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

VOL. VIII. JANUARY, 1908. No. 7.

Proceedings
AT
Ordinary General Meeting, January 18, 1908.

The Ordinary General Meeting of the Society was held in the Chamber of Mines, on Saturday, January 18th, Prof. J. Yates (President), in the chair. There were also present :—

48 Members: Dr. J. Moir, Messrs. T. L. Carter, R. G. Bevington, W. R. Dowling, K. L. Graham, A. Heymann, A. Richardson, G. O. Smart, H. A. White, Prof. J. A. Wilkinson, W. A. Caldecott, G. Andreoli, W. Beaver, W. K. Betty, A. A. Coaton, M. H. Coombe, E. H. Croghan, G. Goodwin, J. Gray, H. D. Griffiths, J. A. Jones, J. Kennedy, M. Knight, G. A. Lawson, H. Lea, J. Lea, C. W. Lee, R. Lindsay, W. P. O. Macqueen, J. P. McKeown, J. McLennan, G. Melvill, J. E. Metcalf, J. T. Milligan, P. T. Morrisby, T. T. Nichol, W. J. R. North, J. F. Pyles, W. H. Roe, S. Shlom, J. J. R. Smythe, H. Taylor, J. A. Taylor, A. D. Viney, H. Warren, J. Watson and J. K. Wilson.

19 Associates and Students: Messrs. S. J. Cameron, J. Chilton, J. Cronin, W. J. N. Dunnachie, A. L. Edwards, J. H. Harris, G. F. Jones, R. W. Leng, A. G. Rusden, H. Rusden, C. B. Simpson, A. Thomas, A. M. Thomas, W. E. Thorpe, W. Waters, J. Whitehouse, L. J. Wilmoth, H. C. F. Bell and W. H. Johnston.

10 Visitors and Fred. Rowland, Secretary.

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

NEW MEMBERS.

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

LATHROP, PERCY DUNBAR, Langlaagte Deep, Ltd., P. O. Box 5, Fordsburg. Surveyor.

MORKEL, ARTHUR, Joker Mine, Abercorn District, *via* Salisbury, Rhodesia. Mine Owner.

The Secretary announced that the following gentlemen had been admitted as Associates by the Council since the last general meeting.

BELL, WILLOUGHBY GEORGE, B.Sc., Cosmopolitan Proprietary Gold Mine, Kookynie, West Australia. Metallurgist.

BRUNTON, CHARLES, Theta G. M. Co., Ltd., Queque, Rhodesia. Cyanider.

BULLOCK, LAWRENCE N. B., Butters' Copala Mines, Copala, Estado de Sinaloa, Mexico. Metallurgist.

MONCRIEFF, ROGER MURRAY, Oriental Consolidated Mining Co., Unsan, Korea. Mining Engineer.

MOSENTHAL, BERTIE, Consolidated Langlaagte Mines, Ltd., P. O. Box 15, Langlaagte. Assayer.

GENERAL BUSINESS.

The President: Mr. Hay, the General Manager of the Witwatersrand Deep, has been kind enough to extend an invitation to us to visit the property, and the date has been fixed for Saturday afternoon next, the 25th inst. Quite recently Mr. Salkinson, of that property, gave us a very interesting paper on "The Utilisation of Waste Heat in Slimes Settlement," and it is partly to inspect the particular apparatus connected with this, and also to look at the surface plant generally, which, I may say, is well worthy of inspection, that we purpose making this visit. I would certainly advise all of you who can get away to avail yourselves of the opportunity of seeing the Witwatersrand Deep.

Mr. E. H. Croghan: I would like to draw the attention of members to the present issue of the *Journal*, and to the very clear photographs contained therein. I think the Council is to be congratulated on the excellent manner in which the *Journal* is now produced.

The President: I am sure that will give much pleasure to the Editorial and Publications Committees, who devote a great deal of valuable time to the production of the *Journal*, We have a note by Mr. G. W. Williams which Mr. Rowland will read to you.

The Secretary: Mr. Williams writes from the Ida H. Gold Mining Company in Western Australia as follows:—

NOTE ON A MODIFICATION OF THE NORMAL TYPE OF BATTERY FRAME.

By Gerard W. Williams, A.I.M.M., F.C.S.

For the past three months the screen frame described below has given every satisfaction, and its adoption has materially decreased the time occupied in changing screens.

The frame is made in 2 in. clear pine in the usual manner. The edges of the screen panels are rabbeted out, $\frac{1}{2}$ in. deep and $\frac{3}{4}$ in. wide. In this recess an iron frame, constructed of $\frac{5}{8}$ in. square rod, fits loosely. Five lugs or buttons keep each frame in position. These lugs are held down by $\frac{1}{2}$ in. bolts, the ends of which are riveted through $1\frac{1}{2} \times 1\frac{1}{2}$ in. squares of $\frac{1}{8}$ in. plate. This plate is countersunk and held in place by screws as shown in the diagram.

The screens are bent on a bench. A block of hard wood, the size of the outer portion of the frame, is fastened to the bench and an iron frame fits loosely over this. The screen is placed on the block, the frame hammered over it and the edges trimmed off.

When a screen in the battery breaks, the lugs are loosened and the iron frame removed. One of the new screens is then put in place, the iron frame replaced and the lug screws tightened. The whole operation only occupies a few minutes. When only one panel breaks, and usually one panel will be found to break more frequently than the other, only the broken panel is removed. A certain saving in the screens is thus effected.

The value of this device is much enhanced when inside amalgamation is used. Changing the panels does not affect the sands which tend to bank up against the lower edge of the screen.

I think that millmen will find this device well worthy of trial, the slight increase in cost of the screen is soon redeemed on the saving of time and material effected.

The President: I move a vote of thanks to Mr. Williams for his little note, and we will now proceed to Mr. J. S. Curtis's paper on "The Origin of Gold in the Banket."

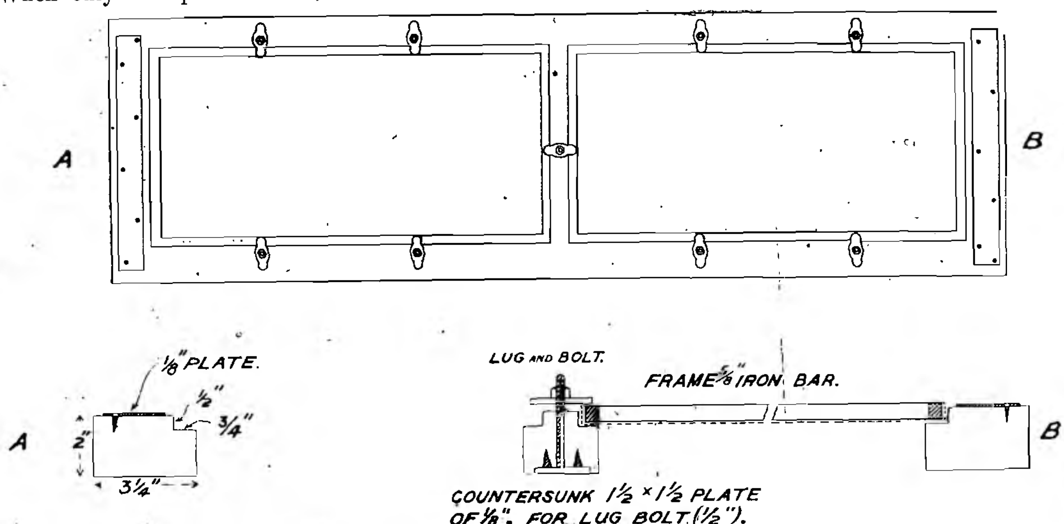
THE ORIGIN OF THE GOLD IN BANKET.

(Having reference to Prof. J. W. Gregory's paper on the same subject, read before the Institution of Mining and Metallurgy.)

By J. S. Curtis (Member).

Professor Gregory is to be congratulated upon the care and research which have enabled him to put in such clear form the numerous theories which have been advanced with regard to the origin of the gold in the banket of the Rand.

Although the object of this answer is to combat some of the views Prof. Gregory has endorsed, and although I cannot agree with him in his opinion as to the origin of the gold, I fully recognise the arguments which have led him to his present belief.



PLAN AND SECTION OF BATTERY SCREEN FRAME IDA H. G. M. CO., LTD., WESTERN AUSTRALIA.

Prof. Gregory's "Summary of Conclusions" contains almost all the points which require answering, so it is probably best to begin at the end of his paper.

I take his divisions and sub-divisions in the order in which they appear.

I. "The theory as to the origin of the banket in best agreement with the facts appears to be that which regards the banket as a marine placer in which gold and black sand (magnetite with some titaniferous iron) were laid down in a series of shore deposits. The gold was in minute particles, and it was concentrated by the wash to and fro of the tide, sweeping away the light sand and silt, while the gold collected in the sheltered places between the larger pebbles. The black sand deposited with gold has been converted into pyrites, and at the same time the gold was dissolved and re-deposited *in situ.*"

The theory of the banket deposits being originally marine placers may or may not appear to be the one "in best agreement with the facts"; it all depends upon the point of view. There are certainly a number of people who do not think that theory is a satisfactory solution of the occurrence.

"The gold was in minute particles, etc."—The deposition of the Witwatersrand beds was probably not later than the Silurian, and at that time the rainfall and consequent freshets which transported the sand and pebbles from a considerable distance to the sea shore, was very much greater than it is at the present day, and would certainly have washed away gold of the extreme fineness of that which is present in the banket of the Rand. Fine gold is certainly not characteristic of placers. There is also nothing to prove that black sand accompanied the quartz detritus which formed these beds. The bluish colour of the quartzite of the Witwatersrand beds is due to very finely divided pyrites. Did the fine quartz sand which furnished the material for this rock also contain black sand, and if so, why did it remain with the quartz sand, and why did it not sink to join the black sand in the banket? The earliest evidence of solfataric action is that which was subsequent to the great eruption of basic igneous rock which tilted up the Witwatersrand beds; and the eruption was a very long period after the deposition of these beds.

II. "The distribution of the gold agrees with that of placer deposits in the following respects:

(*a*) The gold as in a placer is contained in the cement and not in the pebbles."

This is true in the main, but it is not universally the case. It is no uncommon thing to find a pebble which has been cracked and the cracks filled with gold bearing pyrites. No better proof of the contemporaneous deposition of the gold and the pyrites can be found, and if the two were contemporaneous it can hardly be doubted that the pyrites brought the gold.

(*b*) "The gold has a wide-spread horizontal and narrow vertical range."

The meaning of this passage is not entirely clear to me. The banket reefs dip at various angles. Some of them have an inclination of 85° (from the horizontal) at the surface, and some of them an inclination of less than 30°. In depth the reefs naturally get flatter. Of course, the gold bearing deposits which are mostly the banket reefs are confined between compact foot and hanging walls of quartzite. Possibly this is what Prof. Gregory means by "narrow vertical range."

(*c*) "The gold is spread through layers which are conformable to the sediments, and is not deposited in verticals or fault planes across the bedding of the rocks, except in the case of a few unimportant secondary quartz veins."

The fact that the gold has not been deposited in "verticals" or fault planes is hardly a proof that the gold is of sedimentary origin. A large portion of the cross faults or "throws" have occurred since the deposition of the gold. As for the secondary quartz veins, gold is of extremely rare occurrence in them.

(*d*) "The gold is distributed in patches and not in shoots."

The facts do not bear out this contention. There are numerous mines on the Rand in which the gold contents of the reef do not vary a couple of pennyweights in many feet, always provided large samples, and not hand specimens, are taken for assay. "Patchy" can scarcely be reckoned a characteristic of the banket reefs. Taken as a whole, they have been noted for the uniformity of their gold contents, and this is one of the principal factors which has led to the extensive exploitation of this system of reefs. Patchy could scarcely be applied to such mines as the Crown Reef and the Geldenhuis mines. In a gold quartz mine, hand specimens taken from the same place frequently show differences in value, even in a well defined shoot of ore, but the vein is not considered patchy for that reason.

The existence of shoots, "chimneys," or vertical bodies of ore richer than the adjacent reef matter and which extend to a very considerable depth, I think, has been fully established on the Rand. First and most important is that remarkable shoot which outcropped in the ground of the Robinson, Pioneer, and The Mint companies. This shoot extended downwards into the claims of the Robinson Central Deep, into the Bonanza (now nearly worked out) and into the Crown Deep; and in all probability will extend into the claims on the dip of these properties. There is another well pronounced shoot which outcropped in the Primrose and its allied properties, and extended into the Rose Deep. The Nigel Gold Mining Company's property is full of shoots, and many instances of shoots occurring in other mines could be mentioned. If it is desired to prove that the gold of the Rand was originally placer gold, some other arguments will have to be brought forward instead af those that the gold is patchy, and that no "chutes" exist in the banket reefs.

(*e*) "The gold tends to occur on the footwall side of the conglomerate beds, or to rest on layers of quartzites, which acted as false bottoms in the reef series. Owing to the redistribution of the gold during its solution, this rule is not so general as in the case of a recent placer; but it appears to be the general experience through the Rand."

As regards the occurrence of the gold on the footwall, I am willing to admit that in many of the banket veins the richest ore is found on the footwall, but there are so many exceptions that it certainly cannot be regarded as the rule. Among the exceptions can be mentioned the Main Reef Leader, which, in the Central Rand while overlying the Main Reef, is so close to it that it forms practically a part of that banket bed, and, notwithstanding this fact, is much richer than the Main Reef itself.

The theory that the gold was deposited with the pyrite, which was precipitated from the sulphur spring solutions, easily accounts for the better quality of the ore on the footwall, as in many instances the lower portion of the banket beds were less silted up, and therefore offered easier access to these solutions than the upper portions of these beds. This is quite conceivable when it is remembered that in sedimentary beds like those of the Witwatersrand, the pebbles would settle before the finer gravel, and would naturally have more open spaces between them, offering channels for the gold bearing solutions.

Prof. Gregory speaks of the redistribution of the gold during its solution. The solvents for gold are not very numerous, and it is not easy to conceive that the metallic gold of the placers should have been dissolved by any solution which may have emanated from the hot sulphur springs or solfataras consequent upon the eruption of large quantities of the basic igneous rock which uplifted the Witwatersrand beds. On the other hand, it is quite possible that these same solfataras brought in sulphide of gold in the sulphide of iron, which was deposited in the banket beds. The sulphide of gold being a very unstable compound would soon, in the presence of air and water, be resolved into metallic gold and sulphuric acid. It is highly improbable that the sulphur springs themselves had the power to dissolve gold. If the theory of infiltration is accepted, as accounting for the presence of gold in quartz veins, there seems to be no valid reason why the presence of gold in the banket should not be accounted for in a similar manner.

(*f*) "The rich patches occur at varying horizons, dependent upon the frequent local variations in the currents that necessarily occur during the deposition of a series of deposits upon a shore."

This has already been answered under the heading II. (*d*).

III. "The objections to the infiltration theory include:

(*a*) The absence of ore shoots."

As ore shoots certainly do exist [see II. (*d*)], this cannot be taken as evidence against the infiltration theory.

(*b*) "The non-existence of the 'verticals' up which the gold may have been introduced."

"Verticals" are certainly not characteristic of all gold deposits, the genesis of which is attributed to infiltration. Moreover "verticals" have something of the nature of shoots.

(*c*) "The limitation of the gold to special seams of conglomerate and its absence from beds of sand and bastard reef which lie immediately below rich banket, and must have been equally open to percolating solutions."

The gold is unquestionably limited to certain seams of conglomerate. It is also limited to certain quartz lodes in formations where the deposition of the gold is unquestionably due to infiltration with iron pyrites and other minerals. Investigations of gold quartz veins have not yet determined why the gold bearing solutions should take any particular course, and if there has been no general rule discovered governing the distribution of the ore in quartz lodes, why should this argument be used to prove that the gold in the banket was originally placer gold?

"Beds of sand and bastard reef," which last I take to mean a coarse-grained sandstone, or as it now is a quartzite grit, did not admit of the percolation of the gold bearing solution. It is certain that compact sand will not permit of the passage of solutions as well as beds of pebbles, and this is most likely the reason that these beds carry very little gold. At any rate, these beds did not offer as free a field for infiltration as the banket beds.

IV. "The essential difference in the distribution of the gold between the placer and infiltration theories is that, according to the former, the gold should originally have been deposited at the same time as the deposition of the conglomerates; whereas, according to the infiltration theory, the gold should have been introduced after the formation of the whole sedimentary series. That the gold was contemporary with the conglomerates is shown by :—

(*a*) "The beds of ore being always parallel to the bedding planes of the rocks."

This has been answered under the headings II. (*e*) and II. (*c*).

(*b*) "The absence of the 'verticals' of South Dakota, and the copper slates of Thuringia."

Refer to III. (*b*).

(*c*) "The presence of gold in the conglomerates before they were cut through by the contemporary erosion, which led to the formation of the 'wash out' channel in the May Consolidated mine."

It does not seem to me that the case occurring in the May Consolidated mine, mentioned by Mr. Ross Browne, proves that the gold was deposited with the banket. There is no reason why the particular body formed from the sand which filled this wash-out should not also be barren. If the gold bearing solutions did not generally impregnate the quartzite, there should be no reason why this particular stratum should be impregnated.

V. The microscopic evidence shows :—

(*a*) "There is no evidence of infiltration or the presence of the secondary minerals typical of the infiltration processes."

(*b*) "There has been no conversion of the banket into a continuous sheet of vein quartz."

It cannot be denied that there is not a large amount of vein quartz in the reefs. Nevertheless crystals of quartz in small cavities where there was an opportunity for them to form, are found in the banket, and there is a certain amount of binding silica in the matrix. The varieties of lodes formed by infiltration are so numerous, ranging from the gold bearing vein of almost pure quartz to the silver or copper lode containing the greatest assortment of minerals, that it is not a convincing statement to say that there are any particular minerals or combination of minerals, which are characteristic of lodes formed by infiltration or lateral secretion, as Prof. Sandberger called the phenomenon. It must be remembered that the matrix of the banket is basic, and being basic quartz cannot predominate. If it is a fact that a predominance of basic material proves that there has not been infiltration, then only quartz and other acid lodes could have been formed in this way. It cannot be admitted that certain minerals are evidence of infiltration, and others are not. The fact that crystalline minerals are present in a vein can be taken as evidence that these minerals were deposited from solutions. They may have been deposited from infiltrated solutions or they may have been deposited from solutions formed from minerals already present in the vein, and it is not always possible to determine to which cause their presence should be attributed.

