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OF THE
Chemical, Metallurgical and Mining Society
OF SOUTH AFRICA.

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Proceedings
AT
Ordinary General Meeting, August 27, 1910.

The Ordinary General Meeting of the Society was held in the Lecture Theatre of the South African School of Mines,* on Saturday evening, August 27th, Dr. James Moir (President) in the chair. There were also present:—

70 Members: Prof. G. H. Stanley, Messrs. F. F. Alexander, R. Allen, Tom Johnson, A. Richardson, G. O. Smart, H. A. White, Prof. J. A. Wilkinson, J. Littlejohn, A. McA. Johnston, E. H. Johnson, W. A. Caldecott, E. L. Adams, H. A. Adams, W. T. Anderson, A. J. R. Atkin, S. Beaton, G. H. Beatty, W. Beaver, B. V. Blundun, A. L. Chambers, J. Chilton, F. W. Cindel, A. A. Coaton, C. A. Corder, W. M. Coulter, M. Dodd, H. Freedman, R. Gascoyne, J. Gray, W. T. Hallimond, B. J. Hastings, A. Heymann, A. B. Inglis, Dr. L. G. Irvine, A. J. Johnson, A. T. Judge, G. A. Lawson, H. Lea, J. Lea, W. D'A. Lloyd, Dr. D. Macaulay, H. Stuart Martin, E. C. J. Meyer, H. Meyer, J. T. Mitchell, H. Morrell, P. T. B. Morrisby, S. Morison, S. Newton, E. A. Osterloh, E. Pam, S. Penlerick, F. D. Phillips, E. Pinckvos, H. S. Potter, O. P. Powell, W. S. V. Price, J. F. Pyles, C. B. Simpson, J. A. Smith, T. F. Smith, W. H. Smith, A. W. Sly, B. C. T. Solly, S. H. Steels, R. Stokes, J. Stroberg, J. A. Taylor, and C. F. Thomas.

30 Associates and Students: Messrs. A. R. Adams, M. S. Archibald, J. V. G. Clarence, C. J. Crocker, C. A. Damant, A. P. Davis, F. E. Doble, C. Greathead, D. W. Greig, B. de Haas, A. King, G. W. Leach, C. Lipschitz, H. E. Maasdorp, A. McAlister, H. J. v. d. Merwe, G. Musson, E. H. Nellmapius, W. S. New, N. N. Newland, G. H. Olivier, C. O. Palmer, F. J. Pooler, J. M. Robertson, J. R. H. Robertson, R. Sawyer, H. Stadler, M. O. Tillard, W. Waters and A. L. Wright.

* Formerly Transvaal University College.

About 120 Visitors, and Fred. Rowland, Secretary.

The minutes of the previous monthly meeting, as printed in the July *Journal*, were confirmed.

NEW MEMBERS.

Messrs. W. Beaver and B. C. T. Solly were appointed scrutineers, and after their scrutiny of the ballot papers, the President announced that all the candidates for membership had been unanimously elected, as follows:—

COCKING, A. S., Messrs. Kynoch, Ltd., Umbogintwini, Natal.

CROWE, THOMAS BENNET, Portland G. M. Co., Victor, Colorado, U. S. A. Superintendent, Victor Mill.

DRUCKES, ARTHUR EILERT, The Oriental Con. Mining Co,, Paracol, Korea. Consulting Metallurgist.

FREUSBERG, ADOLPH, West Sumatra Mijnen Syndikaat, Mangani via Pajacombo, West Coast Sumatra. Technological Engineer. *(Transfer from Associate Roll).*

HUGHES, ARTHUR ROBERT, Simmer and Jack Prop. Mines, Ltd., P. O. Box 192, Germiston. Mine Foreman.

HUTCHINSON, JAMES WILLIAM, Goldfields Consolidated Mines Co., Goldfield, Nevada, U.S.A. Mill Superintendent.

LAWRIE, W. W., Village Deep, Ltd., P. O. Box 1064, Johannesburg. Underground Manager.

LOFTS, HORACE FREDERIC, *c/o* P. O. Box 1183, Johannesburg. Reduction Works Manager. *(Transfer from Associate Roll.)*

PENLERICK, SYDNEY, East Rand Proprietary Mines, Ltd., P. O. Box 57, East Rand. Joint General Manager.

RAMSAY, JAMES DOUGLAS, Rand Klip, Ltd., P. O. Box 2, Benoni. Mine Manager.

REDFERN, ALFRED, Premier Coal Estates, Brugspruit P. O., Transvaal. Mining Engineer.

RICHTER, ERNEST WILLIAM, Village Deep, Ltd., P. O. Box 1064, Johannesburg. Shift Boss.

RUSH, FREDERICK WILLIAM, Geldenhuis Deep, Ltd., Cleveland. Cyanider.

SIMPSON, junr., GEORGE, M. M. Ketahoen, Lebong Soelit, Benkoelen, Sumatra. Metallurgist.

STROBERG, J., Village Deep, Ltd., P. O. Box 1064, Johannesburg. Mine Foreman.

WALTON, ARTHUR JOHN, P. O. Box 149, Johannesburg. Mining Engineer.

WILSON, HARRY L., Dolores, Distrito, Mina, Chihuahua, Mexico via Guadalupe *y* Calvo. Mining Engineer.

The Secretary: Since the last meeting of the Society the following have been admitted by the Council:—

As Associates.—

BRANTHWAITE, STANLEY, corner of Doran and East Streets, Jeppes Extension. Cyanider.
COURTENAY, BENJAMIN CHARLES, Geldenhuis Deep, Ltd. (North Section), Cleveland. Cyanider.
DONALDSON, DUNCAN LANE, Geldenhuis Deep, Ltd., P. O. Box 5, Cleveland. Cyanider.
GIDDINGS, DONALD SHIRLEY, Portland Gold Mining Co., Victor, Colorado, U.S.A. Chemist, Victor Mill.
GUTHRIE, GILBERT L., c/o Butters Co., 333 Kearney St., San Francisco, California, U.S.A. Cyanide Engineer.
HOWARD, T. C. L., Penhalonga Proprietary Mines, Ltd., Umtali, Rhodesia. Analyst.
JACK, WILLIAM DRUMMOND, Geldenhuis Deep, Ltd., P. O. Box 5, Cleveland. Cyanider.
JEUDWINE, HUGH MYDDELTON, Geldenhuis Deep, Ltd. (West Section), Cleveland. Cyanide Shift Leader.
KEMP, HERBERT SIDNEY, Geldenhuis Deep, Ltd., P. O. Box 55, Cleveland. Junior Amalgamator.
LEACH, GEORGE WILLIAM, Geldenhuis Deep (East Section), P. O. Box 54, Cleveland. Cyanider.
MACER, LIONEL WILLIAM, Post Office, Pilgrim's Rest, Transvaal. Mine Surveyor.
MACKENZIE, ALEXANDER WILKIE, Elandsdrift G. M. Co., *via* Sabie. Miner.
MAINE, LIONEL THOMAS DE, Geldenhuis Deep, Ltd., P. O. Box 5, Cleveland. Cyanider.
MATHEWS, GEORGE FRAZER, B.A.(T.C.D.), East Rand Proprietary Mines, Ltd., Box 159, East Rand. Assistant Chemist.
MOIR, JAMES STANLEY, P. O. Box 62, Knights. Cyanider.
MOORE, WILLIAM, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Assistant Amalgamator.
POTHECARY, GEORGE, Sheba Gold Mining Co., Ltd., Eureka. Cyanider.
WHITE, STANLEY ROWE, Great Boulder No. 1, Ltd., Mt. Magnet, West Australia. Assayer.
ZIPP, WILLIAM FREDERICK, Geldenhuis Deep, Ltd., P. O. Box 39, Cleveland. Cyanider.

As Students.—

ALLISON, WILLIAM, Geldenhuis Deep, Ltd. (East Section), P. O. Box 54, Cleveland. Mill Learner.
ARCHIBALD, MAX STANFIELD EATON, Knights Deep, Ltd., P. O. Box 143, Germiston. Cyanide Learner.
BALL, HENRY HERBERT, Geldenhuis Deep (East Section), P. O. Box 54, Cleveland. Mill Learner.
BROAD, FRANCIS ROUS, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Cyanider.
COPELAND, ANSON WILLIAM SHAW, Geldenhuis Deep, Ltd. (West Section), P. O. Box 54, Cleveland. Cyanide Learner.
GIBBS, NORMAN MURRAY, Geldenhuis Deep, Ltd. (East Section), P. O. Box 54, Cleveland. Learner.
GOLDBERG, SAM, Geldenhuis Deep, Ltd. (East Section), P. O. Box 54, Cleveland. Mill Learner.
HAAS, BRUCE DE, Geldenhuis Deep, Ltd. (North Section), P. O. Box 5, Cleveland. Cyanide Learner.
HASSERÜS, BALDUR F. CHRISTIAN, Geldenhuis Deep, Ltd. (North Section), P. O. Box 5, Cleveland. Sampler.
HAWKINS, THOMAS HENRY, Geldenhuis Deep, Ltd. (East Section), P. O. Box 54 Cleveland. Tube Mill Learner.
KEMP, NORMAN, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Cyanider.
LINDHORST, RICHARD, Geldenhuis Deep, Ltd., P. O. Box 5, Cleveland. Cyanide Learner.
McCAFFERY, HAROLD, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Cyanide Learner.
MERWE, HENDRIK JOHANNES VAN DER, Geldenhuis Deep, Ltd., P. O. Box 5, Cleveland. Cyanider Learner.
NOËL, ARTHUR DE JERSEY, Geldenhuis Deep, Ltd. (East Section), P. O. Box 54, Cleveland. Mill Learner.
PALMER, CECIL OWEN, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Cyanide Learner.
SHEARAR, GEORGE LINDEN, Geldenhuis Deep, Ltd., P. O. Box 54, Cleveland. Cyanide Learner.
TUCKER, BERNARD SOMERS, Simmer Deep, Ltd., P. O. Box 178, Germiston. Cyanide Learner.
WHITE, PERCY, Geldenhuis Deep, Ltd., P. O. Box 1, Cleveland. Cyanide Learner.
WITT, ARTHUR BACHELOR DE, Simmer Deep, Ltd., P. O. Box 178, Germiston. Cyanide Learner.

GENERAL BUSINESS.

The President: We have had letters from Lord Gladstone, who has been good enough to accept the Honorary Presidentship of the Society, and from our four Hon. Vice-Presidents, Hon. J. C. Smuts (as Minister of Mines), Mr. J. G. Hamilton, M.V.O. (President, Transvaal Chamber of Mines), Mr. Lionel Phillips and Mr. J. W. S. Langerman (Past-Presidents, Transvaal Chamber of Mines), accepting office.

With regard to the matter Mr. Crosse raised at the last meeting, as to the procedure at these general meetings, we brought the matter before the Council, and the Council was of opinion that the question had been sufficiently ventilated at last meeting, but that we ought to do our best to accelerate matters at our meetings so as not to waste time. Whenever we get original papers to hand in time before a meeting, the Secretary will try to send out copies to those he knows to be interested.

We have had to abandon the Social Dinner owing to the Union Club being unable to meet us in the matter. They could not guarantee us accommodation, and we could not find another suitable place to go to.

Another matter I want to mention is that we have joined with eight other scientific and technical societies in composing a Loyal Address to the Duke of Connaught, who is due here in about two months. The Secretary has a copy of the proposed Address, if anyone would like to see it. The Society is also going to renew its offer of the prizes to the South African School of Mines which we gave last year.

"PRIMUS STOVES."

Mr. F. J. Pooler (*Associate*): I want very particularly to draw the attention of the Society to a matter which I think we might well take up, namely, the question of the dangers in the use, misuse and abuse of "Primus stoves." It concerns perhaps three classes of people. There are assayers—men who can look after themselves—and the stoves are used very extensively in households, but what I am chiefly concerned with, they are largely used in schools. If this Society does not take the matter up, I do not see who is going to do it. Quite recently there was a serious accident in Jeppe Street, when a lady got very badly hurt. I think a sub-committee of the Council should be asked to take the matter up and report at our next "Chemical" meeting as to the possibility of substituting for Primus stoves, something equally suitable and of course no more or very little more costly, and at the same time perhaps they may be able to report on the general disadvantages of "Primus stoves." There is another point that might be worth considering in the interests of the children generally, whether the attention of the Education Department should not be called to the fact that they are a great danger. This country is not altogether over-populated, and there is no use in putting death traps in the way of the children, especially in our schools.

Prof. J. A. Wilkinson (*Member of Council*): I have much pleasure in endorsing the remarks, which have been made by the last speaker concerning the dangers attendant on the use of "Primus stoves," and am also of the opinion, that this matter may very rightly form a subject for the earnest consideration of the Council of this Society, if only on account of the large number of these articles, which are in domestic use. From the point of view of the heating appliances requisite for laboratories, the nature of the work to be performed must be carefully considered. The means at our disposal may be classified under the headings of solids, liquids and gases. For the prolonged maintenance of high temperatures, such as are required in gold assay work, coke, wood and coal are suitable, but for ordinary chemical work, such as is performed in analytical and teaching laboratories, solids are out of the question, and liquids or gases must be used. The choice in both cases is, however, extremely limited. The only liquids, which are feasible, are alcohol and petrol. The dangers arising from the use of these substances are accounted for by the fact that their vapours form explosive mixtures when mixed with certain volumes of air. Mixtures of gases required for heating purposes may be manufactured from carbonaceous substances, such as, wood, coal, oil, etc. There are few laboratories, however, which are endowed with means sufficient to instal an expensive gas plant for private use. During the last ten years, which has seen the rise of the motor industry and the excessive production of petrol, a cheap method of manufacturing a suitable gas for this purpose has been invented, obtained by passing air through petrol. This gas, known under the names air gas, petrolene, etc., can be used and piped in a manner exactly similar to coal gas, and, as the apparatus is automatic, it needs but little attention. For teaching laboratories more especially it is extremely convenient and useful, and the cost of maintenance small. In conclusion, I may say that I am glad to hear from our President, that the Council will give the matter its attention, and I will therefore defer any further remarks for the present.

The President: Well, gentlemen, I think we are in agreement with what Mr. Pooler says. These things are undoubtedly a danger, and I think the Council will be willing to inquire into the matter and see if we can persuade those in authority to find some better scheme. I should like to know if any assayers have anything to say as to their experience of these things.

Mr. Fraser F. Alexander (*Member of Council*): I agree, as the previous speakers have pointed out, that these things are an abomination, and I believe it would be wise on our part to recommend that the matter should form a plank in the efficiency platforms before the country to-day. No doubt we will find necessity become the mother of invention if legislated upon, and we shall then get something better.

STREET DUST.

The President: There has been some corre-

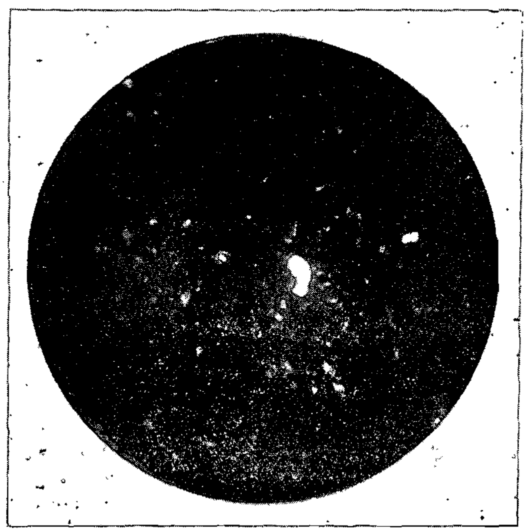


FIG. I.—Dust from Eloff St.: very jagged particle.

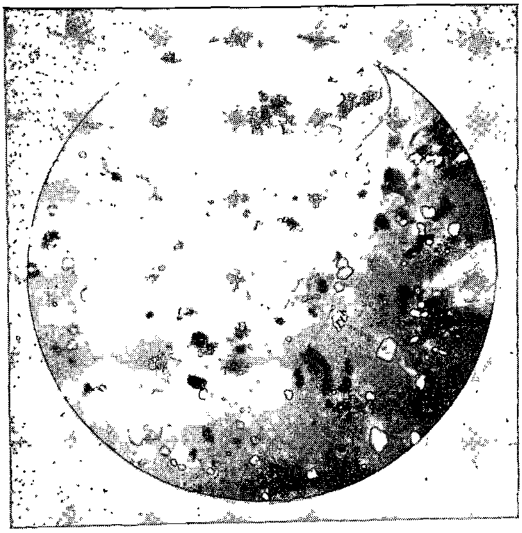


FIG. II.—Dust from Market Square, ×100, polarised. Many angular particles.

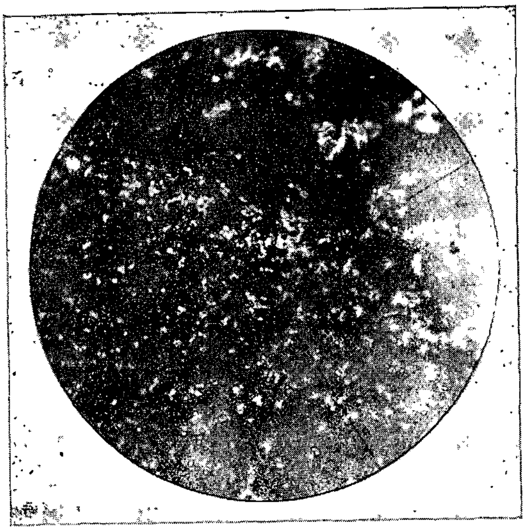


FIG. III.—Finest Dust from Laboratory dark-room (no window). No angular particles.

spondence in the papers as to street dust causing miners' phthisis amongst the inhabitants of Johannesburg. We exhibited some lantern slides of this dust in 1903, and I have some new ones prepared last week which I would like to show you. The street dust is mostly rounded quartz particles stained red with iron oxide, but there is also a proportion of clear angular stuff which has probably come from the tailings dumps.

THE EFFICIENCY OF LABOUR UNDER-GROUND.

By TOM JOHNSON (Member of Council).

The interest I take in increasing the efficiency of labour and machinery must be my excuse for bringing this paper before you.

As you all know, there is plenty of room for improvement; the trouble is, how to bring it about. I have at various times had a little to say about the matter, and many ways have been proposed, but we are advancing very slowly, especially in regard to underground labour. We hear a great deal about shortage of native labour, yet we are continually wasting it. For some years I have been advocating that more use should be made of *mechanical* means of handling rock, both in shovelling and tramming. I recommended motors for drives as they would be more "flexible" than any other mechanical means, but to make such a scheme come out at its best, we must produce more ore at each stope and on each level. These things are, however, intended to increase the efficiency of the mine as a whole, but to-night, on the other hand, I wish to point out how I think the efficiency of the men themselves could be increased.

Many managers of our mines have tried different methods of increasing the efficiency of the workers, particularly the underground workers, but in dealing with whites they do not appear to have had much success. The general system of paying a standard rate, whether to manager or workman, in my mind tends to decreased efficiency, for the reason that the good worker gets only the same pay as the inferior worker. A standard rate of pay is bad, as men are not standard. The employer does not always try to gauge the abilities of the worker or the amount of work he does, with the result that the good workman is not paid as much as he should be, and the inefficient man gets more than he should, a state of affair which dissatisfies the one and demoralizes the other. Of course, some might say "discharge the inefficient man," but that cannot be done here, for we have not enough good men to go round. Again, what is to become of the poor man? It is not always his fault that he cannot come up to high water level. Pay him according to his worth, then there will be a chance for the good man to get his worth also. Under the present system the good man has no remedy but to try and raise the general wage level. So unions are formed, and the idea is bred that—"they should take who have the power, and they should keep who can," and this is true of both sides—employers and employed. Now, this kind of spirit is not right, and as long as the interests of the employers and employés seem to be antagonistic, there will be conflict. Conflict is mostly unnecessary and we should try to do without it. If one side would not try to get the better of the other there would then be a chance of better doings. It is only natural that workmen should try to get as much money as possible for their work, as it is also for the employer to get as much work done as possible for the money he pays. Nevertheless it is our duty to try and harmonize these conflicting factors.

In day's pay work, if one man's wages are raised others are apt to claim a rise also, and in works where no accurate records are kept of the amount of work that the different men are doing, one cannot blame them. If records were kept the manager would know who deserved an increase, but having no records he does not know those who deserve a rise, and consequently decides not to make any. Accordingly the good man naturally gets dissatisfied and slackens his pace to something like the indifferent man's, that is, he does only just enough to keep his job. In this way the employer who pays at the poor worker's rate gets only, at most, the efficiency for which he pays, thereby losing on his good workmen, who are working below their capacity. It must be understood that by capacity I mean quality and quantity of work accomplished by proper effort, that is, not necessarily by sweating, as the man who makes the greatest fuss is by no means the one who usually accomplishes the most work. We very often buy stores on the same principle, quality being a secondary consideration so long as the goods bear the same name. It is a very wasteful way, especially with workmen, for, as a rule, the difference in quality of workmen is far greater than the difference in quality of material.

Below I try to show how we could make the interests of both employers and employed harmonize. Increased efficiency is the remedy, and this is to be gained by paying each man as near as possible by results, and not by the time actually put in. The manner of payment may be either by day's pay and a bonus for accomplishing a certain task, or contract and bonus; as much contract as possible for it puts a greater premium on individual effort, but it must be carried out in an honourable spirit or it will fail. It is true, foremen and shiftbosses cannot always tell which are their best men as far as turning out best results is concerned, so accurate records should be kept of every man's work as much as possible, then a fair task should be set and a bonus paid to all men doing the task, *also for any work done beyond this task.*

Now, it is also true that many of the young fellows who are "shiftbossing," etc., in our mines have not had sufficient experience to know when a man is doing a day's work, and if a man is backward they cannot show him how to advance. These are to be left out of the following scheme for efficiency, and are to be left to carry on the ordinary routine work. I cannot understand how employers expect to get increased efficiency by putting in as "shiftbosses," etc., young fellows who have not actually earned their living at the work they are put to supervise. Most people who understand handling labour know that the man immediately over the workman should be one who has gone through the mill and knows the details, like the N.C.O's. in the Army. To put college youths in as shiftbosses, etc., without their actually having had a few years at manual labour is the wrong way to get increased efficiency, and the results from mines where this has largely been done shows the folly of it. I hope that these young fellows, whom this description fits, will not take it as prejudice on my part, for it is not. Many of these young fellows have been spoilt by having responsibility put on them before they were fit to take it, and have therefore failed. They have a harder job to work up again than if they had not held such a position.

It often happens that the boss or foreman has friends, and he is anxious to secure them the best positions in the mine, regardless of their personal fitness. The result is that less work is performed, the others become disgusted with the conditions prevailing, and the cost of mining is thereby materially augmented. There are also foremen who hold the belief that only such miners as are born and bred in certain districts can be good men. These bosses are unfit for their positions owing to their narrow-mindedness. Mining is a branch of labour that can be acquired by any intelligent man, and intelligence is not confined to the aforesaid districts alone. All these things tend to decrease efficiency.

To work the proposed scheme expert teachers must be used and they should be drawn from the best workers in the class of work under review, using judgment in picking out men likely to be good teachers. These experts know the amount of work that can be done; they know the obstacles that stood in their way when simple workmen, and know how to remove them. Each of these experts should be put in charge of a few others, and teach them how to avoid the obstacles, and the best way of doing things.

Further, the expert quickly learns to develop better methods of avoiding obstacles (after a time the gangs of each expert could be increased). The expert would soon make his services valuable, and it is possible for him to make the *average* efficiency greater than the previous best. The expert after studying the different conditions of different portions of the mine, and getting the best and speediest way of doing the work, has still only gone half way; he will have to get someone to do the task, which will probably take some time, but the desired result will surely follow if the task is fairly set.

When the task is set, it must be adhered to, unless a quicker and easier way is found for doing the work.

I mentioned that the men should be paid a bonus for doing the task, also for work done over the task. In addition to paying this bonus to the workmen, the expert should receive a bonus for every man who does the task, and a further bonus if *every* man under him does the task;—this last bonus is intended to lead him to devote his attention to the poorer workers, otherwise he might give all his attention to those he was sure could get the task done.

Under this scheme, self-interest is brought into play with all, and I fancy that there would be a lot of hustling to see that there was plenty of steel and of a suitable kind, wedges, bars, etc.; that cars, shaking shoots and other conveyors, trucks, etc., were kept in order, and in time that much less supervision would be needed than at present in any mine which adopted this system.

Poor efficiency is, as a rule, not altogether the fault of the workmen but also of the management. I will try to show this, in regard to contract work also, as the same remarks apply.

Contract.—In contract machine work, I fancy most managers take the wrong way of procuring cheap work, and the strange part of it is that, in regard to *natives* they go the right way about it. We set them a task, and for anything done over that task, we pay them more per unit than for the task itself, whereas, in treating with whites, we penalise the best men by cutting the price if the wages are too high in our eyes; this is distinctly wrong, for the effect of penalising the good workman in proportion to his increased effort, is to discourage him, so that he learns to limit his output by that of the poorer worker; and how can we condemn him or be surprised?

There is one exception; in shaft sinking we generally pay a bonus for increased footage and find it cheapens the cost per foot, and we have not the sense to apply this to ordinary producing work, simply because our standing charges do not come all on one thing. It may be argued that the good man is not really penalised since he gets a good wage, but I hold that he is penalised unless he gets the same per unit as the inefficient. Another instance of what I mean is this. Some managers are paying a fixed rate per shift, no matter what is earned, plus a contract price per unit. For example, I know where a friend of mine, wishing that none of his men should go home without wages at the end of the month, gives them 15s. and 13s. 6d. per day—machine and hammer hands respectively—plus say 45s. per fathom contract price. Now, on the face of it, it looks good business, but how does it work out? If we take three men, with three machines each, breaking ground in the ratio of 1 : 2 : 3 then the price per fathom for the first is :=

$$1\text{st} = \frac{15\text{s.} + 45}{1} = 60\text{s. per fathom.}$$

$$2\text{nd} = \frac{15\text{s.} + 90}{2} = 52\text{s. 6d. per fathom.}$$

$$3\text{rd} = \frac{15\text{s.} + 135}{3} = 50\text{s. per fathom.}$$

so that the best man gets 10s. per fathom less than the worst. If machine costs are 14s. per shift the cost to the company is :—

$$\text{No. } 1 = 60\text{s.} + \frac{14 \times 3}{1} = 102\text{s. per fathom.}$$

$$\text{No. } 2 = 52{\cdot}5\text{s.} + \frac{14 \times 3}{2} = 73{\cdot}5\text{s. per fathom.}$$

$$\text{No. } 3 = 50\text{s.} + \frac{14 \times 3}{3} = 64{\cdot}0\text{s. per fathom.}$$

so that the man who saves the company money by his increased efficiency, is penalised for doing so. Is it any wonder that we do not get better results from our machinemen? Where is the encouragement for them to put forth their best efforts?

Take the cost per ton in the above examples:—

Stoping width 4 ft. = 12 tons per fathom.

$$\text{No. } 1 = \frac{102}{12} = 8\text{s. 6d.}$$

$$\text{No. } 2 = \frac{73{\cdot}5}{12} = 6\text{s. } 1\tfrac{1}{2}\text{d.}$$

$$\text{No. } 3 = \frac{64}{12} = 5\text{s. 4d.}$$

Now, if No. 3 can make a good wage at 50s., why should No. 1 get 10s. per fathom more than he. Even were No. 1 paid at 50s. per fathom (like No. 3) he still costs the company more than No. 3, for his cost would be $\frac{92}{12} = 7\text{s. 8d.}$, that is a higher cost than either of the others.

Instances of this kind prove that the efficient man at higher wages, is more profitable to the employer than the inefficient man at low wages.

It is no use saying that we have not enough of the No. 3 men. The remedy is to put experts on and make more; the increased efficiency will more than pay for the experts. The scheme of using teachers is applicable to contract work as well as to day's pay.

It must be remembered that efficient labour requires less machines, material, hoisting, etc., and also that it is not always the total amount of wages paid to men, but the *difference* of wages that stimulates exertion. A permanent increase of exertion will be created, and this by recognition of individual effort and not by compulsion, for it is a sure thing that the man who is driving his workers gets done down when the workers get the chance. Some bosses seem to like getting into a temper and putting their men into one also over every little thing, which is foolishness. There is a great deal of truth in the saying, "men are like tools; of little use when they lose their temper." A ranting, roaring way of giving orders, though much in favour with certain types of foremen and other bosses, never accomplishes one-half as much as the cool, collected, sure-of-himself commands of the official who, by his actions, shows that he knows his business.

Employment of men of different nationalities should be encouraged, as some miners delight in showing their working capacity over men of another race.

Keep men for long periods on the property if possible, so that they get to look at the place as home; they will then take an interest and pride in keeping the property to the front. Men thoroughly used to the mine will do more than newcomers. Bonuses in the shape of shares of the mine itself might be given, thus making them part owners.

Another great essential to efficiency on a mine is team work. By this is meant that every head of a department must co-operate with the other heads of departments; similarly with the men, each must perform his duties promptly and cheerfully. Orders are not issued for amusement; they are intended to fulfil a definite purpose, and it is only by everyone concerned doing his best that things can be kept running smoothly. It is the carrying out of the details, one man working with another, that makes the whole count.

To all, I would say, learn to take a real interest and pleasure in your work. During working hours think of nothing else. Make your work the real thing. Let pleasures and outside interests be on one side, and the results are bound to turn out pleasant.

In conclusion, I hope that members will give me a few hard hits, just to let us know that the mining members of the Society are alive: so come along and do your little share to keep up the reputation of the Society of being composed of the liveliest, hardest and straightest hitters known.

The President: I wish to thank Mr. Johnson on your behalf for bringing forward a paper on such a controversial subject. It will give us plenty of discussion. If I may say so, Mr. Johnson has in the past been perhaps mistaken for a visionary, but I think he is now beginning to come into his own. You will remember, for example, that he was the pioneer on the question of ventilation now so prominent in this country, having read a paper on it before us about the year 1903. In the present paper, one of the new things he has brought forward is the point as how trade unions originate. I fancy some of you will have something to say on that.

VENTILATION AND HEALTH CONDITIONS ON THE MINES OF THE WITWATERSRAND, WITH SPECIAL REFERENCE TO THE VENTILATION SYSTEM OF THE EAST RAND PROPRIETARY MINES.

By S. Penlerick (*Member.*)

"The three main factors directly incident to their occupation, which combine to produce disease amongst the miners on the Witwatersrand are dust, infective processes, particularly tuberculosis and in a lesser degree the fumes arising from the use (or abuse) of explosives."

This statement was made by Dr. Irvine in his evidence before the Mining Regulations Commission in May, 1908, and with that statement there must be universal agreement.

The causes of these diseases have been discussed at great length by numerous authorities, and my object here is to deal with the means to be adopted to remove these causes.

Dust.—This constitutes the greatest danger which the underground worker has to combat. The sources of dust are:—(a) Rock drilling; (b) Blasting; (c) Handling of rock. It must be acknowledged that the proper use of water in conjunction with rock drilling effectually allays the dust generated during the operation. In the face of this acknowledged fact it is astounding that to-day this remedy has not, in many of our mines, been completely carried out. The proper use of water implies:—1. An adequate supply of clean water. 2. Efficient application of same.

With regard to these points the law already has power to insist on their fulfilment—Mines and Works Regulations, Act. 146 and Amendment published in Government Notice No. 1278 of 1908.

As there can be no possible excuse for non-compliance with the Regulations relating to this, which non-compliance should really be considered a criminal offence, I would urge the rigorous enforcement of the law, and, if necessary, an increase of the penalty for offences.

I would here express my agreement with the opinion of the Mining Regulations Commission with reference to respirators. For continuous wear they are useless, although for occasional wear they are useful, *e.g.*, when returning to the face after the cut has been blasted.

To the same system of water supply mentioned above there must also be connected a device for spraying water on to the face after blasting to arrest and settle the dust generated at the time of the blast. For this purpose the "James Water Blast," or some similar device, is quite satisfactory.

On the East Rand Proprietary Mines we simply connect the $\frac{3}{4}$ in. water pipe to the 2 in. air pipe, fitting cocks on each behind the junction at a point where they can conveniently be operated. Care must be taken to prevent the water getting into the air pipe except when the water blast is required.

