

## RAILWAY TRAIN LIGHTING.

BY A. H. BAUER.

The first successful system of railway train lighting is that invented by Houghton, and adopted by the London, Brighton and South Coast Railway of England, in 1881-2. Since then the many improvements suggested by other inventors have made it almost automatic.

The system consists of a Brush dynamo carried inside the baggage compartment, and directly connected by link belting to pulleys on the axle of the car. Attached to the dynamo is a ball governor, rotating vertically, whose office is as follows :

- 1st. To control the movement of a switch, which, when the speed and therefore the E. M. F. of the dynamo reaches a predetermined value closes the circuit, and also opens it again when the E. M. F. approximates that of the secondary battery, which is always in circuit.
- 2d. The adjustment of a resistance which maintains the current constant, and
- 3d. To shift the position of the brushes as the neutral point is changed by the varying speed of the armature.

But one set of brushes is used, carried in rectangular holders, at right angles to the commutator, and always in contact with it.

When the rotation of the armature is reversed by a change of direction of the train, the brushes are carried forward or backward by the friction on the commutator and a connection with the governor until the quadrant passes but a fraction beyond the vertical, when it is drawn to the proper position by a spring, the action being similar to that of the snap switch. Limiting stops are provided to prevent the quadrant going too far.

The same movement of the quadrant also changes the position of a switch controlling the connection of the field coils, and therefore the polarity of the dynamo. It therefore follows that the current is always in the same direction, no matter which direction the armature may rotate. One set of accumulators, consisting of 25 cells, is provided for each train, and placed in the baggage compartment. The maximum number of lamps in a train is 70, of 10 candle power each, at 50 volts.

No attendant is necessary, but at certain stations on the line an examination of the plant is made, and required repairs attended to. I am informed the system is so reliable that since the year 1888 but two failures have occurred.

It will be noted that the key of this system is the convenience with which the connection between the armature pulley and that on the axle can be made.

Throughout Europe the rigid wheel base is universally employed under railway baggage cars; consequently, by setting the dynamo across the car, the armature shaft will always be parallel with the axle, and the connecting belt run in practically the same plane.

In this country the bogie truck is exclusively used. Several attempts have been made to drive dynamos by connections with the axle of bogie trucks. All, however, have failed, for the reason that no provision was made for maintaining the armature shaft and axle parallel at all angles of the truck, and because sand, dirt, etc., gathered by a moving truck will soon destroy any mechanism that may be used for the purpose under the car. The problem, however, has not been abandoned, and I am in hopes that within a very short time a solution will be found.

Numerous propositions have been made to use primary batteries for car lighting, but I am not informed of a successful installation of that character.

Secondary or storage batteries have been more or less employed for the purpose, with varying success. The first attempt in this direction was made in 1887-8 on two Pullman limited trains, of six cars each.

Each car was equipped with thirty cells of battery, having a capacity of 150 ampere hours, and weighing 50 lbs. per cell, or 1,500 lbs. per car. Duplicate sets were kept charged at each end of the line, and on arrival of the train, exchanged for those that had been exhausted while on the road. The average number of lamps per car was 26, of 16 candle power, at 60 volts, or

a total of 156 in the train. After sixty days' trial, it was clearly demonstrated that, under existing conditions, the system could not be made successful, and it was abandoned.

The reasons for its failure were—1st, that the capacity of the battery was insufficient to maintain the number of lamps required for the proper lighting of Pullman cars on long runs.

For example, the current required for 26 60 volt, .8 ampere lamps, is about 20 amperes. Therefore  $\frac{150}{20} = 7\frac{1}{2}$  hours, that

is to say, 1,500 lbs. of battery was able to maintain 26 lamps but  $7\frac{1}{2}$  hours. These trains departed east-bound at 5 P. M., but the light is required at 4 P. M. for inspection, receiving passengers, etc. Consequently the batteries would become exhausted at 11 P. M.; in fact, it would be earlier, as will be explained. Therefore the oil lamps would have to be used when light was required during the remainder of the trip. West-bound the same reasons held good, although not to the same extent, because the train leaves that end in the morning and passengers will, as a rule, after 12 hours' traveling, retire earlier than those going east, leaving at 5 P. M. Consequently less light is required, and a certain percentage of the charge is not used.