(*c*) "The secondary minerals produced, such as the chloritoid, are typical of pressure-metamorphism and have been developed alike in rich and barren rocks. Rich and poor banket, bastard reef and quartzite, are shown by the microscopic evidence to have all undergone the same changes, and the richest material sometimes shows less change than barren material."

This is very likely the case, and there may be very little difference between the banket, bastard reef and quartzite in this respect. The principal mineral brought in by infiltration was the iron pyrites, and this is most predominant in the banket. It is highly probable that the pyrite carried the gold, and, therefore, it can be considered the matrix of the gold. It can be considered more the matrix of gold than quartz, for in gold quartz veins where this mineral (pyrites) is present it is almost always associated with the gold.

VI. "The banket differs from the gold ores due to infiltration in other fields, for example, those of South Dakota; and the best general agreement is with that band of modern beach placers, which extends for 50 miles along the western coast of the South Island of New Zealand. The Kanowna lead is quoted as a case of the solution and redeposition of gold in a modern placer."

Being unacquainted with the Kanowna lead, I am unable to controvert this statement, but in view of the few solvents for gold which are known, the evidence of such a phenomenon should be very carefully sifted before it is accepted.

VII. "The absence of conclusive evidence of any considerable impoverishment in depth is an argument in favour of the alluvial origin of the gold, and is favourable to the further extension of the banket in depth."

This statement means that gold mines give out in depth. This is more or less true, but it can hardly be said to have been proved in all cases where the lodes extended for a great distance on the surface.

De Launey mentions (p. 4) the great abundance of rolled pyrites. The greater part of this pyrites is not water worn, and if a sample is broken it will be found made up of crystals radiating from the centre. The well-known "Buck-shot" ore of the New Rietfontein mine is characteristic of this formation, which resembles that found in nodules of brown iron ore. Moreover, it is hard to believe that pyritic water worn pebbles could be found associated with quartz pebbles which had been subjected to a grinding process such as has given them their present shape.

The variation in value in adjacent parts of the same reef, although not very significant, would argue more in favour of the infiltration theory than it would in favour of the placer theory. But as this argument has been used both *pro* and *con*, it seems to be one of those "rules which works both ways."

It certainly would be a difficult matter to prove that veins due to infiltration are always oblique to the stratification, and as for that it is by no means an uncommon occurrence for the gold to jump from one banket reef to a parallel one. As examples, the ore in the New Rietfontein and the Cason mines can be mentioned. There are, however, numerous similar phenomena in other mines.

Sulphuretted hydrogen was, of course, present in the solfataras, and was very likely due to the decomposition of the iron sulphide dissolved in the alkaline waters of those springs. It is not necessary to account for the presence of iron pyrites in the banket by presupposing the presence of magnetic iron (frequently a secondary product itself) which was afterwards converted into iron sulphide. There is plenty of iron pyrites in the earth's crust which was not formed by the conversion of magnetic iron. It is probable that the precipitation of the gold bearing pyrite was caused as much by the dilution and cooling of the hot spring solutions as it was by other reactions. Nevertheless, to determine what the actual reactions were which caused the deposition of the gold bearing pyrite is hardly possible at the present day, as the elements which composed the solutions were very numerous, and the physical conditions which existed at that time cannot be determined with any accuracy.

Numerous minerals besides pyrite have been found in the banket reefs, among which can be mentioned galena, a silver ore (probably silver glance), zinc blende, calcite, apatite, gypsum and some others, which the writer cannot at present recall, but which at various times fell under his observation. These minerals were not found in any quantity, with the exception perhaps of calcite, but they certainly indicate "vein action," and must have been deposited in the reefs from solutions.

I think it is fairly well established that the bigger the pebble the richer the ore, but this can only be applied to the banket of any particular reef, and there is a notable example of this in the Main Reef Leader of the Aurora West mine, where pebbles larger than a man's head are often found. Some reefs are characterised by small pebbles, for instance, the Rietfontein or Du Preez reef, but this reef, though rich, is a small one. The fact that the ore in any given reef is richer where the pebbles are large can be accounted for on the principle that the large pebbles gave freer access to the gold bearing solutions.

The trouble which I find in accepting most of Prof. Gregory's contentions is that he says the gold has been redissolved and again precipitated, and at the same time almost all the arguments he uses are based on the supposition that the gold is placer gold. If the gold has been redissolved it certainly has been transported from its original place of deposit, for it is difficult to believe that it was redeposited in the same spot a second time. It seems evident that if the gold were in solution this solution would be governed by the same laws which would have regulated its distribution had it been brought in by infiltration, and Prof. Gregory argues that the phenomena of its deposition prove it was originally placer gold.

The President: Mr. Curtis has asked me to express his regret at his inability to be present this evening to read the paper himself. Almost at the last moment he was called out of town to inspect some properties. Mr. Curtis is one of the oldest members of this Society, and it is very pleasing indeed to find him coming forward again at our meetings. To the older residents of the Rand he needs no introduction, because he was one of the men who were most prominent in the early history of these fields. We have to thank him for an able paper on a fascinating subject. This subject, the origin of gold in our banket, has tempted Mr. Curtis to re-enter the fields of scientific controversy. It is a subject which has been before us ever since these fields were discovered, and is likely to be before others when our mills have ceased to crush and our dumps are grass grown. It is of more than academic interest because upon it very largely depends the limit of payable gold in depth. It is very satisfactory to us on these fields to know that there is no conclusive evidence to indicate a material impoverishment as we go down in depth. I move a very hearty vote of thanks to Mr. Curtis for his valuable paper, and I feel sure that some of our mining men will come forward and discuss the paper as it ought to be discussed.

Mr. T. Lane Carter: I beg to second the vote of thanks, and would remark that Mr. Curtis has brought up a subject of vital importance, one which I consider should receive more attention on the Rand than it has in the past. Those of you who have taken an interest in the proceedings of the American Institute of Mining Engineers know that about ten years ago the subject of "Ore Deposits" was brought up in a paper which is now a classic on the subject and which will probably be referred to for many years to come. I refer to the excellent paper by Prof. Posepny on "Genesis of Ore Deposits." One remark he makes in that paper we should take to heart, which is, that the way ore deposits can be studied satisfactorily is for the skilled observer who comes across any phenomena out of the ordinary to carefully note them, and let the world know the facts, because in a mining stope, for instance, an interesting feature which is exposed to-day will, on account of blasting, be gone to-morrow, and unless it is carefully noted and given to the world its evidence is lost for ever. The way to get at the truth regarding the deposition of gold on the Rand is for everyone to give all the data they come across which are of any interest on the subject. I hope, therefore, in the discussion, which is sure to arise on this paper, that those who work underground, especially surveyors and samplers, will bring forward any little point of interest which they may have observed.

The President then called upon Mr. Caldecott to read his paper.

Mr. W. A. Caldecott: The notes I propose to read to-night give a brief account of some observations on works practice made during a recent visit to Mexico. With your permission, I will, at a later date, bring forward the second part of this paper in the form of a discussion on the chemical principles involved in the dissolving of silver from its ores. At present Mr. A. McA. Johnston is kindly carrying out for me some experimental work on this subject, which is not yet completed.

SOME FEATURES OF SILVER ORE TREATMENT IN MEXICO.

By W. A Caldecott, B.A., F.C.S. (Member).

Part I.—Works Practice.

As I have recently had occasion to pay a short visit to Mexico, an account of some salient features of silver ore treatment in that country may be of interest to members. Whilst there, the courtesy of the managers of some of the most progressive mining companies in the Republic enabled me to visit various reduction works, and to receive much information, some of which is incorporated in the following notes.

The remarkable advance during the last few years in the treatment of silver ore in Mexico may be very largely attributed to the replacement of the old and costly patio process by cyanide treatment preceded by very fine crushing, to railway development and to water power installations, which provide electric power cheaply for remote mines, where the cost of fuel would be prohibitive. Power is now being transmitted up to 170 miles, and supplied at 30s. per horse-power per month, or considerably less than the average cost of electric power on the Rand.

The patio process, invented at Pachuca by Bartolome de Medina in 1557, nearly a century before Van Riebeek landed at the Cape, is still in operation at the same mine in that district, but is now mainly of historical interest. The wretched condition of the mules at present employed in working it, in place of the men who used to tread the torta, makes its disappearance less regrettable than if animals had been replaced by the efficient mechanical digging appliances which have been invented for the purpose.* The process of cyanide leaching preceded by a chloridising roast is also now a thing of the past, and much the same applies to hyposulphite lixiviation.

The pioneer work of our past President, Mr. Chas. Butters, is indissolubly associated with the advance in Mexican cyaniding and fine grinding practice, whilst the El Oro Company is famous throughout the mining world for its enterprise in developing metallurgical methods. But apart from these well-known names, the results of the skill and energy of our fellow workers in charge of various ore reduction plants are obvious in every mining district. Whilst these last are without the great advantages of the cumulative experience and resources of the group organisation, this is in some measure offset by the judicious foresight of individual companies in providing means for carrying on extensive experimental work, and also adequate plants for handling the ore under routine working conditions.

The attitude of the Mexican Government under the firm rule of that remarkable man, President Porfirio Diaz, is distinctly favourable towards the investment of foreign capital in mining and other industrial enterprises. It is to be regretted, however, that in spite of the many opportunities which the application of modern methods in Mexico offers, the amount of British capital now invested there is proportionately far less than was the case some eighty years ago in the days of the United Mexican Company.†

Unskilled labour is cheap, costing in all about 1s. 6d. per day, but this advantage is somewhat offset by its irregularity, owing to the occurrence of the numerous church fiestas. The natural hereditary tendency of the Mexican labourer, or peon, to steal all of value he can, is counteracted by a regular system of special clothing for work in the extractor houses, supplemented by watchmen and electric alarms. Shrines and bull-rings to suit the tastes of workmen appear to be almost regular items in a mining company's equipment, and some knowledge of Spanish is a necessity for those engaged in mining work. In the city of Mexico an electrolytic refinery for gold and silver bullion was

* *The Mining World*, p. 693, Oct. 26, 1907.
† *The Mining World*, p. 704, Oct. 26, 1907.

started in 1906 by a private company, whose enterprise in this respect is significant.

The metric system is generally used in dealing with Mexican silver ores. Thus cyanide consumption is expressed in kilograms per metric ton of 1,000 kgm., or 2,204 lb., and silver or gold values are reported in grams per metric ton. Conversion, however, is readily accomplished by taking 1 grm. per metric ton as equal to 14 grains per 2,000 lb. ton, and 1 kgm. per metric ton as equal to 2 lb. per 2,000 lb. ton. Mexican currency is practically equivalent to one half the value of corresponding U.S. coins. Hence the peso, or Mexican dollar, is worth about 25 pence, or 0·5 dwt. gold.* The fluctuating value of silver, however, introduces a disturbing factor in mining operations with which we are happily unfamiliar here; the result of a 10 per cent. depreciation in the silver market may best be realised when the effect is considered of a possible 10 per cent. drop in the percentage recovery of gold from banket ore.

The average Mexican silver ore is usually a hard flinty quartz containing little extraneous base metal mineral.† The bulk of the value exists in the form of silver sulphide, associated at times with a little arsenic or antimony, whilst occasionally silver chloride and native silver occur. A small percentage of gold is found with the silver and constitutes a considerable proportion of the bullion value, since with silver at 2s. 6d. per oz., gold is worth 34 times as much as silver. As a rule the gold is extracted during cyanide treatment a good deal more readily than the silver, so that special attention during treatment is not paid to it. Manganese is occasionally found associated with silver ore, and is reported to exercise a detrimental effect on the extraction, but I am not aware of any accepted explanation for this effect.

The essential features of present day treatment of silver ore in Mexico consist in very fine crushing of the ore with cyanide solution, and treating the bulk of the resultant pulp as a slime by decantation followed by mechanical filtering, and zinc shaving precipitation of the solution. Whilst the foregoing broad statement may be taken as correct, there exists, as is naturally the case with a progressive art, a considerable diversity of opinion among competent operators as to the advisability of many details of practice, and hence the following more detailed descriptions must not be considered as universally applicable.

The fine state of division and uniform distribution of the values in the ore render finer crushing necessary than in common practice on the Rand, but the means adopted for this purpose naturally vary with the existing equipment of mills and with the views of those in charge. Generally speaking, stamps followed by tube-mills represent the most advanced practice, but at a Guanajuato plant stamp-milling alone with slotted screening equivalent to a wire-woven screen of 45 meshes per linear inch, serves to convert the bulk of the ore into slime, though at the cost of the low duty of 2·7 tons per stamp per 24 hours. At a Pachuca plant stamps, followed by Chilian mills crushing through 80 mesh screening, are used and yield much the same resultant pulp.

The most notable and up-to-date plant, however, is the Mexico mill of the El Oro Company, which has forty stamps and six 4 ft. × 20 ft. tube mills to reduce with 16 mesh battery screening 200 tons of hard flinty ore per day to a product, of which 90% passes a 200 mesh screen. Taking each tube-mill as equal to 20 stamps in crushing capacity, this equipment with five tube-mills running, virtually means a stamp duty of about a ton and a-half of ore per 24 hours. This mill, which has only lately started, should throw much light on the debated economic question as to whether under such conditions all-sliming yields more profit than the present usual production of 50% to 75% slimes, with the balance of the pulp as specially hard and tough fine sand requiring treatment by leaching. Should it be possible in the future to secure as rapid dissolving of the sand values as of the slime values, it is probable that the next operation of separation of solution and solid in these two products will be carried out in the same way as, for example, by horizontal mechanical filters. As is realised here, the question of the actual cost of all-sliming is of great importance in view of the simplicity and other obvious attractions of the method.* Other points of interest at the El Oro Company are the satisfactory use of separate iron guides instead of wooden battery guides, and of concrete mortar blocks. Trials are now proceeding in stamp milling without battery screening but with a high slot discharge on the lines of the old German schubersatz.† As at the well-known Homestake Company in the Black Hills district in South Dakota, a foundry is run by the El Oro Company, and also a small blast furnace for periodically working up slag and other by-products, both of which prove of great service. The corrugated cast-iron tube-mill lining block which was described on p. 60 of the August (1907) issue of this *Journal*, is employed and is claimed to give treble the life of plain iron liners.

Amalgamated copper plates are not generally used in Mexican reduction plants, but following

* The legal value of the peso is equivalent to 0·75 grm. fine gold.
† Cp. Hofman's "Hydro-metallurgy of Silver," p. 286, 1907.

* See Mining and Scientific Press, p. 658, Nov. 23, 1907.
† Richard's "Ore Dressing," vol. i., p. 214, 1903.

the stamps and sometimes the regrinding appliances as well, Wilfley or other concentrators are employed to remove any metallic or granular particles of valuable mineral, which would yield but a poor extraction in the sand plant. The concentrates are usually shipped to a smelter together with a certain amount of hand-picked rich ore.

The system of the secondary grinding circuit involving hydraulic classification of all final pulp, with which we are so familiar on the Rand, is not in invariable use, and in general, less attention seems to be paid to minimum water ratio in tube milling, and to maximum practicable weight, drop, and speed of stamps than is considered advisable here.

Sand is commonly separated in vats from the pulp leaving the battery by Butters distributors, and long sand treatment is usual, whilst belt transfer and Blaisdell excavators and aerators are likewise employed at some mills. When the fall and water available permit of it, discharge of sand as well as slime residues by hydraulicking into the creek is practised, and this obvious advantage is little restricted by laws upon the fouling of streams.

In slime treatment, a notable feature is the lengthy agitation and aeration by means of ordinary stirring gear, which sometimes occupies in all fifty hours. This is rendered necessary by the slow rate of solution of the silver.* An ingenious system for the combined aeration and agitation of sand as well as slime, on the principle of a vertical Pohle air-lift pipe in the centre of a conical bottomed vat, 40 ft. high, and 15 ft. in diameter, has been lately introduced at Pachuca from Australia.† In one or two old plants, with shallow rectangular sand vats, converted into slime vats, stirring and aeration are more or less imperfectly performed by means of a small pipe attached to an air-hose, which is plunged by hand below the surface of the pulp into different parts of the vat in turn.

When mechanical stirring gear is used, settlement between the numerous decantations and agitations is not carried to completeness on account of the difficulty of starting stirring again, with the result that although as much as 10 tons of solution per ton of dry slimes are decanted off for precipitation, washing is relatively imperfect, and the strong 0·1% solution frequently used in slime treatment causes a heavy mechanical loss of cyanide in the solution discharged with the residues. To reduce this loss, which may approach 2 lb. of cyanide per ton of dry slimes, as well as to improve the percentage recovery of the silver and gold, mechanical filters to follow and supplement the decantation treatment are coming into general use. The Butters* filter is most generally employed, though the Ridgway,† Burt‡ and others are now also being exploited. As elsewhere, clogging of filters in time with lime salts reduces their efficiency and necessitates periodical treatment of the cloths in a dilute hydrochloric acid bath.

In addition to the use of strong solution in slime treatment a good deal of lead acetate** is added to the charge of slime-pulp, varying from 4 oz. to 12 oz. per ton of dry slimes. This is many times the amount of, say, ½ oz. per ton used here; and the apparent reason for the practice is discussed later in the second portion of this paper.