An ordinary hose pipe is sufficient for spraying water over rock which is being handled, but this spraying must be frequent throughout the operation,

For the prevention of dust in stopes we have nozzles (either directly on the water pipe or on hoses) at convenient points on the drives above, from which a stream is directed on to the face and also on to the top of stulls on which there may be an accumulation of fines from blasting.

The adoption of all these precautions will have changed the bulk of the dust into mud and settled it, but there is still a certain amount of very fine dust in suspension escaping the closest efforts at settlement. This dust must be constantly carried out of the mine and not allowed to accumulate at points where it cannot be attacked, but where periodically it can be stirred up so as to vitiate the atmosphere. This demonstrates one of the necessities for adequate ventilation.

Fig. 1 is an apparatus for taking dust samples. It consists of an aspirator through which the air is drawn by suction. The drum holds about 15 litres of water and the period of taking a sample can be regulated by the valve at the bottom of the drum. This is a convenient size for a two to three hours sample. These samples should be taken periodically to ascertain what has actually been accomplished. To Mr. C. Toombs, Experimental Chemist, E.R.P.M., belongs the credit for this neat and efficient arrangement.

Now so far I have described measures actually employed for dealing with dust, the primary source of our miners phthisis. The Government, employer and employé must all co-operate to eradicate the disease and prevent its ravages.

Fig. 1.—Apparatus for taking Dust Samples.

Tubercular Disease.—The incidence of this disease amongst miners is generally believed to be entirely due to the conditions under which he works. While recognising that this is to a certain extent true, it must be admitted that the conditions of private life have also contributed their share. The unfavourable condition still existing underground is impure air, and there is but one solution, namely, adequate ventilation.

It is necessary now to consider the conditions of living prevalent amongst the class of workmen who are the greatest sufferers. The actual period spent at work underground nowadays cannot in any way be considered excessive, and provided both employer and employé have fulfilled their respective obligations, the possibility of contracting this disease in the mine should be reduced to a minimum; but even with a plentiful supply of fresh air circulating through the mine, one must recognise the existence of circumstances favourable to the development of disease in one predisposed thereto, *e g.*, changes of temperature and humidity; but surely common-sense pracautions on the part of the individual (such as cleanliness, suitable clothing and the proper use of the change-house, which latter must be efficiently equipped in the first place by the employer) would effectively protect the miner.

All the precautions already referred to cannot however have their full effect unless ordinary hygienic conditions of living be observed. Generally speaking, the housing accommodation is reasonably satisfactory and is unquestionably so on the newer properties. The responsibility now rests with the miner for the maintenance of fresh air constantly circulating through his room, for which purpose windows and ventilators are provided, and we think that every inducement should be made to enable him to engage in healthy outdoor recreation. Thereby his general health may undoubtedly be much improved and the spread of infectious disease minimised.

Vitiation of mine air by gases from the use (or abuse) of explosives.—The gases produced by the detonation, or more of less complete detonation, of explosives are well known. For our purpose we will merely consider that we have a quantity of vitiated air to dilute and displace, which is a question again of *adequate ventilation.*

I would here refer to the deplorable carelessness of some men, who, regardless of their own safety and that of their fellow workmen, neglect the most obvious precautions necessary in the handling of dangerous explosives, which neglect has been the cause of some of our most serious calamities. The great majority of miners fully appreciate the seriousness of this matter, and I would urge them to use their influence with their less enlightened fellow-workers to prevent, as far as possible, the recurrence of avoidable accidents which have resulted in deplorable loss of life.

The vitiation of mine air from other sources than that of gases resulting from blasting, namely, respiration, lights, decaying timber, etc., must also be considered. Excessive temperature and humidity are not directly injurious to the health of the miner, but affect his capacity for work.

Wet and dry bulb readings should be taken at least once a month from all development points and occasionally from the various stopes also. All readings must be systematically recorded.

I have so far been considering the factors affecting the health of the miner underground, namely, dust and vitiated atmosphere, and I have stated the necessary provisions for dealing with dust. I now come to the question of ventilating these mines with the object of diluting and displacing the air and maintaining a fresh air current throughout all the working points. As a standard for our fresh air we may assume the adoption of the standard recommended by the Mining Regulations Commission, which will, in my opinion, be quite satisfactory as far as the Rand is concerned :—

(1) " In every metalliferous mine sufficient air shall be provided and such other arrangements made that in any sample of air taken under normal working conditions from any part of the mine not less than one hour after blasting:"

(*a*) " the proportion of carbon dioxide shall not, as regards any mine within the Witwatersrand area, exceed twenty volumes per ten thousand of air ....(0.2%)

(*b*) " the proportion of carbon monoxide shall not exceed one volume per ten thousand of air................. ..(0.01%)

(*c*) " no practically determinable amount of the oxides of nitrogen (NO and NO_2) shall be present."

Our task is : (1) The provision of a sufficient quantity of fresh air. (2) The efficient distribution of same.

I consider that the most convenient way of illustrating the principles to be followed will be to describe the system already installed at the East Rand Proprietary Mines Of course the details will not always be applicable to other mines, but the general principle remains the same.

The position of affairs in 1906, when the question of installing artificial ventilation was taken up, was that the Farrar, Comet and Cason Shafts were the natural downcasts of the property, while the No. 1, Driefontein, and the Main Shaft, Angelo, were upcasts. The old St. Angelo Shaft, West of the Main Shaft of the Angelo, and the present Cason upcast were disused prospecting shafts. Thorough systematic distribution did not exist.

We decided to make all the main shafts downcast and use the two prospecting shafts which were connected to the old stopes as the upcasts, stripping and equipping them accordingly.

The arrangement for the fans at the top of these upcast shafts are shown in Figs. 2 to 7.

Description of Fans.

Shaft.	Fan.	Dia.	Width.	Output.	Water gauge.
		ft. in.	ft. th.	Cub. ft. per minute.	Ins.
Angelo Upcast	"Sirocco" Double Inlet.	10 6	8 6½	300,000	3
Cason Upcast	"Barclay's" Double Inlet Drum Pattern.	16 0	8 0	350,000	4

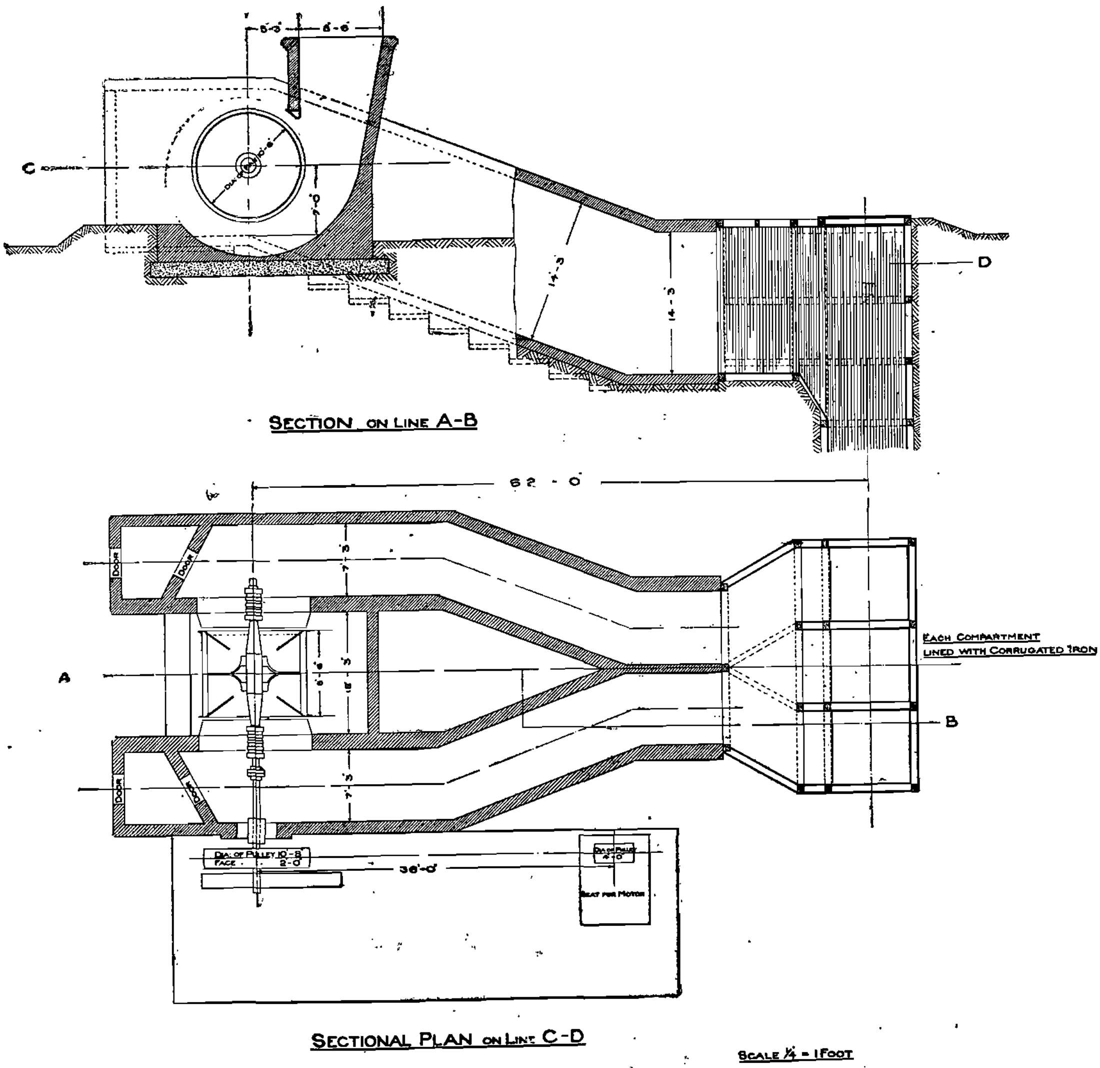


FIG. 2.—General Arrangement at Top of Upcast, Angelo Section, showing Upcast Shaft, Drifts and Fan Setting.

I shall now describe the system of distribution of the air, starting from the collar of the downcast shafts. The Farrar is a five-compartment shaft with an effective ventilating area of 145 sq. ft. Following the course of the air current in the ventilation chart, the crosscuts from the shaft to the levels are securely bratticed off. In the upper levels where no work is proceeding the doors in the brattice are securely fastened, to prevent short-circuiting of the fresh air through the disused portion of the mine. From the 6th to the 17th levels, inclusive, self-closing doors are fitted in the brattice, and in addition regulators for the admission of the required quantity of fresh air for each level. From the 18th to the 22nd (bottom) level the shaft is divided into a downcast and an upcast by means of a close brattice between the hoisting ways and the ladder way. The object of this is to provide a return way for the air from the bottom of the shaft up to that level which is connected through the main upcast. Figs. 8 and 9 show this brattice.

It will now be clear how the air is distributed from the downcast to the various levels as required and how the currents proceed eastward towards the upcast. On the west side of the main upcast there is a transverse dyke running throughout the mine, of which advantage has been taken to form a natural brattice. The levels running through this dyke are permanently closed where

Illustrating "The Ventilation and Health Conditions of a Witwatersrand Mine, with Special Reference to the Ventilation System of the East Rand Proprietary Mines," by Mr. S. Penlerick (Member).

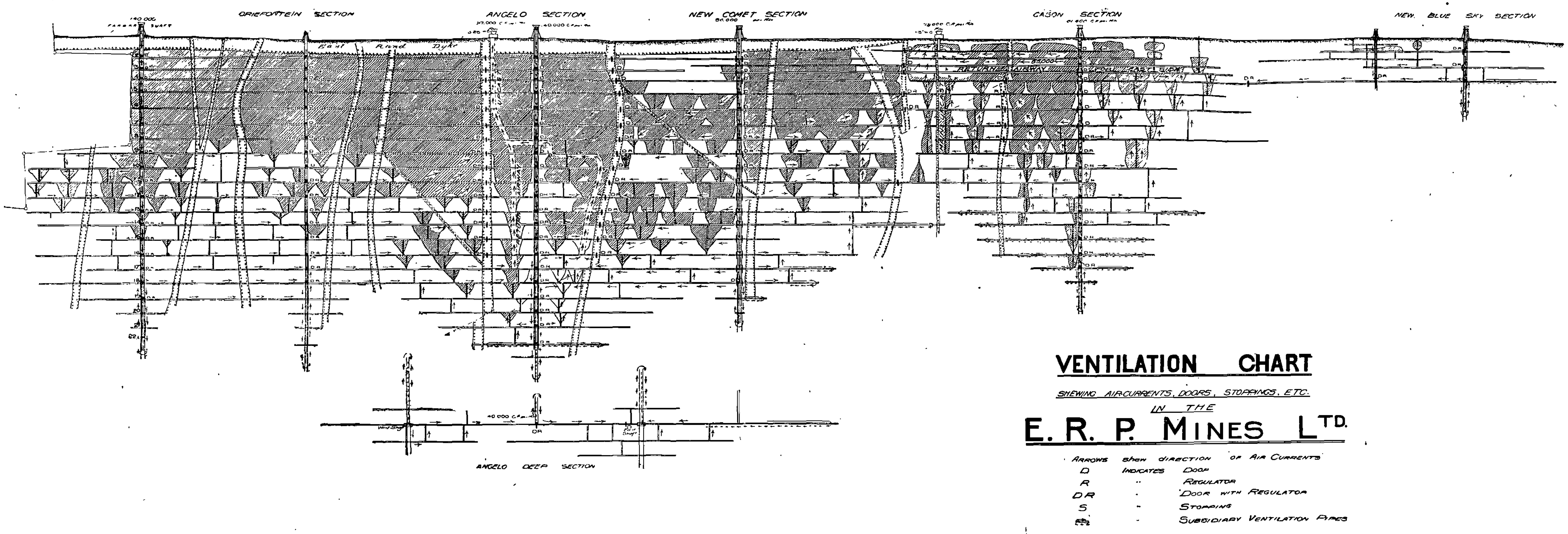


FIG. 3.—Fan and Motor House, Angelo Section.

FIG. 4.—Fan Drifts and Delivery. Angelo Section

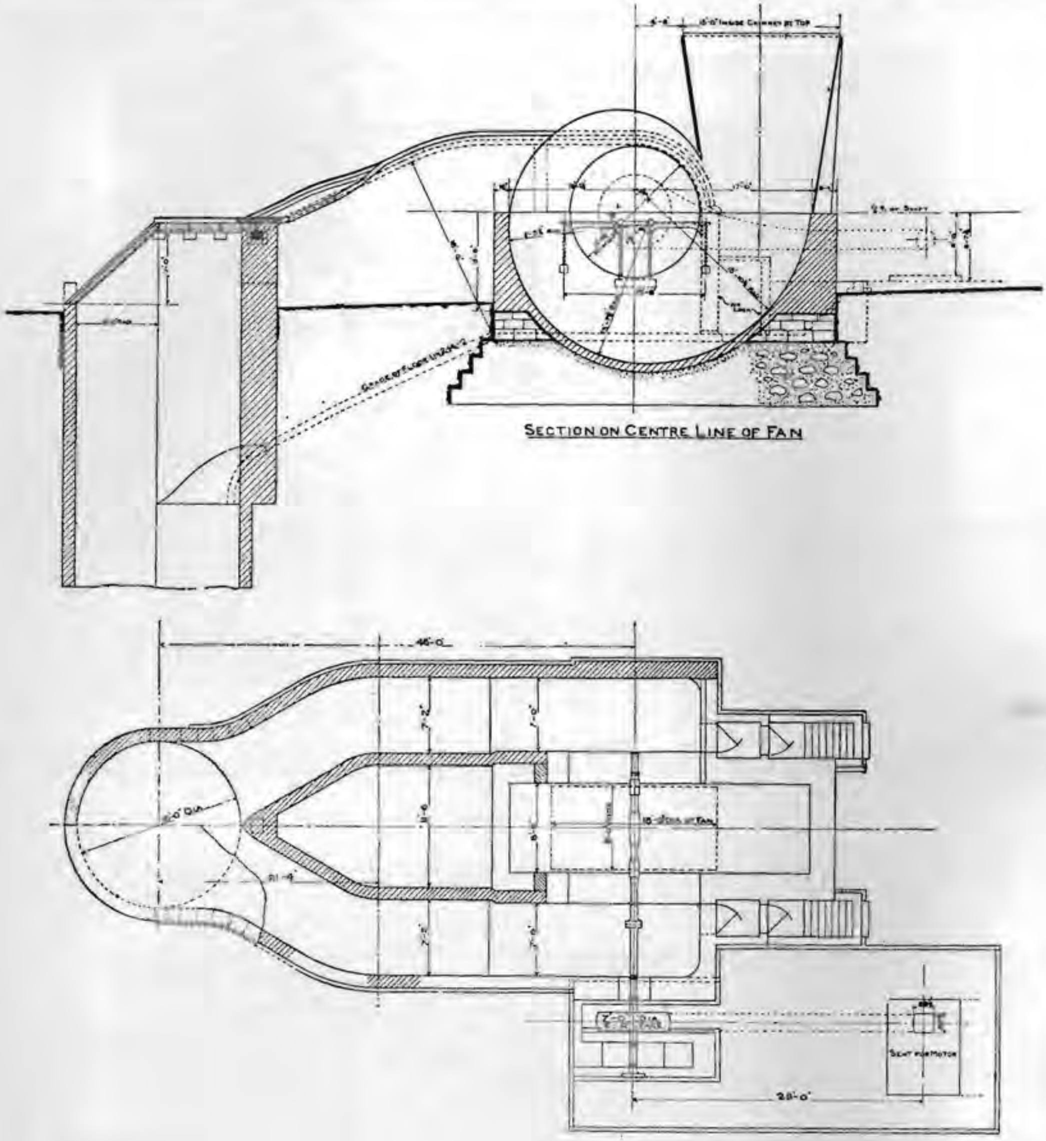


Fig. 5.—General Arrangement at top of Upcast, Cason Section, showing Upcast Shaft, Drifts and Fan Setting.

there is no tramming, and are closed with double swinging doors where tramming has to be carried on. Fig. 10 shows one of these swinging doors. Fig. 11 shows the details.

The course of the air-currents from the collar of the other downcast shafts may be similarly traced.

Fig. 12 shows the method of bratticing the station crosscuts and, at the same time, the door and regulator will be seen.

Auxiliary Ventilation—The 21st level of the Angelo Shaft is the transfer level for this section. The arrangement is shown in Fig. 13. It will be seen that we have three 9 in. and two 15 in. diameter pipes delivering into a 21 in. diameter pipe, with a 21 in. Sirocco fan installed below the 19th level to exhaust the air from this section, the intake air being derived from the main shaft. The delivery from this fan is into the main upcast.

Before installing this small fan here we used a ring jet, Fig. 14, through which compressed air

FIG. 6.—Fan in course of erection. Cason Section.

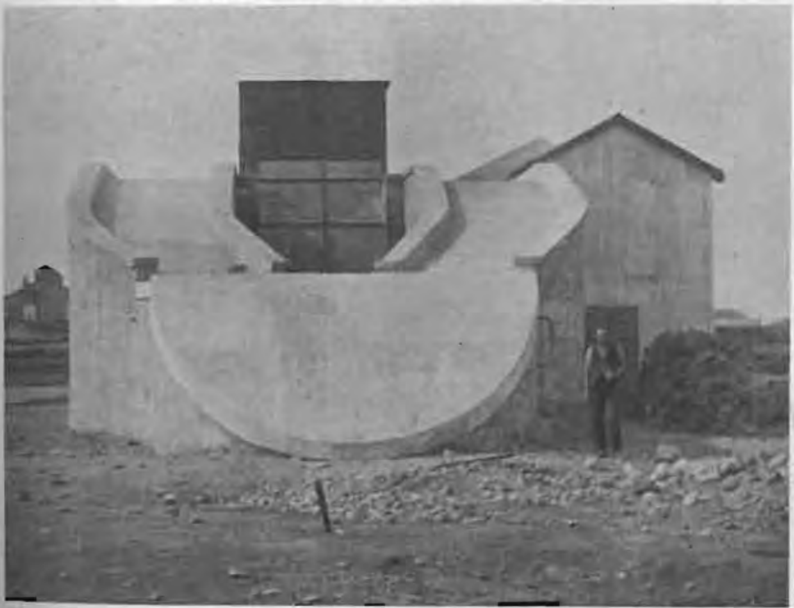


FIG. 7.—View of top of Upcast and Fan Drifts and Delivery. Cason Section.

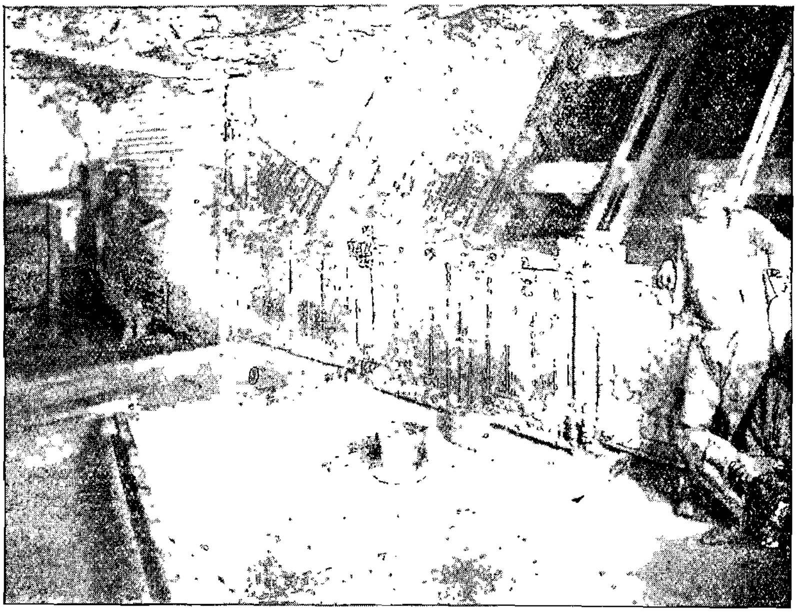


FIG. 8 —Brattice between Ladder-way and Hoisting Compartments, forming Upcast and Downcast in Shafts. Driefontein Section.

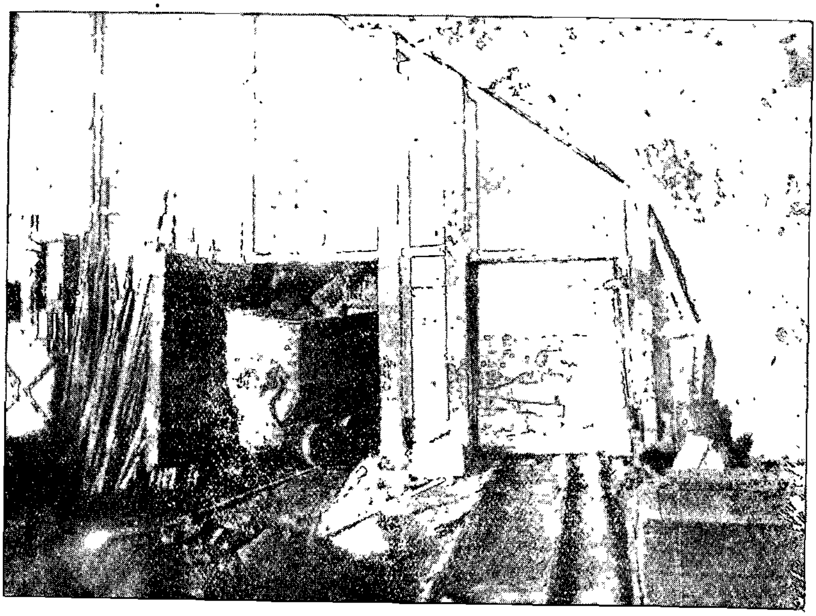


FIG. 9.—Brattice between Ladder-way and Hoisting Compartments, with Swing Doors for Tramming. Angelo Section.

FIG. 10.—Swinging Door and Regulator.

was directed up the pipe inducing a draught and exhausting the air from below. This form of jet is very convenient for temporary use and for requirements below 1,000 ft. per min. at a low water-gauge.

With regard to the ventilation of development drives, where a drive face is being carried far beyond the last connection with an adjacent level, it is necessary to provide for an intake and an outlet. This object is best obtained by using a galvanised iron pipe for the outlet. We prefer to use the pipe for the outlet, as the drive in which there is traffic is kept fresh throughout. An example of this is shown in the Angelo Deep section 27th east drive.

I may here mention that the Angelo Deep section, which is only in the development stage, will depend upon natural ventilation until connection is made with the Angelo section. At present the west shaft is downcast and the east shaft is upcast, as will be seen from the diagram.

In the case of long winzes and rises, these should be bratticed to provide a return. (This brattice at the same time provides protection to the miners in passing between the level and the face, a pent-house covering the travelling way.)

We will now consider what the effect of this scheme has been. Samples were taken from the bottom of three shafts, viz., the Farrar, No. 1 shaft (Driefontein), and the main shaft (Angelo). In all these shafts sinking was proceeding. The average results for these points were as follows :—

$$CO_2 = 0{\cdot}552\%$$
$$CO = 0{\cdot}011\%.$$

After the ventilation scheme was in operation samples were again taken from these points, and the following average results obtained :—

$$CO_2 = 0{\cdot}149\%$$
$$CO = 0{\cdot}006\%.$$

It will be noted that these figures do not represent the average for the mine. The average figures for the mine, however, were :—

1st.—before the adoption of the ventilation scheme :—

$$CO_2 = 0{\cdot}493\%$$
$$CO = 0{\cdot}012\%.$$

2nd.—after the adoption of the ventilation scheme :—

$$CO_2 = 0{\cdot}127\%$$
$$CO = 0{\cdot}005\%.$$

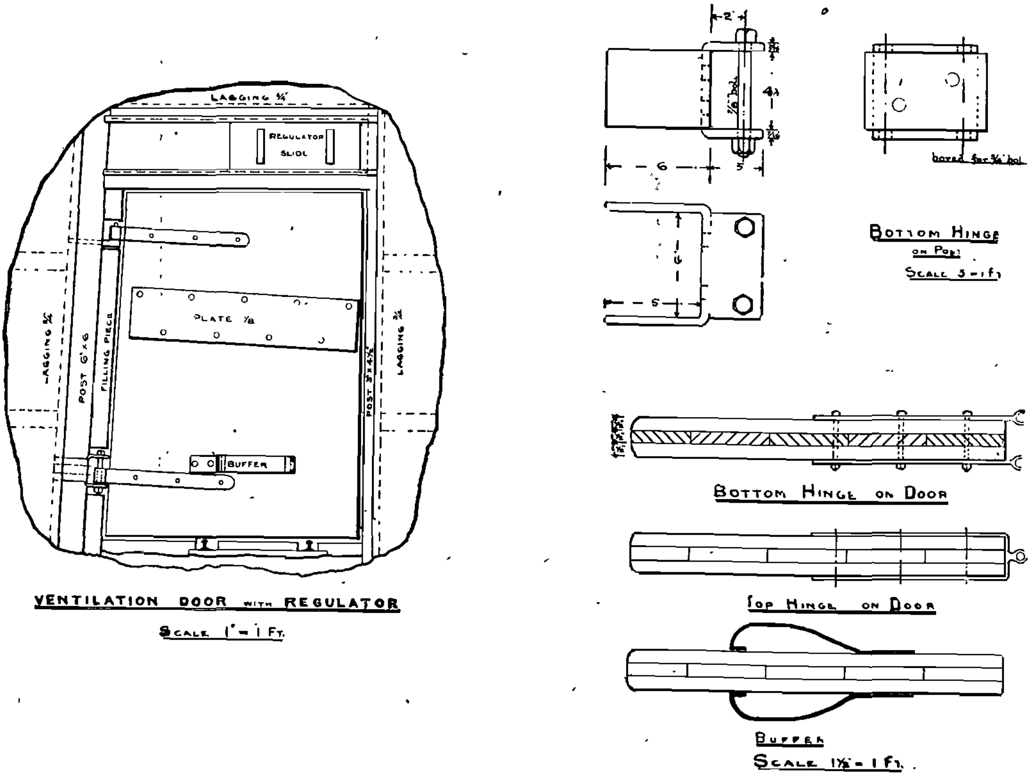


FIG. 11.—Details of Swinging Door and Regulator

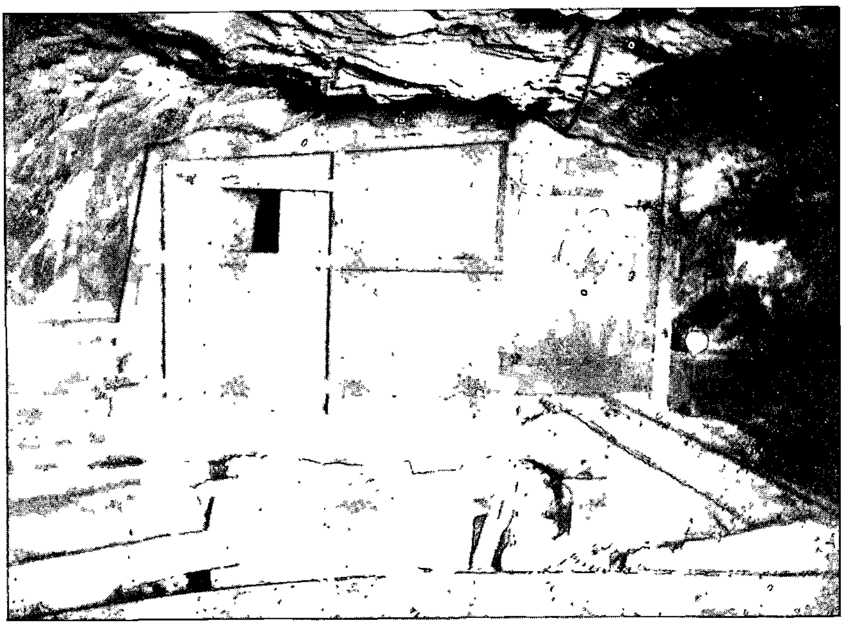


FIG. 12.—Shaft Cross-cut, Brattice, Door and Regulator.

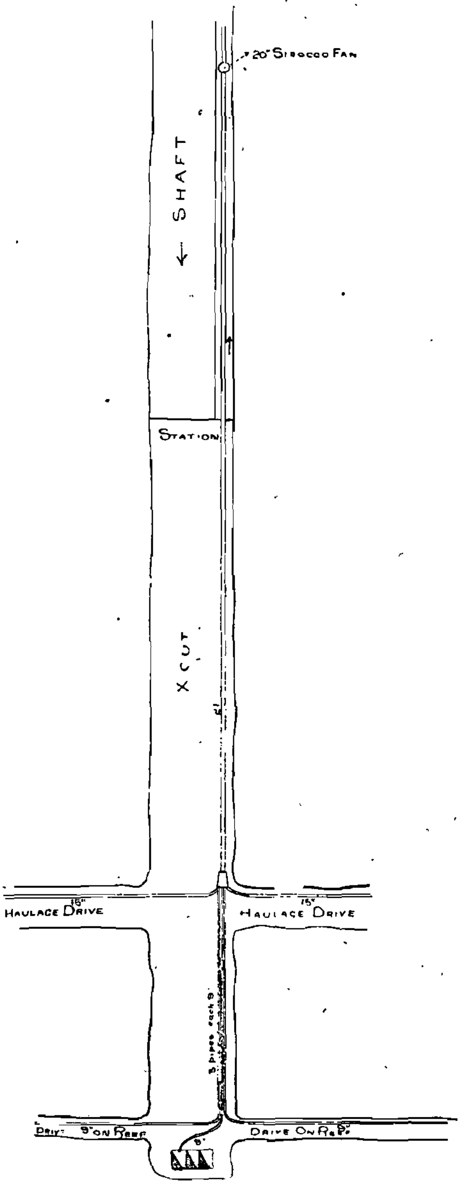


FIG. 13.—Auxiliary Ventilation, 21st Level. Angelo Section.

The samples were carefully taken and the analyses were done by Dr. Weiskopf. Recent samples taken from the air drift at the Angelo upcast directly after blasting when the vitiation of the air should be at its worst, gave the following results; $CO_2 = 0{\cdot}182\%$ and $CO = 0{\cdot}001\%$. The temperatures have been reduced by from 2° to 3°.

The capital expenditure on the installation for the whole property, including fans and motors, erection of same, equipment of up-cast shafts, bratticing, doors, pipes, etc., was about £25,000.

