3

Informed Subject Matter

INTRODUCTION

One of the challenges that a fickle, empirically based, and rapidly changing subject matter posed for nineteenth-century patent law was working out how to define the boundaries of what was being examined or protected. While patent law employed a number of different strategies to delimit chemical subject matter, one stood out. This was the decision to treat intangible chemical property as if it was coextensive with the material chemical compound described in the patent, that is, with the compound itself. Unlike with mechanical inventions, where protection extended beyond the machine as described in the patent to include inventions that were considered to be legally equivalent to the patented invention, the intangible property in a patented chemical compound was not only treated as if it was coextensive with the material chemical compound, it was also treated as if it was a 'chemical individual'[1] or a 'singular point in the general field of matter'.[2]

The decision to deal with some of the idiosyncrasies of organic chemistry by treating the intangible chemical property as if it was coextensive with the individual chemical compound was evident in the way that chemical subject matter was interpreted for the purpose of determining whether it met the doctrinal requirements of novelty and non-obviousness. While in considering the novelty of other types of subject matter, the law was willing to analogise and extrapolate away from the prior art; this was not the case where the prior art consisted of chemical compounds, where the information was restricted to the material chemical compound. The reason for this was that while it was often possible with mechanical inventions to predict whether the operation of a novel material substituted in an old combination could achieve similar results, this

[1] *Dickerson* v. *Mauer* 113 Fed 870, 874 (CCA 3d 1902). Henry Guerlac, 'Quantification in Chemistry' (1961) 52(2) *Isis* 194, 196.

[2] Charles E. Ruby, 'Are True Chemical Compounds, as Such, Inherently Unpatentable Subject Matter: Part II' (1941) *Temple University Law Quarterly* 321, 336.

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was not the case with chemical compounds where prediction could not occur without experiment.[3]

Similarly, as it was not possible to predict what chemical subject matter would be like without creating it first, the courts were cautious about assuming the obviousness of a step taken by a chemist, even when the prior art was very close.[4] This can be seen, for example, in the 1928 Supreme Court decision of *Corona Cord Tire Company* v. *Donovan Chemical Corporation*, which concerned a patent for a chemical compound (an 'accelerator') that improved the elasticity, tensile strength, and other desirable commercial qualities of finished rubber products. The patent in question was for the discovery of a new type of accelerator, called diphenylguanidine. As the patent noted, diphenylguanidine was closely related chemically to another type of guanidine – triphenylguanidine – which had already proven itself useful as an accelerant. Drawing on the fact that the chemical compositions resembled each other, the petitioner argued that the patent was invalid because the utility of diphenylguanidine as an accelerator was 'plainly indicated by general chemical knowledge'.[5] That is, a person skilled in the art could have discovered diphenylguanidine merely using knowledge which 'was fully and readably available to everybody in the art and without exercising any inventive faculty whatsoever'. Chief Justice Taft disagreed saying that 'the catalytic action of an accelerator cannot be forecast by its chemical composition, for such action is not understood and is not known except by actual tests'.[6]

The decision to treat the intangible chemical property as if it was coextensive with the material chemical compound was also evident in the way that chemical subject matter was construed when questions of infringement arose. In many areas of patent law, a desire to protect the equity of an invention – that is a desire to ensure that third parties were unable to avoid an accusation of infringement by making minor (non-inventive) changes to the invention – led to patents being read in a way that extended protection beyond a strict literal reading of the claims to include similar or equivalent inventions. Under the doctrine of equivalents, for example, protection extended to include situations where a would-be infringer replaced or substituted part of an invention with something that performed the same or equivalent function. As Robinson said, an equivalent meant the 'interchangeability of agencies which are known in the arts to be capable of serving the same purpose as integral parts of the invention. By identity is meant, not the identity of tangible embodiments, but identity of effect, function or means'.[7]

3 *Naylor* v. *Alsop Process* 8 Cir., 168 F. 911, 918 ('reasoning by analogy in a complex field like chemistry is very much more restricted that in a simple field like mechanics').

4 *Ex Part Hentrich* 38 USPQ 249 (1937).

5 *Corona Co.* v. *Dovan Corp.*, 276 U.S. 358, 368 (1928).

6 Ibid., 368–69. Anthony William Deller, 'Principles of Patent Law Involved in the Weiss Patent Litigation' (1928) *Industrial and Engineering Chemistry* 1361, 1362. In 'chemistry one cannot anticipate a result. A result may be obtained only be experiment'. *United Chromium* v. *International Silver* 53 F.2d 390. Ridsdale Ellis, *Patent Claims* (New York: Baker, Voorhis, 1949), 275.

7 William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1*, (Boston: Little Brown and Co, 1890), 336.

What occurs in these situations is that the scope of the subject matter is shaped by legal considerations such as fairness to the patentee or a desire to protect the equity in the patent. Whatever term is used, the result is the same: the scope of the subject matter extends beyond a literal scientific or technical understanding to include things which are deemed to be legally equivalent.

While the doctrine of equivalents was widely applied in patent law, the idiosyncratic nature of organic chemistry meant that it was not extended to chemical compounds.[8] Specifically, the lack of prevision that was a characteristic of organic chemistry meant that it was not possible to abstract away from the invention as specified in the claim to include equivalent inventions. This was because while it was possible to 'predict with confidence in mechanics, in chemistry you almost entirely fail … as you can not anticipate the result'.[9] As one commentator noted, with mechanical inventions it was generally possible to state with certainty whether a mechanical element was equivalent to another element. It was possible to 'substitute a gear by a pulley, or a cam by a crank and obtain exactly the same result'. However, 'in chemistry no one element or reagent is universally equivalent to another, and in most cases it is not possible to predict that they are absolutely equivalent except by actual experiment'.[10] This was because '[y]ou cannot, because sulphuric acid will succeed, tell at all that nitric acid will succeed, or that any other acid will succeed, until you have tried. You cannot anticipate the result: it is a mere question of result upon experiment'.[11] Or, as Ruby put it, the fact that a chemical compound was 'an embodied utterly unique indissoluble ensemble of properties' meant that there were 'no equivalents of a chemical compound': the only equivalent of a chemical compound was the compound itself.[12] This meant that unlike the case with mechanical inventions, where protection extended beyond the machine as described in the patent to include inventions that were considered to be legally equivalent to the patented invention, the intangible property in a patented chemical compound was treated as if it was coextensive with the material chemical compound.

The decision to treat chemical subject matter as if it was a closed, singular, and bounded object that was coextensive with the material chemical compound reached its highpoint in the procedural requirement that as part of the application process patentees were required to deposit specimens of their chemical inventions

8 *Stevens* v. *Keating* (1847) 2 *Webster* 181. 'I do not go along with doctrine of equivalents in chemistry. While you could predict with confidence in mechanics … in chemistry you almost always fail … you cannot anticipate the result'. For a rare case where chemical equivalents were recognised see *Treibacher-Chemische Werke* v. *Roessler & Hasslacher Chemical Co* 219 Fed. Rep. 210 (magnesium held to be equivalent of iron, which led to a finding of infringement).

9 *Stevens* v. *Keating* (1847) 2 *Webster* 18.

10 Joseph Rossman, *The Law of Patents for Chemists* (Washington, DC: The Inventors Publishing Company, 1932), 59.

11 *In re Martin's Patent* (1848) 2 *Webster* 172.

12 Charles E. Ruby, 'Are True Chemical Compounds, as Such, Inherently Unpatentable Subject Matter: Part II' (1941) *Temple University Law Quarterly* 321, 351.

FIGURE 3.1 Ferrous carbonate patent specimen
Josiah Lilly, 'Composition for the Production of Ferrous Carbonate' US Patent No. 876,366 (14 Jan 1908). Courtesy of the Division of Medicine and Science, National Museum of American History, Smithsonian Institution.

with their written descriptions at the Patent Office (see Figures 3.1–3.3). This long-standing requirement, which exists in a modified form today, was first introduced into US patent law by the 1793 *Act to Promote the Progress of Useful Arts*.[13] The 1793 law provided that where the invention was of a composition of matter, every inventor was required to submit 'specimens of the ingredients, and of the composition of matter; sufficient in quantity for the purpose of experimentation'.[14] Patent Office practice of exhibiting models and specimens was formalised in the 1836 Patent Act, which provided that 'models and specimens of compositions … patented and unpatented deposited in the Patent Office, should be arranged in suitable galleries and kept open for the inspection of the public'.[15] The rules in relation to specimens

[13] As Judge Rich said in 1980, the Commissioner's ability to require the applicant of a composition of matter to furnish specimens or ingredients for the purpose of inspection or experiment under section 114 of the 35 USC 112 was 'a continuation of the ancient authority vested in the Commissioner to require a model, specimen, or ingredient'. *In re Application of Breslow* (1980 Cust and Pat App) 616 F.2d, 205 USPQ 221, 227.

[14] Where the invention was of a composition of matter, Section 3 of the 1793, *An Act to promote the progress of Useful Arts; and to repeal the act heretofore made for that purpose* (21 February 1793) required every inventor to submit 'specimens of the ingredients, and of the composition of matter; sufficient in quantity for the purpose of experimentation'. See William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1* (Boston: Little Brown and Co, 1890), 88. The 1790 Act spoke of model and drawings.

[15] Patent Act of 1836 (An Act to promote the progress of useful arts, and to repeal all acts and parts heretofore made for that purpose (4 July 1836)). Section 6: 'where the invention or discovery is of a composition of matter' applicants had to 'provide specimens of ingredients, and of the composition of matter, sufficient in quantity for the purpose of experiment'. Section 20 provided that 'models and specimens of compositions … patented and unpatented deposited in the Patent Office, should be arranged in suitable galleries and kept open for the inspection of the public'.

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FIGURE 3.2 Explosive compound patent specimen
Harry D. Van Campen, 'Explosive Compound' US Patent No. 288,516 (13 Nov 1883). Courtesy of Hagley Museum and Library.

remained unchanged until the 1870s when because of a growing concern about the cost of storing and exhibiting models and specimens, the law was changed so that applicants were only required to 'furnish specimens of the composition, and of its ingredients, sufficient in quantity for the purpose of experiment, if required by the Commissioner'.[16] Despite this change, the Patent Office rules retained the proviso that where an article was not perishable, 'a specimen in the composition claimed, put up in proper form to be preserved by the office must be furnished'.[17]

Initially, the public were alerted to the existence of specimens by patentees in their patents, usually in the description but sometimes in the claims. For example, Robert Bartholow's 1865 patent for an improved oil for paint stated: 'I do hereby declare that the following is a full and exact description … being had to

[16] 1870 Congress abolished the legal requirement of models, but the Patent Office kept its requirement until 1880. Act of 1870, ss 28 and 29, RS 4890, 4891 (1874).

[17] *Rules of Practice in the United States Patent Office* (Revised 1 February 1883), Rule 61. When an invention or discovery is a composition of matter, the applicant, if required by the commissioner, shall furnish specimens of the composition, and of its ingredients, sufficient in quantity for the purpose of experiment. In all cases where the article is not perishable, a specimen in the composition claimed, put up in proper form to be preserved by the office must be furnished'. It was for the patent office to determine 'whether the nature of the case admitted of specimens'. *Badische Anilin & Soda Fabrik* v. *Cochrane* 2 Fed. Case 339, Case 718 (CC, 15 April 1879). See also 1920 Rule 61: Under the Patent Act, if required by the Commissioner, applicants were required to provide specimens of compositions of matter and their ingredients, sufficient in quantity for the purpose of experiment. 'In all cases, where the article is not perishable, a specimen of the composition claimed … must be furnished' E. J. Stoddard, *Annotated Rules of Practice on the United States Patent Office* (Detroit: Fred S. Drake, 1920), 216 (re Rule 62) (also rules 56, 60, and 61); Rev Stat. sec 4890.

