WILLIAM KEATES

Some Founders of the Chemical Industry

MEN TO BE REMEMBERED

BY

J. FENWICK ALLEN

SECOND EDITION.

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In Gratitude and Veneration
this Volume is Dedicated
to the Memory of
William Keates,
one of the earlier Pioneers of
Copper Smelting in Lancashire.

PREFACE

The Editor of the *Chemical Trade Journal*, Mr. George E. Davis, asked me, in 1889, to write a few articles for his journal on some of the notable and truly remarkable men who founded the Alkali Trade in Lancashire. The desire has been expressed that I would republish these articles in a more permanent form.

After careful consideration, I have thought it expedient to make no alterations in the original articles, but to republish them just as they appeared, being mainly biographical sketches of men who have passed away, and a story of the industry with which they were connected.

Since 1890 the alkali trade has been transformed, by the absorption of nearly all the leading private concerns into the great trust or combine, the United Alkali Company.

There was a personal element in the story of many private concerns, which is absent from limited companies, and we miss to-day such men as those whose careers I have endeavoured to sketch.

The small manufacturer and tradesman are in danger of becoming an extinct species, and a more general uniformity is suppressing individuality and originality.

Doubtless the great revolution was inevitable, with the equalising of the facilities of communication, the rapid growth of knowledge and the education of the people, the force of union and associations, keen international competition—these and other factors compelled industry to face the financial as well as the social problems of the age, and the extinction of the individual was saved by combination.

This is not the occasion to discuss the advantages and disadvantages that have accompanied the vast change that has taken place since 1890, but one misses the influence of such men as Muspratt, Gossage, Deacon and others, whose personal presence was felt every day in their business and in the community.

In some respects the towns of St. Helens and Widnes have vastly improved during the last fifteen years. There is a great and uniform improvement in the construction of works; the engineer and the chemist, the architect and builder, legislation and municipal administration have wrought wonders. The atmosphere is much more pure, fields and hedgerows are finding their way back to districts that had been laid waste by destructive gases, and beautiful parks and public gardens adorn the suburbs of our manufacturing towns. Horticulture and agriculture no longer look upon manufactures as their enemy. The wealth and influence that works have brought to the localities are resulting in great municipal advantages, the streets are better paved and lighted, the towns are being amply supplied with good water, public buildings are multiplying, and the squalor and barbarism that were so offensive are disappearing.

The main purpose in republishing these memoirs, is not only to put into worthy and permanent form the story of lives that deserved to be remembered, but also to indicate to their successors the path that led to fame and affluence.

J. FENWICK ALLEN.

PREFACE TO THE SECOND EDITION.

The author recognises how much he owes to his critics; but while he has felt grateful to those who have encouraged him by their words of approbation, he has been not less grateful to those who have suggested corrections which have been invariably kindly and just.

During the month of November, 1906, a most interesting and valuable series of articles appeared in *The Times*, entitled, "The Struggle for Supremacy," in which were described the origin and progress of the great company that has incorporated so many of those enterprizes, the story of which has been told in this book.

The great positions of power and promise which the United Alkali Co., Brunner, Mond and Co., and many other similar great chemical concerns fill to-day, owe their beginnings to the individual struggles for existence of the earlier chemists, whose life story is full of interest, instruction, and even of romance, and which the author hopes may be a source of inspiration to many a gifted and patient student and inventor.

The appreciation of this book by the general reader has been most welcome, and to those members of the teaching staff in colleges and schools who have expressed their approval, the author desires to say that he highly values their praise.

NOTE.

I desire to express how deeply I feel indebted to many who assisted me in the compilation of these memoirs, especially Sir David Gamble, Mr. Gossage, Mr. E. K. Muspratt, Mr. Deacon, Mr. Rayner and Mr. Spence.

J. F. A.

On the 15th January (1907), whilst these pages were in the press, Mr. William Gamble, a grandson of Josias Christopher Gamble, died, and just three weeks afterwards his father, Sir David Gamble, passed away. The death of Mr. William Gamble, who was in the prime of life, occurred with startling suddenness; he was a director of the United Alkali Company, having had a most careful and thorough training in all the details of the business whilst associated with his father. He had devoted himself to the welfare and progress of St. Helens, and the whole district was moved with sorrow at the loss of a life that had been for years so useful and beneficent, and from which so much was still anticipated. He was only 54 years of age.

Sir David Gamble's death closed a long and most honourable life; and the grief which was so universally felt when the sad news was known, expressed itself with every mark of reverence and affection on the occasion of his funeral.

In the eloquent words of Dr. Chevasse (Bishop of Liverpool), as true as they were eloquent,— "His whole heart was bound up with St. Helens, and whoever injured St. Helens injured him, whoever tried to help St. Helens seemed to confer a personal benefit or favour upon him.

He seemed to feel he should try and help St. Helens as St. Helens had helped him. He gave generously, but he gave wisely. God gave him great means, but he declined to keep those means to himself. He was a steward of the living God. Every good public cause,—religious, or civic, or philanthropic,—in St. Helens found in him a wise, open-hearted and generous friend.

He was rich in sterling common sense, and, as the greatest only are, "in his simplicity sublime."

He lived with wonderful simplicity himself, with little luxury or extravagance. He was God's steward, and his sense of responsibility prevented him spending upon himself what he spent upon others.

As we think of him there comes back to us the words of the great poet of the Victorian era, in which he described perhaps the greatest Englishman of his day:—

"O good gray head which all men knew,
O voice from which their omens all men drew,
O iron nerve to true occasion true,
O fall'n at length that tower of strength
Which stood four-square to all the winds that blew!"

CONTENTS

WILLIAM GOSSAGE

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No name among the practical chemists of the present century is more deserving of a permanent memorial than that of William Gossage. His character as an inventor was exemplary for the unceasing industry and perseverance with which he pursued his labours; and his inventions illustrate for nearly half a century the progress of more than one department of chemical industry.

With few advantages in the way of early education, for he was the youngest child in a family of thirteen, taken from school before he was thirteen years of age and sent to serve in a druggist's shop with no aids such as evening classes or technical schools or even mechanics' institutes, he acquired such a knowledge of the science of chemistry as the text books of that day afforded, and in order to gain access to the work of some great authors, he mastered the French language.

He was born in the little Lincolnshire town of Burgh-in-the-Marsh, in the year 1799, and his uncle was the chemist and druggist, at Chesterfield, with whom he was placed when twelve years of age. But William Gossage was undoubtedly a thorough genius. However varied or subtle the definitions of genius may be, the demands of all such definitions are met in him. He had a mind of large general powers, he eminently possessed the faculty of invention, in pursuit of his discoveries no labours were too exacting and no pains too great, as long as his physical powers held out he was ever to be found in the front rank of inventors ; he kept ahead of his time and his mind remained alert and capable of incessant growth. The face, the voice, the manner, even the very gait, were those of no ordinary man, he had the presence of a leader, he was himself an inspiration.

On the 11th February, 1823, William Gossage first entered that door, through which for over forty years he was destined so frequently to pass. The records of the Patent Office afford the material by which his career can be traced step by step, his patents reveal not only the subjects on which his own mind was engaged, but they illustrate the history of the alkali trade and allied industries in their varied and rapid developments during the present century.

Gossage's patents are his life. They are continuous, they are connected, they indicate localities and suggest associations. The first patent taken out in 1823, for a portable alarum attached to or detached from clocks and watches, presents to us the picture of the ardent student, who to arouse his teacher, a French refugee, betimes, for his pupil might be often found in his studies between four and five in the morning, invents for him this alarum. Now-a-days every student of science knows that he must be familiar not merely with French, but that without German and even other European languages, he is excluded from the companionship and instruction of some of the greatest teachers. To-day the man of science must be a proficient linguist. Gossage saw this, and with his characteristic industry and enthusiasm led the way.

In January, 1828, there is a patent for the construction of cocks for the passage of fluids. We thus see that mechanical contrivance, and not chemical reaction, first engaged his attention, and throughout his life the machinery that was needed to perfect his inventions was his task. At that time it was not recognised as it is to-day, that the practical chemist must first of all be a practical engineer. That *engineering* must be the foundation on which chemical industries are constructed. Whenever Gossage failed to secure the prize of absolute success, it was not that his chemistry was at fault, but that he had not to his hand the mechanical appliances he needed. It is surprising how ingenious and successful were his contrivances of apparatus, considering he had not received a practical training in mechanical engineering: but he knew how to appreciate talent in other men, and to excite in them enthusiastic co-operation. One instance of this may be recorded. When he was erecting his soap plant, he discovered in Mr. Wm. Neill, of Bold, near St. Helens, whose comparatively early death was a loss to the district, a mechanic of rare ability; and the perfect arrangements of plant in that most successful undertaking, are in no small measure to be attributed to Neill's capacity of carrying out Gossage's ideas and requirements.

No patents are taken out between 1828 and 1836. Having left his uncle's at Chesterfield, he went into the same business, on his own account, at Leamington, and became a manufacturer of Leamington salts. At Leamington he did not long remain, but removed to Stoke Prior, in Worcestershire, where, in partnership with Mr. Fardon, he started a Salt and Alkali Works.

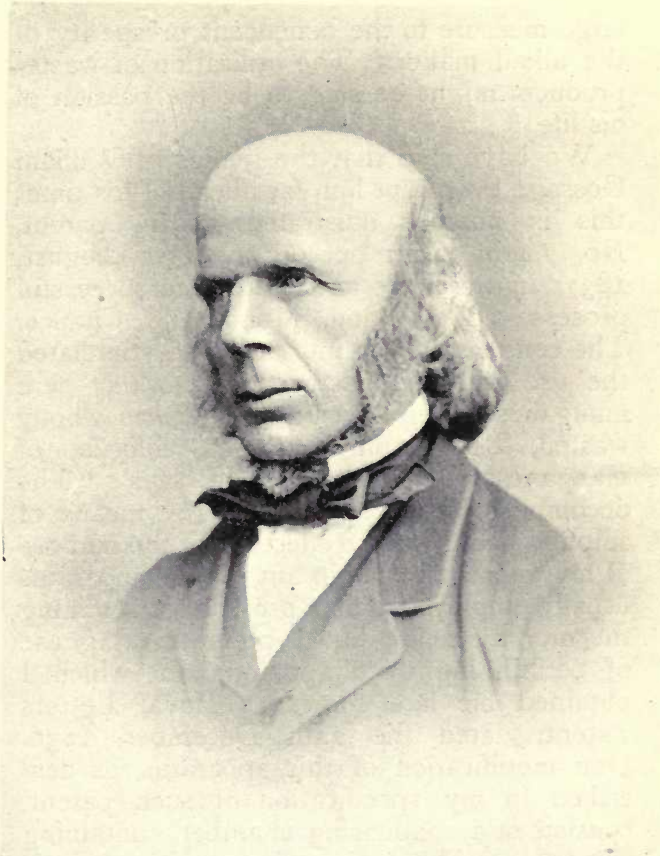
On the 29th of March, 1839, we find a patent in which William Gossage is associated with Edward White Benson; they specify a process for effecting improvement in the manufacture of ceruse or white lead. This Mr. Benson was the father of Dr. Benson, Archbishop of Canterbury. They mixed oxide of lead or massicot with acetic acid or acetate of lead and water, and exposed these to the action of carbonic acid gas. On the 19th of January in the following year, improvements in the manufacturing of oxide of lead for paints, etc., and also bleaching and purifying oils, suitable for mixing paints, are patented. Here we have him engaged in studying the action of carbonic acid gas, and also of chlorine as a bleaching agent, produced by the action of muriatic acid on the peroxide of manganese. But before he applied for the latter patent, he made the invention which promises to be his most lasting and notable monument.

On the 24th of December, 1836, he specified his condensing towers, and wherever the Leblanc process has been established a Gossage condensing tower has been one of the essential features of the plant. In his paper on "The History of Alkali Manufacture," read before the British Association in Manchester, in the year 1861, he thus refers to this subject ;—"In the early days of the soda trade, no attempt was made to condense the liberated hydrochloric acid gas." After a time Woulfe's bottles and earthenware cylinders were adopted, but these proved inadequate to effect the condensation of the quantities of hydrochloric acid gas produced in the rapidly growing manufacture of sulphate of soda from common salt. Many plans were suggested, but none were effective, until, having demonstrated the practicability of effecting complete condensation of hydrochloric acid, by the erection and working of a set of apparatus at the soda works with which he was then connected, at Stoke Prior, he introduced the plan to the trade, and it has since then been used by every manufacturer.

The principle of the invention consists in causing the acid gas to percolate through a deep bed of coke, in small lumps, contained in a high tower, at the same time that a supply of water flowed very slowly over the surface of the pieces of coke. By this means an almost unlimited extent of moistened surface was presented to the gas for effecting its absorption, and as the fluid descended through the tower, it met with more gas, and gradually became charged to saturation; whilst in the upper portion of the tower, any gas which might otherwise escape was exposed to the absorbing power of unacidulated water. But for this invention, the blasting vapours of muriatic acid which were turned out from every alkali works, would have made the soda maker such an intolerable nuisance that he would have been suppressed as a public enemy—no locality would have tolerated his existence. To William Gossage, then, is due the honour of having invented one of those simple contrivances which saved from extinction a trade, the growth of which has contributed largely to the nation's prosperity.

The invention of 1836 paved the way for the passing of the great "Alkali Act" of 1863, and its successors; so that now a chemical works may be planted almost in the heart of an agricultural district, the condensation of its most destructive gases being absolutely perfect. But it was not only the prevention of the destruction of vegetation, and of injury to health and comfort which this invention achieved, it economised what had before been a waste-product, and contributed in a very large measure to the beneficent prosperity of the alkali maker. The utilisation of waste-products might be said to be the passion of his life.

We have said that the genius of William Gossage ever kept him far ahead of his time; this is notably illustrated in his patent, No. 7,416, taken out on the 17th August, 1837, in which he anticipates the successful processes of Weldon, Mond, and Chance. The condensation of muriatic acid stimulated the use and manufacture of chlorine; here manganese, then a costly agent, was wholly wasted, being run away as chloride of manganese. In his patent he says: "The decomposition of common salt by means of sulphuric acid may be effected, for the purpose of my improvements, in any of the apparatus usually employed, which provide for retaining the muriatic acid; but I prefer making use of certain improved apparatus for which I obtained his late Majesty's Royal Letters Patent, dated the 24th December, 1836. One modification of this apparatus, as described in my specification of such patent, consists of a condensing chamber, containing siliceous pebbles, in which the muriatic acid gas may be condensed by water alone,



Dr. ANGUS SMITH

(First Chief Alkali Inspector under Lord Derby's Act, 1863)

yielding liquid muriatic acid, or by a mixture of water with any substance or material on which it is desired that muriatic acid should effect a chemical action. When I use oxide of manganese in this apparatus, I inject a mixture of this oxide and water, and introduce steam, and the oxide of manganese being acted on by the muriatic acid, chlorine gas and liquid muriate of manganese are obtained as products. This liquid muriate of manganese being collected, I decompose it by means of hydrate of lime; and, to effect this operation conveniently, I use large shallow open vessels, each vessel having several shafts fitted with paddles, and extending across it, and so arranged that rapid motion can be communicated to them. I introduce into these vessels a quantity of hydrate of lime, made into cream of lime, and I gradually add the liquid muriate of manganese thereto, and at the same time give motion to the shafts and paddles, so as to cause a perfect mixing of the fluids. During the operation a reaction takes place between the lime and muriate of manganese, and hydrated protoxide of manganese and liquid muriate of lime are produced in mixture. I expose this mixture to atmospheric air from which the hydrate protoxide absorbs oxygen;

I accelerate this absorption of oxygen by causing the fluid mixture to be projected into the air in finely divided particles by communicating rapid rotary motion to the shafts and paddles before mentioned. The absorption of oxygen converts the hydrated protoxide of manganese into hydrated peroxide."

Complete as these reactions are, and simple as the process seems to be, as a fact, it never was adopted, and not until Mr. Walter Weldon gave his attention to the recovery of manganese liquors, more than thirty years afterwards, did the alkali manufacturer save his manganese. Mr. Weldon recognised fully that the chemistry of his process was demonstrated by Mr. Gossage; and Mr. Gossage recognised the ability and the perseverance with which Mr. Weldon, aided by vastly improved mechanical appliances, brought his invention to a tangible success. To the engineer rather than to the chemist is the triumph of Weldon to be attributed.

The second portion of this memorable patent of August, 1837, forecasts the successes of Mond and Chance in their successful sulphur recovery processes. Gossage saw that the sulphur used in the Leblanc processes was absolutely wasted, and nine-tenths of the total sulphur employed went into "vat waste." To save this sulphur was one of his earliest efforts, and as year after year passed by, we find him struggling with the difficulties of the problem, sealing patent upon patent. In the paper read in 1861, to which we have before adverted, he says on this subject: "Thus was presented a problem, which, if it could be solved, would effect a large reduction in the cost of soda. Many chemists, both scientific and practical, had given a great amount of attention to the subject; he had been so unfortunate as to be amongst that number, as he had devoted a great proportion of his time during a quarter of a century, and a large amount of both money and labour to this delusive subject. He commenced by demonstrating that one equivalent of carbonic acid would decompose one equivalent of sulphuret of calcium, producing mono-carbonate of lime and sulphide of hydrogen. This decomposition was contrary to the received views of the scientific chemists of that day, as it was held that an excess of carbonic acid was needful to effect the perfect decomposition of sulphides. *He was convinced that whenever the utilisation of the sulphur in alkali waste should be effected it* *would be by means of carbonic acid.*" This conclusion was not arrived at without long years of patient experiment. His patents at one time indicating that his hopes rested on muriatic acid, and at another time on sulphurous acid, but his first thought was his last thought, and, as Mr Chance proved, was his right thought.

The patent of 1837 states "as to that part of my invention, which relates to the use of the alkali residuum, which, as I have stated, contains sulphuret of calcium and carbonate of lime, when this residuum is acted upon by muriatic acid, a mixture of sulphuretted hydrogen gas and carbonic acid gas is evolved, these mixed gases being placed in contact with another portion of alkali residuum, the carbonic acid reacts on the sulphuret of calcium and liberates therefrom a further quantity of sulphuretted hydrogen. . . . Carbonic acid being thus absorbed and abstracted from a mixture of gases, sulphuretted hydrogen is obtained nearly free from carbonic acid gas, and in a state favourable to undergo combustion, and thereby produce sulphurous acid. Instead of obtaining sulphuretted hydrogen from alkali residuum by means of muriatic acid—he says—I sometimes use carbonic acid gas as an agent for effecting the reaction with sulphuret of calcium. The gas obtained from alkali residuum by the process hereinbefore indicated may at once be used, but I prefer to collect it in a gasometer before I use it, and when I apply it to the manufacture of sulphuric acid, I transfer it through tubes to a suitable apparatus, wherein I cause it to undergo combustion. The action of carbonic acid on sulphuret of calcium contained in alkali residuum, as hereinbefore described, occasions the production of a quantity of carbonate of lime in addition to that previously contained in the residuum. I use the carbonate of lime which I obtain from the residuum for purposes connected with the manufacture of alkali instead of native carbonate of lime." Here we have suggested almost the details of the new plant which was erected more than fifty years after Gossage's specification, to work the process which Mr. Chance, by the expenditure of so much money, and time, and labour, and with such ability, has elaborated and perfected.

Mr. Gossage himself spoke of this problem of the recovery of sulphur from alkali waste as a delusion. He reviews his quarter of a century's work in a tone of sadness; describes himself as one of those unfortunates who had been fascinated to pursue this goalless path, but had he lived to to-day he would have witnessed that his baffled efforts, his renewed struggles, his confident hopes, his cruel disappointments, were not in vain. Once so firmly did he believe that he had grasped success that in a sanguine moment, when all obstacles appeared to have been overcome, he contracted with his neighbours to take their "vat waste" and treat it so as to extract the sulphur. This was a delusion; he soon discovered his error. With one painful exception his competitors released him from his engagement, but the one held him to "his pound of flesh," and relentlessly compelled him to fulfil his contract.

There are in the features of William Gossage, as they are handed down to us, to be detected traces of that sadness which must have been often felt during those long and severe struggles, and which must have been terribly hard indeed to bear when a neighbour's hand smote him a blow that had well-nigh been fatal, for the compulsory execution of that contract abstracted from him nearly all he possessed, possessions which he was always prepared to lavish on those objects to which he had so devotedly given his life, and which had been and are still of such inestimable value to the alkali trade generally.

Before leaving this subject of the recovery of sulphur, there is to be noticed connected with this problem a patent which William Gossage took out thirty years ago; it is No. 2,612, dated November 18th, 1859, "For improvements in the manufacture of carbonate of soda." He therein specifies that the sulphate of soda is decomposed into sulphide of sodium by the action of *carbon* at a temperature insufficient to flux the mixture of sulphate of soda and carbon employed, and converting the sulphide of sodium so obtained into carbonate of soda by the action of carbonic acid; also the use of carbonic acid obtained by such decomposition of sulphate of soda for the production of carbonate of soda.

The chief alkali inspector (Mr. A. E. Fletcher) in his last report, published only a few days ago, revives the subject of this patent by drawing attention to the experiments that are being carried on by Mr. Fred Gossage and his partners at Widnes. He says:—"It is expected that yet another process to effect at once the recovery of the sulphur and the simplification of the Leblanc process will shortly be made public. This process is due to Mr. Gossage, whose father was the pioneer of all such attempts. This gentleman has recently taken out a patent for producing sodium carbonate from salt-cake without the intervention of limestone in the furnace. He claims to have surmounted the difficulties hitherto experienced in converting the salt-cake into sodium sulphide, utilises the ordinary black-ash revolving furnace for the operation, and uses lime-kiln gases, as the others do, for evolving sulphuretted hydrogen from the sodium sulphide, with simultaneous production of sodium carbonate. The inventor regards his inventions on a large scale in the works as perfectly satisfactory, and it is hoped ere long he will favour us with a detailed account of his process. If it is found to answer all his expectations, it must be regarded as a distinct advance on what Chance has done. For, while recovering the sulphur of the pyrites by the same means and a similar method of working to that employed by Chance, it does so with a simultaneous production of sodium carbonate, eliminates the limestone altogether from the operation, and, while retaining the use of the expensive black-ash furnace, dispenses with some of the more cumbersome parts of the old plant, at the same time producing an ash of high strength and comparable in quality with that made by the ammonia process."

It would indeed be a most gratifying result if, after all, the crowning prize of the labours of these fifty years was awarded to the son of the man who was the first to enter the lists, and who fought to the end of his days with such courage and determination.

In 1843, a patent was taken out jointly by William Gossage and Henry Hussey Vivian (the present Sir Henry Hussey Vivian, M.P.), for improvements in treating and reducing ores of zinc, also certain improvements in furnaces to be used for reducing ores of zinc, etc. This appears to have been a first essay in metallurgy, and for a time Swansea became the field of work. The valley of the Tawe would present a scene that would move the inventor of the towers for condensing muriatic acid to grapple with the condensation of copper smoke. At that time large quantities of sulphurous and arsenious, as well as hydrofluoric acids, were emitted from the low stacks of the works that had been built along the river side. The principal ores then smelted came from Cornwall, and were almost entirely sulphurets and arseniurets mixed with a considerable amount of fluor spar. These ores had to be calcined, and the furnaces employed were chiefly "open" calciners, from which concentrated gases were given off, which in the direction over which they were carried by the prevailing winds in wet weather proved most destructive to vegetation; the hill sides on which the smokes impinged, were denuded not merely of trees, but of all herbage, and Landore and the rising ground around Hafod and Foxhole wore an utterly blasted and desolated aspect. It was in 1845 that a patent was taken out which included several metallurgical processes. It related to methods of treating sulphurets of copper, zinc, lead, and iron, and arresting and collecting volatilised products given off in working these metals, also it specified furnaces and apparatus for smelting sulphuret ores. The condensing of the various substances given off in vapour was sought to be effected by means of towers or shafts fitted with siliceous pebbles, which are moistened and present extensive surfaces to the products passed through them.

Another somewhat similar patent was taken out in 1854, when Gossage had erected a smelting works at Woodend (Widnes), but neither his furnaces nor his towers were ever adopted by copper smelters generally; sulphurous acid being a more difficult gas to condense than muriatic acid gas; and the vapours often being too dilute to be economically converted into sulphuric acid. Indeed, in later years, Mr. Gossage recognised that the only methods to treat copper ores were to calcine those ores rich in sulphur in kilns or close furnaces, and condense the gases in leaden chambers making sulphuric acid; and to melt or roast the ores or regulus poor in sulphur in open furnaces, diluting the gases with a large admixture of atmospheric air, and so rendering them, on account of their extreme dilution, comparatively innocuous. His advice was sought during the prolonged litigation, carried on between the late Mr. Tipping, of Bold Hall, and the copper smelters of St. Helens, and these were the conclusions at which in these latest years of his life he had arrived.

Whilst engaged in his copper smelting operations at Woodend, he saw that a process for expediting the final roasting of "white metal" into "Spongy Regulus," or "Regulus" into "Blister Copper" would be a great gain, and he patented his plan. Mr. William Keates, who was at that time the most experienced copper smelter in Lancashire, if not in England, was engaged on similar lines, and he patented his arrangement. But neither of these inventions were adopted and continued even by their inventors. The most daring invention in this direction was one by Mr. John Holloway, who used the Bessemer converter, and really succeeded in smelting Spanish pyrites without the use of coal, generating the necessary heat by the rapid oxydising of the pyrites rich in sulphur; but as the sulphur was blown off and cold air blown in, the heat rapidly went down, the fire went out, and the converter got clogged. Mr. Holloway worked at his experiments with wonderful enthusiasm. It was to be regretted that he spent so much money and time, for his experiments were made on a scale regardless of expense, on an object that could not possibly recoup him. Had he sought to follow out the line of Mr. Gossage and Mr. Keates, there was a much greater probability of some success; for Manhés appears to have invented a furnace to expedite the "roasting" by blowing in air, and by a few this furnace has been looked upon with some favour. At all events, there is no doubt that both Gossage and Keates had about the same time fastened on the one feature in the old method of copper smelting that might be very greatly improved upon, by blowing air *into* the charge, instead of merely exposing the surface of the molten metal. What is known as "rabbling" is a clumsy and tedious device.

When Spain and Portugal began to supply the alkali maker with a pyrites much richer in sulphur and copper than what they had been accustomed to get from Wicklow, a new problem was presented to the metallurgist. He had to discover the best method of abstracting the copper, the silver, and the gold from the burnt ore, and utilising the oxide of iron.

William Gossage was one of the first in the field with a patent of March the 7th, 1859. He proposed to extract the copper by means of a persalt of iron (by preference persulphate), but it was reserved for William Henderson, of Glasgow, to invent, in the same year, the simpler and more economical process of roasting the burnt pyrites with salt, and washing out the copper with water, and

Claudet discovered the process for the recovery of silver and gold; so that, although he was early in the race, he did not succeed in being a sharer in the gain which accrued to those who successfully worked out the problem. Doubtless, his attention was absorbed with other and more engrossing experiments than those which the metallurgy of copper suggested.

The successful men in the alkali trade have been those who have known how to avail themselves of every invention, whilst those who have succeeded in copper smelting, have, with one or two exceptions, introduced no innovations. Their fortunes have been made by their prudent buying and selling, and not by their methods of manufacture. Such a trade would have few attractions to William Gossage, to be subject to frequent and unforeseen fluctuations of markets would be a worrying distraction to a mind bent on scientific invention.

The connection with Stoke Prior was severed in 1850, and the home was removed from Worcestershire to Lancashire. Mr. Gossage took up his residence at Woodend, in the house that stood close to the lock leading into the canal that connected Widnes and St. Helens. The present extensive offices of the soap works stand where the old house formerly was. It was close to the plot of land that was secured for the erection of works. The site was well selected, the St. Helens railway ran sidings into it, and it had advantages of communication both by river and canal. Fuel could be obtained at most favourable rates from the Wigan and St. Helens districts, limestone could be brought from North Wales and Derbyshire, whilst salt and pyrites could be brought up the river from the salt districts, and from Ireland. The prevailing west winds would carry all the vapours, not inland, over farms and residential properties, but away from these over a long stretch of river, so that little or no damage could be done. When Mr. Gossage first came to Widnes, fields with green hedgerows and healthy trees still extended down from his house along the river side past the old "Snig-pie House." This noted hostelry was still a favourite resort for pic-nic parties. The Widnes marsh was used by the neighbouring farmers to graze their cattle on. A prettily situated estate was the property of Mrs. Wright, whose house, with its parklands, overlooked the river from behind the ferry.

Hutchinson and Earle had begun their manufacture of alkali on the eastern side of the canal, Gaskell, Deacon, and Co. had also established their works. Muspratt had his soda processes in operation, and Lambert was smelting copper. Widnes was at that time a village, the works were small and the houses few, residence was not only bearable but even inviting, bathers frequented the shores of the Mersey, round about Woodend, and some of the young men kept their yachts. Woodend was bright and sweet and salubrious.

Mr. Gossage lived at his works. His enterprise led him to erect mills to crush the limestone to be supplied to the alkali works. His life was amongst his workpeople, superintending the industries he had established, or in his laboratory prosecuting his researches. He was not drawn away from his studies by the allurements of social enjoyment, and there were no necessities of circumstances which at that time demanded his attention to public affairs. His house was adjacent to his business, and his recreation as well as his occupation was to be found in the pursuit of his daily calling.

The years 1853 and 1854 were fruitful in invention. In May, 1853, he patents improvements in the manufacture of alkali from common salt. The first of these was, oxidising black-ash liquors by exposing them in a state of minute division to the action of atmospheric air. It is stated that sulphuret of iron is held in solution in the above liquors by sulphuret of sodium, but if the sulphuret of sodium is converted into hyposulphite, or sulphite, or sulphate of soda, the sulphuret of iron is no longer soluble in such liquors. This is effected by pouring the liquors through a tower filled with small pieces of coke. The second improvement was in separating ferrocyanide of sodium from other compounds of soda contained in black-ash liquors, and also thereby obtaining salts of soda free, or nearly free, from such ferrocyanide. The mother liquors after crystallising out carbonate of soda, were further concentrated and crystallised. The ferrocyanide is washed from such salts by water, or by solution of carbonate of soda filtering through the same, until sufficiently free from the ferrocyanide to be suitable for the production of white soda ash of good quality. The washings are ultimately treated with caustic lime, and the ferrocyanide separated from the caustic soda by evaporation and crystallisation. Third, obtaining caustic soda from black-ash liquors by concentration, without the use of lime. The liquors are treated with a hypochlorite of lime solution to convert any hyposulphite into sulphite or sulphate, and concentrated until the whole, or nearly the whole, of the carbonate of soda and ferrocyanide of sodium are deposited as salts. The solution is caustic soda, and may be evaporated to obtain the solid hydrate. This is the first production, on a large scale, of solid caustic soda.

It was on the 3rd of April, 1854, that the first patent was taken out connected with the most successful industry which Mr. Gossage founded. It is as manufacturers of soap that the firm of William Gossage and Sons have become established in fame and fortune. From a very small beginning in 1855 the soap works has grown until it is the largest concern of the kind in the United Kingdom. The patent above referred to was "for improvements of certain kinds of soap, effected by introducing into soap soluble glass, prepared by mixing about nine parts of soda ash, containing fifty per cent. of real soda with eleven parts of clean sand, and melting the mixture in a reverberatory furnace with stirring, to obtain a combination of the sand and soda, when it is run out into moulds. When potash is used in place of soda, mixing about equal weights of dry carbonate of potash and clean sand, melting as before.

The solution of the soluble glass is effected by grinding this to powder and agitating this powder in a pan containing boiling water. The solution is concentrated for use. The viscous solution of soluble glass is applied to the manufacture of certain kinds of soap, by mixing such viscous solution with genuine soap (made from tallow, oil, resin, or other such material), and thereby producing compound soaps, possessing valuable detergent properties, independently of the genuine soap contained in such compound soaps." This first invention was followed up by others having a similar purport. It was in April, 1857, that the celebrated "mottled soap" was patented, which was made by introducing into genuine soap a quantity of solution of silicate of soda and colouring matter, boiling these together until the soap attained such a consistency that when it is put into vessels and allowed to cool slowly the mottling occurs, caused by a semi-crystallisation taking place. The excellent qualities of this mottled soap rapidly gained for it great popularity.

Having in their possession a thoroughly good article, the firm did not fail to make its qualities known by widespread advertisement. It was exhibited in London at the International Exhibition of 1862, and was one of the soaps that won a prize medal for "excellence in quality." Notwithstanding the great competition which has sprung up during the last few years, especially among soap manufacturers, and the excellent makes which are presented to the public, nothing has been found to supersede, in popular estimation, Gossage's mottled soap.

Up to this period, the story of Mr. Gossage's life had been the expenditure of time and money on experiments and inventions, many of which had proved most profitable to his competitors, but costly and exhaustive to himself; but it is satisfactory to record that the soap business was a turn in the wheel of fortune, and that his sons and those associated with them found themselves heirs, not only to a heritage of famous inventions and a name of renown in the chemical world, but also the possessors of a property capable of great development and extension. At the time of the Jubilee Exhibition at Manchester in 1887, it was stated that since 1862, over 200,000 tons of Gossage's mottled soap had been made. The patent of November 17th, 1857, claims improvements in the manufacture of hard soaps by causing soda soap, made from mixtures of strong materials with weak materials, whilst in a state of soft curd to become mixed or combined with silicate of soda. Strong materials are tallow or palm oil, and weak materials are bone-grease, oleine, resin or cocoa-nut oil. Soft curd soap is made by boiling the materials, tallow or palm oil, etc., with resin; when the materials are saponified and the lyes separated by depositions from the soap, the lyes are withdrawn and a certain quantity of soda lyes of a certain gravity added, and the whole boiled so as to saturate the materials employed with alkali. After continuing the boiling, water is added sufficient to bring the mixture to a close state, when a strong solution of common salt is added until the soap again separates from the lye, and assumes the condition of soft, and silicate of soda is afterwards mixed therewith. The soluble alkalies were not merely confined to the manufacture of soap. One process for the production of caustic soda was to boil a solution of soluble glass with caustic lime, so as to produce silicate of lime and caustic soda. The silicate of lime thus formed was found to have a peculiar value as a manure. Other uses to which "liquid flint," as those soluble alkaline silicates are sometimes termed, was applied, are to render impermeable to water, bricks, stone, wood, paper hangings, and distemper colouring, also to produce waterproof fabrics.