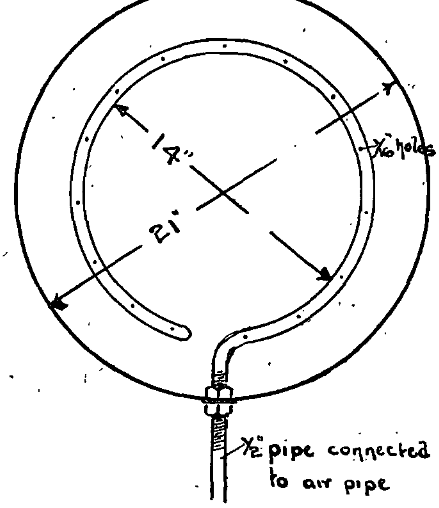


FIG. 14.—Ring Jet for Auxiliary Ventilation.

The running cost, including maintenance of plant, and of the equipment in the mine, is under 1d. per ton milled.

We feel sure that those other companies which have adopted artificial ventilation, namely the Cinderella Deep and Village Deep, have had similarly satisfactory results.

We are perfectly well aware that the scheme applied to the East Rand Proprietary Mines is not in detail applicable to every mine on the Rand but the general principles will apply.

The cost is insignificant compared to the valuable results obtained, and under the circumstances some system of artificial ventilation should be adopted in practically every mine on the Rand.

Another important factor in securing the most satisfactory conditions of the mine air is the practice of confining all drilling and blasting operations to the day shift. We are aware that many companies to-day are not in a position, for financial and other reasons, to adopt this practice, but where the adoption of it is possible, we cannot too strongly recommend it.

Mr. H. Stuart Martin (*Member*): I have been asked to propose a vote of thanks to the author for his valuable paper on ventilation. I can at least say that I am delighted to propose this resolution, and I am sure you will all heartily join with me in thanking the author for the very able way in which he has gone into the matter. It is particularly an interesting paper, and more particularly an important one, and one that concerns all of us and all those working underground. It is a subject which from the very first day I entered into the mining world I have had to pay considerable attention to. In my case, we were forced to go in for mechanical ventilation not only to keep the dust down but also on account of the very dangerous and inflammable gases. In our case we have the dangerous gases from explosives and we have the dangerous dust which is the cause of miners' phthisis. Coal dust does not cause phthisis, but under certain conditions does harm to the body. However, it is highly dangerous in the dry steam coal collieries, owing to its inflammable nature, and is kept down by systematic watering. Good ventilation does not prevent dust, but rather excites it and carries it to other parts of the mine. Still the gases must be cleared. The gases can only be cleared by good ventilation, in conjunction with the proper use of water, and I feel confident that the dangers from deleterious gases and dust can be in a great measure mastered if not almost entirely done away with. I am particularly pleased, and I am sure all of you are, that the author has brought this matter up, and I hope at another meeting we shall have a large number of members here and that we shall enter into a detailed discussion. To-night I am not prepared to say anything on the paper, but I hope that at another meeting, when discussion will ensue, I shall have something more to say. I have very great pleasure in proposing a vote of thanks to the author and I am sure all of you will heartily join me.

Dr. L. G. Irvine (*Member*): I feel that it is a compliment to myself and to Dr. Macaulay to be asked to second this vote of thanks. I do not know what his feeling is, but probably with me he feels rather like Simeon of old, when he said, "Now lettest thou thy servant depart in peace." The author has given us to-night an excellent object lesson of what ought to be done from end to end of the Reef, and I think that he and the group he works for are to be greatly congratulated for the thorough way in which they have taken up the whole problem of systematic ventilation, and demonstrated its practicability, its efficiency, and not least of all its *cheapness*. I think that they have laid this bogey of ventilation once for all. I am sure you will all agree with me that the author's paper is one of the greatest practical use. There is not a superfluous sentence in it, and not a sentence without its practical point. One has not time to go into the paper in detail, but its whole tone is exactly as it should be.

There are one or two points in it, however, to which one may refer. The author appeals for co-operation between the Government, the management of the mines, and the mine employes, in carrying out the regulations regarding dust-laying and other matters, and in effecting the changes which are necessary underground. This is absolutely right and absolutely necessary. We have had far too much in the past of mutual bickering—the men saying they have no appliances, and the employers that the men will not use them when they have them We want a new spirit underground. Employers and employed must heartily co-operate to find out what are the best devices, and to use them when they have them. And we want better discipline. I do not think the regulations will ever be properly enforced till mine officials as well as the miners are made liable to penalty for breaches of the regulations. And it will be of no use for the management of one mine to carry out a strict enforcement of discipline unless all of the mines do so.

The author makes a statement about working hours. He says that the actual period spent at work now-a-days cannot in any way be considered excessive. I take occasion to doubt if that is always so. I think there is sometimes a good deal of delay in haulage, especially in the haulage of natives, and this wants remedying. I do not agree that the number of hours worked is in all cases what one would like to see. Personally, I have a strong sympathy with the 8 hours proposal.

With regard to the living conditions of miners the author says that the incidence of phthisis has been generally believed to be entirely due to the conditions under which the miners work. I do not think that this has ever been quite the expert opinion. We have always agreed that living conditions above ground count for a good deal, and for these the personal responsibility of the miner is of course considerable. But living conditions above ground can also be improved. We want to see "back to back" quarters abolished —we want to see for underground workers one man in one room. I know of shafts also where there are no change houses for white men.

The Mining Regulations' Commission has made certain suggestions regarding tuberculosis. They suggest that men affected by tuberculosis should be legally prevented from going underground. With regard to natives I quite agree With regard to white men I do not. I take up this position. I think the Government, before granting a blasting certificate for the first time to a miner who has applied for it, has a right to have him examined by a Government Medical Officer. If he is affected with tuberculosis I do not think he should be granted a blasting certificate. But once a man has got a blasting certificate it would savour I think of medical tyranny to have him regularly inspected. I think such a system would lead to evasion and concealment, and would tend to defeat its own ends. What we want to do is first to make underground conditions such that the risk of contracting tuberculosis is reduced to a minimum. And second we want to make an avenue of escape from mining work possible for the man who has contracted tuberculosis, by providing sanatorium treatment for early cases, to give a man time to look round for alternative employment, to which he should be helped in every way possible. And for those permanently disabled we want to have the sanatorium, and some sort of pension fund. I believe in a sanatorium, but I want to see it empty all the time. The true "cure" of miners' phthisis is prevention. I believe that these methods would secure the end aimed at, namely, to get the tuberculous workman out of the mine, better than a drastic compulsory measure such as the Commissioners suggest.

The author has also called attention to the important question of gassing accidents. It is high time that we got rid of the idea that gassing accidents are "acts of God." They are almost invariably acts of human negligence, either on the part of the employers in neglecting to provide proper means of local ventilation of close places, or on the part of the men in not using them.

I quite agree with the author that the standard of ventilation ($\cdot 2\%$ CO_2) laid down by the Commission is satisfactory. The value of such a standard is its flexibility. It is applicable to all parts of a mine, and, if the air supply of the "close" places of a mine is below $\cdot 2\%$ CO_2, the general average of the mine air will be much better than that. The author has given us a splendid object lesson as to what has been done in the way of systematic ventilation on the East Rand Proprietary Mines. Detailed application from mine to mine will vary, but the principles may be universally applied. He very rightly makes a strong point about local ventilation. To my mind this is very important, it is one of the most important elements in the problem, both from the point of view of the prevention of phthisis, and from the hardly less important standpoint of the prevention of gassing accidents. It does not matter how much air is going into a mine, if it does not get into the ends of the drives, or the bottom of the winzes, where gases collect. Local ventilation of winzes, rises and drives should become part of the routine work of mining. We want to see mine officials systematically applying the simple devices necessary as part of their ordinary work without waiting for the Government Inspectors to come along and tell them to do it. Every mine may not require general mechanical ventilation, although where doubt exists it should be installed, but everyone of the mines requires means of local ventilation. All winzes, drives and rises must be ventilated sufficiently and have dust-laying devices, to remove the gases and lay the dust. Rises are a specially difficult feature—the best device for dealing with them is to make it the policy to do without them.

One of the most satisfactory points in the paper is that it demonstrates the comparatively insignificant cost of the whole affair. Some mines in this respect of course will have an advantage over others. We have had too much on the Rand of a somewhat slavish adherence to conservative methods of mining. People have said "other metalliferous mines have done without mechanical ventilation so we can do without it too." But the mines of the Rand have to be judged on their merits, and each mine on its merits. If Dolcoath with natural ventilation supplies 300 cub. ft. of air per man per minute, that has no bearing on the fact that the air supply on somes mines on the Rand may sink at times to 15 cub. ft., or even hang at times in a stagnating balance with no air going into the mine at all.

But of one thing I am convinced, and that is that the leaders of the industry are now determined to do their utmost, on the evidence laid before them in the Report of the Mining Regulations Commission, to remove faulty conditions underground. They realise the importance of the problem, not only from the humanitarian point of view, but from the standpoint that it is false economics to permit a state of affairs to contiuue, which leads to inefficient work, inefficient workmen, and an unsatisfactory labour supply. I know you will all join with Mr. Stuart Martin and myself in proposing a cordial vote of thanks to the author for his paper to-night.

Mr. W. S. V. Price (*Member*): As one of the very few practical, or rather working miners, who are members of the Society, I have very great pleasure in supporting this vote of thanks. This question of "ventilation" is so very largely bound up with Mr. Johnson's paper on efficiency, that I think we really cannot do justice to the discussion of them this evening as the time is getting on. To show how these matters are bound up. I was working on a mine not long ago where there was a rise about 500 ft. or 600 ft. from the station, the drive continuing for another 600 ft. or 700 ft. further in. The air naturally was very foul in the drive, and a brattice had been put up in the rise. As there were a lot of old ventilating pipes in the mine, I suggested to the mine captain that we should use some of these, with a bell-mouth in the connecting drive, and the other end up the rise, as it would freshen up the rise, and make the outer portion much fresher, in fact it would be almost as good as if the drive was just starting from the position of the rise. "Why, man," he said, "what for? there is bratticing up there!"

I hope at a later date to make up a few further remarks on this paper. I again wish to support the vote of thanks to the author for his clear and lucid paper, and especially for this admirable scheme of ventilation. I should like to ask the author if the mine has not been repaid for the outlay, by increased efficiency on the part of the men and boys?

Mr. S. Penlerick (*Member*): I believe Mr. Price knows our mine as well as I do myself. Not only from a health point of view, but from an economical point of view, the £25,000 spent has been repaid us many times over.

Dr. Aymard (*Visitor*): It is about seven years since I was here before this Society. I would like to add my testimony to this most instructive paper on ventilation. I know a little about ventilation, but I have learned a great deal more. I think I made a remark the other day that ventilation might be overdone but certainly not in the direction the author indicates. As medical men, whenever we start a new thing we almost invariably overdo it, and the result is that we go a long way round and gradually come back to it again. I fully agree with the interesting remarks Dr. Irvine has made. He and Dr Macaulay have been the great pioneers here. I have come along as a practical worker, following their teachings. I have made great efforts to destroy the dust at the point of origin, and I think I may say that I have succeeded. It has been pointed out by the Mining Regulations Commission that men with tuberculosis should not be allowed underground. I do not agree with Dr. Porter in a great many things, but I think he was justified, from a public health point of view, in saying that such men should not be allowed underground. But as a medical man myself I think it could not be carried out, and it is not necessary. It would be a great hardship on the men, and it would be unnecessary. It is not as if they go down and sit all together in one drive. Immediately they go down the mine they are distributed. There is one other point to which I am opposed. The further you go down into the earth, the drier the atmosphere must be. We have no right to ask a man to work in a steaming or even saturated atmosphere. The forcing of men to work under the spray or atomiser cannot be defended medically.

Mr. R. Gascoyne (*Member*): The system described by the author is an up-to-date one, and quite on a par with the most advanced system you will find in Europe to-day, and I certainly think the other mines on the Rand should take it as a pattern. There is one remark where he deals with the water supply in which the statement occurs: "As there can be no possible excuse for non-compliance with the regulation, non-compliance should really be a criminal offence. I would urge the rigorous enforcement of the law, and, if necessary, an increase of the penalty for offences." Now, if it is necessary to make the law observed in regard to fresh water surely it is equally necessary to make it observed in regard to fresh air. Fresh air is as equally necessary to the miner as fresh water. It used to be enacted in the mining regulations that 70 cub. ft. per person is the amount of air required, and the Commission on Mining Regulations now says that this cannot be obtained in the mines, I say if you cannot obtain that amount it is no use making new regulations because they will require the adoption of fan ventilation just the same as the 70 cub. ft. of air per minute per person underground.

The author points out that efficient distribution is more important than a large quantity of air, a remark with which I agree. Another important matter is that the author takes his air to the lowest point. That is a very important point in a deep mine. It will be found that in a deep hot mine it seems almost impossible to get the air down to the lowest point as it eludes your grasp and escapes by a short cut to the return wherever possible.

With regard to ventilating a drive by pipes, that a pipe should be made a return rather than an intake, will depend upon circumstances. If there is a long length of drive and it is desired to keep that drive clean and fresh, that may be the best plan; but if there is a short pipe, especially in the absence of compressed air, it is best to make it an intake so that the air can be thrown on the working face. If the pipe is a return it will be found that the air escapes to it without touching the face of the drive. On the East Rand the ventilation has reduced the temperature by 2° or 3°, but as a rule if mechanical ventilation be introduced in a deep mine, the temperature of the atmosphere should be reduced from 15° to 20° as compared with the rock temperature. I must congratulate the author on the small cost, because it compares very favourably with European collieries where it also runs at from ½d. to 1d. per ton. Another thing I must congratulate him upon is that the upcast shaft is used entirely for the return air to escape to the surface. It is a very excellent plan, and ought to be carried out everywhere, because if the upcast is used also as a winding shaft it will be found that the return air damages the rope and timbers, and in a short time will either ruin the shaft or it will give a great deal of trouble, not to mention the risks caused by the damage to the ropes. Again, the upcast shaft should always be lined with steel, because steel will stand the return air much better than timber. With regard to the hope expressed that other mines that have started mechanical ventilation will meet with the same results, I have no doubt that if the same system as that the author has adopted is carried out on other mines, they will meet with equally satisfactory results.

Mr. A. T. Judge (*Member*): I am very grateful to the author for the paper he has read. I do not want to criticise his paper for I feel that I do not know enough about ventilation. I wish to answer the remarks made by Dr. Aymard as to killing the dust at its source. I think Dr. Aymard is altogether mistaken about the principal source of dust. The amount of dust from rock drills is trifling compared with that from other sources. I maintain that it does not cause one tenth of the phthisis existing. The main source of dust is due to the amount of explosive used. We can go into drives 1,000 ft. in from ventilation 12 hours after blasting, and find the air hazy with dust. I think what they have done on the East Rand Proprietary Mines is the only cure for miners' phthisis. At the present moment miners may use appliances that palliate the evil, but without ventilation there will be no cure. We want full colliery ventilation.

Dr. D. Macaulay (*Member*): I wish to support my colleague, Dr. Irvine, in seconding the vote of thanks, and for this reason, that I consider the second concluding paragraph in the author's paper is the Magna Charta of the miner in this country. He says the principles of ventilation may not be applicable in every detail to other mines, but the general principles will apply to every mine on the Witwatersrand, and he also says the cost is insignificant. This matter has been under the consideration of one of the most important mining groups on these fields since 1906, who have authorised one of their people to make this statement to night. I wish to say this, that inasmuch as the Society has taken an honourable position in bringing this matter into prominence, it is to be hoped that you will see to it that it does not fall again into insignificance, and that you will work at it without cessation until the author's principles are carried out from one end of the reef to the other. It is cheering for me to come here to-night and find this Society has still so much life. I hope it will continue to live and flourish until we can say that the gold mines on the Witwatersrand are not only the most flourishing but also the healthiest.

The President: This paper is of world-wide interest as it describes the first instance of a metalliferous mine being fully ventilated. I should announce that owing to our having had to postpone the meeting we are not able to have with us Mr. C. B. Saner, Mr. R. W. Schumacher, and Mr. J. G. Hamilton, the President of the Chamber of Mines, who are unfortunately prevented by a prior engagement from being present to-night.

Mr. Tom Johnson (*Member of Council*): The author has told us that although the cost of the installation of the ventilating plant was £25,000, and the running cost 1d. per ton milled, that it has already paid for itself. This is what is to be expected, and I think that the others who have installed ventilating fans might give us their experience, and if the results are like those we have just heard it would be encouragement for those who have not already done so to put in ventilating plants.

Dr. C. Porter (*M.O.H., Johannesburg*): I would like to offer my congratulations and thanks to Mr. Penlerick not only for his excellent paper but for the enlightened lead he has given in regard to mine ventilation on the Rand. I desire also to thank him for the personal courtesy he extended to the members of the Regulations Commission when they had the pleasure and privilege of going over his mine, and seeing the good work he has done there; and I think I may safely say that when considering the reasonableness of the proposals in regard to ventilation, which are incorporated in the Mining Regulations Report, the Commissioners were very considerably influenced and guided by what they had the opportunity and advantage of learning from the author.

Mr. Judge, of the Nourse Deep, has just said that in his opinion by far the largest amount of dust generated in mines resulted from blasting. He also said, if I took him correctly, that the amount generated from the actual operation of the rock-drill was comparatively small. I speak on this point with submission, because I am not a technical man; but, on the other hand, I possess the use of my senses, and I have had very unusual opportunity during the last couple of years of observing these things. So far, however, as I am entitled to an opinion, I venture to agree entirely with what Mr. Judge says; and for that reason, while I fully appreciate and certainly do not wish to discourage in any way, the efforts now being made by a medical man to prevent dust by means of what he calls a "dust destructor," but which I think would be more correctly termed a "dust allayer," I do not see how that apparatus is in any way going to affect the particular source of the evil of which Mr. Judge has spoken. I should like to point out too—and this the Mining Regulations Report (p. 42) shows—that a similar wet-bag apparatus was devised and tried by Dr. Haldane and others in Dolcoath Mine as long ago as 1904, and is thus described in their "Report on the Health of Cornish Miners," p. 26, par. 3:—

"We made a number of experiments as to "the practicability of surrounding the mouth "of the hole by a wetted canvas bag, through "an opening in which the drill passes, the "bag itself being fixed to a metal ring pressed "by means of an adjustable rod against the "rock round the hole, and luted round with "clay. We found that this arrangement was "very effective in stopping dust. It did not, "however, appear to be practicable, as it was "often impossible to fix the ring securely, "particularly when the surface was very irre-"gular, and the rock crumbly."

Whilst preserving an open mind, I am not satisfied, from what I recently observed of the working of the local edition of this contrivance at the Wolhuter Mine, that it offers any great advantage, in ordinary circumstances, over an intelligently-handled jet, and it is certainly at present much more difficult to adjust. But if this practical difficulty can be overcome, the apparatus would undoubtedly be very valuable in rises, as it would prevent much water and mud from falling back on to the rock-driller. Returning to sources and causes of dust, I also venture to believe, for I personally observed it, that in dry working places a very large amount of dust is raised by the exhaust-air from the drills. Merely to wet the dust and let it fall on the ground is not going to prevent that dust being raised again when it is dry, and the necessity for keeping the floor and sides of the working place wet is, therefore, very clear. While then one welcomes any efforts to mitigate the dust evil, I think it is right to indicate sources of danger which occur to one as not having been adequately recognised.

Next, there is the allegation made to-night by Dr. Irvine that it is not by any means certain that tuberculosis is actually contracted underground, and that therefore the proposed exclusion from underground work of white persons suffering from tuberculosis savours of medical tyranny. Now I wish to make it clear—I say it with great respect and I am sure you will not take my remarks in any other sense—that the Commission is not going to answer individual criticism. The Commission is fully aware from the very fact that its members are human, and for other reasons, that there may be, in the very nature of things, many shortcomings in its Report. It is impracticable to cover everything in a report of that kind. Coming back to Dr. Irvine's reference to the doubtfulness of mine-infection and to "medical tyranny," I therefore merely ask you to compare the remarkable statement he has made to-night with his and Dr. Macaulay's joint evidence in May, 1908. In Vol. II. (Evid.), p. 246, pars. 2 and 3 of the Mining Regulations Report, that evidence reads as follows:—

"There is no doubt that every consump-"tive person is, through his sputum, a source "of danger to his neighbours, and that the "disease is largely spread through this agency. "There is no evidence as to what proportion "of white miners or natives infected with "tuberculosis become so infected in the actual "course of their underground work. Probably "the majority are infected in the ordinary "course above ground. At the same time "there is a definite risk of infection being "actually conveyed underground, especially "when we bear in mind the considerable "extent to which tuberculous phthisis exists "amongst native mine workers. *It is probable "that more than one in every two hundred of "the latter is infected.*" And this risk would "of course be increased, quite apart from any "question of dust, if the ventilation of the "working places should be from any cause "inadequate."

"From the simple hygienic standpoint it "would be a wise precaution, in the interest "of those affected as well as that of those "working with them, to prohibit all persons "demonstrably affected by tuberculosis from "working underground. Certainly *this provi-"sion should be made compulsory for all "native workers*, although in them the gener-"ally painfully rapid course of tuberculous "phthisis commonly attains the same end in a "more compelling fashion. With regard to "white workers, opinion is probably not yet "ripe for such a step. No doubt it must be "regarded as a hardship to compulsorily debar "a man, however crippled, from following his "occupation, but the measure would only "anticipate by a few months, or at most by a "year or so, the final irrevocable compulsion "of the disease itself. For the affected man "to continue working underground is merely "suicidal, and the risk of his conveying "infection to his neighbours is certainly a "definite one. That such a step would greatly "prolong the lives of those affected by "advanced tuberculosis we do not assert, "although in early cases of tuberculosis, with "a slight degree of silicosis, it might certainly "do so."

I have quoted fully in order to supply the context, but I invite special attention to the three concluding sentences in each of the two paragraphs cited.

Reverting to the Mining Regulations Commission's Report, I have only to say that what we have written, we have written and we stand by; and up to the present I have not heard nor read anything to induce me to alter any opinion which my colleagues and I have formed during our inquiry. But there is one thing I would like to ask—because criticism is very helpful to everyone—and it is that before people criticise they should first of all read the Reference with which the Government honoured us, and secondly that they should read the Report; because some people have criticised without doing either. I have been asked, for instance, why we did not report on the question of compensation. Well, simply because we were only told to report in regard to underground sanitation and health conditions on mines. We were not asked to report on any matters connected with compensation. Then I would ask that the Report should not be merely read, but that where it is quoted, it should be carefully read and correctly quoted, and not distorted, unintentionally I am willing to believe, as has been done by some of the most pretentious correspondents whose letters have appeared in the Press. There is a journalist in this town who I want to say most emphatically is a thoroughly honourable and upright man, a valued personal acquaintance of my own—I mention this in connection with the necessity for accuracy in use of quotation. This gentleman said in an editorial article that the Commission in general and myself in particular were greatly to blame because we waited for three years before referring to miners' phthisis and pointing out to the Government the condition of things that existed. Well, my friend had evidently not read the Report at all, although he is the editor of the newspaper with perhaps the largest circulation—if I am not libelling our other papers—for in the section of our Report which deals with miners' phthisis, is printed in full a letter which we wrote in November, 1908, to the Government calling their attention to the matter. That is two years ago. This mistake was afterwards discovered by this journalist, and he said in a subsequent article that our letter of November, 1908, was a most full and earnest recommendation; but he nevertheless proceeded to recommend—I am not a politician in any way—that the miners in Fordsburg should not vote for Dr. Krause (the Chairman of the Commission) because the Government did nothing when they got this letter from us. Now, that is absolutely untrue, and absolutely the reverse of all fair-play. This Report was sent to the Government on the 6th of November, 1908, and on the 24th December, 1908, as a Christmas box for the miners, the Government put into force the regulations embodied in the recommendations we made in this interim letter or report. And so this statement by this honourable journalist was not only absolutely untrue, but, after finding it untrue, he for some reason—for what reason I cannot say—perpetrated another gross incorrectness, and attacked the Chairman of the Commission on the ground that the Government had not done what you will find by looking at the *Gazette* and looking at our Report, it did and did promptly. I would say again that the Commission does not intend to defend anything said in that Report. We are satisfied as to our findings, which are based impartially on the evidence before us, and we do not care two pins whether they please you or displease you or anyone else.

Perhaps I may now be allowed to refer to the suggested connection between Johannesburg road-dust and silicosis, though I do not intend to express any final opinion at present on the assertion that has been made, that people who live in Johannesburg, but never go underground, are dying like flies from silicosis. I merely ask you to consider the following facts in connection with this curious allegation. I am informed by several of the leading medical men in Johannesburg, including Dr. Mackenzie, who has unusual opportunity at the Hospital of knowing the results of *post-mortem* examinations regarding deaths from respiratory diseases—that there is no evidence whatever of deaths from silicosis except in persons who have been working underground. The second point is, as shown by your President this evening, that except in the vicinity of the mines the dust is rounded and relatively harmless as compared to sharp dust, and contains much organic matter; and if the older members of the Society will carry their minds back to the slides shown by Dr. Pakes in 1903, they will recall the same fact. Thirdly, I have worked out the death rates from pneumonia per thousand (without correction for age-distribution) in Johannesburg during the three years 1906-1909, and compared them with those in England and Wales—including the country and towns—during the same period. Now, in Johannesburg from 1906 to 1909, the death-rate from "pneumonia at all ages" was 1·31 per thousand. In England and Wales it was 1·24. The rate from "lobar pneumonia at all ages" was 0·88 in Johannesburg and 0·71 in England. From "broncho-pneumonia at all ages" it was 0·43 in Johannesburg and 0·54 in England and Wales. There is no very alarming difference there; certainly not the difference one would expect if everyone was at risk of death from silicosis in Johannesburg. Now, in order to get at how pneumonia specially affects *adults*, I took "lobar pneumonia *over 15 years of age*." The death-rate therefore was 0·71, while in England and Wales it was 1·00. For broncho-pneumonia it was 0·09, and in England and Wales 0·26. I am aware that one cannot always come to a correct final conclusion in a matter of this kind on figures alone; and there is no doubt that the inhalation of dust does markedly predispose to respiratory diseases. But I know of no satisfactory evidence that non-mining people generally, who are walking about the streets of Johannesburg, are at risk of dying of silicosis; and so far as I can find from inquiry there is not a shred of justification for such a statement. But I do not possess any recent details of age distribution of the population of Johannesburg, and have therefore not made any correction in this respect in the rates quoted. We know, however, that in Johannesburg there are a great many more young people per thousand than in England; and, as pneumonia is a disease of old people particularly, it is probable that our true pneumonia death-rates are correspondingly higher than the figures quoted would indicate. But, even then, they would not justify the statement in question, so far as I have been able to ascertain. At the same time I think such suggestions are often very interesting, because they indicate directions of useful inquiry; and one naturally values them much more when they are not merely expressions of opinion, pious or otherwise, but are backed up with something like tangible evidence. I wish most cordially to thank and congratulate Mr. Penlerick in regard to his paper.

SAND-FILLING ON THE WITWATERSRAND.

(Read at June Meeting, 1910.)

By Edgar Pam, A.R.S.M. (Member).

DISCUSSION.

Mr. O. P. Powell (*Member*): Mr. Pam's paper deals with one of the most important mining subjects that has ever been discussed by this Society, and is of great value as a record of pioneer work here of sand filling on Silesian lines. When sand filling was first seriously considered on these fields a certain amount of apprehension was felt as to the lowering of current sand residues underground, an apprehension that was not altogether dispelled by the earlier investigations and tests of possible cyanicides. Consequently, as stated by Mr. Pam, old sand residues free from cyanide have hitherto been used at the Village Main Reef and elsewhere

At the Simmer & Jack Proprietary Mines, Ltd., a sand filling plant has now been in operation on novel lines for close on two months, and from the beginning has been treating current sand residues direct from the cyanide vats, with satisfactory destruction of the cyanide solution moistening them. The system employed comprises the pumping of sand residues as a pulp from the vats to classifiers which deliver a thick underflow into a bore-hole, and return in circuit the overflow water to the pump for bringing up more sand. (See Fig. I.)

The following is a more detailed description. The sand residue as discharged from the vats and containing weak cyanide solution is dumped from trucks into a box beside the track clear of the vats. Into this box water is constantly sprayed, and the pulp thus formed gravitates to a pump and has a ratio by weight of about 3½ of water to 1 of sand. This pulp is then pumped through a 6 in. pipe for a distance of about 900 feet to classifiers at a 6 in. borehole 200 feet deep. The mixing box is 10 ft. long, 5 ft. wide and 4 ft. in depth, and discharges into a launder 20 ft. long with a uniform grade of 8%. This graded launder ensures the pump being supplied in a steady manner with a uniform mixture which is essential to efficient pumping. The truck discharge and wooden mixing box will ultimately be replaced by a system of launders running below the discharge doors of the vats. These launders will convey the sand pulp to the pump, and as is the case with the present arrangement a uniform mixture will be provided, as the pulp will not flow until the requisite quantity of water has been added. A 4 in. centrifugal sludge pump is at present in use. The delivery column rises constantly from the pump to the classifiers at a 60 ft. higher level, and will serve for a larger pump should we decide on replacing the present one. By having a delivery pipe of larger diameter than the delivery of the pump the velocity of the pulp is reduced and the wear of the pipe reduced by partial settlement of sand on the lower side. The underflow from the classifiers at the borehole containing about 30% moisture is delivered by launders with a grade of 30% to the mouth of the borehole down which it falls. The two diaphragm cones (8 ft. diameter, 10 ft. deep) which we started with handle between them 200 tons of sand per day of ten hours. Two additional cones have now been erected, and with a pump of larger size the plant will deal with some 400 or more tons of sand per day of ten hours. (See photograph.) As the classifier underflow entering the borehole is very thick the make-up water necessary to be added to the small volume of water in circuit is comparatively small. The sand residues contain about 12% of moisture as cyanide solution containing up to ·02% total cyanide. It is proposed to instal a vacuum pump*

* See this *Journal*, Vol. ix., Jan., 1909, p. 240.

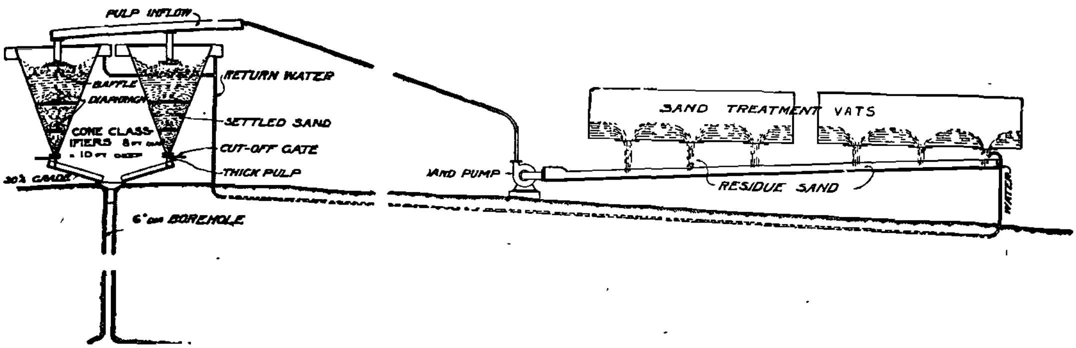
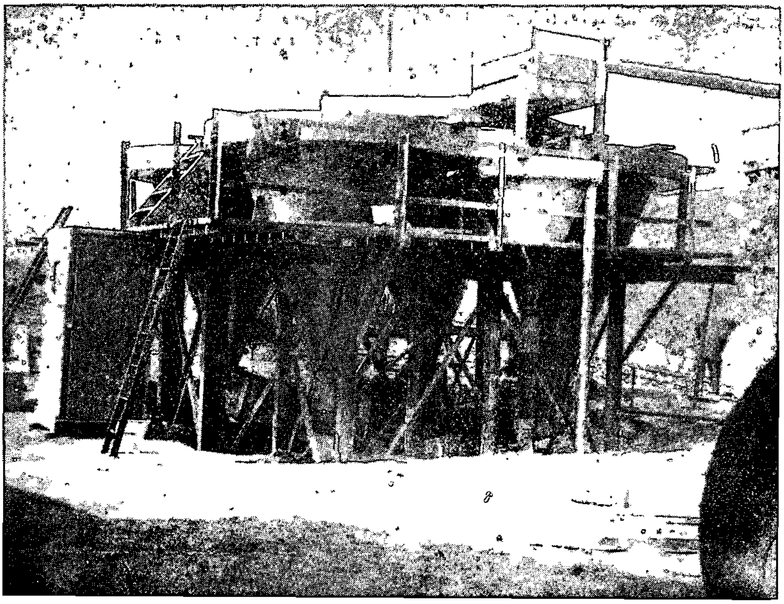


FIG. 1.—Sand Filling Plant. Elevation showing General Arrangement.



connected to the leaching pipes from the vats, which will still further reduce the moisture in the residue, and consequently the cyanide to be destroyed, as well as remove all the gold-bearing solution possible.