In precipitation practice the variations caused by differing conditions from gold ore treatment are likewise very noticeable. The strong solutions employed and the considerable weight of silver to be precipitated cause the employment of somewhat coarse zinc shavings, for which lead-coating is not needed, as the zinc-silver couple soon formed yields a high precipitating efficiency. As a rule, the extractor boxes are placed several feet above the floor so that in cleaning up, the slimes can be gravitated to a common sump, which supplies the suction hose of the filter-press pump. Simple passing through a fine screen of the zinc-box precipitate affords a product containing half its weight or more of bullion, which is briquetted by air pressure, after partial drying with hot air in the press or in a steam heated pan, and is then smelted into a high grade bullion without any acid treatment. As a plant may yield a ton of bullion in a month, a weekly clean up is common practice, and very large (No. 300) graphite crucibles or forged steel pots 1·5 in. thick are used. Furnaces using crude oil as fuel are in common use, and at the El Oro Company a neat quick-acting air-lift is employed to lift crucibles from the furnace for pouring.

At present the total cyanide consumption varies from two to four pounds per ton of ore and the percentage recovery from all sources of the silver contents of the ore from 70% to 90%, and of the gold appreciably more. As might be expected with very fine crushing, and heavy power and cyanide consumption, ore treatment costs are relatively high, and vary between 8s. and 12s. per ton of ore, according to local conditions.††

* See Griffiths and Oldfield, and Proc. I.M.M., p. 448. vol. xii., 1903; also Trans. Am. Inst. of Mining Eng., pp. 279 and 660, Vol. xxxvi., 1905; also Julian and Smart's "Cyaniding Gold and Silver Ores," p. 70, 1907.

† The Mining World, p. 693, Oct. 26, 1907; also, Mining and Sc. Press, p. 689, Nov. 30, 1907; also, this *Journal*, p. 325, April, 1906.

* *The Mining and Scientific Press*, June 22 and 29, 1907.

† See Allen's "West Australian Metallurgical Practice," p. 176, 1906.

‡ *The Mining and Scientific Press*, p. 717, Dec. 7, 1907.

** Patented by J. S. McArthur and C. J. Ellis in 1893.

†† See Transactions American Institute of Mining Engineers, p. 217, May, 1905, vol. xxxvi.

Apart from the fineness and efficiency of crushing, and the reduction of solution value discharged with the residues to a minimum, the chief directions in which future improvement may find scope are probably in reduction of time of slime-pulp agitation and aeration, the more perfect dissolving of the values with lower cyanide consumption, and their concentration in a much less bulk of solution, with corresponding reduction of the precipitation plant. These changes if ever found practicable would reduce power, cyanide, and precipitation costs, as well as lessen the size of plants, which at present greatly exceed in proportion those in operation on the Rand.

Finally, I am sure it will please members to learn that in Mexico, as in the gold mining camps of the United States, our *Journal* is carefully studied, the record of frank discussion which it contains being specially appreciated.

The President: I am sure you will join with me in extending a warm welcome to Mr. Caldecott who has just returned from a long holiday. There are a few members who have taken a conspicuous part in the making of this Society, and I am sure that everyone will agree with me that Mr. Caldecott is one of those few. And as evidence that his energy and interest have in no wise abated, I refer you to the paper he has given us this evening, and to our recent transactions, and, if I may say so on your behalf, this paper is, I hope, merely the forerunner of many others in which he will give us the benefit of what he has seen in his travels. So far as I can gather, his holiday has merely been a holiday in name, for he has covered over 30,000 miles and inspected no fewer than 30 plants in the States and elsewhere. I move a vote of thanks to Mr. Caldecott for his paper.

Prof. J. A. Wilkinson: I have much pleasure in seconding this vote of thanks. This question of the metallurgy of silver is to the teacher a tremendous bugbear, because text books, even modern ones, give innumerable processes, many of which, I believe, are obsolete now, and the ardent enquirer after the truth is left floundering in the mire. The process which Mr. Caldecott has detailed is practically the same as that which is used for the extraction of gold on these fields, namely, crushing in stamp or tube mills, leaching with cyanide, decantation and afterwards precipitation with zinc shavings. It is somewhat remarkable that such a process should be suitable for the treatment of silver sulphide ores, and I think the process as worked out here for gold may claim to be the parent of Mexican silver treatment. The author also mentioned the mining law of Mexico, and in this connection I should like to state that some years ago, when reading a paper on the mining laws of different countries, given before the Institution of Mining and Metallurgy, London,* the author said the mining law of Mexico was one of the best in the world, because it was one of the simplest.

NOTES ON THE ESTIMATION OF CAUSTIC LIME.

(Read at August Meeting, 1907.)

By Edw. H. Croghan (Member).

The Secretary read a note from Mr. J. Gray, pointing out "That on page 183 (middle of the page) the following occurs, 'and its determination by any method would only be a rough guide to cyaniders in arriving at the value of the lime supplied to them.' This should read as follows :—'and its . . . . . . method would not assist cyaniders in arriving at the value of the lime supplied to them.'"

REPLY TO DISCUSSION.

Mr. E. H. Croghan: In opening the reply to the discussion, I wish to express my satisfaction at the interest that has been stimulated by the paper.

Mr. Johnston is of the opinion that the presence of silicates and aluminates in limes is not proved; still, the presence of the former is an acknowledged fact, and the latter may also possibly occur. In trying to account for the discrepancies of the gravimetric method, the error was so great, especially in the blue lime, that it seemed quite evident that the formation of some aluminate had to be assumed, if not necessarily such a simple combination as the one employed in the calculations.

As regards the sampling of limes, this is a question which requires very careful consideration so as to ensure satisfaction to all parties concerned. I think this is a matter which at some future time should be thoroughly gone into with the view of trying to fix some standard method of procedure. It is quite useless testing lime samples when a person feels that one is, under present conditions, purely at the mercy of any individual sampler—a state of affairs which makes it practically a speculative venture whether a buyer is getting really a proper value for his money, and *vice versa* for the seller.

* See "The Mining Law of the United States of Mexico," by W. H. Trewartha James, Transactions Institute of Mining and Metallurgy, vol. ix., pp. 16—23, 1900—1901. *Extract*—"to a mining code for the principles of which the author claims an almost ideal perfection—the present mining code of Mexico."

The procedure Mr. Johnston adopts seems to be pretty thorough, but appears to involve a good deal of time and labour, whereas it is quite within reason that some more expeditious and less tedious method might be agreed on. Personally I do not feel in a position at present to offer any new suggestions.

The deterioration of limes from atmospheric exposure is purely a supposition: still, if the manner in which I have observed limes to be stored on some mines be at all general, it seems to me that especially during damp weather deterioration will take place to quite an appreciable extent. I am therefore still of the opinion that the erection of suitable structures as air tight as possible, is well worthy of consideration. The expense would be very small, and the cyanide manager would be in a better position in feeling that he can, on the basis on which a consignment was bought, use the same amounts, and thus keep his solutions up to the standard alkalinity he requires. As regards the correction of from 0·5 to 1% which Mr. Johnston adds, on the filtration process this is certainly necessary in itself, but if it is to allow for the exposure during sampling, I think it should be possibly a bit more, the variations depending on the weather conditions. I simply mention this, but not for the purpose of letting the seller of limes take advantage of and try and insist upon it, as in consequence of the properties of caustic limes he must allow some degree of consideration. I think if a standard method be adopted, such as the one employed in this paper, the final modifications of which I shall subsequently state, then no corrections need be applied.

Mr. Crosse, I regret to note, absolutely condemns the use of magnesia or dolomitic lime. On our present scanty knowledge of any published data on the subject, this surely cannot be accepted. Cases are believed to be known where equally good results have been obtained with blue limes as with the ordinary white limes generally employed here. The possibilities of the former were especially emphasised by me in consequence not only of their cheapness, but also their contents of manganese oxides. There seems to be generally sufficient caustic lime, which will not only effect slimes settlement, but also the requisite degree of alkalinity, and in this latter connection the magnesia is not a useless factor. Under the conditions of the large volumes of solutions which are handled, even its slight solubility deserves some consideration. I feel sure that collective data on blue limes by those who have had personal practical experience with both kinds would most probably afford a paper of very interesting, useful, and perhaps surprising information, and quite contrary to ordinary theories.

Mr. Taylor mentions the average percentages of his limes at different periods of the year. If other confirmatory data were brought forward, it is quite possible that it would be sufficiently remunerative to lime burners to adopt such precautions for the transport of their material, as would enable them practically alway sto keep up the standard quality of their respective limes.

Prof. Stanley and others are of the opinion that the figures obtained for soluble silica may not be quite correct, and probably are really a little higher, thereby obviating the assumption that an aluminate may be formed, but I think the data are quite reliable.

In stating the method employed, which was open for criticism, it was by oversight not mentioned that after the acid treatment the soluble silica is dehydrated at 150° C. to 160° C. This residue was then proceeded with by dissolving out by very dilute acid the calcium chloride, etc., and extracting the soluble silica from the insoluble residue by sodium carbonate solution, as stated. Quartz sand will not be affected at all.

The corrections pointed out by Prof. Stanley should be as he states; the mistakes were inadvertently overlooked.

Dr. Moir's remarks are chiefly concerned with the slight yet important differences which exist between Mr. Hendrick's work and my own. I may state that it is particularly gratifying to observe the very full abstract in our *Journal* and inserted after my paper, of Mr. Hendrick's detailed work. Still, in view of the points Dr. Moir has discussed between the two papers, there are certain ones I should like also to refer to. These might be considered under three headings:—

No. 1.—The strength of the sugar solution.

No. 2.—The indicator adopted.

No. 3.—The distinction between determining only CaO (caustic lime) in limes, and determining total available alkalinity expressed in terms of CaO, due also to effects of magnesia, carbonate of lime, calcium silicates, etc.

I.—The strength of the sugar solution in Comey's "Dictionary of Chemical Solubilities, Inorganic," is given in a table showing the solubility of CaO in sugar water. As an example, I take the figure that 1·031 gm. of CaO are dissolved by 4·850 gm. of sugar in 100 c.c. of water.

Again, Mr. Hendrick states that whilst 5% of sugar is too low a concentration, there is little difference in the results obtained from the stronger solutions.

Taking the highest figure ·8316 gm. as the true quantity of CaO in 1 gm. of sample, the quantity of actual CaO contained in 5 gm. of the sample is 4·158 gm. From Comey's figures, 19·56 gm. of sugar would be required to dissolve the above amount of 4·158 gm. CaO. This seems a curious point in view of the fact that Mr. Hendrick employed 500 c.c. of a 5% sugar solution which would contain 25 gm. of sugar, and should therefore have been quite sufficient to dissolve the CaO.

If Mr. Hendrick is right, then it follows that Comey is wrong. With regard to Comey's figures, it should be noted that they represent the combined result of the solubility of CaO in sugar water added to that in plain water, but Comey unfortunately calculates a ratio of sugar to lime, which is quite misleading. The true ratio of lime to sugar in the sucrate existing in these solutions can only be calculated after one has subtracted the amount of CaO in solution in the water alone. If this be done, it will be found that the ratio is very near the theoretical, viz. :—1 : 6·1. The solubility of CaO in water alone at 20° C. is some 1·26 gm. per litre. Therefore for 500 c.c. it would be 0·63 gm. If this amount be subtracted from 4·158 gm., we should have 3·528 gm. left for the 25 gm. of sugar to dissolve, a ratio of just about 1 : 7. As the theoretical ratio is as 1 : 6·1, it would therefore seem that Mr. Hendrick's 5% experiment is wrong, and possibly the explanation might be that not sufficient time of contact was allowed, or the sample was too coarse. On the basis of the above argument, that 1·26 gm. CaO at 20° C. are dissolved per litre by water alone, then, since in my experiments 2 gm. of a sample were used, (assuming it to be 100% purity in caustic CaO), and 1 litre of a 2% sugar solution was used, it is quite possible that a litre of only 0·4% sugar solution would dissolve all the lime. This can naturally be verified by further experiment.

II.—*The Indicator Employed.*—In Mr. Hendrick's method the indicator used is methyl orange on the filtered solution, whereas in my process phenolphthalein is adopted on the original unfiltered solution. With the method stated in my paper, methyl orange cannot be employed, as it indicates total alkalinity, inclusive of carbonate of lime, etc. But phenolphthalein can be safely used. The reason of this is, that as long as we have present actual *caustic* alkalinity, the colour remains, but immediately this is neutralised, the colour disappears, and is therefore the true endpoint. Any reappearance of colour which slowly reappears should not be noted.

This leads to the third point, that is the distinction between true caustic CaO and total available alkalinity expressed in terms of CaO. Dr. Moir suggests the above term "total available alkalinity," and this seems to me the most correct phrase, it being always understood here in reference to CaO, and thus the alkalinity due to the slight solubilities of carbonate of lime, magnesia, etc., is covered by the method. The term caustic lime is therefore not a correct expression for the Rand, although right from the agricultural point of view.

I agree that one can minimise the filtration error by adopting rather the decantation process, that is, after shaking, and then allowing the suspended matters to settle and working on an aliquot portion of the clear solution. The addition of alcohol would be possibly unnecessary if the sugar is first dissolved in, say, half the quantity of water, and then the lime sample added, giving at once a gentle rotatory motion, which should prevent any cake being formed. The alcohol is always a possible source of error, unless it has been previously tested and neutralised.

The prussic acid process Dr. Moir suggests would possibly prove of great service if at some future time experiments were conducted with a view to proving the sugar process. At present I have not been in a position to try it, but hope to at some future occasion, when the results will be placed before you, unless some one will have had the time and facilities to proceed with it sooner.

Mr. Gray's contribution somewhat took me by surprise, and I have perforce to divide it into two sections, firstly, the deprecating and caustic vein, and secondly, that appertaining to the paper proper, which only need be considered. Some points he has raised have previously been referred to. The existence of the literature Mr. Gray refers to does not entitle him to adopt the attitude he took up. The investigations I undertook were not originally intended for publication as they did not seem to me of any great value, but that the paper has borne some fruit is self-evident from the discussions that have taken place, especially in view of Mr. Hendrick's work, which, with one or two exceptions, arrives at the same conclusions as mine, and I therefore do not feel that I have lost any of my self-respect, in that Mr. Gray tries to point out my supposed ignorance as to how investigations of this description should be carried out. The aspersion Mr. Gray tries to throw on the results obtained by me with the sugar method is rather narrow-minded. Perhaps Mr. Gray, who uses the sugar method at present, will vouchsafe us the information how he has avoided, at the time of writing, these same errors himself. It seems a curious point that Mr. Gray does not note the close agreement of the acid and the sugar method. Is this an oversight in not discussing it, or is the acid method correct; if so, is the sugar method I propose a proper one? The obsolete gravimetric method has until recently been employed by his confrères, and it therefore seems to me a peculiar proceeding that the sugar method is now adopted by him. Is it possibly due to the fact that it simply entails very little time and is a very ready and convenient process to adopt, without having definitely proved it first, and is therefore good enough for their purposes. I still remember the time Mr. G. W. Williams suggested the sugar method—when by many chemists it was ridiculed not publicly but privately.

In regard to the theory I proposed, which was the final extract from a long series of calculations, it would have been more to the point, if instead of decrying it as Mr. Gray did, he had rather recalculated a fresh one. Extracts from literature are a simple matter, still it would have done Mr. Gray no harm to do a little mathematical work on the more recent investigations of silicates, etc. The only points of interest and any value of Mr. Gray's remarks are the experiments he carried out. The filtration method certainly seems out of it, and the point seems to rest between the shaking and decantation processes. More experiments are needed, and possibly on totally different lines. At present the method I would propose is as follows:—The lime is all ground to pass through a No. 60 sieve. Transfer 2 gm. of the lime sample through a glass funnel into a litre flask containing 20 gm. sugar dissolved in about 300 c.c. distilled water, giving a rotatory motion as the sample falls into the solution. This prevents any caking taking place, and obviates the addition of any alcohol. Make up to 1 litre and shake for half an hour. Let stand about 12 hours or overnight. Shake the mixture thoroughly for about half a minute or so, and immediately measure out 250 c.c. into a large beaker (600 c.c. capacity). Add 5 c.c. of a 1% neutral alcoholic solution of phenolphthalein and titrate with $N/10$ acid, constantly stirring and taking the end point on the first disappearance of the colour, and not that which often slowly reappears. Each c.c. of $N/10$ acid on the 250 c.c. taken is equal to 0·56% of alkali, calculated as CaO, or 0·34% when calculated as Dr. Moir's pet hydroxidion, a name, which to cyanide men and persons concerned might seem in sound akin to the somewhat terrifying illustrations and names of prehistoric times.

To avoid calculations, take 2·24 gm. of the lime sample, and adopt, say, a 2% sugar solution, then proceeding as above, each c.c. of $N/10$ acid is equal to 0·5%.

In conclusion, I would beg to thank not only those who have discussed the paper on its merits and in an impartial spirit, but also Mr. H. D. Bell for the analytical help accorded to me by him.

The President: I have already thanked Mr. Croghan for his paper, and I think we are further indebted to him now for the discussion which it has drawn, and for his reply thereto.

NOTES ON WAIHI ORE TREATMENT.

(*Read at July Meeting, 1907.*)

By Ralph Stokes (Member).

REPLY TO DISCUSSION.

Mr. R. Stokes: In reply to the comments on my paper I must express gratitude to those contributing to the discussion for having so leniently passed over the many shortcomings, essential to a report based upon the observations of an outside observer. The remarks of Mr. Dowling and Mr. Deakin were, for the most, elaborative of my description, but Mr. Alexander has fault to find with the inadequacy of detail provided, relative to tube mill practice, for sound comparative purposes. He says that he "cannot agree with the author that there is any parallel between his description of tube milling at the Waihi and common practice on the Rand . . . ." I cannot admit that I endeavoured to establish any such similarity between the two fields, for I primarily drew attention to the peculiar hardness of the Waihi's chalcedonic quartz. With a fundamental distinction between the ores treated, it seemed to be unprofitable to attempt any detailed comparison of efficiencies or to provide data which might appear to suggest a superiority of skill on either side. Regarding the "home-made" honeycomb liners, patented by Mr. Barry, it may be mentioned that these had only been in operation for a few months at the time of my visit, a year ago, but I hope to obtain from New Zealand some notes upon their life and general economy, in the light of recent performances, for publication in this *Journal*. With regard to vacuum filters, to which Mr. Dowling and Mr. Alexander referred appreciatively, I may add that the Waihi Company has now largely increased its complement of these machines, after an experience of their functions which should have proved conclusive.