A second reason was the deterioration of the batteries themselves, which were of the pasted grid type. It was found that the constant agitation of the acid solution in the jars, as well as the unavoidable rough usage to which they were subjected when changing, caused a loss of the paste or active material, proportionately reducing the capacity. In fact, close observation indicated the loss during one handling to be equal, if not more, than that caused by 1,000 miles travel on the car. The paste, when separated from the grid, accumulates in the bottom of the jar, or lodges between the plates, forming a circuit through which the cell is discharged, resulting in the buckling and sulphating of the plates, and the destruction of the positive elements within a short time. This was five years ago. Since then, improved methods of manufacture, as well as more intelligent care in handling, has, to a great extent, overcome these objections and thereby increased the life of the battery. It may be asked—why not increase the size and therefore the capacity of the cell? The reply is—that to properly light a train of six Pullman cars, for instance, between Chicago and Jersey City, with the number and kind of lamps above stated, would require 30 cells, each weighing not less

than 100 pounds—a total of 3,000 pounds per car, or 18,000 pounds for a six car train. The expense of handling and changing such a weight would make its use almost prohibitory, for each cell would have to be handled singly. The weight on the car would also be objectionable. Since these experiments were made, car lighting for short distances only, from storage batteries, has been made successful. For the past two years four cars, each equipped with 32 cells of 150 ampere hours capacity and 26 16 c. p. 60 volt lamps have been running between Chicago and Cincinnati, and Chicago and Indianapolis. Two of these cars are charged every day at Chicago for about nine hours with sufficient current for a round trip. The batteries, however, are not changed; the cars are always placed on the same side track to which wires from the dynamo are led, and the charging is done without removing them. The average length of time the light is required during a round trip is six hours; the cars leave each end of the line at 8 and 9 P. M. respectively. Repairs are made by removing the defective cell and substituting another if necessary.

The cost of repairs and renewals of all kinds from Sept., 1891, to January, 1892, inclusive, per month, was as follows:

September, 1891.....	\$ 36 44
October, “ .....	108 82
November, “ .....	51 24
December, “ .....	79 21
January, 1892.....	38 31
Total.....	<u>\$314 02</u>

An average of \$62.80 per month.

$$\frac{62.80}{30} = \$2.09 \text{ per day for the four cars.}$$

$$\frac{2.09}{4} = 52.25 \text{ cents per car per day.}$$

$$\frac{52.25}{26} = 2 \text{ cents per lamp per day of hours.}$$

$$\frac{2}{6} = .33 \text{ cent per lamp per hour.}$$

As the engine and boiler are used for furnishing power for other purposes while running the charging dynamo, it is difficult to get the cost of the power for charging these batteries, that factor, therefore, is not included in the above statement

In January, 1888, a solution of the problem of lighting six-car trains for long distances was sought for in another direction. Two trains running between Jersey City and Jacksonville,

Florida, a distance of 1,100 miles, were selected for the experiment. At first an attempt was made to utilize the power of the axle, but for reasons already stated did not prove successful.

The next step was the substitution of a vertical single-stroke engine, located in the baggage car, for the axle connection. This engine was belted to the dynamo, and was supplied with steam from the locomotive boiler.

While this plan seemed to be a step in the right direction, it still had its objections, due to the fact that the upward and downward movement of the driving-rod acted in the same manner as would a heavy blow on the car body, so that the latter would vibrate in unison with the stroke of the engine.

After a few trials, the vertical engine was removed and a three-cylinder reciprocating engine, with three-inch cylinders and four-inch stroke, was substituted. It was connected direct by a flexible coupling to a 75 volt 60 ampere dynamo of the ordinary open frame type, and both run at 1,000 revolutions per minute.

The working of this combination clearly demonstrated that a solution of the problem was attainable, and it was now possible to guarantee a fairly successful lighting of the two trains. A fault soon developed, which could not be anticipated. It is well known that all railway trains, while running, gather more or less dust and dirt, but it was not known until train lighting was attempted, that this dust and dirt contain certain quantities of carbon and metal which adhere to armature and field wires, and being conductive form short-circuits. So frequently did this occur, that it became necessary to carry an extra armature with each plant, and make changes while the train was in motion. Later in the year these dynamos were removed, and the Eickemeyer installed. The Eickemeyer dynamo seems to be perfectly adapted for train lighting. As both the armature and field coils are protected by the iron of the machine, dust and dirt does not reach the wire, except in small quantities, and by removing it every six months, when the car is shopped for repairs, short-circuits have been prevented. Its strong construction is such that it will successfully withstand the general rough usage to which machinery of this character is subjected to on railway trains.

