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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

rate, Mr. Baare, Prussian Counselor of Commerce (and president of the celebrated Bochum Iron Works Company), has been called on by the government for suggestions as to its amendment; and has recommended a new law.

The old law, passed in 1871, makes railway companies responsible for injuries received by their employes in all cases in which the injury cannot be proved to be chargeable to "acts of God" or the personal carelessness of the party injured. The proprietors of mines, quarries, factories, and the like, on the contrary, are made responsible only when the injury is caused by the carelessness of the proprietor or his representatives. This restriction is held by Mr. Baare to be unjust, and he accordingly proposes a law under which any person in the service of another shall have the right to claim damages for injuries received in such service under any circumstances. The maximum damages to be paid to a laborer are fixed at $125 a year, or two-thirds of the usual yearly wages of a laborer. Men of higher grade, in case of injury, are entitled to two-thirds their usual yearly income.

These payments, however, do not come out of the employer's pocket. They are to be met from the funds of an insurance company, under the control of the German Empire, but supported by premiums paid annually by the employers, employes, and the community as a whole.

This arrangement, if carried out, would bring the laboring classes into close dependence upon the government, and Chancellor Bismarck is credited with the expectation that it would go far to check socialistic agitation. To an outsider the plan seems in no way calculated to increase the manliness or thrift of the laboring class of Germany.

THE CORUNDUM MINES, MACON COUNTY, N. C.

These mines are situated on the Sugar Fork River, a tributary of the Tennessee, nine miles from Franklin. They are owned and worked by the Hampden Emery Company, of Chester, Mass. A considerable part of the ore is roasted for the purpose of more easily separating the corundum from the accompanying rock. When sufficiently burned, the ore is conveyed to the stamps, crushed, and carried by a stream of water into troughs to be washed. A portion of the ore is then jigged, the corundum settling on the bottom; the lighter stuff, rising to the top, is skimmed off. The richer ores are cleaned by simple washing. From the jigs the corundum is placed on a drainer, and when sufficiently drained is taken to the loft, spread, dried, and sacked. The corundum is then hauled sixty miles to Mt. Airy, a station on the Charlotte and Atlanta Railroad.

The first mine reached is an open cut. It is situated on a steep hill side, about one hundred feet above the mill. The vein, though quite irregular, appears to have a width of from three to four feet.

The corundum in this vein is inclosed in that variety of chlorite called ripidolite and jeffersite, associated with tremolite and spinel. The corundum occurs in both cleavage and crystalline form, the crystals often having perfect terminations, while many are transparent and constitute the true Oriental sapphire, ruby, emerald, topaz, etc. Among such gems have been found an emerald weighing 30½ carats, and a ruby weighing 10 carats.

Two or three hundred yards south, and apparently on the same vein, is another opening of about one hundred feet in length, from which about a one hundred tons of ore have been taken. Lying on the east side and running parallel with this vein is a continuous vein of beautiful light gray corundun in crystals, from the size of a goosequill to that of the finest cambric needle.

The corundum taken from this vein is so entirely free from foreign matter that it requires very little manipulation to prepare it for use.

At the top of the hill, and two or three hundred feet above the former is still another open cut, twelve feet wide and fourteen deep. In portions of this vein are found large bipyramidal crystals similar to those from the Carnatics in the East Indies. This vein appears to have regular walling made up of tremolite, and carries corundum, spinel, and nearly all the varieties of chlorite. Southwest of this and probably on the same vein as the last, is another mine which has been more extensively worked than any of the, others. The vein is sixteen feet wide, and is uncovered for a distance of ten rods. The rock is so far decomposed that it can without difficulty be mined with a pick.

A tunnel is run in the center of this vein to a distance of twenty feet; connected with this tunnel at the farther end is a shaft eighteen feet in depth. This tunnel and shaft was originally made for the purpose of drying the walls of the vein before removal. It is now used as an oven for drying and roasting the ore. The varieties of chlorite associated with the corundum contains water of crystallization and exfoliates when heated, rendering it more easy to separate from the corundum. Since the first opening of this mine more than six hundred tons have been taken out, two hundred tons of this since April 1, 1880.

HOT JOURNALS.