THE LABORATORY: ITS ECONOMIC VALUE.

(*Read at October Meeting, 1907.*)

By A. McArthur Johnston, M.A., F.C.S. (Member).

DISCUSSION.

Mr. A. Richardson: As the author remarks, the quality of the explosives in use here is so excellent that accidents cannot be attributed to faulty manufacture; it is doubtful, however, if we derive full advantage from the energy available.

It is popularly supposed that in the detonation of a charge the force developed in the first cartridge is the same as that developed in the last, but experiments have proved that there is a diminution in the strength of the detonation as it proceeds down the line of explosive, pointing to the necessity of employing a detonator, which by a powerful initial blow will insure the superior detonation of the charge right to the bottom of the hole, an important consideration if the drilling of 10 and 12 ft. machine holes should become the general practice.

In some tests conducted in America it was found that the relative strength of a 60% dynamite was 59·7, 62·2, and 63·3 when detonated with No. 3 (American) (9 gr.* fulminate), No. 4 (American) (12 gr.), and No. 5 (American) (15 gr.) caps respectively, but on the Rand we have no information to guide us as to whether we may look for an increased effect with gelignite and blasting gelatine if instead of the usual English No. 6 detonator (15·4 gr. fulminate) we use No. 7 (23·1 gr.) or No. 8 (30·9 gr.). Those who have had the opportunity of using No. 8 detonators have told me that they never got an unbottomed hole with them, a statement that did not apply when using No. 6. It is important, therefore, that we should have some tests on this head, as the use of an unsuitable detonator leads to an inferior order of detonation, with its accompanying generation of noxious gases, inefficiency and danger.

There is another point worth investigating, that is, the rate of deterioration in the strength of detonators when exposed to mine air, for although detonators are used up rapidly, a box may remain below a good many shifts before it is finally disposed of, with a resulting loss, in a damp situation, of a large percentage in strength, and, as a consequence, poor detonation and its results. It has been found, for instance, that detonators kept in a bottle on damp sawdust failed, after 40 hours, to explode dynamite, a more sensitive compound than either gelignite or blasting gelatine, although they still exploded themselves.

In conclusion, I would like to ask for a reproduction of the Quinan curve in the *Journal*, its equation, and an illustration of the practical uses to which it can be put.

* The English equivalents are: No. 3, 8·3 grains; No. 4, 10 grains; No. 5, 12·3 grains.

NOTES ON SMALL STOPE DRILLS.

(*Read at October Meeting, 1907.*)

By E. M. Weston (Associate).

DISCUSSION.

Mr. T. Lane Carter: A great deal has been said on this paper, and I have no desire to cover ground already gone over. Mr. Weston, in his paper, gives his experience of small drills up to date, if I can put it that way, and his experience has apparently not been over satisfactory. He mentions the Holman drill, and I can bear out what he says with respect to it. The small drills we have had on the Rand have not hitherto been a success. I have tried these small drills, tried to get a narrow stoping width with them, and after several months found it paid me to take the machines out of the stopes and put in ordinary 3¼ and 2¾ in. Ingersoll-Sergeant drills. I remember one instance before the war where an efficient miner was put on contract on the basis of the width of his stope and with an ordinary 3¼ in. machine he managed to carry the stope 36 in. for a number of months. Of course, conditions were favourable, but it shows that with large machines and good workmen narrow stoping widths are often possible. There is one point to which I do not think sufficient attention has been given. The vital question in regard to small drills is "can they carry a stope narrow enough?" That is what we are aiming for and what we need. It is often the custom of the Rand to consider only from the point of view of the central section, the rich section, but those of you who know the East and West Rand are aware that there is a great difference in the conditions, and that machines suitable for the Central Rand are not so satisfactory in the poorer districts. The question of narrow stoping is one, which is of most vital importance to the poorer sections of the Rand. On the central section there is such a splendid margin of payability that a few inches in stoping width more or less does not mean as much as on the western section, where an average difference of 6 in. in stoping widths may mean the difference between a payable and an unpayable mine, and the narrow stopes therefore become imperative. Personally, I am rather sceptical as to narrow stoping with small drills over an extended period. I know from experience that with a good man working on the bonus system for narrow stoping widths, it is possible to carry stopes in favourable ground, 24 in. and under, but I very much doubt whether any small machine yet invented will carry a stope of this width under similar conditions. I sincerely hope one will be forthcoming, but I have serious doubts. In connection with Mr. Weston's paper I suppose you have read a paper which came out last year in the American Institute of Mining Engineers, dealing with small drills, from which it is interesting to see that the results obtained over there are favourable to their use. There is also the question of air mains and leakages. I think we have at last awakened to the fact that in many mines on the Rand sufficient attention has not been given to this very important point of air mains. The air pipes were put down many years ago, and to put in pipes of the proper size to-day would in many instances involve a large capital expenditure, but where that capital is in hand I think in many cases it would pay to take up the pipes and put down larger ones, as the loss due to inefficient work and extra coal consumption is great. On some mines the direct loss due to air pipes of too small section is from £100 to £200 per month in extra coal consumed for air compression. I am sure the discussion of this paper and of other papers will establish the fact of the necessity of larger pipes and sufficient air pressure in our mines, and in future in our deep level mines more attention will be given to the installation of the air pipes. Mr. Weston mentions electric drills. I believe if an electric drill could be invented which would be efficient it would be a great blessing, but I do not believe there is much scope for a drill which is supplied by air compressed in the mine by an electric machine near by. The only places where such machines would be successful are in countries like the Western States or Italy, where there is enormous water power, and where electricity is very cheap, but until the Victoria Falls electricity gets here I am afraid power will not be cheap enough on the Rand for such machines.

Mr. H. Fraser Roche: In the main I agree with Mr. Weston's ideas of stope drills, and in making a few remarks on the paper, would like to try and emphasise a few of the most important points in it.

High pressure at the machine is a point which most of us recognise the importance of, but are not always able to obtain or maintain, as the requirements of many mills are greater than most compressors can support. The increase in efficiency in drilling, due to higher pressures, is more than directly proportional to the increase in pressure. As Mr. Weston says, it is evidently impossible to make any big installation of stope drills without adequately increasing the compressor plant. While touching on air pressures, I would mention that the management of the Village Deep have during the past nine months carried out exhaustive trials on a new type of machine, the Konomax. Some people claim that they have had this type of machine on the shelves of their curiosity shops for years, and if this is the case, I consider it is very poor testimony to their intelligence that they did not make more use of what is evidently a big step forward in rock drilling machines.

The highest compliment that can be paid to the Konomax, is the fact that the extended trials of the machine have been so satisfactory, that the management of the Village Deep have installed 50 of these machines in their mines.

The net result of these trials shows that, under similar working conditions, they do their day's work as rapidly and as well as any machines at present in use on these fields, and with an air consumption of up to 40% less than other machines. Certainly there are a few small errors in design and manufacture; however, I do not doubt that the Konomax of the future will be even better than that of to-day. Anyway, as it is the most efficient drilling machine at present in use on these fields, it is a considerable feather in the cap of the local inventor. The only other machine of this type is the Minimax, and, so far, this machine has not proved equal to the Konomax; it has several defects in design, the chief being great length of exhaust port. I trust the Rand Drill Co. will try again, and succeed in making a better machine.

Going on to small stope drills, I am not personally acquainted with many of them, and think that these fields have yet to discover a really serviceable one.

I attach very little importance to the stope drill contests, now in progress (it may certainly prove that some drills are quite unsuitable for the work they are expected to perform) and maintain that those that are shown up well have their real tests still to undergo, in trials of six months' duration under normal mining conditions to prove their general reliability, durability, and low cost of maintenance. The Gordon seems to me to be the best I have seen so far, and is now certainly a model of manufacturers' skill. I do not, however, favour a hammer drill for the hard quartzites of our deep levels.

As Mr. Weston says, the Little Konomax is a most ingenious machine, and I was most taken with it; when complete it should prove to be right in the front rank of the stope drills. It has the additional advantage of having an automatic feed. Before leaving the drills, I would like to impress on manufacturers and others the necessity of indicating their machines. The indicator diagram of a rock drill shows up very easily and quickly any defects in the valve motion and internal working of the machine. The cards off the Konomax are now as perfect as those of a big steam engine, and by this means most of the original defects have been removed. Several other types of machines, largely in use on these fields, show considerable wire drawing and compression.

As the author states, we know but little of rock cutting and cutting edges. We have been experimenting a good deal in this line of late, and shall at a later date give some figures of the results obtained. So far, the weakest point in the drilling machine is the shank, about mid-way between point of power and the cutting edge. The drill is out of proportion, and consequently we get much vibration and loss of gauge in our cutting bits; with greater rigidity we can start at 2 in. and finish at $1\frac{3}{8}$ in. To effect this, we are having our shanks made up to $1\frac{3}{8}$ in., instead of $1\frac{1}{8}$ in., and find increases in speed of drilling up to 25%. The employment of big shanks I consider to be one of the most important factors in increasing the efficiency of our rock drilling, and I am certain that this will be shortly taken up universally on these fields.

Another point in conclusion, our cutting edges are too sharp; a greater angle gives us better results. I have seen and tried the Anderson bit, and consider it a most promising tool; it should certainly replace our present system of steels. All the advantages claimed for it by Mr. Anderson are borne out in practice. The increase in drilling speed is, I think, mostly due to the big shanks.

The author, by his excellent paper, deserves our great thanks, and I hope the interest aroused by it may be fully maintained.

Mr. M. H. Coombe: I see that this is the last time this paper is up for discussion, and I would like to take the opinion of members present as to whether the discussion cannot be continued at the next meeting in view of the great interest aroused, and also in view of the recent stope drill contests at the Robinson. A great deal of argumentative matter has accumulated round these contests, and I think it would be better to postpone the final discussion until our next meeting. I have been personally making some notes, as this matter of rock drilling appeals to me very strongly, and I intended to bring them up this evening, until I saw our President's evidence given before the Mining Commission, in which I found some matters which I should like to digest a little more before I come to a conclusion. I am somewhat of the same mind as Mr. Carter. I believe they will have to do a good deal of inventing yet, and bring out a good deal better device than even the Gordon drill, before they will be able to compete economically with hand labour in a small stope. My contention is that if air can be led to a small stope drill it can be led also to a larger drill. My experience has always been in favour of a large drill, and it has shown me over and over again that the big machines beat the little ones. I remember that we were once short of hand labour and I took small machines and two of the best men I could find. They brought the stope from 30 in. with hand labour to nearly 4 ft. I had no false hanging wall and nothing to prevent keeping the stope small. I put in two large machines and did much better work. It is my conviction that where I can work a small machine I can work a large one to better advantage, and if I want to carry a stope economically, I can work anything under 5 ft. with hand labour far more economically than I can work machines, and so can any other man on these fields.

The President: We have already decided to continue the discussion of this paper, and I am very pleased you are going to come forward and give us your views at the next meeting. I promised when Mr. Weston read his paper to say a few words upon it, but it so happens that what I had intended to say in the course of discussion on this paper I said in my report to "South African Mines" and also before the Industry Commission; but I have been asked by several members of the Council to hand that statement in as a contribution to the discussion, and also to read to you the final paragraphs, so with your permission I will do that.

1. ONE MAN STOPING MACHINES.

The competition was confined by the promoters to machines, which, during the trial could be handled by one man. The idea underlying this was presumably, that if a really satisfactory small drill was obtainable, and could be placed in the hands of unskilled white labourers under skilled supervision, or in the hands of selected natives under white supervision, in each case there being one man to each machine, it would be a momentous step in the direction of solving our labour problem. But one man per machine is not absolutely essential for this. It is quite conceivable that the same end could be obtained with two men per machine, and it must be remembered that our coloured labour is comparatively cheap, and the additional cost of a Kafir assistant to the unskilled white man, or of two Kafirs on a machine, one the runner, and the other the assistant, might be more than counterbalanced by exceptionally good work on the part of the drill. Even in the case of the machines which can be quite comfortably handled by one man, the comparative cheapness of our coloured labour may determine that, for the best economic results, they should be run by two men rather than by one. This question as to whether there should be one man or two men to each machine is really of minor importance, but is of interest at this juncture, because a machine weighing $129\frac{1}{2}$ lb. entered the contest, and most of them scaled 100 lb., or over. I believe I am right in saying that in at least some of these cases, the competitors made no pretence of considering their machines one man drills, except for the purpose of this particular competition. That weight is a most important factor in the selection of a machine for stopes of 3 ft. and less, requires no discussion ; in such cramped working places the manipulation of the lightest machine is fatiguing to a degree, and great weight is prohibitive, but it appears to me that between this limit and the 4 ft. 6 in. stopes in which our $2\frac{3}{4}$ in. to $3\frac{1}{4}$ in. diameter machines find economical application, experience may prove that good machines of, say, even 130 lb. are capable of doing satisfactory work, notwithstanding the handicap of this weight.

One important point on which the trials departed from every day practice in very small stopes, was in drilling four holes from each rig up. We are looking for a machine which will prove a satisfactory substitute for hand drilling in our small stopes—stopes which we would like in most cases to see 3 ft. and under, and which do not exceed 4 ft. 6 in., this latter figure bringing the stope within the sphere of large machines. Now with a good hanging and foot wall, one hand hole will cover the width of even a 3-ft. stope, and, generally speaking, the benches in such stopes are often one hole benches, each hole being pointed to take full advantage of planes of weakness, etc., and each hole being blasted before a back one is drilled. In this way a high duty is obtained, and there is economy of explosives, about 60% of that needed with machines sufficing, a saving which is worth noting. With the ordinary machine, the holes, because of the weight, are located in an arbitary fashion ; lines of weakness, etc., are ignored, and generally speaking, everything is sacrificed to the obtaining of as much footage as possible from the expensive piece of machinery. Thus back holes are drilled before the front holes are blasted, and much explosive is wasted because of the almost unvarying arrangement of the holes, the lines of weakness not being taken advantage of. The ideal machine for our small stopes, is one with an exterior as similar to a piece of piping as possible—and the "Gordon" in this respect leaves little to be desired—and so light that it can be set up, say, 8 or more times per shift without undue fatigue ; the manipulation should be so easy that the principles of hand holing can be observed in every respect, and thus a very high duty and small expenditure on explosives be attained.

In other words, we want a machine to drill one or two holes per bench, and not four holes per bench ; we lose every time on the back holes, and further, whilst on this subject of four-hole benches, it is as well to point out that the maintenance of good four-hole benches becomes increasingly difficult as the stopes decrease in width. All this points therefore to the ideal machine having the minimum weight consistent with suitable strength, and the Flottmann and Hardsocg may be cited as examples of what can be done in the direction of reducing weight, the former being $52\frac{1}{4}$ lb., and the latter $44\frac{1}{4}$ lb. It is questionable whether the Gordon, though scaling only 72 lb., has not overstepped the ideal weight limit, but it is a balanced machine, and its design is such that it is easy to both lift and manipulate. Of course, in reducing weights, the difficulty has, from the first, been to maintain sufficient strength in the various parts, but the improvements being effected in the designs of these small drills is so marked, that a good machine of the ideal weight of, say, 60 lb., will, sooner or later, be in the market.

2. CONSTRUCTIONAL FEATURES.

(1) *Hammer Type versus Reciprocating Pistons*—Both types were represented in the contest. Though, perhaps, somewhat irrelevant to the subject of small drills, it is of interest to note that large machines of the hammer type have been tested on these fields with unsatisfactory results. Thus the Leyner water drill was tried and abandoned here, the reason of its failure, so far as can be gathered, being (1) its inability to drill deep holes, the jumpers giving trouble at depth, (2) inordinate wear and tear, (3) the miners disliked it. On the other hand, it has been said that had the air pressure been higher, the drill would have given a much better account of itself, it having been designed for high pressure. The Shaw drill, also of the hammer type, which goes to the other extreme as regards size and weight, the latter being about 30 lb., and the piston $1\frac{3}{8}$ in. diameter, with a short stroke, has also been tested in a small way on the Rand, but proved to be of insufficient power to deal with the banket. Hammer machines strike less powerful but more frequent blows than those of the reciprocating piston type, and the less intensity of the blows of the former, permits of lighter machines, columns and arms, etc., and does not call for the same care in rigging up that the heavy impacts

of the other type demand, a point which was quite noticeable in the contest. In the one type we have a great number of light blows, whilst in the other, the blows are comparatively heavy, but of less frequency. Weight is essential in the reciprocators, it is a defect which is inherent to the type, and it is difficult to imagine how a really serviceable light machine, say, of 60 lb. of this class can be designed. That satisfactorily proportioned machines of this weight of the hammer variety are possible is more than likely.

The high speed of the hammer type has, here and elsewhere, resulted in great wear and tear of the working parts, and proportionately heavy maintenance charges. It is claimed, however, so far as the Gordon is concerned, that this drawback can be surmounted by using metal better suited for the work, and that the latest consignments of drills will demonstrate this. There is no gainsaying that much can be done by careful manufacture, but this wear and tear is a factor to be borne in mind, more especially as, all precautions notwithstanding, it is impossible to keep grit from finding its way into the drill sooner or later.

The question of losing holes, owing to the jumpers becoming fixed in them, naturally crops up in discussing the types of machines. On this point the reciprocators have the advantage, inasmuch that the very frequent projection and withdrawal of the jumper tends to prevent the latter from becoming "mudded," and further, in case of fitchering, the compressed air assists the operator in his attempts to release the drill. Not that I wish to emphasise this latter point, for my experience with the small reciprocating type, extending off and on, over a period of 10 years, has impressed upon me two points among others, viz.:—their heavy maintenance charges, and their fitchering propensities and small withdrawing power; the first is being lessened by better design and material, the latter remains much the same, and can only be met by higher air pressure, or a design like that of the Chersen. But, generally speaking, it may be said that of the two types, the reciprocators will lose fewer holes than the hammer type, and are much better suited than the latter for deep holes, say, over 4 ft. Holes over 48 in. are however seldom called for in very small stopes.

