SESSION 1908-1909

President: JAMES DENNY, ESQ.

Lecture on Artificial Illumination, Historical and Practical.

BY MR. A. E. BATTLE (MEMBER OF COUNCIL).

With Remarks on Electric Lighting.

BY MR. HOLMES (WEST HAM CORPORATION).

Monday, March 9, 1908.

MR. BATTLE: It was my intention to go into this subject very elaborately this evening, but unfortunately I have not been able to devote the time to it which I expected would have been at my disposal. I have been very fortunate, however, in persuading Mr. Holmes to take up the electrical part of the lecture, and will therefore just introduce the subject on the historical side and leave it to him to show the more practical aspect.

The necessity of artificial illumination must have been felt very early in the history of man, and it is probable that its primitive form was simply by means of fire. The camp fire played an important part in the lives of our ancestors in prehistoric times, and even in comparatively recent history was used in our own country for signalling from hilltop to hilltop when the land was threatened with invasion. At the present day it is only used in the backwoods, but those who have once felt the fascination of sitting round a camp fire in those remote regions, know that such an experience gives a peculiar pleasure which vies with that derived from sitting round a fire at home.

The next development was, naturally, the torch, and it may safely be said that the torch was the first portable form of artificial illumination. The torch has undergone many changes, starting with the crude faggot and culminating in the electrical torches of the present day. This form of illumination has not altogether a fair record, as it includes the human torches in the light of which the terrible cruelties of Nero were practised. In London we still have evidences which remind us of the days when the torch was extensively used. In some of the old residential parts we see a cup-shaped depression worked into the design of the gate-posts, used in the days of the link-men as an extinguisher after having safely traced the way in the dark streets.

The lamp was the next improvement. It is very difficult to say where it first originated. Its use is generally credited to the Egyptians, but from the very earliest times to within the last century it underwent very little difference except in form. The first lamps were simply shells. They were afterwards made of terra-cotta and ultimately of glass and clay in the Grecian and Roman periods, still retaining the shell formation. They were made in the shapes of boats, slippers and other forms, but the shell was the most common. The primitive lamp was simply a sea-shell filled with animal or vegetable oil, with a dip or wick hanging from the side, and this prehistoric lamp, little improved upon, is still with us in the handlamp so familiar to engineers. I have seen this lamp in its most primitive form used by Central African tribes, burning the ordinary palm oil. The tendency of the oil to thicken in cold weather, and the difficulty of maintaining the wick moist up to the flame, caused much thought and the exercise of great ingenuity, resulting in productions both fearful and wonderful, excelling in novelty but lacking in usefulness. An oil-lamp invented in about the year 1800 seems to have been the most successful in surmounting the difficulties. It was of an expensive mechanical construction and consequently only found its way into the homes of the rich. It was a French invention, and the apparatus lifted the oil from the reservoir and sprayed it upon the wick through small tubes provided for the purpose, thus maintaining the wick moist, whilst the surplus returned to the reservoir. Another form was a kind of solid oil-lamp. It consisted of a cylinder of fat with a central tube to contain the wick, which could be raised and lowered at will by means of a ratchet and pinion, the cylinder surrounding the wick leaving a space for the fat to accumulate in. This cylinder was also kept up against the cone at the top by means of a spring. To extinguish the light it was only necessary to lower the wick into the tube. The conical nozzle was always slightly hot and melted the oil, which filled up the central chamber and so maintained the wick in a moistened state. The candle in its modern form was first produced, I suppose, in the early sixties. It developed from the dip, which in turn originated in the rushlight, the latter consisting of a piece of pith dipped into melted fat. Its first form was that of a long taper, afterwards strands of wool or cotton were dipped into the boiling fat and allowed to cool, then dipped again until there was a collection of layers of fat, and the candle appeared in the form with which we are familiar. But great trouble was caused when the candle was burning, by the threads fraying out, necessitating the use of snuffers and causing great inconvenience by the objectionable smoke and smell. Palmer was the first to introduce the improvement of the candle which developed into the candle of the present time, and his improvement was to form a wick that would throw itself out, as the candle burnt, into the oxidising part of the flame. To do this he coated one side of the wick with a coating of shellac or gum of some kind, which had the effect of causing the wick to be entirely consumed. Another improvement was effected by having a plaited wick, which prevented the fraying out of the cotton and preserved a steady flame. Other improvements were made in substituting different preparations for the crude fat or tallow, among which one giving the best results has been paraffin wax, and with these improvements the candle of the present time was evolved.

