AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, October 27th, 1897.

The 118th meeting of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, was held at 12 West 31st Street, this date and was called to order by President Crocker at 8.20 P. M.

THE SECRETARY:—At the meeting of the Executive Committee this afternoon the following Associate Members were elected:

Name.	Address.	Endorsed by
BALSLEY, ABE	Chief Electrician, Terre Haute Electric Railway Co., No. 514 6½ Street, Terre Haute, Ind.	R. B. Harrison. Edw. G. Waters. Edw. P. Decker.
BALCOME, HERBERT A.	With The Eddy Elec. Mfg. Co., Windsor, Conn.	W. R. C. Corson. H. E. Heath. H. S. Rodgers.
CHILD, CHAS. T.	Editor, <i>The Electrical World</i> , 253 Broadway, New York.	J. Stanford Brown. Louis Bell. A. E. Kennelly.
GOLTZ, WILLIAM	Hathaway Building, Milwaukee, Wis.	F. B. Badt. Chas. D. Shain. B. J. Arnold.
JONES, M. E.	Contractor, and Student in Senior Class, Cornell University. Ithaca, N. Y.	Harris J. Ryan, S. B. Fortenbaugh. Fred'k Bedell.
LE CLEAR, GIFFORD,	Electrical and Mechanical Engineer, Partner Densmore & Le Clear, 7 Exchange Place. Boston; residence, Cambridge, Mass.	C. A. Adams. E. H. Hall. H. B. Shaw.
THOMPSON, SILVANUS P.	Morland, Chislett Road, West Hampstead, London, N. W., England.	Chas. P. Steinmetz. Ernst J. Berg. Eskil Berg.
WILLIAMS, GEO. HENRY	District Supt. The Edison & Swan United Electric Co., Ltd., 134 Royal Avenue; residence, Culmore, Glenburn Park, Belfast, Ireland.	H. L. R. Emmet. A. G. Inrig. Ralph W. Pope.

WOTTON, JAMES A.	Electrician, Southern Bell Telephone & Telegraph Co., P. O. Box 218, Atlanta, Ga.	F. A. Pickernell. A. N. Mansfield. D. I. Carson.
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Total 9.

The following Associate Members were transferred to full membership.

SAMPSON, F. D.	Manager, Charlotte Electric Light and Power Co., Charlotte, N. C.
DAVIDSON, A.	Cable Engineer and Electrician, Central and South American Telegraph Co., Lima, Peru.
DECKER, EDWARD P.	Electrical Engineer, New York Telephone Co., 18 Cortlandt St., New York,

Total 3.

THE PRESIDENT:—As there is no formal business to attend to we will proceed immediately to the subject of the evening, and I take great pleasure in presenting Mr. Richard Lamb, who will read a paper on a novel and very interesting branch of electrical engineering, "The Development of Electric Cableways." Mr. Lamb will please present this paper, and as the paper is illustrated by lantern slides it will be necessary to darken the room, and Mr. Lamb will refer to them in the course of his paper.

THE DEVELOPMENT OF ELECTRIC CABLEWAYS.

BY RICHARD LAMB.

Large expenditures of thought and money have been made to devise means of transportation that can disregard the insurmountable difficulties of some surface roads, such as excessive grades, too much bridging, or too great a cost for roadway. The natural suggestion has been to make the roadway through the air, and air-ships, flying machines and suspended cableways have been sought for to solve the problem.

Macaulay wrote, "Of all inventions, the alphabet and printing press excepted, those inventions which abridge distance have done most for civilization."

The most baffling problems we have before us to-day are those of abridging distances. With all the expenditure of life and money that has been put into the endeavor, man has not as yet even been able to traverse this orb of the universe upon which we are living, and with untold riches as the goal, thousands stop within a few hundred miles of the Klondike, at the first short pass, to await a less hazardous season to risk the journey.

There are millions of feet of valuable timber in swamps standing within rifle-shot distance of convenient points of navigation that have been practically unobtainable. The miry soil makes regular roadbeds too expensive, and it has been as impossible to get the teams into the swamps as to get the logs out. It was to solve this particular problem of abridging distances that the electric cableway was built.

I first built a cableway, having portable iron bracket supports to attach to the trees, and an endless cable supported by sheaves upon the brackets. The cable was passed around a sheave which

was driven by a steam engine at one end of the line. This cableway worked well, and could haul logs for a distance of half a mile, which is farther than by any other method previously tried. I found that steam cableways were limited to straight lines, and as trees do not always grow in long straight lines, I devised a means by which the car would replace the traction-cable in its sheave if it was dislodged in passing a bracket on account of the cable line not being straight. But this did not obviate the difficulty of having to select the route with reference to a straight line.

