insisted upon too much. Students themselves are often defaulters in this respect, and to such an extent is this sometimes carried that even the best of them will scarcely do more than obtain the marks necessary for a pass, whereas the same students will in technical subjects obtain high percentages, thus showing, as one might expect, their entire lack of true perspective, and in many cases the influence of environment. The



A. TRANSVAAL. B. CALIFORNIA. C. LONDON. R.S.M. D. DURHAM.
E. BIRMINGHAM. F. CANADA. McGILL. G. FREIBERG. H. CLAUSTHAL.

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remaining portion of the time is left for the applied and strictly technical subjects, namely, engineering, mechanical and electrical, metallurgy and mining. This division of the course into halves approximately for fundamentals and essentials is now generally accepted in all the best mining schools of to-day, as is easily seen by reference to the preceding diagram.

This diagram has been compiled from the data given in the calendars of the institutions referred to and also from data given in an invaluable publication* by one of our honorary Vice-Presidents, Mr. Hennen Jennings. Owing to the errors incidental to such a compilation the proportions given are not absolutely correct but are approximately so for all practical purposes. It is also only right to state that lack of literature in this respect here makes it extremely difficult to obtain strictly accurate data. Sufficient evidence, however, can be adduced from the above to show the general concordance, taking into account the relative status of the candidate at entrance. The conditions obtaining at the local institution will also be seen to be the happy mean of all the others, a proportion which has been worked out entirely with reference to local conditions.

Before leaving this subject of fundamentals I desire to quote what Professor Christy, one of the most experienced of American mining teachers, says of the requirements for his own people.† "That which is most necessary is to insist more and more on a solid foundation of scientific training to begin with. If we can secure for the American mining student a foundation training broad, deep and thorough in mathematics, physics and chemistry, he needs little else to make him invincible. The mining engineer must have a broader basal training than either the civil or the mechanical engineer, even though he specialise less. Mathematics, physics and chemistry are necessary for all engineers: the training of the mining engineer cannot be too thorough in all these subjects. Each is an essential support to any superstructure that he may desire

Such a verdict from so eminent a member of our profession should be sufficient proof of the validity of the statements made above and the arguments adduced therefrom.† In another place Professor Christy remarks on the malady from which the American student suffers and which, as stated above, afflicts our South African types. "The necessity for thoroughness in this fundamental work cannot be too much emphasised in American mining schools. The impetuous preference of young Americans for what they deem 'practical' is a serious hindrance to real achievement; and the only way to remove it is to convince them, at the very start, of the power and value of science. This can best be done by leading them, from the beginning, to apply science to some useful purpose. In short, they must be taught by experience the truth of Ostwald's saying: 'The science of to-day is the practice of to-morrow.'"

If then it be granted, that these fundamental subjects are so important as to require such a thorough treatment, surely that must imply that during the latter two years of a student's course his studies will consist in the application of these laws to practical problems. And in its broadest aspect this is merely stating a self-evident truth. Engineering is merely the employment of the principles of physics and chemistry to the practical needs of every day life. Geology is the study of these principles in their particular application to the various phases of the earth's progress and history, and the later developments of chemistry and physics in the hands of such masters as Ostwald and Van 't Hoff are tending to bring geological problems more and more within their realm, a statement which is also equally true of metallurgical problems. Metallurgy is one of the technical branches of chemistry itself, and equally with every other branch of chemistry is governed entirely by the fundamental laws of the physical sciences. Electrotechnics similarly is but one of the technical branches of physics. Mining itself takes from these what it requires for the elucidation of its own particular problems.

To the professional mining man two years will seem a period short enough for the intelligent study and thorough grasp of the subjects which I have here enumerated as "essentials," an opinion with which I am ready to concur. If, however, this period is utilised in the study of the guiding principles of these subjects rather than in the wearisome repetition of unessential details, the period of time allowed should be sufficient, assuming that the introductory period has been satisfactorily overcome. During this period it is also just as necessary that lectures and laboratory work should progress hand in hand, the one without the other being of little, if any, service. In engineering, metallurgy, and electrotechnics this can be accomplished by proper apparatus and buildings on the spot, but with regard to mining proper the case is very different. Two methods of solving this problem have been adopted, the one more generally accepted being a period, varying from three to six months in different schools, which every student is compelled to undertake before he can

* Notes on the Systems of Technical Training in Mining and Metallurgy obtaining in America and Germany, as compared with that of Great Britain, by Hennen Jennings. Published by the Institution of Mining and Metallurgy.

† *Loc. cit.*

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obtain his diploma, and which is spent on an actually working and producing mine in the study of its several branches from the time the ore is mined to the period when it yields its metallic contents. Most of the teachers in our profession consider such a period of probation as one of the most valuable portions of a student's career, a statement which it would be difficult to controvert. But as to the exact time when such a course should be inserted is open to question, and my own opinion in this matter is that it should not be undertaken until the end of the third year of study, when the student is sufficiently grounded to understand some of the problems which are presented in actual practice and with which he is confronted to a certain extent during this period. Lectures in mining, if given before this stage, can be amply illustrated by visits to mining works, and, further, it must not be forgotten that other subjects require and demand also some acquaintance with actual practice at this stage. Should mining work be intruded before this, it must tend to weaken the influence of the study of the other subjects, which at this part of a student's career should, as far as lectures, etc., are concerned, be drawing to a close, leaving the last year as a year of specialisation and the application of principles previously learnt to the solution of the problems presented in mining practice.

The other solution of the question is to have an experimental mine attached to the school, but as far as the author is aware, this plan is only adopted at one school, that of the Birmingham University. Here it has been in use for such a short time that it would be impossible to speak dogmatically of its advantages or otherwise to students as compared with actual mine practice obtained at other schools.

Arrived at the end of his four years' course of study, the student goes forth armed with his diploma with a feeling of youthful enthusiasm for his future work and an inexperience which often makes him insolent in his demands for the highest posts of his profession. Here, however, he is brought at once into contact with the "practical man," at whom he jeers and scoffs, haughty in his full knowledge, as he imagines, of everything in his profession, and pharisaically scornful of the ignorance of the others. *Experientia docet* is an adage which he has sometimes heard, but whose meaning he does not yet comprehend. Fortunately, the attitude of his rivals is now tolerant, more so indeed than in past years, when the diplomé was a rarity in the profession and rivalry was keen. Since then the steady influx of the latter has tended to allay such contests, and so much so is this the case in America that college graduates are sought for by professional engineers in preference to all others. In England the case is almost, but not quite, the opposite. Here we may be said to be in the intermediate stage, the graduate taking his place side by side with his less fortunate confrère who has not had his opportunities. Given equal abilities, there is but little doubt as to who will generally win in such a race. There is, however, unfortunately a tendency to unrest on the part of the former college student in the struggle, to a desire to reach the highest posts without the drudgery of climbing the ladder of practical experience. His conceit of knowledge, sometimes imbued with the flimsiest reality, places him in his own estimation on a level with the best, and he fain would stand upon the pedestal he has reared for himself. This is the mental condition of many an one, and fortunate indeed is he, who is gifted with a clearer vision than this. It is the real existence of this artificial distinction that has brought about the conflict with the "practical man," and the sooner a college student learns that his diploma is but a means of assistance in the battle of professional life against his competitors, and not a method by which he can abridge the earliest years of an essential experience, the quicker will be his future success and the surer will be his position in the end.

The third point from which this problem of mining education should be viewed has hitherto been omitted, namely, what was termed the post graduate course. Unfortunately, many a student has not the means at his disposal for the extra year or years at the end of his examination terms, which such a course would involve, and on the other hand with that lack of foresight, the common endowment of this class of people, the majority of students, with characteristic hauteur, do not consider it either beneficial or necessary. Further, in the case of those who would desire it, and yet have inadequate means to pursue it, the usual means of provision in the form of scholarships or fellowships is not forthcoming. In South Africa generally, and most of all in the Transvaal, such endowment is at the present moment absolutely non-existent, one of the most painful statements of fact, which an educationalist can possibly make. In America, on the other hand, the case is almost an exact opposite, private munificence, aided by State grants, having most royally abridged this gap, as well as providing buildings and equipment, all sufficing for this and previous courses.

The value of this extra year of study is a matter on which there are no two opinions, as it will teach the student far more concerning his own original powers of solving problems, such as he may at a later stage of his career meet with, than any other method.

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Further, during the earlier years of his professional work it may be assumed that he will be engaged in studying the well ordered routine of successful practice rather than in unravelling the difficulties of new and doubtful experimental trials, which demand the knowledge gained in earlier years at college, with the lessons taught by later experience.

It would be useless to dwell further on the real and sterling value of this post graduate study, but before leaving the subject, one example may be adduced to show what such a course may mean, not only to the student, but to the world. A young American student, whilst still working in the laboratory of Oberlin College, Ohio, at the problem of the electrolysis of alumina, discovered during the course of his research that this operation would proceed satisfactorily in a bath of fused cryolite. This discovery at once revolutionised the metallurgy of aluminium, and what that has meant to the world is well known to all.

Such a course as this presupposes a good equipment in the institution where it is undertaken, but this matter is too wieldy a subject to be handled now. Suffice it to say, that equipment, especially for the laboratory, is a million times more needful than gorgeous architectural piles of brick and mortar, and, further, an institution is only worthy of the name when its deficiences in this respect are trivial, no matter how pleasing to a people's vanity its exterior may appear. To put the problem a little more bluntly, I ask, if you are given a limited sum to build a stamp mill, which do you think of first, the mill or the building in which you will house it? *And how would that money be spent most* advantageously? The same argument is in practice found to be applicable to most educational institutions.

Such a course as the one sketched out above will lead, if pursued in South Africa, to the creation of a school of mining engineers who will be able to hold their own not only in our own country, but anywhere on the face of the globe. The goodly record of the past, the breathless mining activities of the present, and the brilliant promise of the future will be their inheritance. The days are long since past for Mark Twain's definition, "A mine is a hole in the ground and the owner thereof is a liar," to be applicable. Mining with agriculture are the fundamental necessities of this new country, and the local conditions are so peculiar that, if scientific skill is not utilised in advancing their progress, if men are not trained to husband the agricultural and develop the mineral resources, it must inevitably return to the obscurity, whence it has just been rescued.

The President: We certainly owe a very hearty vote of thanks to Prof. Wilkinson for the manner in which he has dealt with this very extensive I think he also deserves our congratulation on what I think is his maiden effort in this Society. I hope it will lead to an exhaustive discussion, and one which may be applicable later on to that youthful University of which we are all so justly proud.

Mr. A. Whitby: In seconding the vote of thanks to Prof. Wilkinson, I should like to mention a system that is sometimes adopted in America, which I do not think the author has referred to. We all hold the view that practice must go hand in hand with theory, but this system seems to present aspects more likely to be productive of benefit to young men engaged in the technical work of mining. I refer to the opportunities sometimes afforded young men to work alternately six months on the mines and six months in one or other of the mining colleges. In many cases their billets are kept open for them, and with a little economy the student can set aside enough to pay for his six months' collegiate course. The question as to whether the student should acquire a practical knowledge of his subject before or after he has completed his college training will, I hope, be considered in the discussion on Prof. Wilkinson's paper.

Mr. H. Rusden: I should like to call attention to what, I believe, is an error. Mr. Wilkinson states that there is only one college that he knows of where a mine is worked in conjunction with it. I should like to point out to him that there is also one at Camborne, namely, the King Edward Mine, which is a producing property, worked entirely by the students of the Camborne School of Mines.

Mr. G. B. Adeney: I should like to mention what is being done at the Royal School in the way of a post-graduate course. Two or three years ago they started a post-graduate course in Western Australia. There the student has to spend two years, working in every department. This year they sent out six to South Africa, of whom I had the honour to be one. We work in every department of the mine, six months on the surface and six months underground. It struck me that not much was known about us among mine managers, and that if they knew more of what we were doing we should learn
time, but I believe it has not been the same with all of us.

Prof. J. A. Wilkinson: What the last speaker designated as a post-graduate course, is really a practical course in the various branches of mining and metallurgical work on a fully

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developed and producing mine. A post-graduate course, such as was mentioned in my paper, is intended to mean something entirely different, namely, a year devoted to original investigation in a University or institution of university rank. The "good time" which the last speaker stated he was indulging in, is somewhat of a different nature to the good time spent in research work. Concerning the practical course in mining mentioned above, my friend Professor Yates will be able to speak on that matter with authority, as it lies within his province, and I hope that he will mention this in his promised contribution.

Mr. C. B. Saner: I wish to take exception to one remark, namely, that we have no magnificent buildings for educational purposes. America has been in existence for many years, and we have only started on our career. I am sure that some of our magnates, just as their American cousins have done, will contribute towards buildings here and give their money for educational purposes. I think, seeing that the Transvaal has only been in existence a few years, we have not done so badly.

Prof. J. A. Wilkinson: I think Mr. Saner has misunderstood my meaning. I did not cavil at all at the fact that we have not magnificent buildings, I think my expression was that it was far better, if you have a limited sum at your disposal, to have equipment rather than a gorgeous architectural pile. The buildings will follow. I know perfectly well that we have only been in existence a short time, but what we require first of all is equipment.

The President: I think what Mr. Adeney meant was that he was getting a good deal of practical knowledge of his profession.

Mr. C. B. Adeney: Thank you.

ROUTINE ASSAYING ON THE RAND.

(*Read at March Meeting, 1906.*)

By A. Whitby (Member).

REPLY TO DISCUSSION.

Mr. A. Whitby: It is a matter of regret to me that this paper has to some extent failed in its intent. Knowing well that there were many details in our work of a controversial nature, and many different ideas of the way in which practical assaying may be carried out, I purposely confined myself to broader issues, hoping that thereby I might induce the general body of the profession to participate in the discussion. But, with few exceptions, assayers have maintained a reticent attitude and declined to contribute.

Prof. Wilkinson, as might be expected, deals with the academic qualities of a balance room. We are, however, more concerned with the mere possession of a balance room of any kind which shall be distinct from the rest of the laboratory. Double brick walls, with air spaces between and other contrivances for producing equality of temperature, may be very well in theory but in practice a 9 in. brick wall would have to serve, and I think with Mr. Laschinger's modifications of the furnace arrangement and the ample dimensions of the furnace room given in my sketch, no trouble would be occasioned. The suggestion of a glass partition, or of dividing the office from the balance counter, is a good one. I might offer it as a suggestion to Mr. Rusden that a very interesting paper might be written on the assay of bye-products, but, as the subject requires more time for experimental work than I can afford just now, I would prefer to leave the matter over.

Mr. White's contribution to the discussion is distinctly interesting, although some of his statements can scarcely be considered as criticism. He speaks of "nitre being usual and red lead not a favourite." Quite so, but why are they so? In my paper I stated that nitre gave me lower results, and no one will question this further statement that nitre causes an excessive ebullition. That red lead is not a favourite only goes to prove the conservatism of the assayer since it materially reduces the size of the buttons without affecting the result, and is recommended by many well-known authorities. Before committing himself so far as to ascribe to me the statement that one A.T. of litharge can give a 35 grm. button of lead, I think my critic might have read the text a little more carefully. The whole gist of my argument lies in the little paragraph which Mr. White overlooked. It is the keystone of my practice, this judicious addition of litharge and carbonate of soda, to keep the button of lead soft and free from sulphur, iron and any other reducible bodies.

With Mr. White's objection to borax, and his remark that he can form no idea of any equation of reaction supporting my contention that increased pyrites require an increase of soda, I wish to deal at some length. There are, to my mind, many reasons why borax should not be considered an effete superstition. The following apply to charges where borax has not been used :—

1. The pot requires constant watching or the charge will creep over the side.
2. The fusion is considerably retarded.
3. Greater heat is required than is usually attainable.
4. The slag is in consequence pasty and flows badly.

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5. The other fluxes must be increased unduly, to the detriment of the life of the pot.

6. Comparison has shown no higher results obtainable.

There is no objection to slag surrounding the button so long as that slag is what it should be with Rand ores, a transparent green of varying depth of colour corresponding to the amount of ferrous oxide it contains. That the action of borax in reducing the size of the lead button is due to surface tension I cannot concede. Were this the only explanation, why does too much borax cause the button to retain sulpur?

With regard to carbonate of soda, why is it credited in many text books with a desulphurising as well as a fluxing action?

Chemists are rather prone to consider reactions and to assign equations from the standpoint of observation and induction supplied by the behaviour of liquids at familiar temperatures, and to overlook the possible alteration of conditions at the temperature of fusion. A fusion may be considered as the result of a number of oxidising and reducing actions, none of which are clearly defined. Recent discoveries in the lime roasting of galena, where calcium sulphate, an inert body, is made to play the part of oxygen carrier, bear somewhat on the subject, and teach us that at high temperatures many things may happen of which we can only form the dimmest conception. It appears to me probable that even the CO_2 in some carbonates exerts in fusions an oxidising power, although the fact has been frequently denied in connection with sodium carbonate.

But to return. Let us consider what is the most easily fusible body likely to be formed in a charge containing carbonate of soda, borax and litharge. It is apparent that the double borate of lead and soda is the most readily produced, and I think that in charges where the reducing action is confined to the iron and sulphur of the pyrites, that this body plays a most important part, first in sintering the charge and then in bringing both soda and oxide of lead in contact with particles of ore just at the moment when the main fusion is commencing and the pyritic particles are being liberated from the silicious gangue.

*Beringer says that when the carbonate of soda present is in excess of the silica the tendency is for the sulphur to form sulphate, whereas when the quartz is in excess and the slag acid SO_2 will be evolved. Now I incline to the opinion that borax also acts as an acid, and in this way. We do not as a rule add sufficient soda to form an easily fusible silicate, and some, at least, of the base in the borate goes to supply the deficiency, being replaced by the iron of the pyrites to a slight extent, but the major portion of the boric acid thus liberated tends to render the slag acid. In a good fusion, carried out with charges such as I use, the sulphur is all converted into sulphate, and when there is a large amount of pyrites present the alkaline sulphate even separates from the slag and floats on the surface. If, then, a little more soda is added to the charge this tendency of borax is counteracted, no SO_2 is formed, and the button comes down malleable. The following table shows the effect of varying amounts of carbonate of soda, litharge and borax on the nature of the slag and button. 1 A.T. of ore is taken, and the amounts of flux are also in assay tons.

Rough estimate of pyrites.	PbO	Na_2CO_3	$Na_2B_4O_7$	Weight of button. grm.	Appearance of button.	Appearance of slag.
8 per cent.	3·0	1·0	0·5	22	Clean	Yellow
	2·0	,,	,,	25	Sulphury	Patchy
	1·5	,,	,,	21	Very sulphury	Opaque & black
	,,	1·5	,,	27	Little sulphur	Clear
	,,	2·0	,,	30	Clean	,,
10 ,,	2·0	1·0	1·0	17	Very sulphury	Black opaque
	,,	1·5	,,	20	Sulphury	Clear
	,,	1·0	0·5	21	,,	Yellow & patchy
	,,	1·5	,,	29	Clean	Clear
	,,	,,	0·25	29	,,	,,
	,,	,,	0·5	26	Sulphury	Black
	1·5	,,	,,	28	Little sulphur	Fair
15 ,,	2·5	2·0	,,	38	,,	,,
	,,	1·5	,,	44	Clean	Clear
	,,	2·0	,,	43	,,	,,
	,,	2·5	,,	45	,,	,,
	,,	3·0	,,			

* "A Text Book of Assaying," by C. and J. J. Beringer, 7th edition, p. 98.

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This table is compiled in a more or less haphazard way from a much more extended one, and the results represent fusions as ordinarily conducted in open pots. It does not represent the sum of my experimental deductions, any more than the preceding suggestions relating to the part played by the various reagents in fusions complete the possibilities of reactions which may take place. Before finally leaving this subject I desire to allude to a fact which may be curious, or possibly not since I have had no opportunities of instituting comparisons. It is this, that taking all ordinary reduction-works samples from the screen or battery head to the sands residue and excluding only slimes samples, I do not find it in the least necessary with the Robinson Deep ore, to add any reducing agent to obtain a button of 30 to 35 grm., and in the sands, of course, no spitzlutte being used, I get a very much larger one unless I adopt some means of reducing it in size.

