

much safer and cheaper than the latter, and not nearly so much trouble to prepare and manipulate. Its light is more than ample for the usual requirements of lanternists, and infinitely superior to kerosene. A "Plunger" generator small enough to be carried in a handbag is usually used in conjunction with a group of four one-foot burners. Less than five minutes is required to prepare the apparatus for lighting. Kerosene is being almost universally abandoned in favour of acetylene by lanternists, while the light is found quite sufficient in many cases where lime light has hitherto been used.

Acetylene in Warfare.—You will probably have noticed in the Press that acetylene search lights have been used by the British in South Africa. The portability of acetylene will be greatly in its favour in this connection, and the advantages of a powerful light will be available in places where electricity would be out of the question.

In a recent English paper mention was made of a special acetylene lamp for searching for wounded on the field of battle. An acetylene shell has lately been invented for marine warfare. The shell is filled with carbide of calcium, which on striking the water generates gas. The gas is ignited by an automatic electric spark. It is thought the shell will be most effective for revealing the operations of hostile fleets at night. Once lit the shell is inextinguishable, till it has burned out, and each shell would brilliantly light a large area of water. Acetylene lamps for military flash-light signalling are also being made. This is a lamp designed especially as a mariner's storm lantern, fitted with acetylene on the usual drip principle. For river navigation at night we have designed a search light to be carried on the bow of the steamer. Acetylene lifebuoys are now being made, each being fitted with a number of small charges of carbide; these generate gas, which is ignited by an automatic device, immediately they touch the water. Thus the position of the buoy is clearly indicated, and the probability of rescue greatly increased.

Train Lighting.—On the subject of train lighting by acetylene he could do no better than read the following extract from a paper contributed by Dr. Bork, of Berlin,

Prussian Railway Director, to an Acetylene Conference at Nurnberg in December last:—

“Until 1870 the carriages of the Prussian railways were illuminated by the candles, and oil petroleum was not used on account of the danger of explosion. Experiments made with coal gas showed that if it were compressed the illuminating power was diminished, and as it is absolutely necessary, on account of the limited space, to carry the gas under pressure in iron cylinders, the attempt to introduce coal gas was abandoned. For a long series of years oil gas was used with fairly satisfactory results. It was prepared from gas oil, a by-product of the dry distillation of lignite coal. Its power of illumination, however, which was originally about 7 to 8 candles, began gradually to decline to 5, owing to deterioration of the quality of the gas oil. With the advent of electricity and ‘Auers’ incandescent mantles, an improvement in the illuminating power was confidently anticipated. The adoption of the former, however, would have been equivalent to a total loss of 13,000,000 marks to the Prussian States, this sum having been expended for the installation of 92,000 compartments with cylinders and fittings for oil gas illumination; whilst the application of the latter was rendered useless by the installation of the carriages. The discovery of the manufacture of calcium carbide on an extensive and cheap scale was hailed with satisfaction, as it was possible to use oil gas installations for the new illuminant. In the year 1896 the first experiments were instituted, the results being so favourable, apart from the trouble caused by the formation and deposit of soot on the burners, that extensive preparations were at once made for the production on a large scale of acetylene gas for railway illumination purposes. Shortly afterwards, however, from several explosions which occurred in various places, the danger attendant upon the compression and storage of acetylene was demonstrated. Further experiments made in this direction confirmed the danger of explosion from the use of pure compressed acetylene beyond a doubt, as they were carried out under conditions which would obtain in actual use. Instead of pure acetylene a mixture of oil gas and

acetylene was now used, and with remarkably favourable results. It was found that a mixture containing 50 per cent. acetylene was not explosive under pressure, and possessed a very high illuminating power. At present a mixture containing 25 per cent. acetylene and 75 per cent. oil gas is used, the illuminating power being equal to 15 candles, as compared with 5 candles from the same amount of oil gas.

The comparative cost is:—

Oil Gas,	Oil Gas and Acetylene,	Acetylene,
0.325.	0.152.	0.158.

“By the end of next year all the carriages on the Prussian railway’ will be illuminated with this acetylene oil gas. In the year 1898, 960,000 kilos. of carbide were used. This year the total will probably amount to 3,000,000 kilos., and next year about 4,500,000 kilos. will be the approximate consumption. Other German railways are following suit, so that for railway carriage illumination alone Germany will require about 8,000,000 kilos. carbide in the coming year.”