FIG. 1. First Test of Logging Motor.

In the excellent article on "Railways in the Air," published in a recent number of *The Strand*, the writer states: "Two stout wire carrying ropes are laid parallel on standards of wood or iron and then stretched tightly *in a straight line*. (These words are in italics.) Aerial rope-ways cannot run around corners." This condition is due to the fact that a moving cable has a tendency to work itself out of its carrying sheave, unless the line of the pull of the cable is straight. This fact suggested to me the necessity of the traction cable being stationary. It was a natural advance in the line of thought to note that if a

sheave would transmit sufficient power to haul logs a distance of half a mile from the same, that it would be even more efficient if the power applied to the sheave was near by, and accompanied the load on its travel. As an electrician, the cables of the steam rig naturally suggested to me conductors for an electric motor that would operate the sheave. Such a motor admits of the traction cable being stationary by passing it about the sheave several times and anchoring it at both ends; thus, the motor winds in and pays out the cable, on the principle of a capstan. The fact that the traction cable is stationary, and that the lower bracket catches the cable as the motor passes, makes a system of this kind the only one that can be operated upon concave and convex curved lines.

One of the essential features of the steam cableway is having the traction rope always parallel with the bearing cable. The disregard of the direction of forces in other cable systems has been one of the main causes of their failure. On approaching a support the cable naturally sags, and the carriage has to be propelled up an incline. If the grade of the cable is steep, as it is in practice, and the power is applied in a horizontal direction, the resultant force will neutralize the pull, and the carriage will stop. Cableways, operated by horses upon the ground, pulling the carriage on the cable, have accordingly been inoperative. It was important, therefore, in the electric cableway, to have the traction cable always parallel with the bearing cable. Supposing the incline of the cable to be raised until it is vertical, we would then have an elevator; the bearing cable being the guide, and the traction rope the hauling rope, the motor being on the elevator car instead of at the top or bottom of the shaft. It is this feature that enables this system to operate on grades that would be impracticable by other methods.

This system consists of a carriage with grooved wheels in tandem, that move upon a cable or suspended trackway. From this carriage is hung a frame, pivoted to the carriage so that it can maintain a vertical position regardless of the grade of the track. This frame holds an electric motor, preferably of an iron-clad cylindrical type. The motor is geared to an elliptically grooved sheave. A steel cable is wrapped around this sheave two or more times and is anchored at both ends. For the sake of economy in conductors, the upper or bearing cable is insulated from the lower or traction cable, and is used to carry the electric

FIG. 2. "Finow" Canal Motor.

current. The carriage is insulated from the suspended frame and motor. An insulated wire is attached to the carriage and conveys the current to the rheostat. The other pole of the rheostat is connected with a convenient part of the suspended frame. The rheostat is designed to control the speed and reverse the current. A circuit breaker is put in circuit. The current from the generator passes along the bearing cable to the carriage, thence through the insulated wire, through the rheostat, through the motor, to the frame of the motor, thence through the traction cable, back to the generator. At intervals along the line, connection is made between the traction cable and the ground. A bar of copper-coated iron is buried at the foot of a tree or post to which the cable brackets are attached. A well bonded copper wire extends from this ground plate to the lower bracket, upon which the traction cable rests. In swamp and canal service the plate is buried well in the moist earth. A most marked difference in the resistance is noted when the ground connections are disconnected. When connected, the resistance is the same as if the traction cable was the same size as the bearing cable.

In making the first saddles to support the cable, they were designed for movable brackets, which can be easily put upon trees and removed to other trees when the line is changed to a different location. These saddles have a U-shaped clamp that goes over the cable, and is bolted down with wedge-shaped bolts. Under the saddle is a petticoated recess, designed to shed rain-water from the insulation placed between the saddle and the bracket to keep the current from grounding or short-circuiting.

This develops a new feature in insulation. It appeared that many of the materials ordinarily serviceable for insulating were not available, owing to the fact that often a rolling load of 10,000 lbs. or more passes over the brackets, producing a grinding and crushing effect.