The system which has been used for the past five years on all Pullman trains, consists of a Brotherhood three-cylinder engine and Eickemeyer dynamo, bolted to a cast-iron bed-plate, and lo-

cated in the forward end of the baggage car, occupying an enclosed space of 6 feet 6 inches by 3 feet 3 inches. The engine and dynamo are connected by a flexible coupling which allows for the irregularity should they not be in perfect line. A two-gallon sight-feed pressure lubricator bolted to the end of the car, furnishes oil to all wearing parts of the engine. The average consumption of oil is about one gallon every 20 hours of actual running of the engine.

Steam is taken from the locomotive boiler, a tap being made at the dome, the pipe passing under the tender and car, between which a flexible rubber hose makes connection. It has been found that with a  $1\frac{1}{2}$  inch pipe between the boiler-head and car, there is a loss of 15 pounds pressure due to friction and condensation; therefore, to run the engine with 50 pounds, requires 65 pounds at the supply pipe on the locomotive. With 50 pounds pressure, the dynamo will, at 900 revolutions, generate 80 amperes, at 72 volts, when all the lamps and batteries in a six-car train are in circuit, and 50 to 75 amperes, at 80 to 85 volts, at the same speed when the batteries alone are connected, depending on the counter E. M. F. of the batteries.

On the side of the car is placed an automatic switch, which will break the circuit when the E. M. F. of the dynamo equals that of the batteries. A voltmeter and ammeter are kept constantly in circuit while the plant is in operation. A tachometer, belted to the armature shaft, is also provided for noting the speed of the engine and dynamo. This plant is enclosed by a tongue-and-groove partition surmounted by a wire screen.

The system of wiring adopted is the equi-potential, in which the pressure is practically equal at each lamp and battery. One wire leads from the positive pole of the dynamo to the rear end of the rear car, where it is coupled to a second that returns to the baggage car—but not to the dynamo—being tapped, however by the positive pole of each battery and one side of each lamp. A third wire leads from the negative pole of the dynamo to the rear end of the rear car, where it ends. This third wire is tapped to the negative pole of each battery and the remaining side of each lamp.

All the batteries and lamps are therefore in multiple arc. Double pole, fusible cut-outs are placed in each circuit, and, with the switches, are located in the closets of each car. The wires are always placed on the roof of a car. For this purpose, white-

wood moulding, thickly coated with asphalt paint, is nailed from end to end as near the center as possible, usually one and three-quarter inches from the edge of the smoke-jack if the car is equipped with center oil lamps, and from six to 24 inches when gas lamps are applied. Branch mouldings extend to all points on the roof through which it is desired to run wires to the lamps, switches, etc., inside the car. For instance, the drops to the center lamps in the body of the car pass directly through the center of the roof into the air chamber of the oil lamp, from where they are suitably connected. Those leading to the switches, cut-outs and batteries pass through the panels between the ventilators and into the closets where the switches are located, the battery wires continuing on through the floor to the boxes under the car. After being run in the moulding, the wires are covered with wooden capping and the whole tinned over, practically forming part of the roof. The grooves in the moulding are made of such size as to hold the wire rigidly, so that its movement or abrasion is impossible. Wire so applied has, after five years' service, shown no deterioration whatever, and is apparently serviceable for at least five years more. As the tin covering of the moulding is cut and worn away by cinders and the action of the elements, it is found necessary to renew the moulding about once a year. The sizes of wire used are all of B. & S. gauge, and consist of No. 2 for those leading from the dynamo, Nos. 6 and 10 for the lamp mains and No. 14 for the lamp drops. The connection between cars is made by bringing the wires from the roof through the hood to the inside of the vestibule, where they terminate in square brass tubing called connectors, which are permanently attached to the vestibule frame. The connection between these connectors is made with three conductor flexible cables, each conductor of No. 6 gauge. To the ends of each conductor, brass springs are attached which fit closely inside the tubing, giving about eight square inches contact. If cleaned occasionally this connection will carry 100 amperes without sensibly heating. As the connectors are placed horizontally it is evident that should the train from any cause be parted, the connection will be severed without damage to any part of the system, except to throw the load off the engine and cause it to race. Should this occur, which, in fact, is very seldom, the attendant is at hand to cut off steam and stop it until the connector can be replaced. With a No. 2 wire the average fall of potential in a six-car train is nine volts.

