INSTITUTE OF MARINE ENGINEERS

INCORPORATED

SESSION 1907-1908

President : JAS. KNOTT, Esq.

Report on Lecture V—Electricity.

(Abridged.)

By Mr. A. E. BATTLE (Member,)

Delivered on Monday, February 25, 1907.

The lecturer, upon introducing the subject, "The Principle of the Ordinary Dynamo," said before coming to the main subject, it would be advisable to run over one or two elementary points—"First of all we say that electricity may be taken for practical purposes as a form of energy. It has a current flow, caused by the electro-motive force due to the difference in electric level or potential, the unit of which is the volt, and directly electricity does work it loses its energy and the voltage drops. The analogy of electricity and water is very good, water has its pressure, electricity, voltage ; water, its rate of flow, electricity, ampèrage ; water flowing through a pipe meets with a certain amount of resistance, and practically the same thing occurs with electricity, the unit of resistance being termed the ohm. The volt, the ampère and the ohm, are units, the names of which are derived from the name of the particular scientist associated with the discovery of the respective phenomena."

The next divisional point touched upon was magnetism, which is closely allied to electricity. In the regular form of magnet it was pointed out that there are two poles, north and south, the force acting from these points in certain definite directions, and for which has been coined the phrase "lines of force." "It is assumed that the lines of force of the magnet flow from the north pole to the south. By arranging some iron filings on a piece of paper and putting the magnet underneath you will see how the filings arrange themselves in a certain order showing the direction of the lines of force as has now been demonstrated."

Not only has the magnetic needle this attractive power, every electrical wire possesses magnetic properties, which can be illustrated by passing an electric current through a piece of wire, when the wire exhibits the peculiar properties of an ordinary magnet. A magnetic needle lies along the "magnetic meridian" and is nothing else than a suspended magnet. Like poles repel, and unlike poles attract each other, and as we get that effect in a solenoid of wire with an electric current passing through, it is a magnet in every sense of the word, and clearly proves that every wire with an electric current passing through possesses lines of force. When this wire is curled up, all the lines of force are concentrated, and when an ordinary iron core is passed through the solenoid it has the power of collecting all the lines of force, and is thus transformed into an electro-magnet, the strongest magnet known, merely by concentrating the electrical currents. Another peculiar property is that there must be a complete circuit so that the magnetic pull may be in straight lines. I have here, said the lecturer, a galvanometer and a coil of wire with an iron core. The lines of force coil themselves round and the electrical current is induced into the core. The magnetic effect increases in proportion to the amount of electricity passing through it until the point of magnetic saturation of iron is reached, when the electricity merely increases the magnetic effect on the wire

In the ordinary dynamo we devise an apparatus by means of which the lines of force are cut by a closed circuit. The two main parts of the dynamo are the magnetic field and the armature, and there must be a relative motion between the two.

The armature is usually the part which rotates about the magnet. We can get a dynamo to work without any electro-magnet at all. The usual magnet is made in the following manner.

The coil is wound round the core in the one direction, the two poles brought close together and then by having the pole pieces bored to exactly fit the armature we are able to get the maximum effect of the cutting of the lines of force.

Next the construction of the armature was touched upon, and it was pointed out that in designing the armature it is necessary to arrange it in such a way as not to retard the lines of force passing from one pole to the other and at the same time enable it to rotate easily. At the present day there are two types of armature generally used, the drum armature and the ring armature. The ring armature consists of a laminated ring around which the armature coils are wound. The ordinary drum armature, however, is the one we have to consider most as Marine Engineers. In the first place we have to arrange it upon a spindle, and secondly we have to get the maximum amount of wire so arranged as to cut the lines of force. The core is laminated to provide an easy passage of the lines of force from one magnet to the other. The magnetic current flows more freely through iron, and therefore by having an iron core there is an easy passage of the line of force from the north to the south pole. The laminations of the core prevent the formation of eddy currents, the core being formed by small pieces of carbonized iron sheeting, insulation of a suitable type being placed between each plate, by which means we get the lines of force practically to run through and through.

The principle of the transformer was also gone into and practically illustrated with two induction coils. The low voltage of a few batteries being first in one coil transformed up, and then by means of the other coil again transformed down sufficiently low to light a small four-volt incandescent lamp.

The lecturer, in conclusion, said that he proposed leaving the transmission and distribution of a current to some one as the subject of a very suitable paper at a future date, and that he sincerely trusted that his humble effort had been productive of good, as Marine Engineers must wake up to the fact that a more detailed knowledge is now required of them upon this interesting subject than that acquired by the mere starting and oiling of a dynamo and engine on board ship.