Portable Lamps.—There has been a distinct advance in the matter of portable table and other lamps since last year. He condemned these lamps in his previous paper on account of their unpleasant smell. This trouble can now be entirely removed by fitting the lamp with a purifier. The cause of the smell from a table lamp is the impurities generated by the polymerization of the gas consequent upon the imperfect system of generation which must perforce be adopted in these lamps. The effect of the chemical agent with which the purifying chamber is fitted is to remove these impurities and with them the smell. Thus the acetylene table lamp may now be said to have a bright future. It can be used for practically every purpose for which kerosene lamps are now employed, and many a country householder who cannot afford a complete installation will replace his kerosene lights with the brighter and whiter light of acetylene. I have already shown you the Drip type of table lamp. Here is one in which the Plunger type of generator has been adopted.

Town Lighting.—This had already to some extent dealt with in connection with the Cricket Ground installa-

tion. Of course, for a permanent installation there would be one central generator and gasometer instead of several generators. The advantage of acetylene for a town lies in the comparatively inexpensive nature of the manufacturing plant, and in the very small unskilled staff required to work it. There is another point—a town acetylene installation can be laid in sections as funds permit, and when the job is finished it will have cost very little more than if the entire installation had been put in at the first. A start is made, say, with the Town Hall and two or three nearest lamps, the gas being supplied direct from the generator; as the installation is extended and the drain on the generator becomes too heavy, a gasometer of any desired size is added to the plant, the generator then being used to charge the gasometer. Acetylene has one great advantage over coal gas in the nature of its chemical constitution. Coal gas is a mixed gas, and when for the purpose of forcing it over long distances it is subjected to heavy pressure, the heavier light-giving elements of the mixture tend to deposit in the pipes, thus both reducing the candle power and choking the pipes.

Town Lighting with Lamp-post Generators.—Lamp-posts with automatic generators of the "Drip" or "Plunger" types in their bases are sometimes preferred to piping the streets of a town. In this case, of course, each generator requires daily attention, but the heavy expense of laying down mains is avoided. Where lamp-posts are already erected for kerosene, a generator can be affixed to the foot of each and an acetylene burner put in the lantern in place of the kerosene lamp.

Bicycle and Carriage Lamps.—There seems little occasion to refer to these—they have advertised "themselves" so well. They nearly all work on the Drip principle. For actually showing the way on a dark night they are without a competitor; candles or kerosene serve only to give notice of one's approach to other travellers. A carriage lamp has just been put on the market fitted for both acetylene and candle, which can be interchanged at will.

Acetylene for Heating.—He mentioned last year that acetylene was being used for heating, and now give you evidence of the fact in these acetylene stoves, gas rings,

iron heaters, etc., which are specimens of a large variety of heating apparatus now on the market. The principle is the same as with coal gas stoves, but for acetylene a different proportion of air is used. At the present price of carbide, acetylene is not an economical heating agent, but for occasional and emergency use most acetylene consumers will have a small stove or gas ring in the house.

SAFETY OF ACETYLENE.

The controversy on this subject is practically closed, and it has ended in the emphatic recognition of the fact that acetylene is as safe as any other illuminant and safer than some. Given a generator which admits no air to its interior, and it is almost impossible to explode it; a liberal ventilation of the generator shed will effectually prevent an explosive accumulation of gas therein. And as for the inside of the house, the acetylene burners pass such a trifling quantity of gas, they would have to be left on for days and days to pass enough gas to cause an explosion, even if the room were hermetically sealed.

POSSIBILITIES OF THE CARBIDE BUSINESS.

The invention of the electric furnace with its hitherto unattainable heat marked the birth of a new age in chemical science, and the direct formation of carbide of calcium and acetylene gas from their constituent elements broke down the barrier which has hitherto been supposed to separate organic and inorganic chemistry. It will be seen, therefore, that the industry has distinctly broken up new ground, and no one need be surprised if further valuable or even sensational developments spring from it.

Benzine and a number of other hydro-carbons are manufactured by merely heating acetylene gas, and there is sure to be some business done in this direction.