When the batteries alone are in circuit, the E. M. F. of the dynamo will be from 67 to 83 volts, which, minus the loss, will overcome the counter E. M. F. of the batteries, viz., 57.6 to 73.6 volts. When both lamps and batteries are in circuit the external resistance is of course reduced and the E. M. F. of the dynamo falls in proportion, and that at the lamps will be from 60 to 66 volts.

It is unnecessary to use a resistance in the lamp circuit, as when the lamps are first turned on, the E. M. F. being say 66, a greater candle power is had just at the time when most needed, which, however, gradually falls and ordinarily reaches 60 to 61 volts in from two to four hours, depending upon the amount of charge in the batteries. It is true that this is at the expense of the life of the lamp, but as the handling of the switches is done by the porters and conductors, the use of rheostats or regulators, no matter how simple, would complicate the system and probably cause the total extinction of the light. Each car is provided with 32 cells of storage battery, placed 16 in each of two boxes, securely fastened under the center of the car, and directly over the truss rod. The weight of batteries and boxes complete, is about 2,000 pounds. As already stated, with the system of wiring adopted the batteries and lamps are permanently connected in multiple arc, so that should the train be parted and connection with the dynamo become broken the batteries will supply current necessary to maintain the light; or should the batteries under one car become disconnected, its lamps will be supplied from batteries under other cars in the train.

The lamp equipment of a six-car Pullman train is as follows:

Combined smoking and baggage car.....	21 lamps
Dining car.....	32 "
Three sleeping cars.....	90 "
Combined observation and sleeping car.....	29 "
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Total .....	172 lamps.

Of this number, 98 are 16 candle power and 74 are 8 candle power. The latter are placed in hallways, toilet-rooms and vestibules.

During six months of the year, seven  $\frac{1}{8}$  H. P. fan motors are added, viz.: 3 in the dining, 2 in the smoking and 2 in the observation cars, each absorbing the current of four 16 candle power lamps, or a total of 28, which, added to the 172, makes the total, 200 lamps in the train. To maintain the 200 lamps requires 144 amperes. As the dynamo will generate but 80, the



batteries must supply 64 amperes, or 44 per cent. This is effected by charging the batteries during the day and part of the night *en route*, and while the train is standing in the yards.

The following, taken from the January records of a train, will give an idea of the number of lamp hours required :

## CHICAGO TO JERSEY CITY.

Time.	Hours.	No of Lamps.	Lamp Hours.	
4 A. M. to 9 P. M.	5	172	860	Leaving Chicago.
9 " 11 "	2	140	280	
11 " 12 "	1	42	42	
4 " 7 "	3	172	516	Arr. at Jersey City.
During day in tunnels and depots ..	1	172	172	
Total .....			1870	

## JERSEY CITY TO CHICAGO.

Time.	Hours.	No. of Lamps.	Lamp Hours.	
4 P. M. to 9:30 P. M.	5½	172	946	Leavg. Jersey City.
9:30 " 11 "	1½	140	210	
11 " 12 "	1	42	42	
6 A. M. to 7:30 A. M.	1½	32	48	Arriving at Chicago.
During day in tunnels and depots ..	1	172	172	
Total .....			1418	

Total, 3,288 lamp hours during the round trip.

The cost of an installation for a six-car Pullman train—consisting of one combined baggage and smoking, three sleeping, one dining and one combined sleeping and observation car is as follows :

## COMBINED BAGGAGE AND SMOKING CAR.

1 Brotherhood Engine .....	\$500 00
1 Eickemeyer Dynamo .....	500 00
32 Cells Accumulators .....	392 00
Wiring .....	100 00
1 Set Wire Connectors .....	11 00
Battery Boxes, Crates and Connections .....	71 00
Steam Piping, Lubricator Gauges, etc. ....	155 00
Voltmeter and Ammeter .....	77 50
Safety Switch .....	12 00
Lamps and Sockets .....	17 00
Switches and Cut Outs .....	17 50
Shades—Holders and Fixtures .....	10 80
Partition for Dynamo and Engine .....	38 00
Two ½ H. P. Fan Motors .....	76 00
Miscellaneous .....	50 00