The last great effort to which Mr. Gossage applied himself was to obtain the alkaline silicates by passing the vapours of the chlorides into a tower or stack filled with flints, which were heated to an intense heat. When the volatilised chlorides came in contact with the glowing flints, they were decomposed, silicate of soda or potash was formed, and hydrochloric acid was evolved. The apparatus resembled a small blast furnace, at the base of which were three or four gas producers, such as Siemens applied to his gas furnaces. The gases were ignited just before entering the tower; they passed over a bed of chloride of sodium, which, by the intense heat of the flame, was volatilised; the gases of combustion and the chloride vapours passed up into the shaft filled with flints. These were heated to a white heat, and silicate of sodium was formed, which ran down as molten glass. The obstacles that were encountered were very serious. It was difficult to obtain a sufficiently high temperature, the heat of the tower was not constant, the draught was interrupted, and the process arrested by the melting silicates stopping up the interstices between the flints, and the vapours acted upon the siliceous lining of the furnace. "I am afraid this last baby will not get over its teething," Mr. Gossage once remarked, as he was discussing the difficulties he was combating with. He felt he was beginning to experience the failing of his physical energies, for he added, "I would nurse it through if I were only twenty years younger," but that could not be. He had to leave to others what in his younger days he would have carried through himself, and he found no one who shared his sanguine hopes and indomitable perseverance, and he was reluctantly compelled to abandon this his last serious undertaking. This patent bears the date of July 18th, 1862—he would at this time be sixty-three years of age. It was time he should seek the rest and retirement that he had so deservedly earned, and wear in peace the laurels he had won.

Only one more invention was patented, and that "'a babbled of green fields." It was taken out in the following year, and the purport of it was to enable the farmer to overcome the uncertain conditions of an English summer, and secure his hay in good condition whatever the weather might be. Along the base of a hay-rick formed underneath a shed, flues or pipes were laid; these were connected with a fan or blower which forced hot air along them and up through the rick, which was built of uncured grass; by this means the moisture was driven out and the hay was "made." This invention was successfully applied by his neighbour, Mr. Robert Neilson, of Hale-wood—but we never heard of it being adopted by anyone else. The English farmer is one of the slowest creatures to adopt any innovation, however great an improvement it may be.

The manufacture of sulphuric acid, and the best way of working the chambers, had not escaped his careful ingenuity. There are several patents for which he specified improvements in the manufacture of sulphuric acid and the construction of apparatus used therein. He appears to have had a confirmed opinion that vertical chambers were superior to horizontal ones, and he proposed that from the roof of the chamber there should descend showers of liquid sulphuric acid which should assist in condensing the gases contained in the chamber. It was during the Christmas of 1856, that his mind was busy with this subject; he patents one invention on the 16th December, 1856, and a second on the 17th January, 1857. In this latter he specifies what closely resembles the operations both of the Glover and Gay-Lussac towers; for he claims the production of a supply of concentrated sulphuric acid, by causing hot sulphurous acid gas produced from ordinary sulphur burners or pyrites kilns to pass through a tower containing coke or other suitable material, through which tower sulphuric acid is also caused to pass in such a manner as to be exposed to the evaporative action of such hot sulphurous acid gas. Also the application in the manufacture of sulphuric acid of the concentrated sulphuric acid obtained by the action of hot sulphurous acid gas, for the purpose of absorbing nitrous gas or nitrous acid. The patent also specified the apparatus needed in both these operations.

As far back as August, 1855, we find him operating with the carbonate of ammonia; his invention specifies methods of forming the carbonate, and the apparatus he contrived, and also the uses to which the carbonate of ammonia so prepared should be applied, one of these was no other than the ammonia-soda process. He used the bicarbonate of ammonia which he prepared to decompose common salt, producing bicarbonate of soda and sal-ammoniac.

It seems as if his ingenuity and unwearying industry had overlooked none of the many problems which the manufacture of alkali has presented for solution. Occasionally his attention has been attracted to subjects somewhat outside his immediate business; and he tried to devise an improved method in the smelting of iron and steel, and to make coal gas a better illuminant than he found it.

In this sketch, the career of William Gossage has been traced, exhibiting him as an inventor whose services to the world in the realm of practical chemistry have rarely if ever been surpassed. His knowledge was so correct, his experiments so accurate, his researches so thorough, that those who follow him find how truly he has indicated the work that needed doing, and the best way of doing it. The labours which year after year he undertook, were not expended on problems of mere scientific interest which had no vital connection with the advancement of society and human progress. Few trades can compare with the alkali trade for the great benefits which it has conferred on society; it has utilised our natural resources, our sulphur, salt, limestone, sand and coal; it has afforded occupation to the man of science, the man of business, the mechanic and the labourer: it has given to the people, at lowest cost, glass, and soap, and paper, these articles which we now regard as the very essentials of all civilised life. It was in the promotion of this beneficent trade that Gossage's life was spent.

We have followed the path of William Gossage through Burgh-in-the-Marsh, Chesterfield, Birmingham, Stoke Prior, Swansea, and Widnes, places which now derive an interest from their connection with his memory. He married as a young man, when he was resident at Leamington, and his son is to-day his successor in the business which he founded; but his home and private life we have not sought to touch, our duty has been to try and faithfully record the steps of his career as an inventor, whose inventions have been of incalculable benefit and value. As a master amongst his workmen he was respected, in society his manner was courteous and refined, he was gifted with keen powers of satire and of sarcasm, he was appreciative of the services of others, and sought to promote the education and improvement of those around him; his ambition appears to have been to have dominion over the forces of nature, rather than the acquisition of wealth, or personal aggrandisement and popularity. In the study of his work, succeeding generations will discover how much he achieved for them, how deserving of preservation is the record of his inventions and the story of his life, and how these may still serve as an example that shall long be a stimulus and an encouragement to others. He died at Bowdon, in Cheshire, on the 9th of April, 1877, and his last resting-place is in Smithdown Lane Cemetery, Liverpool.

JOSIAS CHRISTOPHER
GAMBLE.

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During the last half century no name has been more constantly prominent amongst the public men of St. Helens than that of Gamble. Six times it has been associated with the mayoralty of the borough, five in the person of Colonel Gamble, and once in that of his eldest son; and in the present year his son-in-law bears the honours of that position.

When, in the year 1868, St. Helens was incorporated, Colonel Gamble was chosen its first mayor, as for nearly a quarter of a century before that time he had, with indefatigable zeal, given his services to the town as a member of the Board of Commissioners; indeed, he was one of those who were instrumental in obtaining the first Local Improvement Act.

Very few towns in England have attained a position, in connection with the Volunteer movement, so distinguished as St. Helens, and this success is very largely owing to the support which Colonel Gamble gave to it from its inception in 1860. He was one of the most active members of the General Committee, which raised the funds for its first establishment, and which included all the leading men of the district. He was chosen Captain of the first company that was enrolled, and as the regiment grew in strength and thereby became successively entitled to a Major and to a Lieutenant-Colonel, he was promoted to those ranks. By his generosity the excellent drill-hall and parade-ground were provided, and during the seven-and-twenty years that he was commanding officer of the battalion its organisation was perfect. The 47th Lancashire was distinguished for the soldierly bearing of its members on parade, for the admirable commissariat arrangements which drew official notice when a review was held at a distance from home, and in musketry it won not only the highest honours in its county competitions, but also carried off, in the great national contests at Wimbledon, numerous and valuable prizes, on one occasion bearing away the blue ribbon of victory, the Queen's Prize. In yachting circles, too, for many years Colonel Gamble has been a familiar figure, having been

THE LATE SIR DAVID GAMBLE, BART., K.C.B.

Commodore of the Royal Mersey Yacht Club for the past ten years. Having always resided almost within the precincts of the town, he has taken a constant and intimate interest in all its concerns, not merely discharging public duties, but also filling a social position, and thus assisting to arrest the wretched deterioration which too often takes place in the towns devoted to manufacturing industries, especially when the processes are noxious, polluting the atmosphere and destroying the vegetation.

The bane of such places is, that the swarming population of the labouring classes is left comparatively uncared for by its employers, who go to reside in more agreeable neighbourhoods, or who are only members of public companies, and who justifiy their gross neglect of such duties by asserting that boards of directors have no right to be the dispenser of charity, and that their servants must not give their time or attention to public affairs.

The lamentable consequence of this vicious system is that such towns lack efficient local government, and are not provided with those institutions and social arrangements which are essential to health, morality, and civilisation.

Matthew Arnold once designated such towns as "perfect hell-holes."

Colonel Gamble built his residence close to the town, and within an easy walk of his works; the scene of his labours has been constantly before him, and he has been keenly alive to the needs of the district; he has associated himself with every local movement, has spent his wealth amongst those who, to some extent, have contributed to its acquisition, and he has made a local residence at least bearable, if not attractive. It is not to be wondered at that his fellow-townsmen have been anxious to record their grateful appreciation of his services, or that they rejoiced in the public honours which have been awarded him. The local influence and the social position of the Gamble family to-day has not been reached by any royal road, it is the result of sixty years of patient plodding industry, and of great care and thrift. The extensive works of Gerard's Bridge and Hardshaw Brook are the results of slow and cautious development, not that there has been any lack of enterprise or disregard of the progress of invention; on the contrary, it was at Gerard's Bridge that the Weldon invention was wrought out, and every discovery in the manufacture of chemicals has been carefully noted, but no step forward has been rashly taken, the record of this successful business is that it has been slow but sure. Its founder was Josias Christopher Gamble, who was born in the year 1776, at a farm called Graan, near Enniskillen. The Gambles were an Ayrshire family, but were driven from Scotland, and took refuge in Ireland, "when King James the Sixth thrust prelacy upon the Scots." They were staunch and steadfast Presbyterians, and chose to suffer exile for conscience' sake. The almost universal ambition of Scottish parents is to see one of their sons a scholar and a minister, and this was the lot of Josias Christopher Gamble. He was sent, not to an Irish university, but to Glasgow, where he studied and graduated, taking his degree of M.A. in 1797.

In December, 1799, he was ordained minister of the Presbyterian Kirk in Enniskillen, and he continued to be the pastor of that congregation for over four years, until February, 1804.

On leaving Enniskillen he accepted a "call" to a church at Belfast.

In the present day, missionaries, before proceeding to their fields of labour, frequently pass through a short course of training in surgery and medicine, and no small portion of their ministry is devoted to attending to the bodies as well as to the souls of men; they commend their gospel as being a message from "The Merciful One," who "healeth diseases" as well as "pardoneth iniquities;" so in the end of the last century it was customary for theological students who were being trained for the Irish Presbyterian Church to attend a course of medical lectures. One of the classes that Gamble attended at Glasgow University was presided over by Dr. Cleghorn, professor of chemistry. The student in theology was so stirred by the enthusiasm and eloquence of his teacher, and so fascinated by his studies in natural science, that he would pass his long vacations in the prosecution of these studies and in making chemical experiments. His friends did not at all admire the turn his tasks had taken; we fancy that in the fumes he had created, they must have detected heresy. Gamble's researches, however, were not those of a philosophical dreamer, he was practical in his pursuits. The farmers of the neighbourhood in which he lived grew flax upon their lands, and their families prepared and spun it. Gamble utilised the knowledge he had acquired in his studies, and sought to prepare solutions of chlorine, to bleach the linen which was manufactured by the hand-loom weavers.

William Gossage used to say that the success of the Gambles was to some extent to be attributed to their persistent and systematic efforts to use up every by-product, and Josias Christopher Gamble, even in his earliest operations in preparing bleaching solution, did not overlook the importance of preventing any waste: he used to work up the residue left from producing chlorine into Glauber's salts. These experiments afforded Gamble indications and suggestions of the great commercial value of chemical processes, and a vision of a Land of Promise opened out before him, in a lucrative and beneficent industry, so that during his pastorate at Belfast he decided to resign his charge, and follow the bent of his mind, and, without wholly abandoning his sacred calling, to devote himself to the manufacture of chemicals as a means of livelihood. After he had given up his church, and had established himself in business in Dublin, he used occasionally to officiate in the Strand-street Church in that city.

The process of the manufacture of bleaching powder by the absorption of chlorine by slacked lime was patented by Charles Tennant, grandfather of the present Sir Charles, in 1809, and Gamble decided to erect a small plant in County Monaghan to work the process which Tennant had patented on the other side of the Channel. How primitive the plant was, may be judged from the fact that his bleaching powder chambers consisted of half casks inverted over a thin layer of slacked lime; he had no sulphur ovens or vitriol chambers, but the sulphuric acid he obtained from Tennants, of Glasgow.

Before the year 1815 the Monaghan works were abandoned for more suitable premises, which Gamble built on the banks of the Liffey, just below Island Bridge and above Dublin, on land which he purchased from Sir William Worthington, a Dublin merchant. He lived in the house and had extensive garden and grounds; these adjoined the works. This property is at the present day occupied by Mr. James Daly. Here he began to make his own sulphuric acid, instead of getting it from St. Rollox; he claimed to be the first manufacturer who introduced into the United Kingdom what was known as the French plan of working vitriol chambers, that was with a constant draught through them. When his plant was being altered to this plan, his anxiety to retain the secret of the arrangement, induced him with his own hands and during the night to do the necessary plumbing work himself. The articles he manufactured were Sulphuric Acid, Bleaching Powder, Alum, and Glauber's Salts, the last of which he continued to make up from the chlorine residues. The Alum he made from pipe-clay, which he imported from Poole, and potash, obtained from what was known as sulphur ashes. These sulphur ashes were the residues left in the brimstone burners or ovens, into which brimstone, mixed with nitrate of potash, used to be cast; this work was done by small boys, who with iron spoons kept regularly throwing in the charge.

The process for the manufacture of Glauber's Salts from the residues of the chlorine stills, though little mentioned in chemical books, was carried out on an extensive scale nearly down to the year 1840, about which date Messrs. Thos. Bell & Son, of Newcastle-on-Tyne, prepared sulphate of soda for the alkali manufacture by this process. We believe they found it necessary to suspend the process during the summer, as the conversion of sulphate of manganese into sulphate of soda did not take place except at a winter temperature. When Mr. Gamble was manufacturing chemicals in Ireland, both his raw products of what is now called the soda manufacture, viz :—brimstone, and common salt, were subject to heavy duties. A drawback on the brimstone consumed, was refunded upon the affidavit of the manufacturer, but the excisemen attended the chlorine stills as carefully as they did the stills for making spirits, and saw the salt weighed in and gave a certificate for a return of the duty. It would thus seem that the chemical manufacturer was not subject to the duty on salt, but there were other inconveniences, for it was found the duty-paid salt lost far more by so-called drainage on its voyage from Northwich to Dublin, than it did afterwards when no duty had been paid upon it. In the former case it was worth stealing, and in the latter the temptation was not so great.

At the age of forty-four, during the time that he was in business in Dublin, Gamble married Hannah Gower, the daughter of a

Sir J. CHRISTOPHER GAMBLE, Bart.

Dublin solicitor, to whom were born one son and three daughters; the daughters are all deceased, one died in Dublin, the other two in St. Helens. Mrs. Gamble only survived her husband five years, and on the 16th December, 1852, died at the residence of her brother, John Gower, of Roundwood Park, County Wicklow.

During Gamble's residence in Dublin he was acquainted with James Muspratt, who had, in partnership with a Mr. Abbot, also commenced the manufacture of chemicals in that city. In 1822, Muspratt, having perceived that Dublin was less favourably situated for his business than Lancashire, left Ireland and came to England. In the year that the Salt Tax was repealed, 1823, he started his works in Liverpool; five years afterwards, Gamble also came to England, leaving Dublin and coming to reside in Liverpool in the year 1828. Several months elapsed before he could make up his mind as to which was the best locality and site for an alkali works; for a time he was inclined to select a plot of land at the head of the Birkenhead Float, where a copper ore yard in now situated; his idea was that the brine should be conveyed thither by pipes from

Northwich, a scheme similar to that which the Mersey Salt and Brine Company carried out nearly fifty years afterwards, when they established their works at Runcorn. After months of search and consideration, he decided to come to St. Helens, and in this enterprise he was joined by James Muspratt. They erected their works on the banks of the St. Helens Canal, close to the double locks, on the spot which is now occupied by the Globe Alkali Company's works. Gamble was seventeen years Muspratt's senior; they were both men of strong wills; their partnership only lasted two years. Muspratt, in the year 1830, commenced his Newton works, and Gamble remained in sole possession of the St. Helens property, carrying on his operations for five years without any partner. In 1835 a works situated near to his own came into the market; it consisted of five sulphuric acid chambers, two of which had never been worked, and a plant for making alum from the blue clay called "warrant," which was obtained from the coal-pits. These works were erected about the year 1830 by Edward Rawlinson, a blind solicitor from the north of Lancashire; they were managed by a Mr. Williams, who, it is believed, was his brother-in-law. The business was a failure. A bankrupt chemical concern is invariably sold for very much less than its value; Gamble saw that a bargain was to be obtained, and he induced Joseph and James Crosfield, the soap-boilers, of Warrington, to join him in the purchase, which they completed on such terms that the works, after being stripped of the lead they contained, were held by them at a cost of about £400. The connection thus commenced led to the Crosfields becoming partners in Gamble's business in the year 1836, and in the following year Simon Crosfield, a younger brother, who was a tobacco manufacturer in Liverpool, also joined the firm, and undertook the commercial and financial management of the business. The title of the firm was Gamble & Crosfields.

Gamble and Muspratt ran a great risk when they established their works at St. Helens, for the district at that time was a picture of rich fertility. Farmsteads, with their gardens and orchards, came right up to the streets of the small country town, the valleys were watered by brooks that had "here and there a lusty trout, and here and there a grayling" in their clear waters;

game also was abundant; even after various works had begun to spring up, on wintry days, pheasants would venture to seek shelter from the blast in the warm sheds that glowed with the light of furnaces. On one occasion, about the year 1845, a stag pursued by Sir John Gerard's hounds scampered into Gamble's works, and crashed into a pile of disused carboys. The chimneys of colliery engine-houses, and cones of glass-works rose amidst farm buildings and stacks of hay and corn. Cornfields, luxuriant hedgerows, and healthy though always stunted timber, for the soil was not congenial to its growth, adorned the landscape. Families that constituted the society of that day, had their comfortable halls, or commodious and well-built residences, with ample and highly-cutivated gardens.

The names of Greenall, Cross, Caldwell, Fildes, Speakman, Orrell, Robinson, Watson, Pilkington, Gaskell, Casey, Daglish, Bromilow, Keates, West, Fincham, Cotham, Morley, the three Johnsons, Grundy, Eckersley, Haddock, and others will recall many memories of those days; a vivid picture presents itself of the pleasant social life of which St. Helens was the scene, and many a tale is told of the "marlocks" of the men who were then young, and of the convivial gatherings of their fathers.

The Plate, Crown, Flint and Bottle Glass trades were all established in St. Helens when Gamble settled there, and the Crown makers soon after began to use sulphate of soda; the colliery proprietors welcomed a new trade which promised to increase very largely the demand for fuel; these interests lessened the opposition which would otherwise have been fatal to a manufacture which was associated with serious injury to vegetation, and which was suspected of being injurious to health. From the agricultural interest, the pioneers of alkali making encountered bitter opposition. The lawsuits brought against Muspratt by the Corporation of Liverpool and the landowners of Newton are historical; at St. Helens, Gamble, Crosfield, Clough, Darcey, Kurtz, and Morley only avoided the harass of ceaseless and ruinous litigation by the liberal payment of compensation. That the acid vapours emitted from the works did very great damage was unquestionable, when we consider that the whole 100 per cent. of the Muriatic Acid produced from the salt was then emitted from the chimneys, while now the emission of 2½ per cent., or one-fortieth of the quantity then emitted, would cause the stoppage of any works by the interference of the Alkali Inspector. But to make a fair and just assessment of the amount of injury was no easy matter, and it is to be feared that frequently the manufacturers were subjected to extravagant and exorbitant demands, and that the loudest and least reasonable of the claimants often obtained the lion's share of the plunder. Some farmers found that harassing the chemical manufacturers paid them much better than farming well. Doubtless Gamble and Muspratt under-rated the risks they were running, and magnified the advantages of cheap fuel, ready transit, a good market, and abundant supplies of water, with convenient drainage.

How to condense the noxious and destructive gases, and take away the terrible tax which was being imposed upon them by the farmers, was a question of the first importance; and, in the year 1836, William Gossage conferred an incalculable benefit on the alkali trade by the invention of his condensing towers. Gossage also patented one of his processes for the recovery of the sulphur from vat-waste, involving the using up the weak hydrochloric acid which was obtained, and which being produced from the open reverberatory furnace was too dilute to be employed in the decomposition of manganese in the production of chlorine. Gossage's plan was to place the green waste in layers on shelves in wooden stills, to run the weak muriatic acid over it, so causing sulphuretted hydrogen and carbonic acid to be given off, these mixed gases were passed through a further quantity of the waste placed on perforated shelves, such as are used in gas purifiers, and a further quantity of sulphuretted hydrogen was given off by the action of the carbonic acid. The sulphuretted hydrogen evolved in these operations was burnt with an excess of air in an oven covered with a perforated arch, on which was placed a layer, several feet in depth, of broken bricks, and through these the sulphurous acid was passed into the ordinary vitriol chambers.

Joseph Crosfield, dismayed by the demands made upon their firm for damage to trees, hedges, and crops, insisted on the immediate adoption of Gossage's patents; to this Gamble was strongly opposed, as he believed some plans he had himself conceived, would supersede Gossage's inventions. Crosfield, however, was so impressed with the urgency of the situation, and the value of Gossage's work, that on his own responsibility, and in defiance to his partner's wishes, he concluded an agreement with Gossage to erect the necessary plant for them, and put his process into operation. Gamble was very indignant at his wishes being disregarded, and at a contract being made without his consent; a quarrel ensued between the partners, which was so serious, that Joseph Crosfield never put his foot inside the works again. Notwithstanding this, the new process was brought into operation, but the use of it was discontinued about a couple of years afterwards.

Simon Crosfield avoided being drawn into the dispute, and was always on the most friendly terms with Gamble, but the differences between the partners ended in a dissolution of the partnership in 1845, some years prior to which date Gamble had acquired the sole interest in the alum works at Gerard's Bridge. At these works he first had as a partner a Mr. Marsden, the firm being known as Gamble and Marsden, but in a few years it underwent changes, first to Jos. C. Gamble

THE LATE WILLIAM GAMBLE.

and Son, then to Gamble, Son, and Sinclair, and then back to Jos. C. Gamble and Son, which it has retained till the present day, when it consists of Colonel Gamble, in partnership with his four sons, Josias, William, David and George.

The patent which Mr. Gamble took out in 1839, and which he first put into operation at Gerard's Bridge Works, claimed :—

First, iron retorts worked in connection with each other. Two decomposing furnaces are connected with a roasting furnace.

Second, the iron retorts constantly worked through a door, open or partly open while the process is going forward, the draught of the chimney drawing in a portion of the external air with the muriatic acid into the receivers. This claim was disclaimed in January, 1845, on the ground that the words have a doubtful meaning.

Third, the use of receivers so arranged that the acid can pass from one to the other or can be cut off at pleasure when strong acid is required ; these are filled with glass or pebbles.

Fourth, the use of earthen stills with

leaden heads, incased in iron heated by the circulation of hot water, saline solutions, or by steam.

Fifth, the mode of alternate charging of the lime receivers, by which lime already in part saturated with chlorine, is exposed to the strongest gas, and the remnant of gas is absorbed by a surface of fresh lime.

From this patent dated the introduction of the use of the "iron pot" in the decomposition of salt, which, with various modifications, has been continued up to the present day. But some manufacturers, though they adopted the apparatus so patented, maintained that its principle was not patentable, and after protracted litigation succeeded in releasing themselves from any legal liability to pay Gamble royalty for his invention, but Messrs, Tennants, of Glasgow, who produced probably three-fourths of all the bleaching powder then made in the United Kingdom, and who had bought Gamble's patent rights for the whole of Scotland, declined to avail themselves of this decision, and continued their annual payment for the whole term of 14 years, for which the patent was granted. Up to the time they bought Gamble's Scotch patent the Tennants worked the old method of making chlorine from salt, manganese, and sulphuric acid.

Advancing years and declining health told upon Gamble, and in the year 1841 he was compelled to obtain assistance in the superintendence of the works of Gamble and Crosfields. He selected James Shanks, a Scotch engineer, who was born at Johnstone, near Glasgow, and whom Gossage had brought to Lancashire to erect and superintend the plant of his various patent processes. James Shanks proved himself a most capable man, and when in the year 1845 the partnership between Gamble and the Crosfields was dissolved, the Crosfields retaining the business, James Shanks was made a partner in the new firm of Crosfield Bros. and Co., his department being the practical management of the works, whilst Simon Crosfield continued to direct its financial affairs. Shanks continued to be a partner as long as he lived, and his energetic and careful management largely contributed to the repute and success of his firm; not until some time after Shanks's death, and after the retirement of Mr. John Brock, whom he had trained, did Crosfield Bros. and Co. disappear from amongst the chemical manufacturers of Lancashire.

On the 4th December, 1844, Gamble took out a patent to utilise the heat generated in pyrites burners, his idea being to apply it to the concentration of sulphuric acid by passing the hot gas under leaden pans. It is curious that Andreas Kurtz applied for a patent for a similar purpose, passing the heat over instead of under the pans.

After the final separation from the Crosfields had taken place, Josias Christopher Gamble, on account of declining health, took the world very quietly, visiting his works at Gerard's Bridge two or three times a week, often not getting off his pony during these visits. He suffered from chronic bronchitis, and the acid gases inseparable from an alkali works were not bearable by him; his health was permanently impaired, and the anxiety which his lawsuits entailed told upon him very heavily, indeed, it may be said that the final struggle with Andreas Kurtz killed both these enterprising and energetic pioneers of the alkali trade. Both these men had to encounter difficulties of which the present generation has no conception, their business had raised up a host of enemies among the farmers who would have annihilated them if they could, trained and capable assistants were not to be obtained, the master had to train his men in every grade of service, new inventions multiplied themselves, and competitive jealousies brought about lamentable and destructive struggles for supremacy.

Gamble did not take opposition lightly; indolence, stupidity, and neglect irritated him intensely, he threw himself heart and soul into his work, and he expected others to do the same.

The striking feature in the life of Josias Christopher Gamble is the contrast which his career presents to that of manufacturers in the present day. They start after having received a good scientific training in their youth. Technology then was an unknown science, now a competent technologist means a man who has a fair all-round knowledge of natural science, knowing something of geology, mineralogy, and even botany. He must be a fair mechanic, and he must be a good chemist; in addition to this, he must be able to read with ease scientific works in French and German, but in Gamble's early days no such instruction could be obtained, the manufacturer had but a smattering knowledge of the science of his subject, he had to tread an untrodden path and feel his way in dim uncertainty.

Another point of contrast is the facility with which in these days any apparatus, however novel or complicated, can be obtained. No matter what process is devised, that suitable appliances cannot promptly be manufactured is never suggested; pressure, temperature, or chemical action present no difficulties, the chemical engineer is ready at once to make the way plain, but in Gamble's days he had to be his own chemist, engineer, and architect. He had to discover the nature of his reactions, to devise his tests, to conceive his plans, to design their construction; he had no trained draughtsman to whom he could entrust his plans, he had to do all this himself.

The difficulties which he encountered may be illustrated by the way in which he had to make his chlorine stills. They were of earthenware, in them was placed the ground manganese with the acid, the charge was kept continually agitated by a mechanical appliance, and kept hot by the circulation of hot water. There were, however, no manufacturers of such vessels as Gamble required and he had to undertake their construction himself. They were made in the works, being built up like pots used in making glass, and it took six months to build and dry them before they could be burned. He first made vessels of 100 gallons, but afterwards he increased the size to 400 gallons. These earthenware stills were, of course, abandoned when unground manganese and live steam began to be used.

It was thus throughout his whole works, even to things so insignificant as thermometers and hydrometers, which he made himself in his own laboratory, being an expert with the blow pipe.

Not only had he to devise and construct all his plant and apparatus, he had also personally to instruct as well as superintend all his workmen in each department. He never employed the services of a chemist; if he wanted assistance he taught men himself what he required them to do.

Though Gamble loved his business he was never a slave to his work. He was a great reader, both of scientific works connected with his business and of the current literature of the day. He learned French after he was married, probably with the assistance of his wife, and could read French scientific works with sufficient facility. Though his family never heard him speak French he made his way in France when little of the English language was understood in French hotels.

Gamble, when he first came to St. Helens, resided in an old house in Duke Street; he then took a farm and lived for several years in the farmhouse on the property which belonged to Sarah Cowley's estate, and extended from Raven Street to Pocket Nook. The homestead faced Bishop's Bridge; the farm is now covered by the Railway Station and Chemical Works, &c.

In the year 1839 he removed to Sutton House, and resided there to the close of his life.

He died at his residence on the 27th January, 1848, three weeks after the birth of his first grandson, and was buried in the vault in which his two daughters had been interred in the Independent Chapel, St. Helens.

Sutton House is now converted into the Cottage Hospital.

Gamble's personal appearance was as remarkable as his character was original. He habitually wore black broadcloth and a white cravat, and his hat had a brim almost broad enough for a Quaker. The black cloth of his clothes was often besprinkled with acid, showing numerous red spots.

Although descended from a family who were adherents of the old-fashioned Toryism of Ulster, he very early displayed pronounced Liberal opinions, and was probably a member of the body of United Irishmen; indeed, it is said that when the agitation burst out, he hid in his house some of the prominent leaders of that party.

He remained a steadfast and decided Liberal, and was a strong Free Trader, and a liberal supporter of the Anti-Corn Law League. He was an advanced Financial Reformer; he advocated the abolition of all Customs Duties; and, indeed, of all indirect taxation, so much so, that he would have applied the Income Tax to all incomes, even as low as twenty shillings per week, and have abolished all other taxes.

The presentment we have of him is not that of an enthusiastic theorist or an ingenious inventor, not that of a man whc would spend days and nights in experimental research, but of one who was eminently practical, who sought to turn to useful and profitable account the knowledge he had acquired.

His university training did not unfit him for the concerns of manufactures and of commerce, and the benefits which his successors are conferring on the town in which he found his home, would indicate that the deep impressions of the work with which his own life opened are still being perpetuated in the characters and labours of his descendants.

The business was formed by courageous enterprise and self-reliance, was conducted in the face of difficulties and opposition which called forth great endurance and perseverance, and has been established, built up, and extended by unwearying industry and vigilant attention. On the qualities which the story reveals are founded the securities of permanent and increasing prosperity, and the benefits of individual success are ever enhanced when they are associated with devotion to the public weal.

JAMES MUSPRATT.

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Romance, adventure, and enterprise are comprised in the career of James Muspratt, who was the father of the alkali trade in this country. Losh had preceded him on the Tyne in 1814, and in 1816 Tennant had settled at St. Rollox, on the Clyde; however their operations were very limited, and Muspratt was the first to establish a soda works to carry out the Leblanc process on a large scale.

He was born in Dublin on the 12th August, 1793; his father was an Englishman, whose brother was a director of the East India Company; his mother, who was a remarkable woman of fine character and culture, was a Miss Mainwaring, one of the Cheshire family of that name. They resided in Dublin, and to a commercial school in that city sent their son.

We picture the boy amongst his playmates, a strong broad-shouldered lad, one with whom one would not lightly choose to provoke a quarrel, or encounter in a scuffle. His features were even more noticeable than his form; he had a high broad brow, eyes well set and full of fire, large aquiline nose, and massive chin; it was a head indicating dogged determination, strong will, and quick, powerful intellect. In the classes, he made his mark, excelling his companions in their studies, and winning prizes in many subjects. In these days scholarships and exhibitions would have fallen to his lot, and probably a distinguished university career; but in those days, the boy of promise was early sent to engage in the battle of life, and at fourteen years of age he was taken from school and apprenticed to a Mr. Mitcheltree, a wholesale chemist and druggist, in Dublin, with whom he remained between three and four years.

A chemist's laboratory would have many attractions for such a lad. Chemistry at that period retained much that still appealed to the imagination; it was not wholly divested of the mysterious and magical. The spirit of the old alchemist continued to move amongst its retorts and stills, its furnaces and phials. Experiments were made with the crudest apparatus, and there were no text books, that enabled it to be studied as an exact science.

The youth rejoiced to devote what time he could spare to the study of such books as the Dictionary of Chemistry, by Nicholson, and a translation of the works of Guyton de Morveau, and also to the making of experiments.

In the year 1810 he had the calamity to lose his father, and in the succeeding year his mother died. She had excited in him devoted love and veneration, and to his latest day her memory was sacred to him. Just before his father's death the young apprentice had for some cause quarrelled with his master, and was at home unoccupied when he lost his mother. An orphan, his heart heavy with grief, and his prospects darkened, the slight inheritance left him by his parents wasting away in Chancery proceedings, he was attracted by the excitement of a warrior's life, and determined to seek a career in the army. All Europe was at this time watching the exploits of Wellington and Napoleon in the Peninsula, and to this strife of heroes, James Muspratt, full of strength and valour, went.