A great deal of misconception exists about the size of the button affecting the result. My own observation goes to show that in the majority of cases a 25 to 30 grm. button collects all the gold, and I have recorded instances of mine sample assays, in which, though the buttons only weighed 5 grm., it yielded full value: though I should be the last to recommend this for general practice.

That portion of Mr. White's contribution having reference to the old slimes residues controversy is not too clear. I read Mr. Torrente differently and find that co-relation between calculated and assay values is brought about by diminution of gold in solution rather than by that undissolved, although I quite agree with Mr. White that for calculated values the portion filtered or settled from the solution should alone be used for determining undissolved gold.

With regard to the bullion assay, Mr. White is correct in regard to the amount of copper to be added, and one can only surmise that the decimal point was omitted in the original report.

It may be that he is also right about reporting bullion results to the first decimal place, but if we are to carry our bullion assays to such a pitch of accuracy we must be given more time than is usually allowed. If there is one section of our work in which we are given least opportunity of revision, which is most hurried over and where nevertheless we are expected to obtain the best results, it is in our bullion assays. Moreover, the ordinary Rand assayer is usually not supplied with the fine apparatus, special muffles and other conveniences, at the disposal of bullion experts. Personally, I question the possibility of doing duplicate assays of bullion under local conditions with a marginal error of 0·1 per mille. One further remark on the bullion assay occurs to me, and that is, the inadequacy of the present method of determining the silver. In this connection I have found magnesia cupels require an excessively high temperature to give results approximating to those obtained with bone ash, and even the latter to give very variable results with slight alterations in temperature.

There is little to be said in reply to Mr. Durant, who supports me on most points. The matter of weights is merely one of convenience. With balances whose limits of sensibility are tenths and hundredths of a milligramme, I should use the 1,000 = 1 grm.; and with those having limits of twentieths and two-hundredths, the 1,000 = ½ grm. There is something to be said for the latter set, in that it records directly in pennyweights with the single assay ton. A deplorable practice is in vogue with certain balance makers of dividing the beam arbitrarily into twelve divisions, with the object of allowing for reading to the tenth division with their design of beam. This necessitates the use of 1·2 mgrm. and 1·2 mgrm. riders. If what Mr. Durant states with regard to assayers not being able to assign true values to their weights be correct, it is matter for speculation as to how many are using centigramme and milligramme riders for this type of balance in ignorance. This circumstance is to me almost incomprehensible, as the first duty of every one of us is to acquire absolute knowledge of the character of the balances and weights on which our work depends.

Mechanical samplers of a reliable type have not yet come my way, so I can speak with no assurance on the point raised by Mr. Carter. Pilfering in the assay office must be of the smallest, particularly if the assayer is careful, and provided, as he ought to be, with a small safe. I must say I do not like to have visible gold lying about my office, and, at intervals, relieve myself of the responsibility by handing any accumulations over to the secretary.

Mr. Lane Carter is somewhat amusing as an advocate of using only white labour in technical departments, but I do not think that his ideas are capable of general application in this country, where the duties of the menial servant are entirely relegated to the coloured races, and the white races naturally, and I believe rightly, take a superior standpoint in relation to the nature of the work required of them.

Mr. Laschinger confirms my original estimate of the cost of the assay office, he allows much more than I have asked for, and his plan is a distinct improvement on mine.

In conclusion, I should like to express my thanks to my late assistant, Mr. W. R. Daniel, for the valuable aid afforded in working out details of fluxing, and I also wish to thank all my critics for their gentle handling of my paper.

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SAFETY MEASURES IN MINING.

(*Read at April Meeting, 1906.*)

By Donald Macaulay, M.A., M.B., C.M., and Louis G. Irvine, M.A., M.D., B.Sc. (Members).

Part II.

DISCUSSION.

Professor John Yates: One cannot but admire the strenuous endeavours of the authors to secure perfection of conditions in their particular department of our mining work, and it goes without saying that the end they have in view, the prolongation and saving of human life, will always secure for them support and good-will. We all wish them success in their efforts.

But it is perhaps as well to sound a note of warning and draw attention to the danger there is of the many papers and discussions we have had on these fields in connection with mining from the medical point of view giving rise to a very erroneous and harmful impression in the minds of the public and our workers. Drs. Macaulay and Irvine have devoted themselves so closely and patiently to this question of health on our mines that their views and pronouncements have the hall-mark of authority, and I am sure that they are among those who have no desire that the position of affairs should, in any way, be misrepresented or that this much embarrassed industry should be still further embarrassed by misapprehensions set up in the minds of its only too ready detractors.

Now I know I am right in saying that the impression among the members of this Society, the people of South Africa, and of the United Kingdom, is that mining on the Rand is a very unhealthy occupation; that is undoubtedly the impression which has been created by the papers in this Society and the recent Commission on Miners' Phthisis.

Is this belief justified by the facts of the case? It is beyond contention that our accidents are many, but I ask, if, excluding accidents, the mortality among our white miners is really exceptionally high, and inferentially the conditions of work on these fields bad?

I wish to show this old subject in a new light.

We have been told, in effect, by people in Africa, and people out of Africa that the working conditions obtaining on the Rand, quite apart from accidents, are bad even to-day. This has become quite a common belief, but in my opinion the conditions of mining on these fields at the present day are comparatively good, though there is no reason why these conditions should not be further improved upon so far as such improvement lies within the zone of practical politics.

All agree that the health of our miners should have every possible consideration, but there is a difference of opinion regarding the present state of affairs; some say they are bad, I say they are comparatively good, but that we still have a preventible loss of life to cope with and conquer.

I will now proceed to state my case.

In the first place, permit me to refresh your memories relative to the death rate in the great cities of the United Kingdom. For the year 1904 London had a death rate of 16·6 per 1,000 per annum, Glasgow 19·3, Manchester 21·3, Liverpool 22·6, and Dublin 23·3 per 1,000. This includes men, women and children

Dr. Sansom, the District Medical Officer of Health for the Witwatersrand, has very kindly furnished me with the following figures (Table 1), showing the deaths from all causes, both accidental and non-accidental, on the whole of the mines in the Transvaal during the six months ended December, 1905, and covering white, yellow and black workers:—

Table 1.

Mining Death Rate from all Causes, including all Mines in the Transvaal.

Totals for the six months, July–December, 1905.

Cause of Death.	White.		Yellow.		Black.		Total.	
	No.	Rate per 1,000 per annum.	No.	Rate per 1,000 per annum.	No.	Rate per 1,000 per annum.	No.	Rate per 1,000 per annum.
Accidents	48	5·024	132	5·85	286	5·086	466	5·251
Homicide and Suicide	4	·409	31	1·361	10	·176	45	·507
Diseases, etc. ...	149	15·581	249	11·001	2462	43·490	2860	32·204
	201	21·014	412	18·212	2758	48·752	3371	37·962

He has also supplied me with another statement (Table 2), which covers the total deaths

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from all causes, both accidental and non-accidental, in the entire community, mining and non-mining, residing on the Witwatersrand area for the year ended June, 1905.

TABLE 2.

Total Deaths from all causes within the Witwatersrand Area, including Mining Employees. Period, July, 1904, June, 1905.

	per 1,000 per annum.
White mine employees ...	20·899
Other white persons ...	14·655
Coloured mine employees...	46·186
Chinese mine employees ...	20·539
Other coloured persons ...	19·532
Average	25·524

Referring to Table 1, it will be seen that accidents to whites equal 5·024 per 1,000 per annum, which is much higher than it ought to be, that of the United Kingdom being only 1·243 per 1,000 in 1904 and that of Western Australia 2·38 per 1,000, but in this connection it must be remembered that the white miners here often suffer hurt through the ignorance or carelessness of their coloured helpers. But I do not wish to enlarge upon the subject of accidents to day except to express the conviction that our energetic Government Mines Department will ultimately reduce this figure considerably. What I desire to speak to now are the non-accidental deaths which Dr. Sansom has grouped under the head of diseases, etc. These average for white miners 15·581 per 1,000 as against 14·655 per 1,000 for all other white persons in the Witwatersrand area including men, women and children, and the 16·6 to 23·3 per 1,000 for the above-mentioned great cities. Of course in comparing these figures one has to remember that this white miners' rate of 15·581 per 1,000 only includes adult males of years ranging from 20 to 50, and that the deaths among the adult males in the cities named would be less than the 16·6 to 23·3 per 1,000 mentioned, the adult male rate being as a rule about one half the "all person" rate. Thus taking Dublin as an example with its "all person" death rate of 23·3 per 1,000, its male death rate between 20 and 50 years of age, would be about 12·7 per 1,000. These figures 15·581 per 1,000 for Transvaal miners and 12·7 per 1,000 for adult males in Dublin are very illuminating, and I would ask your attention to them. They appear to indicate that conditions are not so bad as they have been painted, that miners' phthisis, pneumonia and fever collectively do not commit the great ravages they are generally credited with, and that notwithstanding all that has been said to the contrary, mining on the Rand cannot be said to be exceptionally unhealthy.

There is one consideration touching this matter of the white miners' death rate from disease which is not often brought forward and which is generally overlooked. It has been generally acknowledged that our Kafir death roll is largely augmented by "weaklings," who die very shortly after their arrival on the Rand, not because of the hardships pertaining to mining, but because of the severity, to them, of our climatic conditions. Now is it not possible, is it not probable, that this white miners' death rate of 15·581 per 1,000 is perceptibly contributed to by men who come to these fields predisposed to disease, and even suffering from disease, who come here to benefit both health and pocket, and whose demise here swells our death roll and lessens that of the Home mining counties? I am rather inclined to think that there is more in this point than people imagine, and that the figure, 15·581 per 1,000, is too high as representing the white miners' death rate due to non-accidental causes under the conditions on the Rand. An allowance of, say, 2 per 1,000 for this importation of predisposed and diseased miners would reduce the figure to 13·581 per 1,000, and bring it comparatively close to the mortality figure for males of like ages in some of our Home cities, Dublin, for example.

Where, then, is this great mortality from disease, of which we have heard so much in connection with our white miners on the Rand? It appears to me that our arrangements for dealing with disease are giving excellent results, though, as I have already remarked, there is room for further disease-preventative measures.

Now let us turn our attention to the Kafir death rate on the mines. The 43·49 per 1,000 (Table 1) death rate from disease is a figure which it is impossible to contemplate without sincerely wishing it was less, but, though the figure is of this unsatisfactory magnitude, it is at least a matter for congratulation that the appalling death rate of but two or three years ago has given way before the earnest efforts of the mining companies and their medical advisers to improve matters. By careful dieting we have purged our compounds of the scourge of scurvy, and in many other directions we have effected improvements which are at last beginning to bear fruit in the form of decreased mortality.

I have already referred to the general acknowledgement that the Kafir death roll is largely swelled by "weaklings," who die very shortly after arrival on the fields, boys so debilitated, so physically unfit, that they cannot withstand the relatively trying climate of the Rand. We have heard much about the alleged shortcomings of the Witwatersrand Native Labour Association, and have often been told that if the Association conducted its business properly our labour

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scarcity would not be so acute as it is. Well, no matter whether this complaint is well founded or not, it is certainly a fact that the Association has been caught sending "unfits" to the Rand, and this would appear to be evidence of zeal rather than of a want of energy in recruiting. The forwarding of these "weaklings" to our mines suggests a very interesting line of reasoning in connection with the high Kafir death rate along the reef. First, let me call your attention to a very noteworthy fact. According to Table 1, the disease death rate among the Chinese stands at the low figure of 11 per 1,000, being even less than the white rate. The advocates of Chinese labour might well take this striking figure as an argument in its favour. Now these Chinese are mostly underground workers, and, if the high mortality amongst Kafirs is indeed due to the unhealthy nature of underground work, then how can we explain that the Chinese, who are so largely confined to this so-called unhealthy work, have a death rate only one fourth of their Kafir co-workers? Does not the explanation of this interesting problem lie in the fact that only physically fit Chinese are imported and retained, but that in our desperate scramble for the desirable Kafir the Witwatersrand Native Labour Association supplies us with all sorts and conditions of boys, that, to supply our large demands they are compelled to send us "unfits" in the absence of sufficient "fits," and that it is to the high mortality among these "weaklings" that our high Kafir death rate is largely attributable, and not to the unhealthy conditions of work. No one who has had to do with boys can fail to have noticed how markedly the physically sound boys improve in health compared with their condition on arrival from their kraals, and it has often occurred to me that, as things are to-day on the Rand, coming down to the mines to work probably extends the lives of the physically sound boys rather than otherwise. I have no figures touching the native death rate under the conditions obtaining at their kraals, but I venture to say that the figure must be high, and that it would be much higher if the "weaklings" were not sent to us.

You will observe the figure 19·532 per 1,000 (Table 2) which represents the death rate from disease of all coloured persons—men, women and children—other than mine employees within the Witwatersrand area. It might be said that here we have proof of the unhealthiness of mining operations, seeing that this figure is less than 50 per cent. of that of the Kafir mine worker. But is this figure a proof of the unhealthiness of mining operations? I think not! In the first place the item covers the Indian and other coolie classes. In the second place, it is only the smart healthy "boys" who are taken into domestic service, business houses, etc.; in other words, they are the pick of the Kafir labour. It is only the mines, because of their necessity, which accept the physical wrecks of the black population. Hence the explanation of the low rate of 19·532 per 1,000 for coloured persons other than mine workers.

Here I must finish for the present; on another occasion I purpose traversing other views expressed by Drs. Macaulay and Irvine in their excellent paper. You will note that I have confined myself mainly to the discussion of non-accidental mortality, and I look forward with interest to hearing the views of our medical friends on the new aspect of Rand mining conditions which I have set forth. I trust I have not been misunderstood. The point I wish to make is that I, personally, consider that at the present day our miners on the Rand work under conditions, touching general health, which compare favourably with very many mines and many other industries throughout the world, and if this be the case there is surely no reason why it should not be acknowledged and credit given where credit is due. Such recognition of good work already performed by the mining industry and by the medical officers in town and along the reef, with the authors well to the fore, will, I am sure, in no wise militate against the attainment of the high standard the mines appear to be striving for.

Drs. Macaulay and Irvine may rest assured that they have the approval and support of all right-thinking men on these fields in their crusade against disease.

Mr. A. McA. Johnston: Drs. Macaulay and Irvine have rendered the mining industry a distinct service in bringing forward, for the benefit of members of this Society and all connected with underground working, their two papers on "Safety Measures in Mining." They have dealt most vigorously with the subject in hand and their impartiality in stating their case, praising where praise is merited and blaming in no uncertain tone where blame is needed, should evoke our warmest congratulation and be an object lesson to all who feel strongly on one side or the other. Before the discussion closes I should like to make a few remarks that I may show my personal appreciation of their efforts.

The subject interests me greatly, mainly because in the course of my researches on mine ventilation, I could not but fail to see how a great deal of good could be effected in this direction by putting forth a little effort. The mine managers I came into contact with, all evinced great interest in the work, but I am afraid their interest did not extend far enough to

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make even a few practical alterations in the workings—most disused—so that the currents of air should be directed where they would benefit the present workings. Could this Society stimulate the mine managers, I feel that a considerable amount of good would be done in improving ventilation. We must also make the case clear to the miner himself and show him that his co-operation is absolutely essential and worthy of every attention.

Undoubtedly, the best safety measure is prevention. Accidents are of two kinds, preventible and non-preventible, by which I mean those attributable to carelessness and those occurring from causes which the foresight of man cannot cope with. The latter is, of course, beyond discussion except in so far that every manager, underground foreman or miner, should be made to understand that it is incumbent on each and all of them to enlighten their fellow workers in all pertaining to the safety of themselves and others, but the former class—the preventible accidents—can be removed, and to attain that end we must insist that defaulters be vigorously dealt with. Too often has it happened on these fields that one man's carelessness is the cause of another's disablement or death. With what result? The conviction, as a rule, of the culprit on a breach of mining regulations. Now I do not want it to be understood that extreme severity should be used, but I would urge on this Society to hold to the view that when carelessness, gross, callous carelessness I mean—is proved, legal remedies should be available for the punishment of the transgressor. We have been told lately in various quarters that the class of miner has deteriorated on the Rand. Perhaps this explains the plethora of accidents; at any rate, it behoves the Government officials and the heads of the mining industry to improve the standard by making our miners more careful workmen. Carefulness usually means capability. Again, how far are the mine officials co-operating in minimising underground dangers? To the honour of many of our managers and underground managers it can be said that they take a keen interest in all pertaining to the lives and interests of their workers, but unfortunately there are many laggards, and this Society should not consider this question settled until these have been made to feel their responsibility in this matter.

The underground worker is entitled to every consideration at the hands of his immediate superiors. If the aid of the law be invoked on behalf of his co-workers, it is but right that every precaution be taken to protect the employee, and not only that, but he should be restrained from entering dangerous places. Let me illustrate this point. A miner is, for example, driving, sinking or raising in a remote part of the mine, remote I mean from ventilation currents. It is no infrequent occurrence for double shifts to be worked for the sake of speedy development, and it is no infrequent occurrence for men to have to start work before the dust and smoke have cleared away. I have suffered from this myself, and so speak from experience. The result is frequent cases of gassing, from which the coloured labourer suffers most, firstly, because his work is in the thick of it till he succumbs or the air clears, and secondly, because the white worker, when his health begins to be affected, moves to a lower paid but more healthy part of the mine. Now, I hold that it is incumbent on the managers to take a strong stand on this question, and to institute some system of ventilation for these dead-ends which would go a long way to remedy the evils spoken of by the authors, indeed, to evolve some plan which would make their safety measures unnecessary.

I should like also to speak of a question closely allied to these safety measures, to wit, the formation of rescue corps on each mine, or it may be, on a group of adjacent mines. In the past this mining area has been fortunate in having very few big accidents. A continuance of such immunity we all sincerely hope for, but it also behoves us to prepare for any emergency which may occur. I would, in this connection, draw your attention to what happened at the Courrieres mine disaster. After the explosion there, the air currents were reversed, and this reversal caused numerous deaths, since instinctively when foul gases are present workmen turn to the intake shaft. Should rescue corps be experimented with here, it would be the duty of the individual miners in the corps to learn the different exits from the mine and let their fellows have a rough idea how these could be reached. The outcrop mines, for instance, are sometimes connected with the adjacent mines only in the upper levels, and I doubt whether any of the miners—a shifting population here at the best—ever find out these or have any but the vaguest idea how these exits can be got at. Haste means everything in an emergency. Again all rescue appliances have value only if the men about to employ them are trained in the use thereof. The question of having rescue appliances at hand and having men skilled in the working of them has engaged the attention of Westphalian authorities and engineers for several years past, but it is only recently that British and French engineers have turned their thoughts in earnest to the perfecting and use of such.

A noticeable feature at the present time is the appointment of a Royal Commission by the British Government to enquire into mining

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matters, amongst which is included the question of rescue appliances and rescue corps. Since such interest is being evolved in other mining communities it behoves us to be by no means backward in settling our own affairs. Our problems are fortunately less difficult than those connected with coal mining, nevertheless, they are present and their solution is imperative. Drs. Macaulay and Irvine have in truth rendered the mining industry a notable service by the compilation of their notes, and this Society should look to it that the subject be not allowed to drop but should be kept prominently before Government officials, mining authorities and the miners themselves. We have prefixed the word "mining" to our Society, and having done so, it is incumbent on every member to tackle this problem and shirk no responsibility. In the past we have attacked quite as difficult duties, and having done so successfully, I personally see no reason why we should not succeed in this. Of one thing we may be sure, and that is that the good wishes of all mining men in other mining centres are with us in our laudable endeavour to benefit humanity.

