'WANT OF NOVELTY' AND PATENT LITIGATION: THE CASE OF THE CYANIDE PROCESS OF GOLD EXTRACTION, 1892-1902

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In the years between 1887 and 1910, two major processes for the extraction of precious and base metals from their ores, the cyanide and the flotation processes, were developed. While these were very important advances in the technology affecting the mining industry (and are still as important now as they were when first used) they were both subjected to fierce litigation in the Courts. This is the story of the cyanide process.[1]

Keywords: technological advance and transfer, gold mining, cyanide process, patent litigation.

INTRODUCTION

The cyanide process was developed in Glasgow in 1887 by the MacArthur-Forrest Research Syndicate,[2] but principally by John Stewart MacArthur, who was also the newly-appointed technical manager of the Cassel Gold Extracting Company. On 21 October 1887, MacArthur announced to the Company's Board the Syndicate's discovery of the process and his application for provisional patent protection (British patent No 14,174 of 19 October 1887).

The Cassel Board immediately directed its patent agents, Allison Brothers of London, to undertake a search for similar processes patented in the United Kingdom after 1840 and, at the same time, sought patent protection in a number of countries.[3] The search yielded 33 patents which referred to potassium cyanide in their specifications, of which 26 were concerned with plating and gilding and one with alloys. In only six were ores even mentioned. Commenting on these cases, MacArthur[4] noted that in none was cyanide used as the depositing agent.

The new process involved the application of a solution of cyanide to the crushed auriferous ore. The cyanide attracted and dissolved the gold forming a gold-cyanide solution from which the gold could then be extracted. The process was named MacArthur-Forrest B after its discoverers. In the following year, the research team developed a method of isolating the gold from the gold-cyanide solution by means of zinc shavings (or filiform). This process, the MacArthur-Forrest C, was patented on 14 July 1888 (No 10,223).

The Cassel Company began to improve the process to a stage where it could be

used commercially, and set up subsidiary companies in South Africa and the United States (and later in Australia and Mexico) to advance the process in the world's major gold mining centres. The Board looked forward to the royalties it was soon to receive. It was in South Africa that the benefits of the process first became evident. After a successful demonstration by MacArthur near Johannesburg in 1890, the process was accepted by the major gold mining companies on the Rand. It improved substantially the processing of difficult ores from which the extraction of gold had been possible before only by very costly processes. From around 55-60 per cent extraction, cyanide allowed over 90 per cent of the gold to be claimed. It also extracted most of the silver from silver-bearing ores or from those containing a mixture of the two metals. Thus it offered greater profits from the lower-cost gold extraction from the rich ores and fostered the mining of 'low-grade' material which had been uneconomic previously. Success was assured. The process was spread to most gold-mining countries.

Although the innovation saved many ailing gold-mining companies, it was soon apparent that the mining industry considered such technological advances should be free gifts and, in the Transvaal and elsewhere, it began to object to the payment of royalties to the patent-owners.

The threat of gathering storm clouds became clear to the Cassel Company when its application for patent protection in Queensland was held up by the Patent Registrar because of the registration of a similar process in that colony in 1883 by John Nicholas. His specification involved the roasting of the gold-bearing ore, crushing, and leaching with water and then the following:

> Dissolve iodine in potassium cyanide solution, having latter in excess; and add it, considerably diluted, to the prepared ore in the proportion of about two ounces of iodine to every ounce of gold the ore is known to contain, and digest it for a short time. It may then be drawn off, and the gold recovered from the solution in several ways of precipitation.[5]

The MacArthur-Forrest *provisional* specification, submitted to the Queensland Patent Office, included the following:

> In carrying out the invention the ore ... is treated with a solution containing cyanogen or a cyanide ... till all or nearly all of the gold and the silver is dissolved; the operation being conducted in a wooden vessel or a vessel made of or lined with a material not acted on to any considerable extent by the solution ... contained therein. The solution is then drawn off and the metal or metals are recovered by any suitable process, and the cyanogen, cyanide or substance containing or yielding cyanogen, may be regenerated.[6]

