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Friday, May 29, 1885.

ADMIRAL THE RIGHT HON. SIR A. COOPER KEY, G.C.B., &c., &c.,
Vice-President, in the Chair.

ELECTRICITY AS APPLIED TO NAVAL PURPOSES.

By Lient. W. A. CHISHOLM-BATLEN, R.N.

- I. Application for General Purposes.
- II. Application for War Purposes.

THESE are in some cases mixed, and there is no sharply defined line between them—take electric lighting as an instance. The ordinary internal lighting of a ship is quite distinct in itself from search-lighting, though produced by much the same means. They have both grown independently; but in a ship of war, the great object should be to combine the two.

Electricity is a great power in skilled hands, and can be used with safety and certainty even by slightly trained men, if only enough care and thought be taken in designing electrical appliances, to make their use easy and abuse difficult.

The applications of electricity on board ship are various, and differ greatly. Sometimes it is necessary to use the electric force in such a way that it has power to melt any metal, to produce an intense light rivalling that of the sun, to propel a vessel, or to give severe and even fatal shocks to those handling its mechanism. At other times it is so gently applied that although it acts through the human body, it cannot be felt by the most tender child; and at others, it is so exquisitely sensitive that it will carry faithfully the distinct tone of a certain voice, and indicate a change in its neighbourhood so slight as the movement by inches of an ounce of lead.

The two properties of the electric current which are generally made use of are, first, that of causing heat when a comparatively great resistance is placed in the circuit; and, secondly, that of giving magnetic properties to any conductor through which it passes.

An apology is due for going into matters so simple, but in case there may be some who may not be familiar with these points, they will be briefly explained.

Electricity for naval purposes is produced by what may be termed a generator, which is generally either a machine deriving its power from the burning of coal, or a battery deriving its power from the slow burning of zinc.

The next part of any electric appliance to be considered is the circuit, that is to say, a conductor, generally metal, which allows the

current to circulate from the generator to the place of application and back again. This is generally formed of copper or iron wire.

The part of the conductor or lead which goes from the generator to the place of application may be called the main, and the part which comes back may be called the return.

When the result desired is the developing of heat or light, a high resistance, that is a small conductor, or one of a comparatively bad conducting substance, is introduced in the circuit at the desired place.

For instance, if the electricity originally obtained by the burning of coal, and then carried in an accumulator, be allowed to pass through a main wire which must touch the accumulator, to an incandescent glow-lamp and back by a return wire, heat and light are produced at the thread of carbon in the lamp, which has a high resistance.

Or again, if the electricity produced by the burning of zinc in a battery be allowed to pass through the main to a small wire and back again, sufficient heat is produced to fire a charge of gunpowder.

When the result required is an exertion of magnetic force, the simplest, or at any rate the most familiar, form is the electric bell. In a circuit from a battery which slowly burns zinc, a current passes round a coil of wire, causing it to act as a magnet and to attract a piece of iron which makes the clapper strike the bell.

Or again, if the current, originally obtained from the burning of coal, be allowed to pass by the main to a magnetic arrangement and back by the return, the result is magnetic action which causes motion and is sufficient to drive a boat or any useful machine.

Thus much of the simple principles of electricity.

Electric Lighting.

The most important application of electricity for naval purposes is perhaps, the lighting of ships.

Electric lighting is almost entirely carried out by an extension of the simple appliances which have been described. The current passes from the electric machine or generator along the main to the lamp and back by the return; that is to say, the illumination in a ship is carried out by a large number of glow-lamps—usually about 300—of about 20 candle-power, that is, 20 wax candles, 8 to the point. The electric machine is usually driven by a steam-engine.

The advantages claimed for the use of electric lighting on board ship are many of them applicable, as you will notice, to its use on shore.

1. It is cheaper than oil—at any rate than the oils allowed to be used on board men-of-war, and still more so than candles, which have hitherto been the general illuminants.

2. There is far greater safety from fire, as there is no occasion for carrying matches about or lighted candles, which in spite of all rules are often used naked. This is hardly surprising when one thinks of the trouble which has to be taken to avoid naked lights being used in mines; the use of electric lighting also does away with that is the danger of fires—the lamp-room.

3. It hardly heats the air, and does not foul it at all.

Many merchant steamers and some ships in the Navy are thus lighted, the principal reason against its extended use in the latter being the fact that men-of-war pass much of their time without getting up steam, but in troop-ships it has been almost universal introduced.

Andrews and Co., of Glasgow, have just completed on board the "Etruria" a large installation which, in its proportions, surpasses anything that has hitherto been attempted in the application of electric light to steam-ships. The "Etruria" carries about 850 lights, and a brief description will no doubt be interesting. Swan glow-lamps are used, and of these 90 are distributed in the engine-room, stoke-holes, &c. 103 lights altogether are used for lighting the main dining saloon, 84 of which are suspended over the tables in 3-light electroliers hanging from the ceiling. The remainder of the lamps are in small brackets and pendants so as to give light over the side seats. Above the saloon is the music-room, having 17 lights round the walls and over the piano and organ. The smoking-room has also 17 lamps. The remainder of the lamps are distributed about the ship, 172 being in the state rooms.

Besides the actual internal lighting of ships, electricity is used for the bow and masthead lights. I understand that the Board of Trade does not object to the use of the electric light for ships' side lights, but it requires oil lamps to be kept in reserve in case of failure. With regard to masthead lights, however, the Board discourages the use of electricity, partly on the ground of its liability to get out of order in consequence of vibration, and partly in consequence of the brilliancy of the light tending to interfere with shore lights, and cause confusion. It is in fact not used for masthead lights, and only in a few cases for side lights, and it has not been thought necessary to issue any general instructions, though the Board of Trade is now in communication with the Admiralty on the subject.

On this point there has been some discussion. The first lights used were very much brighter than the oil lamps which they replaced, and caused mistakes from their being taken for lighthouses, or from the distance of the ship using them being misjudged. There is, however, great advantage in their use, from such use securing certain knowledge that the lights are all right. This is effected by the current passing to the lamp through an indicator on the bridge—in view of the Officer of the watch.

The ordinary lights carried by ships-of-war when cruising in company are now in some cases electric; and the electric light has been ingeniously adapted to signalling purposes.

One of the most complete arrangements got out by the well-known firm of Sautter Lemontier is as follows:—

Two groups, of five glow-lamps each, are suspended at a certain distance above each other, and the current is allowed to pass to one or more of them by a key-board in the deck-house. In order to prevent mistakes, the signal is set before the current is allowed to pass to the required lamps, and this setting lights up a corresponding signal.

front of the operator, thus:—He wishes to show four lights, and four lamps in connection with a main switch. In doing so, he covers four little illuminated windows in front of him. Satisfying the appearance of this signal, he switches on the current from generator, confident that his signal will be correct. A switch is merely a means of connecting or disconnecting one conductor from another, as is also a firing key, which will be mentioned later on. The signalling may be done by hoisting the light and signalling the key; or again by dipping the light in a bucket. There is an application of the glow or incandescent lamp for the purpose of coaling or doing other work at night. In this case a group of a dozen lamps are placed under a reflector which is triced up to the yard-arm, so as to light up the deck of the ship and the coal water vessel alongside.