The lecturer then called attention to the important point in working a dynamo, viz. to keep the commutator in good condition, and on any signs of wear to keep it true ; he also stated that in the Westminster Power Station there is one of the biggest direct current machines in the country, and it is the common practice there to undercut the commutator. The mica wears very much slower than the metal of the respective segments, and the consequence is that a series of holes appear as the brush goes over it. It was not uncommon before this practice to shut down the whole system and overhaul the commutators two or three times a week, but after undercutting the segments they were able to run for six or nine months. The mica was cut away and then the only wear was upon the commutator itself.

For many years the alternating current dynamos were only suitable for lighting. At the present day, by means of induction motors where the armature is nothing else but a solid piece of iron, we are enabled to work, to certain fixed speeds, motors almost as satisfactory as with the direct, and it is anticipated that in the future Marine Engineers will have to deal with, and know as much about alternate current dynamos on board ship as they do at the present time about direct current.

The lecture was illustrated throughout with experiments and models, together with numerous blackboard diagrams of armature winding, and the various details of the dynamo construction. The shunt, reverse, and compound wound dynamos, together with the correct placing of the brushes, etc., being dealt with in detail, thus making the lecture extremely useful as well as interesting.

Report of Lecture VI—Electricity.

(Abridged.)

BY MR. A. E. BATTLE (MEMBER),

Delivered on Monday, March 25, 1907.

THE lecturer in introducing the subject of the evening's lecture namely, "What can we do with Electricity and what is Electricity?" said that that question had been occupying the scientific world for some time past, and was still a long way off being definitely settled.

The various theories set forth were dealt with in turn, illustrated by experiments; the single and double fluid theory, where the two electrical states, positive and negative, permeated all space and neutralized each other, the disturbance of this equilibrium, that is the reducing the + or—electricity in a body or bodies connected, resulted in an electrical flow or current. Whereas the energy theory, as set forth at the present day by modern text-books, maintains that electricity is a form of energy, and in support of this view the theory set forward is that work and heat energy are both convertible into electrical energy and vice versa.

Experiments were here introduced illustrating this, the thermo-pile illustrating the converting of heat energy into electrical. Other experiments illustrated work energy being transformed into electrical.

Scientists, said the lecturer, are to-day apparently coming to the conclusion that the old philosophers were not so far wrong, and it is possible that before a generation is passed away electricity will be proved to be a form of matter possibly in its fourth condition, and that this substance permeates all space.

The idea set forward by Sir Oliver Lodge in his book on electricity is that it is an incompressible fluid, that it is everywhere and that it is the transference of this fluid from one place to another that causes an electrical flow. Of course, in making the assertion that it is incompressible we open up the question "how do we know that it is there?" We can only find that out by observing it under certain conditions. If, for instance, we had two elastic bags connected by a tube, each capable of containing water and immersed them, we could then start a flow from one bag to the other, and the swelling out of the bag would be sufficient evidence that a flow was taking place. This style of evidence is what we have to support the incompressible fluid theory of electricity, and the experiment has its counterpart in a simple Leyden jar. The Leyden jar holds the same position to electricity as the elastic bag to the water; illustrating this we have here a fluid which is held in exactly the same way as the water. If we have a conductor on the one end and a conductor on the other and in between an insulator, namely, the two metal sheets and the glass, a condition can be created enabling us to get the incompressible fluid and to place this under a tension. The fluid cannot be compressed, but it can be put under pressure in the same way as with the water in the elastic bag. In this case we can allow the electricity to pass into the jar until the latter is practically at bursting point, and it is working on these lines that has brought modern scientists to the incompressible fluid theory.

The energy theory, however, it is very handy to have, and gives us something to work upon and serves a useful purpose in electrical designing.

The next section of the subject will now be dealt with, namely, What can we do with electricity ? We find it is generally accepted in the ordinary energy theory that electricity flows from the positive to the negative. Under certain conditions it appears as though the flow were from negative to positive, and one gets involved in such contradictions as we go on that our adherence to the energy theory is greatly shaken. Now let us see the action of the electricity in the electrolysis or splitting up of water into its component gases by experiment. In this case it looks very much as if there were two flows, positive and negative. The atoms of water are separated, with the consequence that the oxygen is attracted to the positive pole and the hydrogen to the negative, it is really an illustration of attraction and repulsion. The principle is this : we have two platinum electrodes connected by a wire, the current is passed through, electrifying the small ions and causing one class to be attracted to the one pole and the other class to the opposite pole. This is clearly shown, and the presence of the gases proved by applying a lighted taper when the hydrogen burns while the oxygen merely supports the combustion.