The various cyanicides suggested by Mr. H. A. White and others have been tested in our laboratory by Mr. McA. Johnston, and until recently we have used permanganate of potash* on a working scale as the most suitable, but we are now using the cheaper chloride of lime† satisfactorily. By adding ·20 lb. to 0·25 lb. of the former reagent in the form of a 5% solution to every ton of sand dumped in the mixing box adequate destruction of cyanide is effected.

* See this *Journal*, H. A. White, p. 443, June, 1910.
† See this *Journal*, H. A. White, p. 15, July, 1910.

Frequent tests are made of the moisture in the pulp entering the bore-hole from the cone underflow, and in no instance has this contained more than ·0025% of total cyanide, whereas the limit allowed by the Westralian Government is ·010% total cyanide. The circulating water is slightly alkaline owing to the alkalinity of the moisture in the fresh residue.

From the point where the cone underflow leaves the bore-hole it is conducted by wooden launders to the stope to be filled. A small stream of water underground is diverted into the launder, in order to form a pulp which will flow on the grade available as this is in places considerably under 30%.

Tests have been made of the air in practically every portion of the stope that was being filled and nowhere could a trace of hydrocyanic acid be found. The water draining from the deposited sand was also tested with similar results, which would indicate a further neutralisation of cyanide taking place after the pulp enters the bore-hole. The sand settles compactly underground and drains readily. Tests made some time ago by Mr. J. A. Vaughan at the Government Mechanical Laboratory showed only 4·5% compression of water-deposited sand supported at the sides under a pressure of 300 tons per sq. ft. It is obvious that the cleaner the sand available for filling the less will be the trouble underground with slime*.

Although we have been working on a relatively small scale, the actual operating surface costs are remarkably low—a little over 4d. per ton of sand lowered. Power costs a 1d. and neutralising with permanganate about the same amount per ton.

The method described affords various advantages as follows:—

(a) The pulp entering the bore-hole contains about 30% of moisture as against the 40% to 50% moisture usually employed, so that much less water than usual, which is liable to contain traces of cyanide, requires to be pumped from the mine Assuming that 1,000 tons of sand are lowered as pulp into a mine to drain there until only 12% of moisture remains, then the water requiring to be pumped out of the mine amounts to only 292 tons if the pulp lowered contained 30% moisture, but it will amount to 531 tons if the pulp contained 40% moisture, and to 864 tons if the pulp contained 50% moisture.

(b) A much longer contact and more thorough admixture is available for action of the cyanicide before lowering than in the usual system of sluicing direct into the mine.

(c) Up to 90% of the water in the sand pulp entering the classifier overflows, and thus at once returns for further use any excess of cyanicide dissolved in it.

(d) Owing to the small amount of water in circulation any soluble gold present in the residues becomes concentrated to a certain extent in the circulating water, which may be periodically transferred with its slime in suspension to the slime plant for recovery of gold contents, or otherwise treated.

(e) The velocity in launders or pipes of the concentrated pulp underflow from classifiers is lower than with a higher ratio of water, and consequently the wear by abrasion less.

(f) The elimination of slime in the water overflowing the classifiers permits of a sandy underflow more free from slime, and the sand deposited in the stopes drains more rapidly and completely.

(g) The capital expenditure and operating cost of the installation is low, the former being mainly for launders, a pump, two pipe lines and classifiers, whilst for the latter the expense of pumping is the main item, and with a large daily tonnage the total working cost, including destruction of cyanide should be less than for sending residues to the dump.

The conditions governing the surface transport of sand for filling will vary on different mines and will influence the choice of a point of lowering, particularly where a bore-hole is to be employed. When this point is on a lower level than that of the sand vats the pulp can gravitate to the classifiers and only the overflow water will need to be pumped (Fig. II.). Where there is no natural fall it may be more advantageous to drive a tunnel or cut a trench than to pump the sand pulp.

* *S. A. Mining Journal*, p. 610, July 23, 1910.

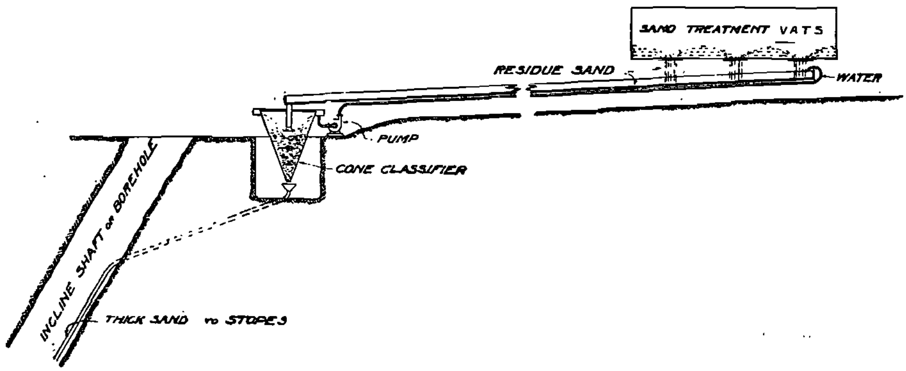


FIG. 2.—Sand Filling. Sand direct from Vats to Classifier at Borehole by Launder.

Among the many advantages of sand filling, to which Mr. Pam has referred in his paper, that of improved underground ventilation is one of the utmost importance. In outcrop mines the question of ventilation does not usually present any serious difficulties. In the deep levels the worked-out area, constantly increasing in size and providing space for the dissipation of air, will be filled in, and by keeping such filling as close to the working faces as is practicable, every cubic foot of air will be usefully employed,

Mr. B. C. Travers Solly *(Member)*: I was working on the Great Boulder Proprietary Mines, Western Australia, when the filling of stopes with residues was started, sometime in 1897 or 1898. and knowing that the Government had, owing to accidents occurring, stopped the system, appointed a Royal Commission, and on its findings passed regulations under which the sand filling was restarted, I wrote in June last to Mr. Richard Hamilton, who was then and still is General Manager of the Company, asking him for particulars of the conditions under which the filling is now carried on, and I have just received his reply.

Inter alia, he says :—" The mines on this field have, as you know, dumped their tailings into the stopes in a fairly dry condition. Those using the residues direct from the presses gave them a good drying with compressed air before dumping them into the stopes. This applies both to the raw and the roasted residues. Our mining regulations specify that the strength of cyanide of potassium in the residues must not exceed ·01%, and the mines find they can comply with this regulation without trouble. The ore on this field contains generally somewhere about 13% of carbonate of lime in the raw state. In roasting, this is converted into calcic sulphate and calcic oxide, while there is also apparently some unaltered carbonate left. With the roasted ore you would not expect so much decomposition of cyanide as with the unroasted ore residues. The raw treatment plants go in for very close concentration, and in some instances they dump residues direct from the presses, and so long as the stopes into which the residues are tipped have free circulation of air there are no attendant cyanide troubles. Where passes have been blocked so that a current of air was stopped there have been instances of men being temporarily overcome by cyanide fumes, but I do not know of any during late years. When these instances occurred there was more ore percolated than at present and salt water was used for washing, and I have no doubt that the residues contained more than ·01% of cyanide of potassium. No mine in W. A. has ever tried to fill stopes by running residues into them by means of water."

It seems to me therefore that the Regulations proposed by the Transvaal Commission, whose report has lately been published, have been taken directly from those in force in W. A., without any thought of the vastly different conditions with which we have to deal.

The recommendations of the W. A. Commission, which may be found in "Notes and Extracts" in the November, 1905, number of the Journal of this Society, read :—"That tailings should not be used for filling (1) in a wet state, (2) when they contain more than ·01% of their weight of cyanide of potassium, (3) in any place where there is not a current of air passing freely."

No. 1 is, however, translated into practice in W. A. as "in a fairly dry condition." The draft Regulations proposed here state that tailings so used must be previously dried.

No. 2 is mutilated in passing from the recommendations of one Commission to those of the other, and we are left to surmise in the latter whether the ·01% of cyanide of potassium is to be calculated, as in the W. A. Regulation, on the weight of the residues or on the moisture contained in them. If the latter is intended the regulation would be reasonable. If the former, the essentially differing conditions of the ores of the two fields make it a highly dangerous allowance. In W. A. the condition No. 2 is, as Mr. Hamilton states, easily complied with, and seeing that, with an allowance of 15% for residual moisture, ·01% on the residue works out at something over ·06% calculated on the contained solution; this is not to be wondered at.

While this limit is safe in Kalgoorlie-Boulder, where the ore contains some 13% of carbonate of lime, it would be highly dangerous on the Rand, with the acid forming nature of our ore.

The main points which strike me as being so widely different in the conditions on the Kalgoorlie-Boulder belt and on the Rand, apart from the chemical conditions of the ore, and which make their method of "dry" sand filling an economic impossibility here are as follows :—In nearly every instance in Kalgoorlie-Boulder the mines are outcrop, the veins are wide (I have worked in stopes 40 feet from wall to wall) and they are very steep. The residue is trammed from vats or presses and dumped directly into cribbed shoots, which lead to the underground workings where the filling is required. The method of mining is that of back stoping, and the sand would run to its angle of repose directly under the working face. Here, however, we have, so far as the future is concerned, to deal mainly with deep level mines and comparatively narrow and flat ore bodies, where in filling with "dry" sand it would be necessary to have an extra compartment in the shaft, tramming on an up grade to the stope to be filled, and, in most cases, mechanical conveyance of the sand down the stope to the portion being filled.

It will be noticed that Mr. Hamilton states :—"No mine in W. A. has ever tried to fill stopes by running residues into them by means of water." There was no inducement to do so. There was every reason against it. At the time when sand filling was started water of any kind was scarce, having to be pumped from Hannan's Lake miles away, and fresh water cost up to 15/- per 100 gallons retail. I believe at the present time, with the extensive water supply system, it costs 2/6 or 3/- per 1,000 galls.

Taking these points into consideration I am not alone in thinking, that this Society would only be doing its duty to the industry by entering, without loss of time, a strong protest against the promulgation of these proposed Regulations.

Mr. H. F. Lofts, M'Toko, Rhodesia (*Member*): The extremely interesting articles on "Sand Filling on the Witwatersrand," by Mr. E. Pam, followed by "The Destruction of Cyanide," by Dr. Moir and Mr. Jas. Gray, and the copious notes by Mr. H. A. White, must appeal to all of us, as touching almost the most important subject ever dealt with by this Society. Therefore I, in common no doubt with many others feel I should like to add my quota to the voluminous discussion which I am sure is bound to follow three such striking papers.

First, I understand the residues contain iron salts, pyrite, and cyanide. These in turn produce (if old) sulphocyanide and HCN, and the object of these tests is mainly to prevent the formation of HCN when the sands are safely lodged in the stopes, as it is very injurious to health.

Of these papers, Mr. Pam's shows the practical aspect, Messrs. Moir and Gray deal with the chemical details, and Mr. White with the experimental side and costs per ton.

With reference to Mr. Pam's article, I would suggest the use of launders instead of pipes, because they would pan out considerably cheaper than $\frac{7}{16}$ piping, and lengths could be added and alterations made with less expense, also a launder is less liable to choke than a pipe. In order to make a tight joint in the planks erected in stopes, a system of grooving and tongueing with soft timber similar to that used in the bottom of cyanide vats, if bolted would be perfectly water-tight, and there would then be no possibility of the barricades breaking as suggested by Mr. Laschinger, and no necessity for the tedious method of filling up the crevices with grass. One of the advantages not mentioned by the author is that it would induce cyanide men to work with as weak a solution as they possibly can, and battery managers to make use of lime, thereby reducing costs in one department and increasing efficiency in the other.

Dr. Moir states that ·002% KCN yielded the best results, and I fail to see why solutions of this strength should not be in general use, personally I have used ·001 on a practical scale and obtained 100% precipitation, and found the solution as rich in gold as others of much higher strength. Working with this strength, it was important to keep the extractor well filled with zinc, to use acetate of lead and occasionally add some KCN at the head of each box to prevent the formation of cyanide of zinc. There can be no necessity for the use of a strong solution, the coarse gold being caught in the battery and by the concentrator. As even the water wash carries off 0·25 dwt. Au it is obvious that the only necessity for increasing the strength of a solution is for precipitating purposes. As it is it appears necessary first to oxidise and then to produce an alkalinity, I would like to suggest that as sal ammoniac is in such general use as an oxidiser a few more experiments with this substance might not be amiss. From Dr. Moir's remarks, it is evidently of very little use to consult the text book, but a question of experimenting in every likely direction.

A final water wash after treatment with very weak solutions, should remove most of the cyanide, and it is possible then that with the use of lime in the battery very little more would be required. It resolves itself into a question of how best to deal with the total cyanide, the acid itself is harmless except in conjunction with cyanide, as far as the question of health is concerned, and the volume of water in use to carry the sands down the mine would probably neutralise any free acid which is formed, so that the water when returned by the mine pump would be ready for the reduction works and boilers.

The question of the large space taken up by dumps, especially from those mines centrally situated is one of an importance which cannot be under estimated, as before long it must involve the purchase of stands as depositing sites at high figures. It is to be hoped that before long it will be possible to deal with all cyanide sands without handling, by a first and final treatment in the collecting vat and a sluicing away of the residues through a pipe with a gate valve, direct to the mine. The thorough ventilation of the mine and dispersal of the CO_2 which must follow, will naturally enable all workers, whether white or coloured, to do the maximum of work in a given time, which is impossible when the air is vitiated.

Mr. White has stated that permanganate is the best and cheapest reagent to employ, but, of course, it must also be borne in mind in this connection that simplicity is always to be desired. Any complicated tests would involve delay and much trouble. One wholesome result, which is not to be despised, is that it should tend to encourage the retreatment of tailings all over the world. On some mines which are just on the border of the profit-making stage, the gold obtained in this way would help them materially towards the dividend paying stage. It has now been proved that the gold left in the residues is not (now fine grinding is resorted to) in a free state but combined with the pyrites: therefore a thorough concentration would eliminate practically all the gold-bearing material and would be the end point as far as the reduction works are concerned. If you take the average mine dump as assaying ·5 dwt. this would result in the case of a 100 stamp mill dealing with 12 tons per stamp in a recovery of practically 30 oz. per day, equal about £40,000 per annum, quite a round sum. To emphasise the speed with which a dump could be transferred, the Robinson Company put through 200 tons per hour, equal to the output of a 400 stamp mill. This sand filling, I am informed, has been in use in Australia for some years, but has not become quite a success owing to their failure to remove all the HCN. It is not necessary that sand-filling should be limited to the Rand, an up-country mine is quite as much justified in making use of the latest ideas involving increased profits and efficiency as the Rand mines. So often because a property is a small one and situated up country the owners think it is only advisable to work in a rough and ready way. If this is an advantage on the Rand, where so many mines are low grade, how much more important and profitable it would be where only high grade propositions are working and where all expenses (and in this comparison the difference is not only a trifling one) are correspondingly higher and heavier, including timbering, transport of timber, wages and cost of handling residues. This latter point is one which though already mentioned, should be emphasised. The increasing scarcity of mine timber renders it more expensive every year, therefore the outcrop companies (this would not apply to nearly the same extent to the deep levels) should find a considerable diminution in their expenses on this account alone.

We notice in town the roads are being watered with oil and asphalted, trees are planted to filter the air, and in fact no expense is spared to minimise the dust evil, but all this is a step in the wrong direction. The movement should have commenced at the mines, whence the poisonous dust originates. Laws are passed compelling factories to consume their own smoke: it is surely (on the score of health alone) just as important to pass an act compelling all mines to deal with their residue dumps for their own benefit and that of the whole of the South African public. The only way in which attempts to utilise the dumps have been made is in building; there are no other industrial uses to which they can be put. This may be compared to the proverbial emptying of the sea with a tea cup. I understand many dumps have been retreated in the past few years, but this meant simply removing the sands from one spot and placing them in another. The system now in use goes a step further and completes the process. For this reason I am sure Messrs. White, Pam, Moir and Gray earn the lasting thanks not only of the community but the public generally, in originating and improving upon a system which is likely to have such far-reaching results.

Mr. W. J. N. Dunnachie (*Associate*): In connection with Mr. Pam's most interesting paper on sand filling, there is a suggestion that the sand pack, owing to a want of cohesion, may be limited to the life of the timber enclosing it, and when that life is spent the sand may "run."

I throw out the suggestion that *self-supporting* waste packs be built; with a foundation cut in the footwall, if thought necessary. These waste packs should be built on the inside—that is the sand side—of the $1\frac{1}{2}$ in. deals and uprights which the author is at present putting in. If all the protection the Village Deep and Ferreira Deep levels have to keep the sand from coming through the boxholes, is a few "uprights well hitched" with some $1\frac{1}{2}$ in. deals nailed on, I feel certain those $1\frac{1}{2}$ in. deals are in for a tough time.

The President: I have just had an official letter from the Government Analyst of Western Australia in which he re-affirms the statement that the ·01% limit of cyanide refers to dry sands and not to any liquid contained in them, and that nothing except dry filling is done there, and that thorough ventilation of the place being filled is prescribed whenever any person is present there. I agree with Mr. Solly that a ·01% limit is dangerous under local conditions, and that the limit should be stricter.

NOTES ON PRECIPITATION.

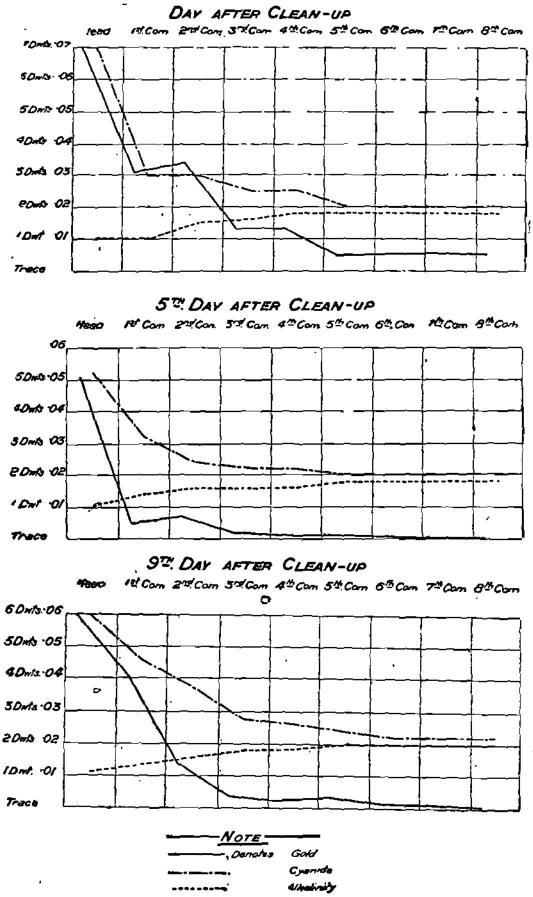
(Read at July Meeting, 1910.)

By F. D. Phillips (Member).

DISCUSSION.

Mr. H. Brazier *(Associate)*: The points raised in this paper in regard to the last two or three compartments of an extractor box were gone into very thoroughly on the Crown Mines some time back, with results very similar to those obtained on the Knights Deep; and it was during these investigations that a certain fact came to light which is of considerable interest and which seems hitherto to have escaped notice, or at any rate, publication.

The solution deposits its gold, loses free cyanide, and gains in alkalinity, and by representing these three occurrences graphically we find that all three reactions coincide. I append three diagrams taken from a series, all of which demonstrate the same fact, and it is from the information conveyed by the diagrams that I venture to query the result of the author's calculations in regard to expense. There being no further reaction after the precipitation, wherein does the extra expense enter beyond the labour of dressing? Also, allowing that there is no further decomposition it will surely be admitted that the zinc is likely to be of more use in the boxes than in the store, even if only in the light of a safety measure, or as a filter for trapping particles of slime that may and often do come along.



Note error in two lower diagrams: The "gold" line should run out parallel with "cyanide" and "alkalinity."

Regarding the effect of temperature on precipitation, the slime solution here is divided between two sets of boxes—1,000 tons a day is passed through one set of boxes direct from clarifier; another 1,000 passing *via* a waste heat installation and clarifier, and entering 10° F. higher—the precipitation in both cases being practically perfect, the "tails" invariably assaying "traces," capacity and rate of flow in both cases being identical.

Will the author enhance the value of his paper by giving actual temperature of solution at head of boxes? One is led to think that the comparative absence of white precipitate at Knights Deep is attributed to increased temperatures, whereas our experience is the reverse—the formation of white precipitate in the warm boxes being far more pronounced than in the cold, and where any appreciable quantity of this white precipitate is formed the author will, I fancy, agree that more zinc is required in the boxes than would be the case in clean solution such as at the Knights Deep.

GRADING ANALYSES AND THEIR APPLICATION.

(Read at May Meeting, 1910.)

By H. Stadler (Associate).

DISCUSSION.

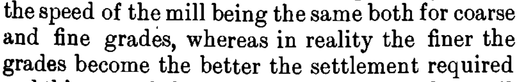
Mr. G. A. Robertson *(Member)*: It is well to read the author's paper in conjunction with his other contributions partially dealing with the same subject. Taking the efficiency of stamps as zero the author finds that "from a purely mechanical point of view tube mills are very poor machines at least in comparison with stamps.* To arrive at these conclusions the author evolves formulæ for the determination of the useful work done by crushing or grinding machines and arriving at the mechanical efficiency of such machines, "29, 30."* The chief consideration there is the reduction of the cube by volume and the energy (H.P.) required for this reduction, the same formulæ being applicable to all types of grinding machines irrespective of the size of the feed cubes or even where such cubes can be

* See *Journal S.A. Association of Engineers*, Dec., 1908.

reduced by a few grades only, such as for instance the work done by tube mills.

"Stamps though no ideal fine grinding machines are certainly better than their reputation."* Since the author penned these words he now finds from practical work that the "efficiency per H.P. of tube mills (17·42) is only about $\frac{1}{4}$ that of the stamps (70·40)." The "practical usefulness" of the tube mill, as the author said in reply to the discussion on his paper,† had never been brought into question nor does it appear that even now the good work done by tube mills has ever been questioned except from a "purely mechanical point of view." The writer does not know the tensile strength of a cube of pyrite in relation to a cube of quartz, but the author makes no distinction in arriving at the mechanical work done by stamps and tube mills. In arriving at the efficiency of the tube mill the author takes the load at 290 tons. I gather that this is the average load during the life of a Hornstone tube mill liner which can be reduced in volume though of course it is profitable to put through a much larger load from a metallurgical point of view; but when we go much over a 300 ton load, though we may not reduce any additional tonnage in volume we utilize the tube mill as a classifier, the tendency being for the coarser and specifically heavier particles to be reduced in preference to the more silicious portion of the ore.

The tube mill in itself is a classifier; the greater part of the coarser and specifically heavier particles of ore are reduced on the liner of the tube. By the rolling action of the cascade of pebbles on a grinding surface (the liner) these particles are reduced perhaps by a few grades only, and the smaller these particles become as they travel towards the discharge end of the tube so have they the tendency to go into circulation amongst the pebbles, depending of course upon their specific gravity, when they undergo but little further reduction. This is partially due to the speed of the mill being the same both for coarse and fine grades, whereas in reality the finer the grades become the better the settlement required and this can only be effected by decreasing the speed in feet per minute at which the liner is travelling. The accompanying sketch represents the wear of a common iron "rib" of the Osborne patent tube mill liner the measurements being $\frac{3}{4}$ in. at inlet and $1\frac{1}{4}$ in. at the discharge reckoning 2 feet from the extremities. This would appear to be about representative of ordinary wear and tear of tube mill liners of uniform dimensions



*See *Journal S.A.A.E.*, Dec,. 1908.
†See *Journal S.A.A.E.*, Jan., 1910, also this *Journal* July, p. 29.

and hardness. The wear there is almost entirely due to the abrasion of the coarse sand and its effect on the liners as the sand gets finer. It may be argued that this uneven wear is due to the rough edged and larger pebbles fed at the inlet end of the tube, but as the same wear was in evidence on Silex liners in the earliest days of tube milling on the Rand this argument gives no explanation, more especially when in those days round imported flint pebbles were only used. The discharge end of the tube has obviously less work to do than the inlet end, and at the same time we give it the same dimensions as regards the diameter and pebble load. It was found more economical in Australia to cut down the tube mills to 12 × 13 ft.? thereby increasing their efficiency per H.P. The Rand has arrived at a standard size of tube mill, 22 ft. × 5 ft. 6 in., a recent exception to the rule, however, being the tube mills of the Roodepoort United, whose dimensions are 16 ft. 5 in. × 5 ft. 9 in. As I have already indicated, the finer the sand becomes the greater its tendency to be stirred up and take part in the turmoil and motion of the pebbles, and I am of opinion that the Hardinge conical mill is much more efficient than the cylinder tube mill due to better settlement being allowed for the finer grains, less interstitial space and less pebble load where less work has to be done. Improved concentration within the tube mill would also be obtained, due to the fact that the pulp has to travel up an inclined channel from the time that it reaches the liner of the tube at its greatest internal diameter.

The tube mill is much more fool proof than its reputation, and when we consider that with a good iron liner exposing as large a grinding surface as possible, a 6 months run can be obtained without a single renewal of a wearing surface, it is obvious that this machine requires but little attention. The mechanical efficiency of the tube mill is evidently low, that is to say if no credit is to be given it for the hard work we get it to do. The author has no doubt some good reason for taking the whole as one, and by his method of calculation based on "Kick's Law" referring to impact "the amount of energy absorbed is proportional to the volume of the body to be crushed."

The idea of a well run ball mill is to have balls of many sizes, ranging from 6 in. dia. downwards thereby having a minimum of space between the balls. Assuming that 1 cub. ft. of ore is 168 lb. as against 451 lb. for iron, it is obvious that a good deal of crushing is done amongst the balls on account of their being so close. An examination within a tube mill will show that the largest of the pebbles are at the inlet end of the tube, and it is safe to say that there is even sufficient space between the pebbles to afford shelter for a number of snakes!

In the writer's opinion there are several alternatives which would tend to increase the efficiency per H.P. of the cylinder tube mill, most of which are already in use in other industries where grinding machines form an essential part of the equipment.

(1) Taper off the diameter after the first 14 ft. the liners running up to the perimeter of the discharge screen.
(2) Discard trunnions and set the tube mill on rollers, the bands and tyres being on the perimeter of the tube. Gear in the centre.
(3) Dry grinding a classified ore from the jaw crushers with peripheral discharge.
(4) Partition off a section of the tube mill and make it in conformity with the "Molitor Compound Mill" iron or steel balls in the first compartment reducing the coarse particles of ore which in ordinary practice takes many more tons of pebbles.

Under 1 and 4 the inventor's royalties would no doubt have to be paid. No. 2 has already been tried as far as regards the bands and tyres on the perimeter and set on roller bearings, but was not a success. Considerable improvements, however, have been made in roller bearings, etc., of late, and the writer has every reason to believe that with the gear in the centre less H.P. would be absorbed. Another advantage in the successful operation of that type of tube mill is that we have full command over inlet and discharge areas, whereas at present we are entirely limited to the internal diameters of both trunnions. No. 3 has already been tried in wet grinding but without success, partly due to the fact that the peripheral discharge allowed an immediate release of the specificially heavier particles which reached the discharge end of the tube. Without water dry concentration will take place inasmuch that the silicious portion will find its way to the discharge before the pyrite. To get full advantage of dry concentration here the design of the liner requires to be taken into account.

By a combination of Nos. 1 and 4 the writer is of opinion that good work could be done. A good portion of our scrap iron or steel might also be thus turned to profitable account.

The question of hydraulic classification and regrinding in stamp batteries has been advocated from time to time in this journal and other sources, and the idea has even been tried upon the Rand but without success. A recent note, however, which appeared in the *South African Mining Journal* of August 13th evidently bordering upon this question, stated that "the New Kleinfontein mill is being prepared for crushing operations, in which the work of the tube mill, now considered an essential almost of the metallurgical scheme of the Rand, will be done much more efficiently, conveniently and cheaply by stamps alone." If that is so we must change our minds in accordance with the times, and it is to be hoped that the author will be in a position to give us the details of the experimental data there conducted, which I understand was on behalf of the Mines' Trials Committee.

The meeting then closed.

INSTRUCTIONS FOR HANDLING EXPLOSIVES.

Drawn up by a Sub-Committee of the Council of the Society, and approved by the Transvaal Chamber of Mines for Exhibition on all Mining Properties.

The following instructions must be strictly observed, as any deviation from them may cause a serious accident:—

Detonators.—Detonators must always be kept dry; moisture or dampness, even when invisible, reduces their effectiveness, and may even cause misfires. Before inserting the fuse, the sawdust must be thoroughly shaken out of the detonator tube. This can be done by gently tapping the open end of the detonator upon a piece of wood. On no account must any instrument, whether of metal or wood, be inserted into the detonator tube to clean out the sawdust. Should it be found that the sawdust, owing to dampness, cannot be thoroughly shaken out, the detonator must be placed aside as unfit for use.

Preparing a Charge.—Safety fuse of the required length must be cut square with a sharp knife, and then inserted into the detonator tube until it reaches the fulminate. The top end of the detonator tube must then be squeezed round the fuse with special fuse pliers. Care must be taken not to squeeze the lower end of the detonator tube containing the fulminate, otherwise an explosion is likely to occur. The wrapper at one end of a cartridge must next be opened and a small hole made in the explosive by a piece of wood or the copper end of the fuse nippers. Into this hole the detonator (with fuse attached) must be inserted to two-thirds of its length, and the cartridge paper must then be firmly tied with string. On no account must the detonator be buried in the explosive (unless it be an electric detonator).

Safety fuse must always be handled with the greatest care. The powder core of even the best fuse can easily be damaged by twisting or kinking the fuse, and this in turn may lead to misfires.

Charging the Hole.—Cartridges must be inserted one at a time into the hole, and each one squeezed gently but firmly home. The primer (viz, the cartridge with a detonator and fuse attached) must always be placed on the top of the charge, care being taken to use as little pressure as possible while inserting it. In wet workings the junction of the fuse and detonator must be made water-tight, either by means of Chatterton's Compound, insulating tape, or tough grease.

The tamping bar must be of wood, but the end may be sheathed with either copper or brass. Under no circumstances must either iron or steel bars or scrapers be used.

Tamping.—The material used for tamping should be preferably of a clayey nature, and should be made up in the form of cartridges of a slightly smaller diameter than the hole. In order to avoid any interference with the detonator, the first tamping cartridge must be put into the hole with the greatest care. The remaining tamping cartridges may then be firmly but carefully tamped. When tamping, care must be taken to avoid withdrawing the primer, etc., from the charge.

Lighting the Fuse.—The fuse must be prepared for lighting by splitting the end about an inch down with a sharp knife. As soon as an efficient fuse lighter is available the cheesa stick made of blasting gelatine should be prohibited, as poisonous gases are formed by this burning explosive.

Misfires.—In the event of a misfire, only sufficient tamping must be withdrawn by means of a wooden swab stick to enable the misfired shot to be fired. The procedure to be followed must be strictly in accordance with Section 9 of the Mining Regulations.

Plugging of Sockets.—After a blast, all the rock thrown down, and also all the remaining holes or sockets, must be carefully examined for unexploded cartridges or detonators.

General.—All nitro-glycerine explosives are, when the temperature is below 45° F., liable to congeal or become hard from the effect of cold. On no account must they be used when in this condition, and not until they have been carefully softened or thawed in a warming pan specially constructed for the purpose.