A good quantity of acetylene will be consumed in the manufacture of lamp-black. Acetylene lamp-black is superior to that produced from any other source.

Alcohol can be produced synthetically from acetylene, and so produced it is said to be free from certain impurities incidental to its manufacture from vegetable sources by the usual and directly opposite method of decomposition.

PATENT RIGHTS.

Since six months ago an important patent case was decided in Germany. In that country the patent rights were held in the name of M. Bullier, an assistant of the French Chemist Moisson, for whom some have claimed priority over Willson in the discovery of the modern method of making carbide. Bullier filed his application in Germany before Willson, and was granted the patent; Willson and others then took action to quash. After a number of appeals the Bullier patent was finally declared void, largely on the ground that Willson was the actual discoverer. This, of course, throws the German market open to all, but strengthens the position of the holders of the Willson patents elsewhere. The English patentees are now engaged in two law suits in vindication of their rights, which, according to latest advices, was adjourned pending the taking of evidence abroad. In the United States the patents have never been attacked, and the patentees, the Electro Gas Company of New York, control the business for the States absolutely.

In Australia the business has been considerably damaged by a number of inferior machines that are put upon the market; these are invariably automatic, and betray great ignorance of the properties of the gas. He recently took the measurements of an automatic generator which was sold by the manufacturer to run 1000 lights. The size of the gas holder was under 8 cubic feet capacity. The manager stated in his catalogue that the machine would hold 50lbs. of carbide to one charge; you can imagine what sort of trouble would accrue to the unfortunate householder who bought a machine of this class. The acetylene industry in the Australian colonies has had a large number of difficulties to overcome. The fire insurance companies for some time discouraged the use of acetylene as much as possible; their objections to it have now been largely overcome. As an instance of the absurdities we have to contend with: To the port of Melbourne we can ship 100 tons on a steamer, but from the port we cannot ship 100lbs., as the authorities there have very peculiar regulations in force, which will not allow inflammable goods to be carried where there are steerage passengers. The authorities have decided that carbide

of calcium is inflammable, although as a matter of fact it is impossible to burn it. The carriage of carbide inland is also attended with a lot of absurd regulations, which make the progress of the industry slower than there is any necessity for.

As Englishmen we pride ourselves on our advancement, but when we look at the way the Germans treat a new industry we must take a back seat. The carbide industry in Germany has been built up by the foresight and enterprise of the German capitalists. Every inducement is offered in Germany to improve all the various details connected with the business. Exhibitions are held in the principle centres, so that those interested in the industry can meet together and compare notes for their general advancement. Newspapers are published devoted solely to the advance of acetylene. German steamship lines carry the carbide under deck as ordinary cargo. The result is that Germany has practically annexed the carbide business of Europe. When we compare this with the position that England takes in the acetylene industry we cannot help feeling ashamed of the stolid ignorance that exists as to the magnitude of this new industry. The Board of Trade regulations in England are so stringent that on one occasion recently two policemen were sent to a dealer's shop to take charge of 1lb. tin of carbide which he had placed in his window for sale. As time goes on no doubt the English will wake up to the absurdity of the position, but by that time it will be too late—the business will be lost.

The principal improvements in acetylene are principally in the purification of the gas and the improved apparatus for using it. In the manufacture of the carbide there is very little novelty to record. In America the pot furnaces are used, whilst in Germany the continuous furnaces find favour; the advantage of the continuous furnace is that the carbide is more even in quality, but contains less gas.

Mr. A. M. Howarth, in opening the discussion, congratulated the author, Mr. Tyree, for the interesting manner in which he had again brought the subject of acetylene gas under our notice. He believed he voiced the unanimous feeling of the members of the Associa-