In 1739 a clergyman of the name of the Rev. — Clayton delivered a paper before the Royal Society calling attention to the extraordinary properties possessed by coal when burnt in a certain way, and to prove this he made experiments somewhat similar to that which delights the boys of the present generation when they fill the bowl of an ordinary tobacco pipe with powdered coal, seal it up and light the gas issuing from the stem. That was the first introduction of coal gas. In 1793 Mr. Murdoch made a series of experiments and suggested carrying the gas in pipes and leading it to any particular locality required, for the purpose of illumination. This was carried into effect the same year and the gas used for lighting a foundry at Soho in London. In 1802 gas was used as an illuminant in a public display at the Lyceum Theatre, and from that time forward began to occupy a prominent position. It is most interesting to know that it was in about 1800 that the value of electricity as an illuminant was discovered, and so we have the development of these great illuminants running parallel to one another, and we have yet to decide which is going to occupy the premier place in this respect. Gas, of course, was what we might call one of the nineteenth century wonders, one of the early discoveries and first-fruits of the mechanical advances made during that period. There were many drawbacks to contend with, and the gas of those days was not gas as we know it. All kinds of contrivances were adopted for purifying it and for obtaining a better light, different types of burners and means of regulating the quantity of gas consumed, many of them excelling in their unsuitability rather than usefulness, and it was not until Baron Welsbach in 1885 discovered and introduced the incandescent mantle that any great practical progress was made. Long before the Welsbach mantle was introduced, a coating for the flame, of some metallic substance that would become incandescent when heated, occupied the attention of the scientific world. Various attempts were made at the solution and all kinds of substances tried. Platinum was found to be very good, but it was too expensive and had other drawbacks, they tried various forms of zinc which were all inefficient, and not until Welsbach experimented with a mantle made of cotton wool saturated with a solution composed largely of a peculiar kind of soil was there any practical or useful development of the incandescent mantle. He patented this particular type of mantle in 1885, but the 1885 patent was unsatisfactory and another taken out in 1886. In 1892 it had developed into the mantle as used at the present day, consisting of 99 per cent. of thoria and 1 per cent. of ceria. The principle upon which the incandescent mantle glows is not known, at least the theorists have not been able to come completely to any decision on the point; one section says one thing and another section says something else, and even the experts who have been successful in adapting it cannot tell us why the mantle should glow. I was in hopes of being able to show an experiment with a bunsen burner having a non-inflammable cylinder so arranged that there is a fierce flame at the top of the cylinder, and if the mantle is held in the flame until it glows, then lowered to the cold gas in the cylinder, it still continues to glow. From this it seems that it is not the heat that causes the mantle to glow, and it is suggested by some authorities, including Professor Vivian Lewes, from whom I am taking this experiment, that the small particles of ceria have the power of condensing the hydrogen on the surface and altering the temperature of ignition to such a point that chemical combination actually takes place upon the surface of the mantle, resulting in the intense heat sufficient to bring the mantle up to incandescence. Of course whether this is so or not is a question for experts—many of them tell us that it is not, and give some other theory. I only bring this forward to show that there is more mystery surrounding the incandescent mantle than most people think.