FIGURE 3.3 Detergent compound patent specimen
Edward Henderson, 'Detergent Compound' US Patent No. 259,389 (13 June 1882).
Courtesy of Hagley Museum and Library.

the accompanying specimen'.[18] Similarly, the 1845 patent for a new and improved dye made from spent madder called 'carasene' stated that: 'A specimen of the spent madder from which the carasene is made accompanies the specification in a packet marked "spent madder", and of the dye-stuff, after it is prepared, in another packet marked "carasene"'.[19] From 1880, notification that a specimen had been lodged as part of a patent application shifted from the body of the patent to the header material, where it accompanied information about the patent, including the name of inventor and assignee, the name of the invention, when the application was filed, and the date when the patent was granted (see Figure 3.4). From 1880 to 1905, the Patent Office also included information about whether a specimen had been deposited with a patent – 'specimen' or 'no specimen' – in the monthly summary of patented inventions that was published in the Patent Office's *Official Gazette* (see Figure 3.5).[20]

[18] Robert Bartholow, 'Improved Oil for Paint' US Patent No. 47,083 (4 April 1865).

[19] Frederick Pfanner, 'Improvement in Preparation of Dye-Stuff from Spent Madder' US Patent No. 4,192 (13 September 1845).

[20] The practice of indicating whether a specimen had been deposited in conjunction with compound inventions in the Official Gazette by either 'Specimen' or 'No Specimen' ended in 1905. As Commissioner Allen said: 'Hereafter the words. "No Specimens" will be omitted from the specifications and drawings of patents when … specimens have been admitted as part of the applications, under Rule 56. The word … "Specimen" will be prefixed to the specification and inscribed upon the drawing when a … specimen has been so admitted'. F. I. Allen, 'Models and Specimens' (Order No.

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UNITED STATES PATENT OFFICE.

JOSIAH K. LILLY, OF INDIANAPOLIS, INDIANA, ASSIGNOR TO ELI LILLY & COMPANY, OF INDIANAPOLIS, INDIANA, A CORPORATION OF INDIANA.

COMPOSITION FOR THE PRODUCTION OF FERROUS CARBONATE.

No. 876,366. **Specification of Letters Patent.** **Patented Jan. 14, 1908.**

Application filed September 1, 1906. Serial No. 333,026. (Specimens.)

To all whom it may concern:

Be it known that I, JOSIAH K. LILLY, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Composition for the Production of Ferrous Carbonate, of which the following is a specification.

The object of my invention is to produce in liquid form a mixture or solution which will remain practically permanently in condition to readily produce ferrous carbonate for introduction into the human system. Attempts have heretofore been made to this end but difficulty has been experienced in preventing the oxidation of the ferrous iron.

I have discovered that by suspending or dissolving a ferrous salt, as for instance ferrous sulfate, in a liquid carrier which will protect it from oxidation and by associating with this mixture or solution a carbonate, or substance capable of furnishing the CO_3 group at the moment of use, a solution or mixture may be obtained which may be kept for a considerable period with only slight oxidation of the ferrous iron. It is preferable that the liquid carrier be soluble in water, to facilitate introduction into the system, and I deem it advisable to use a carrier of this kind which is practically inert therapeutically, such a substance for instance as glycerin.

In producing the compound I find the following method advisable. A ferrous salt, such for instance as ferrous sulfate, is dissolved in glycerin; to this mixture is added a carbonate, preferably sodium carbonate, or potassium carbonate, being careful not to introduce an excess of the carbonate. If desired the carbonate may first be dissolved in glycerin and this mixture added to the glycerin solution of the ferrous salt. If desired a hydroxid, such for instance as sodium or potassium hydroxid, may be used instead of the carbonate and the mixture then carbonated with carbon dioxid.

In practice I have found that, for producing the medicine in commercial quantities, the following formula has been satisfactory. 1. In 11 gallons pure glycerin, dissolve by aid of gentle heat, 3 pounds, 4 ounces, 292 grains pure ferrous sulfate. 2. In 4 gallons pure glycerin, dissolve by aid of gentle heat, 1 pound, 10 ounces, 90 grains pure potassium carbonate. 3. When cool, place solution (1) in an earthenware vessel of sufficient capacity and add slowly, with stirring, solution (2). When thoroughly mixed, pour sufficient pure mineral oil to cover the surface in order to protect from oxygen and moisture in air. It is now ready to be drawn off below into bottles. This produces about 15 gallons.

If desired, mannite may be substituted for glycerin as it possesses substantially the same qualities, with respect to ferrous salts and any desirable carbonate, as gylcerin although it is a soft solid at ordinary temperatures and, if a liquid mixture is desired, it will be advisable to mix a small proportion of glycerin with the mannite.

I claim as my invention.

1. A composition consisting of a stable solution of a ferrous salt and an alkaline carbonate in a neutral liquid miscible with water and forming a protection against oxidation of the ferrous salt, substantially as described.

2. A composition consisting of a stable solution of ferrous sulfate and potassium carbonate in a neutral liquid miscible with water and forming a protection against oxidation of the ferrous sulfate, substantially as described.

3. A liquid composition consisting of a stable solution of a ferrous salt and an alkaline carbonate in glycerin.

4. A liquid composition consisting of a stable solution of a ferrous salt and potassium carbonate in glycerin.

5. A liquid composition consisting of a stable solution of ferrous sulfate and an alkaline carbonate in glycerin.

6. A liquid composition consisting of a stable solution of ferrous sulfate and potassium carbonate in glycerin.

In witness whereof, I, have hereunto set my hand and seal at Indianapolis, Indiana, this 30th day of August, A. D. one thousand nine hundred and six.

JOSIAH K. LILLY. [L. S.]

Witnesses:

ARTHUR M. HOOD,
THOMAS W. MCMEANS.

FIGURE 3.4 Lilly Patent
Josiah Lilly, 'Composition for the Production of Ferrous Carbonate' US Patent No. 876,366 (14 Jan 1908). Courtesy of the United States Patent and Trademark Office.

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JANUARY 14, 1908. U. S. PATENT OFFICE. 255

dies while the sheet is interposed between said dies, said means being adapted to buckle the sheet to conform approximately with the dies before said sheet is compressed by the dies.

2. In a device of the class described, the combination of a pair of opposed embossing dies, one of the same being movable toward and away from the other, means for imparting a reciprocating movement to said movable die, feed mechanism controlled by said means and adapted to feed a sheet of material into position between said dies when the same are separated, and means adapted to operate in advance of the dies for buckling a sheet to approximately conform to the shape of the dies before said sheet is compressed thereby.

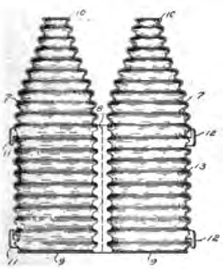
3. In a device of the class described, the combination of a pair of opposed dies, one of said dies being movable toward and away from the other and said dies being adapted to co-act with each other for embossing a sheet of material, and a part mounted on one die extending in advance thereof for buckling the paper to approximately conform to the shape of the dies, said part being adapted to yield to permit the remainder of the die to engage the sheet for pressing the same to form.

4. In a device of the class described the combination of a pair of opposed dies, one of said dies being movable toward and away from the other and said dies being adapted to co-act with each other for embossing a sheet of material, a part mounted on the movable die, being normally extended in advance thereof for buckling the paper to approximately conform to the shape of the dies and being adapted to yield to permit the remainder of the die to engage the sheet for embossing the same, and means for causing said part to recede with said movable die for a certain distance and then to assume its advanced position for discharging the sheet.

5. In a device of the class described, the combination of a pair of opposed dies, one of said dies being movable toward and away from the other and said dies being adapted to co-act with each other for embossing a sheet of material, a part mounted on the movable die and having a limited sliding movement longitudinally of the path of the movement thereof, and a stop adapted to engage said part when said die is moving away from the other die and cause said part to shift on the die for discharging a sheet therefrom.

[Claims 6 to 10 not printed in the Gazette.]

876,365. BOTTLE-WRAPPER. WILLIAM D. LEGGE and LOUIS N. WEIL, Chicago, Ill., assignors to Universal Bottle Wrapper Company, Chicago, Ill., a Corporation of South Dakota. Filed July 30, 1906. Serial No. 328,358.



A bottle wrapper, comprising two similar parts, having corrugated side-walls formed to surround a bottle, said walls being provided with integral flanges extending inwardly at one end of the wrapper to protect the corresponding end of the bottle, each of said parts being provided upon one edge with a pair of oppositely directed hook-like ears adapted to be interlocked for holding together the parts of the wrapper at one side, said parts being joined together at the opposite side.

876,366. COMPOSITION FOR THE PRODUCTION OF FERROUS CARBONATE. JOSIAH K. LILLY, Indianapolis, Ind., assignor to Eli Lilly & Company, Indianapolis, Ind., a Corporation of Indiana. Filed Sept. 1, 1906. Serial No. 333,026. (Specimens.)

1. A composition consisting of a stable solution of a ferrous salt and an alkaline carbonate in a neutral liquid miscible with water and forming a protection against oxidation of the ferrous salt, substantially as described.

2. A composition consisting of a stable solution of ferrous sulfate and potassium carbonate in a neutral liquid miscible with water and forming a protection against oxidation of the ferrous sulfate, substantially as described.

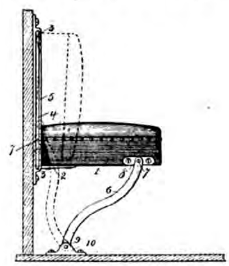
3. A liquid composition consisting of a stable solution of a ferrous salt and an alkaline carbonate in glycerin.

4. A liquid composition consisting of a stable solution of a ferrous salt and potassium carbonate in glycerin.

5. A liquid composition consisting of a stable solution of ferrous sulfate and an alkaline carbonate in glycerin.

[Claim 6 not printed in the Gazette.]

876,367. FOLDING SEAT. EDWARD LINDOW, Toledo, Ohio. Filed June 29, 1906. Serial No. 323,979.



1. In a folding device of the character described, a seat, a pair of legs pivoted at their upper ends to the lower part of the seat near its forward edge, floor-brackets, pivotal connections between the floor-brackets and the lower end of the legs, upright guides at the rear of and above the horizontal plane of the seat, said pivotal connections being disposed in advance of the plane of said upright guides and means upon the seat for slidably engaging said guides.

2. In a folding device of the described character, a seat, a pair of legs disposed at opposite sides of the seat, pivotal connections between the upper ends of the legs and the seat near its forward edge, a pair of floor-brackets adapted to be rigidly secured to a floor, a pair of slotted guide-plates adapted to be secured to a wall at opposite sides of and to the rear of and above the horizontal plane of the seat, said floor-brackets and slotted guide plates being disposed in different vertical planes, and laterally projecting pins at the rear of the seat engaged with and adapted to slide in the slots of said plates.

3. In a folding device of the described character, a series of seats disposed side by side, a pair of legs for each seat, pivotal connections between the upper end of the legs and the forward part of the seat, pivotal connections between the lower end of the legs and the floor, an upright guide-plate having guides for each neighboring pair of seats, said guide-plate being disposed above the horizontal plane of the seat and in a vertical plane back of said floor pivots, and means upon the seats at their rear for slidably engaging said guides.

FIGURE 3.5 USPTO Official Gazette summary of Lilly patent
US Patent Office, Josiah Lilly, 'Composition for the Production of Ferrous Carbonate' US Patent No. 876,366 (14 Jan 1908), patents granted January 14, 1908 (1908) 132 *Official Gazette of the United States Patent Office* 255. Courtesy of the United States Patent and Trademark Office.

Historically, there has been very little consideration given to chemical specimens and the role they play in patent law. To the extent that they have been discussed, it was usually as an afterthought when patent models were being considered. As with chemical patents generally, chemical specimens were overshadowed by mechanical inventions and their models. While it is unclear how frequently specimens were used and what role they played in the examination process, there is evidence to suggest that in the later part of the nineteenth century, specimens were commonly used when chemical compounds were patented (even when the use of patent models declined). As Walker said in his 1883 patent law treatise, the Commissioner 'does at least call for at least a specimen of the composition, put up in proper form to be preserved, unless that composition is in its nature perishable'.[21] Specimens were also important enough in 1880 for the Patent Office to include information about whether a specimen had been deposited in the header information of each chemical patent and in the Official Gazette.[22] While it is difficult to obtain exact figures, an examination of the chemical patents granted across the later part of the nineteenth century shows that specimens were widely used. It also seems that specimens continued to be used in the early part of the twentieth century. As Hugo Mock wrote in 1911: 'It is a somewhat curious feature of Patent Office practice that for some years the only department of the Patent Office requiring what may be termed models of inventions, is that relating to novel chemical products, as specimens of new chemical products are generally requested by the Patent Office examiners. It is many years since models have either been requested or accepted in other lines of invention.'[23]

Chemical specimens performed a number of different roles in patent law. Like patent models, specimens functioned as proof of the existence of the invention.[24] In the

1,616) Department of the Interior, United States Patent Office (6 December 1904) *Official Gazette of the United States Patent Office* 1421.