To overcome the Queensland objection and to take into account their latest discovery, an Amended Complete Specification dated in Glasgow 17 July 1888 was dispatched to the Queensland Patent Registrar. This amendment was much more specific, as the following extract shows:

> In carrying out the invention the ore ... in a powdered state is treated with a solution containing cyanogen or a cyanide ... In practice we find the best results are obtained with a *very dilute* solution, ... such dilute solution having a *selective action* such as to dissolve the gold or silver in preference to the baser metals.[7]

Thus the Cassel Company distanced its process application from that of Nicholas

but it was not until 1890 that the registration of the patent occurred in this colony. In addition, to be more precise concerning the use of cyanide, the discoverers noted in the amended specification that they generally used 'a quantity of cyanide the cyanogen of which (was) equal in weight to from one to four parts in every thousand parts of the ore or compound, and ...(dissolved) ... the cyanide in a quantity of water of about half the weight of the ore.'

It is clear that, by June 1888, the Cassel research team had discovered that only a very dilute cyanide solution was required. It was then debated by the Board whether or not the British specification should be amended along the lines of the Queensland amendment.[8] The decision not to do so was possibly the most disastrous decision ever made by the Board as subsequent events show.

Other difficulties arose for the Company in the early 1890s as opposition grew in gold-producing countries to the exaction of royalties. The first attack came from the *Engineering and Mining Journal* which claimed that the MacArthur-Forrest patents were not novel. Despite this American opposition, no court decision was ever handed down in the United States.[9] Although many infringements occurred there in the 1890s, Cassel's American subsidiary did not press legal charges, largely because its Board expected a rebuff in the courts but also because it lacked financial resources for a costly court battle.

By 1894, however, opposition was not confined to the *Engineering and Mining Journal*. There were two major issues on which all opposition to the MacArthur-Forrest B and C patents was centred - *want of novelty* and *lack of precise specification* - and it was on these two issues that the decisions of the courts in all countries were based.

PRIOR CLAIMS

Numerous investigations were made in the mid-1890s to uncover all the patents registered in the United States, United Kingdom, and the British colonies which may have preceded the MacArthur-Forrest patents. Restricting the list to those which were concerned only with the extraction of gold and silver from their ores using potassium cyanide and the use of zinc for the precipitation of the precious metals from solution, three stand out in subsequent court proceedings, those of J.H. Rae (1867), J.W. Simpson (1885), both of which were said to anticipate MacArthur-Forrest B, and that of A.P. Price (1884), claimed to precede MacArthur-Forrest C, by noting that the precious metals could be precipitated from solution by the use of zinc.[10] All three patents were registered only in the United States.

Rae's process was concerned with

> the use of an electrical current with suitable liquids and chemical substances, such as potassium cyanide, in such a manner that by the combined action of the current and chemicals the metal was first obtained in solution, and then collected and deposited in a pure state.[11]

His process was therefore one of extraction and precipitation by combining electricity and chemicals, possibly potassium cyanide. One could argue that whether

the use of electricity was superfluous in practice or not is beside the point. The specification stipulated a combination of the two, and electricity was an essential element in the process. Moreover, 'it seems doubtful whether Rae was actually aware of the solubility of gold in cyanide solutions without the aid of the electric current.'[12] Had he been aware of it, why was he so general in his specification to state 'chemical substances, such as potassium cyanide'?

Simpson's patent, involved the process of crushing the ore (containing gold, silver, or copper), its immersion in a vat or tub of a solution of potassium cyanide and carbonate of ammonia (one pound of the former to one ounce of the latter), the settling of the solution and then the precipitation of the metal.[13]

Once again, it was the combination of two active agents which was expected to dissolve the gold, silver or copper from the ore. While the quantity of cyanide predominated in the solution, the carbonate of ammonia was still expected to be active in the dissolving process.[14] Thus, it could be argued that, whether Simpson knew that potassium cyanide alone could have been used with the same results as the combination of the two chemicals even in the proportions used, is irrelevant. According to Simpson in his specification: 'What I claim as new in the process of separating gold and silver from their ores is subjecting the ore to the action of a *solution of cyanide of potassium and carbonate of ammonia*, and subsequently precipitating the dissolved metal ...'[15]