The glow-lamp is also useful for the diver, either in thick water at night; but special precautions have to be taken to prevent the globe being broken by pressure, and for this purpose it is enclosed in a second thick glass globe.

The electricity for the lamp is either derived from above or through wires kept carefully dry, and not touching any metal, or in some cases provided by a battery carried by the diver with the lamp.

Messrs. Siebe and Gorman's lamp is of the latter kind. The lamp is mounted in a parabolic reflector fixed to the side of the battery. The battery will keep a constant light going for four to five hours.

We now come to a different form of illumination, called the arc light. In this arrangement, a suitable current of electricity is allowed to pass through two carbon rods in contact, and then the rods are slightly separated. The effect of this resistance or space introduced into the circuit by separating, is to produce a very brilliant light, proceeding partly from the heated carbon rods, and partly from a luminous arc between them.

This light is very intense, too much so for many purposes. The carbons burn away, so that some arrangement is necessary for bringing them within the proper distance for the arc, and for replacing them when entirely consumed.

This arc light has been used for internal lighting, masthead light and coaling lights, but the necessity of having some apparatus for feeding the carbons and other causes have forced it to give way generally for these purposes, to the simpler glow light.

For the search light, however, used for discovering torpedo-boats approaching a ship, bombarding forts, and so on, the arc light is necessary, as great intensity is required. The search light is a very like appliance, but had better be considered in connection with other uses of electric lighting. It is very useful for other purposes, such as clearing the anchor at night, and such peaceful, or at any rate warlike, operations. When the arc is used for a search light, the rays are all collected by means of lenses or mirrors, and projected into one beam, so as to get the strongest possible light.

The difference in power is immense between the glow and arc light.

in ordinary use at sea—the glow-lamp representing only a few candles, seldom more than 20—but the arc as now used, about 25,000, and a far more intense arc light has been produced on shore.

A boat can be discovered by it at a great distance.

In the West Indies, in a fine clear atmosphere, a building has been picked out clearly enough to be aimed at with a gun, at a distance of two and a half miles, the light used being about 8,000 candles; but great difficulty was experienced in keeping the beam on the object, as one could not see any distance unless standing away from the light.

To obviate this, means have been devised for directing the beam by an observer at some distance from the lamp.

The search lights in general use are worked by a man who screws the carbons together as they burn away; this method, undoubtedly crude, has been adopted chiefly for simplicity's sake, but it is high time that a suitable automatic lamp—that is, one which is self-feeding—should be introduced, and that the directing of the beam should be in the hands of the observer, although he is necessarily at some distance from the light.

The electric lights belonging to the ships have been considerably used during the operations in Egypt; one was landed, generator and all, at Alexandria, and another at Suakim. The light was also much used at the latter place from on board, for discovering the approach of the enemy at night.

For signalling, the arc light has been used for many years, the process being to flash the beam up in the sky in longs and shorts, using the Morse or some similar code.

To show what may be done in this way, it may be mentioned that during some of the electric light night exercises carried out at Portsmouth from the Torpedo School, the flashes of a light of about 20,000 candles were distinctly seen 31 miles from the ship, a low range of hills intervening; and a similar light was reported to be seen still further when shown from a tower of the Philadelphia Exhibition last year.

Again, some ships being anchored in Ragusa and others in Gravosa, signalled to each other in spite of the hills between, by flashing an arc light up in the sky.

There is no difficulty in lighting up a building at 2 miles distance with a 20,000 candle light.

Electric Communications.

From signalling by the light at a distance, one passes naturally to other means of communication for which purpose electricity is more universally used than for any other.

Telegraphy in the nature of things is not in use much outside the ship, from the difficulties of bringing in the wires with a ship swinging round her anchor; but means have been devised for this useful object, which are especially applicable to light ships: telephones, and so on, can of course be used from a ship moored head and stern—in fact, light is sometimes supplied in this way.

As regards electricity within the ship herself, the uses are many. The ordinary electric bell I need hardly dwell upon, but the appliances most especially required in men-of-war are first, a means of knowing the speed of the vessel at any time, and second, telegraphing distances of the enemy ascertained in the tops, Captain and gun batteries.

I am not aware of any method, which is in very general use for obtaining the first result. But there are numerous appliances for it.

There are many instruments which give the speed of the engines for a greater or less period of time, but what is required in a man-of-war is to know the speed at any instant.

Various electric logs do the first, that is to say, the speed over can be noted during any period, but the speed at a given instant is not shown. Even an instrument which showed at any instant the speed of the engines would be a useful improvement.

The principle of most electric logs is that the revolutions of a fan periodically close a circuit. When this is done, a dial hand on one division, usually a tenth of a mile. If, then, the electric log be joined up to a recorder in the Captain's cabin, and another in the chart-house, and set at noon, both the Captain and the Officer of the watch can see at any time how far the ship has run since the last time the instrument was looked at.

The difficulties of a joint which shall connect two conductors, yet be able to stand continually being revolved, appears to have been dealt with in an original manner in the "Dollond" log; the principle is protected by patent, and is applicable to the attachment of wires, for signalling to light ships or other vessels swinging their anchors.

This log will be sufficient to give an idea of these instruments.

The log used in the Navy for recording the distance passed by a ship consists in a fan which is towed on the quarter of the ship, which, as it revolves, shows the number of miles passed over on a plate attached. The disadvantage is that it has to be got on board in order to see how much distance has been run.

Other logs which are much used in mail steamers have a fan to which the recorder is on the taffrail, and is turned by the towing cable.

The disadvantage is that the recorder can be in one place only, and only one recorder can be used.

It is claimed for the electric log that it is more trustworthy than the taffrail log, and more useful than either, in so far as one or more recorders can be placed in any required position. The advantage is obvious in any ship in cruising time; but in a ship of war its value is enormously increased, for it is easy to place telegraphic connection at any required point in the pilot towers, at the head directors, gun directors, and gun deck, for in firing a ship it is necessary to know speed, and still more necessary when firing at a torpedo.

It indicates at once any mishap to the log, by fouling or coming away.

It saves the labour, loss of time, and error of registration involved in hauling in the log, which can remain in the water, unless fouled, until entering port.

The instantaneous registration of the distance run between two bearings enables navigators to calculate with accuracy their position in reference to a light, headland, or other fixed object.

The indicator can be re-set on board at any moment.

The addition of a small self-contained apparatus and a bell, which can be placed with the indicator or in any other part of the vessel, communicates by sound the regular working of the log, and enables the Officer on watch to detect any irregularity and to take instantaneous bearings at given distances, without referring to the indicator or the log.