The cavalry of England had won much glory in these campaigns, and he was determined in it to obtain a cornetcy. But commissions in mounted regiments were retained for those favoured in high quarters, and Muspratt was only able to obtain the offer of a commission in the infantry. This he scorned to accept, but still attracted by military and camp life, he followed in the wake of the troops.

Two or three days after the 22nd July (1812) he visited the bloody but glorious field of Salamanca—and during the next month or two was with his countrymen in Madrid. Wellington received the acclaims of the Madrileños on the 12th August, on his triumphant entry into the capital. General Hill, to whose keeping he handed over the city, was compelled to retreat ten weeks later, and during that time the fever, which had hovered around the pathway of the armies and their halting grounds, seized on young Muspratt. He received scarcely any care, or attention of any sort, and had he not had a splendid constitution he must have succumbed to the disease.

Before he had risen from his sick bed the city was full of tumult at the rapid approach of the French forces in overwhelming numbers, and a hurried retreat had to be made down the valley of the Tagus west-ward. Weak as he was he determined not to fall a prisoner into the enemy's hands, and set out to follow the English, who had abandoned the city. It was then he accomplished the remarkable feat of walking 100 miles in two days, and made his way to Lisbon. His diary contains graphic accounts of the great hardships which he underwent; the history of that campaign relates how wretched was the state of the country, and how great were the sufferings of the troops and the inhabitants from hunger and sickness. Muspratt would gladly have got back again to his own country. and he hoped that at Lisbon he would find a vessel that would convey him home; but in this he was disappointed. Although his warlike longings had failed to be satisfied in the army, he succeeded in securing an appointment as midshipman in the navy, and in his ship, the "Impetueux," he took part in the blockade of Brest, and was engaged in the chase of the United States frigate, the "Constitution," the ship that vanquished the "Guerrière" in one of those celebrated naval duels.

He was promoted to the rank of second officer in a smaller craft than the "Impetueux"; but the stern discipline and irksomeness of his post, accompanied, as was too often the case, with insult and humiliation, was intolerable to him, and he determined to desert. A comrade joined him in this resolve, which they carried out one dark night when the vessel lay in the Mumbles roadstead, off Swansea. The boatman who rowed them ashore only performed his perilous task under the terror of threats, that if he did not do it they would throw him overboard. In this escapade these young fellows ran great risk of disgrace and death, for such would have been their fate had they failed. Not until the morning was their escape detected, and then pursuit was fruitless. The hard experiences through which he had passed had quenched the spirit for military adventure—his ideas, derived from songs and romances, had proved illusions that faded amidst the stern realities of life. As soon as he could he made his way back from Wales to Ireland. His affairs were still in Chancery, and for the termination of the suit he was compelled to wait; but little of the property that had been left him would come into his possession, the greater portion would have been wasted in its passage through the court.

His literary and artistic tastes drew him during this period of leisure into the society of authors and actors. A young man, about twenty-one, of a romantic and adventurous turn such as he had shown himself to be, would be filled with enthusiastic admiration of that star of unusual brilliancy which at that time attracted great attention in the dramatic world.

In the year 1791, at Drogheda, was born Eliza O'Neill. Her father was an indigent stage manager and actor. The pretty little child might often be seen running about the streets of the dirty town, barefooted. She was compelled before she reached her teens to appear upon the stage with her father, and when she was but twelve years of age she drew large houses, attracted by the charms of her acting. She was only a girl when she played the part of "Juliet," in Dublin, which excited the greatest enthusiasm, and by the time she was one and twenty, she inspired the line of a prologue—

"Then fair O'Neill ranks first on Britain's stage."

Lord William Lennox wrote:—"She was loveliness personified; her voice was the perfection of melody; her manner graceful, impassioned, irresistible. In Lady Macbeth, the Siddons was unrivalled; while O'Neill in her matchless representation of feminine tenderness as Juliet and Mrs. Haller, was faultless." Her character was one of singular modesty and gentleness, she "wore the white flower of a blameless life." She married in 1819, William Wrixen-Beecher, M.P. for Mallow, who succeeded to a baronetcy, and the poor little maid of Drogheda, became Lady Wrixen-Beecher.

James Muspratt came under the spell of her beauty and genius, and although only a young man, was honoured in being able to assist in bringing her before the fashionable Dublin circle. Probably it was at this time that he made the acquaintance of the youth who afterwards became his intimate friend, the humorous, pathetic, romantic, artistic, poetical Samuel Lover. The man to whom he was most drawn was James Sheridan Knowles, the celebrated dramatist, actor and scholar, whose gift of authorship dawned on him when a mere child, and who, when he was but fourteen years old, wrote the extremely popular ballad, "The Welsh Harper." He made his debût also on the boards of the

Crow Theatre. The intimacy of this friendship is seen in the fact that James Muspratt named two of his sons, James Sheridan, and Edmund Knowles, after him. These early friendships revealed traits of character and tastes which were strikingly developed in after years. James Muspratt loved literature, especially romance, poetry, and the drama; he highly appreciated the gifts of literary and scientific men, who found in him a worthy and congenial friend.

As soon as his small inheritance came into his hands he determined to use the knowledge which he had acquired during the years he spent with the Dublin apothecary. He began by manufacturing a few simple chemicals, one of which was hydrochloric acid, but in the course of a short time he was joined by a Mr. Abbott, who put some money into the business, and then they made prussiate of potash, for which there was a great demand. He would now be a young man of about five-and-twenty.

France had nurtured the sciences to a greater extent than any other European country, and towards the close of the last century it was the focus of genius: Lavoisier, Arago, Thénard, Berthollet, Vauguelin, and many others, had constituted a glorious constellation. The Académie des Sciences stimulated invention and discovery. In the year 1775 it offered a prize of 2,400 livres for the best practical and profitable process of producing soda from common salt. The alkali in common use was that obtained from kelp; it was seen that some method should be devised for obtaining a more plentiful and cheaper supply of alkali from the abundant salt of soda.

In the year 1753, at Issoudun, a town of some 10,000 inhabitants, about nineteen miles south of Orleans, where various manufactures were carried on, and where there was a college, was born Nicolas Leblanc. He was trained in an apothecary's shop, and having studied pharmacy, passed on to surgery. He must have been a man of considerable ability, for he was appointed surgeon to the Duke of Orleans, and he was the author of various scientific works. Incited to the research by the prize offered by the Académie, he devoted his attention to the treatment of common salt. Many others were also at work. A Benedictine Father, Malherbe, had his process of lixiviating the fused mixture of sulphate of soda, iron and charcoal, Guyton de Morveau and Carnay made their mixture of common salt and lime, and were so sanguine of their invention as to erect works at Croisac, in Picardy, in 1782. De la Métherie heated sulphate of soda and coal in close retorts; sulphurous acid was given off, which was condensed in leaden chambers. Athénas decomposed the salt with copperas, and decomposed the sulphate formed by employing Malherbe's method. Finally, in 1787, Nicolas Leblanc projected his process of decomposing common salt with oil of vitriol, condensing the muriatic acid in ammonia water: then after the sulphate had been well heated, it was mixed with half its weight of chalk and quarter its weight of charcoal, these were intimately ground together and heated in a crucible; then the contents were powdered and lixiviated; the soda evaporated and dried in hot air. The patent was obtained on the 25th September, 1791, and the works of "La Franciade" were built by Leblanc and Dizé at St. Denis—the Duke of Orleans having found the capital of 200,000 livres.

When the Duke was executed on the 6th November, 1793, the works were confiscated. Leblanc was not awarded the prize, for a special commission appointed to examine the various processes, considered those of Malherbe and Athénas the most likely to prove successful, but judged none of the competitors worthy of the reward.

On the death of his patron and the stoppage of his works Leblanc was thrown into most distressing poverty. For several years he struggled on, and in the year 1806, the works that had been confiscated were returned to him by the Emperor Napoleon; but the property was useless to him as he had no capital, and with the burden of years and sorrows pressing upon him, he had to seek refuge in the workhouse, where he died by his own hand.

This is the sad story of the life of the great inventor, whose discoveries have so largely contributed to the wealth and development of this country.

The year Leblanc died, works were established by Payen at Dieuze, to carry out his process, and twelve months afterwards, plate-glass made with soda instead of potash was exhibited by the S. Gobain Plate Glass Co.

As we have before stated, Losh had started a small work on the Tyne, and Tennant had made a beginning, *but only a* *beginning*, on the Clyde. Doubtless, Muspratt, as a young man full of activity, intelligence and enterprise, had made himself acquainted with what was going on. He and his partner were making money by their existing business, but could not afford to launch into new and expensive plant; still the process was being studied and watched, and when in the year 1823 the extravagant duty of £30 per ton was taken off salt, Muspratt saw the chance and seized it. He had in the previous year (1822) separated from his partner, and came to Liverpool. Mr. Abbott declined to accompany him. Mr. Muspratt perceived that the Mersey with its splendid port, its neighbouring coal fields, and its proximity to the salt district of Cheshire, presented advantages not excelled, if even equalled by the Tyne or the Clyde. He appeared to think that an old glass works on a site not altogether the most favourable, could advantageously be converted into a new Chemical works. He was determined to work the Leblanc process, but he did not possess the capital to begin at once to put up the plant for it; he had therefore to continue the manufacture of prussiate of potash, and devote the profits he made to erecting the necessary lead chambers for his sulphuric acid, and the other requisites of a complete soda works.

When he commenced the production of soda ash, he found the consumers of alkali so prejudiced in favour of potash, that it was no easy matter to sell his products. The soap-boilers had actually to have the soda given to them before they would use it, and even then he was compelled personally to watch and superintend the making of the soap. But when once the consumers got over their stupidity and ignorance, the demand for the new article far exceeded his powers for production: he rapidly enlarged his Liverpool works until the ground he had leased was wholly taken up, and there was no room for further extension. He therefore joined another countryman of his, an Irishman like himself, with whom he had become acquainted in Dublin, Mr. Josias Christopher Gamble, and they selected a piece of land at St. Helens, near Gerard's Bridge, where they erected a new works. This was in the year 1828.

A site on the canal side, adjacent to a colliery, and in the town in which the manufacture of glass had become established, with probably cheap land, good drainage, and a pleasant place of residence, may have been the principal reasons that caused St. Helens to be selected as the seat of the alkali trade by Muspratt and Gamble. They invaded a very prettily situated, nice little country town. It was the residence of several well-to-do families, who lived in substantial, comfortable homes, attached to their shops, or close to their business. Gardens and well-stocked orchards ran from street to street, the roads that led out from the town were lined with avenues of trees, and on all sides were rich farm lands, with well-cultivated hedges, and abundant timber. The streams that converged from Eccleston and Rainford, and ran down the Newton and Sankey valleys to the Mersey, were stocked with trout. If, when these founders of the industry that would so enrich this town, could, when they were selecting the site, have had a vision of the transformation they would initiate, they might have shrunk from the enterprise. There lay a smiling, peaceful valley, rich in fruits and flowers, and a rippling, crystal brook :—

> "And even while I drank the brook, and ate
> The goodly apples, all these things at once
> Fell into dust, and I was left alone
> And thirsting, in a land of sand and thorns."

The partnership between the compatriots only lasted a couple of years. Gamble remained at St. Helens and Muspratt took some land at Newton, close to the new railway between Liverpool and Manchester, and on the St. Helens canal. The only drawback to this site was, that it was in the very heart of an agricultural district. Newton and Winwick were well wooded and highly cultivated, and the lands belonged to rich and influential landowners. It was to continue working the Leblanc process that these works were first erected; but wherever salt was decomposed, the appliances for the condensation of the acids were so imperfect that large quantities of gas escaped, causing great destruction to the surrounding vegetation. Gossage had not yet invented his condensing towers.

Before leaving Dublin, in the year 1819, Muspratt married Miss Connor, by whom he had ten children; his four sons, James Sheridan, Richard, Frederic, and Edmund Knowles, he had educated to be chemists, and to succeed in the business.

About the year 1835 the fame of the young professor, Justus Liebig, was beginning to attract men of all nationalities to his lecture room and laboratory at Giessen.

Born in the town of Darmstadt in 1803, he early evinced extraordinary talent, especially in scientific pursuits; he went at fifteen years of age into the employ of a pharmaceutical chemist, and a year later to the University of Bonn, from thence, after three years' study, he was sent by the Grand Duke of Hessen-Darmstadt to Paris, where he remained two years, having as his contemporaries and companions Gay Lussac, Dumas, Pélouze, and other men of note. In 1824, when only 21 years old, he was appointed professor extraordinary of chemistry at Giessen.

In 1837 he attended the meeting of the British Association, at Liverpool, on which occasion the Council of the Association appointed him to draw up a report on organic chemistry. On his visit to Liverpool he would have met James Muspratt, whose works in the Vauxhall-road would have been one of the objects of great interest to the chemist. Liebig and Muspratt became intimate friends. Three of the sons were sent to study at the University of Giessen, and their father frequently made the little

Hessian town a place of residence. From the old Laboratory adjoining the Klinik, many eminent men have emerged; Hoffmann, Weiss, Fresenius, Lyon-Playfair, Gregory, Johnstone, Schorlemmer, are old Giessen students who have won high honour in their profession; and around Liebig were gathered professors, who alone would have given renown to their colleges. There was Hermann Kopp, the profound scholar, and ceaseless worker; the genial Will, the courtly Buff, Knapp, Ettling, and Dieffenbach, all men associated with the classes of Physical Science.

James Muspratt's son, Sheridan, was an earnest student, he became a translator of some of Liebig's works, also of Plattner's work on the blowpipe, but he is better known as the founder of the Liverpool College of Chemistry and the author of what was for a long time the standard work, "Muspratt's Dictionary of Chemistry." He is also remembered for his dramatic tastes and as the favoured lover and husband of the beautiful Susan Cushman, the accomplished actress. Two of the other sons spent some time first at Glasgow and afterwards at London under his friend Professor Graham who became Master of the Mint, and whom he had been instrumental in getting appointed to the chair of chemistry in University College, London, and where James Young, in later years so celebrated in connection with paraffin, was assistant.

Troubles gathered round the Leblanc soda manufacturers; Liverpool, St. Helens, and Newton rose against them, and they found themselves beset with legal proceedings. On James Muspratt the chief burden rested, for he was attacked by the Liverpool Corporation, and also by Mr. Leigh and other landowners and farmers at Newton.

From 1832 to 1850 his business was harassed by almost continuous and most expensive litigation, which finally resulted in his being compelled to close and abandon both his works. He had hoped that by the erection of very tall chimneys he could carry his fumes so far into the air that before they alighted on the earth they would be so diffused and diluted as to be no longer noxious and injurious. This certainly did to some extent mitigate the evil, especially in the immediate neighbourhood of the works; but at Newton it was found that, although the chimney was 400 feet high, in damp, heavy weather the gases condensed and fell, doing great mischief over a large area.

In 1836 Gossage brought out his coke tower condenser, and Muspratt was one of those to whom he specially commended it as the apparatus which was absolutely indispensable to him. Muspratt, however, was incredulous; he did not quite believe in the power of large moistened surfaces to condense the acids, he thought large quantities of water were necessary, and Gossage used to enjoy relating how he said: "Sure, all the waters of Ballyshannon itself, would not suffice to condense the acid I make."

Whilst his sons were in London, Hemming and Dyer were working at their ammonia process which was brought under the notice of James Muspratt, who requested Professor Graham to investigate it for him. Graham's report was favourable, but the following letter from James Muspratt to his son, shows how truly he estimated the mechanical difficulties, which neither James Young, nor William Gossage, nor Henry Deacon were able to surmount. There was no date to the letter, but it was probably written in 1837, the year before Hemming and Dyer took out their patents; he writes:—"I have received

E. K. MUSPRATT

Mr. Graham's and your letter containing a description of Messrs. Hemming's patent. *The only doubt I have of its success, is the difficulty of making apparatus on a large scale where there will not be much greater loss of ammonia than either five or ten per cent., but I have no doubt that this may be ultimately obviated*, but until I am acquainted with the apparatus, I cannot enter into it. You are aware that Mr. Gossage stated to me that £500 worth of apparatus would recover the sulphur from our waste, and about £5,000 now has been expended, and the tenth part of the sulphur is not yet recovered, though we are now nearly at full work; therefore until I have a plan of the intended apparatus, I cannot give an opinion of its feasibility." Further investigations must have been made, for Muspratt decided to erect the necessary plant, to give the process a fair trial; and that it should not fail for lack of ability in the superintendence of it, James Young, Professor Graham's talented assistant, was appointed to take charge of it. Two or three years were devoted to it, but it had to be abandoned, as the Leblanc process turned out its products in much larger quantities, at much less cost.

It is interesting to notice, how ready Muspratt was to undertake, and carry out the inventions of others; his unfortunate lawsuits prevented him devoting his own thought and attention to science and research, even if he had possessed the taste and knowledge for such work, but he was able to detect ability and knowledge in other men, and to utilize their inventions and their labours.

In 1849, he resolved to end his troubles, as far as they arose from battling with his neighbours in the law courts, and to leave Liverpool and Newton, and in 1850 the works at Widnes and Flint were begun. A time of great prosperity dawned upon the alkali trade, and although when Muspratt went to Widnes, it contained only from between three and four thousand inhabitants, yet in 1861 the population had risen to 6,905, and in 1881 to 24,905, and the production of the alkalies in Lancashire, were:—

	In 1852.	In 1872.
Alkali	26,343 tons.	93,600 tons.
Soda crystals	3,500 tons.	8,840 tons.
Bicarbonate of soda..	1,200 tons.	11,700 tons.
Bleaching powder ...	1,250 tons.	8,060 tons.

Works were extended as soon as they were erected, and new works rapidly sprang up. Widnes, on account of its position, and Flint likewise, were comparatively free from the incessant legal troubles to which the St. Helens manufacturers were constantly exposed. The works at Widnes increased so rapidly, the amount of uncondensed vapour was so large, and the volume of smoke so dense, that notwithstanding the long stretch of river over which the vapours were carried by the westerly winds, which are the winds during which the principal damage is done, the plantations, and even the farm lands on the Runcorn side toward Norton Priory, received very great injury. Sir Richard Brooke moved in the matter, and in the other manufacturing districts found many who deeply sympathised with him in his complaints. A royal commission was appointed, and the Alkali Act of 1863 was the result. But James Muspratt had left the business to his sons some six years before the passing of the Alkali Act—he was weary of the incessant warfare and worries to which for five and twenty years he had been subjected, and he retired to enjoy the delights of travel and the pleasures of a social life, spent in the companionship of literary, artistic, and scientific men. During his business years, fights with farmers were not his only worries. In partnership with his friend, Mr. Tennant, of Glasgow, he bought some sulphur mines in Sicily. These English adventurers awakened the jealousy of the Neapolitans, and a duty of £4 per ton was placed on all sulphur exported to England. This action being contrary to treaty rights, a protest was made, supported by the presence of the British fleet; the King of Naples listened to the representations thus made to him, but instead of taking off the duty he had imposed on the English export, he placed a duty upon all exports of sulphur to any country. The consequence was, ingenuity set to work to make sulphuric acid from the mineral sulphides of iron and copper instead of from brimstone, and the pyrites mines of Wales and Ireland, the latter especially, displaced the sulphur mines of Sicily.

When Liebig was making his researches and working out his theories in Agricultural Chemistry, and when he thought he had discovered the secret of the refertilization of the soil, the principal thing being to restore to the soil, as manure, the inorganic constituents which it was found by the analysis of the ashes of the vegetation, had been taken out of the soil by the plant, he got James Muspratt to carry out his ideas by manufacturing certain manures. This manufacture was carried on at Newton, about the years 1843-44. In this venture, Muspratt was joined by Sir Joshua Walmsley, a gentleman of much ability and enterprise, who had only a few years before been Mayor of Liverpool; he was a member of Parliament, and a friend of Richard Cobden and George Stevenson. There is a letter of his in which he refers to this manufacture of Liebig's manures:—"Having read Liebig's work on agricultural chemistry, and being impressed with the force of the reasoning; in conjunction with Mr. James Muspratt, of Liverpool, a man well versed in chemistry, I entered into an arrangement with Professor Liebig to manufacture an article that would give back to land all that cropping had taken out of it. The ingredients were found too expensive for the returns, and after a fair trial on which was spent some thousands of pounds, the undertaking was relinquished. Yet I always felt pride in the thought that Mr. Muspratt and I had been the first in England to endeavour to put into practice Professor Liebig's evident theory." Liebig in a note in his "Letters on Chemistry," says:—"I do not conceal from myself that the discredit into which the employment of the constituents of the ashes of plants, as manure, may have fallen in England, arises in part from the failure of the so-called "Patent Mineral Manure." It was the discovery of a new and remarkable compound of carbonate of potash and carbonate of lime which led at that time to the idea of the composition of this manure. And it was on account of this compound, which appeared likely to be of use in other ways, that, according to the custom of England, and by the advice of sagacious men, the manure was patented. The composition of the manure itself could be no secret, since every plant showed by its ashes the due proportion of the constituents essential to its growth. It was a circumstance deeply to be regretted that the idea which this manure was intended to bring into operation, took the form of a commercial speculation. This was not, I know, the intention of the excellent persons who manufactured the manure; for in regard to the commercial working of the patent they did exactly the reverse of what would have been necessary to render it a source of profit. The idea was brought forth prematurely, and as in the case of a child born before its time, death quickly follows." There appears to have been a radical error in the composition of this artificial manure: instead of making plant-food soluble they made it insoluble to prevent its being washed out of the soil, not recognising the action of the soil on the soluble constituents. Although this venture was a failure, it paved the way for the great chemical manure trade of to-day.

The proprietors and managers of chemical works at no time have a life of repose; new inventions and discoveries, on which so many minds are bent, may any day work a revolution which may render much of their property comparatively valueless; their apparatus is so complicated and various that it needs constant and minute observation to see that it does not get out of repair, and that products are not thereby wasted. Workmen have to be instructed and watched, the laboratory has to be properly organised and supervised, markets have to be watched in the face of keen competition, but if in addition to all these worries, there are legal proceedings, that too often degenerate into bitter and unjust persecution, then the life of a chemical manufacturer is one that must often create an intense longing for retirement and repose. It was so with James Muspratt, and he gratefully entered on the rest he had earned. But the land of the lotus eaters was not his paradise. The cause of education found in him an ardent promoter; himself such a lover of books and reading, knowing the priceless value of knowledge, he did great service to the cause of popular instruction by the work which he and his friends, James Mulleneux and George Holt, accomplished in connection with the Mechanics' Institute of Liverpool. The work of mechanics' institutes became somewhat obsolete, and this institution was transformed into an ordinary public school, the Liverpool Institute, which to-day ranks amongst the first schools of the class in the land.

In politics he was no less enthusiastic. He was a thorough-going Liberal: one of the earliest supporters of the Anti-Corn Law movement. His Free Trade principles were so strong that even when his own manufacture of Prussiate of Potash was threatened

JAMES MUSPRATT

(Late in life)

by German competition, and those in the same trade in this country were agitating for Protection, he protested with scorn against such actions; if they could not hold their own they deserved to be beaten, and the consumer had the right to buy in the cheapest market. Michael James Whitty, of the *Liverpool Daily Post*, was his friend, and they shared the same views of strong sympathy and approval of the policy of the Northern States of America in their great conflict with the South.

In the land of his birth he always took the deepest interest; he watched, even in his latest days, with strongest approval and admiration the policy of sympathy and succour which Mr. Gladstone had initiated towards Ireland.

He was fond of continental travel, and at times took up his residence at Giessen and Munich, to enjoy the companionship of Baron Liebig, and of the scientific circle in which he moved. He also travelled and resided in Italy. He was gifted with an extraordinary memory, which was enriched with an extensive and accurate knowledge of the best English poetry, even in his eightieth year he could repeat the whole of Goldsmith's

"Traveller" and "The Deserted Village." Those who were the companions of his travels, remember how he would repeat whole cantos of "Childe Harold," and Roger's "Italy."

His extensive reading, romantic adventures and social tastes made him a delightful companion. He gathered round him in his home at Seaforth a circle of literary and artistic friends, as well as comrades with whom he had fought hard battles for the social and political progress of the people. Many a young artist found in James Muspratt a true and generous patron. He was an intense admirer of the sculptor's as well as the painter's art; it was his design to have made a collection which would have illustrated the progress of English art during the first fifty years of the century, but this he was prevented from achieving. How he would have rejoiced to have seen how splendidly his idea was carried out in the Manchester Jubilee Exhibition of 1887.

He had in his own collection some very valuable pictures, he greatly admired Linton's landscapes, and he possesssd Sir George Harvey's "Battle of Drumclog."

He died when he was 93 years of age at his home, Seaforth Hall, near Liverpool, on Tuesday, 4th May, 1886, and was buried in the Parish Churchyard of Walton.

In him there passed away from the stage of life a remarkable man who had acted many parts. Physically and mentally he was robust. We have seen how his strong constitution bore him through the dangers and hardships of his youth, and enabled him to battle bravely through his stormy business career. Strength was his great trait,—ein kräftiger Mann—he signalised himself by strength of body, by strength of intellect, by strength of purpose, and not unfrequently by strength of expression. He was a man of strong emotions as well as deep convictions. He was a character long to be remembered, bold, daring, impetuous, self-willed, and restless; a man to cherish as a friend, to dread as a foe. He believed in progress, realised that "knowledge was power"; was ever ready to utilize talent and invention; literature was his delight, and men of letters his boon associates and companions; the mark he left upon the trade, which he did so much to found and to build up, was not that of an inventor, he will not be remembered as an eminent chemist or engineer, but as a man of unusual energy, of keen perception, of indomitable perseverance, and of farseeing enterprise, and such men have been large contributors to the greatness of their country as well as to the fortunes of their families.

ANDREAS KURTZ.

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The ancient town of Reutlingen was the birthplace of Andreas Kurtz. In the old church-book of the venerable Marien Kirche it is recorded that on the 20th August, 1777, Erard Kurz (or Kurtz) married Anna Barbara Schaefer, and that on the 16th September, 1781, was born their son, Andreas. His native town is prettily situated almost under the shadow of the Swabian Alps; undulating cornfields, rich orchards, and terraced vineyards lie around. In the immediate neighbourhood rises in sugar-loaf form the Hill of Achalm, of which Uhland sings:—

"Zu Achalm auf dem Felsen, da haust manch kühner Aar
Graf Ulrich, Sohn des Greiners, mit seiner Ritterschaar;
Wild rauchen ihre Flüge um Reutlingen die Stadt;
Bald scheint zie zu erliegen, von heissem Drange matt.

"Ach Allm!" stöhnt einst ein Ritter; ihn traf des Mörders Stoss—
"All mächt'ger" wollt er rufen—man hiess davon das Schloss—

Herr Ulrich sinkt vom Sattel halbtodt, voll Blut
und Qualm;
Hatt' nicht das Schloss den Namen, man hiess es
jetz Achalm.

The country abounds in beautiful woods; rocky glens and gorges open out into lovely valleys. On the Hill of Achalm once stood the castle of the Count of Achalm; its ruins still remain, and near them has been built the observatory. A little stream, the Echatz, flows through Reutlingen, and for about six miles meanders through the valley until it joins the Neckar. The population has of yore been given to manufactures, the combing and weaving of wool, the spinning of cotton, dyeing and tanning, and various engineering and other industries, which always collect around a manufacturing centre. There are corn mills in the town to which the farmers of the district round bring their corn to be ground; and at the present day the book-trade of Reutlingen is extensive and prosperous. It was in this hive of industry that the Kurtz family resided; they carried on the business of traders.

Andreas was born in stirring times. The whole of Western and Southern Europe was in a state of religious, social, and political ferment. In France the gathering clouds of the approaching storm were darkening the horizon, and in the unwonted hush that preceded the tempest, Europe listened with forebodings of terror to the distant rumblings of the thunders of revolution, and watched the nearing flashes of the lightnings of war. It was the birth-time of a new era, at whose nativity :—

> "The front of heaven was full of fiery shapes,
> And burning cressets."

Cowper, writing of these days, says :—

> "When were the winds
> Let slip with such a warrant to destroy?
> When did the waves so haughtily o'erleap
> Their ancient barriers, deluging the dry?
> Fires from beneath, meteors from above,
> Portentous, unexampled, unexplained,
> Have kindled beacons in the sky, and th' old
> And crazy earth has had her shaking fits
> More frequent, and foregone her usual rest."

Achalm had in ages past looked down on the tide of war surging over the fruitful fields and round the busy little town. From his lofty perch, high in the air, on the old church tower, the watchman had often sounded his trumpet of alarm; behind the walls of the town its inhabitants in frequent struggles had suffered siege, for it lay not far distant from the path of armies that came in successive periods from north and south, from east and west. It was no fortress, but walled ramparts encircled the homes of its active, thrifty people. Tübingen, with its celebrated university, the *alma mater* of the reformers, Reuchlin and Melancthon, and the home of Wieland, was only a few miles distant, and Reutlingen itself played no unworthy part in the great drama of the Reformation: with Nürnberg it was one of the earliest towns to accept the Augsburg Confession. The intellectual and spiritual life of the people of this district had been quickened by the influence of Tübingen, and Reutlingen enjoyed the privilege of possessing excellent town schools. In Kurtz's day the population amounted to only between 7,000 to 8,000 inhabitants; to-day it numbers about 18,000, and yet with this small population, it has its primary schools, its classical gymnasium, a "Real" school, where modern languages and the sciences are taught, its technical school, where instruction is given in the arts, especially spinning and weaving; then there is a most excellent and celebrated high class school for girls, and besides this there is a school of fruit-culture, which is taught practically and scientifically. In this interesting old town, Andreas Kurtz spent the first thirteen years of his life.

If there be any truth in the saying, "Children are what their mothers are," his own future career, and that of his brothers and sisters, for there were eight or nine of them altogether, must be traced to that old Swabian home, and especially to the influence of the mother. She was a very remarkable woman, and although she had passed through the terrors and hardships inflicted by war, had seen her home destroyed, her family ruined, and her children scattered, survived to hear of the revival of her house in the east and in the west. Two younger members of the family migrated to Southern Russia, and settling in Odessa won by their energy, ability, and character, positions of opulence, honour, and rank. The mother lived to the age of 97.

France, with her Louis XVI. and his queen, Mary Antoinette, occupied the most prominent position in the European situation, and in Paris was to be found all that was most brilliant in literature and science.

In the year that Andreas Kurtz was born, Louis XVI. had been seven years on his fatal throne, and the monarchy was tottering to its fall. Necker succeeded Turgot, and Joli-de-Fleury, D'Ormesson, and Calonne succeeded Necker; each sought to save the crown with its power, to retain the aristocracy with its privileges, and to ameliorate the condition of the people without ceding to them authority and dominion; but the rottenness of the State made its dissolution inevitable, and neither Necker nor Brienne, "Assembly of Notables," "Parliament of Paris," nor "States General," could ward off the catastrophe; the monarchy was doomed. France travailed in birth of the Republic. It is not for us here to trace the tragic history of the Revolution, nor the horrors of the "Reign of Terror," but it was during those years of political upheaval that a change, no less extraordinary than that which was taking place in the relation of the people to their rulers, was occurring in the world of science, and Paris was the scene of both these revolutions.

In England, Black and Priestley, by their discoveries in pneumatic chemistry, had paved the way for Lavoisier and his companions in France, and it was around Lavoisier that at this time the first minds in the scientific world circled. At his residence a society of savants of all nationalities used to meet on two or three evenings each week to discuss problems and inventions in chemistry and physics.

The overthrow of the Monarchy on the 12th of July, 1789, and the subsequent treatment of the King and his family by the revolutionists, alarmed the other monarchial powers; they must stem the tide of anarchy, and a coalition was formed to restore the royal supremacy in France. The "Legislative Assembly" fiercely resented this foreign interference; three armies were organised to repel the forces of Austria, Prussia, and Piedmont, which were being marshalled against the revolutionists.

In 1792 war was declared between France and Austria. Dumouriez was dispatched to oppose the Austrian forces in Belgium; in their first encounters the French suffered defeat; the disasters were attributed to the treachery of the "emigrants," the Paris mob was maddened, Danton raised the flag of insurrection, the country was declared in danger, on the 31st September the Republic was proclaimed, the National Convention displaced the Legislative Assembly, and in January, 1793, the King was guillotined.

In the years 1793-94 the whole energies of the nation were put forth, and the armies of the Republic were everywhere victorious. The young Corsican officer, Bonaparte, although only twenty-six years of age, had already greatly distinguished himself, and in the campaigns of 1795-96 received a high command in Italy. General Moreau led the army of the Rhine in the Palatinate and Baden; and Jourdain the army of the North in Belgium and Holland. These several armies were to converge on Vienna, but the plan was frustrated by the failure of Jourdain; Moreau victoriously passed through Würtemburg and on into Bavaria; Bonaparte was equally successful in Italy, but the defeat of Jourdain compelled Moreau to make his celebrated retreat through the Black Forest. It was during these marchings and counter marchings of French and Austrians, in the years 1794-96, that the district of Reutlingen appears to have been touched by the armies.

Andreas Kurtz retained vivid memories of those early days. He used to relate how the women were compelled to seek refuge in the cellars of their houses; and how he and his father were witnesses of an incident that he well remembered. A Jew pedlar, who had been permitted to pass among the soldiers to dispose of his wares, was caught in the act of theft, he was summarily tried and sentenced to be shot. The miserable wretch was dragged round the camp, through brake and briar, at the heels of a horse, and when he arrived at his place of execution, fearfully lacerated, and more dead than alive, he was compelled to dig the shallow trench that was to serve as his grave. All being ready, he was blindfolded, and knelt at his graveside awaiting his doom. The volley was fired and the victim reeled over. It had been arranged that the muskets of the firing party should be loaded with only blank cartridge, and when the prisoner was seen to fall, it was supposed that terror had killed him; it was found, however, that he had only swooned, and on coming to himself he was liberated, it being considered that he had received sufficient punishment. Hardly a month elapsed before this same pedlar was caught committing a similar theft; on this second occasion he paid the full penalty of his crime.