Price's patent referred to the use of zinc as a precipitant of precious metals, but did not state the form in which the zinc was to be used. In this respect, the MacArthur team found that zinc in shavings (filiform) was much more efficient as an extractor of gold and silver than zinc in any other form. Their C patent specifically stipulated *filiform* of zinc, and was thus new to the extent that the method substantially improved previous knowledge.[16]

EARLY SETBACKS

Cassel's perused the specifications of the many new patents being registered and successfully opposed the registration of one of them in Transvaal. This was the Siemens-Halske patent, registered in Britain in February 1888, covering a process based on cyanide as a solvent and electricity as a precipitant.[17] In July 1892, MacArthur began to investigate the patent application of C.P. Pielsticker of the Cyanide Gold Recovery Syndicate (later the Electro Cyanide Gold Recovery Syndicate).

The first legal setback occurred, however, in March 1894, when the MacArthur-Forrest patents were declared invalid by an Austrian court. In addition, towards the end of 1893, DEGUSSA, a German cyanide manufacturer, challenged the validity of the cyanide patents in Germany before the Patent Office[18] but on 17 April 1894, the Patent Office ruled in favour of Cassel's, a ruling set aside by the German Supreme Court in mid-1895, after an appeal by DEGUSSA and Siemens-Halske. The Supreme Court argued that Simpson's patent was essentially the same as that of the defendants and that his neglect to specify 'selective action' did not affect his prior claim. 'Lack of novelty' prevailed.

THE "PIELSTICKER" CASE

MacArthur's examination of the Pielsticker process revealed that it was very similar to MacArthur-Forrest B, As a result, in December 1892, the Cassel Board began legal proceedings against the Cyanide Gold Recovery Syndicate for infringement of its patent rights.[19]

On 8 November 1894, Mr Justice Romer delivered his judgment in the Lower Court against Cassel's.[20] This was the first important legal decision to go against the Company, a prelude to others. As in Germany, 'want of novelty' formed the major grounds for rejecting the Cassel arguments. The patents of Rae and Simpson were cited by Judge Romer as antecedents of the MacArthur-Forrest B patent. In his judgment, Rae's recommendation to use potassium cyanide as a solvent of gold was not rendered 'worthless because he also recommends the use of electricity to facilitate the action of the solution and to do other work with the solution after the gold was extracted.' The judge also considered that Simpson's patent was 'substantially identical with the plaintiffs' except that the solution he mentions is not of cyanide of potassium only, but of a comparatively small quantity of carbonate of ammonia added.'[21] He therefore concluded that there was no invention or discovery made by MacArthur and his team.

The Cassel Company appealed against the decision. The Appeals judges handed down their decision on 9 April 1895. While they decided against Cassel's, the company had a pyrrhic victory in that the setting-aside of the appeal was based only on a weakness in the patent specification. The decisions of the Appeals Court on the 'want of novelty' or 'prior anticipation' are interesting when compared with those handed down elsewhere.[22]

First, in their judgment, it was proved that, while it was common knowledge before 1887 that cyanide of potassium by itself would act as a solvent of gold in a finely-divided or precipitate condition, the evidence provided in the Court showed that it was not known that cyanide *by itself* would act as a solvent so as to extract gold from its ore nor from the tailings derived from the amalgamation and the chlorination processes. Second, that the plaintiffs solved the problem of extracting the gold from refractory ores containing base metals without affecting the latter was judged 'the undisputed facts of this case established.' The 'selective action' argument, stressed by the plaintiffs, was thus accepted by the Appeals Court.

Third, on Rae's patent, the Appeals judges concluded that Rae's specification was useless because, as he did not state that a dilute solution of cyanide should be used, his process would ensure that the cyanide would also attack the base metals in the ore as well as the gold. Fourth, they considered Simpson's patent to be the only one on which some grounds for anticipation of MacArthur-Forrest B could possibly be argued. The question this patent raised was:

> Does this specification add to the stock of common knowledge so as to inform men skilled in chemistry that, by the application of a very dilute solution of an extremely small quantity of cyanide of potassium alone to gold as it exists in nature, when the ore is crushed the gold can be extracted therefrom, leaving behind the baser metals?