\$2,027 80

## SLEEPING CAR.

32 Cells Accumulators.....	\$392 00
1 Set Wire Connectors.....	11 00
Wiring.....	90 00
Battery Boxes, Crates and Connections .....	71 00
Lamps .....	15 00
Sockets, Receptacles, etc.....	47 00
Switches and Cut Outs.....	17 50
Shades and Shade Holders.....	9 00
Berth Lamps .....	90 00
Miscellaneous.....	20 00
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	\$762 50

## DINING CAR.

32 Cells Accumulators.....	\$392 00
1 Set Wire Connectors .....	11 00
Wiring.....	70 00
Battery Boxes, Crates and Connections.....	71 00
Lamps.....	16 00
Receptacles and Fixtures.....	32 00
Switches and Cut Outs.....	17 50
Three $\frac{1}{8}$ H. P. Fan Motors .....	114 00
Miscellaneous.....	20 00
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	\$743 50

## COMBINED SLEEPING AND OBSERVATION CAR.

32 cell accumulators .....	\$392 00
1 set wire connectors .....	11 00
Wiring .....	90 00
Battery boxes, crates and connections.....	71 00
Lamps .....	14 50
Sockets, receptacles and fixtures.....	19 50
Shades and holders.....	10 40
Berth lamps .....	45 00
Two $\frac{1}{8}$ H. P. fan motors .....	76 00
Miscellaneous.....	20 00
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	\$749 40

A total of \$5,808.20, or an average of \$968.00 per car.

As the fan motors are used but six months in the year, the average number of lamps will be  $172 + 14 = 186$ . Therefore, the cost of equipment per lamp will be  $\$5,808.26 \div 186 = \$31.22$ .

The average cost of labor and material for maintaining the lighting of three trains, or 18 cars for 19 months, from August, 1890, to February, 1892, inclusive, was as follows:

Average total cost per month .....	\$1265 95
“ “ per car per day.....	1 99
“ “ of labor per month . . . . .	712 39
“ “ “ per car per day.....	1 11
“ “ of material per month .....	511 51
“ “ “ per car per day.....	87
“ “ per lamp per day .....	07.17
Average number of lamps in use.....	558

The item of labor includes the wages of five attendants on the train, at \$3.00 per day each, and two men at each terminal station, at \$90.00 and \$55.00, and \$75.00 and \$50.00 per month respectively.

That of material includes the cost of renewal of batteries, etc.

The cost of labor is practically constant, while that of material varies from 12 cents to \$2.04 per car per day, the average for 19 months being 87 cents. The cost per lamp per day varies from  $3\frac{8}{10}$  cents to  $12\frac{5}{10}$  cents; the average is 7.17 cents.

The cost of power furnished by the locomotive boiler is not included in the statement, for the reason that a satisfactory measurement of the quantity of coal and water used has never been made.

So long as the dynamo can be run, and the batteries properly charged, the system is reliable.

During the coldest part of the winter, or as sometimes happens, when a poor quality of coal is furnished, it is difficult for the locomotive to supply sufficient steam to run the dynamo. In such cases the batteries are called upon to maintain the light. As a rule, they have sufficient charge to do so for about four hours. Trains so equipped have been run between Jersey City and St. Augustine, Florida, during the months of January, February, March and April of each year since 1888.

The conditions there are decidedly more favorable, for the reason that the trains leave both terminals early in the morning. In consequence, the dynamo is run nearly all day, and the batteries are therefore fully charged and in condition to furnish current for the maximum number of lamp hours. So successful has been the electric lighting of these two trains, that it is rare for other sources of illumination to be used. The system has also been used on other trains, viz., between New Orleans and the city of Mexico, Omaha and San Francisco, Chicago and Portland, Me.

Several specials have also been similarly lighted, notably—the Presidential, from Washington to San Francisco and return; the National Electric Light Association trains, between Jersey City and Chicago, and Jersey City and Kansas City; the National Telephone Exchange Association train to Minneapolis, and that of the Pan-American delegates, which was almost constantly on the road for three weeks.

