ON THE APPLICATIONS OF ELECTRICITY.

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In selecting, as the subject of the present paper, the many uses to which electricity has already been applied for our benefit, I am obliged, by the brief limits to which I am confined, to pass in rapid review many of those applications which have become familiar to us, in order to devote more space to inventions comparatively recent and novel.

Few, perhaps, are fully aware how extensively electricity enters into our every-day life, or that at the present time probably fifty thousand people are earning their daily bread through its use in commerce and art.

Before entering upon a description of the various apparatus by which this subtle power is turned to account, I propose to pass a few remarks upon its nature. Electricity is simply force existing in a latent form in all substances, and shown to us when we decompose or disturb the particles of which they are constituted. In practice it is obtained by the decomposition of air or water. By the well-known experiment of rubbing a piece of sealing wax with a silk handkerchief we produce electricity, by altering the relations of the oxygen and hydrogen gas composing the thin layer of air between the silk and sealing wax. Electricity is thus left on the surface of the wax and attracts any light bodies to which it is brought near. This form of electricity is, however, too volatile and evanescent to be turned to practical account. It is from the decomposition of water that we obtain the electricity of commerce, if I may so term it. Dissimilar plates of metal being placed in a vessel containing water slightly acidulated, and the upper part of the plates linked together by a piece of wire, the oxygen of the water is absorbed by one metal and the hydrogen given off at the other—a current of electricity flowing through the wire between the plates as a consequence of this chemical action.

The transmission of electricity through a conducting wire may be likened to that of water through a water-pipe—if there is a leak at any point, it escapes; and as the earth is a general reservoir of electricity, it is necessary to interpose non-conducting substances, such as glass, earthenware or gutta percha, between the wire and the ground when we wish the current to pass to any considerable distance. Electricity also resembles, in a measure, steam or gunpowder. If we desire to obtain powerful effects we must compress it by passing it through a conductor of limited size or imperfect conductivity. Magnetic or chemical action then results. If we squeeze the current still more, it assumes the form of heat; and if it has to pass through a layer of air, offering further resistance to its passage, the electricity, Proteus-like, becomes light.

From these phenomena we obtain various practical results. I will first refer to the magnetic effect of the current. To this we owe the telegraph in most of its forms, from the early instruments of Cooke and Wheatstone, in which the alphabet was formed by movements of a suspended magnetic needle, to the various telegraphic systems now in operation—comprising signalling by sounds produced upon muffled bells, of different pitch, by the attraction of light hammers on the passage of the current through coils of wire; signalling by means of marks in cypher, made upon paper; and, lastly, by printing the ordinary form of letter upon a riband of paper. Probably all present will be acquainted with the various forms of telegraphic apparatus, and I need only mention that for general use it is found that the simpler the apparatus is the better. If we endeavour to print each letter of the alphabet in its ordinary character we can only do so by complicated and expensive apparatus, and at a rate not practically exceeding that attained by the more simple methods. For use between offices and warehouses at a short distance, a variety of telegraph instruments have been designed, in all of which an index hand or pointer is carried round a dial on which the alphabet is printed—pauses being made at each letter signalled.

The magnetic action of electricity has also been applied as a motive power, with the object of superseding the steam engine; but although great attractive strength can be obtained, the cost has hitherto been too great to admit of its successful introduction, unless in connection with small machines, such as lathes. M. Froment of Paris uses it to work the apparatus by which he cuts microscopic scales, the electric current being applied to turn on the dividing machine in the middle of the night; when the tremour of the ground, consequent upon vehicles passing, has ceased. By this means the attendance of workpeople is rendered unnecessary and the delicacy of the work not interfered with by vibration.

It is in submarine telegraphy that we are to look for the greatest and most useful results as regards communication between distant points of the earth's surface. Seas divide one land from another, and it is by this invention that the means of intercourse are given to the various families of the human race. The principle of a submarine telegraph is simply coating a wire of a good conducting material, such as copper, with a substance impervious to water and electricity, such as gutta percha. In order to protect the gutta percha envelope from injury when coiled away in the vessel, and during or after submersion, various outer coverings, such as spiral wires, hemp and steel wire, hemp etc., have been devised, some with the view of lessening the specific gravity of the cable, so as to obtain increased facility in laying. It has, however, been found in practice that a considerable weight is requisite to make the cable assume promptly the irregularities presented by the bottom, and to avoid the lash of the waves in paying out. It is also found that a mere covering of hemp is liable to destruction by various marine animalculæ, and that a metallic casing is requisite. It has been assumed by many not conversant with the details of such operations, that the weight of the Atlantic cable presented special difficulties in submersion, but such is far from being the case. The difficulty in laying a submarine cable in very deep water arises from the grip of the water upon the cable, owing to the friction of such a great length of line between the surface and the bottom. If the sea is quiet no danger is incurred from this, but if it is rough, the rise and fall of the ship have to be compensated by machinery on board, as the friction will not allow the cable to be drawn quickly out of the sea to meet the ship's motion.

In order to protect cables further from decay, through rust and the attacks of marine insects, an outer wrapping of yarn saturated with pitch tar, and pulverised silica has been introduced by Sir C. Bright and his partner Mr. L. Clarke, who are now carrying out the construction of the Persian Gulf line of telegraph which, as soon as extended between Kurrachee and the heads of the Persian gulf and thence to Bagdad, will unite this country by wire with Hindostan and eventually with Australia and China.