[21] Albert H. Walker, *Text-Book on the Patent Laws of the United States of America* (New York: L. K. Strouse & Co, 1883), 83–84 (citing Revised Statutes, section 4890 and Patent Office Rule 61).

[22] This coincided with the introduction of the new Rules of Practice in the United States Patent Office, Revised 1 December 1879 (in effect 1 January 1880).

[23] Hugo Mock, *Handbook of Chemical Patents: How Procured, Requisites of, and Other Information Concerning Chemical Patents in the United States and Abroad* (Washington, DC: Mason, Fenwick and Lawrence, 1911), 16. By 1915, it was said that a specimen would only be required when the Examiner found it useful or necessary but that 'as a rule models or specimens are neither asked for nor desired'. Seabury Mastick, 'Chemical Patents II' (1915) *The Journal of Industrial and Engineering Chemistry* 874.

[24] The utility of patents issued for making iron and steel directly from ore was determined from specimens which 'seem[ed] to possess considerable utility'. Annual Report of the Commissioner of Patents (1865), 17. Edward Thomas, *Handbook for Chemical Patents* (New York: Chemical Publishing Company, 1940), 183. The retention of chemical specimens was seen as an integral part of good laboratory practice. For example, an 1869 article in Scientific American extolling the virtues of both chemical inventions and their patenting, spoke of what was needed if someone was to invent an alloy that could substitute for brass. Following a life-work of systematic experiment, the chemist was advised to record 'the results of his experiments in tables, and preserving specimens of all alloys possessing any useful quality, and patenting such as prove applicable to special purposes, could not fail of success and fame'. Anon, 'Chemical Inventions' (20 February 1869) *Scientific American* 121, 121–22.

same way in which the Patent Office used the model requirement as a way of deterring applicants from applying for improbable inventions such as perpetual motion machines, the specimen requirement was also seen as a de facto workability requirement for chemical compositions.[25] For example, in an action relating to the patentability of artificial alizarine (a red dye originally obtained from the root of the madder plant) that was produced from the chemical compound anthracene (that was derived from coal tar), it was argued that the absence of a specimen showed that the claimed artificial alizarine was not a patentable composition of matter. While there was some indication that workability was one of the reasons why specimens were required in the United States, it was not a primary reason. This was in contrast to the position in the United Kingdom where from 1907 applicants for chemical patents were required to deposit samples of their invention at the UK Patent Office. This was to prevent foreign (German) patentees from lodging incomplete or faulty applications, or applications that did not properly disclose how to make the patented invention.[26]

Importantly, because the specimens deposited at the US Patent Office had the same proportions of elements as the chemical compound that had been made in the laboratory, the specimen not only functioned to define the invention: the specimen *was* the invention. By requiring applicants to place their chemical inventions in glass bottles, paper sachets, and metal cans, the chemical specimen helped to reinforce the mental or semiotic representation of the chemical substance as an individual bounded object. This also allowed chemical compositions to be seen as bounded 'wholes' (which helped to answer the question of what it means to speak of closed chemical subject matter given that chemical compounds as liquids, powders, amorphous solids, and gases have no inherent shape or form). In turn, by limiting protection to the specific substance contained in the specimen bottle, paper sachet, or metal can, the specimen requirement also reinforced the idea that protection was not available for abstract classes or groups of inventions. That is, it helped to individualise the subject matter.

25 The Paige Bill, which proposed to add to section 4886 a 'compulsory working' provision, sought to make it necessary for foreign patentees to manufacture their products in the US within two years after a patent had been granted. See Bernhard C. Hesse, 'Compulsory Working of Patents in the United States. Germany and Great Britain' (1915) 7 *The Journal of Industrial and Engineering Chemistry* 304; Bernhard C. Hesse, 'Coal-Tar Dyes and the Paige Bill' (1915) 7 *The Journal of Industrial and Engineering Chemistry* 963.

26 Sections 2(5) of the UK 1907 *Patent and Designs Act* (along with rule 36 of the 1908 *Patent Rules*). Specimens were required in many other jurisdictions. For example, the Hawaiian patent law of 1884 required applicants in relation to compositions of matter to furnish specimens of the ingredients and the final product 'sufficient in quantity for the purpose of experiment'. Act of 29 August 1884, to regulate the issuing of patents, section 4. In Switzerland (Law of 15 November 1888) patents were not granted for 'inventions which do not in themselves represent a visible and tangible marketable article'. As part of this process, applicants were required to deposit specimens of the invention. In Switzerland, prior to 1907, a requirement that all inventions needed to be able to be represented by a model meant that all chemical inventions (along with manufacturing processes) were excluded from protection. P. J. Federico, 'Patents for New Chemical Compounds' (1939) *Journal of the Patent Office Society* 544, 545.

Interestingly, the ability for chemical samples to individualise inventions was used by the German Patent Office in the 1880s to deal with a problem that had arisen in relation to chemical patents in Germany. While the German Patent Law of 1877 excluded chemical substances from the scope of patentability, it did allow chemical inventions to be patented insofar as they 'concerned "a particular process" (*ein beslimmles Verfahren*) for the manufacture of such substances'. While the law had been designed to exclude product patent protection for chemical compounds, nonetheless applicants attempted to use the fact that the law did not define what was meant by a particular process to circumvent the exclusion by indirectly claiming large classes of compounds.[27] This was particularly the case with azo dyes (which was a large class of synthetic organic dyes). The reason for this was that the dye industry used a specific process called a coupling reaction or Griess's method to produce new synthetic compounds that involved 'the pairwise combination of diazo compounds with aromatic amines or phenols to form azo compounds, i.e., compounds with a double nitrogen (azo) group uniting aromatic rings'.[28] The making of azo dyes was 'an endless combination game. The number of possible combinations was estimated at more than 100 million'.[29]

Building on the fact that the coupling reaction used by the dye industry could be construed as a *particular* process, patent applications for processes for the preparation of chemical substances frequently claimed the protection of groups or classes of compounds that had been produced by this process. To maximise protection, patents in the field of azo dyes also often claimed classes of analogues, homologues, and isomers of those compounds. As a result, patents for chemical inventions would often claim hundreds of individual substances. The practice of claiming classes or groups of compounds (rather than individual compounds) not only created administrative problems for the German Patent Office, who had to examine and classify the applications, by effectively allowing de facto product protection it also undermined German patent policy that had sought to exclude chemical products from the scope of patentability. In 1887 the German Patent Office responded to this problem by issuing a regulation that required patent applicants to provide samples of the substances for which they claimed protection.[30] As the new regulation stated:

> In view of the fact that patent applications for processes for the preparation of chemical substances frequently claim the protection of entire groups of bodies without convincingly demonstrating the technical utility of the individual members of

[27] Henk van den Belt and Arie Rip, 'The Nelson-Winter-Dosi Model and Synthetic Dye Chemistry' in (ed) Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: The MIT Press, 2012), 129, 151.

[28] Ibid., 146.

[29] Ibid., 151.

[30] This was criticised because it put individual inventors at a disadvantage with respect to large scale industry. Ibid., 152–53. See also Andrew Pickering, 'Decentering Sociology: Synthetic Dyes and Social Theory' (2005) 13(3) *Perspectives on Science* 352, 395.

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these groups, samples of the substances presented will be kept in the Patent Office so that, for instance, if they are important pieces of evidence in the course of any controversy and for the appraisal of new patent applications, in accordance with the wishes of the industrialists involved.[31]

While an exception was made in the case of explosive substances, the new regulation provided that for 'those patent applications which relate to new methods of presentation of chemical substances, samples of these substances, as well as those intermediaries necessary for the production of substances which are still unknown, should be attached in two copies'. Specifically, applicants had to submit samples with a mass of approximately 8–10 grams in glass flasks of approximately 30 mm diameter and 80 mm height with glass stoppers, sealed with the seal of the patent examiner, and with a description matching the contents provided. By limiting protection to individual physical samples, the German Patent Office found a way of excluding applications for classes of chemical compounds. As in the United States, the intangible chemical property was treated as if it was coextensive with the chemical compound in the glass flask.[32]

The treatment of intangible chemical property in the United States as if it was coextensive with the material chemical compound was effectively a taxonomic-like decision that limited chemical subject matter to the level of species.[33] One of the consequences of this was that the intangible chemical property did not extend *upwards* to include more abstract classifications such as classes or families of chemical compounds, nor to what a more generous abstract (equity-based) legal reading might have provided. It also meant that the intangible property did not extend to equivalent or similar inventions, to abstractions of the invention, nor to other inventions in a species-genus like relationship. Rather, patented chemical compounds were treated as if they were interchangeable with the individual material chemical compound. In this sense, patent law mirrored nineteenth-century organic chemistry

31 Der Präsident des Kaiserlichen Patentamt, 'Bekanntmachung: 19 March 1887' (1887) 12 *Patentblatt und auszüge aus den patentschriften* (Berlin 23 March 1887), 119.

32 A similar process occurred in the UK in the beginning of the twentieth century. Sections 2(5) of the 1907 Patent and Designs Act (along with rule 36 of the 1908 Patent Rules) introduced a provision into British law that gave the Comptroller the power to demand the submission of samples in the case of chemical patents. This arose because 'in the past some patentees have framed their specifications in such a way as to secure proprietary rights in whole classes of imaginary chemical processes and not tried to make all the substances covered by the specification'. Anon, 'Patents for Chemical Inventions' (13 April 1907) *The Lancet* 1033.

33 Claims were 'limited to the precise ingredients mentioned in each, no more and no less. They do not stand in the relation of genus and species to each other nor as combinations and sub-combinations'. A. M. Lewers, 'Composition of Matter' (1921–22) *Journal of the Patent Office* 530, 546. 'Species … are not equivalents and therefore comprehensive claims are needed to cover them. Species are distinct inventions and involve patentable differences. No range of equivalents can therefore overcome a patentable difference'. Joseph Rossman, *The Law of Patents for Chemists* (Washington, DC: The Inventors Publishing Company, 1932), 214; citing *Cheatham Electric Switching Device Co* v. *Brooklyn Rapid Transit Co* 238 Fed Rep 172 (1915).

where the 'most fundamental category of chemical practice – that is, of experimentation and classification – was that of a chemical substance'.[34]

The legal focus on specific compounds rather than on more abstract classes of subject matter helped US patent law to deal with the empirical nature of chemical subject matter. It also allowed the law to deal with the fickleness of chemical compounds, with the fact that slight changes in the ingredients in a compound or the conditions under which the ingredients were combined could fundamentally change the nature of the resulting compound. This was done by ensuring, for example, that if an inventor disclosed a new chemical compound (sulphanilyl cyanamide) that was made up of five elements: carbon (42.6%), hydrogen (3.5%), nitrogen (16.3%), sulphur, (16.3%), and oxygen (21.3%) with the empirical formula $C_7H_7N_3SO_2$, they would not be entitled to claim 'a compound consisting of carbon, hydrogen, nitrogen, sulphur and oxygen' because of the rule that 'an inventor is not entitled to claims broad enough to cover subsequent independent discoveries of others'.[35] While in this case the inventor may have discovered one compound consisting of these five elements, they 'would not be entitled to a patent covering every other compound which might therefore be discovered having those same elements in its make up'.[36] For similar reasons, an inventor was not entitled to claim a range of the various elements such as a 'compound consisting of carbon 15 to 45 %, hydrogen 2 to 6 %, nitrogen 10 to 25 %, sulphur 15 to 39 % and oxygen 10 to 40%',[37] the reason being that these proportions would extend to cover a number of different chemical compounds with very different structures and properties, including taurine ($H_2NCH_2CH_2SO_3H$), acetylthiourea ($CH_3CONHCSNH_2$), and nitrothioene ($NO_2C_4H_3S$).