A distance indicator, devised by Lieutenants Jackson and Anson of the "Vernon," has undergone already a trial in the "Excellent" and "Vernon," and has been favourably reported on, the indicating hand is rotated in either direction, one step at a time. A spring brake prevents it from being thrown out of adjustment by the concussion of firing heavy guns. A bell is fitted in the receiver which rings each time a signal is completed. In the transmitter, a red disc shows when the circuit is completed, and the battery running on circuit. The instruments are carefully protected from wet; they will work in any position, and are entirely unaffected by damp and gun-fire; two wires are used with each circuit for connecting transmitter with receiver. The commutator, however, is of delicate construction, and the springs on the armatures require careful adjustment for efficient working with low battery power.

The great defect seems that there is no method of telling whether the two instruments, transmitter and receiver, are indicating the same signal, and if the battery be left on circuit for long it may fail to work the instrument.

The telephone is used from ship to shore, when ships are moored. In the "Vernon" one was used to the Captain's house and found most useful. Through this telephone, some eight years ago, an Officer recognized Professor Bell's voice, which he only knew from having heard him lecture in London, and he did not know the Professor was in Portsmouth.

The application of the telephone to diving is most valuable, and in my experience was perhaps the means of saving a man's life. He was just able to say, "Pull me up," and was found quite insensible. It is strange to be capable of hearing a man below water, a mile away, as well as if he was at your side. Some difficulties were experienced at first, but have now been completely overcome. The same apparatus can be adapted for use on shore.

Telegraphy for parties landed, though not a usual equipment, is very useful, and I have been shipmates with a small field telegraph consisting of a couple of sounders and reels of wire carried by men.

For automatic indicators, electricity may be used to indicate too great a rise of temperature in any compartment, to indicate if the ship is off her course—this is similar to an arrangement which will be

described for steering a torpedo—or to indicate if the barometer beyond a certain point.

The application of electricity to testing the lightning conductors of ships is so simple that any trained seaman can obtain the resistance without delicate instruments, with fair accuracy.

The propulsion and steering of boats by electricity is a subject which almost requires a separate paper to itself, and although sometimes used for war and sometimes for peace, the appliance is naturally similar whether a boat be carrying a torpedo or a policeman. A few particulars of two boats which could carry either may be of interest.

The "Electricity," which was fitted by the Electrical Power Storage Company two years ago, and which has run successfully for hundreds of miles, is 25 feet long.

The "Australia," built by the order of Messrs. Stephens, Sons and Company, is of the same length; batteries or boxes of stored electricity in the boat, work a screw propeller. The cost of "Australia" is about 180*l.* complete.

Each boat carries eight besides the coxswain. Speed about 8 knots.

The advantages of electric propulsion are—

(1.) Entire absence of noise in the boat; in fact the only noise that caused by the splash of the water against the boat's bows.

(2.) No smoke to interfere with the man steering.

(3.) No "flare up," which is practically impossible to prevent very fast boats from the great draught up the funnel.

(4.) No heat, which tells so much on the stokers in a torpedo-boat.

(5.) Not so large a number of men required as in a steam boat.

The disadvantage of this form of motive power is of course the necessity of having means to re-charge the cells again after use. Should this prove a successful experiment, regular charging stations could easily be provided for a boat to go alongside and have her recharged, as, for instance, night patrol boats could be recharged at a jetty during the day for use at night. From the absence of heat this form of motive power would be most valuable in very hot climates.

The various appliances in a submarine cable ship are special in their character, and are hardly to be considered generally naval.

One of these is a cable creeper which has a push in angle of creep, so that if it catches a cable it rings a bell.

Now in the descriptions about to be given, reference will be made to "testing." This testing is for the purpose of ascertaining whether the circuit, including the actual place of application, is in good order. The principal test is to see that the conducting appliance have a complete circuit. To do this, a small current allowed to pass round the circuit, too small to cause any appreciable heat, or to work the magnet, but large enough to affect an indicator or ring a bell, which only require a small current, thus showing the circuit correct. Should there be any break in the circuit, the little current cannot pass, and so cannot ring the bell or affect the indicator.

The current is supplied by a battery. A simple test battery and indicator will easily show whether there is any break or not in a coil of wire, or any electric circuit.

Electricity Applied to War Purposes.

Firing Guns.

We will now consider the applications of electricity to war purposes afloat, the first, the one considered most important, being firing guns.

The method of firing guns by electricity is simple.

The method of heating a wire by passing electricity through it has already been explained.

To fire a gun, the electric current is allowed to pass through a piece of fine wire surrounded by powder, and placed in the vent of the gun. A firing key is used to allow the current to pass from the battery through the main wire to the little tube of powder in the gun, and then back by the return. If a very small current be sent through the circuit, it will not heat the resistance; and if it be made to ring a bell in the pilot tower, the Officer in charge knows that the circuit is all right.

Some of the advantages of firing guns by electricity are as follows:—

When firing a broadside of guns together, if electricity be used, it is fired much more simultaneously than when using hand firing; and when firing single guns, the action is more instantaneous. This may be illustrated by a well-known machine. Any man trying to fire a gun at a certain time, or when certain objects are in a line, is only more or less successful in doing so—generally less.

Another very important advantage of firing guns by electricity is that they can all be fired by an observer clear of the smoke of the gun-deck.

Again, the guns can be fired from a bullet-proof pilot tower as the ship passes close by the enemy by any one person or the Captain himself, the crew lying down or being placed out of the way. This is especially advantageous in ships which have their guns on the upper deck exposed to machine-gun fire.

Again, there are cases where the object cannot be seen from the gun, and electric firing provides an easy means of firing from aloft on the mast. Thus a ship in the Suez Canal fired at a train in motion, which was only visible from aloft, and hit it.

Again, the gun can be aimed at a fixed floating plank, and be arranged so as to fire when the plank is touched. In fact, it acts as a spring gun against torpedo-boats.

Electric firing for a single gun was recommended by the Chilean Officers after the action in which the "Huascar" was taken, as the most likely to be effective.

It must be allowed that there is the disadvantage with electricity of the chance of damage being done to the circuit, but this would be

shown by the bell in the pilot tower. On the other hand, the advantage is that its use simply alters a heavy pull off to a light one—fact it may be called a hair trigger.

Automatic Firing.—This is an arrangement for firing when ship is rolling; for instance, the gun is required to be fired when ship is upright, then the circuit passes through a balance so arranged as only to connect the two parts of the circuit, that from generator and that to the gun, when the ship is upright; so that directly the ship is in that position the guns are fired.

The method is claimed to have been brought to great perfection but is not so simple as it looks.

Electricity may be used to light up the foresight at night. An appliance for this purpose has been invented by Captain McEvoy the well-known torpedoist. It consists of a little battery and glow lamp, which is screened except in the direction of the foresight. The electricity has to pass through a similar arrangement to that mentioned above for automatic firing, so that the lamp is only when required.