All open lights must be removed to a safe distance before any case containing explosives is opened, and also during the preparation of the charges. No light of any kind must ever be placed on the cover of a box containing explosives, and smoking must be strictly prohibited in the immediate vicinity. No iron or steel tools must ever be used for the opening of explosive cases, or for charging holes with explosives. Nitro-glycerine explosives must never be exposed to the direct rays of the sun,

Obituary.

Mr. J. S. Fisher.

It is with much regret that the death is recorded of Mr. J. S. Fisher (Member), who died after an illness of over three months, on the 26th July. The deceased was born in the Isle of Man 42 years ago, and was educated at Victoria College, Douglas, and then served an apprenticeship in mechanical engineering at Barrow. Coming to the Transvaal in 1892, he commenced work on the mines in a subordinate position, and towards the end of the war (during which he served with Bethune's Mounted Infantry; medal and three clasps) he was appointed manager of the New Rietfontein Mine. In 1902 he joined the Mines Department as a Deputy Inspector of Mines, and in July, 1904, was promoted to the post of Inspector of Mines for the Johannesburg District, and had recently been transferred to the charge of the Germiston District. Mr. Fisher married in 1904, and leaves a widow and two children to whom the Society extends its condolence in their bereavement. Mr. Fisher was elected a member of the Society in September, 1902, and although not taking any active part in its discussions, on the several occasions in which his advice and assistance was sought by the Society's officials he was always most considerate, courteous and ready to help in every possible way.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Photochemistry of Sulphuric Acid.—"The authors have studied the formation of sulphur trioxide from sulphur dioxide and oxygen under the influence of the radiation from a quartz mercury lamp. Experiments made with a quartz reaction vessel mounted within a mercury lamp showed that the formation of sulphur trioxide proceeds fairly rapidly even at the ordinary temperature and more rapidly at higher temperatures. The equilibrium is quite distinct from that attained in daylight. With the mixture, $2SO_2 : O_2$, equilibrium is attained with a production of 65% of sulphur trioxide, and this equilibrium can also be attained starting from sulphur trioxide. At 160° C., with the gases confined in the reaction chamber, equilibrium was attained in one hour. In daylight at temperatures below 450° C. the equilibrium condition corresponds to practically 100% of sulphur trioxide. Again the light-equilibrium (attained on exposure to the radiation from the mercury lamp) is not displaced by rise of temperature up to 800° C., whereas the temperature- or dark-equilibrium (in daylight) is displaced considerably by rise of temperature above 450° C. With a mixture in the proportions, $SO_2 : O_2 = 1 : 13$, for example, at 800° C., the yield of sulphur trioxide is 80% on exposure to the rays from the mercury lamp, whereas in daylight, the yield is 44% of sulphur trioxide. The temperature-coefficient of the velocity of the photochemical reaction was found to be 1·2. The authors consider that a technical photochemical process for the production of sulphuric acid is quite feasible, since on using air in place of oxygen, no oxides of nitrogen are formed. Some experiments were made with a special mercury lamp composed essentially of a quartz tube, 115 cm. long and 1·8 cm. diam. This was enclosed in a tube of opaque, English quartz, 100 cm. long and 5 cm. diam., the annular space between the two serving as reaction-chamber. At 450° C. and with the gaseous mixture passing at the rate of 100-150 c.c. per minute, yields of 67·4, 70 8, 92, and 90% respectively of sulphur trioxide were obtained, with 0·78. 0.66, 8 7 and 9·3 mols. of oxygen per mol. of sulphur dioxide."—A. COEHN and H. BECKER. *Z. physik Chem.*, 1910, 70, 88-115. *Journal Society of Chemical Industry*, Mar. 15, 1910, pp. 269-270. (A. W.)

CARBON TETRACHLORIDE VAPOUR; ACTION ON MINERALS.—"The vapour of carbon tetrachloride acts on mineral metallic oxides, transforming them into chlorides, as readily as on artificial products, provided they are sufficiently finely divided. Silica is not attacked, anhydrous silicates are attacked in inverse proportion to their silica content, while hydrated silicates are totally transformed. The separation of the volatile chlorides, and the removal of the insoluble silica from the residue, makes this process of considerable value in mineral analysis, and in the detection of oxide in non-oxide minerals (*e.g.* molybdenite)"—P. CAMBOULIVES. — *Comptes rend.*, 1910, 150, 221-223. *Journal Society of Chemical Industry*, Mar. 15, 1910, p. 275. (A. W.)

AUSTRIAN STATE SALE OF RADIUM.—"The sale of radium has been entrusted to the 'Bergwerksproduktenverschliess-Direktion' in Vienna, under the control of the Austrian Minister for Public Works. The radium is sold in the form of radium-barium chloride of three different grades, the price for each milligram of radium chloride, including the containing cell, being 400 Kronen (£16 13s. 4d.). It is packed in cylindrical cells of 21 mm. diam. and 9 mm. long, formed of nickel-plated brass. On the bottom of the cell a layer of lead is cast, in which is a square depression for the reception of the radium-barium chloride. The cell is closed by a mica plate held in position by the screwed-on upper part of the casing. On the bottom of the casing is an official stamp (an eagle) and the series number Radium cells sealed with lead, and stamped on the soldered part, are also supplied. The cells are packed in cotton-wool and sheet-lead in a small box, together with a certificate bearing the number of the cell, and the weight and radium-content of the preparation. The boxes are sealed with strips bearing the numbers of the cells, and are dispatched by post as registered packets at the cost and risk of the purchaser."—*Z. Allgem. Oesterr. Apoth.-Ver.*, 1910, 48, 71. *Journal Society of Chemical Industry*, xxix., 5, Mar. 15, 1910, p. 276. (J.A.W.)

CARBON SUBNITRIDE.—"By removing two molecules of water from the diamide of acetylene dicarboxylic acid, $CONH_2 \cdot C : C \cdot CONH_2$ a subnitride of carbon (dicyanacetylene or carbon cyanide, N : C·C : C C : N) is obtained as a crystalline body, of m. pt. 21° and b. pt. 76° C., and having an odour resembling that of cyanogen. It is readily combustible and takes fire spontaneously at 130° C., burning with a purple flame. Its molecular refraction and dispersion are abnormally high, probably on account of the three triple linkages. The high vapour pressure and the phenomenon of spontaneous combustion render analysis and vapour density determinations difficult, but both have been made to agree with the formula, C_4N_2."—C. MOUREU and J. C. BONGRAND.—*Comptes rend.*, 1910, 150, 225-227. *Journal Society of Chemical Industry*, xxix. 5, Mar. 15, 1910, p. 276. (J. A. W.)

NEW VOLUMETRIC METHODS OF DETERMINING ZINC AND LEAD.—"The author has investigated the application of potassium cyanide in the volumetric determination of lead and zinc. The estimation of zinc is similar to that of silver by Liebig's method, and depends on the formation of the soluble double cyanide, $K_2Zn(CN)_4$, which is decomposed immediately by excess of zinc ions, producing insoluble zinc cyanide: $K_2Zn(CN)_4 + Zn^{\cdot\cdot} = 2Zn(CN)_2 + 2K$: The end point is rendered much more definite by the presence of a small quantity of any ammonium salt (except the acetate). 10 or 20 c.c. of *N*/2 potassium cyanide are titrated with a 0·2—0·8% solution of the zinc salt (free from acid) till a permanent cloudiness remains after shaking. 1 c.c. of *N*/2 potassium cyanide=0·008171 grm. of zinc. Lead cyanide is not soluble in excess of alkali cyanide, but it is readily soluble in acids. On adding excess of potassium cyanide to a lead solution, and filtering, the excess of potassium cyanide can be titrated with hydrochloric acid and methyl orange. 20 or 25 c.c. of *N*/2 alkali cyanide are treated with a known volume of lead salt solution (free from acid) in a 100 c.c. flask. After making up to the mark, allowing to stand for ten minutes, and filtering, the cyanide is titrated in 50 or 75 c.c. of the filtrate by means of *N*/4 or *N*/2 acid. The cyanide solutions are standardised by pure salts of lead or zinc, though the purest samples may be standardised simply by hydrochloric acid with methyl orange."—E. RUPP.—*Chem. Zeit.*, 1910, 34, 121. *Journal Society of Chemical Industry*, xxix. 5, March 15, 1910, p. 300. (J. A. W.)

POTASSIUM CYANIDE AS AN INSECTICIDE.—"An aqueous solution of potassium cyanide acts as a powerful insecticide when injected into the soil, by reacting on the calcium bicarbonate present and slowly liberating hydrogen cyanide. It possesses certain advantages over carbon disulphide, as it is slower and more thorough in its action, insects are not aware of its presence from its odour and therefore do not escape, and it has no effect on growing plants, even in strong doses, nor does it stop fermentative changes in the soil as carbon disulphide does."—T. MAMELLE.—*Comptes Rendus*, 1910, 150, 50. *Journal Franklin Institute*, April, 1910. (J. A. W.)

PROCEEDINGS OF THE INTERNATIONAL COMMISSION ON ATOMIC WEIGHTS.—"*Chlorine.*—By passing nitrosylchloride, NOCl, over silver to remove chlorine, then over heated copper to remove oxygen and finally over metallic calcium to absorb nitrogen, a full analysis of this compound was made. From the ratio or oxygen to chlorine it resulted that the At. wt. of chlorine is 35·468, and *nitrogen* is 14·006.

Carbon.—Baumé and Perrot have found from the density of methane that carbon = 12·004. From the density of toluol vapour, as determined by Ramsay and Steele, Leduc finds carbon = 12·003.

Iodine and Silver.—Baxter and Tilley have determined the ratio between iodine pentoxide and silver, They conclude that silver lies between 107·847 and 107·850. The corresponding value for iodine is 126·891.

Phosphorus.—From the density of phosphoretted hydrogen, PH_3, Ter Gazarian finds the value of phosphorus = 30·906.

Arsenic.—Baxter and Coffin compared the ratios of silver arsenate with silver chloride and silver bromide respectively, by two methods. For the value 107·880 for silver, the final mean of arsenic was 74·957.

Chromium.—Baxter, Müller and Hinnes found by the analysis of silver chromate a mean value for chromium of 52·008, when silver is 108·88 Similar analyses of silver dichromate gave Baxter and Jesse for chromium the value 52·018. This gives chromium a mean value of 52·01.

Tellurium.—Lenher led the double potassium tellurium bromide over potassium chloride, and then heated it in a current of chlorine and lastly in hydrochloric acid. The mean value from 16 experiments gave Te = 127·55.

Mercury.—Easlay found the unusually high values of 200·48 and 200·62 for mercury; but as he is still continuing his investigation, it is not desirable to accept his figures until his work is completed.

Palladium.—Gutbier, Haas and Gebhardt analysed pallados-ammonium bromide and found as the most probable mean value Pd = 106·689.

Krypton and Xenon.—Moore isolated both gases in considerable quantities from the residues of liquid air. From the densities of the two gases he found Kr = 83·012 and Xe = 130·70."—F. W. Clarke, and others.—*Zeit. für ang. Chem.*, xxiii., 1, 21. *Journal of the Franklin Institute*, May, 1910, p. 417. (J. A. W.)

Silicon Carbide, Artificial Gems.—"The theoretical reaction on which the manufacture of carborundum is usually based is $SiO_2 + 3C = SiC + 2CO$, and the following proportions by weight (affording a slight excess of carbon over that theoretically required) are used in practice: 35·1 per cent. ground coke, 54·4 sand, 7 sawdust, 3·5 common salt. The silicon carbide thus produced occurs in the form of opaque crystals of various colours, the black predominating. Mr. Frank J. Tone, superintendent of the Carborundum Company, has discovered another reaction $3\,Si + 2CO = 2SiC + SiO_2$. This is a gaseous reaction, gaseous silicon combining with carbon monoxide at a temperature below the temperature of dissociation of silicon carbide. The silicon carbide thus produced builds up in large crystals, which start upon crystals, initially formed by the direct union of silica and carbon of the charge, and by prolonging the operation of the furnace these crystals can be made to attain a large size. For this purpose the charge mixture should be constituted so as to afford spaces for the mingling and combining of the gases. This space is afforded by using sawdust in the charge mixture, preferably in a larger percentage than heretofore employed. Mr. Tone uses a carborundum furnace with a core of carbon, preferably in the form of carbon granules, free from contamination of metallic oxides (for instance, a carbon core taken from previous runs of a furnace). This he surrounds with a mixture of pure silica, petroleum coke (or purified ground coke), and sawdust. These are mixed in a proportion so that the silica will be somewhat in excess of the amount theoretically required by the formula

$$SiO_2 + 3C = SiC + 2CO.$$

These proportions by weight are attained by the following mixture: ground carbon, 30 per cent.; silica, 57 per cent.; sawdust, 9 per cent.; common salt, 4 per cent. The furnace is then started and the operation is carried on for such a length of time that the zone of carborundum crystals adjacent to the core is decomposed to a considerable thickness, preferably to an extent of 2 in. or 3 in. The decomposition of these crystals results in the liberation of silicon vapor, which combines with the carbon monoxide gases in the furnace and builds up large crystals of carborundum just outside the zone of graphite which is formed by the decomposition. The crystals thus produced are clear and transparent, being free from coloration, and can be made of a large size. It is important that the carbon of the charge should not be in excess, since otherwise the crystals produced are apt to be black. These crystals have a very high index of refraction (exceeding that of crown glass and the diamond) and possess double refraction and are stated to be of great value as gems, since they can be cut with regular facets and polished. By adding to the furnace charge a small amount (not more than 0·5 per cent.) of a coloring matter, like oxide of chromium or oxide of manganese, the crystals can be tinted without destroying their transparency." (949,386, Feb. 15, 1910; assigned to Carborundum Company.)—*Metallurgical and Chemical Engineering*, March, 1910. (J. A. W.)

Calcium Silicide for Steel Refining.—"The production of calcium silicide, which is now finding more and more extended use in steel works, is the object of a patent of Mr. Georges Strauss (assigned to Société Anonyme La Compagnie Générale d'Electro-Chimie de Bozel, of Paris, France). By heating a mixture, in definite proportions, of lime, silica and carbon in an electric furnace, calcium silicide is obtained according to the equation

$$CaO + 2SiO_2 + 5C = CaSi_2 + 5CO.$$

But the direct formation of silicates is a troublesome element in this process. To avoid this, Strauss uses calcium carbide (instead of lime) and metallic silicon (instead of silica) as starting materials. He gives the following equations for the reactions:

$$CaC_2 + 2SiO_2 + 2C = CaSi_2 + 4CO.$$
$$2Si + CaO + C = CaSi_2 + CO.$$

Experiments made with calcium silicide have shown that this metallic silicide is capable of replacing with advantage the aluminium usually employed in steel works for the purpose of preventing the formation of blow holes in steel ingots. The advantages ensuing from such application are, in addition to the economy secured by the very low price of calcium silicide, very great rapidity of reaction and the suppression of the undesirable 'shortness' which aluminium communicates to ingots of steel." (948,190, Feb. 1, 1910.) *Metallurgical and Chemical Engineering*, Vol. viii., No. 3, March, 1910, p. 150. (J. A. W.)

Preparation of Hydrocyanic Acid. — "By passing a mixture of air and steam over coal heated, in a generator, to a red heat one obtains a gas consisting of nitrogen, hydrogen, carbon-dioxide and carbon monoxide. If one uses for 1 Kg of coal 3 cbm air and 0·6 kg steam one obtains a gas most suitable for this process. This gas consists of about 51·8% N, 15·3% H, 27·6% CO, 3·9% CO_2 and 1·4% CH_4. This mixture is then passed through a pipe into an electric oven filled with coke. By passing the electric current between two carbon electrodes the coke is heated to such a temperature that the C, N and H combine to form hydro-cyanic acid. The yield at a temperature of about 3500°C is 35%. The gases are then quickly drawn off, cooled and passed into a suitable absorption apparatus, in which the HCN is retained, while the free gases are returned up the generator." — O. DIEFFENBACH and W. MOLDENHAUER.—*Chemiker Zeitung*, No. 55, 1910. (T. D.)

THE USE OF PHOSPORUS SOLUTIONS IN GAS ANALYSIS.—"The absorption of oxygen with phosphorus has certain drawbacks. In pure oxygen the phosphorus does not oxidise; the presence of traces of hydrocarbons, the vapours of organic substances and certain inorganic gases also hinder the oxidation. However, if a solution of phosporus is used the absorption is complete and easy to regulate. A 1%-1½% solution of phosphorus in purified castor-oil was used and prepared in the following way: 3 grs. well dried phosphorus were brought into a 250 cc. flask containing 230 cc. castor oil and heated to a temperature of 200°C in an oil bath. The hot flask was then removed, tightly stoppered, dried outside and thoroughly shaken until complete solution took place. The analysis of dilute oxygen is carried out in the ordinary way with a Hempel pipette. If the oxygen is pure or mixed with hydrocarbons the absorption takes place by heating the solution with an electric current. Points to be noticed :—

1. The wire for heating must not come in contact with the gas.
2. To prevent electrolysis an excess of water in the pipette must be avoided.
3. The phosphorus must not be oxidised to ignition point as, in this event, the oil burns and forms CO_2; this objection can be overcome by not heating too strongly and by using a not too concentrated solution. A solution of 0·8 grs. in 100 grs. castor oil will be found useful."—

M. CENTNERSZWER. — *Chemiker Zeitung*, No. 56, 1910. (T. D.)

SOLUBILITY OF GOLD IN NITRIC ACID.—"The author has conclusively proved that nitric acid used for the separation of gold dissolves some of the gold. He carried out very carefully an experiment in which he treated 20 grams of fine gold for 2 hours in hot nitric acid of 1·42 specific gravity. After filtration the solution contained 660 milligrams gold per litre." — FRED. P. DEWEY (transactions of American Chemical Society, Boston 27-3112, 1909.)—*Zeitschrift fur Angewante Chemie*, May 27, 1910. (T. D.)

METALLURGY.

STEEL INDUSTRY IN THE TRANSVAAL.—"The establishment of an iron and steel industry in the Transvaal would be welcomed by mining engineers because it would tend to reduce the cost of mining, not only by a possible diminution in the price of the steel used underground, but by improvement in quality. At present the quantity of drill-steel annually imported into the Transvaal is from 5,000 to 5,500 tons, which is sold at a price varying from £30 to £35 per ton. This is shipped principally from England, but considerable competition from American, German, Swedish, and Belgian manufacturers is felt. As a result, prices are lowered and inferior qualities of steel are put on the market.

The best steel for drilling was formerly made in the crucible, but gradually this has been replaced by Swedish bessemer, English bessemer, and even open-hearth steel. Swedish bessemer is steel made in the converter from Swedish raw materials, which are remarkable for their low sulphur and phosphorus contents. A similar material is made in England from equally pure materials, but owing to the enhanced value of any steel to which the mystic word 'Swedish' is attached, this epithet is retained in the case of many steels that are not derived in any sense from the Scandinavian peninsula. The use of Swedish raw material in making high-class steel is generally supposed to give certain definite good qualities and 'body.' What 'body' is has not been accurately determined, and the cause is equally obscure. The Sheffield steel-maker of the old school attaches the utmost importance to this mysterious property, which he attributes to his Swedish ingredients, but it is probable that he under-estimates the value of his long experience in the melting and subsequent treatment, often the result of several generations of careful observation, and that it is to this, and this alone, that the property of 'body' is due, provided suitable raw material be used.

Steel, equal to the best Sheffield bars, could be made in the Transvaal by the electric furnace. This produces an intense heat, permitting of the most basic slags; as a result, common scrap, such as is found in large quantities in South Africa, can be melted and refined to a steel of crucible quality. The establishment of this industry would not only provide a steady market for scrap-iron and steel, but would also enable the mining and railway companies to obtain first-class steel castings at short notice. The success of this industry appears to depend on the use of an electric furnace, as this is the only means by which common scrap can be economically refined to produce high-class steel. In the case of any other process about 30% of pig-iron must be imported or made, otherwise complete refining cannot be effected. In Europe and America there are several electric furnaces in use. It is interesting to note that a company controlling the process most generally adopted by American and English firms has already sent engineers to South Africa with a view to the establishment of this industry, while the Transvaal Government has sent representatives to visit the principal works in Europe, where electric steel-making is established.

The mining companies will profit in two ways: by obtaining better steel and by having a ready market for their scrap steel, the price of which during recent years has only been from 5s. to 7s. 6d. per ton, while the quantity exported during the last two or three years has amounted to 40,000 tons.

The possibility of starting blast-furnaces for the manufacture of pig-iron is being investigated carefully, and also the question of export. It will be impossible to export pig-iron to Europe under present conditions of labour and supplies. The export trade would have to compete with such producers as the Dominion Iron & Steel Co. or the North of England blast-furnaces, where excellent ore and coal are available on the sea-coast, together with efficient labour. The deposits of iron ore in the Transvaal are undeveloped, and though the outcrops are large, tho composition of the ore in depth is unknown, coal of suitable coking qualities is not widely distributed, while the labour and transport conditions alone present serious difficulties for the successful establishment of this industry.

There remains then only the possibility of pig-iron manufacture for local use. Rail-mills cannot be worked economically on small outputs. The market for foundry-iron is comparatively small and largely fed by scrap cast-iron, which sells at about 80s. per ton. The only considerable items on the import list of iron and steel are large quantities of corrugated sheet-steel. The possibility of erecting a small

Swedish blast-furnace to supply a small mill to make sheets and rails is under consideration. These might be made economicaly, if a thorough investigation proves all the conditions favourable, but at present the only industry that can be deemed profitable is the refining of scrap-iron and steel in the electric furnace.

South Africa is essentially a market for high-grade steel. Of the iron and steel imports, which have a value of about a million sterling, there are 5,500 tons of mining bars and an equal tonnage of shoes and dies, of a value of over £250,000. Small railway-castings, axles, and crusher-jaws could all be made profitably, provided a suitable quantity of iron and steel scrap be available at a reasonable price. This industry should prove beneficial to the mining community, the power-supply companies, and the promoters; incidentally improving the quality of steel used on the Rand and preventing the wasteful export of scrap, which is part of the undeveloped wealth of the country and should not be allowed to go elsewhere.

Extreme care must be exercised in the choice of the locality in which the first blast-furnace is erected. Coking coal exists in the Middelburg district and also iron ore, both titaniferous and good hematite. It remains to consider the effect of the proposed improvements intended to make Delagoa Bay the principal port of South Africa and the possible influx of Indian labour into the adjacent Portuguese territory. Africa is in a stage of transition. United South Africa has internal and international questions of the utmost importance before her, and not the least important is the future of Delagoa Bay and the surrounding territory. Steel-works designed to make a small tonnage of high-class material require an expenditure of less than £100,000, and Johannesburg alone provides a market, but blast-furnaces and rail-mills involve some hundreds of thousands of pounds, as well as questions of wide and international importance. After the smaller industry is firmly established, it will be quite soon enough to consider possible expansion.

The subject is of the greatest practical importance to the industrial stability of the Transvaal. Iron is the bread of commerce and steel is the staff of industry."—DONALD F. CAMPBELL.– *Mining Magazine*, Jan., 1910, p. 55. (H. A. W.)

GOLD REFINING.—"In German patent 207,555, Sept. 22, 1908, of the *Norddeutsche Affinerie A. G.*, a modification of the original Wohlwill process of gold refining is given, which appears to broaden greatly its scope and applicability. If gold, rich in silver, is refined in a solution of $AuCl_3$, containing HCl or other chlorides, a layer of AgCl forms on the anodes which must be removed from time to time. In practice this has been found necessary, whenever the silver content in the anode is more that 6%. If the layer of AgCl is not removed from the anode, chlorine is set free and this will take place at an earlier stage of the process, the higher the current density used and the higher the silver content of the anode. To overcome this a pulsating current instead of a constant direct current is used, which is best obtained by connecting a direct current dynamo in series with an alternating current dynamo. With raw gold containing 10% silver an anodic current density of not more than 750 amps. per sq. meter must be used in the original process, but with an alternating current about 1·1 times as strong as the direct current, 1,250 amps. per sq. meter can be used without any necessity for scraping off the silver chloride. Another advantage is that in the original process gold passed into the slime to the extent of about 10% and had to be recovered by chemical means, whereas with the pulsating current only a little gold passes in at the beginning of the process and afterwards none at all. The slime, therefore, consists essentially of AgCl and its spongy structure causes it to drop off by itself."—*Metallurgical and Chemical Engineering*, Vol. viii., No. 2, p. 82, Feb., 1910. (J. A. W.)

METALLURGICAL TRIALS.—"From Johannesburg we learn that systematic milling tests of great interest are being made by Mr. F. L. Bosqui, in behalf of H. Eckstein & Co. Twenty stamps, a tube mill, the requisite classifiers, and amalgamation plates have been set aside at the Jumpers Deep mill for this purpose. A small zinc-dust precipitation press, with a capacity of 60 tons of solution per day, is on its way to supplement this trial plant. It is hoped within six months to ascertain (1) the economic limit to fine grinding in tube mills, (2) how much of the minus 150 sand now treated by percolation can be treated advantageously—while in mixture with the slime—by agitation, followed by vacuum filtration, (3) whether Brown agitators and vacuum filtration are preferable to decantation, (4) how the work of comminuting the ore should be apportioned between stamps and tube mills; and (5) whether zinc-dust is better than zinc-shaving as a precipitant. We may add that a 500-ton Butters plant is being installed at the Crown Reef, and should be ready in June. Thus several points affecting the development of local metallurgical practice will be decided at an early date."—*The Mining Magazine*, Feb., 1910, p. 87. (W. R. D.)

MEASUREMENT OF PULP AND TAILING, III.—"*Tonnage Crushed in Mills.*—This is often estimated merely by count of cars dumped per week or month, and gives at best only a rough approximation to the truth. If a fair proportion of the cars are weighed daily, if moisture samples are taken when the material is not quite uniform in this respect, and if a correction is made periodically for differences in the volume of ore in the storage-bins, the results are reliable within about 2%. A slightly higher degree of accuracy is claimed for the continuous-weighing devices, which are operated by the pressure of a belt-conveyor, and the accuracy of which can be checked by occasionally comparing the record obtained with a cartload of ore weighed by reliable scales. When using these devices the corrections for moisture and fluctuations in mill-storage must not be neglected. When 'mill time' is used in reckoning tonnage, the time lost in repairs, etc., must be carefully recorded, and the results are reliable only when based on past experience of the average duty performed with a particular ore.

If the density of the dry material is nearly constant, and frequent measurements are desirable, it is advisable to draw up a table covering the readings usually observed: at the head of the vertical columns is given either the gravity or the number of pounds of pulp per cubic foot, the seconds per cubic foot at the left of the horizontal rows; the tons of solid per day are entered at the corresponding intersections, as in Tables B, C, and D.

Even if the gravity methods were less accurate as regards a single observation, they would give more accurate results in many cases than the first method described, provided two or three were taken at intervals during the day and averaged; the time occupied in drying usually precludes repeated deter-

TABLE A.—Tons of Solid Slime in Agitator.
Marysville, Montana.
Density of Dry Slime=2·60.

Average level of pulp is read with respect to datum mark on staves, specific gravity of pulp is determined by weighing 1,000 c.c.; total tons dry slime in agitator read directly from table, interpolating.

Upper datum-mark=420 fluid tons. Lower datum-mark=310 fluid tons.
One inch=3 fluid tons.

Specific Gravity of Pulp.	Water Ratio.	Solid Factor for 100 tons.	TONNAGE OF DRY SLIME. When capacity of Vat to same level in fluid-tons 420	410	400	390	380	370	360	350	340	330	320	310	300
1·268	1·9	43·8	184	179	175	171	166	162	157	153	149	144	140	136	131
1·257	2·0	42.0	176	172	168	163	159	155	151	147	143	138	134	130	126
1·247	2·1	40·3	169	165	161	157	153	149	145	141	137	133	129	125	120
1·238	2·2	38·7	163	139	155	151	147	143	139	136	131	127	123	120	116
1·229	2·3	37·3	157	154	150	146	142	138	134	130	127	123	119	115	112
1·220	2·4	36·0	151	147	144	140	137	133	129	126	122	119	115	112	108
1·213	2·5	34·7	145	142	139	135	132	128	125	121	118	114	111	107	104
1·206	2·6	33·5	140	137	134	130	127	124	130	117	114	110	107	103	100
1·200	2·7	32·4	136	132	129	126	123	119	116	113	110	106	103	100	97
1·193	2·8	31·4	132	128	125	122	119	116	113	110	106	103	100	97	94
1·187	2·9	30·5	128	125	122	119	116	112	109	106	103	100	97		
1·181	3·0	29·6	124	121	118	115	112	109	106	103	100	97			

TABLE B.—Tonnage table for Five Stamps.
Density of Ore=3·0.

Pulp is run into cylinder holding 15 U.S. gallons (2 cub. ft.) and weighed on platform scale: time for 2 cub. ft. is taken with stop-watch. Value in last column divided by seconds=tons per stamp per day.

Net weight of 2 cub. ft. pulp lb. avp.	Specific Gravity of Pulp.	Water Ratio.	Tons per Stamp per 24 hours, if 2 cub. ft. caught in one second.
131·50	1·052	12·40	84·3
0·675	1·053	12 22	86·0
0·75	1·054	12·00	87·5
0·875	1·055	11·79	89·1
132·00	1·056	11·57	90·8
0·125	1·057	11·36	92·4
0·25	1·058	11·155	94·1
0·375	1·059	10·96	95·7
132·50	1·060	10·775	97·2
0 675	1·061	10·59	98·8
0·75	1·062	10·42	100·4
0·875	1·063	10·25	102·0

TABLE VII.—Sluicing Data.
Based on Wet Slime-cake or Residues containing 33·33% water (M=·50 C=66·66).

	Density of Dry Solid.	Specific Gravity of Final Pulp=p=Hydrometer Reading.*** 1·01	1·03	1·05	1·07	1·10	11·15	1·20	1·25	1·30	1·35	1·40	1·45	1·50
Values of Q=tons water added per ton of dry solid in wet cake or residue sluiced=R−M	2·4	57·4	18·5	10·75	7·41	4·92	2·98	2·0	1·417	1·026	0·750	0·542	0·380	0·250
	2·6	60·7	19·6	11·4	7·90	5·27	3·22	2·19	1·575	1·166	0·873	0·654	0·483	·346
	2·8	63·5	20·6	12·0	8·33	5·57	3·42	2·36	1·715	1·286	0·98	0·75	0·571	·429
	3·0	65·8	21·4	12·5	8·68	5·83	3·61	2·50	1 833	1·389	1·072	0·833	0·648	·500
Tons water added per ton of wet material sluiced $T=\frac{Q\ C}{100}$	2·4	38 3	12·3	7·17	4·94	3·28	1·99	1·33	0·945	0·684	0·500	0·361	0·253	·167
	2·6	40·5	13·0	7·60	5·27	3·51	2·15	1·46	1·05	0 778	0·582	0·435	0 322	·231
	2 8	42·3	13·7	8·0	5·55	3·71	2·28	1·57	1·14	0·858	0·658	0·50	0·381	·286
	3·0	43·9	14·3	8·33	5·79	3·89	2·41	1·67	1 22	0·926	0·715	0 555	0·432	·333
Tons water added per cubic foot of wet material sluiced**	2·4	1·96	·630	·351	·252	·168	·102	·068	·0485	·0350	·0256	·0185	·0130	·0086
	2·6	2·146	·689	·403	·279	·186	·114	·077	·0557	·0412	·0304	·0231	·0171	·0122
	2·8	2·315	·750	·438	·305	·203	·125	·086	·0624	·0469	·0357	·0273	·0208	·0156
	3·0	2·470	·805	·470	·325	·219	·136	·094	·0686	·0522	·0402	·0312	·0243	·0167
Efficiency of sluicing=E=tons dry solid moved per 100 tons of added water R−M100	2·4	1·74	5·40	9·3	13·5	20·3	33·6	50·0	70·5	98·3	133·	184·	263·	400·
	2·6	1·65	5·10	8·77	12·7	19·0	31·0	45·7	63·5	85·7	114·	153·	207·	289·
	2·8	1·575	4·78	8·33	11·6	18·0	29·2	42·4	58·3	77·7	102·	133·	175·	233·
	3·0	1·52	4·67	8·0	10·7	17·1	27·7	40·	54·5	72·0	93·	120·	154·	200·

** Assuming material compacted so that interstices are full of water.

*** p=pounds per cubic foot × 0·016.

TABLE VIII.

