and outlet pipes for the gas; as well as showing the mode of dividing the bottoms of the vats into sections. The latter shows in detail the dimensions and construction of the dry lime purifiers used at the Brick-lane Gas Station.

Mr. Lowe confirmed the statements in the paper, relative to the advantages of the new system. Formerly, when the dry lime purifiers were used at the Brick-lane Gas Station, the health of the men suffered, and the complaints by the neighbourhood, of the nuisance when the lime was changed, were so constant, that the system was abandoned; at present, although ten times the quantity of gas was purified, there was not any nuisance, either in the works, or in the neighbourhood.* Mr. Lowe.

It had been stated, that the system had been used in other places, and that the credit of the invention was not due to Mr. Croll. Although it was not the province of the Institution to enter into such an inquiry, he might perhaps be allowed to state, that a similar plan had been tried at Bristol, at the suggestion of Mr. Herapath; the idea had originated in the same chemical facts, which had induced Mr. Croll's attention to the subject, but the *modus operandi* was essentially different. In Mr. Herapath's plan there was not any continuous supply of acid; no valuable product was obtained; it was troublesome and expensive, hence it was not successful, and the plan was abandoned. Mr. Croll had entered upon the subject, with perhaps more practical skill, which, joined to his chemical knowledge, had enabled him to attain the success which attended the present system.

The economy of the process, the diminution of the destructive effects of the purified gas upon the apparatus and the fittings, its increased illuminating power, and its greater fitness for combustion in dwelling-houses, with other advantages, had been fully and fairly stated in the paper.

The chemical products obtained from the process, deserved very

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* In a report to the Directors of the Chartered Gas Company, dated November 19th, 1841, Professor Brande says,—" I think it probable that much of that anomalous fetor and penetrating effluvium which infects the gas mains and the soil in which they lie, and which is generally, but, I think, erroneously, merely ascribed to tar and naphtha, is in great part attributable to ammonia and its compounds, and that this nuisance will be found greatly diminished, if not altogether prevented, by passing the gas through dilute acid liquors before it enters the main. Ammonia, and some of its compounds, exhibit penetrating and peculiar reactions upon certain metals, and are also probably concerned in some of those curious phenomena of exosmose and endosmose, which now constitute an important element of the philosophy of gaseous chemistry."

careful attention, and their adoption for agricultural purposes was important. The effect of sulphate of ammonia, in assisting vegetation, was remarkable, and it was already extensively used in agriculture. It also revivified cut flowers, when they were apparently withered and dying. Flowers, whose stems were cut diagonally, so that their capillary tubes were not bruised or torn, on being put into a solution of 8 grains of sulphate of ammonia to 1 pint of water, would be speedily restored to vigour, if somewhat faded, and they might be kept fresh by this means for a long period. For watering geraniums and other plants growing in pots, $\frac{1}{4}$ lb. of sulphate of ammonia should be dissolved in 1 gallon of water, and a wine-glass of this solution, added to every quart of water; the strength and beauty of the plants was found to be much improved.

Professor Graham.

Professor Graham bore testimony to the efficacy of Mr. Croll's process for removing ammonia from coal-gas, and to the valuable nature of the products obtained. Looking at the purifying of coal-gas as necessarily founded upon sound chemical principles, he thought, that more attention might still be advantageously paid to several parts of the process.

In the first step of the purification, namely, the proper cooling of the gas, as it escaped from the retorts; he suggested a gradual refrigeration of the gas, or the retaining it for a short time, at an intermediate temperature, such as 212° Fahrenheit, before it was cooled down to the temperature of the air, in the usual refrigerators. The tarry matters in the gas, being the least volatile, would thus condense first, and by themselves, at a temperature which, being inadequate to condense the naphtha, would prevent their carrying down with them, so much of the valuable naphtha vapour, as at present. These tarry matters having an affinity for naphtha, tended powerfully to denaphthalize the gas, when in contact with it at a low temperature, and to deprive it of that valuable adjunct for combustion.

The mode of purifying coal gas from sulphuretted hydrogen, by dry lime, was gradually superseding the wet lime process, particularly when the former was used in combination with the acid process. The dry lime, however, was so far disadvantageous, as that it could never be entirely saturated with sulphuretted hydrogen.

Professor Graham had found, that by mixing an equivalent proportion of sulphate of soda with the lime, more than twice the quantity of sulphuretted hydrogen was taken up. The lime was entirely converted into sulphate of lime or gypsum, and the whole soda became bi-hydro-sulphuret of soda, which might be easily washed out of the former. The latter salt might be again converted into sulphate of soda by roasting it; and thus might be used to mix with the lime in the purifiers over and over again. Sulphate of lime, which was the only residue, was valuable for agricultural purposes.