1. VALVES. 2. ROTATIVE DEVICES, AND 3. FEEDING ARRANGEMENTS.

(1) *Valves.*—Piston (spool) valves, slide valves, actuated by tappets, and ball valves, together with combinations of these, as for instance in the case of the Little Holman, were all represented in the machines which competed underground. The Kimber was the only valveless machine. The ball valves (examples Flottmann and Chersen) are a new feature on this field, and it would be difficult to imagine anything simpler in either action or design, or better calculated to help in the direction of reducing weight. Further, because of their nature, little inertia and negligible friction, it is reasonable to assume that they do not suffer from that insensitiveness at low pressure which is a characteristic of the piston type, nor again, are they so likely to be interfered with by the presence of grit. It is a valve which would appear worthy of the attention of manufacturers of light weight drills. It is worth noting that the spool valve of the Gordon is made of vulcanised rubber, and is both small and light.

The machines fitted with the tappet actuated slide valves, as, for example, the Little Wonder Tappet, Baby Ingersoll, and Little Kid, doubtless, like their large prototypes, have good running powers at low pressures, in consequence of the positive character of their valve action.

(2) *Rotative Devices.*—In six out of the eight machines, the rotation of the drill was effected automatically by twist bar and ratchet wheel, the exceptions being the Gordon, in which this duty devolves upon the operator, and the Kimber, which has no twist bar, but has a ratched wheel actuated by a pawl, moved by an independent piston. Non-automatic rotation is a not uncommon feature of the smaller machines of the hammer type, and it would appear in such cases that automaticness has been sacrificed because of considerations of weight and simplicity. Whether the non-automatic action of the Gordon, for instance, is a strong or weak feature in the design, is a matter on which there will be difference of opinion. On the one hand, it might be urged that the fact that the operator is compelled, on account of the nature of the rotative arrangements, to give the machine the closest possible attention, is calculated to result in better all round work being done with the machine; but others might maintain in opposition to this view, that any piece of mechanism which requires incessant attention and handling, more especially when such mechanism is in the hands of unskilled workmen, black or white, is more likely to give trouble than the machine which will take care of itself to a greater extent. It is one of those points which a twelve months' trial will best decide. It is true that we have an analogy to this handle turning, in the case of the ordinary screw feeding arrangement attached to most rock drills, but it seems to me, that if fitchering is to be prevented, and holes not lost, the rotation on the Gordon is going to prove more irksome than manipulating a feed. But if this non-automatic rotative device will do satisfactory work with such attention as it will receive from

the unskilled operators, that is all that is needed.

(2) *Feeding Arrangements.*—The two representatives of the hammer type of machine which ran underground—the Gordon and the Flottmann—differed from the others, the reciprocating class, in having an air piston feed instead of the screw feed, which is invariably used with the latter. There is much to be said in favour of this air feed, for it is simple, speedy, and automatic. The Flottmann was an especially good example of a wholly automatic drill, both the feed and rotation were automatic, and the only work the operator had to do, was to rest his hand on the cylinder of the machine, in order to detect threatened fitchering.

But in designing the latter machine, the makers, so far as the air feed is concerned, have not properly appreciated the hard knocks and general rough usages the machine will be called upon to withstand, but this part of their drill, at present so obviously weak, is, I understand, to be both shortened and strengthened.

The feed screw of the Kimber machine is very exposed, being affixed to the top of the machine, an arrangement which, whilst keeping the centre line of the cylinder low, does not favourably impress me.

(3) *General Design.*—One of the most striking features of the contest, was the rapidity with which the Gordon was erected and adjusted, and its drills changed. On the column and arm, bolts were entirely absent, their place being taken by steel wedges. Much time was undoubtedly saved by this simple and effective device, and it would be interesting to know whether the idea would give satisfaction with the heavier blows of the reciprocating machines.

The fact that the Gordon is balanced about its long axis, and is therefore not likely to twist in one's arms, that it is cylindrical, and is slipped, nose first, into the clamp, and not lifted on to it, is in its favour, these being points which a machine man would appreciate in a small stope. It is also entirely free from projections, and is thus less likely to be harmed by rough usage and blasting.

There is no reason why the mounting of the Flottmann, for instance, should not be equally simple and convenient.

In order to derive the greatest benefit from these small machines, they will, as already pointed out, have to be erected several times in the course of a shift, and, in view of the fact that making the column secure, even in the case of a small machine, calls for very great exertion on the part of the machine man, I think that makers of small reciprocating machines especially, would do well to consider the advisability of so modifying their columns as to call for less exhausting efforts on the part of the operator.

(4) *Dry and Wet Holes.*—Some years back, when the comparatively highly inclined reef of many of the outcrop mines was being worked, a system of stoping almost exclusively practised was the underhand, a method of work having advantages, but in which the broken reef lodged on the working face, and often caused inconvenience and delav. At the greater depths of the present day, the dip of the reef is steadily approximating to 30°, and our stoping is becoming more and more of the overhand or the breast variety, underhand stopes still predominating here and there, owing to special circumstances or high dips, as, for instance, on the Randfontein mines and the East Rand.

In both overhand and breast stoping, the broken reef is flung by the explosion more or less clear of the working face, with the result that misfires are easily seen, and drilling can be resumed with the minimum delay. In all three systems of stoping above mentioned, the holes on the Rand are down holes, and are, of course, drilled wet, thus advantaging the machine, or the boy, as the case may be. In some parts of the world, dry "uppers" are common in connection with overhand stoping, but where such is the case, the conditions are not comparable to those on the Rand.

The above explanation is necessary in view of the fact that the task given the machines underground was the drilling of an equal number of so-called dry and wet holes. The number of dry holes we are at present drilling in our stopes is, expressed as a percentage, so small that it may be ignored, and it is difficult to imagine how this percentage can be increased with advantage. In the trial, the upper holing resulted disastrously for all the machines, with the exception of the Gordon and the Baby Ingersoll, though the performance of the latter was much behind that of the premier drill; but it is only fair to mention that all the other machines would have done better than the figures expressed, had it not been for the behaviour of the drill steel. With the Kimber it was a clear case of the steel being of a section too light for the blow; in other instances bad tempering resulted in the chipping away of the cutting edges and reduction of gauge, making it impossible for the other drills to follow, whilst in other cases the shoulders of the cutting edges were rapidly worn away, resulting also in reduction of gauge and loss of the hole. But, apart from the drill steel, the rate at which these upper holes were drilled, was very slow indeed, compared with the pace on the wet holes, and it was obvious that the drilling of dry holes by these machines would be a failure from an economic standpoint. The Gordon was really the only exception, drilling the uppers apparently without difficulty, and almost as quickly as the down holes. It was the only machine which used water in the uppers, and there is little doubt that this had much to do with the successful accomplishment of its task. It is instructive to place on record that the Gordon drill steel retained its cutting edge and gauge admirably; this, to some extent, is undoubtedly due to the light blows, and the comparatively stationary position of the jumper, but that water also has an incidence on this matter was proved by the fact that the Flottmann steel failed, and that the drills of the other machines, which gave satisfaction in the wet down holes, were very unsatisfactory in the dry up holes, the drills, I was assured, being of precisely the same steel and tempering. In view of this excellent performance claimed for machines with air blast, drilling dry—the Climax Imperial $1\frac{3}{4}$ in. diam. machine, for example—it is a matter for regret that one of this type did not come forward and afford an opportunity for comparing speed of drilling and behaviour of steel. The health aspect cannot be left out of account in this connection, and the use of water with all drilling should be compulsory. Messrs. Hosken & Co. claim that by using their water spray with the air blast, all dust is allayed. The Gordon, by passing the water to the cutting edge, has adopted the ideal principle of preventing the formation of dust, but, of course, any drill can be provided with a dust allaying attachment, or, on the other hand, a jet of water, quite independent of the drill, may be played about the collar of the hole. So that, from the humanitarian point of view, there is little to choose between the various machines; the dust can be allayed in every case. One point in connection with the water arrangements of the Gordon calls for remark; the spray rebounding from the working face, or coming out of the hole or chuck, was such as would undoubtedly result in the operator's clothes being decidedly damp at the end of a shift of ordinary length.

In leaving this section of the subject—dry holes—which, having little incidence on our operations, is of comparative unimportance to us, it is as well to call attention to the great strain on the machine man which this upper holing entails.

(5) *Drill Steel.*—It is now beginning to be admitted that one of the points in which there has been false economy on the Rand, is drill steel. Quality has too often been a consideration quite secondary to the cost per lb., and further, it is also dawning on us that insufficient attention has so far been paid to the tempering of our drills, both hand and machine. This contest proved an excellent demonstration of the advantage to be derived from sharp drills as against blunt ones, and from drills which retained their gauge as against those which speedily lost their shoulders, resulting in the inevitable trouble with the followers. This was very strikingly illustrated indeed in the case of the dry holing, and, as I have already remarked, many of the machines would have done materially better, had it not been for the defective drills. Several of the competitors retired from the dry holes on this account.

(6) *Effect of High and Low Air Pressure.*—The poor performances of several machines, both large and small, on this field have been largely attributed to insufficient air pressure. It is an open secret that our air pressure underground on the Rand leaves much to be desired, and that what with pipe lines badly laid, and much too small, leakages and inadequate compressor power, many of our machines have been working under most unfavourable conditions.

Now that we are cognisant of this, it is to be hoped that the time is not far distant when every machine will be supplied with reasonable driving power. Some drills—large tappet drills for example—will do a certain amount of work satisfactorily, with air of even 30 and 40 lb., though they would, of course, have a higher duty with a higher pressure; others, however, demand high pressure—60 to 100 lb.—for anything like satisfactory performances. The small drills, as a class, call for higher pressure than large machines, and of the former, the hammer type requires higher pressures than the reciprocating type. Many makers of the hammer type ask for 100 lb., and over, for good results. The trials underground were carried out with air of 60 lb. pressure at the machine, and there was evidence that good work could be done with such pressure by both types of baby machines. The majority of the mines on this field are working below this pressure, and it will be a costly business to raise the standard to it; to carry it above it, say, to 80 or 90 lb., would be very expensive, both as regards capital outlay and running charges. The higher pressure would entail larger compressor installations, and we would experience greater loss in the way of leakage. Many of our properties might advisedly be furnished with large or duplicate pipe lines.

Would it pay to increase the pressure to 60 lb. and more at the machines underground? There are few mine managers nowadays who would think it advisable to deny 60 lb. to their machines, if such a pressure could be supplied, but regarding pressures exceeding this, opinions will doubtless differ. Would an adequate return be given in the form of footage drilled for the increased cost of the air, or would such an innovation merely result in shortening the hours of labour of the machine man? It is difficult to say. Coming back to small machines, there is no doubt whatever that they would give increased footage with the higher pressures, but, on the other hand, it is equally beyond doubt that the wear and tear would be seriously augmented, and that grit would become a more destructive factor. Experience may possibly prove that, viewed from any economic standpoint, 60 lb. to 70 lb., at the machines, is the happy medium; it is a case of trying to strike the mean between the inordinate wear and tear associated with high pressure, and the small footage which will be accomplished if inadequate motive power is furnished.

(7) *Result of Wear and Tear.*—With a new machine of the large type, a miner can often do his four holes in but little over 60% of the time he would need with an average old machine, and not only so, but he goes off shift much less fatigued in the former case. The operator's troubles make their appearance as the machine becomes worn, and it may be taken for granted that what holds good in the case of the large machines will also pertain, in some degree, to the small types. The air losses also increase with the wear. This is a consideration which it would be unwise to ignore in connection with the present competition; all the machines might be described as new, for such as were not actually so, had been made the equivalent. So the competitors had all the advantages attending the use of new machines.

(8) *Incidence of the Man at the Handle.*—It is almost unnecessary to point out that the operator is a very important factor in any calculation of a machine's capabilities. In this competition, naturally, the men were carefully selected by the agents, and we may assume that the latter looked upon them as expert machine men. These men during the trial, worked under competitive, and not normal, conditions; in other words, they begrudged no effort, and spared themselves no strain calculated to help themselves and their machines to the first place in order of merit. The men were of good physique, in some cases exceptionally so, but every man of them was obviously exhausted at the end of the shift, and the four days' run, two days on the surface, and two underground, resulted in a condition of physical strain which must have taken several days to recover from. Of course, such exceptional efforts could not be kept up in every day practice, and the competition results do not therefore truly reflect what these expert machine men would do under normal conditions. How the machines will behave in the hands of the average unskilled whites or Kafirs, it is difficult to forecast. I am of opinion, that fitchering and "mudding" is more likely to happen with these small machines than with our large ones, and therefore, that they call for greater skill, or, at any rate, greater care than the latter, for successful runs. But careful selection of operators, be it white or black, and intelligent and patient teaching, would do much towards surmounting this obstacle; many of our natives are apt pupils when it comes to machine work. But here again it is obvious that only after the machines have been in the hands of hundreds of such operators for twelve months or so, will the true average capacity of the machines, under Rand conditions, be known. The performance of the Gordon machine in the hands of a native since the competition, is a matter on which the Gordon Drills Co. is to be congratulated, for it is promising achievement, even after making all allowances for the fact that the boy was specially selected, and worked under exhibition conditions. A very good performance is claimed for the $1\frac{3}{4}$ in. Climax Imperial Drill, in the hands of a Kafir.

(9) *Conclusion.*—If the down holes only are taken, and these represent the work which the drills will be called upon to deal with in practice, the order of merit is as follows:—

	Average in. per min.
Gordon	1·82
Chersen	1·44
Little Holman ...	1·21
Baby Ingersoll ...	1·16
Little Kid	0·82
Little Wonder (tappet)	0·68
Flottmann	0·56

(The Kimber drilled no wet holes).

In the case of these wet holes, the Little Kid and Flottmann lost time on their drill steel, whilst the Little Wonder dropped behind in consequence of the early exhaustion of its operator. The Gordon, Chersen, Little Holman, and Baby Ingersoll, made very satisfactory runs, and the above figures probably represent approximately their capabilities under the conditions which obtained at the trials.

It is unfortunate that the drill steel interfered so largely with the performances on the back stope, but I have no hesitation in saying that, under the rules of the competition, the Gordon would have maintained its premier position in any case.

This drill is of the hammer pattern, to which, in view of developments, I believe we must look for the ideal 60 lb. stoping drill for our present hand stopes. It is too much to expect that a serviceable reciprocating machine can be made of this weight, and though greater weights can admittedly be handled in even 3 ft. stopes, yet so laborious will their manipulation be in the cramped space, that, other things being equal, the lighter machine cannot fail to win favour in the end. But in this connection, it would be unwise not to recognise the apparently satisfactory work the Little Wonder (118½ lb.), the Little Kid (102½ lb.), and the Little Holman (97½ lb.) for instance, have done in quite small stopes. The all round improvement which has been effected in the design of small machines generally, is most marked, and augurs well for future possibilities.

Regarding the decision of the Advisory Committee to award the trophy exclusively on speed, it was perhaps somewhat difficult to adopt any other course under the circumstances, and certainly speedy drilling is a matter of the first importance in our machines. In fact, so vital is the question of footage that a machine eminently successful in this direction must indeed have grave defects in its design, if it is not accepted as the best machine for our mines. It is not difficult to see that a full appreciation of this point has led to the design of the Chersen and Kimber, wherein power is very liberally provided, in the hope of obtaining a satisfactory return in the shape of very rapid drilling. The Kimber was unfortunate during the trials, but the behaviour of the Chersen must have afforded considerable encouragement to its designers. Both these drills, the Chersen especially, are of great interest, because their power approximates to that of the ordinary 2¾ in. machine, whilst their weight is less than 50% of the latter, and, therefore, in developing these machines, the inventors might perhaps advisedly consider the possibilities in connection with both large and small stopes.

The review of these two machines, with their large piston areas naturally raises the question of air consumption. It is a matter which has, I think, been unduly laboured, for it is largely academic. It is true that it is as well to be cognisant of the air requirements of a drill, just in the same way that it is desirable to know the maintenance charges, but to imagine that primary importance is to be attached to air consumption in selecting a drill for our mines is altogether a mistake, in view of the fact that extra expenditure on air may be more than returned in the form of additional footage; a few extra inches per shift balances the cost of a considerable amount of air. The compressed air is merely one of many charges, and it is immaterial, for all practical purposes, whether it forms a small or large percentage of the total costs. The all important point is that the total inclusive running charges should bear comparison with that of our hand labour. There are, however, two conditions under which the question of air consumption would assume importance, the first being, where in two drills, otherwise equal in every respect, one consumed much less air than the other, in which case the former would naturally be selected, whilst the second is where a mine has insufficient compressor power, and is unable to obtain more, in which case the machine which is called for little air might possibly be installed, regardless of other considerations. But whilst it has become common knowledge during the past few months that many of our compressed air installations are not what they ought to be, it is inconceivable now we are cognisant of the fact, that this state of affairs will obtain much longer.

Only 12 months' experience on a large scale with these small stoping machines will disclose their defects and tell us the full story of their weaknesses and advantages. Such a trial will afford reliable data regarding maintenance charges, the fall of efficiency due to wear and tear, the sufficiency or otherwise of suitable operators, and above all, the inclusive cost of running. With the 200 Gordons, just to hand, running on the Rand Mines, Ltd., and the Little Kid and others already at work, it will not be long before the above important points are known quantities.

In the foregoing remarks it will be observed that I have dwelt but little on the financial aspect of this small machine question. A machine may be very cleverly designed, and leave little to be desired as a piece of mechanism, but unless it can do the work on terms which our mines can afford it is of no value to the industry, except perhaps indirectly in the direction of easing our labour difficulties. In other words, unless these small drills can do the work at an inclusive cost which does not exceed that attending the present hand labour, the mines cannot reasonably be expected to adopt them; but, on the other hand, it is obvious that for any machine which can demonstrate its ability to do the work at the price, there is a large reward in store in the form of extensive sales.