Specific Gravity and Weight per cubic foot of Wet Cake or Residue. Moisture ranging from 25 to 40%. Data for constructing tables similar to Table V. for material differing in moisture content.

Material compact so that interstices are full of water.

Moisture in Cake or Residue Sluiced %	Value of **C** % Solid.	Value of **M** Water Ratio.	Density of Dry Solid **d**	Specific Gravity of Wet Material.	Weight of Wet Cake per cubic foot lbs.	Weight of Dry Solid per cub. ft. of Wet Cake lbs.
40·0	60·0	0·6667	2·4	1·538	96·15	57·69
			2·6	1·585	99·08	59·45
			2·8	1·628	101·74	61·05
			3·0	1·667	404·17	62·50
35·0	65·0	0·5384	2·4	1·610	100·67	65·43
			2·6	1·667	104·17	67·71
			2·8	1·718	107·36	70·08
			3·0	1·765	110·39	71·70
33·33	66·67	0·50	2·4	1·636	102·27	68·18
			2·6	1·696	106·0	70·66
			2·8	1·750	109·38	72·92
			3·0	1·80	112·50	75·0
30·0	70·0	0·4286	2·4	1·690	105·63	73·94
			2·6	1·756	109·69	76.83
			2·8	1·820	113·75	79·62
			3·0	1·875	117·19	82·03
25·0	75·0	0·3333	2·4	1·778	111·11	83·33
			2·6	1·857	116·06	87·05
			2·8	1·931	120·7	90·53
			3·0	2·00	125·0	93·75

minations by Method No. 1. It must be remembered that any flow-determination is usually instantaneous, or at least represents a period not exceeding a minute or two, which may be far from the average flow of the entire day when the various adjustments of a mill or concentrator are considered. Several rapid and fairly approximate determinations, at more or or less regular intervals during a day and averaged, are preferable to a single observation made with all possible precautions and carried out with scientific accuracy, if the sample taken in the latter case is subject to momentary variations.

Mill Tables.—In the daily control of mill-work, particularly that of an experimental character, it is desirable to make the labour of computation as light as possible, so that results for rate of crushing or the contents of a vat can be read off rapidly after making the required observations by weighing pulp, etc For this reason it is convenient to have a suitable table prepared to meet any special case, and an hour or two spent in making such a table will be saved many times over in subsequent work when systematic experimentation is carried on."—W. J. SHARWOOD. —*Mining Magazine*, Jan., 1910, p. 45. (H. A. W.)

SORTING: AN ECONOMIC PROBLEM ON THE RAND.—"Sorting on the Rand is an operation generally understood to mean the removal from the gold-bearing ore of all barren rock, usually called waste rock or, in short, 'waste.' Wager Bradford, in his excellent paper read before this Association, dealt with the question of sorting very exhaustively, but he put particular stress on sorting underground, not, as generally understood in late years, that is by erecting sorting plants underground, but as meaning careful mining, and, if the waste has unfortunately been mined, its elimination in the stope before any further expense is incurred in handling. As an example he gives the result of milling waste rock at the Rose Deep mine, where the average value was 1·62 dwts. as against ·609 dwts., the returned value of waste rock for nine months previously.

It appears to me that in those days (1903) with high working costs all round, and with the limit of payability somewhere in the neighbourhood of 8 dwts., they did not sufficiently discriminate between barren rock and low grade ore. This is, to my mind, the fundamental error made by Wager Bradford. Obviously, waste is rock containing no gold whatsoever, while rock going 1·5 dwts. is gold-bearing ore and must be regarded as such, and its unpayability is only a matter of degree and not of fact What was unpayable in 1903 is highly payable to-day when mines make good profits on ore going 4 dwts. and under. Assuming waste rock assaying 1·5 dwts., and also that by closer sorting half of the waste discarded could be retained, and would probably give a screen sample of 2·5 dwts., say 10s. per ton. All this waste is brought to the surface, and if it is not sent to the mill it probably costs 3d. per ton to send to the waste dump. If it were milled, the cost of sorting per ton would not exceed 1s. 6d.: the cost of milling and cyaniding can now be brought down to 3s., so that with an extraction of 90%, 9s. can be obtained for an expenditure of 4s. 6d., or a very handsome profit.

With waste rock assaying originally only 1 dwt., and more intensive sorting as recommended, the saving would be 1s. 6d. after allowing 1s. 6d. for sorting and 3s. for milling and cyaniding, the value after sorting being 1·5 dwts.

The question of sorting therefore resolves itself into:—

(1) Is it practically possible to sort out barren rock only; and

(2) If so, can it be done at a profit.

In order to decide the first point it must be known whether, given efficient labour and mechanical appliances, it is possible to distinguish barren rock from gold-bearing ore. I am not competent to decide this, and shall leave it to mining engineers, metallurgists and geologists.

Once the first point is satisfactorily decided, the second point becomes merely a mathematical investigation, which, taking into account all known factors, determines the most profitable life of the mine with the working costs and capital expenditure on the basis of the altered conditions, as was so ably done by Ross E. Browne and R. N. Kotzé before this Association.

It can be fairly said that sorting can be divided under two main headings covering operations entirely distinct, and each requiring special considerations, as follows:—

1. Sorting as part of the mining operations, comprising (a) careful sampling of the rock *in situ* with a view of only breaking gold-bearing ore; and (b) eliminating waste rock in the stopes before any expenditure is incurred in handling same.
2. Sorting, as generally understood, which comprises the picking out of the waste after the total ore has been prepared by preliminary breaking and washing to facilitate the work and to render the labour employed efficient.

The work comprised under (1) raises many questions, and as it is outside the province of the writer, he will leave it in the able hands of the mining engineers for exhaustive treatment. However, the question of sorting, as expressed under (2), is a purely mechanical one, and with your permission the writer proposes to make a few remarks dealing with some features of this work. Sorting operations may be conducted underground and on the surface. Many references to underground sorting have been made, but they generally referred to the work which the writer regards as part of the mining operations; and it remained for W. Calder to seriously propose abandoning all sorting and preliminary breaking on the surface in order to do the work underground, presumably at a saving in working costs if not in capital outlay. Calder says that the chief objection hitherto has been the cost of power. This is new to the writer, as the power requirements are generally very small if compared with those of the whole reduction plant; and they certainly do not exceed 5% of the total, leaving out the power used for hoisting rock and for compressing air. If the cost of power in the reduction plant is approximately 1·0s. per ton milled, the cost of the power required in the sorting and breaking plant would be ·05s. per ton milled. To seriously claim that work underground can be more efficiently done than in the light of day the writer cannot understand, and I have no doubt the packs in stopes resulting from sorting underground will in time become very valuable gold mines on their own account. The disadvantages attaching to sorting underground are obvious and need re-iterating only to be appreciated. They are:—

(1) Increased capital cost;
(2) Higher operating costs.

The necessity of keeping an even grade requires work to be done on many levels, and to do sorting underground under these conditions would require a sorting plant at each level, say from 6 to 10 and more. The cost of these sorting plants, taking into account the greatly increased size of the excavations and the fact that numerous small sorting belts and breakers would be required in lieu of the one large belt and breaker on the surface, would be from 60% to 100%, more than for a plant at the surface. Any-one interested can easily make the necessary estimate. Operating charges will be higher than on the surface for several reasons.

The writer claims that there is no case for sorting underground, as none of the reasons advanced will bear a close examination, and sorting on the surface, having established its claim, it is now only a question of how to do the work economically. Before dealing with this point in detail it is as well to point out that although sorting and breaking are two distinct operations, they overlap to a certain extent, and for that reason are generally considered as one. The arrangements made for doing the sorting and breaking on the surface vary considerably on the different mines on the Rand; and while on one mine a very elaborate plant can be found, the adjoining one has only the veriest fragment of a sorting and breaking plant, showing conclusively that there is no general agreement in respect of the plant required. Before the waste can be picked from the ore, the whole must pass through a certain preliminary preparation such as screening, coarse breaking, and washing. To permit of efficient work on the part of the operators, it is necessary to so prepare the ore that a mistake cannot possibly be made; that is to say the waste should be clearly seen and small pieces of ore adhering to large pieces of waste should be detected. The work of picking out waste rock may be done on a sorting table or on a sorting belt, the old-fashioned sorting floor being practically defunct and quite useless with the large quantities of ore now handled.

A complete sorting station contains therefore as a rule:—

(a) Screening plant.
(b) Coarse breaking plant.
(c) Washing plant.
(d) Sorting plant proper, and
(e) Fine breaking plant.

The sorting and breaking plant may be erected close to the reduction plant, providing a central plant for dealing with all the ore handled and the advantage of this arrangement is that the work of sorting and breaking is performed under the most favourable conditions as regards—

(a) Supervision;
(b) Concentration of work;
(c) Capital outlay;

The drawbacks are:—

(a) Unnecessary hauling of waste rock on the surface;
(b) Re-elevating of all the ore at the central sorting plant;
(c) Risk of a complete stoppage of work due to fire or other serious breakdown.

As against the central sorting and breaking station there can be a separate station at each shaft head, as is the case on many mines. The advantages are:

(a) No unnecessary hauling of waste rock;
(b) The necessary elevating of the ore is done in the headgear;
(c) Damage by fire or a serious breakdown in one of the stations will disable only a portion of the plant.

The disadvantages are that the supervision is more difficult; the capital outlay is greater; and the benefits that could be derived from concentration of the work cannot be obtained.

Dealing now with the various appliances used, there is first of all the question of screening. Screening is done in one or two stages, and in the former case the appliance generally used is the grizzley, while with double screening the operation may be performed on two grizzleys, or by a combination of grizzley and screening trommel. The first, and in many plants the only, screening is performed in the head frame by a grizzley in front of the shaftways, and set at an angle of 38 degrees from the horizontal. The spacing of the grizzley bars is arranged to give a clear opening of 1¾ in. The grizzley is too well-known to require describing, and it may be sufficient to state that there are two ways of holding the bars, the old method holding the bars by means of tie rods and distance pieces, and a method of holding each bar independently. The latter method has the advantage that each bar can be taken out and replaced when worn, with a minimum of labour; while in the former case the whole set has to be lifted by block and tackle, requiring much time and labour. The length of the grizzley depends on the minimum area required to obtain efficient screening under given conditions, but headgear grizzleys should not be less than 14 ft. Stationary grizzleys are cheap to maintain, and for that reason the use of shaking grizzleys has not become general.

Screening trommels for single stage screening can be only used if the supply of the ore is more or less continuous and not intermittent, as in the case of the ore supply coming direct from the shaftways.

The coarse breaker is not found in all plants, but it serves to relieve the fine breaker of some of its work, and also assists in sorting as after coarse breaking a piece of ore previously adhering to a large piece of waste rock is frequently broken off, thus permitting of discarding the waste rock or at least the greater part of same. Unfortunately, the coarse breaker also produces a large percentage of 'fine,' and as this consists of both waste rock and ore, which is not afterwards subjected to sorting, the usefulness of the coarse breaker is greatly reduced, and may be entirely negatived. It is obvious that in order to obtain the full benefit from a coarse breaker all the material passing through should be subjected to a close examination, with the intention of removing all waste rock. The washing of the ore may be done on the sorting belt or table, or by a separate appliance, for which a trommel is generally used. Washing on the sorting belt, although not so effective as in a trommel, is nevertheless fairly efficient, and for that reason the washing trommel is not always used. The portion of the sorting belt on which the washing is done should have a steep grade, say, up to 18°, so as to permit of the water and slime flowing back. The amount of water required varies with the condition of the ore, but should not exceed from 20 to 40 gallons per ton of ore passing over the sorting appliances. The water and slime is generally collected in two settling vats, the first of which can be comparatively small, as the sand will settle freely, but the second or slime vat should have a large area to permit of settling all slime prior to returning the water for re-use.

The actual picking out of the waste rock is done on a sorting belt or a sorting table. The sorting table usually consists of a rim of from 20 to 30 ft. diameter, and from 30 in. to 42 in. wide, on which the ore is spread out, so that the sorting hands can see and remove the waste. The velocity of the rim should not exceed 30 ft. per minute. The ore left on the table is scraped off by a plough, rigidly held against lateral movement, but suspended in guides and well balanced so that it can follow the movements of the table. The sorting belt is an enlarged conveyor belt, travelling a speed not exceeding 30 ft. per minute, and should be arranged horizontally or, if required, at angle not exceeding 10° from the horizontal. The sorting belt has the advantage over the sorting table that it serves not only for sorting, but that it can also be made to elevate the ore, a point of great use in many plants. It has also been found that the maintenance on the sorting belt is considerably less that on the sorting table. I do not propose to give details of either table or belt, as they are too well known to require description. The sorting capacity of either table or belt depends upon the space available for sorting hands, and it may be taken that each man requires 3 ft. of length of belt or rim of table, and that he can pick from 2 to 3 tons of waste per shift of 10 hours.

The carrying capacity of sorting table and belt can be taken approximately as in the table hereunder, the assumed speed of belt or table being 30 ft. per minute :—

Width of sorting surfaces.	Carrying capacity of Sorting tables. Tons per hour.	Carrying capacity of Sorting belts. Tons per hour.
30 in.	60	54
36 in.	72	66
42 in.	84	78
48 in.	96	90

Either appliance can carry considerably more, but only at the expense of efficient sorting. There is no limit to the diameter of sorting tables except constructional reasons; whilst the length of the sorting belt is determined by the tensile strength of the material of the belt. However, since all the waste on either table or belt of a given width can be picked off in a certain distance, it is useless to make the table larger or the belt longer. The waste rock obtained from the sorting appliance can be disposed of in various ways, conveyor belts, trucks, and other means being in use on the Rand.

The fine breaker is usually of the gyratory type, and it is too well known to require a description. One point worth mentioning is that breakers of any type require a very substantial foundation, and if they cannot be arranged on a concrete foundation near the ground level, a very heavy structure, which should be of steel, will be needed.

There can be no doubt that the question of sorting has, in spite of all the papers written on the subject, not yet received the attention it deserves. I am unfortunately unable to go more fully into this matter at the present time, but I would like to throw out the suggestion that the Mines Trial Committee consider the advisability of making tests for the purpose of bringing the solution somewhat nearer than it is to-day. Meanwhile I would like to point to the following facts :—

According to Ross E. Browne, the cost of sorting per ton of rock sorted out was 1·435 shillings for the average mine of the Rand Mines Group, say in 1903, and it can safely be assumed that to-day, with greater efficiency all round, the cost per ton sorted out would not exceed 1s. The cheapest cost of milling and cyaniding a ton of rock, ore, or waste, is about 3s.; therefore, every ton of waste rock not sent to the mill results in a saving of 2s. It is common knowledge that a good deal of waste is milled every day, and it is also commonly believed that the waste rock dumps contain a good deal of ore, or in other words, the sorting as at present carried out is inefficient. But how can this be altered? I would suggest as an experiment—

(a) That the design of the sorting and breaking plant be so altered that all rock, waste and ore, is open to close scrutiny.

(b) That only people with good eyesight and a fair amount of sense be employed in the sorting plant, instead of the usual collection of piccannins, cripples, and other nondescripts.

(c) That a close and constant supervision by qualified men be exercised.

(d) That the management of the sorting plant be under an official not concerned with the tonnage mined, and who should be paid a bonus depending on the difference between the value of the screen sample and the value of the waste dump.

In order to meet these conditions a sorting and breaking plant as sketched might be useful. In this plant all screening as at present in vogue will be discarded, and instead the ore from the shaft will fall directly into the coarse ore bin (A), from which it will pass to washing trommels (B), provided with holes not larger than $1\frac{1}{2}$ in. Only the very finest material will fall through, and the balance will be fed to two sorting belts (C) of the required width and length, and moving at a speed not exceeding 20 ft. per minute. The sorting hands will be placed, as at present, on both sides of the sorting belts, and they will pick out, those on the inside, waste rock and clean ore, the former to be dropped through the floor to waste rock conveyors (G), and the ore to be placed on the conveyor (D). The picking hands on the outside of the sorting belts will pick out waste, and such waste to which small pieces of ore adhere, the former to be dropped on the waste rock conveyors (G), and the latter on the conveyors for waste and ore (E). The clean ore is conveyed direct to the fine breakers (K); the waste rock to the waste bin (M), and the mixed ore to the coarse breakers (F). After passing the coarse breaker the ore is again passed through washing trommels (B), and from there passes again to sorting belts (H) (called second stage belts) where further waste can be removed, to be carried by the waste rock belts (I) to the waste bin.

The underlying idea is that by at once removing the ore and waste that can be readily detected, the chances of efficient sorting are greatly increased, and should be inversely proportional to the reduced quantity of material on the sorting belts.

The sorting belts have to be so long and must run at so low a speed that all the material reaching the end can safely be classed as ore to be passed through the fine breakers. It is assumed that only by giving the sorting hands ample time to see the ore, and ready means for sorting same into three classes, can the work be done in an efficient and satisfactory manner. Naturally many variations in the arrangement of the plant are possible, depending on the method of working proposed. It is claimed that in a plant as described, or one equally efficient, it will be possible to remove practically all the waste without risking any loss of ore due to faulty arrangements. It should be possible to keep the value of the waste rock at or near ·1 dwt. per ton.

The cost of this type of plant would not be much greater than one of the old type, as the breaking plant remains the same, and only the sorting plant is amplified. The power demand also should not increase by more than 30 per cent., but since the power requirements of the sorting and breaking plant are only about 5 per cent. of those of the reduction plant, this point does not carry much weight.

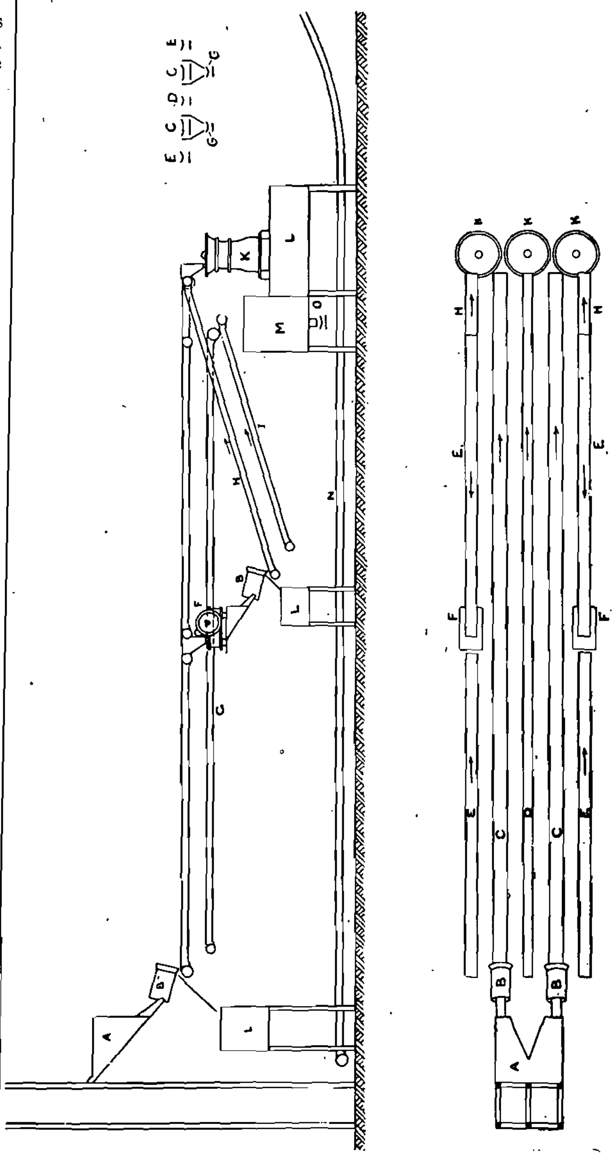
The new design of plant would naturally lend itself most readily for central sorting stations, as there the conditions would be the most favourable for efficient work. I have calculated that with a plant of this type and the principle of close sorting strictly carried out, the profits from a given mine can under certain conditions be considerably increased, while the capital outlay can at the same time be reduced. The following tabulated statement embodies these calculations :— (See 1st table, p. 95).

To the difference in favour of more intensive sorting must be added the saving in capital outlay equivalent to £68,000.

It will be interesting to see how a better extraction from higher grade ore milled affects the result, and to that end the following calculations have been made. It is assumed that a further expenditure of 5 per cent. on the reduction plant will raise the extraction by 2 per cent., whilst an additional outlay of 10 per cent. would raise the extraction by 3 per cent. or 94 per cent. and 95 per cent., which seems to be the economic limit for ore milled at a value of 23·106s. We have therefore :— (See 2nd table, p. 95).

An extraction of 94 per cent. for the 30·55 ore will give practically the same residue as 92 per cent. extraction for 23·106s. ore.

Provided, therefore, that it is possible to sort so as to have a waste dump at an average value of ·1 dwts., the very useful saving of £2,480 will result when obtaining 94 per cent. extraction. If it should be thought that the value of the waste dump cannot be kept at ·1 dwt. per ton, the profit of £2,480 can then be used for increasing the value of the dump. A calculation shows that the value of the waste



PROPOSED IMPROVED SORTING AND BREAKING PLANT.

A. Coarse-Ore Bin.
B. Washing and Screening Trommels.
C. First Sorting Belts.
D. Ore Conveyor.
E. Conveyors for Waste and Ore.
F. Coarse Breakers.
G. Waste Rock Conveyors.
H. Second Stage Sorting Belts.
I. Second Stage Waste Rock Conveyors.
K. Fine Breakers.
L. Fine Bins.
M. Waste Rock Bin.
N. Ore Conveyor to Mill.
O. Waste Conveyor to Dump.

Comparative Statement of Capital Outlay, Working Costs, and Profits of Closer Sorting and Ordinary Sorting.

Method of Working.	Ordinary Sorting.	Closer Sorting.
1 Tons hoisted per day ...	4,000 tons	4,000 tons
2 Percentage sorted out ...	15 per cent.	35 per cent.
3 Tons sorted out ...	600 tons	1,400 tons
4 Tons milled per day ...	3,400 tons	2,600 tons
5 Capital cost of sorting and breaking Plant ...	£36,000	£48,000
6 Capital charges at 12 per cent. per annum ...	£4,320	£5,760
7 Capital charges per day ...	£12	£16
8 Capital charges per ton milled ...	·070s.	·123s.
9 Capital charges per ton sorted out ...	·40s.	·228s.
10 Capital cost of reduction plant ...	£340,000	£260,000
11 Capital charges at 12 per cent. per annum ...	£40,800	£31,200
12 Capital charges per day ...	£113 6s. 8d.	£86 13s. 4d.
13 Capital charges per ton milled ...	·667s.	·667s.
14 Capital charges per ton sorted out ...	3·77s.	1·238s.
15 Cost of sorting per ton milled ...	·264s.*	1·908s.
16 Cost of sorting per ton sorted out ...	1·767s.*	3·534s.†
17 Cost of breaking per ton milled ...	·279s.*	·279s.
18 Total cost of sorting and breaking per ton milled (8+13+15+17) ...	1·278s.	2·977s.
19 Cost of milling and cyaniding per ton milled (assumed) ...	3·500s.	3·500s.
20 Total reduction costs per ton milled ...	4·778s.	6·477s.
21 Value of ore mined per ton (assumed) ...	20s.	20s.
22 Value of waste sorted out per ton ...	·6 dwts. = 2·4s.	·1 dwts. = ·4s.
23 Value of ore milled per ton ...	23·106s.	30·55s.
24 Value of gold recovered (92 per cent. extraction) ...	21·275s.	28·106s.
25 Cost of mining and hoisting per ton milled ...	8·000s.	10·461s.
26 Total working costs per ton milled ...	12·778s.	16·938s.
27 Net profit per ton milled (24—26) ...	8·497s.	11·168s.
28 Net profit per month ...	£43,334	£43,550
29 Difference in favour of close sorting ...	£216	—

*According to Ross E. Browne.
†Based on doubling the cost given by R. E. Browne.

Method of Working.	Ordinary Sorting.	Closer Sorting.
Percentage of Extraction.	94%	95%
10 Capital cost of reduction plant ...	£273,000	£286,000
11 Capital charges per ton milled ...	·700s.	·735s.
18 Total cost of sorting and breaking per ton milled ...	3·010s.	3·045s.
24 Value of gold recovered ...	28·717s.	29·023s.
26 Total working costs per ton crushed...	16·971s.	17·006s.
27 Net profit per ton milled ...	11·746s.	12·017s.
28 Net profit per month ...	£45,814	£46,866
29 Difference in favour of closer sorting...	£2,480	£3,532

discarded (when sorting at the rate of 35 per cent.) can be raised to approximately ·365 dwt. before the saving is wiped out, still leaving a saving on capital account of £55,000.

There is another point to be considered, and that is the greater expenditure of the mine with closer sorting, amounting to nearly £1,000 per month, practically all of which will be used to pay for extra labour, and assuming that all the profits go to shareholders abroad, this extra expenditure increases the purchasing power of the local population.

I trust that I have made out a case for further investigation, although I have no doubt that many points can be raised against the arguments advanced, particularly from the mining point of view. The difference of 2·461s. per ton milled (line 25) in mining costs points to the fact that the ore should be so mined that the percentage of waste sorted out is reduced, while at the same time keeping the value of the waste dump at a low figure. I do not presume to have solved the problem, and I merely intended to provide an opportunity for discussing the most important question of sorting before this Association."—C. O. Schmidt, *Journal of S. A. Association of Engineers*, Feb., 1910, p. 151. (H. A. W.)

Improvement in Copper Alloys.—"The manner of introducing certain other constituents into brass for the purpose of increasing its tensile strength and ductility is the basis of a patent granted to S. C. Peck and W. R. Hodgkinson, of London. Small proportions of chromium, manganese, nickel, cobalt or zinc may improve the quality of the alloy. The preferred manner of introducing these elements is by the addition of the phosphate of the metal with a reducing agent such as carbon, to a small quantity of copper or one of its alloys. This gives a metallic solution of the phosphide of the metal to be added, and this metallic solution may then be used to alloy molten brass in the desired proportions. In the second operation some of the zinc in the brass is volatilized as zinc phosphide, leaving the brass alloyed with the metal added. An actual test was as follows: 2600 grms. of brass (Cu. 70%, Zn. 30%) were melted in a crucible with 200 grms. of a mixture of equal parts of chromium phosphate and powdered charcoal. The temperature was about 1000°C. The addition of charcoal and chromium phosphate was repeated twice at intervals of an hour. After four hours heating the cast was made and this metal containing chromium phosphide was used to improve the qualities of brass as follows: 1516 grms. copper and 655 grms. zinc were melted together and to the melt was added 82·5 grms. of the chromium phosphide brass. The resulting metal tested 19 tons per sq. in. tensile strength, and showed an elongation of 72% on two inches. The same brass without the chromium phosphide added showed tensile strength of 14·4 tons per sq. in. and elongation of 38·5% on two inches. (943,159, Dec. 14, 1909.)"—*Metallurgical and Chemical Engineering*, viii, 4, 209, April, 1910, p. 209. (J. A. W.)

A NEW PROCESS IN IRON METALLURGY.—"One of the most important additions to the list of structural materials, and the most interesting appearance in iron metallurgy, of recent years, is a remarkable product of the open-hearth steel furnace, placed on the market a short time ago by the American Rolling Mill Company, of Middletown, Ohio, under the name of 'American Ingot Iron.' While it is produced by the basic open-hearth process, in chemical composition and mechanical properties the ingot iron is closely similar to wrought iron. It differs from steel in having its carbon, manganese and silicon contents reduced to small fractions of the amounts found in ordinary soft steel. In a typical sample, the carbon and sulphur are each reduced to 0.02%, manganese to 0·01% oxygen to 0·03%, and phosphorus and silicon to slight traces. In appearance, strength (tests indicate an ultimate tensile strength of 47,000 to 49,000 lb. per sq. in.), and ductility the new metal is practically identical with wrought iron.

The prime quality of the ingot iron, however, is its resistance to corrosion.

The earliest product of the mills was an ordinary soft steel, running 0·20% carbon and 0·40% manganese. Attention was first directed to the reduction of the carbon, and after some time of working this impurity was brought down to 0·10%, giving a dead-soft metal, sheets rolled from which attained a special reputation. A demand for corrugated-steel culverts, which arose in 1904, was an incentive to still further reduction of impurities. The ferromanganese addition for clearing and recarburizing was cut down to what was thought a minimum consistent with producing workable metal, and steel running as low as 0·08 to 0·10% carbon, 0·10 to 0·20% manganese, and 0 03% phosphorus was thus obtained. So far the reduction of the manganese had been undertaken only as part of the general scheme for lowering the impurities, but the publication of Dr. Cushman's research results, which showed manganese to be the most important element in the promotion of corrosion, led to experiments on the reduction of manganese which resulted in a decision to omit entirely the ferromanganese treatment. A long period of struggle with defective metal ensued, but eventually the difficulties, chief of which were the cracking of the edges of the sheets in rolling and poor galvanising quality due to blistering, were completely overcome.

The process by which the ingot iron is made is essentially very simple. 'The same basic-lined furnace is used as in regular open-hearth practice, and practically the same charge is made, but the boiling is continued to an excessive degree, so as to oxidize the impurities more thoroughly than in ordinary steel practice. Naturally the process in its final stages goes on at a much higher temperature, on account of the higher melting point of the purer material. The usual ferromanganese recarburizer is omitted, and instead an addition of ferro-silicon or an equivalent substance is made to purify the bath of its entrained oxides. Finally, aluminium is added in the ladle, to carry out the gases dissolved in the fluid metal.'

The furnaces now in use work entirely on cold pig iron, low in silicon and sulphur, of a grade slightly above the limiting phosphorus content for Bessemer working. A fairly large proportion of scrap is charged, some of it open-hearth scrap from the mill itself, but the larger part low-carbon steel turnings. Ore is not conveniently obtained, and whenever a sufficient quantity is available mill scale is substituted for ore in the charge. To produce a slag, limestone and fluorspar are used. A comparatively large amount of the latter flux is necessary to prevent the return of the phosphorus to the metal at the high temperature maintained towards the end of the process (3,000 to 3,100° F.).

'The essentials of the melting process are the maintenance of an active basic slag, continuance of the boiling process until all foreign elements in the iron are reduced practically to zero, keeping up a sufficiently high heat for complete fusion and active boiling, and finally the treatment for removing oxygen and other gases by the addition of purifiers. In the removal of the impurities, ordinary oxidation and absorption by the basic slag plays the chief part, as usual. It is found advantageous, however, to add ore, or mill scale, for helping with the oxidation.'

'The removal of oxygen (presumably contained in the metal as oxides) is most important. When this part of the process is imperfect, the metal is red-short and cracks on rolling. In ordinary steel making, spiegeleisen or ferromanganese have the chief duty of burning out the oxygen, reducing it from the metal both through their carbon and their manganese. In the present ingot-iron process, it has been found, the removal of the oxygen can be accomplished by various substances. Pig iron in itself is a satisfactory means, but ferrosilicon is a more active agent.' The removal of other gases is accomplished by adding granular aluminium in the ladle, the quantity usually running well below 0·1% of the weight of the iron charged.

The average time from charging to tapping is 10 hours, an increase of several hours over steel furnace practice wholly traceable to the thorough elimination of impurities. The long duration of the melt necessarily increases the cost of the product materially over that of ordinary steel. Increased expenditure for fuel and, more important, increased plant and labour charges (the average output being admittedly brought down to two-thirds the usual figures) must appear in higher cost. The cost is increased also by the destructive effects of the high temperatures on furnace and ladle linings, brickwork, ingot moulds, etc., all of which require more frequent renewal than in steel practice.

With watchful, intelligent control the process is in no way erratic or variable, and highly pure metal, carrying total impurities (except oxygen) amounting to 0·05 to 0·08% can be regularly produced. The best evidence obtainable points to strength and and ductility identical with those of wrought iron. For a highly ductile metal with an ultimate strength of 47,000 to 50,000 lb. per sq. in., the yield point is unusually high, 39,000 to 42,000 lb. per sq. in. As to the relative resistance to corrosion of steel, wrought iron and ingot iron, sulphuric acid tests show ingot iron to have a resistance 40 to 60 times as great as that of steel and 20 to 40 times as great as wrought iron. The large ratios of resistance make it permissible to transfer the comparison to atmospheric rusting, after making a large reduction as a safety margin. It may be concluded that the ingot iron will resist atmospheric corrosion at least several times as well as mild steel, probably many times better, and markedly better than good grades of wrought iron.