In the distribution of coal gas, every means for counteracting the porosity of the pipes, should be adopted. In experiments upon cast iron gas-pipes, he had found as much as 25 per cent. of atmospheric air, mingled with the coal gas, which had been in the mains for 12 hours. This arose entirely from the porosity of the metal; air entering by the diffusive power of gases, although the coal gas in the main was under a small pressure. This should be guarded against, not only on account of the positive loss of gas which it indicated, but because, as was well known, a moderate proportion of atmospheric air mixed with the gas, greatly diminished its illuminating power.

Mr. Bethell said, that his attention had been directed to the use of chemical agents for agricultural purposes, by a notice in the journals, of the professions of a German chemist, to obviate the necessity for manuring corn land. Mr. Bethell, in consequence, tried various solutions, in which seeds were steeped for 40 hours; they were then sown in different patches of unmanured land, and he found, that although with some of the seeds which had been in other solutions, vegetation was more rapid, yet that the produce of the seed, which had been steeped in a solution of 1 lb. of sulphate of ammonia to 1 gallon of water, was more vigorous and prolific, and that during a dry season, when all the other wheat became yellow, the plants from the steeped seed remained green. **Mr. Bethell.**

Mr. Simpson stated, that in connexion with the subject of gas-making, the porosity of the iron pipes, through which it was circulated in the streets, should be noticed. He believed that formerly, considerable quantities of pipes had been laid without their being previously proved; and even now, experiments he had made convinced him, that few pipes were not in some degree porous. When they were proved with water, under a heavy pressure and a mirror was placed near the surface of the metal, a damp film showed the permeability, and after the pressure had been continued for some time, the exudation of moisture was very visible. Oxydation would, to a certain extent, close the pores of the metal and prevent this effect, and he would suggest, that all pipes should be proved with a solution of sal-ammoniac, which being forced into the body of the metal, would effectually oxydize it, and to a great extent cure the evil. He felt convinced, that 25 per cent. of the gas was lost, from the leakage of the pipes and the joints; and in opening the streets, the difference between the gas and the water pipes, was immediately perceived, by the soil around the former being saturated with gas. **Mr. J. Simpson.**

Mr. Simpson quoted an instance where, in a length of 1000 yards of iron pipes 2 inches in diameter, there had been a loss of 357 cubic feet of gas in 24 hours. By perseverance in repairing the escapes, the porous spots and other defects in the metal of the pipes, the leakage had been reduced in three years to about 13 cubic feet in 24 hours.

Mr. Lowe. Mr. Lowe said, that although in the early stages of gas lighting, the pipes laid in the streets might not have been proved, such was not now the case; at present all were severely tested, and great attention was paid to the formation of the joints, which were made by ramming in layers of gasket, previously soaked in hot pitch and tallow, then running in the lead, and after that was well driven up with a caulking-iron, the joint was smeared over with pitch.

The gas companies were fully aware of the loss they had sustained, from defective pipes and bad jointing and every attention was now given to the subject. Some time since, Mr. Lowe had been called upon, to examine a provincial gas-work, where, although the consumers paid by meter, and an allowance of 6 cubic feet of gas per hour, was made for each public light, 75 per cent. of the gas which was manufactured, was not accounted for. On examination, it was found, that from the ignorance of the superintendent, a pressure of 2 inches of water was kept constantly by day upon the pipes. The process of exosmose was thus carried on to an enormous extent As soon as the pressure was diminished, the loss was reduced in proportion, and when, by his advice, the gas was allowed for a time to pass into the pipes, in a less pure state than usual, the leaks were soon discovered and repaired. It was certain, that the process of endosmose and exosmose was constant with gas-pipes, as the cast-iron was of a porous and cellular texture; and he believed, that a great portion of the loss arose from this permeability of the metal. He noticed, on opening the streets, that the soil in contact with the whole length of the gas-pipes, was saturated with gaseous products, and not merely those spots near the joints.

Mr. A. Murray. Mr. Murray remarked, that Mr. Hague had found great difficulty, in remedying the permeability of cast-iron, when he attempted to work his engine with condensed air; it was only by coating the pipes with a mixture of tallow and pitch, that he succeeded in rendering them partially impermeable.