This attraction and repulsion is well illustrated by the Wimshurst machine, which is only one of the ways of inducing electricity (it is absurd to speak of "generating" electricity). In the Wimshurst machine the important parts are the two plates which revolve rapidly in opposite directions, and the electricity is really induced by the friction. Frictional electricity is of an oscillatory nature, which is never dangerous, the oscillations being so rapid that there is charge after charge in such quick succession that they neutralize each other, whereas if the charge was in the one direction with such a voltage as I am now generating the effect of receiving it would be very serious. We get an illustration of the fact that like electrically charged bodies repel each other in the case of these small pieces of paper which have been similarly electrified and consequently repel each other as you see. A very good illustration is to induce a young lady to stand upon an insulator when by receiving the current her hair is made to stand on end. Possibly the lady may object. Another illustration is in making this elevated steel pendant swing round. It was shown in the electrolysis how gases can be electrified, the water was split up into the gases and the small electrified particles, repelling each other, were attracted on to the respective poles. Here the air is electrified by the electricity passing off these points and the reaction of the air from the similarly electrified points, causes the pendant to swing round.

The experiment of condensing smoke is practically upon the same lines, as it is really the solid particles of smoke being electrified, and attracted to any substance that might be anywhere near. This is an illustration which shows how in the near future it will be possible to dispel even the London fog (the lecturer here took a tube filled with smoke which he dispelled by charging it with electricity). It would be interesting to see the effect of an enormous frictional machine fixed on the funnel of a ship, or the effect on fogs on the Banks of Newfoundland, and when you consider that 60 years ago or 100 years at most, electricity was nothing more than a toy, and that even now we have simply tried a few experiments with it, it certainly suggests possibilities of what might be done and that it might be worth the while of Marine Engineers to investigate matters more fully than they do.

Before going any further we will again look at the Leyden jar. The insulator becomes charged to such an extent that it ultimately becomes a very good conductor under high electrical tension. The consequence is that the charge finds its way from one side to the other, oscillating backwards and forwards, and what appears to be one spark is really a succession of eight or ten sparks. This may be proved by catching the spark on a rotating mirror and reflecting it on to a screen, the oscillations are then very apparent, as has been done by experiment.

We will now see how electricity discharges. Taking this induction coil we find that it gives a spark which appears to be of a continuous nature but is really a shower of sparks. The electric coil mystified people a long time and held the place of a scientific toy, but to-day we find it very useful. To illustrate its action I will cut a stencil in this piece of paper. Taking one of the wires, highly insulated, we trace out the pattern and we find the paper beautifully perforated, the perforation proving that the spark is of a showery nature.

We find that different substances manifest peculiar properties under an electrical discharge and to illustrate this, we have here a small piece of sugar. Placing the high tension terminals of the induction coil on either side you will see how the sugar is made to glow. Quite a number of substances exhibit the same phenomena, and it is the study of such experiments as the effects of passing an electrical charge through a vacuum tube that has provided the scientific electrician with the fluid theory of electricity. I have a tube here with a very low vacuum, the two terminals are fixed at either end and are the discharge points. The electrical discharge, as you see, passes right through from one end to the other. Now I take an ordinary magnet, and passing it outside the tube you will observe that the electrical discharge is deflected in the same way as metal is.

Not only will the electricity split up water, but it will also split up air, and with this tube you will be able to see the air stratified. You see the discharge is now in layers, and this is nothing less than the air being split up into its component gases.

We will now leave the speculative aspect and confine ourselves to the picturesque. The induction coil holds the same position as the ordinary pressure pump in engineering, which takes low pressure water and converts it into high pressure water, so an induction coil takes low pressure electricity and converts it into high pressure electricity. The current that flows from an induction coil is alternating, or oscillatory, but it has, as it were, a bias towards being a direct current, and a shock from a large induction coil is very dangerous. Tesla invented a coil which takes the direct current and converts it into an alternating current by means of introducing two Leyden jars which discharge and produce the oscillations required. This oscillating current is then conveyed into the primary of another coil and made to oscillate still further with the result that we get a purely oscillating current which can be handled with perfect safety. Before giving one or two experiments with the Tesla apparatus, however, I have here two small instruments that I would like to call your attention to. This one contains the principle of what you might call a fire alarm, very interesting from an engineer's standpoint, illustrating as it does how slight a variation in temperature affects a metal. A coil is made of two metals, iron and zinc, coiled up together, and the co-efficient of expansion of one being greater than that of the other, the slightest variation in temperature affects one metal more than the other, and you will see when this coil is taken to the other end of the room, the temperature of the hand even will cause sufficient deflection to ring a bell as has now been demonstrated. This illustrates the conversion of heat into electricity.