Lava, hard rubber, micanite, shellac, mica and its products, glass, porcelain, ozite and all products of rosin, proved to be too brittle. Vulcanized fibre was finally used and proved quite satisfactory for a time. As only 220 volts are used in logging plants, and as it is an advantage from a construction standpoint to have the insulation as thin as possible, sheets of fibre $\frac{1}{8}$ " thick were used. It was found that although this insulation was protected from the rain, by being shellaced and covered by a petticoat, after being exposed for some time, it would lose considerable of

its resistance, and while some of the brackets could be passed by the electric motor, the heavy load on others would cause a short circuit through the insulation. This was averted by painting the saddles, brackets and fibre with insulating paint, and by increasing the thickness of the insulation to $\frac{1}{4}$ " and using fibre that had been solidified under unusual pressure. This was found to work all right.

The saddles for the plant for the Erie Canal towing test, referred to hereafter, were made so that the tread of the bearing wheels would leave the rope, and the wheels would pass over the saddles on their rims, guided by flanges cast upon the saddles. On curves these flanges were made concave or convex as required. These saddles worked excellently; and the motor passed over them easily and satisfactorily. These brackets were insulated

FIG. 3. "Finow" Canal Motor on Cable Line.

with ozite and vulcanized fibre, and painted with insulating paint.

Work in swamp logging demonstrated that small short saddles are all that are needed, even for deflections in the line of from 20 to 25 degrees. The needle was much simplified by attaching to the brackets an insulated cone-shaped pin, over which the saddle is placed, by having a cone-shaped recess in the under part of the saddle to fit the pin. This recess also acts as a petticoat to protect the insulation. The question of insulating the cone-shaped pin was an important one. Vulcanized fibre could not be molded upon the pin. A material was needed that, while having a high resistance, would adhere to the pin, and that would stand a great crushing strain. It should be preferably non-hygroscopic, and show a minimum absorption of water.

Insulated trolley hangers were secured, that showed an insulation resistance measured under 150 lbs. vertical stress above 300,000 megohms, and after sprinkling with water one-half hour, measuring immediately above 300,000 megohms. After again sprinkling with water twenty minutes, they measured immediately above 300,000 megohms.

Tested for absorption after soaking in the water four days showed weight of 312.9 grammes; weight as received 312.7 grammes; absorbed 000.2 grammes. [Tests by Stone and Webster.]

In the insulated stud made for the saddles, the breaking strain measured over 35,000 lbs. At that point the insulation showed no signs of giving way, and the same stud was subsequently used for regular work. The instrument used for measuring the crushing strain measures only 50,000 lbs. It was thought best not to test above 35,000 lbs., which was more than needed in any service it would be required to perform. The pressure was put upon the top of the saddle and the bottom of the stud. As the thickness of the insulation is over twice as great on these saddle pins as was used on the trolley studs tested, the resistance should be at least over twice as great. [Test by Pope Mfg. Co.]

The best steel cables for cableways are the interlocked and patent locked wire rope. These are almost as compact as solid bars of steel, and yet can be easily coiled by hand in coils four feet in diameter. A simple coupling is used to connect the cables. The wheels of the car pass over these couplings so smoothly that the rider on the motor scarcely notices the fact. These points of connection are as strong as any section of the cable. An advantage in these interlocked cables is that they present a smooth surface of comparatively flat steel, which wears a great many times longer than the ordinary cables whose surfaces present round wires that wear through and unravel. These cables are made to bear much greater strains than the ordinary cables, and being so nearly solid they make much better electrical conductors.

The traction cable is made of $\frac{5}{8}$ " or $\frac{3}{4}$ " specially strong "19 wire" steel rope, with a soft iron wire core, in place of hemp, which is ordinarily used. This increases the conductivity. One of the most remarkable results in practice in this system is the fact that the traction cable does not have to be pulled very taut, in fact a sag in the cable seems to be of no disadvantage, as the motor does not tighten the line far ahead, even when doing con-

FIG. 4. Hauling Canal-boat at Trenton, N. J.

siderable service. The sag adds to the weight of the cable and to the friction on the brackets, and these two resistances act as an anchor for the traction cable, independent of the terminal anchorages. For example in the case of a trial plant for a German canal the resistance to be overcome by a motor, or its "draw-bar pull" was to be 645 lbs. Now at one pound per running foot of traction cable, the influence of the motor pull would only be felt 645 feet ahead of the motor. Therefore with motors distributed 645 feet apart, each one practically has its traction cable anchored from the motor ahead, and, in consequence the combined pull of all the motors is not exerted upon the terminal anchorage.