tion. The author's paper read during last session showed conclusively that acetylene gas production had passed from experimental investigation into practical use, and it was certainly evident from the paper now being discussed that the new illuminant had come to stay. The author's estimate (that, at the present moment, the world's output of carbide was something more than 200,000 tons per annum, was somewhat a pleasant surprise, and furthermore tempted one to imagine what amount of acetylene could be generated from such a vast weight of material. It was known that one ton of fairly good carbide would produce 10,000 cubic feet of gas, therefore 200,000 tons of carbide would produce two thousand million cubic feet of acetylene. Assuming that carbide gas had at least twice the illuminating power of coal gas, even when the latter was burnt in large-sized incandescent lamps, the stored-up light of not less than four thousand million cube feet of coal gas would be required as the equivalent of the volume of carbide gas referred to. Seeing that one ton of fairly good coal would produce 10,000 cube feet of gas, it was obvious from the preceding figures that $\frac{4,000,000}{10,000}$ or not less than 400,000 tons of coal, would be necessary to balance the light-giving properties of the present annual production of carbide. The one noticeable connection of figures in his (the speaker's) calculation was that if equal volumes of gas were given off, whether we used a ton of coal or a ton of carbide; we must, however, remember that each unit of coal gas was rather less than half the value of each unit of acetylene. He trusted that his figures were not wearisome, seeing that the object of their use had been to illustrate the wonderful progress already made. When we considered that, although there was abundance of cheap fuel and raw materials in this colony, it was to be regretted that nothing had as yet been done to utilise the present opportunity of creating a most promising industry. The average market price of American and European carbide was £16 per ton, the price in Sydney was about double those figures, and in contemplation of the different sums, it was difficult to understand why shipping, insurance, transit charges, storage, and all reasonable profits, should raise the ori-

ginal wholesale price by 100 per cent. The rapid growth in the production of carbides suggested to him that the long-sustained price of £16 a ton was collateral with good dividends, otherwise there would not be such an ever-increasing rush for solid investments. He hoped to be excused for the following digression from the unwritten law of our Association, deprecating the discussion of matters foreign to the subject at issue, and herewith ventured to say, that if an energetic canvass was made amongst the good investment seekers of Sydney, reinforced with an intelligent explanation of the financial possibilities of a local carbide manufactory, the successful establishment of a new and profitable Australian industry would be an event of the early future. In reference to the purifying of acetylene, the author attributed the choking of pipes and smoking of burners as being largely due to the use of gas, contaminated by certain impurities, which seemed to elude even the best of purifying mediums. From this it appeared that the scrubbing or purifying apparatus was a redundant member of the generating plant, and that it ought not to be required; it detracted from the simplicity and doubtlessly added to the cost of the machine, and it was questionable if the improved product compensated for the complication, and the increased prime cost. Perhaps it would be a much better plan to thoroughly wash, or otherwise purify, the original constituents of the coke and lime used in making the carbide. This should eliminate sulphur and phosphor impurities, and possibly then by adding distilled or filtered water, the cycle of pure acetylene would be completed without extraneous cleansers. The author also mentioned the deposit of carbon on the burners at low pressure, and the unrequited demand for an acetylene burner that could be turned down like ordinary gas and without choking. He presumed to suggest the use of a multiplex burner consisting of several sections, any number of which could be turned right off, and yet retain the original pressure at each of the remaining orifices; such a burner as described might not be as easy of application as would appear, and perhaps the author would give an opinion as to its practical use. In railway carriage lighting it was a great advantage to be able to

carry gas stored in reservoirs at almost any reasonably high pressure. The greater the pressure and the higher the illuminating value of the gas used, the less necessity there would be for the recharging of reservoirs. Oil gas when compressed to nine atmospheres lost some of its valuable hydro-carbons by liquification, whereas acetylene retained its gaseous form, and all its illuminating properties at a pressure of 18 atmospheres. This meant that two volumes of acetylene could be safely stored in a vessel built to hold one volume of oil gas at similar pressure. Two volumes of 45 candle-power acetylene would have eleven times the lighting endurance of one volume of eight candle-power oil gas. If only a percentage of acetylene be used merely as an enricher for the oil gas, the necessity for frequent recharging of cylinders would be considerably reduced. Acetylene gas was of so rich a character that it could not be consumed to advantage excepting by large burners; its great illuminating value was best revealed when used to enrich ordinary oil gas. The enrichment of the latter by a given percentage of the former, after noticing the illuminating powers of the enriched and the unenriched, enabled the value of the enriched to be calculated. In the German train lighting experiments cited by the author, the oil gas was of the very poor quality of five candle-power, and to secure the stated result of 15 candle-power in the mixed gases it was plain to see that acetylene of not less than 45 candle-power had to be provided. Professor Lewes's "Cantor Lecture" at the Society of Arts on the 7th December, 1896, gave the results of his experiments on the burning of acetylene in railway carriages: With 97.8 per cent. acetylene at 2 inches pressure, and consumption of 1.05 cube feet per hour, the light was 30½ candle-power; with 10 per cent. of air added, a 2-inch pressure, and a consumption of 1 cube foot, gave 26 candle-power; whilst 2-inch pressure and ½ a cube foot consumption gave only 17 candle-power. It would be observed that although the same pressure was used in each case, a little diminution of volume caused serious loss in light, and when a trial was made for a light suitable for an ordinary compartment of a railway carriage (17 c.p.), the economic value of the small burner was