I have here an ordinary thermo-pile and an ordinary galvanometer which will indicate the flow of electrical current. Looking into the mirror behind you can see the deflection of the needle showing the conduction of the electricity from a higher to a lower electric level. It was the principle of these two experiments that gave rise to the energy theory.

In connexion with the Tesla experiments, I propose to show you a number of vacuum tubes. In this case the tubes are filled with different fluids, which on the current being passed through, fluoresce to different colours, giving, as you see, most beautiful effects. These are all produced by electricity excited with an ordinary induction coil.

The next experiment shows the operation of the X-rays. The rays come from the vacuum tubes and have the property of causing certain fluorescent bodies to become luminous. This screen is coated with a peculiar salt, fluoride of barium, and the rays penetrate through opaque bodies rendering the screen luminous. The denser the substance the less transparency there is, consequently when the hand is held before the screen the rays pass easily through the flesh while the bones, being denser cast a darker shadow.

Perhaps the most wonderful of all the developments of electrical science is the wireless telegraph, the working of which you will be able to understand from the apparatus here to-night. The apparatus consists of an induction coil at the sending station and a coherer and receiving apparatus at the other.

The lecturer here explained in detail the principle involved, and also the details of construction, practical demonstrations being given by apparatus placed at either end of the room, considerable interest being evinced as the wireless messages were transmitted and received upon the Morse inker, which were distributed among the audience for their closer inspection.

After the lecture a considerable time was spent by the lecturer and his assistants in further explaining various points of interest to the members who clustered round the lecture table, and a number of impromptu experiments were conducted illustrating the subjects under discussion.

Lecture on Engine Construction.

By Mr. J. G. HAWTHORN (Member of Council .

Delivered on Monday, March 11, 1907.

In this lecture Mr. Hawthorn showed the conditions under which an engine designer would go to work in fixing the sizes of cylinders, sizes of shafting and other details in the design of engines proportionate to the size of a vessel, and to develop a certain power and speed. In leading up to the rule for determining the sizes of cylinders he commenced by working out the builder's formula for arriving at the indicated horse-power to obtain a specified speed in a vessel of assumed dimensions, explaining in detail the significance of each term in the formula and how obtained. Assuming the engines to be triple expansion the lecturer deduced the pressures for the different cylinders, prefacing his remarks by giving a brief survey showing the important part the question of terminal expansion pressure had played in the history of engine design, afterwards describing a few of the conditions which bring about terminal expansion pressure. He then showed how to obtain the practical mean effective pressure for the low pressure piston when referring all down to the low pressure engine, the referred mean effective pressure from which the size of piston was obtained, the sizes of high pressure, low pressure and intermediate cylinders, size of piston and the method of balancing. The size of the shafting was then gone into, the lecturer explaining the strains and moments to be taken into account in the calculations, describing more particlarly the derivation and value of constants. He then briefly outlined the method of erecting the engines and concluded with a few words on valve setting. In reply to questions the lecturer described the different methods of lining the cylinder and the sighting of engines in course of erection.

Lecture on Self-Help.

By Mr. T. F. AUKLAND (Companion).

On Monday, April 8, Mr. T. F. Aukland gave a lecture on "Self-Help," consisting for the most part of extracts from the book on this subject by the late Dr. Samuel Smiles. Dr. Smiles presented his views in a simple, direct style, the short, crisp sentences and the apt and frequent use of illustration having a very forceful effect. Mr. Aukland preserved these characteristics, and by its human interest, its appeal to the spirit of independence, its inspiring words to the toiler under difficulties, and its high ideals, the lecture could not fail to produce a lasting and character-forming effect.