Dr. J. Moir: Although the points which call for notice are really points that only call for emphasis, yet I cannot help remarking on the refreshing attitude of scientific open-mindedness which the authors have developed in this paper; to such an extent as, for example, to allow Dr. Macaulay to speak of "reputed pneumonias" and Dr. Irvine to give us a new definition of miners' phthisis which is after our own heart. Far be it from me to gloat over the return of these sinners to the scientific fold: I only rejoice that all the factors which caused this dreadful mortality are now receiving due consideration. I am not sure whether anyone has already called attention to the fact that there is a distinct fear that there will be no miners left in a year or two except the younger and more unskilled ones; and that the supply of *skilled* white labour promises to afford another problem for this distressful country, unless the heads of the mining houses, or whoever is responsible, wake up to the danger which they have so long neglected. The fact that there is a death rate from accident alone of over 5 per 1,000 per annum, brings home to us the extent of the carelessness on the one side and of the callousness on the other which prevail. This death rate is actually as much as one-third of the total death rate from all causes in any decently-conducted British town, and is at least five times as great as it ought to be.

I do not think it is quite fair of Prof. Yates to separate accidents from disease, for gassing is included under accidents, and by excluding these cases you make out the number of deaths from disease to be very small. The probable percentage from disease amongst whites is rather 17 or 18 per 1,000. Prof. Yates has also taken some rather dirty towns in England for comparison. I think in some towns the death rate is only 11 or 12 per 1,000.

I hope that one of those mines which are guilty of a high accident rate will set the example of having ready for use all the essentials of treatment recommended by the authors, namely, the emetic, the stimulant, and the "elixir of life"; and that some of the staff will take the trouble to learn those ambulance measures, without waiting for it to be made compulsory through the Mining Regulations. I am afraid that to get all these *desiderata* embodied in the law will take a lot of pegging away at the powers that be (or shall be).

There are two theoretical points I wish to refer to, namely, (1) the probable maximum of vitiation in winzes and raises, and (2) the action of nitrous fumes.

(1) Recent analyses of air after blasting, which I shall report next month, lead to to the conclusion that a large blast of, say, 25 lb. of gelatine, will produce about 140 cub. ft. of CO_2 and from 10 to 40 cub. ft. of CO. The actual analyses usually exhibit 3 per cent. of CO_2, whence it follows that the total volume of air of this composition existing in a closed place like a winze, is about 4,700 cub. ft. Now this is a quantity far greater than the cubic capacity of ordinary winzes, whence it follows that the vitiation is frequently greater than 3 per cent., and indeed, the accident-records show cases of such instant suffocation as can only be explained by assuming 5 or 6 per cent. of CO_2 and nearly 1 per cent. of CO—yet there actually exist people who will venture into such danger without any idea of precaution.

If we apply this calculation to an ordinary drive of 35 sq. ft. section, we find that a vitiation of 3 per cent. CO_2 and, say, $\frac{1}{2}$ per cent. of CO exists for 140 ft. from the face at the very least. Well, I am quite certain that the miner has to go much nearer the face than that, as a rule, before he can turn on the compressed air.

Regarding "nitrous fumes," there is an important point which wants to be brought out, and that is, that the symptoms which the authors describe are really due to nitrous acid, and certainly not to NO or NO_2 as such. The reason for this statement is that there is always an enormous excess of water-vapour present, and that NO_2 reacts with the latter *in a few seconds* to form nitrous or nitric acids. The latter, in this great dilution, is as harmless as, say, citric acid.

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Even if the atmosphere be dry, the water produced from the explosive itself is far more than is required for the purpose. From my analysis of the fumes from burning "gelatine" (this *Journal*, 1906, p. 307), I have constructed the following equation to represent the reaction :—

$$5C_{12}H_{20}N_{11}O_{34} + 8O_2 = 54CO_2 + 6CO + 11NO_2 + 22N_2 + 50H_2O$$

This shows that the amount of water vapour produced is about nine times as much as is required to convert the NO_2 into nitrous and nitric acids. Even if we suppose that all the nitrogen contained in the explosive burns into NO_2—which is never the case—there will be still more than enough water-vapour to react with it, independently of the water-vapour from the atmosphere.

The authors describe the very remarkable phenomenon of the delayed action of "nitrous fumes," which still awaits explanation, in spite of having been described thirteen years ago in Kobert's text-book, as the following rough translation from p. 386 shows : "Sometimes, according to Schmieden always, the poisoned man is not perceptibly affected, so that he is capable of continuing his work in the vitiated atmosphere for hours. Later on, a desire for fresh air and an insatiable thirst constitute the only abnormality for many hours. Suddenly, after six or eight hours, without provocation, acute symptoms of lack of breath and anxiety supervene, so much so that patients with normal lungs resemble asthmatics. A feeling of strangulation, etc., comes on . . . . and death from pulmonary œdema with complications occurs within 40 hours. On venesection the blood is black, tarry, very coagulating, and has a greatly diminished alkalinity ; nevertheless on dilution the colour and spectrum are fairly normal." I do not pretend to be a pathologist, but I should imagine that the effects of HNO_2 on the organism would be compounded of the two specific actions of (1) alkali nitrites formed in the blood, and (2) a physical disintegration of the epithelial cells. The latter would be caused by combination of their protoplasm (and other constituents) with nitrous acid itself. All proteids react very easily with nitrous acid, and it is easy to imagine that the products possess properties inconsistent with the ordinary vital functions of the original proteids. It is thus possible that the alkali nitrites contribute to the causation of the lasting sensation of "swelled head" on exposure to nitrous fumes, as well as being the cause of loss of oxyhæmoglobin by conversion into methæmoglobin; whereas the delayed and acutely-dangerous symptoms may be really due to the gradual contraction of the air-passages and of the alveoli which would result from (1) the increase of bulk of the proteids when diazotised by nitrous acid (see this *Journal*, Sept., 1903, p. 113), and (2) the liberation of nitrogen gas inside their substance, from the (delayed) decomposition of these diazo-derivatives. I only put this forward because a plausible theory is better than none.

In conclusion, I should like to ask the opinion of the mining members on this proposal, namely, to inject, by means of an air-blast, the large quantity of 200 cub. ft. of water after each blast (of, say, 25 lb. of explosive). This quantity of water would be enough to dissolve practically all the CO_2, CO and NO_2 fumes, if discharged, say, 200 ft. from the face, to say nothing of laying the dust. It would be uncomfortably damp afterwards, but the idea seems to me not altogether hopeless.

Mr. A. Heymann : Taking into consideration the importance of the paper given us by the authors (who I am glad to see are now both members of our Society), it has been most surprising to me to see the small amount of discussion we have had until to-night. I think, when I point it out, you will agree with me that after all the paper is not faultless ; it has one fault at least, namely, that they have left very few loopholes for us to attack them by. Still, there is, I think, a great deal to be said and discussed as to the most practicable means for adopting some of their valuable suggestions. Take for instance the suggestions of placing safety-helmets at convenient places (which was commented upon to-night by Mr. McA Johnston), and that of having a kind of volunteer corps of fully trained men for giving first-aid in emergency cases—how much could be said on these points alone. I am sure that were such corps started on every mine it would become thoroughly efficient in a very short time, and its members would know how to help themselves in emergency cases. Look for instance at the excellent work performed recently by the Westphalian rescuers in the French coal mine ?

Had we had such an efficient and trained body here I am sure the authors would have had no complaint to make at the common practice of applying cold water liberally on the body and administering whisky as a restorative measure. Of course these people must be excused on account of their ignorance, yet I would go one step further in defending them. Since whisky and water are always at hand and are a sort of force of habit, I suggest that their application should be just reversed ; just give the water internally with a little NH_3 if at hand, and apply the whisky externally. Rub it in well,

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cause a good friction—that will warm the body more than its internal use.

I next come to the suggestion of placing mice in the coal mines for the detection of CO. By the way, they suggest *white* mice—I suppose it is to kill two birds with one stone. The actual mouse to serve as an indicator of danger, and its colour to determine the "colorific" (!) value of the coal—to see how soon the whiteness of the mouse will disappear. Joking apart, I would say that in some cases it would be an excellent precaution, since it is known that a mouse is so much more susceptible to CO than man, but only in some cases will it serve its purpose, and that is when the amount of CO is comparatively large; in this case the miner can escape before his blood is saturated, that is to say, provided that his watchful eye has been kept on his noble little bodyguard all the time. But if there is only ·01 per cent. of CO in the air—or indeed any quantity too small to actually kill the mouse, but enough to be injurious to health in course of time, then in such a case the mouse would be of little value as a forestaller of danger. Of course it might be argued that the same effects will be produced in a stronger degree on the mouse and that the miner by carefully watching it daily as he comes down the mine might notice a change in the mouse, for example, that it is not so playful as usual; but the miner would require to be also of a playful disposition, if he is to watch his mouse, when he comes down the mine, for 10 minutes before he starts work!

Another case in which it would be little use to its master as an indicator of danger is if the amount of CO in the air approaches 1 per cent., in this case the miner would never survive to reach the place where his mouse is stationed. Nevertheless, since some precaution is better than none, it would be advisable to enlist such a "bodyguard" for fires in coal mines, providing there is no objection raised by the S.P.C.A.

There are, however, other conditions in our *metalliferous* mines. Under ordinary working conditions there *should never be* any large amount of CO except directly after blasting, if the ordinary precautions of turning on plenty of air and not going down the mine too soon, be adopted.

I notice that the authors now make a statement, for making the like of which a couple of years ago I was nearly mutilated by some of our medical friends in this very room. I refer to the following (p. 153): "We have also reason to believe that many of the reputed pneumonias, which contribute so largely to underground native mortality, may have their origin in this manner," why "reputed?" Well, I did not use exactly the same words, but you will all, no doubt, remember what I said and meant. Let bygones be bygones; now that the medical men themselves admit it, the remedy is at hand and I am pleased to see that I have achieved my object although after several years.

The direct proof that I have achieved my purpose is seen when we glance at the statistics of death rate—we see a much larger proportion of deaths ascribed to poisonous gases now than before, although there is a general decrease in the mortality. To what can this be due? Our ventilation in the mines is rather better than before, neither have our explosives changed, nor have the miners deteriorated in their skill of firing; only one thing remains—a more careful classification of deaths.

I am very pleased to note that the authors now accept my opinion of three years ago, that chronic carbon monoxide poisoning is probably much more common than is generally supposed, to use Dr. Black's words in the W. Australian Report. This was one of my chief arguments. Since that is now accepted, a remedy is easily to hand, and although at the time of discussing my paper it was not "all jam" to me, I feel now, for the benefit it has done, I am rewarded tenfold.

I perfectly agree with the writers of the paper that it is not necessary now to resuscitate at length the old discussion on miners' phthisis—miners' silicosis *versus* other "silly causes"—(as the epigrammatist of that time put it), for now we all agree that there are three chief factors to which the alleged high mortality is due and these factors must be ameliorated, viz.:—Dust, noxious gases and infective processes. Against noxious gases the only remedy is good ventilation, against infective processes—good hygiene.

Water is admittedly effective in laying dust, the only thing not decided upon is the right way of application. The authors deal so ably with the merits of the different atomisers, sprays, etc., that there remains nothing for me to say, but one thing they mention which I would like very strongly to comment on, is to be careful in the choice of water so that it shall be free from organic contamination. I am afraid that will be more difficult to achieve than is suspected. Amongst hundreds of analyses I have never yet come across a mine water which was not strongly contaminated, therefore the only thing is to get a supply from the surface such as is used for drinking purposes; this will be found in some cases to present difficulties.

There are other objections to the use of water for laying the dust, such as oversaturating the air by its too free use and thus compelling the miner to be

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in a damp atmosphere, and there is also the danger of ankylostomiasis. Now I would like to make a suggestion; it is not based on experimental facts, it is simply an idea which struck me the other day, I therefore wish to suggest it with all reserve. It is a known fact that some of the mineral oils are used for spraying the streets in order to lay dust; so could this not be used in conjunction with *a little* water in the mines? The expense would be trifling, a mechanical distributor could be easily got up, the effects of the oil would be by no means deleterious, in fact possibly disinfectant. If some of our members who have the means and opportunity of actually trying such an experiment, would do so, and report the results, some good might accrue.

I do not think I can say anything more on this most valuable paper, which is a careful compilation of facts against which nothing can be said. Accepting these facts, it now remains for all of us to do his level best to further their suggestions in practice, to improve the working conditions of the mines and thereby the mining industry in general.

Prof. J. A. Wilkinson: Dr. Moir has brought forward this evening an ingenious hypothesis, as to the chemical combinations these gases may form after inhalation and absorption into the blood, but one fact rather tends to weaken it, namely, that most diazo-compounds are decomposed and cannot exist above 10 deg. C. and could not therefore exist at the body temperature. One other matter I should like to mention. I was surprised to hear that some people have the belief that the white mice kept on board submarine boats were merely pets for the crew. As far as memory serves, they were intended for use as a definite and specific test for noxious gases, more especially carbon monoxide.

Prof. J. Yates: I am under the impression it was for the detection of petrol fumes.

A Member: Yes, the specific cause was carbon monoxide. At any rate, the point is they were not kept as pets.

Mr. M. H. Coombe: Does the 15·581 per 1,000 represent the actual death rate amongst the white mining community?

Prof. J. Yates: Amongst the miners along the reef.

Mr. M. H. Coombe: Well, I am afraid Prof. Yates will have a hard task to persuade the mining community along the reef that their calling carries no more danger here than the same calling in other countries. I have the honour to be a member of the Rand Pioneers Association, and I venture to say, from enquiries I have made, that I am about the only surviving member of the Association who used to run a rock drill here when they were first introduced to these fields.

Many of the pioneers came as miners to open up these outcrop mines, and when these machines were first brought to the Langlaagte Estate, Ferreira and other mines, many of us thought we could make a few pounds extra per month thereby. We did so. To-day I know of only two men left out of scores that were confrères with me in learning the rock drill work. The majority of the men I knew are up in Braamfontein cemetery, but a good many died during the war in the Old Country, and others in America, New Zealand and Australia. Another point that Professor Yates brings forward, is the small percentage of deaths amongst Chinese labourers compared with the percentage of deaths amongst Kafirs. One reason for that probably is that the Chinaman is a newcomer, and has not been here long enough to get thoroughly impregnated with the poisonous gases and vapours one picks up in the mines. Another thing is that the man underground who works hard, perspires, and opens the pores of his skin, and such men go under first; but there are very few men in this room to-night who ever saw John Chinaman perspire. He takes care not to go into any particularly hot place, and you cannot drive him in with a drill or charging stick. A Kafir will go anywhere, but the Chinaman will not. Hence there can never be a large death rate amongst the Chinese population of these fields, let them be here for the next 20 years. Again, Professor Yates' figures cannot take into account the number of men, who, contracting miners' phthisis here, go to their homes in other countries to die, thus minimising the death rate here and proportionately swelling it across the seas.

Prof. J. Yates: Still there is a great margin between 44 and 11 per 1,000, and it will take a lot to explain that away.

Prof. J. A. Wilkinson: There is another point also. Prof. Yates has given us statistics from Manchester and other places, but it must be remembered that in these cities there is factory legislation for the protection of labourers. Does Prof. Yates deal with the *general* population of such large cities as Manchester?

Prof. Yates: I think what Prof. Wilkinson has said rather supports my case. By the Factory Acts the people of Manchester, Liverpool, and other large cities I have referred to, have had every protection afforded them, yet, notwithstanding that, they have a death rate of over 20 per

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1,000. This makes it all the worse in comparing them with these fields. There they have with all their protection 20 per 1,000 as their "all person" death rate, and here we have 15·581 per 1,000 among the miners.

Dr. L. G. Irvine: In the mining population is included, of course, 30 per cent. of surface workers who have a lower death rate. It would be more to the point if Prof. Yates could give us the death-rates amongst underground workers separately.

Mr. C. B. Saner: Many miners who are in the last stage of phthisis go home to die. I know that before the war, out of 35 or 40 I was personally acquainted with, no less than 15 men died.

Dr. L. G. Irvine: I should like Prof. Yates to refer to Dr. Haldane's report, in which he states that the death rate amongst miners at Home has been considerably raised by men coming home from the Transvaal.

Prof. J. Yates: Against that I put forward the point that diseased miners come to these fields.

Dr. L. G. Irvine: Never looking for health.

Prof. J. Yates: There we must agree to differ.

Mr. T. Lane Carter: I should like to move that the discussion on this paper be continued at the next meeting.

Prof. J. Yates: I second that, and hope Dr. Irvine will agree to it.

Dr. L. G. Irvine: I shall be glad if you will do that, for I have written home to Prof. Haldane, at Oxford, and Dr. Sims-Woodhead, at Cambridge, asking them for criticisms on the paper.

The President: As I said at the last Council meeting, considering the importance of the paper, I think the time for discussion should be extended, and we will therefore postpone further discussion until the next meeting. I am delighted to find that at last so many have come forward to discuss this important paper.

I have an announcement to make. I see by the papers that one of our Past Presidents, Mr. Charles Butters, has been awarded the gold medal of the Institute of Mining and Metallurgy for this year. I am sure Mr. Butters' old friends will be glad to learn of this mark of distinction awarded to him. (Applause.)

The meeting then closed.

TUBE-MILL PRACTICE.

(Read at April Meeting, 1906.)

By W. R. Dowling (Member).

DISCUSSION.

Mr. Jas. E. Thomas: The thanks of those who are being initiated into the troubles of running tube mills, whether for fine grinding or increase of tonnage, are due to Mr. W. R. Dowling for having put his experience of these machines on record. In looking over the original paper and the contributions to the discussion I cannot find any figures given for the difference in grading of the pulp entering and leaving the tube mill. Although these figures are not of the same importance as those of the pulp entering the cyanide works, they would serve as a guide to those starting up tube mills and give them some idea of what they have to equal or excel.

The method in vogue of giving the speed at which a tube mill is running, viz., so many revolutions per minute is, in my opinion, somewhat misleading, and I would suggest that the speed be expressed in feet per minute at the internal circumference of the shell.

As Mr. White points out, the speed should be changed in proportion to the actual internal diameter of the tube as the liner wears down and would therefore, I presume, be based on the average internal diameter.

It might be possible to vary the speed by means of slightly conical pulleys, driver and driven, so that the speed could be altered to compensate the wear of the liner. On the Luipaardsvlei Estate and G. M. Co. small tube mills have been installed, and the experience with them so far bears out that of the El Oro, *i.e.*, that small mills are more efficient per h.p. consumed than large ones.

Mr. Osborn's suggestion of porcelain nozzles for the spitzlutten and dewatering spitzkasten is a very practicable one.

On talking over the scheme with our resident engineer, Mr. Rodwell, he suggested utilising the necks of bottles, which would enable one to have the discharge diameter just right by cutting the bottle neck at the right place. The idea was at once adopted and has been working successfully for some time. For the spitzlutten ordinary gauge-glass tubes of the desired internal diameter

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set in wooden plugs made to fit the underflow hose will meet the case quite well. These nozzles last a considerable time but should be renewed when the glaze is worn off the glass as, after that has taken place, the wear is very rapid. These nozzles will last about ten days and allow of much better regulation of the pulp than when nozzles have to be frequently changed.

In bringing the stream of pulp to the dewatering spitzkasten, it is important that the velocity of the stream be checked somewhat, as it may happen that, owing to the neglect of this precaution, coarse grains are carried over the spitzkasten, instead of being led through the tube mill. This, of course, can only be effected if enough fall is available.

Mr. Dowling's estimate of 7·5 per cent. of launders is a rather meagre allowance. Where the ore is fairly high in percentage of pyrites, I find that 10 per cent. is not too much, and would, if possible, give the launders even more grade. Bends and turns in the launders to the shaking tables should be avoided when possible, as their presence increases the difficulty of a proper distribution of the pulp.

Mr. Laschinger's scheme of driving by a belt directly into the tube would get over the present bad arrangement, in which any spill from the dewatering spitzkasten or choked nozzle generally gets into the driving belt.

I do not see any objection to putting the driving gear at the outlet end of the tube-mill where belts and gear would be free of sand. The discharge launders would not be in the way in many cases.

I would like to point out that changes in direction of all launders should be avoided as much as possible, as I am sure it will be found cheaper in the long run to extend the countershafting somewhat than to have to re-elevate the water—or water-slime—necessary to carry the re-ground or separated pulp when such changes exist.

The pulp entering the spitzlutten should have had time to settle down to a steady flow if good work is to be done.

The shaking-tables at the Luipaardsvlei Estate and G. M. Co.'s plant are slung by spring-steel bars from an overhead framing, and each two tables are set so as to balance the strain on the eccentric shaft.