Mr. Farey. Mr. Farey observed, that the porosity or permeability of cast-iron was a well-ascertained fact. This first came to his knowledge many years ago, in the case of a hydrostatic or Bramah's press, wherein the water, when very forcibly compressed, made its way slowly through the thick cast-iron cylinder by a sort of perspiration at the external surface, so that the press relaxed its pressure and the plunger descended considerably during the night, after a large package of elastic goods had been left in it, under strong compressure in the evening. The external surface of the cast-iron cylinder was found the next morning, covered with very minute drops of water, particularly towards the lower end, where the drops were larger. Before this exudation of the fluid was observed, the workmen said, the water had leaked out at the leathering around the plunger, or at the joints, but as a considerable quantity of water must have leaked, in order to have so much relaxed the press, and as little or no water showed itself at the leathering, or joints, further search was made and the real cause was discovered, but as only very little water had dripped down on the ground, it had probably evaporated in the air, nearly as fast as it exuded, in a state of minute division.

It was remedied by withdrawing the plunger, warming the cylinder over a fire of shavings, and lining the interior surface, when warm, with a mixture of melted bees'-wax and resin, forming a thick varnish. The press stood well afterwards, and the case showed, that leather, not thicker than the sole of a strong shoe, was less permeable to cold water, under great pressure, than cast-iron of some inches in thickness.

On mentioning the circumstance to the late Mr. Maudslay, he said, that whilst he was engaged with Mr. Bramah, and made the small hydrostatic presses for copying letters, he observed that some of the cylinders permitted the water to exude through the gun-metal, which was a composition of copper and tin, from which they were cast. By watching the proceedings of the workman who poured the melted gun-metal into the moulds, which were placed in an inclined position for the convenience of receiving the melted metal, Mr. Maudslay observed, that immediately after the pouring, it was a habit with the workman to set the moulds upright with a sudden motion. This Mr. Maudslay thought, might disturb the metal at the moment of its solidification, and after prohibiting that practice, and leaving the moulds quite at rest, until the metal must have become completely set, the cylinders generally proved sound.

As to cast-iron, it was not always a close-grained metal; the carbon, which it contained, and which constituted its difference of substance from pure malleable iron, pervaded the mass, divided into minute particles, which kept the molecules of iron apart, and impaired their cohesion. Such cast-iron was very fusible, ran well into the moulds, and was soft for working with tools. It was called No. 1 rich iron, of best quality, for foundry metal; it was also called 'kishy' iron, from an appearance of particles of carburet of iron, or black lead, on its surface, after the iron had been left to cool, in the open air. That was accounted for, by supposing that the iron absorbed more carbon from the fuel, in the blast furnace, whilst it was in the fluid state, than the same iron could retain when it afterwards cooled and solidified; and that the molecules of iron in approaching each other, during the solidification, expelled a portion of the excess of carbon from between them, with a curious vermicular motion, which could be observed, on the surface of the melted metal, whilst it was cooling; and it was the carbon which was so expelled that showed itself in those particles of carburet, after the iron was cold.

That vermicular motion must be inimical to the future solidity of the metal, and such kishy metal, although soft for working with tools, was in fact deficient in cohesion; it did not make strong castings, was unfit for wearing to resist friction, and was porous to gas, air, and water under pressure.

It was only by causing cast-iron to absorb carbon slowly from the fuel, in the blast furnace, that it could be wholly freed from the oxygen, with which the iron was combined, when it was in the state of ore, and the more carbon that was so absorbed, the more completely the oxygen was got rid of.

At least that was the case in the ordinary process of smelting iron with cold blast, by a slow process of such absorption; but the hot blast process appeared capable of inducing a very rapid absorption of carbon, by a mass of cast-iron in the blast furnace, which rapid absorption was not attended with such a complete deoxydation of the iron, as would take place with a less absorption of carbon, by a slower process of such absorption in the cold-blast process. Probably by the hot-blast process, when urged too rapidly, some portions of the cast-iron contained in the furnace, were very completely deoxydated, and had absorbed such a great excess of carbon into the interstices between them, as would keep the molecules of metal apart, and impair their cohesion, whilst other portions of the same mass of iron might remain imperfectly deoxydized, and for want of time, had not absorbed their proper share of the carbon, which was contained in the mass generally; such imperfectly deoxydized particles would be deficient in cohesion for want of complete metallization.

These suppositions might serve to explain, why hot-blast iron having the character of rich kishy iron, was so deficient in cohesion, but by allowing more time for the smelting operation, hot-blast iron might, he conceived, be made of excellent quality.