Up to the present ingot iron has been produced only in the form of sheets. It has become popular in this form on account of its high degree of weldability and the case with which it lends itself to the galvanising and enamelling processes."—*Engineering News*, Jan. 6; *Engineering Magazine*, Feb., 1910, p. 766. (J. A. W.)

MINING.

ACCIDENTS IN MINE SHAFTS.—"*Winding Engines.*—Attention is first directed under this heading to the probable adoption, to an increasing extent in the future, of electricity as the motive power for winding purposes in the United Kingdom, allied with the Koepe and Whiting system, which allows of great reduction in the weight of the drum, and, because of its more balanced load, gives a more effective use of the power available for winding. The apparatus at the No. 11 Pit of the Bethune Collieries is quoted as typical of this combination. In this case the drum is 26 ft. in diameter, and a steel rope 2·24 in. in diameter makes a half turn only, lying in a birch 'trod' or groove-way, the friction of steel against birch affording sufficient grip to prevent slipping. No preference from the point of view of safety is given to vertical over horizontal winding engines or *vice versa*. Attention is, however, drawn to two recent accidents due to defective forging of crank or drum shafts, and a suggestion is made that the marine practice of boring a hole through the centre of the shaft would indicate beforehand the quality of the shaft. The question of more than one winding engine in one room is also dealt with, and such practice is deprecated. With regard to speed of winding, the general rule (26) on the subject is quoted, and it is pointed out that although the 'automatic contrivance' therein mentioned is generally interpreted to mean a detaching hook, and the majority of mines are now so provided, such a contrivance only comes into action after the overwind, and therefore it is doubtful whether such contrivance satisfies the requirements of the Act in this respect. There is, too, considerable divergence in the different codes of special rules in the fixing of the point in the shaft within which the slow speed is operative It is suggested that the fixing of the point should depend on the diameter of the drum and speed of wind, but that if detaching hooks and speed controllers were in universal use no provision of this kind would be necessary. No recommendation is made with regard to the number of men raised or lowered per wind or to the actual speed of winding.

Speed Controlling Devices.—Detailed descriptions and drawings of the three arrangements best known in Great Britain are given, namely:—The Whitmore, the Visor, and the Futer's gear. General approval of these gears is noted with a qualification in these terms: 'when properly set and regulated.' Two cases are quoted where accidents might have been entirely avoided had winding engines been fitted with satisfactory speed-controlling devices.

Brakes.—In the drafting of a new rule in place of general rule 30, it will be necessary to include electricity as one of the forms of motive power. It is also suggested that the term 'adequate brake power' is in need of closer definition. Brakes are classed under three heads—foot brakes, steam brakes, and special brakes. The Committee seem to have little faith in the former, and suggest that 'however efficient a foot brake may be, as such, its holding power is not very great.' No preference is given to, or distinction made between, band or post brakes. Approval is expressed in the modern practice of providing both foot and steam brakes, but the possible occurrence of an accident is mentioned where the steam brake is rendered ineffective, and the foot brake being of insufficient power to hold the drum. The Committee therefore recommend that 'drums of winding engines should be fitted with two brakes, either one of which will hold the cage, and of these one should be connected to a device for putting it into operation should the engineman, for any reason, fail to do so.'

Winding Ropes and their Attachment to the Cage.—Under this heading are comprised winding ropes, capels or socketings, detaching hooks, and suspension chains. At the outset the Committee express an opinion that nothing is to be desired as regards the standard of excellence of winding ropes in use in this country. A table is given showing grounds for this opinion in the comparative fewness of cases of accident due to breakage of ropes. During the ten years, 1898-1907, the accidents numbered 13 fatal, causing 32 deaths, and 5 non-fatal, causing injuries to 8 persons.

In discussing ropes the Committee deal first with the safety factor, pointing out that this varies from one-sixth to one-tenth of the breaking strain of the rope as determined by the manufacturer. This factor is not, however, a recognised fraction of the total winding medium existing between drum and cage, *i.e.*, rope, capel, detaching hook, and shackles.

The Committee, in view of the difficulty of maintaining a minimum factor of safety in cases of great depth, recommend that the better plan would be to specify the margin that should be allowed as between the breaking strain of the rope, chains, etc., and the load, instancing that in a deep shaft with 20 tons load and rope having a breaking strain of 200 tons, there is a margin of 180 tons, whereas in a shallow pit, with load of 1 ton and rope breaking at 20 tons, there is a margin of 19 tons only. In the former case the factor of safety is 10, and in the latter, 20.

The following recommendations are made as to ropes:—

(*a*) When kept in stock they should be carefully stored, and on no account placed on the ground, but coved and placed on a stand or shelf, and should be regularly inspected.

(*b*) When about to be used a rope should be placed on a turn-table, in order to avoid kinking, and carefully uncoiled from the outer end.

(*c*) A rope should not be worked round a drum or over a pully of insufficient diameter, and should be prevented from striking against any hard substances.

(*d*) It should daily receive a regular dressing of suitable grease, which should be thoroughly laid on, (*e*) Steadiness of movement at starting should be aimed at.

(*f*) A rope should not be changed from a large to a smaller drum and *vice versa*.

(*g*) Extreme variations of heat and cold should be avoided as far as possible.

Capels are considered under six heads as follows:—(1) Grooved link or eyepiece with clamp or splicing; (2) rope cone with socket and collars; (3) white metal capping; (4) Derbyshire's patent capping; (5) Becker's patent wedge capping; (6) Scott and Caddy's patent capping.

The use of rivets for holding the socket in the second type is condemned as tending greatly to weaken the rope. The tendency of wires to break at the point where they are bent back is also noted.

In the third type the necessity for thoroughly cleaning the wires and avoiding too high a temperature of the molten white metal is recognised, as well as the advantage derived by keeping the wires straight after untwisting.

Periodical recapping is strongly approved of; it ensures a continuously efficient capping, it allows of an internal examination of the rope, and it tends to lengthen the life of the rope by altering the positions of weak points at the contact of the rope with the pulley and drum. The practice, noticed at several collieries, where recapping is carried out every six months and a record kept and posted up in the winding engine house, is highly recommended, and it is suggested where such a rule is lacking that one on this matter might be incorporated in the special rules. The Committee deem the use of detaching hooks very desirable in all cases, and recommend the provision of jack catches in the headgear to hold the cage when disconnected from the rope.

As regards the attachment of the cage to the rope, the use of rigid rods instead of chains, as was the case at Fogg's Colliery Bolton, where an accident occurred on October 4, 1907, causing the loss of ten lives, is considered unsatisfactory, as their rigidity does not allow sufficient play. An instance of the introduction of a spring or buffer box between the detaching hooks and the cage is quoted, the use of which has been attended with considerable saving in the lives of the winding ropes.

Finally, under this head, the Committee recommend the use of a minimum of four chains for suspension of the cage from the shackle ring or plate in shafts where persons are raised or lowered, and suggest the introduction of a rule making compulsory the periodical annealing of these chains.

Cages.—The Committee having considered only that part of the subject relating to existing and completed shafts, draw attention to the fact that their remarks throughout the Report are not applicable to shafts in course of being sunk. The desirability of cages being used either for winding men or mineral, both from the point of view of safety and convenience, is expressed. Although their use for these purposes is now almost universal, there are still a few instances to the contrary. Little or no fault is to be found with the protection of the sides of the cages at all well-equipped collieries. There is still, however, room for considerable improvement in this respect at a number of mines where the sides of the cage (which is a mere skeleton carriage) afford practically no hindrance to the falling out of persons, materials or minerals, and no means exist to prevent contact with guides, buntons, etc., in the shaft.

On the question of cage gates to protect the otherwise open ends, the Committee find 'that the balance of probabilities appears to be in favour of the use of such types of gates which admit of persons being got out of the cage in case of emergency, rather than in the disuse of gates altogether.'

Some cages inspected were provided with slanting or conical tops, the suggestion being that this shape induced a less injurious effect on the ventilation and conduced to a steadier movement of the cage. Information supplied by Mr. C. E. Rhodes from actual experience admits of no other conclusion than that such effects are not obtained, while a slanting top has further disadvantages in that it is inconvenient for loading timber on the cage, and prevents the use of the spring attachment referred to above.

With regard to securing tubs in cages, it is suggested that an automatic arrangement which will act independently of manipulation, possesses advantages both in respect to safety and economy over catches or stops whose action is governed by hand.

The question of safety catches or clutches designed to come into action in the event of the rope breaking is discussed at considerable length. The conclusion of the Committee is summed up in these words: 'In our opinion it is much better to rely on good material in the ropes, chains, and other tackle, careful periodical examination and recapping, annealing, etc., during their working life, to fix a maximum period for the life of a rope, and to allow a liberal margin between the working load and the breaking strain of the winding tackle, than to employ safeguards, which, under the conditions obtaining in this country, can only be considered of doubtful value.' The conditions specified are the rope guides, in these days so largely used, and the great loads and high speeds of winding in modern shafts. The Committee commend to the consideration of the Institution of Mining Engineers a suggestion for putting these appliances to practical test in a colliery shaft in order to stimulate invention in this direction.

It is pointed out that smoothness of motion of the cages is conducive to safety, and that the best means to secure this, especially in deep shafts, is by the attachment of a balance rope beneath the two cages.

Guides.—Cage guides are divided into two classes—rigid and flexible guides. The former includes those constructed of wood, iron, or steel, and the latter those of iron or steel wire rope. At the outset preference is given to rope guides, except where owing to the narrowness of the shaft their use is precluded.

In the case of rigid guides, the importance of good joints is emphasised. Dangers to be guarded against in the use of flexible guides are of two kinds—(1) cages meeting owing to too much swaying of the guides; (2) breaking the rods. The former difficulty is surmounted by ensuring sufficient tension on the guide rods, and by the introduction of rubber or dummy guides between the cages; the latter difficulty, by care in examination of the guides as to wear and corrosion, and by avoiding the application of excessive strain. The daily examination of the guides gives warning of undue wear, and frequent measurement of the diameter of the rod by the calliper in as many places as possible is recommended. Corrosion can be noticed in the exposed portions of the guide, and can be avoided by efficient daily lubrication. The difficulty lies in the portions hidden from view, where it passes through the fast scaffold, at which point also it is subject to damage by fraying, owing to side movement. Descriptions and drawings are given of effective methods of obviating these difficulties, and whereby the portions of the guide usually hidden from view are brought into such positions that a proper examination may be made.

No generally agreed upon rule is available as to what weight should be attached to rope guides to produce the necessary tension or rigidity. Where weights are used, it is pointed out that in order to keep them as steady as possible they are frequently immersed in the sump, protected or unprotected from the action of the water, but if they are so immersed it is difficult, if not impossible, to carry out that part of General Rule 5 relating to the daily examination of the guides.

Signalling and Indicators.—The Committee summarise their conclusions in respect to signalling in shafts as follows :—(1) A universal code of signals is advantageous in so far as relates to sending the cages away either from the top or the bottom of the shaft, and in what may be called the 'simple' signalling, common to every colliery. (2) It is desirable that the banksman should receive signals at the top of the shaft direct, and not as in some cases, hear them as delivered in the engine-house. The best means of signalling is that in which the signals are communicated simultaneously to both engineman and banksman.

The need for uniformity in the so-called 'simple signalling' is emphasised by the fact that the codes of signals now in use in different parts of the country are subject to much variation, and dangers are likely to arise through confusion of the different codes, especially as both miners and other colliery workmen are somewhat of a migratory class. The circumstances of the shaft accident at Rawdon Colliery have drawn attention to the danger arising where a banksman has to depend on his hearing for signals delivered only in the engine-house. The signalling arrangements introduced at Barrow Colliery are quoted as remarkably efficient. Here the method is electrical, and signals from three landings are received by banksman and engineman simultaneously, the engineman only being able to give down signals.

A description of the Karlik Tachograph is given, and its use is commended to the notice of mining engineers. It is considered that any apparatus which would record with exactness the time occupied by a wind and the variation in the rapidity of the same, when drawing coal or men, would be of great value. The above-mentioned instrument fulfils these conditions admirably.

Loading and Unloading of Cages.—Under this head are included :—Keps, fallers, or pillars; winding men or minerals from mid-insets; barriers; persons riding against full tubs, or with gear; additional outlet for persons. The use of keps at the surface is strongly advocated as tending to conditions of greater safety. At intermediate levels, however, they are likely to be a source of danger, for, if by any chance they were left projecting into the shaft, a descending cage going to a lower level might cause a serious accident. At the bottom of the shaft their use should not be made compulsory, as frequently when single-decked cages are used the cage rests on a platform.

Mid-insets it is stated, are not often used for loading mineral into the cage, more frequently serving the purpose of hangings-on for men. Where the latter is the case, a staging to suit the number of cage decks, in order to avoid raising or lowering the cage, is suggested, and this staging should be as far as practicable of non-inflammable material. Where mineral or men are wound, it is recommended that the drop-sheet, where such a contrivance is necessary, to span the interval between the cage and the landing, should be arranged so that in the event of the cage being signalled away before the drop-sheet is drawn back it may be forced back by the cage in its ascent. Again, in cases where men are being wound it is desirable that the cage should proceed direct to the surface after being signalled away, without being lowered down to a lower level to allow some of the occupants of the cage to get off it, or others to get on, at the lower level.

No recommendations are made with respect to the barriers, either at the surface or at insets, but an arrangement in use at the Mariemont Pits in Belgium is described. This is a subsidiary gate, attached and lifted by jointed rods from the ordinary gate which the cage lifts, at such a distance below the surface level that it comes into use when the bottom deck of the cage is lifted a little too far above the landing, so protecting the workmen against the danger of pushing a tub, and being himself drawn by the tub into the shaft.

The practice of persons riding against loads or with gear is strongly deprecated. It is recommended that it should be universally prohibited.

With regard to additional outlets, the Committee consider that greater use might be made, in some cases, of the shafts commonly known as 'back' shafts, especially in case of emergency; and that better provision could be made by providing these shafts with a cage instead of a 'hoppit' or 'kibble,' as is frequently the case. It is indicated that a kibble cannot be considered a 'proper apparatus' as required by Section 16 (1) of the Coal Mines Regulation Act."—F. H. WYNNE.—*North Staffordshire Institute of Mining and Mechanical Engineers. Iron and Coal Trades Review*, Feb. 4, 1910, p. 166. (A. R.)

WINDING AT THE CITY DEEP, LTD.—"The development of 'deep levels' on a large scale on the Rand has once more induced a discussion of the most economicl and safe methods of bringing the miners to and from their work. At the City Deep special gear has been invented for the purpose of changing from skip to cage with as little delay as possible, the transition from ore-hoisting to man-transport being thereby effected rapidly. The shaft has six hoisting compartments, of which two will be used solely for transporting the men and the remaining four can be used either for hoisting the ore or transporting the men. The cages in the two former will accommodate 60 men each and the latter 48 men each. The changing gear consists of a carriage travelling on rails, which are laid in line upon opposite sides of each hoisting-compartment. The main portion of the carriage consists of two steel side-plates 21 ft. 6 in. long, 4 ft. deep, and ½ in. thick, rigidly braced together and carried on two pairs of wheels, one of each pair of wheels resting on the rails on each side of the shaft. The side-plates are at a sufficient distance apart to permit the free passage of the skip between them when the gear is not in use. Upon one end of the carriage is borne a 3-deck cage with a capacity to hold 16 men on each floor, and upon the other end there is a platform that receives the skip when the latter is removed from the hauling rope. In making the change the skip is raised above the level of the rails and retained by 'dogs' and the platform end of carriage is brought beneath it by a worm-gear connected with the hind wheels. The skip is lowered to the platform and unhooked, and the carriage is then moved back again so as to bring the cage to the centre of the shaft. During the travel the cage is hooked to the hauling rope and filled with men, and is immediately ready for its upward journey. When all six compartments are being used for transport of men the total load per trip will be 156, and allowing 3 minutes for each trip, including loading and discharge, it will be possible to transport 3,120 men per hour. Whitford and Mills have also devised a new form of hopper for rapidly filling the skips. It is suspended from a pair of swinging arms at a point just above its centre of gravity. The descending skip tilts the hopper and receives its charge, and when ascending again lifts the hopper back into its place ready to receive another charge from the bin. This system is to be adopted at the main loading-station of the mine, where, at a depth of 3,000 ft. there will be a bin having a capacity of 800 tons."—*Mining Magazine*, March, 1910, p. 223. (A. R.)

FENCE GATES FOR WINDING SHAFT CAGES.—"After a fatal accident, observations were frequently made by the coroner, jurymen, or the inspector of mines that improvements might be made whereby the danger might be avoided or lessened, as was the case some little while ago after an accident involving loss of life through the tilting of a cage whilst running in the shaft. In that case the coroner's recommendation, endorsed by the inspector of mines, was 'that gates should be on each cage when men ascend or descend.' That incident induced the writer to give some consideration to the subject. He was of opinion that gates could be attached to all cages at small expense, thus assuring the safety of the workmen while not affecting the output. He brought before the notice of the meeting three methods he had devised of attaching gates to cages, and recommended that they should be adopted when drawing coals in conjunction with the existing cage snecks. It was not an uncommon experience to have tubs insecurely snecked, which often caused an accident in the shaft, a danger which would be entirely avoided if his recommendations were acted upon. The first type of gate he submitted was a collapsible gate for cages with one or more decks. The object of that type was to allow the gate to collapse into a minimum of space available in the case of complicated head gears and onsets. If possible the gate should be so constructed that in case the cage was signalled away without its being closed, no fouling would take place during its journey in the shaft. The gate might be constructed of flat iron bars built up in such a manner as to allow of both a horizontal and a vertical motion. The vertical bars were $1\frac{1}{4}$ in. wide by $\frac{3}{8}$ in. thick, and were rivetted 9 in. apart to the horizontal bars (which were $1\frac{3}{4}$ in. wide by $\frac{7}{16}$ in. thick) with loose rivets $\frac{5}{8}$ in. diameter, so as to allow the gate to collapse into the desired form. The vertical bars were placed on the inside of the horizontal bars in case of an undue stress being thrown on them, when the rivet heads would not be strained, as would be the case if they were fixed on the outside. The horizontal bars were spaced 24 in. apart, the lower bar being 6 in. from the bottom of the cage deck, making the total height of the gate $33\frac{1}{2}$ in. The whole gate swung horizontally upon a pivot $\frac{3}{4}$ in. in diameter, to which the horizontal bars were attached by loose rivets, $\frac{3}{4}$ in. in diameter, thus allowing of the vertical movement. The top horizontal bar had a handhole, 4 in. by $1\frac{1}{2}$ in., to allow for the lifting of the gate. When the gate was closed, the ends of the horizontal bars rested in slots, being kept in that position by catches. When opening the gate, it was lifted clear of the catches and was moved first in a horizontal and then in a vertical direction, in which latter position it was retained by the shackle until the cage was ready for moving away, when the gate was closed. The second type of gate was a rigid gate for cages with one or more decks. That was of a somewhat similar type to the collapsible gate and was recommended when space was not a serious consideration. It must, however, be closed before any movement of the cage took place, otherwise it would foul obstacles while the cage was running in the shaft. In that gate the vertical bars were rivetted with fixed joints to the horizontal bars, and the whole gate swung vertically on only one pivot or axis, which was $\frac{3}{4}$ in. in diameter. On the hinged end of the gate there was attached an additional vertical bar, $1\frac{3}{4}$ in. by $\frac{3}{8}$ in. for the purpose of stiffening the structure. There was, moreover, an additional hand-hole provided in the lower horizontal bar, to which was also attached a stop-piece, $2\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{1}{2}$ in., which prevented the gate, when opened, from going too far through the slot. In all other particulars it was identical with the collapsible gate. Being in its general construction very simple, it was not likely, when once installed, to get out of order. The third type was a false-bottom or telescopic frame gate for cages with one deck only. In that type, a framework, attached to the gate by pins $\frac{7}{8}$ in. in diameter was constructed under the cage in such a manner that when the cage was lowered to the bottom of the shaft the framework came into contact with the beating beams, the result being the vertical lifting of the gate, which of course gave access to the inside of the cage. The gate slid in slots provided at each side of the cage. When the cage was lifted, the gate, by its own weight, automatically closed itself. At the bank-level, the opening and closing of the gate were also automatic. A lever was pivoted at its centre to the side of the cage, the lower end being attached to the bottom of the gate. When the cage ascended, the free end of the lever engaged with a fixed sheave at bank, the depression of the one end of the lever lifting the gate attached to the opposite end. When the cage was lowered away, the gate, as when at the bottom of the shaft, automatically closed itself. The framework below the cage was constructed of flat iron bars, $2\frac{1}{2}$ by $\frac{1}{2}$ in., fixed securely and rigidly by bars of a similar section and by bars, 2 in. by $\frac{3}{8}$ in., which ensured the proper gauge of the bars mentioned at the beginning of the sentence. The gate itself was made up of an expanded metal panel, in the centre of which was a small door, to allow of access to offsets in the shaft. This door, which was constructed of flat iron bars, $1\frac{1}{2}$ in. by $\frac{3}{8}$ in., opened inwards on hinges, and was so hung as to close of its own accord. It was kept in that position by a self-closing latch which locked into a flat iron bar, 1 in. by $\frac{1}{2}$ in. The small door might, if preferred, be constructed in halves, so as to take up less room in the cage when opened. When the gate was opened, the height from the floor of the cage to the bottom of the gate was $35\frac{1}{2}$ in."—C. A. CROFTON, *North of England Inst. Mining and Mechanical Engineers Mining Engineering*, March, 1910, p. 351. (A. R.)

MINE SUBSIDENCES.—In our issue for December last we gave some particulars of the proposed method for packing old stopes on the Rand. This new departure has drawn attention once more to the general question of the safety of the workings. Some weeks ago there was an accident at the Ferreira Deep, indicating that sufficient ground had not been left intact in the neighbourhood of the shaft. In order to remedy the defect concrete pillars are being provided. Similarly weakness has been discovered at the Robinson Deep, just to the South of the Ferreira Deep, and in order to prevent any collapse a large concrete pillar has been built. In connection with the Jupiter, at which mine the shafts are unusually deep, a pillar 500 ft. in diameter has been left round them, while at the Cinderella Deep, where there is only one shaft, a pillar 600 ft. in diameter is to be left. These supports may be considered unnecessarily large, and the policy of leaving so much ore in the mine may be debated, but the engineers would hardly have adopted such a policy without good reason. Another point in connection with the safety of the mines that has arisen lately is the question of the advisability of working under the battery foundations. The stamps are so heavy and the plant so extensive nowadays that the vibration is felt a long way down. For instance, at the Simmer and Jack, vibration of the 320-stamps can be felt in the hanging wall 300 ft. below the surface although strong pillars have been left. It is generally considered that, having regard to the heavier machinery and the larger reduction plants, it will be necessary to make close inquiry into the state of the workings at many of the older mines."—*Mining Magazine*, March, 1910, p. 228. (A. R.)

EARTH-SHAKES IN MINING DISTRICTS.—" Certain mining districts in Great Britain are visited from time to time by sharp local shocks, which in some ways resemble earthquakes, but in others are very different. To distinguish them from true earthquakes, and yet to represent the points of similarity, they have been called 'earth-shakes.' I propose in this paper to describe their characteristic features, and also to offer a theory of their origin, which, if correct, would seem to indicate that they are due to natural causes aided by the working of the mines.

During the last twenty-one years I have been able to study seventeen of these earth-shakes, though probably many more, unknown to me, have occurred. Five of them have taken place in the Little Rhondda Valley in Glamorganshire, four in Cornwall, four at Pendleton, near Manchester, and one each at Kilsyth, Barnsley, Abercarn, and Eastwood, near Nottingham.

Nature of the Earth-Shakes.—The small size of the disturbed area is one of the most remarkable features of these earth-shakes. It ranges from one square mile or less to 144 square miles, but only one (that at Pendleton in 1905) exceeds 20 square miles. Excluding this, the average of the disturbed areas is only 10 square miles. In seven cases the disturbed area is so small that the course of its boundary cannot be determined; in five, the boundary is approximately circular in form; while, in five others, it is slightly but distinctly elongated. Notwithstanding the small size of the disturbed areas, however, the intensity of the shocks was in some cases considerable. Two of them attained the degree 7 of the Rossi-Forel scale—that is, they were strong enough to throw down ornaments, vases, etc., five were of intensity 5, and the remainder of intensity 4. The contrast between the earth-shakes and British earthquakes is shown in the following table, in which the average disturbed areas in square miles are given for the three degrees of intensity involved :—

	Earth-shakes.	Earthquakes.
Intensity 7	80	27,850
" 5	11	859
" 4	$8\frac{1}{2}$	376

In its nature, the shock resembles that of a true earthquake, except as regards brevity and its sudden onset. In an ordinary earthquake the shock generally begins with a faint tremor, which rapidly increases in strength until a series of strong vibrations are felt, and then dies away again in a tremor. An earth-shake, as a rule, begins with one strong vibration, like that caused by blasting or the fall of a very heavy body; and this may be followed by a very brief tremor, such as would naturally follow either of these occurrences. Thus, instead of an average duration of from 4 to 8 or more seconds, the earth-shake lasts on an average for not more than 2 secs. It is worth noticing that the average duration of an earth-shake depends on the form of the disturbed area, being $1\frac{1}{4}$ secs. when the area is approximately circular and $2\frac{1}{2}$ secs. when it is elongated in form.

The sound which accompanies the earth-shake also bears a close resemblance to that which attends an earthquake shock, and again is distinguished by its brevity. This is shown in the following table, in which the figures represent percentages of the observations for each class under the seven principal types of sound :—

	Passing wagons, etc.	Thunder.	Wind.	Tipping of a load of stones.	Fall of a heavy body.	Explosions.	Miscellaneous.
Earth-shakes—							
With elongated disturbed areas	20	20	1	13	15	26	5
Circular	5	22	—	5	32	35	—
*Earthquakes**—							
Strong	47	22	10	5	4	7	5
Moderate	46	27	3	5	6	9	3
Weak	29	31	6	7	8	15	4

The first three types may be regarded as of long, and the next three as of short, duration. Taking these six types only, we find that the percentages of reference to types of short duration are 57 and 72 for the two classes of earth-shakes, and 17, 20, and 31 for the three classes of earthquakes.

One other point of contrast between earth-shakes and earthquakes is worthy of notice. Though the number of records of earth-shakes in mines is much less than on the surface, it is clear, from the information we possess, that the region effected by the shake underground is not less extensive than the area disturbed by it on the surface, also that the shock is stronger and the sound louder in the mines than on the surface. Now, in ordinary earthquakes, the shock, if felt at all in mines, is much weaker than on the surface, and the average distance at which it is felt underground is only about one-third of that at the surface. Moreover, in earth-shakes, the sound is sometimes referred to as resembling that of the discharge of a shot in the workings, fragments of rock fall from the roof and dust rises from the floor.

Origin of the Earth-Shakes.—Such marked contrasts between earthquakes and the earth-shakes of mining districts point to an essential difference in origin, and especially to difference in the depth and magnitude of the originating foci.

The most significant feature of the earth-shakes is the great intensity of the shock near the centre of a very small disturbed area and its rapid decrease towards the boundary. As will be seen from Fig. 1, this implies the existence of a comparatively shallow focus. The curves marked A and B in this diagram represent the intensities of the shock at different distances from the origin, A corresponding to a focus at a depth of one-quarter of a mile, and B to one at a depth of two miles. Both curves are drawn on the

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* 'Strong' earthquakes are those which disturb areas greater than 5,000 square miles; 'moderate' earthquakes, between 1,000 and 5,000 square miles; and 'weak' earthquakes, areas less than 1,000 square miles.

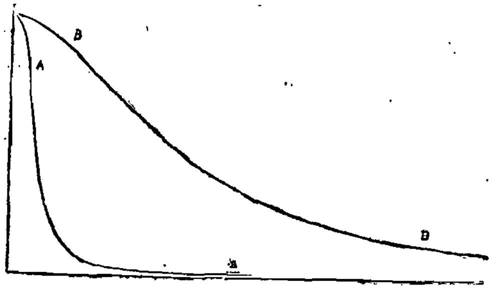

Fig. 1.

assumptions that the intensity of the shock at any point of the surface varies inversely as the square of the distance from the focus, and that the impulses are such that the intensity of the shocks at the point vertically above both foci is the same. On these assumptions, it follows that the shock that would be just perceptible at a distance of two miles from the centre for the shallow focus, would be perceptible at a distance of thirty-two miles for the deeper one—that is, the disturbed area of the latter shock would be 256 times that of the former. The observations made in mines also lead to the conclusion that the earth-shakes originate in foci which are not far below the surface, and, approximately, at the same depth as the workings in the neighbouring mines.

A second inference, of hardly less consequence, is that the foci of the earth-shakes are as a rule of small dimensions. This is shown by the small size of the disturbed areas, by the approximate circularity in form in some, and by the small difference between their length and width in others. The brevity of the shock and sound, especially in those which affected a nearly circular area, points to the same conclusion; for a focus several miles in length would give rise to a disturbance of some seconds duration—at any rate, at places in the direction of its longer axis.

These two conclusions regarding the small depth and size of the foci are clearly in favour of a local origin of the earth-shakes. In the Rhondda valleys they are generally, I believe, attributed to the rock falls in old workings; and this is, no doubt, the origin of some shocks, for such falls from the roof are known to occur and to lead to a subsidence of the ground above. The chief difficulties in the way of this explanation for the earth-shakes here referred to arise from the absence, so far as known, of any fallen masses, but chiefly from the close connexion between the earth-shakes and neighbouring faults.

As an example of this connexion, I reproduce here the map of the Pendleton earth-shake of November 25, 1905 (Fig. 2). This was one of the strongest earth-shakes felt for more than twenty years. It disturbed an area of 144 square miles, and the observations are so numerous that it is possible to draw a series of four isoseismal lines corresponding to intensities 7 to 4 of the Rossi-Forel scale. The centre of the innermost curve lies three-quarters of a mile north of the centre of Pendleton, and the longer axis of all the isoseismals are directed, approximately, N. 37 degs. W. Now, the Pendleton or Irwell Valley fault (represented by a broken line on the map), which has been traced for a distance of more than twenty miles from near Bolton to Poynton in Cheshire, passes close by the centre of the innermost isoseismal, and its mean direction in that district is N. 34 degs. W.

The evidence of other earth-shakes is similar, though not quite so detailed. On February 27, 1899, and April 7, 1900, earth shakes in the same district

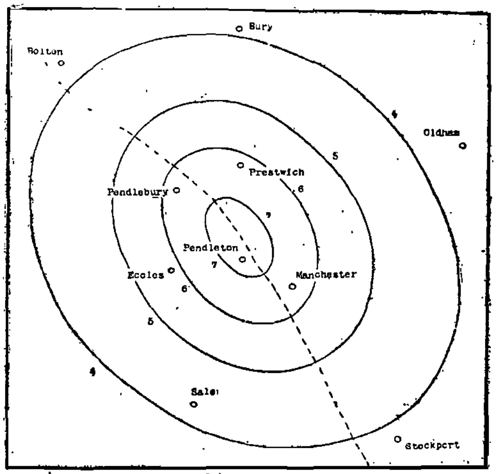

Fig. 2.

disturbed nearly circular areas, with their centres close to, and on the downthrow side of, the Pendleton fault. The Barnsley earth-shake of October 25, 1903, disturbed an elongated area with its longer axis directed N. 38 degs. W. and its centre close to, and on the downthrow side of, a fault running N. 41 degs. W. In the Little Rhondda Valley, the disturbed areas of the earth-shakes are nearly circular in form, the centre of the Llwynypia shake of June 22, 1889, being close to the north-west end of the Cymmer fault, and that of the Pentre shake of October 16, 1896, one-third of a mile on the downthrow side of the Dinas fault. From this and other evidence it may be concluded that the centres of the areas disturbed by the earth-shakes lie close to, and on the downthrow side of, known faults, and that the areas, when otherwise than circular, are elongated in directions which are very nearly parallel to those of the faults.