The treatment of the intangible chemical property as if it was coextensive with the material chemical compound also meant that the intangible chemical property did not extend *downwards* (or internally) to the hidden microworld of the chemical compound. Rather protection was limited to the surface of the compound. In this sense, patent law followed the practice within science where the inability to explain what went on below the surface meant that when chemists interpreted or represented the results of their experiments or when they described and talked about what they had created, they 'were restricted to an operational level of macroscopic objects'.[38] To do this, patent law embraced the agnosticism that allowed chemists to work with and create new chemical compounds without having to commit to a

34 Ursula Klein, 'The Creative Power of Paper Tools in Early Nineteenth-Century Chemistry' in (ed) Ursula Klein, *Tools and Modes of Representation in the Laboratory Sciences* (Dordrecht: Springer, 2001), 15.

35 Ridsdale Ellis, *Patent Claims* (New York: Baker, Voorhis and Co, 1949), 584.

36 Ibid.

37 Ibid.

38 Ursula Klein, 'Objects of Inquiry in Classical Chemistry: Material Substances' (2012) 14 *Foundations of Chemistry* 7, 10. See also Wolfgang Lefèvre, 'Viewing Chemistry through Its Ways of Classifying' (2012) 14 *Foundations of Chemistry* 25, 31.

particular way of thinking about what went on below the surface in chemical compounds.[39] In so doing it allowed patent law to deal with the fact that organic chemists were unable to explain the reasons why things had happened and why it was, for example, that mixing compound A with compound B produced compound X.

Based on the idea that the 'law requires no further certainty than science can afford',[40] patent law was indifferent to what happened below the surface of the compound, to the reasons why chemical change occurred, and to the workings that occurred when ingredients were combined. It did not matter, for example, that the 'method by which the ingredient perform[ed] its function in the combination' may have been 'entirely undiscernible',[41] nor that 'the inventor was … in total ignorance of the scientific nature of what he employed and what he did'.[42] Instead, all that mattered was that the patentee had created something that could be called a composition of matter, that they had ensured that the composition was in a format that allowed third parties to replicate the invention, and that they had met the other criteria for patentability.[43] For example, in response to an argument that a patent for a 'spirit varnish' that gave leather a bronze finish similar to a French metallic bronze finish was invalid because the specification did not explain why 'the articles are so compounded as to produce a chemical change', Justice Sheplex said it was 'not essential that the inventor should have been sufficiently understood or accurately stated the philosophy of a process which he had invented and reduced to practical use'.[44] So long as the specification allowed for the invention to be used, this was enough. It did not matter that the reasons why something occurred were unknown; what was important was that the end result was achieved by following the directions in the patent.[45]

39 In the same way in which the agnostic nature of the rational formula allowed chemists to take for granted that the formulas were true representations of the composition of the substances being investigated, they also allowed chemists to 'go on with their experiments and identification of material substances without having to answer many theoretical problems … their mode of comprehending chemistry was independent of an explanation of chemical combination at a deeper level'. Ursula Klein, 'Objects of Inquiry in Classical Chemistry: Material substances' (2012) 14 *Foundations of Chemistry* 7, 10.

40 William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1* (Boston: Little Brown and Co, 1890), 411.

41 Ibid.

42 *Reed* v. *Street* 34 OG 339, 86 CD 65 (1885).

43 While in most cases, chemical reactions were simply black-boxed and ignored; one exception was William Robinson who explained 'the intermixture of ingredients results in the co-operation of their respective forces in such a manner as to produce a new force, which is distinct from the forces of the individual elements and from the sum of their collective forces, and is exhibited in the new qualities with which the composition is endowed'. William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1* (Boston: Little Brown and Co, 1890), 279.

44 *Cahill* v. *Beckford* (April Term, 1871), Circuit Crt, D. Mass, Case No 2,290, 1003, 1005 (1871). *St Louis Stamping Co* v. *Quinby* 16 Official Gaz 135 (1880); *Andrews* v. *Cross* 8 Fed Rep 269 (1881). Anthony Deller, *Principles of Patent Law for the Chemical and Metallurgical Industries* (New York: The Chemical Catalog Company, 1931), 66.

45 *Cahill* v. *Beckford* (April Term, 1871), Circuit Crt, D. Mass, Case No 2,290, 1003, 1005.

While the law's response to the fact that chemists were unable to explain what was happening beneath the surface was typically framed as one of indifference, the law's pragmatic acceptance of the end products of the research process was not neutral. This was because although the law may have been indifferent to the reasons why chemical change occurred, this did not mean that the science that it accepted was. Like a Trojan horse, the veil of legal indifference not only allowed patent law to accommodate and protect organic chemical compounds, it also allowed certain types of scientific thinking to be inculcated within the law. Although science could not explain why and how chemical change occurred, it did embody theories (models, formulas, etc.) about what was going on, along with the language, rules, and techniques to identify and describe what was created. This was particularly the case in relation to the acceptance of chemical formula as a way of representing chemical compounds. This is because the writing of a chemical formula 'is not innocent. It is ideology laden. It carries, besides its face value, another message; in this case, the modern reunification of the theoretical and the experimental'.[46] As we will see, the adoption of structural formula in the later part of the nineteenth century profoundly changed the way that patent law interacted with chemical subject matter.

INFORMED SUBJECT MATTER

While the decision to treat intangible chemical property as a singular bounded object that was coextensive with the material chemical compound played an important role in allowing nineteenth-century American patent law to accommodate some of the idiosyncrasies of chemical subject matter, it only tells part of the story. The reason for this is that chemical subject matter was not merely coextensive with the physical chemical compound; it was also an 'informed material' that carried particular ways of thinking about the world with it. The idea of informed material is based on Whitehead's argument that material entities, including chemical compounds and molecules, are not bounded, discrete objects.[47] Rather, material entities extend into other entities while folding elements of other entities inside them. From this perspective, chemical compounds 'should not be seen as discrete objects, but as constituted in their relations to complex informational and material environments'.[48] Importantly, while chemical compounds exist in an informational and material environment, this environment is not simply external to the object. Rather, this environment enters into the constitution of the chemical compound itself.[49] From this

[46] Roald Hoffmann and Pierre Laszlo, 'Representation in Chemistry' 30(1) (1991) *Angewandte Chemie* 1, 3.

[47] Alfred North Whitehead, *Process and Reality* (New York: Free Press, 1978), 80; Andrew Barry, 'Pharmaceutical Matters: The Invention of Informed Materials' (2016) 22(1) *Theory, Culture & Society* 51.

[48] Andrew Barry, 'Pharmaceutical Matters: The Invention of Informed Materials' (2016) 22(1) *Theory, Culture & Society* 51, 52.

[49] Whitehead, who focused on the variability of the *association between* atoms and molecules (rather than the invariability of atoms and molecules, as Ruby had done), saw chemistry as a science of

perspective, the research process operates to build information into the chemical compound. In this sense, to say that a material entity such as a chemical compound is informed or 'rich in information' is to say that the material *embodies* information.

The result of this is that even when chemical substances were treated as closed, fixed objects, they still embodied information that connected compounds to other compounds, that told something of the compound's past (and whether it was novel and non-obvious) and, in some cases, its potential future (utility). Patent law relied upon the informed nature of chemical subject matter to accommodate the idiosyncrasies of nineteenth-century organic chemistry in a number of ways, perhaps the most important being in the identification of the subject matter (both during the application process and also after protection was granted). Specifically, patent law relied upon the fact that as informed chemical compounds carry their context with them, this meant (at least in theory) that compounds could be traced as they circulated beyond the reach and control of their creators.

The question of how the ephemeral and malleable intangible interest is to be described and identified has long troubled intellectual property law. These problems were amplified with chemical subject matter because chemical reactions (along with 'atoms' and molecular structures) were invisible processes that could not be seen, touched, or otherwise observed.[50] As Judge Lacombe said in the 1897 decision of *Matheson* v. *Campbell*, while the 'observation as the eye can give to the machine at rest and in action … will be ordinarily sufficient to determine its classification', it was 'far different … with a chemical compound'. The reason for this was that '[n]o mere observation by the eye, supplemented even by taste and touch, can go very far towards a solution of the problem. The same mysterious forces through whose action and reaction the compound was produced must be availed of to disintegrate and disrupt before there can be any assurance of what it is that we have before us'.[51] The problems that arose in 'defining something invisible',[52] which Edward Thomas saw as the root cause of many of the problems that arose with chemical subject matter, were compounded by fact that chemical subject matter had no inherent external shape or form.

As Robinson said, the particular nature of chemical compounds led 'to radical differences in the rules by which the identity of these' compounds is determined.[53]

associations. From this perspective he argued that a molecule or chemical compound should not be understood as a table or a rock, but rather as an event: 'a molecule is a historic route of actual occasions; and such as route is an "event"'. Alfred North Whitehead, *Process and Reality* (New York: Free Press, 1978), 80.

50 Ursula Klein, 'Paper Tools in Experimental Cultures' (2001) 32 *Studies in History and Philosophy of Science* 265, 273.

51 *Matheson* v. *Campbell* 78 Fed 910, 917 (CCA 2d, 1897).

52 Edward Thomas, *Handbook for Chemical Patents* (New York: Chemical Publishing Company, 1940), 11.

53 William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1* (Boston: Little Brown and Co, 1890), 279.

To understand the reasons why these rules were so different, it is important to appreciate that the ingredients, along with the way they were combined, were critical to the nature of the resulting chemical compound; a slight change in proportions or the conditions in which the ingredients were combined could lead to a very different compound. In this sense the ingredients determined the nature and make-up of the compound. At the same time, however, chemical compounds differed from other combinations in that once they were united, the 'ingredients or elemental forces' 'often become individually undiscernible by human sense'.[54] This is because chemical compounds do 'not carry any characteristics peculiar to the process used in the manufacture by which the latter could be identified and by which infringement could be established directly'.[55] In other words, a chemical 'composition of matter is a complete and independent means, having an existence distinct from that of the substances of which it is composed, and the processes by which it is created'.[56] One of the consequences of this is that the 'character of a composition of matter cannot … be determined from an examination of its elements alone, nor of the method by which they have been combined. It must be judged also by its own intrinsic attributes'.[57] The upshot of this was that products had to be identified *independently* of the process by which they were made. As Lewers said, 'Every patent for a product or composition of matter must identify it, so that it can be recognised aside from the description of the process for making it, or else nothing can be held to infringe the patent which is not made by that process'.[58]

The fact that a chemical compound was integrally connected to the ingredients and how they were combined and, at the same time, independent and distinct from those ingredients meant that description was a two-stage process (which was mirrored in the requirement that patentees needed to deposit specimens of both the ingredients and the resulting compound as part of the application process). This meant that it was necessary to describe the ingredients and how they were combined to create the compound in question. At the same time, it was also necessary for patentees to describe the resulting chemical compound so that it could be identified as an entity in its own right.

The first stage of the process of describing a chemical compound was to detail the ingredients and how they were combined to create the compound in question. The

54 Ibid.

55 B. Herstein, 'Patents and Chemical Industries in the United States' (1912) *The Journal of Industrial and Engineering Chemistry* 328.

56 A chemical composition of matter 'is a group of ingredients intermingled in a specific manner and producing a specific result which has new properties of its own'. William C. Robinson, *The Law of Patents for Useful Inventions: Vol 2* (Boston: Little Brown and Co, 1890), 101.

57 William C. Robinson, *The Law of Patents for Useful Inventions: Vol 1* (Boston: Little Brown and Co, 1890), 280.

58 *Holliday* v. *Pickhardt* (1887) 29 Fed 853 quoting *Cochrane* v. *Badsiche Anilin & Soda Fabrik* 111 US 293, 4 Sup Crt 455 (1884). Although chemical compounds needed to be evaluated independently of the ingredients, nonetheless the ingredients and the manner in which they were combined formed part of the tests of identification. A. M. Lewers, 'Composition of Matter' (1921–22) *Journal of the Patent Office* 530, 532 (the 'mode of operations to produce the composition is undiscernible').