After examining all the evidence presented before Mr Justice Romer they concluded that, by 1887, the chemical world did not know that the use of cyanide in a

very dilute solution would extract gold selectively from its ore. They also concluded that the use of a compound of potassium cyanide and ammonium carbonate was not only what Simpson relied upon but what was the *natural meaning of his discovery*, and that 'it would not lead anyone to suppose that a very dilute solution of an extremely small amount of potassium cyanide alone would do what it was supposed the compound of the two would do.' They therefore found 'novelty and utility' in MacArthur-Forrest B and noted:

> We would point out that the invention consists, not merely in discovering that cyanide of potassium can be used to extract gold from its ore, but in showing the public the best practical method of doing it by leaving the baser metals behind, *which had never occurred to any one before.* We cannot doubt that upon the evidence given in this case .... if the plaintiffs' specification is read as contended for by them there is ample novelty and meritorious invention in their discovery.

On 'anticipation' the judges noted precedents in which it was defined along these lines:

> That to constitute a *paper* anticipation the description in the prior publication must be such that a person skilled in the matter of reading it would find in it the invention which is sought to be protected by the patent, and unless this can be found ***in the writing itself*** it is not an anticipation at all.

But Cassel's still lost the appeal, because of the absence of the word ***dilute*** in their specification. The judges noted:

> If in the specification there had been the second claim alone, that is, for the dilute solution containing the small quantity of cyanide of potassium as therein substantially described, there would not, in our judgment, have been any real difficulty in this case, and we would have been of opinion that this was a good patent.

For the lack of one word (the insertion of which had actually been made in the Queensland specification but rejected by the Cassel Board for inclusion in an amended British specification), the case was lost. Amendments to the original specification to include the word *dilute* in the appropriate places were sought in all gold-mining countries and were allowed in most of them. Before outlining some of the difficulties encountered in amending the patent, however, it is necessary to discuss the other 'great cyanide case'.

THE 'GREAT CYANIDE CASE' IN THE TRANSVAAL

The MacArthur-Forrest B and C processes were patented in the Transvaal as Numbers 47 and 74 in September 1888 and May 1889 respectively and these patents were assigned to the African Gold Recovery Company (a Cassel subsidiary, henceforth the Af.GRC) on 9 July 1891.[23] The events which led up to the litigation are well documented.[24] The Af.GRC assumed the role of a monopolist with regard to its patent rights, remained largely inflexible in its royalty contracts, and charged comparatively high royalties. On the other hand, the cyanide users, while deploring these high rates, began to regard the payment of any royalty as an unwarranted burden. Efforts of the Transvaal Government to establish lower royalties met with opposition from both sides. Litigation became inevitable when some mining companies began to ignore the Af.GRC's demands for royalty paymemts.

On 17 February 1896, the case of James Hay v. the African Gold Recovery Company began in the Transvaal Supreme Court.[25] The plaintiff was supported by the Transvaal Chamber of Mines. It was to be a test case. Much of the information used in the British cases was used by both sides. In mid-November 1896, the Court's judgment was delivered, in favour of the plaintiff although one of the three judges issued a minority report favouring Cassel's for the MacArthur-Forrest B patent.

The majority decided that there was want of novelty and that this would have been so even if the word *dilute* had been included in the specification of the B patent as Simpson's specification also included cyanide in a dilute form (a statement not confirmed elsewhere in the literature). Moreover, it was decided that mere dilution was not a new discovery as many chemists using expensive chemicals would attempt economy by testing dilute solutions. The two judges did not take into account the fact that dilution was not only a case of economy but, more importantly, essential to improve the efficiency of the process. They also noted that the word *dilute* is very vague and asked the hair-splitting question of what is the dividing line between a dilute solution and a strong one. On the C patent, all judges concurred that the patent was bad for want of novelty as it had been anticipated by Price's patent of 1884 which noted the use of zinc as a precipitant. Thus, no account was taken of the fact that zinc in shavings form was the essential mode in which the zinc had to be used to obtain the highest precipitation rate and that this was unknown to Price.