It is capable of a much more practical application than automatic firing, as a wide margin can be allowed to cover any error from the rolling of the ship.

It seems specially useful for resisting night torpedo attacks.

And now for torpedoes, which come next, at least, in importance.

Electricity is used for firing, propelling, and discharging torpedoes. Just a word as to what torpedoes are. They are movable submarine charges of explosives, used offensively.

The name "torpedo" is, oddly enough, derived from the electric fish, but I do not suppose he who first applied the word ever thought that electricity would be so much used for firing these charges.

Firing Spar Torpedoes.

The spar torpedo is the simplest form, consisting of a charge at the end of a pole, which is put under an enemy's ship, and exploded.

For this form of torpedo electricity is now exclusively used, and the arrangement is usually as follows:—To the battery a firing key attached by a wire. This key is joined to the main, so that by pressing the key the circuit is complete through a fuze which is similar in principle to the glow-lamp and which is in the torpedo then back by the return to the battery—an exactly similar plan to switching on lamps or firing guns.

There is also an arrangement by which the battery is joined to the main direct, and the main goes to an automatic firing key in the head of the torpedo, which acts on striking, then by the fuze and return wire back to the battery.

A combination of these methods is generally used, though probably a separation of them would be better. The spar torpedo though so simple, has at present the greatest score—at least half-dozen ships—against travelling torpedoes, one; and towing torpedo

none. The cases occurred in the American Civil War, Russo-Turkish, and Franco-Chinese wars.

As in the case of the gun, a small current can be sent through the fuze, and can ring a bell or work an indicator so as to show the circuit is correct.

Firing Towing Torpedoes.

The next torpedo, which to a great extent owed its want of favour in our Service to being introduced without electrical means of ignition, is the towing torpedo. This is, I believe, always fired by contact with the enemy's ship. When electricity is used, the circuit is from the battery to a contact piece in the torpedo, then to the fuze, and back by the return to the battery.

Though we are only concerned with electric firing, it should be explained that if any other method of exploding a torpedo is used, it is, after once being made dangerous, equally so to friend or foe.

With all electrical appliances the removal of the wires from connection with the battery renders the torpedo as harmless as a box of explosives can be.

Batteries are the usual generators for firing torpedoes. Sometimes, however, an exploder is used in which the power is derived from a man's muscular action.

Firing, Propelling, and Steering Fish Torpedoes.

Fish torpedoes claim our attention next, and there are many kinds of them; but those with which electricity is used are few; in them the force developed in some part of the circuit is made use of to produce motion or put the rudder one way or the other, or simply to fire.

When electricity is used for igniting the charge, all torpedoes are fired in a similar way to one of those described for the spar and towing torpedoes, namely, at will or by contact.

1. There are torpedoes which are propelled from, and controlled from their base, as the Sims, named "controlled torpedoes."

2. There are torpedoes which contain their own propelling power and are uncontrolled and unconnected with the position from which they are started; for instance, Paulson's. They have been called "auto-mobilo" torpedoes.

3. There are others which contain their own propelling power but are connected with and controlled from their "base;" for instance, the Lay. They have been called locomotive.

First, those driven by electricity.

This is done either by electricity stored in accumulators and put in the torpedo, or through wires bringing the electricity from the base of operations.

In addition to fixed submarine mines, it has been considered necessary, in some cases, for coast defence to make use of a controlled motive torpedo, principally for attacking ships which attempt to clear a passage through the submarine defences.

For this purpose a torpedo is required having the following properties:—

1. Long range.
2. Handiness with the helm.
3. A heavy charge, so as to be dangerous even if stopped by a net defence.
4. Security from enemy's fire.
5. Power of passing floating obstructions.
6. Not easily seen or stopped by enemy.
7. A motive power always ready, and not dangerous.
8. Constant speed to end of run.
9. Charge exploded at proper depth, for a charge on the surface comparatively harmless.

The torpedoes of Ericson, Lay, Howell, Whitehead, &c., are considered by some good judges to fulfil these requirements as completely as that of Sims.

Common defects are, great complication, difficulty of preparing the torpedo ready, danger of explosion from the surface which drives it, great exposure to fire of enemy, want of speed, at the surface, &c.

The Whitehead is considered unsuitable on account of its comparatively short range, because it cannot be steered, and for other reasons.

The Sims torpedo is of the ordinary cigar or fish shape, driven by a current of electricity from a generator on shore, passes through a wire laid out by the torpedo as it goes, and has a screw propeller. The torpedo can be steered and fired by electricity from the shore through the same cable. The torpedo is suspended a few feet below the surface from a float which is just awash. There are two different sizes—the larger carrying 2 miles of wire and a charge of 400 lbs. of dynamite.

The 2-mile torpedo is of copper so as not to rust, and is 28 feet long. The cable, which will just sink, is carried in a chamber to which the water is freely admitted, so that the buoyancy of the torpedo is but little increased as the cable is paid out. The cable is in the head. The wire chamber, which has a short tube under the leading aft, through which the wire is paid out, is in the centre, and driving and steering gear are in the after part of the torpedo. Steering is done by a separate current from a battery; the helm can only be put hard over either way, and when released is brought back to the straight position by the action of the water.

The torpedo is suspended by strong steel frames about 4 feet apart, from a boat-shaped copper float of about the same length as the torpedo, but whose bow is a few feet further aft. A steel cutwater connects the bow, and, as it slopes downward and forward from the float, it forces the torpedo under any boom or floating obstruction it may meet with.

The float is built in water-tight compartments, and filled with some buoyant substance, so that it is difficult to sink it. It is supported by the usual two upright rods—one with a white, the other a red

in the day time, and lamps at night. The rods are pivotted with counter-weights so as to give and lie flat when passing under an obstruction, and to rise again when clear. The speed is said to be 12 knots.

The cable is of copper wire, and a small insulated wire in the heart of the main cable is used for steering.

The torpedo may of course easily be arranged to fire on contact if required. When it was tried by running at a spar, a spectator who was in a boat near did not see it, although watching for it, until it was within 500 yards. The torpedo hit the spar in two successive trials within 4 feet of the point aimed at, and the marks on the spar were $1\frac{1}{2}$ feet from each other.

The float has been riddled by bullets, and yet remained serviceable.

The great disadvantage of the torpedo is its want of speed. Some less clumsy method of maintaining it at its proper depth would, doubtless, very much increase the speed.

There is no doubt an advantage in controlled torpedoes which have their motive power on shore, and therefore have to carry less weight, but they can be only used from a special base.

Then those *steered* by electricity, though with some other driving power.