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fickle nature of chemical compounds meant that it was important that the ingredients that were used to create a composition were set out clearly and precisely.[59] This was because while replacing 'an iron bar in place of a wooden one and serving the same purpose' did 'not change the identity of the machine', with chemical inventions even a very small change either in the ingredients used or in the way that the ingredients were combined could lead to a very different compound.[60]

As Rossman explained in his 1932 treatise on chemical patent law, a 'patent for a composition of matter must name or describe and give the exact proportions of the ingredients used in addition to describing how the ingredients are mixed or combined to give the desired result. Inasmuch as the discovery of a new substance by means of chemical combination is empirical, and results from experiment, the law requires that the description in a patent for such a discovery should be specially clear and distinct'.[61] Unlike the case with mechanical compounds, where the law was willing to allow the patentee to leave the proportions to be determined at a later stage (so long as the elements and their characteristics were known), with chemical compounds, where the end result was often dependent on the precise proportions used, the law not only required the patentee to provide details about the ingredients and how they were to be combined, it also required patentees to provide details about the specific proportions needed to produce the compound.[62]

In order to describe ingredients with the requisite degree of precision, patentees tended to describe the ingredients in terms of proportions or ratios, rather than in terms of a fixed specific weight (such as 'rosin, three hundred pounds, Kentucky cement seventy-five pound' etc.[63]). As Ruby said, chemical compound were 'defined and claimed in terms of the chemical elements that are ultimately composed, by bloc- or graphic formula, parts-by-weight, or percentages compositions, and hence in terms of invariant ratios of the amounts of the chemical elements present in chemical combination in the true chemical compounds'.[64] In some cases (particularly in earlier patents), the proportions were simply listed in the patent, such as in US Patent Number

59 'Exactness of detail should be given in describing the invention'. George S. Ely, *Chemical Inventions and Discoveries: A Paper Read November 23, 1916, before the Examining Corps of the United States Patent Office* (Washington, DC: The Law Reporter Printing Company, 1916), 10.

60 *Hicks* v. *Kelsey* (1873) 18 Wall 670.

61 Joseph Rossman, *The Law of Patents for Chemists* (Washington, DC: The Inventors Publishing Company, 1932), 37.

62 *North American Chemical* v. *Dexter* 252 F. 147, 165 (1916) US Dist 908. *Tyler* v. *Boston* (1868) 7 Wallace 327.

63 For full list of ingredients see C. D. Smith, 'Improved Paint for Wood, Metal, and Woven Fabrics' US Patent No. 68,661 (10 September 1867). Occasionally patents would combine the two. For example, a 1845 patent for a new dye provided specific quantities (such five gallons of water, three pounds of washed madder, eight ounces of soda dissolved in warm water) and the advice that the specification was for three pounds of spent madder and that 'for a greater or less quantity a corresponding quantity of the other material must be used'. Frederick Pfanner, 'Improvements in Preparation of Dye-Stuff from Spent Madder' US Patent No. 4,192 (13 September 1845).

64 Charles E. Ruby, 'Are True Chemical Compounds, as Such, Inherently Unpatentable Subject Matter: Part I' (1940) *Temple University Law Quarterly* 27.

45,518 for 'Improved Composition for Crayons', which said that for ordinary school uses on a blackboard, the crayon should be made up using the 'formula': 'kaolin 48 parts, calclined plaster-of-paris (gypsum) 16 parts, water 35 parts, and white glue 1 part'.[65] More commonly, the proportions were captured in empirical or rational formula that specified the elements and their proportions in the patented compound. Thus, for example, US Patent Number 775,978 claimed a new product, 'a fragrant oil having the [empirical] formula $C_{15}H_{26}O$'.[66] Or, US Patent Number 719,720, which claimed a new indigo-reducing agent that had 'a chemical composition corresponding to the [rational] formula $Na_2S_2O_4 + 2H_2O$'.[67] Here, the chemical formula, which provided a succinct guide or blueprint to the elements in a compound, denoted its composition and helped to distinguish it from other compounds. The fact that the ingredients were listed in proportions or ratios rather than in fixed quantities reinforced the idea that a chemical compound was an individual that had no inherent size or (external) shape and whose parameters were determined by the proportion of its parts.

The fickle nature of chemical compounds also meant that it was important that the patentee provide clear and precise instructions as to how the ingredients were combined.[68] Typically, the descriptions of how the ingredients were to be blended read like cooking recipes. For example, an early patent for artificial alizarine (dye) began by stating: 'We take one part, by weight of anthracine, two and half parts, by weight, of biochromate of [potash], potassa, and ten or fifteen parts, by weight, of concentrated acetic acid, and we heat these substance together in a vessel either of glass or clay to about 100° centigrade to 120° centigrade, till nearly all of the bichromate of potash is dissolved and the liquid has acquired a deep green colour'.[69]

As well as describing the ingredients and how they were combined in order to create the compound, it was also necessary for patentees to describe the resulting chemical compound as an entity in its own right. Importantly, this had to be done in such a way that the compound could be identified independently of the ingredients that it was made up of. For the most part, patent law followed the practice within chemistry when it came to describing and identifying chemical compounds.[70]

[65] Isaac Peirce, 'Improved Composition for Crayons' US Patent No. 45,518 (20 December 1864).

[66] Max Kerchbaum, 'Process for Making Sesquiterpene Alcohol' US Patent No. 775,978 (29 November 1904).

[67] Max Bazlen, 'Hydrosulfite for Reducing Indigo' US Patent No. 719,720 (3 February 1903).

[68] Robinson advised against adding anything that was not part of the ingredients to stop people claiming they were not infringing. William C. Robinson, *The Law of Patents for Useful Inventions: Vol 2* (Boston: Little Brown and Co, 1890), 101.

[69] See *Cochrane* v. *Badische Anilin & Soda Fabrik* 111 U.S. 293, 295; 28 L ED 433, 434 (1884).

[70] Patentees were advised to follow the Journal of the American Chemical Society, which sets out the 'minimum and desirable standards of description of new compound'. Eugene Geniesse, 'Adequate Description' (1945) 27 *Journal of the Patent Office Society* 784, 785. The Journal of the American Chemical Society's notice to authors of papers (in a sheet inserted at the beginning of each new edition) specified the 'minimum and desirable standards of description of new compounds'. Geniesse suggested that these instructions should form the basis for a standard of adequate description in composition cases.

While the techniques used to describe chemical subject matter changed considerable across the nineteenth century,[71] one thing that remained constant was that the identification of chemical substances 'always took place on the macroscopic level of substances'.[72]

At the beginning of the century, plant and animal materials were identified and classified according to their natural origin, the mode of extraction or preparation, observable properties, and practical uses.[73] Using these criteria, early chemists were able to distinguish and characterise a substantial number of simple chemical substances such as sea salt, soda, magnesia, potash, along with certain elements (such as sulphur). 'These were set apart from each other by qualitative distinctions: texture, color, odor, taste, the source from which the material was obtained, or the use to which it was put.'[74] Early chemical patents followed this practice and described chemical subject matter using qualitative criteria.

As the century progressed, patentees increasingly relied on more quantitative 'chemical' criteria to describe their chemical compounds.[75] Thus, patentees began to describe their chemical substances in terms of physical constants and measurable chemical properties such as how the compound reacted when it was combined with other compounds (or reagents), along with the all-important melting and boiling points (which were 'the best tools available for the identification of substance').[76] For example, the traditional practice of describing sugars by their sweet taste and their ability to support fermentation was slowly supplemented by descriptions that

[71] The improvements that occurred in the chemist's ability to identify chemical compounds was the result of an array of factors including a better understanding of chemical reagents, improved chemical apparatus (notably glassware) that allowed chemists to control the reaction, purification, and characterisation of substances more accurately, improvements and standardisation of laboratory techniques (such as the depth thermometers should be submersed in a liquid), and laboratory training, which aimed to produce reliable results (such as how to use standard reagents, how to coax products to crystalize, how to measure reliable melting points, and how to perform accurate quantitative analyses). See Catherine M. Jackson, 'Emil Fischer and the "Art of Chemical Experimentation"' (2017) 55(1) *History of Science* 86, 93.

[72] Ursula Klein, 'Objects of Inquiry in Classical Chemistry: Material Substances' (2012) 14 *Foundation Chemistry* 7, 11.

[73] Ursula Klein and Wolfgang Lefèvre, *Materials in Eighteenth-Century Science: A Historical Ontology* (Cambridge, MA: MIT Press, 2007), 299; N. W. Fisher, 'Organic Classification before Kekulé' (1973) 20 *Ambix* 106, 107; Catherine M. Jackson, 'Chemical Identity Crisis: Glass and Glassblowing in the Identification of Organic Compounds' (2015) 72 *Annals of Science* 187, 202–3.

[74] Henry Guerlac, 'Quantification in Chemistry' (1961) 52(2) *Isis* 194, 196.

[75] These quantitative criteria were used to define compounds 'in concrete units of measurable physical or chemical quantities … a boiling point of 100° F, being a physical condition does not depend upon the imagination of the individual and is certainty is definite' Carroll F. Palmer, 'Patent Claim Construction and the Halliburton Oil Case' (1947) *Journal of the Patent Office Society* 515, 521.

[76] Catherine M. Jackson, 'Emil Fischer and the "Art of Chemical Experimentation"' (2017) 55(1) *History of Science* 86, 89. See also Catherine M. Jackson, 'Chemical Identity Crisis: Glass and Glassblowing in the Identification of Organic Compounds' (2015) 72 *Annals of Science* 187. The melting point is still one of the standard characterizing techniques employed. Joel Bernstein, 'Structural Chemistry, Fuzzy Logic, and the Law' (2017) *Israel Journal of Chemistry* 124, 126.

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used empirical formula, melting points, and hydrazine tests (which examined how the compound reacted with phenylhydrazine).[77] While the Patent Office did not formally insist on a particular 'style or phraseology', patentees were advised 'to use the conventional chemical nomenclature wherever possible for the sake of definiteness and clarity'.[78] As we will see in Chapter 4, patentees followed this advice and adopted the naming practices developed by chemists to identify chemical compounds.[79]

The result of this was that as well as including the name and chemical formulae of the patented compound, it was also common for compounds to be described in terms of how they looked, smelt, or tasted, along with their melting and/or boiling point, and a description of what happened when particular chemical reagents were applied to the compound. To situate and contextualise the subject matter in relation to similar types of subject matter, patentees also often included a history of the invention, along with what amounted to a 'brief essay on the materials or the steps usable and a brief mention of the difficulties and failures of the prior art, and to include detailed examples of practising the invention'.[80] For example, US Patent Number 400,086, which was for a pharmaceutical product known commercially as 'phenacetine' and chemically as 'mono-acetyl-paramido-phenetol', stated:

> The product herein described, which has the following characteristics: it crystallizes in white leaves, melting at 135° centigrade; not colouring on addition of acids or alkalies; is little soluble in cold water, more or so in hot water; easy soluble in alcohol, ether, chloroform, or benzole; is without taste; and has the general composition $C_{10}H_{13}O_2N$.[81]

In a similar manner, Hoffman and Weinbergs's 1886 patent for 'a new coloring matter', which they called napthol-black, was described as producing 'on the fiber in an acidulated bath dark-blue shades' and as being 'very soluble in water, insoluble in spirit, dissolves in strong sulphuric acid with green color'.[82]

While patent law followed the practice within chemistry of describing chemical compounds in terms of how they smelt, looked, and tasted, the temperature that

77 Catherine M. Jackson, 'Emil Fischer and the "Art of Chemical Experimentation"' (2017) 55(1) *History of Science* 86, 107.

78 Joseph Rossman, *The Law of Patents for Chemists* (Washington, DC: The Inventors Publishing Company, 1932), 110. Patentees were advised not to use trade-names to describe chemical compositions, given that their meaning was often transient and their composition subject to change. Ibid.