Andreas Kurtz was only about thirteen years of age when his native town was exposed to the disasters of war. Trade was paralysed, his father ruined, and the homestead burnt, and from amidst the misery and desolation, he came forth resolved that, child as he was, he would go out and alone seek his fortune. The boy bade a long farewell to all that was dearest to him on earth, and left behind him the happy scenes of home and childhood.

> "Lebt wohl ihr Berge, ihr geliebten Triften,
> Ihr traulich stillen Thäler lebet wohl!"

The child's star led him to Paris; on he trudged from day to day, footsore and weary, away from his fatherland, away from his mother tongue. What ideas inspired him we fail to surmise. Was it that France seemed to him the great nation, whose armies had subdued all her enemies, and that work and wealth were to be found in her? that she was the land of liberty and learning? had the schoolboy heard of her glories and longed to see them? Whatever may have been the incentive that induced him to encounter the difficulties and dangers of so long and perilous a journey, they were sufficient to enable him to brave it out, and to reach his destination. It was a rare act, for a boy so young to go forth on foot, alone, from his home in the Swabian highlands to the great city, in the strange land.

The factories and industries of Reutlingen would have imparted to the youth ideas of work, and when he came to Paris it was amongst its manufacturing community that he sought and obtained employment.

Unhappily there is no record of his Paris life; he passed within the gates of the city, a foreigner, ignorant of the language; a child, who had only received a simple, elementary training in the school of his native town. In Paris he toils and studies for twenty years, and at the end of that period comes forth an operative chemist, educated, cultured, enthusiastic. The situation he obtained was in some chemical works, it has been rumoured that his employer was Payen himself, and we have reason to believe that this rumour is correct, and that he was with Payen exclusively. If such were the case it would account for the opportunities that must have been afforded to him. The variety of subjects in which he wrought, also make it probable that he was connected with some master of

"Industrial Chemistry," in which subject Payen was most eminent.

Those twenty years in Paris were lived in the midst of some of the most momentous events that have occurred in modern Europe.

It was the era of Napoleon Bonaparte, it began with his achievements in Italy, and it terminated with his final overthrow at Waterloo. When Andreas Kurtz arrived in Paris, the Directory was at the head of affairs, he saw it succeeded by the Consulate, and then the Empire; before his residence concluded he had seen the power of Napoleon shattered for a time by the catastrophies of his retreat from Moscow; the Emperor driven to Elba, Louis XVIII. for a few months on the throne of his fathers until Bonaparte returned again to lead his army to his final and irreparable disaster. He witnessed the humiliation of Napoleon and the triumphal entry of the armies of the Allies into the capital.

When, in 1795-6, Andreas Kurtz went to France, a marvellous change was being wrought in chemical science. It was in 1794 that Lavoisier perished in the mad fury of the "Reign of Terror," but he, and those associated with him, had succeeded in exploding for ever the fundamental fallacies on which chemical science had up to this time been based. They had founded what is historically known as "La Chimie Francaise," to which the world is indebted not only for a reform of chemical nomenclature, displacing the "alchemistic jargon," which up to that date had prevailed, but also for the establishment and the arrangement of those facts on which the system of modern chemistry is grounded.

The occupations of the factory proved full of interest to young Kurtz, they incited him to study, they called forth the powers with which he was naturally endowed; they brought him into contact with several of those distinguished and eminent men who were the instructors of the youth of France in the natural sciences. Gay-Lussac was one of his companions, and doubtless he would be among the hundreds who crowded to listen to the lectures of Berthollet and Thénard, and to receive instruction from Fourcroy and Vauquelin. Before he left France he had become a thorough enthusiast in his calling. It is not to be wondered at, therefore, that at the age of thirty-three, when he emerged from Parisian life, he had attained some distinction, and that his labour had won for him the award of the "Legion of Honour."

War had made great demands on the services of science. Lavoisier had been appointed by Turgot to superintend the manufacture of gunpowder; and under both Republic and Empire Gay-Lussac had laboured on the same explosive; Berthollet had to direct the preparation of saltpetre and the casting of iron and steel. The subject which Gay-Lussac had been compelled to investigate naturally attracted the attention of his companion Andreas Kurtz, and when in 1815 he left France, it was with an invention of his own in the manufacture of gunpowder that he sought to begin his new career.

He crossed to England on the 15th August, 1815, and thence set sail to America, accompanied by a General Rubel. They arrived at New York on the 17th December, and there in conjunction with a Dr. Bollman sought to exploit Kurtz's invention. The venture was not a happy one, and although he became an American citizen, probably to comply with legal technicalities connected with his patent, he remained a very short time on the shores of the new world. After a hurried visit to such cities as Philadelphia and Baltimore he recrossed the Atlantic, and returned to England on the 14th of May, 1816.

His first enterprise in this country was to take a small chemical works at Thames Bank. It had been in the occupation of a Mr. Sandemann, who was a chemist of considerable ability; he died, and it was from his widow that Kurtz accepted the tenancy. The introduction which had taken place through their business negotiatious resulted in Mrs. Sandemann becoming Mrs. Kurtz.

Happily there are still preserved some records which enable us to catch a glimpse of Andreas Kurtz as a chemist at work in his laboratory and his works. These writings go back to the first January, 1818, they are a series of miscellaneous memoranda or reports on experiments he had made or operations he had carried out. They refer at first to the time when he was resident in London, and when he had a Mr. Cavendish as his partner. Cavendish, like his celebrated namesake, Henry Cavendish, who died in 1810, was very eccentric. It will be remembered how Henry Cavendish was so shy that he made himself absolutely ludicrous. When visitors, attracted by his renown, were honoured with an interview, whilst they were paying him their compliments, he would rush away and leave them alone, not to return. He was morbidly averse to all society, and especially shunned the presence or attendance of any female domestic, if he even caught sight of one it involved her dismissal; he used to give his orders for his dinner by depositing on a table a paper with written instructions. Again he was so methodical that whenever he took a book down from his library shelf, even for his own use, he would enter it in a book kept for the purpose; when his librarian died he appointed no successor, but took the work himself. He used to lend his books to distinguished students and men of science with whom he was acquainted, but books were lent on only one day a week, during certain honrs, when he himself attended to deliver and to receive. Kurtz's partner's eccentricity was much more grotesque; he fancied his nose was a china teapot and ever in danger of being smashed.

The genius and inventions of Henry Cavendish had been much more highly appreciated by the great chemists and philosophers of the French school, than by his own countrymen, so that Kurtz, who was so essentially a scholar of that school, would come highly commended and well introduced to Cavendish. The partnership, however, does not appear to have lasted very long.

In the memoranda that have been referred to, dating back to January, 1818, soap boiling is the earliest subject of remark. The entries are not merely records of experiments, but of manufacturing operations. We shall quote them precisely as they occur, as they will illustrate how Andreas Kurtz was accustomed to use the three languages, English, French, and German, not only in speaking, but also in writing. Stories are told of how exquisitely funny it was to hear him mix up these languages in giving vent to his wrath against someone or something that had irritated or annoyed him.

In his notes on soap boiling he writes :—

January 3rd, 1818. Put the stof-pan in the brickworck. The bricklayer did the whol fournace in 7 days.

January 5th. We received two tonn of kitchen stuff at £48 a ton.

Thursday, the 6th. Begin to melt at nine o'clock at once 14 cwt. in one pan and finished at 7 o'clock in the evening.

January 14. In the morning Mr. Roberts

has begin to melt 1,200 lb. kitshen stoff. It was not quit finish the same day. The greaves was not done enough. This day matin on allumé le feu, sur la même operation (et on a commencé à presser à deux heures) le tout état fini à 5 heures après midi. Buying kitshen stoff muss man einer 3 ten theil verlust rechnen a 100 loss 33⅓ on 100 = 66⅔ pur.

Mr. Newell dit que la charge l'on met à la chaudière pour le savon jeaun se multiple par 10 et se divide par 7 or multiply by 40 and divide by 28. Per example :—

600 Rosin
600 Kitshen Stoff
2000 Russian Tallow
200 Baum Oil

$$3400 \times 10 = \frac{34000}{7} = 4857 \text{ lbs.}$$

Et alors they deck of the dixième. Palm oil soap bey mir gemacht im kleinen 100 content 13 alkalimetrique die Seife war nicht sehr hart. Russell's soaft soap continent 13½ alkalimetrique per 100 soap. Meine blanc model-seif, 10¼ ; diese seife habe ich in gute Lauge gelegt, und sie wurde hart wie ein Stein und wenn ich sie analysirte war sie 14½ alkalimetrique in 100 seif.

Yellow soap is made with:—

Barilla	18 lbs.	28	Produce 94 lbs. Soap.
Blackash	10 „		
Tallow	25 „	37	
Oil	4½ „		
Rosin	7 „		
Balmoil	½ „		

These extracts, selected from a considerable number of entries, must suffice to indicate the subject on which Kurtz was at that period at work, and the way in which he used to record his operations. Amongst the same memoranda are sketches of apparatus, descriptions and dimensions of plants, analyses and examinations of materials employed, exact records of temperatures, of strength of solutions and liquors, in degree (Baumé), and the time which various operations required. Here and there also are details of cost. These facts are carefully written, occasionally in English, but more frequently in French and German, his thoughts seemed to have worked indiscriminately in both these languages; for grammatical construction, his French appears more correct than his

German; this was to be expected on account of his leaving his German home so young.

In the spring of 1818, he appears to have visited Dublin, and there to have made some experiments in soda making, for there is the entry:—

"Resultat de la Soude fait a Dublin, le 20 April, 1818:—J'ai pris le residu d'eau de gavell et calciné jusque parfait fusion ensuite reduit en poudre, ce residu a perdu en calcinant 28 %, reste 72 sec qui est un compose de 50 sulfat de soude sec et 22 mangan, 100 de ce melange sec contient 70 sul: de S sec et 30 manganes.

Première essai a été fait avec:—

1,000 de melange.
500 carb: de chaux.
250 charbon de bois

1,750

a produit en Soude 1,000 rich à 10 deg. cette soude a été fait en ½ heure de temps, je pense qu je l'ai retiré trop tôt du feu, elle a été en parfaite fusion." Then he appears to give the description of how he lixiviated the product, and what results he obtained.

Again. "Dublin, 14 April, 1818:—J'ai fait une operation avec sulfat de Soude, charbon de terre et la chaux vif et calciné."

On the same page is a notice of "chrome de fer" giving the specific gravity of several qualities of ore; and also an account of an experiment in "distillation d'acide acétique."

It can here be mentioned, that Andreas Kurtz claimed to be the inventor of a very fine vinegar, and that he was the original maker of the article which more than fifty years ago was manufactured by an eminent firm, and which firm is to-day celebrated for the excellence of its manufacture.

Before passing from his operations in soap-boiling, the following entry may be interesting:—"Une lb. de Soude de Muspratt rich à 70 produit 2 lb. alkali caustique at 38 deg. 1 lb. rosin sec et 1 lb. huile de lin et 4 lb. liqr caustic á 38 fait un superbe savon jeaun = 6 lbs. cost 9d. per 6 lbs. or 1½d. per lb."

This experiment must have been of a later date than the preceding one as "soude de Muspratt" was not to be had as early as 1818.

About the year 1820 Kurtz changed his place of residence, left London and came to Manchester, in which town he lived and carried on his business for about ten years. When he came to the north, we find he turned his attention principally to the making of colours, and especially to the production of chromate of potash. It is not necessary to cite his various recipes for making standard solutions, still they are interesting as indicating his methods of analysis. We quote just one: "10 fr. in silver = 80 gram silver and copper with sufficient quantity nitric acid and water produces 700 at 26 sp: gr: 1 gram metallic silver will precipitate 4½ of salt. One gram metallic silver gives 2¼ of dry nitrate of silver, therefore 1 gram dry nitrate of silver will precipitate 2 oz. of dry muriate of soda."

There is a paper on bleaching powder, but it appears to be a study rather than an original work, for he heads it:—"Bleaching Powder, see Turner, page 447." No. 1, good commercial bleaching powder contains.—

Chlorine	23
Lime	46
Water	31
	100

No. 2, made by himself, is:—

Chlorine	40
Lime	45
Water	14

No 4. Dr. Ure found in good powder:—

Chlorine	...	...	...	36
Lime	...	...	...	28

"From Gray's 'Operative Chemistry,' page 436, a chamber from pitch and Paris plaster is made, 12 feet long and 2 feet wide, of bricks, and numbers of shelves, filled with fresh slaked lime, 4 days are usually required to impregnate the lime with the gas to saturate it well, the layers of lime are generally very thin, say half an inch thick, and when this is saturated another layer is put upon it, and so on, they can see by the colour of the powder whether it is quite saturated. The mixture recommended by Gray, page 437, is 3 of manganese, 8 of common salt, 6 of sulphuric acid, and 12 of water." Then he has sketches, and makes what appears to be suggestions of his own:— He does not see why the chambers should not be increased in size and that the apparatus might possibly be worked with advantage by a fan. Of course, these references have only a historical interest.

We must now come to his work in Manchester. A date is given that may serve as a starting point.

"Agreement with Edward Flower and Thomas Taylor, Manchester, 15th of March, 1822."

"Prices of our divers articles to flour at Manchester."

Chrom. C.	...	...	3s. 3d. to 3s. 9d.
B.	...	...	4s. od. to 4s. 3d.
A.	...	...	4s. 6d. to 5s. od.
Siberian	...	...	2s. od. to 2s. 6d.

Prussian green paint in powder or in oil:—

Saxon green	...	...	1s. 3d. to 1s. 6d.
Pea "	...	...	1s. 6d. to 1s. 9d.
Grass "	...	...	1s. 9d. to 2s. od.

New permanent Imperial green paint in oil:—

No. 1 ...	...	...	1s. 6d. to 1s. 9d.
No. 2 ...	...	...	1s. 3d. to 1s. 3d.
Verdigris	...	...	3s. od. to 3s. 3d.
Sugar of Lead		...	1s. 2d.

Fortunately, his memorandum book enables us to see how in Manchester his dwelling-house adjoined his works, his laboratory leading almost directly out of his sitting-room. The sketch also shows the character and arrangement of his apparatus.

He devoted his attention in the first instance to the production of various shades of green. There are several mixtures given which he experimented on to produce "Scheele's green":—

1. White oxide of arsenic	...	4 parts
Sulfat of copper	... ...	12 "
Caustic potash	... ...	10 "
Water	... ...	520 "
2. Arsenic	... ...	4 "
Sulfat of copper	... ...	12 "
Carbonate of potash	...	10 "
Water	... ...	520 "
3. Arsenic	... ...	4 "
Sulfat of copper	... ...	12 "
Carbonate of soda	... ...	16 "
Water	... ...	520 "
4. Arsenic	... ...	4 "
Crystallised verdigris	...	12 "
Carbonate of potash	...	12 "
Water	... ...	520 "
5. Arsenic oxide	... ...	4 "
Nitrate of copper	... ...	12 "
Perlash	... ...	12 "
Water	... ...	500 "

In his Manchester business he was associated with a Mr. Richard Niven of Belfast. This partnership, as long as it lasted, was most fortunate, and a very successful and lucrative business was carried on. Kurtz proved himself to be a most skilful, practical chemist and competent manufacturer, whilst

Niven was an excellent man of business, who discovered markets and customers for their products, and was a clever salesman.

About the year 1828 fortune smiled upon them so graciously that in one year they made a profit, which in those days was looked upon as a very handsome fortune. Whether there were faults on both sides we cannot now relate; but Kurtz was naturally excitable, irritable and hasty, and although the relationship between Niven and himself had contributed so largely to the benefit of both, they nevertheless quarrelled, and the partnership was dissolved. To Kurtz this event was little short of a calamity. Niven was the very man he needed to be associated with. Kurtz was no man of business, although a good arithmetician and fair mathematician, his tastes drove him to his laboratory instead of his counting-house; chemical experiments were far more congenial to him than the keeping of accounts, and the superintendence of the processes of manufacture than the visiting of markets, the winning of customers and the disposal of goods. The "value of money" was a subject in which he had never been trained; he had not the instincts of a miser nor the qualities of a merchant. He was a chemist, he loved his science, he revelled in research. After Niven left him, Kurtz encountered disaster upon disaster; whether his misfortunes were the result of his own inaptitude for business or whether he was out-manœuvred by men less scrupulous and more cunning than himself, we cannot say, but the remaining years of his life were disturbed by many worries and troubles in his business, but seldom in his manufacture; in that department he was a master.

The price he got for bichromate of potash when he commenced to manufacture it was five shillings a pound. It did not long remain at this figure, but fell from stage to stage until it was sold at 8d. per lb.; Kurtz then considered the business was no longer worth following, and abandoned it.

In Liverpool his most important operations were the manufacture of bichromate of potash, in works that he had in Parliament Street and Sefton Street; and borax, in Harrington Street; in addition to these he had a works for general experimental purposes in Greenland Street. There are numerous memoranda to assist in tracing his labours.

Take his first experiments in chromates:—"Good chrome ore loses only 5% in muriatic acid boiling, and is not acted on by magnet" The quality of chrome ore appears to have been decided more by its specific gravity than anything else, as seen in the following entries:—

Chromate of iron from Sweden, four sorts, sp. gr. 24, 25, 27, 30.
Chromate of iron from East India, sp. gr. 23, like metal.
Chromate of iron from America, four sorts, sp. gr. 22 to 31.
Best American, sp, gr. 22 quite metallic.
2nd best „ „ „ 23 fine black reddish colour.
3rd sort „ „ 23 dirty looking, ochre-like.
Norway best „ „ 24 in square little tubes.
Shetland Island „ „ 32½.
From Cappé in 1831 sp. gr. 30.
American good, bad, altogether from mill, sp. gr. 27.
Norway, all mixed from the works, „ „ 27.

Then there is a memoranda on the grinding of chrome ore :—"Our 4 stone in Parliament Street do grind 800 lbs. of fine ore per hour, and our sifting machine can sift 1000 lbs. per hour. It was Scotch ore."

The ore being ground, there are scores of mixtures given, extending over several years, from 1831 to 1838, of which we select a few to illustrate his work :—

American ore	1000	Dry 63
Old ore ...	1000	25 of it = 22½ = — bichrome
Nitre	500	25
American ...	1000	Dry 90
Lime burnt...	220	17 = 15 = — bichrome.
Saltpetre ...	500	25
American ore	1000	
Saltpetre ...	250	75
Pearlash ...	200	1550 = 1440 = — bichrome.
Lime	100	25
American ore	1000	63
Salt	500	1700 = 1500 = — bichrome.
Manganese..	200	25

April 30, 1832, in our large way :—

Swedish ...	1000	19 = 16½ at 30	99
Saltpetre ...	500		—
Chalk... ...	400	5 : 30 :: 16½ : 99	100

"This is better than No.—because there is 100 lb. more chalk with it, and works better in our fournaices," and so on—after many of these mixtures there are remarks as to whether they are good or bad, whether they work well, give good results, or are too costly.

We must conclude this notice of the manufacture of bi-chrome, by selecting two entries on cost. Having given certain mixtures he writes :—

> 4 lb. ore cost 4d., 5 lb. nitre 6d., 1d. labour and fire = 11d.

More fully he gives the cost of other mixtures :—

Swedish best ore,	800 lbs.	@	72/-
Pure potash liquor. 4°,	500 lbs.	@	100/-
Lime pure	450 lbs.	@	6/-
Old Mixture	250 lbs.		—
Nitre	28 lbs.	@	8/-
Labour and coals			40/-
Unforseen			24/
			250/-

This should produce 500 lbs. of chrom, but in my large way I only get 400 lbs. net.

Cost prime about 8d. per lb."

From the manufacture of bichromate, he turns to the preparation of colours in which bichrome is used :—

"308 lbs. of prussiate, 230 lbs. copperas, 20lbs. tin solution, 154 bichromate, 100 pails of nitrate of lead 20 to 24°, and 10 pails of zinc. This has produced a very fine dark green, like the same from the Dutch. Mine is rather better to 6,000 lbs. of baryta."

"For light yellow green, as sample from the Dutch, 150 lbs. prussiate, 115 lbs. copperas, 10 tin, 300 bichrome, 200 pails nitrate of lead at 20°; 20 pails of zinc solution to 6,000 baryta."

"May 1st, 1835. Chrome yellow.

No. 1.—Nitric acid 100 + Litharge 150 + 750 Water = 1000A.

Bichrome 50 + Red Sulphate 50 + 900 Water = 1000B.

The whole of these two solutions together give No 1.

No. 2.—Nitric acid 100 + Litharge 150 + 750 Water = 1000A.

Bichrome 72 + Red Sulphate 75 + 850 = 1000B.

"Copper Green:—100 blue vitriol and 110 acid gives 100 verdigris, 100 verdigris and 100 arsenic produces light green, if to this light green 100 verdigris is added the colour is much deeper and finer, and if 100 of verdigris is added to this it is still finer, but if more verdigris is added it gets bad again.

Kurtz's chrome yellow was such a splendid success that the Princess Charlotte had her carriage painted with that dazzling pigment, and the result was that for a season or two all the carriages of the day in the fashionable world were similarly coloured. Andreas Kurtz was highly gratified at this triumph.

Leaving these records of work with colours and paints, we notice a series of experiments he made with madder. He says:—"Take two gram and pour 100 of boiling water on it and stir well but let it settle, and take the clear, put one or two drops of carbonate of soda solution, and compare it in the test tube as to the density in colour to the best madder. This is the most certain and easiest way.

A solution of acetate of lead on madder powder will also indicate the quality; with good madder the powder gets a deep red, and the bad madder is brown."

Then follows a tabulated form, showing various reactions:—

	MADDER.	BRAZIL.
With soda ...	Solution like Old Port wine	Solution like Damson juice
Diluted sulphuric acid	Madeira wine	Crimson red
Acetate of Alumina	Light yellow	Damson colour
Sugar of Lead ...	Brown red	Dark lilac
Nitrate of Iron ...	Black	Black
	LOGWOOD.	SAFFLOOR.
With Soda ...	Solution like Very dark crimson	Solution like Small beer
Diluted sulphuric acid	Crimson red, light	A little lighter
Acetate of Alumina	Dark lilac	Light brown
Sugar of Lead ...	Blue black	Red yellow
Nitrate of Iron ...	Deep black	Black

He made numerous experiments in oxalic acid, and tartaric acid, carbonate of ammonia, muriate of ammonia, muriate of tin, borate of ammonia, neutral chromate of potash, and other compounds. There is a series of tests showing the specific gravities of saturated solutions of various salts, such as sulphate of soda, sulphate of magnesia, sulphate of zinc sulphate of copper, sulphate of potash, sulphate of alumina, sulphate of iron, borate of soda, borate of potash, borate of ammonia, carbonate of soda, carbonate of potash, and muriate of soda. These observations appear to have been made when he was studying and preparing for the manufacture of borax, which he entered on with Messrs.. Wood and Co., of Burslem. Borax was ordinarily prepared from "Tincal" a natural borate of soda, which was imported from India and China, being found in certain inland lakes of Asia, Payen says: "The water of these lakes is simply evaporated by the summer heat, leaving behind a crystalline mass containing earthy, fatty, and other impurities, which is known in the market as 'Tincal.' This 'tincal,' or raw borax, was formerly submitted to a process of crystallisation at Venice, and came into the market as Venetian borax." Kurtz does not appear to have had anything to do with the purifying of "tincal." He manufactured borax from boracic acid and soda, the process invented by Payen and Cartier in 1818, and we believe we are perfectly correct in saying he was the first in this country to make, by this process, the exquisite article which he introduced. Before his day, the borax of commerce was very inferior stuff.

In his "Laboratory Book" there are very numerous observations, fully and carefully recorded, on his experiments in the manufacture of borax.

It is headed :—"Borax Operation," and the date is March 1, 1832.

First there are tests of boracic acid and borax, then notices of soda : "the caustic soda of Mr. E. P. Thompson is 40° sp. gr.

"Muspratt's alkali contient 70 dry carbonate of soda, 12 muriate and 18 sulphate."

"The pearlash of Lutwych, 5 of it precipitated by 15 of tartaric acid produces 11½ of supertartarate of potassa.

Then comes the account of mixings.

"When boracic acid is saturated with caustic soda, all crystals of borate of soda are soft and of a form like 'Tincal'"

"Boracic acid cannot be boiled in copper, nor iron, but rather in iron than in copper, but lead is the best of all."

"The boracic acid must be dissolved and purified before the soda goes to it."

And finally there are the results of the mixtures, and the tests of the borax:—

"J'ai disout 100 boracic acide dans 500 d'eau et j'ai saturé by 100 carb. de soude cryst. et j'ai crystallisé, cette opération a produit about 2 heures 95 crystaux, et les eaux mère marquait 6°," etc., etc,

There is a very curious note: "Sur la clarification du borax." "Le poisson frais, pas salé, ni fumé est le meilleur précipitant des matières colorantes. 2 lbs. de poisson frais purifie 100lbs. borax, et la couleur est deux fois plus blanc que par l'eau de la mer, et 4 fois plus blanc que de l'eau de pluie.

Les œufs de poisson frats sont encore le meilleur, mais c'est trés lent à précipiter, therefore can only be used in faible solutions qui ni crystallisent pas desuite.

Le blanc d'œuf ne neut pas servir non plus cela ne précipitate pas de tout."

In passing from borax, we notice a recipe he gives for a "glaze for erthernware. 18oz. borax, 18½oz. granite, 9¼oz. flint, 3¾oz.

carb. of lime, these are mixed and melted together, and afterwards mixed with 12½ oz. of white lead and ground together."

In August, 1837, there is a note on "alum operation." To prepare sulphate of alumina.

100 of calcined clay (called crackling clay),
100 of brown sulfuric acid,
50 of water, dissolve by heat, then add
400 more water and let it settle, it will produce
550 lbs. of liquor at 20 sp. gr. called A liquor.

Ammonia liquor at 15 sp. gr. from borax operations, I call B liquor.

I take 400 of A with 200 of B, and bring it to a boiling point and crystallise it, I obtained 150 of alum in fine crystals, the mother liquor from this gives 10 sp. gr.

William Joseph found in the large way that 1 ton of calcined clay, in 1 ton of brown acid gives generally 2½ tons of alum."

The book closes with experiments on—"Essence of oil of rosin, naphthas, rectified spirit, mastic, sandarac, india-rubber, shellac. copal, etc."

This review enables us to perceive how numerous and varied were the researches and investigations which he personally made. He used to live in his laboratory; if he had anything very important or interesting going on, he would go to his work between two and three o'clock in the morning, remain at it all day, and sometimes all night; he would have his meals sent into the laboratory from his house, and at times his food would be left untouched, so absorbed was he in his occupations.

About the year 1842, he was compelled, very much against his will, to become an alkali manufacturer, and to take over a works at St. Helens.

A Mr. John Darcy, who had been in the employ of Muspratt, at Newton, and had at Newton married a Miss Dierden, came to St. Helens, and on a plot of land near the canal, built a small alkali works, to work the Leblanc process; he was in partnership with a relation of his wife, and the firm was Darcy and Dierden. The firm had business connections with Andreas Kurtz, and he was induced to lend them money to extend their operations. They got into difficulties and Darcy tried to make out that Kurtz was a partner in the concern; he even painted it in large letters on his sulphuric-acid chambers, "Darcy and Kurtz." Kurtz was compelled to take proceedings in Chancery, a very costly litigation ensued, Darcy became bankrupt, and Kurtz, after having lost several thousand pounds, was compelled to take over the works. When they came into his hands, they were in a very dilapidated condition; he put them into repair, and let a portion of them, the sulphuric-acid plant, to a man named Clough. Clough had had a soda works on Greenbank, near Ravenhead copper works, but like Darcy had been unsuccessful. Kurtz let him have on rental, kilns and chambers, and from pyrites he made sulphuric acid which was bought from him by neighbouring alkali makers. Clough, however, could not get on, the plant wore out, he failed, and Kurtz having lost money again, for he had put the works into repair, thought it best to take the property into his own hands and work the Leblanc process himself. This, as we have said, was about the year 1842.

There is little or nothing to notice about his operations as an alkali manufacturer. He had been one of the first, if not the first, to suggest the use of pyrites instead of sulphur, and before the Wicklow mines were at work, he had begun to open up a pyrites deposit near Port-Madoc. Other chemical manufacturers got wind of his ideas, and they selected the better and more profitable mines of Ireland. Kurtz had to abandon his mining operations, and endure the loss.

In 1836, Gossage patented his apparatus for condensing muriatic acid, in the same year Lutwyche patented his salt-cake furnace, his close roaster, with one portion for decomposing, and the other for roasting; in 1839, J. C. Gamble patented his salt-cake furnace. The validity of Gamble's patent was disputed; Lee on the Tyne, Kurtz at St. Helens, and probably others, worked furnaces, which Gamble considered to be an infringement of his patent, and he entered actions, first against Lee, and then against Kurtz, which led to prolonged and most expensive lawsuits. The case Gamble v. Kurtz was tried at Westminister, in the spring of 1846, before Mr. Justice Coltman. Sergeant Channel was retained for Gamble, and Sergeant Talfourd for Kurtz.

There were six pleas entered by Kurtz in his defence, and the verdict of the jury was for Gamble on the first, fourth, fifth, and sixth issues, whilst on the second and third pleas their decision inclined to Kurtz. The result was that leave was reserved to either party to move to enter the verdict for him on this special finding. During Easter term, both parties made applications to the courts, which were argued by Channel and Byles on the one side and by Talfourd on the other; and on the 6th July, 1846, Justice Coltman delivered the following judgment:—

"This was an action in the case for infringing the plaintiff's patent, granted for improvements in apparatus for the manufacture of sulphate of soda, muriatic acid, chlorine and chlorides.

The defendant pleaded, 1st, not guilty; 2nd, that plaintiff was not the first inventor; 3rd, that the alleged invention is not new, and several other pleas which it is not necessary to mention. At the trial, it was shown by the plaintiff, that the apparatus formerly used for making sulphate of soda was a brick reverberatory furnace, consisting of a single chamber with a fire at one end of it, the fire striking against the roof of the chamber reflected down to the floor, and the smoke and gas passed out at the other end of the chamber. It appeared that prior to the date of Gamble's patent, one Lutwyche on the 13th October, 1836, had obtained a patent "for improvements in the construction of apparatus used in the decomposition of common salt, and in the mode or method of working or using the same." By his specifications Lutwyche stated amongst other things as follows: "These improvements are designed to prevent the muriatic acid gas from escaping into the atmosphere during the decomposition of the salt; which is effected by condensing such gas in suitable apparatus."

"The improved construction of the apparatus for the decomposition of common salt and the condensation of muriatic acid gas, consists, first, in a novel and peculiar construction of closed oven or decomposing chamber, with its fireplaces and flues, composed chiefly of bricks and mortar. Within this oven there are two beds or floors, one about six inches lower than the other, and over them is formed an arch of firebricks, which arch separates the oven or chamber from the fire and prevents the flame and smoke coming into contact with the materials under operation, but admits of sufficient heat for the purpose of decomposition. In Lutwyche's furnace, one part of the floor was iron and the other brick, but the whole furnace was heated by one grate; when the materials had been decomposed in the lower part of the chamber they were removed to the raised part, where the heat was greater than at the other end, and there dried or roasted. Gamble stated—"that instead of the brick furnaces hitherto employed for the decomposition of common salt, and for its conversion into sulphate of soda, he had found that iron retorts, constantly employed at an elevated temperature, may be advantageously substituted for that purpose, the muriatic acid disengaged effectually, and condensed by the receiver hereafter described." He then describes his apparatus as "consisting of two iron retorts, each having a separate furnace (grate), one for decomposing the salt, the other for finishing and roasting the sulphate of soda. The materials when decomposed were to be pushed from one retort into the other along an inclined plane." Gamble proceeded, "I do not claim the exclusive use of iron retorts, but I do claim as my invention iron retorts worked in connection with each other as described."

Now Kurtz had used for making sulphate of soda, two chambers, one of iron and one of brick, both connected by an opening, through which the materials when decomposed in one could be pushed into the other for roasting, the finishing chamber being heated by a separate furnace.

By Gamble a good deal of evidence was given to show that the object for which his patent was obtained was the use of two separate furnaces, which was not known before. But Kurtz proved that a person of the name of Beswick had previously used two chambers, connected by a spout, ten or twelve feet long, through which the materials when partially decomposed ran from one to the other, in which state they were roasted or finished. The jury decided that the use of two separate furnaces was not new, but Gamble contended that his claim was not for the use of two retorts *worked in connection with the whole apparatus for the condensing of muriatic gas*, although the words of the specification were "in connection with each other," not in connection with the whole apparatus. The verdict was contrary to Gamble's contention; the judge now upheld the verdict, and the judgment was accordingly given in favour of Kurtz on the 2nd and 3rd issues, viz., that Gamble was not the first inventor, and that the alleged invention was not new. But whilst this trial was proceeding, shortly after the first decision of the jury, and several weeks before the judgment on appeal, death intervened. On the 31st March, 1846, smitten by a stroke of apoplexy, the result of the harassing excitement which his anxieties and worries had occasioned him, Andreas Kurtz was found to have passed away during the night; he died in his sleep, alone.