Cast iron which was rich in carbon, might be made to part with so much of its excess of carbon in re-melting as to acquire a full cohesion; and such excess might be neutralized, by melting the rich iron along with a suitable proportion of old castings, which by previous meltings had been deprived of their excess of carbon. Messrs. Boulton and Watt, at the commencement of their career, paid great attention to that subject for the casting of cylinders, and other parts of their steam-engines, and by availing themselves of all that had been learned in the casting of iron cannon, and by the judicious mixture of different sorts of cast-iron in the operations of the foundry, they obtained castings which have never been excelled, and rarely equalled, for solidity and strength.

Cast-iron of that first-rate quality had the molecules of metal in close contact, hence their cohesion was great, and the metal was impervious to water, gas, or air.

Respecting the leakage of gas from cast-iron pipes, a very large proportion proceeded from the joints of the lengths of pipes. At Manchester it had been the custom for several years past, to form the joints of cast-iron pipes, by boring and turning the ends to fit truly one into the other, and very recently, Mr. Hick, of the firm of Forrester and Co. at Liverpool, had shown him a machine which performed the operation of both boring and turning the two ends of a pipe very rapidly. It was a slide lathe bed, having two head stocks with strong mandrils, fixed upon it, one near each end; they were placed at such a distance asunder on the bed, as to receive the length of the pipe between them; each mandril had a chuck upon the end of it, with notches into which steel cutters were wedged, like a boring head. One such chuck was adapted for boring out the interior of the socket end of the pipe to a suitable cone; the other chuck had its cutters set for turning the exterior, at the other end of the same pipe, to a corresponding cone. The pipe was fastened down on a sliding carriage, so as to present first one end of it to one chuck, and then the other end of it to the other chuck, by which means the whole operation was very expeditiously and perfectly performed. This mode of preparing pipes was becoming common in Liverpool and Manchester, and was, he thought, deserving of more general adoption.

Mr. Cooper reminded Mr. Lowe of an experiment at which he was present a few years since, where the process of endosmose and exosmose was shown very strikingly. A bag formed of two sheets of paper, pasted together all around the edges, was inflated with coal gas, by introducing a quill at one corner; in 10 seconds it was discovered, that the gas had entirely escaped and its place was occupied by common atmospheric air, although no visible defect existed in the bag. Mr. Cooper.

He thought, that the soft and porous quality of the iron, of which the pipes were made, for the convenience of drilling and tapping them, for the service branches, conduced to the process and the consequent loss of gas.

Mr. Croll's system would, Mr. Cooper thought, be of much benefit, not only to gas companies, but also to manufactures generally, by reducing the cost of ammonia. Some years ago the price of sal ammoniac was 3*s.* per lb. for a quality inferior to that which was now sold for 6*d.* per lb. This reduction was entirely owing to the increase of gas lighting, the products being converted into this useful salt.

Among the manufactures in which sal ammoniac was used, was that of tinning and zincing iron; it floated in a liquid state, upon the fluid metal, preventing oxydation, and the plate traversed it before it reached the metal, when it was plunged in the bath of tin or zinc.

The President.

The President observed, that Mr. Croll's paper was so important in its character, and the new process had been so fully and liberally described, that an obligation had been conferred, not only on the Institution, but towards the public, by its production. It was an additional proof, if such were wanting, of the intimate connexion of engineering, with all the useful arts. From the purifying of gas, for domestic consumption, the transition was, it appeared, inevitable to the consideration of the chemical products of the process, and their influence on agriculture and horticulture, and the facts developed, were most interesting. He hoped, that this discussion would prove an additional inducement to members, or to those who felt any interest in science, to bring forward papers at the meetings, as during their discussion, useful facts would most probably be elicited.

In his connexion with the conservancy of the river Thames, his attention had frequently been directed to the nuisance, arising from the products of purifying, flowing from the gas-works, into the river. He believed, that the ammoniacal liquor was one of the most noxious of these products, and it would be no inconsiderable benefit, if by the adoption of this new system, by using dry lime instead of wet lime purifiers, this nuisance could be even abated, if not finally got rid of.*

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* In a recent communication from Mr. James Muir, New River Water-works, he observes :—" The coal-gas may literally be said to saturate the ground, in localities through which the pipes of several gas companies have been laid; and it there frequently effects an entrance into the adjacent water-pipes.

" When water services so situated are opened, they have been found to discharge no small volume of gas into one or more of the attached houses, followed by a small quantity of gas-impregnated water, which, being received by the cistern, serves to taint all the following supply, however pure. Not only is this discharge highly offensive, from its smell, but imminently dangerous, from its liability to produce explosion. A lighted candle is carried, without