79 Eugene Geniesse, 'Adequate Description' (1945) 27 *Journal of the Patent Office Society* 784, 785. If the law is to adopt a scientific term such as homology for a legal purpose, 'it has an obligation to employ that term in its scientific context'. Bruce M. Collins, 'The Forgotten Chemistry of the Hass-Henze Doctrine' (1962) *Journal of the Patent Office Society* 284, 285.

80 Edward Thomas, *Handbook for Chemical Patents* (New York: Chemical Publishing Company, 1940), 20–21.

81 Oskar Hinsberg, 'Phenacetine', US Patent No. 400,086 (26 March 1889) (Specimens); upheld in *Dickerson* v. *Mauer* 108 Fed 233 (CCED Pa 1901); affd 113 Fed 870 (CCA 3d 1902).

82 Meinhard Hoffman and Arthur Weinberg, 'Naphthol-Black Color Compound' US Patent No. 345,901 (20 July 1886).

they boiled or melted at, and how they responded or reacted when combined with other compounds, patent law added a subtle twist. This was because rather than merely providing a description of a compound's witnessable properties, the description of a compound in a chemical patent also included specific instructions that explained how the identity of the compound was to be determined.[83] That is, the descriptions included the experimental tests that were to be used to identify the patented compounds.[84] As Judge Lacombe said, these 'tests of identity' were 'devised by those skilled in the art and science of chemistry, which, in their opinion, as experts, will reveal the secrets of the composition to make the answer to the question positive enough to support the judgement of a court'.[85] In this sense, patentees included both the experiments and the results of those experiments in their patents as ways of identifying their patented chemical compounds.

Like many things in relation to chemical subject matter, the process of identification and description used in patent law was an inherently empirical process.[86] As in organic chemistry, the process of identifying and classifying chemical compounds in patent law was 'tied to processing and interpreting the experimental marks of the invisible object, and to the application of sign systems, culturally impregnated with meaning, in that endeavour'.[87] In the absence of any other way of identifying a chemical substance, the alleged infringing or anticipating compound was 'tried' to determine whether it met the experimental criteria set out in the patent: did it 'melt at 135° centigrade', was it 'easily soluble in alcohol, ether, chloroform, or benzole' and 'without taste'?[88] Patentees used the presence or absence of these identifying traces or 'marks of identification'[89] as litmus tests for determining whether a compound was the same as or different to the patented compound. If a claimant could show that the product 'answers all the tests of the patent, and other well-known test not therein named', this was taken as proof of similarity.[90] As the court said in

83 Edward Thomas, *Handbook for Chemical Patents* (New York: Chemical Publishing Company, 1940), 17–18.

84 *Pickhardt* v. *Packard* (1884) 22 Fed 530.

85 *Matheson* v. *Campbell* (CCA, 13 January 1897), 78 Fed Reporter 910, 917.

86 This is similar to the crimes of witchcraft, rape and poisoning in the early modern period which were seen as quintessentially hidden acts that depended on the evidence of things unseen. As in patent law, criminal law allowed indirect evidence – *indicia* –to stand as sufficient grounds of proof without recourse to torture (circumstantial evidence). This was in contrast to wounds which were seen as a classic legal exemplar of visible and physical violence. See Ian A. Burney, 'Testing Testimony: Toxicology and the Law of Evidence in Early Nineteenth-Century England' (2002) 33 *Studies in History and Philosophy of Science* 289.

87 Ursula Klein, 'Introduction' in (ed) Ursula Klein, *Tools and Modes of Representation in the Laboratory Sciences* (Dordrecht: Springer, 2001), viii.

88 *Badische Anilin & Soda Fabrik* v. *Cochrane* 2 Fed Case 339, 342 (CC, 15 April 1879).

89 In *Maurer* v. *Dickerson* 113 F 870 (CCA, 1902), Judge Acheson said the 'patent in suit describes a new product with such clear marks of identification that it readily be recognised aside from the process of making it'. That is, the compound had sufficient 'distinguishing characteristics' for it to be patentable.

90 In relation to process patents, once a plaintiff had shown using the tests of identity that products were the same, the onus shifted to the defendant to prove that the (same) product was made by a different

Matheson v. *Campbell*, (an action in relation to a patent for a black azo dye), the 'proofs show satisfactorily … that the defendants' colouring matter possesses the same peculiar characteristics of the patented article'.[91] This was sufficient 'to establish the chemical identity of the defendants colouring matter with the complainants by the evidence of the results produced by each in the experimental tests'.[92]

One of the consequences of the decision to use experimental tests to identify chemical compounds was that it increased the role that science played within the legal process. Another consequence of the decision to use experimental tests to identify chemical compounds was that it further embedded the chemist as expert within patent law.[93] This was because chemists not only devised the tests that were used to identify chemical compounds, they were also called on to undertake those tests and to interpret and explain the results to the courts.[94] While experts were commonly used in patent law to assist the courts in reaching decisions, the nature of chemical subject matter meant that the chemical expert or 'patent chemist'[95] took on a particular importance. While with a mechanical device like a drill or a typewriting machine, 'the deliverances of the experts are mere aids to the comprehension of the structure. If there be disputes among them as to how various parts are correlated and how they act, a judge must examine the device and decide for himself as to which is correct'. However, the situation was different with chemical patents. The reason for this was that there were 'things which the independent senses cannot appreciate, which cannot be seen or felt or heard … the reactions of bodies into some chemical union or disunion, are matters in which a court must perforce depend upon the assertions of someone who has made a profound study of the matter'.[96] As a result, when dealing with chemical patents, the court had to 'wait till someone skilled in

process; *Matheson* v. *Campbell* 77 Fed Reporter 280, 281 (Circuit Court, SD New York, 18 May 1896). When the body 'under investigation fails to responds to the specific test the patentee has himself selected, he cannot fairly insist that it is identical with his product'; *Matheson* v. *Campbell* (Circuit Court of Appeals, Second Circuit, 13 January 1897, 78 Fed Reporter 910, 917.

91 *Matheson* v. *Campbell* 77 Fed Reporter 280, 281 (Circuit Court, SD New York, 18 May 1896).

92 *Pickhardt* v. *Packard* (1884) 22 Fed 530.

93 The 'multiplication of … analytical instruments served to give chemists social authority in their role as experts in legal proceedings'. Bernadette Bensaude-Vincent and Jonathan Simon, *Chemistry: The Impure Science* (2nd edn, London: Imperial College Press: 2012), 67. For Klein, this was a consequence of the change in plant materials from 'ordinary, everyday materials and commodities in the eighteenth century to purified carbon compounds and organic substances familiar only to experts in the 1830s'. Ursula Klein, 'Shifting Ontologies, Changing Classifications: Plant Materials from 1700 to 1830' (2005) *Studies in the History and Philosophy of Science* 261.

94 For example, see Complainant's Record, *Read Holliday* v. *Paul Schulze-Berge* (Circuit Court of the United States: Southern District of New York), (New York: Evening Post Job Printing House, 1895) (detailed and lengthy transcript of the evidence of several chemical experts).

95 The label 'patent chemist' was suggested because it made the expert 'more nearly part and parcel of the working staff' of the legal system 'than does the designation "patent expert"'. Bernhard C. Hesse, 'The Patent Expert and Chemical Manufacturer' (1913) *The Journal of Industrial and Engineering Chemistry* 854, 855.

96 Edward Thomas, 'An Outline of the Law of Chemical Patents' (1927) 19 *Industrial and Engineering Chemistry* 176, 177.

the intricacies of that science and art appears to lead the way though its labyrinth of terms and symbols'.[97] Or, as the court said in *Matheson* v. *Campbell*, the determination of the issues raised in relation to the patentability of naphthol-black colour compound was made 'more difficult by reason of the mass of expert testimony concerning chemical characteristics and laboratory processes, which the court cannot verify by inspection or experiment'.[98]

The reliance on technical chemical information within the patent process led to calls for scientific experts to be embodied more formally within the legal process, rather than merely as witnesses (who largely operated as temporary visitors).[99] This included calls for the establishment of 'technical juries' consisting of experts engaged in the industry or science to which the action relates,[100] an unofficial and independent patent court which would be 'equipped to deal quickly, economically and wisely with patents, especially in the highly technical chemical field',[101] and the appointment of 'technical referees to assist the court to pass judgement' on technical chemical patents.[102]

The increased reliance on chemical information within the patent process also added impetus to the calls being made for a chemical laboratory to be established within the Patent Office to allow examiners to test the validity of applications.[103] The growing number of chemical applications was said to 'render it highly desirable, and indeed indispensable, that the examiners should have at hand the means of arriving at correct and definite decisions'.[104] As a research engineer said in 1918, a 'complete fireproof laboratory in the Patent Office Building for making physical, chemical, mechanical and electrical qualitative tests' was needed 'so that any questions arising in the course of the prosecutions as to the actual performance of processes and mechanism could be answered by authoritative tests'.[105] To this end, it was proposed to 'have room fitted up as a laboratory, and that the Commissioner be authorized to procure the requisite apparatus at an

97 Ibid. Specification of a chemical compound was 'not addressed to persons who are ignorant of chemistry'. *Allen* v. *Hunter* Case No 225, Circuit Court D. Ohio, 6 Mclean 303, (April Term, 1855); 1 Fed Case, 476.

98 *Matheson* v. *Campbell* (1895) 69 Federal Reporter 597, 600.

99 A large part of the cost of litigation was said to arise because of the way that chemical inventions were described. Horatio Ballantyne, 'Chemists and the Patent Laws' (June 1922) *The Journal of Industrial and Engineering Chemistry* 529.

100 F. W. Hay, 'Chemical Industry and Patent Law' (1918) *Journal of the Royal Society of Arts* 221, 222.

101 Anon, 'More on Patents' (April 1929) *Industrial and Engineering Chemistry* 299. Thomas W. Shelton, 'Why a Special Patent Court?' (13 May 1921) 92 *Central Law Journal* 333. For a critique see Ford W. Harris, 'Patents and Court Procedure' (June 1929) *Industrial and Engineering Chemistry* 609.

102 L. E. Sayre, 'Patent Laws in Regard to the Protection of Chemical Industry' (1919–1921) 30 *Transactions of the Kansas Academy of Science* 39, 41.

103 The 4500 German-owned patents, which were reputed to be faulty, was said 'to stand as a silent monument to the lack of such a [laboratory]'. See Abraham S. Greenberg, 'The Lessons of the German-Owned US Chemical Patents' (1926–27) 9 *Journal of the Patent Office Society* 19, 31.

104 *Report of the Commissioner of Patents for the Year of 1851* (1852) 32 Congress, Senate Doc No. 118, 18.

105 N. S. Amstutz, 'Needs of the Patent Office' (1918–19) 1 *Journal of the Patent Office Society* 453.

expense not exceeding $800'.[106] The provision of experimental facilities in the Patent Office, which was intended to provide a legal-space in which chemical compounds could be tested and witnessed,[107] would 'enable the examiner to verify or disprove alleged ingredients and results of applicants for patents for materials, processes and compounds':[108] particularly in relation to whether an application met the requirement of adequacy of disclosure.[109]

The repeated calls for the establishment of a chemical laboratory in the Patent Office were reinforced by the absence of a compulsory working requirement in US patent law which allowed foreign companies to take out product patents without requiring them to manufacture the products in the United States.[110] The lack of a working requirement was particularly problematic in relation to chemical compounds given that the only way of knowing whether a patent did what it claimed to do was to follow the instructions in the patent and to replicate the invention. The lack of a working requirement (which would have acted as de facto proof that the written patent properly disclosed how to make the patented compound) created the potential problem that patents could be granted for chemical compounds that did not meet the disclosure requirement. This became a concern in the early part of the twentieth century when complaints were made that many of the chemical patents that had been granted to German companies were 'faulty' in so far as the patented chemical compounds could not be made following the instructions in the patents. The fact that attempts to replicate inventions had been made by scientists of high standing led to the conclusion that the patents contained deliberate misrepresentations and that the 'literature on chemistry was clogged with such deceit'.[111] While it was possible for faulty patents to be invalidated after they had been granted, this was seen as a 'tedious process, necessitating a great amount of laboratory work and expense and loss of time in litigation'.[112]

Despite repeated calls by successive Commissioners of Patents for the establishment of a laboratory within the Patent Office, concerns about ventilation, explosion,

[106] *Report of the Commissioner of Patents for the Year of 1851* (1852) 32 Congress, Senate Doc No. 118, 18. For the UK see F. W. Hay, 'Chemical Industry and Patent law' (1918) *Journal of the Royal Society of Arts* 221 (calling for the establishment of Government laboratories to validate problematic and obscure chemical patents. Mere 'supply of samples' was 'deemed insufficient for this purpose').