A duplicate of this system was tried for a short time on the Chicago, Milwaukee, and St. Paul Railway. I must look to others to explain the causes for its being abandoned, and also describe that which has been substituted and which it is understood has proven very satisfactory. One of the most serious sources of trouble met with in train lighting was the effect of the vibration of the car on different members of the plant. At first it was almost a daily occurrence to have lamps drop out of sockets—the shade-holders, which were made of thin sheet brass, were broken at the rate of eight or 10 during one trip. Trains would arrive at terminal stations with two or three batteries out of circuit caused by connections between cells being broken. In the earlier days it was the practice to use a rigid connection between battery cells, as it was considered best to prevent the elements moving in the rubber jar. It was soon discovered that the element would move irrespective of the rigid connection, and in doing so would break the terminal, and in a majority of cases the fracture was next to the plates. As we had no means of burning the lug on again the element was useless. To overcome this difficulty flexible connections were substituted. Contrary to all expectation no damage was done by the movement, and since then should a terminal be broken, which however is seldom, it is in every instance due to a defect in burning on at the factory. Cast brass shade holders were substituted for those of sheet brass. To prevent shades working loose and dropping out, ordinary rubber bands were placed under the lip, against which the holder screws were driven, and they having a soft foundation were prevented turning and held the shade in place. The cause of the lamps falling out was due, in a great measure, to the socket rings working loose. This was overcome by the invention of a tool that would drive the ring into place much tighter than was possible by hand. Many minor causes of trouble that could not be foreseen were eliminated as fast as they developed.

A system of safety cut-outs was devised that protect each

wire in the car. They are placed on the same baseboard with the lamp switches, and are located in the locker or closet, convenient for inspection and renewal. Later on portable lamps were demanded that could be placed in the sleeping car sections, either before or after the berths had been made up. For this purpose No. 18 wire was connected to one of the lamp circuits on the roof, and led to a connecting block placed over the mirror between the windows in each section. Connection with the block was made with a plug, to which flexible lamp cord was attached. On the other end of the cord a frosted 16 candle power lamp was connected, the lamp hanging from an arm which was placed in a receptacle in the corner formed by the side of the car and the partition between sections, and immediately over the shoulder of the passenger, the most favorable position for the lamp when used for reading.

It was early seen that the only uncertainty connected with the system is due to the absolute dependence upon the locomotive boiler for power to run the dynamo, for, as explained, there is a constant liability of the failure of the steam supply which, if prolonged beyond the capacity of the battery will result in the use of oil or gas for light. As many other problems connected with the system have been successfully worked out, it is believed that the solution of this one will also be found.

There is no doubt that the ideal way of running the dynamo is by a connection with the axle. Many apparent solutions have been suggested, only to be condemned as uncertain or impracticable. It is, however, thought that within the next year a reliable connection will be had, after which I believe the lighting of railway trains by electricity will be universally adopted.

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#### DISCUSSION.

MR. C. R. GILMAN:—Referring to the cost of installation for a six-car Pullman train, given in Mr. Bauer's paper, for comparison with ours, that is, the Chicago, Milwaukee and St. Paul system, I give the following:—Cost of equipping one ten-car train, consisting of one baggage car, two mail cars, two coaches, three sleeping cars, one dining and one parlor car. Baggage car, including one Westinghouse 6x6½ automatic 15 horse power engine, one No. 4 compound Edison dynamo, switches, meters, etc., \$1,183.19. Two mail cars, \$119.84 each—\$239.68. Two coaches, \$147.92 each—\$295.84. Three sleeping cars at \$299.88 each—\$899.64; one dining car, \$192.23; one parlor car, \$205.50; making a total of \$3,016.08, or an average of \$301.61

per car, a total cost per lamp of \$15.82. Our cost of labor and repairs on four trains, 35 cars for one month, is as follows:—Labor, \$650; material, \$175.86—total, \$825.86. Cost per car per car day, 78.6 cents; cost per car per car day for labor, 61.9 cents. The cost per car per car day for material, 16.7 cents. Cost per lamp per day, 5 cents. Average number of lamps in use, 542.

THE CHAIRMAN:—How much is that per lamp per hour, roughly, Mr. Gilman?

MR. GILMAN:—I will have to figure that out.