40 per cent. worse than the larger one. Possibly the author could state what has been done recently to avoid the waste of acetylene in railway carriage lighting.

In addition to calcium carbide, there were at least three others that would produce pure acetylene, as follows:— BaC_2 , SrC_2 , and Li_2C_2 , and several more that would produce from 40 to 70 per cent. of acetylene. None of them seemed to be commercial carbides, and he (the speaker) hoped that the author would explain the reason for their not being included. On the question of heating by acetylene, he desired to mention a matter which might be of special interest to those of this Association who were closely connected with workshop practices. If a mixture consisting of two parts of acetylene to one part of oxygen, be burnt at low pressure, the heat of the resultant flame was from 6,500 deg. to 7,000 deg. F^{ah}. It would be readily seen that such an intense heat would be very useful in assay or other furnaces, brazing or sweating operations, and local heatings, and perhaps it was not too much to expect that such a flame would be useful in many instances in that field now given up to electric welding. In discussing such a subject as the one set before us, it was practically impossible for any member of this Association to quote an experience in any way comparable to that of the author, and in due recognition of this fact, he desired (the speaker) to assure him that the preparation of his few remarks on this subject had been to him the pleasant task of a willing student.

Mr. Tyree, in reply to Mr. Howarth, said he had had no experience in mixing gases for train lighting purposes. He had simply quoted the experiences of the Director of the Prussian Railways. He might mention that Professor Lewis had discovered that some of the conclusions arrived at in his lecture of 1898 were erroneous. He (the speaker) had also found that errors had been made in the early stages of acetylene. Regarding the candle power of acetylene gas, it was exactly the same as coal gas when used by small burners. For instance, the gas passing through a 50 c.p. burner would not give 50 c.p. if passed through two smaller burners of half the size. At the first meeting he had shown this

by passing coal gas through a 1ft. acetylene burner, and they would no doubt remember the coal gas gave no light at all. Regarding a multiplex burner, there was little doubt that large sales would be made if a burner were introduced in which you could turn out the bulk of the gas without taking the pressure off the remainder. He lately received a burner which was made somewhat on these lines, where by turning a screw which operated in the interior on the outlet hole the gas could be turned out in one-half the burner. It also acted as a cleaner to clean the burner when it was getting choked. Since reading his paper he noticed there had been a slight accident at Coolamon. He would explain how it had occurred, as the more the public know about acetylene the more would they be assured of its safety under reasonable conditions. A young man went to obtain some carbide from a drum with the head off; over the top of it a sack had been placed. He put the candle over the drum to see where to pick out a lump of the carbide. The moisture from the atmosphere acting upon the carbide had caused acetylene gas to form. Naturally, when he thrust the light into the drum, the gas exploded. It showed how rapidly the people here were becoming accustomed to the use of the gas when there was little or no comment made on the occurrence in the press. Had it occurred twelve months back, there would have been a considerable amount of attention drawn to it. Regarding Mr. Howarth's questions as to whether acetylene gas could not be manufactured from barium, etc., he might say that for commercial purposes calcium was the cheapest mineral. There was some misunderstanding re purifying the acetylene gas. If the gas was made at a low temperature, it did not require purifying. The gas came up from the water cold, and the acetylene was to a large extent freed from impurities. At his house at Mosman the gas had been in use for some 18 months. The burners had required no attention. With an automatic generator the gas became polymerised, and the burners would have to be looked after and cleaned every month or so. For a stationary plant a non-automatic generator was best, as it required no purifying plant.