[107] On the role of laboratories see Isabelle Stengers, *Power and Invention: Situating Science* (Minneapolis: University of Minnesota Press, 1997), 95.

[108] *Report of the Commissioner of Patents for the Year of 1851* (1852) 32 Congress, Senate Doc No. 118, 18.

[109] See Abraham S. Greenberg, 'The Lessons of the German-Owned US Chemical Patents' (1926–27) 9 *Journal of the Patent Office Society* 19, 26. The problem was made worse by the absence of a compulsory working clause (highlighted by *US* v. *Chemical Foundation* 272 U.S. 1 (1926) which 'revealed that the majority of German owned chemical patents were not of such sufficient and clear disclosure as to teach one skilled in the chemical art in the United States to commercially follow then'. Ibid., 23).

[110] Francis P. Garvan, 'Some Patent History and Its Lesson to American Chemistry' (March 1922) *Chemical Age* 127.

[111] Anon, 'A Patent Abuse' (March 1918) *The Journal of Industrial and Engineering Chemistry* 173.

[112] Ibid.

and fire (the latter being particularly important in light of the fires that had occurred at the Patent Office in 1836 and 1877 and the fact that the call for the establishment of a purpose-built laboratory in the Patent Office came at a time when the 'practice of chemistry had never been more dangerous'[113]), combined with concerns about the cost of building and maintaining a laboratory meant that an in-house laboratory was never built. Other suggestions, including that the Patent Office could make greater use of existing government laboratories such as the Bureau of Standards[114] or that the onus of proof be placed on the applicant to show the 'correctness of the specification'[115] were also rejected: the former because the Bureau was already overworked and the high cost, the later because it thought to be onerous on applicants of 'small means'.

DECOUPLING CHEMICAL SUBJECT MATTER FROM ITS MATERIAL FORM

While the ability of chemists to describe and identify chemical compounds improved greatly across the nineteenth century, many problems remained. In part this was because despite improvements in the accuracy of chemical analysis, there were still many problems including errors in collection, sampling, and measurement[116] caused by things such as inaccuracy in chemist's manipulations, accidental contaminations of samples, or parts of samples being lost when they were moved to new vessels or when they were weighed.[117] As a result, when experiments were repeated, they often yielded different results. Given that 'a relatively small error in the percentage composition could significantly affect the formula assigned to the compound',[118] these errors undermined the accuracy and thus the effectiveness of chemical formulae, which 'remained unstable for much longer than is usually recognised'.[119]

Given that the study of chemical compounds often produced ambiguous outcomes, this undermined the effectiveness and accuracy of the empirical formula

[113] Catherine M. Jackson, 'The Laboratory' in (ed) Bernard Lightman, *A Companion to the History of Science* (Oxford: Wiley Blackwell, 2016), 296, 299.

[114] Anon, 'A Patent Abuse' (1918) *The Journal of Industrial and Engineering Chemistry* 173–74. See Abraham S. Greenberg, 'The Lessons of the German-Owned US Chemical Patents' (1926–7) 9 *Journal of the Patent Office Society* 19, 31.

[115] Anon, 'A Patent Abuse' (1918) *The Journal of Industrial and Engineering Chemistry* 173–74.

[116] Melvyn C. Usselman, C. Reinhart, K. Foulser and A. Rocke, 'Restaging Liebig: A Study in the Replication of Experiments' (2005) 62 *Annals of Science* 1, 2.

[117] Ursula Klein, 'Paper Tools in Experimental Cultures' (2001) 32 *Studies in History and Philosophy of Science* 265, 274.

[118] Catherine M. Jackson, 'Visible Work: The Role of Students in the Creation of Liebig's Giessen Research School' (2008) 62 *Notes & Records of the Royal Society* 31, 46 n 37.

[119] Catherine M. Jackson, 'The Curious Case of Coniine: Constructive Synthesis and Aromatic Structure Theory' in (ed) Ursula Klein and Carstein Reinhardt, *Objects of Chemical Inquiry: The Synergy of New Methods and Old Concepts in Modern Chemistry* (Sagamore Beach, MA: Science History Publications, 2014), 61, 70.

that were developed from this empirical information. These problems were compounded by the fact that while patentees used melting and boiling points to identify their compounds, nonetheless the 'problem of how to obtain reliable, comparable boiling points that would function as useful markers of identity and purity proved persistent' across much of the nineteenth century.[120]

Another related problem facing nineteenth century chemistry and by default patent law was that absolute chemical purity was an unobtained ideal: local samples of chemical species were rarely identical with other samples in every single aspect – there were 'varieties of indigo, potash, steel purchased from merchants; varieties of vitriolic acid, nitric air, spirit of wine prepared in the laboratory'[121] – samples often differed in colour, smell, taste, consistency and properties.[122] While the purity of chemical elements improved greatly across the century, this only served to create a new problem; namely, that chemical records were 'often difficult to interpret because the names of substances … remained constant while their purity has undergone changes of various magnitudes'.[123] This undermined the effectiveness of patents as a source of reliable technical information.

The ability for patent documentation to identify and recreate the patented compound was also undermined by the fact that in many cases important aspects of 'chemical knowledge did not reside in formula and structure, but rather in laboratory reasoning, the process by which chemists connected the minutiae of laboratory work with major advances in chemistry'.[124] This was particularly the case in relation to the creation of synthetic chemicals which was dependent 'on practical experience that was developed, learnt and taught in a very particular place: the institutional chemical laboratory'.[125]

These problems were compounded by the fact that in some ways organic chemistry was a victim of its own success. Improvements in chemical knowledge consistently forced chemists to 'differentiate between compounds that were previously considered to be identical, and to recognise as mixtures materials hitherto thought

[120] Catherine M. Jackson, 'Chemical Identity Crisis: Glass and Glassblowing in the Identification of Organic Compounds' (2015) 72 *Annals of Science* 187, 196.

[121] Eduard Farber, 'Errors in Chemical Identification: A Precautionary Note to the History of Chemistry' (1970) 61(3) *Isis* 379.

[122] See, for example, *Matheson* v. *Campbell* where the failure of the defendant's expert to recreate the patented invention from the written specification was explained away on the basis of impurities in the acids used in the experiments. *Matheson* v. *Campbell* (1897) 78 Federal Reporter 910, 914.

[123] Eduard Farber, 'Errors in Chemical Identification: A Precautionary Note to the History of Chemistry' (1970) 61(3) *Isis* 379.

[124] Catherine M. Jackson, 'Emil Fischer and "Art of Chemical Experimentation"' (2017) 55(1) *History of Science* 86, 90.

[125] Catherine M. Jackson, 'The Laboratory' in (ed) Bernard Lightman, *A Companion to the History of Science* (Oxford: Wiley Blackwell, 2016), 296, 304; Catherine M. Jackson, 'The Curious Case of Coniine: Constructive Synthesis and Aromatic Structure Theory' in (ed) Ursula Klein and Carstein Reinhardt, *Objects of Chemical Inquiry: The Synergy of New Methods and Old Concepts in Modern Chemistry* (Sagamore Beach, MA: Science History Publications, 2014), 61, 99.

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of as pure'.[126] The constant revision had flow-on effects as it called into question and undermined existing practices which only served to complicate things further.

The ever-expanding number of chemical compounds also presented problems for patent law. Unlike the position with inorganic substances where the relatively small number of substances meant that 'a statement of a novel compound's constituent elements along with an identifying characteristic was enough to identify the compound',[127] the huge number of organic compounds meant that more complex modes of description were needed. The rapid increase in the number of organic compounds not only exacerbated and highlighted the taxonomic and nomenclatural uncertainty that existed, it also made it much more difficult to navigate the prior art (which was essential for determining whether a would-be patent was novel). These problems were reinforced by the fact that it often took some time for the scientific community to reach agreement about a compound's formula. Until this happened, a compound could be represented by a number of different formula. Water, for example, was represented at times as $2H+O$, H_2O, and HO. In 1854, there were 11 different formula for acetic acid, which increased to 19 by 1861.[128]

While the ability to name, describe, and identify new compounds was essential to the ongoing success of organic chemistry, it took second place to the creation of new compounds. As a result, there was often a lag between scientific innovations leading to new compounds and the development of the taxonomic tools needed to describe these innovations. This can be seen, for example, in relation to Graebe and Liebermann's 1868 preparation of artificial alizarin (a red dye for cotton and a red pigment in painting) which is often seen as 'the first time a chemist had succeeded in producing a particular target molecule by synthesis'. Prior to this, (natural) alizarin had been sourced from plants and insects. While the creation of the artificial synthetic dye marked a major advance in organic chemistry, the same cannot be said for the way that the invention was described in the patent. This is reflected in the fact that because Graebe and Liebermann were unable to demonstrate either the purity or the chemical identity of their synthetic alizarin, which 'could be used in the same way as various madder compounds', they were limited to identifying their product by the 'yellow

[126] Ibid., 100. See also Catherine M. Jackson, 'Chemical Identity Crisis: Glass and Glassblowing in the Identification of Organic Compounds' (2015) 72 *Annals of Science* 187. 'Since there are indefinitely many characteristic properties in which chemical substances can differ, one has to determine and compare indefinitely many properties of two samples in order to prove their substance identity, which is impossible. Hence, all identity claims in chemistry based on an open set of characteristic properties are necessarily only provisional'.

[127] For example in *Potter* v. *Tone* CD 295, 36 App DC 181 (1911) a claim for a 'compound of silicon and oxygen, which when pure, has a soft brown color' was acceptable.

[128] Alan J. Rocke, 'Vinegar and Oil: Materials and Representations in Organic Chemistry' in (ed) Ursula Klein and Carstein Reinhardt, *Objects of Chemical Inquiry* (Sagamore Beach, MA: Science History Publications, 2014), 47, 50.

flocks of alizarin' that was produced in the compound when a particular process was followed.[129]

The upshot of this was that although there were many improvements in experimental practices across the nineteenth century, a number of problems undermined the accuracy and effectiveness of the way compounds were described and identified both within organic chemistry and by default in patent law. Here, the law was faced with a number of options. One possibility, which was not considered, would have been to deny chemical compounds patent protection on the basis that they did not meet the basic requirements of patentability. Another possibility, which was also not adopted, would have been simply to accept the best efforts of chemists to describe chemical subject matter, forcing examiners, patentees and interested third parties to make do with the descriptions that science could offer.[130] A third option, which was adopted, was to modify and adapt the nomenclatural and taxonomic practices used within chemistry to suit legal ends. As a result, the process of describing and identifying chemical subject matter in patent law became a scientific-legal hybrid. While this took many forms, I focus here on patent law's use of physical specimens as a means of identifying patented chemical compounds. I look at the efforts by the Patent Office to ensure that the scientific prior art was legible to a legal audience in the next chapter.

CHEMICAL SPECIMENS

While specimens did not have a direct bearing on the patentability of chemical compounds[131] nonetheless they played an important role in improving the accuracy and effectiveness of the way compounds were described and identified. In this sense it may appear that chemical specimens operated like patent models to evidence and showcase the invention. While chemical specimens were exhibited alongside patent models in the Patent Office Museum[132] and at industrial exhibitions,[133] they

129 Charles Graebe and Charles Liebermann, 'Improvements in Dyes or Coloring-Matter Derived from Anthracene' US Patent No. 95,465 (5 October 1869); reissue No. 4,232 (4 April 1871).

130 Another possibility would have been to reject chemical patents.

131 *In re Application of Breslow* (1980 Cust and Pat App) 616 F.2d, 205 USPQ 221.