The Paulson Torpedo.—In this fish torpedo the steering is electrical. The motive power is supplied by liquefied carbonic acid. This torpedo is automatically steered in a direct or straight course by means of a mariner's compass, the needle of which, on any deviation of the torpedo from its course, makes contact with one or other of two insulated studs situated on either side of one end of the needle, and completes an electric circuit; a lever then causes one propeller to revolve at a quicker speed than the other, and thus steer the torpedo and bring it back to its set course. Supposing the torpedo to be approaching an ironclad, the mass of iron would cause the needle to make contact with one of the studs and the torpedo to be steered directly away from the ironclad, unless its path were due north and south (magnetic), and, to prevent this, a needle of a second compass in the head of the torpedo is arranged to short circuit the battery when attracted to one side or the other by the mass of iron.

The shell of the torpedo is made of compressed waterproof paper pulp, which is light and strong, has no effect on the compass needles, and is not easily affected itself.

In order to render the weapon more effective, it may be controlled over part of its course by means of an electric cable paid out from the torpedo as it progresses, and by which the current from a battery on shore or on a ship is conveyed to the two magnets so as to steer it on any desired course. When the whole of the cable is paid out, it is automatically detached, and the self-steering apparatus comes into operation.

The Lay Torpedo.—This well-known weapon is another example of the application of electricity to steering a torpedo. It is driven by other means, but lays out an insulated cable as it runs, and through this it is steered. It carries a very heavy charge, and is usually run

just on the surface. . . It has not made such rapid improvements the Whitehead in point of speed. The usual rods or lights are used for directing the torpedo, and very good practice is said to have been made by it.

It has not been fortunate in war, for although there was a rumour that during the late war in South America a Chilean vessel was blown up by the Lay, I do not think that was the fact. There was an attempt to use it from a ship in the same war, but that method could hardly be expected to be successful.

Discharging Fish Torpedoes.

The simplest form is to ring an electric gong as a signal for a man standing by the torpedo to start it, for it must be understood that it is usually started from somewhere down below in a ship and therefore it is necessary to have somebody up above to decide when it is to be sent on its journey. An improvement is, at the order "Ready," to full cock the discharging arrangement, the same movement connecting up an electric circuit which has only a break on deck, and which, when traversed by a current, puts in motion the machinery for discharging the torpedo.

Another and greater improvement is the torpedo tube, being fitted on the inside with a cartridge, which, when ignited, projects the torpedo.

The clutch, which keeps the torpedo in the tube, is arranged such a way that when withdrawn it makes electric contact with otherwise insulated binding screw on the right of the gun.

The torpedoes are arranged to be discharged by an Officer who is in the pilot-tower. In this case the firing key is in the pilot-tower between the battery and the place of application, and there is a break at the tube, so that there are two breaks in the circuit; when very nearly at the moment for firing, the word is passed down, when the lever is pulled by hand, freeing the torpedo and making contact with the gun. The torpedo is then fired by pressing the key in the control house.

The torpedo battery, which may be considered as a part of a defence system, has been devised to defend any channel left in mines for the passage of friendly ships.

It consists of a submarine framework, in which are fixed torpedo tubes, each holding a fish torpedo.

The observing station, which may be distant and quite invisible to an enemy, is connected to the battery by a wire which goes to an electric fuze.

A weight released by the explosion opens the valve of the engine and frees the torpedo from the tube.

Firing Submarine Mines.

Submarine mines are used by ships for the purpose of defending themselves, or any harbour in which they may be lying, or for the security of which they may be responsible, or for dropping behind

them when retreating. They are charges of explosive, defensive and fixed, fired under water.

The difference between torpedos and mines is this:—If you want to be blown up, you must go to the mine; but if you don't want to be blown up, you must stop the torpedo coming to you.

The electrical methods of firing them are two: (1) firing at will; (2) firing by contact.

The observation method of firing at will may be briefly described as firing a submarine mine when the enemy is within range of the effect of its explosion.

There are two difficulties in carrying out this otherwise certain and simple plan. The enemy may not come within the range of the mine, and when he does you may not know he is there.

With the first difficulty we have nothing now to do.

The second must be considered, as on it depends the difference between the two electrical methods of firing mines.

The simplest, and in its usual form, perhaps the worst plan, is by the method of cross bearings.

To go back to our circuit.

There is a generator in this case, a battery that is on shore. The main wire goes from the battery to No. 1 observer, from whom the mine bears, say south, that is, the mine is directly south of him, then passes through his key; then goes to No. 2 observer, who has the mine, say, due east of him, and who also has a key. The main then goes on to a fuze in the mine, and the return takes the current back to the battery.

A word about return wires: the resistance of a conductor depends, other things being equal, on its size; the earth being large does not offer much resistance, and is often used as a return wire.

Now the circuit is not complete unless No. 1 and No. 2 both press their keys. A ship comes in. If ever she is south of No. 1 he presses his key. If ever she is east of No. 2 he presses his key; but the keys are never pressed together unless the ship is south of No. 1 and east of No. 2, that is, over the mine.

This system has lately been well described by an eye-witness, and I dare say you will understand his description better than mine.

"And now we are going to fire 'by observation.' There is a mine of 18 lbs. of gun-cotton down yonder, 2 feet under water, and that barrel there is an enemy's ironclad steaming up the harbour. But she may also run close by without actually touching it. This contingency has been provided for by putting the mine in electrical connection with two observing stations. Yonder is one perched up there some feet above the water. It is a wooden shed, constructed so as to be readily taken to pieces and put up again wherever it may be desired. In actual service, it would probably be half buried in the ground, and the front of it protected or rather concealed by a bank of turf. There are two of these observing stations at different points of the compass, but both on the same electric circuit. The observers within them are keeping the object glasses of a couple of small telescopes following the ship there as it approaches the mine.

"These telescopes are so mounted, that until they both pass exactly to the destructive area around the mine, the electric circuit which it is to be automatically fired, is incomplete. The enemy may pass too far from the explosive underneath the water to be not affected by it. In that case there would be no use in firing. Two telescopes looking from different points of view, would not any instant converge their lines of sight at the mine, and there would always be a break in the circuit. The ship would go on her way. She is working straight for the mine, however. The gear of one telescope clicks into a sort of notch, and one break in the circuit is repaired. Click goes the other telescope. The circuit is complete. A tiny piece of platinum wire is instantly raised to a white heat inside the mine, and up goes the ship, a volume of water leaping into the air, some of it to the height of a church steeple, bearing with it fragments of the unlucky tub that has done duty for the former ironclad, which, under similar conditions, would not have gone up into the air probably, but would have had a hole knocked in her bottom which would speedily have sunk her."

Other methods are the camera obscura; the plane table and telegraph from the second station; firing all the mines in the neighbourhood of the ship, so that one of them must hit her, and so on.

The plane table is electrical. The telescope at one station works as a ruler at the other, and when the observer finds this line and his own over a mine, he fires.

"Observation" firing cannot be used at night or in a fog.

The other system, that of contact mines, is different. To connect from the battery, the circuit goes to a contact key in the torpedo and on to the fuze; when the torpedo is struck, then back by return.