The riffles recommended by Mr. Dowling are most effective and do not bank up the pulp in the launders to any great extent.

NOTES ON THE USE OF THE FILTER PRESS FOR CLARIFYING SOLUTIONS.

(Read at July Meeting, 1906.)

By S. J. Truscott and A. Yates (Members).

DISCUSSION.

Mr. W. R. Dowling: On reading Messrs. Truscott and Yates' paper on clarifying slimes solution before precipitation, I cannot help thinking that the plant they describe as sand filters should have been included in the original construction of the works, and that the make-shifts now discarded should never have been even started. Whatever the apparatus used, the solution for precipitation should be delivered to the boxes absolutely free from suspended matter, not only for the purpose of reducing the bulk of precipitate to be smelted but to ensure efficient precipitation. There is no mention in the paper of the effect of filtered solution on precipitation, but the improvement should have been marked. If there was a large excess of zinc in the boxes the upper compartments probably did the filtering and the lower compartments the precipitation. This being the case, the zinc consumption ought to show some reduction.

The method of clarifying solution before precipitation by filter presses is the usual practice in Australia whilst, as members know, shallow vats with a bed of spitzlutten concentrates or coarse sand is usual on these fields. A shallow vat 20 ft. in diameter and 4 ft. deep with 12 to 18 in. of spitzlutten concentrates or coarse-washed sand, such as masons use for mixing with cement, would clarify the 300 tons of solution per day required by the authors of the paper and, as shown by their own figures, would pay for itself in a month.

Mr. K. L. Graham: The experiences of Messrs. Truscott and Yates at Redjang Lebong of which they have given us the benefit, are certainly interesting, and the method they advocate for filtering the unprecipitated slimes solutions undeniably more efficient than the sand filters generally used on these fields. However, it is also undeniable that the arrangement of tanks they describe, in use previous to the

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adoption of the presses, could have been anything but efficient, and to this cause is largely due the marked improvement apparent after the installation of the latter. Judging from the figures given by the authors, to handle 600 to 700 tons of solution a day, as we do here, it would be necessary to have four presses of the type they mention, at a cost of about £200 apiece, whereas a tank of the dimensions required to do the same work could be erected for from £350 to £400, roughly a square foot of area being required for every ton filtered per 24 hours. This difference is considerable, and I venture to think, the higher initial cost would only be justifiable where a suitable filtering agent, such as a sand, was unprocurable, the economies effected by Messrs. Truscott and Yates being rather due to the defective system previously in use than to any other cause. Looking over the figures given under costs, although the totals exhibit a very considerable difference, chiefly in the items European wages and fuel, yet I should like to point out that had both lots of precipitate and short zinc been dealt with, say, in the Tavener pan furnace, instead of in pot or in tilting furnaces, the cost of smelting would have been practically the same in each case, and would most assuredly have been less than 6d. per oz. of fine gold recovered. Moreover, under the circumstances, the basis of comparison, viz., per fine oz. recovered, is hardly admissible. Using this method, the results depend entirely on the value of the precipitate cleaned up; it is therefore essential that the conditions of working for the periods under comparison should be approximately similar, particularly in regard to the value of the ore treated. That this was not the case is evidenced by the difference in the figures given opposite "gold recovered" in January and December, and, as I take it that the authors do not wish us to conclude that the extraction was affected to this extent by the introduction of the clarifying presses, it is clear that there was a very considerable difference in the gold contents of the slimes treated during the two months under review. The figures are still further affected in favour of December, owing to the fact that less short zinc was taken out of the boxes during that month than in January, a circumstance in no way connected with the change in the filtering plant. The marked difference, nearly £120, for fuel and labour, is certainly striking, the authors' remark on "the total absence of effort in smelting" not being sufficiently explanatory to make the reason of this clear, taking the weight of material smelted in each case into consideration. Perhaps in their reply they will elucidate the point.

Visit to Luipaardsvlei Estate and G. M. Co., Ltd., August 22nd, 1906.

The Society, by the kind invitation of Mr. Hayes, the General Manager, paid a visit to the Ore Reduction Works of the Luipaardsvlei Estate and G. M. Co., Ltd., at Krugersdorp, on Wednesday, the 22nd August, 1906. Over ninety members and their friends availed themselves of the invitation, amongst those present being:—

Mr. E. H. Johnson (President), Dr. J. Moir, Messrs. A. F. Crosse, R. G. Bevington, W. R. Dowling, K. L. Graham, Prof. J. A. Wilkinson, S. G. Bartlett, W. Beaver, A. Boyd, T. Bromley, P. Browne, A. F. Bruun, W. O. Brunton, J. A. Burrus, J. Carruthers, P. Cazalet, C. W. Chater, J. F. Cook, J. M. Crofts, J. Davidson, H. Edwards, N. M. Galbreath, Dr. Garny, W. C. Gell, W. H. Graham, J. Gray, H. L. Harland, J. Harris, J. Hiddleston, C. L. Johnson, H. H. Johnson, W. H. Jollyman, M. F. Kline, M. Knight, E. J. Laschinger, G. A. Lawson, C. W. Lee, R. W. Leng, H. Leupold, J. Littlejohn, H. Mahaut, A. McNaughtan, G. Melvill, H. Meyer, C. G. J. Moore, S. Morison, S. Newton, W. J. North, J. D. O'Hara, D. J. Peplar, T. W. Read, D. W. Rossiter, A. G. Rusden, H. Rusden, W. Schonfelder, W. B. Semple, S. Shlom, F. Simon, G. O. Smart, S. H. Steels, H. Taylor, J. E. Thomas, E. C. Townsend, F. R. Trapp, P. O. Treloar, W. H. Visser, L. J. Wilmoth, A. H. Wilkins, and Fred. Rowland, Secretary.

The party were officially received by Mr. Hayes and staff in the extractor house and hospitably entertained.

Mr. H. Hayes in welcoming the Society to the property said:—

Mr. President and gentlemen, I beg to welcome you to the Luipaardsvlei Estate. Before going round the surface plant I should like to point out that some of our apparent defects are the result of shortness of money rather than of design, as, for instance, in our mill engine of which only the high pressure cylinder has as yet been installed. Our plant was designed for the sand to be transferred from the collecting vats by belt conveyors, but a mechanical haulage had to be substituted on account of economy in first cost. The result of limited capital expenditure can also be seen in our refinery, and the cramped space for the shaking tables of our tube mills is the result of a laudable effort to keep within the estimates.

The battery will perhaps prove the most interesting part of the plant. The weight of the stamps is 1,556 lb. each when new. To maintain the crushing efficiency as the shoes wear, counter weights of 51 lb. are periodically added, and as we are running with a drop of 8 in. at 96 drops a minute, this results in a duty of 7·8

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tons through 400 screening. As soon as the mill engine is compounded, giving us the necessary power, this will be raised to an 8 ton duty. Our tube mills (14 ft. x 3 ft. 6 in.) are smaller than those in general use on the Rand, but their duty is coming up to our expectations, and the cyanide pulp shows only 14 per cent. of + 60 grade.

One of the aims of your Society is research with the object of improving mining practice, and I would therefore like to call your attention to two points in milling, which I do not think have received the attention they deserve. One is the ratio of crushing surface to the weight of our present stamps, and the other the benefit which would be derived could a more even crushing surface be maintained on the dies. In respect to the first, if the ratio was correct with the old 750 lb. stamps it is certainly not so for the present heavy ones, and hence this is a question which requires determination. In respect to the *second, a considerable loss of duty occurs through* the uneven wearing surface of the dies, especially in the first wear after new ones are used. To try and overcome this loss we have tried (until proper dies are obtained) a recessed false bottom in which shoes, when worn down to about 4½ in. and from which the shanks have been cut off, have been used as dies. So far the experiment has met with fair success, a more even surface having been maintained while light shoes are continued in use as dies.

I will not detain you longer, gentlemen, and trust you will find something to interest you in our plant.

The President: On behalf of the Chemical, Metallurgical and Mining Society I should like to express to Mr. Hayes our appreciation of his kindness in inviting us to visit and inspect the new plant installed on this company, as well as to thank him for our very hospitable reception. This property was once celebrated for a courageous effort to prove the advantages of dry crushing. The present plant is evidence that the company's views on this subject have undergone modification, *and I think Mr. Hayes' hospitality* will have convinced you that there are certain advantages in wet treatment! As our time is limited and the plant will prove far more interesting than anything I can say I will not detain you longer than to ask you to join me in wishing every prosperity to the Luipaardsvlei Estate, to its courteous manager, Mr. Hayes, and to his able staff.

The party, after being photographed, were then escorted in parties round the surface works by members of the staff, who explained and pointed out the various improvements and points of interest in the works. Among these were the small suspended tube mill tables, and the use of zinc fume for precipitating the dissolved gold in acid solutions from the clean up before being run to waste.

Contributions and Correspondence.

THE STANDARDISATION OF BATTERY SCREENING.

WEIGHT OF SCREENING PER SQUARE FOOT AND A NOTE UPON THE EFFECT OF USING SCREENING OF A LESSER WEIGHT THAN THAT CALCULATED.

The weights given refer to the screenings enumerated as the approximate equivalents of ordinary "standard," "heavy" and "light" screening in the three final tables accompanying the Standardisation Committee's Report on Battery Screening, dated 6th June, 1906. They were calculated in the following manner :—

1 cm. = ·3937079 in. = (log) ·5951742

therefore (log) $\overline{\cdot 4048258}$ cm. in one in. linear

therefore (log) 1·2144774 gram. in 1 cub. in. water

and (log) 4·2144774 mgrm. in 1 cub. in. water

Specific gravity of steel wire 7·85 (log) ·8948697

Area of circle 1 in. dia. ·785398 (log) $\overline{1}$·8950900

(log) $\overline{5}$·0044371 = 101,027 mgrm.

A. The diameter (in decimals of an in.) squared, multiplied by 101,027, gives the weight of 1 in. length of straight wire.

B. The number of wires in 1 sq. in. of screening =

$$2\left(\frac{1}{\text{aperture} + \text{diameter of wire}}\right)$$

C. The length of the wires varies according to the percentage of aperture and the form of crimping. When wires are equidistant and crimped alike in each direction the length in inches of any wire in 1 in. of screening is :—

$$\frac{8\sqrt{(\tfrac{1}{2}\text{ dia. of wire})^2 + (\tfrac{1}{2}\text{ wire} + \text{aper.})^2} - (\text{wire} + \text{aperture})}{3\,(\text{wire} + \text{aperture})}$$

When, however, the crimping of the wires is different in one direction to what it is in the other, and the surface of one set of wires is half the thickness of a wire below the other set, the formula for the first set becomes :—

$$\frac{8\sqrt{(\tfrac{1}{4}\text{ dia. of wire})^2 + (\tfrac{1}{2}\text{ wire} + \text{aper.})^2} - (\text{wire} + \text{aperture})}{3\,(\text{wire} + \text{aperture})}$$

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and for the second it is :—

$$\frac{8\,(\tfrac{3}{4}\text{ dia. of wire})^2 + (\tfrac{1}{2}\text{ wire} + \text{aperture})^2 - (\text{wire} + \text{aperture})}{3\,(\text{wire} + \text{aperture})}$$

The mean of the quotients gives average length of wires.

A × B × C × 144 = weight in milligrammes of 1 sq. ft. of screening.

This weight is the weight the screening should be if the wire is of a specific gravity of 7·85 exactly, and the wires in crimping have not been so overstrained as to have stretched, in which case the weight will be less. When in the manufacture stretching does take place it is obvious that the part of the wire most affected and weakened is the centre of every projecting curve, which is also the part most exposed to wear, and therefore the agreement or otherwise between the actual and the calculated weights of screening is a matter which affects somewhat the duration of its life.

SIDNEY G. HOBBS.

Johannesburg,
July 15th, 1906.

CALCULATED WEIGHTS IN GRAMMES FOR SCREENING (1 sq. ft.) SHOWN ON APPROXIMATE EQUIVALENT OF ORDINARY TABLES IN REPORT.

"LIGHT."			"STANDARD."			"HEAVY."		
Apertures.	"X"	"Y"	Apertures.	"X"	"Y"	Apertures.	"X"	"Y"
62·99	315·250	318·840	61·04	571·225	581·280	62·98	802·520	820·34
104·08	245·195	247·990	96·10	307·660	314·960	100·00	513·340	523·260
148·72	179·360	181·700	148·72	398·910	406·360	152·38	524·070	535·710
204·20	175·140	177·130	210·02	261·900	266·030	192·90	467·230	477·865
297·22	172·725	175·000	297·22	265·300	270·040	307·75	327·360	334·125
409·78	169·750	171·830	400·00	256·670	261·630	400·00	316·400	323·340
498·23	152·340	154·550	493·82	231·004	235·460	493·82	291·150	297·630
606·65	142·200	144·310	612·66	214·180	218·380	594·87	258·160	263·820
714·92	128·160	130·020	699·87	185·210	188·680	714·92	234·890	240·020
789·05	117·565	119·230	789·05	165·380	168·370	780·25	197·500	201·485
885·78	125·530	127·460	896·40	145·850	148·050	885·77	177·000	180·475
988·91	114·700	116·440	1,014·23	156·750	159·710	1,001·47	190·415	194·500
1,205·62	128·530	130·790	1,222·57	151·330	154·300	1,239·74	176·680	180·520
1,371·74	117·300	119·325	1,392·26	139·780	142·570	1,413·20	165·030	168·630
1,574·71	106·140	107·930	1,600·00	128·330	130·810	1,625·00	153·390	157·450

"X" means regular spacing and interlacing of each wire, with crimping equal on all wires.

"Y" means regular spacing and interlacing of each wire, but with surface of the curves in one direction half the thickness of a wire below the surface of the curves in the other direction.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

REPAIRING PLATINUM WARE.*—"An interesting method of repairing platinum ware consists in welding a piece of heavy platinum foil, used as a patch, upon the article in question. A non-conducting block, of the proper curvature for use as an anvil, is made by filling the dish, previously greased, with a mixture of pumice stone and plaster of Paris. The block is now rigidly mounted in a convenient position and the dish is placed over it with the cleaned surface to be repaired upward. A piece of heavy platinum foil of the proper size to cover the hole is cut and kept in readiness. With the blast-lamp in the right hand and the small piece of platinum held with a pair of forceps in the left, turn the flame upon the spot to be repaired; when this becomes white hot, bring the patch into the flame until it is also white hot. Now, while both parts are heated to incandescence, bring them firmly together with the forceps. The flame may now be removed and the parts examined to see if the patch has been put in the proper position; if so, the flame is again turned on, and while white hot the patch is gently tapped all around with any convenient tool. A small three-cornered file which has been rounded on its untempered end answers the purpose admirably."—B. S. CUSHMAN.—*The Journal of the American Chemical Society*, June, 1906, *Review of American Chemical Research*, p. 249. (J. A. W.)

* See this *Journal*, p. 173, November, 1905; also 327, April, 1906.

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THE ELECTRIC FURNACE FOR THE MANUFACTURE OF PHOSPHORUS.*—"The advantages claimed for this method for the production of phosphorus are that cheaper raw materials may be used, the temperature is more easily regulated, a purer product is obtained, and the use of sulphuric acid is avoided, thus removing the element of serious deterioration, due to its action upon retorts, etc.

In Germany, where one-third the output is already obtained by electric furnace methods, iron retorts are used, lined with fire-clay, and with internally projecting carbon electrodes. The process is continuous, as calcium silicate is drawn off at the bottom while the charge is fed in at the top.

One precaution is given, which is that of keeping the upper part of the furnace and condensing pipes cool (to below 200 deg. C.), in order to avert explosions.—S. P. SADTLER.—*The Journal of the American Chemical Society*. May, 1906, *Review of American Chemical Research*, p. 220. (J. A. W.)

I. THE PROPERTIES OF MATERIALS OF CONSTRUCTION.—"When wood is to be placed near heated surfaces, it should be well seasoned, for obvious reasons. Pitch pine is probably the most suitable kind of wood to be used where there is exposure to fumes, because of the protecting action of the rosin. Cypress wood is best for tanks, due to its smaller degree of shrinkage and expansion, its straight grain and the small amount of colour and odour that it imparts to solutions.

A table giving the weights per cub. ft. in pounds, tensile strength, crushing strength, cross-section and shearing strengths of most of the woods, is given.

Cast Iron, Wrought Iron and Steel.—Although iron is acted upon by most acids, it is largely used for making vessels in chemical plants because of its cheapness. Cast iron is not so readily attacked by acids as wrought iron, and stands sulphides and alkalies at high temperatures very well. Sulphuric acid may be kept in wrought iron tanks, if the gravity does not go below 1·7, and it is kept cool. The more concentrated acid can be kept in, and even boiled in cast iron vessels.

The resistance of steel to corrosion by acids is said to increase with the percentage of combined carbon. To investigate the action of the various substances upon metals, weighed bright strips of the same are put into the solutions at the temperatures desired, and finally removed, cleaned, dried and weighed. The loss in weight will show the corrosion.

Copper.—This is usually employed for stills, condensers and digesters, because of its heat-conducting properties, it malleability and tenacity. The chief reagent to be avoided is ammonia and its fumes, and the fumes of mineral acids. Mineral acids, such as nitric, sulphuric and hydrochloric attack copper, but the weaker organic acids have little or no effect upon it. Gun-metal and manganese bronze are important alloys of copper, which stand dilute sulphuric acid and are used for making acid pumps, etc.

Lead is of low tensile strength, and soft, but much used because of its resistance to corrosion by acids and its ductility. Lead is little acted upon by sulphuric acid of less than 1·7 specific gravity. It is used for sulphuric acid chambers and denitrators, and also for pans used in concentrating, until the gravity gets up to 1·7, when cast iron is used.

Joints in lead are made by 'burning,' which consists in fusing the surfaces together with a hydrogen blowpipe. Where there is much pressure upon the apparatus, lead is covered on the exterior with wood or steel. Lead piping is much used in chemical works, but must be protected from mechanical injury.

Tin is much used for condenser worms and lining copper.

Aluminium has similiar properties to copper in resisting weak organic acids. Cast aluminium stills are now used with worms of aluminium tubing in acetic acid factories.

A useful table is given, stating the specific gravity, melting-point, electrical conductivity, heat conductivity, tensile strength, weight per cub. in. in pounds, weight per cub. ft. in pounds. An approximate price per pound of the most important metals is given.

Stone.—Stone is much used for resistance of acids in cisterns and stills, especially in the case of hydrochloric acids, although iron covered with acid-proof porcelain is much used. The kind of stone used is generally of great density, such as slate.—S. P. SADTLER.—*The Journal of the American Chemical Society*, May, 1906, *Review of American Chemical Research*, p. 216. (J. A. W.)

PREPARATION OF PURE CHLORIC ACID AND ITS APPLICATION AS AN OXIDISING AGENT.—"Eight hundred grams of pure barium chlorate are dissolved in 1,700 c.c. of hot distilled water; the solution is filtered into a capacious flask, and, when cold, treated with 243 grm. of sulphuric acid of sp. gr. 1·847, diluted with sufficient water to make about 2 litres of liquid; this is added to the barium chlorate solution in successive small quantities with thorough agitation, care being taken to obviate rise of temperature, as otherwise the acid formed will be oxidised to perchloric acid. After mixing, the barium sulphate is allowed to deposit, and the supernatant liquid is filtered through asbestos. About 1,750 c.c. of chloric acid of sp. gr. 1·11 at 20 deg. C. are thus obtained, containing only a trace of free sulphuric acid.

This acid is a valuable oxidising reagent, usefully replacing nitric acid or potassium chlorate in many analytical processes. It is specially useful in the determination of tin in brass and bronze by Hollard's electrolytic method, and for the oxidation of chromium salts in Storer's process."—V. BERNARD.—*Journal of the Society of Chemical Industry*, May 15, 1906, p. 426. (A. W.)