His son Andrew George, who at the time of his father's death was studying for the law, was thus suddenly summoned to succeed him in the business, to leave his legal studies and become a chemical manufacturer. Fortunately, he entered the trade in its halcyon days, and, supported by capable men in their various departments, he was enabled to make his father's busines a very great success. From that day to this "The Sutton Alkali Works" has been regarded as one of the best arranged and best managed works amongst the chemical works of St. Helens. Although from it have proceeded no novelties of invention, yet it has always been to the front in adopting every improvement — improved facilities for the transit of goods, convenient railway access, labour-saving appliances, methodical arrangement of plant, the application of new apparatus, and the manufacture of new products—in every way it has been

ANDREW GEORGE KURTZ.

in the van, and secured for all the articles there produced a world-wide repute. Although neither Andreas Kurtz nor his successor ever saw their way to become local residents, a misfortune to St. Helens, still the duties that devolve upon employers of labour have never been neglected; religious bodies, irrespective of their creed, have received assistance, liberal support has been afforded to various educational institutions, the firm erected the only public baths the town has ever possessed, and the same hand founded and endowed the St. Helens Cottage Hospital.

In the story of the growth and progress of St. Helens, the business, so reluctantly taken over by Andreas Kurtz, will ever hold a prominent position; and we have sought to bring back out of the shadows of the past, a man who was probably the most remarkable representative of the French school of practical chemists that Lancashire has had. There is only one patent of Kurtz's to be found in the records of the Patent Office, and that was not completed; it was "My Patent Fourneau, for concentrating vitriol." He seems to have laboured almost incessantly at his chemical studies and operations in laboratories and works, but patents were not his line, not that he sought to keep his knowledge to himself, for his skill and good nature were well known, and papermakers, dyers, calico-printers, colourmen and others would resort to him for advice and information, they would bring him substances to analyse or processes to examine, and he was ever ready to give his time and labour freely to such work, asking no compensation.

Whenever he granted himself any leisure hours for relaxation, he preferred to spend them in the retirement of his own family. He was fond of drawing and music, he played on the piano fairly well, but only by ear, the flute was his favourite instrument, and that he played by note. He was a Liberal and Anti-Corn-Law leaguer, and although Robert Owen was his friend, he did not share his socialistic views. Many men of science, both French and German, enjoyed his hospitality when they visited this country, and they would meet as his guests such men as Humphrey Davy, Cane, E.P. Thompson, Chance, Tennant and Muspratt. He was benevolent, although sometimes irritable and hasty, his bearing was courteous, he had been trained in a school where politeness was a study.

It is much to be regretted that so little is known of his life from his thirteenth to his thirty-third year. We know nothing of his occupations, his studies, his companions, his methods of self-culture, or the development of his character; but we know something of the time in which he lived, and the circumstances by which he was surrounded, we have further been able to see how the friendless child fought his way up in a foreign land, how he availed himself of his opportunities and made his mark, how he laid in stores of knowledge, and became an expert manipulator, so that in later days he was able to found and to carry on, with considerable success, many operations connected with various manufactures, and to lay the foundations of a great and permanent business. He does not appear to us, to have been a man fertile in theories, nor to have given his mind to work out ingenious ideas or conceptions, in fact, there is a notable absence in his memoranda of everything that is essentially theoretical, he never used symbols or alludes to equivalents or atomic weights; his days were spent in patient investigation, experiment and research, and in this practical work he was exact, methodical, and versatile. Men who knew him, and knew well, have said :—"If ever there was a genius, Andreas Kurtz was one"—"As an inventor and investigator, I never knew his equal."

HENRY DEACON.

HENRY DEACON

HENRY DEACON.

A philosophical mind applied to the arts and manufactures, to commerce and to public affairs; such was Henry Deacon. He was born in London on the 30th July, 1822.

An old and intimate friend of the family writes:—About 1680, a William Deacon was born at Crawford, Northamptonshire; he is said to have invented some weaving machinery, which was broken up by the populace, as they said it took the bread out of poor men's mouths. His son William lived at Kettering, Northamptonshire. I believe he made cloth. He and his wife lived 56 years together, having 12 children, five of the sons grew up, and all came to London; they were quick, versatile, and inventive. They all made money, though some of them lost it again; one of them established "Deacon's Coffee House," another made hot-air pipes and heating and ventilating apparatus, another wrote a book on conical wheels. The youngest, Daniel, apprenticed to a watchmaker, became one of the largest carriers, before railways. The mother

(Hannah Bentford) was always very much thought of by her sons, and there is an interesting letter of hers extant which gives a curious insight into the life of four generations since. Henry Deacon, of Appleton, was grandson of two of these brothers, one being his father's father, and the other his mother's father. His father and mother were therefore cousins.

Henry, when quite young, was much with his mother's father, Daniel Deacon, with whom he was a great favourite, at Tottenham, and went to a Quaker's school."

The whole system of education in those days widely differed from that in vogue to-day. Schools in the subjects of instruction, in the methods of imparting knowledge, in the discipline, in the buildings and appliances, in the very aims and ends of all school-life, were totally unlike anything which has fallen to the lot of the present generation.

The mass of the people were densely ignorant, the key of knowledge was not to be entrusted to the custody of the common folk, they would admit themselves to paths in which Providence never intended them to walk. Book-learning would unfit the working classes for hand labour, and so popular education not only was not promoted, but it was absolutely condemned as a project of unpractical men, schemers, and Radicals. As soon as the children of the lower classes were strong enough to work, aye, and often long before, they were sent to the factory, the forge, the mine, to labour out long, weary days, and to grow up acquainted only with what they could learn in following their daily toil. This ignorance of the poorer classes had its effect on those above them; a prolonged school life was looked upon as the heritage and the prerogative of the rich, it was presumptuous for the tradesman or the farmer to give his boys and girls a good "schooling," and so it was the common thing for children to be taken early from school. This was the lot of Henry Deacon.

The boy had shown a taste and talent for mechanical subjects, and had given such indications of character that his parents were enabled to discern his vocation, and apprenticed him to the well-known engineering firm of Messrs. Galloway and Sons, of London. At 14 years of age he stood at the foot of the ladder which was to conduct him to the position of an accomplished mechanic.

It was whilst spending his days at the bench in the Galloway's shop, that he attracted the notice of the master who gave tone and colour to his whole future career. At the Royal institution "the greatest experimental philosopher the world has ever seen," was engaged in his vast and profound researches. Michael Faraday was an intimate friend of the Deacon family; he noticed the bright boy and drew him to his side, gave him access to his laboratory, and encouraged him to apply himself, as far as his time permitted, to chemical and physical science, becoming his tutor, directing and superintending his studies and experiments.

During the boyhood which he spent in London, Henry Deacon lived in the sunshine of the splendid genius of Faraday. The influence of this contact is manifest in the mental development of the pupil as well as in the character and peculiar features of his life-work. Faraday was no mere experimenter. Professor Tyndall says of him: "Faraday has been called a purely deductive philosopher. A greal deal of nonsense is, I fear, uttered in this land of England about induction and deduction. Some profess to befriend the one, some the other, while the real vocation of the investigator like Faraday, consists in the incessant marriage of both." Again, "his principal researches are all connected by an undercurrent of speculation. Theoretic ideas were the very sap of his intellect—the source from which all his strength as an experimenter was derived. And so it must always be; the great experimenter must ever be the habitual theorist, whether or not he gives to his theories formal enunciation." "Faraday was more than a philosopher, he was a prophet, and often wrought by an inspiration to be understood by sympathy alone."

On the 19th January, 1844, Faraday gave a lecture at the Royal Institution, entitled, "A speculation touching electric conduction and the nature of matter," and "this lecture," says Professor Tyndall, "reveals the manner in which Faraday himself habitually deals with his hypotheses. He incessantly employed them to gain experimental ends, but he incessantly took them down, as an architect removes the scaffolding when the edifice is complete." Faraday himself, on the same topic says, "I cannot but doubt that he who as a mere philosopher has the most power of penetrating the secrets of nature, and *guessing by hypotheses* at her mode of working, will also be most careful of his own safe progress and that of others, to distinguish the knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws." The method of Faraday in the pursuit of truth was the method of Deacon. The philosopher who made "theoretic divination the stepping-stone to his experimental results" was the father of men on whom the lineaments of his intellectual life were deeply impressed.

But the influence of Faraday was not simply seen in the methods of research and discovery which he pursued, he was an intense lover of order, "which ran like a luminous beam through all the transactions of his life." The most entangled and complicated matters fell into harmony in his hands. His mode of keeping accounts excited the admiration of the managing board of the Royal Institution. His science was similarly ordered.

In his Experimental Researches he numbered every parapraph, and welded their various parts together by incessant reference. His private notes of Experimental Researches, which are happily preserved, are similarly numbered; their last paragraph bears the figure 16,041. What an inestimable privilege it was for the boy, Henry Deacon, at the most impressionable period of his life, to have enjoyed the intimacy and to have had the instruction of such a master.

Misfortune overtook the firm to which Deacon was apprenticed; the business collapsed, and the works were closed. With the opening of the Liverpool and Manchester Railway, on the 15th September, 1830, a new era dawned on the engineering trades, especially in Lancashire.

In 1836 James Nasmyth had started his new engineering works on the banks of the Bridgewater Canal, at Patricroft. For five years he had been at work in Manchester, in a building in Dale Street, Piccadilly, where his business had very rapidly grown from the smallest of beginnings. The premises had been an old cotton mill; a glass cutter tenanted the floor beneath Nasmyth's fitting shop, and one day the floor gave way under the weight of a piece of machinery that was being constructed, and the landlord and tenants agreed that the building was not suitable for the work. The Bridgewater

Foundry was the result. Nasmyth, although quite a young man, had already won a name by his skill, and for the excellence of his workmanship. He was especially sought after for the self-acting tools which he made. The increasing business demanded a division of labour, and a partner was selected, a young man who had served his time with Messrs. Yates and Cox, iron merchants, Liverpool, Mr. Holbrook Gaskell. He introduced some capital into the concern, and his business capacity and training fitted him to take charge of the counting-house.

When J. Galloway and Sons failed, the apprenticeship indentures of young Henry Deacon were transferred to Messrs. Nasmyth and Gaskell. He left London and settled at Patricroft. It was about the time that Nasmyth made the first drawing of his celebrated steam hammer that Deacon entered his employ. That drawing was a testimony to the ability of the designer. It was to forge an intermediate paddle shaft for that leviathan, as she was then regarded, the "Great Britain," that the steam hammer was devised. The work needed was laid before James Nasmyth, he took out his "Scheme Book" and therein he sketched his steam hammer. The date of that sketch is November 24th, 1839.

M. Schneider, accompanied by his mechanical manager of the Creuzot works in France, visited Patricroft. Nasmyth's design was not taken up in England, no one wanted it, and no hammer was made, but when on a visit to France, he called at Creuzot, and there saw that M. Schneider's engineer, who was with him at Patricroft, had carried out most successfully Nasmyth's idea.

It is said that Deacon made the first model of the steam hammer for the patent.

Nasmyth was no unworthy successor to Faraday, to be entrusted with the training of the lad who was to leave his name and mark in one of the cardinal manufactures of Lancashire; and the youth who had sat at the feet of Faraday would know right well how to appreciate the character of Nasmyth, and to make the most of the opportunities which were afforded him at Patricroft.

There is a letter from Faraday to Nasmyth dated 29th May, 1847, which is of some interest, showing how these two men, who were Deacon's teachers, regarded each other. He says, "If ever I come your way I hope to see your face; and the hope is pleasant, though the reality may never arrive. You tell me of the glorious success of your pile driver, it must be indeed a great pleasure to witness the result. Is it not Shakespeare who says 'The pleasure we delight in physics pain'? In all your fatigue and labour you must have this pleasure in abundance, and a most delightful and healthy enjoyment it is. I shall rejoice to see some day a blow of the driver and a tap of the hammer. You speak of some experiments in tempering in which we can help you. I hope when you come to town you will let us have the pleasure of doing so. Our apparatus, such as it is, shall be entirely at your service. I made, a long time ago, a few such experiments on steel wire, but could eliminate no distinct or peculiar results. You will know how to look at things, and at your hand I shall expect much. Here we are just lecturing away, and I am too tired to attempt anything. much less to do anything just now; but the goodwill of such men as you is a great stimulus, and will, I trust even with me, produce something else praiseworthy."—Ever, my dear Nasmyth, yours most truly,

M. FARADAY."

The training and experience which Henry Deacon had had, enabled him to obtain an appointment as a manager in the glass works of Messrs. Pilkington Bros., St. Helens. He went to St. Helens about the year 1848, when he was about 26 years of age.

Deacon would especially have had to plan and superintend machinery for smoothing and polishing "German Plate." In those days the manufacturing of glass was a very "pottering" affair compared with what it now is. Small furnaces, little pots, imperfect combustion, inferior machinery, badly arranged grates, dark, low, stuffy, dingy, dimal sheds, and few, if any, appliances for economising labour. This was the state of affairs forty years ago, when Henry Deacon was employed in the glass works.

In glass making, and in St. Helens, he made no very decided mark by any lasting and original invention; he was then a young man and had much to learn, especially in a business to which he had not been brought up; but wherever he went his personality made itself felt. His quick intellect, his philosophical and speculative habit of mind, his sharp, incisive manner, his thorough careful training, and a certain restless enterprise of character, these would be infallible indications that he would sink into no rut of sheer common-place.

Messrs. Pilkington permitted their manager to utilize their laboratory for research and experiment, and Deacon had the clear foresight to discover the dawning greatness and importance of the alkali trade, and that to him it held out the promise of far greater possibilities than the glass trade. It could be entered on with less capital and on smaller lines; it was a new, and at that time an almost unbounded field.

At about the time that Deacon was with Messrs. Pilkington, there was a man in the employ of Mr. Kurtz, who also was wide awake to what was coming, John Hutchinson. He recognised the splendid position of Widnes as a seat for the manufacture of chemicals. Giving up his situation at St. Helens he went to Widnes, and there in an exceedingly small way commenced business on his own account.

When he needed a manager for the works that he had founded he selected Henry Deacon.

In those days, at least, he would be a man to recognise ability, and it is a tribute to the capacity of Deacon that he was selected by Hutchinson to manage his works.

But Deacon was not the man long to wear the yoke of service; he had in him those qualities that cannot be restrained; a consciousness of power, an active, energetic spirit, no lack of ambition, and a certain restlessness under restraint that made it more congenial to him to rule than to be ruled. John Hutchinson, too, was hardly the man who could control or even co-operate with one of Deacon's character and culture, and so they parted, and Deacon was joined in partnership by his former employer at St. Helens, the younger of the brothers Pilkington, William, of Eccleston Hall, and they started the chemical works at Widnes. The site was everything that could be desired—a railway on one side and the canal on the other. When the land was first acquired, it was never contemplated to what extent that insignificant venture would attain: to-day, large as the area covered by the works is, it is inconveniently restricted, and the plant has to be arranged so as best to economise the space.

Mr. William Pilkington withdrew from Widnes, and Mr. Deacon in the year 1855 was joined by his old employer, Mr. Gaskell, who dissolved partnership with Mr. Nasmyth after they had been connected for sixteen years. The reason of Mr. Gaskell's retirement from the firm of Nasmyth was a dangerous illness, which his medical man feared would compel him to retire altogether from active life; happily he recovered from this serious breakdown, and such was the opinion he had formed of Henry Deacon when he was in the shops at Patricroft, that he was now prepared to become his partner, and to place his capital in the concern, to carry on the manufacture of alkali, as Deacon & Co., subsequently Gaskell, Deacon & Co.

Widnes was at this time a centre of attraction in the chemical world, not merely on account of the growing prosperity of the place, but the inventions of William Gossage were drawing the attention of all manufacturing chemists to the complete revolution which his discoveries would bring about in several industries. In 1853, Gossage was the first to invent the process for producing caustic soda as an article of commerce, on a large scale. The great importance of this invention was at once discerned; caustic soda would be an article for which there would undoubtedly arise a large foreign demand; there would be an export of caustic and a consequent decrease in the import of tallow, for those nations that had hitherto imported their tallow would be our purchasers of caustic soda and make their own soap.

Gossage's caustic soda also affected to an enormous extent the paper trade. It was just at the time when Gossage was bringing out his great and valuable inventions, that Gaskell, Deacon and Co. commenced their business. They caught the tide of fortune at the flood.

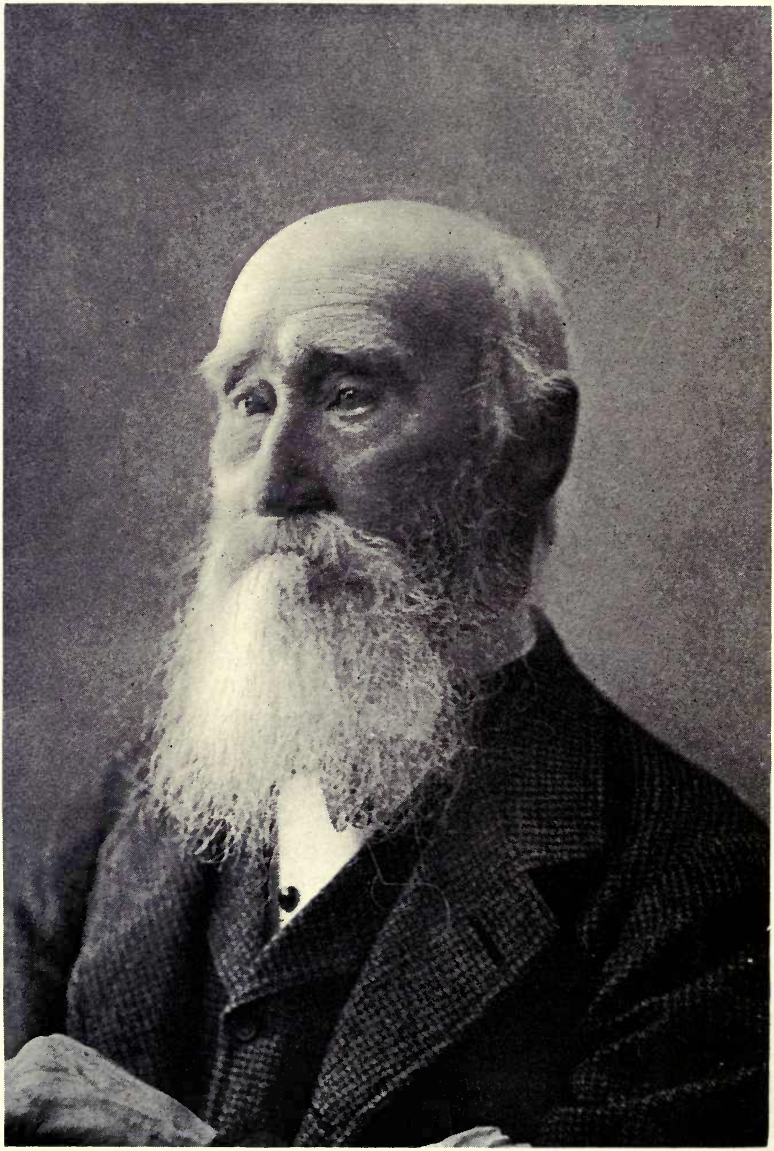
Muspratt, Gossage, and Deacon, and probably it would be unfair to exclude Hutchinson, were the men who laid deep and strong the foundations of the renown and prosperity of Widnes. They had something to work for, there was the vision of a golden age before their eyes; impelled by genius and energy, and drawn forward by the prospect of a limitless field of enterprise, they realised the greatness of their opportunity, and for many years Widnes became the scene of ceaseless activity, of fertile invention, and of wonderful and rapid development. The works grew, new processes were introduced, new apparatus sprung up; chemists were busily engaged at researches in the laboratories, engineers were scheming plans for economising labour and adapting plant, the dock and canal became inadequate to the increasing requirements of the district, houses and streets spread themselves over the open spaces around the works, and in a very few years Widnes was transformed from a pretty, sunny riverside hamlet, with quiet sleepy ways, into a settlement of thousands of labouring men, mostly Irish, with dingy unfinished streets of hastily constructed houses, with works that were belching forth volumes of most deleterious gases and clouds of black smoke from chimneys of inadequate height, with trees that stood leafless in June, and hedgerows that were shrivelled in May. The air reeked with gases offensive to the sight and smell, and large heaps of stinking refuse began to accumulate.

But the minds of men were full of projects, and the air was full of stir, and amongst those busy minds there were none more keenly interested in everything that was going forward than Henry Deacon. He did not underrate the importance of having capable and highly-trained men in his laboratory; to him a chemist was not merely a man "who could wash out bottles;" and he was able to understand and appreciate their labours and worth. In laying out works and erecting plant there was no one in Widnes who had received such a training as he had. His experience at Patricroft and St. Helens had fitted him to manage men, and in all that pertained to business, he was discerning, courageous, and accurate.

Like his friend and neighbour, William Gossage, he frequently availed himself of the Patent Laws. As we have already stated, it was in 1853 that Deacon, in conjunction with Mr. William Pilkington, took land at Widnes and erected works to make carbonate of soda. They attacked the Dyar and Hemming ammonia soda process.

Harrison Grey Dyar and John Hemming, of London, patented their process on the 30th June, 1838. Delaunay, acting as their agent in France, took it out in that country on the 27th May, 1839, and on the 18th May, 1840, patented improvements of the same process, and in a small works in Whitechapel they tried to carry it out as a commercial undertaking. As such, however, it was not a success, the loss of ammonia was their stumbling block. The chemical reactions were complete, but they failed in the adaptation of their plant. Muspratt followed in the footsteps of Dyar and Hemming, and under the superintendence of the skilled chemist, James Young, he put up a works at Newton, on the banks of the canal, between St. Helens and Warrington, but after an expenditure of about £8,000, and two years' experience, it was abandoned in favour of the Leblanc process. Chemists were not disheartened by these failures; Kunheim, Seybel, Bowker, Gossage, Turck, Schloesing, and Deacon, discerned the great value of the invention, and persistently worked at it.

The year 1854 saw a revival of the endeavours to displace the Le Blanc process. On the 21st February in that year, William Gossage led the way with his patent for producing the carbonate and sesquicarbonate of soda and potash, and the bicarbonate or sesquicarbonate of ammonia in aqueous solution. He was followed by Turck on the 26th



HOLBROOK GASKELL

(President of the United Alkali Co. Ltd., 1907.)

May, by Schloesing on the 21st June, and by Henry Deacon on the 8th July. Deacon's plant resembled the arrangement as described by Schloesing and Rolland, only that Deacon took a step far in advance by using carbonic acid under pressure. But the experiment of 1854 was not more successful than that which preceded it.

Mr. Pilkington soon discovered that protracted experiments and deferred profits was the prospect before them; this did not suit him, and so he severed his connection with Henry Deacon, leaving him alone to do as best he could with his ideas and his hopes—but difficulties, disappointments, and desertion did not daunt him. Mr. Holbrook Gaskell came to his aid, and found capital to continue the work, but the expenditure needed was more than he had anticipated, and the obstacles to be overcome seemed interminable, so that he too lost patience, and declared he would be no party to any further prosecution of this process. Deacon pleaded earnestly that another thousand pounds might be spent, he was confident that amount would avail, but Mr. Gaskell was firm; unless Deacon would abandon his ammonia process, and follow the example of his neighbours with the Le Blanc, he would withdraw.[1] Deacon was compelled to yield, although fully assured that perfect success would have resulted from a little more perseverance; and so the plant on which some thousands of pounds had been spent, and on which he had bestowed such thought and pains, had to be abandoned and demolished; and sulphuric acid chambers, with saltcake pots and condensers, black-ash furnaces, lixiviating tanks, and vat waste had to be endured, whilst the beautiful and most profitable ammonia process was a treasure to be hidden for ten years longer, reserved for Solvay and for Brunner and Mond.

From 1854, Deacon's career and work can be best seen and followed by an examination of his patents. There is a remarkable sequence and development in all his inventions; they are not spread over a great variety of subjects—they are concentrated around the most important points of alkali manufacture. They are not mere amend-

1. I find that I was mistaken, in my former edition, in my remarks on Mr. Gaskell's decision regarding the ammonia soda process. The Le Blanc process at that time was very profitable, and any further expenditure on the ammonia soda process would have meant the neglect of a certainty for a possibility. Mr. Gaskell's experience and judgment had taught him how easy it is to under-rate difficulties and under-estimate expenditure. I have no doubt that Mr. Gaskell came to the only decision possible under the circumstances.—J. F. A.

ments of other men's designs—they are profoundly original in conception and in execution. They are the outcome of philosophical reasoning and of scientific hypotheses, as well as of patient and masterly investigation and experiment. The subjects which he treated are not exhausted; a minute and careful examination of some of Deacon's inventions will show that he only broke ground for a future generation, and has left the promise of a rich reward to the men who are capable of following in his footsteps.

It is as no mere useless inventory of invention that we give the following record of his discoveries as they were patented:—

No. 1,504. 12 December, 1854. This is Deacon's patent, although taken out in the name of his patent agent, John Henry Johnson, London. This invention relates to the application of the gases arising from the combustion of fuel or fuel gases in the manufacture of carbonated compounds of soda, by double decomposition with corresponding compounds of ammonia, as is well understood by practical men. The fuel gases and ammonia in any convenient form are introduced into suitable vessels containing the salt of soda which is to be decomposed; the object being by aid of the fuel gases, to form marketable compounds of soda in the presence of or by the reaction of ammoniacal compounds. An atmosphere of the fuel gases may also be used during the completion of such process or manufacture. Previous to the final escape of the uncombined or unabsorbed fuel gases, they are passed through or in contact with a solution capable of retaining any ammonia contained in the gases. It is preferred to form these compounds with the fuel gases under pressure; coke or anthracite coal is preferred as fuel, the combustion being effected with a strong draught, whilst smoke is to be avoided as much as possible. The heat arising from the combustion of such fuel may be economically employed in heating water, burning limestone, or for any other purpose requiring but a moderate heat, and wherein the fuel gases are not deteriorated or injuriously contaminated.

No. 2971. Nov. 30, 1857. A peculiar construction of apparatus for boiling caustic soda or soap liquors so as to prevent any waste by boiling over, or in effervescence.

No. 1404. June 21, 1858. The purification of alkaline lyes, by the addition of protoxide of iron to such lyes at a temperature not exceeding 130° Fahrenheit. Separating at a temperature under 130° the precipitate obtained, and then decanting off the alkaline solution, and lastly using the precipitated sulphides by roasting them with an alkaline chloride to obtain an alkaline sulphate.

No. 352. Feb. 9th, 1860. Taken out by Henry Deacon and Thomas Robinson (Robinson, of Robinson and Cooks, engineers, St. Helens, and of Hargreaves and Robinson, of Widnes). It was for the use of a cupola or separate combustion chamber, and blasted air, in combination with any decomposing apparatus, reverberatory or other furnaces used in the manufacture of soda, for the purpose of decomposing the salt or salt cake, roasting the salt cake, making the black ash, and evaporating, or finishing, or calcining.

No. 1030. 10th April, 1862. In the ordinary manufacture of caustic soda the caustic liquors are evaporated, and during evaporation the salts precipitated are removed, and evaporation is continued until the residual liquors become so concentrated as to solidify on cooling, or until so much of the water is driven off as is required. The improvements specified are:—stopping the evaporation at an earlier stage, removing the salts precipitated during evaporation as usual, and continuing the evaporation or concentration, until the caustic alkaline liquors will deposit crystals of hydrated caustic soda on cooling to the ordinary atmospheric temperature. The mother liquor to be used for subsequent operations or finished alone.

No. 1,030. 10th April, 1862. A process of obtaining crystals of caustic soda containing more than one atom of water by cooling caustic soda liquors, and then removing the last portions of mother liquors from caustic soda crystals by means of an elevated temperature below but approaching to the melting point.

No. 1,455. 14th of May, 1862. It is well understood that certain colours are produced, by the action of an elevated temperature on mixtures of clays, with sulphate or carbonate of soda, or both, of sulphur and of carbon, atmospheric air being excluded during the first heating. The patent specified improvements in the vessels or retorts in which these substances are heated, so that the materials during the process might be easily inspected, stirred, &c., during the heating; and also the method of washing the colours in circulating lixiviating tanks.

No. 1,403. 29th April, 1868. Chlorine is usually produced by heating peroxide of manganese in aqueous solution of hydrochloric acid, the materials if perfectly utilized yielding one equivalent of free chlorine and one equivalent of chloride of manganese in solution (as a by product of little value) for every one equivalent of peroxide of manganese and two equivalents of hydrochloric acid employed. The patent specifies the heating of oxide of copper or oxide of manganese or other similar oxides or compounds in a current of hydrochloric acid gas and atmospheric air. In this manner the whole of the hydrochloric acid gas may be decomposed at a moderate temperature, say about 400° Fahrenheit; the chlorine of the acid gas is set free, and the hydrogen of the acid gas combines with atmospheric oxygen. The mixtures of oxides remain unaltered, and the process becomes continuous. Water that is formed is removed by condensation, and the chlorine absorbed and utilized in any well-known manner.

In this process oxygen is the element required to unite with the hydrogen of hydrochloric acid; and one at least of the compounds employed must be of such a character that it will have the power of uniting with oxygen, either at the ordinary temperature or when heated, and when it is afterwards heated with hydrochloric acid, and heated either alone or in the presence of oxygen it must possess the property of decomposing such acid, and of ultimately yielding chlorine as one of the results of decomposition. By applying this test to the metallic compound employed, the suitability of the mixture will be ascertained without difficulty. "My process is essentially a continuous one, and it depends upon the power of one or more of the compounds employed to cause the various reactions just described. The hydrochloric acid and air, which is by preference previously heated, are passed over the heated metallic compounds, which absorb more or less of the hydrochloric gas and become saturated therewith, the saturation depending in part upon the temperature employed, and then so long as the temperature remains constant no further change is noticeable in the compounds, but the hydrochloric and the oxygen of the air react on each other in the presence of these compounds, and a continuous stream of hydrochloric acid, and air in entering the apparatus employed, results in the issue of a continuous stream of chlorine and of the vapour of water, mixed of course with nitrogen of the air, unused oxygen, and hydrochloric acid." A copper salt was selected from a large number of substances, because it acts at a comparatively low temperature. Pieces of burnt clay were saturated with a solution of the salt.

No. 2,469. 13th September, 1870. Improvements in the apparatus required in working the process described in No. 1,403.

No. 2,476. 14th September, 1870. The "Deacon" bleaching powder chamber with its arrangement of shelves, for producing strong bleaching powder by the use of chlorine when diluted with inert gases.

No. 2,641. 5th October, 1870. For improvements in the manufacture of sulphuric acid, by employing salts of copper in conjunction with hydrochloric acid and sulphurous acid gases together with oxygen, or air, so that sulphuric acid and chlorine may be produced.

No. 753. 20th March, 1871. This invention is for the production of sulphuric acid by the employment of salts of copper in conjunction with sulphurous acid gas together with oxygen or air. The process is to impregnate pieces of burnt clay with a strong solution of sulphate of copper and dry them; these are placed in a tower, and through them are passed heated mixtures of sulphurous acid gas and oxygen in equivalent proportions with or without super-heated steam, and sulphuric acid is produced, and can be condensed in any convenient manner. The success of this invention depends not only upon the use of such a chemical re-agent as sulphate of copper, but also upon the temperature at which it is performed, which temperatures vary between the point at which sulphate of copper begins to be decomposed in a current of hot air, and about that point at which tin melts, so that the sulphate of copper may continue and remain sulphate of copper.

No. 1,682. 27th June, 1871. Improvements in apparatus for producing chlorine and sulphuric acid; this apparatus applies to the process previously specified.

No. 691. 15th March, 1871. The employment in the manufacture of bleaching-powder, and of sulphate of soda, &c., of inclined shelves on which are placed solid material, over which gases pass and act on the solid materials—chlorine on dry slaked lime, sulphurous acid gas, air and vapour of water on common salt; also drying diluted chlorine by means of chloride of calcium or sulphuric acid.

No. 1,908. 21st July, 1871. This invention consists in causing heated sulphuric anhydride (SO_3) to pass over or through heated chloride of sodium, by the reaction that takes place the sulphate is formed corresponding to the chloride employed and chlorine is liberated. The working of this process is connected with processes previously mentioned which had been patented. For the complete conversion of an alkaline chloride (MCl) into its corresponding sulphate (M_2SO_4) with the liberation of its chlorine (Cl), one equivalent of oxygen (O) is required, for every equivalent of sulphuric acid (SO_3), or two equivalents of oxygen (2O) for every equivalent of sulphurous acid (SO_2), or four equivalents of oxygen (4O) for every equivalent of sulphur (S), or is expressed in the following formula:—

$$S + 4O = SO_2 + 2O$$

$$SO_2 + 2O = \text{(ultimately) } SO_3 + O$$

$$SO_3O + MCl = \text{(ultimately) } MSO_4 + Cl.$$

The necessary amount of air or oxygen may be introduced at intervals, and need not be more than an equivalent, but I prefer that before the sulphurous acid is first specially treated for the production of sulphuric acid therefrom, it should be mixed with the full equivalent quantity or number of equivalents of air or oxygen, but preferably with a quantity in excess of an equivalent quantity or number of equivalents, but it is not usually convenient to add the whole of this air or oxygen to the burning pyrites or sulphur, and so I arrange the apparatus and materials that the heated gases are brought in contact with heated common salt and over or through heated sulphate of copper (or other similar substances), to form anhydrous sulphuric acid from heated sulphurous acid and oxygen, these substances to be kept separate from the alkaline chloride.

The claim put forward in this patent is: The manufacture of the sulphates of the alkalies and of chlorine, and of bleaching powder, by causing heated anhydrous sulphuric acid, mixed with air or oxygen, to come in contact with the chlorides of the alkalies at an elevated temperature, such mixture with air or oxygen being effected either before or during the decomposition of the chlorides under treatment, when such chlorides and the sulphates resulting therefrom are kept separate and distinct from the solid materials used to form or promote the formation of anhydrous sulphuric acid.