A ship must actually hit this mine to set it off. The ship is blown herself up. She may pass close to any number of mines, only a small charge is required.

The electrical disadvantage of this system is, that you cannot send a small current through for testing, unless a boat or a friendly vessel bumps the mine for you. This has led to complicated additions. The simplest of these is a very high resistance which bridges over the break in the circuit, so you can always send a small testing current round the circuit; but when the mine is struck, enough current goes through the fuze to fire it.

The next addition was by means of a further appliance, so that the action of a ship striking the mine could be imitated.

This has been arranged by causing the magnetic effect of current passing through the high resistance to attract the other end of the break in the circuit, so as to cut the high resistance out.

This is useful in two ways—it gives a far more trustworthy than a simple resistance, as it stands to reason that a delicate instrument which works all right in the mine shows no serious damage done to it; and again, it is possible by this means to fire a mine as well as by the contact of an enemy's ship.

There is another means of testing an electric contact mine—

to have a telephone in the mine with a ball on the diaphragm, so that the motion of the mine in the water makes a noise in the telephone.

Electro-mechanical mines are those which carry their own battery inside. This saves wire, but if the mines are picked up, is extravagant in boats and men's lives.

In these mines means must be used to keep the mine safe, when being laid down. This is effected in the simplest form by keeping the wires apart, and joining them at a safe distance when the mine is laid.

The dynamiters imitated a very common form which works by means of some chemical action. They put acid on blotting paper and got away while the acid was eating through it. This mine works without a circuit-closer.

These electro-mechanical mines were used for the defence of Suakin and were very successful, or seemed so, for after the explosion of one mine, the night attacks, to guard against which they were laid, ceased for two months.

The Torpedo Detector.

This consists of a sinker, which is a heavy case, and a boat designed to be carried in a boat, from which the cable hangs. It can be so adjusted that no sound is heard in the receiver. If, now, the boat is pulled slowly through the water and the sinker is thus dragged along the bottom, no noise will be heard in the receiver unless the sinker comes into proximity with some mass of magnetic metal, such as a torpedo case. In this event, however, a humming noise will be heard in the receiver.

A slight and imperfect sketch has now been given of the appliances which come under the heading of this paper, and I think you will agree with me that no trouble, no care, no money is wasted, which is spent in teaching our men to make a proper use of electricity, which, as a servant, has been aptly compared, for ability and docility, to the slave of the lamp, but which as a master, is always mysterious and sometimes terrible.

The CHAIRMAN : When Lieutenant Batten announced his intention of lecturing, "the application of electricity to naval purposes," I felt pretty sure that he would not be able to exhaust his subject nor to exhaust his knowledge in one hour; and I can tell you that as I have been reading the lecture whilst he has delivered it, that he has been obliged to omit many very interesting and important parts of it. There are also many experiments that he has been unable to give owing to the unfortunate accident which has happened to his assistant operator. We shall be very glad to hear any remarks which anyone present may wish to make upon this very interesting subject.

Admiral R. A. SCOTT : A remark was made by Admiral Arthur when I was here to the effect that recent discoveries have been of great advantage to our nations. I think they have been of especial advantage to our Colonies, which by the use of torpedoes and with the aid of the English Squadron (which we in New Zealand always gladly welcome) will be rendered practically safe. I think I may say, Sir, that you being present on occasions like this is of very great advantage, especially for the encouragement of young Officers, and inducing them to come forward with

their opinions. I am sure all who have heard this lecture must acknowledge the information it has conveyed has been exceedingly valuable. I would the lecturer to tell us whether the electric circuit cannot be completed by the return when the mine is laid out at a distance of two or three miles from the as a return cable for that distance would be an expensive thing. It is said plate of metal—say about 2 feet square—is required on the shore side in connection with the instrument. At any rate the earth circuit answers for a considerable distance; but I should like to know whether it will do for great distances. We have had to-day practical illustration of the many advantages of the electric light. In passenger vessels it largely conduces to comfort, for it tends to keep the atmosphere cool as compared with old systems of lighting. With respect to the lecturer's observation as to laying down torpedoes to protect wide and narrow channels, I think there is no necessity to have a very large number of mines even in former case, for the fact that mines are laid down would be a deterrent to approaching. No man would risk his vessel (costing perhaps half a million) all his crew by coming within a mile of a mine. I think therefore the mere laying down of mines would be a sufficient safeguard to most harbours. With respect to numerous automatic appliances and devices for various purposes, I venture to say that nothing can supersede the look-out of the person. An automatic log is good, but it may go wrong—and I have seen a great many automatic experiments fail—but the observation of the person does not fail, that is of one properly instructed; for instance, an Officer knows how many revolutions the engines of a ship are making, should also know the speed those revolutions are giving, and believe any person who observes carefully is able to calculate accurately the distance the vessel runs, &c. I do not say that automatic appliances should not be used, but they should always be supplemented by the skill of the person—in observing different points of departure as well as the distances run by the ship, and things of the same kind. The lecturer did not state how near the electric circuit might pass without any disadvantage to the action of the compasses; but he mentioned that in the "Kaikoura," in which I came home, Sir William Thomson's compass—the after one—was not of the slightest use; it kept spinning round the forward compasses (also Sir W. Thomson's) were perfectly steady. The compass itself, although an admirable one, yet under the circumstances of vibration does not appear to act correctly. As regards the value of torpedo-detectors I believe if the defenders are vigilant that the detectors can be used. I think the defenders must be asleep to allow their torpedoes to be found and lifted. In New Zealand, for instance, we have whale and other boats, tugs, &c., as well as torpedo-boats, that could always be moving, and would certainly prevent any mines from being taken up. The great thing we require is to have the defence of our Colonies perfectly worked out in full accordance with the opinions of the Admiralty, because it is naval attack Colonials have to guard against, and, therefore, any local defence to be efficient must necessarily be supplemented by the Imperial Squadron.