One of the most important cares of an engineer is to see to it that the various bearings of the machinery in his charge are smooth, of uniform surface, and rightly adjusted. This apparently simple duty frequently requires the exercise of his best judgment; it is not only necessary that the journal box surfaces be close to the journal, but it it frequently just as necessary that the journal boxes be prevented from accidentally approaching closer to the journal. In a steam engine under full head of steam the play of one-sixty-fourth part of an inch between the crank pin boxes and the crank pin may be sufficient to jar the whole engine; and yet, if the engineer in endeavoring to take up this lost motion, should accidentally overtighten the crank pin boxes, the chances are that a broken crank pin or pitman, and a knocked out cylinder head, will serve as an illustration of the union which is apt to take place between the crank pin and its boxes under such circumstances. Many an apparently unaccountable break in a revolving shaft has occurred from a defective bearing. Heavy shafting, carefully lined in hangers secured to the workshop ceiling, may for months run without any sign of heating; but a pile of iron castings, or other heavy weight, unequally disposed on the floor overhead, may cause just sufficient deflection to expose the revolving shaft to one of the most destructive strains, and cause one or more of the hanger bearings to heat. In machinery the wearing away of one of the parts may subject another part to destructive strain, and it generally requires the exercise of experience and judgment in the construction and handling of the machinery, in order to prevent the harm. Many tons of coal have been wasted and much wear and tear of belts and machinery caused by inattention to these defects. In steam engines especially the adjustment of the journal boxes requires close attention. The expansion of the journal by heat, the quality of the lubricant used, the condition of the bearing surfaces and the amount of pressure they will be subjected to, exclusive of dust, speed of revolution, etc., should be taken into account. In all metal there is more or less elasticity, and when one box of a journal is by means of its screw bolts drawn to the right position in regard to its journal, it should also bear solidly on the other box, in order to maintain the adjustment of the boxes to the journal; if this precaution is neglected, when the shaft is revolving the elasticity of the screw bolts appears to act to cause an approach of the boxes, thereby squeezing out the oil from between the bearing surfaces and causing them to heat or grind. It appears that the continuous motion in one direction of one metal in close contact with another, tends to produce a still closer contact and finally a union of the metal surfaces; the lubricating oil, by preventing direct contact of the metal surfaces, opposes this tendency, and the use of liners or equivalent means to prevent the improper approach of the journal boxes, aids the oil in insinuating itself between the bearing surfaces. It is surprising to watch the effect of a few minutes' grinding of a journal in its bearing. We have seen a twenty-horse engine, under full pressure of steam, brought almost to a standstill by the sudden grinding of one of the bearings of a shaft about two inches in diameter. It appeared that the shaft would have twisted off sooner than revolve in the defective hearing.

WORLD'S FAIR IN 1883.

The matter having been pretty conclusively settled that we are to have a world's fair in the city of New York or in its immediate vicinity in 1883, the next important thing to be settled is the location for holding it.

A committee has this matter in charge, and at its weekly meetings they have placed before them various suggestions as to available space to be had for the purpose, and propositions as to terms for its occupancy.

The city of Brooklyn claims to have facilities superior to New York for the requirements of the Exhibition, and in some respects its claim seems to be well based. The Prospect Park Commissioners have generously consented, we understand, to allow the Exhibition to be held within the limits of the park, which our Commissioners very properly refuse to permit in Central Park, New York.

The following from the *Daily Bulletin*, of this city, echoes the opinion of many of the leading citizens of both New York and Brooklyn:

"If we are really to have another World's Fair," says the editor of the *Bulletin*, "it seems to us Prospect Park, Brooklyn, all things considered, would be the best site that could possibly be selected. True, the charter restricts the choice to some location on Manhattan Island; but if everything is satisfactory in other respects, it is presumed there would be no difficulty in having that instrument modified accordingly. The tender of the park is certainly a very generous one on the part of our sister city, and its numerous advantages are apparent. It would preserve our Central Park from invasion, and place at the disposal of the Commission 'ample room and range enough' for every purpose of the Exhibition without costing them a dollar; and this, too, with excellent sewage and other sanitary arrangements complete. With abundant railroad facilities for the transportation of merchandise and visitors, good roadways and carriage drives, and one of the finest boulevards in the world, we do not see what other locality can begin to compete with it. The Fair, there, would also attract the vast multitude that in the course of the summer go to and from the near-by watering places on the sea shore; and that of itself is a basis of financial success, it seems to us, which ought not to be overlooked."

Beet Sugar Making in Delaware.