No. 2,667. 9th October, 1871. This process is to manufacture the alkaline sulphates by causing heated sulphuric or sulphurous acids, mixed with oxygen and with vapour of water, to pass in succeeding alternations in contact with certain chemical substances called catalytic substances, and in contact with alkaline chlorides, which are kept separate from the catalytic substances.

No. 3,309. 7th Nov., 1872. Bleaching liquor is usually formed by causing a mixture of caustic lime and water to absorb chlorine; this patent is to use certain kinds of carbonate of lime to replace wholly, or in part, the caustic lime usually employed.

No. 505. 11th Feb., 1873. This is to accelerate the "Deacon" process by mixing the active catalytic substance, sulphate of copper, with other substances such as sulphate of soda which when used alone are inactive and inert.

No. 3,092. 20th Sept., 1873. This

invention relates to the "finishing" of salts obtained in the manufacture of alkali by causing heated air to pass through them when at an elevated temperature.

No. 3,253. 7th Oct., 1873. This specifies improved apparatus in working the "Deacon" process for the utilising of heat evolved in the decomposition of the hydrochloric acid.

No. 3,336. 15th Oct., 1873. A patent for an improved arrangement in connection with the black ash revolver to secure more perfect combustion.

No. 163. 12th Jan., 1874. In working the "Deacon" process, the porous substances need reviving, that is re-impregnating, and this specification describes a method of doing this by means of steam.

No. 332. 28th January, 1875. This specifies an improvement of apparatus for withdrawing the porous substances employed in working the "Deacon" process.

No. 906. 11th March, 1875. Here the claims are for an invention in the manufacture of chlorine by a mixture of common salt with a compound of copper in conjunction with air and hydrochloric acid, the same being obtained from a separate source.

No. 1,632. 3rd May, 1875. The use of

burnt pyrites, "cinder," instead of clay for the absorption of the copper salt in the "Deacon" process.

No. 1,909. 25th May, 1875. The use of magnesia for a similar purpose.

No. 2,003. 1st June, 1875. The purification of the hydrochloric acid used in the "Deacon" process from sulphuric acid.

No. 3,920. 11th November, 1875. Improvements in the apparatus for containing an arrangement of the porous materials used.

No. 176. 8th July 1876. Deacon's "plus pressure" salt-cake roaster.

The object of this invention was to make a "close," "blind," or "muffle" furnace, in such a manner that the gases of combustion should exert a pressure around the muffle, and so that there should be no suction of any gases within the muffle, through any defective masonry.

This was achieved by the patent which claims the novelty of constructing a furnace in such a manner that the fire which is contiguous to the furnace is placed so low in relation to the muffle that the ascending power of the column of hot air over the fire is sufficient so to propel the flame, and other products of combustion through the flues round the muffle, as to prevent the escape of gas from the muffle into the flues.

In the year 1867, Weldon was at work; his labours at Messrs. J. C. Gamble and Sons works, at Gerard's Bridge, St. Helens, were attracting general notice, and manufacturers were beginning to realise the probability that the plan of Gossage, on which success was denied him thirty years before, was now about to be carried out. But Deacon was never content to be a mere imitator; to follow in the wake of other men was distasteful to him, he strove to originate and to lead. To work out his designs he was fortunate at this time in engaging the services of a young chemist, Dr. Ferdinand Hurter. He was a man whose capacity and training Deacon knew how to appreciate, and from the date of the earliest experiments which he entrusted him to make, he had one who could execute his designs, and intelligently carry out his instructions.

Masters are sometimes accused of growing rich and famous on the inventions of their servants; there was no suspicion of this in the initiation or working out of the "Deacon chlorine process;" no one will more readily acknowledge than those who co-operated with him, that it was Deacon who initiated, superintended and directed the experiments, who explained as the result of his own thought and reasoning its philosophy, and who designed its working plant. The reactions were somewhat occult, the plant was involved and complicated, so many points had to be considered in the working, that its advantages were not so readily apprehended as those of Weldon's invention; and before the "Deacon" process was understood, the "Weldon" was widely adopted and at work. Nevertheless, he prophesied that his must be the process of the future, and whereas Weldon's at the best could only give one ton of bleach for 43 cwts. of salt; his would certainly give a ton of bleach for 13 cwts. of salt.

The philosophical character of Deacon's mind is well illustrated in the various papers he read and lectures he delivered. Before the British Association in Liverpool, in September, 1870, he read a paper on "A new method of obtaining chlorine." It was here that he put forth his theory that chemical reactions, as well as mechanical motions, were obtained in obedience to the law enunciated in the parallelogram of forces. "My idea is that concurrent chemical forces unite and are resolved into other equivalent forces. A chemical result, therefore, may be the resultant of indirect forces, or the resultant of many indirect forces acting in many directions; and also the resultant of indirect forces may bring about a chemical result, which lies outside the path or direction of many, and, in some cases, perhaps outside the path of all the forces engaged. That is to say, we may deal with the composition and decomposition of concurrent chemical forces, much in the same way as we deal with these problems in mechanics." "May it not be said that the skilled chemist, like the skilled navigator, can so use the union of forces that by the aid of the wind itself he sails nearly in the wind's eye?"

His lecture given before the fellows of the Chemical Society, June 30th, 1872, on "Deacon's method of obtaining chlorine, as illlustrating some principles of chemical dynamics," is full of abstruse philosophical reasoning on the following points:—

1. As to the most suitable active catalytic substance.

2. Whether the mass or the surface of the substance was the active element.

3. As to the effect of various temperatures.

4. As to the best arrangement of the substances.

5. As to the effects produced in and by currents of gas of different velocities.

6. As to the effect of various proportions of air, or of oxygen and hydrochloric acid.

He supports his thories by an accumulation of results given in tabulated form; and he illustrates his ideas by means of many geometrical diagrams.

He thus states his conclusions:—

1. That the same mixture of gases, and and at the same temperature, the amount of hydrochloric acid decomposed by the acid of a molecule of the copper salt in a given time, depends upon the number of times the molecules of the mixed gases are passed through the sphere of action of the copper salt. Conversely, that the activity of a molecule of copper depends upon the speed with which fresh matter is presented to, and the products are removed from it. Not that force is in this way created, but using Bunsen's words, "Catalytic action is not an equivalent to an unlimited amount of labour, but for every decomposition effected, an equivalent amount of force is absorbed, just as in the case of a weight raised by a falling

body, a force is expended exactly equivalent to the work done."

2. That in long parallel tubes of the same diameter, the number of opportunities of action in the same time is nearly the same at all velocities of the current gas.

3. That in long parallel tubes of different diameters, the number of opportunities of action of each molecule of copper salt is the same when the velocities of the current of gas are in inverse proportion to the squares of the tubes' diameters.

4. That in porous masses the opportunities of action increase with increased velocities of the current gas in nearly direct proportions.

5. That, other conditions remaining the same, the percentage of hydrochloric acid decomposed in any given time varies with the square root of the proportionate volume of oxygen to hydrochloric acid, conversely of course, the percentage of oxygen used varies with the square root of the proportionate volume of hydrochloric acid to oxygen.

6. That the cupric chloride formed bears no definite proportion to the quantity of chlorine produced.

7. That as the sphere of action includes molecules not in contact with the copper salt,

therefore hydrochloric acid must be decomposed under circumstances where the union of either element with the copper salt is impossible, *i.e.*, that the decomposition must in part, if not entirely, be caused by the resultant of the forces engaged, and therefore direct from :—

$$2\ HCl + O \text{ to } H_2O + 2\ Cl.$$

In February and April, 1874, there are two papers, one given before the Warrington Literary and Philosophical Society, on "Thought about Atoms," and the other contributed to the *Quarterly Journal of Science* on "The modern hypothesis of atomic matter and luminiferous ether." His conclusions are: "Tangible matter does transmit forms of motion of all kinds, and appears to be elastic; and if elastic, needs no medium for transmitting motion, and the so-called necessity for the hypothesis of ether disappears. It must then be more philosophical to endow appreciable matter, even hypothetically, with the qualities it appears to possess, than to create matter of an unknown kind in order to endow it with qualities we see, but refuse to appreciate, in matter that lies before us."

These questions serve to illustrate to what an extent his mind had been imbued with the spirit of Faraday. Faraday asked him, when a mere lad, "How it was that snow disappears when the temperatures of the ground and the air are below the freezing point!" The teacher left the question unanswered as a mental exercise for his pupil, to cultivate the habit of observation and reasoning.

Henry Deacon was as practical as he was philosophical; he was no mere dreamer. His chemist, after several days close work on an analysis of ultramarine, a material on which he sometime experimented, and in connection with which he took out one of his patents, brought it complete and exact to his employer, who looked it over, and then handed it back with the remark that caused no little chagrin, "Such absolutely accurate analyses are no use to me, they come a week after they are wanted; I want an analysis at the time, and not days after a thing is done with." On another occasion, leakages in the Deacon chlorine apparatus were causing great trouble. Dr. Hurter complained to Deacon that he could not get the workmen to do their work, so as to make the joints of some pipes tight; "then do it yourself, and when you have

FERDINAND HURTER

succeeded you will be able to make others do it," was the reply.

While engaged on this job, Deacon came into the works with a visitor, Dr. Vernon Harcourt, of Oxford. Hurter was busy at his pipes, and looked as black as a sweep, hands and face and dress resembling those of a furnace bricksetter. In this plight he was introduced to Dr. Vernon Harcourt as "the chief of my laboratory, Dr. Ferdinand Hurter." Deacon doubtless was proud that the most responsible men in his employ were men not above soiling their hands at any work that needed their doing.

One day shortly after he came to Widnes, Dr. Hurter was busy in the laboratory, making some experiments in which he was using bisulphide of carbon. He was carefully distilling this substance and condensing it. Whilst this was going on Deacon came in,

"What are you distilliing?"

"Bisulphide of carbon."

"What for?"

"To save it, and to prevent being inconvenienced by the smell."

"Do you know the value of bisulphide of carbon?"

No really I don't."

"Well you had better ask, and remember your time is of infinitely more value to me than a few ounces of bisulphide of carbon; and another time evaporate in an open vessel." This was a lesson not to be forgotten, its bearings reached far beyond the mere incident in connection with which it was given.

He had a most retentive memory, and he often puzzled those associated with him at the readiness with which he could lay his hand on a book or document, which were not arranged with any pedantic order but piled up on his table or his desk. Once asked how he was able to remember such things he replied, "Oh, I have pigeon-holes in my head, and I have only to go to my memory and look in the right pigeon-hole."

In business he was far-seeing and full of enterprise, keen, precise, and exact. He was not the man to take liberties with. Under the direction of himself and his partner his concern so rapidly developed as to be one of the first in the trade, and for the quality of its products it stood second to none.

He loved an argument, but never for mere arguments' sake; with managers, foremen, and others, he liked to thrash out a subject thoroughly. He had the quickness of preception and alertness of mind of a Frenchman, combined with the laborious painstaking, cautious characteristics of a German, he allowed no detail, however minute, to be overlooked, and whatever he did, he did it with all his might.

He cared for his workpeople, and knew well how to value the services of those who co-operated with him. It was not for the purpose of paying a mere idle compliment that more than once he said: "I wish to record my thanks to my partners for their forbearance during the years over which my researches have extended;" and again, "Whilst I claim the discovery and the reasoning that led up to it, yet all subsequent progress has been the result of constant conference between Dr. Hurter, Mr. Eustace Carey, the manager of the work, and myself, and I am glad to have this opportunity of acknowledging the value of their assistance."

In public life he promoted every beneficent undertaking. He was chairman of the Local Board; to him Widnes is mainly indebted for its waterworks at Pex Hill, which affords the district such an ample supply of excellent water. He was chairman of the first School

Board. These, and indeed every other public movement at Widnes, had his sagacious and enthusiastic support. He was particularly active and anxious for the promotion of the scheme of a Ship Canal from Hale Point, through Dutton and over Widnes Marsh to Widnes, but he was baffled by the opposition of various interests. He was ever on the alert to watch every point that affected the interests of the Widnes traders and manufacturers, not neglecting those of the inhabitants. No Bill came before parliament affecting the district, but Henry Deacon was foremost, either in energetic support or equally energetic opposition. When the St. Helens Railway and Canal was transferred to the London and North-Western Railway Co. by the Act of 1864, so eminent were his services in the interests of the Widnes traders, in securing the insertion of clauses in this Act for the protection of the trade of the district, that they made him a presentation of very handsome plate. He was mainly instrumental in obtaining for Widnes the exceedingly favourable railway rates that it enjoys to-day, and so making its prosperity assured. He infused vivacity and energy into all public affairs, and as a magistrate he was painstaking and fair.

His family in London belonged, with Faraday, to the small sect of the Sandemanians, but he was a liberal churchman, or probably with more accuracy he might be described as a very broad churchman: he had a perfect horror of all cant and shams; in politics he was a philosophical Radical.

It was at the early age of only 53, that his career was cut short; but for several years his health had not been good; he subjected his physical powers frequently to no ordinary strain, the wear and tear was too great, or, as he himself acknowledged when he found his health breaking down, "I have taken too few holidays." We surmise that it was the ceaseless activity of his intellect and his temperament, engaged in undertakings that were varied, difficult, and complicated, needing constant labour and anxious thought, that undermined his constitution, and made him an easy prey to an attack of typhoid fever, of which he died, after a week's illness, at Appleton House, near Widnes, on the 23rd of July, 1876. He was twice married, to his first wife in 1851, and to his second in 1866. His widow survives him with a family of seven sons and four daughters.

By this brief review of the life of Henry

Deacon, we are impressed by the influence, we might also say the inspiration exercised on a boy's mind, by a great master. Let those appointed to instruct and influence the young ever be our strongest characters and our finest minds: *the teacher's chair is of all places the one where dull common-place is intolerable.*

But Deacon also is a notable illustration of the great advantage of a thorough all round training; his knowledge of mechanics and geometry was good, he was a careful student of chemistry, and a good practical engineer. These acquisitions, with the qualities of indomitable perseverance, unwearying industry, a devotion to duty that might be described as an article of faith, and shrewd common sense, made him a man who has obtained a lasting name in technical chemistry, and who has handed down to posterity, in his numerous inventions, a heritage not soon to be exhausted, or in his own words, "I trust my efforts will only be a prelude to a full generalisation by abler hands."

JAMES SHANKS.

JAMES SHANKS

JAMES SHANKS.

In Lancashire James Shanks, as the managing partner of Crosfields Bros. & Co , won for himself the name of being an exemplary works manager. In this capacity he signalised himself by great industry, energy, tact, and uprightness. For years he made a point of being at the works before the six o'clock bell rang of a morning, he watched the workmen file in to their duties, and if any unfortunate laggard was a few minutes late, he would be greeted with ironical obsequiousness by his master taking off his hat, bowing to him, and saying, "Good morning, sir!" But Shanks was not only an admirable superintendent of men and director of works, he was an excellent practical chemist, and although possessed of but little of the marvellous inventive genius of William Gossage, he was fertile in resource, and has associated his name with one invention of great and abiding utility in the manufacture of alkali, the "Shanks' Vat."

James Shanks was born at Johnstone, in Renfrewshire, on the 24th April, 1800. His father, William Shanks, who belonged to Fife, was a practical millwright and engineer.

In the year 1807 he came to Linwood, a small village in the neighbourhood of Johnstone, to erect and fit up a cotton mill. His ability was discerned, and he was made a partner in one of the large cotton mills of Johnstone. He continued his engineering work, and made machinery for the whole district. He had six sons all of whom were trained up to a practical acquaintance with his business. James Shanks therefore, had the sound practical training of a mechanic's shop, and the engineering knowledge and experience he there acquired proved of great value to him in after life. The routine of the shop was an admirable school for the man who was to make his mark as a capable and highly successful chemical manufacturer. The father selected James, his eldest son, to enjoy the advantages of a University training and to study for the medical profession. He remained at home, assisting his father and learning his business until he was of age. He then proceeded to Glasgow University, and in due time obtained his diploma. Returning to Johnstone, he there entered on his professional career, and for two or three years, was the young doctor of that small manufacturing town. During his medical studies at Glasgow, Dr. Andrew Ure was the professor of chemistry, under whom it was his privilege to be placed.

About the time that Shanks went to Glasgow (1821), Ure was bringing out the first edition of his "Dictionary of Chemistry."

Ure was a native of Glasgow, having been born in that city in 1778. He was undoubtedly an admirable teacher, his works indicate great labour and research, and he was specially accurate in all he did. It is recorded, "he was remarkable for his accuracy in chemical analysis, and it is asserted none of his results have ever been upset."

In these days, in almost every walk of life, men are compelled to be specialists, they have to select some subject with which they shall become thoroughly and profoundly acquainted, but a few of the great names of the past generation have taken a wide survey in the world of science, and Ure was one of these.

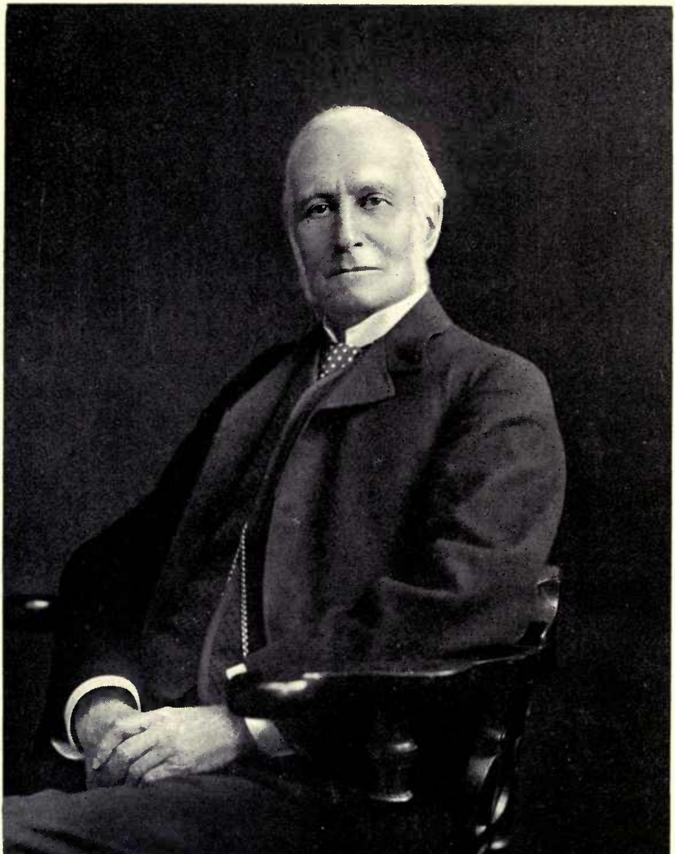
In 1818 appeared his "New experimental researches on some of the leading doctrines of caloric, particularly on the elasticity, temperature, and latent heat of different vapours, and on thermometric measurement and capacity." This subject was brought before the Royal Society and published in their annual transactions.

In 1829, he published his work entitled, "System of Geology," and also works on "The Philosophy of Manufactures, and "On the Cotton Manufactures of Great Britain."

Then in 1830 and 1831 he gave to the world his great book., "The Dictionary of Arts, Manufactures, and Mines," which has gone through several editions, and been translated into most of the European languages. He was the intimate friend of Sir Humphrey Davy, Dr. Wollaston, and Dr. E. D. Clarke. He was a member of the Astronomical Society, and other learned and scientific societies. At Glasgow, he succeeded Dr. Birkbeck as Andersonian Professor of Chemistry.

This, then, was the master under whom Shanks studied, an enthusiastic teacher, accurate, painstaking, laborious, a man of broad culture and wide views, an author who occupies a first rank in technological literature, and whose name we associate with Payen, Knapp, Wagner, Watts, and Muspratt. Shanks was always of an enthusiastic nature, there was a genuine glow of healthy enthusiasm in everything he took up. When he returned from the University, he brought with him some of his master's spirit, and in connection with the Mechanics' Institute at Johnstone, he used to give scientific lectures, always to crowded audiences. Whether it was that chemistry had greater attractions for him than medicine, or whether the pecuniary advantages which the career of a chemical manufacturer appeared to present to him were greater, we know not, but he decided to abandon his profession and started a small Chemical Works in Paisley, where he manufactured Alum and Chromate of Potash. This early venture was not a success, and Paisley was left; a situation was accepted at Worcester, where he remained only a very short time, taking another appointment at Newcastle-on-Tyne. His force of character, intelligence and shrewd common sense, as well as his scientific attainments, were not long in being discovered, and in 1836, when William Gossage was bringing out his valuable inventions, he needed thoroughly capable and intelligent men to erect the plant and carry out the processes he designed. Two of these that Gossage selected were Shanks and Elliott. Elliott afterwards became associated with Russell, and they were the inventors of the revolving black-ash furnace. Together they managed the Greenbank Alkali Works, at St. Helens, where they worked out Longmaid's Soda Process. It is said that Elliott was the first to introduce into Lancashire the Scotch lixiviating vat, which Dunlop had first worked at St. Rollox. Shanks was employed by Gossage in putting up his condensing towers, and his plant for the recovery of sulphur from vat-waste, and whilst thus engaged, he was sent to St. Helens to construct these works for Gamble and Crosfields. This firm needing some one to assist Josias Christopher Gamble in the practical management of their works, as his health was failing, retained the services of James Shanks. When Gamble retired from the partnership with Crosfields, Shanks remained with them and was made a member of the firm of Crosfields, Bros., & Co., a position which he filled as long as he lived.

In the spring of 1841, about the time of his coming to St. Helens he took out his first patent, for improvements in the manufacture of carbonate of soda. These he specifies as being, first, the placing of black-ash or impure



JOHN BROCK
(Chairman of the United Alkali Co. since it was founded, 1892)

carbonate of soda in fragments, on trays in a chamber, making it moist, and passing carbonic acid gas through, until the whole of the soda and lime is carbonated. Second, a lye made from the black-ash is made to percolate through a bed of pebbles, through which carbonic acid is being passed. The soda is perfectly carbonated when the liquor has lost its greenish yellow colour. He says this last method of carbonating the soda is preferred. Mr. John Brock writes, he found this patent being worked at Crosfields' works when he went to them in 1857, and that it was continued until the works were closed. During the year 1853 and 1854, when Gossage had, by his inventions, quickened into life and activity the whole trade, Shanks shared in the enthusiasm of that chemical revival, and once more patented a process for improvement in the manufacture of alkali from common salt, his idea was, that he could work a practical process of producing sulphate of soda by mixing together, alkali waste, common salt, and small coal, using sufficient clay and water to give them cohesiveness, and then heating this mixture in kilns resembling pyrites burners. We have no record that this attempt was attended with any measure of success. One of Shanks' friends was a German, Baron von Seckendorff, who lived at Dresden; he was a man of scientific leanings, and inclined to invention, and he appears to have persuaded Shanks to take out for him in this country a patent for an improved mode of manufacturing sulphuric acid, His project was to decompose sulphate of lime, natural or artificial, by means of chloride of lead, and to form chloride of lime and sulphate of lead with hydrochloric acid, and obtain chloride of lead and sulphuric acid, which was drawn off and concentrated. We fancy it must be cited as one of the instances of Shanks' good nature, that he allowed himself to stand sponsor for this idea of his friend. In September, 1858, Shanks patented a process of preparing chlorine by the use of chromate of lime. He placed a quantity of chromate of lime in a stone or other still, and to it added hydrochloric acid, until the liquor became of a grass green colour, when about half the chlorine was expelled, heat was applied by steam or otherwise, either externally or internally, as is commonly practised in bleaching-powder stills. From the residue, chromate of lime was recovered by running it into a tank, adding to it a quantity of hot water and lime by preference to milk of lime, to neutralize the acid, and adding a further quantity of lime to precipitate the oxide of chromium, and an excess to combine with the chromic acid obtained in the calcination of the precipitate, for the precipitate is collected in a drainer, and afterwards manipulated in a furnace at low redness, with a free admission of air; chromate of lime is thus recovered ready to perform its part in the repetition of the original process in the production of chlorine.

For this patent a medal was awarded Shanks by the Jury of the International Exhibition, 1862, and Dr. Hofmann, the reporter, adverts to it in his report. He says:—"The reaction between hydrochloric acid and chromate of potassium is well known, chloride of potassium, chromic chloride and water being formed with liberation of chlorine.

M. Peligot and M. Gentèle have recommended this process for the preparation of chlorine upon a large scale, but unless there be a demand for the chromic chloride the reaction would probably prove too costly.

An analogous process, patented by Mr. Shanks, appears to be much more practicable. This process consists in submitting hydrochloric acid to the action of chromate of calcium, the products being chloride of calcium, chromic chloride, water and chlorine.

In Mr. Shanks' process the chromic oxide acts as a carrier between the oxygen of the air and the hydrogen of the hydrochloric acid. He does not obtain, however, so much chlorine as the manganic oxide eliminates from the same quantity of hydrochloric acid. For whereas by the action of manganic oxide 16 equivalents of hydrochloric acid evolve 8 of chlorine, Mr. Shanks' process only eliminates 6 equivalents from the same quantity of hydrochloric acid.

It is a question only to be solved by experience on a large scale, whether the cost of roasting the mixture of chromic oxide and lime will not exceed the value of an equivalent quantity of manganese.

It is also doubtful whether the expense of precipitating by lime and roasting be not greater than the expense involved in the regeneration of peroxide of manganese from residues.

Taking into consideration all the circumstances, it seems improbable that this process, ingenious as it is, will be extensively adopted."

We now know how accurate this forecast was, still the patent is an instance of Shanks' inventive ingenuity.

The only other patent with which his name is associated is one "to improve the manufacture of caustic soda and caustic potash," taken out in December, 1863.

His process is thus described:—First, the dessication and oxydation (when such oxydation is required) of a mixture of carbonate of soda or of potash, as the case may be, by heating the same in a reverberatory furnace, or other suitable apparatus with access of air, and then producing a dry compound in a state favourable for the extraction of caustic soda or caustic potash by lixiviation and filtration. Solutions of carbonate of soda or solutions ordinarily occurring in the manufacture of soda, and known as blackish liquors or red liquors, are employed. If these solutions are not already in a state of saturation, or nearly so, they are concentrated until carbonate of soda crystals begin to deposit, when the quantity of carbonate of soda contained in the liquid is estimated, and about forty-two parts of caustic lime is added for each fifty-four parts of carbonate of soda present therein, and mix them well together. A violent reaction takes place, and the mixture becomes a pasty mass. This is treated as above until it no longer shows the presence of sulphide. In working with solutions of carbonate of potash about forty-two parts of caustic lime are used for each seventy parts of carbonate of potash.

Second, the abstraction of solutions of caustic soda and caustic potash from such dessicated compounds by lixiviation and filtration, such solutions being thereby obtained at higher gravities than similar solutions have hitherto been obtained from mixtures of solutions of carbonate of soda or carbonate of potash with lime. The dry powder withdrawn from the furnace is mixed with water or with weak solution of caustic soda, and by injection of steam therein, together with thorough agitation, the mixture is reduced to the consistence of cream; this mixture is transferred on to a filtering bed, under which a partial vacuum is formed.

When the filtration has proceeded to such an extent that the solid matter is no longer covered with the supernatant fluid, water is made to flow into the filtering vessel, so as to keep the solid matter constantly covered with liquid, and continue such addition of water until the solution running off is free or nearly free from caustic soda.

This patent appears never to have gone beyond the experimental stage; we cannot learn that the process was ever adopted in the works.

The one process with which Shanks' name is permanently associated is not connected with any patent. When he came to Lancashire, and for some years afterwards, he found in use the old apparatus employed for lixiviating the black-ash, but when he undertook the management of Crosfield's works he introduced the system of vats which, to the present day, everywhere goes by the name of "Shanks' vats."

The lixiviation of black-ash would at first appear to be an exceedingly simple matter; it is, however, one of the stages in the production of alkali requiring great care and attention. The main points to keep in view are:—

1. To secure a good production by washing out completely the soda contained in the black-ash.

2. To get as much as possible of the soda out as carbonate.

3. To get concentrated liquors.

To achieve these ends it has been found that the lixiviation should be performed:—

(1). As quickly as possible.
(2). With a minimum quantity of water.
(3). At as low a temperature as possible.

There have been three arrangements of apparatus for the purpose.

The first, the oldest, and the one which was universally used in Great Britain, consisted of tanks arranged tier above tier. The black-ash was put into the lowest tank, and after being washed with the lyes from the tanks above it, yielding a concentrated solution, the black-ash was emptied by hand labour with spades from the lowest tank to the one next above it, and so on, but this operation was tedious, costly, and ineffective. It entailed much labour in emptying the black-ash from one vat to another, the handling of the ash caused the balls to break up and so become dense instead of retaining their porosity, and the moist residues were exposed to air, and so the sodium carbonate was to some extent decomposed. The principle of this method was nothing more than mere filtration.

The second arrangement was one invented by Clément-Dèsormes. It was principally used in France, Germany, and Belgium. We believe that Muspratt was the only English manufacturer who ever adopted it. Clément-Dèsormes' method was to place the black-ash balls in perforated boxes that were suspended in tanks, so that the solution in the tanks, when they were full, just covered the black-ash in the boxes.

Clément-Dèsormes had observed that any substance dissolves more rapidly when placed near the surface of the solution than when at the bottom, the reason being manifest, the more material dissolved the greater the density of the solution, and the denser portion sinking, causing the lighter and less concentrated to rise and so come in contact with the substance, or if the tank was being regularly supplied with fresh water or weak lye, then the more dense sinking to the bottom was drawn off into another vessel by a pipe from the bottom.

In some respects this was a great improvement on the original plant; it prevented the breaking to so great an extent of the black-ash balls, and they retained more of their porosity; it also prevented the exposure of the ash to the air for any length of time; but the plant took up too much room, was costly, and entailed too much labour in working; still in some places on the Continent it has only been abandoned during the latter years.

The third arrangement or "Shank's Vats" is the one now universally adopted in Great Britain. Wagner, who was professor of technology at Würtzburg, and whose work, "Chemical Technology," which is translated and edited in this country by William Crookes, F. R. S., states:—"Mr. James Shanks, of St. Helens, Lancashire, was the first to found a rational and economical plan of lixiviation, or what is termed methodical filtration, based upon the fact that a solution becomes more dense the more saline matter it has in solution, and that a column of weak lye of a certain height equilibrates a shorter column of stronger lye;" but Lunge, in his treatise on the manufacture of alkali, states:—"It was usual to call it Shanks' lixiviating process, after A. W. Hofmann, in his report by the Juries of Exhibits in the International Exhibition, 1862—page 22 of the report, upon the authority of Mr. Gossage, had unconditionally claimed the honour for the late Mr. Shanks, of St. Helens.

Muspratt had previously asserted (in his Dictionary II. p. 926) that he knows it is a foreign invention which was introduced by Mr. C. T. Dunlop into the St. Rollox Chemical Works about the year 1843, "but Hofmann's statement was almost universally credited." Lunge then proceeds to say:—"This cannot be done now since Scheurer Kestner (in the 'Bulletin de la Société Industrielle de Mülhouse,' February 28th, 1868), has completely elucidated the matter, and proved Muspratt's statement to be substantially correct." He reports that, in October, 1856, he had visited Messrs. Tennants' works, on a journey to Scotland, in company with Mr. Gundelach, Mannheim.

Mr. Dunlop then showed them the apparatus working by displacement of the liquor, *just in the same form as to-day*, and stated to them that it had been at work for more than ten years (this agrees with Muspratt's year, 1843); moreover, Mr. Dunlop told them that he had constructed the apparatus in consequence of advice given him by Mr. Gundelach on a previous visit.

Mr. Gundelach now informed Mr. Sheurer Kestner that the original idea had been given to him by the well-known physicist, Professor Buff, of Giessen, who a few years before had made a few experiments with it at Kestner's works at Thann, to which no further development was given; on the strength of these Mr. Gundelach had given that advice to Mr. Dunlop."

This explanation by Lunge would appear to prove that to Shanks did not belong the honour of priority of invention.

In the report of the Juries, page 22, there is a note which says:—"The reporter makes this statement upon the authority of his friend and brother juror, Mr. William Gossage, who had most attentively watched the development of the soda manufacture. It deserves, however, to be noticed, that the honour of invention is claimed by others." Notwithstanding Lunge's explanation, we are not prepared to deny to Shanks the originality, if not the absolute priority, of his vats.

The claim of Dunlop was not unknown to Gossage when he asserted Shanks' right to the place of honour; neither is it likely that he could have been ignorant of the fact that Elliott had also introduced similar vats into

Professor H. BUFF
(Professor of Physics, University of Giessen)

the works under his management, for, as we have previously remarked, Elliott was in his employ, and he would be thoroughly acquainted with all improvements that were taking place. He would never have authorised the award of honour to Shanks had he not known—if not of the absolute originality of the idea, at least of the perfection of its application—that Shanks was fully entitled to it. On the authority of Mr. Brock we can state: "Mr. Shanks did not patent them (the vats, &c.), but I have frequently heard him express regret at not having done so."

If James Shanks had not been perfectly convinced that he was the inventor of his vats he would never have expressed regret that he did not adopt and patent as his own the invention of another. Probity and sterling uprightness were strong traits in his character; he was not the man to accept honours and awards which he knew belonged to others; and if Hofmann or Gossage were mistaken, Shanks would have corrected their error, and given the honour to whom it was due.

Professor Buffs suggestions and experiments, to which Lunge refers, do not appear to have been thought very much of by Mr. Gundelach, for they were not followed up or developed by him; and Professor Buff's own colleagues, Drs. Henry Will and Hermann Kopp, the Professors of Chemistry at Giessen, have no knowledge of Dr. Buff having considered himself as the originator of the perfected method of lixiviation. Dr. Buff is no longer with us; we cannot refer the disputed point to him for further elucidation; and we do not feel justified in reversing the verdict of the best instructed and most experienced contemporaries, and shall most certainly attribute to Shanks the honour of being one, at least, who was mainly instrumental in introducing the present perfect arrangement and method of lixiviation, and shall continue to apply to them the term "Shanks' Vats," and not, as Lunge suggests, "Buff-Dunlop Vats."