"Whatever is done for men or classes, to a certain extent takes away the stimulus and necessity of doing for themselves, and where men are subjected to over-guidance and over-government the inevitable tendency is to render them comparatively helpless." "Daily experience shows that it is energetic individualism which produces the most powerful effects upon the life and action of others, and really constitutes the best practical education. Schools, academies and colleges give but the merest beginnings of culture in comparison with it. Far more difficult is the life education daily given in our homes, in the streets, behind counters, in workshops, at the loom and the plough, in counting houses and manufactories, and in the busy haunts of men." "All experience serves to illustrate and enforce the lesson that a man perfects himself by work more than by reading—that it is life rather than literature, action rather than study, and character rather than biography which tend perpetually to renovate mankind." "Great men of science, literature and art, apostles of great thought and lords of the great heart, have belonged to no exclusive class nor rank in life. The poorest have sometimes taken the highest places, nor have difficulties, apparently the most insuperable, proved obstacles in their way. Those very difficulties in many instances would even seem to have been their best helpers by evoking their powers of labour and endurance, and stimulating into life faculties which might otherwise have lain dormant."

These are some of the thoughts collated by the lecturer, and their truth was borne home by the recital of the names of famous men whose lives embodied them. "From the barber's shop came Jeremy Taylor, Richard Arkwright, and Turner the landscape painter; the common class of day labourers has given us Brindley the engineer, Cook the navigator, and Burns the poet. Masons and bricklayers can boast of Ben Jonson, Edwards and Telford the engineers, Hugh Miller the geologist, and Allan Cunningham the writer and sculptor, whilst among distinguished carpenters we find the names of Inigo Jones the architect, Harrison the chronometer-maker, John Hunter the physiologist, Romney and Opie the painters. Weavers, shoemakers and tailors have contributed to the roll of famous names. Cardinal Wolsey, De Foe, Akenside and Kirk White were the sons of butchers, Bunyan was a tinker and Joseph Lancaster a basket-maker. Among the great names identified with the invention of the steam engine are those of Newcomen, Watt, and Stephenson, the first a blacksmith, the second a maker of mathematical instruments, and the third an engine-fireman.

From the "ranks" came Bewick, Herschel, Baffin, Faraday, Copernicus, Kepler, Newton, Hugh Miller, Livingstone and numerous others who were born of obscure parents, and whose lives are incentives to self-denial, self-reliance and self-control, incentives to emulate the constant application, the indomitable courage and the infinite patience which was the true secret of their genius. "Looking at some of the more remarkable instances, it might almost be said that early encounter with difficulty and adverse circumstances was the necessary and indispensable condition of success." "Riches are so great a temptation to ease and self-indulgence to which men are by nature prone, that the glory is all the greater of those who, born to ample fortunes, nevertheless take an active part in the work of their generation." That the wealthier classes have taken their fair share in the work of the state, the records of philosophy and science, literature and politics show, containing as they do the names of Bacon, Worcester, Boyle, Cavendish, Rosse, Palmerston, Derby, Russell, Disraeli, Gladstone, Brougham, Sir E. Bulwer Lytton, and others equally famous. The outstanding feature in the characters of these men of genius, was their ceaseless perseverance, and this feature could not be better exemplified than in the instance of Palissy, the French potter—quoted at length by the lecturer from Dr.

Smiles' book—who spent ten years of disappointing and expensive experimenting in search of the secret of enamelling. Reduced at last to penury he was obliged to borrow money to enable him to obtain material for a further experiment.

"It was the last and most desperate experiment of the whole. The fire blazed up, the heat became intense, but still the enamel did not melt. The fuel began to run short! How to keep up the fire? There were the garden palings, these would burn. They must be sacrificed rather than that the great experiment should fail. The garden palings were pulled up and cast into the furnace. They were burnt in vain. The enamel had not yet melted. Ten minutes more heat might do it. Fuel must be had at whatever cost. There remained the household furniture and shelving. A crashing noise was heard in the house, and amidst the screams of his wife and children, who now feared Palissy's reason was giving way, the tables were seized, broken up and heaved into the furnace. The enamel had not melted yet! There remained the shelving. Another noise of the wrenching of timber was heard within the house, and the shelves were torn down and hurled after the furniture into the fire. For an entire month his shirt had not been off his back, and he was utterly worn out—wasted with toil, anxiety, watching and want of food. He was in debt and seemed on the verge of ruin. But he had at length mastered the secret, for the last great burst of heat had melted the enamel. The common brown household jars, when taken out of the furnace after it had become cool, were found covered with a white glaze!"

The lecture was abundant in illustration, and evidenced throughout the lecturer's power of discrimination, his ability to seize upon the vital parts of his subject, and to impress them in a way calculated to awaken a responsive note in the minds of his hearers. A hearty vote of thanks was accorded to Mr. Aukland for his excellent lecture.