We will now go back and start with electricity, and as Mr. Holmes will speak at some length on that subject, I will content myself with a brief sketch on the historical side. In 1800 Sir Humphrey Davy was experimenting with electric light. As the source of power was, for a long period, the battery, it is easy to understand why electric light did not make anything like the advance of gas, on account of the expensive method of developing the power, and, chiefly owing to this cause, it was not until 1860 that there was any great development with electricity as an illuminant. Sir Humphrey Davy's experiments led up to the arc-lamp, and it is well known that this form requires a very high voltage. In fact, if we bring together the wires from two batteries, it will be necessary to bring them together almost until they touch, before the electricity leaps across, unless there is a very high voltage. To make the spark leap across a quarter inch of space would, I should say, require about 2,000 volts, but directly contact is made and the electricity starts to flow, the flow can be continued at a very low voltage, the sparks seem to surround the terminals with a vapour which enables the electric current to pass freely from one to another. It was this discovery that practically gave us the arc-lamp as used at the present time. It was Sir Humphrey Davy also who discovered that the sparks were more intense and brilliant when using points of carbon than any other material, and so the use of carbon in arc-lamps dates back to 1800 or thereabouts. It was not, however, until the introduction of the Gramme dynamo that electricity took up a practical position as an illuminant, as before that time it was a matter of obtaining power from batteries, and as the batteries were expensive, dirty and unreliable, the business men and speculators would not take up the matter and put it upon a commercial basis. In the year 1867 Dr. C. W. Siemens read a paper before the Royal Society treating of the conversion of dynamical into electrical energy, and as a result of his efforts and those of the Gramme Company, the Gramme machine was introduced and a starting point made of practical electrical illumination as we see it developed now. The first display of electric lighting in the form of arc-lamps took place at the Crystal Palace at the Electrical Exhibition many years ago, and afterwards the Thames Embankment was illuminated with this form of lighting. The lighting of the Thames Embankment, however, was not a success for many years. All kinds of means were tried to regulate the supply of carbons, because, as you know, the carbons of arc-lamps soon burn away. They tried regulation by clockwork, and then the electrical device invented by Jabblockkoff, which did not prove a success, and it was not till the introduction of the modern type of electrical regulation of arc-lamps that any improvement was made. In the early days of electric lighting it was practically all in the series form; they could not split it up, and the splitting up of the electric light is largely due to the efforts of the most famous of living electricians, Edison. Edison was one of the pioneers of the introduction of the incandescent electric lamp. The first filament was of platinum, but this was soon discarded in favour of carbon, a substance largely used at the present time. It is very interesting to know, however, that we started with metallic filaments and are gradually going back to them. There are many different kinds of incandescent lamps used at the present time, but I shall now merely explain the construction of an ordinary carbon and will then ask Mr. Holmes to explain some of the modern improvements. There are some specimens here showing the stages of improvements in the construction of the electric lamp, which Mr. W. H.

Flood was kind enough to suggest might be of interest. These are some of the earliest forms of lamps. We can see from these that an incandescent lamp consists of five "parts," as some electricians put it, the filament, the terminals, the glass, the cap, and then they call the vacuum another part. I suppose it is well to use that term, because it is a very important part in connection with the electric light. When they first introduced carbon it was found necessary to protect it from the atmosphere. Directly the carbon was brought to a certain heat oxidation set in and CO_2 was formed which destroyed the carbon filaments, and it was found necessary to make the glass globe. Then it became necessary to find some metal that could be used for connecting the carbon filaments to and it was found that the only satisfactory metal for that purpose was platinum, on account of the co-efficient of expansion of platinum being about the same as glass, or, to put it into more everyday language, they had to get a metal that would fuse into the glass and expand the same amount, because if the metal expanded more it would crack the glass, or if it did not crack the glass, on contracting it would contract more than the glass and so allow the air to get in. The only satisfactory substance is platinum, and platinum is used in all good lamps. The process of manufacturing the filament is most complicated, in fact it goes through about forty processes. For the filament itself the first substance to start with is cotton wool immersed in certain chemicals, preparations from zinc that destroy all the vegetable substances and leave the carbon, although, of course, the carbon itself is a vegetable substance. When it is treated in this way it forms into a glutinous state; then it is drawn out in long threads, and by a process of drawing on drums it is brought down to a long, thin glutinous thread. Then the thread is wound round a mould to the shape required, the mould is subjected to intense heat, and the carbon filament is the result. The filament has then to be connected to the terminals, and the most modern way to cement it on is by the electrical process. There is a hydrocarbon substance such as benzine into which the lamp filament is inserted, and by flashing up the carbon is deposited all round and makes a joint. The trouble is that this filament has to be of a very even or uniform thickness throughout, because if there is the slightest variation in thickness it will result in overheating at that point, and the lamp will give out earlier than it should. The terminals with the carbon new attached are secured on to suitable wires connected to some electrical supply source, and after being immersed in benzine are brought up to just a glowing red. The effect of the electrolysis set up is that the hydrocarbon is split up into the hydrogen and carbon. The hydrogen bubbles up and escapes, whilst the carbon adheres to the solid surface. As this effect is most intense where the distance is greatest, it naturally follows that the longer the filament the more uniform will be the thickness. It is upon this uniformity of thickness and also upon the degree of vacuum in the bulb that the efficiency and life of the carbon lamp depend. In addition to the carbon lamp there are numbers of others. We had the introduction of the metallic filaments, many of which we have here to-night, but I will now ask Mr. Holmes to go further into that part of the subject.