"Shanks' Vats" have proved successful in accomplishing all that was sought in perfect lixiviation:—

1st. Rapidity of Solution,
2nd. Little water employed,
3rd. Low temperature,

and they have secured:—Good production;

minimum of decomposition; greatest concentration.

As the arrangement is capable of extended application, we draw attention to Lunge's remarks (II., page 468), where he says, "In the soda manufacture, and following its example, in many other cases the circulation of the liquid is caused without any mechanical assistance, simply by its hydrostatical pressure. Singularly enough, this matter, extremely simple as it is, is wrongly explained in Hofmann's Report by the Juries. There the principle of the liquor motion is reduced to the fact that solutions become heavier as they become richer, and that any given column of a weak solution is balanced by a shorter column of a dense one. Hence, in a series of horizontally disposed lixiviating vats, the water level will be lower in each successive vat, viz., highest in that receiving pure water, lowest in that containing saturated liquor. Thus, though the vats be horizontal, a "working declivity" of from 12 to 15 inches is stated to be gained. Now, a declivity, of course, exists, but not a "working" one; the liquor cannot flow from the *weaker* tanks to the *stronger* ones, although their level may be very different if this difference is only caused by that in the specific gravities of the solutions. In the connecting tubes, &c., a certain amount of friction has to be overcome by a corresponding pressure, the tanks must be made higher, and those openings from which the strong liquor issues must be made low enough to satisfy not merely the difference of level between the water and the strong liquor, but also the pressure required for overcoming the friction. *The head of water between the top of the tank and the lateral exit opening is the real moving principle;* if it is made too low, or, if by a partial obstruction of the connecting pipes the friction is increased, the weak tank will run over before the strong ones begins to run."

Dr. Hofmann concludes his remarks on this subject by observing: "It is not only in the manufacture of soda that the process of methodical lixiviation is applicable. It is available in all branches of arts and manufactures, for the economical collection and concentration of all kinds of soluble matter, whenever such matter is diffused in small proportion throughout the substance of bulky, porous, insoluble masses.

Considered, then in its general bearings, methodical lixiviation, as perfected by Shanks, in continuation of Desormes' ever-memorable improvements, is undoubtedly entitled to rank among the most valuable and beautiful of the great typical processes in applied chemistry; and it will probably be regarded by posterity as one of the most important industrial bequests of our age."

Associated with Shanks in the working of the business was Simon Crosfield, who was a kindly, easy-going man; he attended to the commercial routine, but it was Shanks who put all fire and "go" into the concern.

He took into his employ, as a young man, in the year 1857, Mr. John Brock, in whom he found a man after his own heart, and whom he trained to be his successor; what the character of that training was, is seen in the establishment and management of the British Alkali Works at Widnes, which has been under Mr. Brock's direction and management from its commencement.

Shanks and Simon Crosfield were both generous men; the devouring competition of the present day, with its watchword of "The survival of the fittest," and its policy of crushing down into extinction the weak, would have ill accorded with their natures or their principles; certainly they lived in times when the struggle for existence did not appear to be so fierce as it is to-day, but, for all that, we can scarcely conceive such a revulsion of ideas and sympathies in these men, men who, instead of crushing down a weak competition, are known to have given valuable assistance to a young firm just starting in the same business. An unselfish, chivalrous spirit manifested itself sometimes in those days, which might well be treasured as an inheritance more precious even than the most splendid inventions.

"Do as you would be done by," was not then an exploded fallacy.

Amongst his workpeople, Shanks was a strict disciplinarian; there was no laxity or want of vigilance in his management, he expected every soul in his employ to do his duty—he was everywhere, he looked *into*, not merely *at* everything. Still, he was very tender-hearted and felt deep sympathy with the labouring classes. In him the poor ever had a large-hearted and wise friend, and by those in his employ he was most highly respected, one might almost say beloved.

James Shanks will ever be remembered by those amongst whom he moved as one of the cheeriest and most genial of men, full of kindliness, and possesed of a quaint bright humour; fun twinkled in his eye, and even in his more serious moods there was a sprightly playfulness in his manner.

He paid little atteution to mere conventionalities, and of appearances he was utterly regardless. He might be often seen driving through the town with articles on the seat of his open carriage that he had purchased at his baker's or his grocer's.

He was no worshipper of the Sartor; the importance or dignity which dress could confer went for very little in his eyes; he had a supreme contempt for the dandy, his estimate of men was akin to that of his nation's bard :—

> "The rank is but the guinea stamp,
> The man's the gowd for a' that."

James Shanks was intensely social, he delighted in entertaining his numerous friends. He had acquired the art of making the gatherings at his house extremely interesting; he himself was a centre of vivacity and good humour. He usually was enthusiastic over some new philosophical or scientific apparatus or contrivance. The gyroscope was a great delight to him. Then he frequently managed to include amongst his guests some one or two who could give special interest to the gathering—sometimes a traveller who had come home from some perilous expedition, or a philanthropist full of some new scheme of beneficence. The evenings were seldom dull, and never commonplace. Shanks himself was so delightfully unaffected and free from all self-consciousness.

But his sympathies were far too broad to allow him to confine his social gifts to a mere circle of private friends.

His connection with the Mechanics' Institute of his native town when he left college, and when mechanics' institutes were a novelty, gave him a life-long interest in those institutions, and their motto very truly expressed what Shanks ardently desired and ceaselessly sought to accomplish: "To make the man a better mechanic, and the mechanic a better man."

For many years he was the president of the Mechanics' Institute at St. Helens, and together with others, amongst whom may be mentioned Messrs. Watson and Wilson, of the Bridgewater Works, and the brothers Lacy, who, for so many years, have done such splendid service in connection with popular education in St. Helens, made it a very important and most valuable agency. It supplied the town with a good public building, fine assembly-room, a public library, numerous classes, and regular series of public lectures.

This was the excellent public work which Shanks did in St. Helens, it was congenial to him in every respect, it was work for which he was admirably fitted. He never accepted any public position in municipal affairs, but spent his energies in philanthropic and religious work. Shanks was a Baptist, and he did much to promote the formation of the Baptist Church, which has grown to be a community of great usefulness and considerable influence in St. Helens.

He was a great admirer of the Rev. Hugh Stowell Brown, and every Sunday morning his carriage might be seen rolling along the highway through Prescot, taking him to Myrtle-street Chapel, Liverpool, of which congregation he was a member. Stowell Brown and Shanks became intimate friends, and when Shanks died his friend and minister, together with Mr. William Windle Pilkington, were his executors. Twenty-six miles—rather a long Sabbath day's journey —to attend Church! But this gives an idea of the character, the enthusiasm, the tastes of the man.

Like most Baptists, he was a rigid stickler for principles. At many works much assistance is often obtained by giving what is known as "allowance"; but whatever the consequences, however great the inconvenience, he would never sanction the payment of a farthing.

Church rates were his particular abomination, and although on very friendly terms with Dr. Carr, the Vicar of St. Helens, the Doctor had no more uncompromising and determined opponent than James Shanks. He would have allowed himself to be spoiled of everything he had rather than have paid one penny.

In politics he was a thorough Liberal, indeed a Radical of those days. Free trade, vote by ballot, extension of the franchise, the liberation of religion from state patronage and control, these were the principles he most enthusiastically advocated. Laodiceans, whether political or religious, were utterly distasteful to him, but with a good old Tory like Gaskell Taylor, the eccentric solicitor, and with a fiery, fighting Irish churchman like Dr. Carr, he could be on the best of terms. He did much good service in instructing the working classes in habits of thrift by promoting and assisting the St. Helens Permanent Building Society.

James Shanks was twice married, but never had any children. It cannot be said he wore himself out prematurely by his most active, industrious, and energetic life. Still, probably had he been less lavish of his powers of work he might have been amongst us some years longer; his heart gave way, and with this came a complication of disorders; the bright intellect became dimmed, the retentive memory failed, "the windows were darkened," and on the 13th August, 1867, "the silver cord was loosed, the golden bowl was broken, the pitcher was broken at the fountain, and the wheel broken at the cistern," and the merry countenance, the vivacious manner, the ready thought, the liberal hand, were seen no more, and St. Helens mourned the loss of a man of sterling worth, who had done much to advance her trade, and who left behind him an example of a master who ruled with diligence, but who was a sympathetic friend to all working people, and who did all in his power to elevate their lot, and to make their lives purer, brighter, and happier.

The Shanks family still reside at Johnstone, and carry on the engineering business which their father founded. The concern has attained high repute; it supplies all kinds of machines for engineers and shipbuilders, and, from its shop, work of the heaviest class is turned out. Shanks' brother, Thomas, a man over eighty, still survives, and appears to share something of his eldest brother's freshness and vivacity. There is a letter of his in the Paisley Paper of the 19th February, this year, in which he says: "I have been in Johnstone since 1808. I think it will be interesting to both old and young, as well as to many who are strangers, and may serve as instruction to the rising generation, as to when our now thriving borough made a commencement in 1780, when the first mill was built, and only a few houses required for workers, now having a population of about ten thousand."

James Shanks' qualities are, we believe, to some extent, shared by others of his race; men, hardy, industrious, intelligent, and high principled.

CHRISTIAN ALLHUSEN.

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CHRISTIAN ALLHUSEN.

Christian Allhusen died on the 13th January of the present year (1890), and his will has been proved during the last few days for upwards of £1,126,000 personal estate. His father was a gentleman of fortune, a Schleswig-Holsteiner; he resided at Kiel.

When the armies of Napoleon Buonaparte over-ran Europe they occupied the department of Elbmündungen, and General Davoust was made its Governor. The hardness and cruelty of this man's character had earned for him the name "Butcher." He occupied the residence of the Allhusens as his headquarters. Dispossessed of their home and wealth the family was scattered, and the sons had to seek their livelihood by engaging in business.

As a youth Christian Allhusen obtained an appointment in the employ of one of the first firms in the grain trade on the Continent, Messrs. Koch and Sons, of Rostock. When about nineteen years of age, he came across to England, to Newcastle-on-Tyne, whither two of his brothers had preceded him, and had obtained employment with Messrs. Campbell and Reveley, who also were grain merchants. Christian Allhusen was admitted into the same office, and remained with the firm until his brothers left to commence business as corn merchants on their own account.

Only a very short time elapsed before one of the brothers went to London, the other who remained in Newcastle took Christian into partnership, although he was only twenty-one years of age. But this arrangement did not last long, the senior partner going out of the business and leaving England to settle in Nova Scotia.

When Christian Allhusen was at Rostock, with Messrs. Koch and Sons, the senior clerk in that office was Mr. Bolckow; between these two men an intimate friendship sprang up, and now when Allhusen was left alone, he succeeded in getting Bolckow to join him. These young men did not confine themselves to the grain trade, but struck out as general merchants, also creating for themselves a large business as ship and insurance brokers; the title of the firm was "Christian Allhusen and Co." After a time Allhusen retired from the direct personal management of the grain and shipping business, although retaining an interest in it; in later years the firm was changed from Christian Allhusen and Co. in the first instance to Boldman, Borries and Co., and afterwards to Borries, Craig and Co.

Thus, as a young man, Allhusen had proved himself endowed with a spirit of enterprise, and had shown that he possessed the faculties of a financier and a man of business.

About the year 1840 Allhusen discerned the opportunity which the manufacture of alkali presented, and, although no chemist and with no experience as a manufacturer, he entered on the industry before which such a great future was opening. He and Bolckow severed their connection; the talents of Bolckow were directed to the manufacture of iron, he became the financial partner in the firm of Bolckow, Vaughan; John Vaughan, who possessed the technical knowledge and ability, being the practical manager of the works, he having gained his experience in the employ of Messrs. Losh, Wilson, and Bell, at Walker.

In the same year that Henry Bolckow, John Vaughan, and Joseph Pease held their memorable meeting in Pilgrim Street, Newcastle, when they formed the resolution to smelt the Cleveland ore at Middlesbrough, Christian Allhusen became the possessor of the small chemical and soap works which

Charles Attwood and Co. started in the year 1834. This firm failed to make them a success during the six years they were in operation. From 1840 to 1846 the business was conducted under the title of Allhusen, Turner and Co.; then it was changed to C. Allhusen and Co., and afterwards to C. Allhusen and Sons.

After the Limited Liability Acts were passed, and when the chemical trade was in a prosperous state, this private firm was converted into a joint-stock company, entitled the Newcastle Chemical Works Company, Limited. It was registered on the 30th December, 1871—the capital was £510,000, in 60,000 shares of £8. 10s. each; but in June, 1883, it was reconstructed, the capital being reduced to £300,000, £240,000 being in 60,000 shares of £4 each, and £60,000 in 60,000 shares of £1 each, *the dividend of the preference shares being cumulative.*

This firm has suffered from the general depression which for so many years has rested on the Leblanc soda trade; and although Christian Allhusen has been the chairman of the company, yet with all his astuteness he has not been able to earn for the ordinary shareholders any dividend since the year 1880, and in that year only 1⅓ per cent. was paid.

The policy which this firm has pursued in the conduct of their works has been the prompt introduction of improved appliances and new processes; and Christian Allhusen always acted on the principle that whatever was worth doing was worth doing well. He prided himself on the perfection with which the plant was constructed; he believed that a niggardly management was an extravagant one.

Surrounded by great engineering industries in which every method that science can suggest to economise labour, and to prevent loss by imperfect combustion is adopted, these Tyneside chemical works were similarly conducted. The engineering skill for which Newcastle is so distinguished, not only contributes to create the position which Newcastle engineers themselves hold, but other industries are greatly assisted and advanced by the scientific and progressive mechanical engineering of that district.

In Allhusen's works the system of working mechanical salt-cake furnaces was first wrought out by Messrs. Jones and Walsh, whose furnace was patented in 1875.

At the present day a very large outlay is being incurred to carry out thoroughly Mr. Chance's process of sulphur recovery from vat waste. Then, again, these works have been specially laid out on an extensive scale for the production of caustic soda of high strength. As far as we can judge, this business has not been signalised by any important original discoveries or inventions, but whenever anything new seemed capable of profitable employment it was promptly adopted and effectively carried out. This must be regarded as the principal feature of Allhusen's policy as a manufacturer, to be ever on the look out for improvements, and never to risk the chance of failure by unwise parsimony in construction.

Although Christan Allhusen remained chairman of the Newcastle Chemical Company until the close of his life, he did not continue to reside in Northumberland, but removed to Stoke Court, Slough, Buckinghamshire. His spirit of enterprise led him to accept positions in connection with undertakings that had their origin in London.

At one time we find he was a director of the Royal Aquarium, Westminster, but he does not appear to have found this an object worth sacrificing time and attention to, and his name is only on the list for a short period.

In the north, he connected himself with projects for the supply of water to Newcastle and Gateshead. He promoted the Whittle Dean Water Co., and became a Director of the company into which this developed, the Newcastle and Gateshead Water Co.; but in London he became a director of the "Brazil Great Southern Railway Co.," "The British Land Mortgage Co. of America," "The International Bank of London," "The New Oriental Bank Corporation," and of the "Grand Hotel," the "Hotel Metropole," and others.

The ability that fitted him to attain to the position of director of these various companies enabled him also to utilise the opportunities that were thus afforded him; he was able to get on the course that led him to the golden goal which he finally attained. It was mainly his financial ability, not his success as a chemical manufacturer, that enabled him to amass the fortune which he left behind him. He appears to have had the genius to discern the right moment and the proper sphere in which to act, and his calmness of judgment and promptness of action earned for him the reputation that everything he touched he turned to gold.

But Christian Allhusen not only had the prescience to discern the flowing of the tide that led on to fortune, he had grasped the principles of political economy. The prime of his life was spent in an active political sphere, for Newcastle has always been a school of strong, vigorous, independent, political opinion. Its sons have been stirring politicians, and have seriously studied with earnest purpose not only home affairs, but the wide field of international and foreign politics. At one time David Urquhart made Newcastle the scene of his agitation; then its voice was heard in the manly, independent utterances of Joseph Cowen, and to-day it is represented by the man who, whilst he is an accomplished scholar and a famous man of letters, is also the embodiment of philosophical Radicalism, John Morley.

But not only the place, the time also during which Allhusen lived—especially in his earlier days—was of exceptional interest; it was the day of agitation in favour of the abolition of the Corn Laws, and he was associated with the trade which most of all would be directly affected by any fiscal changes.

He was the contemporary of those great popular agitators, Richard Cobden and John Bright, with whom he was personally acquainted, and he mixed amongst that group of illustrious characters whose names are for ever associated with the great struggle and triumph of Free Trade.

Christian Allhusen became a sound, thorough Free Trader, his clear vision in business enabled him to discern the policy that secures the wealth of nations.

When, in the year 1860, the Cobden Treaty was being negotiated with France the alkali trade of the north was represented by Christian Allhusen, that of Lancashire having selected Mr. E. K. Muspratt to be associated with him.

Mr. Muspratt, recalling the events, says: "We met frequently from 1860 to 1870, when the various commercial treaties were being negotiated, and were together in Vienna, in 1865. I was especially interested with his great energy and commercial ability, and with the thorough grasp he had of Free Trade principles. He was a thorough Free Trader, and I think we made some impression on the French Government, as the suggested 30 per cent. duty was finally reduced to 10 per cent. He took great interest in every movement in favour of free commercial intercourse with the Continent of Europe."

As a merchant, who was recognised as a most astute and shrewd man of business, his influence would be considerable, and his opinion carry great weight.

We learn from the *Newcastle Chronicle* that: "Mr. Allhusen was a large shareholder in the Northumberland and Durham District Bank. When it failed (1857) he propounded a project for certain shareholders to take over the responsibilities of the Consett Iron Works, upon the liquidators of the Bank giving them a guarantee that no call would be made upon the shareholders who did this. The reason for this arrangement was that the iron works had to be carried on, but the liquidators were not in a position to become traders or manufacturers. This daring project, as it was then esteemed, met with a good deal of opposition, but Mr. Allhusen succeeded in inducing the late Mr. R. P. Philipson, Mr. John Benson, and others, to interest themselves in it; and a number of the Bank shareholders took over the works on the condition named. The result justified to the letter all the foresight and business astuteness of Mr. Allhusen. Since its reconstruction there is no enterprise that has been so conspicuously successful in this neighbourhood as the Consett Iron Works."

Were we permitted to enter more minutely into the story of this transaction, we may say it would be a very entertaining and instructive one, and one that would bring out the remarkable astuteness of Christian Allhusen, how well he knew "what he was about."

The following facts may indicate the magnitude and prosperity of this great concern with which Allhusen had so much to do. The Consett Iron Co., Limited, was registered in 1864. The original capital of the Company was £400,000, but it has since been increased at various times (viz., 1866, 1872, 1880, and 1886) to its present nominal amount of £1,000,000. On the old shares the following dividends have been paid:—

1880-1	...	26⅔ per cent.
1881-2	...	20 ,,
1882 3	...	18⅓ ,,
1883-4	...	18⅓ ,,
1884-5	...	10 ,,
1885-6	...	10 ,,
1886-7	...	11⅓ ,,
1887-8	...	11⅓ ,,
1888-9	...	20 ,,

The company is connected with another company, the Consett Spanish Ore Co., Limited. The Directorate is almost the same in both companies. The capital of this mining company is £55,200, and the dividends that have been divided are:—

1880-1	...	10 per cent.
1881-2	...	15 ,,
1882-3	...	15 ,,
1883-4	...	32½ ,,
1884-5	...	36¼ ,,
1885-6	...	42½ ,,
1886-7	...	40 ,,
1887-8	...	38¾ ,,
1888-9	...	37½ ,,

Christian Allhusen was at one time president of the Newcastle Chamber of Commerce, he was for some years a member of the Gateshead Town Council, and was one of the members of the Tyne Commission, but his speciality was finance, and commercial enterprise had for him an absorbing interest.

During his life in Newcastle, at least from 1842, he resided at Elswick Hall. We are indebted to the *Newcastle Journal* for the following information: "When Allhusen took up his residence in Buckinghamshire, Elswick Hall came into the market, and great efforts were made to induce the Corporation to purchase it and convert the grounds into a park. At that time the Corporation were not prepared to do anything of the sort, and, in order to prevent the land falling into the hands of the builders, several public-spirited gentlemen bought it, as they put it, in trust for the people, being sure that sooner or later the Town Council would perceive the advisability of a west end park, and would be convinced of the eminently suitable position of the Elswick Hall grounds. In the course of time the Council were educated up to the point and finally acquired the place, and converted the grounds into the beautiful park which is now the delight of west-enders, and they found in the hall a capital resting place for the Lough and Noble models."

We could have wished that it were a part of our story to tell how by the munificence of the successful merchant and manufacturer the people of Newcastle would remember his remarkable career by a permanent benefaction that would have for generations havepromoted their health and happiness; but such expression of a desire to benefit the people do not appear to have been consonant with his views, and he is not singular in the opinion, that the man who, in pursuit of his own personal enrichment and who with broad and intelligent conceptions of the science of business seeks his own interests, is a benefactor of the people. His prosperity affords occupation to hundreds of families; his wise expenditure of capital fosters invention; his business becomes a nucleus whence other trades and occupations spring, and a fine works erected on a site that, by its suitability, attracts other similar works, gives a character to a population, and tends to promote the institutions that elevate and enrich social life. Undoubtedly, there is much to be said for such acts of benevolence which are prompted by those elementary virtues of sympathy, compassion and goodwill.

It was only as politics were connected with trade that Christian Allhusen took much interest in them publicly. He was the chief promoter of a banquet to Mr. Gladstone at Newcastle in the year 1862, but this was to celebrate the successful conclusion of the Treaty of Commerce with France, a negotiation in which, as we have already noticed, Allhusen had been one of the delegates of the alkali trade.

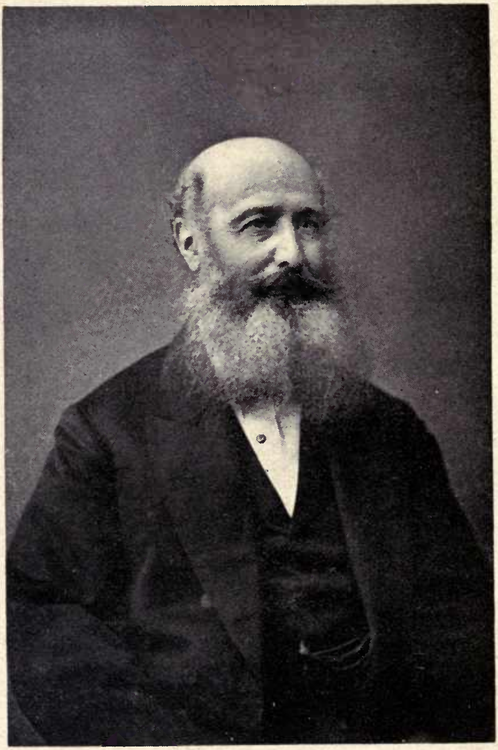
In his later years, when the Irish question had come to the fore, he very naturally sided with the opinions of those with whom, by his wealth and recognised ability, he had succeeded in becoming associated.

County gentlemen and London financiers, whether plebeian or patrician, have little sympathy with the popular movements of the present day; they dread the socialistic spirit which is one form or other is manifesting itself, and he joined the ranks of the Unionists in opposition to the views and policy of Mr. Gladstone.

We can hardly speak of Christian Allhusen as an "Industrial Celebrity;" he has little or nothing in common with Gossage or Deacon, Kurtz or Gamble, Spence or Shanks; these men had made themselves acquainted with chemical science, and they devoted their lives to the application of their knowledge to manufactures; they were inventors, they were engineers, they were trained to direct and manage men, but Allhusen was eminently the man of business, early placed in the counting-house of a great mercantile firm, which proved a scene congenial to the earliest development of his gifts and talents; called almost before he was of age to direct an independent business, thrown upon his own resources, quickened by the spirit of the times and the conditions by which he was surrounded and the men with whom he associated to great and active enterprise in the pursuit of riches; floating his vessel upon the rising tide of a new and lucrative industry; rescuing from ruin a business in which he saw possibilities of great prosperity, and then seizing the most favourable moment to spread all his sail to catch the favouring winds of commercial progress and financial development, he reached the haven of opulence and commanding social status.

Born in 1806, making money whilst he was in his teens, he was favoured with a career of exceptional length and opportunity, and in his eighty-fourth year he died a millionaire.

PETER SPENCE.



PETER SPENCE

PETER SPENCE.

Lord Macaulay in his essay on Milton describes the Puritans as: "Men whose minds had derived a peculiar character from the daily contemplation of superior beings and eternal interests. Not content with acknowledging in general terms an over-ruling Providence, they habitually ascribed every event to the will of the Great Being, for whose power nothing was too vast, for whose inspection nothing was too minute. To know Him, to serve Him, to enjoy Him, was with them the great end of existence. If they were unacquainted with the works of philosophers and poets, they were deeply read in the works of God. If their names were not found in the register of heralds, they were recorded in the Book of Life." It was from families of this class that Peter Spence was descended. His mother's family had for generations farmed lands, situated on the Grampians; his father was a hand-loom weaver in the burgh of Brechin. Though of lowly station, his parents were distinguished for their genuine piety and lofty character;

his father commanded the greatest veneration, he was a man of wisdom and sound judgment, of great purity and uprightness.

Peter Spence was born at Brechin, on the 19th February, 1806, and in the parish school of that town he acquired the rudiments of knowledge; he was trained to a life of hardihood and industry, and from his earliest years was made familiar with a religious life and doctrine that had in them much that was stern and narrow, but which, nevertheless, produced characters of great strength and beauty.

At an early age he left home for the city of Perth, where he was apprenticed to a grocer. During these years he manifested a great love of reading, works on science having a peculiar attraction for him.

It is sometimes thought that there is little in common between the poet and the man of science, but how far is this from the truth! The genuine philosopher of nature must be a seer; the geologist must have the fancy that can call up, instinct with life, the successive stages of the world's story; the astronomer has to do not merely with weights and distances of inconceivable magnitude, he has to dwell amidst the splendours of an infinite realm of light; and the chemist, his imagination must be able to perceive the metamorphoses which his ingredients are capable of, and to build up to the eye of the mind structures adapted to work out his processes. The inventor and discoverer are closely akin to the poet; to both, the imagination and fancy are indispensable; and if, in this utilitarian age, we neglect the culture of those faculties which poetry and romance, history and travel do so much to develope, we shall extirpate those very powers essential to the extension of science and to the perfecting of the arts.

We shall see how in after years Peter Spence became a fertile inventor, but in his earlier years when he was engaged in the prosaic duties of a grocer's store he manifested the gifts of the poet.

There lies before us a volume of his poems "written in early life." His thoughts are revealed to us in the subjects he has selected:

"In the Primeval Forest,"
"The Destruction of Pompeii,"
"Ode to Palestine,"
"The Death of Bolivar,"
"Navarino,"
"Napoleon's Russian Campaign,"

and others similar.

An idea of the general character of these may be formed from the last stanza of his "Pompeii":—

"The morrow comes! But where's Pompeii now?
She sat smiling 'neath Vesuvius' brow,
So lovely yester e'en that the bright sun
Lingered with her, although his course was run.
Hath she with sackcloth clothed her as a vow,
Or 'neath a covering hid her from the frown
Of the enraged mountain that pours
Its liquid lava and red ashy showers,
Blasting its sides where aught of life hath grown?
Ah! no; on her Death's dismal pall is spread,
O'erwelming all the living 'mong the dead,
A sea of lava boils above her streets,
Upburning all its horrid rolling meets,
And beauteous Pompeii sleeps beneath its gloomy
bed."

But it is not merely in efforts to sing the glories of nature, or the great tragedies of history, or the struggles of the patriots for freedom that he invokes his muse; he can delight us with a pretty ballad, "The Tale of a Minstrel," or amuse us with a clever, witty parody on Gray's Elegy:—

"Beneath yon rugged elms, that beech tree's shade,
Where rests the river o'er its pebbly bed,
Each in its place the finny tribe is laid
Till tide shall help them o'er the ford to sped.

Ah, soon for them, the angler with his rod.
With wormy bait, or fly hook feathery clad,
Or fisher's net shall lay them on the sod
To writhe with pain and make their captors glad.

Ah, soon for them the blazing hearth shall burn,
And cook shall then the oily sauce prepare,
While gourmand Cockneys to the dish return
And gobble each his more than glutton share.

Let not ambition mock the humble theme
That now expands obedient to my wish,
Nor cast aside, as 'twere an idle dream,
The short and simple annals of a fish."

We have selected these few verses just to illustrate his humour. There are sonnets, and there is a pretty little poem he terms "A Lyric," of which we also venture to quote a verse or two.

"I love the land where my fathers have dwelt,
The rock, and the stream, and the plain,
I love to read how the southern felt
The might of these patriot men.

I love the stream where the minnows swam,
And the slippery sliding eel,
And the big stepping stones where we built the dam,
To run our little mill wheel

I love to look on a handsome girl,
    (And many a one I see),
When a smile on her ruby lips doth curl,
And I love when she looks at me,

I love to engage in a friendly debate
    With one who will argue by rule,
I love to hear others my praise relate;
    Who does not, may say I'm a fool."

Perth must have been a happy scene for a youth of Peter Spence's tastes; its history, going back to the days of the Romans, who discovered in the Tay another Tiber, and in the celebrated plain, the North Inch, another Campus Martius, its antiquities, its traditions, its romance, and, above all, the beauty of its site.

Sir Walter Scott writes: "One of the most beautiful points of view which Britain, or perhaps the world can afford, is the prospect from a spot called the Wicks of Baiglie. There stretches the valley of the Tay, traversed by its ample and lovely stream; the town of Perth, with its two large meadows or Inches, its steeples, and its towers; the hills of Montcrief and Kinnoul faintly rising into picturesque rocks, partly clothed with woods; the rich margin of the river, studded with elegant mansions; and the distant view of the Grampian mountains, the northern screen of this exquisite landscape." Such scenery imparts an inspiration to a nature susceptible of such impressions, and is lasting in its beneficial influence on life and character.

> "Though absent long,
> These forms of beauty have not been to me
> As is a landscape to a blind man's eye;
> But oft, in lonely rooms, and 'mid the din
> Of towns and cities, I have owed to them
> In hours of weariness, sensations sweet,
> Felt in the blood, and felt along the heart;
> And passing even into my purer mind,
> With tranquil restoration."

The industrious apprentice, the scientific student, and the romantic youth is, we believe, a faithful picture of Peter Spence during the years he spent in the city of Perth and its lovely neighbourhood. He had few helps in his chemical studies, but had to depend almost entirely on what books he could get; his daily occupations were no assistance to him, but rather the contrary. Several men, who have risen to eminence as chemists, have been won to the science by having been placed, in their early years, amidst surroundings that invited to its study, and were offered opportunities for experiment and research, but Spence had no such advantages. It is a mystery to us how he was attracted to study works on chemistry after he had spent his days in the dull monotony of the shop. When work was done, or before the shutters were taken down in the morning, the grocer's apprentice might be seen absorbed in his studies and his books, week after week and month after month; extemporising some elementary experiments with a very rough and crude apparatus; but these days were the seed time of his life; these voluntary studies, when, in pursuit of knowledge, he denied himself the ordinary recreations of his companions, fitted him to fill a far wider and more influential sphere than he could otherwise have done. When he was out of his apprenticeship, he and an uncle commenced business together, as grocers, under the name of Sime and Spence. In this establishment there was also for a time a younger brother of Spence, who afterwards became superintendent engineer of H.M. Dockyard, Portsmouth, and who, on being strongly tempted to accept a much better position in the Russian Steam Naval Department, declined to leave the old flag. This brother, Mr. James Spence, is now a well-kown naval architect and consulting engineer in Newcastle-upon-Tyne.

In 1831 the subject of our memoir was married to Miss Agnes Mudie (second daughter of Mr. Francis Mudie, linen manufacturer, Dundee), and who, during the many years he had to struggle against all sorts of difficulties, enough to have crushed almost any other man, stood nobly by him, doing her part in their struggle with exemplary patience, courage, and devotion. She died in 1858, leaving a family of four sons and four daughters.

The grocery business proving unsuccessful, and Mrs. Spence having started coffee rooms with the same unfortunate result, she got her husband to remove to Dundee. Here he obtained a situation at the Gas Works; and it was the insight into some of the chemical operations connected with the manufacture and purification of gas that laid the foundations to the principal achievements of his manufacturing career.

At Dundee Peter Spence and his wife lived in her mother's house, and there, in a small wash-house about 12 feet square, he experimented a great deal with gas products.

In the year 1834 he left Dundee and proceeded to London, where he established himself in a small way as a chemical manufacturer, and his earliest patent is dated July 27th, 1836, his address being Henry Street, Commercial Road, in the County of Middlesex. His first essay in invention was to achieve, what Peter Spence constantly aimed at, the Utilisation of Waste Products or Refuse Material; in the present instance he sought to manufacture Prussian Blue, Prussiate of Potash, and Plaster of Paris from the refuse lime and the refuse lime liquors of gas works.

The London venture was a failure, and Spence and his wife had again to undergo great hardships. The scene of his labours is next transferred from London to a chemical works at Burgh, in Cumberland. His spirit of invention found no recorded outlet for some years; not until 1845 was Peter Spence able to do anything that he deemed worthy of patenting, although he had been incessantly experimenting, but on the 27th of November in that year he sought protection for a process for the manufacture of copperas and alum. This discovery was the result of accident; he had been seeking in every direction a suitable source of alumina, and, after trying all kinds of materials, was at the time experimenting on coal shale; the experiment seemed to be a failure, and he proposed abandoning the idea, but after completing his operations, he unintentionally left the materials in the basin which he meant to have emptied; the next morning to his delight and surprise, there was a fine crop of alum crystals. This accident was the foundation of his success. The 1845 patent was the initiation of Spence's alum process, which was destined so completely to revolutionise the alum trade, and make alum so cheap a product as very greatly to increase its consumption.