Rear-Admiral the Hon. E. FREMANTLE: We must all agree with what the Chairman has said, that this lecture is one of the greatest interest to the Service, and also that it is a subject which it was scarcely possible to deal with all satisfactorily to the lecturer in the space of one hour. I sympathized much with him on that point, and I dare say it is probable that most of the questions which I now propose to ask would have been answered if he could have had his lecture a little longer. There are only two or three points on which I propose to dwell. One is the question of the electric light. We have all heard of the incandescent lights on board ship, and we all understand how extremely useful they must naturally be. But I do not wish to touch on that at present, as I am speaking now of the arc light. I was extremely glad to hear the lecturer say that some arrangements were likely to be made enabling the carbons to approach each other automatically. All those who have had to deal with the electric light on board ship must be aware that occasionally there is a splutter and a flash that is when the man in charge is obliged to rearrange the carbons. It would be a very great advantage if that could be rectified. Then there is the question of keeping the light bearing on an object as it passes. I have recently fortunately

the opportunity of conducting some experiments, in conjunction with the Officer in charge of the "Dreadnought." In accordance with orders we received, we tried the experiment of attacking the ship with torpedo-boats, and more especially the question of discovering the boats and keeping them in sight by the electric light. One of the greatest difficulties we experienced was after we had discovered the boat, in keeping the light upon it, and the reason for that has been mentioned by the lecturer. I only wish to confirm what he has stated, that the man who is moving the projector is partially blinded by the light, and cannot keep it on the boat approaching, while we below or above can see perfectly well; the result is, we call out to him to move the projector, and he perhaps pulls it a little too far, and so we lose the object. If, therefore, it could be so arranged that it could be directed by some person below the light we should find it of very much greater use. As regards my experience in finding boats with the electric light, I must say I think, on the whole, the use of the light is very valuable. We allowed the torpedo-boats to attack the ship while she was in darkness, and they had some difficulty naturally in finding us. At the same time, when we wished to put the electric light on them there was considerable delay, by which I mean some half a minute's delay, and a question of half a minute at such a moment is very valuable indeed. We found that the position of the light was of considerable importance, and that is a point to which attention has been directed by the Admiralty. I understand the Germans are in the habit of having the light aloft, and we were directed to try some experiments in that way. We found that when the electric light was put into the main top, although unquestionably we had a greater range, yet certainly the boat got under the ray of the light on several occasions, and on the whole, we were unanimously of the opinion that the nearer the light was to the water the better. I should like to have heard a little more about the torpedo-boats in which the motive power is electricity. The lecturer, through want of time—perhaps the experiments have not been sufficiently carried out—was not able to give us very much detail as to that question. One great thing which we discovered, referring again to these small experiments I have mentioned, was that we could always hear the torpedo-boat before we could see her. The picket boats could hear the torpedo-boat a long time before it could be seen. That points to the absolute necessity of having quietness in the torpedo-boat, and shows the great advantage of having one which could be moved by electricity, where we have only just the screw moving and the slight spray made by the boat and nothing else. On some occasions we were able to see the sparks from the funnel. Of course with an electric boat we shall not have the sparks from the funnel, therefore it will be a distinct advantage if we can use the electric boat for torpedo purposes. No doubt there are some disadvantages. As regards speed, I understand that some boats have been ordered and contracted for by the German Government which allow of 12 knots speed. 12 knots is a considerable speed, and a speed which, as far as I understand, has not hitherto been attained by electric boats: at the same time, we know perfectly well that our torpedo-boats are expected to go 21 knots. I should like to know from the lecturer whether he is of opinion that any speed like 20 knots may be expected to be obtained at some future day in these electric boats. Not only that, but it appears to me that there is some difficulty with reference to the number of revolutions of the screw. I understand that electricity acting directly from the motor will drive the screw some 400 or 500 revolutions, but that you have the distinct disadvantage of not being able to regulate the revolutions of the screw. In the electric boats which I have seen you have been unable to ease the speed, but you must go full speed ahead or astern. I would like to add one word to what fell from the lecturer with reference to the necessity, or the very great advantage, of being able to place the electric light somewhere else besides on board the ship herself. We know that foreign Powers have the electric light fitted in their steam launches, the Russian ships are so fitted, and a great many foreign Powers have many ships so fitted. It could very easily be done, and I am given to understand it has been contemplated by our Admiralty to place them in our boats. I certainly think, in agreement with the lecturer, that if we could land them in certain places, or place them in picket boats, they would be a very great advantage to us, and it would be very poor fun for an enemy who was going to

attack a ship to run ashore under the electric light, and instead of attacking ship, to get stranded. In attacks made by torpedo-boats, the Officers in the speak very distinctly as to the extremely blinding effect of the light, and that the light is kept shining upon them it is absolutely impossible for them to judge the distance at all. The result was that they were liable to discharge their torp at something like 1,000 instead of 400 yards, which was the object aimed at wish expressly, on my own part, to thank Lieutenant Batten for having come to give us this lecture.

Admiral BOYS: I should like to be permitted to ask one question with regard a very important point, which I think has a great bearing on future torpedo fare, namely, the propulsion of boats by electricity. I would first bring to r one conspicuous object, not mentioned by Admiral Fremantle, always present steamboats, which, from my experience, is the first thing discovered at night b electric light, and that is the waste steam from the funnel. What I want t the lecturer with regard to the electric propulsion is, whether any improve has been made since last year in the charging of the accumulators for the prop of the vessel. We were then told, I think in this theatre, that it took as lo charge the accumulators as the actual run of the boat; so that if you wanted a to run six, eight, or ten hours it took actually that number of hours to charg accumulators, and consequently the boat was laid up for that time before the could be repeated, which is a very material objection to the principle. I v ask whether that objection still exists, and if there is any prospect of its removed.

Admiral GORE JONES: I think it is exceedingly satisfactory to us all to find the torpedo question has made such little progress for a great number of year: is to our advantage, no doubt, to do without them if we can, and when I v America nothing gave me greater pleasure than to see a new torpedo tried, a find that it was an utter failure. It is only experience that teaches us by degrees what an uncertain thing electricity is, and how little we really know: it, and how little we have been successful. I saw all the torpedoes in An tried, especially the Lay torpedo; everything was done that could possibly be to make it a success, and it certainly ended in failure. The torpedo which weapon of attack, we thought so much of at first, has never distinguished yet; whether it will eventually do so or not I do not know, but I hope not. the Ericson torpedo tried, but it was a failure, and, in fact, I have not seen a torpedo that has not failed in most attempts when it has been tried. I remark on another thing—the unexpected always happens. Commander Matt at the head of the American torpedo school for a great many years, was sur when he got into the Chinese rivers to find that his circuit did not act; it ca a dead stop. He had the usual metal plates and the water circuit, but he coul get it to act. Then he found out it was the mud in the river that caused difference, and I recollect reading a very interesting report on that. The thing perfectly successful in America, and also in the late Franco-Chinese Wa the spar torpedo, and it is the only thing I believe in still, because you ha intelligence of the Officers to work it. With the spar torpedo you know c: what you have to do, and I have seen the most admirable experiments carri: I have seen vessels of 200 tons blown up—a vessel going 8 or 10 knots, p another vessel, putting her spar torpedo under it and blowing it up. I nev an experiment like that with anything else, but that was done over and over. I saw the whole of the American squadron in succession pass and use their torpedoes, in every instance successfully, but I never saw them successful anything else. The fact is the spar torpedo is the only thing that brings the intelligence to bear, and the bravery of the men who have to do the work. say, notwithstanding all this apparatus and the number of years we have working at this subject, we have no more certainty with regard to electricity present moment than we had six or eight years ago. I will point out another which occurred when I went out to America; there was nothing that was so impressed on my mind by Captain Fisher, then the head of the torpedo esta ment, as the necessity of splicing the cable in such a way as to make the insu perfect—that a pin's point would destroy the effect of the current if it w

water and was allowed to escape. Well, the first thing I saw when I got over to America was that they took up the ends of two parts of the cable, twisted the wires together, and pitched them into the water without any insulation, and it acted as well as ever. I could not make it out at all after all I had heard of the necessity of insulation. However, I thought over the circumstance, and I supposed that they were using a superior form of dynamo-electric machine to ours, but this was not so, as two of our machines were superior in power. I think we certainly ought to push more ahead in our experiments than we do, and not allow any other nation to beat us with superior instruments to our own.