Mr. Holmes: I feel after the remarks Mr. Battle has made, that I shall have to do something very wonderful to satisfy your expectations, but I will do my best, and if I make mistakes I hope the electrical experts will not make too much of them, because my work generally is with electrical power rather than with lighting. Power supply in West Ham has become a great factor, bringing in a revenue amounting to about five-sixths of the total, with the consequence that we devote more attention to power supply. At the same time we are not losing sight of lighting. Mr. Battle, in speaking of the carbon filament lamp, mentioned that the discovery of electricity as an illuminant was coincident with the first application of the gas flame on a commercial scale—both in about the year 1800—and it may be asked how it is that gas is now practically universally adopted while electricity is almost in its infancy so far as commercial matters are concerned. To explain that, it may be of interest to know that gas was an agent for lighting which had its tools almost ready to hand when it was first introduced, while electricity had a great number of drawbacks. The possibilities of the carbon filament lamp were known forty years before it was put into use simply because they were unable to get the proper vacuum, and it was only when the Sprengle pump was invented that the necessary high vacuum could be obtained. The carbon filament lamp is the one in which most electric lighting extensions have been made and, at the time when first introduced, was undoubtedly the cheapest and most efficient form of lighting. It was equally as cheap as its great rival, gas, and for some time it looked as though electricity was going to oust gas from the field, but at that time, when the use of electricity was fast gaining ground, the Welsbach mantle was introduced and gas once again took the lead. I am not going to detain you so much now with particulars regarding the introduction of electric light, but will say a few words from the commercial point of view. I will try to put what I have to say into ordinary everyday words, but technical terms are apt to slip out which may not be quite clear to those who are not so conversant with them. Mr. Battle alluded to the dynamo. That was the first introduction of an electrical apparatus which would give a constant current of electricity at a reasonable cost. Within the last week I happened to be talking to a man who was working on the first installation in London, and he said the prices charged were never put down on paper, the installation was put in and at the end of a certain time a fixed charge was made to cover all expenses. The actual price, however, came to about 2*s*. 6*d*. per unit. For some time plants were put down for different electric lighting schemes and no accounts at all taken of the price per unit, the people who had the electric light had to pay whatever those who supplied them thought would be the cost. But soon after electricity was supplied on a commercial basis a law was made by the Government that no charge should be made over 8*d*. per unit, and for some time that maximum was paid, simply because the cost of generating and distributing the electricity was so high that no price under that would be profitable. The prices gradually came down to 6*d*., then as low as 3*d*. for lighting and 1*d*. for power, the latter being the prices charged by the West Ham Corporation. A question often asked is, what is the reason that electricity is sold at 1*d*. per unit for power and 3*d*. per unit for lighting? and the discrepancy between the two seems puzzling to a man not in the business. The Gas Companies seem to think the price is lowered for power simply to compete with other works and that the loss is made up by raising the charge for the lighting. The reason is this. In the case of gas, the gas is made, stored and sent out at any time it is called for, but with electricity supply it is a different matter. In the modern form of electricity generation the plant must be put down in stations to supply the maximum amount for a specified time. In the case of power that plant is going eight hours a day, in the case of lighting only three hours a day, that is a ratio of about 3 to 1, consequently the capital charges per unit for lighting are one-third of those for power, and as the capital charges amount to about 80 per cent. of the total in the case of lighting, that explains the difference in the prices charged to the consumer. At the time to which I referred, when electricity was competing with gas successfully as an illuminant, people began to realize the advantages of electricity, the ease with which it could be turned on and off, its cleanliness and its advantages from a hygienic point of view, and electric light, in spite of the cheapness of incandescent gas, continued to make headway. The electrical apparatus was much more reliable than it used to be, and the prices for current were also considerably lower ; but it was not until during the last two years that any great advances in electric light economies were made. The Gas Companies had made a great step forward in having introduced for them, rather against their wish, the Welsbach mantle. That mantle meant a great reduction in cost of lighting, but it was by its introduction that the Gas Companies began to find that they had a weapon in their hands with which they might oust electricity as electricity had threatened to oust gas previously. But another point arose. Due to the economy of gas effected by the mantles, the companies found their revenue declining. They looked about for other fields, and as a result the gas cooker was introduced, causing large increases in the consumption of gas, the wholesale production bringing about a lowering of the price. For five or six years the gas mantle was in great demand, but electricity also kept in the forefront so far as cleanliness, healthfulness, etc., were concerned, and at the end of those years there was a new revolution in electric lighting through the introduction of the metallic filament lamp. The first metallic filament lamp introduced was the "Osmi" lamp, a lamp not quite so efficient as the "Osram" and with a very delicate filament, which prevented it coming into general use. Shortly after its introduction came the "Tantalum" lamp, of which I have some specimens here. This lamp is made in exactly the same way as the carbon filament lamp, excepting that the filament is made of pure tantalum metal. The introduction of this lamp brought the cost down to about one-half or one-third of the former cost, but it had various drawbacks. The price of the lamp was fairly high—that was not such a great drawback—but the lamp did not last very long. Of course it is now improved and is far better than it was. Another drawback was that it could not be used on alternate supplies. To those who are not acquainted with electrical matters I might say there are two systems of supply, one the direct current system, the other the alternate system used for the purpose of keeping down the distributing and generating charges. (It is, as the general rule, the only system under which commercial electricity can be supplied for power at a low price.) In the greater number of supply areas, therefore, the use of the "Tantalum" lamp was debarred on account of its very short life. There was a concerted action against electricity in the middle of 1906, and it seemed that electricity would have to go to the wall as far as lighting was concerned, but just at that time the "Osmi" lamp came in again in a practical form, and I think it was one of the greatest commercial electrical achievements of the last ten years that the "Osram" lamp, after being used for a short time almost as an experiment, within six months was being supplied on a sound commercial basis to the extent of thousands a day, so great was the demand in this country. Of course it was first introduced in Germany—most of these things are—but it was not taken up so much in Germany as in England. In Germany the carbon filament is still very much in use. The saving effected by the "Osram" lamp is approximately in the ratio of 4:1, that is to say, if the carbon filament lamps in a room are taken out and "Osram" lamps put in their place, the quarterly bill would be only quarter of what it was. Electricity, therefore, is now on a footing which makes it a serious competitor to gas for lighting in the matter of cost alone. The effect of this lamp bringing the cost down to one-quarter has given to electricity a lead-off similar to the impetus given on the introduction of the carbon filament, when it had to face only the ordinary gas-burner. That, up to the moment, gives the history of incandescent lighting in small units. I will now show the different kinds of lamps. This is the "Tantalum," this is the "Osram," and that is an ordinary 16 c.p. carbon filament lamp. This is a 50 c.p. "Osram" lamp.