But Cumberland was not the best locality that could be selected. Spence soon saw that Manchester and its neighbourhood were much more advantageously situated; coal shale could be much more abundantly obtained, close at hand, and the markets for the finished products were equally convenient.

The next patented invention came from Pendleton, near Manchester, on the 12th November, 1850, and this was also for alum, and with it cement. The previous patent was very crude and simple, but it contained the germ, which during the succeeding five years had developed until the one now under consideration appeared, which was in every way very much more complete.

Shale from the coal measures was the raw material which he principally relied on. After being calcined in large heaps over flues, the burnt scales were cast, warm, into leaden tanks, in which there was sulphuric acid; the shales in time absorbed the acid and became quite dry. The vat was then emptied of the saturated shales, which were put into another vat and covered with boiling mother liquor, which had been neutralised with ammonia vapour; the sulphate of alumina was hereby dissolved out, and crystallised alum obtained. If it was found that the sulphate of alumina was not sufficiently soluble, that the shales had not been sufficiently acted upon by the sulphuric acid, the saturated shales were heated in the furnace and then put into the dissolving vat. But one point Spence kept in view was that no expense must be incurred by any process of evaporation prior to crystallisation—"the clear solutions of sulphate of alumina must be of sufficient strength for the crystallisation of alum without evaporation."

The same patent specifies that the mother liquors obtained after the alum is crystallised out, and which contain a considerable quantity of free sulphuric acid, shall be stored in a covered tank, this tank shall have a pipe at the top leading to the flue or chimney, and another, a lead pipe, leading into it at the bottom to convey ammoniacal compounds and vapour of water, obtained when ammoniacal gas liquor is being boiled or distilled, into it. Sulphate of Ammonia is formed, quantities of sulphuretted hydrogen are given off, this gas is conveyed away to the chimney and the sulphate liquor is then used in mixing with the sulphate of alumina, and so forming ammonia alum. It may here be mentioned that the sulphuretted hydrogen is now completely utilised by the patent subdivision combustion process of Mr. David Spence, one of Mr. Spence's sons. The same specification claims a process for distilling ammoniacal gas liquor and other volatile, or partly volatile, liquors by an arrangement of two or more boilers or vessels by which the liquid to be distilled can be run from one to the other through the whole range, and the passing of steam charged with volatile matter from one to the other through the whole range in an opposite direction.

The formation of cement, which he calls Patent Zinc Cement, from the spent shale after the sulphate of ammonia was washed out was another item of this most inclusive patent.

He took two parts of refuse lime from the gas works, and one part of his spent shale, and to that he added a little sulphate of zinc solution; these are mixed to about the consistence of mortar, made into bricks, dried, and afterwards calcined or burned at a moderate red heat; after cooling it is finely ground and constitutes cement.

The zinc was used for two purposes; to prevent the oxydisation of any iron, causing the colour of the stone to be degraded, and also to prevent the stone being attacked by mosses and lichens.

The last point he claimed is one of much interest; it related to the manufacture of the carbonates of the alkalies from the sulphates by means of sulphate of baryta.

Powdered sulphate of baryta was mixed with carbonaceous matter and heated. After this mixture is burnt it is lixiviated, and a solution of sulphide of barium is obtained; to this the sulphate of the alkalies (in solution) is added, sulphate of baryta is thrown down, and the sulphide of the alkali remains in solution. This solution is pumped into a tank, in which it is heated to boiling, and then run through a tower packed with coke, through an atmosphere of carbonic acid gas; carbonate of the alkali is formed and sulphuretted hydrogen is given off, which is collected and burnt to produce sulphuric acid ; the liquor which runs through the tower is collected in a tank and evaporated to soda ash, or is made into soda crystals. Spence says, "I am aware that a process similar to this has been previously described, but the temperature was not raised, my point being that the liquor must be acted on at an elevated temperature."

Spence's alum process was a great success, both chemically and commercially, and at Pendleton his business rapidly grew, until he was the chief alum manufacturer in the world. After a time he established two other works (at Birmingham and Goole), and entered into other branches of manufacture (copper smelting, copper precipitate, carbonate, muriate and sulphate of ammonia, sulphate of potash, aluminoferric, and sulphate of alumina).

The prosperity that attended him enabled him to prosecute various researches, and from this time forth the records of the Patent Office reveal how varied were the subjects he investigated, and how fertile he was in resource.

It is impossible for us in this short article to follow his labours and ideas as they are unfolded in his various patents; we must content ourselves with classifying his fifty-six patents and summarising their results.

The patent last described, and worked out at the Pendleton Alum Works, was his main achievement. On it he built up a very large and successful business; and the other patents to which we shall advert are, for the most part, quite subsidiary as compared with it.

The following are the subjects to which his patents refer:—

1. Prussian Blue and Prussiate of Potash.
2. Manufacture of Sulphate of Alumina and Alum.
3. Manufacture of Copperas.
4. Manufacture of Sulphuric Acid, and obtaining Sulphur from Iron Pyrites.
5. Calcination of Copper and other ores.
6. Separation of Copper from its ores.
7. Separation of Zinc from its ores.

8. Separation of various metals from their ores.
9. Purification of Gas.
10. Production of Salammoniac.
11. Manufacture of Sulphocyanide of Ammonium.
12. Manufacture of White Lead.
13. Treatment of Phosphate of Alumina and Iron.
14. Treatment of Sewage.
15. Manufacture of Manure.
16. Treatment of Bauxite, and the Manufacture of Aluminoferric Cake,
17. Purification of Water.
18. Treatment of Gases arising from the manufacture of Salts of Ammonia from Gas Liquors.
19. The Use of Oxide of Manganese in the manufacture of Salts of Ammonia from Iron.
20. Obtaining Power by Steam.
21. Repairing Fractured Bells.

Most of the above are the subjects of more than one patent, some of several, and the same subject is treated after the interval of several years. Some of the patents are modifications of preceding patents, others put forth entirely new ideas. Some had little or no practical value, others revealed results and methods of great and permanent interest; and nearly all assist in marking the progress of chemical discovery in the sphere to which they apply.

One of his patents for producing Prussian blue and prussiate of potash, illustrates his tendency to try and utilise refuse. He employed the alkaline sulphates, fused them in a pot, and, when in a fused state, added refuse leather, and calcined them together; then lixiviated and crystallised. To the mother liquors he added sulphuric acid, and converted the alkalies into the sulphates. This being done, he added sulphate of iron, and so precipitated Prussian blue.

In the Island of Anglesey, at the Parys Mine, there are enormous heaps of refuse ore, called bluestone. It contains zinc, lead, copper, and a little silver, but the percentages of the various metals are so low, that metallurgists have failed to devise a method to extract any or all of them, so as to make the process a commercial success.

To use up the abundant refuse, which is found in numerous localities in many parts of the world, has been one of the problems which metallurgists have failed to solve. Peter

Spence tried his hand at it. He ground the ore into a fine powder, and treated it with hydrochloric acid, so dissolving out the sulphide of lead, the sulphide of zinc remaining unacted on; the undissolved blend he calcined, and extracted the zinc by volatilising it in the usual way, and the residue containing the copper and silver he melted, and separated the metals by one of the well-known processes. He succeeded no better than others who have undertaken the same task. His treatment of copper ores was, by two or three methods, to bring the copper into solution, and out of the solution to precipitate the copper as sulphide with sulphuretted hydrogen obtained from chemical waste.

In his smelting processes, his patents refer to the construction of calciners. His object was to utilise, as much as possible, waste heat, and to bring the calcined ore, while hot, direct from the calciners into the melters. Some of his furnaces were built directly over the smelting furnaces, and others had a series of floors and the ore was drawn from one to the other; then, again, he invented a mechanical rabble which worked backwards and forwards at intervals, and he designed a method for cooling this rabble so as to prevent its destruction.

The "Henderson" process excelled all his attempts to treat copper ores by the wet way, but his automatic calciners are still, in vitriol making, in use in certain districts, where "smalls" are plentiful.

The discovery of immense quantities of phosphate of alumina and iron in the West Indies, on the Island of Redonda, aroused him to seek to discover a method of utilising this mineral, so as to produce alum from the alumina, and use the phosphoric acid in the manufacture of manures. He patented five processes (in 1870, 1871, 1873, and 1875). The first idea was to dissolve the phosphate of alumina in sulphuric acid, and to the solution add potash salts, or, preferably, ammonia vapour, to form an alum; then crystallise. The mother liquor was then mixed with sawdust, and dried to a state fit for manure. The second patent proposed to refrigerate the mother liquor before mixing it with sawdust to make it yield up more alum. In the third patent, after the iron in the mother liquor had been thrown down as sulphide by ammoniacal gas water, and phosphate of ammonia had been obtained, using this phosphate as a fertiliser; or, pure ammonia was added to the monophosphate, and a tri-ammonic phosphate suitable for use in sugar refining was formed.

The process of the fourth patent consisted in mixing the mineral phosphate with sulphate of soda (salt cake) coal and a little oxide of iron, and heating these together until decomposition took place; then lixiviating out the phosphate of soda that is formed; to this solution caustic lime is added, phosphate of lime is precipitated, and caustic soda remains in the liquor, this is boiled down in the usual way; the precipitated phosphate is either used as it is or is converted into superphosphate.

By the fifth patent he evaporated the sulphuric acid solution of the Redonda to a specific gravity of 1·5, added sufficient sulphate of ammonia to convert all the alumina into alum, and finally a certain proportion of sawdust as absorbent. The whole, congealed into a dry granular mass, formed a highly phosphatic and nitrogenous manure.

Spence was so confident of the success of his Redonda alum process that he decided to erect plant on a large scale, and to alter the arrangement of his works. He was too sanguine, and his conclusions were at least premature, for after incurring heavy expense the process had to be abandoned, and large quantities of the mineral were thrown on his hands.

We may here suggest, and the suggestion is the result of experience and experiment, that if Mr. Spence had *very finely* ground the Redonda and got it carefully tried by some competent judges he would have found that the natural phosphate of alumina by itself, provided only that it was reduced to a very fine powder or meal, would form a phosphatic manure which would yield its phosphoric acid to the crop in the course of several seasons; and if mixed with sulphate of ammonia, or nitrate of soda and a little potash in the form of calcined Kainite, would have been an excellent general manure.

His manufacture of sulpho-cyanide of ammonium was also an invention worthy of note. He patented this first in 1863, and completed it in 1864. In this process he utilised the ammoniacal liquor from gas works, drove off the volatile salts of ammonia, and then crystallised the chloride of ammonium.

The mother liquor he then diluted so as to precipitate extraneous matters, and the clear solution was taken for use. To this was added a mixed solution of sulphate of iron and copper, by which sulphocyanide of copper is produced, which being treated with a solution of sulphide of ammonium the copper was separated, and the sulphocyanide of ammonium formed and obtained in crystals.

In 1875 he took out in conjunction with his son Frank his first patent for the treatment of Bauxite and the production of Alumino-ferric. These salts he found to be of value in the purification of sewage, and also in the purification of water; valuable also in paper-making and dyeing, and the firm at present makes a large quantity of this low-priced aluminous compound.

His last patent, taken out just a year before he died, is the one unhappily associated with the memorable law suit between A. G. Kurtz and Co., of St. Helens, and his firm. The invention is that in solutions of sulphate of alumina, which contain iron, the iron is precipitated by black oxide of manganese being added to the liquor.

The same tastes that induced Peter Spence, as a youth, to be an active member of the Debating Society, at Brechin, caused him to take a lively interest in the proceedings of the Manchester Literary and Philosophical Society.

Several papers which he read before that society are published; they have principally a scientific, rather than a literary, interest.

A favourite theme of his was embodied in a paper read before the society and published in pamphlet form in the year 1857; it is entitled "Coal, Smoke and Sewage scientifically and practically considered, with suggestions for the sanitary improvement of the drainage of towns, and the beneficial application of sewage." He divided the contaminations of the atmosphere proceeding from drains and chimneys into evils visible and invisible, and the latter he regarded as much more pernicious than the former. The removal of solid filth from drains and cesspools, and of black smoke and soot from chimneys was, he considered, a most imperfect, crude, and unscientific method of dealing with the evils.

He writes: "The invisible evil is completely ignored, the smoke nuisance is held as *the* evil of our atmospheric condition. 'Burn your smoke,' is the united cry of the Sanitary Association, the public, and the law." He calls the attempt simply to do away with black smoke "the sanitary smoke-consuming mania."

"Perfect freedom from smoke would, if accomplished, only increase the evil arising from the purely gaseous results of combustion"; and again: "While demonstrating that to the mere economist, there is great inducement to get rid of all visible smoke, as a consequence of his obtaining perfect combustion of fuel, I would at the same time say to the sanitary smoke consumer, that he had better not interfere further, as every step he takes in enforcing the consumption of smoke, will only tend to deteriorate the atmosphere, and that every cloud of visible smoke he is successful in dispelling, is only making way for a more baneful, though invisible agent." He regarded carbonic acid, carbonic oxide, and sulphurous acids, as far more prejudicial to health than visible smoke; indeed, he believed soot to have an antiseptic influence, and to be beneficial rather than prejudicial.

From the economical standpoint he did not advocate permitting imperfect combustion, but he would construct arrangements that would ensure that all ammonia would be condensed and converted into sulphate of ammonia, and such gases as could not be condensed and utilised should be carried up lofty stacks, and diffused before they could alight among human habitations.

The nitrogen, phosphates, and alkalies in sewage he would also utilise; he regarded the system of town drainage into watercourses as wasteful and injurious in the extreme. In fact, he would have all house flues connected with drains; the drains should be smoke culverts as well as water conduits; the gases resulting from combustion would act destructively on the sewage gases, and both should be carried away by means of very strong draft up very lofty chimneys; his idea was 600 feet high, at least.

The vision his project presented to his mind, he thus described: "The removal from the interior of all our dwellings, from the mansion to the cottage, and even to the cellars, of the slightest trace of those pestiferous emanations which feed our fevers, consumption, and cholera, and which, more than any other physical cause, serve to lower the vital energies of our town population, making them an easy prey to every epidemic.

"Instead of the atmosphere of our towns being as now, a dim, and dull, and murky compound of black and yellow and grey smoke, blended into a haze, and containing besides its proper elements a mixture of carbon, carbonic oxide, carbonic acid, and sulphurous acid gases, with the considerable hydro-carbon compounds of our domestic fires, we should then continually revel in an atmosphere transparent, pure, and salubrious as that which encircles the mountain's side, or reclines on the ocean's bosom; and instead of vegetation, with its charming green being banished from the interior of our towns, and even in their suburbs holding only a stunted, miserable, and withering struggle for life, every nook and corner where light could descend might be enlivened by the evergreen leaves of the climbing ivy, or with other parasitical plants, and might be made fragrant to the smell, while the eye was delighted with their beautiful and variegated flowers."

He felt assured these anticipations were not extravagant, that this vision was no chimera; but "a most desirable and practicable reality," which he was convinced would in time be realised.

The proposal of ventilation by tall shafts was some years after embodied in the construction of the Manchester Assize Courts by the architect, Mr. Waterhouse, who obtained the necessary data from Mr. Spence.

It is mournful to contemplate, that in the very year, 1857, when he published the pamphlet referred to, he was himself being assailed by a number of the residents of Pendleton, for permitting gases to issue from his works, which they asserted were noxious and injurious to health and vegetation.

The trial of Regina *v.* Spence, which occupied three days of August, 1857, when the firm was proceeded against on the charge that they had so conducted their works as to be a public nuisance, is one of those notorious cases long to be remembered. Baron Channell was the judge, Mr. Wilde, Q.C., was leading counsel for the plaintiff, and Sir Frederick Thesiger, Q.C., for the defendant. A large number of witnesses were called on both sides, and eminent experts in chemistry, horticulture, and botany gave evidence for and against.

Dr. E. Frankland, who at that time was a professor at Owens College, and who had been employed by Spence to superintend his processes, so as to be able to suggest, if possible, any apparatus or arrangement that might prevent any nuisance arising, was induced to give evidence for the plaintiff.

Spence felt this very much. Having

retained Dr. Frankland's services, and being prepared, as far as possible, to carry out any improvements he could suggest, he considered Dr. Frankland had no right to side with the prosecutors against him. To say the least, it was an unfortunate circumstance, and we are not surprised that it gave rise to very bitter reproaches from Sir Frederick Thesiger, Dr. Angus Smith and Professor Crace Calvert, who were called by Mr. Spence.

Scientific witnesses have too often justified the severe judgment that has been pronounced against them; it is with satisfaction we find Baron Channell, referring to the scientific witnessess that gave evidence in this case, saying: "I think, when you come to sift and examine for yourselves the evidence of those whom I have called scientific witnesses, you will not find a great discrepancy between them. There are a great many points upon which they agree, and the difference will really be with reference to those whom I have ventured to call the non-scientific witnesses."

The verdict went against Spence, but only on one count out of three; the jury found that a disagreeable smell emanated at times from the works, but that it was not proved that they were injurious either to health or vegetation. He was compelled to leave Pendleton and remove to the site of his present works at Miles Platting. He had anticipated that this would be the only way out of his troubles, and with that energy and foresight, which were so characteristic of him, had so made his arrangements that the new works was going before the old one was stopped.

In reviewing this celebrated trial, we believe Peter Spence had to contend against a great amount of prejudice, and that the social position of those who instigated the proceedings, told heavily against him ; we think, also, it was probably a mistake that the special jury were not brought over to view the works and the neighbourhood.

The Literary and Philosophical Society afforded him a constant and agreeable retreat from the worries of business ; he frequently had interesting communications to make, and ably assisted in the discussion of scientific subjects introduced by others.

He was much inclined to humour, and thoroughly enjoyed a joke ; indeed, it was noticed that on the very day he died his bright humour did not forsake him.

One trait of his character used to exhibit itself at these meetings, his aversion to take anything for granted; he would try to test theories and to prove facts.

The question of the effect of cold on iron was raised at one of the meetings of the society. A railway accident had just occurred, occasioned by the breaking of the tyres of the carriage wheels. It was generally advanced that cold and frost made iron and steel more brittle, but Dr. Joule stated that, however general the impression might be, he knew of no experiments that tended to prove that contention to be a correct one.

Peter Spence at once determined to make a series of thorough and conclusive experiments, the results of which were that he proved "that a specimen of cast iron having at 70° Fahr. a given power of resistance to transverse strain, will, on its temperature being reduced to zero, have that power increased by 3 per cent." Dr. Joule simultaneously made an experiment with refrigerated needles and obtained substantially the same result.

One of the discoveries of great scientific interest and practical utility made by Mr. Spence was communicated by him to the Chemical section of the British Association, at Exeter, in August, 1862. He desired to obtain a temperature 228° Fahr., to extract alumina in the form of sulphate from minerals containing that earth. His apparatus was heated by steam and fire, and he was able to digest for a long period the solutions at the necessary temperature. It happened that, by accident, the fire was neglected and the steam alone operated; nevertheless, to his surprise, he observed the high temperature was preserved; he was led to investigate, and experiment on this phenomenon; he selected a solution of a salt (nitrate of soda) having a high boiling point—about 250° Fahr. The nitrate of soda was placed in a vessel surrounded by a jacket; steam at atmospheric pressure was let into the intervening space, until a temperature of nearly 212° Fahr. was obtained; the steam was then shut off, and an open pipe immersed in the solution, and the steam from the same source was thrown directly through it into the liquor; in a few seconds the thermometer slowly, but steadily moved, and minute after minute progressed until it touched 250° Fahr.

This thoroughly confirmed the results obtained in the digesting vessel and became to the author of great practical value.

As a corroboration of the theory, which seems to explain the apparent paradox, the author found that the temperatures of his solutions were in the exact ratios of their specific gravities, and had no connection with the temperature of the steam, which never exceeded 212° Fahr. The greater the specific gravity of the acid solutions, the higher the boiling-point; and, therefore, whatever the boiling-point of the solution in water of any salt, to that point, or nearly, will steam of 212° Fahr. raise it.

When Peter Spence made this statement at Exeter it was received with general surprise, amounting almost to incredulity; in fact, Professor Williamson declined to accept the fact, until he had himself seen the experiment performed by Spence, and had personally examined the thermometer. The explanation was then apparent, that the latent heat evolved by the condensing steam had become sensible heat, measurable by the thermometer,

In 1881-2 Peter Spence gave evidence before a House of Commons Committee, on Railway Rates; and his evidence is reprinted in pamphlet form, with the title: "How the Railway Companies are crippling British Industry and destroying the Canals; with suggestions for reforming the whole system of railway charges and for rescuing the water-ways permanently for the nation."

The pamphlet is still worthy of careful perusal, as it abounds in well-authenticated facts, and contains many valuable and ingenious suggestions. Its extensive circulation at the time of the inception of the Manchester Ship Canal scheme greatly aided the launching of that project. The Ship Canal had Mr. Spence's enthusiastic support, and he was one of those who first subscribed £1,000 towards the needed funds.

Peter Spence never felt that his duties were limited by his business. He never regarded his workmen as mere "hands," destined to toil and poverty, that by their labours the few might rule in affluence and ease. He laid to heart the well-being of the community, and especially of those who were immediately dependent on him. His early training and experience of life contributed, with other influences, to make him recognise that Christianity should regulate the relationships of life, and compel those who profess to be guided by its teachings to care for the physical, moral, and spiritual well-being of their fellow men. He made no secret of his firm adhesion to the Christian religion; the Deity was to him no mere "tendency that made for righteousness," but "Our Father," Who profoundly interests Himself in the little lives of His children, and helps and delivers them in their needs and troubles. Peter Spence threw his activities into the church in Oxford Road, under the pastoral care of Dr. McLaren, and was elected one of its deacons, in which capacity his intelligence, enterprise, and generosity were most valuable.

It is a pleasure to us to record here an incident that occurred at a very critical period of Peter Spence's business. After the great losses which he incurred by the too hasty alteration of his plant, to work the Redonda Phosphate process, which proved to be a failure, he was so crippled, financially, that there appeared to be no alternative but to liquidate the business, and get it converted into a limited company.

This was a crushing sorrow and disappointment, after so many years of persevering industry and successful invention. The wife of his friend and pastor becoming, privately and totally without Spence's cognisance, acquainted with the circumstances, mentioned the matter to one of the worthy deacons of the church, the late Mr. Richard Johnson, the well-known iron master, who at once wrote and asked Spence to call on him, and at the interview, inquired what amount would enable him to "turn the corner." Spence said it would take five thousand pounds; his friend at once replied, he should instruct his banker to place the amount needed to his credit. Spence was overwhelmed at the splendid generosity of his brother deacon, and unspeakably thankful for the unexpected succour thus accorded to him, and which he ever regarded as a most merciful Providence. The prompt and generous aid thus afforded, enabled him to re-arrange his works, and revert to his former processes. The months that followed brought with them a period of very great prosperity, and within the year he was enabled to repay the total sum lent to him. In these days such an incident would, perhaps, be regarded as an unwise and unscientific interference with that gospel, so dear to strong monopolists, that the "fittest must survive," and the "weak must go to the wall."

Moved by the terrible and wide-spread evils of drunkenness, Mr. Spence became at an early age an adherent of the great temperance movement, and throughout the remainder of his life was one of its most earnest advocates. He was a teetotaler, a Good Templar, a Blue-Ribbon man, a founder and vice-president of the United Kingdom Alliance, a patron of Bands of Hope, and President of the Manchester Temperance Union, and the English Anti-Tobacco Society. Although all these, and similar movements had his hearty support, he was unable to approve of the policy of the Church of England Temperance Society, and often made the remark, "There are only two classes: those who drink and those who don't." He believed total abstinence was absolutely necessary in combating the evils of drunkenness, and that temperance reformers made a great mistake in seeking to sanction and secure mere moderate drinking.

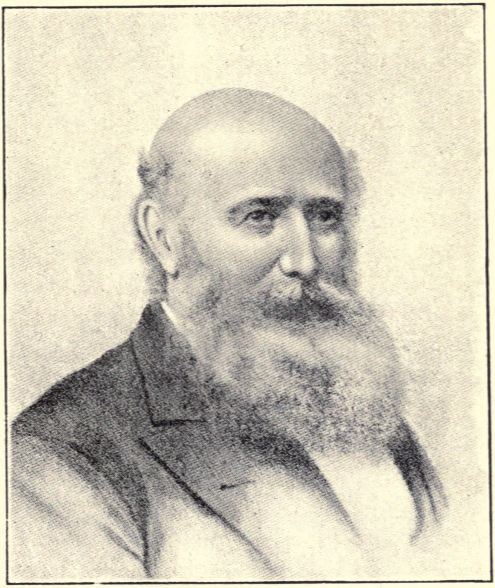
His precept and example practically stamped out drunkenness amongst those in his employ, and, in conjunction with his practice of paying higher wages than his neighbours in order to get the pick of workmen, he secured a staff of sober and industrious men, to whom he proved himself a kind and generous employer.

He was an active member of the Manchester Chamber of Commerce, and a very diligent Justice of the Peace, also a director of the Mechanics' Institution (now the Technical School). In fact, Peter Spence took a keen interest in all public movements: in politics he was an advanced Liberal; in Church polity a Nonconformist; a Parliamentary position was offered him, but this he declined.

Although he inherited a delicate constitution, with a tendency to consumption, yet his habits through life were so rational, and the measures he took to preserve his health so wise, that he enjoyed excellent health, and was, after he had passed three score years and ten, a picture of happy, bright, vigorous old age. Although short in stature, his appearance was most attractive, there was always the flash of speculation in his eye, and a beaming, hopeful expression on his countenance.

The death of his wife, in February, 1883, was a blow from which he could not rally. Without any attack of disease, his strength gradually failed, until on the 5th July, the same year, he passed peacefully to his rest, at the age of seventy-eight.

He was another illustrious example of men who have climbed the ladder of success from very insignificant beginnings, who have shown



that the noblest heritage a man can receive, is the inspiring power of high principle, that the diligent and persistent pursuit of knowledge is the true way to eminence, and that the man who cares for others has discovered the secret of a happy life.

We conclude this notice with the beautiful words which Dr. McLaren applied to him; "One has gone from us who was as well known in other circles as in the Church, and was everywhere the same man. Clear and active in intellect, prompt in deed, generous, and conscientiously liberal, fervently and always passionately attached to such principles and causes as had won his allegiance, and possessing in a very remarkable manner a force of will and tenacious adherence to convictions, with large sympathies and warm affections. His devout Christianity was of an unfortunately rare type; his conscientious liberality of rarer type still. To a green old age he kept much of his interest, the vigour, the buoyancy of youth, and he died in peace, calm of mind, and clear of heart, not eager to go, but satisfied with what God had given him, leaving behind him in many a good cause a great blank, and in many of our hearts a green and perpetual memory.

APPENDIX I.

Mr. William Keates, to whose memory this volume is dedicated, was not one of the Founders of the Alkali Industry, but he did much to establish, in Lancashire, Copper Smelting, which may certainly be considered one of the many branches of Chemical Industry.

He was born at Cheadle, in Staffordshire, on the 18th of February, 1801, and, as a youth, was employed in the Cheadle Copper and Brass Co's. Works where he obtained a good practical knowledge of the business.

The Cheadle Co. conducted Copper Smelting operations at Neath Abbey (South Wales), but in 1821 they decided to close these works and wind up the business; young Keates was entrusted with this work.

In 1822 he severed his connection with the Cheadle Co., and was appointed by a Mr. Sneyd, of Ashcombe, near Leek, to manage the Whiston Copper Works near Cheadle.

These works were built by the Duke of Devonshire to smelt the ore from his Copper mine at Ecton; in 1819 Mr. Sneyd acquired the works and continued to smelt the ore from a local mine (Mixon).

In 1824 William Keates was offered the management of the smelting operations at Real-del-Monte, Mexico, but his father was averse to his leaving England.

When the Mexican business fell through he made an arrangement with Messrs. James Shears and Sons, who had a large Copper-smith's business in London, to restart a dilapidated Copper Works at Spitty, on the Lloughor River, Carmarthenshire, and he continued to manage these works until 1829, when he left South Wales and came to Lancashire.

A London Company had been formed to work the Copper mines of Arosa in Venezuela; the produce of the mines was imported into Liverpool, and an arrangement was made with Mr. Keates to erect a Smelting Works in Lancashire. The site he chose was at the upper end of the St. Helens Canal, and in 1830 he started the old Ravenhead Copper Works. About 1838 these works were disposed of to Messrs. John Bibby and Co., of Liverpool, who were the commercial Agents of the Bolivar Mining Association. In later years the St. Helens Copper Co. acquired these works, Messrs. John Bibby and Co. having erected much larger and more convenient works a little further down the Canal.

Messrs. Newton, Lyon and Co., of Liverpool, who had Copper Rolling Mills near Holywell, Flintshire, decided to become Smelters as well as Manufacturers, and engaged Mr. Keates to erect works for them. In 1832 he built the Sutton Copper Works near St. Helens Junction, and these were carried on for nearly fifty years by Messrs. Newton, Keates and Co.

JOSEPH SHENTON
(Copper Refiner and Foreman, Sutton Copper Works)

This firm also erected the Parr Copper Works about the year 1855, having an arrangment with Messrs. Brownells, of Liverpool, to smelt ores that were being imported by them from Chili and Peru.

At Bagillt, in Flintshire, Mr. Keates carried on the business of lead smelting and rolling.

When the business of Messrs. John and Thomas Johnson, Alkali Manufacturers at Runcorn, was converted into a Limited Company, Mr. Keates was, for a short time one of the Directors; he was also a Director of the Alliance Bank.

As a practical Copper Smelter and Brass and Yellow Metal Manufacturer he was thoroughly conversant with every detail; in going through the works nothing escaped his notice and when a young man, he would not only superintend the refining process but would actually join the laders in their work or show a workman how to handle a ladle or skim a charge. He was a strict disciplinarian, but both in his home and at the works he was a considerate employer and secured the loyal attachment of those in his service. He was an excellent instructor of others, and prided himself in the men whom he trained and on retaining them in his employ.

When he came from Staffordshire he brought with him a workman and his family, the Shentons. The father, old John Shenton was a fine type of English workman, of great physical strength, thoroughly intelligent, and devotedly loyal to his master; he was the foreman at Sutton Copper Works up to the time of his death; he had several sons, all of them brought up in the works, and no less than four generations filled the position of foremen or refiners under the firm.

His eldest son, Joseph Shenton, was an exceptionally fine character, and an admirable manager of men, stern and strict but at the same time just and reasonable.

The writer gladly offers this tribute to a man who, during a period of many years, he found to be exemplary in the discharge of his duties, and whom he learned to regard not only as a servant but as a friend.

How many of our most successful manufacturers owe much of there prosperity to the loyal services of men of this type.

When Mr. Keates first settled at St. Helens he lived in Ravenhead Hall; he married a Miss Andrew of Redruth, whose family were eminent among the Assayers of the Duchy of Cornwall.

In later years he resided at Greenfield Hall, near Holywell, so that he might direct personally the three Rolling and Wire Mills that were established in that valley.

Mr. Keates was conservative in his politics, and he and Mr. Gladstone together canvassed the electors of Flintshire in the days when they were of the same school; he did not follow the lead of his distinguished neighbour but to the end of his days remained a protectionist and a thorough conservative. He was an attached and earnest adherent of the Church of England and took an interest in parish work, but his religious views were free from all intolerance and bigotry.

Some few years before he retired from business he went to reside at Pickhill Hall, near Wrexham, but later he removed to Devon,having purchased a fine estate at Bishops Nympton. He died in his 88th year at Leamington, and was buried in the Churchyard at Cheadle. He was the High Sheriff of Flintshire in the year 1874. His only surviving son, Mr. Joseph Andrew Keates, succeeded to the business and the estates.

When Mr. Keates came to Liverpool, copper ores were purchased by the old method of a varying standard, and a fixed returning charge, which was not easily understood by the uninitiated. Mr. Keates devised and introduced the simpler method of purchase by unit which was easy of comprehension. He was not the first to introduce Copper Smelting into Lancashire; there had once been a Smelting Works near Blackbrook, between St. Helens and Haydock; there was also a works at Ravenhead, where the ores from the Parys mine in Anglesey were smelted, and, in 1717, Thomas Patten erected a Copper Works at Bank Quay, Warrington.

The Bank Quay Works were discontinued about the year 1782. In 1720, Thomas Patten started the Brass Works at Cheadle, and founded the Cheadle Copper and Brass Co.

The manager of the Bank Quay Works was a Mr. John Watkins, who lived to be over 80 years of age, and died in 1821, at his residence, Ditton Hall, near Widnes. His father was his predecessor as manager of the works.

In the earlier days the copper from Bank Quay was conveyed to Cheadle on pack horses, later by waggons, until 1778, when the Trent and Mersey Canal was finished, and the copper was then forwarded by it to Stoke and thence by cart to Cheadle.

Mr. Keates made for himself a position that placed him among the leaders of the Copper Trade in this country; his name will be associated as a worthy compeer with the Vivians, the Williams, the Grenfells, and the Nevills.

Tall and erect, strong and active, of dignified presence, his was a striking personality. His features were those of a soldier and had he lived in days of yore he would doubtless have been found holding his own with shield and spear.

The device and motto, would not have been unfitting to the characteristics of vigilance and courage, of enterprize and fidelity. The family crest is, "a tiger proper, charged with three bezants, resting the dexter paw upon an escutcheon sable, thereon a cake of copper proper" and with the words, "Esto memor."!

Mr. Joseph Andrew Keates has very kindly supplied me with many of the facts for this reminiscence.

J. F. A.