The new sugar mill of the Delaware Sugar Company, at Riverside, a short distance above Wilmington, has begun work. Last year the entire product of sugar beets in Delaware amounted to about 300 tons, but this season the company expect to obtain from three to four thousand tons of better beets than last year, the cultivation having been better understood. The beets already delivered are testing from 8 to 14 per cent of saccharine matter, and the company are paying from $3.50 to $7 per ton for them, and are working up about 50 tons a day. If they obtain the quantity of beets calculated upon, the product, under the new and improved process now in use in the new mill, will be about 550,000 pounds of raw sugar, 200,000 pounds of molasses, and 1,700 tons of pulp, which is now selling at the factory to farmers at $1 per ton. It is stated that some of the beets were allowed to remain in the ground too late in the season, and thereby were somewhat deteriorated for producing sugar. This, with other defects in the cultivation, will, it is said, be remedied the next season.

AN INVENTION WANTED.

In carrying out their laudable and highly promising efforts to introduce silk production as a domestic industry in this country, the Women's Silk Culture Association of the United States have discovered the need of a suitable hand reel for home use, and appeal to the inventive readers of the SCIENTIFIC AMERICAN to supply the need.

The economical production of cocoons is no longer a problem in this country. The worms thrive almost everywhere, and in every community are women and children who have plenty of unoccupied time which can be utilized easily and pleasantly in the production of cocoons. But silk manufacturers furnish no market for cocoons; they want reeled silk. The unwinding of the cocoons may be done in special establishments erected for the purpose; and were the silk growers sufficiently numerous to supply the requisite cocoons, such "filatures" would no doubt be provided, and so furnish a market for the cocoons raised.

As yet, however, the silk growers are too few and too scattered to support such establishments. Accordingly, it becomes necessary in the domestication of the silk industry to provide a simple hand reel with which those who raise the cocoons can also unwind them. The reel should be simple in construction, small and inexpensive; preferably of metal, as less liable than wood to be affected by atmospheric changes; and capable of turning off a warp answering the requirements of marketable silk.

Obviously a reel to meet the present demand will make for itself a much wider demand; since many who are now prevented from engaging in silk production by their inability to meet the demands of the trade for reeled silk, would doubtless engage in the work if the proper reel were provided. Our silk manufacturers are now, in the infancy of the business in this country, using $10,000,000 worth of raw silk a year. The association believe that the agriculturists of the United States will ultimately produce, nay, must produce this amount of raw silk, and more. They report that the industry is exciting a warm interest in all parts of the country, and that from every State in the Union there comes a plea for the establishment of just such a home industry. The office of the association is at 1328 Chestnut street, Philadelphia. Intending inventors should communicate with Mrs. John Lucas, President.

Death of "One of Nature's Gluttons."

The readers of the SCIENTIFIC AMERICAN will regret to hear of the death of the frog Rana Pipen, whose portrait appeared in this paper of February 7. He was found by Mr. Dan. Beard, November 17, dead in the glass globe that has been his home for nearly two years. The immediate cause of his death is supposed to be indigestion caused by the combined effects of supping upon two-thirds of a white perch and resting all night under the steam heater. His loss will be mourned by a large circle of friends.

RANA PIPEN'S MENU.

May, 14, one dozen "June bugs."
" 15, one full grown live mouse.
" 19, one leopard frog, one-third smaller than Rana.
" 24, large piece of meat.
June 2, 9 A.M., one full grown live mouse.
" 2, 1 P.M., " " "
" 5, one large piece of meat.
July 18, one live mouse, full grown.
" 20, one young alligator.
" 27, one live mouse, full grown.
" 29, " " "
August 9, " " "
September 17, one large brown bat.
" 20, one craw fish.
" 21, two "
" 22, one "
" 25, one live mouse, full grown.
" 27, " " "
October 8, " " "
November 15, white perch.
" 17, *dead.*

Convergent Squint.

Dr. C. A. Bucklin, in an article in the *Medical Record*, on the cause and treatment of squint, expresses the opinion that every squinting eye that is not due to paralysis of a muscle can be straightened. In convergent squint the use of one eye is usually lost; consequently its earliest symptoms should receive prompt attention. Dr. Bucklin has had the advantage of examining over two hundred cases of squint, and illustrates his text with a few of the more interesting ones to show the success that has attended the treatment which he therein recommends, that of tenotomy, or division of the tendon of the abnormally shortened muscle.