One judge, in his minority report, argued that there was no anticipation of the MacArthur-Forrest B claim that the action of cyanide on refractory ores was selective. He dismissed Rae's patent because there was nothing to show that Rae discovered anything for practical application as he did not present any information regarding the strength of the cyanide solution. Moreover, this judge did not consider that Simpson's process would produce any practical results. He considered that, in his view, MacArthur-Forrest B contained novelty and invention and should be allowed.

It is interesting to note that had the British provisional specification been amended in the same way as the Queensland one, the MacArthur-Forrest B patent would have been judged legal by the Court of Appeals but not by the Transvaal Supreme Court. The differences in interpretation between the two legal bodies are also striking. With no avenue of appeal from the Transvaal decisions, the use of the cyanide process became free in the Transvaal.

PATENT AMENDMENT IN AUSTRALIA AND NEW ZEALAND

Legal attitudes towards the amendment of the cyanide patent varied from one Australian colony to another. When the Cassel subsidiary, the Australian Gold Recovery Company (henceforth the Aust.GRC), applied to the Commissioner of Patents in Victoria in 1895 to amend the B specification in accordance with the British amendment, the application was opposed by the Minister for Mines and other parties. In May 1896, the Commissioner refused to allow the amendment. Subsequent action in the Victorian Supreme Court endorsed this decision but an Aust.GRC appeal to the Full Court was successful. This judgment was not delivered until

May 1899.[26] Although an appeal to the Privy Council was considered, the Victorian Government approached the Aust.GRC with a proposal for purchasing the Company's patent rights for the colony. Early in 1900, this purchase was completed - for £20,000.[27]

In Queensland in 1896, a similar action was avoided as the relevant amendment had been made in 1888. The Minister for Mines in that colony asked the local representative of the Aust.GRC. Gordon Wilson of Charters Towers, for justification of his Company's royalty policy. Wilson's reply[26] satisfied the Minister and thus the legality of the patents in Queensland was not challenged at that time.

New Zealand followed the Victorian approach. In May 1895, the Cassel agents in Auckland applied to the Registrar of Patents for permission to amend the patent's specification. Considerable opposition arose and, early in October 1896, the application was refused. Cassel's appealed to the New Zealand Supreme Court which, in June 1897, decided in favour of the Company. In the following month, the Government began negotiations with the local Cassel representatives for the purchase of the patent rights. The Government's offer of £10,000 was accepted. The payment was made in January 1898 and was recouped by the Government by levying a small royalty.

In Western Australia late in 1895, the Registrar of Patents granted the Aust.GRC leave to amend its MacArthur-Forrest B patent as required. In 1898, the Company began proceedings against the Lake View Consols Gold Mining Company for failure to pay royalty dues. Eventually, after argument before the Supreme Court and the Privy Council on points of law, in December 1899, the Privy Council declared that the Registrar of Patents' recording of the amendment had contravened the Act and the amendment was thus illegal. Given that its patent protection would expire in 1901 under normal circumstances, the Aust.GRC refrained from further litigation.

The final instance of objection to the legality of the B patent occurred in the Supreme Court before the Chief Justice, Sir Samual Walker Griffith (later the Chief Justice of the High Court of Australia). In April 1902 the case of the Aust.GRC v. the Day Dawn PC Gold Mining Company of Charters Towers was heard, the former seeking to recover royalty payments unpaid from December 1900 to the end of 1901. Much of the evidence used in the British and Transvaal cases was heard by the Chief Justice. In addition, the defendants argued the anticipation of the Nicholas's cyanide-iodine patent noted above. Griffith, who was well aware of the problems associated with the local registration of the patent from 1888 to 1890, for he had been consulted by Cassel's at the time, decided in favour of the Aust.GRC, arguing that the whole question of the legality of the patent had been investigated fully in the late 1880s when the Cassel Company had been allowed to register its amended specification.[29] He expressed his agreement with the judgment of the English Appeals Court and, as the Queensland specification covered the Appeals Court objection to the Cassel English specification, he could not find against the Aust.GRC.

Thus ended the series of legal proceedings covering the period from 1894 to 1902. Reviewing the numerous decisions, the arguments of the various legal experts before the Courts, and the deliberations in the Legislative Assemblies and

Councils in Australia and New Zealand, one can only conclude that there was a very fine distinction between the legality and illegality of the MacArthur-Forrest B and C patents and the Company was very unlucky not to have been much more successful.