DETECTION AND DETERMINATION OF MINUTE QUANTITIES OF IRON.—"To 50 c.c. of the extremely dilute solution of iron salt, 3 c.c. of ammonia solution free from iron (62 grm. of NH_3 per litre) are added and hydrogen sulphide is passed through for 10—12 minutes. A dark-green solution is formed, apparently containing the iron in a colloidal condition; and the amount of iron present can be determined colorimetrically by comparison with solutions of known strength. Mineral acids and many inorganic salts destroy the green colour; but many organic substances—glycerol, cane-sugar, dextrose, mannitol, lactic acid, tartaric acid, or citric acid, and especially albumin—increase the stability of the colloidal state and the sensitiveness of the reaction. Iron can be detected by this method in a solution containing 1/800,000."—A. MOUNEYRAT.—*Journal of the Society of Chemical Industry*, June 15, 1906, p. 562. (A. W.)

* See this *Journal*, p. 200, Dec., 1905.

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ASSAY OF AURIFEROUS TIN STONE.*—"Five methods were employed, viz.:—(1) Scorification assay followed by cupellation; (2) crucible assay and cupellation; (3) solution in *aqua regia*, precipitation of gold by ferrous sulphate, and cupellation; (4) concentration of the gold in part of the tin by ordinary crucible assay, using anthracite, solution of the tin button in hydrochloric acid, and cupellation of the residue; (5) collection of the gold in the whole of the tin by fusion with potassium cyanide followed by solution of the tin and cupellation. For ores containing up to 26 oz. of gold to the ton convenient quantities to be taken are:—(1) 5 grm., (2) 25 grm., (3) 25 to 50 grm., (4) 25 grm., (5) 10 grm. It was found that the scorification method (1) always gave low results, the crucible assay (2) gives excellent results, the wet method (3) is tedious and gives good results as to the gold but loses the silver, methods (4) and (5) give low results and are unreliable for silver."—C. O. BANNISTER.—*The Journal of the Society of Chemical Industry*, May 15, 1906, p. 430. (A. W.)

THE OXIDATION OF ATMOSPHERIC NITROGEN.—"The author said that the enormous consumption of Chilian saltpetre had made the nitrate problem a very important one. The requirements of the world in regard to saltpetre were still increasing at an average rate of about 4 per cent. per annum, and it was calculated that the present rate of export, 1½ million tons per annum, would exhaust the Chilian deposits by the year 1940. The nitrogen problem had, however, been solved in two ways. In the one process Professor Frank, of Berlin, in conjunction with Mr. Caro, had applied the power possessed by certain metals of directly fixing nitrogen, and had introduced calcium carbide as an absorbent of pure nitrogen. The other method by which the atmospheric nitrogen could be fixed was by oxidation of the nitrogen in electric arcs. In May of last year a factory was started at Notodden, in Norway, for the manufacture of calcium nitrate from air and limestone by the aid of electric flame on the Birkeland-Edye process, and another factory was to be put in operation at Svelgfos-Notodden next year. Attempts made prior to 1903 had not resulted in the discovery of any method for the wholesale production of saltpetre on a commercial basis, but Edye and the author, in combination with the Norwegian Nitrogen Company, had been able in 1904 to obtain results which convinced the experts called in that the saltpetre problem had been satisfactorily solved. They had succeeded with simple and easily regulated apparatus in working with so large an amount of energy that the quantity of nitric acid produced was for the first time sufficiently large to justify a direct transfer of results and calculations to industrial undertakings. The principal elements in the Birkeland-Edye process as adopted at Notodden was a peculiar form of high-tension flame which had never been previously employed in technics, but had proved to be a powerful aid in producing various chemical reactions. At the Notodden factory three furnaces were in operation, each employing 500 kw. The furnaces worked with a factor of reduction of 0·7 and with a working potential of 5,000 volts; 3,500 volts and more were obtained on the electrodes. In the new factory the furnaces would be of 750 kw., and the cost per kw. for the erection of the furnaces could be put down at £1, and was likely in the future to be considerably reduced. The volume of air treated at Notodden was 75,000 litres per minute, and the final product, answering to a concentration of from 75 to 80 per cent. of calcium nitrate, contained about 13·5 per cent. of nitrogen. The results of experiments showed that for fertilising purposes lime saltpetre was as good as natural saltpetre. On the important question of cost of production, although no actual figures were available, fairly definite conclusions could be drawn, and it had indeed been stated that the cost of production per ton of calcium nitrate containing 13·2 per cent. of nitrogen would be £4, while the selling price was £8. With regard to the practical output, it had been stated that the yield was between 500 and 600 kgm. of anhydrous nitric acid per kilowatt year. In all experiments in which an attempt was made to fit the theory to the experimental results obtained by the oxidation of nitrogen in the electric arc, the greatest difficulty met with was in the slight knowledge we possessed of the temperature of the arc. He had tried to form some opinion as to the temperature conditions in the disc-flame produced. The output of NO per minute with 2,500 deg. C. was 187 grm., while the actual output from the furnace was 179 gm. The *maximum* theoretical output coincided with about 5,200 deg. C., and it seemed not unreasonable to think that when the magnetic force of the furnaces was adjusted so as to give the highest output the best temperature conditions that could practically be obtained would be arrived at."—Prof. BIRKELAND.—The Faraday Society, July 2, 1906.—*The Times* (London) *Engineering Supplement*, July 11, 1906, p. 223. (W. A. C.)

A RAPID METHOD OF BABBITT METAL ANALYSIS.—"Babbitt and bearing metals usually contain lead, antimony, tin and copper. Small amounts of zinc and arsenic are sometimes found, but these are usually volatilised during the heating the metals receive before casting.

Weigh and treat, in a small beaker or casserole, 1 gm. babbitt metal filings or borings with 20 c.c. of nitric acid (sp. gr. 1·42) and water (1 : 2). Place on the water-bath and cover with a watch-glass. When spattering ceases, wash spatterings from the glass back into the beaker, and evaporate to dryness. Then bake in an air-bath one hour at 120°. Attention is called to the baking of the oxides, as without baking results are low. Moisten well with concentrated nitric acid and add 30-40 c.c. hot water and boil vigorously five minutes. Filter off the mixed oxides of tin and antimony, wash with hot water, dry and ignite in a porcelain crucible, using a few drops of concentrated nitric acid to oxidise any metal reduced in burning the filter. Weigh as $Sb_2O_4 + SnO_2$.

Dilute the filtrate from the above to 250 c.c. in a calibrated flask. Take out with a pipette 50 c.c. Add 10 c.c. of ammonia (1 part of ammonia, sp. gr. 0·9, to one part of water) and 6 c.c. glacial acetic acid. Heat to incipient boiling and titrate the lead with a solution of ammonium molybdate (1 c.c. = 0·01 gm. lead) which has been standardised against pure lead dissolved in nitric acid. Use tannic acid (1 to 300) as indicator.

To the remaining 200 c.c. of the solution add sodium carbonate until a precipitate forms, then add 1 or 2 c.c. of ammonia. Stir well, and allow to settle; if copper is present, the well-known deep blue colour of the copper-ammonium salts will be observed. Then titrate with standard solution of potassium cyanide until the colour disappears. The lead carbonate and hydroxide present do not interfere.

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* See this *Journal*, p. 320, June, 1905.

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While conducting the above, weigh out a fresh portion of babbitt metal, and determine the antimony by the method by Andrews as described by Walters and Apfelder. One gm. of filings is treated in a 150 c.c. beaker with 1 gm. potassium iodide, 40 c.c. concentrated hydrochloric acid (sp. gr. 1·2) and 40 c.c. of water. Boil gently one hour, and filter, washing the precipitate with hot dilute hydrochloric acid (1 : 13), then with hot water, finally once with alcohol. Treat a duplicate filter paper in the same way, dry both at 100° C. one hour and weigh the precipitate as metallic antimony. Calculate antimony to Sb_2O_4, and subtract the same from the weight of mixed oxides of tin and antimony, giving the weight of SnO_2 from which tin is calculated.

Copper is usually present in babbitt and bearing alloys in small amounts, seldom over 1 per cent., and a weak solution of potassium cyanide is used for titrating. One c.c. KCN = 0·0025 gm. copper.

Some results are appended, the values for lead by the $PbSO_4$ method giving 78·55 per cent. as compared with 78·47 per cent., 78·6 per cent., 78·54 per cent. by this method, the latter being three different determinations on the same specimen as the former. Another sample similarly treated gave 68·82 per cent. by the $PbSO_4$ method and 68·76 per cent., 68·86 per cent. and 68·84 per cent. by the molybdate titration. The complete analysis requires from three to three and a half hours."—H. YOCKEY.—*The Journal of the American Chemical Society*, May 1906, p. 646. (J. A. W.)

TESTS FOR PAINTS.—"All paints contain pigment and vehicle, generally with a diluent and frequently a drier.

The object of painting is to preserve and cover. The vehicle acts as a preservative for holding the pigment together, and may consist of glue, gum, rosin, resin, starch, liquid glass, blood, cheese, linseed oil, (raw and boiled), also varnish.

If the vehicle is water-soluble, such as most of those mentioned, the paint will have a short life. The drier used is generally manganese dioxide. The diluent may be turpentine, alcohol, gasoline, kerosene, wood alcohol, water, potash and soda. Only turpentine and alcohol are considered as desirable. Only a chemical examination will show the composition of a paint.

The different agencies which a paint should resist, and the tests to be applied, are given at length. The paint is spread on plates of glass, wood, tin sheeting, galvanised iron, sheet steel, etc., cut 1 by 3 in. or 2 by 5 in. Eight days are allowed to elapse after painting.

Samples are immersed for 24 hours in 10 per cent. and 25 per cent. solutions hydrochloric, nitric and sulphuric acids. A repetition is then made of heating for two hours in a water-bath.

Fumes of hydrochloric, nitric and sulphuric acids are allowed to play upon the paint for three minutes. The articles are dipped in 10 and 25 per cent. solutions of caustic soda. The vapours from strong ammonia are blown over the plates for five minutes.

The action of sulphurous acid, hydrogen sulphide, steam, both at normal pressure and ordinary boiler pressure, are applied for about 30 minutes. For the first two, one hour is required for steam under pressure and 12 hours for steam at ordinary pressure. With steam at ordinary pressure the sample should not be affected.

The spreading capacity is found by measuring the amount of paint used. This is done by weighing the plates before and after painting, and finding the amount necessary to cover satisfactorily. The time of drying is found and should be between 12 to 18 hours.

The elasticity is a point that is gone into in detail, and is determined by painting strips of tin which are coated with the paints and should resist bending when dry.

Penetration of the paint into wood is determined by using white pine wood strips, $1\frac{1}{2} \times 4\frac{1}{2}$ in. After painting, the strips are cut crosswise and lengthwise and examined with a magnifying glass for penetration.

Another important test is to determine the absorption of water. Wood, stone, brick and concrete are tested by making into cubes of about 1 to $1\frac{1}{2}$ in. The blocks are put in a water-oven for three hours. After cooling, one, two or three coats of paint are used, allowing each to dry thoroughly, and after the final coat, dried for eight days. Weigh the blocks and put the thoroughly dry ones into distilled water and put on to boil, wipe dry with blotting-paper and weigh the blocks. Increase in weight is due to absorption of water.

The adhesion of paint to the surface is obtained by a vacuum produced in a funnel with a rubber-ring.

The fineness of the pigment is determined as follows: Use two plates of glass 2 × 5 in. Mix the paint thoroughly, place a small amount of paint upon the glass and press down with the other. Now stand both glasses up and allow the paint to run. After one hour examine the paint; no separation of the pigment particles should appear for at least 1 in. of downward surface.

Colour comparisions are obtained by dropping the two paints on a microscope slide and bringing them together by pressing down a cover glass, so that the two surfaces touch. They can then be compared from white or black surfaces.

Heat tests are applied by heating in ovens to 100°, 300° and 500°. In some cases paints are supposed to protect from fire, and the degree of protection can be somewhat determined by testing painted and unpainted wood with the open flame."—S. P. SADTLER.—*The Journal of the American Chemical Society*, May 1906, *Review of American Chemical Research*, p. 215. (J. A. W.)

REGENERATION OF AIR FOR SUBMARINES WITH FUSED SODIUM PEROXIDE.*—The authors give an account of certain experiments carried out to prove the suitability of "oxone," a fused sodium peroxide, for the regeneration and purification of air in places where ventilation by ordinary means is impracticable. There seems no reason why this preparation should not be used in vitiated atmospheres, as found in many of our mines. The reaction of the chemical is automatic. One kilogram of oxone will sustain a man for 5 hr. 12 min., provided that he has to breathe the same air over and over again.

A box of strong wood, 3 ft. by 3 ft. by 6 ft., tin lined and soldered, was built. In the top was a plate glass window, which also served as the entrance. This was hermetically sealed and kept in place by iron clamps. Inside the box was placed the apparatus, consisting of an electrically-driven blower, so arranged that its discharge was connected to a horizontal sheet iron cylinder, in which was placed the oxone. In addition to this was a cyclometer, an incandescent lamp, wet and dry bulb thermometers,

* See this *Journal*, p. 258, Feb., 1906.

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whilst an Orsat apparatus was placed outside on the top of the box and connected with the inside by means of a glass tube. Preliminary tests showed that a crust of carbonate formed on the outside of the oxone, but a mechanical contrivance, by which this was kept in agitation, soon solved this difficulty, and no further trouble was experienced.

The initial experiments were carried out with rabbits, and the results proving to be of a satisfactory nature, a man was sealed up in the box for six hours, with 1 kilogram of oxone in the little revolving cage. One of the interesting features of this test was the smoking of cigarettes by the man inside. The various points where the carbonic acid curve goes up from zero to 0·2 and 0·3 per cent. show the times the cigarettes were smoked. Another most noticeable thing was the absorption of the smoke and the drop of CO_2 again to zero within 15 minutes after the extinction of the cigarette. Also, when the box was opened, there was not the faintest smell of cigarette smoke. After 4½ hours nearly all the oxone had gone, only a few small pieces remaining in the cage, and the oxygen started to go down. The man inside asserted that throughout the run he felt exceedingly well, in fact, better than before he entered. He described the conditions as being similar to a hot, dry summer day, and only towards the end were the effects of the increasing CO_2 and humidity noticeable.

An interesting feature of the paper is the accompanying charts, showing the dry temperature, the percentage of CO_2, the percentage of oxygen and the percentage of saturation during each and all of the experiments, the longest of which lasted for 15 hours. —BRINDLY and VON FOREGGER.—*American Electrochemical Society*, May, 1906. (A. McA. J.)

MAGNESIUM PERMANGANATE AS AN OXIDISING AGENT.—"Magnesium permanganate was best prepared by the first method of Mitscherlich (Gmelin-Kraut: 'Anorg. Chem.' Vol. II., 527). The anhydrous salt is insoluble in chloroform, carbon tetra-chloride, benzene, toluene, nitrobenzene, ligroin, ether, and carbon disulphide, and is without action on these compounds at ordinary temperature unless some solvent for the salt be added. It is soluble in aliphatic alcohols, esters, acids, ketones, and in pyridine. Methyl alcohol, glacial acetic acid, methyl and ethyl acetates, and pyridine are only slowly changed by the permanganate; the others are easily and in some cases violently oxidised. Glacial acetic acid and pyridine proved to be the two best solvents for oxidation experiments. In the first it is a powerful oxidising agent, much stronger than the corresponding potassium salt. Benzene and its homologues and open-chain hydrocarbons such as hexane are readily oxidised to carbon dioxide even in the cold. Pyridine, on the other hand, exerts an inhibitory influence on the oxidising action of the salt; compounds such as alcohol, ethyl acetate, and acetone are acted upon less easily if pyridine be added to their solutions."—V. J. CHAMBERS.—*Journal of the American Chemical Society*, June, 1906, p. 270 *Review of American Chemical Research.* (J. A. W.)

INJURIOUS EFFECT OF ACID PICKLES ON STEEL.—"A discussion of the influence of such treatment on the physical properties of the metal. Tests were made on the amount of flexure which a steel strip or wire would stand before and after being pickled, the stress being applied by a low-pitch screw, whose turns measured the deflections. Results are stated in percentage of deterioration, as measured by the falling off of the deflection producing rupture, after immersion, compared with the previous deflection. Sulphuric acid is found to produce less brittleness than hydrochloric, and nitric acid more than either, without, however, removing scale as satisfactorily. Arsenic in the solution, as arsenious acid, is a great preventative of the brittleness; it causes almost complete suppression of gas, and reduces the percentage of deterioration 85 to 98 per cent. of that normally occurring in a sulphuric acid solution. In hydrochloric acid the benefit is less pronounced. Tin, antimony or bismuth in solution act in the same direction as arsenic, but not so efficiently. Samples tested by pickling and nickel-plating afterwards were found to have an average deterioration of 11·85 per cent. when cleaned simply by emery, 15·58 per cent. when pickled in ordinary sulphuric acid solution, and only 6·8 per cent. when pickled in the same containing arsenious oxide. The conclusion is that the brittleness or 'rotting' of iron and steel is due to the penetration of hydrogen into its pores, rather than of acid; but this cannot be avoided, since the evolution of hydrogen is necessary to loosen the scale. The best way to treat steel is to temper it without forming scale on it, by immersing it in melted lead covered by melted borax. The sand blast is also preferable to acid pickling, wherever it can be used.—J. W. RICHARDS.—*The Journal of the American Chemical Society*, June, 1906, *Review of American Chemical Research*, p. 254. (J. A. W.)

THE TECHNICAL ANALYSIS OF FLUORSPAR.—"A direct and indirect method are given for the rapid determination of fluorine. In the direct method the fluorspar is mixed with powdered quartz and heated to 160 deg. with concentrated sulphuric acid for about an hour. The silicon tetrafluoride evolved is passed into a solution of potassium chloride in 50 per cent. alcohol where potassium fluosilicate is precipitated and hydrochloric acid is set free. The free hydrochloric acid is then titrated with standard sodium hydroxide solution. The indirect method depends upon the fact that calcium fluoride is not attacked by acetic acid while calcium carbonate is dissolved. The fluorspar is treated with acetic acid and the undecomposed residue filtered and washed and decomposed by evaporating to dryness with sulphuric acid. The calcium is extracted from the decomposed residue by hydrochloric acid and is determined by the oxalate method in the usual manner. The fluorine is calculated by finding the amount necessary to form CaF_2 with the calcium determined above. Extreme accuracy is not claimed for these methods but they are rapid and yet accurate enough for technical purposes. A scheme is also given for the complete analysis of fluorspar, including determinations of CaO, MgO, Fe_2O_3, Al_2O_3, SiO_2 and F."—L. F. HAWLEY.—*The Journal of the American Chemical Society*, June, 1906, *Review of American Chemical Research*, p. 247. (J. A. W.)

VOLUMETRIC METHOD FOR TIN.—The following volumetric assay for tin is reported to give good results, and may be completed in one hour. Fuse 1½ to 2 gm. of the ore at a dull red heat with from 3 to 10 gm. of sodium peroxide in a nickel crucible, and continue for five minutes after melting completed. During this latter period agitate contents by swirling until the contents set on cooling. Cool in water and then extract contents with boiling water. Transfer the total solution, without filtering, to the flask in

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which titration is to take place. Acidify with hydrochloric acid, add some strips of zinc, and boil. The tin is precipitated on the zinc. Acidify strongly with hydrochloric acid and boil until the excess of zinc and the tin are dissolved. Titrate with a standard solution of ferric chloride. The titration should be done slowly as the end point is approached, and the solution should be again brought to boiling at this stage, as the reaction is not very rapid in the cold.

The reaction is complete when the solution assumes a yellow tinge (due to the presence of ferric chloride) which does not disappear on boiling. The assay should be thoroughly shaken during titration. Ammonium sulphocyanide solution, on a spot plate, may be used as an indicator, if desired, to mark the end point. Should arsenic, antimony, bismuth, copper (or any substance likely to interfere with the titration) be present, it may be precipitated by boiling the solution with iron. The interfering substance is filtered off, and the estimation conducted as above. —DARROCH and MEIKELJOHN.—*Engineering and Mining Journal*, June 23, 1906, p. 1. (A. McA. J.)

METALLURGY.