What is the financial aspect of this small drill question at the present day? It is venturesome to forecast events, even under ordinary circumstances; in connection with this country of kaleidoscopic changes it is especially hazardous, but cannot always be avoided. The failures of the small machine in the past may be ascribed largely to the breakages and heavy maintenance charges, poor material, general unsuitability of design, and to the labour charges being on the same costly scale as those of the large machines. Are the machines at present before us going to do any better? Can they do the work with reasonable wear and tear, and thus keep down maintenance charges, and prevent labour standing idle though drawing wage? How are they going to work in the second year as compared with the first twelve months, so far as maintenance and efficiency are concerned? Can runners be found for them, either unskilled whites or natives, in whose hands they will drill an average of at least 8 well placed 3 ft. holes, or the equivalent, per shift? Will unskilled white runners be content to receive 10s. as a shift's pay, or a scale of remuneration which will not handicap the machine's performance to a greater extent than this figure? Can the inclusive cost attending small machines be brought down to a figure not greater than that associated with hand drilling? The advance exhibited in the design of the present machines, and the possibilities it foreshows, the economic revolution which has taken place during the past 6 months in connection with our white labour, inclines one to answer the above questions in a manner favourable to the present machines, or their early successors. The open minded attitude of the mines in this matter is, I think, commendable. After having tried, during the past 10 years or more, machines of many promises, but dreadfully poor performances, there is reasonable ground for sceptism on their part, and for a policy of making haste slowly, more especially as the perfect small drill has yet to be produced. It now lies with the manufacturers to arrange with the mines for, say, a 12 months' trial of their machines under normal conditions, and it is sincerely to be hoped, for the sake of the industry and all concerned, that such a test will result in a really satisfactory machine being discovered.

With your permission I would like to add just a few figures. They are figures which bear upon two of the most important points we have had before us for some years past, dealing with the subject of small drills and bearing upon the labour and cost associated therewith. We have had flying about during the last month or two some rather wild statements regarding the incidence of these machines upon our native labour, and the figures which have been hurled broadcast have varied from 20,000 to 50,000, and I believe in some cases more. But what is the position? Let me say, in the first place, that I think it is possible that with eight 3 ft. holes well placed, these small machines can give us per shift about 5 tons of rock, and seven boys with holes well placed can give us the same tonnage, which works out at 0·7 ton per boy per shift.

You start, therefore, with a basis of seven hand drillers equal to one small machine. Now I may tell you that the number of stoping boys at work on these fields at the present time is about 36,000, so that in the first place it is pretty obvious you cannot send out 50,000, and of these 36,000 you certainly cannot dispense with all of them. You must retain some as stopers; I will tell you why. We have in quite a number of stopes insecure hanging, or where there is merely a thin parting between that particular stope and the stope above or below. Now it is unsafe to run even a small machine in a stope like that, for it might very soon bring the hanging wall down on you. In such a stope you have no option but to use hand drillers, and that is one reason why you must retain some hand stopers. Another reason why you must retain them is for scaling the hanging wall or for taking up leader in the foot. Another is for putting in short holes for breaking up large chunks of rock in the stope or for trimming the stope. You must remember that these small machines will probably do 5 tons of rock per shift under favourable conditions, but you cannot expect them to do their full duty unless you give them good benches, and so you would have to retain a few stoping boys to trim these benches now and then. These are just a few of the many reasons which will call for the retention of a certain number of these 36,000 boys. I have estimated that about 8,000 boys will have to be retained for the purposes enumerated. That leaves us with a total of 28,000 boys, whose services may be dispensed with. If you take that number and divide it by seven, you arrive at the number of machines we can take, viz., 4,000 if these machines only work a single shift. But every machine, of course, works double shift. You divide the number and you get 2,000 machines working two shifts as being equivalent to 28,000 hammer boys. Therefore there is a possible market for 2,000 satisfactory small stoping machines. Let us see how the running of this number of machines would affect our labour. Take the cost of running these machines with white unskilled labour, one man one machine and with one superintendent also for each ten machines. That gives you 4,000 unskilled whites to run the machines and 400 superintendents, total 4,400 whites, and if you take the gangers at present engaged with these 28,000 hand stopers, you get that number reduced to between 3,000 and 3,500. So that by installing these machines and running them with white labour you find work for 3,500 extra white men. Now I believe that no matter how small these machines may be it will be wise to let each white man have a Kafir assistant. If he does not get a Kafir assistant that machine will be standing idle quite a large part of the shift, I can assure you. That would call for 4,000 natives being retained which will reduce the figure to 24,000 natives. It is customary in our hand stopes for the stoping boys themselves to do quite a lot of lashing. It may be that you have 30 hammer boys in one stope, and if you displace these with machines you have to allow for additional lashing boys. Therefore I figure on another 3,000 boys as having to be retained. Therefore, out of the 36,000 stoping boys at present at work you can only dispense with the services of, say, 21,000. Taking now the case where the machines are run by two natives per machine per shift, and one white superintendent per four machines, the 2,000 machines call for 8,000 natives and 1,000 skilled whites. This item of 8,000 natives brings the 28,000 down to 20,000, whose services can be dispensed with. But here again you have to allow for additional lashing, and therefore you can only really dispense with about 17,000 natives. Therefore, if you run these machines by natives, you may possibly dispense with 17,000, if you run them with whites, you may dispense with about 21,000, and, speaking generally, the machines have an incidence on our labour supply of about 20,000. The white labour complement in the case of the Kafir run machines is practically the same as with hand stoping. What about the cost? Will it work out at the same price as our present hand stoping? I will just give you a few figures, though I wish to emphasise the fact that figures are very supple, and I do not attach much importance to them, and you must take them for what they are worth. I have taken, for instance, two boys per machine per shift and one white man superintending four machines. We have assumed that each machine will average 5 tons per shift in the hands of the 4,000 unskilled whites or in the hands of 8,000 natives. I do not say it is impossible they will average that. It is not necessary in comparing the cost of machine work and hand labour to compare every item, you need only take certain items, and that I have done. Where you have two boys per machine per shift and one white man to four machines, I have taken the maintenance and redemption, drill sharpening, etc., and divided them by the tonnage, and I get 4s. 6d. per ton.

If I run the machines with unskilled whites, allowing 10s. per shift for the white man, and giving him a Kafir assistant and allowing for additional lashing, I get the figure of 5s. 5d. per ton as compared with 4s. 6d. with natives. Turning now to hand labour with our present force I get the figure 5s. 4d. per ton. By running the drills with unskilled whites you thus get 5s. 5d., a difference of 1d. against the machine. In conclusion, I may say that I base these figures upon ·7 ton per boy per shift, that being calculated upon a 3-ft. hole; but certain of our boys are increasing in efficiency, and you may get a higher tonnage, and if it so happens the tonnage is materially increased, then it goes against the machine. If, on the other hand, the labour which we obtain for running these machines—assuming that we get the machines at all, and it is by no means certain—turns out better work than we are anticipating, then the cost is in their favour. I may say I think our boys are too well paid, and if we grant for a moment that the wage per boy is reduced, there again you get an interfering factor, because the hand stoping would be done at less cost. Turning to the wage per shift for white labour, I do not say that you will not get men here to accept 10s. a day; you may even get the number required in a comparatively short time, but it is one thing to persuade them to accept 10s. a day, and it is quite another matter for them to be contented with it, and it remains to be seen whether they would be permanently satisfied with this rate of pay. I am afraid they would be a thorn in the side of the mine manager.

The meeting then closed.

Contributions and Correspondence.

THE FALSIFICATION OF NITRO-COTTON WITH MERCURIC CHLORIDE AND ITS DETECTION.

Mercuric chloride is frequently added to wet collodion cotton, ostensibly to prevent its becoming mouldy, but sometimes also to make it pass the official heat test, even when it is really defective.*

Ordinary tests for mercury fail because $HgCl_2$ cannot be extracted (except by volatilisation) owing to its affinity for organic matter. I have therefore invented the two following simple processes:—

(a) *Combination of Hargreaves and Rowes' Method with E. A. Mann's Method.*—The moist cotton, along with a piece of (ignited) silver foil is placed in a flask immersed in boiling water, and air is aspirated through it, and then through potash bulbs containing 2% sulphuric acid. After two hours the $HgCl_2$ which has escaped the silver is deposited thereon by using the foil as anode in electrolysing the dilute sulphuric acid from the bulbs (2 hours with about 4 volts required). The foil is dried and sublimed on to a microscope slide, as in the other methods.

(b) *Conversion into non-volatile compound.*—The cotton is extracted with hot very weak KI solution, and the extract (containing K_2HgI_4) concentrated to a small bulk and electrolysed.

*See this *Journal*, vol. viii., Nov., 1907, p. 156, and Dec., 1907, p. 190.

Iodine separates on the platinum basin used as cathode, and the whole of the mercury collects on the gold or silver foil anode after two or three hours, and is worked up as above. The latter method is the quickest and most sensitive I have tried as yet, and has the advantage of having no danger of explosion attached to it.

James Moir.

January, 1908.

Queries and Replies.

No. 1.—"Can any member recommend any particular form of agitator to handle slimed pyritic (85%) concentrate? There will only be 50 tons per month to handle. Prime cost is a consideration, and we wish to avoid the use of compressed air, although this is not a rigid condition." H. C.

Notices and Abstracts of Articles and Papers.

CHEMISTRY.

Qualitative Analysis of Nickel in Cobalt.*—"We are aware of the very great difficulty of detecting nickel in presence of very large masses of cobalt salts, and we may say that this is one of the most delicate problems of qualitative mineral chemistry. Hitherto there was no specific and sensitive reaction for nickel. The proposed method is based upon the following reaction. Nickel molybdate, which can be obtained by double decomposition of a nickel salt and alkaline molybdate, is insoluble in a neutral or slightly acid aqueous solution containing a sufficient excess of alkaline molybdate. Cobalt molybdate, on the contrary, is exceedingly soluble in the same conditions. As for formation of nickel molybdate by double decomposition, it does not seem to have been hitherto indicated. No mention is made of it in Moissan's chemical treatise, nor in the dictionary by Wurtz. The preceding observation is applied as follows:—Sulphides of cobalt and nickel, obtained by the general method of qualitative analysis, and, in particular, the Carnot method, or simply pure nickel and cobalt salts, or pure nickel salt, are dissolved in nitrohydrochloric acid; the aqueous solution is almost exactly neutralised with an alkali, care being taken to preserve a slight mineral acidity; an excess of saturated ammonium molybdate aqueous solution is added; finally, all is heated gently to about 70° C. while agitating. In presence of cobalt the solution acquires a pink tint, and if there is nickel there is immediately, or in a few minutes, a very heavy crystalline greenish white precipitate, more or less abundant. In the absence of nickel the solution remains perfectly limpid. Formation of a precipitate is absolutely characteristic of nickel in the absence of other metals than cobalt; zinc, cadmium, manganese, etc., also precipitate, but as there are excellent means to eliminate them, there is no inconvenience. If requisite to follow up the characterisation of the elements filtration is employed, and all the cobalt is found in the filtrate and the nickel molybdate is left on the filter. It is washed with a saturated solution of ammonium molybdate, and it is easy to identify the nickel after eliminating the molybdenum by some process. This method enables identification, with absolute certainty, of very small quantities of nickel in presence of cobalt. Thus an inexperienced person can detect 1 cgm. of nickel in presence of 500 times its weight of cobalt in a few minutes. None of the hitherto known methods attains this result without great experience and considerable loss of time. If the cobalt is in form of a cobaltamine salt it will be immediately precipitated, even cold, by alkaline molybdate. This, in fact, is the reaction proposed by Mr. Carnot to characterise cobalt. In this case, and only in this case, the reaction would not be applicable; but it is to be noted that cobaltamine salts are readily transformed into cobalt salts. This reaction also gives a microchemical process for detection of nickel which presents a sensitiveness greater than all the other methods proposed. Nickel molybdate is crystalline, and in form of very distinct small square lamellæ, the corners of which are often slightly decomposed. This method is the first to enable microchemical identification of nickel in presence of cobalt, and from the microchemical point of view is one of the most sensitive. It is well, however, to note that zinc molybdate greatly resembles nickel molybdate; cadmium and manganese also precipitate but cannot be confounded with it. To conclude, let us observe that pure cobalt salts, sold in commerce, contain a small percentage of nickel. Thus, if 1 gm. of pure Merck cobalt, dissolved in 1 c.c. of water, is treated with an excess of ammonium molybdate, a very light greenish white precipitate is obtained in less than an hour. Addition of 0·0005 gm. of sulphate of nickel to the filtered solution almost immediately produces an abundant precipitate."—*Comptes Rendus de l'Académie des Sciences.—London Mining Journal*, Oct. 19, 1907, p. 472. (A. R.)

* See this *Journal*, vol. viii., Dec., 1907, p. 192.

Prevention of Rusting.—"According to the electrolytic theory, when a plate of iron is immersed in water the rusting that takes place develops positive and negative areas of greater or less extent relatively. It is possible to conceive two cases as occurring among all the possible arrangements of positive and negative areas. The first case would be that of a positive spot surrounded by an extended negative area, and the second would be of a negative spot surrounded by an extended positive area. At the positive areas iron will pass into solution and be rapidly oxidised to the loose colloidal ferric hydroxide and oxide which are known to migrate, under the influence of electrolytic action, to the negative polar areas. In the progress of the rusting under water it would be expected that in the first case the ferric hydroxide would be piled up in a crater with the metal eaten away at the centre, while in the second case it would be expected that the hydroxide would form in a conical mass with the surrounding metal eaten away. A low power microscope clearly shows that these two formations do occur on every sheet of iron that has rusted under the water.

According to the electrolytic theory, all substances in solution which contain hydrogen ions should stimulate the rusting of iron, and all substances which develop hydroxyl ions in solutions to a certain extent inhibit the rusting, and, if the concentration is sufficient, absolutely prohibit it. This application of the theory is borne out by the behaviour of acids, salts of strong acids and weak bases (which hydrolyse in solution or decompose to an acid reaction), and by the alkalis or salts of strong bases with weak acids.

It has been long known that solutions of chromic acid and potassium bichromate inhibit the rusting of iron. Experiments have shown that iron immersed in a $\frac{1}{500}$ normal or stronger solution of the latter will not rust. It has been observed, too, that if a rod of bright iron or steel is immersed for a few hours in a 5 or 10 per cent. solution of potassium bichromate, and removed, thoroughly washed and wiped and then immersed in water, rusting is inhibited for a length of time averaging from a few hours to weeks. Cushman explains the effect as one of polarisation produced by the separation of oxygen from the solution and its retention on the surface of the metal in some way without the formation of an oxide. If, as the electrolytic theory assumes, rusting is due primarily to the exchange of hydrogen ions, iron in the condition of an electrode, polarised with oxygen, should be protected from electrolytic action for a greater or less time depending on the amount of polarisation. There is little doubt that all conditions which inhibit electrochemical action also inhibit rusting of iron, which fact in itself argues for the electrolytic theory." —Prof. W. H. WALKER.—*Iron and Coal Trades Review*, Oct. 25, 1907, p. 1565. (A. McA. J.)

INSOLUBLE SILICIOUS RESIDUE.—" The use of the term insoluble is exceedingly vague, and in order that different chemists may arrive at concordant results, it is necessary to adopt some uniform method for its determination. The author calls attention to three points in the determination: (1) merely putting an ore into solution does not necessarily throw out all of the insoluble matter, and the quantity of insoluble matter throughout will vary greatly according to the time of treatment and strength of acid; (2) that it is necessary to evaporate to dryness to obtain constant results on the same ore; and (3) that all of the insoluble silicious residue is not thrown out by one evaporation and that a second evaporation of the filtrate is necessary to obtain all of the silica and other insoluble matter.

The author's definition is that 'insoluble silicious residue' is that portion of a mineral substance remaining insoluble after the following chemical treatment: solution in hydrochloric and nitric acids, with subsequent evaporation to dryness, filtration, washing and ignition of the residues.

Oxidised Ores.—Weigh 1 gm. of the ore into a No. 1 beaker, add 15 c.c. hydrochloric acid, cover with a watch glass, and digest at a gentle heat until the ore appears to be quite decomposed, add a few drops of nitric acid, heat until action has ceased, and then wash off the cover with a fine jet of water, and evaporate to dryness. Redissolve in hydrochloric acid and evaporate to dryness a second time to render all the silica insoluble. Redissolve in 10 c.c. hydrochloric acid and 30 c.c. water, filter, transfer all the residue to the filter with a fine jet of cold water, using a 'policeman,' and wash the filter with a little hydrochloric acid and plenty of cold water. Ignite and weigh the residue as 'insoluble silicious residue.'

Complex Ores containing Sulphides. — Treat a weighed portion (0·5 gm.) of the ore with 10 c.c. nitric acid (sp. gr. 1·20) and heat gently until the first intense action ceases and the sulphur has separated out in a clear yellow ball. If the decomposition occurs too violently, due either to too strong acid or too great heat, the sulphur ball will probably include some ore and require to be treated separately. If this occurs it will usually be found better to start a new determination. After the effect of the nitric acid is exhausted and the greater portion of it evaporated off, add 15 c.c. hydrochloric acid and evaporate to dryness; take up with 15 c.c. hydrochloric acid (1—1), boil, filter and wash; evaporate the filtrate to dryness, treat as before, adding the second residue to the first. Wash clean with hydrochloric acid and hot water, ignite and weigh as insoluble silicious residue." -H. C. PARMELEE.—*Engineering and Mining Journal*, from *Western Chemist and Metallurgist*, Oct. 19, 1907, p. 729. (A. McA. J.)

THE REACTIONS OF CALCIUM HYDRIDE ("HYDROLITE").—"Attention has already been drawn to the employment of calcium hydride in the production on a large scale of hydrogen gas suitable for the inflation of balloons. The commercial hydride, known as 'hydrolite,' furnishes hydrogen on treatment with water, and the gas thus obtained is free from acetylene and ammonia. The yield, however, is far short of the theoretical amount, and the slaked lime, which is the other product of the decomposition of the hydride by water, contains an impurity liberating a spontaneously inflammable gas on treatment with hydrochloric acid. This inflammable product has not been definitely identified, for although it behaves like phosphuretted hydrogen, yet the original calcium hydride is apparently free from phosphorus. Should further investigations show that this inflammable gas is set free only in the presence of acid, the decomposition of hydrolite should always be effected with water which has been rendered alkaline, in order that the hydrogen produced may not be contaminated with this dangerous constituent." —*Times Engineering Supplement*, Oct. 9, 1907. (J. A. W.)