COMMENTS ON THE LEGAL STATUS OF THE CYANIDE PATENTS

Clearly the legality of the patents depended on whether or not those of Rae, Price, and Simpson, especially that of Simpson, anticipated MacArthur-Forrest B and C and, as the above indicates, legal opinion differed. The Cassel Company relied on the argument that a *dilute* solution of potassium cyanide *alone* had a *selective action* on the gold and silver contained in the refractory ores, extracting the precious metals *without* dissolving the base metals. Its legal representatives stressed this aspect of the B specification and claimed that this was novel and therefore an invention in the legal sense. Moreover, it was also claimed that, while the MacArthur-Forrest Syndicate knew that zinc was a precipitant of gold from solution, MacArthur's discovery that zinc in shavings form was a more efficient precipitant than in block form was also novel and that therefore the C specification was novel. Nevertheless, had the B patent been declared legal in the courts Cassel's could have charged royalties legally without the need for the legality of the C patent to have been substantiated.

That the MacArthur-Forrest Syndicate was unaware of the United States registration of the patents of Rae and Simpson is clear enough. MacArthur later noted that potassium cyanide had been tried as a potential solvent of gold from its ore almost a year before he realised its value. In addition, it must be noted that the whole object of the Syndicate's endeavours was to find a solvent which would remove *selectively* the gold from its refractory ore. MacArthur had been involved in such a project for several years before he joined Cassel's.[30]

Moreover, after the patent search of 1887, MacArthur stressed that 'in no case is our reagent used as a depositing agent' and 'to the best of my knowledge and judgment, the specifications contain nothing detrimental to the MacArthur-Forrest process or its specification.'[31] But then, no search had been made of the United States patents.

An interesting point to note is that Cassel's acquired the rights to the Simpson patent. A Board Minute of 17 May 1892 refers to a cable sent to William Jones, the Company's American agent, advising him 'to endeavour to secure control of Simpson's patent for all the world' and another of 24 May 1892, advising Jones to make sure 'the transfer of Simpson's patent is registered.' Furthermore, in the *Mining and Scientific Press* of 2 July 1892, Cassel's American subsidiary noted that 'they control the Simpson's patents only granted in the United States.' There is also reference in the Board Minutes to the approaches made to Rae concerning the acquisition of his rights but then his patent rights would have been outdated well before the 1890s.

What were not, and could not have been, taken into account in the legal battles over the patents were the practical implications of the MacArthur-Forrest discoveries. Mindful of the profits to be made from the exploitation of the process, imme-

diately after the discovery the Cassel Company initiated a programme aimed at advancing the rapid diffusion of the innovation to the world's goldfields. This programme involved further testing of the process on many kinds of auriferous ores, its improvement, the designing of cyanide equipment, the gaining of practical knowledge, training of cyaniders, dispatch of cyanide plant and staff to the goldfields, public demonstrations, and the commencement of the manufacture of potassium cyanide.

Even so, without the efforts of numerous Cassel field agents such as Alfred James, who 'forced' the process on to disinterested mining companies, it would have been many more years before the world's gold mining industry could have taken advantage of the benefits offered by the process.[32] However, once the recalcitrant mine owners were persuaded to adopt the process and discovered what profits they could earn from its use, they resented paying a proportion of the income accruing from the innovation to the discoverers of the process and successfully sought means to avoid such payments.

Alfred James later commented on the reference to 'anticipations' in the legal proceedings of the 1890s:

> It is essential that sufficient inducement be offered to obtain that fostering care which provides the main difference in results between many a successful process and previous attempts to accomplish the same purpose by similar or even well-nigh identical means. It is for this reason that so-called 'anticipations' are pernicious. Disinterred from the dust and cobwebs of antiquity, unexplored except for the purpose of an action in law, they by-pass the main wealth and value of a patent - the toil, skill, perseverance, and grit expended in its development. The anticipations were absolutely valueless from the lack of these adjuncts - ideas are cheap; it is work which develops fruitfulness.[33]

On the cyanide process in particular, he noted:

> After five years' hard work involving the training of many metallurgists, the erection of a cyanide manufacturing works to prevent the supply of cyanide to the mines being restricted, the dispatch of six expeditions, the fighting of two law suits, and the carrying out of much mechanical research, such as the use and the effects of cyanide, alkalies, oxidizers, lead salts, and alkaline sulphides, ... and the expenditure of over £100,000, an epoch-making success had been forced on an industry.[34]

The major points made by James are, first, no anticipations had an impact on the gold industry before 1887; second, the Cassel Company virtually had to force the cyanide process on to the gold-mining industry by showing the huge benefits to be derived from its use; and, third, those who obtained the benefits were reluctant to compensate the patent-holders for their efforts. Yet, against these arguments are those in favour of the protection that a patent provides for an inventor. Without patent legislation offering a short-term reward, perhaps fewer discoveries would be made. But if a process is improved in some way, does the improvement enjoy an independent identity? Was this the major problem in the cyanide litigation which led to the different and often conflicting legal interpretations?

A feature of the numerous legal decisions emanating from the courts is the different personalities of the various judges in the many countries. Even so, it is very difficult to accept that groups of judges, confronted with virtually the same evi-

dence could arrive at so many different conclusions, some diametrically opposed to others. Was litigation in patent law so much of a gamble as the above implies? Or is this just an example of the hazards of litigation in general, even those which exist today?

CONCLUDING COMMENTS

The cyanide litigation was not alone in mining affairs in the years up to 1914. In addition, legal battles were fought in the 1900s over the use of vacuum filters and the flotation case around World War I vied with that of cyanide in its attraction to the legal profession.

As for the impact of the cyanide litigation, it is clear that the process could be used freely from 1895 in the Transvaal and from 1899 in Western Australia while Cassel's African and Australian subsidiaries had to curtail their activities considerably. In the United States, few gold miners paid for the privilege of using the process and this adversely affected the profitability of the American subsidiary. The Cassel Company did not reap the rewards it had expected for all its efforts in advancing the popularity of the process it had developed and, by 1897, it had decided on a new start, by concentrating its activities almost exclusively on the manufacture of cyanide. At that it was highly successful.

It is also clear that Cassel's and its affiliates were not recompensed fully for their efforts in presenting the gold mining industry with an important technological breakthrough, one which rapidly transformed gold and silver extraction in most parts of the world, and increased the annual yield and profits of the gold-mining companies. As Gray and McLachlan noted:

> ... the fact remains and cannot be disputed that he ... (MacArthur) ... was the first person to make the reaction a commercial success. Though he was deprived of the material prosperity which should have been his through the agency of the law courts, yet the service he rendered to metallurgy was one of outstanding merit ...[35]

Finally, having obtained control of the Simpson patent, Cassel's could have attempted to obtain royalties on the basis of this and the two MacArthur-Forrest patents, by registering the Simpson patent in (say) the Transvaal, where so much credence was laid on its importance. But the Cassel Board did not consider this interesting possibility. Moreover, there is no evidence anywhere in the literature that any of the processes of Rae, Simpson, or Price, were ever adopted by a mining company.

NOTES AND REFERENCES

1. The flotation process was important in extracting base metals from their ores. It was developed in Australia. Geoffrey Blainey (*The rush that never ended*, Melbourne University Press, Melbourne, 1963, p. 271) described these processes as two of the three major metallurgical advances of the last thousand years.
2. The Syndicate comprised J.S. MacArthur, Robert and William Forrest (two physicians) and George Morton, the finance member. For a comprehensive account of the early history of the cyanide process see my 'Discovery, development, and diffusion of new technology: the cyanide process of gold extraction, 1887-1914', *Prometheus*, 7, 1, 1989, pp. 61-74.