CALCIUM STEEL.—"It now appears that efforts are being made in Germany to produce a new form of improved steel by combining it with a certain proportion of calcium metal, the same as is done with nickel and chromium in the manufacture of nickel and chrome steel. That calcium thus combined with molten iron in the process of steel manufacture might add some highly desirable qualities to the ultimate product, has long been believed by certain metallurgists, and the experiments now in progress are destined to definitely confirm or disprove this theory.

At the works of the Electrotechnical Company, in Bitterfeld, in Prussian-Saxony, means have been found for producing calcium metal from certain minerals in quantities and at a cost which permits it to be freely used for industrial purposes. With the calcium thus provided, a series of experiments are being made, as it is understood, by the Electrotechnical Company itself and by several leading steel manufacturing firms in Westphalia and Rhineland. As to the results of these studies nothing conclusive can yet be definitely ascertained. From an occasional paragraph in the German technical press it does not appear that the results thus far are entirely reassuring. In "Metallurgie" has appeared a statement, based on the extensive studies and tests made by an eminent specialist, to the effect that :—'Through these experiments it is proven that calcium metal does not combine with iron in a molten condition, and its use for the formation of alloys with iron is therefore impracticable.'

In the same publication L. Stockern writes as to the conclusion of researches which he describes :—'From the foregoing facts the conclusion follows that calcium metal can scarcely be considered as applicable to the production of steel from pig iron, but on the other hand it may be very useful in refining copper and in bronze casting, and will not unlikely replace the hitherto more costly magnesium metal in the refining of nickel.'

It remains to be seen whether further experiments will succeed in overcoming the apparently natural want of affinity between molten iron and calcium, which at present seems to bar the way to the production of an industrially practicable calcium steel."—*Mining Reporter*, June 21, 1906, p. 614. (J. Y.)

REDUCTION OF AURIFEROUS ANTIMONIAL ORES.*—"In the Report of the Department of Mines for Nova Scotia for the year ending Sept. 30, 1905, is an account of the method of treating auriferous antimony ores. The deposits are worked by the Dominion Antimony Company. The amount of ore produced during the year was as follows :—No. 1 ore, 46 per cent. Sb. and 2·56 oz. gold, 4,30 tons. No. 2 ore, 8 per cent. Sb. and $10 gold, 3,570 tons. No. 1 ore only has been shipped to English smelters, who, however, only gave a percentage (50 per cent.) of the gold values; No. 2 ore has remained at the mine, and experiments have been undertaken by Messrs. Mason, Sexton, Brown and MacArthur, with a view of recovering the gold values and concentrating the low grade ore. The antimony mainly occurs as stibnite. The liquation process of concentrating antimony ore is wasteful, and the attempt is now being made to replace it by mechanical dressing. It was found impossible to concentrate the ore by wet crushing, 90 per cent. of the antimony being carried off in the water as slimes and lost. Dry crushing with wet concentration was then adopted with success, the procedure being as follows :—(*a*) Rock-breaker to ¾ in. ; (*b*) rolls to ¼ in. ; (*c*) dry sizing on 24 mesh screen ; (*d*) repassing over size through rolls until passed all through screen ; (*e*) Wilfley table (wet concentration), with the following results (6¼ tons of ore were crushed as above) :—

	Gold Per Ton.	Ant. Per Cent.	Weight.	Total Gold.	Total Ant.
Ore ...	$7.00	6·2	6¼ tons	$43 75	775 lb.
Concentrates	24.00	50·5	1,400 lb.	16.80	700 lb.
Sand ...	4.00	1·0	10,665 lb.	21.34	100 lb.
Slimes ..	18.00	5·0	444 lb.	3.99	20 lb.

Thus 90 per cent. of the total antimony was recovered in concentrates. The sand is comparatively free from antimony and will probably yield its gold to bromo-cyanide treatment. The treatment of the slimes would be difficult, but in practice their amount would probably be small. Experiments were made in smelting the concentrates in graphite crucibles ; a charge composed of concentrates 25 lb., bicarbonate of soda 25 lb., iron 4 lb., gave a bar of antimony weighing 12 lb., and fairly free from iron, but the crucible was attacked ; it would probably pay better to ship the concentrates with high grade ore. A few experiments were made on cyaniding the sand, and it was sufficiently indicated that this would be quite feasible. As will be noticed, only 50 per cent. of the gold remains in the sand, and nearly 40 per cent. in the concentrates, which would probably have to be electrolytically separated from the antimony metal. In Mason's process for treating auriferous stibnite, the Sb. is simply roasted off and condensed as oxide. Professor Sexton experimented with the process on the Dominion Antimony Company's ore with success : 73½ per cent. of the antimony was eliminated by roasting, and practically all the gold remained in the residue, from which it could be got by amalgamation and cyaniding, though the amalgamation alone of both high and low grade antimony ores after such roasting is not a success. On the raw product neither cyaniding nor amalgamation are successful. In MacArthur's process, which also appears to be quite practicable, the ore is treated with 2 to 4 per cent. caustic soda solution ; the antimony is precipitated from the solution with CO_2, and the gold, of course, remains in the residue."—*The Mining Journal* (London), July 28, 1906, p. 103. (W. A. C.)

*See this *Journal*, p. 20, July, 1906.

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GREAT BOULDER PROPRIETARY GOLD MINE.—The mine is situate at Kalgoorlie, in the East Coolgardie Goldfield, West Australia.

At the lower levels the ore contains :—

Silica	75	per cent.
Carbonate of lime ...	7	,,
Magnesia	5	,,
Carbonate of iron ...	3	,,
Alumina	2	,,
Iron pyrites	6	,,

The ore is hard and tough.

After coarse breaking the ore is milled dry by two large Krupp ball mills and twelve Griffin mills.

The ball mills with a screen of 30 x 30 mesh by 28 I.S.W.G. wire have a capacity of 90 tons per day each, and yield a product with 21 per cent. of + 60, whilst 50 per cent. passes a 200 mesh screen.

The Griffin mills are 30 in. in diameter, run at 200 r.p.m., take 20 h.p. to drive, and with a screen of 15 x 15 mesh by 21 I.S.W.G. wire, crush 30·8 tons per day each, and usually run 82 per cent. of full time. The product contains 5·5 per cent. of + 60 and 67·7 per cent. passes a 200 mesh screen.

The dry crushed ore is roasted in twelve Edwards and eight Merton furnaces, each furnace being capable of roasting 25 tons per day.

The roasted ore, whilst still hot (600 deg. F.) is then mixed with cyanide solution in the ratio of 3 to 1 in a covered agitation vat, ¼ lb. of lead acetate per ton of ore being added at the same time. The stream of pulp is distributed to twelve Wheeler pans, which overflow to ten more pans, and from the latter passes to a return sands spitzkasten. The underflow of the spitzkasten is returned to the pans for further grinding, whilst the overflow passes to a large settler composed of 32·6 ft. x 6 ft. spitzkasten, giving a settling area of 48 ft wide and 24 ft. long. Clear solution overflows from this settler.

The grinding pans are 5 ft. in diameter, run at 62 r.p.m. and use 4·5 h.p. each. 40 lb. of mercury are fed into each pan per month, the consumption amounting to 0·6 oz. per ton. About 34 per cent. of the gold is recovered by amalgamation. A set of shoes and dies lasts 96 days.

The sizing analyses of the roasted ore before and after grinding are :—

	Before.	After.
+ 60	12·33 per cent.	0·21 per cent.
− 60 + 100	12·28 ,,	3·74 ,,
− 100 + 200	12·08 ,,	17·43 ,,
− 200	63·31 ,,	78·62 ,,

The sludge from the settlers is stored in a large vat, where it is kept in suspension by agitation, and from which eighteen smaller agitation vats, holding from 25 to 32 tons of dry ore each, are fed. Here the ore is treated for sixteen hours with a ·1 per cent. solution. The cyanide consumption is 1·2 lb. per ton of ore. After treatment in the agitation vats the pulp is filter-pressed. Four Delme presses, holding 4·5 tons each, and nine Martin presses, holding 3·6 tons each, are in use. Filling a press takes 25 minutes, first wash 5 minutes, second wash 20 minutes, water wash 3 minutes, and drying by compressed air 1 minute. The residues contain 27 per cent. of moisture. The solution from the charges and the first wash are precipitated, the remainder being used for making up fresh pulp at the mixers.

The solution is passed through four Delme clarifying presses and made up to 0·09 per cent. KCN before precipitation, and flows through the extractors at the rate of 2·12 tons of solution per cub. ft. of zinc per 24 hours. Entering the extractors the solution assays 5 dwt., and leaving 0·3 dwt.

The treatment costs (not including general charges) are :—

	s.	d.
Rock breaking	0	11·487
Milling	2	11·977
Roasting	2	4·642
Fine grinding and classification ...	1	1·545
Agitation with cyanide	1	8·634
Filter pressing	0	11·249
Precipitation and clean up	0	3·734
Disposal of residues	0	5·343
Supervision	0	3·903
Assays and electric light	0	4·663
Total cost per ton	11	7·177

—ROBERT ALLEN.—*The Mining Journal* (London), May 23 and June 30, 1906. (W. D.)

SHEET LEAD FOR ANNULAR LAUNDERS.—"This week's patents include a new departure in classifiers, patented by Charles W. Merrill. The classifiers previously invented by Mr. Merrill, and used by him at the Homestake plant, are large conical vats, and although they were set on secure foundations, the slightest settling on either side resulted in disturbing the even flow of pulp over the upper periphery of the cone, and prevented proper classification of the sand and slime. To obviate this Mr. Merrill employed various materials in making the rim of these cones, but not meeting with satisfactory results, he tried sheet lead—and the problem was solved. Any subsidence of the classifier, disturbing the overflow, can be quickly adjusted by carefully planing the soft metallic edge of the overflow rim."—*Mining and Scientific Press*, June 9, 1906, p. 375. (K. L. G.)

THE USE OF THE IMPACT SCREEN IN TIN DRESSING.—"In a short paper before the April 19, 1906, meeting of the British Institution of Mining and Metallurgy, the author gives some information concerning the first use of the impact screen in the United Kingdom and its first application to the dressing of tin ore. At the Wheal Kitty Mine, Cornwall, about two tons of material per hour are stamped with old-fashioned stamps through a 20-mesh screen. The screen analysis of the pulp gave the following results :—

Remains on a 30 mesh ...	23·5	per cent.
Passes 30, remains on 60 ...	40·0	,,
Passes 60, through 80 ...	13·5	,,
Passes 80	21·0	,,
Fine Slime	2·0	,,

The fine slime and most of the fine sand which passes the 80-mesh screen, and which constitutes about 20 per cent. of the whole, is removed for separate treatment by four small hydraulic separators. The whole of the remainder of the pulp is fed on four Wilfley tables, and the heads and middlings of these tables are removed for separate treatment, while the tailings, which amount ordinarily to about 1½ tons per hour, were formerly treated by "stripping" before they were run to waste, and a little tin was thus recovered from them.

The tailings were examined by vanning, and it was ascertained that they consisted of comparatively coarse sands, which contained less than 0·1 per cent. of tin oxide, mixed with finer sands which were rich

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enough in tin to pay for special treatment. A Wilfley impact screen was installed for the purpose of treating them. It is 3 ft. sq. and is covered with 60-mesh brass wire cloth, the wires of which are of No. 26 gauge. The screen is set at an angle of 45 deg. and is operated by a cam wheel and a spring, so that the screen frame receives 300 blows per minute. The tailings, water and all, are elevated by a 20 ft. dipper wheel and thrown in a thin sheet on the screen.

The oversize is about 1 ton per hour, and is run to waste, as it never contains over 2 lb. of tin oxide to the ton and sometimes only 1½ lb. The undersize amounts to about ½ ton per hour, and it contains from 6 up to 12 lb. of tin oxide to the ton. The product is run directly into settling pits and, as it is of very even size, it is cheaply and effectively treated at intervals in an ordinary convex bucket. The whole arrangement is automatic, and the author states that the cams are a little worn after about 300 hours' work, but that the screen cloth so far shows few signs of wear, and it has never been at all choked."—J. H. COLLINS.—*The Mining Magazine*, June, 1906, p. 521. (J. Y.)

BABBITT METAL AND ITS MANUFACTURE.—"The original babbitt metal was 50 parts tin, 5 antimony, 1 copper. Great variations, principally by introducing lead or zinc, have been made, so that there are three classes of these white bearing metals sold to-day, viz., 'genuine babbitts,' in which tin predominates, with 5 to 10 per cent. of antimonial lead usually present; 'antifriction metals,' in which antimonial lead is the chief constituent; 'white brasses,' containing zinc in excess. Of the first class, there is the standard, the hard and the soft, composed as follows:—

	Standard genuine.	Hard genuine.	Soft genuine.
Tin	90	88	84
Antimony	7	4	6
Copper	3	8	3
20 per cent. antimonial lead	—	—	7

The addition of more hard lead than 7 per cent. is not advised, for the naive reason that 'the colour and fracture are then such that the customer becomes suspicious' (!) Nickel, manganese or iron is of no advantage to to these genuine babbitts, zinc and magnesium are injurious, a fraction of 1 per cent. of aluminium removes the yellow surface colouration, phosphorus does likewise and thins the metal. Of the second class, lead with 15 per cent. of antimony is the best; 5 per cent. of tin in addition improves its looks but not its wearing qualities. Mixtures intermediate between these and genuine babbitts are also used, such as lead 50, tin 40, antimony 10, with very satisfactory results. White brasses are not described in the article."—J. W. RICHARDS.—*The Journal of the American Chemical Society*, June, 1906, *Review of American Chemical Research*, p. 259. (J. A. W.)

ELECTRICAL SMELTING OF CANADIAN IRON ORES.—"The experiments described were made for the purpose of amplifying the results obtained at La Praz and Livet by the Canadian Commission in 1904, in view of the special conditions obtaining in Canada. The furnace, which is fully described and illustrated, was of the Héroult type; it absorbed 5,000 amperes at 35 to 40 volts (power factor 0·919), being fed from a transformer of 225 kw. capacity. The official experiments, of which a selected number are explained in detail with full chemical, electrical, and thermal data, lasted nearly two months, and during that time 150 casts were made, yielding 55 tons of pig iron. The experiments indicated that under normal conditions about 11·5 tons were produced by an expenditure of 1,000 e.h.p. days; with an improved furnace of, say, 1,500 e.h.p. capacity, a figure of 12 tons should, it is stated, be reached. The mean figure provisionally adopted by the Commission was only 7·8 tons per 1,000 e.h.p. days. The consumption of electrode was about 18 lb. per ton of pig iron; it was greater for white than for grey iron.

The results obtained are summarised as follows:—(1) Magnetite (which is the chief Canadian ore) can be as economically smelted by the electro-thermic process as hematite. (2) Ores of high sulphur content not containing manganese can be made into pig iron containing only a few thousandths of 1 per cent. of sulphur. (3) The silicon content can be varied as required for the class of pig to be produced. (4) Charcoal, which can be cheaply produced from mill refuse or wood which could not otherwise be utilised, can be substituted for coke as a reducing agent, without being briquetted with the ore. (5) A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite. (6) The experiment made with a titaniferous iron ore containing 17·82 per cent. of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5 per cent. titanic acid can be successfully treated by the electric process.

The paper concluded with an estimate of Dr. Héroult for a 10,000 h.p. plant capable of producing 120 tons of pig iron in 24 hours."—Dr. EUGENE HAANEL, before the Faraday Society.—*London Mining Journal*, July 14, 1906, p. 41. (J. Y.)

STAMP MILL PRACTICE.—Height of discharge and quantity of feed water, as well as diameter of screen opening, determine size of pulp. Every mill should be provided with at least three "testing" screens, one having openings equal to the diameter of the maximum size of grain admissible for the ore under treatment, one having openings equal to the middle-sized product desired, and the third of 150 mesh or about ·00876 mm. diameter of openings. The product from every battery should be tested at frequent intervals by wet screening. When the pulp on the coarsest screen exceeds ·5 per cent., the screen in that battery should be changed or extraction will suffer. The ratio between the middle-coarse and the middle-fine should be nearly constant and uniform throughout the entire mill, and, above all, a constant ratio by weight between the total oversize and undersize material from the finest screen must be maintained. Stamp duty is relative, depending not only on the character of the ore, but on the rate of discharge which has been found to give the most economical results. The metallurgist who has not advanced to the point of tolerating the low crushing efficiency per h.p. of the stamp mill for the sake of the extraction by amalgamation which he can make it yield, is in error at the very foundation of the trade. It should be borne in mind that it is not necessarily the mill man who can put through the largest tonnage who is earning the most money. As an example: In a recent experience in California I found that I could obtain a recovery of 91·5 per cent. when crushing 0·121 tons per stamp per hour; and that using the same screen (0·028 in. diameter of opening) but re-adjusting the mill as to drop, discharge, etc., the duty could be run up to 0·188 tons per stamp per hour, with a reduction of the recovery to 77 per cent.

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To clean plates borax soap is altogether the best material to use under modern conditions. It is sufficiently alkaline to clean off any stray animal fats, and it will emulsify the mineral oils, and leave the plates bright and ready to take mercury or catch gold. Caustic alkalies do not touch the mineral oils, and practically all modern lubricants are petroleum derivatives. Cyanide of potassium should never be used under any pretext, it hardens the amalgam and causes it to scale. If bare copper occurs from any cause, scour with sand, wash with borax soap, rinse well, and burnish with a dry cloth. A surface so prepared will promptly start to catch amalgam. If ores carry copper sulphides, copper sulphate will usually be present also, or will be formed to some extent in the battery. This may be largely decomposed and the copper amalgamated with the gold, by feeding common salt with the ore. This practice is often useful in protecting the cyanide treatment of the mill sands. Abundant area of copper plate beyond the battery is important. Most mills are deficient in this regard. It pays to have enough. There is no advantage in using copper plates plated with more than 1 oz. of silver per square foot. In fact, more than this is a positive disadvantage. The chief advantage in silver-plating is to reduce the absorption of gold by the plate. A first dressing on bare copper with dilute silver amalgam will yield a surface more sensitive as an amalgam catcher than a silver-plated copper plate.—COURTENAY DE KALB. —*Canadian Mining Review*, June, 1906, p. 188. (R. G. B.)

THE USE OF MUNTZ METAL AMALGAMATED PLATES FOR MILLING WITH CYANIDE SOLUTION.—"A brief note on the performance of two Muntz metal plates at the mill of the Bamberger-De Lamar Gold Mines Co. The ore is ground in a ·15 per cent. cyanide solution, and the pulp flows direct from Chilean mills to amalgamating plates. Formerly, copper plates were used, ⅛ in. thick, with one ounce of silver per square foot.

These plates rapidly became rough and pitted, and at the end of two months they were found to be ragged at the lower end and practically destroyed. Two Muntz metal plates ⅛ in. thick with 1 oz. of silver per square foot were then installed, and the author states that they proved such a success that the copper plates were replaced by Muntz metal plates throughout. The life of the latter plates is stated to be four times that of the former, and the Muntz metal amalgamates readily, the amalgam is easily detached, and a rapid clean up obtained. It was proven on bars formed by melting two old copper and two Muntz metal plates, which latter had been in use much longer than the former, that amalgam is not absorbed by Muntz metal to such an extent as by copper. New plates from the alloy are stated not to require the careful attention and manipulation necessary with the copper plates, while the discoloration and appearance of verdigris experienced with copper plates is no longer noticed. Care must be taken in dressing up the plates with mercury, as the Muntz metal will not hold the mercury like copper, and if a slight excess is used, it will collect in globules. It is therefore advisable to brush the plates more frequently than is customary with copper. The author recommends the use of such plates where amalgamation is carried on in the cyanide solution."—PARSONS.—*Mining and Scientific Press*, April 28, 1906.—*Mines and Minerals*, p. 573, July, 1906. (W. A. C.)

MINING.

DRILLING MACHINES, LARGE AND SMALL.*—"The purpose of this paper is to discuss the relative merits of the large 3⅛ in. machine and the small 2¼ in. tappett machine in driving development headings.

Recently we drove two parallel cross-cuts through the same formation, using a 3⅛ in. machine at the breast of one cross-cut, and a 2¼ in. machine of the same make at the breast of the other.