THE CHAIRMAN:—While Mr. Gilman is getting some additional figures, is there any discussion on the paper that any gentleman would like to participate in? This is a very important subject, and one which is receiving a great deal of attention from companies which are lighting trains by gas, recognizing the demand for electric lights and the necessity for their having electric lighting systems in order to protect their already established gas lighting industries. The figures which Mr. Gilman has given us would indicate an extremely low rate for the production of light on the trains of the Chicago, Milwaukee and St. Paul Railway, and he will have for us presently the exact figure per lamp hour, which is perhaps the best way of making comparisons as to economy with other systems.

PROF. SHEPARDSON:—I would suggest, Mr. Chairman, that possibly the plan Mr. Sperry has used for coupling together four axles on his mining locomotive could be used for transmitting power to the dynamo on our trucks. I understand that plan has been quite successful in Europe, where the car axles are not swiveled.

MR. WILLYOUNG:—Mr. Chairman, Mr. Bauer was talking about this matter, Sunday, and I asked him whether he had finally secured the results that he was after, and he said he had; he had plans in his office, but he said it was not an original plan. He said it was a plan that has been used in Europe for some time with considerable success, and it may be that it is a similar plan to that to which the gentleman refers.

MR. SPERRY:—Mr. President, I would like to call attention to the fact that it would be impossible in such a system, although on the face it cost about half to install, to detach any of the cars without leaving them in darkness during the time that they are so detached.

MR. HERING:—I would like to ask also what you would do when the cars are in the station?

MR. GILMAN:—Oil lamps are used during stops.

THE CHAIRMAN:—The figure that Mr. Gilman presents is five cents per lamp per day. He says the average burning is about nine hours a day, and it brings the cost of the lamp hour down to approximately a half a cent per lamp hour. That is extremely low, as the cost of the production per lamp hour of the largest central stations to-day is in the neighborhood of a quarter of a

cent. But it is natural to suppose that the cost of production per lamp hour by a system such as this, would be much less than in a system which would involve storage batteries, although this system would be applicable only to through trains, on account of inability to take care of breaking up the trains.

MR. CLEMENT F. STREET :—Mr. Chairman, there is one criticism I wish to make regarding this paper. The average total of material per car per day is given as 87 cents. Now, it seems to me that is the cost per day while this plant is in existence. It is not the cost per day of 24 hours, of 12 hours during which the light is being used, and I do not think this is the proper basis on which to figure. If the number of hours which the plant was in use had been taken and the figures derived from that, it seems to me it would have given more information. As I understand it, he has given the cost of the 24 hours during which the plant is in existence, whether it is in use or not.

There is another point, in regard to breaking up the train. Of course, in the system which is in use on the St. Paul road the statement was made that when the train was in the depot it was necessary to use oil lamps. This occurs only at points when the engines are changed and when the baggage car plant is used. When the light and heat tender is used in connection with the system, it is never necessary to use the oil lamps at all, because the light and heat tender has an independent engine and boiler. This is used in the winter, when it is necessary to supply steam heat to the cars. In the summer the same engine and dynamo are transferred from the light and heat tender to the baggage car, and steam taken from the locomotive, consequently it is necessary to shut down the plant during the time of taking one engine off and putting another on, which will be every 100 or 150 miles, depending on circumstances, and only in rare cases more than once during a single period when the lights are in use.

THE CHAIRMAN :—I would like to say in this connection that I have had brought to my attention a system which is likely to be put into commercial use, in which the number of storage batteries which will be used will be very much reduced, so that there will be but two or three batteries per car, although the lamps which are in ordinary service will be lamps of 110 volts, and the main lighting of the train will be direct from the dynamo engine, upon the locomotive probably; although in case of the removal of the locomotive or separation of cars the storage batteries will act automatically, lighting by electric lamps of different voltage from the main lamps in the car, which will obviate the necessity of lighting up some other lamps by hand means, which would be troublesome.

MR. GILMAN :—I would like to say that Mr. Gibbs has already got that system started. We have three cars equipped on the road with small batteries and an automatic switch that throws them in when the train is cut off from the locomotive.

[Recess.]

## EVENING SESSION,

At the Chicago Electric Club, June 7th, 1892, at 8.30 P. M.  
President Sprague in the chair.

THE PRESIDENT:—The first business before the meeting this evening will be the consideration of the report of the committee appointed at the New York meeting, to make some changes in the Rules with reference to the election of officers. It has been concluded, and I think very reasonably, that the method we now have of electing our officers is not a satisfactory one, that is, it does not necessarily represent the choice of the Institute as a whole. At that meeting a committee was appointed, consisting of Dr. Herzog, Mr. Upton and Mr. Martin, which was instructed to submit recommendations for such changes in the Rules as would make the election of officers somewhat more representative of the feeling of the Institute.