THE DETECTION OF TRACES OF MOISTURE.—"The presence of water, either in the liquid or vaporous condition, plays a very important part in the determination of many chemical changes, and in some instances the reactions are completely inhibited when the reagents are thoroughly dehydrated. In other cases certain preparations are only possible when the reagents can be brought together in anhydrous media. The detection of slight traces of moisture is accordingly of great importance to the chemist. Anhydrous copper sulphate has generally been employed in this test, as the white colour of this salt assumes a bluish tint when the compound is introduced into a moist solvent. In a recent number of the *Berichte der Deutschen Chemischen Gesellschaft*, W. Biltz recommends the use of colourless potassium lead iodide for this purpose, claiming that this double salt is even more sensitive than copper sulphate. A sample of absolute alcohol, which gave no indication of moisture after contact with the latter salt for one hour, showed immediately the presence of water by decomposing the double iodide into its components, potassium and lead iodides, the latter of which was indicated by its intense yellow colour. Bibulous paper and silk fibre may be impregnated with this colourless double salt in a finely divided condition, and these materials then serve as a delicate reagent, assuming a yellow tint in the presence of traces of moisture."—*Times Engineering Supplement*, Oct. 9, 1907. (J. A. W.)

EXPLOSIONS UNDER ROADWAYS.—The newspapers make frequent reference to somewhat mysterious explosions which occur without any warning in the underground connection-boxes of electric light and power systems. It is usually explained that an accumulation of coal gas, due to leakage from adjacent gas mains, has been accidently fired by a spark from the electric conduits. Thus the electric light companies shift at least half the responsibility upon their special enemies, the gas companies, and explosions continue to occur, to the great discomfort and even danger of the innocent way farer. However, if a recent discovery is to be credited, the electric companies must bear all the blame themselves for these mysterious accidents. Dr. Bassett, speaking before the Society of Chemical Industry, placed on record a case of the production of metallic potassium and sodium by the electric leakage from a subterranean cable of which the insulation had become faulty. The leakage occurred at a point where the negative cable had been joined, and according to Dr. Bassett the electrolysis of the surrounding water containing potassium and sodium salts had resulted in the production of a liquid alloy of the two metals. As everybody knows, either of these two metals will burst into flame if brought into contact with water; and as it is evident that during the electrolytic process considerable quantities of hydrogen must have been formed at the same time, all the materials for an explosion were ready to hand. The inference is that the coal gas mains are innocent in connection with many of these underground explosions. Electrical leakage through moisture must result in the eletrolytic decomposition of the water, and the product must be oxygen and hydrogen gases mixed in the most explosive proportions. Given a connection box or other fitting in which the explosive mixture can accumulate, the smallest spark would precipitate an explosion, and even the spark would be unnecessary if either sodium or potassium in the metallic form had also been produced by electrolysis in even the smallest quantities.—*Chambers' Journal*, Oct., 1907, p. 556. (A. L. E.)

The Use of Sodium Carbonate and Zinc Oxide in Sulphur and Arsenic Determinations.

This is a modification of Eschka's method, and it is stated to have given uniform satisfaction in various assay offices for a number of years. One part dry Na_2CO_3 and 4 pt. ZnO are mixed thoroughly. Half a gram of the sample is then mixed intimately with enough of the $Na_2CO_3 + ZnO$ mixture to afford at least twice as much Na_2CO_3 as would be required by the S, As, etc., present, placed in a small porcelain dish, covered with the reagent and heated to redness for 15 to 20 minutes. The residue is then extracted with water, boiled, filtered, acidified with HCl, precipitated with $BaCl_2$ and weighed as $BaSO_4$. In an As determination the substance is treated as above until the alkaline solution is filtered from the residue. This filtrate is acidified with acetic acid, precipitated with $AgNO_3Aq$, boiled for a few minutes and then filtered. The precipitate of Ag_3AsO_4 is washed thoroughly with hot water, then dissolved in dilute HNO_3 and titrated with KCNS or NH_4CNS, ferric sulphate being used as an indicator. In calculating the As use the proportion 3Ag : 1As : : Wt of Ag found : Wt of As present. The advantages stated are: (1) The mass resulting from the heating is not fused and can be removed readily from the dish and leached with water. (2) The ease and speed with which sulphides, sulphates and arsenates, etc., are decomposed. (3) No time consuming evaporations are necessary. (4) The absence of a large quantity of alkaline and other salts from the solutions in which $BaSO_4$ and Ag_3AsO_4 are precipitated.—W. C. Ebaugh and C. B. Sprague.—*Journal of the American Chemical Society*, xxix., 10, p. 1475. Oct., 1907, (J. A. W.)

METALLURGY.

New Australian Cyanide Process. — "The recently patented Nicholson apparatus for the filtration of solutions from ores is thus described in a recent issue of the *Queensland Government Mining Journal*:—The slimes are first tipped into a patent agitator with 50% of water, carrying sufficient cyanide salt dissolved in it. The whole is then agitated until the gold in the slimes is dissolved. In order to prove this, the solution is assayed in the ordinary way. The slimes, then in form of a cream, are passed from the agitator into the Nicholson apparatus. This cream goes into the receiver, which is revolving at high speed inside a narrow vessel. The outer vessel travels at a higher speed, and in an opposite direction. The vessel has an enclosed chamber, which contains sand and lime in proportion. On the outside of the wall canvas and such like is fixed. The receiver, while revolving steadily, rises 3 in. from the top, and as it comes down it forces the slimes on the inside of the surface of canvas. The outer vessel travels at a high speed and by the time the receiver reaches the bottom the cyanide solution is forced by pressure through a filter, and runs into a circular launder at the bottom for treatment by zinc shavings. There is a screw on the outside of the receiver, and to this screw movable shovels are fixed by means of springs. As the receiver rises the shovels get caught into the slimes, which are carried out of the vessel at the top into a launder for their reception. A brush surrounds the screw, and above the brush are jets of water. The jets play on the canvas and keep it clean, and at the same time the brush cleans the canvas, and carries everything collected to the top. The apparatus has been constructed in such a manner as to deal successfully with poor slimes that will not pay under present circumstances. A plant to treat 1,000 tons of slimes per week is estimated to cost about £600, while the cost of treatment is placed at about 1s. per ton, and it is claimed that slimes going 12 gr. to the ton would yield a profit. Leading mining men in Adelaide have taken the matter in hand, with a view to forming a syndicate for treating slimes by the new process."—*Mining Reporter*, Oct. 10, 1907, p. 332. (J. Y.)

Aluminium in Steel Smelting.—"Employment of aluminium in metallurgy, to prevent blisters and fissures in steel ingots gives excellent results. Suppression of blisters is due to the fact that aluminium has so great an affinity for oxygen that when it is thrown into a crucible of melted steel it absorbs all the oxygen, free or combined with iron, disengaging such heat that the metal is extremely fluid; about 0·01% aluminium suffices." —*Elettricita.* — *London Mining Journal*, Oct. 19, 1907, p. 474. (A. R.)

Process for Treatment of Complex Zinciferous Ores.—"This invention relates to treatment of complex sulphuretted minerals with a zinc base, such, for example, as those of Broken Hill, Australia. The object is to separate the lead and zinc, in the first phase of the process, so as to make the lead insoluble and dissolve all the zinc in form of sulphate. Thus the two metals are brought to a suitable form for subsequent metallurgical treatment. Hitherto great difficulty has been experienced in the treatment of mixed sulphuretted ores, owing to the intimate mixture of the chief elements constituting the ore (blende and galena). It is, in fact, difficult to completely extract the zinc and separate it from lead and other substances. The new process separates the zinc from the lead perfectly by the wet method, each element being obtained in the form of a chemical compound sufficiently pure to make subsequent treatment most easy. The result is attained solely by the wet method without the aid of electricity. The process is as follows: The ore is first reduced to an impalpable powder in one or several suitable mills. It is then heated to boiling in a closed vessel with a ferric sulphate solution containing free sulphuric acid. With properly crushed ore all the zinc enters into solution as sulphate, whilst the lead, silica, and sulphur formed by the reaction remain insoluble. The reaction can be expressed as follows:—

$$ZnS + Fe_2(SO_4)_3 = ZnSO_4 + 2FeSO_4 + S.$$

The solution, free from lead, which remains insoluble in form of sulphate, is filtered in a suitable apparatus; the insoluble residue, after washing and drying, is subjected to dry distillation. The sulphur distils and is collected by condensation, and the residue of distillation is then treated with a view to extraction of lead by ordinary methods. The filtered liquid contains zinc and iron sulphate. Were it left to cool in this state there would be a deposit of crystals of a double salt (ferroso-zincic sulphate). To avoid formation of this double salt the liquid is previously treated with an oxidising agent, preferably nitric acid, so as to transform the ferrous salt, formed during the reaction, into ferric sulphate, very soluble and difficult to crystallise. By allowing the liquid to cool now, only the zinc crystallises in the state of sulphate, and the ferric sulphate remaining in the mother water serves for a new operation. The suitably washed and dried sulphate crystals are subjected to calcination in a muffle furnace. Thus non-volatile zinc oxide is formed, whilst the sulphur is eliminated in form of oxygenated compounds which are retransformed into sulphuric acid by the ordinary methods. This regenerated acid is again utilised, and mixed with new ferric sulphate to treat more ore. The zinc oxide from the muffle furnace is commercially pure, and can be transformed into zine free from lead by the usual methods.

The process described theoretically needs only, as raw material, mineral coal and fluxes for fusion of the leady residue in a blast furnace. Moreover, the same reagents continually remain, so that the process is cyclic and self-sufficient. Practically, however, as it is impossible to avoid mechanical losses, a certain amount of nitrate of soda must be employed just as in the manufacture of sulphuric acid in lead chambers. The result obtained by this process is almost complete separation of zinc and lead, which enables them to be isolated in the metallic form by ordinary methods without difficulty.

As regards other metals in the mixed ores—*i.e.*, copper, silver, gold—they remain largely insoluble with the plumbic residue, and at fusion of the latter a cupreous matte is obtained, and gold and silver alloyed with lead as usual. If the ore, as is generally the case, contains manganese and iron, all or part of these metals can dissolve in treatment with ferric sulphate. When this is so, the amount of iron in the liquids continually increases, and a time arrives when part of the liquid must be thrown away, which involves loss of zinc, or, the removal of the excess of iron chemically. The most simple method is to precipitate the excess of iron as hydrate or basic ferric sulphate. The liquid is filtered, and the insoluble ferric compound utilised either to prepare iron compounds, or as flux in the fusion of the plumbic residue. As regards manganese, it is dissolved in the form of sulphate, and accumulates in the liquids. As, however, the sulphate of manganese is more soluble cold than hot, it ceases to dissolve at a certain point and remains in the form of sulphate with the plumbous residue. To isolate the manganese the residue is washed with a saturated solution of manganese sulphate from a previous operation to eliminate the mother water, and then the manganese salt is extracted with water. It is then easy to obtain manganese sulphate by evaporation, or oxide by calcination. By operating in this way the zinc sulphate which is deposited from the liquids is pure, and consequently gives an oxide and pure metal without traces of lead, by the ordinary processes in metallurgy."—*London Mining Journal*, from *Revue Chimique*, Oct. 19, 1907, p. 472. (A. R.)

Fixation of Atmospheric Nitrogen.*—"In Italy, a large factory, the first in the world, has been established recently for the production on a large scale of nitrogenised products obtained by the fixation of atmospheric nitrogen. It makes use of a new process discovered by Prof. Frank, of Charlottenburg, and Dr. Caro. The factory is situated at Piano d'Orte, in the province of Chieti. It employs hydro-electric power of 15,000 h.p., drawn from the Pescara river, and it is estimated that in time it will have a daily output of over 13,000 lb. of the new product, which its inventors have called calcium cyanamide. Of course, the process is based upon the property of calcium carbide to fix nitrogen at high temperatures. For reasons of economy, and owing to the immense power at the disposal of the plant at Piano d'Orte, the calcium carbide is here produced on the spot by means of a complete equipment of electric furnaces. The carbide is then ground to a very fine powder by special machinery, and is placed in special iron retorts. It is then heated until it fuses at a temperature of from 800 to 1,000° C. At the same time, very powerful pumps blow over it a continuous current of nitrogen that has been separated from liquified air by the fractional distillation mentioned above. After a couple of hours the carbide is transformed into calcium cyanamide ready for use. Calcium cyanamide as obtained from the retort has the appearance of a very dark mass, composed of extremely fine crystals and of free carbon. Furthermore, it always contains a small quantity of calcium carbide that has not become transformed. Therefore, after grinding the product very finely, it is necessary to expose it for some days to the air, in order that the small quantity of water vapour in the air may remove the portion of calcium carbide still remaining."—*Page's Weekly*, Oct. 5, 1907, p. 832. (A. R.)

Electro Metallurgy in 1906.—The application of the electric furnace to steel refining is a new development which may lead to very important changes in the iron and steel industries, for in conjunction with gas engines and dynamos it may serve as a means of utilising the enormous power now lost in the waste gases from blast furnaces.

Aluminium can now be autogenously welded, and sheets, rods, tubes of any thickness, can be welded without any difficulty, whilst the points are said to be as strong as the other parts of the metal; this method of welding will probably lead up to increased consumption of the metal in many industries and to its use for larger articles and vessels than have yet been manufactured from it.

Electrolytic methods have been applied with great success on both sides of the Atlantic in the refining of gold and silver bullion, the Moebius process being used for silver and the Wohlevill process for gold. In

* See also this *Journal*, vol. v., p. 247, where *cyanogenamidine* should read *cyano-guanidine*.

the Moebius process a dilute solution of silver nitrate containing free nitric acid is employed as electrolyte while in the Wohlevill process a solution of gold chloride is utilised. In America, the Philadelphia and Denver mints are equipped with electrolytic parting apparatus, and a similar installation of electrolytic baths is now being erected at the Government mint, San Francisco. In Europe electrolytic refining is carried on at Frankfurt, by the Deutsche Gold und Silber Scheide-Anstalt, and by the Norddeutsche Raffinerie, at Hamburg, details of the Wohlevill gold refining process having been worked out at the latter refinery. A recent improvement of the Moebius process is the use of gelatine, which gives a smooth coherent in place of a rough crystalline deposit at the cathode.

Although calcium carbide is being employed chiefly for generating acetylene for illuminating purposes, its application for production of calcium cyanamide is likely to lead to developments of some importance. The use of acetylene gas in the oxy-acetylene blow-pipe, for the autogenous welding of metals is another application of considerable industrial importance, since temperatures can be obtained with this apparatus, which approach those of the electric arc, and the size and shape of the flame are more suited for welding purposes. Calcium in the metallic state is one of the latest electro-metallurgical products, the metal being produced by electrolysis of fused calcium chloride and fluoride with a rising cathode, which just touches the surface of the fused electrolyte. This method is adopted to prevent the resolution in the molten electrolyte of the calcium deposited at the cathode. The temperature of the bath is kept at about 670° C., and the process works most satisfactorily with fresh and neutral calcium chloride. The metal is obtained in the form of an irregular rod, made up of a series of buttons, fused together. The metal is dark grey in colour, of specific gravity 1·51. Calcium is now being manufactured upon a commercial scale by the Electrochemische Werke of Bitterfeld, in Germany.

Carborundum is the trade name given to a carbide of silicon, first made by E. G. Acheson, at Niagara Falls, by heating coke, sand and sawdust to a temperature of between 2,000° and 3,000° C. in an electric furnace of the resistance type. The product has the formula SiC, and the manufacture has grown into one of considerable importance on account of the excellent abrasive properties of the carbide.

Another artificial substitute for emery has also appeared, in the form of an electric furnace product called "alundum," obtained by heating bauxite to a high temperature.

Tucker and Lampen have recently carried out some laboratory experiments with carborundum, and have found that the temperature originally given by Acheson for its formation and dissociation are too high. According to Acheson, these temperatures were over 2,500° C., while Tucker and Lampen give 1,600° to 1,900° C. and 2,200° C., respectively.

The electrolytic copper refining industry is the oldest of the electro-metallurgical industies, having been started by James Elkington in South Wales in 1869. The process and methods used by Elkington in this small refinery were similar in all respects to those in use at the present day, copper sulphate being employed as the electrolyte with raw copper anodes and thin sheets of pure copper as cathodes. The only change has been in the magnitude of the operations.

The chief progress of recent years in this industry has been in the substitution of machine for hand labour, the casting of the raw copper anodes and the charging and discharging of the vats by mechanical methods, now being carried out in all the large and up-to-date refineries. The chief improvement on the chemical side of the process has been the addition of a small amount of hydrochloric to the electrolyte in the vats. This, according to Caslon, prevents the loss of silver which otherwise occurs, the insoluble silver chloride being precipitated with the slimes.

Diamantine.—This is a trade name given to a new product obtained by heating alumina with small quantities of silica to a high temperature in the electric furnace. When finely powdered and mixed with clay and water, the new material is said to form a useful wash for the inside lining and walls of furnaces exposed to high temperature. The new product is being manufactured upon a commercial scale by the Diamantine Werke, at Rheinfelden, Germany.

The production of a hard variety of artificial graphite has been carried on since 1892 by Acheson, at Niagara Falls. The method of manufacture is to form first a carbide in the electric furnace, and then to decompose it by increasing the heat up to a point at which it dissociates and the second element is volatilised. Under these conditions the carbon remains in the furnace in the form of graphite. Acheson, in his earlier work, used coke mixed with silica or sand, but he has since found that it is simply necessary to start with ordinary anthracite coal, the impurities of this suffice to provide the second element of the carbide, and when raised to a definite temperature, these elements volatilise and leave the carbon as graphite. The manufacture has been a very successful one, the greater portion of the output being used for electro-chemical and electro-metallurgical work, the Acheson artificial graphite having been found specially suited for electrodes. During 1906 Acheson discovered a process by which the soft variety of graphite can be produced in the electric furnace, and it is expected that this new artificial graphite will become a keen competitor of the natural variety, especially as it shows more uniformity of composition.—*The Engineering Magazine*, Oct.. 1907, pp. 105-109. (A. L. E.)

