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ON PROTECTION FROM LIGHTNING.

The condition that determines the direction of an electric current is difference in potential between the two points, the current always being from the point of higher potential to the point of lower potential.

Upon the surface of the earth and within it electricity is constantly being generated by various means: by the friction of the wind upon it, by running water, by heat at the junction of two dissimilar substances, by magnetic disturbances, and so forth. The electricity so generated is quickly distributed to points of lower potential, and the whole is ultimately metamorphosed into that molecular vibration called heat. Let an ordinary magneto-telephone be properly attached to a wire a hundred feet long, and the two ends of the wire be stuck into the earth almost anywhere, and the ear may detect the presence of electric currents by the well known sputtering sounds. These are called earth currents, and sometimes they are very troublesome in telegraphy.

Professor Trowbridge, of Harvard College, found last summer that the ticking of the observatory clock could be detected at the distance of a mile from the line wire that goes to Boston furnishing the time service, and this when the terminals of the experimental line were no further than fifty feet apart. This shows that the observatory battery charges the earth for a great distance every time the circuit is completed by the seconds pendulum.

Suppose now that the positive terminal of a battery or of a dynamo-electric machine should be grounded at any place, and the negative terminal at a distant place, say a half mile or more away, the developed electricity would charge the first place to a potential higher than any other neighboring place, and a charged thunder cloud immediately overhead could not discharge itself there so easily as at any other place at a distance, for, as stated at first, it is *difference of potential* that determines the direction of an electric current, and the difference of potential is less in this supposed case than elsewhere. If the potential could be raised as high as that developed in the cloud, it would be absolutely impossible for any discharge to take place between the cloud and the earth at that place, no matter how near they might be together.

Now, the potential of any ordinary battery is relatively weak, but whatever its source may be, it may be raised in various ways: by providing points, by employing secondary coils, by increasing the resistance in the primary circuit. In whatever way it might be done the effect of induction by the cloud would be lessened by it so that the reaction upon the charged cloud would be either to necessitate the discharge at some other place where there was a greater difference in potential, or else to delay it until the potential had been raised still higher, which would only make it still easier to strike elsewhere. The evidence gathered from places where lightning has struck seems to indicate that the conditions which determine the stroke are comparatively trivial. For instance, a comparatively low limb upon a tree may be struck instead of the topmost part, and it is here argued that the charging of the earth at a given place with positive electricity may be a sufficient guard against lightning stroke, while at the negative end of the circuit it would be more likely to strike than elsewhere. This end of the circuit could be so arranged that lightning could harm nothing.

It is also taken for granted that lightning is always positive, and that all appearances of the so-called up stroke are optical delusions. The source of lightning in a thunder cloud appears to be always the same, the so-called latent heat of the watery vapor, the energy of which must be accounted for, and where the precipitation is rapid there is no time for distribution by convection or by conduction.

Perhaps the cost of such a method would render it altogether impracticable for ordinary buildings, but for powder magazines, oil tanks, etc., the cost might not be considered too great.

THE ELECTRIC LIGHT ON WESTERN RIVER STEAMERS.

From present indications the electric light is destined to play an important part in inland navigation, particularly on the tortuous rivers of the West and Northwest. As a rule the Western river men are very slow to adopt new ideas in their profession, but within the past few months the electric light has been affixed to some of the finest steamers on the Mississippi and Ohio.

The first boat to adopt the light was the Reuben R. Springer, plying between Cincinnati and New Orleans, and to-day the list includes the S. H. Parisot, the Natchez, the C. P. Chouteau, and Golden Crown, on the Mississippi; the Scotia, on the Ohio; and the towboats Iron Age and Iron Duke, plying between Pittsburg and St. Louis; also the towboat Harry Brown, described some time since in these columns, and engaged in coal towing between Pittsburg and New Orleans. Other steamers will shortly be fitted with the new light. In most cases a single light is used, of 1,500 or 2,000 candle power, and located at the forward end of the cabin deck. The carbons are placed in a movable lamp, similar to a locomotive "headlight," whose reflector projects the rays to the point desired, keeping the pilot house and the rest of the boat in shadow. To drive the generator an independent engine, vertical type, 8 or 10 horse power, is located in the engine room, usually 200 feet or more from the lamp. The main result so far is noted in the reduction of the time required in making landings. With the old cresset or "torch" the pilot was unable to land at the precise point desired, and backing and reloading was necessary. But with the electric light every object on shore is clearly defined in the darkest night, and the boat touches the shore just where desired. The handling of freight is also facilitated greatly. In actual running, the Western pilot as yet refuses to tolerate the light, and prefers the old time guides of hills and other landmarks. In fog also the electric light is pronounced useless. When steamers are fitted with two lights, the second is portable, and can be taken on shore or moved to any portion of the boat or of the "tow" of coal craft surrounding the steamer. In all these cases the Brush light is used.

THE HARMONIC TELEGRAPH.

Recently certain users of telephones along the line of telegraph between this city and Boston have noticed a novel addition to the assortment of sounds which telephone wires pick up by induction from neighboring telegraph wires. The new sound is more musical than welcome, and is obviously made up of several distinct tones singing together, while each is independently interrupted by rapid breaks or short spaces of silence. These breaks correspond with the "dot and dash" sounds of the ordinary telegraphic instrument, so that the message may be spelled out by the interruptions of the singing tone. Tracing these sounds to their source, they are found to be due to a relatively new system of multiplex telegraphy now on trial on the Western Union Telegraph line between New York and Boston. The system is a development of Elisha Gray's original electro-harmonic or electro-acoustic multiplex telegraph, the early history of which is familiar to all who are at all acquainted with the investigations which led to the invention of the first speaking telephone. The tones of the harmonic telegraph are produced by the vibration of steel reeds operated by electro-magnets, the pitch of the tone produced being determined by the number of vibrations the reed makes in a second. The current operating one reed, when passed over a line, will set in motion at the further end a reed exactly corresponding to the first in rate of vibration, and cause it to yield the same note, while a reed tuned to a different note is entirely unaffected. When two or more reeds are sounding separately or simultaneously at one end of a circuit, their counterparts at the other end will exactly respond, each singing or keeping silent as its corresponding vibrator at the other end of the wire is started or stopped. Obviously any interruptions of the current passing through any transmitting vibrator will be produced by its corresponding receiving instrument, but not by any other in the series, causing clearly recognizable breaks in the singing tone emitted by the vibrator. The message spelled out by such interruptions of the current may be read by the receiver in the interruptions of the tone, or the receiving vibrator may be used as a relay in operating an ordinary sounder.

In the practical work, on the Boston line referred to, it has been found possible to send simultaneously by one wire, and analyze at the other end, four distinct tones, thereby transmitting four separate messages in one direction at one time. This offers a signal advantage over the quadruplex system, which transmits two separate messages simultaneously each way, but cannot send four messages one way. In cases of extraordinary pressure of business the full capacity of the harmonic system may be utilized in either direction. It is hoped that the harmonic system will ultimately make possible the simultaneous sending of four or five messages both ways on a single wire; in other words, four tone messages and one ordinary Morse message in each direction, or ten in all. In this way all the tones of the octave will be made use of, and that is the probable limit of the system, unless it be found possible to operate with fractional tones.

RESPONSIBILITY OF EMPLOYERS IN GERMANY.

The Employers Liability Bill before the British Parliament was noticed in a recent issue of this paper as an indication of the tendency of modern law to throw especial safeguards around human life.

It appears that the practical working of the "Enforced Responsibility Law" in Germany, designed to make employers amenable for injuries received by those at work for them, has not proved altogether satisfactory. At any