In the first plant, the clamps on each of the lower or traction cable brackets were made with steel jaws, with springs under them, such as are used on grip-pulleys. When the traction cable was pulled the clamps gripped the cable, and when the motor lifted the cable, on passing the bracket, the jaws released the cable. These clamps were found to be unnecessary.

In canal practice the terminals will be ten miles apart with tension stations every two miles. At the terminal stations rotary transformers will transform the high voltage alternating current to 500-volt direct current, and send the same each way a distance of five miles. Where the traffic justifies, a line will be placed on each side of the canal, when the insulated or bearing cables will be connected at intervals to feed each other. The anchorage of the traction cable will be made with a series of clamps, and the motors will be passed through them as canal boats through locks. At the end, the motor is released from its traction cable and is conveyed across the canal on a cable, or where masts are allowed on boats in the canal, by a hinged trussed track that can be opened like a gate, or raised out of the way. The handle of the rheostat is easily controlled from the boat by a cord attached to the handle. When the cord is pulled from the opposite direction to which the motor is to be run, the current is admitted in the proper direction, and the motor proceeds. When the cord is released, the handle flies back to a vertical or cut-off position, and the motor stops. When two boats pass, they exchange motors by simply exchanging tow-lines and controller cords.

The first test of canal boat towing with this system was made on the Delaware and Raritan Canal, at the Trenton Iron Works. The motor was made to go over concave and convex curves and up and down grades while towing the boat.

In reference to the test of canal boat towing on the Erie Canal, at Tonawanda, it is not necessary to make any apologies for the system. Superintendent of Public Works Aldridge, in his report to the Legislature, unqualifiedly endorsed the system and stated: "Early in the season of 1895 application was made to me to officially designate a part of the Erie Canal for the proposed test of the efficiency, economy and practicability of the so-called 'Lamb System' for improving the present system of towage on the canals of the State. The location selected was a piece of canal about one and one-quarter miles in length at Tonawanda, N. Y. The purpose was to select such a portion of canal as would embrace as many practical obstacles to the success of such a plan of towing as could be found anywhere in a section of canal that length."

In the report of Chas. R. Barnes, electrical expert for the Public Works Department of the State of New York, he sums up by saying: "The electric towing system appears to present

so many meritorious features that I have no hesitation in endorsing it as the system deserving preference over any other hitherto experimented upon, or likely to be devised in the near future."

So short a time was given in which to construct the trial plant that existing models had to be copied. The motor was over 9

FIG. 5. Test on Erie Canal at Tonawanda, N. Y.

feet in length; it weighed 2,213 pounds. The elliptically grooved sheave was driven by a worm-gear. The voltage, which was gotten from a trolley line, fluctuated from nothing to 500 volts, but seldom equalled the latter amount. The bridges under which the motor had to go were very low, and had to be ap-

proached by reverse curves on a grade of about 20 degrees. Trenches had to be dug next to the abutments to give room for the motor to pass under the bridges. Both convex and concave curves had to be passed over, and at one point the deflection was about 30 degrees. In spite of the difficulties, the trial showed that the system performed economically and efficiently all that it was designed to accomplish.

In the plant recently constructed for trial on a German canal, the motor has been shortened to less than five feet in length; its weight reduced to 1,300 pounds. The worm-gear has been avoided by a double reduction direct gear, gaining 50% in efficiency over the worm-gear, and the elliptically grooved sheave

FIG. 6. Motor used at Tonawanda.

has been placed about the cylindrical electric motor, getting a large bearing surface and increasing the efficiency accordingly. At the test made at the Trenton Iron Works this motor, using a 5 horse-power Storey motor, wound for 500 volts, and going at the rate of 23 miles per hour, pulled 800 pounds when having the use of only 220 volts. This shows a remarkable efficiency, which is due to the mechanical principles utilized, viz., hauling the motor along by a fixed rope, attached to a capstan operated by practically a winch.

The uses to which this method of telpherage can be put are so numerous that I will not attempt to give descriptions of plans

that have been, and are now, being made for various parties, for such services as fortification work, rice culture, mining plants, ship building and sewer excavating plants. I will confine my descriptions to completed work.