You will see the filament in the latter is much longer. It is one of the disadvantages of the metallic filament that its resistance is low. The metallic filament allows a lot more current to pass over the same length, with the consequence that it is difficult, with the metallic filament, to keep the current low enough, thus necessitating an increase in the length of the filament. It is a big disadvantage, as it makes the lamp comparatively brittle, but every fresh delivery from Germany is better than the preceding one. At present, however, it cannot be used in a slanting position. If it is so used, the filament being soft, bends, touches the glass and breaks, bringing the cost of renewals up to a somewhat big figure. Referring to the competition between the "Osram" lamps and gas, there has been some considerable agitation in the gas and electrical world on this matter, and the supporters of gas have sent me a mass of figures showing that gas must be at least three times as cheap. The figures obtained from the people of West Ham who have adopted electricity show that there is a saving of at least 40 per cent. on their gas bills. The reason for the difference between these figures is due to a fact which I will explain. Take, for instance, one of your own lights in this room. That light in the back of the hall is supposed to be giving 64 c.p. and is supposed to be burning $3\frac{1}{2}$ ft. of gas per hour. I am almost sure it is burning nearer 5 ft. of gas and that the candle-power is under 30 at the present moment. But even assuming the candle-power and consumption of gas is what they say, the people who have adopted electricity find that there is a saving of 40 per cent. in their bills, and that is a big amount to explain away. I have spoken of the incandescent part of electric lighting, but there is another form of electric lighting which has been altogether from the start up-to-date and more forward than the incandescent, that is, the arc lighting. The "Nernst" mantle comes between the two, and was going to do for electricity what the "Welsbach" mantle did for gas, but, unfortunately, they could not get sufficient life out of the filament or mantle to make it a commercial success. The filament was made of practically the same material as the Welsbach mantle. There was the trouble, first of all, that it was a non-conductor, with the consequence that they had to put a subsidiary filament in to heat the main filament up so that it could pass electricity through it. Then again it was of no use with the alternate supplies.