I have now to call your attention to the mode of discovering the position of faults, if any arise, in submarine lines. It is obvious that if a cable fails, the nearer the locality of the fault can be determined, the more readily will the communication be restored. It is well known that the resistance to the passage of the current increases with the diminution of the conductor ; so that a hundred yards of very thin wire may offer as much resistance, as a mile of the thicker wire used for the conductor of the cable. Thus we may have a measure in a small compass of any line of telegraph, and by offering the electricity from a battery the choice of passing through the cable, and also through series of lengths of thin silk-covered wire wound upon bobbins ; and by subsequently increasing or diminishing the lengths of the latter, until the electricity passes equally through both the cable and the standard coils, the precise distance of the leakage may be determined.

The many services the telegraph now renders scarcely need any illustration at my hands ; but, before passing from this part of the subject, I may refer to the weather prognostications and storm cautions recently introduced by Admiral Fitzroy and the Board of Trade, as the basis of the plan may not be well understood and it is desirable these forecasts should not be looked upon as empirical, like those of the weather prophets of years gone by, but as derived from scientific results, the deductions from which will be rendered every year more certain. A set of meteorological instruments, consisting of a barometer, wet and bulb thermometers etc., is placed at each of a number of places round the coasts of Europe, that are joined together by telegraph. The apparatus generally is in charge of the telegraph staff at the various points selected ; and every morning and afternoon, messages are sent from all these points giving the height of the mercury in the barometer and thermometers, the direction and strength of the wind, the condition of the sky, state of the weather, and amount of sea disturbance, if the station is actually on the coast. Thus an approaching change of the wind or weather is telegraphed beforehand, perhaps from a distance of a thousand miles, and the advent of a storm signalled onward by station after station. Now, although the rotary motion of a storm may be exceedingly rapid, its onward progress as a whole may not exceed a few miles an hour and, being first indicated by the fall of the barometers etc., on the west coast of Ireland or south of France, it may not reach the east coast of England for a day or two after, when shipping have been warned by cautionary messages.

We all place some faith in the admonitions of a barometer but how much more certain does an inference drawn from its reading become, when corroborated by simultaneous readings of many other instruments spread over the world. The further the telegraph is extended, the longer will be the period of forecasting; and when, as will shortly be the case, America, Hindostan, China and Australia are linked by the wires to Europe and Africa, the pulsations of the weather will be signalled days beforehand all over the globe, and a vast meteorological system carried on by telegraph.

The objection has been raised that mariners may be made unnecessarily fearful of venturing to sea by these warnings of an approaching storm, but surely this is not probable. All captains consult their ship barometers to judge of coming weather, as well as they can, in their own immediate vicinity, and how much better is it to be furnished at the same time with the condensed result of a vast series of observations. Forewarned on board ship is forearmed; and, if a captain sails knowing the approach of bad weather and the quarter from which it is coming, he can get well clear of land and have everything ready on board to meet a storm.

The following are instances of the advent of dangerous storms having been signalled to our ports during the past six months, which I have extracted from the *Shipping Gazette* and the records of Lloyd's, kindly placed at my disposal by Mr. Court, Secretary of the Liverpool Underwriters' Association. The nature of Admiral Fitzroy's cautionary messages is attached in each case.

Admiral Fitzroy's Warning Signals.	Subsequent Weather reported.
Sept. 13, 1861.—Cone, point down	13th to 15th. Liverpool—heavy gale.
„ 20, „ —Drum indications, S.W., Ireland	22nd and 23rd—S.W. Fleetwood, Whitehaven—hurricane. 23rd. Liverpool, 16lbs. to the square foot.
„ 24, „ —Drum and cone down	24th. Dover—gale, W.S.W. 25th Dartmouth—S.W., gale. 27th. Falmouth—S., violent gale. 27th and 28th. Liverpool—11 to 14lbs. to the square foot.
Oct. 11, „ —11 a.m. Cone down	11th. Galway—gale, S. 11th and 13th. Holyhead—strong gale, S. to S.W.
„ 11, „ —11 p.m. Cone up over drum	12th. Fleetwood, Milford, and (13th) Plymouth—hard gale. Liverpool also records 11lbs. to the square foot.
Dec. 4, „ —6.30 evening. Cone point down	4th—night. Milford—gale for a few hours. Liverpool, 6½lbs. to the square foot.
„ 6, „ —Hoist drum	7th. Cardiff—gale from W.
„ 7, „ —Hoist drum	8th. Milford—S.W. gale. 9th. Milford—strong gale, thunder and lightning. 7th. Liverpool, W.S.W.—19lbs to the square foot.
„ 13, „ —Hoist drum	12th and 13th. Penzance, S. 14th. Shields, N.W. 13th, 14th and 15th. Liverpool (15th, 13lbs. to the square foot.)
Jany. 9, 1862.—Drum and lights	10th and 11th. Gale, Liverpool—11 to 14lbs. to the square foot.
„ 11, „ —Cone over	11th. Cardiff; Port William—gale and hurricane. 12th. Holyhead—gale.

N.B.—The cone signals the probable direction of the wind. If upwards from the N. If down from the S. The drum indicates unsettled or veering gales.

[The Author then gave brief explanations, from diagrams and models, of the application of electricity to plating with silver, &c. ; lighting ; weaving in substitution for the Jacquard loom and cards ; regulation of clocks ; indicating targets &c.]