A fact of some importance is that some coal-seams have been worked out right up to the faults referred to. This is certainly the case at Pendleton and Barnsley, and probably also in the Rhondda Valley. Now, by the withdrawal of the coal (or, it may be, by the lowering of the water-level by pumping in other parts of the mines), the rock above is deprived to a great extent of its support, and tends to sink down and close up the worked-out seam. Nowhere can this tendency be greater than where the rock is severed by a fault. Here the sinking would take place by small fault-slips, each of which, by the friction resulting, would give rise to a rather strong shock. But, as the slip would only affect a small region of the fault, and would occur at a slight depth, the intensity of the shock would fade away rapidly from the centre; the disturbed area would be small and circular, or slightly elongated in form; the shock and sound would be of brief duration, and would closely resemble those produced by the fall of a heavy mass of rock.

If this be a correct explanation of the origin of the earth-shakes—and it seems to account for all their peculiar features—it follows that the shakes cannot be classed either with true or with spurious earthquakes. They are of natural origin in so far as they are produced by fault-slips, but of artificial origin in that the slips are precipitated by human labour and not by the gradual cooling and warping of the earth."—CHARLES DAVISON, *Mining Journal*, London, March 12, 1910, p. 310. (G. H. S.)

Possibilities of Rescue Work in Coal Mines. —"Dr. Haldane remarked at the outset that there had been a great deal of discussion recently on mine rescue apparatus and organisation of rescue stations and rescue corps. In his present contribution he intended to discuss the wider question of the possibilities of rescue work with or without rescue apparatus. He had come to the conclusion that immediately after a blast few, if any, of the men were already dead, and the great majority could be saved if they could only be protected from the action of after damp. To prove this the author recounted the circumstances of the recent explosion in the Derran Colliery, South Wales. There were three possible ways of protecting men from after damp, one was to get pure air to them, another to get them out of the after damp, and a third was to give them pure air to breathe until they are in the pure air again. If, as generally is the case, down cast and up cast shafts were close together, separation doors and air crossings would be destroyed so that air could not be got round in the ordinary way. If the workings were connected with any other pit it might be possible to clear out the after damp by opening the communicating door and closing the down cast shaft with planks. In many cases it may be found very desirable to reverse the ventilation, and the author thought that in any case means for reversing the ventilation ought always to be provided. In connection with rescue work, means of testing the air in the mine are very important, and for this purpose a mouse or a bird enclosed in a box capable of being shut air tight might be used, the box being capable of connection with the exhaust valve of a rescue apparatus in order that the animal could be revived at once if necessary. A rescue corps might also be provided with light subsidiary apparatus for fixing over the faces of disabled men in order to protect them until they could be moved, but this has not yet been properly considered. The lecturer also referred to the advisability of mine managers discussing with their staff what action should be taken in the event of an explosion."—Dr. J. S. Haldane. *Colliery Guardian*, May 6, 1910. (T. D.)

MISCELLANEOUS.

Ambulance Work on the Goldfields. — "Despite all precautionary methods adopted by the mining companies, the possibilities of accidents cannot fail to be great in such a large field of labour as Kalgoorlie, and nearly all persons connected with mining, sooner or later, become eye-witnesses of some form of accident. The question then arises—What can be done to alleviate the suffering of the injured one? and it is lamentable to reflect how very few mining men are capable of rendering 'first aid.' The needless suffering so frequently caused by the ignorance of those unskilled persons with whom the patient is first brought in contact is as undoubted as it is deplorable. By rough handling or even the mere want of the slightest knowledge of how to lift an injured limb, a simple fracture may be converted into a compound or even complicated one The method of arresting hemorrhage is easily learned yet many lives have been lost, the very life-blood ebbing away in the presence of sorrowing spectators, perfectly helpless because none amongst them had been taught the first rudiments of an ambulance pupil's work, viz., the application of an extemporised tourniquet.

It is scarcely necessary to multiply instances to demonstrate the incalculable value of a knowledge of 'first aid.' The object of this article is to draw attention to the work being carried on by the St. John Ambulance Association. About four years ago a centre of this Association was established on the goldfields, at which time, with the exception of a few obsolete stretchers on some of the big mines, practically no provision had been made for the proper handling of the injured. Since then casualty wards have been erected and equipped with up-to-date appliances, and on some of the mines a special ambulance corps is always at hand.

The casualty wards are fitted with electrically-heated beds, hot and cold water, medicine chests, splints, bandages, etc., and it is here that much can be done to relieve pain before the arrival of a doctor. The electrically-heated bed is a valuable acquisition to an accident ward, seeing that a man brought up from underground wet and cold can be placed between warm blankets immediately, if necessary. The beds are inexpensive and can be made on the mine.

The Association has given great attention to transport work and the mines are gradually becoming equipped with proper ambulance wagons or litters. But although a mine may have every up-to-date appliance all these are practically useless without a trained body of men to use them. To supply this want the Association has instructed a number of men from many of the mines, has proper training quarters for use of members, and from time to time lectures are given by medical men.

Although so much has been done there still remains the absolute necessity for all those in charge of a number of men, both on the surface and underground, being trained to render first aid. From statistics it is apparent that the majority of fractures that occur underground are of a simple nature and if those first on the scene of accident apply suitable splints, the possibility of a more serious fracture is prevented. The broken ends of the bone are so sharp that any attempt to remove the patient without first securing the limb in splints are likely to lead to serious injury. A good improvised method of splinting is to use parts of the side of the candle box or similar pieces of wood tied by means of handerchiefs, braces, string, etc. Extreme cleanliness should be exercised in regard to wounds of every description as by thoroughly washing and treating the wound with some antiseptic the possibility of blood-poisoning is considerably lessened. This applies not only to large, but to small wounds.

The pamphlets published by the Mines Department of W.A. and South Africa fully describe the proper methods to be adopted when men are overcome by gases underground. The suggestions made by the writers of these pamphlets have been carried out as far as possible, and no difficulty has been experienced in treating bad cases. It has been found that the electrically-heated tables in use are of great assistance in restoring patients suffering severely from shock. Too much precaution cannot be taken in cases of 'gassing' and the old idea of giving large quantities of alcoholic stimulants is indeed dangerous. The brandy bottle which was so much in evidence in the early days has given place to readily prepared doses of sal volatile.

Experiments have recently been made with two kinds of safety appliances for underground rescue work; these are the Vajen-Baden safety helmet and the Fleuss-Davis-Hall apparatus. The construction of the Vajen helmet is remarkably simple and it requires only a few moments explanation for one to thoroughly understand the working of it.

The great advantages of this helmet lie in the use of compressed air, instead of special cylinders of oxygen, as required by other similar appliances, and the entire absence of complicated mechanism. The air reservoir at the back of the helmet is first filled with air to 150 lb. pressure; the helmet is then placed over the head, which it entirely covers, and strapped tightly to the shoulders. By opening the valve on top of the reservoir, the air is forced through the supply-tube to an inside point directly above the nostrils, and in practice the supply is ample for one hour, at least, without causing the wearer any discomfort. The fresh air being constantly forced into the helmet creates an outward pressure, and the foul air escapes through the neck-gear and around the bottom, which is lined with absorbent lamb's wool. The side or ear-pieces have special sounding diaphragms which render the hearing perfectly distinct. A whistle attached in front is used for a call and is a convenient means of signalling at any desired time. The helmet furnishes full protection to the head from falling debris, as it is padded on top and reinforced with eight ribs over a double thickness of leather so that no ordinary blow can penetrate the skull. It weighs only 6 lb. There is no hose attachment which is liable to kink or break and thus impede the movements of the wearer. This helmet has been extensively used in mines in many parts of the world and has been most favourably reported upon.

With reference to the Fleuss-Davis-Hall apparatus, Mr. E. A. Mann, Government Analyst, says;—'Its weight is considerable as compared with other similar appliances, but it is so well distributed and carried from the shoulders that one soon becomes accustomed to it. The rubber tubes may probably be found not to stand this climate well. The apparatus is complicated and has many parts which may get out of gear. The use of oxygen instead of compressed air is inconvenient. But on the other hand, it is cool and comfortable and can be used readily from the moment it is put on. The head is not confined in a helmet which makes observation readier. The provision of a gauge in front enables the operator to tell exactly what limit of time he has available for work at any moment. It has stood the test of long trial and was very favourably reported upon by the Royal Commission on Mines."

It will be seen from the foregoing that each of these rescue appliances has points in its favour, but owing to the intricate mechanism of the Fleuss, the Vajen helmet appears to be the more suitable for ordinary rescue work underground."—C. A. Bolton. —*Monthly Journal of the Chamber of Mines of Western Australia*, Jan. 31, 1910, p. 387. (H. A. W.)

Swedish Radium.—"Work is now in full swing in the radium factory at Islinge Lidingo, Sweden. A short time ago the new large smelting plant was started and it is working very well. It is calculated to smelt one ton of ore per day, but as a matter of fact has been doing about 20 per cent. more. There are thirty workmen employed in the factory. At present the most critical work being done is the production of radium concentrate, from which the pure radium will ultimately be extracted. The ore is obtained at Kohn-Bellingen where sixty miners are employed. It is expected that the annual production of radium will be four to five grammes, which is a large quantity compared with the yield of other lands. The value of radium is now 400,000 f. per gramme."—*Chemical Trade Journal*, May 7, 1910. (T. D.)

The Origin of South African Tin Deposits.—The following are the summary and conclusions of the valuable paper on "The Origin of South African Tin Deposits," read recently by Mr. R. Recknagel before the Geological Society of South Africa:—

"It has been shown that the pneumatolytic theory does not give a satisfactory explanation of the formation of tin ore deposits and that it is unsound in principle, as it rests on assumptions which are in part contrary to chemical and physical facts. The fact that cassiterite has been proved to exist as a primary accessory constituent of granite in many parts of the world where workable tin deposits occur is considered of the utmost importance and forms the starting point of the theory advanced. The source of the tin ore deposits is not the unknown "great depth," but the acid igneous rocks in which the deposits occur or which are actually or presumably in existence in close neighbourhood to the deposits. In normal cases tin is supposed to occur as a silicate within the acid rocks—in accordance with Sandberger's investigations. Contrary to Sandberger, and in accordance with the ascensionists, it is considered unlikely that a concentration of the metals from the silicates into workable deposits could be achieved in one process by lateral secretion. It is considered likely that the occurrence of cassiterite as a primary constituent of the acid rocks marks the first stage of an igneous concentration of metals. The metals which in the normal state are distributed as silicates in minute quantities throughout the igneous rock masses were, in certain cases, concentrated by magmatic differentiation into zones of the igneous rocks and solidified there as native metals, oxides, sulphides and arsenides. In the case of tin, the first product of concentration was almost invariably cassiterite, in rare cases only, stannite. Besides some metallic minerals, as oxides of iron and copper pyrites, certain minerals containing fluorine and boron, especially fluorite and tourmaline, are often found in the above-mentioned zones, which seems to indicate that these elements played an important part even in the first stage of igneous concentration. These impregnated zones constitute workable ore deposits only in exceptional cases. In the case of cassiterite impregnations, however, they are of the greatest importance, as they are the source of most of the workable tin deposits. Within these zones a further igneous concentration of metals seems to have gone on in certain instances by a further differentiation of the magma, the result of which was the formation of an extra-fluid magma—the residual magma which in consolidation formed "pegmatites." In the case of tin-bearing magmas, the following kinds of deposit are the results of this further concentration:—Tin-bearing pegmatites proper, lode-like pegmatitic zones, pockets, lenses and pipes of tin ore associated with minerals usually found in ordinary pegmatites. These deposits, on account of their irregularity in shape and distribution, are rarely the objects of mining operations on a large scale, in spite of their richness. One of the most remarkable exceptions is the pipe and lense occurrences of the Potgietersrust district. After the complete solidification of the rock masses, a further concentration of the metallic parts they contain can take place by means of hydrous solution only, by lateral secretion. The majority of the workable lodes have been formed by lateral secretion, either within the rock masses, which contained the metals in a less concentrated state, or within neighbouring rocks, which were connected with the former through fissures. The grade of concentration of metals, in lodes formed by lateral secretion, depends in the first instance on the grade of concentration of the metals in those parts of the rocks which are affected by lateral secretion. Workable lodes will be formed by lateral secretion mainly in those instances where the rock masses undergoing the leaching and concentrating action of moving solutions contain the metals in some concentrated state already, in igneous rocks where a concentration by differentiation of the magma has preceded the concentration by hydrous solutions. The formation of the South African tin deposits is due to magmatic differentiation only, or to the combined action of magmatic differentiation and lateral secretion. The following table shows the grouping of the main South African deposits according to their probable origin as indicated in this paper:—

SOUTH AFRICAN TIN DEPOSITS.

A.—Origin due to magmatic differentiation:	*Examples:*
I. of *Granite*:	
1. Inclusion or so called impregnations.	Groenfontein, Zwartkloof.
2. Segregation in situ.	
a. Irregular pockets, lenses, pipes, etc.	Zaaiplaats, Groenfontein, etc., Elandsfontein, Zwartkloof, Quaggasfontein, Vlaklaagte.
b. Vein-like bodies.	Groenvlei, Enkeldoorn.
3. Segregated masses removed from place of segregation—	
a. Pegmatite dykes.	Oshoek, Swaziland.
b. Aplite dykes.	Zululand.
c. Lodes in sedimentary formations.	Rooiberg lodes?
II. of *Felsite*:	
1. Inclusions or impregnations.	?
2. Segregations in situ—	
a. Irregular pockets, nodules, lenses, pipes.	Doornhoek, Kromkloof.
b. Vein-like bodies.	Elandsfontein.
3. Segregated Masses removed from place of segregation, felsite dykes.	?
B.—Origin due to lateral secretion preceded by magmatic segregation:	
I. In granite:	
I. Lodes.	Vlaklaagte, Kuils River.
II. In sedimentary formation:	
1. Where the original seat of SnO_2 is *granite*—	
a. Lodes.	Rooiberg.
b. Bedded impregnations.	Rooiberg.
2. Where the original seat of SnO_2 is *felsite*—	
a. Lodes.	Doornhoek.
b. Stockworks in shale	Doornhoek.

—R. RECKNAGEL, *South African Mining Journal*, March 12, 1910, p. 25. (A. R.)

PREVENTION OF ANKYLOSTOMIASIS.—"The ankylostoma, or miner's worm, has been for over two years the subject of experiments at the College of Medicine, Newcastle, England, by Sir Thomas Oliver and Hermann Belger. The chief object was to find a way to prevent infection of wet and ill-ventilated mines. On January 21, 1910, Sir T. Oliver read a paper before the Society of Tropical Medicine. According to the statements in this paper, of the 41 disinfectants tried by Mr. Belger, the best was sulphate of iron. This costs $39 a ton. A one per cent. solution of it would cover 100,000 sq. yd. of floor 1 cm. deep. It would prevent the development of any eggs that might be present and kill larvæ within a day. Almost equally effective are cinders. Old cinders are better than fresh, because richer in sulphate and poorer in chlorides. Ankylostoma larvæ are often found in the grooves at the sides of main entries; these grooves should be filled with cinders. Cinders should be sprinkled round the sanitary pails, both above and below ground.

Other Disinfectants.—Sea water is a third possible disinfectant; it kills larvæ within an hour. Creosote also kills larvæ quickly. Hence, where the air is moist and there is no danger of fire, the lower end of props should be creosoted to a height of about half a yard. Ankylostoma larvæ are fond of climbing, and wooden props easily become reservoirs of them. Managers of collieries and brickfields in cold climates are apt to think that their winter secures them from the ankylostoma, but Oliver and Belger found that larvæ frozen for six days revived and were little the worse. Tenholt found larvæ in miner's worn boots, although these had not been in the mud in which the men had been working; this suggests that the larvæ may migrate in boots from one mine to another. The interval between the infection of a man (through his mouth or skin), and the appearance of eggs in his feces, is 30 to 35 days."—C. HARPUR.—*Engineering & Mining Journal*, May 7, 1910, p. 976. (A. R.)

SILICA STANDARDS OF LENGTH.—"Silica standards of length are quite a novelty. As mentioned in the recent annual report of the National Physical Laboratory, careful experiments have demonstrated that silica is superior to glass as to thermal hysteresis, the co-efficients per degree Centigrade being: Silica, from 0·5 to 1; Jena glass, 59^{III}, 2·7; Jena glass, 16^{III}, 3·5, all expressed in 10^8 units. The 1-m. silica standard of the National Physical Laboratory is a tube supplied by the Thermal Syndicate, 2 cm. in diameter, having half discs fused into its ends. The difficulty of getting good defining lines on the silica has been overcome. Ordinary scratches chipped off in a day or two, and could not be seen when the tube was immersed in water. The ends have, therefore, been platinized, but on the lower surface; the graduation is cut through the platinum film into the silica, and the protecting glass cover rests against the lower platinized surface. The reading from above is, therefore, not affected by any tilt in the cover glass." —*Metallurgical and Chemical Engineering*, May, 1910. (J. A. W.)

Reviews and New Books.

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

THE MINER'S GUIDE. By F. P. MENNELL, F.G.S. A Practical Handbook for Prospectors, Working

Miners, and Mining Men generally. Fully illustrated. 4s. (London: Gerrards & Co.)

"This clearly written little book is to be regarded as an elementary introduction to the principles underlying metalliferous mining in unexplored countries, and should be a useful guide to prospectors and those taking up mining without having any preliminary training. The origin and characters of ore-bodies are briefly discussed; methods for sampling, testing, prospecting, and easy tests of the recognition of minerals and precious stones are given. Since the book is practically a third edition of the author's "Rhodesian Miner's Handbook," many of the examples cited are chosen from South Africa, and those interested in the mineral prospects of the less known and undeveloped regions will find much useful information.—*London Mining Journal*, May 14, 1910. (A. R.)

THE VALUATION OF MINERAL PROPERTY. Rules and Tables. By T. A. O'Donahue, M.E., F.G.S. 7s. 6d. (London: Crosby Lockwood & Son.)

"In a paper upon the 'Valuation of Mineral Properties,' read in 1906 before the North of England Institute of Mining Engineers, Mr. O'Donahue contended that the published tables for discounting deferred values of mineral properties at high rates of interest were not based upon sound principles. That paper the author has expanded into the present work, and he has had the satisfaction of being informed by the authorities of the Estate Duty Office that he correctly gives the objections which they raise to certain tables, and that his rule embodies the principle for which they contend. The work contains numerous definitions, rules, and examples illustrating and explaining the principle advocated, and is furnished with an appendix of interest tables and of logarithms, with a particularly clear note as to the use and value of the latter calculations."—*London Mining Journal*, July 2, 1910. (A. R.)

MODERN COKING PRACTICE, INCLUDING THE ANALYSIS OF MATERIALS AND PRODUCTS. By T. R. Byrom and J. E. Christopher. $3.50. The Norman W. Henley Publishing Company.

"This book, as is stated by the authors, is a handbook for those engaged in coke manufacture and the recovery of by-products. The volume is broad in its scope, treating the subjects of coal washing, classification of fuels, sampling and valuation of coal, coke, etc., as well as the science of coke manufacture. The illustrations showing various modern plants are excellent, and the drawings have been well selected and carefully executed. Not least in merit are the many useful tables, showing specific gravities, melting points, weights of materials, heat units, calorific values, etc."—*The Engineering and Mining Journal*, May 21, 1910. (W. A. C.)

TEXT BOOK OF ORE DRESSING. By Robert H. Richards, assisted by E. S. Bardwell and E. G. Goodwin. 16×24. Cloth. XI—702 pages. 354 illustrations. Price $5.00. McGraw-Hill Book Company, New York. 1909.

"The main subjects treated are as follows: General Principles. Part I.—Preliminary Breaking. Part II.—Final Crushing. Rolls, Gravity Stamps and Amalgamation, Grinders other than Gravity Stamps, Laws of Crushing. Part III.—Separating, Concentrating or Washing. Preliminary Washing and Hand Sorting, Preparation of the Crushed Ore for Concentration, Principles of Screen Sizing and Classifying, Coarse-Sand Concentrating, Fine-Sand Concentrating, Slime Concentrating, Miscellaneous Processes of Separation. Part IV.—Accessory Apparatus. Part V.—Mill Processes and Management. Management. Mill Principles and Processes, General Considerations. Part VI.—Coal Dressing.

Inseparable and indispensable as the industry of ore dressing is to other industries it constitutes a distinct branch of engineering art. As a study it may properly be classed as a separate branch of applied science. Between the subjects of mining and metallurgical engineering ore dressing is the connecting link, as indispensable to the one as to the other. No course either in mining or metallurgy is complete unless it deals very considerably with the preliminary treatment of ores.

Prof. Richards' book is the first comprehensive text book on ore dressing, and should arouse great interest, especially among teachers and students of this and allied subjects. It will be welcomed as coming from so eminent an authority and teacher. The author's successes in practice and in writing are too well known for recital here. The new book is a condensation of the author's well known treatise, 'Ore Dressing,' now filling four large volumes. It has the clearness, thoroughness and reliability of his former books without being burdened with details of practice. Much descriptive matter and data relating to machinery and practice in different localities is eliminated, and consequently the book will not soon be out of date. It would have been better, perhaps, if the process of elimination and condensation had gone further, resulting in still greater emphasis on the principles. While such a criticism would be made by some teachers, all will concede that the subject is treated thoroughly in both the academic and the technical sense. Expressed in a few words, Prof. Richards' book is a practical presentation of the principles and practice of ore dressing."—*The Chemical Engineer*, March, 1910, Vol. XI., No. 3. (W. A. C.)

THE CYANIDE HANDBOOK. By J. E. Clennel, B.Sc (London), Associate of the Chemical, Metallurgical and Mining Society of South Africa; author of "Chemistry of Cyanide Solutions," etc., etc. Published by the McCraw-Hill Book Company, New York and London. 520 pp. 21s. nett.

A much larger share of attention than is usually given in works of this description is devoted to the chemical principles underlying the practice of the extraction of gold and silver by cyanide solutions. Almost half of the volume is occupied by the history, manufacture and reactions of cyanogen and its compounds, their analysis and behaviour in working solutions. The compounds noticed include cyanates, isocyanates, ferricyanides, manganicyanides and many other such combinations and many facts of interest to the scientific metallurgist, such as usually require a long and painful search through technical literature, are here for the first time brought together into one convenient work. This forms the principal reason why it deserves a place on the bookshelf of all who are interested in this branch of our industry. An outline only is given of practice in modern cyanide plants, and even this is by no means up to date, and such things as diaphragms, collecting tables, and the use of heavy stamps with coarse screening do not appear to have reached the author's notice. For details of Rand milling practice reference is made to papers written in 1903, and the use of the 'Alkali Wash' is stated to be still common practice. Very good chapters on assaying and sampling will be found, as also a useful section on analysis of bullion and other products. We note, however, that the author, while condemning the use of bicarbonates as fluxes on page 335 admits their use in his own work on page 357, and quotes with approbation their use in many other instances. The work is well produced and free from typographical errors. The spelling is English with the exception of 'Niter,' which is consistently so spelt. A few tables of general interest are given, and the index provided seems well up to the mark. This work will take a high place in the ever increasing volume of cyanide literature, and we offer the author our hearty congratulations upon it. (H. A. W.)

Abstracts of Patent Applications.

(C.) 274/10. Sven Emil Sieurin. Process of producing metals.

This application refers to a method of treatment of metallic ores by heating them with a solid reducing material, such as cheap coal containing much ash, to such a temperature that the metal is reduced but not melted. In this way the metal is obtained free from contamination, and may be obtained by physical means from the reduction mixture. The addition of lime in alternate layers is proposed where sulphur is to be eliminated.

(C.) 278/10. M. P. Boss. Improvements in stamp mortars.

This application relates to certain variations in the forms of mortar box liners and in the arrangement of screens for same.

(C.) 279/10. H. A. Humphrey. Improvements in methods of raising or forcing liquids, and in apparatus therefor.

This invention relates to a method of raising or forcing water or other liquids by the energy developed by the periodic explosion or combustion of a combustible mixture and to apparatus for carrying out the method.

It is essential for the carrying out of the method that the apparatus should comprise a combustion chamber which is provided with an inlet valve for combustible mixture and an exhaust valve and communicates with a delivery or discharge pipe or duct leading to a place of higher level or higher pressure and of a length sufficient to ensure the acquisition by the moving liquid of the momentum necessary for the desired effects to be produced, the length depending principally upon the desired speed of operation.

(C.) 305/10. Janus Simpson Island. A process of extracting precious values from ores. 21.6.10.

This application relates to a chloridising process for the extraction of precious metals, in which chlorine and sulphur dioxide are separately generated and delivered to a chamber containing camphor (the precise purpose of which is not stated), from whence the combined gases are led into a converter containing pulverised ore, preferably heated, steam also being projected into the ore simultaneously. The soluble salts of the precious metals which are formed are subsequently leached out in separate vessels.

Selected Transvaal Patent Applications.

RELATING TO CHEMISTRY, METALLURGY AND MINING.

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

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

(C.) 339/10. Frank Humphris. Improvements relating to tooth driving gear. 14.7.10.

(C.) 340/10. Edward Jonah Wiggins. Improvements in the method of and apparatus for preparing liquid hydro-carbon for combustion. 14.7.10.

(C.) 341/10. Fred Bedford (1), Charles Edward Williams (2). Improvements in and connected with the catalytic synthesis of methane. 14.7.10.

(P.) 343/10. Gaston Jacquier. A new or improved alloy. 16.7.10.

(P.) 344/10. Victor T. Frolich. Corrugated metal rollers for use in connection with circular ropes used in mechanical haulage. 18.7.10.

(C.) 345/10. Thomas Henry Bradbury. Improvements in rock drill forging and sharpening machines. 18.7.10.

(C.) 347/10. Hans Charles Behr. Improvements relating to bearings for stamp cam shafts. 19.7.10.

(P.) 348/10. Andrew Frederick Crosse. An improvement in the treatment of auriferous and argentiferous ores containing graphite and other carbonaceous material. 20.7.10.

(P.) 349/10. Edward Henry Johnson (1), Frances Allen (2), Hugh McMenamin (3). Improvements for feeding ore to the stamps of stamp mills. 21.7.10.

(P.) 351/10. William Cullen. Improvements in the treatment of cyanided residue. 21.7.10.

(C.) 352/10. Sandys Stuart Macaskie. Improvements in or relating to superheaters. 22.7.10.

(C.) 353/10. Giovanni Cornaro. Improvements in the manufacture of explosives. 22.7.10.

(C.) 354/10. Charles Anderson Case. Improvements in a panning and concentrating machine. 22.7.10.

(P.) 355/10. Frederick George Fell (1), G. D. Hock (2). An improvement in the means of loosening cams and the like. 23.7.10.

(P.) 356/10. John Archibald Maclachlan (1), Andrew Trimble (2). Improved apparatus for ventilation of workings by means of vacuum. 23.7.10

(P.) 358/10. Arthur J. Dickens. An improved mechanism for elevating water or other liquids from a flowing stream. 25.7.10.

(C.) 359/10. Samuel John Herbert Wilkes (1), George Wilkes (2). Improvements in nut locks. 26.7.10.

(P.) 360/10. Edmond Erskine (1), Cecil Murray (2). Spiral tube scraper. 26.7.10.

(C.) 361/10. William Badger. A shark grip split, serrated, segmental, adjustable, eccentric, turned, self tightening, easy releasing, bolted driving cam for stamp batteries. 27.7.10.

(C.) 362/10. Ernest Albert Brinkman. Tube mill liner. 27.7.10.

(P.) 363/10. Hans Charles Behr. Improvements in the construction of stamp batteries. 27.7.10.

(P.) 364/10. Hermann Daetwyler. Improvements in fluid actuated boiler scaling tools. 27.7.10.

(P.) 365/10. Allan Thomas Cocking. Improvements in torches for fuse lighting and analogous purposes. 28.7.10.

(C.) 366/10. Arthur Merriam Wight. Improvements in collapsible boxes. 29.7.10.

(C.) 367/10. William Woodward Robacher. Improvements in or relating to filtering apparatus particularly intended for the cyanide process of extracting precious metals from their ores. 29.7.10.

(C.) 368/10. William Woodward Robacher. Improvements in or relating to filtering apparatus particularly intended for the cyanide process of extracting precious metals from their ores. 29.7.10,

(C.) 369/10. Pedro Pingjauer. Multiple rotary steam engine. 29.7.10.

(C.) 370/10. Lewis Condict Hayles. Improvements in combined throttle valves and oilers. 29.7.10.

(C.) 371/10. Albert Henry Midgely. Improvements in dynamo electric machinery. 29.7.10.

(C.) 372/10. Arthur Francis Berry. Improvements in or relating to apparatus for use in the distribution of alternating electric current. 30.7.10.

(C.) 374/10. James Alexander Borbour. An improvement in valves, taps, and articles of a like nature. 3.8.10.

(C.) 376/10. William Banks (1), Alexander Warrell (2). A new or improved compound of substances for use as a packing and analogous purposes. 3.8.10.

(C.) 377/10. George Alfred Julius. Improvements in and relating to apparatus for printing and issuing tickets or checks of diff rent denominations and for registering and totalling numbers and indicating the totals. 4.8.10.

(C.) 378/10. Kenneth Bertram Lamont (1), Arthur Henry Winlerton (2), Gordon Travers Easton (3). A mechanical device for separating the fines from the rock before entering mortar box. 4.8.10.

(C.) 379/10. Ivor Scott Winby. Improvements in or relating to devices for securing the rails of permanent ways or similar tracks. 5.8.10.

(C.) 380/10. Dr. August Vö lker. A new or improved method of forming bodies from semiliquid quartz and like material. 5.8.10.

(C.) 381/10. Alom Ward Ambler. Improvements in means for propelling vehicles, implements an the like. 5.8.10.

(C.) 383/10. Frank George Symmonds Price. Improvements in apparatus for mixing and consolidating concrete and like materials. 5.8.10.

(C.) 384/10. Hans Peter Hansen. Improvements in and relating to the manufacture of pipes, tubes and the like from wood and in apparatus therefor. 5.8.10.

(P.) 386/10. Reginald Shadforth Scott. Improvements for linings for tube and similar grinding mills. 6.8.10.

(P.) 387/10. Junius Hamilton Anstruther Macadam. Improvements in pebble catching devices and like mills. 6.8.10.

(P.) 388/10. Junius Ford Cook (1), Arthur Frederick Lord (2). Improvements in the construction of gravity stamp batteries. 6.8.10.

(P.) 389/10. Ernest Alfred Newton. An improved spitzkasten for the treatment of ores and the like. 6.8.10.

(C.) 391/10. Morley Punshon Reynolds. An improved metallic screen or sieve. 9.8.10.

(P.) 392/10. William Cullagher. Improvements applicable to rotary deep boring apparatus. 10.8.10.

(P.) 393/10. William Cochran Boyd. Improvements in rollers. 10.8.10.

(C.) 395/10. William James Barnett. Improvements in acetylene generators. 12.8.10.

(P.) 396/10. Charles William Dowsett (1), Henry Saunders Kenny (2). Improvements in ore concentration and means therefor. 12.8.10.

(P.) 397/10. William Rundle (1), John Main Ellen (2). Improvements in railway vehicle couplings. 12.8.10.

(P.) 398/10. Arthur Chicele Plowden (1), George Taylor Philip (2). Improvement relating to coupling (automatic) for railway trucks and the like. 13.8.10.

(P.) 399/10. Francis Allen (1), Gordon Travers Euston (2), Hugh McMenamin (3). Improvements in driving means for ore feeders. 13.8.10.

(P.) 400/10. Francis Allen (1), Gordon Travers Euston (2), Hugh McMenamin (3). Improvements in means for feeding ore to the stamps of stamp mills. 13.8.10.

(C.) 401/10. Julius Stromeyer. Improvements in and relating to brake shoes. 13.8.10.

(C.) 402/10. Joen George Inshaw (1), George Richard Inshaw (2). Improvements in apparatus for pilgering metal blooms, tubes or rods. 13.8.10.

(P.) 403/10. Reuben Jones. Improvements in stamp tappets. 17.8.10.

(C.) 406/10. Edmund Scott Gustave Rees. Improvements in ejectors, condensers, and air pumps or compressors. 19.8.10.

(C.) 407/10. Ciro Fidel Mendez. Improvements in and to relating compositions for use as a building material paint and the like. 19.8.10.

(C.) 408/10. Charles Walker. Improvements in and relating to linings for pits, shafts, and the like. 19.8.10.

(C.) 409/10. Carl Giesecke. Process for dressing ores. 19.8.10.

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