The old idea I refer to is seen in the Jabblockoff candle, consisting of a couple of carbons in a converging position, held together by non-conducting material in the centre, the arc being formed at the bottom by a mechanical arrangement. As the carbon burnt away, the non-conducting material in the centre burned also, and the arc gradually burnt upwards. In the latest type the same idea of the converging carbons is used, but of this later. The next great step was the introduction of the open type arc lamp. It has been briefly explained by Mr. Battle, and I have not much more to add excepting that it consists of a couple of carbons in a vertical position. These are brought together automatically, the current switched on, and brought away again and the arc formed between the two. There is a crater at the top, and the carbon there is raised to an intense heat, the highest temperature obtainable. It is only a small thing, only $\frac{1}{16}$ in. square in some lamps, and the whole of the light is admitted from that crater. That is the first type of arc-lamp that was really satisfactory, there are some of them in the Romford Road now. They run on direct current. The alternate current was not a success because, owing to the rapid alternations, there was first the crater at the top to be formed, and then at the bottom, and the light was only going half way between the two, giving only half the efficiency. Of course the drawback to arc-lights is the cost of carbon renewal, a great amount is spent on labour and a large number of carbons are used, and to obviate this the Jandus Arc Light Co. introduced a lamp in which the arc was enclosed in a vacuum. There is a later one similar to the one they introduced. The arc is inside the globe, with the consequence that the air in the globe is burnt up and the carbon dioxide and carbon monoxide formed in the globe prevent the further burning away of the carbon. The difference in the amount of light obtained is very marked, because the light is not only obtained from the crater, but also from the arc. That is an ordinary enclosed arc-lamp. The amount of light given in different directions by that is much more than that given by the ordinary open type arc-lamp. This was considered a very great improvement in arc lighting, but shortly afterwards the " Bremer " lamp was introduced, which went back to the old form of converging carbons, with the use also of a secret mixture of impregnated salt. These vaporized salts gave an intense yellow light, the amount of candle-power given out being nearly six to one as compared with the ordinary open type lamp. This Bremer lamp was later materially altered in its construction, improvements being made in the salts, in the cores of the carbons and in the shape of the arc. The arc was regulated by a magnetic field which, although invisible, had the property of holding the arc in any desired position. The difference in candle-power is very marked, and in the matter of cost as compared with gas, the cost of this type of electric light is cheaper than any other form of illuminant. The draw-back is that it is not easy to make it as a small current lamp, otherwise the gas companies would not have much chance. The carbons are comparatively expensive and need renewing about once every eight to ten hours, but this very week I have received a communication from a gentleman to the effect that a new arc has now come out that will do for the flame arc what the enclosed arc did for the open type. They call it the Regenerative Arc Lamp. The principle is that instead of burning the vapour from the core of the arc, the vapour, first of all, is brought into the arc from the core, but then taken round different parts of the lamp and brought back again, the salts being burnt over and over again, and, whereas the carbon in the ordinary flame lamp lasts ten hours, in the new lamp will last about seventy hours. I will not say much more about the different kinds of lamps, but what I have said may have sufficiently interested you in electrical matters to lead you to visit the generating station, which I have no doubt would prove a most interesting visit, as it is one of the most up-to-date stations in the country. If I were to make a prophecy as to the future of electricity as against gas, I would say that for very many years there will be room for both, but I am fully persuaded of this, that electricity, if electrical engineers are more businesslike and enterprising than the majority are now, will soon oust gas from the foremost position as an illuminant.