The results obtained in working the property of the Portland Gold Mining Co. show that during a period of two years there have been driven, with the small machine, 4 miles and 308 ft. of development-headings, through a diversity of ground, including Pike's Peak granite (a coarsely porphyritic type of granite), highly indurated, andesitic or phonolytic breccia, true massive andesite, trachytic phonolyte, tuffas, and along dykes of decomposed basalt and hard phonolyte; in every instance a satisfactory record was made.

The headings here described were driven through highly indurated, andesitic breccia, having a hardness of from 5·2 to 7·2 and a sp. gr. of from 2·2 to 2·8. The action of the breccia under the drill was not materially different from that of ordinary red granite. The breccia was not as free-drilling as granite, and sludge accumulated very rapidly after a shallow depth of hole has been gained, but broke better than granite.

Aside from the usual work of setting-up, drilling, and loading, the machine-men or helpers mucked back, cleaning the floor 3 or 4 ft. back from the breast of muck in order to position the column properly. If the "lifters" acted properly at the previous firing, the muck was fairly-well thrown back from the breast; but if either missed fire or were exploded before the other holes, considerable muck was left at the breast which required much additional labour. The usual time needed to muck back was 1·25 hr., but this varied considerably. Flat steel, 48 by 96 by ⅜ in. sheets, were used, from which to shovel the material. These sheets were placed in position 3 or 4 ft. back from the breast by the trammer just before going off shift. The ground broke fine enough to require little or no sledging. A cubic foot of breccia in place will average 154 lb. in weight as compared with 90 lb. on the muck-pile, giving an average of 42 per cent. of void space. All the waste was trammed to the shaft, 800 ft. distant, and hoisted to the surface. No timber was used in either heading.

	Feet per Shift.
Large machine (3⅛ in).	
Cross-cut (5·5 ft. x 7·5 ft.).	
5 day run	2·85
8 day run	2·91
7 day run	2·54
Totals	2·76
Small machine (2¼ in.).	
Cross-cut (4·5 ft. x 7·0 ft.).	
5 day run	2·40
8 day run	2·50
7 day run	2·39
Totals	2·44

The best record for a shift's run, made by the large machine, was 4·08 ft., as compared with 2·96 ft. for the small machine. In drilling these rounds it was found that the large machine had made 3,109·56 cub. in. of hole, and the small machine 971·10 cub.

* See this *Journal*, p. 93, Sept., 1905.

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in. Comparing these figures with the cubic feet of ground pulled, 1 cub. in. of hole drilled by the large machine broke 0·053 cub. ft. of breast, while the small machine gave 0·097 cub. ft. This comparison shows that too much work was done by the big machine on the breast for the amount of ground broken.

The air was furnished by a 50 drill, cross-compound, Ingersoll-Sargent compressor, having steam cylinders 24 x 44 x 48 in., and air cylinders 22¼ x 38¾ x 48 in. The air pressure at the receiver was 100 lb., and at the drills 85 lb. per sq. in.

The bore of the large machine cross-cut is 5·5 x 7·5 ft., that of the small machine is 4·5 x 7 ft.; it is held that the increase of 1 ft. in width and 0·5 ft. in height of the large machine cross-cut over that of the small machine cross-cut does not facilitate mining operations in any way.

The merits of the work done by the two machines may be briefly stated thus:—The use of the small machine saves 25 per cent. of the cost of labour necessary to operate a large machine foot per foot. The cost of operating a small machine is 50 per cent. less than that of operating a large machine, shift for shift. The general tramming cost of the large machine cross-cut is lessened 20 per cent. by using a small machine. The cost of explosives per foot driven by the large machine can be reduced 37·7 per cent. by the use of the small machine. The cost of hoisting and general expense of the large machine cross-cut is lessened nearly 20 per cent. by using the small machine.

Greater speed, regardless of cost, can be obtained with the large machine, the small machine being from 10 to 20 per cent. slower. The cost of the large machine cross-cut was reduced 27 per cent. by using the small machine."—F. T. WILLIAMS.—*American Institution of Mining Engineers*, May, 1906, pp. 269-272. (J. Y.)

DIVERS IN MINING.—"In order to take out machinery, tools, pipe lines, etc., from mines that are filled with water, it is very often possible to use a diver. The kinds of apparatus used by divers in Germany are of two principal types, the English and the German system. In the former system the diver is clothed in an air-tight suit with a metallic helmet. The suit is filled with air and a hose is attached to furnish fresh air. The diver inhales what air he requires, and the air which he exhales mingles with the fresh air inside of the helmet. In order to relieve the excess of air, a valve which works automatically is attached, allowing the air to escape when the pressure passes a certain limit. The diver has control of this valve, and by a sidewise movement of the head can open it at will. The system has the disadvantage that the diver is not breathing pure air, and his lungs are subject to the pulsations of the pump by which the air is furnished. Also his safety depends more or less on the strength of the diving suit. The German system differs from the English in that the diver carries with him an air receiver which is divided into two parts by a partition. One of these parts serves as a fresh-air reservoir, and the other one is connected with the mouth of the diver by means of a rubber tube. By a simple valve in this partition the pressure is equalised as he breathes. The complete apparatus consists of the suit, the helmet, breathing tube, the tank, the air pump and air hose, cages, weights, signal line and belt with knives. The use of these several parts is well known. By a special valve the air which has been breathed is discharged from the tank."—Engineer KUPPERS.—*Minesand Minerals*, April, 1906. (J. Y.)

AIR-LIFT PUMPING.*—"Several things important to success and economy must be taken into consideration in the installation of this system of raising water. The first is a sufficient supply of water, as this method is not suitable where a small supply only is obtained. The tables should be consulted and the well then permanently piped for the size pipe given in the proper column corresponding to the amount of water furnished by the well. If one well does not furnish the amount of water required, more wells can be put down, and the air furnished by one compressor, located in any convenient place, as has been previously suggested.

Economical compression of air is also essential. Air is a gas subject to rapid expansion under the rise of temperature, and, as we are dealing with volumes at atmospheric pressure, it is necessary that the air should be taken into the compressor at as low a temperature as possible. By the use of a good compressor, economical results can be obtained.

The well lately tested is 300 ft. deep, the water being elevated above the surface of the ground 85 ft. When the well is being worked, the water level is 44 ft. from the surface of the ground, making a total lift of 44+85=129 ft. The water pipe extended down 297 ft., or within 3 ft. of the bottom of the well, and from the bottom of the water pipe to the bottom of the air pipe is 5 ft., making a total of 5+3=8 from the bottom of the well. This taken from 300 ft. equals 292 ft., and 292+85=377 ft., making a total length of the water pipe, from the point at which air enters to the point of discharges 377 ft. Substracting the lift, 129 ft., from 377, give, 248 ft. submersion.

Pipes were arranged in the following manner: from the surface of the ground to the end of the pipe extending into the well, the water pipe is 3·5 in. in diameter; to the upper end of this pipe a Y is fastened. Into the centre, a 1·25 in. air pipe is put, extending within 5 ft. of the bottom of the water pipe. From the side outlet of the Y, a 3 in. pipe extends to the point of discharge. This arrangement would be the same as a 3 in. lift. The well is 8 in. in diameter; the water delivered is 82·5 gallons a minute, or 11 cub. ft.; the air used to raise this amount was 81·81 cub. ft. of free air, being equal to a little more than 7·43 cub. ft. of air to 1 cub. ft. of water.

Air pressure was 107 lb., with a loss of 9 per cent. in its compression. The horse-power required to compress the amount of air used in the operation of this system was 12·134. A percentage of the efficiency of the lift obtained by different submergence will be seen by Table I.

Table II. shows the size of the well tube, water and air pipes corresponding to the given quantity of water delivered. These figures have been exceeded by very productive wells, but will often be found too large.

TABLE I. SUBMERGENCE AND EFFICIENCY.

Submergence, per cent. of length of Water Pipe.	Efficiency per cent.
60	50
50	40
40	30
33	25
30	22

* See this *Journal*, p. 281, March, 1906.

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There being 7·5 gallons of water in 1 cub. ft., this number must be used to convert gallons into cubic feet. Table III. gives us the ratio of volume of air to water, the submersion air pressure, cubic feet of free air per gallon of water, and the horse-power required for lifting.

Remarks: Special submergence should be used where there is a long horizontal discharge or a great number of turns in the discharge pipe as shown in

TABLE II. CAPACITY AND PIPE SIZES.

Size of Well in Inches.	Water Pipe in Inches.	Air Pipe in Inches.	Gals. Water per min.
4	1½	¾	25
4½	2	1	50
5	2½	1	75
6	3	1¼	100
7	3½	1½	150
8	4	1½	200
9	5	2	300
10	6	2	450

the fourth and sixth columns of Table III.

In concluding this paper, I wish to say that for some wells which accumulate foreign matter and sand in the bottom, it is a good idea to put a gate valve in the discharge pipe in some convenient location where it can be easily reached. This valve should be closed about once a month and the air pumped up and allowed to blow out all dirt, slime or gravel which has accumulated therein. This will assist in maintaining the efficiency of the well, as any accumulation will retard the flow of water. When a well is blown out or reversed, where the air

TABLE III. LIFT, SUBMERGENCE AND AIR NEED FOR AIR-LIFT PUMPING.

Lift in Feet.	Volume of Air to 1 ft. of water.	Subm. equals 60 per cent. total water pipe ft.	Submergence for special lift, ft.	Air pressure Submergence 60 per cent., lb.	Air press. for sp'l. lift: submergence 60 per cent. lbs.	Cu. ft. free Air per gal. per min.	H.P. per gal. per min.
25	2	38	50	17	20	0·3	0·0184
50	3	75	100	33	44	0·4	0·0426
75	4·5	113	150	49	65	0·6	0·0828
100	6	150	200	65	87	0·8	0·1320
125	7·5	188	250	82	109	1·0	0·1910
150	9	225	300	98	120	1·2	0·2544
175	10·5	263	350	115	152	1·4	0·3150
200	12	300	400	130	173	1·4	0·3808

pressure is high, the water and accumulations are blown out with great force, and it will be necessary to protect objects within 10 or 15 ft. of the well from possible injury."—Paper by G. C. H. FRIEDRICH, before the Ohio Society of Mechanical, Electrical and Steam Engineers.—*The Engineer* (Chicago), June 1, 1906, p. 373. (J. Y.)

A NOVEL METHOD OF MINING KAOLIN.—"The kaolin-deposit at West Cornwall is an alteration *in situ*—that is, it is not sedimentary. A series of clay veins dipping about 50° from the vertical, lie between a foot-wall of limonite and a hanging-wall of gneiss and hornblende schist. The clay-veins alternate with veins or seams of more or less broken quartz, and unaltered feldspar. The deposit, which occurs at a point about 600 ft. above the Housatonic River, was opened five years ago, and about 5,000 tons of a superior grade of washed kaolin has been extracted from open pits and sold. It soon became evident that this mode of extracting the product would prove unremunerative, by reason of the dip of the vein and the intercalary strata and lenses of quartz, and a more satisfactory method of working the deposit was sought. It is well understood, that, in the preparation of all clays for market, especially residuary kaolin, the most important as well as the most difficult step is the washing of the crude product. The difficulties increase with the percentage of foreign matter, especially quartz and mica, contained in the product, hence a system of working a clay-deposit by which it would be possible to obtain the crude material from great depths without removing the overburden (or, in the case of veins, without resorting to shafts, drifts and other underground workings requiring timbering), and, at the same time, minimise the raising of waste material with the marketable product, would be of great advantage.

Proceeding on the logic of these observations, Mr. Wanner, the engineer temporarily in charge of the operations at the mines, conceived the scheme to disintegrate the kaolin *in situ* by means of jets of water under sufficient pressure and floating the resultant product to the surface. This product is technically known in the pottery trade as "slip." To accomplish this result holes are drilled through the overlying gneiss, a pipe of 4-in. internal diameter is inserted into the bore and driven into the clay body to within a few feet of the foot-wall. The wells in operation are from 50 to 198 ft. deep. Into this 4-in. pipe or "casing," an interior pipe is inserted of 2-in. external diameter, leaving an annular space of 1 in. for the flow of the slip. The lower end of the internal is provided with a mouth-piece with several nozzle-like openings for the exit of the water; the mouthpiece rests on the clay body, and the interior pipe sinks gradually as the clay is removed until it rests on the footwall of the vein. For the operation of these "hydraulics" a head of water equivalent to a pressure of from 40 to 60 lb. per sq. in. is required, according to the nature of the vein matter.

Residuary kaolin slacks more or less readily, according to the amount of sand and mica mixed with it. In the case in point, it has been found that a pressure of 40 lb. is amply sufficient to cause the disintegration, the vein-matter contains 20 per cent. and the slip, discharged by the hydraulics, from 60 to 75 per cent. of pure kaolin. The purity of the discharged slip is inversely proportional to the velocity of the overflow.

Observations made during the past summer's work have shown that the overflow contains from 5 to 10 per cent. of solid matter. A discharge of 100 gal. per min. through the annular space of 9·42 sq. in. from a depth of 127 ft. yielded 5 per cent. of solid matter, of which 75 per cent. was pure kaolin, while a discharge of 200 gal. per min. through the same orifice from the same depth, gave a slip containing 10 per cent. of solid matter but only 54 per cent. of pure kaolin, the rest being finely-divided quartz and mica.

One of the factors directly responsible for the purity of the slip as well as for the facility of the separation or washing of the product is the accumulation of the waste material in the cavities caused by the withdrawal of the product through which the slip has to pass to arrive at the lower orifice of the casing. The passage of the slip through this mass, which consists principally of a breccia of quartz, acts as a scouring medium, effectively helps in the

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separation of the clay particles from associated fine scales of mica, and renders easy its final division by subsidence.

In addition to the lessening of the cost of extraction, the method described has effectually solved the transportation of the product to the railroad. Heretofore, the kaolin washed and dried at the mines was carted by teams over a difficult mountain road to West Cornwall, 4 miles distant. The fuel for the whole plant had to be hauled up the mountain the same distance. With slip issuing from the hydraulics of only 10 per cent. of solid matter and sufficient fineness to pass through 100-mesh screens, the conveyance of the product through a pipe-line to the Housatonic Valley offers no difficulty, and the company now contemplates the erection of a new washing-plant adjacent to the river and railroad."—ALBERT R. LEDOUX.—"Transactions of the American Institute of Mining Engineers," May 1906. (J. Y.)

THE CRUSHING OF COPPER ORES IN THE LAKE SUPERIOR DISTRICT.—"The practice of crushing has made considerable advances within recent years in the Lake Superior district. A brief résumé of present conditions is given by the author in an article in *Mines and Minerals*, March, 1906.

The Osceola mill, near the Tamarack mine, has a new compound steam stamp which has the high record of crushing 779 tons of copper ores per day, the average maintained during a two weeks' run being 725 tons per 24 hours and 700 tons including stops. It has been found that it is economical to concentrate the work in a few huge stamps, and the old type of small batteries is rapidly disappearing. The rock of the region contains pieces of copper as large as potatoes, and much trouble was formerly encountered from these pieces getting caught in the stamps, which necessitated the stopping of the mill to remove them. This trouble has been overcome by the invention of automatic dischargers, and to-day a stamp is rarely stopped for any such reason.

Slight differences in crushing exist at the different mills, according to the nature of the rock, amygdaloid rock being much easier to crush than conglomerate. Otherwise, practically the same methods are pursued. At the Isle Royale mill three new large stamps are in operation, the largest of which is capable of crushing 500 tons of hard rock per day. The stamp is driven in its descent by the piston of a steam engine of 190 h.p. Each shoe of the stamp weighs 800 lb. and the stamp head develops a maximum velocity of 25 ft. per second. The total weight of the stroke is from 3 to 4 tons. The stamp drops over 100 times per minute. The shoes are of the hardest chilled iron and last two weeks. At the Quincy mill, on Torch Lake, the new stamp mill has a capacity of 550 tons per day, and the old stamps in use have each a capacity of 475 tons. The latter stamps are operated under a steam pressure of 98 lb. per sq. in., while the new one runs at 118 lb. The die in the new mill weighs 800 lb. and lasts from six to eight months, when it weighs from 200 to 250 lb. The new shoes weigh about 700 lb. and they last only eight days, when they are worn down to a little over 400 lb., owing to the copper rock being very rough and hard.

At the plant of Calumet and Hecla, near Torch Lake, the rock is a conglomerate and not amygdaloid, as is the case at the other two mills. This fact necessitates a different treatment, as in the conglomerate rock the copper is found in the very hard portions and both crushing and re-grinding are necessary. For this reason, the copper stamp mills of the Calumet and Hecla are smaller than those at the Isle Royale or at the Quincy. The 28 stamps in the Torch Lake district average only 300 tons per stamp. The stamps have a falling weight of only 2½ tons when the shoes are new.

A great variety of re-grinding mills are in operation at the Calumet and Hecla plant, including the Chilean, Huntington, Heberle, Monadnock and Allis types. The Chilean mill at the above plant is provided with a roller which has a crushing weight of 6,000 lb., the operation requiring from 25 to 30 h.p. The roller makes 25 to 30 revolutions per minute. The consumption of steel reaches as high as 15 cents per ton of ore ground when the rock is very hard and ragged, and re-grinding in the Chilean mill costs as much as 30 to 35 cents per ton. The author states that efforts to reduce this cost by the introduction of a huge Huntington mill with overhead drive and great crushing capacity have resulted in lowering the cost down to 10 to 15 cents per ton.

In the past year experiments have been made with gyratory crushers supplemented by rolls, and good results have been obtained, one plant capable of 350 tons per day being now in operation. The rock is gradually reduced by gyratory crushers to sizes suitable for rolls instead of by the steam stamps. The author is of the opinion that if the expense of operating steam stamps can be saved, it may be that the process will prove profitable. The saving will be in the cost of steam power and also in the amount of water required for separation. The tailings loss at the Calumet and Hecla is given as 0·7 per cent. on conglomerate and ·25 to ·35 per cent. on amygdaloid rock; at the Champion mills it is ·30 to ·35 per cent. At the Quincy mill the tailings loss is about ·26 per cent."—A. S. ATKINSON.—*Mining Magazine*, June, 1906, pp. 506-7. (J. Y.)

COMPARATIVE MERITS OF AIR AND ELECTRIC DRILLS.—"The air drill seems to occupy a very secure position with regard to its retention as a standard form of apparatus; and it is quite remarkable that as a labour-saving device one of the most inefficient pieces of apparatus ever designed should have proved the most economical in its particular field.

Drilling holes in rock is an operation in which an exhibition of bull strength and awkwardness is desirable, and this feature the air drill seems to possess to a commercially marketable degree, to the exclusion of all other types of power drills. A jarring hammer blow, transmitted to a cutting edge, is the way of all ways for putting in rock holes of moderate depth; and for this class of work, tools driven directly by air or steam are practically ideal, as all of the parts of the reciprocative piston that are liable to damage are easily protected from mechanical injury, and so enclosed in a chamber of elastic and compressible gas that no damage results to them, even when the drill is instantly stopped by sticking in the hole—a not infrequent occurrence. Of course the electric drill, with its short, rapid stroke, cuts a cleaner and straighter hole than the air drill; but it does stick and stop short, with damaging results.

The particular advantages claimed for the electric over the air are low first cost of plant, ease of installation, and great economy of power—and every one of these claims are true; but when the high cost of maintenance and time lost incident to break-downs are considered, the above claims sink into insignificance—particularly when the continuous operation of the entire mine depends more upon the reliability

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of the rock-drilling apparatus than on perhaps any other operation.

The reasons that the air and steam drills are a success, as above noted, are that the essential delicate parts are protected from jar, and that no injury to the apparatus occurs when the drill is stopped by a "sticky hole." The reason why the electric drill has proved a failure is because it is impossible to properly protect the motor from jar, and at the same time properly transmit and transform its rotary motion to the reciprocatory stroke necessary to operate the drill steel.