The report will be read by Mr. Martin.

### REPORT OF COMMITTEE ON REVISION OF THE RULES REGARDING THE ELECTION OF OFFICERS.

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#### V. ELECTION OF OFFICERS.

During the first week in February of each year the Secretary shall mail to each full and associate member of the Institute a list of members; a list of the offices to be filled at the ensuing annual election in May, giving the names of the incumbents, and a copy of this rule, with the request that nominations, propositions and suggestions as to desirable candidates be made promptly and prior to March 1st.

The Secretary shall submit all answers to the Council, who during the month of March shall prepare a complete ticket to be headed "Council Nominees," containing the names of members whom they deem best suited, all circumstances considered, for the offices falling vacant. This ticket shall be printed on the same sheet with a "General Proposal list" containing the names of all eligible members proposed, with a memorandum stating the reason of ineligibility of all other names proposed, and with a statement that the nominations by the Council are in nowise governing, but are intended only to assist members in making a choice. The voting shall be restricted to the names on this sheet. This sheet, together with an envelope, on which shall be printed the address of the Secretary, and the words "Voting Envelope—Enclosing a Ballot Only," shall, not later than the 15th of April be mailed by the Secretary to every member in good standing.

Each member may cast three votes for Vice-Presidents and he may cast all three votes for one candidate or two for one and one for a second, or one for each of three. Each member may cast four votes for Managers, which he may in like manner divide between from one to four candidates. This division shall be specified by the appropriate numeral marked opposite the desired name.

All names voted for shall be written, printed or otherwise marked on a



single ticket or ballot, which shall be enclosed in a sealed, unmarked and unidentified envelope of any suitable size to be in its turn enclosed in the voting envelope received from the Secretary. On this outer envelope the member shall add his signature, and the postage stamp.

At the annual meeting, these outer "Voting Envelopes" shall be opened in the meeting room by two tellers, then and there appointed by the presiding officer. After all the inner envelopes shall have been thoroughly commingled, they shall be opened and the votes shall be counted by the tellers, who shall report the results in writing. The eligible persons receiving the greatest number of votes for the respective offices shall be declared duly elected. The tellers shall reject all names that do not appear on the "Council Nominee" list or the "General Proposal" list, and they shall also reject that part of a ballot which shall name for any office or offices more candidates than there are vacancies.

This method of election shall apply to the offices of President, Vice-President, Treasurer and Manager. No unsalaried officer except the President and Treasurer shall be eligible to immediate re-election to the same office (as provided in Rule IV). The Secretary and any other salaried officer shall be chosen each year from among the members of the Institute by the Council. The Secretary shall be a member of Council, but shall have no vote in its proceedings.

New York City, June 4, 1892.

<i>Committee to report on Improved Plan of Elec- tion and Change of Rules for that purpose.</i>	{	F. BENEDICT HERZOG, Chairman, FRANCIS R. UPTON, T. C. MARTIN, Secretary.
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## APPENDIX.

The following is the section of the existing Rules, which it is proposed to amend:

### V. ELECTIONS.

The annual election shall be held in the city of New York, on the third Tuesday in May of each year. Nominations of officers may be made in writing to the Secretary at any time previous to the meeting, but the votes shall be by ballots deposited only by members actually present. *Provided*, that no member or associate in arrears since the last annual meeting shall be allowed to vote until the said arrears shall have been paid. If for any reason it is deemed proper to postpone the election, it may be adjourned from day to day with the consent of two-thirds present or voting.

The following is the existing Rule regarding Amendments:

### VIII. AMENDMENTS.

The Rules may be amended at any regular meeting by a two third vote of the members present, provided that written notice of the proposed amendment shall have been given at a previous meeting.

It was voted that the report be printed and a copy mailed to each member, but that action upon the report be postponed until the first regular meeting in New York City. After considerable discussion an informal vote showed that the sentiment of those present was entirely favorable to the proposed plan.

The following papers were then read by Professor R. B. Owens on "Electro Technical Education," and by Professor Dugald C. Jackson, on "The Technical Education of the Electrical Engineer." They were discussed jointly.