132 As Keim's 1874 *Illustrated Guide to the Museum of Models at the Patent Office* explained, case 4 in gallery 1 of the Museum contained compounds including specimens of Goodyear's patented vulcanized rubber and samples of glue, soap, salt and candles. R. Keim, *Illustrated Guide to the Museum of Models at the Patent Office* (Washington, DC: Deb Randolph Keim, 1874), 13. In the 1823 classification of patent models, Class XIII was for chemical compositions (patent medicines, cements, dyes etc.): Class XIV was for fine arts included paints and varnishes. *An Authentic account of the fire of September 24, 1877 which destroyed the north and west halls of the United States Patent Office Building* (Washington, DC, 23 October 1877), 8.

133 The South Gallery of the Great Exhibition of 1851 contained a number of chemical specimens, some of which were either patented or the product of a process that was patented. See *Official Catalogue of the Great Exhibition of the Works of Industry of All Nations* (Cambridge: Cambridge University Press, 1851), 22 ff.

were very different. This was because while the 'materiality of the model' may have 'provided the basic medium in which inventions were revealed, scrutinized and compared',[134] the materiality of chemical specimens performed a different role. The reason for this was that while patent models (along with some biological specimens) could be evaluated on their face,[135] chemical specimens were mute. As Lloyd Van Doren explained in an article written in the Journal of Chemical Education that introduced chemical students to patent procedure, the key difference related to the fact that 'a mechanical patent has to do with something which is tangible, for example, a machine'. It was 'quite possible for a court to look at the drawings or perhaps even at a model of the machine and be able to satisfy itself that' the machine described in the patent would operate. 'In short, something tangible will be presented'. In contrast, in the case of a 'chemical patent which deals, for example, with a process for making anthraquinone, the court is not able from a drawing or even from a demonstration in the court room to visualise directly the operativeness of that process'.[136]

One of the notable things about chemical specimens was that there was little to see.[137] Other than the specimen number, the names of the patentee (or assignee) and the invention, and the date the compound was patented, a dark glass bottle or a sealed paper sachet revealed little about the intangible chemical property that was hidden inside (see Figures 3.1–3.3). As a clerk of the US Patent Office said when reporting back on his visit to the 1851 Great Exhibition in London, while the machinery displays presented the spectator with 'much to attract his observation and occupy his thoughts', the specimens of chemical and pharmaceutical products provided 'little that was interesting'.[138] The mute nature of chemical specimens meant that chemical proof was something that had to be mediated through the expertise of the chemist.

In so far as chemical samples were objects that either revealed or had the potential to reveal the 'traces of the invisible objects of inquiry', they were there to be

[134] Alain Pottage, 'Law Machines: Scale Models, Forensic Materiality and the Making of Patent Law' (2011) *Social Studies of Science* 621, 624.

[135] Whether it was in the courtroom, where models were required to 'exhibit every feature of the machine which forms the subject of invention' (E. J. Stoddard, *Annotated Rules of Practice on the United States Patent Office* (Detroit: Fred S. Drake, 1920)) or in the Patent Office Museum, where models, which were organised into classes and arranged chronologically, 'illustrated to the eye of the visitor' to the Patent Office Museum – patent models could be construed by non-experts on their face with little or no additional effort.

[136] Lloyd Van Doren, 'What the Chemistry Student Should Know about Patent Procedure III: Preparation of the Application' (May 1929) *Journal of Chemical Education* 966, 969.

[137] In determining whether an application for a process for purifying oil was novel, the Commissioner of Patents said that on examination of the 'specimen of powered copper matte which the appellant has submitted' it was found that 'no separation of the particles can be effected by a magnet'. *Ex parte Frasch* (1896) 77 OG 1427, Decisions of the Commissioner of Patents 77, 79.

[138] Edward Riddle, *Report on the World's Exposition*: Part 1 *Chemical and Pharmaceutical Products* in *Report of the Commissioner of Patents for the Year of 1851* (1852) 32 Congress, Senate Doc No. 118 347, 440.

tested (or at least potentially tested). This was reflected in the language of successive patent statutes which required applicants to provide specimens of ingredients and of the composition of matter 'sufficient in quantity for the purpose of experiment'.[139] While the patent legislation required applicants to deposit samples to allow the application to be tested, as successive Patent Commissioners complained, the absence of an in-house laboratory in the Patent Office meant that it was not possible to examine chemical applications properly. As the Commissioner of Patents Benton J. Hall said, the lack of laboratory facilities in the Patent Office meant that there was 'no means of testing such specimens that have been provided, although obviously within the meaning of the law'.[140] Despite this, specimens were still important.

The reason for this was that by linking the description of the patented invention to the physical chemical specimen, and by ensuring that sufficient materials were available 'to allow experiments to be undertaken that revealed the essential features of the invention',[141] specimens ensured that the accuracy of the written description could be tested during the application process if needed. In doing so, chemical specimens provided 'greater accuracy and completeness in the description of patented inventions'.[142] This was because once a patent had passed through the examination process and received the official imprimatur of the Patent Office, it could be presumed that the written description was accurate: either because the description was clear on its face, or because when the Commissioner asked for a specimen to be deposited, the written description corresponded with the material specimen (if it didn't, the patent would not have been granted). While applicants sometimes provided affidavits that attested to the qualities of the invention, the Patent Office was reluctant to rely upon this information because while the assertions may have appeared to be reliable, as the Commissioner of Patents said, 'in the absence of some means of testing the truth of the facts claimed, it is impossible for the Office to determine with what degree of certainty which should exist whether the invention is novel and useful and should be covered by a patent'.[143]

In this context it did not matter whether or not the patented compound had in fact been tested (the absence of an in-house laboratory within the Patent Office meant that this was rarely the case). It also did not matter if there were problems in the way

[139] Section 6 of the Act of 1836 provided that 'every applicant for a chemical patent shall accompany his application with specimens of ingredients and of the composition of matter, sufficient in quantity for the purpose of experiment'. *Report of the Commissioner of Patents for the Year of 1851* (1852) 32 Congress, Senate Doc No. 118, 18.

[140] *Annual Report of the Commissioner of Patents to Congress for the Year Ending December 31, 1887* (Washington: Government Printing Office, 1888), v.

[141] William C. Robinson, *The Law of Patents for Useful Inventions: Vol 2* (Boston: Little Brown and Co, 1890), 161. 'It is for the Patent Office to decide whether specimens of ingredients should be filed'. *Anilin* v. *Cochrane* (1879) 16 Blatch 155; 4 Bann & A 215; *Tarr v Folsom* (1874) Holmes 312; 5 OG 92; 1 Bann & A 24.

[142] William C. Robinson, *The Law of Patents for Useful Inventions: Vol 2* (Boston: Little Brown and Co, 1890), 156.

[143] *Annual Report of the Commissioner of Patents to Congress for the Year Ending December 31, 1887* (Washington, DC: Government Printing Office, 1888), v.

chemical compounds were described. This is because the legal fiction of the chemical specimen allowed the patent system to operate on the basis that the description was accurate. By ensuring that any potential problems there might have been in identifying or replicating a patented compound were 'resolved', chemical specimens allowed third parties to place trust in the written descriptions of the patented chemical compound.

At first blush it may seem that chemical specimens operated like biological specimens in so far as they provided an objective standard against which the written description could be evaluated. While in some ways they were similar, they differed in a number of ways. With biological subject matter the deposited specimen, the name, and the description all worked in tandem to define the invention.[144] In contrast, with chemical inventions, the specimen did not operate in conjunction with the written description (and the name) to define the invention: the specimen was the thing that was being described: it *was* the invention. This had important consequences for the way patent law interacted with chemical compounds. Because the written description and the chemical specimen were the same thing, and because it was possible to replicate the specimen from the written description, after a patent was granted the written description of the chemical invention could be uncoupled from its material form (unlike the type specimen in biology which is permanently tied to the name and the description). Thus, while during the grant process chemical specimens played an important role in building trust in the accuracy of the written description, after a patent was granted the specimens were no longer needed. Post-grant, the written description not only provided third parties with all that they needed to know about the patented chemical compound (both to identify the compound and to recreate it), they also did so in an easy-to-use and comparatively uncomplicated way. Uncoupling the tangible chemical specimen in this way allowed people interacting with chemical patents to focus on the written description in the patent documentation, rather than having to go through the timely and arduous process of testing the specimen. Post-grant, it was no longer necessary to refer back to the specimen at all. In so doing, it allowed chemical (paper) patents to circulate as immutable mobiles: as closed, fixed, and trustworthy scientific objects.

The shift away from the material specimen towards the written description that occurred after grant was reinforced by the fact that once a patent was granted, the findings of the Commissioner in relation to specimens could not be questioned or challenged. This can be seen, for example, in the 1874 decision of *Tarr v. Folsom*, which concerned a challenge to a reissued patent for an antifouling paint that was said to have 'launched the first industrial revolution in North America, that was commercial fishing'.[145] The patent was challenged on the basis that the reissued patent 'described substantially different inventions from any described and shown in the original

[144] When 'biologists identify organisms', they focus on the 'type, side by side with its description, as the standard against which other specimens are measured'. Lorraine Daston, 'Type Specimens and Scientific Memory' (2004) 31(1) *Critical Inquiry* 153, 164.

[145] Janie Franz, 'America's first copper paint' (August 2009) (Copper Development Association).

patent … or in the samples filed in the patent office in illustration thereof'.[146] The Circuit Court of New York rejected this argument and held that as the specification 'clearly describes the composition of matter and all the ingredients and proportions, in language perfectly intelligible to those skilled in the art, it would not be invalidated by the failure to deposit in the patent office a sample of one of the ingredients'.[147] Importantly, the court was not willing to reopen the question of the accuracy of the specimen and its relationship to the written description and the intangible chemical property. As Judge Shepley said, the requirement to deposit a specimen was obligatory before the granting of the patent, where it 'was for the commissioner to decide, before granting a patent, whether it is complied with. If he does so decide, and grants the letters-patent, that cannot be subsequently impeached by evidence tending to show a want of compliance with the law as to giving notice, or paying fees, or performing the other acts, or performing the other acts required before the patent is granted'.[148] That is, once the Commissioner had accepted that the written description corresponded to the deposited specimen, their decision could not be reopened or challenged.

By simultaneously black-boxing the chemical specimen and by decoupling the physical specimen from the written description, it was possible to focus on the paper form of the invention in the patent documentation. The focus on the written two-dimensional form of the invention was reinforced by the absence of a workability requirement which would have required patentees to show a material instantiation of the invention. The focus on paper-based inventions meant that in an infringement action or where the novelty of a patent was challenged, the written specification was treated as if it encapsulated the invention (or at least provided instructions for how the invention could be identified); it was the alleged infringing or anticipating compound, rather than the physical specimen, that was tested to see whether it complied with the descriptive tests set out in the patent documentation. In this sense, chemical specimens not only helped patent law to deal with any problems that might have arisen in the way chemical compounds were described, they also allowed the patent system to circumvent some of the problems that arose when dealing with empirical inventions more generally. In this sense, the legal fiction of the chemical specimen allowed the patent system to deal with chemical inventions in the much the same way as it interacted with mechanical inventions. While the process was not complete, it also played an important role in decoupling chemical subject matter from its material physical form.

[146] *Tarr* v. *Folsom* 1 Ban & A 24; 1 Holmes 312, 23 Fed Cas 704 (1874) Case 13,756. James Tarr and Augustus Wonson, 'Paint for Ship's Bottoms', Letter Patent No. 40,595 (3 November 1863). James Tarr and Augustus Wonson, 'Improvement in Paints for Ship's Bottoms' US Patent No. 40,595 (3 November 1863); reissue No 2,722, (6 August 1867), reissue No. 4,598 (17 October 1867).

[147] Ibid., 705.

[148] Ibid. The decision stands at the juncture of different ways of thinking about chemical compounds. The court had to consider the change in scientific nomenclature (old language of oxide of copper on the one side and sulphuric acid in another, compared to the new nomenclature 'as sulphuric acid in which two atoms of hydrogen have been replaced by copper'). See *Wonson* v. *Gilman* 30 F Case 420, 421 (1877) Case No. 17,933 (dealing with the patent in *Tarr* v. *Folsom*).