With the motor removed from the drill body, the insulation difficulties are overcome, and the transmission of the power from the revolving armature to the reciprocating draw bar, and from it to the chuck and ratchet bar is the last point to consider. As the travel of the draw bar, driven by a crank shaft and internal cam, must have definite limits of motion, and as the connection between the draw and chuck bars must be sufficiently flexible to permit the draw bar's continued operation when the chuck bar is held stationary by reason of the drill sticking in the hole, and at the same time be sufficiently rigid to permit of the chuck bar striking a blow representing a hundred or more foot pounds of energy under normal conditions, an exceedingly efficient spring transmission is necessary. Though wonderful things have been accomplished in spring manufacture, it does not seem that the art has reached the stage where the above results can be obtained in regular practice."—G. E. PALMER.—*Compressed Air*, June, 1906, p. 4,061. (T. L. C.)

MINE ACCIDENTS IN GREAT BRITAIN.—"The complete returns of the British mine inspection bureau, have now been issued. The mines of Great Britain are classed under three heads, coal mines, metalliferous mines and quarries, or open workings. The total number of employees in the mines of the United Kingdom in 1905 was as follows:

	Underground.	Surface.	Total.
Coal Mines	691,112	167,261	858,373
Metalliferous Mines ..	17,286	11,865	29,151
Quarries	59,978	34,841	94,819
Total ...	768,376	213,967	982,343

Women are no longer employed underground, but of the surface workers last year 5,929 at coal mines and 225 at metalliferous mines were females. In the coal mines, 60,058 boys under 16 years of age were at work. At quarries, underground employees are those who work in the pits or excavations.

The number of persons killed and injured during 1905 is reported as below:

	Killed.	Injured.	Total.
Coal Mines	1,159	3,380	4,539
Metalliferous Mines ...	43	245	288
Quarries	97	1,193	1,290
Total ...	1,299	4,818	6,117

As compared with 1904, there was an increase of 104 deaths in coal mines, and of 11 at metal mines; but a decrease of 13 deaths in quarries. The report notes that the figures given for numbers injured are not a sure guide to the number of non-fatal accidents which actually occurred, because the standard of severity governing the notification of accidents at mines and quarries is vague, and allows much latitude to the agent in his interpretation of it. Until a definite standard is fixed by statute no stress should be laid upon these figures, excepting as regards injuries caused by explosions of firedamp, explosives, and steam boilers; in these three cases notifications have to be sent to the inspector, no matter how slight the injuries.

The proportion of boy workers under 16, in the coal mines, was 7 per cent. The number of boys killed was 87, or 7·5 per cent. of the total. The difference in proportion was slight.

The number of deaths per 1,000 employees was as follows in 1905:

	Inside.	Outside.	All Workers.
Coal Mines	1·49	0·75	1·35
Metalliferous Mines	2·49	0·25	1·58
Quarries	1·42	0·40	1·04
All workings ..			1·32

This is a low death rate, the small number of 1,299 killed out of nearly a million persons, shows that mining in Great Britain can hardly be called a hazardous occupation."—*Engineering and Mining Journal*, June 23, 1906, p. 1,034. (T. L. C.)

THE DEEPEST GOLD MINE.—"According to the *Daily Chronicle* correspondent, Australia now possesses the deepest gold mine in the world. Within the last few weeks the shafts at New Chum Railway at Bendigo, Victoria, have been sunk to a depth of over 4,300 ft., and the quartz there tapped has been sampled and crushed, with the result that a yield of gold equal to an ounce per ton has been obtained. The operations in the mine have been tested by Government officials in view of the fact that never before in the world's history has gold been obtained from so low a depth as three-quarters of a mile. The Victorian Director of Geology, Mr. E. J. Dunn, in the course of an official report upon a sample from the 4,300 ft. shaft of the New Chum, writes:—'This remarkable specimen of auriferous quartz is evidence of the vast stores of wealth in gold possessed by the State. It is a guarantee of the stability and progressive prosperity of Bendigo that such rich ore exists at such great depths. The winning of such ore from a vertical depth of over three-quarters of a mile from the surface is an achievement of which Bendigo miners may justly feel proud.'"—*Science and Art of Mining*, June 16, 1906. (T. L. C.)

THE SHAMROCK RESCUE APPARATUS AT THE COURRIÈRES COLLIERIES.—"A circumstance in this rescue expedition which is of great and general interest is the evidence that the Westphalian rescue arrangements resisted, both as regards the men and appliances, the test of fire. Although the Westphalian party did not succeed in saving any human lives, it was, nevertheless, shown that both men and appliances could resist for weeks the severest strain. The appliances only satisfied in the fullest measure the demands made upon them, because they were continually and most carefully looked after, and were constantly being overhauled and tested.

As regards the construction of these oxygen appliances, the experiences at Courrières collieries have shown that for difficult and serious use in mines, no apparatus can be practically employed unless it is made in the most substantial fashion, protected against all the ill effects of mine work, and without a helmet. The lamentable accident that occurred to Mr. Heierle, a Swiss, shows how thoroughly justified the writer has been in repeatedly opposing the employment of helmet appliances in dangerous gases in the mine. After the German rescue party left

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France, it appears that the man in question was found lying dead in irrespirable gases, whilst his helmet, which seems to have been dragged off his head, lay beside him. Furthermore, the Paris firemen, of whom we thought so highly, did not use their Dräger helmets while the writer was at the mine; they took them down with them into the mine, but they always took them off before they started to work, and explained to the Germans that these appliances could not be used in the pit.

Another instructive deduction from the experiences at Courrières is that it is necessary that not only officials and miners shall be practised in using the rescue appliances, but that the mechanics shall be thoroughly acquainted with the handling and cleaning, and, above all, the intelligent testing of these appliances. It is to be expected that the regular course in rescue work now instituted at the mining school in Bochum will also take this point into consideration."—Extracted from paper by G. A. MEYER, before the Federated Institute of Mining Engineers.—*London Mining Journal*, July 14, 1906, p. 35. (J. Y.)

THE OILFIELDS OF TRINIDAD.—"I have omitted as yet to say anything about the quality of the oil, as this is a point which concerns the chemist more than the geologist; but a few words on this point are necessary. Professor Carmody, the Government Analyst of Trinidad, has made many analyses of samples taken from "shows" on the outcrops and from the wells that have been drilled, and the Director of the Imperial Institute has also published several chemical analyses. Many different varieties of oil have been obtained; most have an asphaltic base, but some of the minor oil-rocks seem to be rich in paraffin. Speaking generally, the petroleum resembles Russian petroleum very closely, and this is the more interesting as—in the age of the rocks, the nature and composition of the strata, and the geological structure—the Trinidad oilfield presents many striking resemblances to the Baku oilfields. The percentage of sulphur is very small, and will not entail any expensive special refining process, as is the case with Texan oil. An average sample of crude oil from the Galeota oil-sand will probably have a specific gravity of ·880 to ·910, and will contain from 12 per cent. to 20 per cent. of petroleum spirit, 30 per cent. to 50 per cent. of illuminating oils, 30 per cent. to 50 per cent. of lubricating oils, and not more than 5 per cent. of residual bitumen.

Oils from the Rio Blanco oil-sand, while still containing a considerable percentage of petroleum spirit, will, as a rule, be richer in lubricating oils and residue, at the expense of illuminating oils.

It will be possible to refine these oils so as to make a large percentage of fuel oil, which will probably prove the most profitable branch of the industry in Trinidad. Situated as the colony is, with a magnificent harbour, it cannot fail to become in the future a very important centre of trade and shipping; and if, as we are assured on all hands, oil fuel is to be the fuel of the future for ships, it will be possible to sell every gallon of the fuel oil produced in Trinidad without coming into competition with any of the great oil companies of other countries. The demand for petrol is steadily increasing, and the percentage of it in Trinidad oils should also find a ready sale, while lubricating and illuminating oils can be disposed of in the colony, to the neighbouring islands, and at home."—E. H. CUNNINGHAM CRAIG.—Royal Colonial Institute.—*London Mining Journal*, July 14, 1906, p. 37. (J. Y.)

OVERWINDING IN HOISTING.—"Overwinding is guarded against by numerous mechanical devices, and every fresh accident stimulates inventors to the design of new contrivances. These devices fall into three general classes, viz.: (1) Those which depend upon the use of some kind of detaching hook, placed between the cage and the rope, the purpose being that when the cage reaches a certain point in the upper part of the head frame, the detaching hook comes into contact with a releasing apparatus, which unlocks the hook and frees the rope from the cage. (2) Arrangements for automatically shutting off the steam and applying the brakes to the winding engine. (3) Arrangements for cushioning the cage as it rises into the head frame.

The efficiency of devices of these various types is discussed by Prof. Robert Peele in an excellent paper in the *School of Mines Quarterly* for January, 1906. Prof. Peele points out that none of the detaching hooks really prevents overwinding; they merely do what is possible to avert or mitigate the serious consequences resulting from it. Some detaching hooks are found to work satisfactorily with moderate hoisting speeds; such as may be attained by geared engines, say, up to 1,200 or 1,500 ft. per minute, where the momentum of the cage is comparatively small. But no detaching apparatus can be used successfully with the high velocity reached by a heavy cage and load hoisted by a large direct-acting engine. The rope may be freed at the last moment, but a tremendous shock and some damage are inevitable. It is true that the cage is prevented from being pulled clear over the head sheave, an accident which has actually occurred, and after the collision the wrecked cage may be supported by the detaching apparatus, but if men are on the cage they would have a poor chance for their lives.

In conclusion, Prof. Peele remarks that there is a very simple method by which much may be done towards easing the shock of an overwound cage as it rises in the head frame, viz., by cushioning or gradually destroying the momentum of the cage. This may be accomplished by long powerful spiral springs, encircling the guide ropes above the surface landing, when guide ropes are used; or if the guides be of the ordinary timber construction, the head frame can be made extra stiff and strong, and the guides be brought gradually closer together, beginning at a point just above where the cage ordinarily comes to rest upon the landing chairs. If then the cage should rise too far, the guides bind upon it tighter and tighter, and the cage is brought to rest by the frictional resistance without a dangerous shock. This plan is undoubtedly effectual, for the cage will wedge itself so tightly that (even if the rope should break) it cannot fall. It has been used for some time in France and Germany, and has been proposed in this country. It cannot fail if the head frame and guides are sufficiently strong and unyielding to exert an elastic compression upon the sides of the cage when the latter rises too far."—*Engineering and Mining Journal*, June 16, 1906, p. 1,148. (W. A. C.)

MISCELLANEOUS.

THE SPONTANEOUS IGNITION OF COAL.—"The storage of inflammable material in large bulk causes dangers of a serious character, which do not exist when small quantities are stored. It is the increase in mass which in most cases leads to those actions which culminate in spontaneous ignition. Substances, especially those of vegetable origin, undergo

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slow oxidation at temperatures below the ignition point; and it is only the action being spread over a long interval that prevents our realising that heat is being evolved. A certain increment of temperature, however, is generally needed to start slow combustion; but when once the required rise takes place and the operation commences, the surrounding mass of material retains the heat, the temperature increases and the ignition point is finally reached. The initial increase may be brought about in several ways—first, by physical action, as in the absorption of a large volume of gas and its compression in the pores of a substance; by a rise in atmospheric temperature; by a direct chemical action taking place at the ordinary temperature; and by the action of ferments on most organic matter. To the first class belongs the spontaneous ignition of a mass of powdered charcoal or lampblack.

Coal may be considered as consisting of carbon, hydrocarbons and inorganic constituents. Among these latter we find iron pyrites, which occurs sometimes as bright golden laminæ in the cleavage of the coal, sometimes as heavy and metallic lumps where it has formed in a cavity, and occasionally in a finely divided and feathery form spread through portions of the coal itself. If these pyrites are collected from the coal and made into a large heap exposed to air and moisture, they rapidly heat and often inflame, owing to the oxidising action of the air and moisture upon the sulphur; and it is still believed by many observers that it is this action in the coal itself which gives rise to its spontaneous ignition.

A careful study of the phenomena occurring during the heating of a mass of coal, however, leads to the conviction that the pyrites present can only play a very subsidiary part, and that it is in reality the absorption of oxygen by the freshly won coal and the activity of the condensed gas in contact with the hydrocarbons of the coal that are the active factors in causing the ignition. In the coal seams the pores of the coal are filled with methane, or a mixture of methane and carbon dioxide. When this coal is mined and brought to the surface it exudes these gases and in turn absorbs oxygen from the air. As long as the pieces are fairly large no heat shows itself; but, as the coal gets more and more broken by handling and jolting during carriage, the surface becomes enormously increased. The mere absorption of the oxygen however, is insufficient to bring about serious consequences, unless there is an initial rise in temperature to start the action. In coal cargo ships it is found in the increased air temperature while going through the tropics, in ship's bunkers by contact with the casings near the boilers, and in coal stores on shore by proximity to a steam pipe or a flue—it being found in every case that the spontaneous ignition of the coal started at the point where the cause of the initial rise of temperature was to be found.

The old idea as to the treatment of coal to prevent spontaneous ignition was to provide ventilation; but this is impossible in a cargo on board ship, and difficult in a coal store; the result generally being to supply just enough air to lead to dangerous heating. Moisture is a very powerful agent in aiding chemical action; and, as is well known, many forms of combination—such as the burning of carbon monoxide in oxygen, and even the combination of phosphorus with oxygen—are prevented if both the reacting substances are perfectly dry. In the same way, the action of the occluded oxygen in the coal is enormously aided by the presence of moisture; so that heavy rain, while a coal cargo is being taken on board or stored, generally results in heating, and often active danger.

Both steam and water have failed to act successfully in extinguishing fires originating from spontaneous ignition in large masses of stored coal.

There are certain gases, however, such as carbon dioxide and sulphur dioxide, which have a great power of stopping combustion by keeping away the oxygen of the air from the burning substance; and some of these have been proposed for the extinction of such fires."—V. B. Lewes, Society of Arts, March 26, 1906.—*The Engineering and Mining Journal*, p. 65. (W. A. C.)

Detection of Adulteration in Cement.—"The simplest test for adulteration is to examine the cement under a small three-lens pocket magnifier. To do this, spread the residue obtained by sieving 100 to 200 gms. of cement through a No. 200 sieve on a piece of black glazed paper and move the lens over it. The particles of well-burned clinker will appear black or brown in colour, and of a waxy or vitreous lustre, and spongy-looking, resembling coke or gum arabic. The particles of clinker are always rounded. Slag usually presents a greenish or bluish colour, and the edges of the particles are much sharper than those of the bits of cement clinker. Limestone and cement rock, if present, are in flattened particles, and the latter is always dark gray in colour. Both of these may be readily detected by effervescence with dilute acids. The foreign particles may also be picked out of the residue with a pair of tweezers, ground finely and identified by chemical analysis. The residue from the sieving will also contain particles of flint from the tube-mill pebbles, if these have been used to grind the cement, or splinters of iron, if Griffin mills are used. Neither of these can, of course, be considered as adulterants and both can readily be identified; the former by the fact that even when finely ground it is insoluble in hydrochloric acid, and the latter by its magnetic properties."—Abstracted from *Chemical Engineer.—Mining and Scientific Press*, June 9, 1906, p. 382. (K. L. G.)

Reviews.

(We shall be pleased to review any Scientific or Technical Work sent to us for that purpose.)

Mine Accounts and Mining Bookkeeping. Fourth Edition. By J. G. Lawn, A.R.S.M., late Professor of Mining at the South African School of Mines. Cloth, 147 pp. Price 10s. 6d. (London: Charles Griffin & Co., Ltd.)

"The issuing of a fourth edition of this standard work bears witness to its adaptability for the uses of the mining fraternity. As the *Accountants' Magazine* pronounced upon the first edition, 'It seems impossible to suggest how Professor Lawn's book could be made more complete or more valuable, careful, and exhaustive.' Suffice it for us to simply list the contents of the work as follows:—Part I.—Engagement and Payment of Workmen. Part II.—Purchases and Sales. Part III.—Working Summaries and Analyses. Part IV.—Ledger, Balance Sheet and Company Books. Part V.—Report and Statistics."—*Mines and Minerals*, July, 1906, p. 549. (W. A. C.)

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TEXTBOOK OF MINING GEOLOGY. By JAMES PARK Professor of Mining, Otago University School of Mines. Cloth, 220 pp. Price $2. (Philadelphia: J. B. Lippincott.)

"Mining geology has made such a rapid advance in recent years, and the demand for good books on the subject is such, that the work at hand from the well-known author of the 'Cyanide Process of Gold Extraction' is assured of a cordial reception. The introductory chapter serves as a brief review of general geology, and is succeeded by one giving a comprehensive classification of mineral deposits in which copious illustrations are employed to advantage. This is followed by two sections descriptive of ore veins, their filling, pay shoots, etc., and the dynamics of lodes and beds, faults, and a graphic method of finding them. Ore deposits genetically considered and the theories of ore formation are sections which are especially valuable as digests of a mass of literature on the subject. Ores and minerals considered economically is the title of a chapter giving a brief outline of the most important deposits of the various minerals and their principal uses in commerce. A chapter on mine sampling and ore valuation gives a terse statement of current practice, while the concluding chapter, descriptive of the process of examining and valuing mines, is especially valuable for its exact statements where too often other writers are open to the charge of serving up generalities."—*Mines and Minerals*, July, 1906, p. 549. (W. A. C.)

MINES AND METALS. A condensed compilation from various sources. By J. G. GOESEL, M.E. Morocco, 16mo., 289 pp. Price $3. (New York City: John Wiley & Sons.)

"This work is intended as a reference book for useful data and tables of information concerning geological classification, rock composition, chemistry, assaying, mineralogy, metallurgy, hydraulics, gases, explosives, and many other subjects of interest to the mining and metallurgical professions. As is stated in the preface of the book, it is a matter of common knowledge that practical men using reference works of this kind obtain the required information principally from the tables contained therein. These tables in common use have been collected into Mr. Goesel's compact little volume, making a very complete digest of a sizable technical library. Tables especially worthy of mention are those in the blow-pipe analysis section, the tables of mineral characteristics and of useful ores and minerals. The metallurgical abstract gives a very brief resumé of the properties of minerals, their occurrence and use in commerce. Part III. deals with rocks and rock structure, and here the essentials of geology are briefly described and copiously illustrated with half-tone cuts. The last section deals with economic geology, classification and origin of ore-deposits, and discusses the economic uses of the non-metallic minerals."—*Mines and Minerals*, July, 1906, p. 549. (W. A. C.)

INDUSTRIAL FURNACES AND METHODS OF CONTROL. By EMILIO DAMOUR. Price 16s. (New York: *The Engineering and Mining Journal.*)

"The first part of the volume is a translation by Mr. Queneau of Emilio Damour's 'Le Chauffage Industriel et les Fours à Gas'; the rest of the book is due to Mr. Queneau. The second part covers the field of pyrometry, calorimetry, gas, and fuel analysis; while the third portion deals, among other things, with chimneys, regenerators, and recuperators. Part I. begins with a theoretical study of recuperation, followed by sections on progress in industrial heating, and direct and gas-fired furnaces, together with good chapters on types of furnaces and furnace testings. Mr. Queneau follows with a chapter on pyrometry. The Le Chatelier thermo-electric pyrometer and various optical pyrometers are fully described, along with useful forms of laboratory furnaces. This is quite a good chapter. We like the volume, and feel confident in directing the student's attention to it. Clear and good diagrams abound, and the general get-up is excellent. The book generally is strong in practical detail, and has enough merit to secure a place among good metallurgical literature. Printer's errors are more numerous than would be expected after careful proof reading."—*The Mining Journal* (London), July 28, 1906, p. 97. (W. A. C.)

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ANNALS of the Cape Observatory, Vol. 10, Spectroscopic Researches, Part II., The Spectra of Silicon, Fluorine and Oxygen. (Wyman.) 3s.

BELL, LOUIS.—Electric Power Transmission. A Practical Treatise for Practical men. 4th Edition Revised and Enlarged. 8vo, pp. 732. (Constable.) 16s. net.

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BOUSFIELD, W. R.—Ionic Size in Relation to the Physical Properties of Aqueous Solutions, 1906. 4to, sewed. (Dulau.) 3s.

BULMAN, H. F. and REDMAYNE, R. A. S.—Colliery Working and Management. Illustrated. 2nd Edition Revised and Enlarged. 8vo, pp. 438. (Lockwood.) 18s. net.

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