MINING.

Temperature in Deep Colliery Working.—"Two main, and perhaps more immediate, difficulties appeared to affect this question of the development of deeper mines in the district—one the question of temperature and the other the commercial one. On the former question, much very valuable evidence, some of which was gathered in their own district, was given before the Royal Commission on Coal Supplies of 1902, and it was then stated that coal was being mined at a Lancashire colliery at a depth of 3,483 ft. from the surface with the temperature of the air between 92° and 93° F., no great inconvenience being felt by the men employed. Assuming, as had been variously stated, that 98 was not an impossible temperature for effective labour, it was possible that such a temperature would be reached in the development of deeper mines in North Staffordshire. No practical suggestions had ever been made for the reduction of the underground temperature other than by ventilation, and the question of how far ventilation could reduce the temperature became of serious importance in the deeper mines. Mr. Gerrard communicated in 1904 to the same Commission a very interesting account of an experiment in mining at great depths which had been carried out at the Produits Colliery, Mons, Belgium, where he had observed men working in a temperature gradually rising in the workings to 103° F. in a dry, brisk ventilation in a seam about 3 ft. thick, the depth of the shaft being 3,773 ft. The miners did not suffer distress, nor was there very marked perspiration. The rock temperature was 113°, and it was thought the ventilation had reduced the temperature approximately 20°. Such an experiment, however, hardly reproduced the conditions of working which would obtain in a deep mine with its necessarily large output. In his own experience of working in the North Staffordshire district at a depth of 2,958 ft. probably the deepest workings in the district, the temperature of the seam at a distance of 3,300 ft. from the shaft was 94°, whilst the temperature of the air in the heading was 81¼°, with about 3,000 ft. of air passing. This showed a reduction of temperature of 12¾°. But in a longwall face, upon which 82 men were employed in the same seam at a depth of 2,490 ft., the temperature of the coal was 85°, while the temperature of the air was 82°, at a point where 14,000 cub. ft. of air were passing, showing a reduction of only 3°. It was, he thought, probable that the reduction of temperature which might be obtained by ventilation would in deeper workings be greatly influenced by the quantity of mineral exposed in fresh faces each day. The deeper pits must inevitably have large outputs, and it was difficult to think that the reduction of temperature of 20°, noted in the Produits case, could be general or be obtained in actual work in this country. One conclusion, however, might be drawn from this, that as workings became deeper it would be necessary to have smaller ventilating districts than had been the case in extensive English collieries, so as to reduce the amount of freshly-exposed face swept by each current. Deeper mines would also undoubtedly involve very rigid attention to the question of leakage of the ventilation, and would probably ultimately necessitate that this point should be under the special care of a properly qualified official, to whose requirements many other considerations would have to be subordinate. The instance to which he had referred, of a temperature of 94° of the strata at 2,958 ft., gave a rise of temperature of 1° for each 66 ft. in depth, assuming a constant temperature of 50° F. at a depth of 50 ft. Assuming that a reduction in temperature of 10° by means of ventilation could be obtained, then the temperature of 98° would not have been reached in the atmosphere of the working places until a depth of 3,878 ft. was reached. In the case of the Produits Colliery, however, it was found that with a brisk dry ventilation men were at work in a temperature of 103°, and they might therefore conclude that, so far as the present developments of their local coalfield showed, there would be no overwhelming difficulty with regard to the rise in temperature in working the mines to a depth of 4,000 ft., with their present means of ventilation efficiently carried out."—G. P. HYSLOP.—*Colliery Guardian*, Oct. 18, 1907, p. 715. (A. R.)

RATE OF TEMPERATURE INCREASE WITH DEPTH.—With regard to the main subject of increased temperature, the formerly accepted increase of 1° F. for each 60 ft. of depth is found not to be reliable. With regard to the deep thick coalseam (Warwickshire), we have some very carefully taken data by Dr. J. S. Haldane and Mr. F. G. Meachem. The subject is so fully considered and the conclusions so clear that it is not necessary to say more than that the heat of the rocks will probably not exceed 1° F. for every 120 ft. in depth or half the old estimate.—ALEXANDER SMITH.—*Colliery Guardian*, Oct. 18, 1907, p. 716. (A. R.)

SCIENTIFIC INSTRUMENTS IN MINING.—"The wet and dry bulb thermometers, used for measuring the amount of moisture in the air, are capable of giving very useful information at the present time when so much is heard of coaldust in deep and dry mines, and the methods of dealing with it. We want definite knowledge and comparisons of work and health in dry and humid mines of the same temperatures. Advocates of thorough watering to prevent dust are to be found as well as opponents, and legislation is to be expected on this matter. This legislation should be guided by the widest experience. On this subject some of our shallow mines might give hints, for I could point to more than one case in which the roads for some distance from the shaft have been bricked solely to prevent the decay and fall of the roof and sides under the influence of alternate wetting and drying due to the cold walls of the mine condensing moisture from the air on hot humid summer days.

Some data bearing on this question will be found in the following tables :—

Temperature. °F.	Weight in grams of 1 cub. ft. of water vapour.	Percentage increase in the volume of dry air when saturated with moisture.
30	1·97	0·56
40	2·86	0·83
50	4·10	1·21
60	5·77	1·76
70	8·01	2·50
80	10·98	3·52
90	14·85	4·93
100	19·84	6·83

Quantity of water contained in an air-current of 200,000 cub. ft. per minute, saturated with water vapour at

°F.	Lb.
60	164 per minute.
70	228 ,,
80	314 ,,
90	424 ,,
100	567 ,,

—Prof. G. R. THOMPSON.—*Colliery Guardian*, Nov. 1, 1907, p. 823. (A. R.)

WIND POWER. — "Although for any purpose requiring a more or less continuous supply of power, the wind is a wholly unsuitable source of energy, there are, nevertheless, many cases in which it can be utilised with advantage. Even if it has to be supplemented by a stand-by such as an oil engine, and worked in conjunction with a storage battery (which is generally an indispensable adjunct), wind-power may prove a source of economy. A few results derived from a series of experiments which have been carried on for some years by the Danish Government may, therefore, be of interest.

The velocities of the wind which are practically utilisable lie between 10 and 50 ft. per second, and the motor must be so constructed as to adapt itself automatically to all conditions, including storms. It has been found that a motor with only four wings is the best, and that if the surface of the wings in square feet is S, the velocity of the wind V in feet per second, and the output in horse-power is W, then $W = SV_3 \div 456,000$. Thus for a surface 100 sq. ft., with velocities of 10, 20, 30, and 40 ft., per second, the power available is 0·22, 1·8, 6 and 14 h.p. At the experimental station of Askow, with a petrol-motor as stand-by and a storage battery, an installation of 450 incandescent lamps has been successfully run for two years, at a fair profit even after allowing for interest and sinking fund charges on a 25-year basis."—*Mining Science.*—*Canadian Mining Journal* (Toronto), Oct. 10, 1907, p. 330. (J. Y.)

MISCELLANEOUS.

THE ORIGIN OF THE GOLD IN THE RAND BANKET. "I.—The theory as to the origin of the banket in best agreement with the facts appears to be that which regards the banket as a marine placer in which gold and black sand (magnetite with some titaniferous iron) were laid down in a series of shore deposits. The gold was in minute particles, and it was concentrated by the wash to and fro of the tide, sweeping away the light sand and silt, while the gold collected in the sheltered places between the larger pebbles. The black sand deposited with gold has been converted into pyrites, and at the same time the gold was dissolved and re-deposited *in situ*.

II.—The distribution of the gold agrees with that of placer deposits in the following respects:—

(*a*) The gold, as in a placer, is contained in the cement and not in the pebbles.

(*b*) The gold has a widespread horizontal, and narrow vertical range.

(*c*) The gold is spread through layers which are conformable to the sediments, and is not deposited in verticals or fault planes across the bedding of the rocks, except in the case of a few unimportant secondary quartz veins.

(*d*) The gold is distributed in patches and not in shoots.

(*e*) The gold tends to occur on the footwall side of the conglomerate beds, or to rest on layers of quartzites which acted as false bottoms in the reef series. Owing to the redistribution of the gold during its solution this rule is not as general as in the case of a recent placer; but it appears to be the general experience through the Rand.

(*f*) The rich patches occur at varying horizons dependent upon the frequent local variations in the currents that necessarily occur during the deposition of a series of deposits upon a shore.

III.—The objections to the infiltration theory include:—

(*a*) The absence of ore-shoots.

(*b*) The non-existence of the 'verticals' up which the gold may have been introduced.

(*c*) The limitation of the gold to special seams of conglomerate, and its absence from beds of sand and bastard reef, which lie immediately below rich banket, and must have been equally open to percolating solutions.

IV.—The essential difference in the distribution of the gold between the placer and infiltration theories is that, according to the former, the gold should originally have been deposited at the same time as the deposition of the conglomerates; whereas, according to the infiltration theory, the gold should have been introduced after the formation of the whole sedimentary series. That the gold was contemporary with the conglomerates is shown by:—

(*a*) The beds of ore being always parallel to the bedding planes of the rocks.

(*b*) The absence of the 'verticals' of South Dakota and the copper slates of Thuringia.

(*c*) The presence of gold in the conglomerates before they were cut through by the contemporary erosion, which led to the formation of the 'wash out' channel in the May Consolidated mine.

V.—The microscopic evidence shows:—

(*a*) There is no evidence of infiltration, or the presence of the secondary minerals typical of infiltration processes.

(*b*) There has been no conversion of the banket into a continuous sheet of vein quartz.

(*c*) The secondary minerals produced, such as the chloritoid, are typical of pressure-metamorphism, and have been developed alike in rich and barren rocks. Rich and poor banket, bastard reef and quartzite, are shown by the microscopic evidence to have all undergone the same changes, and the richest material sometimes shows less change than barren material.

VI.—The banket differs from the gold ores due to infiltration in other fields—for example, those of South Dakota; and the best general agreement is with that band of modern beach placers which extends for 50 miles along the western coast of the South Island of New Zealand. The Kanowna lead is quoted as a case of the solution and re-disposition of gold in a modern placer.

VII.—The absence of conclusive evidence of any considerable impoverishment in depth is an argument in favour of the alluvial origin of the gold, and is favourable to the further extension of the banket in depth."—Prof. J. W. GREGORY, Institute of Mining and Metallurgy.—*London Mining Journal*, Oct. 26, 1907, p. 523. (A. R.)

CUBIC CAPACITY OF COAL.—"Nut coal passing through a $1\frac{1}{4}$ in. screen and over a $\frac{3}{4}$ in. screen, and having a specific gravity of 1·3 will weigh about 52 lb. per cub. ft., or $38\frac{1}{2}$ cub. ft. per ton of 2,000 lb. when loose. If well shaken down, the same coal will weigh about 56 lb. per cub. ft., or about $35\frac{1}{2}$ cub. ft. per ton of 2,000 lb."—*Mines and Minerals*, Oct., 1907, p. 117. (A. McA. J.)

Reviews and New Books.

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

A MANUAL OF FIRE ASSAYING. By CHARLES HERMAN FULTON, President and Professor of Metallurgy in the South Dakota School of Mines. Published by the Hill Publishing Co., 505, Pearl Street, New York; 6, Bouverie Street, London, E.C. Price, $2.

Amongst the numerous treatises on assaying this work stands out as a quite refreshing treatment of an old subject. There is nothing, of course, particularly novel in the chapters on furnaces, reagents, sampling, etc., but the author puts in valuable work in those dealing with the reactions taking place in the crucible. Mr. Fulton also treats the assay of complex ores in a sympathetic manner, and the chapter dealing with the platinum ores is in itself worth the price of the book. We are surprised to find that the author quite ignores the various types of magnesia cupels which are so universal on the Rand. Is is somewhat incredible that the satisfaction they give here and in Australia has not caused writers on assaying seriously to consider their qualities, in many ways so superior to boneash. We also find the old heresy of bicarbonate of soda dying hard, and perpetuated once more in this manual. The well-known fact that the extra molecule of carbonic acid is sometimes the occasion of loss to the charge by reason of its rapid evolution before sintering has taken place, should be enough to condemn it, and in view of the many excellent brands of desiccated normal carbonate on the market its continued use seems anomalous. The work contains valuable chapters on errors in gold and silver assaying and the assay of bullion, whilst the dry assay of some of the base metals is also briefly described. The book is printed in large, clear type, with copious references, and is singularly free from typographical errors. (A. W.)

THE ELECTRIC FURNACE IN IRON AND STEEL PRODUCTION. By JOHN B. C. KERSHAW. With 24 Illustrations and a List of Patents. 68 pp. $8\frac{1}{2} \times 5\frac{1}{2}$. (*The Electrician* Printing and Publishing Co., Ltd.)

" Mr. Kershaw is sufficiently imaginative to picture the coalfields of Europe and America exhausted, so that supplies of iron and steel will depend upon the electric furnace, fed with energy from water resources. This, however, does not hinder him from presenting an altogether practical account of what has been achieved already by such workers as Moissan, Héroult, Keller, Kjellin, Stassano, and others. As this contribution to the subject has already appeared twice in the form of articles in technical journals, it is unnecessary here to do more than call attention to the permanent form in which it can now be procured, and to recommend it as a well-written and well-illustrated account of one of the most valuable processes developed in our time. The first patent is that of Sir William Siemens, dated 1879."—*Times Engineering Supplement*, Oct., 1907. (J. A. W.)

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.) 538/08. W. S. Simpson. Improvements in connection with the uniting or welding metals. 31.13.07.

(P.) 1/08. E. M. Weston. Improvements in water supplying attachments for rock drilling machines. 6.1.08.

(P.) 2/08. R. Bowman. An improved process for the reduction of metals from their ores. 6.1.08.

(C.) 3/08. H. Prinder (1), F. Engeler (2). Improvements in ore concentrating tables. 8.1.08.

(C.) 5/08. J. Mazlin. Improvements relating to pick heads usable with removable points, and the like. 8.1.08.

(P.) 6/08. H. Glumann. Trailable point lock. 8.1.08.

(P.) 8/08. P. H. Partridge. Process for seasoning lumber grown in South Africa to prevent it cracking and twisting. 9.1.08.

(P.) 9/08. J. M. Hall (1), T. Kerr (2). A mechanical contrivance for the better extraction of gold or its alloys and black sands, silver and its alloys, and other metals and their alloys. 9.1.08.

(C.) 10/08. W. W. Seay. A process of and apparatus for the production of ice and cold. 10.1.08.

(C.) 11/08. G. M. Capell. Improvements in centrifugal fans and pumps. 10.1.08.

(C.) 12/08. A. F. von Schmidt. Improvements in and relating to the valve gear of rock drills and other tools worked by compressed air. 13.1.08.

(C.) 13/08. P. de Wilde. A process for the extraction of gold from the auro-cyanic solutions. 14.1 08.

(P.) 14/08. W. J. Gold. Improvements in the charging of holes with explosives and means therefor. 14.1.08.

(P.) 15/08. E. Henry. Improvements in the treatment of the surfaces of roads and the like for laying dust and for other purposes. 15.1.08.

(P.) 16/08. H. Schwarz. Improvements in and relating to percussive rock drills. 15.1.08.

(P.) 18/08. Wilhelm Manss. Improvements in percussion machines. 17.1.08.

(P.) 19/08. James Taylor Carrick. Improvements in treating pyritic copper and nickel ores. 17.1.08.

(P.) 22/08. Donald Mackenzie (1), Richard Nicholson (2), Robert James Nicholson, trading as John Nicholson & Sons. Improvements in hand rock drills and machine rock drill bits. 20.1.08.

(C.) 23/08. James Norman Caught. Improvements in that type of marine and other steam engine in which a reciprocatory motion is converted into a rotary motion. 21.1.08.

(C.) 24/08. Jonas Pehrson. Improvements in hose and pipe couplings. 21.1.08.

(P.) 25/08. Edward Harrison. Improvements in means for building dumps. 23.1.08.

(P.) 26/08. Frank Masters Castleman. Driving gear for forcing grease into bearings or the like. 24.1.08.

(C.) 27/08. Leon Gerard. Improvements in or relating to apparatus for producing and utilising electrical effluvia. 24.1.08.

(P.) 28/08. Alec. Hewitt. Improvements in percussive drills or bits for boring in rock or the like. 25.1.08.

(C.) 29/08. Babcox & Wilcox, Ltd. (1), Theodore Reunert (2), Otto Lenz (3), Harry Reynolds (4), 2 and 3 trading as Reunert & Lenz. Improvements in the furnaces of water-tube or like boilers. 27.1.08.

Changes of Addresses.

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

COE, W. C., *l/o* Rhodesia ; The Bungalow, Hengoed, Cardiff, Wales.

DYKES, J. J., Jun., *to* 11, Royal Exchange Square, Glasgow.

GALBREATH, N. M., *l/o* Roodepoort ; 6, Kelly Street, Greenock, Scotland.

HAMILTON, E. M., *l/o* Mexico ; Ellesmere, Osterley Park Road, Southhall, Middlesex, England.

JORY, J. V., *to* P. O. Box 109, East Rand.

LACEY, E. D. DE, *to* P. O. Box 206, Roodepoort.

MARQUARD, J. D., *to* P. O. Box 184, Germiston.

MILLER, J., *l/o* S. Australia ; Mount Paris Tin Mines, Ringarooma, Tasmania.

MILLIGAN, J. T., *l/o* Pretoria ; P. O. Box 647, Johannesburg.

NICKLIN, W., *to* P. O. Box 1908, Johannesburg.

NITCH, H. G., *to* Meyer and Charlton G. M. Co., Ltd., P. O. Box 1127, Johannesburg

PEEBLES, J. G., *to* P. O. Box 32, Cleveland.

WILEY, H., *l/o* Germiston ; Crossmolina, County Mayo, Ireland.