Mr. Holmes then gave a demonstration of the different kinds of lights, also of various domestic labour-saving electrical apparatus, including heaters, cookers, kettles, flat-irons, etc.

Mr. J. H. Redman (Assoc. Member): What is the voltage of that "Osram" lamp?

Mr. Holmes: This is 100 volts, and about the average. The carbon lamps are done after 600 to 800 hours' use, and have to be dispensed with, but the "Osram" lamp lasts for 3,000 to 5,000 hours.

Mr. Redman: How do the "Osram" lamps stand the vibration in ships?

Mr. Holmes: I have no experience in that respect, but it will not be long before we shall be able to recommend them. Used on low voltages, say 25 volts, they are as suitable as the ordinary lamps, but for the high voltages I do not know whether they should be used. Lamps will be introduced in a few weeks on a commercial scale which will get over that trouble, and also over the difficulty at present experienced when the lamps are placed in a slanting position. Referring again to the question of voltages, they are only made just now up to 100 volts, but they will soon be made up to 200 and 300 volts.

Mr. W. P. Durtnall (Member): Are they just as efficient at 200 to 300 volts?

Mr. Holmes: Just as efficient.

Mr. Durtnall: Would it pay to put in a 2 to 1 transformer for the 200 volt supply?

Mr. Holmes: Not only 2 to 1 but also 4 to 1, bringing the pressure down to 25 volts; the general practice is to reduce the amount of current by half and double the amount of light.

The Hon. Secretary: The Edison lamps are very good, they turn out very well as a rule in respect to life.

Mr. Holmes: Yes, but they are only carbon lamps, nobody would think of buying carbon lamps nowadays, except for isolated low candle-power points.

The Hon. Secretary: What would be the comparative cost for, say, 10,000 hours, for 16 or 32 c.p. lamps, including renewals?

Mr. Holmes: The carbon filament lamp for 10,000 hours would cost about £15 for current and for renewals about 12*s.*, or about £15 12*s.* in all. The metallic filament lamp would cost about £3 15*s*. for current and 25*s*. for renewals. It might be considerably less, but that is a fair average.

Mr. W. Britton (Assoc. Member). I heard a statement last week that the Welsbach Company were offering to provide and fit up a house with gas, to the same extent as electricity, in a similar house, provided by the West Ham Corporation and guaranteed a cheaper cost.

Mr. Holmes: With regard to that challenge, first of all, the West Ham Corporation, as a Corporation, could not take up a challenge of that kind. Secondly, the Welsbach Company would probably put in special mantles, they would also probably obtain the services of an expert like Professor Vivian Lewes to look after the costs, and in that way they could get laboratory costs. With electricity, laboratory costs are actual costs. These are the conditions against which we would have to compete, but when it comes to the open market we are only concerned with the results to the ordinary consumer. They judge by their quarter's bill. There is no single case where electricity has been installed in private houses during the last four or five months where there has not been a decrease on the gas bill. I could quote numbers of instances.

Mr. Britton: The same gentleman I heard speaking instanced the case of a firm which installed electricity and went back to gas again because of the cost, which was in the ratio of 4 to 1 against electricity.

Mr. Holmes: It is just possible. You can have too many lights fitted, and fitted in the worst possible positions, with the consequence that the cost will be infinitely more. As a matter of fact some of the biggest firms in Stratford are taking on electricity for power because of the saving effected in lighting.

Mr. Durtnall: More attention should be paid to the switch gear. In competition the lower tender is accepted, and probably there are only half a dozen switches controlling 100 lamps. If people would pay more attention to that, their consumption would come down, that is my experience.

Mr. Redman: You have not referred to the mercury vapour lamp.

Mr. Holmes: I have not referred to it because it cannot be called a commercial success at the moment. It is being used, but it is not a commercial success.

Mr. Redman : Is it suitable for photo printing ?

Mr. Holmes : I am not an expert on photography, but most people use arc lamps for that purpose.

A hearty vote of thanks was accorded to Messrs. Battle and Holmes, on the proposal of Mr. G. W. Newall, seconded by Mr. E. W. Ross.