Lieutenant CRISPWOLD BATTEN: Admiral Scott asked whether there might not be a saving of wire by using the earth current for a mine at a distance. That is quite so, and it is always done in practice; in fact, on that drawing the complete wire circuit was merely put in to make it simpler. There has been a controversy, not in the matter of long distances but in the matter of short distances, such as firing guns and using lights on a ship, as to whether it is advisable to use a wire or an earth circuit. As there was not time to enter into all that controversy, I thought it better to have complete wire circuits. In telegraphs and firing mines at a distance an earth return is always used to save wire. With reference to the deflection of the compasses, I think I am right in saying if a wire is 30 feet from a compass the compass is perfectly safe. The torpedo detector is not a machine for removing the torpedo, but for showing its presence. It is made on the same principle as that little thing which was used to show the position of the bullet when President Garfield was shot. It is dragged along the bottom of the water, and there is an increased noise from the telephone when it approaches any metal substance. The picking up of torpedoes is a thing outside the lecture. I am afraid I was slightly misunderstood about the automatic lamp. I did not say that they were actually being introduced for search lights, but that I thought it was time they were introduced. Automatic lamps are used for very long periods on shore without requiring any attention, but the old argument in favour of using the hand lamp was that as the man had to be there to direct the ray of light he might as well attend to the lamp as well. What we want to get is that the man who directs the light shall be away from the lamp, and therefore he cannot attend to the carbons, and it is no use putting another man up there for that purpose.

Admiral FREMANTLE: Are automatic arrangements being introduced?

Lieutenant BATTEN: No, Sir, not into the Service. With respect to running boats by electricity, the boat I mentioned was a 25 feet boat, and they got 7 or 8 knots out of her. I do not think any experiment has been made with a much larger boat, but no doubt with a larger boat a very much larger number of cells could be carried, and a very much higher speed obtained. There is no reason why a boat driven by electricity should not be slowed; it is very simple to arrange that. As to the question of the charging of the accumulators detaining the boat for a long while in a useless condition, it is quite true that it takes a long time to charge the accumulators for driving a boat, but the accumulators need not be fixed in the boat—it is only necessary to have two or more sets of accumulators, and the boat can then come alongside and get in her charge of accumulators the same as she has to get in coal. No doubt it takes as long to charge the set as it does to run the boat. With regard to the insulation, I think there used to be an arrangement for firing an outrigger torpedo with a bare wire twisted in two different lays of the rope, the two ends being kept apart by a bit of stick. Of course, it is very easy to fire with bare wire if you have a proper battery.

Admiral FREMANTLE: They used rather a weak battery.

Admiral GORE JONES: It was better than the two others we had in use at the time.

Lieutenant BATTEN: It is perfectly easy to fire a torpedo with a bare wire, but there is a certain amount of loss, and in order to fire it in the best way, it is better to insulate the junction.

The CHAIRMAN: I am sure I need not press you to allow me to return your thanks to Lieutenant Batten for his interesting lecture and for the opportunity he has given us all of thinking over this important subject. I will offer a very few remarks on what we have heard from him. After telling us of the great advantages of illumi-

nating a ship by electricity—which are certainly fully as great as he has pointed out—the safety from fire, and the perfect light given—especially in the engine- and gun batteries, he pointed out that there was a danger of the whole of the ship in the “Etruria,” or any of these large ships, being extinguished by one accident to the dynamo or engine. I think I am right in saying that in the “Etruria” have five sets of dynamos and five sets of engines, so that it would require an unusual combination of accidents to put her in darkness. This safeguard multiplicity of dynamos is absolutely necessary when lighting a ship by electricity. One application of electricity to naval purposes which is much wanted is a self-recording electric log. In those fast Atlantic steamers that steam at the rate of 18 knots, the only means they have of ascertaining their speed is by heaving the ship’s log that we were brought up with fifty years ago. They use the old ship log, timing it every two hours. They have a hand reel for hauling it in; but that is the only log they depend upon at the present moment. No doubt there is nothing to be trusted to the skill of the Officers and men using it, but I still believe in mechanical assistance and scientific assistance, and I should be very glad to see scientific knowledge applied to give us the speed of the ship at any moment. It is a matter of very great importance. I cannot allow Admiral Scott’s statement, that Sir William Thomson’s compass will not stand vibration, to pass unnoticed. We have tried every possible way, and we find that it will stand vibration better than any compass we have, excepting the vibration of a torpedo-boat, and in a torpedo-boat no compass the liquid compass is the steadiest compass you can use. I do not wish to let forward to the world that Sir William Thomson’s compass is not steady under ordinary vibration of a ship. I think it is the best compass we have, and one relied upon in all circumstances on board ship.

Admiral SCOTT: There were two or three of those compasses. It was the compass I spoke of where there was vibration. I did not speak of them generally where there was great vibration.

Admiral GORE JONES: His sounding machine is not alluded to, but it is the most perfect thing in the world.

The CHAIRMAN: I wished generally to give my experience and that of the Service for the compass. There was one remark the lecturer made that I think we should all take to heart—young Officers, and I might say old Officers as well—when he said this, that the boat with the electric propulsion does not require skilled men to work it; that a seaman who can steer a boat, and do as he is told, will work that boat and its machinery with perfect ease. I have no doubt that a great many Officers, young and old, have an idea that it requires very high scientific attainments to control the machinery for using electricity on board ship. No doubt the apparatus on this table would frighten many, but the fact is, although it does require high scientific attainments to elaborate and to apply electricity to all those operations of which we have heard to-day, yet most of them are actually manipulated and used by men of any scientific knowledge at all. Three-fourths of the work of the Service has always been done and always will be done (electricity notwithstanding) by working, practical men of the Service, and they need not be afraid that they will be unable to do their work as well as it always has been done because it requires a great amount of scientific knowledge to invent and arrange the apparatus used by electrical means. I am afraid that some of them are needlessly alarmed by the idea that a large amount of scientific information and preliminary education is required to work that apparatus; but such is not the case; much no doubt is required by those who, like the lecturer, are capable of thoroughly understanding its invention and of proposing means for improving it. I am sure you will authorize me to return your thanks to Lieutenant Batten for his interesting lecture. I only wish it had been divided into two lectures instead of one.

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