Possibly the most universally serviceable application that has been made of the system is traversing motors with double hoisting drums for quarry purposes. These motors are to go on 700 feet span cableways. Each of these cableways has one end stationary and the other is movable on a curved track. They are designed to lift 10,500 pound rocks at the rate of 50 feet per minute and traverse at the rate of 300 feet per minute. At a test at Trenton made upon a temporarily erected cableway we raised 6,600 pounds, and ran on the cable at the rate of ten miles per hour, part of the time going up a grade of over 15 per cent. There will be no difficulty in these motors raising over 10,500 pounds and running 300 feet per minute. A 15 horse-power Storey motor is used. The rheostat reverses the motor and regulates the speed. A band brake also is used to regulate the stopping. This is controlled by a lever in front of the motorman. There is a safety brake to be used in case the band brake should fail. This is operated by a wheel. The shoe of this brake clamps the upper cable. It is attached to the car proper, and with the wheel handle oscillates with the carriage as it climbs or descends grades. A lever in front of the motorman is used to control the speed of the drums that raise and lower the skip. A friction clutch, controlled by a wheel handle, disconnects the traversing sheave gear and engages the hoisting drums or vice-versa.

In a place within reasonable distance of an electric plant having surplus power, these electric cable hoists can be erected and operated for a comparatively small cost. In contracting work, where electric lights are also used, these cable cranes can be used to great advantage. In other places the small generating plant necessary to operate these motors will add but little to the expense of an outfit.

Those who think that electrical machinery is of such a delicate nature that it is only serviceable for cities of advanced civilization, should go to the Dismal Swamp, and see a so-called dainty machine doing as rough and dirty work as any service to which a machine could be put. He would see the laborers, over their knees in mud, sawing down giant trees, and hear the woodsman

sing: "Stand from under, she's saying good-by to her neighbors." With a crash that throws mud and water high into the air a tree will fall and fill a space with broken limbs, embedding

FIG. 7. Loaded Crane on Cable.

itself well into the mire. This means work for the motor. Logs are to be drawn from their beds, and when the ammeter in the generator room on the scow, for an instant runs up, possibly to

a point of overload, it is the motor overcoming the suction in drawing out a buried log. With the voltmeter standing at 220 volts, you would see the needle momentarily go to 35 amperes and then drop to about from 10 to 16, depending upon the size of the log. As the cone over the end of the log strikes a stump or a cypress knee, the needle flies to about 20 and then back, and as the log dives off from an obstruction it may be crossing, the cur-

FIG. 8. Crane Motors in Shop.

rent drops to zero momentarily. Finally when the log reaches the tail-tree, about 20 amperes is recorded as the log rises from the ground and hangs suspended by the hauling cable. This cable is reeved through a sheave, which is attached to the tail-tree fifty or more feet from the ground.

After a number of logs are drawn to the tail-tree, they are transported over the cableway to the terminal on the banks of

the canal. Reading the ammeter as the log comes in we see it start at about 5 then go up to 12 or 14, as it crosses the bracket

FIG. 9. Logging Motor working in Swamp.

saddles, then go down to 5 again. In this process of transportation, one end of the log is suspended by a car on the cable. The

end of the log is raised from the ground by holding fast the bight of the grip-block rope and going ahead with the motor. The block is attached to the car, when the same results are produced, as if the power was applied to the rope direct. When the end of the log has been raised to the proper elevation, the grip holds it from falling, and the rope is coiled and placed on the tongs which holds the log, and after getting a couple of cars loaded you are ready to carry your valuable logs from one of nature's worst fastnesses to a point where they become valuable to mankind.

The question has been asked, "do you require expert help about these logging plants?" In answer, I would say that I am satisfied with my superintendent. He has spent his life in swamp logging, and has had no chance for education, much less scientific studies. When I assembled the generator, the first time that I put up the plant, he put on a pair of rubber gloves, not wishing to run any chances of getting a shock, even if there was no fire in the boiler. While testing the plant a fuse blew out on the generator, and one of my negro help started on a run into the swamp and never returned again to work. I afterwards heard that he stated: "Mr. Lamb can't fool dis nigger, I done worked on the government dredge boat, and knows what a dynamite machine is."

In spite of the lack of electrical information of the logging crew, no inconvenience has been occasioned on that account. All features of insulation are provided for before the plants are shipped. An ordinary steam engineer acquires quickly the necessary information for running the dynamo. The motor is shipped with all parts adjusted, and the extent of the motorman's duties is simply to push the handle of the rheostat according to the direction he wishes to go.

The light first cost, the high efficiency, the ease with which it can be operated by ordinary mechanics, portend for this system an important place among the useful applications of electricity of this century.