3. See the *Board Minutes* of the Cassel Company (henceforth *CBM*), 21 June 1886, housed in the Cheshire Record Office, Chester.
4. *CBM*, 11 November 1887.
5. See 'The Australian Gold Recovery Company Ltd v. The Day Dawn P.C. Gold Mining Company Ltd', Council of Law Reporting by the Queensland Law Journal Ltd, *State Reports, Queensland: Decisions of the Supreme Court of Queensland*, Brisbane, 1902, p.130.
6. See Provisional Specification of Patent No. 1011, dated by MacArthur and the two Forrests on 27 October 1887, held in the Australian Archives, Queensland Section, Brisbane, the date of receipt being 7 March 1888. This appears to have been an exact copy of the specification tendered to the British Patent Office.
7. See Amended Complete Specification, Patent No. 1011, housed as above. My italics.
8. *CBM*, 21 June 1888.
9. The only case that could have come before the courts, in which the American subsidiary sued the Mercur Gold Mining Company for infringement, was settled out of court in March 1896.
10. MacArthur-Forrest B covered the use of cyanide alone to dissolve precious metals from their ores. The British specification was amended in 1895 to cover the use of a dilute solution of cyanide (see fn ref. 7 above). MacArthur-Forrest C covered precipitation using filiform zinc and the use of alkalies for the initial neutralising of any acids present in ores (See Gray, J. and McLachlan, J.A., 'A history of the introduction of the MacArthur-Forrest cyanide process in the Witwatersrand goldfields', *Journal of the Chemical, Metallurgical, and Mining Society of South Africa*, 33, 12, 1933, p. 379).
11. See Gray and McLachlan, *ibid.*, p. 379.
12. *Ibid.*
13. See 'The Cassel Gold Extraction Company (Limited) v. The Cyanide Gold Recovery Syndicate (Limited) and Others', Appeal Decision, *The Times*, 10 April 1895 (henceforth Appeal Decision).
14. *Ibid.*
15. *Ibid.* My italics.
16. Other registered patents introduced into court evidence but rarely commented upon included those of Elkington (1840), Sanders (1881), and Hannay (July 1887).
17. When the process was eventually used at the George Goch and the Metropolitan mines on the Rand in 1895, it was soon abandoned in favour of the Cassel process.
18. See Gray and McLachlan, *loc. cit.*, p. 389. DEGUSSA's full name was the Deutsche Gold und Silber Scheideanstalt.
19. The specification of the Pielsticker process was very similar to that of Siemens-Halske, involving the use of a cyanide solution and electric precipitation.
20. See 'The Cassel Gold Extracting Company (Limited) v. The Cyanide Gold Recovery Syndicate (Limited) and Others', before Mr Justice Romer, cited in *The Times*, 9 November 1894.
21. *Ibid.*
22. Citations below are from the recorded decisions of the Appeals Court as published in *The Times*, 10 April 1895.
23. See Gray and McLachlan, *loc. cit.*, pp. 383-4.
24. *Ibid.*
25. See *Ibid.* The following is based on this source.
26. See *The Age*, Melbourne, 29 May 1896 and 4 May 1899.
27. Miners using the cyanide process were then charged a 2.5 per cent royalty until 1905, by which time the purchase money had all been recouped by the government.
28. See 'Saving of gold by the cyanide process', in Queensland: *Votes and Proceedings of the Legislative Assembly* 1897, vol. 4, p. 275.
29. For details see Queensland State Reports, *Decisions of the Supreme Court*, Brisbane, 1902, pp. 123-66. The Chief Justice accepted the British Court of Appeal's rulings, cited the millions of pounds extracted from tailings as proof that the discovery was patentable and of general usefulness and, concentrating on Nicholas's specification, stressed the difference between the use of two substances and that of each one separately where only one was the active substance (an argument also applicable to the patents of Rae and Simpson).

30. See his 'Discovery of Cyanidation', *Mining and Scientific Press*, 113, 23, 1916, pp. 851-7.
31. *CBM*, 11 November 1887.
32. See Alfred James's hard-hitting arguments in 'The difficulties of developing invention: the story of the cyanide process', *Engineering and Mining Journal*, 113, 1, 1922, pp. 9-12.
33. *Ibid.*, p. 9. At this time James was an independent commentator. His links with Cassel's had been broken in 1895.
34. *Ibid.*, p. 11.
35. *Loc. cit.*, p. 395. Note, however, MacArthur's reward for his invention obtained from Cassel's was considerable: rather it was the Company and its affiliates that lost most from the law courts.